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CORRECTIVE MEASURES STUDY WORK PLAN FOR ZONE C AREA OF CONCERN 517 AND AREA OF CONCERN 517 AND 523 CNC CHARLESTON SC

4/1/2013

TETRA TECH

Comprehensive **L**ong-term **E**nvironmental **A**ction **N**avy

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Corrective Measures Study Work Plan
for
Zone C, Area of Concern 517 and Area of Concern 523

Charleston Naval Complex
Charleston, South Carolina

Contract Task Order 0104

April 2013

NAVFAC
Naval Facilities Engineering Command
NAVFAC SOUTHEAST
NAS Jacksonville
Jacksonville, Florida 32212-0030

TETRA TECH

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CORRECTIVE MEASURES STUDY WORK PLAN

For

ZONE C, AREA OF CONCERN 517 AND AREA OF CONCERN 523

CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

Submitted to:
Naval Facilities Engineering Command
Southeast
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This document, identified as the Corrective Measures Study Work Plan for Zone C, Area of Concern 517 and Area of Concern 523, Charleston Naval Complex, Charleston, South Carolina, has been prepared under the direction of a registered professional engineer. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice.

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
BCT	BRAC Cleanup Team
bgs	Below ground surface
BRAC	Base Realignment and Closure Act
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental, Response, Comprehension, and Liability Act
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
CNC	Charleston Naval Complex
COC	Contaminant of concern
COPC	Contaminant of potential concern
DoD	Department of Defense
DRO	Diesel Range Organics
EnSafe	EnSafe Inc.
GRO	Gasoline Range Organics
HASP	Health and safety plan
HAZWOPER	Hazardous Waste Operator and Emergency Response
HUD	Department of Housing and Urban Development
LUC	Land Use Control
MCL	Maximum Contaminant Level
$\mu g/ft^2$	Microgram per square foot
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
OWS	Oil-water separator
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PID	Photoionization detector
POTW	Public-owned treatment works
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	Regional Screening Level
SCDHEC	South Carolina Department of Health and Environmental Control
SVOC	Semi-volatile organic compound
SWMU	Solid Waste Management Unit

TPH	Total petroleum hydrocarbon
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound
WP	Work Plan

1.0 INTRODUCTION

In 1993, the Charleston Naval Complex (CNC) was added to the list of bases scheduled for closure as part of the Base Realignment and Closure (BRAC) program established by the Base Closure and Realignment Act, which identified excess Department of Defense (DoD) property and provided appropriations to conduct the mission closure and environmental cleanup as required under Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA), as amended by the Community Environmental Response Facilitation Act.

The corrective action activities at the CNC are being conducted under the Resource Conservation and Recovery Act (RCRA). The South Carolina Department of Health and Environmental Control (SCDHEC) is the lead agency for corrective action activities at the site. All RCRA corrective action is performed in accordance with the conditions and requirements of the RCRA Part B permit (Permit No. SC0 170 022 560) issued to the Navy by SCDHEC and the U.S. Environmental Protection Agency (USEPA), Region IV. The layout and location of CNC are shown on Figure 1.

Areas of Concern (AOCs) 517 and 523 are within Investigative Zone C at the CNC. Figure 2 illustrates the location and layout of Zone C, and AOCs 517 and 523. As part of the RCRA corrective action activities, the Zone C Final RCRA Facility Investigation (RFI) report (EnSafe, 1997b) was completed, submitted, and approved. Zone C, one of the 12 investigative zones that make up the CNC, is located on the western facility boundary in the northern portion of the base and is comprised of administrative areas, former military housing, warehouses, and the former base coal storage yard. The zone is bounded by McMillan Avenue on the south, Hobson Avenue on the east, Avenue D on the northeast, Noisette Creek on the north, and St. John's Avenue (facility boundary) on the west. After the Zone C RFI, a draft Zone C Corrective Measures Study (CMS) Work Plan (WP) Rationale for No Further Action (NFA) was prepared by the Naval Facilities Engineering Command Southeast (NAVFAC SE) in 2001 (NAVFAC, 2001). SCDHEC commented on the CMS WP (SCDHEC, 2001), and a response to comments was prepared by Tetra Tech, Inc. in 2009 (Tetra Tech, 2009). It was subsequently determined that the NFA recommendations of the 2001 Zone C CMS Work Plan would be reconsidered, and Tetra Tech prepared this CMS WP. The comments and responses for both the 2001 and 2011 versions of this CMS WP can be found in Appendix A.

1.1 AOC 517 BACKGROUND AND SUMMARY FOR CORRECTIVE MEASURES STUDY WORK PLAN

AOC 517 is the area around and including Building M-192, a former indoor firing range that was operated by the Navy between 1959 and 1974. The building was converted into a classroom and storage building

in 1974. The building was identified as an AOC because of the potential for lead dust release to the environment from firing range activities. The property is currently owned by South Carolina Public Railroad.

The Navy completed the Zone C RFI report (EnSafe, 1997b) and submitted it to SCDHEC and USEPA for review and comment. According to the RFI report, 10 soil samples were collected around the exterior of the building and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, cyanide, and pesticides/polychlorinated biphenyls (PCBs). No contaminants of concern (COCs) were identified as a result. Wipe samples collected inside the building confirmed the presence of lead on wall, floor, and ceiling surfaces. The RFI report conclusions recommended addressing the lead dust as an industrial hygiene matter, depending on the intended reuse of the building. Because there were no contaminants in soil contributing to an unacceptable risk, the RFI report recommended no further action for AOC 517. A Zone C RFI results summary presentation (EnSafe, 1996) and background data information (EnSafe, 1997a) are included in Appendix B. Background studies for PAHs and inorganics were completed after the RFI Report was submitted and are included in Appendix C.

The Department's approval letter (SCDHEC, 1998) for the RFI listed this site as requiring a CMS, while noting that there are no regulations governing exposure to lead dust. The Navy has undertaken corrective action for the COCs consistent with appropriate Department of Housing and Urban Development (HUD) regulations and guidance for exposure to lead dust from lead-based paint (HUD, 1995). Beyond implementing a corrective action to encapsulate lead dust, there have been five surface soil samples collected at AOC 517 which were all clean, particularly with respect to lead. While there have been no groundwater samples collected at AOC 517, it is the opinion of the Navy that if the lead dust were a surface concern and no surface impacts were detected, then the groundwater can be considered clean. Based on these findings, the Navy proposed NFA for AOC 517 in the previous version of this CMS WP.

Prior to changing the status of any site to NFA in the CNC RCRA permit, the BRAC Cleanup Team (BCT) has agreed that the following issues, collectively referred to as site closure criteria, should be evaluated:

- Status of the RFI
- Presence of metals (inorganics) in groundwater
- Potential linkage of Solid Waste Management Unit (SWMU)/AOC to sanitary sewers
- Potential linkage of SWMU/AOC to storm sewers
- Potential linkage of SWMU/AOC to railroad lines
- Potential migration pathways to surface water bodies

- Potential contamination associated with oil-water separators (OWSs)
- Relevance or need for land use controls (LUCs) at the site

These issues are addressed in Section 2.0. As noted in the September 2011 SCDHEC review comments, encapsulation of the lead is an engineering control (i.e., a LUC) that must be maintained. Thus, the Navy is now proposing via this CMS WP to change the status of and remedy for AOC 517 to LUCs only, rather than NFA.

1.2 AOC 517 CORRECTIVE MEASURES SELECTED

The corrective measure selected for AOC 517 is LUCs only, along with the preparation of all appropriate documentation.

1.3 AOC 523 BACKGROUND AND SUMMARY FOR CORRECTIVE MEASURES STUDY WORK PLAN

AOC 523 is the area around and including former Building M-1234, a former gas station which was operated by the Navy between 1958 and 1962. The former building is within the footprint of Building 198, which is currently owned by the Space and Naval Warfare Systems Command (SPAWAR), and as such, is not accessible to the public. The site was identified as an AOC because of the potential for waste oil, solvent, or petroleum releases to the environment from the former gas station activities. As presented in the Final RCRA Facility Assessment, Naval Base Charleston (EnSafe, 1995), "…the gasoline station storage operated from 1958 to 1962. Since the storage unit was taken out of service approximately 32 years ago, no records have been found providing any information on its design features or operating practices of unit." The gas station was demolished and the USTs removed or closed in place prior to construction of Building 198.

Figure 3 shows the approximate location of Building M-1234 in relation to Building 198 at the CNC. According to the RFI report, two soil samples, upper interval and lower interval, and two groundwater samples were collected through the Building 198 floor near the footprint of the former Building M-1234 and analyzed for VOCs, SVOCs, metals, cyanide, pesticides/PCBs, and total petroleum hydrocarbons [TPH - Gasoline Range Organics (GRO)/Diesel Range Organics (DRO)]. The RFI summary presentation included in Appendix B identified aluminum, arsenic, manganese, and TPH as groundwater COCs, with no soil COCs. As reported in the Zone C RFI Report, aluminum, arsenic, barium chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc were detected at concentrations greater than background levels in use at the time. Tables 1 through 3, below, summarize contaminant concentrations detected in soil and groundwater, and compare them to current risk-based screening criteria, the 1997 background concentrations used in the RFI report, and the background concentrations developed in 2000

and 2001. The data used to calculate the 1997 background concentrations are presented in Appendix B, and the 2000 and 2001 background studies are included as Appendix C. Should the historical data presented below be used during the CMS, it will be screened using the most recent background values and risk-based screening values available.

TABLE 1

COMPARISON OF GROUNDWATER CONCENTRATIONS TO SCREENING LEVELS AND BACKGROUND LEVELS AT AOC 523

Constituent	Range of Detected Concentrations in RFI	Risk-based screening criteria [T] and/or [M]	1997 RFI Comparison Criteria (Background Level or RBC)	2001 Background Study Level
Inorganics (µg/L)				
Aluminum	3870	16000 [T]	410	289
Arsenic	15.75-26.6	0.045 [T]/ 10 [M]	6.07	4
Barium	47.85	2900 [T]/ 2000 [M]	16.7	11
Calcium	17,750-30,300	NA	NA	82,450
Chromium	1.1-7.6	100 [M]	1.99	2
Cobalt	3.7-14.1	4.7 [T]	1.33	2
Copper	5.05	620 [T]/ 1300 [M]	1.9	ND
Iron	9,730-21,000	11000 [T]/ 270 [M]	NA	1,719
Lead	8.0	15 [M]	3.27	4
Magnesium	4,330-4,450	NA	NA	5,108
Manganese	240-923	320 [T]	608	346
Nickel	5.4	300 [T]	3.59	3
Potassium	1,760-2,205	NA	NA	4,113
Vanadium	1.7-10.2	78 [T]	1.96	2
Zinc	28.6-65.9	4700 [T]	13.2	10
Pesticides (µg/L)				
Sulfotep	0.15	5.3 [T] / 0.0039 [M]	NA	NA
TPH (mg/L)				
TPH (GRO)	12.12	NA	NA	NA
Dioxins (pg/L)				
OCDD	12.675	NA	NA	NA
1234678-HpCDD	2.33	NA	NA	NA

Constituent	Range of Detected Concentrations in RFI	Risk-based screening criteria [T] and/or [M]	1997 RFI Comparison Criteria (Background Level or RBC)	2001 Background Study Level
123789-HXCDF	3.789	NA	NA	NA
1234678-HpCDF	1.351	NA	NA	NA
OCDF	1.515	NA	NA	NA

NA = No criteria available.
ND = Copper was not detected in any of the 8 wells sampled.
M = MCL (USEPA Region III Screening Levels, November 2012)
T = Tapwater RSL (USEPA Region III Screening Levels, November 2012)

TABLE 2

COMPARISON OF SURFACE SOIL CONCENTRATIONS TO SCREENING LEVELS AND BACKGROUND LEVELS AT AOC 523

Constituent	Range of Detected Concentrations in RFI	Risk-based Screening Criteria, Industrial[1]	Risk-based Screening Criteria, Residential[1]	Risk-based Screening Criteria, Soil to Groundwater[1]	1997 RFI Background Level	2000 and 2001 Background Screening Levels
Inorganics (mg/kg)						
Aluminum	4,760-4910	990000	77000	23000	9990	4988
Antimony	0.46	410	31	0.27	0.55	0.22
Arsenic	2.7-6.3	1.6	0.39	0.0013	14.2	4.2
Barium	21.2-34.7	190000	15000	82	77.2	28
Calcium	2,450-3,850	NA	NA	NA	NA	15,713
Chromium	5.0-59.2	NA	NA	NA	0.65	6.2
Cobalt	0..88-1.1	300	23	0.21	3.22	1.0
Copper	9.8-33.2	41000	3100	22	34.7	11
Iron	2,570-3520	720000	55000	270	NA	3848
Lead	47.8-64.8	800	400	14	330	69
Magnesium	262-1,460	NA	NA	NA	NA	574
Manganese	24.5-34.4	23000	1800	21	92.5	43
Mercury	0.25	43	10	0.033	0.24	0.10
Nickel	3.1-6.0	20000	1500	20	12.3	3.7
Potassium	130-235	NA	NA	NA	NA	258
Tin	1.6-2.3	610000	47000	2300	2.95	1.4
Vanadium	4.7-8.1	5200	390	78	23.4	8.8
Zinc	23.2-115	310000	23000	290	159	76
SVOCs (µg/kg)						
Benzo(a)anthracene	130	2100	150	10	NA	597
Benzo(g,h,i)perylene	43	NA	NA	NA	NA	NA

Constituent	Range of Detected Concentrations in RFI	Risk-based Screening Criteria, Industrial[1]	Risk-based Screening Criteria, Residential[1]	Risk-based Screening Criteria, Soil to Groundwater[1]	1997 RFI Background Level	2000 and 2001 Background Screening Levels
Benzo(k)fluoranthene	240	21000	1500	350	NA	590
Chrysene	130	210000	15000	1100	NA	603
Fluoranthene	61.0-180	22000000	2300000	70000	NA	NA
Indeno(1,2,3-cd)pyrene	48	2100	150	200	NA	516
Phenanthrene	83	NA	NA	NA	NA	NA
Pyrene	52.0-170	17000000	1700000	9500	NA	NA
BEQ	20.3	210	15	3.5	NA	1258
Pesticides and PCBs (μg/kg)						
4,4-DDD	4.0	7200	2000	6.4	NA	NA
4,4-DDE	14.0	5100	1400	46	NA	NA
4,4-DDT	22.0	7000	1700	67	NA	NA
Endrin	2.7	180000	18000	68	NA	NA
Endrin aldehyde	1.4-5.4	NA	NA	NA	NA	NA
Heptachlor	1.3	380	110	0.14	NA	NA
Methoxychlor	14.0	3100000	310000	1500	NA	NA
TPH (mg/kg)						
TPH	239.0-321.0	NA	NA	NA	NA	NA

NA = No criteria available.
1 - USEPA Region III Screening Levels, November 2012

TABLE 3

COMPARISON OF SUBSURFACE SOIL CONCENTRATIONS TO SCREENING LEVELS AND BACKGROUND LEVELS AT AOC 523

Constituent	Range of Detected Concentrations in RFI	Risk-based Screening Criteria, Industrial[1]	Risk-based Screening Criteria, Residential[1]	Risk-based Screening Criteria, Soil to Groundwater[1]	1997 RFI Background Level	2001 Background Study Level
Inorganics (mg/kg)						
Aluminum	1,300-6,150	990000	77000	23000	23700	6481
Barium	11.6-16.8	190000	15000	82	68.5	17
Calcium	346.5-419.0	NA	NA	NA	NA	4,636
Chromium	3.8-4.2	NA	NA	NA	0.28	9.6
Cobalt	0.325-0.710	300	23	0.21	7.1	1.2
Copper	1.2-1.4	41000	3100	22	42.2	4.6
Iron	1,135-1220	720000	55000	270	NA	5639
Lead	3.9-18.55	800	400	14	73.2	14
Magnesium	156-213.0	NA	NA	NA	NA	590

Constituent	Range of Detected Concentrations in RFI	Risk-based Screening Criteria, Industrial[1]	Risk-based Screening Criteria, Residential[1]	Risk-based Screening Criteria, Soil to Groundwater[1]	1997 RFI Background Level	2001 Background Study Level
Manganese	6.3-11.9	23000	1800	21	106	54
Nickel	2.4	20000	1500	20	16.7	2.3
Potassium	78.5-137.0	NA	NA	NA	NA	346
Tin	1.40-1.45	610000	47000	2300	2.37	0.97
Vanadium	2.25-3.0	5200	390	78	56.9	11
Zinc	4.75-5.50	310000	23000	290	243	30
Hexavalent Chromium	0.261	5.6	0.29	0.00059	NA	NA
SVOCs (μg/kg)						
Di-n-butylphthalate	50.0	62000000	6100000	1700	NA	NA
Pesticides and PCBs (μg/kg)						
Alpha-BHC	0.006	270	77	0.036	NA	NA
Delta-BHC	0.07	NA	NA	NA	NA	NA
Dieldrin	0.10	110	30	0.061	NA	NA
Endosulfan I	0.24	NA	NA	NA	NA	NA
Endosulfan II	0.15	NA	NA	NA	NA	NA
Endosulfan sulfate	0.095	NA	NA	NA	NA	NA
Endrin	0.57	180000	18000	68	NA	NA
Endrin aldehyde	0.10	NA	NA	NA	NA	NA
Heptachlor	0.0058	380	110	0.14	NA	NA
Methoxychlor	0.565	3100000	310000	1500	NA	NA
TPH (mg/kg)						
TPH	63.9-107.0	NA	NA	NA	NA	NA
Dioxins (ng/kg)						
1234678-HpCDD	1.73	NA	NA	NA	NA	NA
1234678-HpCDF	3.59	NA	NA	NA	NA	NA
123678-HxCDF	0.54	NA	NA	NA	NA	NA
123789-HxCDF	0.64	NA	NA	NA	NA	NA
OCDD	12.07	NA	NA	NA	NA	NA
OCDF	8.57	NA	NA	NA	NA	NA
TCDD TEQ	19.2	18	4.5	0.26	NA	NA

NA = No criteria available.
1 - USEPA Region III Screening Levels, November 2012

No VOCs, SVOCs, or PCBs were detected in groundwater samples collected during the RFI at AOC 523. No VOCs, dioxins or PCBs were detected in surface soil. No VOCs, PCBs, or PAHs were detected in

subsurface soil. The SCDHEC approval letter for the Zone C RFI (Appendix D) did not require a CMS and instead suggested that the RCRA Subtitle I UST program address the site. An issue of inorganics in groundwater was also suggested, which was intended to be resolved by a base-wide study of thallium. AOC 523 was transferred to the UST Program after the Navy sent a letter requesting the transfer to the SCDHEC Director of the Division of Health and Infectious Waste Management on April 22, 2002.

Initially, investigations indicated that under the Subtitle I program, the only contaminants of potential concern (COPCs) would be inorganics, as petroleum-related VOCs and SVOCs were either not detected or were detected at concentrations less than groundwater Maximum Contaminant Levels (MCLs) and soil Risk-Based Concentrations (RBCs). However, upon re-examination of the data and comparison with current screening levels, benzo(a)pyrene would be considered a COC at this time. Also, the data available for a risk assessment has been determined to be too limited in quantity and in type of data (surface soil only) to conduct an appropriate risk assessment for the site, as stated in a memorandum prepared by Tetra Tech regarding Zone C, AOC 517 and AOC 523, NFA Status Investigation, July 31, 2008. This memorandum is included in Appendix E.

1.4 AOC 523 INTERIM CORRECTIVE MEASURES SELECTED

Based on the lack of sufficient data to conduct a thorough risk assessment, and the transfer of this AOC to the UST Program, it is recommended that a field sampling effort be conducted including surface soil, subsurface soil, and groundwater analyses. A field investigation will likely be complicated by the current location of Building 198 on the site, thus scanning with a ground-penetrating radar or similar geophysical device may be required to determine if USTs are present or have been present under the building. The data collected during this sampling event will be analyzed and a risk assessment will be conducted. A CMS report will be prepared to present the concentrations and risk levels determined to be present at AOC 523, and will determine whether NFA can be recommended or corrective measures are required for the site.

2.0 AOC 517 SITE CLOSURE CRITERIA

2.1 STATUS OF THE RFI

The Zone C RFI is complete and approved without conditions. AOC 517 was recommended for CMS, although SCDHEC noted there are no regulations governing exposure to lead dust. The Department approval letter recommended lead dust removal on the basis that the reuse is likely to be residential.

2.2 PRESENCE OF INORGANICS IN GROUNDWATER

Release to groundwater was not suspected at this site, therefore no groundwater monitoring wells were installed. Given the non-detects in soil samples, there was no reason to believe that a release occurred to the exterior of the building and, therefore, no subsequent concern of a release to groundwater.

2.3 POTENTIAL LINKAGE OF AOC 517 TO THE SANITARY SEWER

Lead dust may have been discharged to the sanitary sewer system as a component of wastewater during cleaning on the floors. Given the small concentrations found in wipe samples on the floor surfaces, it is unlikely that a significant concentration of lead was contained in the sewage discharges. The wastewater would not be considered a RCRA regulated waste by exclusion under the definition of a hazardous waste. As a result of the cleanup done by the Navy of the interior surfaces, this migration pathway would no longer exist.

2.4 POTENTIAL LINKAGE OF AOC 517 TO THE STORM DRAIN

No linkage is suspected to exist between the AOC and the storm drain based on the investigation results (no COCs in soil).

2.5 POTENTIAL LINKAGE OF AOC 517 TO THE RAILROAD SYSTEM

No linkage is suspected to exist between the AOC and the railroad system based on site investigation results and research of railroad line location.

2.6 POTENTIAL MIGRATION PATHWAYS TO SURFACE WATER BODIES

Lead residue in cleaning water that was discharged to the sanitary sewer prior to 1972 could have migrated to the Cooper River. The sanitary sewer system discharged directly to the Cooper River prior to 1972. After 1972, the sanitary sewer discharged to a main outfall point leading to an offsite, public-owned treatment works (POTW) under a National Pollutant Discharge Elimination System (NPDES) permit

issues to the Navy by the North Charleston Sewer District. No other pathways exist for lead dust from the building interior to migrate to surface water bodies.

2.7 POTENTIAL CONTAMINATION ASSOCIATED WITH OIL-WATER SEPARATORS

No OWSs exist at the facility. Based on the operations of the facility, no OWSs were necessary.

2.8 RELEVANCE OR NEED FOR LAND USE CONTROLS AT THE SITE

Based on the site investigation and subsequent corrective action taken (encapsulation) by the Navy for the interior of the building, LUCs in the form of engineering controls are required to maintain the painted surfaces encapsulating the lead dust surfaces in Building M-192. The corrective action taken by the Navy for the lead dust is consistent with HUD guidelines for lead-based paint dust and residue in residential structures. These guidelines, which indicate that the screening level for lead dust in residential structures is 125 micrograms per square foot ($\mu g/ft^2$), were used conservatively as remediation goals considering the structure may be used for residential purposes. The lead loading level detected at Building M-193 was found to be 25 $\mu g/ft^2$, significantly less than the screening level. As such, existing lead dust controls are consistent with HUD standards.

3.0 AOC 523 SCOPE OF WORK

3.1 HEALTH AND SAFETY PLAN PREPARATION AND IMPLEMENTATION

A site-specific health and safety plan (HASP) will be prepared. Modifications to the plan may be implemented as needed, based on the direction of the Site Safety Officer or Project Manager if there are any changes at the site or in work conditions. Each site worker will be required to have completed a 40-hour course (and 8-hour refresher, if applicable) in health and safety training [Hazardous Waste Operations and Emergency Response (HAZWOPER)] as described under Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(b)(4) (OSHA, 2002).

3.2 SAMPLING IMPLEMENTATION

The proposed sampling plan will include the collection of surface soil samples, subsurface soil samples, and groundwater samples, the measurement of groundwater elevations, and the scanning of the surface with a ground-penetrating radar or similar geophysical device. All samples will be analyzed for metals, cyanide, SVOCs, VOCs, and pesticides/PCBs.

Prior to sampling, a survey should be conducted using ground-penetrating radar (or similar geophysical) technology to determine if the USTs were closed in-place and are present under the building. It is currently unclear whether any USTs were present, thus the survey will clarify the history of the AOC and potential sources of contamination, along with providing information on how best to approach sampling at the AOC, should adaptations be necessary.

Figure 4 shows the proposed sampling locations. A judgmental sampling plan was chosen for this site based on the pre-existing knowledge of the site, including the former activities, the previous results, and the potential for difficulty in obtaining samples in and around Building 198. The proposed sampling plan includes four surface soil samples, between four and eight subsurface soil samples, and four permanent groundwater monitoring wells to be installed and sampled. The surface soil, subsurface soil, and groundwater sampling locations were chosen with the rationale of placing two co-located surface soil, subsurface soil, and groundwater samples at the locations of the previous samples to allow for a comparison of the results to the RFI results; with two additional locations included to allow for a risk assessment to be conducted, and groundwater flow to be determined. The two additional locations were selected as the approximate center of former Building M-1234 and a location that is just north of the former Building M-1234 footprint that is expected to serve as an upgradient sample.

Surface soil samples will be collected from a depth of 0- to 1-foot below ground surface (bgs), and subsurface samples will be collected from the same locations at depths of 1- to 3-feet bgs, and potentially from 3- to 5-feet bgs. Subsurface soil samples will be screened with a photoionization detector (PID) to determine if the 3- to 5-foot depth sample is necessary at each location. Four permanent groundwater wells will be installed with 10-foot screens, intersecting the water table. The monitoring wells will be installed by a South Carolina-certified driller and will be constructed and identified in accordance with the requirements of SCDHEC standard R.61-71, included in Appendix F. An additional two to three temporary groundwater piezometers will be installed in the grassy areas near AOC 523 to help delineate the groundwater gradient and flow direction at AOC 523.. The table below summarizes the proposed sampling plan, analyses and analytical methods.

TABLE 4

PROPOSED SAMPLING PLAN FOR SOIL AND GROUNDWATER AT AOC 523

MEDIA	NUMBER OF SAMPLES				
	VOCs (USEPA Method 8260B)	SVOCs (USEPA Method 8270)	Metals (USEPA Method 6010B/7000A)	Cyanide (CLP ILM05.4)	Pesticides and PCBs (CLP SOM01.2)
Surface Soil	4+ duplicate + trip blank	4+ duplicate	4+ duplicate	4+ duplicate	4+ duplicate
Subsurface Soil	4+ duplicate + trip blank	4+ duplicate	4+ duplicate	4+ duplicate	4+ duplicate
Groundwater	4+ duplicate + trip bank	4+ duplicate	4+ duplicate	4+ duplicate	4+ duplicate

Once approval is obtained for this CMS WP, the sampling will be conducted and the results will be reported to SCDHEC and USEPA. The data will then be analyzed, a risk assessment conducted, and a CMS will be completed presenting appropriate alternatives for remediating AOC 523, based on the new results.

3.3 COMPARISON CRITERIA

During the data analysis and risk assessment process, soil and groundwater results will be compared with various promulgated screening criteria. For soil samples, data will be compared against federal Regional Screening Levels (RSLs), Ecological Soil Screening Levels, and 2000 (PAHs) and 2001 (inorganics) Zone C background values (Appendix C). Groundwater data will be compared against

federal MCLs, Tapwater RSLs, and CNC background criteria (as available). Prior to completion of the CMS, these results will be closely analyzed by the project team and a risk assessor to ensure that the data is sufficient to characterize the site, and then to determine the most appropriate path forward.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 AOC 517

Based on the results of the RFI, no COCs were identified in the soils around the exterior of Building M-192. Corrective Actions taken by the Navy in the interior of the building have addressed lead dust residual on the floors, walls, and ceilings. The source of lead dust, either through the indoor range activities or the wastewater, has been removed. The existing lead dust levels in Building M-192, AOC 517 are below the HUD Lead Hazard Screening Level. Encapsulation is in place and the interior surfaces are within lead loading standards. Maintenance will be required at the painted surface to ensure the continued encapsulation of lead dust. No further restrictions are necessary for use of the building. On the basis of the information provided in this CMS WP and referenced herein, the Navy recommends LUCs only for AOC 517.

4.2 AOC 523

Based on the results of the RFI and the discussions between the Navy, SCDHEC, and USEPA, it is recommended that further sampling and investigation take place at AOC 523 prior to the preparation of a CMS that will present remedial alternatives for the site. While data does exist that previously indicated that NFA may be appropriate for this site, further investigation has shown that the limited data available was not enough to conduct a risk assessment (Tetra Tech, 2008), and the COPCs presented during the previous steps of the investigations for this AOC 523 are no longer appropriate based on adjustments in the comparison criteria used to determine the COPCs. On the basis of the information provided in this CMS WP and referenced herein, the Navy recommends further sampling for AOC 523, to be followed with the preparation of a CMS that will present potential remedial alternatives for AOC 523, based on the findings of the proposed sampling.

REFERENCES

EnSafe, 1996. Zone C and I RCRA Facility Investigation (RFI) Results, Naval Base Charleston, Charleston, South Carolina. November 1996.

EnSafe, 1997a. Zone C Background Reference Values. June 1997.

EnSafe, 1997b. Zone C Final RCRA Facility Investigation RFI Report, Charleston Naval Complex, Charleston, South Carolina. November 1997.

HUD (United States Department of Housing and Urban Development), 1995. Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. June 1995.

NAVFAC SE (Naval Facilities Engineering Command Southeast), 2001. Corrective Measures Study Work Plan, Rationale for No Further Action, AOC 517 and AOC 523 Zone C, Charleston Naval Complex, Charleston, South Carolina. July 2001.

OSHA (Occupational Safety and Health Administration), 2002. 29 Code of Federal Regulations 1910.120(b)(4). 2002.

SCDHEC (South Carolina Department of Health and Environmental Control), 1998. Zone C Final RCRA Investigation (RFI) Report Approval Letter, Charleston Naval Complex, Charleston, South Carolina. May 1998.

SCDHEC, 2001. Engineering Comments to the Corrective Measures Study Work Plan, Charleston Naval Complex, Charleston, South Carolina. September 2001.

Tetra Tech (Tetra Tech, Inc.), 2008. Memorandum RE: Zone C, AOC 517 and AOC 523, NFA Status Investigation, Charleston Naval Complex, Charleston, South Carolina. Prepared by Ronald J. Kotun, PhD. July 2008.

Tetra Tech, 2009. Response to SCDHEC Engineering Comments to the Corrective Measures Study Work Plan, Charleston Naval Complex, Charleston, South Carolina. June 2009.

FIGURES

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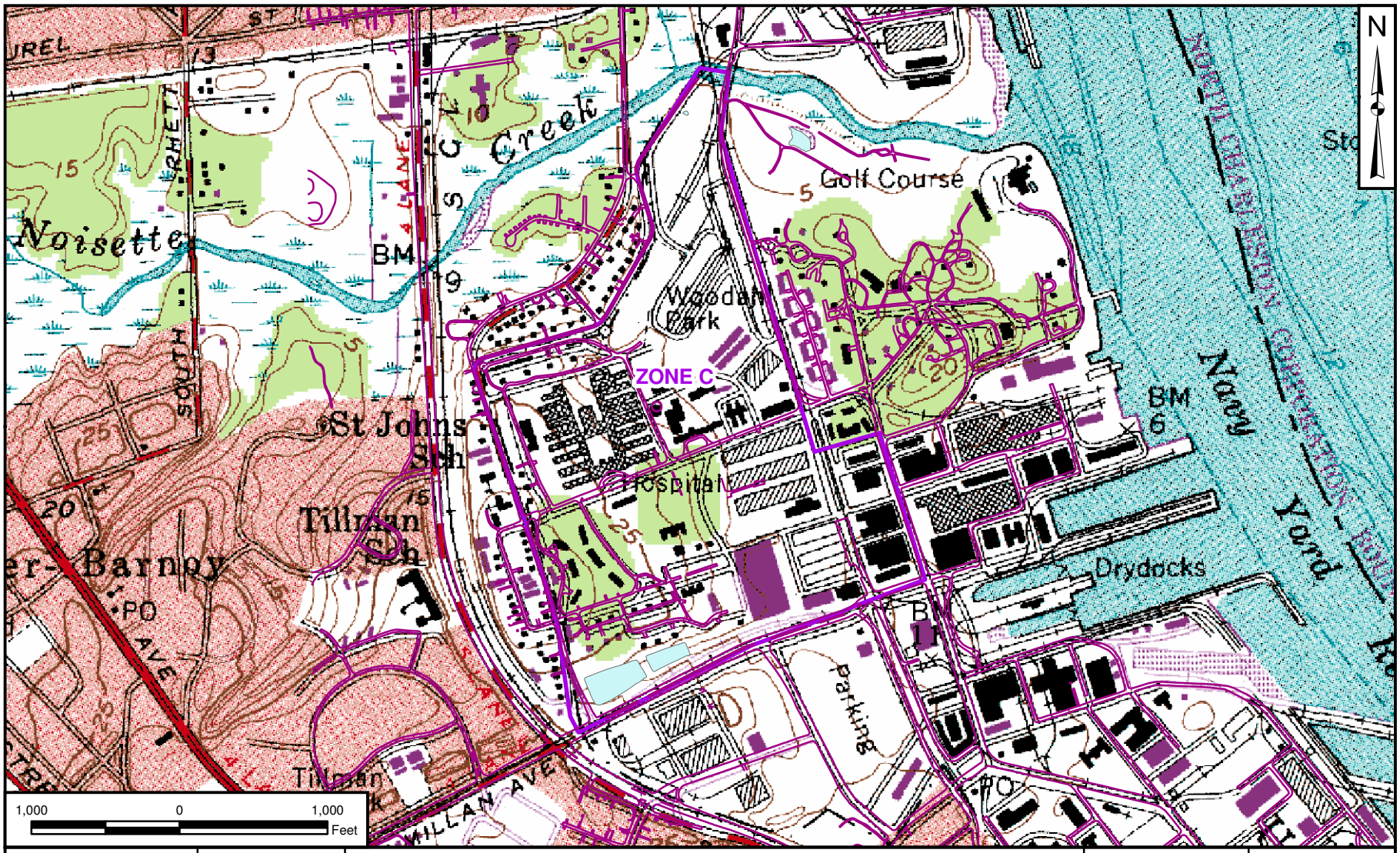

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NAVFAC

SITE LOCATION MAP
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

CONTRACT NUMBER	CTO NUMBER
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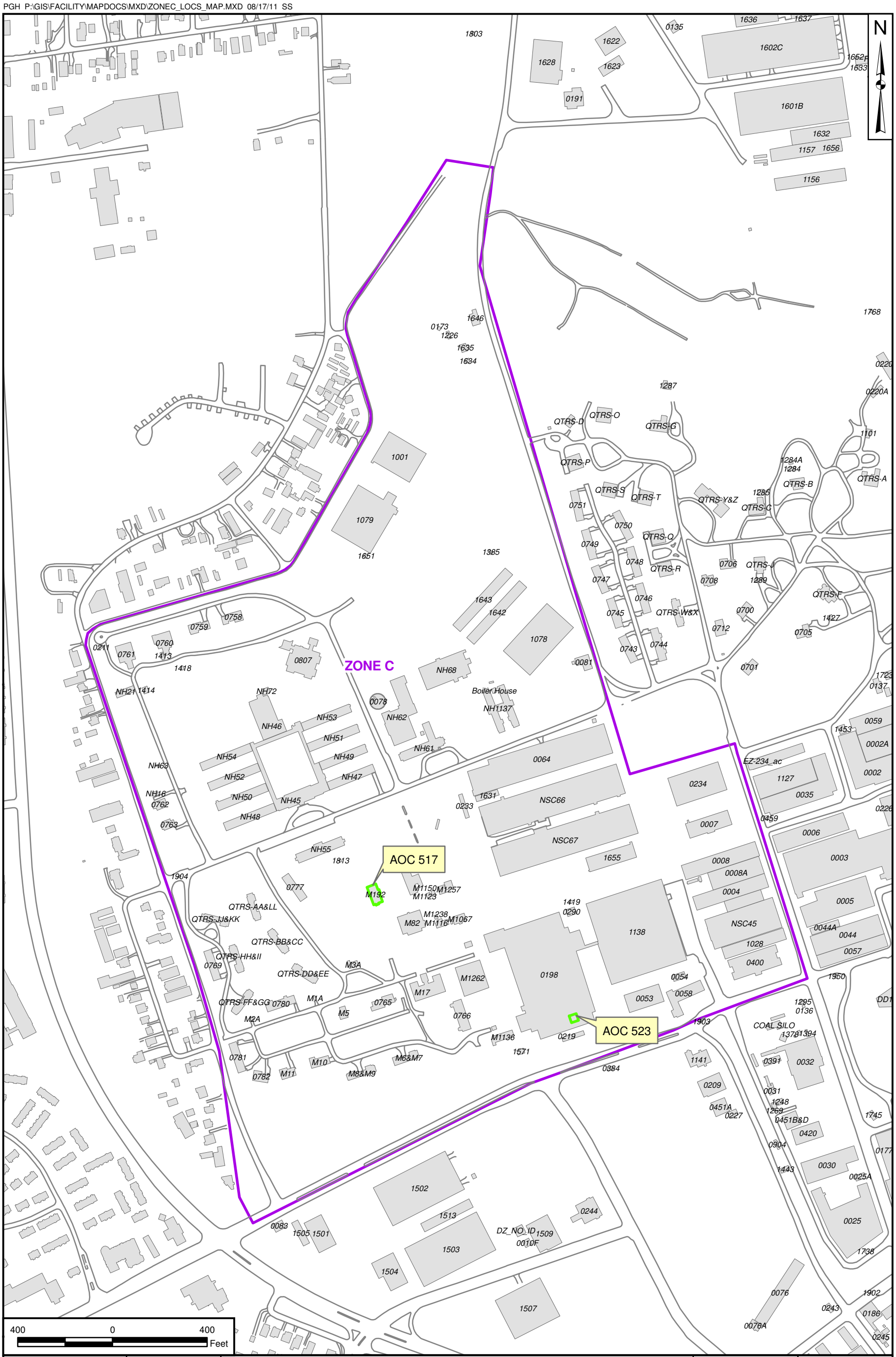

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NAVFAC

ZONE C, AOC 517, AND AOD 523 LOCATIONS
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

CONTRACT NUMBER	CTO NUMBER
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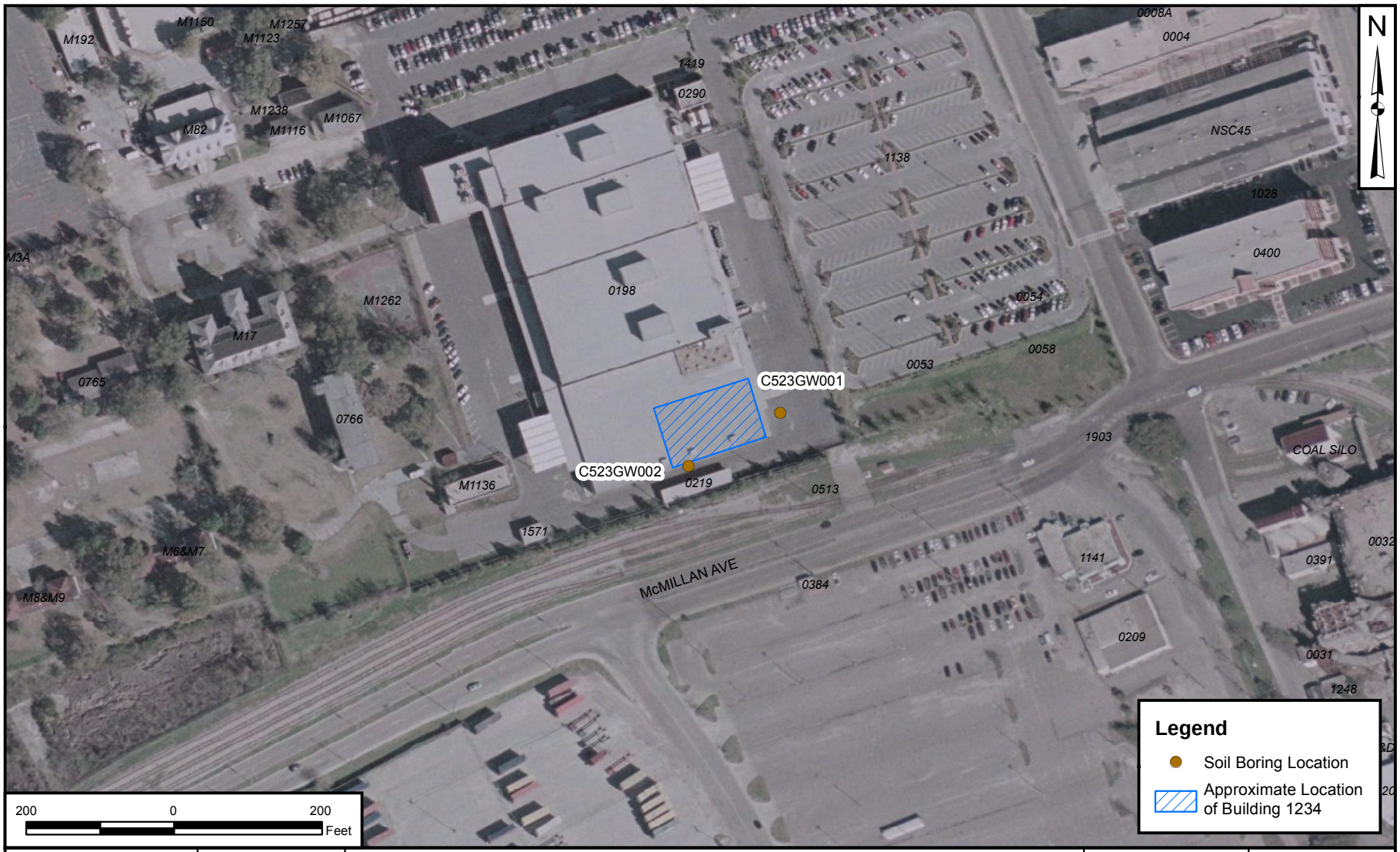

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NAVFAC

AOC 523 SITE LAYOUT AND PREVIOUS SOIL BORING LOCATIONS
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

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NAVFAC

AOC 523 PROPOSED SAMPLING LOCATIONS
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

CONTRACT NUMBER	CTO NUMBER
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FIGURE NO.	REV
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APPENDIX A

RESPONSES TO SCDHEC COMMENTS

September 13, 2001

Ms. Amy Daniell
Caretaker Site Office
Charleston Naval Complex
CSO 1895 Avenue F
North Charleston, SC 29405

RE: Corrective Measures Study Work Plan
Rationale for NFA – AOCs 517 and 523
Charleston Naval Complex
SC0 170 022 560

Dear Ms. Daniell:

The South Carolina Department of Health and Environmental Control (the Department) received the above referenced work plan on July 23, 2001. The Department reviewed this document with respect to the approved Zone C RFI Report and applicable sections of the CNC Hazardous Waste Management Permit (the Permit). Based on this review, the Department has determined that the document requires revisions. Please refer to the attached engineering comments.

The response to these comments may be addressed by submitting revised pages to be inserted into the original document, or by submitting another document. If new or revised pages are submitted, please indicate whether each submitted page is a revision to an existing page in the original document or a new page not contained in the original document. Each revised page should be coded; for example, 32(R-9/10/88) would be page 32, revised 9/10/88. In addition to revisions, please provide a summary of the comment responses. If you have any questions regarding this issue, please contact me at (803) 896-4255.

Sincerely,

Stacey French, Environmental Engineer Associate
Corrective Action Engineering Section
Division of Waste Management
Bureau of Land and Waste Management

Attachment
cc: Tony, Hunt, P.E., SOUTHDIV
Rob Harrell, P.E., SOUTHDIV
Dann Sparioso, USEPA Region 4
Rick Richter, Trident EQC District

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

ENGINEERING COMMENTS

Corrective Measures Study Work Plan
Rationale for No Further Action
AOC 517 and AOC 523, Zone C

Prepared by:
Stacey French, Environmental Engineer Associate
Corrective Action Engineering Section
Division of Hazardous and Infectious Waste
Bureau of Land and Waste Management
September 11, 2001

Specific Comments

AOC 517

1. Section 2.8 Relevance or need for land use controls at the site, page 1-4
   The first sentence states that no land use controls (LUCs) are required. However, Appendix B, Completion Report Process Closure for AOC 517 recommends that the painted surfaces be maintained to ensure the encapsulation of lead dust. The Department interprets this as an engineering control, thus a LUC. Therefore, the Department does not concur with the statement that no LUCs are required. This section should be revised to be consistent with the Navy's recommendations in Appendix B.

   Additionally, this section goes on to state that the corrective action for the lead dust is in consistent with HUD guidelines. Based on the following sentence, the Department assumes that this is a typographical error and that the corrective action was consistent with the HUD guidelines. Please revise this typographical error to eliminate confusion in the administrative record.

2. Section 3.0 Conclusions and Recommendations, page 1-4
   The last sentence of the section recommends No Further Action (NFA) for SWMU. See specific comment #1 for discussion of LUCs. Based on this information, the Department does not concur with the NFA recommendation for AOC 517. This section should be revised in accordance with specific comment #1.

AOC 523

1. Section 1.0 Introduction, page 2-1, fourth paragraph
   The second sentence states that the former gas station (building M-1234) is within the footprint of building 198, which is still in use. There is no discussion of the use of building 198. This information is needed for the Department to determine if current practices have the potential to impact the decision for AOC 523 and to clarify the administrative record. This section should

be revised to state the use of building 198.

2. Section 1.0 Introduction, page 2-1, fifth paragraph
The first sentence states that Figure 1 shows the approximate location of building M-1234 in relation to building 198. Please note that Figure 1 was not included in the document.

3. Section 1.0 Introduction, page 2-2, first paragraph
The last sentence of the paragraph states that an issue of inorganics in groundwater concentrations to identify samples with concentrations significantly higher than background. The meaning of significantly higher than background is vague and should be clarified.

4. Section 1.1 Background and Summary for Corrective Measures Study Work Plan, page 2-2
The third sentence states that the Department's approval letter for the RFI suggests additional investigation under the RCRA Subtitle C (UST) program. Please note that RCRA Subtitle C regulates hazardous waste. The correct reference is the RCRA Subtitle I program. Please revise accordingly.

   Additionally, it should be noted that the Department's approval letter states that a decision is pending verification that the UST program has or will address the unit, and the base wide thallium study by the RCRA Subtitle C program. No verification has been provided in the CMS Work Plan that the RCRA Subtitle I program will investigate petroleum related contamination at AOC 523. Based on discussions with Michael Bishop of the SCDHEC Bureau of Water, there is no record of Subtitle I investigation for buildings M-1234 or building 198. Please clarify and provide the appropriate verification.

5. Section 2.1 Status of the RFI, page 2-3
The third sentence states that there are no constituents to address under the Subtitle C (UST) program. This sentence should be revised in accordance with specific comment #4.

6. Section 3.0 Conclusions and Recommendations, page 2-4
The last sentence of this paragraph states that the Navy recommends a No Further Action (NFA) for AOC 523. However, the Department does not concur with the No Further Action Recommendation for the following reasons:

   - The fourth paragraph of Section 1.0 Introduction, page 2-1 states that the site was identified as an AOC because of the potential for waste oil, solvents, or petroleum releases to the environment. The CMS Work Plan does not provide adequate information regarding number and location of samples for the Department to concur with a NFA determination.

   - No verification has been provided in the CMS Work Plan that the RCRA Subtitle I program will investigate petroleum related contamination at AOC 523. Based on discussions with Michael Bishop of the SCDHEC Bureau of Water, there is no record of Subtitle I investigation for buildings M-1234 or building 198. Additionally, the Department generally defers a NFA determination for these sites until after the investigation under the RCRA Subtitle I program is complete.

Subject: Response to comments to the Corrective Measures Study Work Plan Rationale for No Further Action AOC 517 and AOC 523, Zone C, Charleston Naval Complex, Charleston, South Carolina

Dear Ms. French:

Thank you for your comments dated September 11, 2001 regarding the Corrective Measures Study (CMS) Work Plan Rationale for No Further Action AOC 517 and AOC 523, Zone C, Charleston Naval Complex (CNC), Charleston, South Carolina. In response, to your comments, Naval Facilities Engineering Command, Southeast (NAVFAC SE) is pleased to provide the following Addendum to the CMS Work Plan.

AOC 517

Comment 1:
Section 2.8 Relevance or need for land use controls at the site, page 1-4

> *The first sentence states that no land use controls (LUCs) are required. However, Appendix B, Completion Report Process Closure for AOC 517 recommends that the painted surfaces be maintained to ensure the encapsulation of lead dust. The Department interprets this as an engineering control, thus a LUC. Therefore, the Department does not concur with the statement that no LUCs are required. This section should be revised to be consistent with the Navy's recommendations in Appendix B.*
>
> *Additionally, this section goes on to state that the corrective action for the lead dust is in consistent with HUD guidelines. Based on the following sentence, the Department assumes that this is a typographical error and that the corrective action was consistent with the HUD guidelines. Please revise this typographical error to eliminate confusion in the administrative record.*

Response:

Acknowledged: As mentioned by the South Carolina Department of Health and Environmental Control (the Department), maintenance of a painted surface to encapsulate the lead dust surface does indeed constitute an engineering control, and a Land Use Control (LUC). It is therefore intended that the painted surface are to be maintained in Building M-192 at AOC 517.

Guidelines set forth by the Department of Housing and Urban Development (HUD) in Code of Federal Regulations (CFR) Chapter 26, Part 35, Lead-Based Paint Poisoning Prevention in Certain Residential Structures, Subpart R in § 35.1320 (26 CFR 35.1320(i)) as published in the Federal Register on June 21, 2004 (69 FR 34273), specify the standards for lead dust screening level of 125 micrograms per square foot ($\mu g/ft^2$). This screening level (Lead Hazard Screening Level) is greater than the < 25 $\mu g/ft^2$ loading that was found to be present during the post remediation monitoring reported in the Completion Report (SUPSHIP, 1999). As such, exisiting lead dust controls are consistent with HUD standards.

Comment 2:
Section 3.0 Conclusions and Recommendations, page 1-4

The last sentence of the section recommends No Further Action (NFA) for SWMU. See specific comment #1 for discussion of LUCs. Based on this information, the Department does not concur with the NFA recommendation for AOC 517. This section should be revised in accordance with specific comment #1

Response:

As mentioned in the response to Comment 1, the existing lead dust levels in Building M-192, AOC 517 are below the HUD Lead Hazard Screening Level. Encapsulation is in place and the interior surfaces are within lead loading standards. It is therefore requested that a No Further Action (NFA) be granted for AOC 517.

AOC 523

Comment 1:
Section 1.0 Introduction, page 2-1, fourth paragraph

The second sentence states that the former gas station (building M-1234) is within the footprint of building 198, which is still in use. There is no discussion of the use of building 198. This information is needed for the Department to determine if current practices have the potential to impact the decision for AOC 523 and to clarify the administrative record. This section should be revised to state the use of building 198.

Response:

Building 198 is currently in use by the U. S. Department of Defense (DoD) as a secured research facility. As such, the structure is not accessible to the public and is not intended as a residential facility.

Comment 2:
Section 1.0 Introduction, page 2-1, fifth paragraph
The first sentence states that Figure 1 shows the approximate location of building M-1234 in relation to building 198. Please note that Figure 1 was not included in the document.

Response:

As depicted on Figure 1 the approximate location of former Building M-1234 as recorded in historical base records. According to these records Building M-1234 occupied the southern portion of existing Building 198.

Comment 3:
Section 1.0 Introduction, page 2-2, first paragraph
The last sentence of the paragraph states that an issue of inorganics in groundwater concentrations to identify samples with concentrations significantly higher than background. The meaning of significantly higher than background is vague and should be clarified

Response:

Inorganic constituent analysis was conducted during the 1997 RCRA Facilities Investigation at AOC 523 for both soil and groundwater. These analyses reflect the results from samples that were taken at down gradient and cross gradient locations. Groundwater samples were taken at the two locations (NBCC523GW001 and NBCC523GW002)as depicted on Figure 2. As reported in the Zone C RCRA Facilities Investigation Report; Aluminum, Arsenic, Barium, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Vanadium, and Zinc, were above background levels. The amount of inorganic constituent detected in the groundwater at AOC 523 varies from 1.5 to 10.9 times the background concentration. Table 1 summarizes the comparison of the maximum detected concentration to the respective constituent background levels.

Table 1
Comparison of Maximum Concentration to Background Level at AOC 523

Constituent		Maximum Detected Concentration (µg/l)	Background Level (µg/l)	Amount Above Background
Aluminum	Al	4040	410	9.9
Arsenic	As	26.6	6.1	4.4
Barium	Ba	48.2	16.7	2.9
Chromium	Cr	7.9	2	4.0
Cobalt	Co	14.2	1.3	10.9
Copper	Cu	5.3	1.9	2.8
Lead	Pb	8.1	3.3	2.5
Manganese	Mn	925	608	1.5
Nickel	Ni	6.9	3.6	1.9
Vanadium	V	10.5	2	5.3
Zinc	Zn	79.1	13.2	6.0
			Maximum	10.9
			Average	4.7

Comment 4:
Section 1.1 Background and Summary for Corrective Measures Study Work Plan, page 2-2
The third sentence states that the Department's approval letter for the RFI suggests additional investigation under the RCRA Subtitle C (UST) program. Please note that RCRA Subtitle C regulates hazardous waste. The correct reference is the RCRA Subtitle I program. Please revise accordingly.

Additionally, it should be noted that the Department's approval letter states that a decision is pending verification that the UST program has or will address the unit, and the base wide thallium study by the RCRA Subtitle C program. No verification has been provided in the CMS Work Plan that the RCRA Subtitle I program will investigate petroleum related contamination at AOC 523. Based on discussions with Michael Bishop of the SCDHEC Bureau of Water, there is no record of Subtitle I investigation for buildings M-1234 or building 198. Please clarify and provide the appropriate verification.

Response:

Acknowledged: The RCRA Subtitle I program addresses Underground Storage tanks. As discussed in the previous response, the two Sample locations depicted on Figure 2 at AOC 523 were analyzed during the 1997 RCRA Facilities Investigation. Analytical results from these locations indicated that there were no petroleum VOCs or SVOCs above Maximum Contaminant Level (MCL) for groundwater or Risk-Based Concentration (RBC) for soils at AOC 523. Consequently, there are no constituents to be addressed and transfer of AOC 523 to the RCRA Subtitle I program is not necessary.

Comment 5:
Section 2.1 Status of the RFI, page 2-3
The third sentence states that there are no constituents to address under the Subtitle C (UST) program. This sentence should be revised in accordance with specific comment #4.

Response:

Acknowledged: The RCRA Subtitle I program addresses Underground Storage tanks.

Comment 6:

Section 3.0 Conclusions and Recommendations, page 2-4

The last sentence of this paragraph states that the Navy recommends a No Further Action (NFA) for AOC 523. However, the Department does not concur with the No Further Action Recommendation for the following reasons:

- *The fourth paragraph of Section 1.0 Introduction, page 2-1 states that the site was identified as an AOC because of the potential for waste oil, solvents, or petroleum releases to the environment. The CMS Work Plan does not provide adequate information regarding number and location of samples for the Department to concur with a NFA determination.*

- *No verification has been provided in the CMS Work Plan that the RCRA Subtitle I program will investigate petroleum related contamination at AOC 523. Based on discussions with Michael Bishop of the SCDHEC Bureau of Water, there is no record of Subtitle I investigation for buildings M-1234 or building 198. Additionally, the Department generally defers a NFA determination for these sites until after the investigation under the RCRA Subtitle I program is complete.*

Response:

As discussed in the Response to Comment 3, the two locations depicted on Figure 2 at AOC 523 were sampled during the 1997 RCRA Facilities Investigation. These two locations are down gradient and cross gradient from AOC 523 as described in Base records. Sets of two soil samples were taken at each site and monitoring wells were installed and sampled into the shallow aquifer. The four soil samples and two groundwater samples were analyzed for VOCs, SVOCs, pesticides / PCBs, metals, cyanide, and TPH.

Results of these analysis indicated that no contaminants exceeded the respective MCL for groundwater or RBC for soils. As such, further investigation is unnecessary and it is requested that a No Further Action (NFA) be granted for AOC 523.

Response to SCDHEC Comment Letter Dated April 3, 2012
Prepared by Meredith Amick, P.E., Environmental Engineer
Draft Final Zone C Corrective Measures Study Work Plan
Areas of Concern 517 and 523
Charleston Naval Complex
North Charleston, South Carolina

Comment 1: The Department Reiterates the following Comment.

Table 1 Page 1-3

- Please explain where the Maximum Detected Concentration values were found. They do not appear to match those provided in the November 1997 RFI for AOC 523.
- Please explain where the Background Levels were obtained. They do not appear to match the Zone C background values provided in the November 2001 background study. Please use the Zone C values for both surface and subsurface soil to appropriately screen the data.
- Providing a "Multiple Greater than Background" number is not an appropriate use of the background study. Additionally the average "Multiple Greater than Background" is irrelevant.

To address this comment, in the CMS WP please provide summary tables of detections for both soil and groundwater from the Zone C RFI Report for AOC 523. If the RFI data is to be used in the CMS Report, please rescreen with new screening criteria as well as the more recent 2001 background study data. In addition in the CMS Report, please screen the new data with the data from the 2001 background study for Zone C.

Response to Comment 1: Given the age of the analytical data presented in the *Zone C RCRA Facility Investigation (RFI) Report* (EnSafe, 1997), this data was presented in Tetra Tech's CMS Work Plan for reference and to help outline the sampling rationale presented in the Work Plan. To avoid any potential confusion moving forward, Table 1 in the CMS Work Plan will be revised to compare the soil and groundwater detections reported in the *Zone C RFI Report* to current screening criteria and the Zone C background values presented in the *Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex* (CH2MHill, 2001).

Additionally, the CMS Work Plan will be revised to recommend that new analytical data and any historical analytical data used during the CMS be screened against current screening criteria and the 2001 background study data. The 2001 background study has been added as an appendix to the CMS Work Plan.

Comment 2: Section 1.4

In the RTCs to Amick Comment #3 as well as Section 1.4, it is stated, "…thus scanning with a ground-penetrating radar or similar geophysical device may be required to determine if USTs are present or have been present under the building." However Section 3 does not include discussion of any ground-penetrating radar or geophysical device work to be done as part of this work plan. Please include this in Section 3 as part of the scope of work for the CMS WP at AOC 523.

Response to Comment 2: Agreed. Information regarding scanning with ground-penetrating radar or similar geophysical device will be included as part of the scope of work for the project in Section 3.

Comment 3: Response to Amick Comment #5

The Department reiterates, "Prior to the Department approval of this work plan recommending Land Use Controls as a remedy for AOC 517, the Navy must provide proof of acceptance of the Land Use Controls from the current property owner." Additionally, in the CMS WP please state who owns the property associated with AOC 523.

Response to Comment 3: The Navy will ensure that the current property owner for AOC 517 (the South Carolina Public Railroad) accepts Land Use Controls as the remedy. Acceptance of LUCs by the South Carolina Public Railroad has been demonstrated by their participation in the 2012 annual LUC inspection for AOC 517 and their submittal of the 2012 annual LUC compliance certification form which they signed on December 27, 2012.

Additionally, the property owners for both AOCs 517 and 523 (the South Carolina Public Railroad and the Space and Naval Warfare Systems Command [SPAWAR], respectively) will be named in the CMS.

Response to SCDHEC Comment Letter Dated September 30, 2012
Prepared by Annie M. Gerry, Hydrologist
Draft Final Zone C Corrective Measures Study Work Plan
Areas of Concern 517 and 523
Charleston Naval Complex
North Charleston, South Carolina

Changes to Remedial Action Completion Report text are italicized and enclosed in quotation marks.

SCDHEC Comment 1: The Department's original comment

...The text reads, *"An additional two to three temporary groundwater monitoring wells will be installed in the grassy areas near AOC 523, and groundwater elevations will be monitoring at these wells.*" This statement makes it appear that a total of six or seven wells are planned to be installed. However, the location of these additional wells is not shown on any of the figures and construction details are not provided. Please clarify the location, the total number, and type of proposed monitoring well.

Navy Response: …The four wells to be installed and sampled as part of the plan will be permanent monitoring well, and will be installed by a SC certified well driller. More details will be added to the Work Plan regarding all locations and types of wells, along with the installation procedure."

While the Navy response indicates that only four wells are to be installed, the text states that four permanent groundwater monitoring wells are planned for installation in addition to two to three temporary monitoring wells (See Page 3-1). If the Navy plans to install a total of four monitoring wells, the text must reflect the number and type of monitoring wells in the revised document. In addition, please submit a separate groundwater monitoring well installation request to the Department.

Navy Response to Comment 1: A groundwater monitoring well installation request will be sent to SCDHEC as requested. A total of six to seven wells will be installed, with four being permanent wells and two to three being temporary wells (referred to in the text as piezometers for clarity). The permanent monitoring wells are intended to be used in the long-term monitoring plan, and the temporary wells are intended for groundwater level measurement purposes only. This will be made clearer in the document.

SCDHEC Comment 2: Page 1-3, Section 1.3-AOC 523 Background and Summary for Corrective Measures Study Work Plan – Please provide the date when the underground storage tanks (UST's) were removed and a date when the removal reports were submitted to the Department.

Navy Response to Comment 2: As presented in the *Final RCRA Facility Assessment, Naval Base Charleston* (EnSafe, 1995), "…the gasoline station storage operated from 1958 to 1962. Since the storage unit was taken out of service approximately 32 years ago, no records have been found providing any information on its design features or operating practices of unit."

To that end, the removal dates and removal report dates are unknown and can therefore not be included in this report.

TETRA TECH

PITT-12-11-030

December 9, 2011

Project Number 112G01284

Ms. Meredith Amick, PE
South Carolina Department of Health and Environmental Control
Corrective Action Engineering Section
Division of Waste Management
Bureau of Land and Waste Management
2600 Bull Street
Columbia, South Carolina 29201

Reference: a. Contract N62467-04-D-0055
b. Task Order 0104; Zone C CMS Work Plan (Draft Final)

Subject: Zone C – Corrective Measures Study (CMS) Work Plan (Draft Final)

Dear Ms. Amick:

Enclosed, please find four copies (two hard copies and two CDs) of the (Draft Final) Zone C – CMS Work Plan. This Work Plan incorporates the review comments issued by your department on September 30, 2011, following review of Tetra Tech's (Draft) *Corrective Measures Study Work Plan for Zone C, Area of Concern 517 and Area of Concern 523, Charleston Naval Complex, Charleston, South Carolina.*

Should you have any questions regarding the enclosed report, please contact me at (901) 523-9500.

Very truly yours,

Geoff Pope, PE
Project Manager

GP/clm

Enclosure

Cc:
Tim Riordan, NAVFAC Atlantic (1 hard copy, 1 cd)
Art Sanford, BRAC PMO SE (1 hard copy, 1 cd)
David Criswell, BRAC PMO SE (cover letter only)
File

Tetra Tech
661 Andersen Drive, Pittsburgh, PA 15220-2700
Tel 412.921.7090 Fax 412.921.4040 www.tetratech.com

RESPONSE TO SC DHEC COMMENT LETTER (DATED: SEPTEMBER 30, 2011), prepared by Meredith Amick, P.E., Environmental Engineer
DRAFT ZONE C CORRECTIVE MEASURES STUDY (CMS) WORK PLAN
AREAS OF CONCERN 517 AND 523
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

Comments are shown in bold font. Responses follow each comment and are shown in regular font. Changes to Remedial Action Completion Report text are italicized and enclosed in quotation marks.

Comment 1: Table 1 Page 1-3

- **Please explain where the Maximum Detected Concentration values were found. They do not appear to match those provided in the November 1997 RFI for AOC 523.**
- **Please explain where the Background Levels were obtained. They do not appear to match the Zone C background values provided in the November 2001 background study. Please use the Zone C values for both surface and subsurface soil to appropriately screen the data.**
- **Providing a "Multiple Greater than Background" number is not an appropriate use of the background study. Additionally the average "Multiple Greater than Background" is irrelevant.**

Response to Comment 1:
The table on Page 1-3 was prepared in response to the SCDHEC Review Comments on the Corrective Measures Study Work Plan (EnSafe, Inc. [EnSafe], 2001), dated September 13, 2001. It has come to our attention that while these comments may have been discussed as a previous partnering team meeting, a formal Response to the Review Comments may not have been submitted. To this end, SCDHEC's 2001 Review Comments and Draft Response to Comments are included as an Attachment to Tetra Tech's 2011 Zone C CMS Work Plan.

Background concentration came from the Zone C RCRA Facilities Investigation Report. Maximum Detected Concentrations come from the 1997 RCRA Facilities Investigation at AOC 523. The "Multiple Greater than Background" column is only meant to offer a means of comparison, and is not used in making decisions.

Comment 2: Section 1.3
Please respond to Comment #1 for AOC 523 from the September 13, 2001 comments to the CMS Work Plan.

"The second sentence states that former gas station (building M-1234) is within the footprint of building 198, which is still in use. There is no discussion of the use of building 198. This information is needed for the Department to determine if current practices have the potential to impact the decision for AOC 523 and to clarify the administrative record. This section should be revised to state the use of building 198."

Response to Comment 2: This comment was addressed in the Draft Response to SCDHEC Comments on the Corrective Measures Study Work Plan (2001); however, as previously stated, a formal Response to the Review Comments addressing this revision may not have been submitted. As stated, SCDHEC's 2001 Review Comments and Draft Response to Comments are included as an Attachment to Tetra Tech's 2011 Zone C CMS Work Plan.

Additionally, the current use of Building 198, as a secured DoD research facility, is included in Section 1.3 of the 2011 Zone C CMS Work Plan.

Comment 3: Section 1.2 and 1.4, Page 1-4
The last paragraph of Section 1.3 states, "Also, the Navy has attempted to locate any remaining USTs using geophysical techniques without success." However, the next paragraph says, "A

field investigation will likely be complicated by the current location of Building 198 on the site, thus scanning with a ground-penetrating radar or similar geophysical device may be required to determine if USTs are present or have been present under the building." These statements appear contradictory. A geophysical survey should be performed to determine if any USTs are remaining.

Response to Comment 3: This change has been made as recommended.

Comment 4: Section 3.2, Page 3-1 and Table 2 Page 3-2
It is not necessary to sample for TPH, as it is an indicator parameter and there are no screening values available.

Response to Comment 4: This change has been made as recommended.

Comment 5: Section 2.8, Page 2-2 and Section 4.1 Page 4-1
No Further Action and Land Use Controls are two separate remedies. As written the report indicates that the remedy recommended for this site is Land Use Controls. Prior to Department approval of this work plan recommending Land Use Controls as a remedy for AOC 517, the Navy must provide proof of acceptance of the Land Use Controls from the current property owner.

Response to Comment 5: The recommended remedy is Land Use Controls, and the text will be adjusted accordingly.

Comment 6: References

- **Please reference the September 13, 2001 Engineering Comments to the Corrective Measures Study Work Plan. Additionally Response to Comments should be provided in this document.**
- **Please reference the newly effective Permit.**
- **Please reference the July 2001 CMS Work Plan for AOCs 517 and 523.**

Response to Comment 6: These references will be added as recommended, and the 2001 Review Comments and Draft Response to Comments are included as an Attachment to Tetra Tech's 2011 Zone C CMS Work Plan.

Comment 7: Figure 3
Page 1-3 states that "Figure 3 shows the approximate location of Building M-1234 in relation to Building 198." However, Building M-1234 is not shown on Figure 3.

Response to Comment 7: The location of M-1234 will be clearly shown on this Figure.

Comment 8: Figure 4
Please provide sampling location rationale.

Response to Comment 8: Sampling location rationale will be added to Section 3.2.

RESPONSE TO SC DHEC COMMENT LETTER (DATED: SEPTEMBER 30, 2011), prepared by Annie M. Gerry, Hydrologist
DRAFT ZONE C CORRECTIVE MEASURES STUDY (CMS) WORK PLAN
AREAS OF CONCERN 517 AND 523
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

Comments are shown in bold font. Responses follow each comment and are shown in regular font. Changes to Remedial Action Completion Report text are italicized and enclosed in quotation marks.

Comment 1: Page 1-4, 2nd paragraph, Section 1.3 – AOC 523 Background and Summary for Corrective Measures Study Work Plan: The text reads, "This CMS WP provides the rationale for NFA for AOC 523." However, this contradicts Sections 1.4 and 4.2 which proposes additional sampling since there was limited data collected previously to conduct a thorough risk assessment. Pleas clarify and revise this WP.

Response to Comment 1: Additional sampling is the proposal with AOC 523, and this change will be made as recommended on Page 1-4.

Comment 2: Page 3-1, Section 3.2 – Sampling Investigation

A) This section states that the proposed sampling plan for AOC 523 will include collection of surface and subsurface soil samples, and groundwater samples. All samples collected will be analyzed for metals, cyanide, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), pesticides/polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (TPH). The analysis of TPH is inapplicable since there are no screening values available. Therefore, TPH should be taken out of the analysis program and Table 2 – *Proposed Sampling Plan for Soil and Groundwater at AOC 523* should be updated to reflect this change.

B) This section also states that four groundwater monitoring wells are to be installed and sampled. The text does not state whether these are permanent or temporary monitoring wells. In addition, the construction details are not provided (wells must be constructed in accordance with R.61-71) and do not specify whether a S.C. certified well driller will install these wells. Please provide more information on the construction details and that the wells will be constructed by a S.C. certified well driller in accordance with R.61-71.

C) In addition, the text reads, "*An additional two to three temporary groundwater monitoring wells will be installed in the grassy areas near AOC 523, and groundwater elevation will be monitored at these wells.*" This statements makes it appear that a totally of six or seven wells are planned to be installed. However, the location of these additional wells is not shown on any of the figures and construction details are not provided. Please clarify the location, the total number, and type of proposed monitoring wells.

Response to Comment 2: TPH will be removed from the proposed sampling program as recommended. The four wells to be installed and sampled as part of the plan will be permanent monitoring wells, and will be installed by a South Carolina-certified driller. More details will be added to the Work Plan regarding all locations and types of wells, along with the installation procedures.

Comment 3: Please include the data collected from the AOCs 517 and 523 RFI report in this WP. In addition, more historical information is needed that discusses past operation of these two sites. Historical aerial photos and/or maps of these two sites should also be included.

Response to Comment 3: Additional historical information and data will be added to this Work Plan as an attachment, as recommended. The data will also be discussed in the text.

Comment 4: Figure 4, AOC 5234 Proposed Sampling Locations- Please show the location of former Building M-1234 on the figure.

Response to Comment 4: The location of Building M-1234 will be added to Figures 3 and 4.

APPENDIX B

ZONE C RFI PRESENTATION AND
ZONE C BACKGROUND DATA

Zones C & I
RCRA Facility Investigation
Results

Naval Base Charleston

Scan

Zone C & I
RCRA Facility Investigation
(Administrative Record

Presented by: EnSafe/Allen&Hoshall
November 12, 1996

ACRONYMS

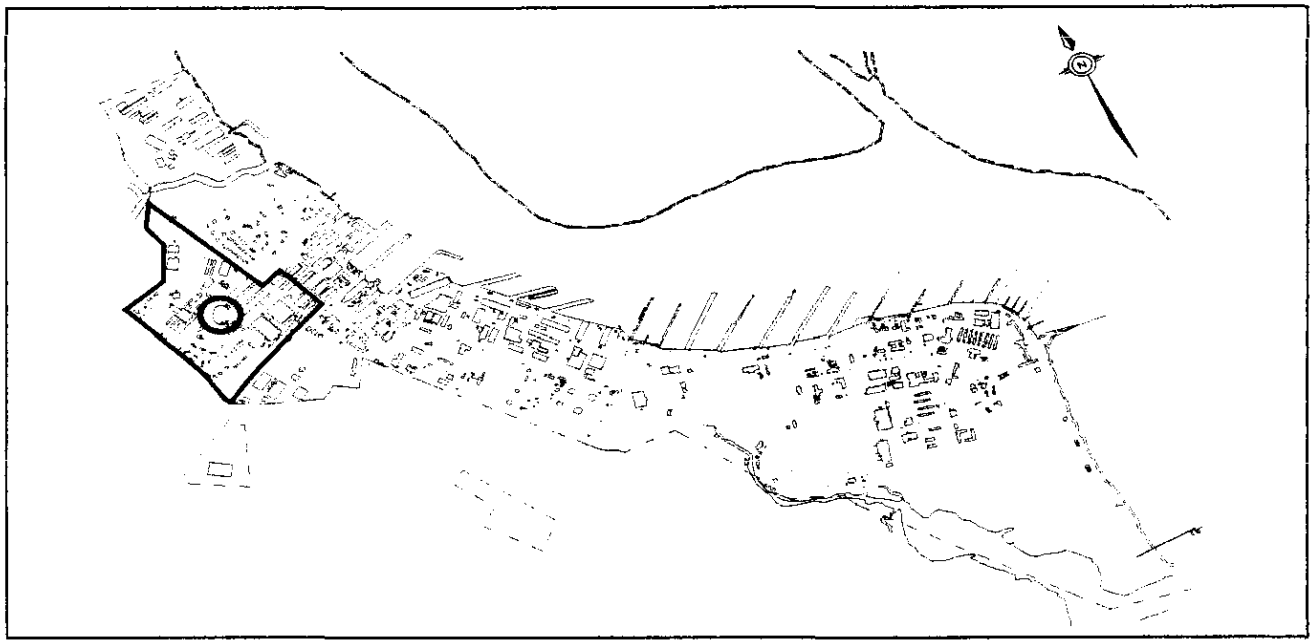
AOC	Area of Concern
CMS	Corrective Measures Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
DHEC	South Carolina Department of Health and Environmental Control
EPA	U. S. Environmental Protection Agency
HI	Hazard Index
HQ	Hazard Quotient
ILCR	Incremental lifetime excess cancer risk
NFA	No Further Action
PCB	Polychlorinated Biphenyl
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
TPH	Total Petroleum Hydrocarbons
VOC	Volatile Organic Compound

Outline - Zones C & I RFI Results

- Background
- Site-specific Results
- Risk Assessment Review
- Summary of Risks
- Recommendations
- Questions & Answers

Charleston Naval Shipyard

Zone C Overview



Location

- Zone C is located in the developed northwest portion of Naval Base Charleston.

Reuse

- Portions of the zone are currently slated for use as open buffer space, parking lots, office property, and limited residential areas.

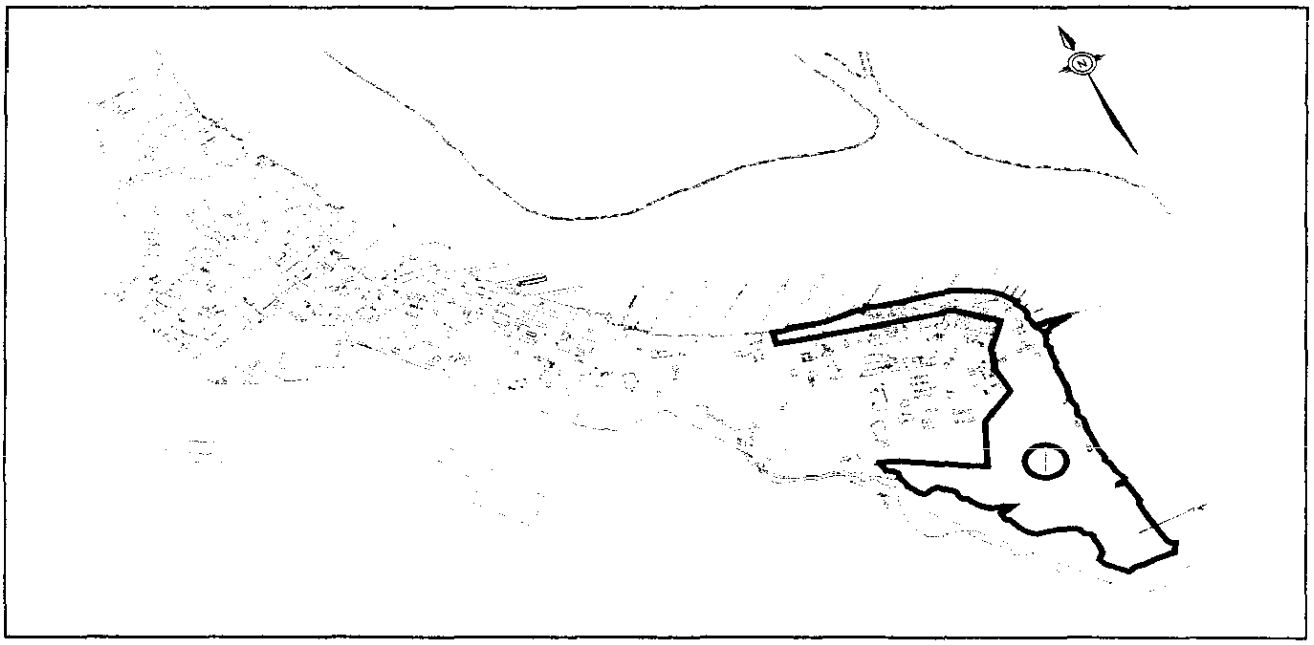
Purpose of Investigation

- To evaluate the nature and extent of hazardous waste impacts and to identify, develop, and implement appropriate corrective measures to protect human health and the environment.

Sampling Approach

- 3 Solid Waste Management Units (SWMUs)
- 14 Areas Of Concern (AOCs)
- 123 soil samples, 26 water samples

Zone I Overview



Location

- Zone I is the southern portion of the peninsula formed by Shipyard Creek and the Cooper River.

Reuse

- Identified for marine cargo terminal, marina, office space and open buffer.

Purpose of Investigation

- To evaluate the nature and extent of hazardous waste impacts and to identify, develop, and implement appropriate corrective measures to protect human health and the environment.

Sampling Approach

- 2 Solid Waste Management Units (SWMUs)
- 15 Areas Of Concern (AOCs)
- 2 Other Designated Sites
- 158 soil/sediment samples, 22 water samples
  9 asbestos samples, 7 wipe samples for lead

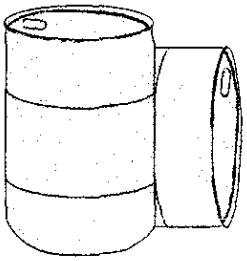
Common Contaminant Categories

Metals

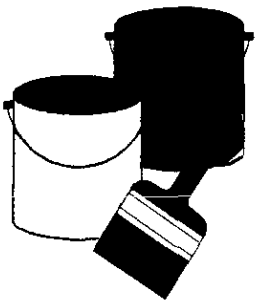
Metals are naturally occurring elements that are generally flexible and good conductors of electricity. These properties, along with the relative abundance of metals, make them valuable materials in industrial and manufacturing processes. Household items that commonly contain metals include paint and enamel, batteries, coins, and electrical components.

Pesticides, Herbicides, & PCBs

Pesticides are chemicals used to eliminate insects and other pests. Herbicides are chemicals used to kill unwanted plants or weeds. PCBs, or Polychlorinated Biphenyls, are industrial compounds that are used as insulating and heat exchange fluids in electrical transformers, and are found in hydraulic fluids used in electrical components and systems.



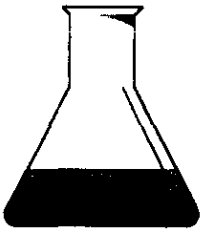
Semivolatile Organic Compounds



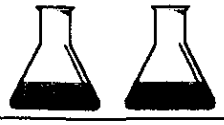
Semivolatile Organic Compounds, also called SVOCs, are common components of asphalt, coal tar, and pitch. Some SVOCs are components of diesel, jet fuel, waste oil, and hydraulic oil. A commonly used household SVOC is naphthalene, which is the main ingredient in many furniture refinishing products including paints, stains, finishes and varnish thinner.

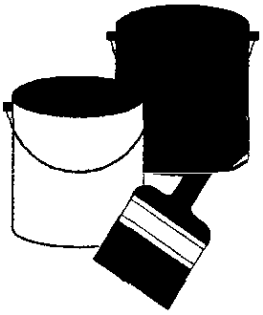
Volatile Organic Compounds

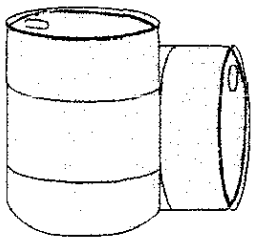
Volatile Organic Compounds, also called VOCs, are commonly used chemicals. Many VOCs are solvents, which are liquid compounds used to dissolve other substances. Ordinary household solvents include paint thinner and mineral spirits. Other household products that contain VOCs include hair spray, nail polish remover, air fresheners, and oven cleaners.

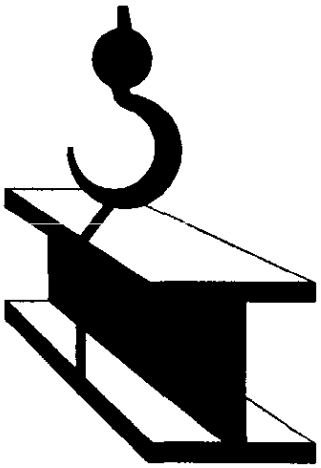


Zones C & I Chemicals of Concern (COCs)









Contaminant	Category	C	I
1,4-Dichlorobenzene	VOC		✓
Methylene chloride	VOC		✓
3, 3 - Dimethyl Benzidine	SVOC	✓	
Acetophenone	SVOC	✓	
BEHP	SVOC	✓	
Benzo(a)pyrene equivalents	SVOC	✓	✓
Dioxins/Furans	SVOC	✓	✓
N-Nitroso-di-n-propylamine	SVOC		✓
4,4'-DDT	Pesticide	✓	
Chlordane	Pesticide	✓	
Dieldrin	Pesticide	✓	
Isodrin	Pesticide		✓
Polychlorinated Biphenyls	PCB		✓
Aluminum	Metal	✓	
Antimony	Metal	✓	
Arsenic	Metal	✓	✓
Beryllium	Metal	✓	✓
Cadmium	Metal		✓
Lead	Metal	✓	
Manganese	Metal	✓	✓
Nickel	Metal	✓	✓
Thallium	Metal	✓	

Note: This table includes only chemicals that are primary contributors to Risk/Hazard.

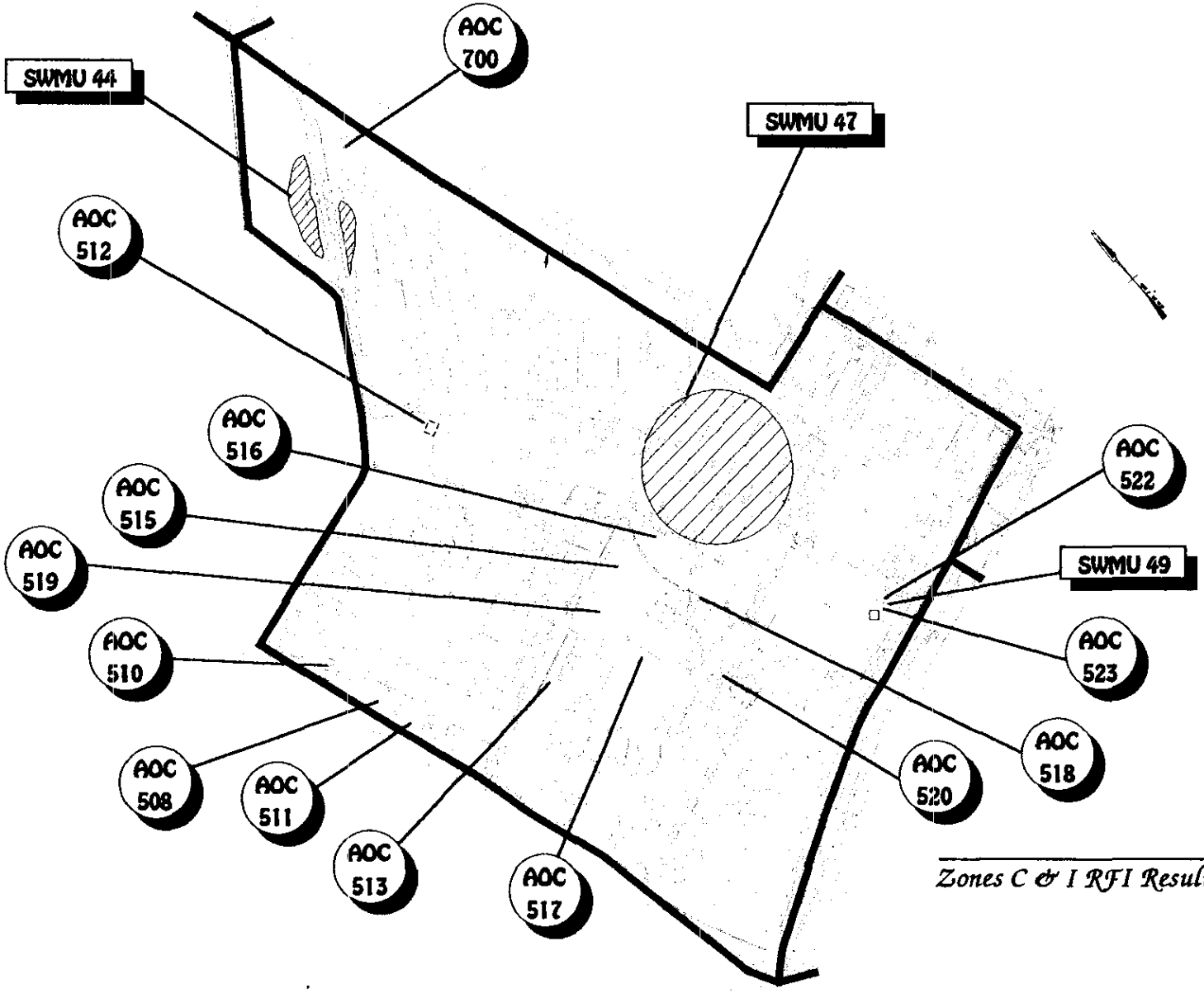
Grouping of Sites - Zones C & I

Grouping 1 - Petroleum Sites

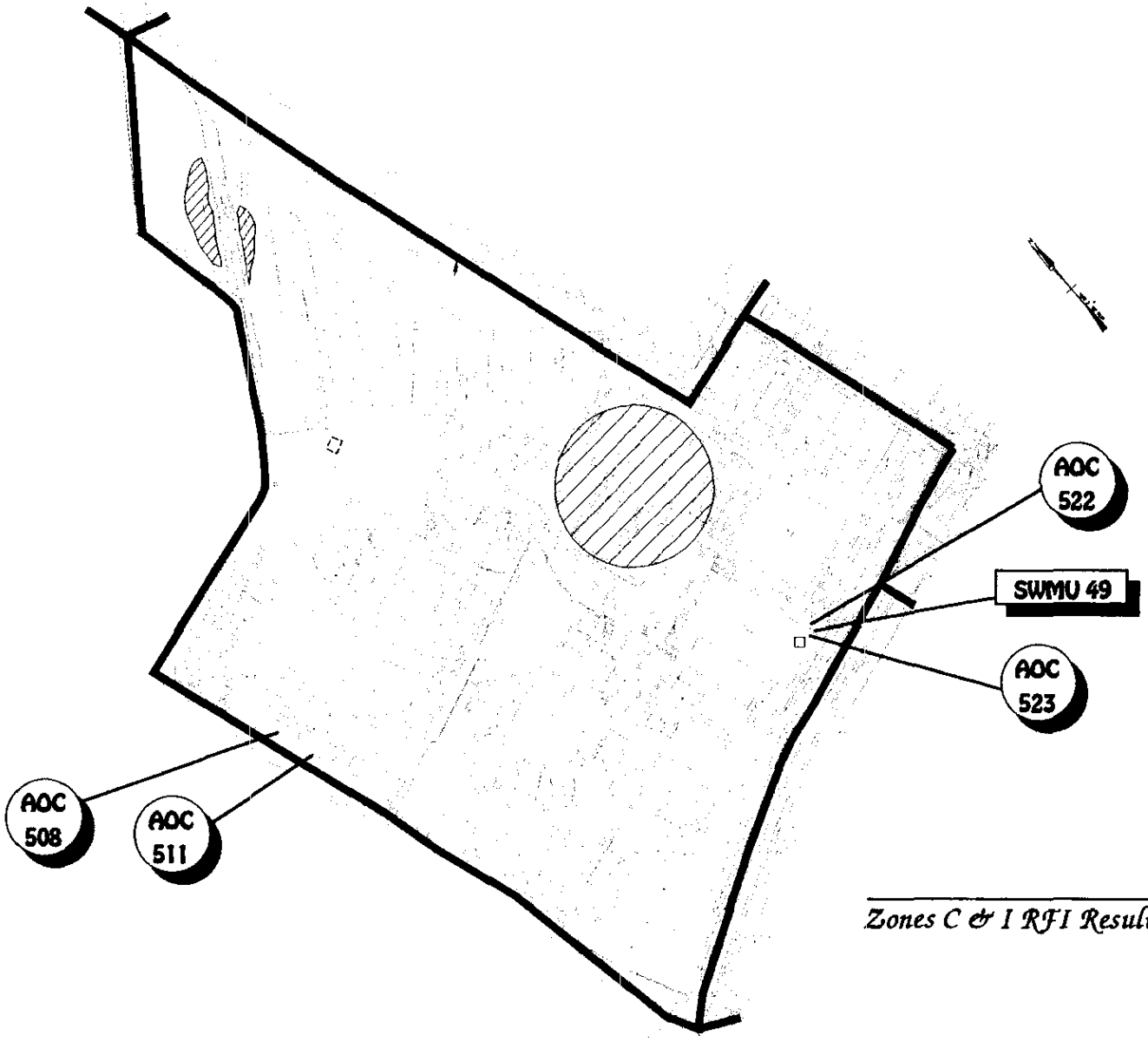
Grouping 2 - Other Designated Sites

Grouping 3 - Sites Recommended for No Further Action

Zone C AOCs/SWMUs



Zone C Grouping 1 - Petroleum Sites



Zone C Grouping 1 - Petroleum Sites

Site #	Site Description	Samples Collected
AOCs 511/508	Former Oil Storehouse/ Former Incinerator	Soil (19)
AOC 522	Former Grease and Wash Area	** Not presented in Draft RFI Report*
AOC 523/SWMU 49	Former Gas Station	Soil (2) Groundwater (2)

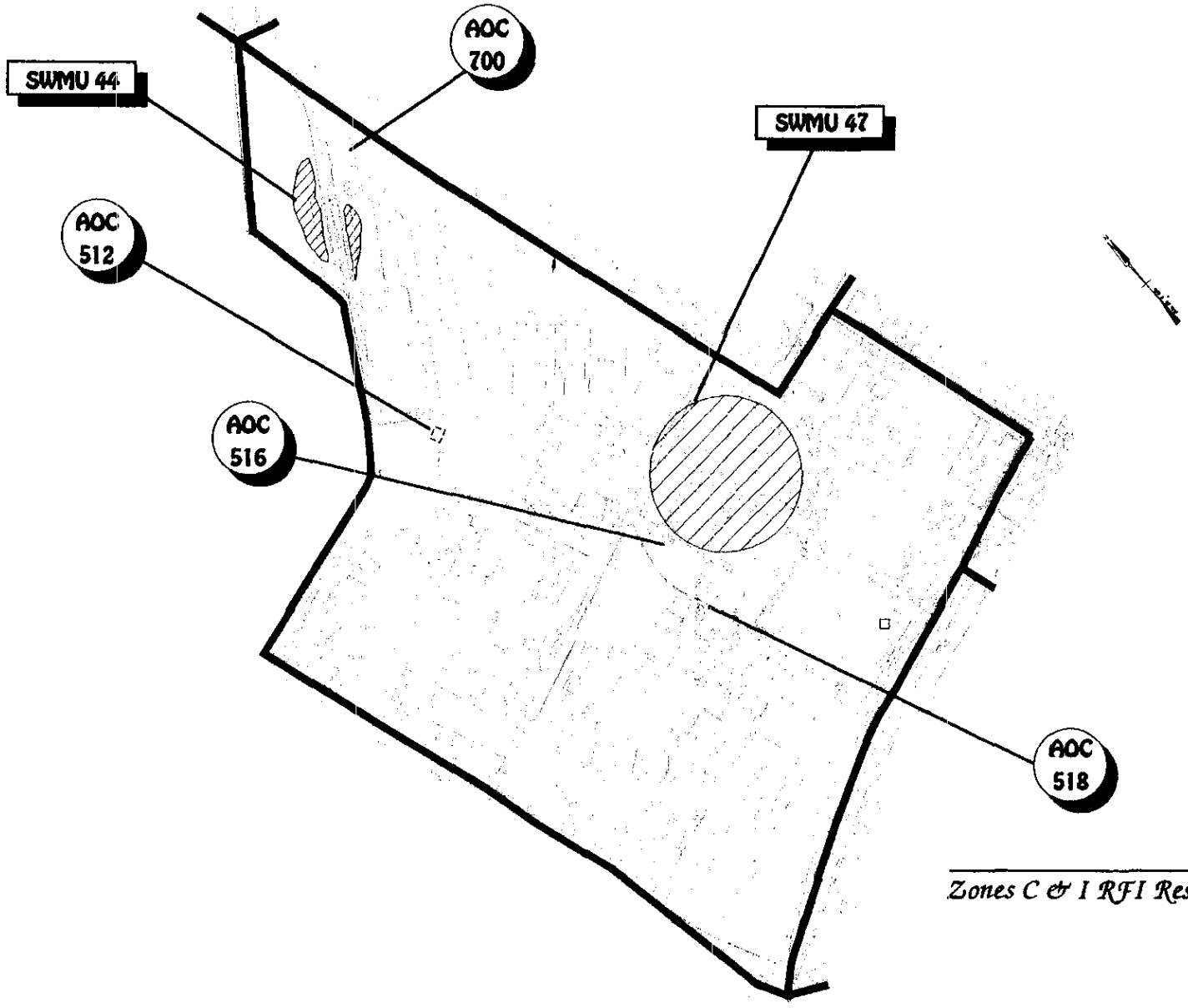
Zone C Grouping 1 - AOC 508/511

Primary Contributors to Risk/Hazard

Soil:
- Benzo(a)pyrene Equivalents
- Chlordane
- DDT
- Dieldrin

Groundwater:
- None

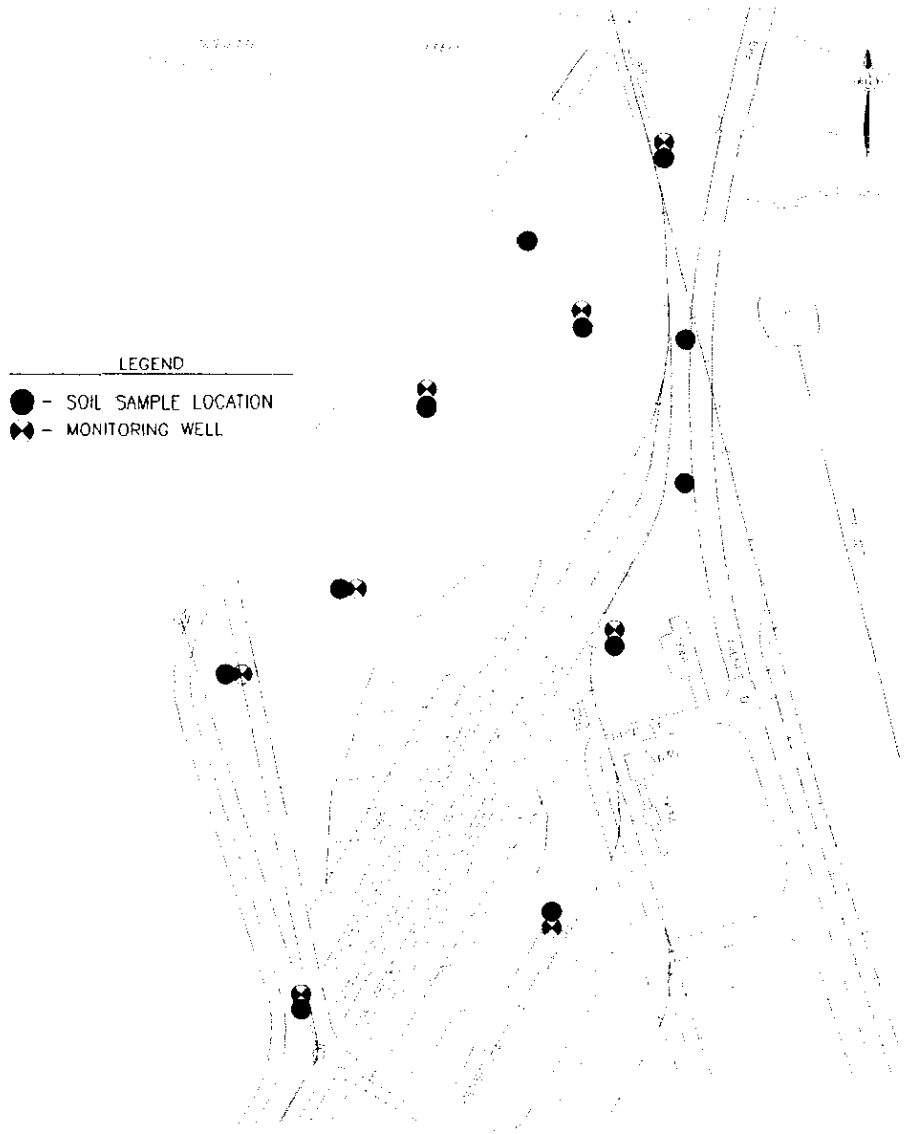
Zone C Grouping 2 - Other Designated Sites



Zone C Grouping 2 - Other Designated Sites

Site #	Site Description	Samples Collected
SWMU 44	Coal Storage Area	Soil (19) Groundwater (8)
SWMU 47/AOC 516	Wash Area/Battery Charging and Former Burning Dump	Soil (24) Groundwater (14)
AOC 512	Former Incinerator	Soil (9)
AOC 518	Coal Storage Bins	Soil (10)
AOC 700	Golf Course Maintenance Building	** Not presented in Draft RFI Report*

Zone C Grouping 2 - SWMU 44

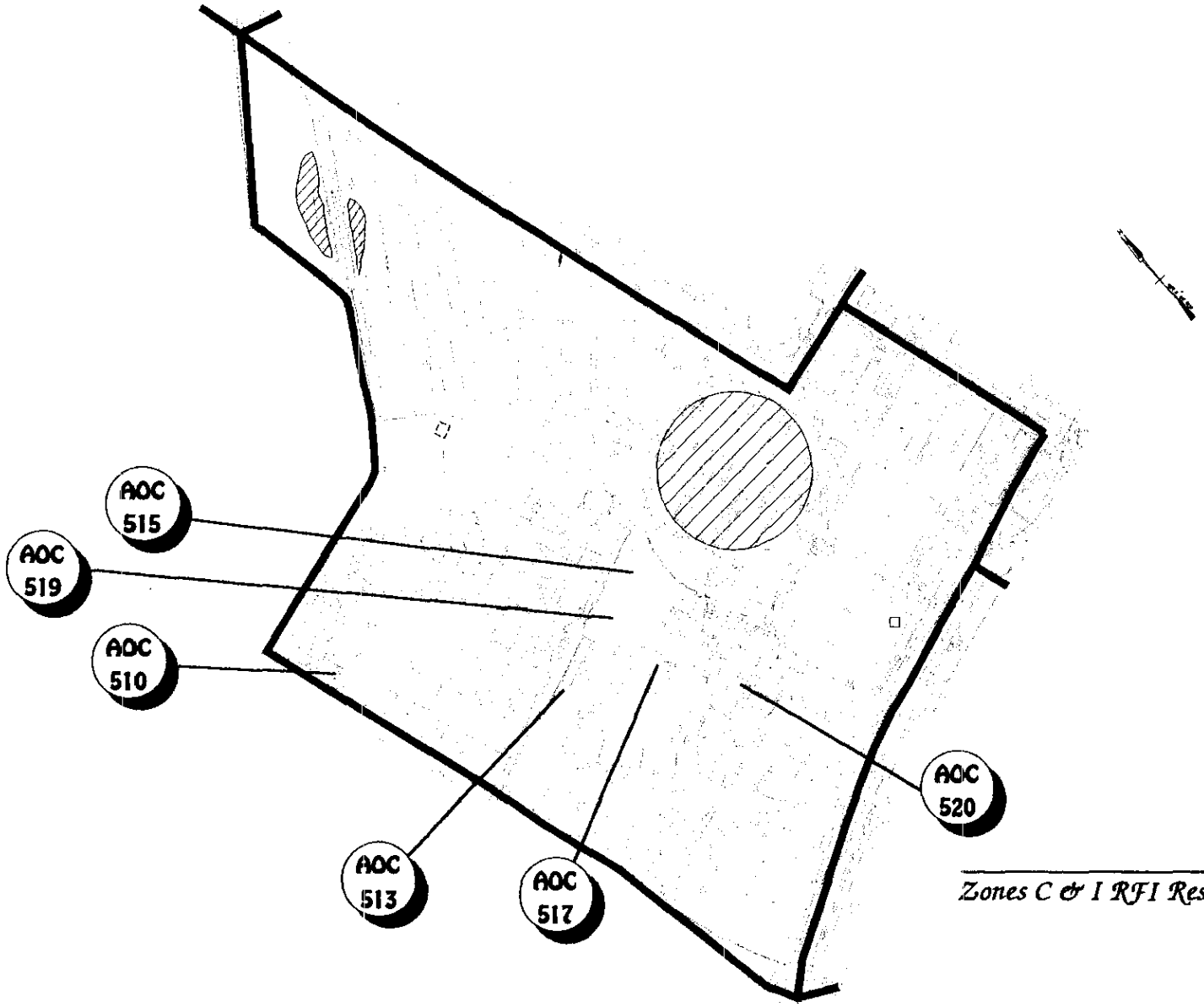


Primary Contributors to Risk/Hazard

Soil:
- Arsenic
- Benzo(a)pyrene equivalents

Groundwater:
- Aluminum
- Arsenic
- Beryllium
- Manganese
- 2,3,7,8-TCDD

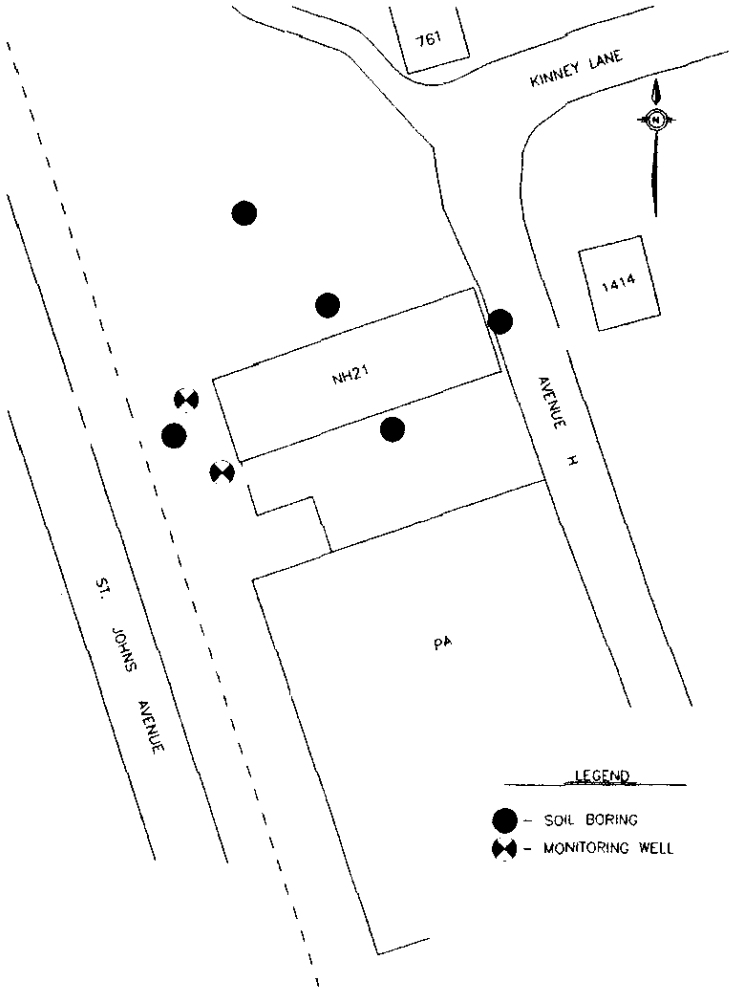
Zone C Grouping 3 - No Further Action



Zone C Grouping 3 - No Further Action

Site #	Site Description	Samples Collected
AOCs 515/519	Former Incinerator & Paint Shop/ Former Boiler House	Soil (14)
AOC 513	Former Morgue	Soil (6)
AOC 517	Former Indoor Firing Range	Soil (5)
AOC 520	Former Garbage House	Soil (8)
AOC 510	Geotechnical Laboratory	Soil (7) Groundwater (2)

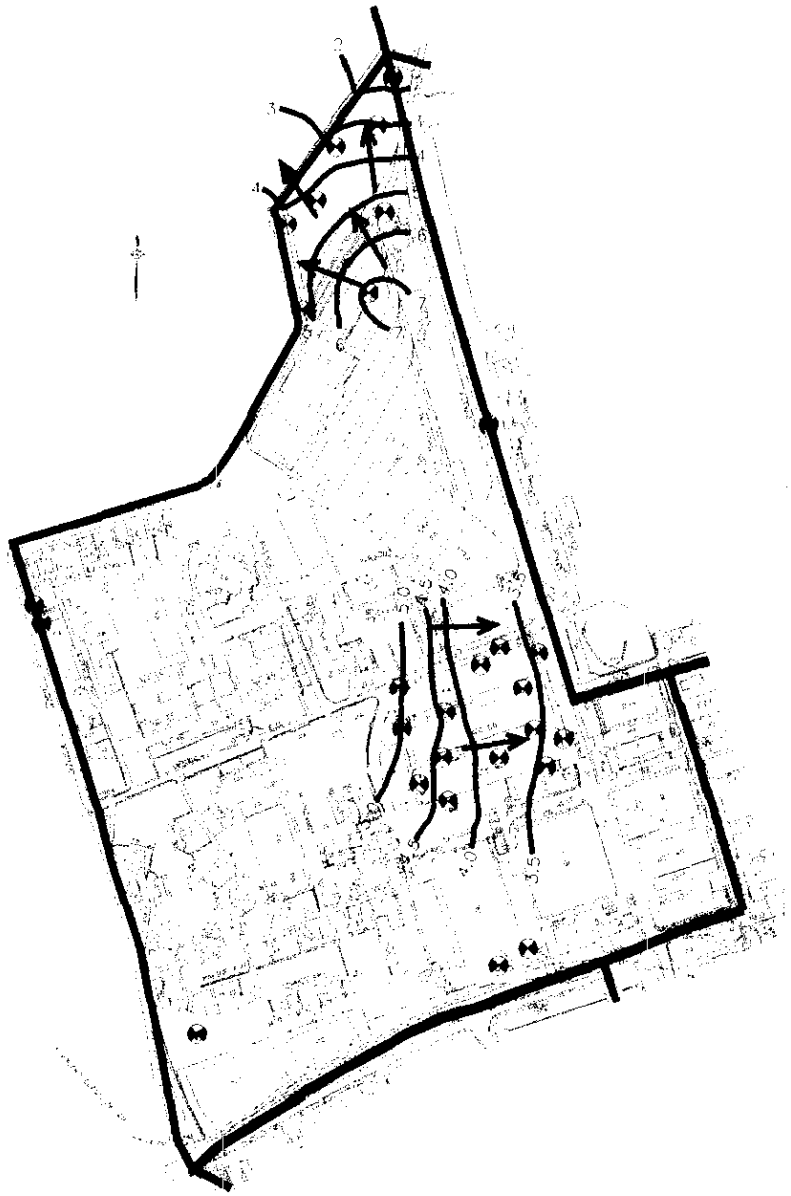
Zone C Grouping 3 - AOC 510



Primary Contributors to Risk/Hazard

Soil:
None
Groundwater:
None

Zone C - Groundwater Monitoring Network



LEGEND

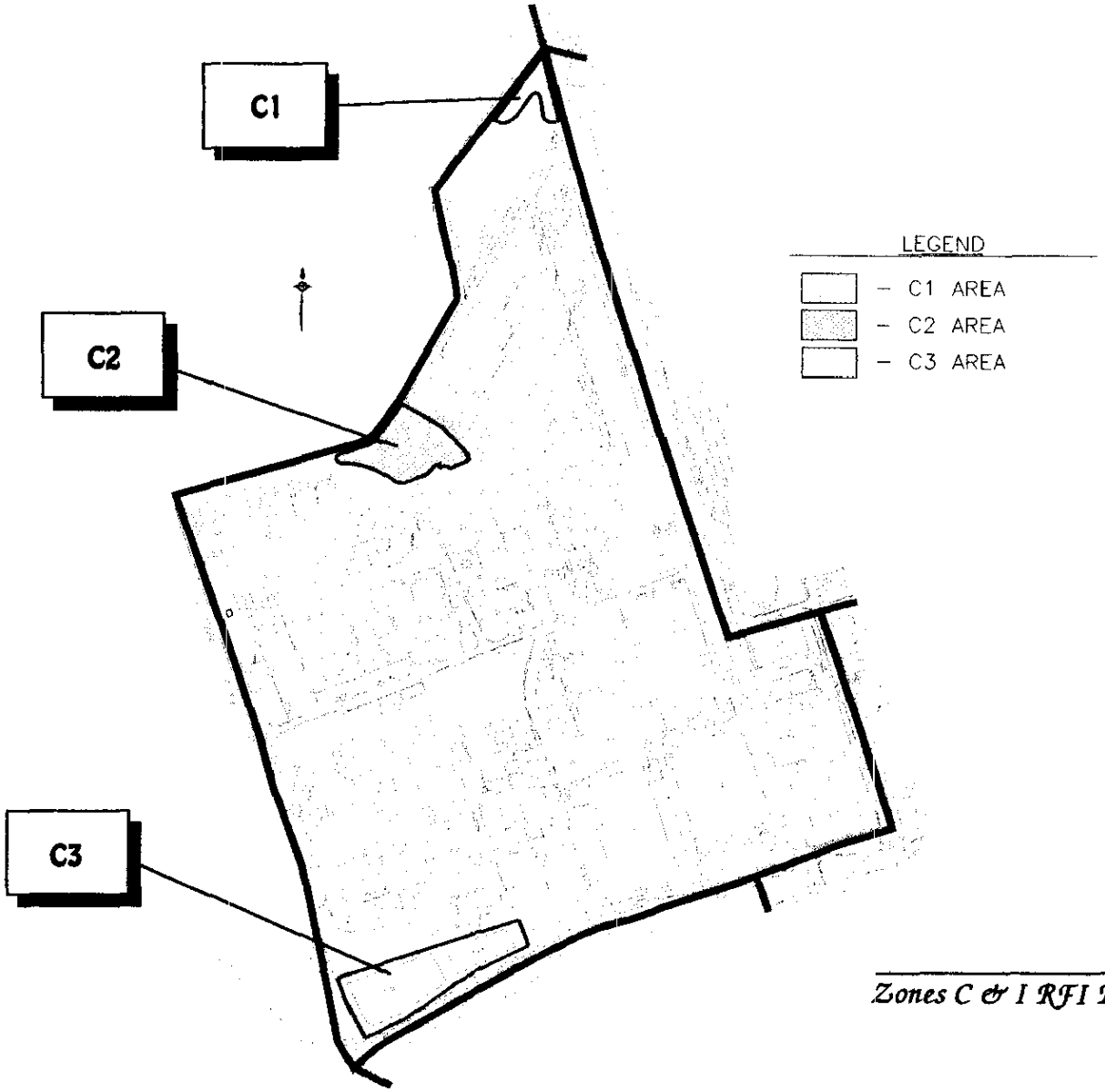
- MONITORING WELL
- 4.5 CONTOUR
- GROUNDWATER FLOW

Contour Interval is 0.5 feet

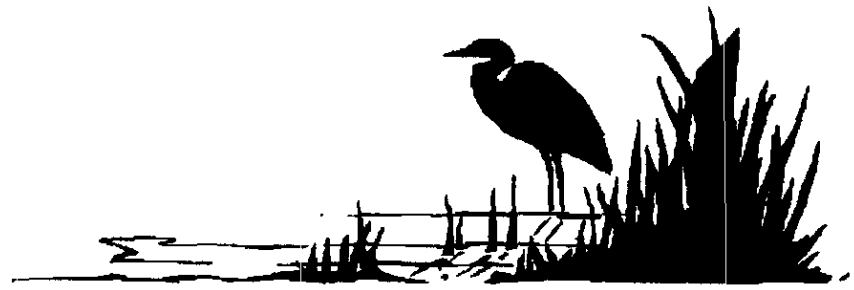
Shallow Groundwater - COCs in Zone C

Area of Significant Impact	Site Description	COCs Driving Risk
SWMU 44	Coal Storage Yard	Aluminum Arsenic Beryllium Manganese 2,3,7,8-TCDD
AOC 516/SWMU 47	Wash Area/Battery Charging Former Burning Dump	Antimony Arsenic Lead Manganese 3,3-Dimethyl benzidine
AOC 523/SWMU 49	Former Gas Station	Aluminum Arsenic Manganese

Zone C - Ecological Areas

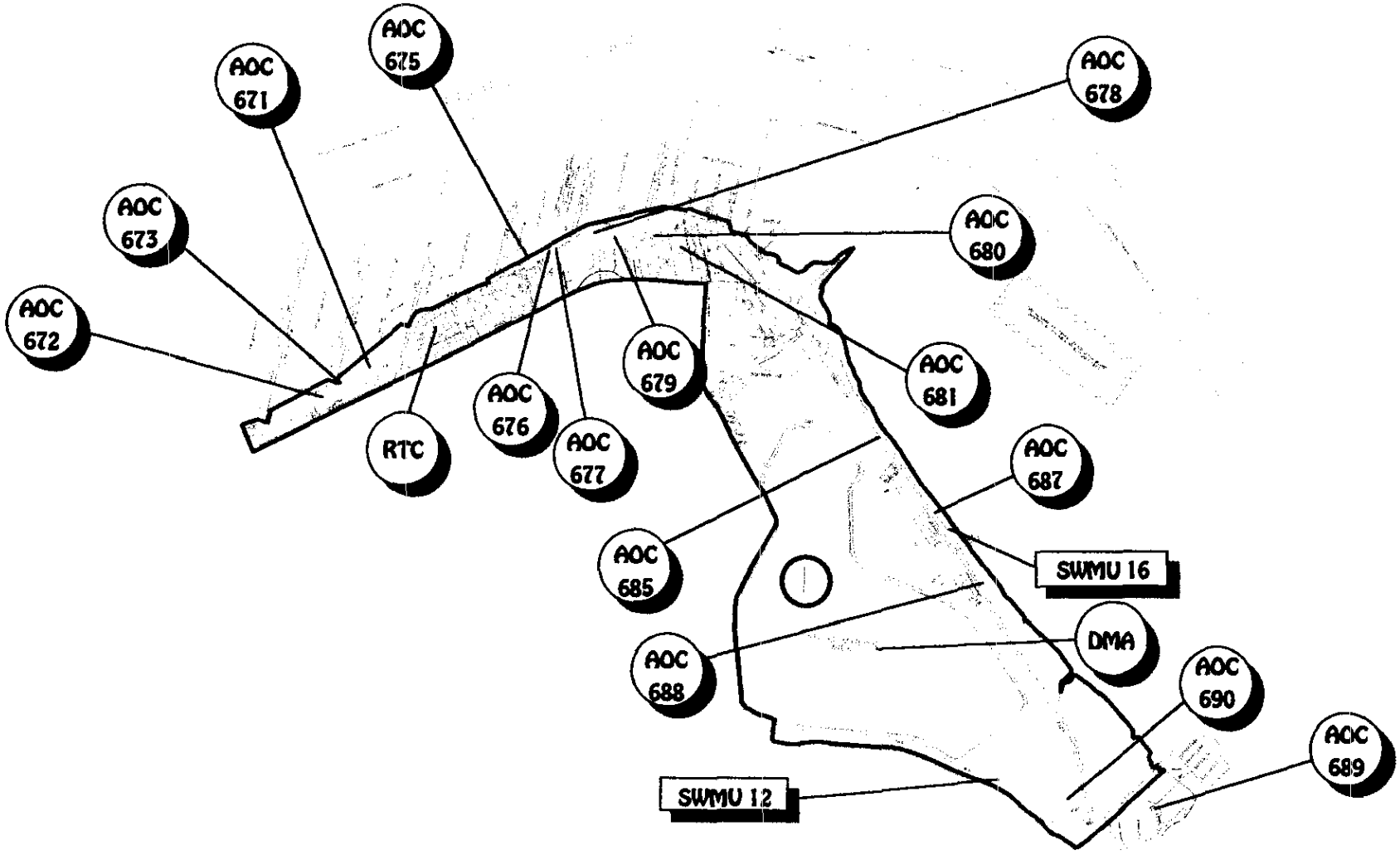


Ecological Impacts - Zone C

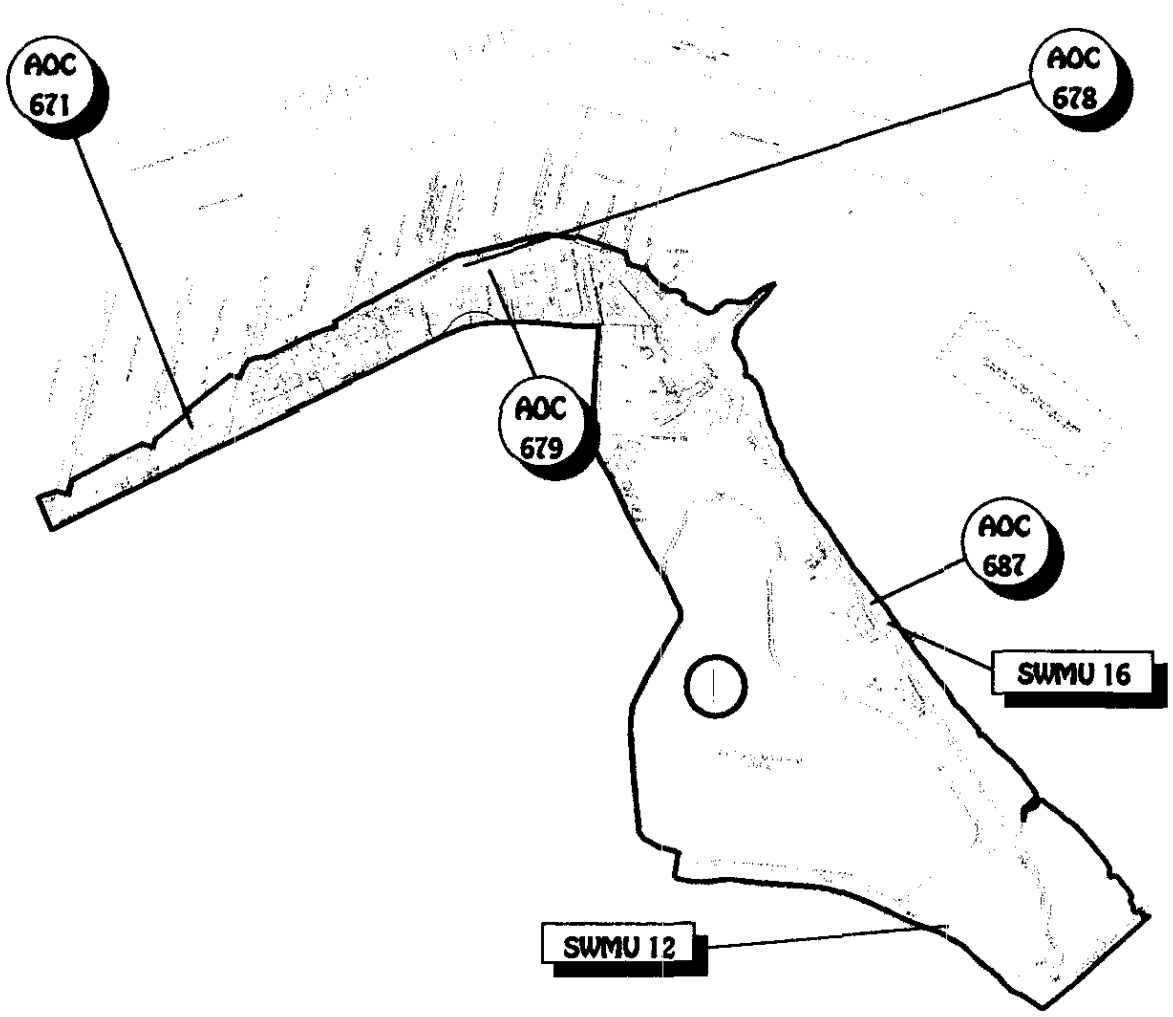


Sub Zone	Description	Associated Sites	COCs	Receptors Potentially at Risk
C-1	Dense shrubs and tall grasses	SWMU 44	Metals (arsenic, copper) in soil	Noisette Creek (Zone J), small mammals, soil biota, and vegetation (seedlings).
C-2	Grass field with few trees	AOCs 512 & 509	Metals (arsenic, copper) in soil.	Small mammals, soil biota, and vegetation (seedlings).
C-3	Detention ponds with aquatic vegetation	AOC 504	Arsenic in nearby soil.	Small mammals and birds.

Zone I AOCs/SWMUs



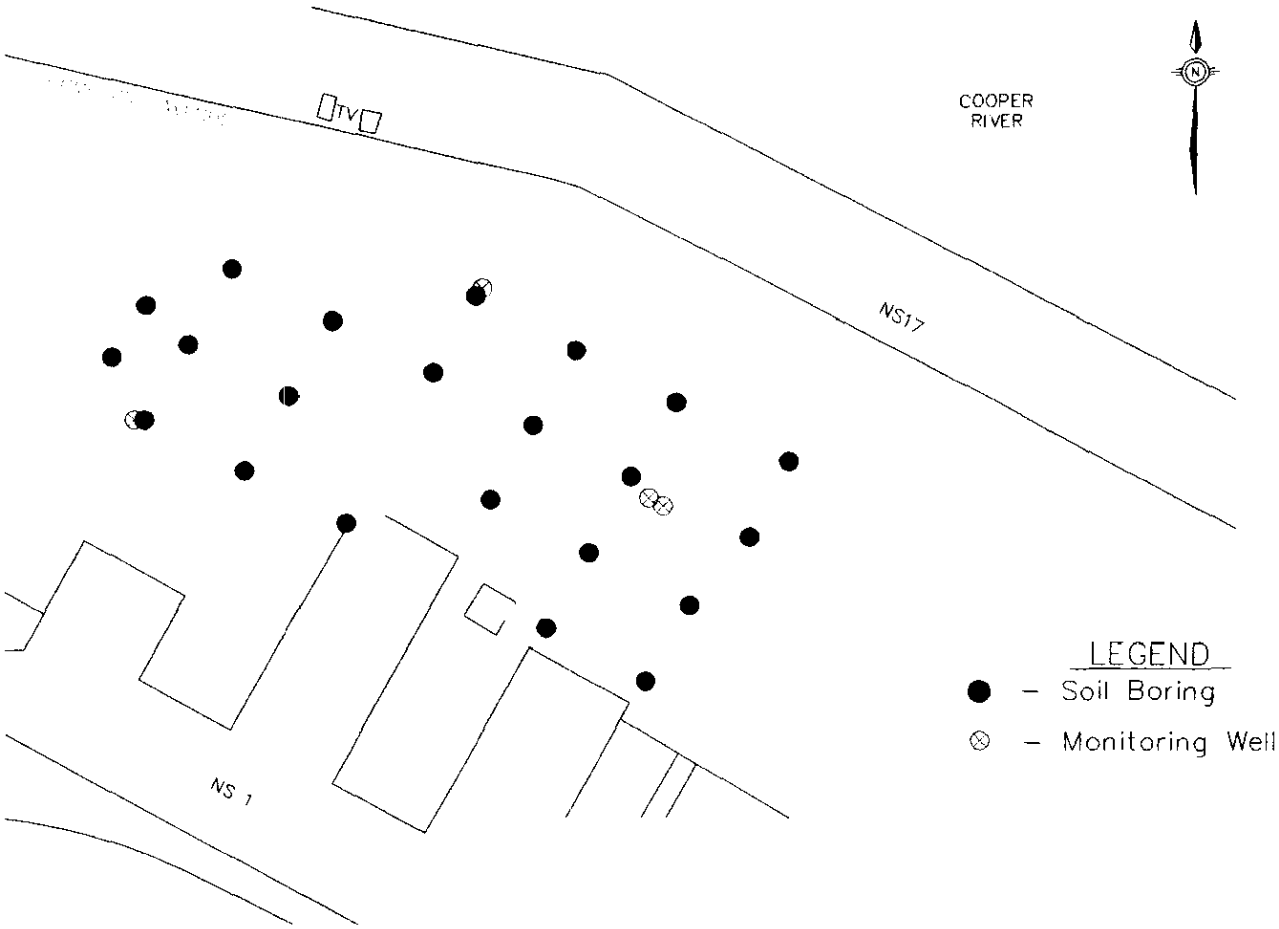
Zone I Grouping 1 - Petroleum Sites



Zone I Grouping 1 - Petroleum Sites

Site #	Site Description	Samples Collected
AOC 671	Underground Storage Tanks for Aviation Gasoline	Soil (10) Groundwater (4)
AOCs 678 & 679	Former Firefighter School/Former Firefighter Wash Rack	Soil (23) Groundwater (2)
SWMU 12	Former Firefighter Training Site	Soil (15) Groundwater (3)
SWMU 16/AOC 687	Unauthorized Open Storage Site/Ammunition Storage Bunker	Soil/Sediment (6) Groundwater (4)

Zone I Grouping 1 - AOC 678/679

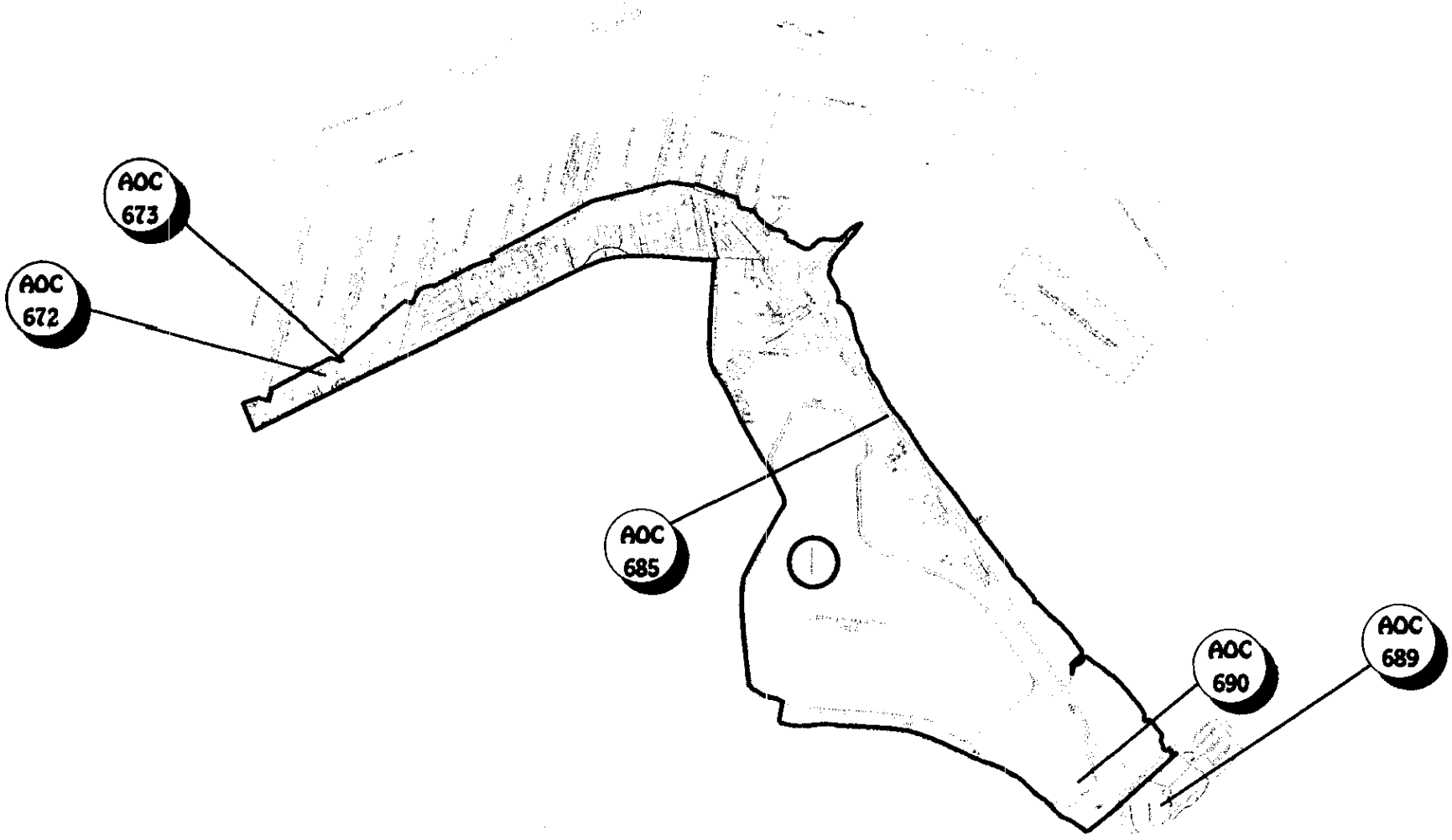


Primary Contributors to Risk/Hazard

Soil:
- Isodrin

Groundwater:
- 1,4 - Dichlorobenzene
- Aroclor - 1260

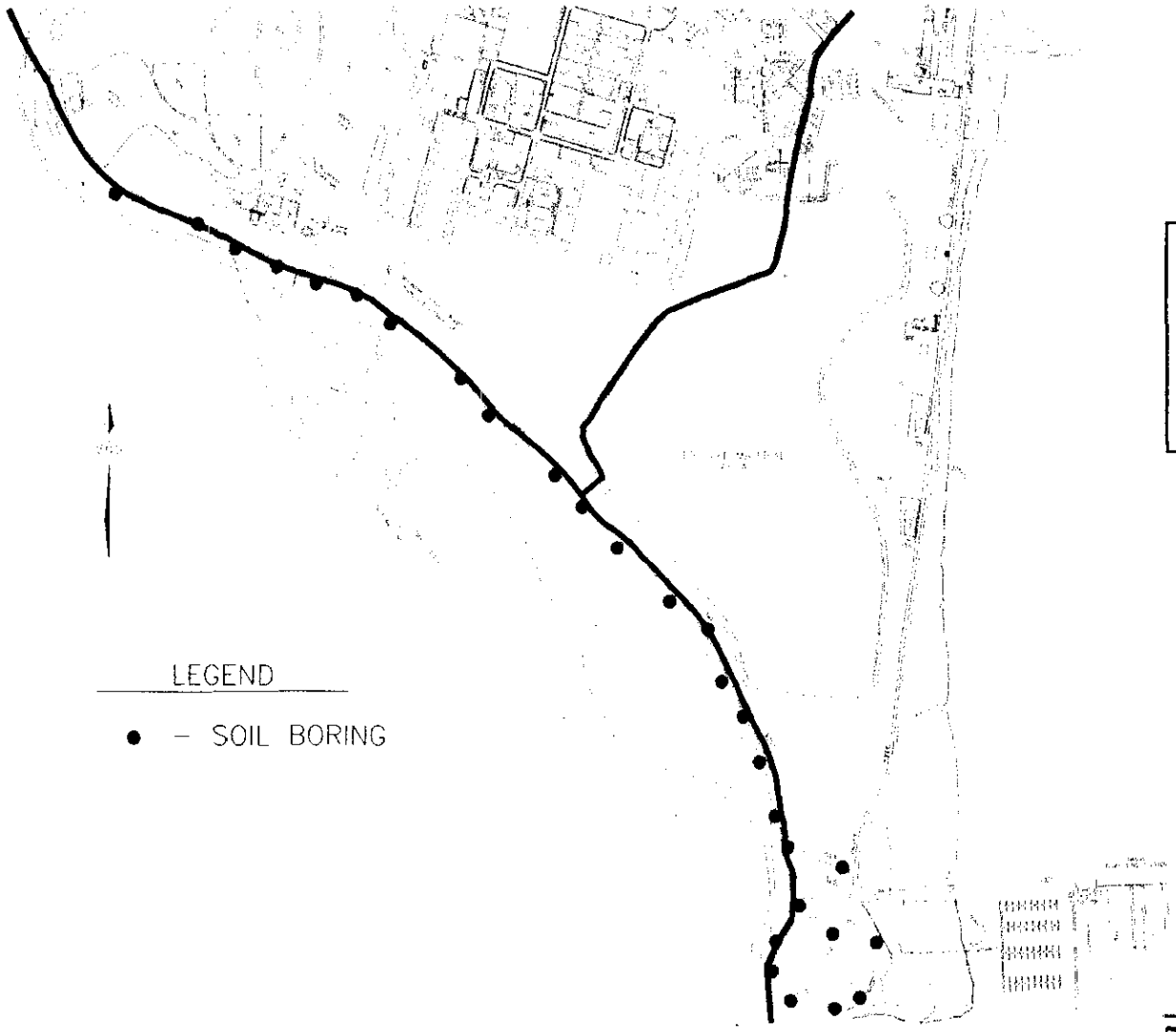
Zone I Grouping 2 - Other Designated Sites



Zone I Grouping 2 - Other Designated Sites

Site #	Site Description	Samples Collected
AOCs 672 & 673	PCB Transformer Substation	Soil (10)
AOC 685	Former Smoke Drum Area	Soil (15)
AOCs 689 & 690	Unknown Material Disposal Site Dredged Materials Area	Soil (33)

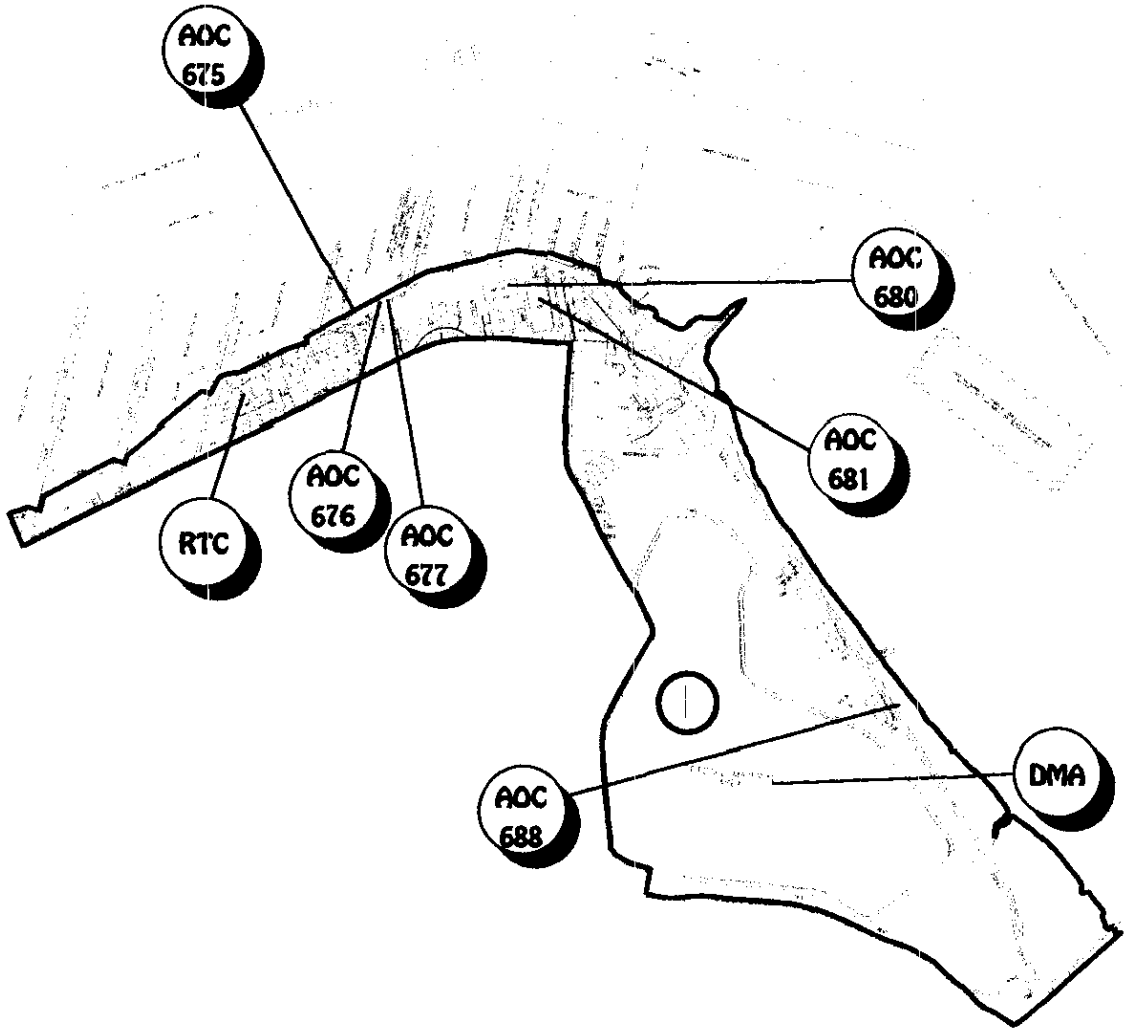
Zone I Grouping 2 - AOC 689/690



Primary Contributors to Risk/Hazard

Soil:
Benzo(a)pyrene Equivalents
Groundwater:
None

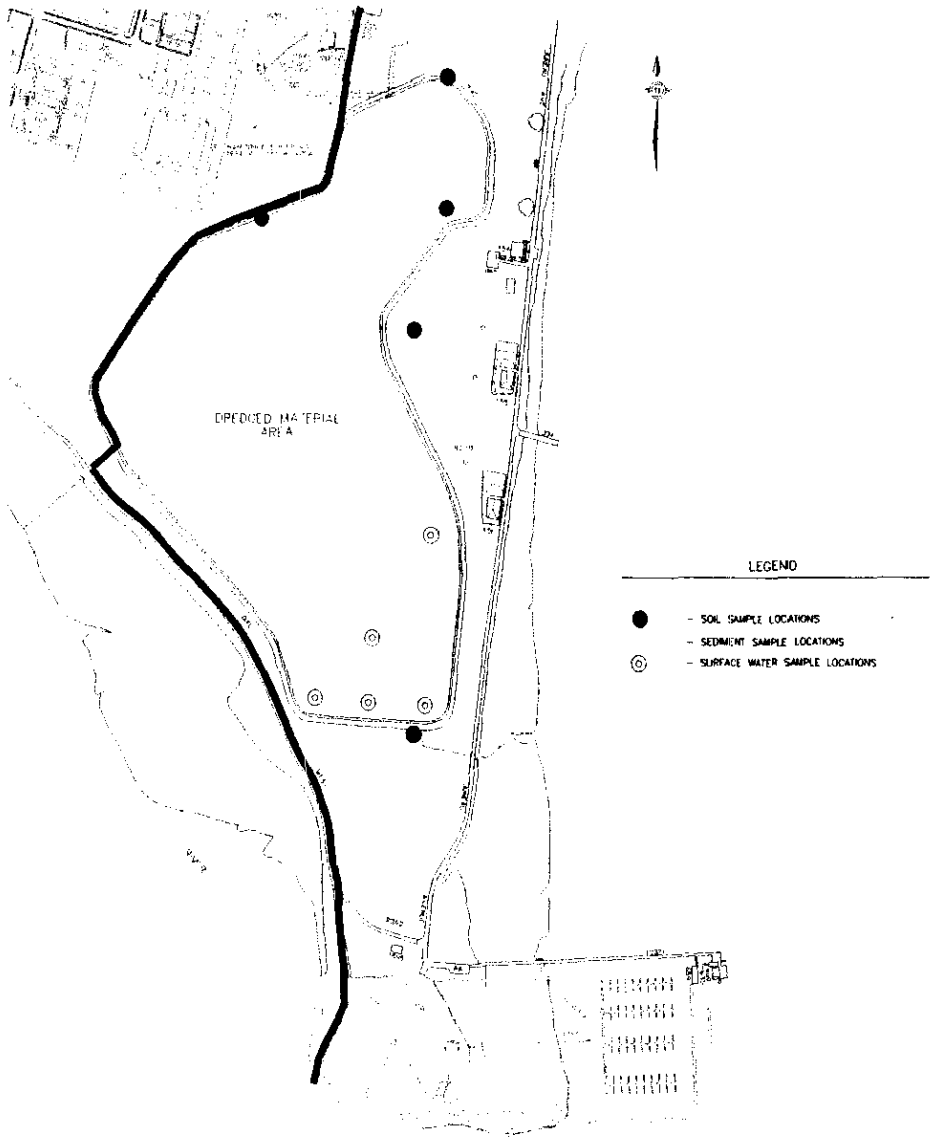
Zone I Grouping 3 - No Further Action



Zone I Grouping 3 - No Further Action

Site #	Site Description	Samples Collected
DMA	Dredged Materials Area	Soil/Sediment (14) Surface Water (5)
RTC	Reserve Training Center	Soil (10)
AOC 680	Former Grinding Room/Brake Repair Area	Asbestos Samples (9) Lead Wipes (7)
AOC 681	Blast Booth	Soil (5)
AOC 688	Ammunition Storage Bunker	Soil/Sediment (2)
AOCs 675, 676, 677	Diesel Fuel UST Incinerator Petroleum Spill Site	Soil/Sediment (15) Groundwater (4)

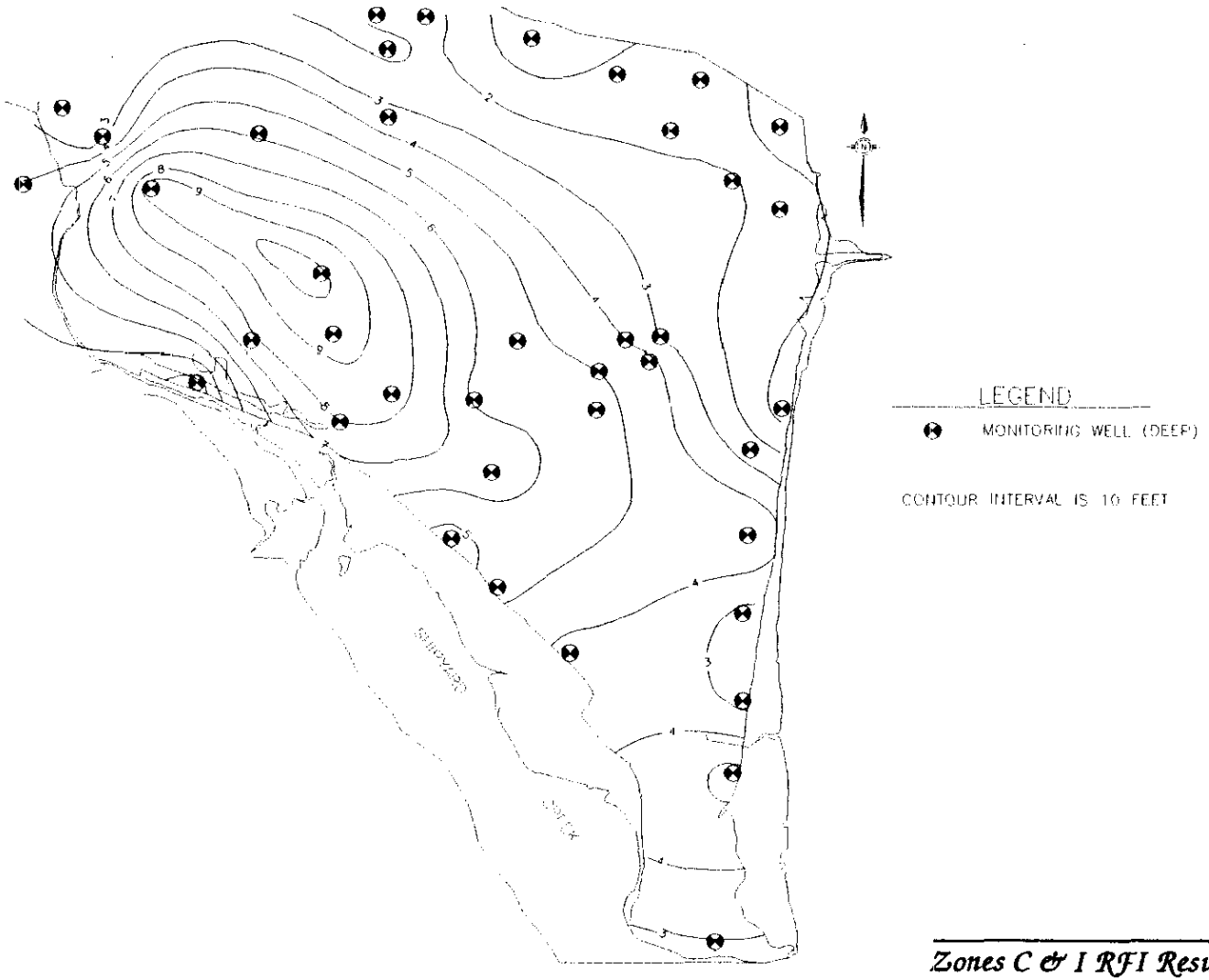
Zone I Grouping 3 - DMA



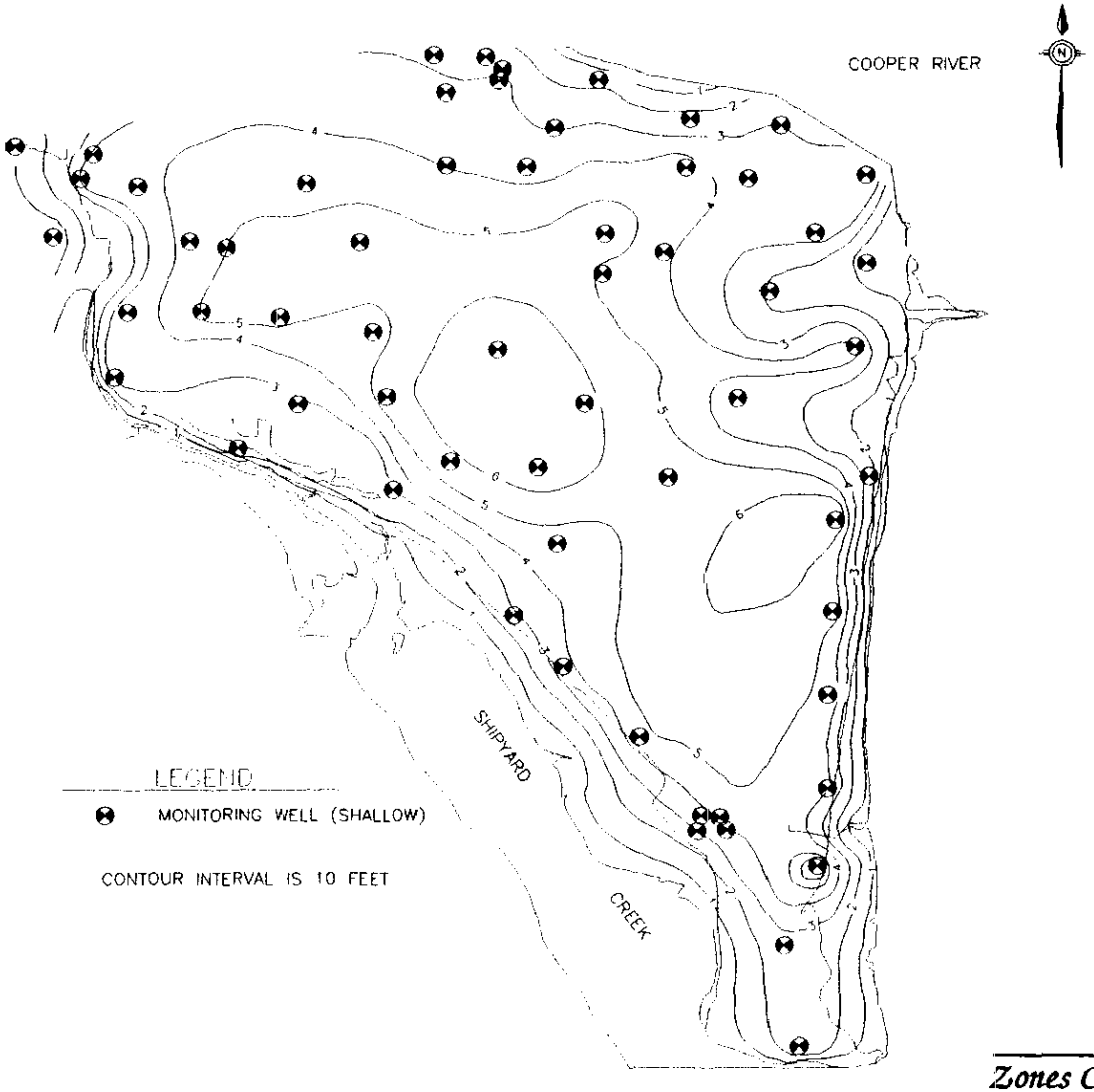
Primary Contributors to Risk/Hazard

Soil:
None
Surface water:
None

Zone I - Groundwater Monitoring Network
Lower Zone/Shallow Aquifer



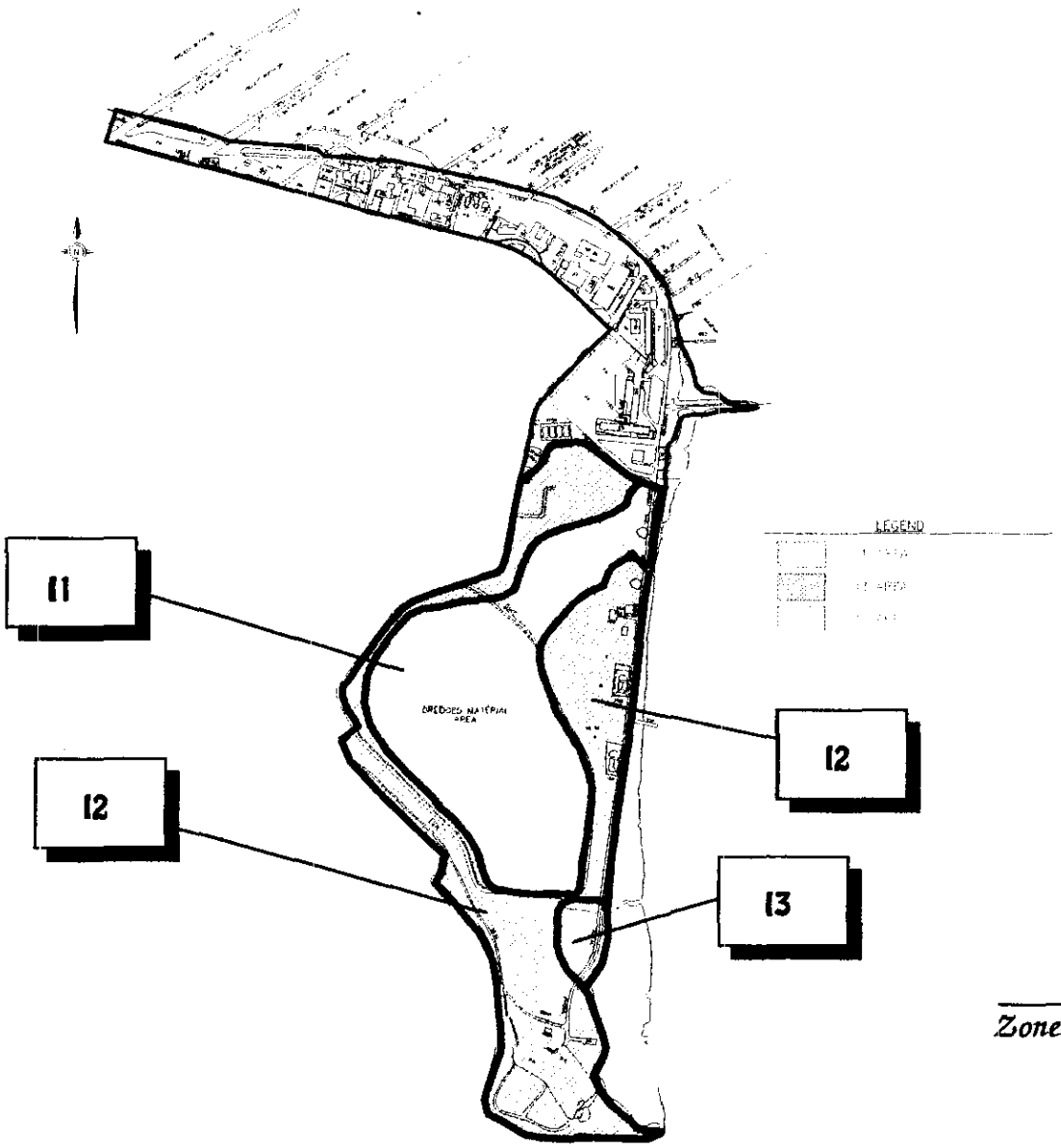
Zone I - Groundwater Monitoring Network
Upper Zone/Shallow Aquifer



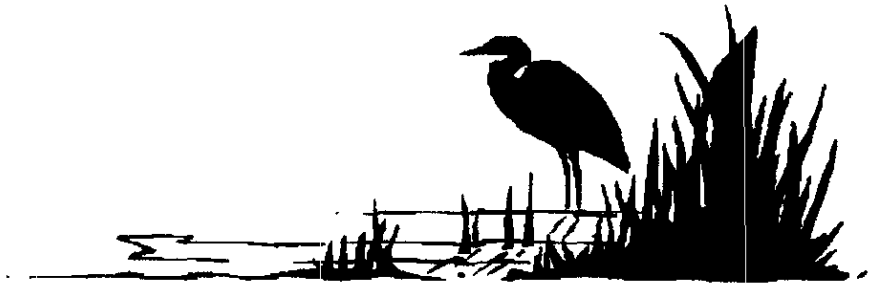
Shallow Groundwater - COCs in Zone I

Area of Significant Impact	Site Description	COCs Driving Risk
AOCs 678 & 679	Former Firefighter School Former Firefighter Wash Rack	1, 4 - Dichlorobenzene Aroclor - 1260
AOC 687/SWMU 16	Ammunition Storage Bunker Unauthorized Storage of Paint and Other Materials	Arsenic Methylene chloride
SWMU 12	Former Firefighter Training Area	2,3,7,8 - TCDD equivalents Arsenic Cadmium Manganese Nickel

Zone I - Ecological Areas



Ecological Impacts - Zone I



Sub Zone	Description	Associated Sites	COCs	Receptors Potentially at Risk
I-1	Dredged Material Area with shrubs and grasses	None	Surface Water Metals and pesticides Sediment Metals and semivolatiles Soil Zinc	Aquatic wildlife in the Cooper River and Shipyard Creek. Herbaceous vegetation (seedlings)
I-2	Forest with some grass fields	AOCs: 685, 687, 688, 690 SWMU: 12	Metals (arsenic, copper, lead, zinc) and pesticides in soil.	Small mammals Soil biota Vegetation (seedlings)
I-3	Wetland	None	Metals and pesticides in sediment.	Aquatic wildlife in the Cooper River.

Review of Risk

There is no such thing as ZERO risk.

Risk Assessment - Procedure to evaluate risk.

STEP 1 . . . . . Hazard Identification

Collect samples. Analyze for type and concentration of contaminants.

STEP 2 . . . . . Exposure Assessment

Will people come into contact with the hazard? And if so, who? how? how often? and why?

STEP 3 . . . . . Toxicity Assessment

What is harmful about the chemical? Is it carcinogenic or non-carcinogenic?

STEP 4 . . . . . Risk Characterization

Determine if potential exposures are great enough to cause human health problems.

Risk Management - How to manage risk.

Question 1 . . . . Should cleanup be undertaken?

Question 2 . . . . What should cleanup levels be?

Question 3 . . . . What cleanup methods should, or can be used?

Review of Risk (cont'd)

Carcinogenic Risk

- Potential to cause cancer.
- Risk estimated as probability of getting cancer from exposure.
  - ✓ 1 in 10,000 risk = 10^{-4}
  - ✓ 1 in a million (1,000,000) = 10^{-6}

Non-carcinogenic Risk (Toxicity)

- Health effects other than cancer.
- Risk is compared to a calculated value called a hazard index or hazard quotient.
  - ✓ $\frac{\text{Intake}}{\text{Reference Dose}}$ = Hazard Quotient (HQ)
  - ✓ Sum of Hazard Quotients = Hazard Index (HI)

Review of Risk (cont'd)

Carcinogenic Risk

- ✓ $< 10^{-6}$ EPA/DHEC generally doesn't require action.
- ✓ $> 10^{-4}$ EPA/DHEC generally requires action.
- ✓ Risk Management: EPA/DHEC must consider many factors that may influence risk such as:
  - Who will be affected and how?
  - Future site use.
  - Existing features (e.g., buildings).
  - Probability of exposure.

Non-carcinogenic Risk (Toxicity)

- ✓ A hazard index < 1 indicates that no toxic effect is likely.
- ✓ A hazard index >1 indicates that a toxic effect is likely, typically in sensitive individuals.
- ✓ Example of a Conservative Assumption:

Chemical 1:	HQ = 0.7	- lungs
Chemical 2:	HQ = 0.2	- kidney
Chemical 3:	HQ = 0.2	- mucus membrane
	HI = 1.1	

(Although no organ specific HQ is > 1, assume an overall toxic effect is possible.)

Summary of Surface Soil COCs
Naval Base Charleston Zone C
Charleston, South Carolina

Chemical	SWMU 44	AOC 516 SWMU 47	AOC 508 511	AOC 510	AOC 512	AOC 518	AOC 515 519
Semivolatile Organic Compounds							
Benzo(a)pyrene Equivalents	X	X	X	X	X		
Metals							
Aluminum	X						
Arsenic	X	X					
Beryllium	X	X			X		
Manganese	X						
Thallium	X						
Chlorinated Pesticides							
Dieldrin			X				
DDT			X				
Chlordane			X			X	
General Petroleum Products							
Total Petroleum HC		Y	Y				Y

NOTES:
X indicates the chemical was identified as a COC in surface soil.
Y indicates petroleum hydrocarbons were detected in soil at concentrations exceeding 100 mg/kg.

Summary of Groundwater COCs
Naval Base Charleston Zone C
Charleston, South Carolina

Chemical	SWMU 44	SWMU 47 AOC 516	SWMU 49 AOC 523
Semivolatile Organic Compounds			
BEHP	X		
Acetophenone	X		
3,3-Dimethylbenzidine		X	
Dioxins/Furans			
2,3,7,8-TCDD equivalents	X		
Metals			
Aluminum	X		X
Antimony	X	X	
Arsenic	X	X	X
Beryllium	X		
Lead		X	
Manganese	X	X	X
Nickel	X		
General Petroleum Products			
Total Petroleum HC		X	X

NOTES:
X indicates the chemical was identified as a COC in groundwater

Summary of Surface Soil COCs
Naval Base Charleston Zone I
Charleston, South Carolina

Chemical	AOC 671	AOC 672 673	AOC 678 679	AOC 685	AOC 687 SWMU 16	AOC 689 690
Semivolatile Organic Compounds						
Benzo(a)pyrene Equivalents	X		X	X	X	X
N-Nitroso-di-n-propylamine	X					
Chlorinated Pesticides						
Isodrin			X			
Metals						
Arsenic		X		X		
Beryllium				X		

NOTES:
X indicates the chemical was identified as a COC in surface soil.

Summary of Groundwater COCs
Naval Base Charleston Zone I
Charleston, South Carolina

Chemical	AOC 678 679	AOC 687 SWMU 16	SWMU 12
Volatile Organic Compounds			
1,4-Dichlorobenzene	X		
Methylene chloride		X	
Chlorinated Pesticides/PCBs			
Aroclor-1260	X		
Dioxins/Furans			
2,3,7,8-TCDD equivalents			X
Metals			
Arsenic		X	X
Cadmium			X
Manganese			X
Nickel			X

NOTES:
X indicates the chemical was identified as a COC in groundwater

Summary of Risk and Hazard Projections
Naval Base Charleston Zone C
Charleston, South Carolina

Site	Matrix	ILCR			Hazard Index		TPH	Primary Contributors to Risk/Hazard
		< 10-6	10-6/10-4	>10-4	< 1	> 1		
SWMU 44	Soil		W	R	W	R		Arsenic, Benzo(a)pyrene equivalents
	Groundwater			R, W		R, W		Aluminum, Arsenic, Manganese, Beryllium, 2378-TCDD
SWMU 47/AOC 516	Soil		R, W		W	R	Yes	Aluminum, Arsenic, Lead, Thallium, Beryllium, Benzo(a)pyrene equivalents
	Groundwater			R, W		R, W	Yes	Antimony, Arsenic, Lead, Manganese, 3,3-Dimethylbenzidine
AOC 508 & 511	Soil		R, W		R, W		Yes	Benzo(a)pyrene equivalents, Chlordane, DDT, Dieldrin
AOC 515 & 519	Soil	R, W			R, W		Yes	None
AOC 523/SWMU 49	Soil	R, W			R, W			None
	Groundwater			R, W		R, W	Yes	Aluminum, Arsenic, Manganese
AOC 510	Soil	R, W			R, W			None
	Groundwater	R, W			R, W			None
AOC 512	Soil	W	R		R, W			Beryllium, Benzo(a)pyrene equivalents
AOC 513	Soil	R, W			R, W			None
AOC 517	Soil	R, W			R, W			None
AOC 518	Soil	W	R		R, W			Chlordane
AOC 520	Soil	R, W			R, W			None

NOTES:

R indicates the resident projections fell within the corresponding risk/hazard range.

W indicates the site worker projections fell within the corresponding risk/hazard range.

AOC 522 & 700 were not investigated during initial field efforts; results and findings are to be presented in Draft Final RFI Report

Yes indicates petroleum hydrocarbons were detected in soil at concentrations exceeding 100 mg/kg.

Summary of Risk and Hazard Projections
Naval Base Charleston Zone I
Charleston, South Carolina

Site	Matrix	ILCR			Hazard Index		Primary Contributors to Risk/Hazard
		< 10-6	10-6/10-4	>10-4	< 1	> 1	
AOC 671	Soil	W	R		R, W		Benzo(a)pyrene equivalents, N-Nitroso-di-n-propylamine
	Groundwater	R, W			R, W		None
AOC 672 & 673	Soil		R, W		W	R	Arsenic
AOC 675, 676 & 677	Soil	R, W			R, W		None
	Groundwater	R, W			R, W		None
AOC 678 & 679	Soil	W	R		R, W		Isodrin
	Groundwater		W	R	R, W		1,4-Dichlorobenzene, Aroclor-1260
AOC 680	Wipe	R, W			R, W		None
AOC 681	Soil	R, W			R, W		None
AOC 685	Soil		R, W		R, W		Benzo(a)pyrene equivalents, Arsenic, Beryllium
AOC 687/SWMU 16	Soil	R, W			R, W		None
	Groundwater			R, W		R, W	Arsenic, Methylene chloride
AOC 688	Soil (sediment)	R, W			R, W		None
AOC 689 & 690	Soil	W	R		R, W		Benzo(a)pyrene equivalents
SWMU 12	Soil	R, W			R, W		None
	Groundwater			R, W		R, W	2,3,7,8-TCDD, Arsenic, Cadmium, Manganese, Nickel
RTC	Soil	R, W			R, W		None
DMA	Soil (sediment)	R, W			R, W		None

NOTES:
R indicates the resident projections fell within the corresponding risk/hazard range.
W indicates the site worker projections fell within the corresponding risk/hazard range.

Zone C Recommendations

Site #	Site Description	NFA	Further Action	
			TPH	BRA
SWMU 44	Coal Storage Area			✓
AOC 516/ SWMU 47	Wash Area/Battery Charging and Former Burning Dump		✓	✓
AOC 508/511	Former Incinerator and Former Oil Storage House		✓	
AOC 515/519	Former Incinerator/Paint Shop and Former Boiler House		✓	
AOC 523/ SWMU49	Former Gas Station		✓	✓
AOC 510	Geotechnical Laboratory	✓		✓
AOC 512	Former Incinerator			✓
AOC 513	Former Morgue	✓		
AOC 517	Former Indoor Firing Range	✓		
AOC 518	Coal Storage Bins			✓
AOC 520	Former Garbage House	✓		
AOC 522 AOC 700	Former Grease and Wash Bldg. Golf Course Maintenance Bldg.	* To be addressed in Draft-Final RFI Report.		

NFA = No Further Action
TPH = Further Action is required due to presence of *Total Petroleum Hydrocarbons.*
BRA = Further Action is required according to *Baseline Risk Assessment.*

Zone I Recommendations

Site #	Site Description	NFA	Further Action	
			TPH	BRA
SWMU 12	Former Fire Fighter Training Area			✓
SWMU 16	Unauthorized Storage Area			✓
AOC 671	Underground Storage Tank Site			✓
AOC 672	PCB Transformer Site			✓
AOC 673	Oil, Solvent, and Paint Storage Area			✓
AOC 675	Underground Storage Tank Site	✓		
AOC 676	Incinerator	✓		
AOC 677	Petroleum Spill Site	✓		
AOC 678	Former Fire Fighter School			✓
AOC 679	Former Fire Fighter Wash Rack			✓
AOC 680	Grinding Room/Brake Repair Area	✓		
AOC 681	Blast Booth	✓		
AOC 685	Former Smoke Drum Area			✓
AOC 687	Ammunition Storage Bunker			✓
AOC 688	Ammunition Storage Bunker	✓		
AOC 689	Unauthorized Disposal Area			✓
AOC 690	Dredged Materials Area			✓
DMA	Dredged Materials Area	✓		
RTC	Reserve Training Center	✓		

NFA = No Further Action
TPH = Further Action is required due to presence of *Total Petroleum Hydrocarbons.*
BRA = Further Action is required according to *Baseline Risk Assessment.*

Next Steps

- Regulatory Review
  - (Reports Submitted January 1996)
- Public Comment
- Permit Revision
  - → NFA
  - → CMS
  - → UST

ZONE C BACKGROUND

Zone C: Proposed background reference values for soil and groundwater 5-12-97

Background reference values for groundwater are based on four sampling rounds in 2 wells at each depth.

Inorganic chemical	Surface soil [mg/kg] (n = 45)	Subsurface soil [mg/kg] (n = 30)	Shallow GW [µg/L] (n = 8)	Deep GW [µg/L] (n = 8)
Aluminum	9,990 P	23,700 P	620 N	18.1 N
Antimony	0.55 N	0.92 N	ND	ND
Arsenic	14.2 P	14.1 N	5.6 N	ND
Barium	77.2 P	68.5 P	16.4 N	70.4 N
Beryllium	X	0.98 N	0.36 N	0.33 N
Cadmium	0.65 N	0.28 N	ND	ND
Chromium	26.4 P	39.8 N	2.1 N	ND
Cobalt	3.22 P	7.1 N	1.6 N	ND
Copper	34.7 P	42.2 P	1.5 N	ND
Lead	330 P	73.2 P	4.4 N	ND
Manganese	92.5 P	106 P	789 N	123 N
Mercury	0.24 N	0.30 N	ND	ND
Nickel	12.3 P	16.7 P	5.0 N	ND
Selenium	1.44 P	2.90 N	ND	ND
Silver	X	ND	1.5 N	ND
Thallium	ND	X	ND	ND
Tin	2.95 P	2.37 P	ND	ND
Vanadium	23.4 P	56.9 N	1.9 N	0.43 N
Zinc	159 P	243 P	14.6 N	ND
Cyanide	ND	ND	ND	ND

Note:
P = Parametric UTL
N = Nonparametric UTL
X = No UTL calculated (NDs >90%)
ND=Not detected

Outliers removed from background datasets: Zone C 5-12-97

Upper interval soil

Antimony	GDCSB00501	1.4 mg/kg
Arsenic	GDCSB00201	39.4 mg/kg
	GDCSB02801	22.4 mg/kg
	GDCSB03101	22.3 mg/kg
Barium	GDCSB04001	193 mg/kg
Lead	GDCSB01501	588 mg/kg
Manganese	GDCSB04101	101 mg/kg
Mercury	GDCSB03601	0.75 mg/kg
Nickel	GDCSB00601	27.7 mg/kg
Tin	GDCSB00101	8.1 mg/kg
Zinc	GDCSB02901	414 mg/kg
	GDCSB04001	779 mg/kg

Lower interval soil

Arsenic	GDCSB03002	31.6 mg/kg
Manganese	GDCSB00402	502 mg/kg
	GDCSB01002	520 mg/kg
Mercury	GDCSB01002	8.5 mg/kg

Shallow groundwater

Arsenic	GDCGW00204	15U μg/L (nondetect)
Cobalt	GDCGW00103	5.2U μg/L (nondetect)
	GDCGW00104	5.2U μg/L (nondetect)
	GDCGW00203	5.2U μg/L (nondetect)
	GDCGW00204	5.2U μg/L (nondetect)
Copper	GDCGW00104	4.75U μg/L (nondetect)
Lead	GDCGW00101	9.1U μg/L (nondetect)
Nickel	GDCGW00203	11.6U μg/L (nondetect)

Deep groundwater

Aluminum	GDCGW01D01	54.3U μg/L (nondetect)
Vanadium	GDCGW01D03	3.4U μg/L (nondetect)
	GDCGW02D03	3.4U μg/L (nondetect)

MEMO 5-12-97

FROM: EnSafe
TO: Project Team technical subcommittee

RE: Zone C: Critical background reference values

Upper interval soil

Aluminum was detected in all 45 upper interval soil samples, with a maximum value of 9720 mg/kg in sample GDCSB03101. LN-transforming the data produces a distribution (Figs. 2a, 2b) with extremely low CV and skewness, and an excellent box-and-whisker plot. Although the four highest values form a small cluster at the top end of the scale (Figs. 1a, 1b), they are not outliers in any conventional sense. For the LN-transformed version of the original dataset (n = 45),

UTL = exp[8.448 + (2.092)(0.364)] = **9,990 mg/kg**

The residential RBC for aluminum in soil is 7,800 mg/kg; the industrial RBC is 100,000 mg/kg (noncarcinogenic; THQ = 0.1). The relatively low aluminum levels in Zone C surface soil samples probably reflect the sandier composition of the soils here.

Arsenic was detected in 31 of 45 samples, with a distribution strongly skewed to the right (Fig. 1a). The highest concentrations reported were 39.4 mg/kg in sample GDCSB00201, 22.4 mg/kg in GDCSB02801, and 22.3 mg/kg in GDCSB03101; all other results were below 13 mg/kg. A background value based on the LN-transformed original dataset (Figs. 2a, 2b) (n = 45) would be UTL = exp[0.479 + (2.092)(1.328)] = 26.0 mg/kg. The three highest values may be considered outliers, especially since they do not correlate with particularly high concentrations of aluminum or iron, as do most high-As samples in soils of other zones. If they are removed from the dataset for the sake of conservatism and the data are LN-transformed (Figs. 3a, 3b),

UTL = exp[0.278 + (2.112)(1.125)] = **14.2 mg/kg**

The residential RBC for arsenic in soil is 0.43 mg/kg, while the industrial RBC is 3.8 mg/kg (carcinogenic).

Lead was detected in all 45 samples; the maximum value was 588 mg/kg in sample GDCSB01501. The data distribution is strongly skewed to the right (Fig. 1a), and remains slightly skewed in the same direction after LN-transformation (Figs. 2a, 2b). Although not a conventional outlier (Fig. 2b), the maximum value of 588 mg/kg was removed from the dataset because it is both higher than EPA's *de facto* residential and industrial soil RBC of 400 mg/kg and higher than background sample concentrations seen in other investigatory zones. For the reduced dataset (n = 44), the LN-transformation (Figs. 3a, 3b) provides the best approximation to normality.

UTL = exp[3.418 + (2.099)(1.134)] = **330 mg/kg**

Lower interval soil

Arsenic was detected in 13 of the 30 subsurface soil grid samples, with a maximum value of 31.6 mg/kg in sample GDCSB03002. This sample was removed from the dataset as an outlier (Figs. 1a, 1b). Because nondetects exceed 50% of the total, a nonparametric UTL is appropriate:

UTL = maximum remaining detection = **14.1 mg/kg**

The generic (draft) SSL for arsenic at the time the Zone C RFI report was submitted was 15 mg/kg (assuming DAF = 10); the current generic SSL (assuming DAF = 20) is 29.

Chromium was detected in all 30 samples. The four highest values were:

GDCSB01002 = 39.8 mg/kg
GDCSB02702 = 34.2 mg/kg
GDCSB03602 = 31.8 mg/kg
GDCSB00402 = 30.0 mg/kg

The next highest value below these four was 11.1 mg/kg. The four high-concentration samples reported greater than 10,000 mg/kg for both aluminum and iron — the only samples above 10,000 mg/kg in either aluminum *or* iron. Field descriptions confirm that three of the samples consisted of green or black clay (the fourth, sample GDCSB03602, was described as "green, orange, tan, and brown sandy soil," implying the presence of clay minerals as coloring agents). These same four samples provided three of the four highest arsenic detections (after removing the outlier); three of the four total beryllium detections; two of the three total cadmium detections; the four highest detections of cobalt, selenium, and vanadium; the two highest detections of copper and manganese; the highest detections of lead, mercury, and nickel; and the only thallium detection. Although the distribution is dramatically bimodal (Figs. 1a,1b,2a,2b), the four high chromium values should not be considered outliers. The background dataset represents two distinct soil types found in the zone: sand (the majority) and clay (represented by the four high values). Because of the nonnormal distribution, it is appropriate to use a nonparametric UTL consisting of the maximum value, **39.8 mg/kg**. The 1994 generic SSL for hexachrome was 19 mg/kg, while the current standard is 38 mg/kg; trivalent chromium is of no concern at any concentration. Hexachrome was detected in three of the 22 Zone C soil samples in which it was analyzed, at a maximum concentration of 1.19 mg/kg in an upper interval site sample. No grid samples at either depth reported hexachrome.

Selenium was detected in 12 of 30 samples, with a maximum concentration of 2.9 mg/kg in sample GDCSB03602. The four highest values were found in the four high-Al, high-Fe samples discussed above; like the high chromium values, they should not be considered outliers (Figs. 1a,1b,2a,2b). Because nondetects exceed 50% of the total, the UTL is nonparametric: the maximum value is **2.9 mg/kg**. The 1994 generic SSL for selenium was 3 mg/kg; the current SSL is 5 mg/kg.

Shallow groundwater

Background datasets for shallow and deep groundwater in Zone C consist of four sets of samples from each of two wells. Although EPA considers a sample size of eight or more to result in an adequate tolerance interval for detection monitoring (*Interim Final Guidance*, 1989, p. 5-20), the large tolerance factor k for a dataset of this size generally produces a high UTL when parametric

methods are used. The parametric approach is also inappropriate since each dataset consists of two groups of four samples, with each group autocorrelated because it comes from the same well. This lack of randomness frequently results in bimodal datasets with significant gaps between results from the two wells. For these reasons, nonparametric UTLs were chosen to represent background reference values for all of the metals with detections in groundwater. Using nonparametric UTLs with datasets this small, however, entails a significant loss of coverage (the percentage of the population included in the tolerance interval): the minimum coverage for a sample size of eight is 68.8% ($\alpha = .05$) rather than the desired 95%. Consequently, the UTLs for groundwater in Zone C are somewhat lower (and therefore more conservative) than they would otherwise be.

Arsenic was detected in four of eight samples, with a maximum value of 5.6 μg/L in sample GDCGW00202. The nondetect result from sample GDCGW00204 (15U μg/L) was removed from the dataset because the estimated value (using one-half the reported PQL) was greater than the largest detected value (Fig. 1a). The nonparametric UTL is the maximum value of **5.6 μg/L**. For the reduced dataset of n = 7, the corresponding parametric UTL for LN-transformed values would be 19.0 μg/L, but the bimodal distribution (Figs. 2a, 2b) does not allow use of this approach. The tap water RBC for arsenic is 0.045 μg/L (carcinogenic); the MCL is 50 μg/L.

Beryllium was detected in a single sample, GDCGW00202, at **0.36 μg/L** (Fig. 1a). Since a single detection represents more than 10% of the dataset, it constitutes a nonparametric UTL. The tap water RBC for beryllium is 0.016 μg/L (carcinogenic); the MCL is 4 μg/L.

Seven of eight samples reported **manganese** detections, with a maximum of 789 μg/L in sample GDCGW00202. The distribution is bimodal (Figs. 1a, 1b), grouped by well. The nonparametric UTL is the maximum value of **789 μg/L**. The tap water RBC for manganese is 84 μg/L (noncarcinogenic; THQ = 0.1); there is no MCL.

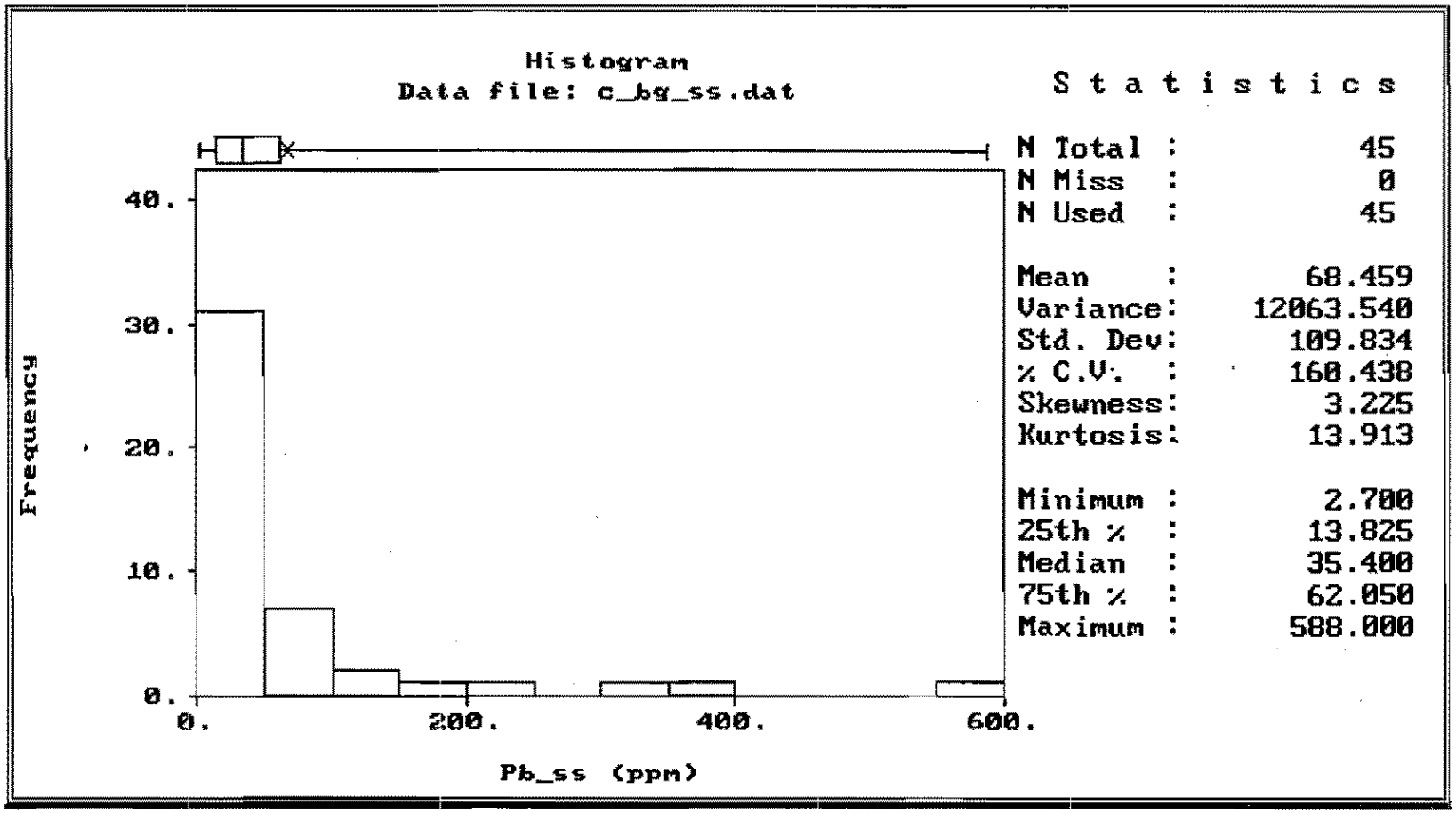
Deep groundwater

Beryllium was detected at 0.33 μg/L in one sample, GDCGW02D02 (Fig. 1). PQLs for the nondetects were slightly lower than the detected value, ranging from 0.2 to 0.3 μg/L. The single detected value of **0.33 μg/L** serves as the nonparametric UTL. Beryllium's tap water RBC is 0.016 μg/L (carcinogenic); its MCL is 4 μg/L.

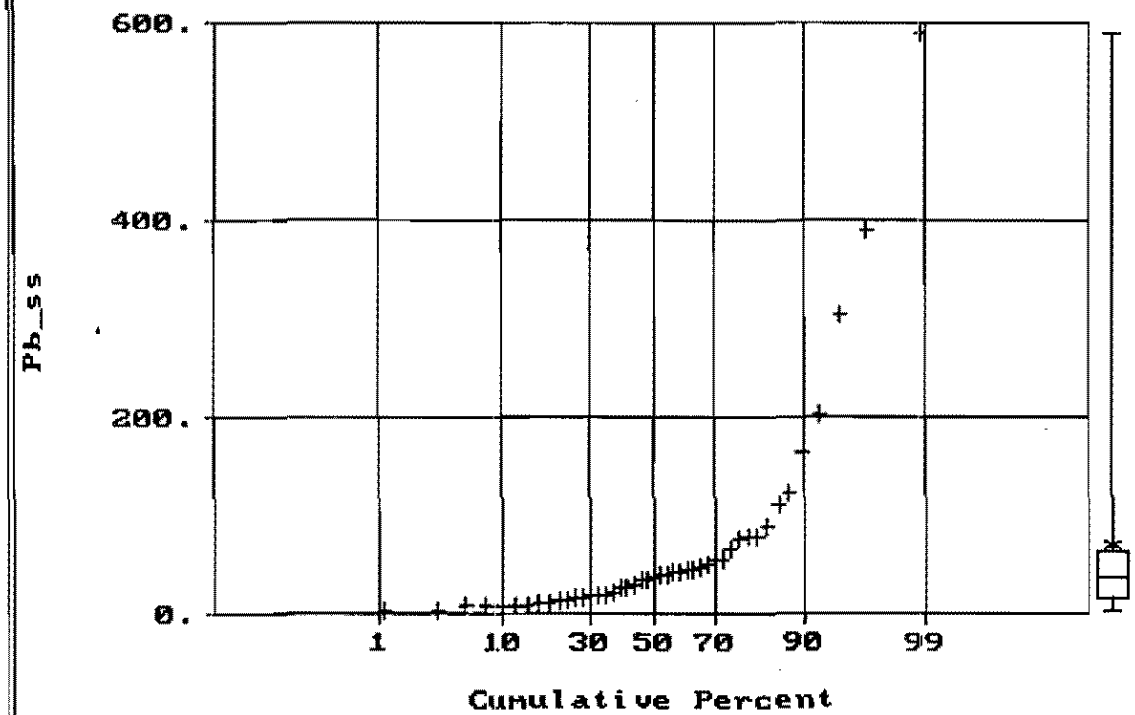
All eight samples reported **manganese** detections. The distribution was moderately continuous (Figs. 1a, 1b), with a maximum concentration of 123 μg/L in sample GDCGW02D02. The maximum value serves as the UTL: **123 μg/L**. The corresponding value of a parametric UTL based on LN-transformed data (Figs. 2a, 2b) is 284 μg/L. The tap water RBC for manganese is 84 μg/L (noncarcinogenic; THQ = 0.1); there is no MCL.

Zone C
Lead in surface soil grid samples
Original dataset (N=45)
Original values

1a



Normal Probability Plot for Pb_ss
Data file: c_bg_ss.dat

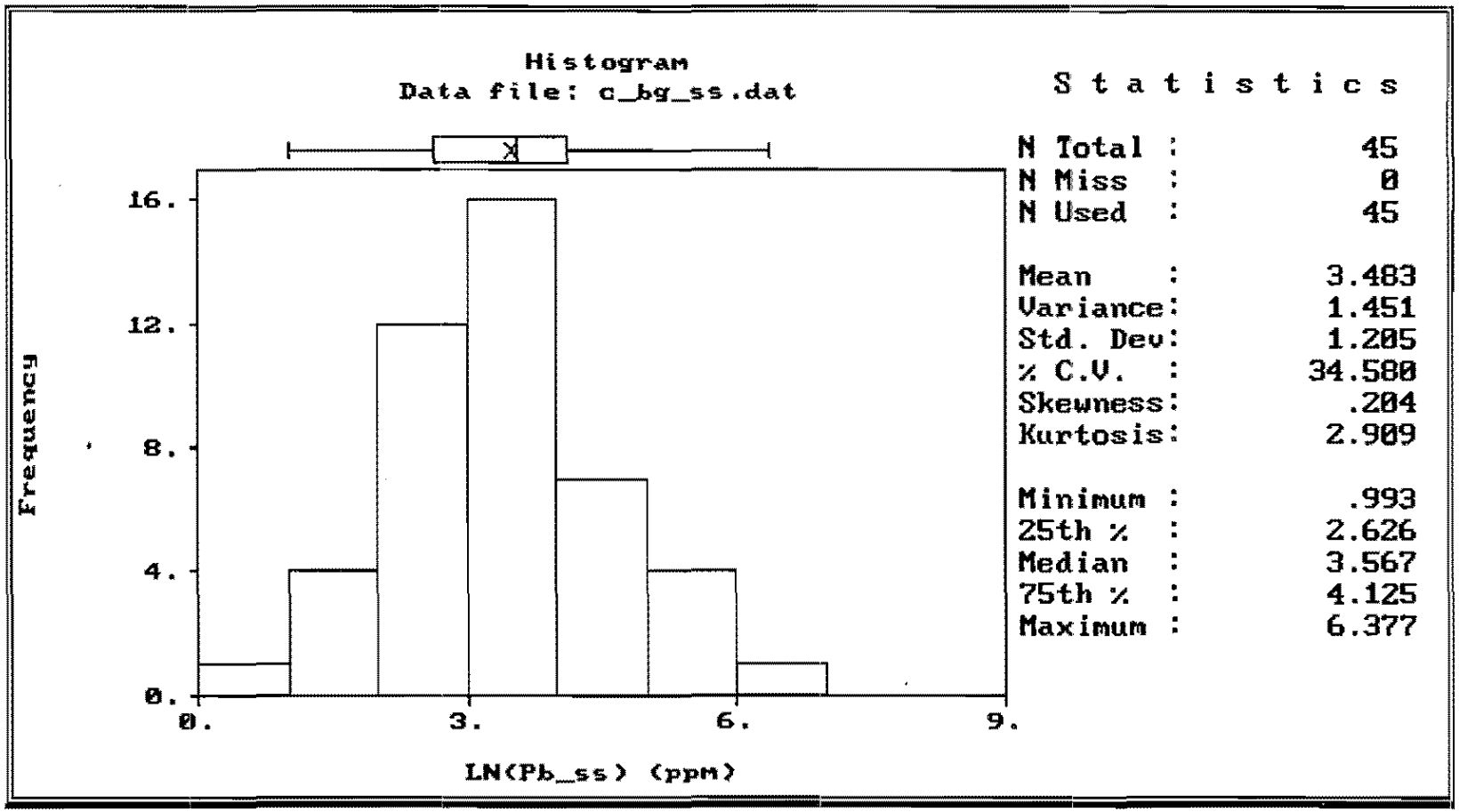


Statistics

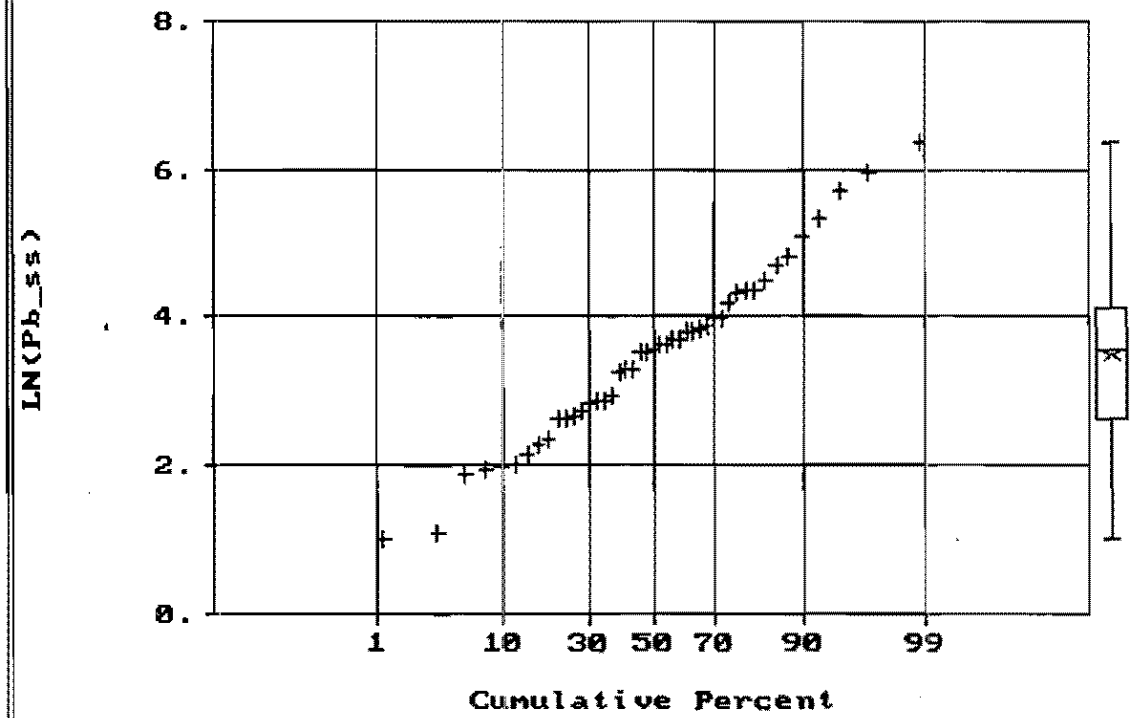
N Total :	45
N Miss :	0
N Used :	45
Mean :	68.459
Variance:	12063.540
Std. Dev:	109.834
% C.V. :	160.438
Skewness:	3.225
Kurtosis:	13.913
Minimum :	2.700
25th % :	13.825
Median :	35.400
75th % :	62.050
Maximum :	588.000

Zone C
Lead in surface soil grid samples
Original dataset (N = 45)
LN-transformed values

2a



Normal Probability Plot for LN(Pb_ss)
Data file: c_bg_ss.dat

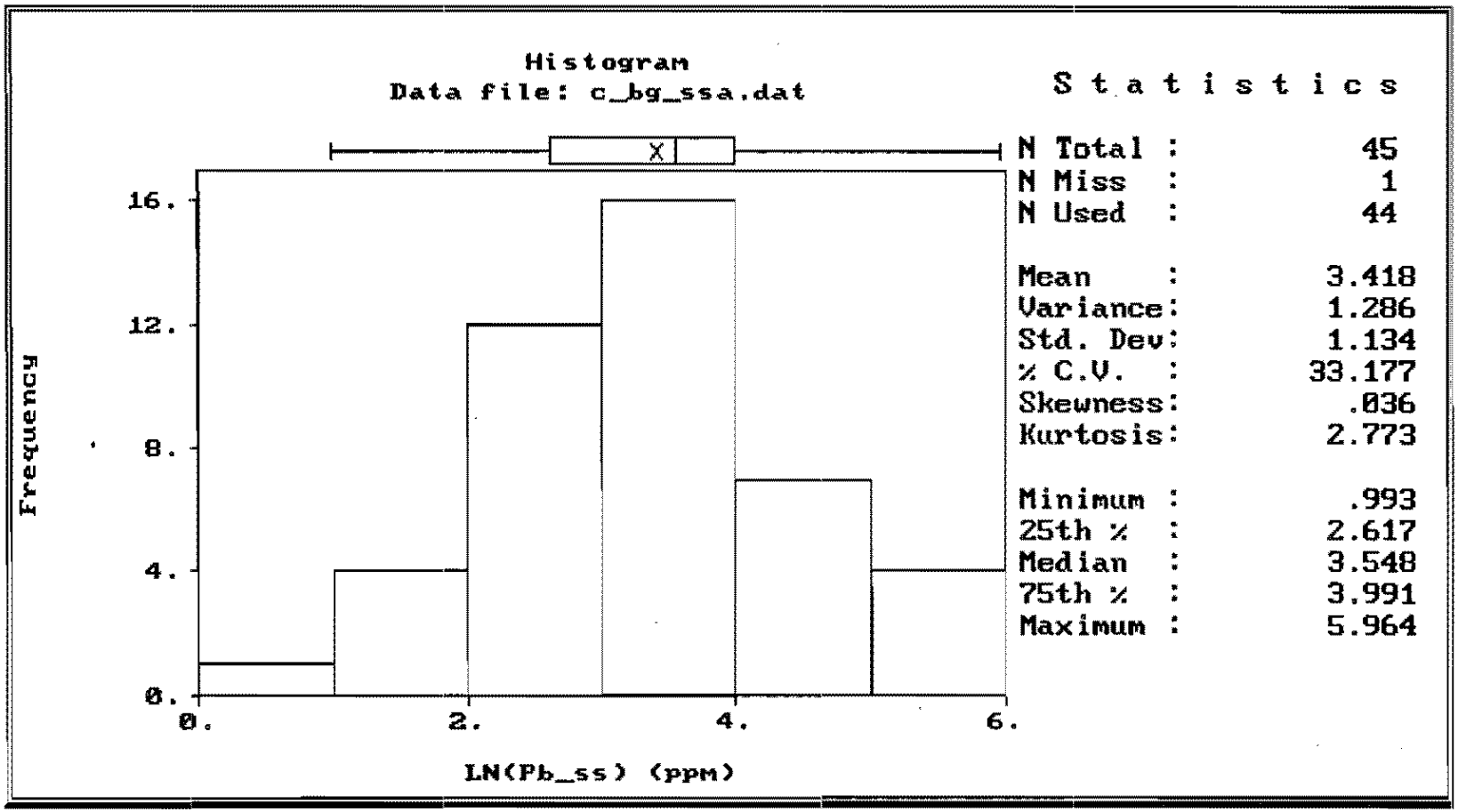


Statistics

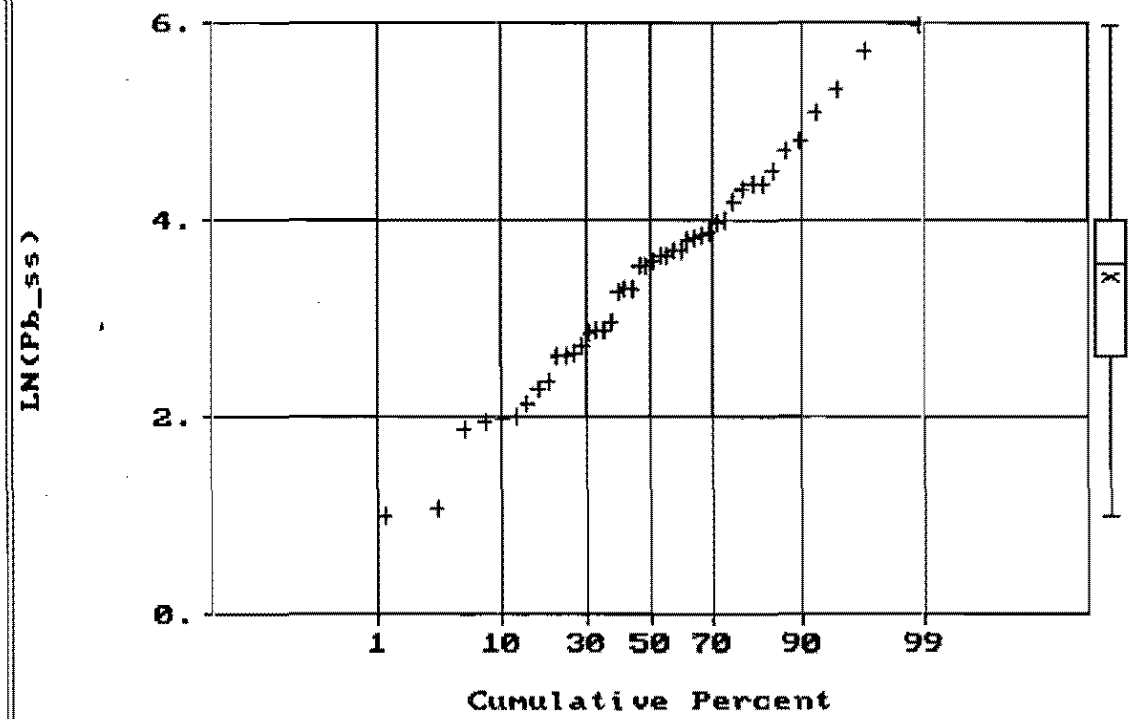
N Total :	45
N Miss :	0
N Used :	45
Mean :	3.483
Variance:	1.451
Std. Dev:	1.205
% C.V. :	34.580
Skewness:	.204
Kurtosis:	2.909
Minimum :	.993
25th % :	2.626
Median :	3.567
75th % :	4.125
Maximum :	6.377

Zone C
Lead in surface soil grid samples
Sample # 15-01 removed from dataset
LN-transformed values

3a



Normal Probability Plot for LN(Pb_ss)
Data file: c_bg_ssa.dat



Statistics

N Total :	45
N Miss :	1
N Used :	44
Mean :	3.418
Variance:	1.286
Std. Dev:	1.134
% C.V. :	33.177
Skewness:	.036
Kurtosis:	2.773
Minimum :	.993
25th % :	2.617
Median :	3.548
75th % :	3.991
Maximum :	5.964

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B001-01		GDC-S-B002-01		GDC-S-B003-01		GDC-S-B004-01		GDC-S-B005-01		GDC-S-B006-01	
	ORIGINAL ID ----->	GRDSB00101		GRDSB00201		GRDSB00301		GRDSB00401		GRDSB00501		GRDSB00601	
	LAB SAMPLE ID --->	690546		689925		691120		703505		691100		691083	
	ID FROM REPORT -->	GRDSB00101		GRDSB00201		GRDSB00301		GRDSB00401		GRDSB00501		GRDSB00601	
	SAMPLE DATE ----->	03/15/95		03/13/95		03/17/95		04/14/95		03/17/95		03/17/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	0001MI	VAL	0001MI	VAL	0002MI	VAL	50012M	VAL	0002MI	VAL	0001MI	VAL
7429-90-5	Aluminum (Al)	5960.		2110.		5910.		4080.		4000.		3270.	
7440-36-0	Antimony (Sb)	0.67	UJ	0.23	UJ	0.28	J	0.22	UJ	1.4	J	0.22	UJ
7440-38-2	Arsenic (As)	3.		39.4		2.4		0.73	J	7.2		3.4	
7440-39-3	Barium (Ba)	69.1		9.4	J	15.7	J	11.1	J	15.9	J	4.4	J
7440-41-7	Beryllium (Be)	0.26	J	0.18	U	0.18	J	0.07	U	0.16	J	0.12	U
7440-43-9	Cadmium (Cd)	0.65		0.06	U	0.16	J	0.03	U	0.06	U	0.06	U
7440-70-2	Calcium (Ca)	2270.		20800.		50100.		12700.		25100.		10200.	
7440-47-3	Chromium (Cr)	18.8		8.8		14.4		4.4		9.5		7.4	J
7440-48-4	Cobalt (Co)	1.2	J	0.92	J	1.2	J	0.57	J	1.4	J	1.4	J
7440-50-8	Copper (Cu)	39.7	J	6.2	J	6.2		1.7	J	11.8		11.9	J
7439-89-6	Iron (Fe)	4270.		3280.		4230.		1510.		6210.		5710.	
7439-92-1	Lead (Pb)	389.	J	13.7	J	54.1		7.1		14.2		7.4	J
7439-95-4	Magnesium (Mg)	268.	J	792.		1080.		248.	J	639.		183.	J
7439-96-5	Manganese (Mn)	62.8		48.9		53.		72.7		41.8		42.9	
7439-97-6	Mercury (Hg)	0.09	U	0.11		0.11	U	0.11	U	0.12	U	0.11	U
7440-02-0	Nickel (Ni)	3.9	J	3.	J	5.5		1.4	J	4.9		27.7	
7440-09-7	Potassium (K)	132.	J	283.	J	490.	J	180.	J	305.	J	64.6	J
7782-49-2	Selenium (Se)	0.62	J	0.63	J	0.51	UJ	0.5	U	0.6	J	0.55	J
7440-22-4	Silver (Ag)	0.07	UJ	0.07	UJ	0.07	UJ	0.06	U	0.07	UJ	0.07	UJ
7440-23-5	Sodium (Na)	159.	U	254.	J	424.	J	120.	U	536.	J	186.	U
7440-28-0	Thallium (Tl)	0.61	U	0.61	U	0.64	U	0.51	U	0.63	U	0.64	U
7440-62-2	Vanadium (V)	7.3		7.2		11.1		4.7	J	8.5		4.5	J
7440-66-6	Zinc (Zn)	142.		33.1		62.5	J	9.6		35.4	J	33.5	
7440-31-5	Tin (Sn)	8.1		1.	J	1.1	J	1.3	J	1.2	J	0.91	U
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B007-01		GDC-S-B008-01		GDC-S-B009-01		GDC-S-B010-01		GDC-S-B011-01		GDC-S-B012-01	
	ORIGINAL ID ----->	GRDSB00701		GRDSB00801		GRDSB00901		GRDSB01001		GRDSB01101		GRDSB01201	
	LAB SAMPLE ID --->	703440		691126		696973		702562		702571		702019	
	ID FROM REPORT -->	GRDSB00701		GRDSB00801		MAC001		MAC009		MAC013		MAC015	
	SAMPLE DATE ----->	04/14/95		03/17/95		03/31/95		04/10/95		04/10/95		04/11/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50010M	VAL	0002MI	VAL	50003M	VAL	0011MI	VAL	0011MI	VAL	50009M	VAL
7429-90-5	Aluminum (Al)	3540.		4240.		5420.		3890.	J	4890.	J	6730.	
7440-36-0	Antimony (Sb)	0.21	UJ	0.2	UJ	0.21	UJ	0.24	UJ	0.23	UJ	0.21	UJ
7440-38-2	Arsenic (As)	1.	J	0.58	J	2.7	UJ	0.41	UJ	0.38	UJ	1.5	
7440-39-3	Barium (Ba)	11.7	J	11.6	J	13.5	J	6.	J	15.6	J	17.1	J
7440-41-7	Beryllium (Be)	0.12	U	0.11	J	0.17	UJ	0.05	UJ	0.12	UJ	0.2	U
7440-43-9	Cadmium (Cd)	0.03	U	0.05	U	0.03	U	0.04	UJ	0.04	UJ	0.03	U
7440-70-2	Calcium (Ca)	3800.	J	16400.		18600.		1210.	J	887.	J	133.	UJ
7440-47-3	Chromium (Cr)	4.3		7.6		8.7		5.3	J	9.	J	6.	
7440-48-4	Cobalt (Co)	0.78	J	0.62	J	1.2	J	0.41	UJ	0.68	UJ	0.51	J
7440-50-8	Copper (Cu)	10.9		0.81	J	5.8		2.1	J	11.5	J	3.5	
7439-89-6	Iron (Fe)	2930.		2140.		4700.		1540.	J	2670.	J	3290.	
7439-92-1	Lead (Pb)	17.6		2.7		13.6		7.	J	35.4	J	46.7	J
7439-95-4	Magnesium (Mg)	431.	J	394.	J	555.		184.	J	236.	J	240.	J
7439-96-5	Manganese (Mn)	61.8		19.7		45.5		19.9	J	32.3	J	37.7	
7439-97-6	Mercury (Hg)	0.11	U	0.11	U	0.11	U	0.13	U	0.12	U	0.11	U
7440-02-0	Nickel (Ni)	1.1	J	1.2	J	2.9	J	0.54	J	2.	J	1.9	J
7440-09-7	Potassium (K)	292.	J	236.	J	315.	J	144.	J	162.	J	124.	J
7782-49-2	Selenium (Se)	0.49	UJ	0.46	UJ	0.79	J	0.56	UJ	0.53	J	0.49	UJ
7440-22-4	Silver (Ag)	0.06	U	0.06	UJ	0.05	UJ	0.06	UJ	0.06	UJ	0.06	U
7440-23-5	Sodium (Na)	103.	U	139.	U	368.	J	133.	U	174.	U	124.	U
7440-28-0	Thallium (Tl)	0.5	U	0.58	U	0.49	U	0.57	U	0.54	U	0.5	U
7440-62-2	Vanadium (V)	5.7		5.7		9.2		4.7	J	8.1	J	6.4	
7440-66-6	Zinc (Zn)	24.7		4.1	J	19.9		9.	J	36.4	J	13.4	J
7440-31-5	Tin (Sn)	1.2	J	0.94	J	1.7	U	0.92	J	0.7	UJ	1.3	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B013-01		GDC-C-B013-01		GDC-S-B014-01		GDC-S-B015-01		GDC-S-B016-01		GDC-S-B017-01	
	ORIGINAL ID ----->	GRDSB01301		GRDCB01301		GRDSB01401		GRDSB01501		GRDSB01601		GRDSB01701	
	LAB SAMPLE ID --->	702008		702014		703517		702559		702570		702572	
	ID FROM REPORT -->	MAC001		GRDCB01301		MAC017		MAC007		MAC012		MAC001	
	SAMPLE DATE ----->	04/11/95		04/11/95		04/14/95		04/10/95		04/10/95		04/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	0006M	VAL	0011MI	VAL	0011MI	VAL	0011MI	VAL	0011MI	VAL
7429-90-5	Aluminum (Al)	3450.		1850.	J	5320.	J	7530.	J	6160.	J	9850.	J
7440-36-0	Antimony (Sb)	0.33	J	0.35	J	0.21	UJ	0.21	UJ	0.23	UJ	0.21	UJ
7440-38-2	Arsenic (As)	0.77	J	0.33	U	0.35	UJ	2.4	J	0.62	J	9.6	J
7440-39-3	Barium (Ba)	16.4	J	14.1	J	7.	J	51.1	J	25.	J	20.3	J
7440-41-7	Beryllium (Be)	0.1	U	0.06	U	0.07	UJ	0.27	UJ	0.13	UJ	0.37	UJ
7440-43-9	Cadmium (Cd)	0.28	U	0.27	J	0.03	UJ	0.2	UJ	0.04	UJ	0.12	UJ
7440-70-2	Calcium (Ca)	6090.	J	13300.		34800.	J	2670.	J	27600.	J	23800.	J
7440-47-3	Chromium (Cr)	7.1		7.		6.6	J	21.	J	9.1	J	15.9	J
7440-48-4	Cobalt (Co)	0.75	J	0.71	J	0.75	J	2.	J	1.7	J	2.	J
7440-50-8	Copper (Cu)	13.7	J	12.6		1.5	J	15.	J	5.8	J	12.7	J
7439-89-6	Iron (Fe)	2450.		2400.		841.	J	6370.	J	4170.	J	9020.	J
7439-92-1	Lead (Pb)	97.6	J	121.		8.4	J	588.	J	26.6	J	50.7	J
7439-95-4	Magnesium (Mg)	435.	J	477.	J	432.	J	591.	J	901.	J	1070.	J
7439-96-5	Manganese (Mn)	33.6		39.1		55.2	J	82.1	J	69.5	J	86.1	J
7439-97-6	Mercury (Hg)	0.1	U	0.11	U	0.11	U	0.24		0.12	U	0.11	U
7440-02-0	Nickel (Ni)	3.1	J	3.2	J	1.4	J	5.2	J	2.4	J	6.6	J
7440-09-7	Potassium (K)	199.	J	185.	J	141.	J	369.	J	360.	J	621.	J
7782-49-2	Selenium (Se)	0.46	UJ	0.58	J	0.48	J	1.	J	0.67	J	0.51	J
7440-22-4	Silver (Ag)	0.05	U	0.05	UJ	0.05	UJ	0.05	UJ	0.06	J	0.05	UJ
7440-23-5	Sodium (Na)	110.	U	138.	U	158.	U	158.	U	178.	U	729.	J
7440-28-0	Thallium (Tl)	0.47	U	0.47	U	0.49	U	0.49	U	0.55	UJ	0.49	U
7440-62-2	Vanadium (V)	9.1		7.8		2.7	J	17.1	J	9.3	J	21.2	J
7440-66-6	Zinc (Zn)	133.	J	123.		9.2	J	128.	J	58.5	J	42.7	J
7440-31-5	Tin (Sn)	0.71	J	2.4	J	0.79	J	1.1	J	0.72	J	0.64	UJ
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META															
	SAMPLE ID ------->	GDC-C-B017-01		GDC-S-B018-01		GDC-S-B019-01		GDC-S-B020-01		GDC-S-B021-01		GDC-S-B022-01	
	ORIGINAL ID ----->	GRDCB01701		GRDSB01801		GRDSB01901		GRDSB02001		GRDSB02101		GRDSB02201	
	LAB SAMPLE ID --->	702599		703516		703514		702563		701983		702006	
	ID FROM REPORT -->	GRDCB01701		MAC016		MAC014		MAC010		MAC002		MAC012	
	SAMPLE DATE ----->	04/10/95		04/14/95		04/14/95		04/11/95		04/11/95		04/11/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50010M	VAL	0011MI	VAL	0011MI	VAL	0011MI	VAL	50009M	VAL	50009M	VAL
7429-90-5	Aluminum (Al)	7000.		2720.	J	3500.	J	4940.	J	4590.		4030.	
7440-36-0	Antimony (Sb)	0.24	UJ	0.29	J	0.2	UJ	0.21	UJ	0.2	UJ	0.2	UJ
7440-38-2	Arsenic (As)	3.8	J	1.7	J	3.8	J	1.4	J	12.5		0.4	J
7440-39-3	Barium (Ba)	15.7	J	11.1	J	14.4	J	33.5	J	19.4	J	20.4	J
7440-41-7	Beryllium (Be)	0.3	U	0.08	UJ	0.15	UJ	0.24	UJ	0.1	U	0.1	U
7440-43-9	Cadmium (Cd)	0.07	U	0.03	UJ	0.13	UJ	0.08	UJ	0.03	U	0.05	U
7440-70-2	Calcium (Ca)	12500.	J	9370.	J	71400.	J	16900.	J	728.	J	799.	J
7440-47-3	Chromium (Cr)	14.1		7.3	J	8.9	J	11.2	J	8.5		7.4	
7440-48-4	Cobalt (Co)	1.7	J	0.62	UJ	1.4	J	1.6	J	0.4	J	0.46	J
7440-50-8	Copper (Cu)	9.9		21.4	J	26.1	J	12.5	J	38.3		4.3	
7439-89-6	Iron (Fe)	6110.		4630.	J	3660.	J	4100.	J	2340.		2190.	
7439-92-1	Lead (Pb)	38.6		37.9	J	34.1	J	88.1	J	34.	J	64.7	J
7439-95-4	Magnesium (Mg)	884.		261.	J	1140.	J	462.	J	177.	J	180.	J
7439-96-5	Manganese (Mn)	74.2		16.2	J	73.	J	43.1	J	22.2		32.2	
7439-97-6	Mercury (Hg)	0.12	U	0.11	U	0.1	U	0.11	U	0.11	U	0.09	U
7440-02-0	Nickel (Ni)	6.7		2.1	J	4.8	J	6.1	J	1.6	U	1.3	U
7440-09-7	Potassium (K)	429.	J	127.	J	461.	J	301.	J	83.9	J	135.	J
7782-49-2	Selenium (Se)	0.55	UJ	0.64	J	0.55	J	0.71	J	0.46	UJ	0.46	UJ
7440-22-4	Silver (Ag)	0.06	U	0.05	J	0.05	UJ	0.05	UJ	0.05	U	0.05	U
7440-23-5	Sodium (Na)	251.	U	142.	J	237.	U	185.	U	110.	U	118.	U
7440-28-0	Thallium (Tl)	0.56	U	0.48	U	0.47	U	0.49	U	0.47	U	0.47	U
7440-62-2	Vanadium (V)	18.3		8.6	J	7.	J	9.5	J	5.3		5.6	
7440-66-6	Zinc (Zn)	41.9		37.6	J	34.4	J	40.1	J	40.	J	122.	J
7440-31-5	Tin (Sn)	0.73	U	1.9	J	1.7	J	1.6	J	1.4	J	1.2	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B023-01		GDC-S-B024-01		GDC-S-B025-01		GDC-S-B026-01		GDC-S-B027-01		GDC-S-B028-01	
	ORIGINAL ID ----->	GRDSB02301		GRDSB02401		GRDSB02501		GRDSB02601		GRDSB02701		GRDSB02801	
	LAB SAMPLE ID --->	701989		702004		702454		704087		705231		705233	
	ID FROM REPORT -->	MAC004		MAC010		MAC004		MAC019		GRDSB02701		GRDSB02801	
	SAMPLE DATE ----->	04/11/95		04/11/95		04/12/95		04/17/95		04/20/95		04/20/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	50009M	VAL	0011M1	VAL	0011M1	VAL	50013M	VAL	50013M	VAL
7429-90-5	Aluminum (Al)	4760.		5520.		5990.	J	5590.	J	2770.		2250.	
7440-36-0	Antimony (Sb)	0.44	J	0.2	UJ	0.21	UJ	0.28	J	0.2	UJ	0.2	UJ
7440-38-2	Arsenic (As)	0.79	J	1.8		3.3	J	0.74	J	0.7	U	22.4	
7440-39-3	Barium (Ba)	22.3		17.5	J	65.5	J	29.9	J	6.9	J	10.9	J
7440-41-7	Beryllium (Be)	0.14	U	0.16	U	0.29	UJ	0.21	UJ	0.08	U	0.09	U
7440-43-9	Cadmium (Cd)	0.03	U	0.03	U	0.15	UJ	0.33	UJ	0.03	U	0.03	U
7440-70-2	Calcium (Ca)	1620.	J	484.	J	2070.	J	4050.	J	1060.	J	1660.	J
7440-47-3	Chromium (Cr)	5.4		8.4		7.4	J	13.8	J	3.2		3.1	
7440-48-4	Cobalt (Co)	0.57	J	0.86	J	2.9	J	1.4	J	0.35	J	0.34	J
7440-50-8	Copper (Cu)	14.8		7.3		18.4	J	33.8	J	1.	U	3.6	
7439-89-6	Iron (Fe)	2580.		3680.		3690.	J	3990.	J	1640.		1640.	
7439-92-1	Lead (Pb)	44.7	J	77.7	J	163.	J	78.	J	2.9		9.9	
7439-95-4	Magnesium (Mg)	201.	J	282.	J	333.	J	445.	J	160.	J	143.	J
7439-96-5	Manganese (Mn)	23.		42.8		45.3	J	64.9	J	11.3	J	10.4	J
7439-97-6	Mercury (Hg)	0.12		0.11	U	0.15		0.11		0.11	U	0.13	J
7440-02-0	Nickel (Ni)	2.3	J	2.5	J	3.4	J	4.8	J	0.82	J	0.82	J
7440-09-7	Potassium (K)	89.4	J	149.	J	160.	J	255.	J	86.6	J	118.	J
7782-49-2	Selenium (Se)	0.47	UJ	0.47	UJ	0.78	J	0.62	J	0.59	J	0.46	UJ
7440-22-4	Silver (Ag)	0.05	U	0.05	U	0.06	UJ	0.05	UJ	0.05	U	0.05	U
7440-23-5	Sodium (Na)	118.	U	105.	U	172.	U	154.	U	108.	J	119.	J
7440-28-0	Thallium (Tl)	0.48	U	0.48	U	0.5	U	0.48	U	0.47	U	0.47	U
7440-62-2	Vanadium (V)	5.3		8.7		6.2	J	9.5	J	3.6	J	3.8	J
7440-66-6	Zinc (Zn)	43.6	J	47.8	J	135.	J	109.	J	3.4	J	12.5	J
7440-31-5	Tin (Sn)	1.6	J	2.8	J	2.6	J	1.4	J	1.4	U	1.8	U
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B029-01		GDC-S-B030-01		GDC-S-B031-01		GDC-S-B032-01		GDC-S-B033-01		GDC-S-B034-01	
	ORIGINAL ID ----->	GRDSB02901		GRDSB03001		GRDSB03101		GRDSB03201		GRDSB03301		GRDSB03401	
	LAB SAMPLE ID --->	704089		704098		704096		702447		702002		702000	
	ID FROM REPORT -->	GRDSB02901		GRDSB03001		GRDSB03101		MAC002		MAC008		MAC006	
	SAMPLE DATE ----->	04/17/95		04/17/95		04/17/95		04/12/95		04/11/95		04/11/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50013M	VAL	50013M	VAL	50013M	VAL	0011MI	VAL	50009M	VAL	50009M	VAL
7429-90-5	Aluminum (Al)	3630.		3390.		9720.		3810.	J	3860.		3480.	
7440-36-0	Antimony (Sb)	0.2	UJ	0.2	UJ	0.44	J	0.2	UJ	0.26	J	0.2	UJ
7440-38-2	Arsenic (As)	2.5	U	2.1	U	22.3		0.33	UJ	0.6	J	0.33	U
7440-39-3	Barium (Ba)	93.1	J	9.	J	31.6	J	12.8	J	97.4		9.8	J
7440-41-7	Beryllium (Be)	0.12	U	0.08	U	0.47	U	0.16	UJ	0.12	U	0.07	U
7440-43-9	Cadmium (Cd)	0.24	J	0.03	U	0.52	J	0.03	UJ	0.23	U	0.03	U
7440-70-2	Calcium (Ca)	34800.	J	4200.	J	38500.	J	12100.	J	1190.	J	497.	J
7440-47-3	Chromium (Cr)	6.3		5.4		31.8		5.9	J	5.3		2.7	
7440-48-4	Cobalt (Co)	0.79	J	0.5	J	2.3	J	0.96	J	0.71	J	0.18	J
7440-50-8	Copper (Cu)	10.2		7.9		23.9		2.4	J	5.8		1.5	J
7439-89-6	Iron (Fe)	2960.		1750.		7960.		2510.	J	2060.		1440.	
7439-92-1	Lead (Pb)	17.7		19.		53.4		17.2	J	202.	J	6.5	J
7439-95-4	Magnesium (Mg)	623.		197.	J	2390.		296.	J	205.	J	130.	J
7439-96-5	Manganese (Mn)	33.3	J	12.2	J	53.	J	16.8	J	19.		15.1	
7439-97-6	Mercury (Hg)	0.11	J	0.11	J	0.2	J	0.1	U	0.1	U	0.1	U
7440-02-0	Nickel (Ni)	1.8	J	1.5	J	11.6	J	1.3	J	1.2	U	1.	U
7440-09-7	Potassium (K)	229.	J	96.8	J	775.	J	155.	J	114.	J	67.9	J
7782-49-2	Selenium (Se)	0.55	J	0.46	UJ	1.3	J	0.46	UJ	0.46	UJ	0.46	UJ
7440-22-4	Silver (Ag)	0.05	U	0.05	U	0.08	U	0.05	UJ	0.05	U	0.05	U
7440-23-5	Sodium (Na)	221.	J	98.6	J	583.	J	263.	J	131.	U	99.6	U
7440-28-0	Thallium (Tl)	0.47	U	0.47	U	0.69	U	0.47	U	0.47	U	0.47	U
7440-62-2	Vanadium (V)	6.9		4.	J	24.3		5.2	J	3.6	J	2.8	J
7440-66-6	Zinc (Zn)	414.	J	42.	J	73.1	J	11.7	J	88.7	J	6.2	J
7440-31-5	Tin (Sn)	3.	U	1.2	U	1.5	U	0.7	J	1.3	J	1.4	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META	SAMPLE ID ------->	GDC-S-B035-01		GDC-S-B036-01		GDC-S-B037-01		GDC-S-B038-01		GDC-S-B039-01		GDC-S-B040-01	
	ORIGINAL ID ----->	GRDSB03501		GRDSB03601		GRDSB03701		GDCSB03801		GDCSB03901		GDCSB04001	
	LAB SAMPLE ID --->	702438		704097		702441		737129		737225		737248	
	ID FROM REPORT -->	MAC017		GRDSB03601		MAC019		GDCSB03801		GDCSB03901		GDCSB04001	
	SAMPLE DATE ----->	04/12/95		04/17/95		04/12/95		06/29/95		06/29/95		06/29/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	50013M	VAL	50009M	VAL	21521M	VAL	50022M	VAL	50022M	VAL
7429-90-5	Aluminum (Al)	8660.		8930.		4530.		3100.		5220.		4560.	
7440-36-0	Antimony (Sb)	0.21	UJ	0.29	J	0.21	UJ	0.35	J	0.33	J	0.45	J
7440-38-2	Arsenic (As)	10.2		6.6		2.7		2.3	U	2.6		2.6	
7440-39-3	Barium (Ba)	23.8		27.5	J	15.7	J	22.3		18.2	J	193.	
7440-41-7	Beryllium (Be)	0.35	U	0.34	U	0.22	U	0.15	U	0.12	U	0.15	U
7440-43-9	Cadmium (Cd)	0.23	U	0.45	J	0.03	U	0.12	U	0.06	U	0.37	J
7440-70-2	Calcium (Ca)	32400.	J	29700.	J	21600.		85600.		8360.		48100.	
7440-47-3	Chromium (Cr)	22.8		22.7		13.2		5.		7.4		7.5	
7440-48-4	Cobalt (Co)	1.8	J	1.7	J	0.84	J	1.1	J	0.62	J	1.	J
7440-50-8	Copper (Cu)	16.5		17.4		6.7		5.4		6.5		18.1	
7439-89-6	Iron (Fe)	5800.		7720.		3220.		2400.		4330.		3300.	
7439-92-1	Lead (Pb)	27.	J	121.		40.2	J	10.5		15.2		25.9	
7439-95-4	Magnesium (Mg)	1680.		1930.		1380.		1040.		345.	J	945.	
7439-96-5	Manganese (Mn)	45.4		48.5	J	27.6		54.8		25.3		47.2	
7439-97-6	Mercury (Hg)	0.22		0.75	J	0.1	U	0.11	U	0.1	U	0.12	
7440-02-0	Nickel (Ni)	7.8		7.4	J	4.3	J	3.3	J	2.6	J	4.4	
7440-09-7	Potassium (K)	836.	J	752.	J	322.	J	208.	J	155.	J	276.	J
7782-49-2	Selenium (Se)	0.48	UJ	1.1	J	0.71	J	0.49	UJ	0.37	U	1.1	
7440-22-4	Silver (Ag)	0.05	U	0.06	U	0.05	U	0.06	U	0.07	U	0.06	U
7440-23-5	Sodium (Na)	373.	J	321.	J	240.	J	283.	J	209.	J	360.	J
7440-28-0	Thallium (Tl)	0.49	U	0.52	U	0.49	U	0.5	U	0.4	U	0.39	U
7440-62-2	Vanadium (V)	17.2		19.5		10.		5.2	J	9.3		7.9	
7440-66-6	Zinc (Zn)	46.	J	86.2	J	23.7	J	115.	J	40.		779.	
7440-31-5	Tin (Sn)	0.64	U	2.5	U	0.9	J	1.7	J	1.4	J	3.4	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

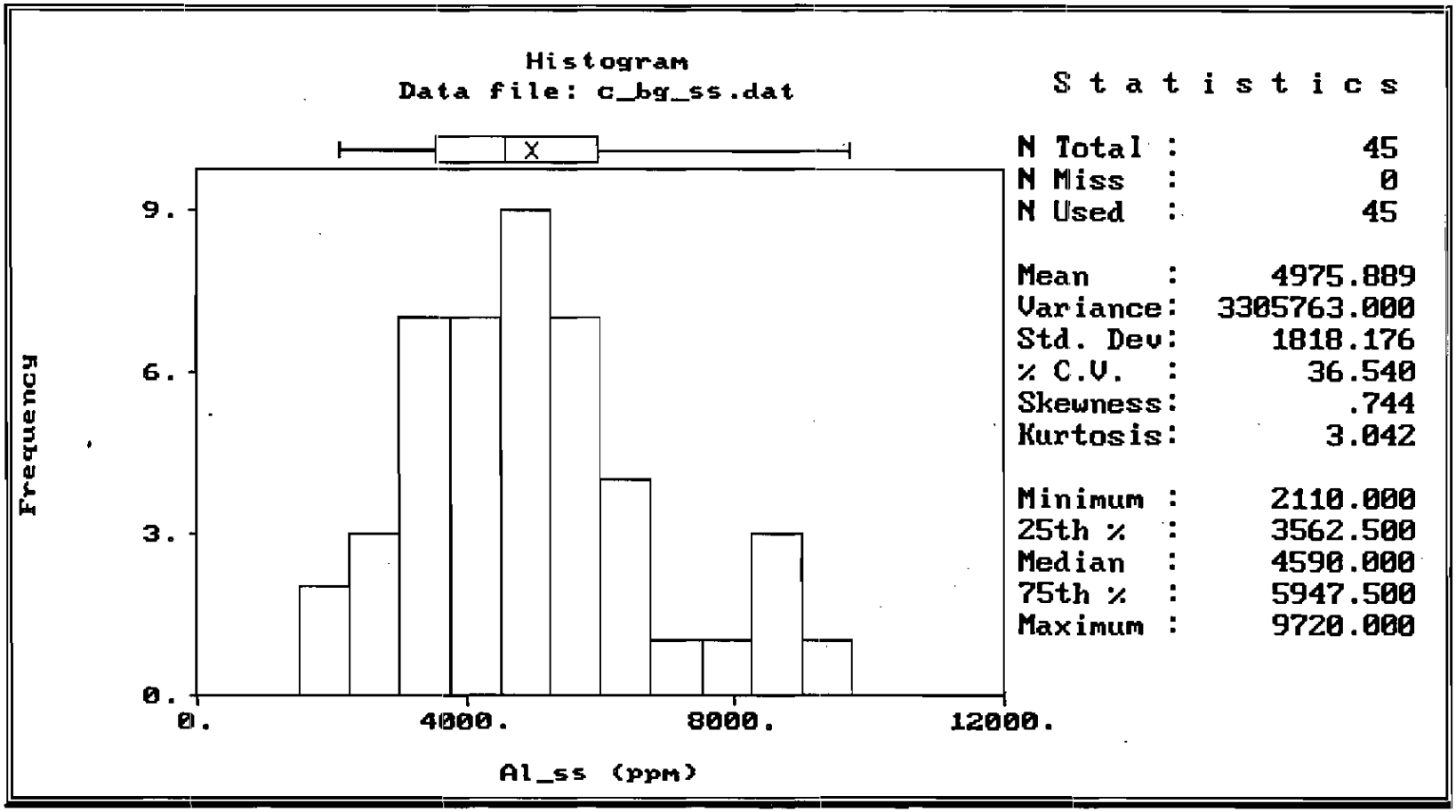
CHARLESTON - ZONE C
Background Sample Results
Surface Soil: Samples 1-45

SW846-META											
	SAMPLE ID ------->	GDC-S-B041-01		GDC-S-B042-01		GDC-S-B043-01		GDC-S-B044-01		GDC-C-B045-01	
	ORIGINAL ID ----->	GDCSB04101		GDCSB04201		GDCSB04301		GDCSB04401		GDCCB04501	
	LAB SAMPLE ID --->	736736		736739		736745		736788		736420	
	ID FROM REPORT -->	GDCSB04101		GDCSB04201		GDCSB04301		GDCSB04401		GDCCB04501	
	SAMPLE DATE ----->	06/28/95		06/28/95		06/28/95		06/28/95		06/27/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	21521M	VAL	21521M	VAL	21521M	VAL	21521M	VAL	21521M	VAL
7429-90-5	Aluminum (Al)	7230.		5060.		6710.		4570.		6670.	
7440-36-0	Antimony (Sb)	0.38	J	0.22	UJ	0.55	J	0.3	J	0.3	J
7440-38-2	Arsenic (As)	5.3		1.6	U	3.	U	2.	U	2.8	U
7440-39-3	Barium (Ba)	17.7	J	18.4	J	39.1		22.3		20.3	J
7440-41-7	Beryllium (Be)	0.36	U	0.16	U	0.27	U	0.18	U	0.22	U
7440-43-9	Cadmium (Cd)	0.03	U	0.03	U	0.14	U	0.03	U	0.03	U
7440-70-2	Calcium (Ca)	1590.		914.		2810.		1780.		449.	J
7440-47-3	Chromium (Cr)	17.6		6.8		17.		6.2		8.	
7440-48-4	Cobalt (Co)	1.2	J	0.45	J	1.3	J	0.52	J	0.29	J
7440-50-8	Copper (Cu)	7.		6.8		15.7		3.9		9.2	
7439-89-6	Iron (Fe)	12000.		2800.		5650.		3920.		2990.	
7439-92-1	Lead (Pb)	37.9		47.8		304.		74.8		40.1	
7439-95-4	Magnesium (Mg)	529.	J	305.	J	542.	J	259.	J	232.	J
7439-96-5	Manganese (Mn)	101.		26.		78.2		27.9		25.7	
7439-97-6	Mercury (Hg)	0.19		0.11	U	0.19		0.13		0.1	U
7440-02-0	Nickel (Ni)	3.3	J	2.5	J	4.8		1.7	J	2.5	J
7440-09-7	Potassium (K)	295.	J	178.	J	344.	J	162.	J	108.	J
7782-49-2	Selenium (Se)	0.94		0.51	J	0.5	J	0.62		0.76	
7440-22-4	Silver (Ag)	0.06	U	0.06	U	0.06	J	0.05	U	0.05	U
7440-23-5	Sodium (Na)	202.	U	175.	U	214.	U	184.	U	172.	U
7440-28-0	Thallium (Tl)	0.51	U	0.51	U	0.5	U	0.49	U	0.47	U
7440-62-2	Vanadium (V)	25.4		8.3		15.8		8.2		9.3	
7440-66-6	Zinc (Zn)	27.1	J	15.3	J	138.	J	23.7	J	17.5	J
7440-31-5	Tin (Sn)	2.1	J	1.6	J	2.6	J	2.	J	1.9	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

Zone C
Aluminum in surface soil grid samples
Original dataset (N = 45)
Original values

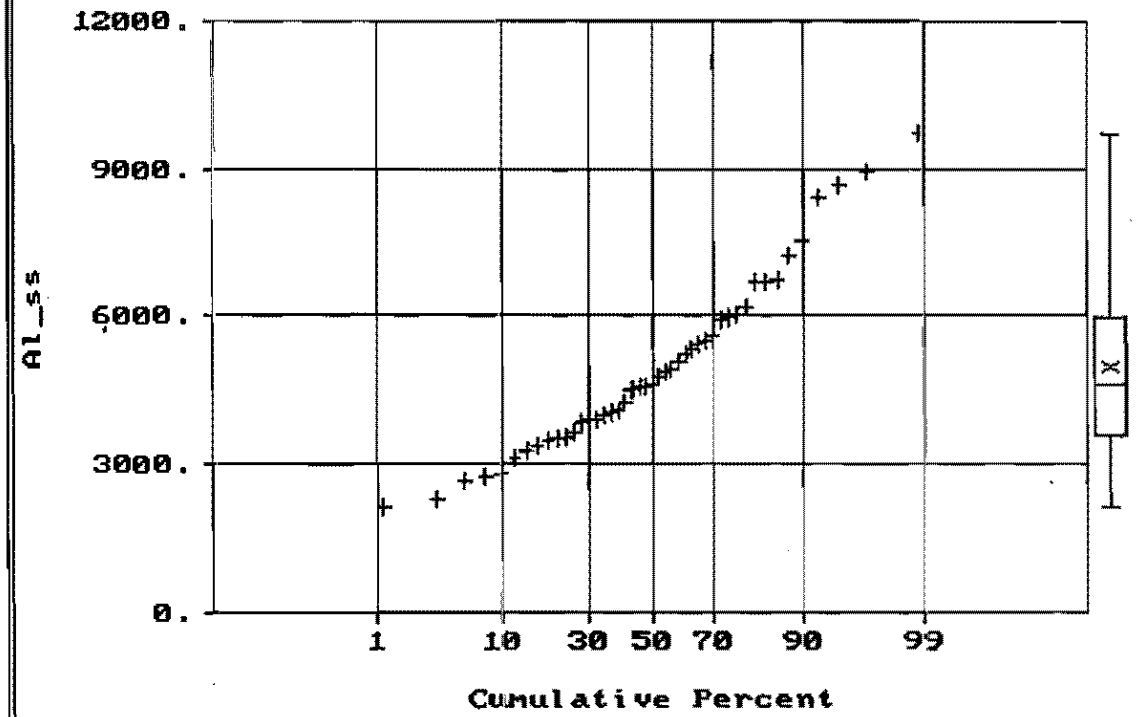
1a



Statistics

N Total :	45
N Miss :	0
N Used :	45
Mean :	4975.889
Variance:	3305763.000
Std. Dev:	1818.176
% C.V. :	36.540
Skewness:	.744
Kurtosis:	3.042
Minimum :	2110.000
25th % :	3562.500
Median :	4590.000
75th % :	5947.500
Maximum :	9720.000

Normal Probability Plot for Al_ss
Data file: c_bg_ss.dat

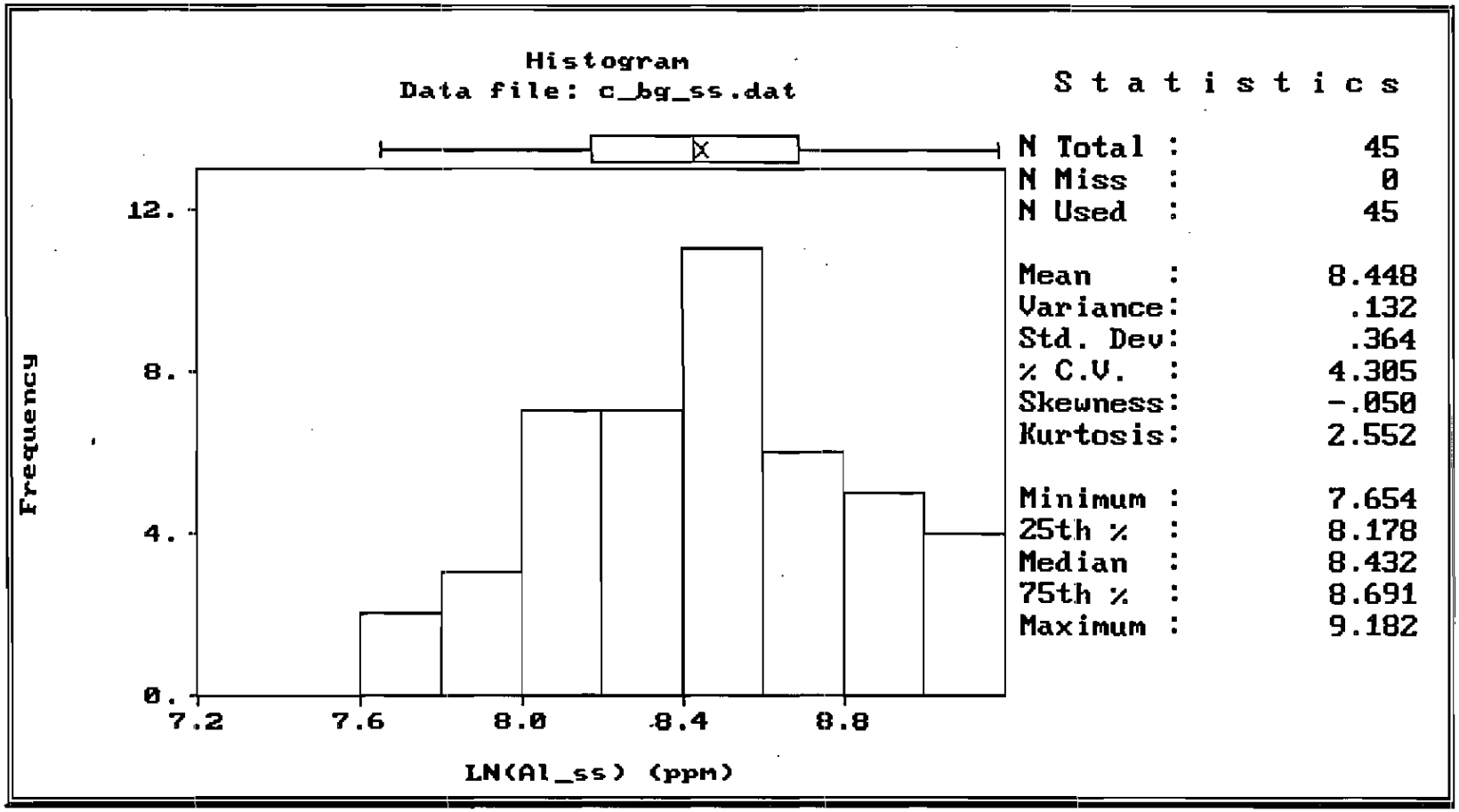


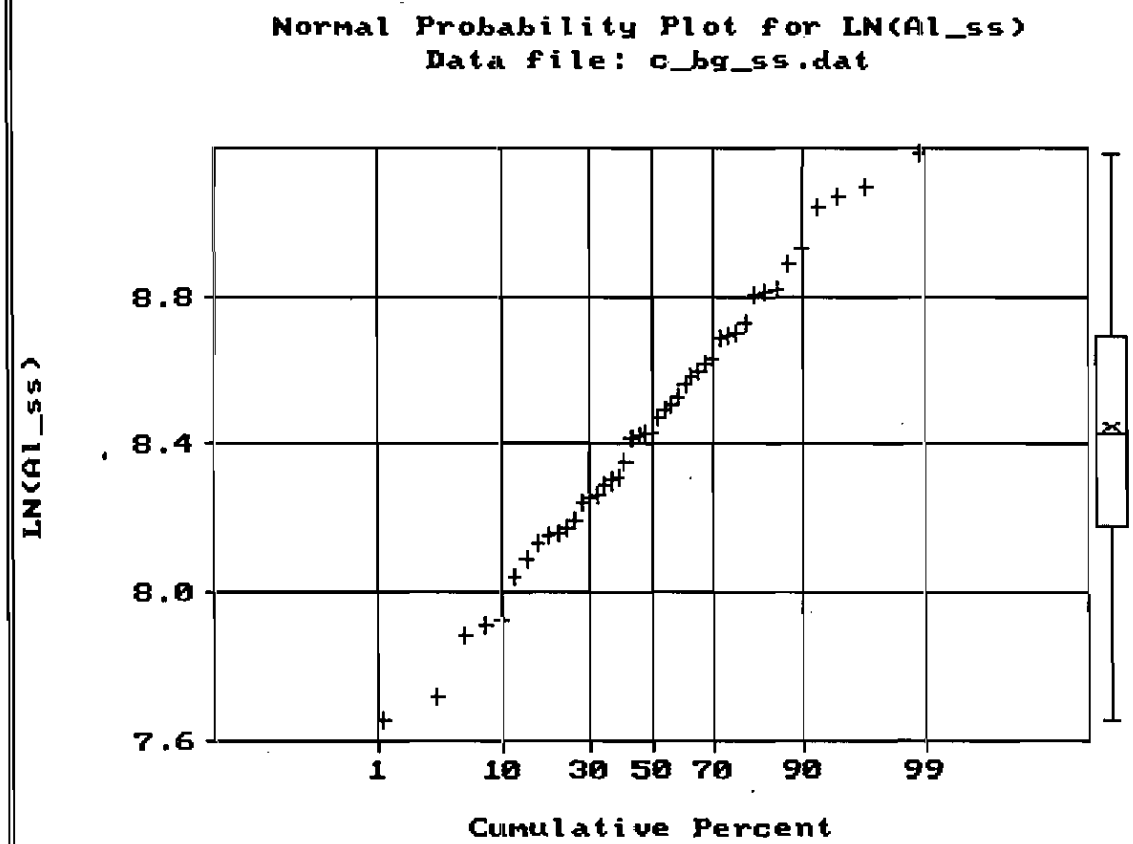
Statistics

N Total :	45
N Miss :	0
N Used :	45
Mean :	4975.889
Variance:	3305763.000
Std. Dev:	1818.176
% C.V. :	36.540
Skewness:	.744
Kurtosis:	3.042
Minimum :	2110.000
25th % :	3562.500
Median :	4590.000
75th % :	5947.500
Maximum :	9720.000

Zone C
Aluminum in surface soil grid samples
Original dataset (N = 45)
LN-transformed values

2a



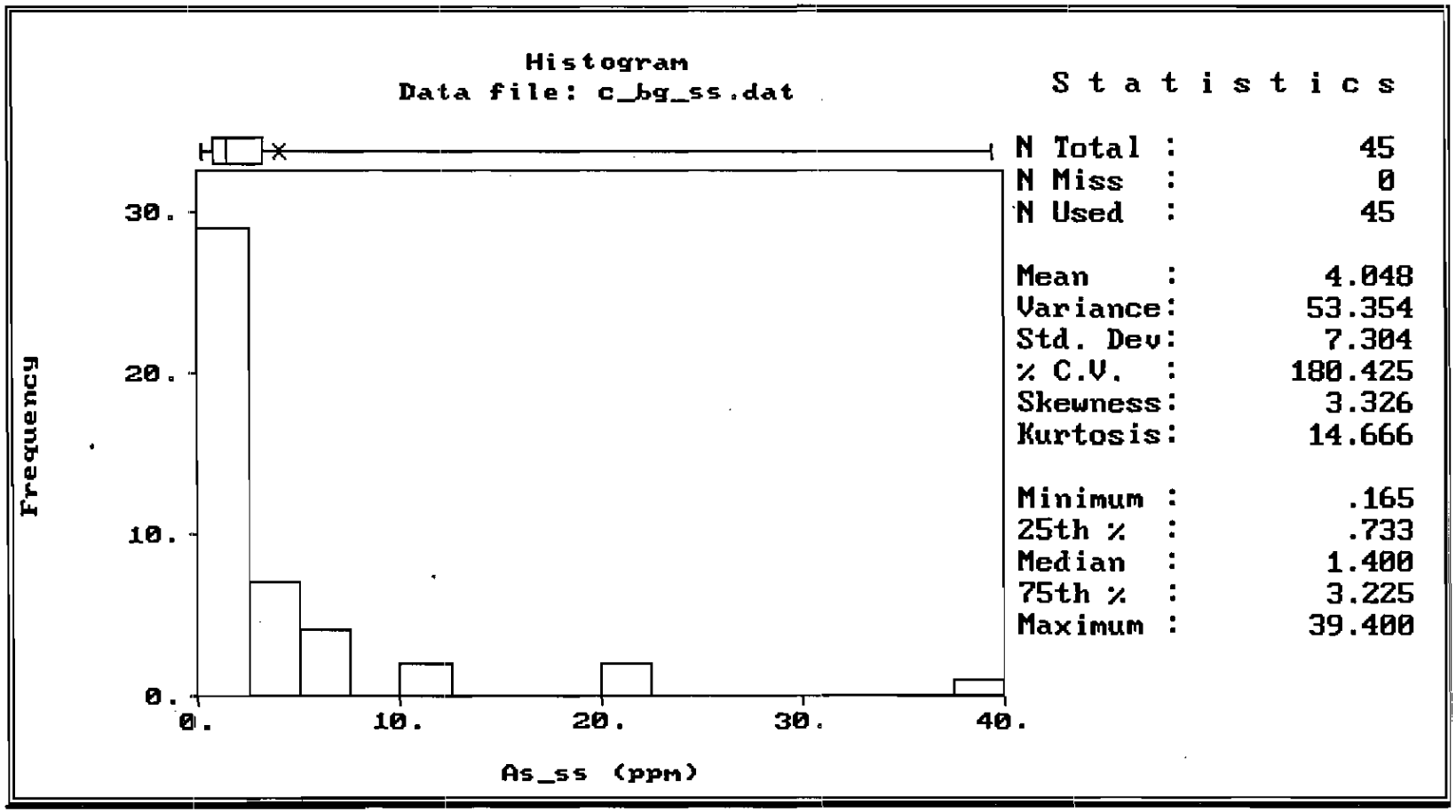


Statistics

N Total :	45
N Miss :	0
N Used :	45
Mean :	8.448
Variance:	.132
Std. Dev:	.364
% C.V. :	4.305
Skewness:	-.050
Kurtosis:	2.552
Minimum :	7.654
25th % :	8.178
Median :	8.432
75th % :	8.691
Maximum :	9.182

Zone C
Arsenic in surface soil grid samples
Original dataset (N=45)
Original values

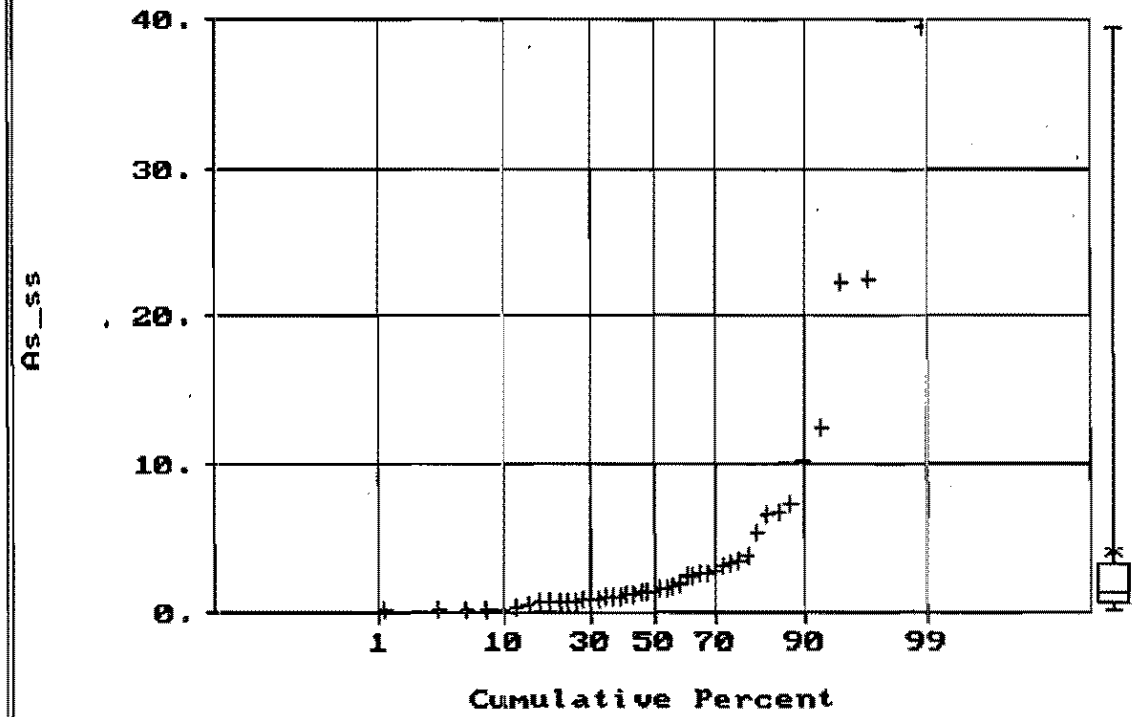
1a



Statistics

N Total :	45
N Miss :	0
N Used :	45
Mean :	4.048
Variance:	53.354
Std. Dev:	7.304
% C.V. :	180.425
Skewness:	3.326
Kurtosis:	14.666
Minimum :	.165
25th % :	.733
Median :	1.400
75th % :	3.225
Maximum :	39.400

Normal Probability Plot for As_ss
Data file: c_bg_ss.dat

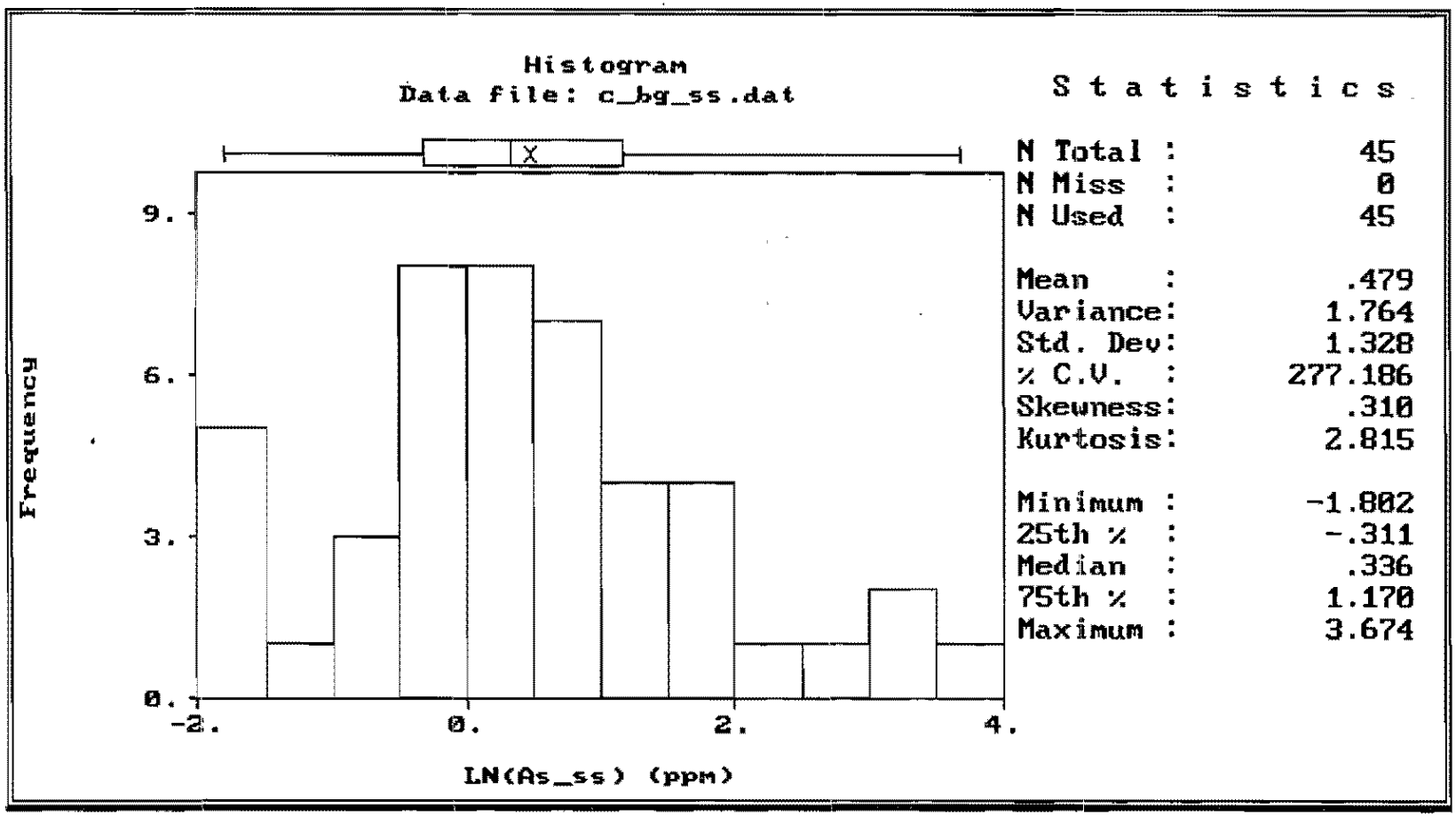


Statistics

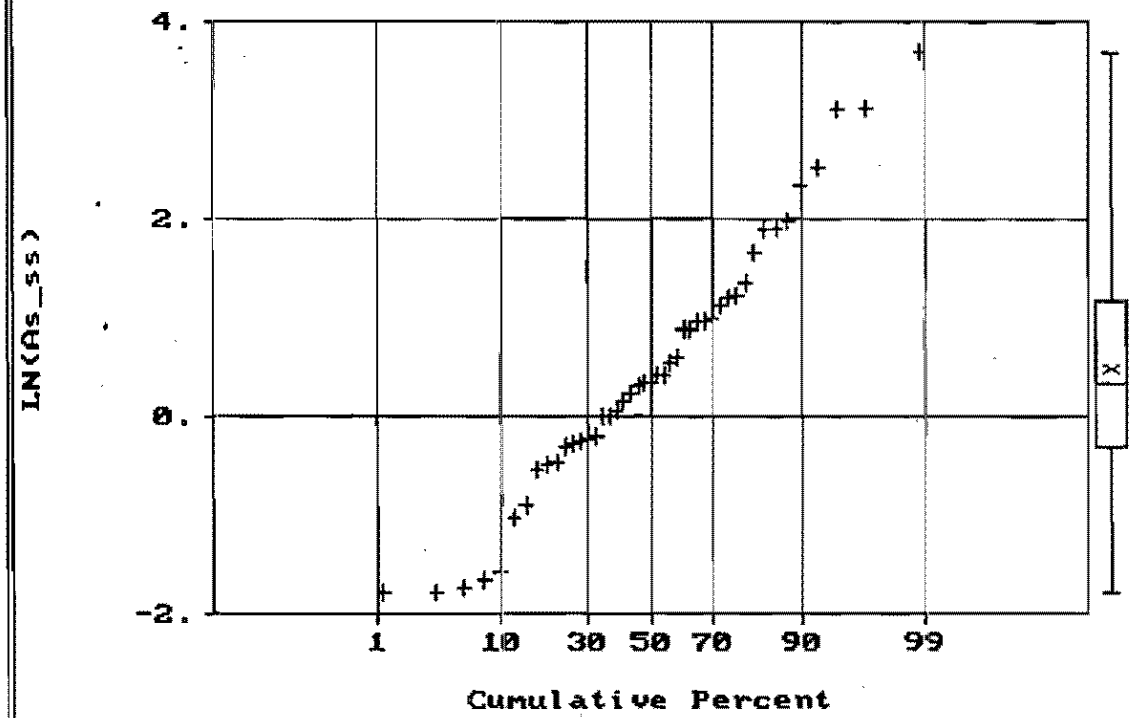
N Total :	45
N Miss :	0
N Used :	45
Mean :	4.048
Variance:	53.354
Std. Dev:	7.304
% C.V. :	180.425
Skewness:	3.326
Kurtosis:	14.666
Minimum :	.165
25th % :	.733
Median :	1.400
75th % :	3.225
Maximum :	39.400

Zone C
Arsenic in surface soil grid samples
Original dataset (N=45)
LN-transformed values

2a



Normal Probability Plot for LN(As_ss)
Data file: c_bg_ss.dat

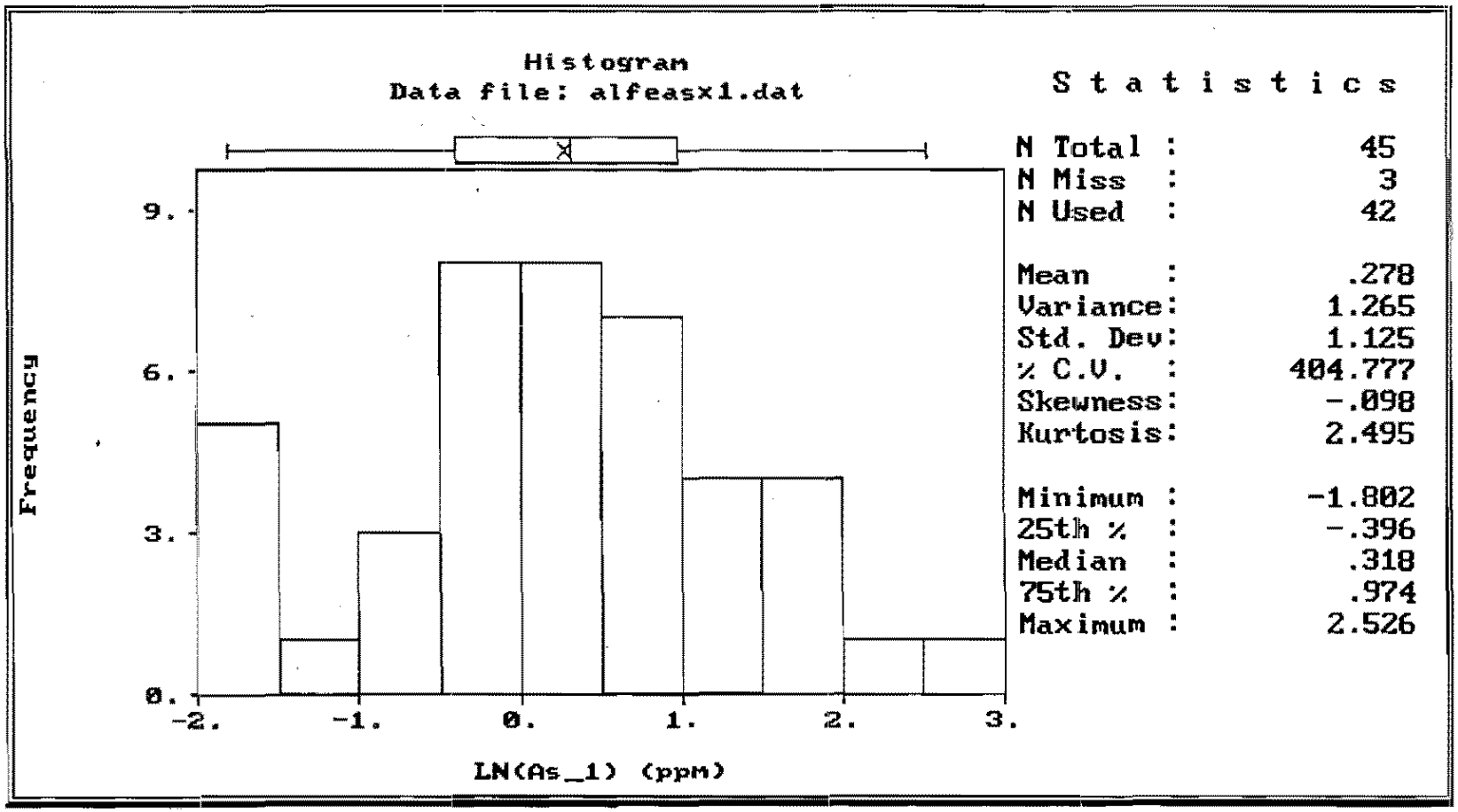


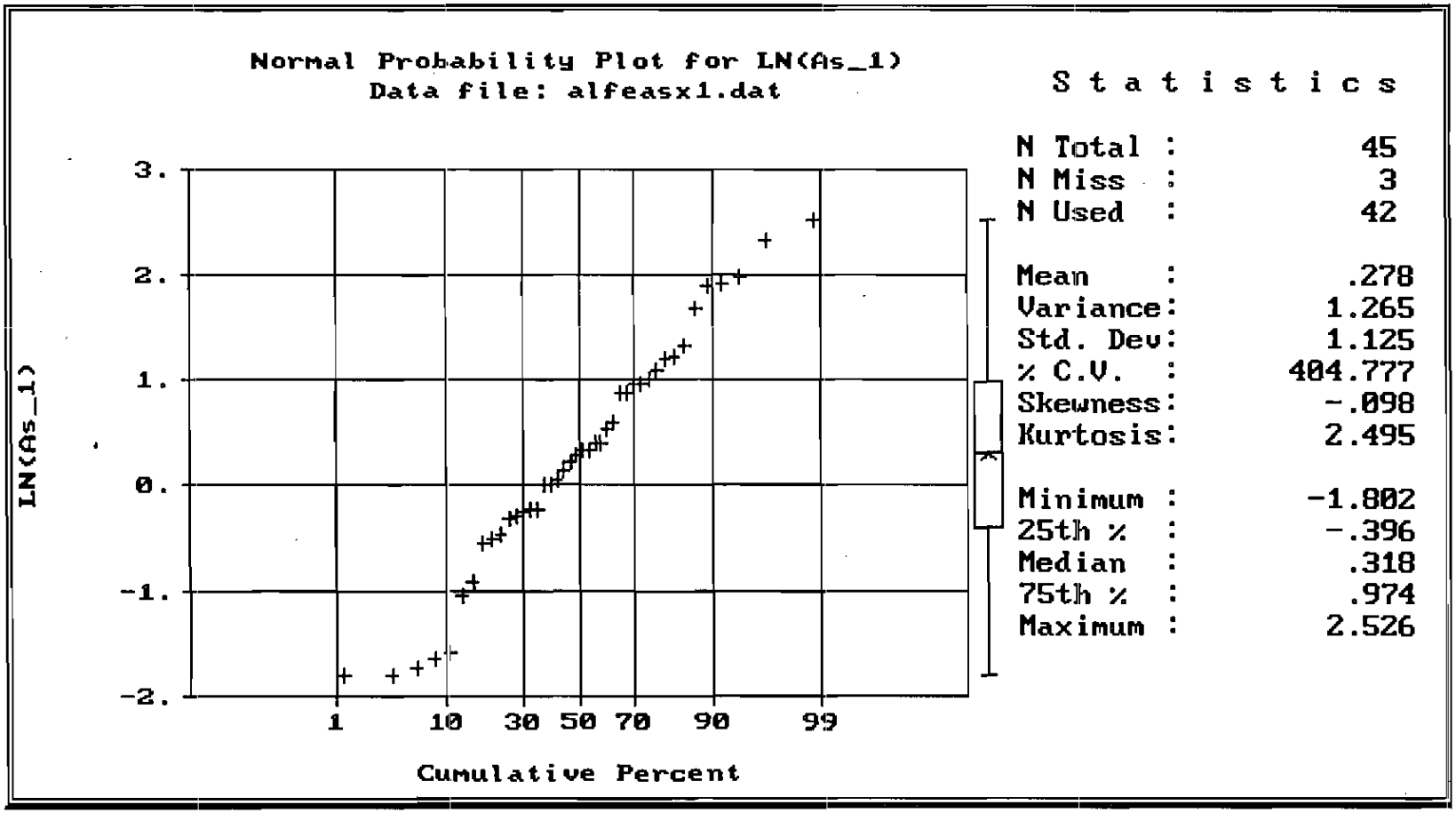
Statistics

N Total :	45
N Miss :	0
N Used :	45
Mean :	.479
Variance:	1.764
Std. Dev:	1.328
% C.V. :	277.186
Skewness:	.310
Kurtosis:	2.815
Minimum :	-1.802
25th % :	-.311
Median :	.336
75th % :	1.170
Maximum :	3.674

Zone C
Arsenic in surface soil grid samples
Samples 02-01, 28-01, and 31-01 removed from dataset (N = 42)
LN-transformed values

3a




Normal Probability Plot for LN(As_1)
Data file: alfeasx1.dat
LN(As_1)
3.
2.
1.
0.
-1.
-2.
1
10
30
50
70
90
99
Cumulative Percent
Statistics
N Total : 45
N Miss : 3
N Used : 42
Mean : .278
Variance: 1.265
Std. Dev: 1.125
% C.V. : 404.777
Skewness: -.098
Kurtosis: 2.495
Minimum : -1.802
25th % : -.396
Median : .318
75th % : .974
Maximum : 2.526

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------->	GDC-S-0012-02		GDC-S-B001-02		GDC-S-B004-02		GDC-S-B008-02		GDC-S-B009-02		GDC-S-B010-02	
	ORIGINAL ID ----->	GRDSB01202		GRDSB00102		GRDSB00402		GRDSB00802		GRDSB00902		GRDSB01002	
	LAB SAMPLE ID --->	702020		690547		703511		691132		697006		702558	
	ID FROM REPORT -->	MAC016		GRDSB00102		GRDSB00402		GRDSB00802		MAC006		MAC006	
	SAMPLE DATE ----->	04/11/95		03/15/95		04/14/95		03/17/95		03/31/95		04/10/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	0001MI	VAL	50012M	VAL	0002MI	VAL	50003M	VAL	0011MI	VAL
7429-90-5	Aluminum (Al)	5220.		3630.		14000.		9320.		5630.		25400.	J
7440-36-0	Antimony (Sb)	0.2	UJ	0.2	UJ	0.36	UJ	0.23	UJ	0.54	UJ	0.34	U
7440-38-2	Arsenic (As)	0.44	J	0.37	U	12.1	J	5.4		3.1	J	14.1	J
7440-39-3	Barium (Ba)	11.5	J	6.9	J	30.2	J	17.1	J	16.7	J	39.6	J
7440-41-7	Beryllium (Be)	0.07	U	0.07	U	0.86	J	0.24	J	0.16	UJ	0.98	J
7440-43-9	Cadmium (Cd)	0.03	U	0.05	U	0.3	U	0.06	U	0.04	U	0.34	UJ
7440-70-2	Calcium (Ca)	64.4	UJ	392.	J	40300.		2490.		9380.		17200.	J
7440-47-3	Chromium (Cr)	6.5		3.7	J	30.		9.8		11.1		39.8	J
7440-48-4	Cobalt (Co)	0.67	J	0.23	J	6.	J	1.4	J	1.	J	7.1	J
7440-50-8	Copper (Cu)	0.71	J	0.55	J	18.6		3.7		17.5		31.5	J
7439-89-6	Iron (Fe)	3460.		732.		20900.		4530.		4700.		26200.	J
7439-92-1	Lead (Pb)	4.3	J	4.3	J	32.6		8.6		57.4		94.6	J
7439-95-4	Magnesium (Mg)	203.	J	109.	J	3940.		494.	J	489.	J	3870.	J
7439-96-5	Manganese (Mn)	18.9		5.1		502.		42.3		31.7		520.	J
7439-97-6	Mercury (Hg)	0.1	U	0.09	U	0.3		0.12	U	0.14		8.5	
7440-02-0	Nickel (Ni)	1.6	U	0.16	UJ	9.3		3.3	J	3.8	J	12.5	J
7440-09-7	Potassium (K)	125.	J	67.1	J	2460.	J	302.	J	237.	J	2170.	J
7782-49-2	Selenium (Se)	0.46	UJ	0.46	UJ	1.5	J	0.69	J	0.52	UJ	2.	J
7440-22-4	Silver (Ag)	0.05	U	0.06	UJ	0.09	U	0.07	UJ	0.06	UJ	0.09	UJ
7440-23-5	Sodium (Na)	91.9	U	124.	U	2160.	J	130.	U	406.	J	290.	J
7440-28-0	Thallium (Tl)	0.47	U	0.58	U	0.85	U	0.68	U	0.53	U	0.8	U
7440-62-2	Vanadium (V)	6.3		1.5	J	40.4		11.		10.6		56.9	J
7440-66-6	Zinc (Zn)	5.	J	3.6		82.3		17.7	J	49.1		149.	J
7440-31-5	Tin (Sn)	1.3	J	0.83	U	1.1	UJ	1.5	J	2.4	U	1.6	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

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*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------->	GDC-S-B013-02		GDC-S-B014-02		GDC-S-B015-02		GDC-S-B019-02		GDC-S-B020-02		GDC-S-B021-02	
	ORIGINAL ID ----->	GRDSB01302		GRDSB01402		GRDSB01502		GRDSB01902		GRDSB02002		GRDSB02102	
	LAB SAMPLE ID --->	702018		703518		702560		703515		702569		701988	
	ID FROM REPORT -->	MAC014		MAC018		MAC008		MAC015		MAC011		MAC003	
	SAMPLE DATE ----->	04/12/95		04/14/95		04/10/95		04/14/95		04/11/95		04/11/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	0011MI	VAL	0011MI	VAL	0011MI	VAL	0011MI	VAL	50009M	VAL
7429-90-5	Aluminum (Al)	3470.		5050.	J	7530.	J	4010.	J	3860.	J	1720.	
7440-36-0	Antimony (Sb)	0.2	UJ	0.2	UJ	0.21	UJ	0.21	UJ	0.2	UJ	0.19	UJ
7440-38-2	Arsenic (As)	0.34	U	0.33	UJ	0.62	J	0.36	UJ	0.34	UJ	0.33	UJ
7440-39-3	Barium (Ba)	10.5	J	3.9	J	18.7	J	16.9	J	18.5	J	3.6	J
7440-41-7	Beryllium (Be)	0.06	U	0.08	UJ	0.21	UJ	0.21	UJ	0.13	UJ	0.03	U
7440-43-9	Cadmium (Cd)	0.03	U	0.03	UJ	0.03	UJ	0.03	UJ	0.03	UJ	0.03	U
7440-70-2	Calcium (Ca)	269.	J	331.	J	738.	J	884.	J	713.	J	96.4	UJ
7440-47-3	Chromium (Cr)	4.1		5.9	J	7.1	J	5.5	J	5.	J	2.5	
7440-48-4	Cobalt (Co)	0.26	J	0.38	UJ	0.66	UJ	0.86	J	0.58	UJ	0.14	J
7440-50-8	Copper (Cu)	0.6	UJ	0.35	J	3.7	J	1.	J	1.3	J	1.5	J
7439-89-6	Iron (Fe)	2410.		726.	J	3220.	J	4280.	J	2740.	J	1170.	
7439-92-1	Lead (Pb)	4.5	J	2.8	J	14.9	J	6.9	J	5.3	J	2.9	J
7439-95-4	Magnesium (Mg)	130.	J	144.	J	330.	J	191.	J	299.	J	74.3	J
7439-96-5	Manganese (Mn)	9.5		3.2	J	57.4	J	72.8	J	24.3	J	5.	
7439-97-6	Mercury (Hg)	0.1	U	0.1	U	0.11	U	0.11	U	0.11	U	0.1	U
7440-02-0	Nickel (Ni)	0.79	U	0.6	J	2.1	J	1.2	J	1.4	J	0.76	U
7440-09-7	Potassium (K)	77.2	J	103.	J	166.	J	111.	J	149.	J	55.5	J
7782-49-2	Selenium (Se)	0.47	UJ	0.49	J	0.72	J	0.58	J	0.47	UJ	0.45	UJ
7440-22-4	Silver (Ag)	0.05	U	0.05	UJ	0.06	UJ	0.06	UJ	0.05	UJ	0.05	U
7440-23-5	Sodium (Na)	114.	U	101.	U	118.	U	136.	J	114.	U	117.	U
7440-28-0	Thallium (Tl)	0.48	U	0.46	U	0.5	U	0.51	U	0.48	U	0.46	U
7440-62-2	Vanadium (V)	5.3	J	1.9	J	5.9	J	8.8	J	4.	J	2.4	J
7440-66-6	Zinc (Zn)	6.1	J	1.3	J	11.4	J	4.7	J	7.4	J	3.6	J
7440-31-5	Tin (Sn)	1.9	J	0.61	UJ	0.65	UJ	0.66	UJ	0.86	J	1.1	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------>	GDC-S-B022-02		GDC-S-B023-02		GDC-C-B023-02		GDC-S-B024-02		GDC-S-B025-02		GDC-S-B026-02	
	ORIGINAL ID ----->	GRDSB02202		GRDSB02302		GRDCB02302		GRDSB02402		GRDSB02502		GRDSB02602	
	LAB SAMPLE ID --->	702007		701990		701996		702005		702456		704088	
	ID FROM REPORT -->	MAC013		MAC005		GRDCB02302		MAC011		MAC005		MAC020	
	SAMPLE DATE ----->	04/11/95		04/11/95		04/11/95		04/11/95		04/12/95		04/17/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	50009M	VAL	0006M	VAL	50009M	VAL	0011MI	VAL	0011MI	VAL
7429-90-5	Aluminum (Al)	3350.		2990.		2180.	J	5020.		5940.	J	4970.	J
7440-36-0	Antimony (Sb)	0.2	UJ	0.2	UJ	0.19	UJ	0.24	UJ	0.21	UJ	0.21	U
7440-38-2	Arsenic (As)	0.33	U	0.33	U	0.32	U	0.4	U	1.9	J	0.36	U
7440-39-3	Barium (Ba)	7.3	J	7.8	J	6.3	J	5.	J	29.8	J	18.2	J
7440-41-7	Beryllium (Be)	0.06	U	0.06	U	0.05	U	0.06	U	0.17	UJ	0.12	UJ
7440-43-9	Cadmium (Cd)	0.03	U	0.03	U	0.03	U	0.04	U	0.28	UJ	0.03	UJ
7440-70-2	Calcium (Ca)	181.	J	89.2	UJ	93.8	J	141.	UJ	1250.	J	490.	J
7440-47-3	Chromium (Cr)	4.2		3.8		2.9		6.2		7.3	J	8.	J
7440-48-4	Cobalt (Co)	0.24	J	0.23	J	0.17	J	0.35	J	1.2	J	0.86	J
7440-50-8	Copper (Cu)	0.57	UJ	0.79	J	0.78	J	1.1	J	11.4	J	1.7	J
7439-89-6	Iron (Fe)	2450.		1880.		1640.		1980.		3350.	J	3820.	J
7439-92-1	Lead (Pb)	3.7	J	3.2	J	2.5		7.1	J	30.	J	4.8	J
7439-95-4	Magnesium (Mg)	156.	J	138.	J	77.	J	69.	J	374.	J	425.	J
7439-96-5	Manganese (Mn)	6.9		9.4		8.5		13.4		38.	J	30.9	J
7439-97-6	Mercury (Hg)	0.09	U	0.1	U	0.1	U	0.12	U	0.26		0.11	U
7440-02-0	Nickel (Ni)	0.81	U	0.97	U	0.57	J	0.5	U	4.1	J	2.1	J
7440-09-7	Potassium (K)	116.	J	68.4	J	41.5	J	52.7	J	160.	J	307.	J
7782-49-2	Selenium (Se)	0.46	UJ	0.45	UJ	0.68	J	0.55	UJ	0.77	J	0.49	UJ
7440-22-4	Silver (Ag)	0.05	U	0.05	U	0.05	UJ	0.06	U	0.06	UJ	0.06	UJ
7440-23-5	Sodium (Na)	109.	U	106.	U	129.	U	125.	U	128.	U	113.	U
7440-28-0	Thallium (Tl)	0.47	U	0.46	U	0.45	U	0.56	U	0.5	U	0.5	U
7440-62-2	Vanadium (V)	5.2		3.9	J	2.7	J	3.3	J	5.8	J	7.1	J
7440-66-6	Zinc (Zn)	6.6	J	3.2	J	2.4		47.6	J	58.1	J	10.2	J
7440-31-5	Tin (Sn)	1.3	J	1.6	J	1.7	J	1.3	J	2.	J	0.66	UJ
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------->	GDC-S-B027-02		GDC-S-B028-02		GDC-S-B029-02		GDC-S-B030-02		GDC-S-B031-02		GDC-S-B032-02	
	ORIGINAL ID ----->	GRDSB02702		GRDSB02802		GRDSB02902		GRDSB03002		GRDSB03102		GRDSB03202	
	LAB SAMPLE ID --->	705232		705234		704094		704095		704100		702453	
	ID FROM REPORT -->	GRDSB02702		GRDSB02802		GRDSB02902		GRDSB03002		GRDSB03102		MAC003	
	SAMPLE DATE ----->	04/20/95		04/20/95		04/17/95		04/17/95		04/17/95		04/12/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50013M	VAL	50013M	VAL	50013M	VAL	50013M	VAL	50013M	VAL	0011MI	VAL
7429-90-5	Aluminum (Al)	17300.		8280.		3120.		4020.		1450.		5740.	J
7440-36-0	Antimony (Sb)	0.26	UJ	0.22	UJ	0.92	J	0.22	J	0.23	UJ	0.2	U
7440-38-2	Arsenic (As)	4.9	U	6.4		1.6	U	31.6		0.83	U	0.36	J
7440-39-3	Barium (Ba)	24.5	J	22.2	J	17.5	J	14.9	J	7.6	J	24.5	J
7440-41-7	Beryllium (Be)	0.61	J	0.12	U	0.11	U	0.13	U	0.06	U	0.17	UJ
7440-43-9	Cadmium (Cd)	0.28	J	0.03	U	0.03	U	0.13	J	0.04	U	0.03	UJ
7440-70-2	Calcium (Ca)	23400.	J	742.	J	1740.	J	2870.	J	638.	J	8740.	J
7440-47-3	Chromium (Cr)	34.2		11.1		3.5		5.5		3.1		6.1	J
7440-48-4	Cobalt (Co)	4.4	J	0.6	J	0.29	J	0.56	J	0.34	J	0.65	UJ
7440-50-8	Copper (Cu)	5.9		1.7		4.8		15.5		0.83	U	2.	J
7439-89-6	Iron (Fe)	16500.		6410.		2160.		2320.		1390.		2810.	J
7439-92-1	Lead (Pb)	20.3		6.4		7.9		24.8		2.4		11.7	J
7439-95-4	Magnesium (Mg)	2480.		331.	J	142.	J	180.	J	137.	J	307.	J
7439-96-5	Manganese (Mn)	40.5	J	3.8	J	18.1	J	18.3	J	11.9	J	26.	J
7439-97-6	Mercury (Hg)	0.19	J	0.12	U	0.11	U	0.18	J	0.12	U	0.11	U
7440-02-0	Nickel (Ni)	7.4	J	1.6	J	0.79	J	1.8	J	0.68	J	1.7	J
7440-09-7	Potassium (K)	1690.	J	253.	J	75.2	J	105.	J	67.2	J	153.	J
7782-49-2	Selenium (Se)	1.2	J	0.51	UJ	0.46	UJ	0.46	UJ	0.53	UJ	0.47	UJ
7440-22-4	Silver (Ag)	0.07	U	0.06	U	0.05	U	0.05	U	0.06	U	0.05	UJ
7440-23-5	Sodium (Na)	125.	J	113.	J	109.	J	126.	J	133.	J	214.	U
7440-28-0	Thallium (Tl)	0.63	U	0.52	U	0.47	U	0.47	U	0.54	U	0.48	U
7440-62-2	Vanadium (V)	35.2		16.9		4.1	J	4.7	J	2.9	J	5.	J
7440-66-6	Zinc (Zn)	57.5	J	8.2	J	17.4	J	86.9	J	4.8	J	9.7	J
7440-31-5	Tin (Sn)	0.82	U	1.7	U	1.6	U	2.8	U	1.6	U	0.64	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------->	GDC-S-B033-02		GDC-S-B034-02		GDC-C-B035-02		GDC-S-B035-02		GDC-S-B036-02		GDC-S-B037-02	
	ORIGINAL ID ----->	GRDSB03302		GRDSB03402		GRDSB03502		GRDSB03502		GRDSB03602		GRDSB03702	
	LAB SAMPLE ID --->	702003		702001		702433		702439		704099		702445	
	ID FROM REPORT -->	MAC009		MAC007		GRDSB03502		MAC018		GRDSB03602		MAC020	
	SAMPLE DATE ----->	04/11/95		04/11/95		04/12/95		04/12/95		04/17/95		04/12/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A	MG/KG	A
CAS #	Parameter	50009M	VAL	50009M	VAL	50010M	VAL	50009M	VAL	50013M	VAL	50009M	VAL
7429-90-5	Aluminum (Al)	3950.		1480.		9340.		8460.		16600.		4060.	
7440-36-0	Antimony (Sb)	0.2	UJ	0.2	UJ	0.24	UJ	0.24	UJ	0.25	UJ	0.2	UJ
7440-38-2	Arsenic (As)	0.34	U	0.33	U	2.2	J	1.9		11.2		0.34	U
7440-39-3	Barium (Ba)	9.8	J	3.7	J	37.9		30.		64.6	J	12.9	J
7440-41-7	Beryllium (Be)	0.06	U	0.03	U	0.37	U	0.32	U	0.43	U	0.13	U
7440-43-9	Cadmium (Cd)	0.03	U	0.03	U	0.04	U	0.04	U	0.23	J	0.03	U
7440-70-2	Calcium (Ca)	248.	J	86.7	U	13400.	J	20700.	J	1590.	J	537.	
7440-47-3	Chromium (Cr)	5.1		2.		7.2		9.4		31.8		4.8	
7440-48-4	Cobalt (Co)	0.4	J	0.14	J	0.6	U	0.68	J	4.7	J	0.44	J
7440-50-8	Copper (Cu)	0.54	UJ	0.26	UJ	5.5		5.3		1.1	U	0.72	J
7439-89-6	Iron (Fe)	1570.		1010.		3040.		2910.		36700.		1360.	
7439-92-1	Lead (Pb)	5.5	J	1.9	J	15.4		13.	J	9.6		3.	J
7439-95-4	Magnesium (Mg)	101.	J	62.2	J	623.	J	896.		1070.		210.	J
7439-96-5	Manganese (Mn)	11.4		3.2		35.3		31.6		17.8	J	8.6	
7439-97-6	Mercury (Hg)	0.11	U	0.1	U	0.13	U	0.12	U	0.13	U	0.1	U
7440-02-0	Nickel (Ni)	0.85	U	0.62	U	3.1	J	4.1	J	4.6	J	1.3	U
7440-09-7	Potassium (K)	70.	J	41.3	J	187.	J	278.	J	615.	J	109.	J
7782-49-2	Selenium (Se)	0.47	UJ	0.46	UJ	0.94	J	0.61	J	2.9	J	0.47	UJ
7440-22-4	Silver (Ag)	0.05	U	0.05	U	0.06	U	0.06	U	0.07	U	0.05	U
7440-23-5	Sodium (Na)	108.	U	124.	U	206.	U	237.	J	107.	J	108.	U
7440-28-0	Thallium (Tl)	0.48	U	0.47	U	0.57	U	0.57	U	0.93	J	0.48	U
7440-62-2	Vanadium (V)	2.3	J	1.7	J	4.9	J	6.4		51.2		2.5	J
7440-66-6	Zinc (Zn)	26.8	J	2.1	J	16.9		19.3	J	23.4	J	4.6	J
7440-31-5	Tin (Sn)	1.1	J	1.	J	0.75	U	0.74	U	0.79	U	0.86	J
57-12-5	Cyanide (CN)	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results
Subsurface Soil: 30 Samples

SW846-META	SAMPLE ID ------->	GDC-S-B038-02		GDC-S-B039-02					
	ORIGINAL ID ----->	GDCSB03802		GDCSB03902					
	LAB SAMPLE ID --->	737186		737243					
	ID FROM REPORT -->	GDCSB03802		GDCSB03902					
	SAMPLE DATE ----->	06/29/95		06/29/95					
	MATRIX ---------->	Soil		Soil					
	UNITS ---------->	MG/KG	A	MG/KG	A				
CAS #	Parameter	21521M	VAL	50022M	VAL				
7429-90-5	Aluminum (Al)	2260.		6590.					
7440-36-0	Antimony (Sb)	0.2	UJ	0.59	J				
7440-38-2	Arsenic (As)	0.34	U	2.7					
7440-39-3	Barium (Ba)	8.6	J	18.	J				
7440-41-7	Beryllium (Be)	0.1	U	0.08	U				
7440-43-9	Cadmium (Cd)	0.03	U	0.05	U				
7440-70-2	Calcium (Ca)	404.	J	2600.					
7440-47-3	Chromium (Cr)	2.4		7.3					
7440-48-4	Cobalt (Co)	0.06	U	0.46	J				
7440-50-8	Copper (Cu)	0.68	U	3.					
7439-89-6	Iron (Fe)	1290.		4180.					
7439-92-1	Lead (Pb)	2.5		21.1					
7439-95-4	Magnesium (Mg)	95.1	J	247.	J				
7439-96-5	Manganese (Mn)	9.8		15.2					
7439-97-6	Mercury (Hg)	0.11	U	0.11	U				
7440-02-0	Nickel (Ni)	0.75	J	1.9	J				
7440-09-7	Potassium (K)	63.6	J	135.	J				
7782-49-2	Selenium (Se)	0.46	U	0.63					
7440-22-4	Silver (Ag)	0.05	U	0.07	U				
7440-23-5	Sodium (Na)	189.	U	201.	J				
7440-28-0	Thallium (Tl)	0.47	U	0.39	U				
7440-62-2	Vanadium (V)	2.7	J	8.7					
7440-66-6	Zinc (Zn)	3.	J	168.					
7440-31-5	Tin (Sn)	1.	J	1.5	J				
57-12-5	Cyanide (CN)	??????????		??????????					

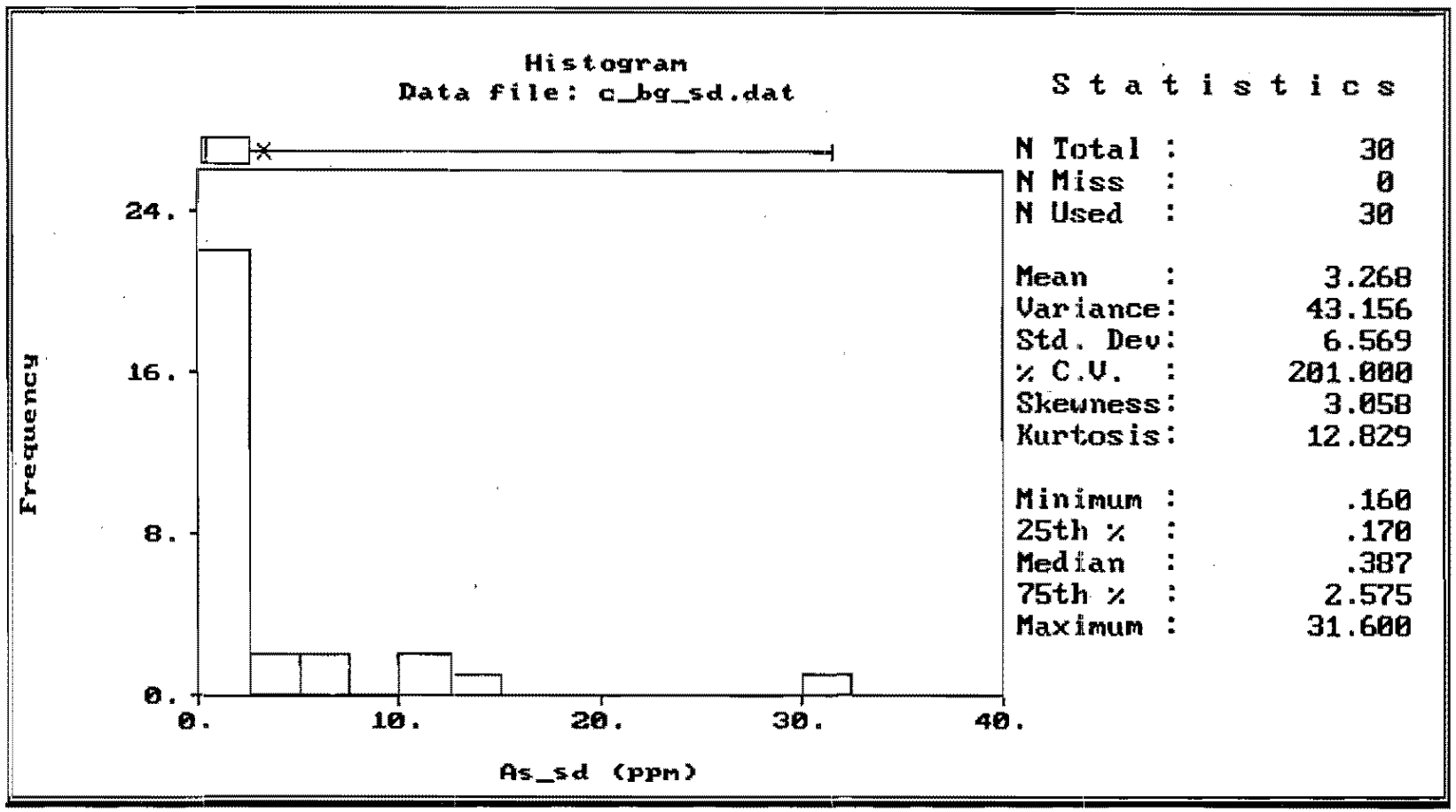
O

O

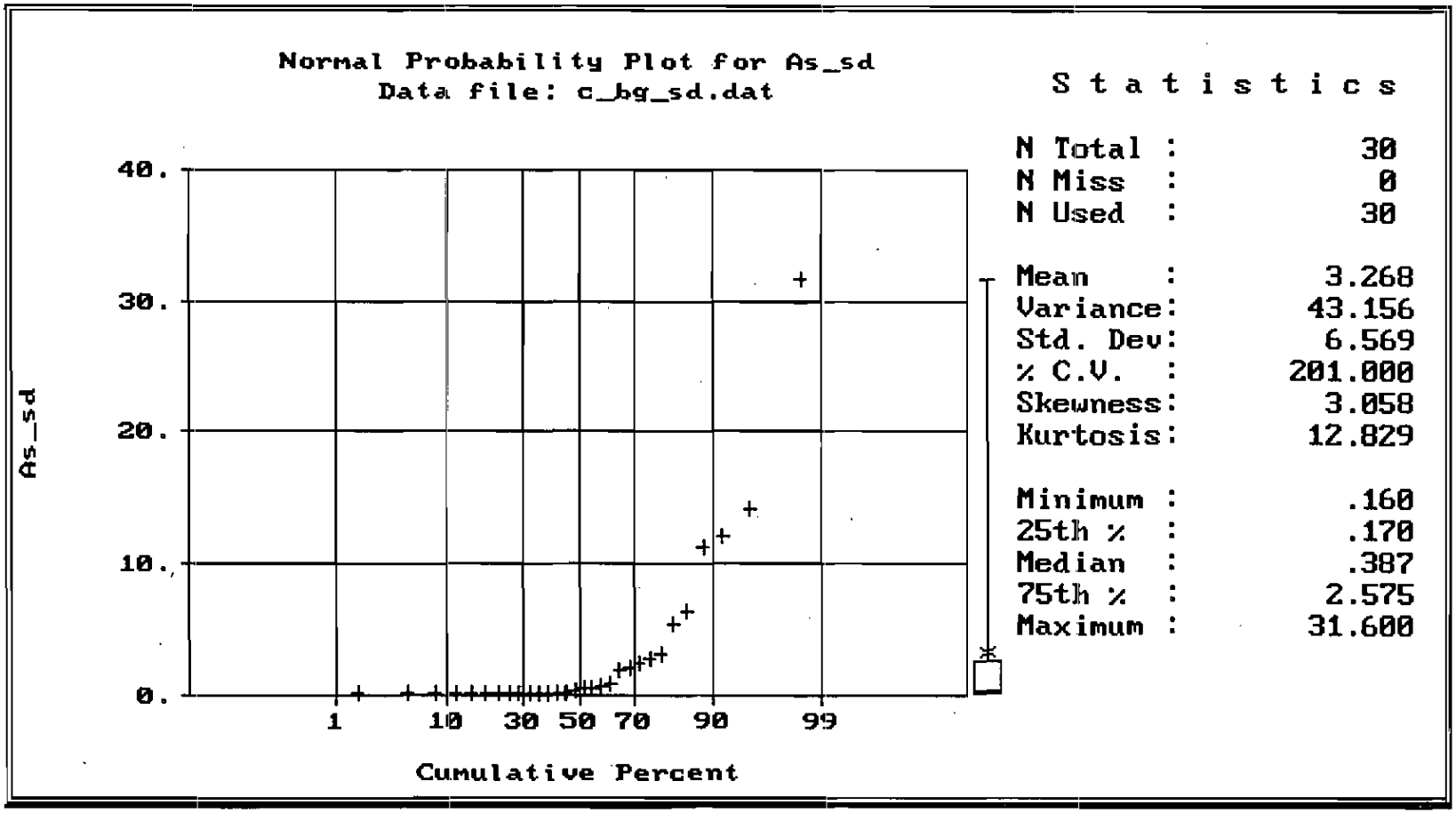
*** Validation Complete ***

Zone C
Arsenic in subsurface soil grid samples
Original dataset (N = 30)
Original values

1a

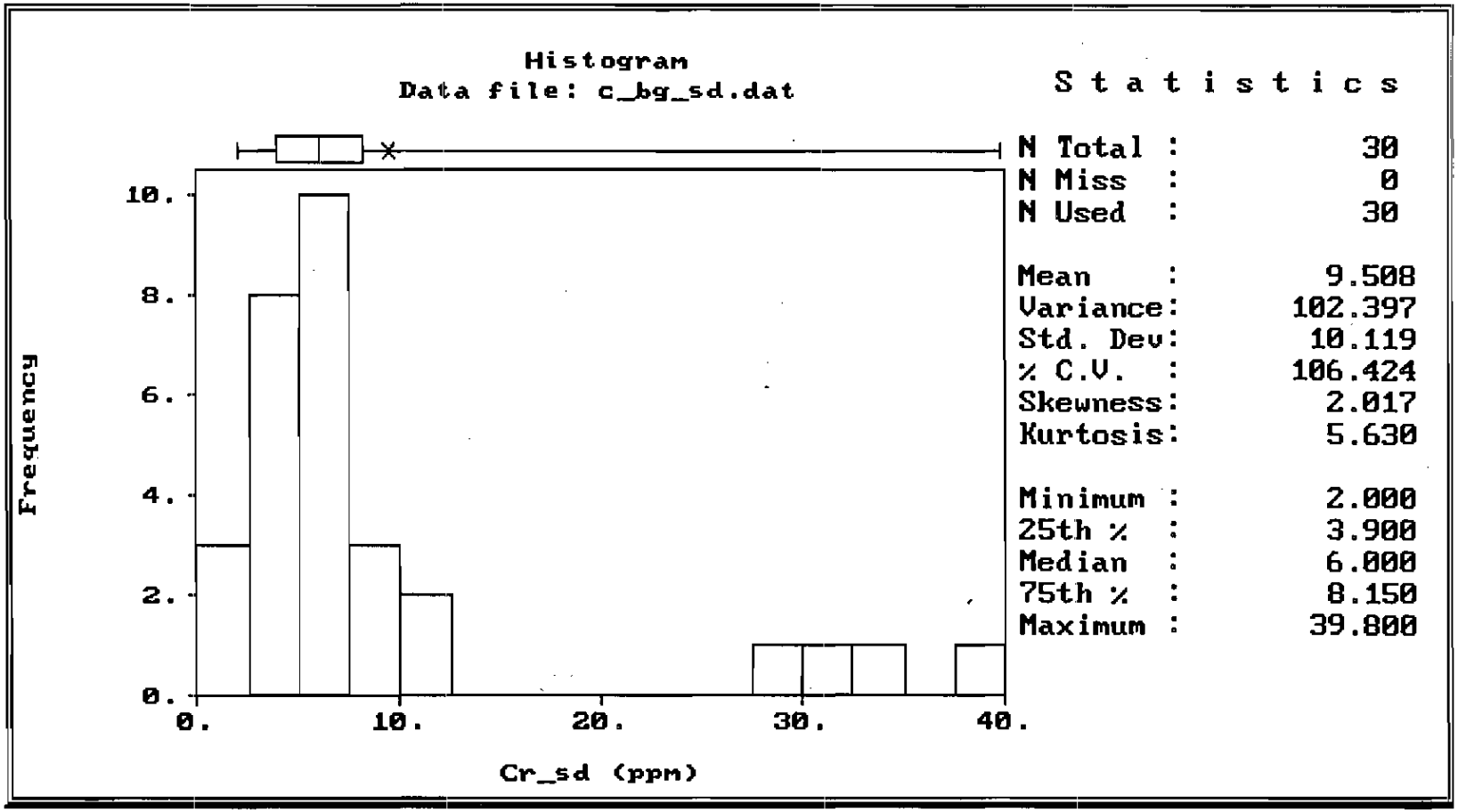


1b

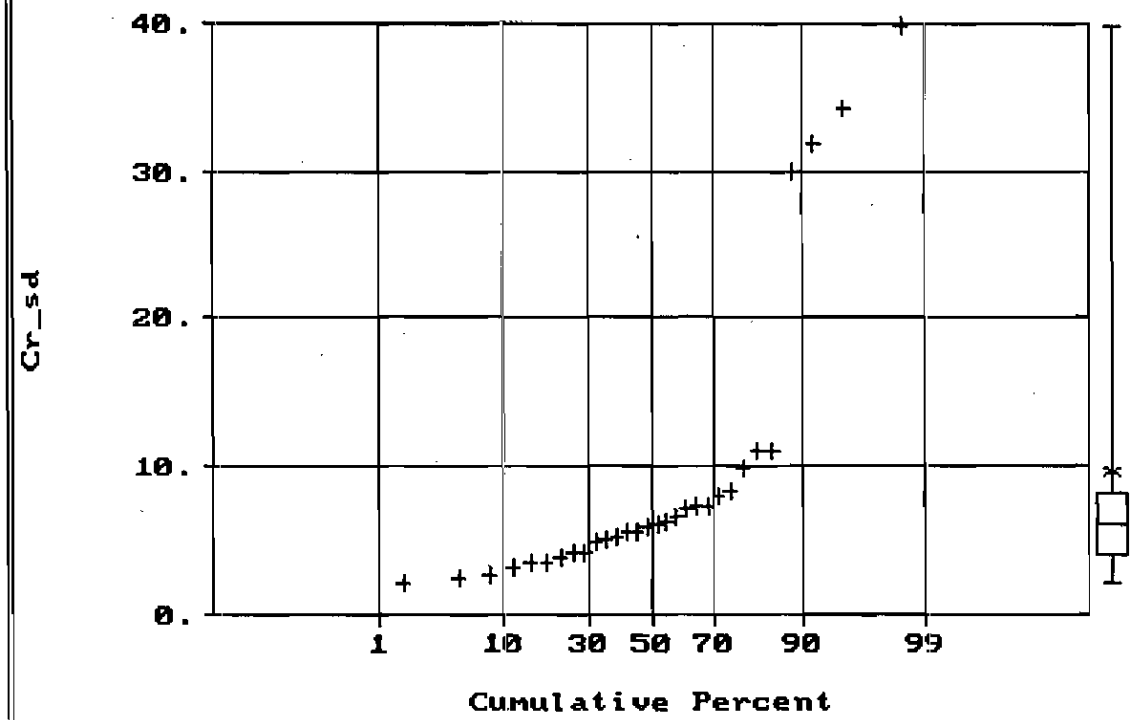

Normal Probability Plot for As_sd
Data file: c_bg_sd.dat
As_sd
40.
30.
20.
10.
0.
1
10
30
50
70
90
99
Cumulative Percent
Statistics
N Total : 30
N Miss : 0
N Used : 30
Mean : 3.268
Variance: 43.156
Std. Dev: 6.569
% C.V. : 201.000
Skewness: 3.058
Kurtosis: 12.829
Minimum : .160
25th % : .170
Median : .387
75th % : 2.575
Maximum : 31.600

Zone C
Chromium in subsurface soil grid samples
Original dataset (N = 30)
Original values

1a



Normal Probability Plot for Cr_sd
Data file: c_bg_sd.dat

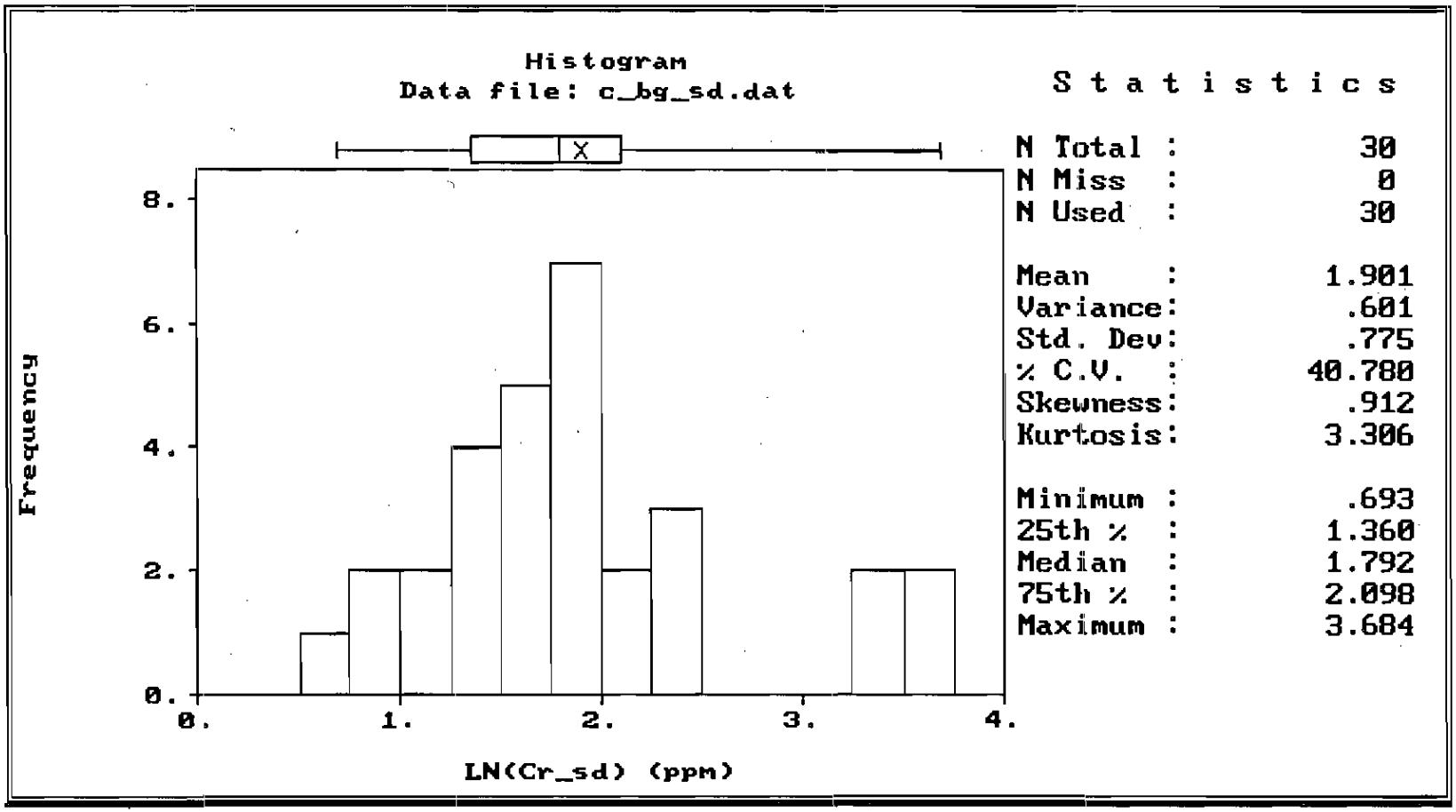


Statistics

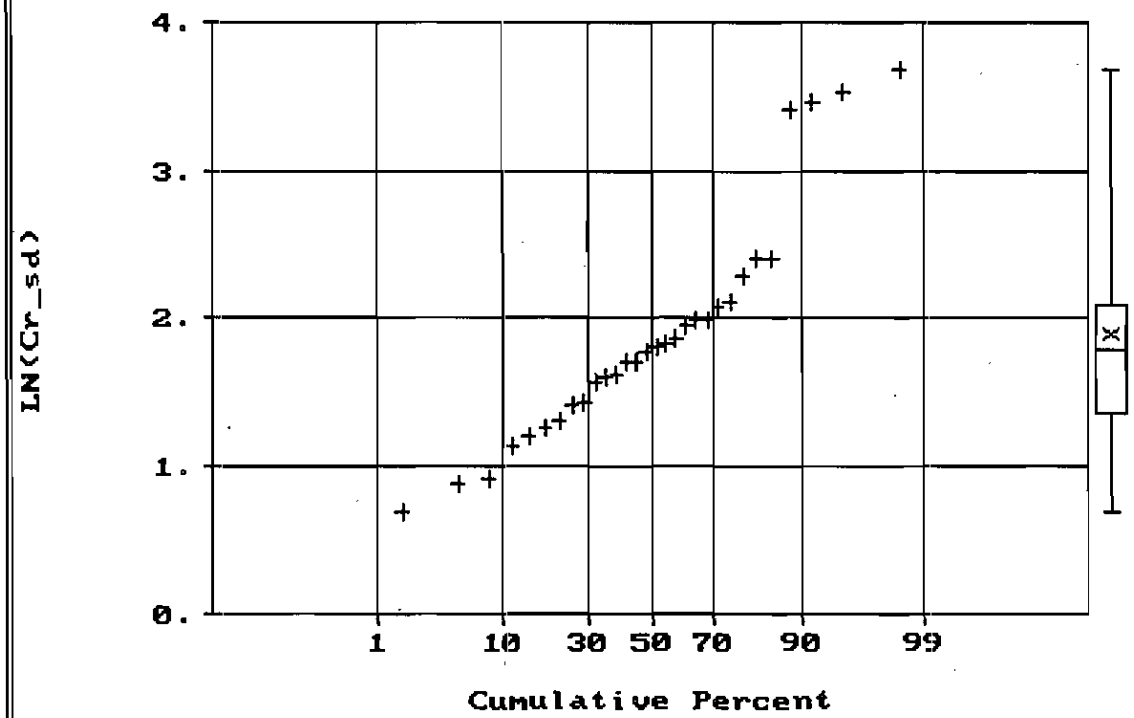
N Total :	30
N Miss :	0
N Used :	30
Mean :	9.508
Variance:	102.397
Std. Dev:	10.119
% C.V. :	106.424
Skewness:	2.017
Kurtosis:	5.630
Minimum :	2.000
25th % :	3.900
Median :	6.000
75th % :	8.150
Maximum :	39.800

Zone C
Chromium in subsurface soil grid samples
Original dataset (N=30)
LN-transformed values

2a



Normal Probability Plot for LN(Cr_sd)
Data file: c_bg_sd.dat



Statistics

N Total :	30
N Miss :	0
N Used :	30
Mean :	1.901
Variance:	.601
Std. Dev:	.775
% C.V. :	40.780
Skewness:	.912
Kurtosis:	3.306
Minimum :	.693
25th % :	1.360
Median :	1.792
75th % :	2.098
Maximum :	3.684

E N V I R O N M E N T A L S A F E T Y & D E S I G N S

2903-00001 - CHARLESTON ZONE C - SOIL ~~& 1ST GW~~

Samples by Chemical Report

18540-29-9 - Chromium (Hexavalent)

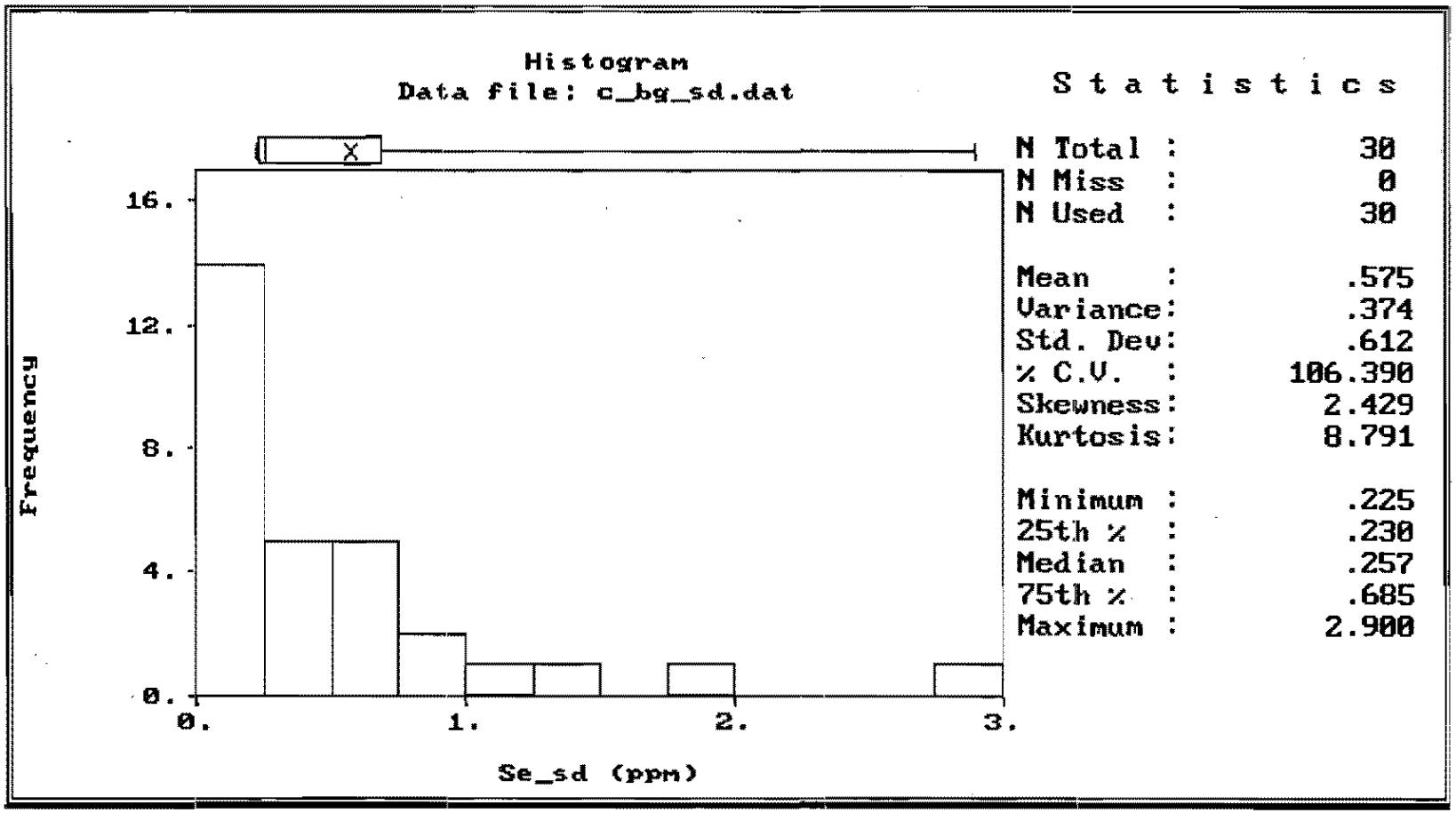
>= 0.0000 for MG/KG

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
044-C-B007-01	044CB00701	Soil	03/14/95	0.0100	UJ	MG/KG	30215.IT	VAL
047-C-B004-01	047CB00401	Soil	04/13/95	0.0100	UJ	MG/KG	30215.1OT	VAL
047-C-B009-01	047CB00901	Soil	04/14/95	0.2590		MG/KG	30215.12T	VAL
508-C-B006-01	508CB00601	Soil	03/21/95	0.0100	UJ	MG/KG	30215.1T	VAL
510-C-B005-02	510CB00502	Soil	03/14/95	0.0100	UJ	MG/KG	30215.IT	VAL
511-C-B005-02	511CB00502	Soil	03/21/95	0.0100	UJ	MG/KG	30215.1T	VAL
512-C-B003-01	512CB00301	Soil	03/15/95	0.0100	UJ	MG/KG	30215.IT	VAL
513-C-B002-02	513CB00202	Soil	04/12/95	0.0100	UJ	MG/KG	30215.1OT	VAL
515-C-B006-02	515CB00602	Soil	04/18/95	0.0100	UJ	MG/KG	30215.12T	VAL
517-C-B002-02	517CB00202	Soil	04/11/95	0.0100	U	MG/KG	30215.4T	VAL
518-C-B004-01	518CB00401	Water	04/05/95	0.0100	U	MG/KG	0005T	VAL
518-C-B006-01	518CB00601	Water	04/01/95	0.0100	UJ	MG/KG	30215.21T	VAL
519-C-B001-01	519CB00101	Soil	04/22/95	1.1900		MG/KG	30215.15T	VAL
520-C-B003-02	520CB00302	Soil	04/07/95	0.0100	U	MG/KG	0006T	VAL
522-C-B003-01	522CB00301	Soil	06/06/96	0.2740	U	MG/KG	25887	VAL
523-C-B002-02	523CB00202	Soil	04/11/95	0.2610		MG/KG	30215.4T	VAL
700-C-B003-01	700CB00301	Soil	06/05/96	0.2660	U	MG/KG	25887	VAL
GDC-C-B013-01	GRDCB01301	Soil	04/11/95	0.0100	U	MG/KG	0006T	VAL
GDC-C-B017-01	GRDCB01701	Soil	04/10/95	0.0100	UJ	MG/KG	30215.1OT	VAL
GDC-C-B023-02	GRDCB02302	Soil	04/11/95	0.0100	U	MG/KG	0006T	VAL
GDC-C-B035-02	GRDCB03502	Soil	04/12/95	0.0100	UJ	MG/KG	30215.1OT	VAL
GDC-C-B045-01	GDCCB04501	Water	04/01/95	0.0100	UJ	MG/KG	30215.21T	VAL

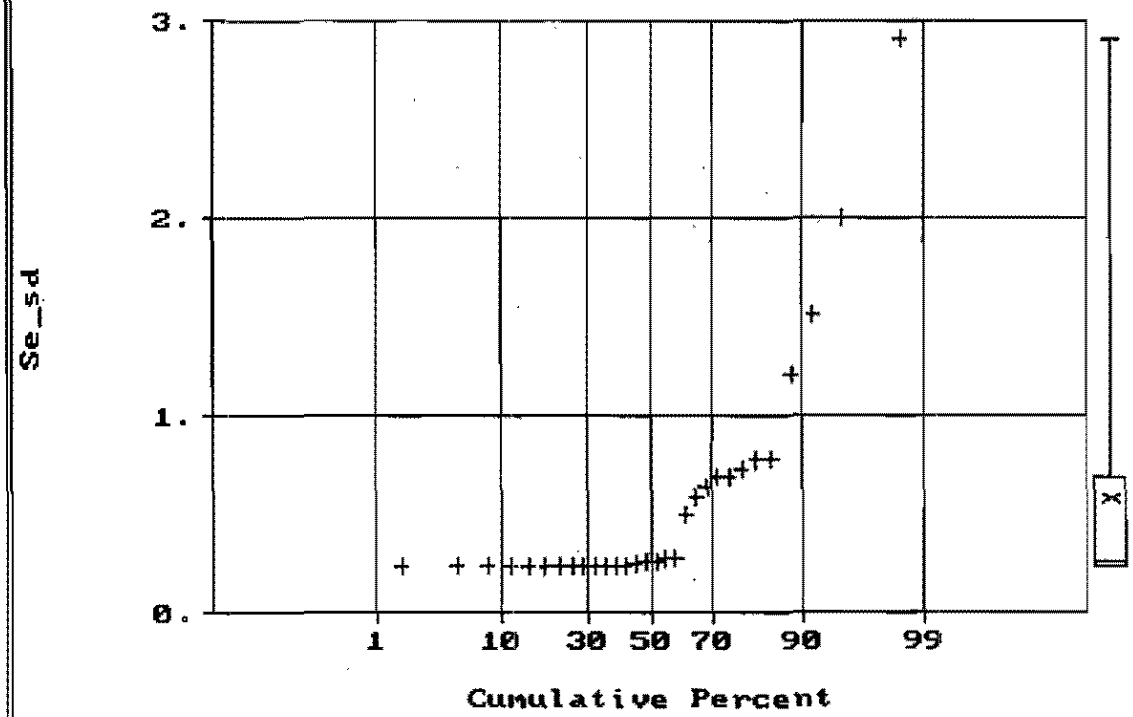
*** End of Report ***

Zone C
Selenium in subsurface soil grid samples
Original dataset (N=30)
Original values

1a



Normal Probability Plot for Se_sd
Data file: c_bg_sd.dat

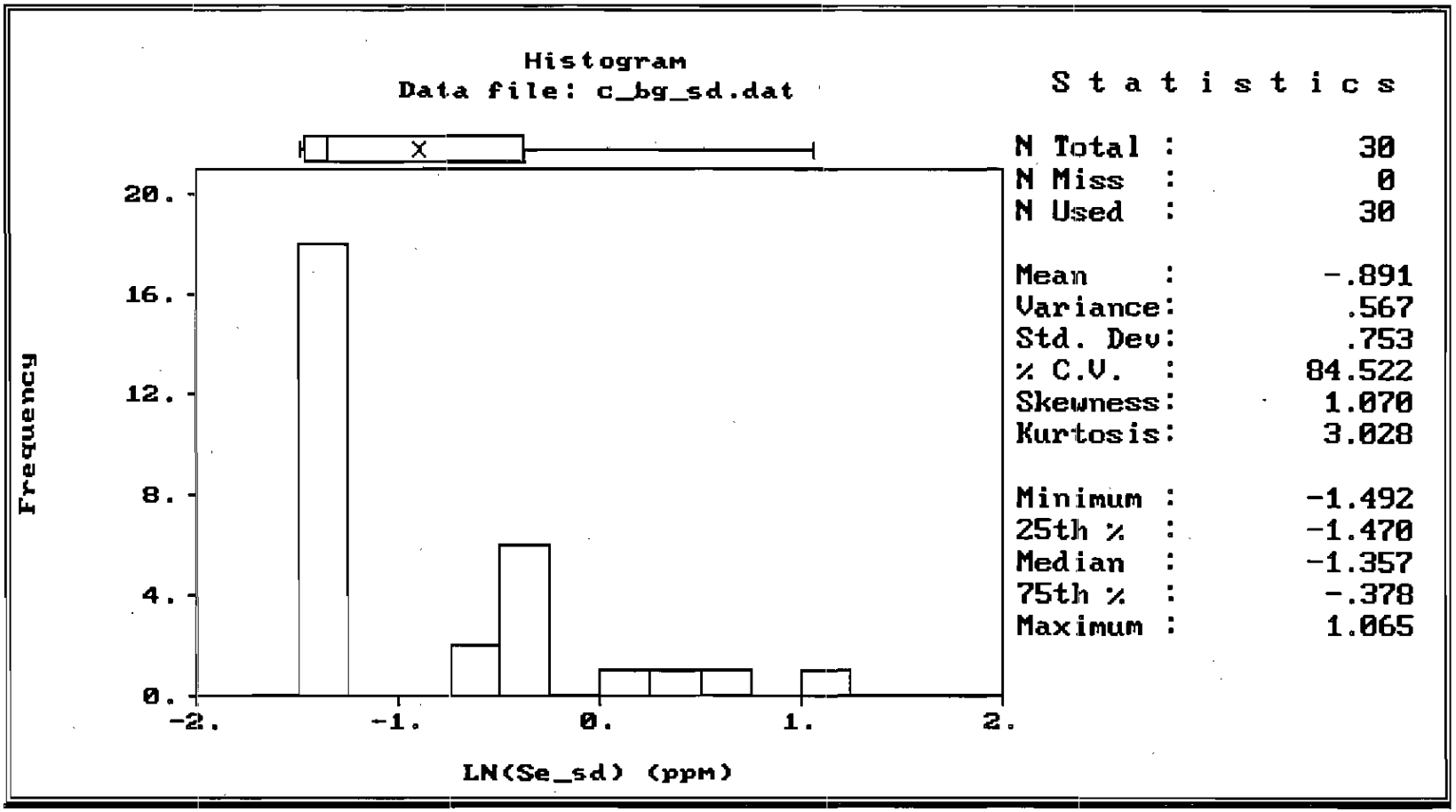


Statistics

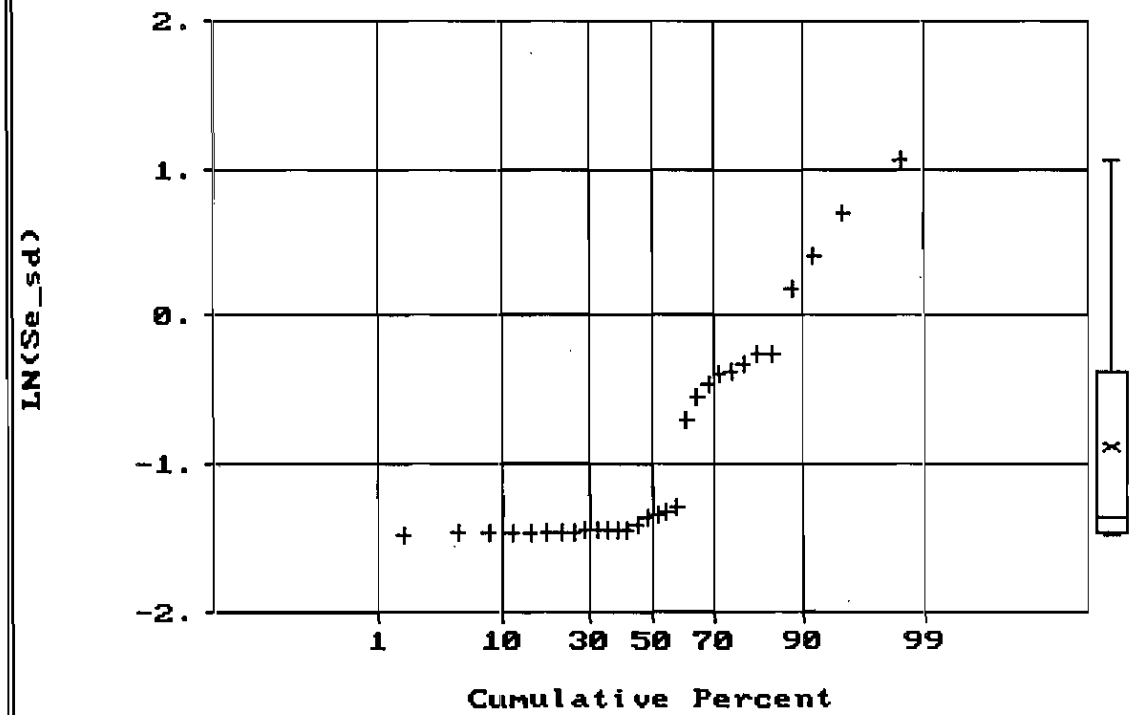
N Total :	30
N Miss :	0
N Used :	30
Mean :	.575
Variance:	.374
Std. Dev:	.612
% C.V. :	106.390
Skewness:	2.429
Kurtosis:	8.791
Minimum :	.225
25th % :	.230
Median :	.257
75th % :	.685
Maximum :	2.900

Zone C
Selenium in subsurface soil grid samples
Original dataset (N = 30)
LN-transformed values

2a



Normal Probability Plot for LN(Se_sd)
Data file: c_bg_sd.dat



S t a t i s t i c s

N Total :	30
N Miss :	0
N Used :	30
Mean :	-.891
Variance:	.567
Std. Dev:	.753
% C.V. :	84.522
Skewness:	1.070
Kurtosis:	3.028
Minimum :	-1.492
25th % :	-1.470
Median :	-1.357
75th % :	-.378
Maximum :	1.065

DATALCP3
04/29/97

CHARLESTON - ZONE C
Background Sample Results - Round 1
Shallow Groundwater, Wells 1-2

SW846-META											
	SAMPLE ID ------->	GDC-G-W001-01		GDC-C-W002-01							
	ORIGINAL ID ----->	GDCGW00101		GRDGW00201							
	LAB SAMPLE ID --->	730822		709211							
	ID FROM REPORT -->	GDCGW00101		GRDGW00201							
	SAMPLE DATE ----->	06/12/95		04/25/95							
	MATRIX ---------->	Water		Water							
	UNITS ---------->	UG/L	A	UG/L	A						
CAS #	Parameter	1517MI	VAL	50016M	VAL						
7429-90-5	Aluminum (Al)	620.		63.9	J						
7440-36-0	Antimony (Sb)	1.9	U	1.9	U						
7440-38-2	Arsenic (As)	3.2	U	3.2	U						
7440-39-3	Barium (Ba)	8.4	U	13.4	J						
7440-41-7	Beryllium (Be)	0.2	U	0.2	U						
7440-43-9	Cadmium (Cd)	0.3	U	0.3	U						
7440-70-2	Calcium (Ca)	35200.		128000.							
7440-47-3	Chromium (Cr)	2.1	J	0.9	U						
7440-48-4	Cobalt (Co)	0.6	U	0.6	U						
7440-50-8	Copper (Cu)	2.7	UJ	1.8	U						
7439-89-6	Iron (Fe)	566.		3480.							
7439-92-1	Lead (Pb)	9.1	U	1.9	U						
7439-95-4	Magnesium (Mg)	1000.	J	7710.							
7439-96-5	Manganese (Mn)	30.4		527.							
7439-97-6	Mercury (Hg)	0.2	U	0.2	U						
7440-02-0	Nickel (Ni)	1.6	J	1.4	U						
7440-09-7	Potassium (K)	560.	J	5380.							
7782-49-2	Selenium (Se)	4.4	U	4.4	U						
7440-22-4	Silver (Ag)	0.5	U	0.5	U						
7440-23-5	Sodium (Na)	3550.	U	9640.							
7440-28-0	Thallium (Tl)	4.5	U	4.5	UJ						
7440-62-2	Vanadium (V)	1.9	J	0.86	U						
7440-66-6	Zinc (Zn)	13.4	J	5.8	J						
7440-31-5	Tin (Sn)	56.3	U	5.9	UJ						
57-12-5	Cyanide (CN)	??????????		??????????							

*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results - Rounds 2-4
Shallow Groundwter, Wells 1-2

SW846-META													
	SAMPLE ID ------->	GDC-G-W001-02		GDC-H-W001-02		GDC-G-W001-03		GDC-H-W001-03		GDC-G-W001-04		GDC-H-W001-04	
	ORIGINAL ID ----->	GDCGW00102		GDCHW00102		GDCGW00103		GDCHW00103		GDCGW00104		GDCHW00104	
	LAB SAMPLE ID --->	24543.01		24544.01		25504.03		25505.01		25997.01		25998.01	
	ID FROM REPORT -->	GDCGW00102		GDCHW00102		GDCGW00103		GDCHW00103		GDCGW00104		GDCHW00104	
	SAMPLE DATE ----->	01/22/96		01/22/96		05/06/96		05/06/96		06/12/96		06/12/96	
	DATE EXTRACTED -->	01/24/96		01/24/96		05/16/96		05/16/96		06/30/96		06/30/96	
	DATE ANALYZED --->	01/26/96		01/26/96		05/30/96		05/30/96		07/03/96		07/03/96	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L	A	UG/L	A	UG/L	A	UG/L	A	UG/L	A	UG/L	A
CAS #	Parameter	24514	VAL	24514	VAL	25504	VAL	25504	VAL	25997	VAL	25997	VAL
7429-90-5	Aluminum (Al)	272.		288.		317.	U	322.	U	392.		408.	
7440-36-0	Antimony (Sb)	2.1	U	2.2	U	13.	U	13.	U	2.1	U	2.1	U
7440-38-2	Arsenic (As)	3.9	J	3.2	J	3.2	J	3.5	J	2.8	UJ	4.3	J
7440-39-3	Barium (Ba)	4.6		4.3		5.7	U	5.2	U	4.9	J	5.	J
7440-41-7	Beryllium (Be)	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U
7440-43-9	Cadmium (Cd)	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
7440-70-2	Calcium (Ca)	27000.	J	27100.		27700.		24700.		25700.		26500.	
7440-47-3	Chromium (Cr)	0.8	U	1.5	J	2.2	U	2.2	U	0.8	UJ	0.92	J
7440-48-4	Cobalt (Co)	0.9	U	0.9	U	5.2	U	5.2	U	5.2	U	5.2	U
7440-50-8	Copper (Cu)	1.6	UJ	1.5	J	1.4	UJ	1.4	U	4.5	U	5.	U
7439-89-6	Iron (Fe)	288.		316.		416.		371.		785.		765.	
7439-92-1	Lead (Pb)	1.7	U	1.7	U	1.7	U	1.7	U	2.7	J	1.7	U
7439-95-4	Magnesium (Mg)	722.		705.		756.	U	642.	U	697.		713.	
7439-96-5	Manganese (Mn)	18.3		18.2		22.8	U	19.9	U	25.8		26.5	
7439-97-6	Mercury (Hg)	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
7440-02-0	Nickel (Ni)	0.8	U	0.8	U	6.6	U	5.3	U	0.8	UJ	0.8	UJ
7440-09-7	Potassium (K)	2330.	U	1600.	U	1600.	U	1600.	U	1600.	U	1600.	U
7782-49-2	Selenium (Se)	2.8	UJ	2.8	U	2.8	U	2.8	U	2.8	U	2.8	U
7440-22-4	Silver (Ag)	1.2	U	1.5	J	1.7	U	1.3	U	1.2	UJ	1.2	UJ
7440-23-5	Sodium (Na)	3000.		2820.		3910.	U	2100.	UJ	2870.		2930.	
7440-28-0	Thallium (Tl)	3.5	U	2.7	U	3.2	UJ	4.3	UJ	2.7	UJ	2.7	U
7440-31-5	Tin (Sn)	2.6	U	2.6	U	2.6	U	2.6	U	2.6	UJ	2.6	UJ
7440-62-2	Vanadium (V)	1.4	J	1.3	J	3.4	U	4.	U	0.5	UJ	0.5	U
7440-66-6	Zinc (Zn)	5.3	U	5.3	U	20.	U	6.9	U	5.3	U	5.3	U

*** Validation Complete ***

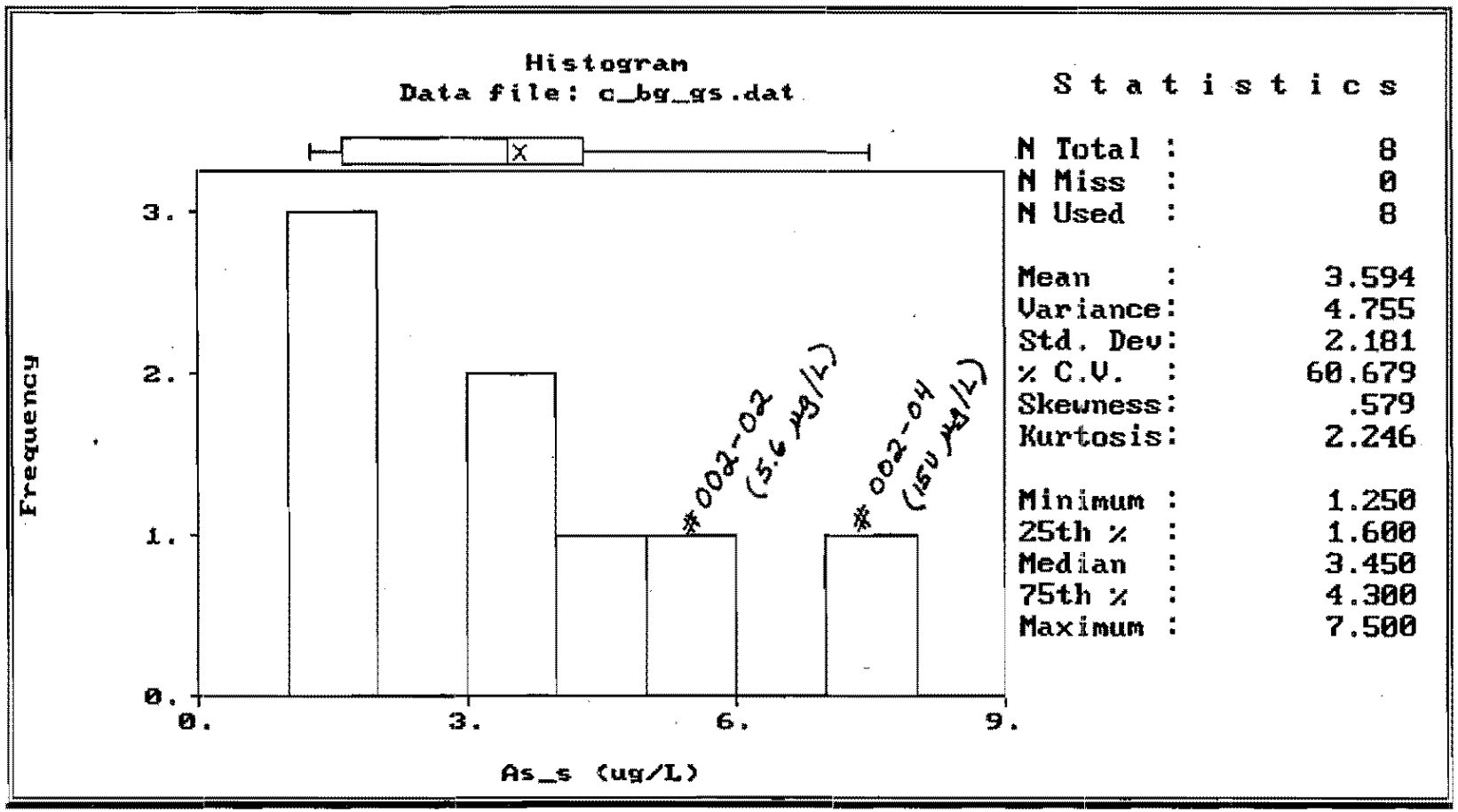
CHARLESTON - ZONE C
Background Sample Results - Rounds 2-4
Shallow Groundwter, Wells 1-2

SW846-META													
	SAMPLE ID ------->	GDC-G-W002-02			GDC-G-W002-03			GDC-G-W002-04					
	ORIGINAL ID ----->	GDCGW00202			GDCGW00203			GDCGW00204					
	LAB SAMPLE ID --->	24536.01			25513.03			26016.01					
	ID FROM REPORT -->	GDCGW00202			GDCGW00203			GDCGW00204					
	SAMPLE DATE ----->	01/19/96			05/07/96			06/13/96					
	DATE EXTRACTED -->	01/22/96			05/16/96			06/28/96					
	DATE ANALYZED --->	01/25/96			05/30/96			07/04/96					
	MATRIX ---------->	Water			Water			Water					
	UNITS ---------->	UG/L		A	UG/L		A	UG/L		A			
CAS #	Parameter	24514		VAL	25504		VAL	25997		VAL			
7429-90-5	Aluminum (Al)	18.		U	24.9		U	95.7		J			
7440-36-0	Antimony (Sb)	2.1		U	13.		U	2.1		U			
7440-38-2	Arsenic (As)	5.6		J	2.5		UJ	15.		U			
7440-39-3	Barium (Ba)	16.4			13.1		U	14.1					
7440-41-7	Beryllium (Be)	0.36		J	0.3		U	0.3		U			
7440-43-9	Cadmium (Cd)	0.5		U	0.5		U	0.5		U			
7440-70-2	Calcium (Ca)	152000.		J	127000.			137000.					
7440-47-3	Chromium (Cr)	0.8		U	2.2		U	0.8		UJ			
7440-48-4	Cobalt (Co)	1.6		J	5.2		U	5.2		U			
7440-50-8	Copper (Cu)	1.2		UJ	1.4		UJ	1.8		U			
7439-89-6	Iron (Fe)	1700.			1860.			4660.					
7439-92-1	Lead (Pb)	1.7		U	1.7		U	4.4					
7439-95-4	Magnesium (Mg)	9250.			7390.			8990.					
7439-96-5	Manganese (Mn)	789.			368.			665.					
7439-97-6	Mercury (Hg)	0.1		U	0.1		U	0.1		U			
7440-02-0	Nickel (Ni)	5.		J	11.6		U	3.6		UJ			
7440-09-7	Potassium (K)	6710.		U	5420.		U	6400.					
7782-49-2	Selenium (Se)	2.8		UJ	2.8		U	2.8		U			
7440-22-4	Silver (Ag)	1.2		U	1.2		U	1.2		UJ			
7440-23-5	Sodium (Na)	9910.			9410.		U	11300.					
7440-28-0	Thallium (Tl)	2.7		U	2.7		UJ	2.7		UJ			
7440-31-5	Tin (Sn)	2.6		U	2.6		U	2.6		UJ			
7440-62-2	Vanadium (V)	0.5		U	3.4		U	0.5		UJ			
7440-66-6	Zinc (Zn)	5.6		J	9.4		U	14.6		J			

*** Validation Complete ***

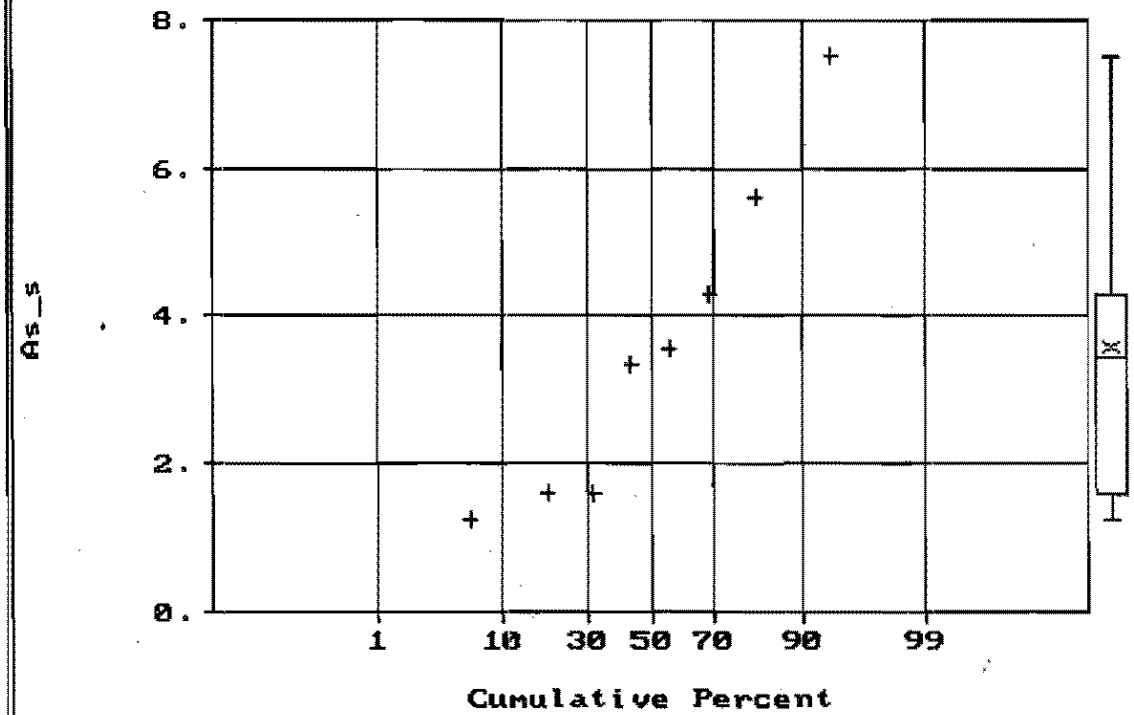
Zone C
Arsenic in shallow GW grid samples
Original dataset (N=8)
Original values

1a



16

Normal Probability Plot for As_s
Data file: c_bg_gs.dat

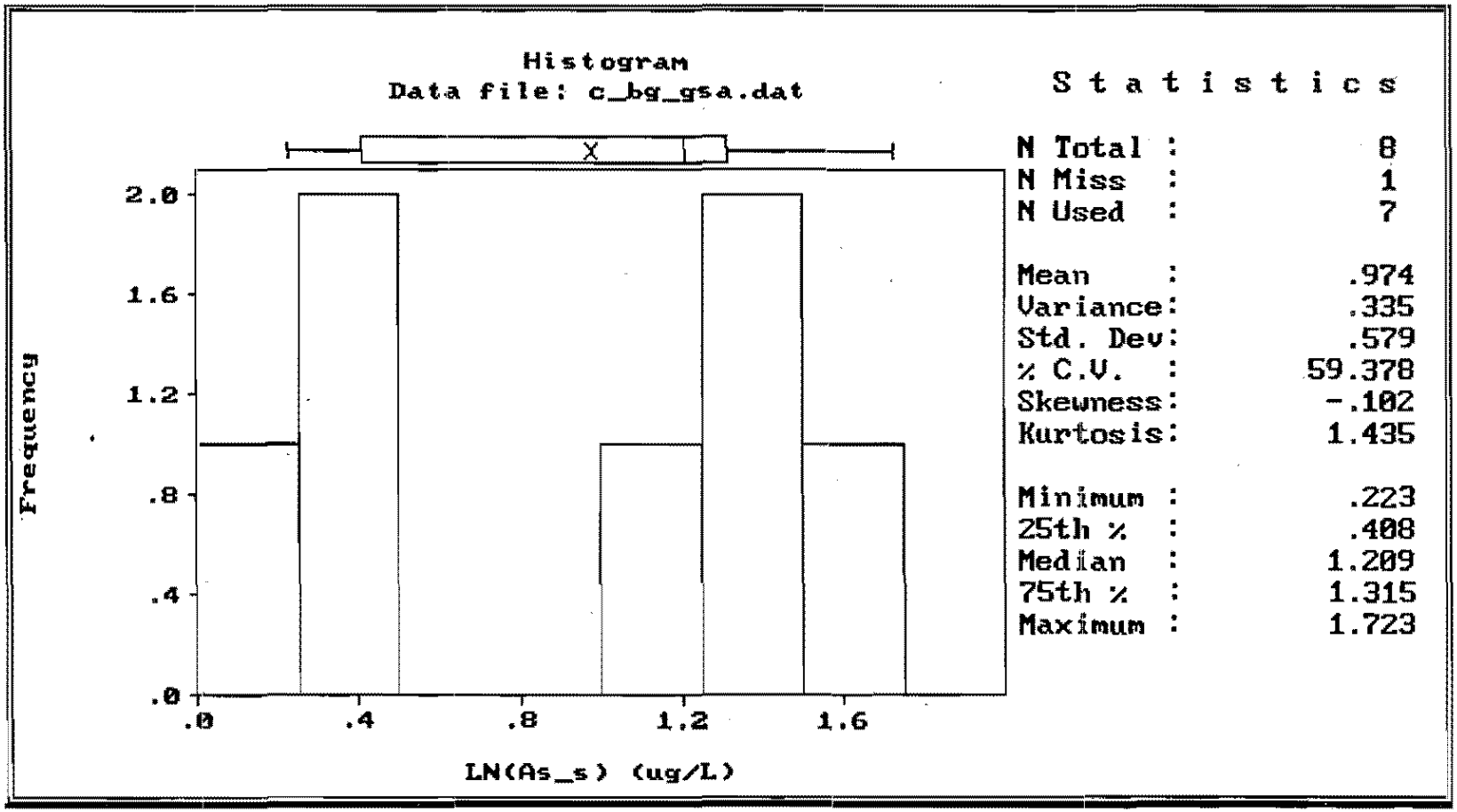


Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	3.594
Variance:	4.755
Std. Dev:	2.181
% C.V. :	60.679
Skewness:	.579
Kurtosis:	2.246
Minimum :	1.250
25th % :	1.600
Median :	3.450
75th % :	4.300
Maximum :	7.500

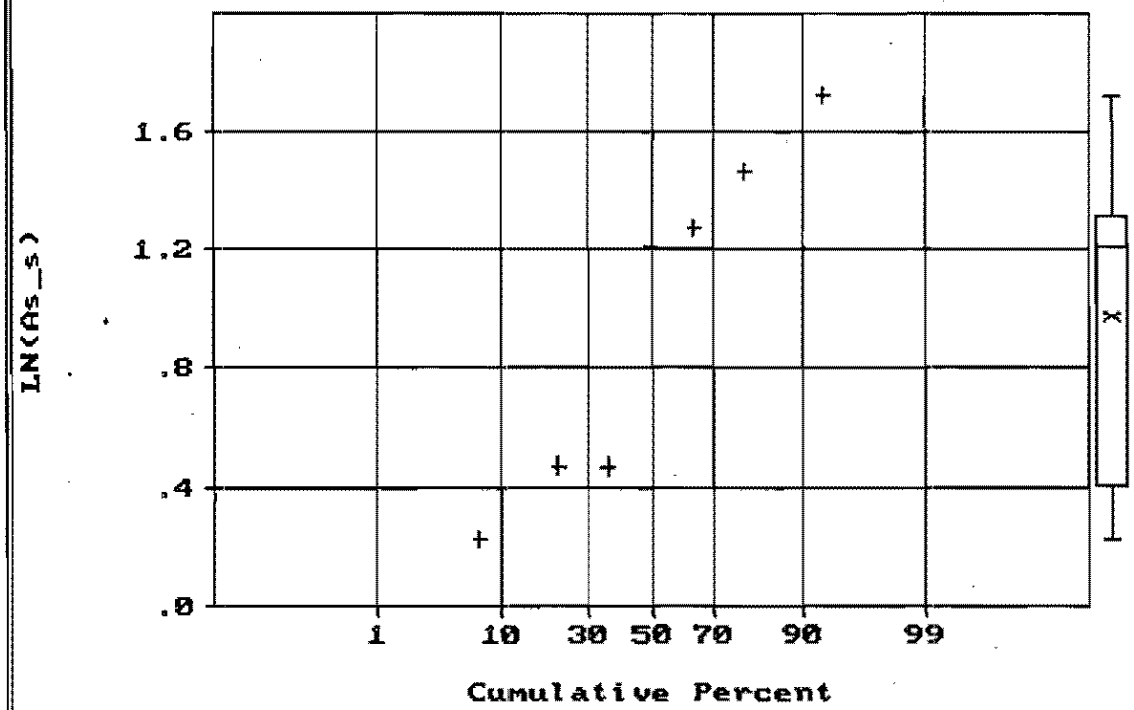
Zone C
Arsenic in shallow GW grid samples
Sample # 002-04 removed from dataset (N = 7)
LN - transformed values

2a



2b

Normal Probability Plot for LN(As_s)
Data file: c_bg_gsa.dat



Statistics

N Total :	8
N Miss :	1
N Used :	7
Mean :	.974
Variance:	.335
Std. Dev:	.579
% C.V. :	59.378
Skewness:	-.102
Kurtosis:	1.435
Minimum :	.223
25th % :	.408
Median :	1.209
75th % :	1.315
Maximum :	1.723

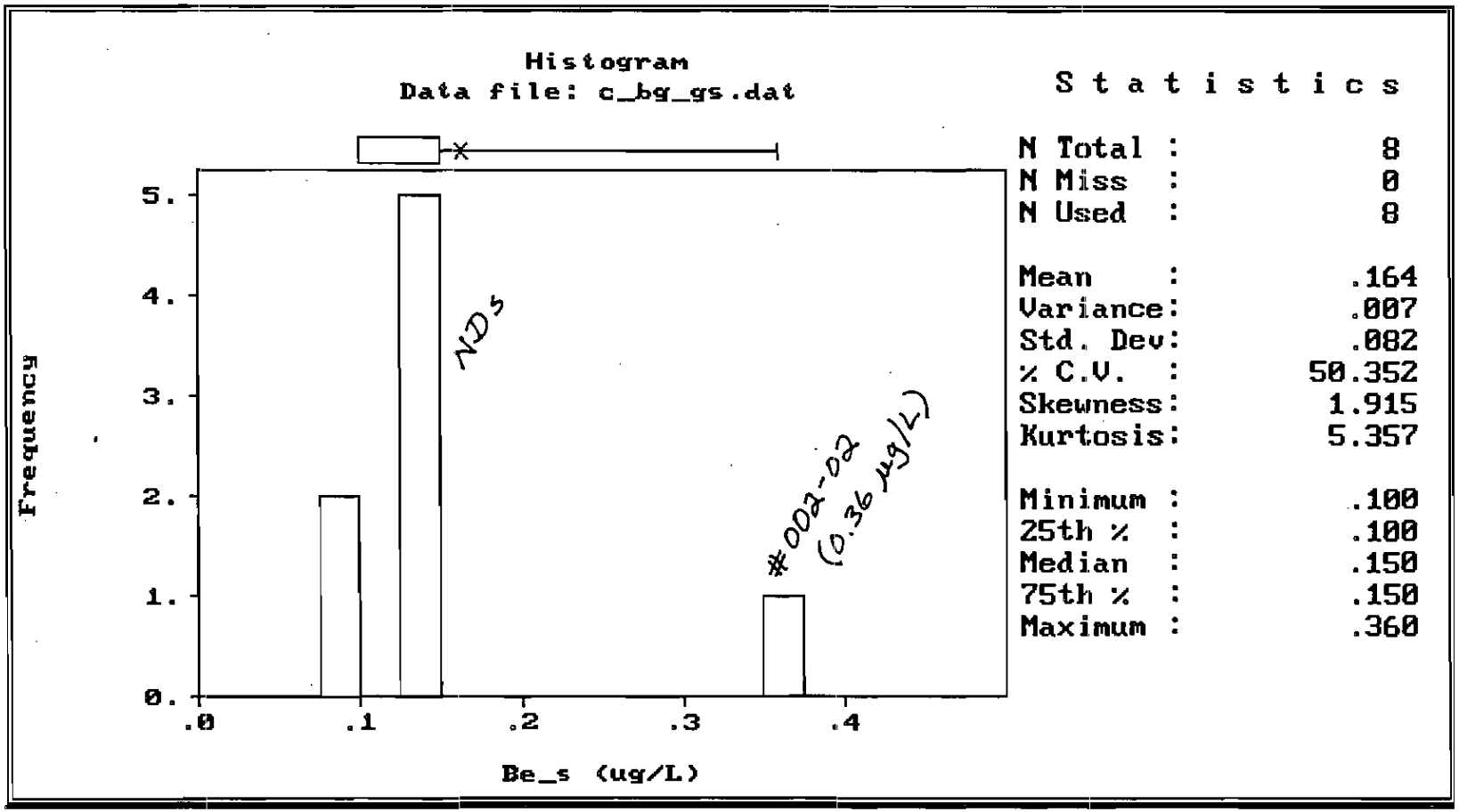
Zone C

Beryllium in shallow GW grid samples

Original dataset (N=8)

Original values

1a

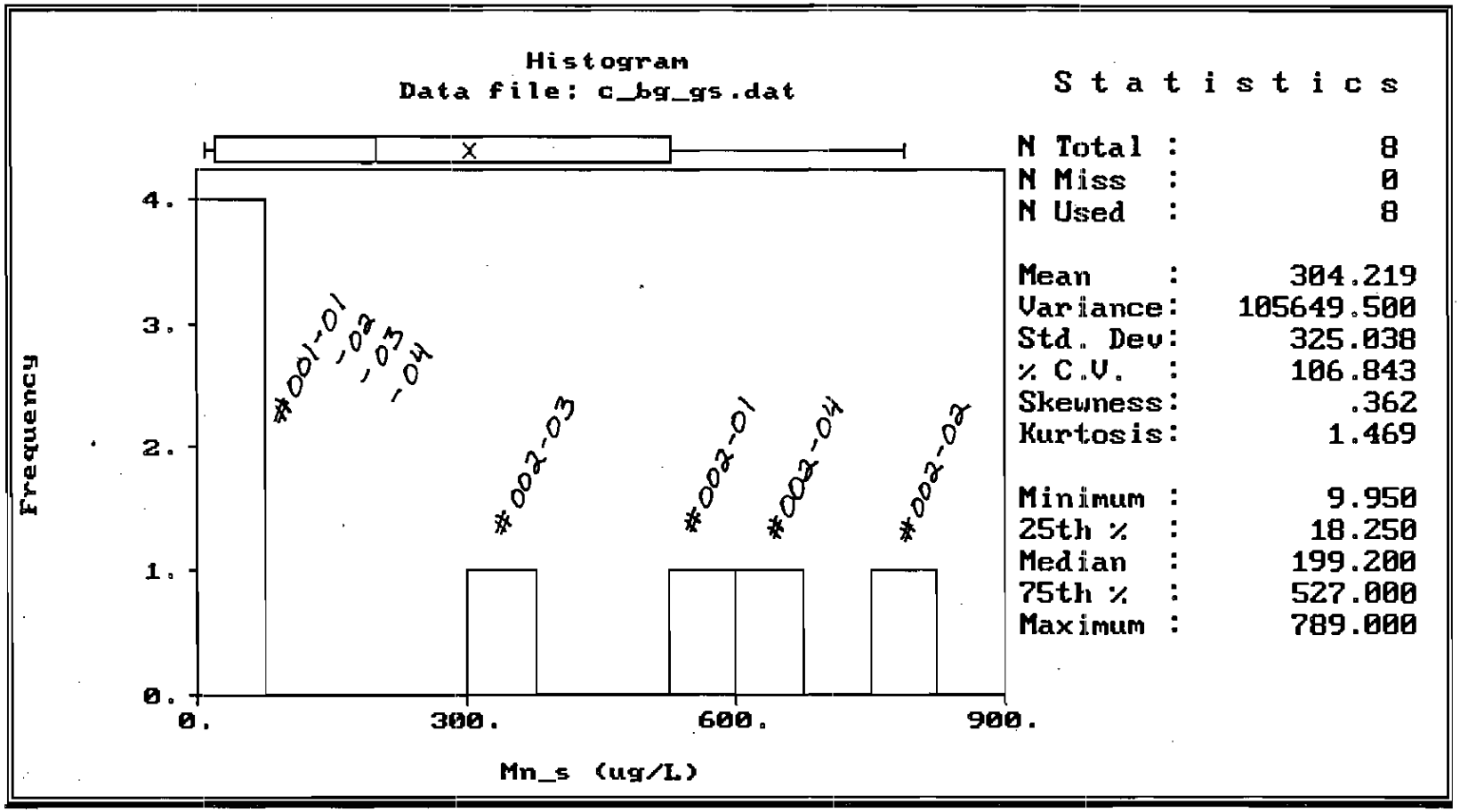


Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	.164
Variance:	.007
Std. Dev:	.082
% C.V. :	50.352
Skewness:	1.915
Kurtosis:	5.357
Minimum :	.100
25th % :	.100
Median :	.150
75th % :	.150
Maximum :	.360

Zone C
Manganese in shallow GW grid samples
Original dataset (N=8)
Original values

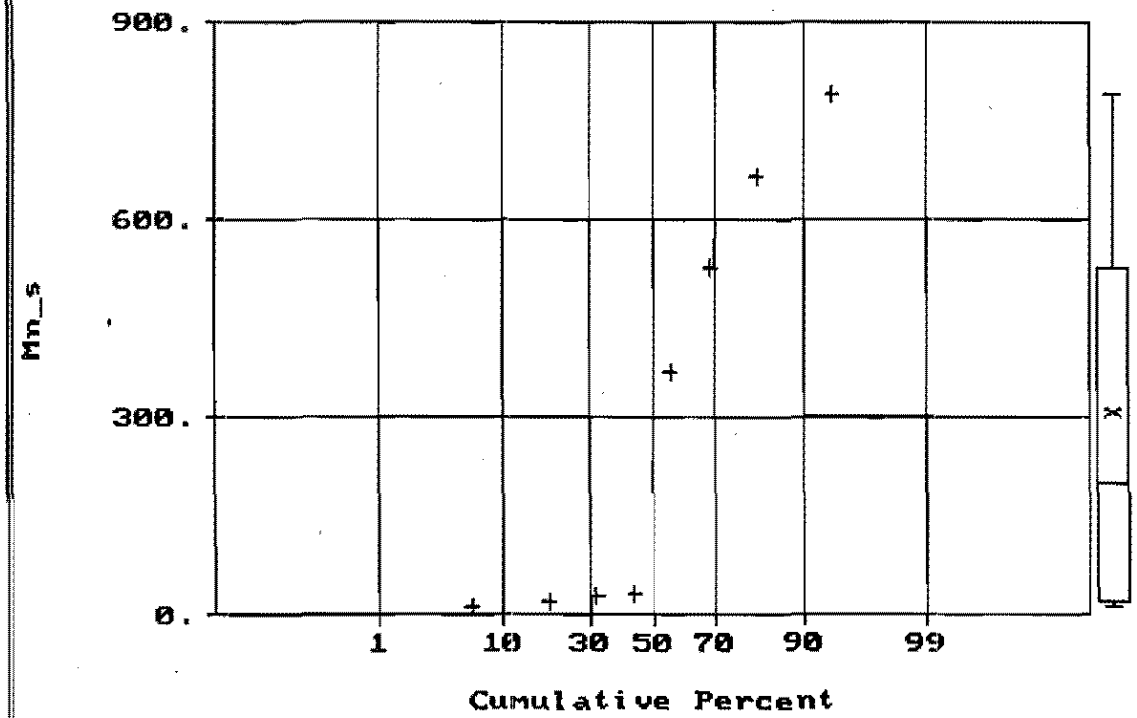
1a



Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	304.219
Variance:	105649.500
Std. Dev:	325.038
% C.V. :	106.843
Skewness:	.362
Kurtosis:	1.469
Minimum :	9.950
25th % :	18.250
Median :	199.200
75th % :	527.000
Maximum :	789.000

Normal Probability Plot for Mn_s
Data file: c_bg_gs.dat



Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	304.219
Variance:	105649.500
Std. Dev:	325.038
% C.V. :	106.843
Skewness:	.362
Kurtosis:	1.469
Minimum :	9.950
25th % :	18.250
Median :	199.200
75th % :	527.000
Maximum :	789.000

CHARLESTON - ZONE C
Background Sample Results - Round 1
Deep Groundwater, Wells 1D-2D

SW846-META											
	SAMPLE ID ------->	GDC-G-W01D-01		GDC-G-W02D-01							
	ORIGINAL ID ----->	GDCGW01D01		GDCGW02D01							
	LAB SAMPLE ID --->	730830		731350							
	ID FROM REPORT -->	GDCGW01D01		GDCGW02D01							
	SAMPLE DATE ----->	06/12/95		06/13/95							
	MATRIX ---------->	Water		Water							
	UNITS ---------->	UG/L	A	UG/L	A						
CAS #	Parameter	1517MI	VAL	1517MI	VAL						
7429-90-5	Aluminum (Al)	54.3	UJ	19.2	U						
7440-36-0	Antimony (Sb)	1.9	U	1.9	U						
7440-38-2	Arsenic (As)	3.2	U	3.2	U						
7440-39-3	Barium (Ba)	11.9	U	38.5	U						
7440-41-7	Beryllium (Be)	0.2	U	0.2	U						
7440-43-9	Cadmium (Cd)	0.3	U	0.3	U						
7440-70-2	Calcium (Ca)	44800.		101000.							
7440-47-3	Chromium (Cr)	0.9	UJ	0.9	UJ						
7440-48-4	Cobalt (Co)	0.6	U	0.6	U						
7440-50-8	Copper (Cu)	0.7	UJ	0.7	UJ						
7439-89-6	Iron (Fe)	587.		220.							
7439-92-1	Lead (Pb)	3.6	U	2.3	U						
7439-95-4	Magnesium (Mg)	1420.	J	13200.							
7439-96-5	Manganese (Mn)	35.4		67.5							
7439-97-6	Mercury (Hg)	0.2	U	0.2	U						
7440-02-0	Nickel (Ni)	1.4	U	1.4	U						
7440-09-7	Potassium (K)	918.	J	11200.	J						
7782-49-2	Selenium (Se)	4.4	U	4.4	U						
7440-22-4	Silver (Ag)	0.5	U	0.5	U						
7440-23-5	Sodium (Na)	8200.		181000.							
7440-28-0	Thallium (Tl)	4.5	U	4.5	U						
7440-62-2	Vanadium (V)	0.43	J	0.4	UJ						
7440-66-6	Zinc (Zn)	3.7	U	2.8	U						
7440-31-5	Tin (Sn)	56.3	U	56.3	U						
57-12-5	Cyanide (CN)	??????????		??????????							

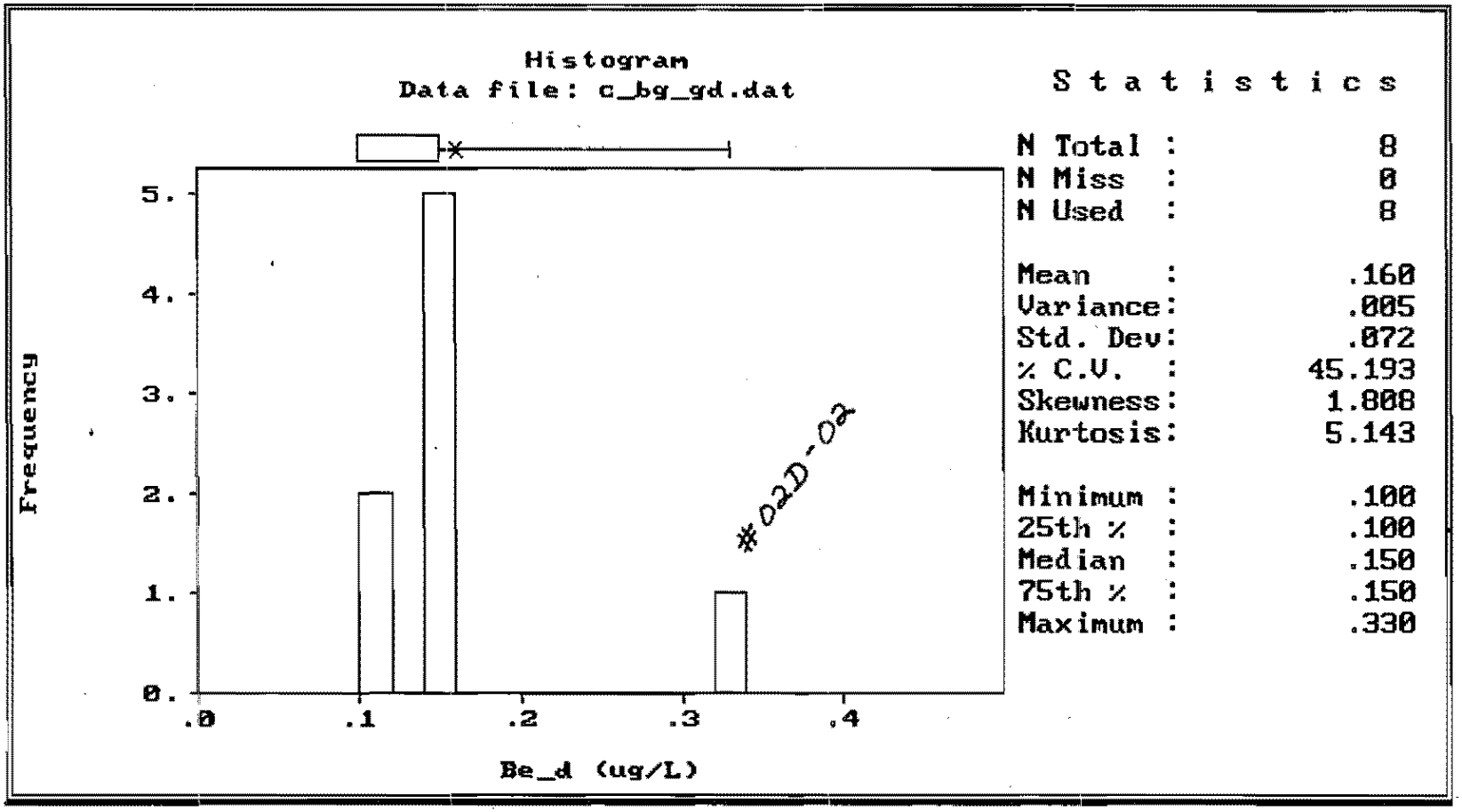
*** Validation Complete ***

CHARLESTON - ZONE C
Background Sample Results - Rounds 2-4
Deep Groundwter, Wells 1D-2D

SW846-META													
	SAMPLE ID ------->	GDC-G-W01D-02		GDC-G-W01D-03		GDC-G-W01D-04		GDC-G-W02D-02		GDC-G-W02D-03		GDC-G-W02D-04	
	ORIGINAL ID ----->	GDCGW01D02		GDCGW01D03		GDCGW01D04		GDCGW02D02		GDCGW02D03		GDCGW02D04	
	LAB SAMPLE ID --->	24543.02		25504.04		25997.02		24536.02		25513.04		26016.02	
	ID FROM REPORT -->	GDCGW01D02		GDCGW01D03		GDCGW01D04		GDCGW02D02		GDCGW02D03		GDCGW02D04	
	SAMPLE DATE ----->	01/22/96		05/06/96		06/12/96		01/19/96		05/07/96		06/13/96	
	DATE EXTRACTED -->	01/24/96		05/16/96		06/30/96		01/22/96		05/16/96		06/28/96	
	DATE ANALYZED --->	01/26/96		05/30/96		07/03/96		01/25/96		05/30/96		07/04/96	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L	A	UG/L	A	UG/L	A	UG/L	A	UG/L	A	UG/L	A
CAS #	Parameter	24514	VAL	25504	VAL	25997	VAL	24514	VAL	25504	VAL	25997	VAL
7429-90-5	Aluminum (Al)	18.	U	23.	U	18.1	J	18.	U	23.	U	18.	U
7440-36-0	Antimony (Sb)	2.1	U	13.	U	2.1	U	2.1	U	13.	U	2.1	U
7440-38-2	Arsenic (As)	2.5	UJ	2.5	UJ	2.5	UJ	2.5	UJ	2.5	UJ	2.7	UJ
7440-39-3	Barium (Ba)	11.6		11.4	U	12.8		70.4		56.8	U	54.5	
7440-41-7	Beryllium (Be)	0.3	U	0.3	U	0.3	U	0.33	J	0.3	U	0.3	U
7440-43-9	Cadmium (Cd)	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
7440-70-2	Calcium (Ca)	55400.	J	57500.		62800.		179000.	J	167000.		171000.	
7440-47-3	Chromium (Cr)	0.8	U	2.2	U	0.8	UJ	0.8	U	2.2	U	0.8	UJ
7440-48-4	Cobalt (Co)	0.9	U	5.2	U	5.2	U	0.9	U	5.2	U	5.2	U
7440-50-8	Copper (Cu)	0.6	UJ	3.9	UJ	0.75	U	0.81	UJ	1.4	UJ	0.89	U
7439-89-6	Iron (Fe)	485.		611.		788.		240.		213.		224.	
7439-92-1	Lead (Pb)	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
7439-95-4	Magnesium (Mg)	1900.		1930.		2190.		22400.		20000.		21600.	
7439-96-5	Manganese (Mn)	48.1		49.		54.6		123.		105.		105.	
7439-97-6	Mercury (Hg)	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
7440-02-0	Nickel (Ni)	0.8	U	7.9	U	0.8	UJ	0.8	U	5.3	U	1.3	UJ
7440-09-7	Potassium (K)	1650.	U	1600.	U	1600.	U	11200.		8210.	U	9700.	
7782-49-2	Selenium (Se)	2.8	UJ	3.3	U	2.8	U	2.8	UJ	2.8	U	2.8	U
7440-22-4	Silver (Ag)	1.2	U	1.2	U	1.2	UJ	1.2	U	1.2	U	1.2	UJ
7440-23-5	Sodium (Na)	8320.		7260.	U	9680.		243000.		221000.		213000.	
7440-28-0	Thallium (Tl)	2.7	U	2.7	UJ	2.7	UJ	2.7	U	2.7	UJ	2.7	U
7440-31-5	Tin (Sn)	2.6	U	2.6	U	2.6	UJ	2.6	U	2.6	U	2.6	UJ
7440-62-2	Vanadium (V)	0.5	U	3.4	U	0.5	UJ	0.5	U	3.4	U	0.5	UJ
7440-66-6	Zinc (Zn)	5.3	U	40.2	U	5.3	U	5.3	U	6.9	U	5.3	U

*** Validation Complete ***

Zone C
Beryllium in deep GW grid samples
Original dataset (N = 8)
Original values



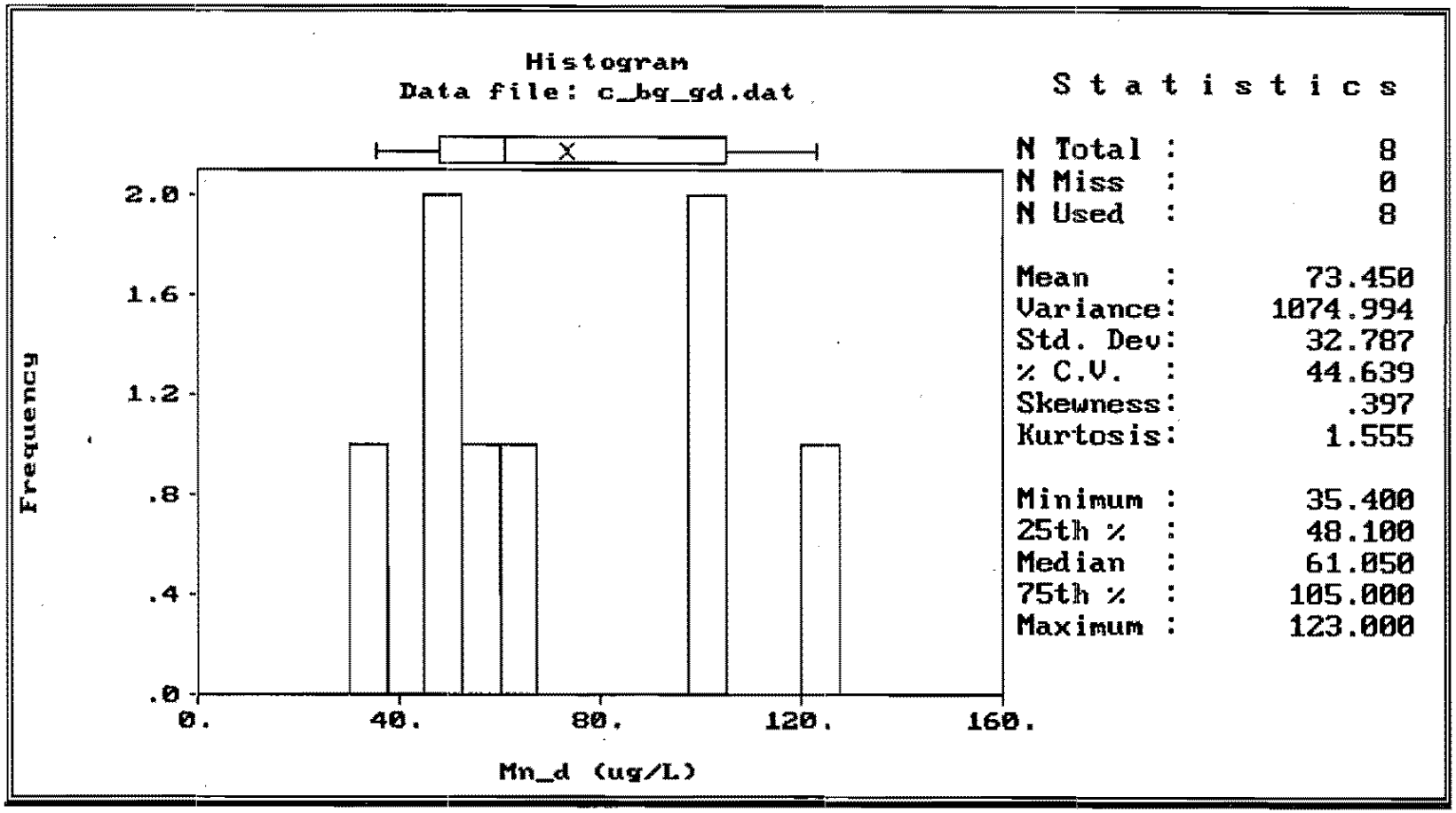
Zone C

Manganese in deep GW grid samples

Original dataset (N=8)

Original values

1a

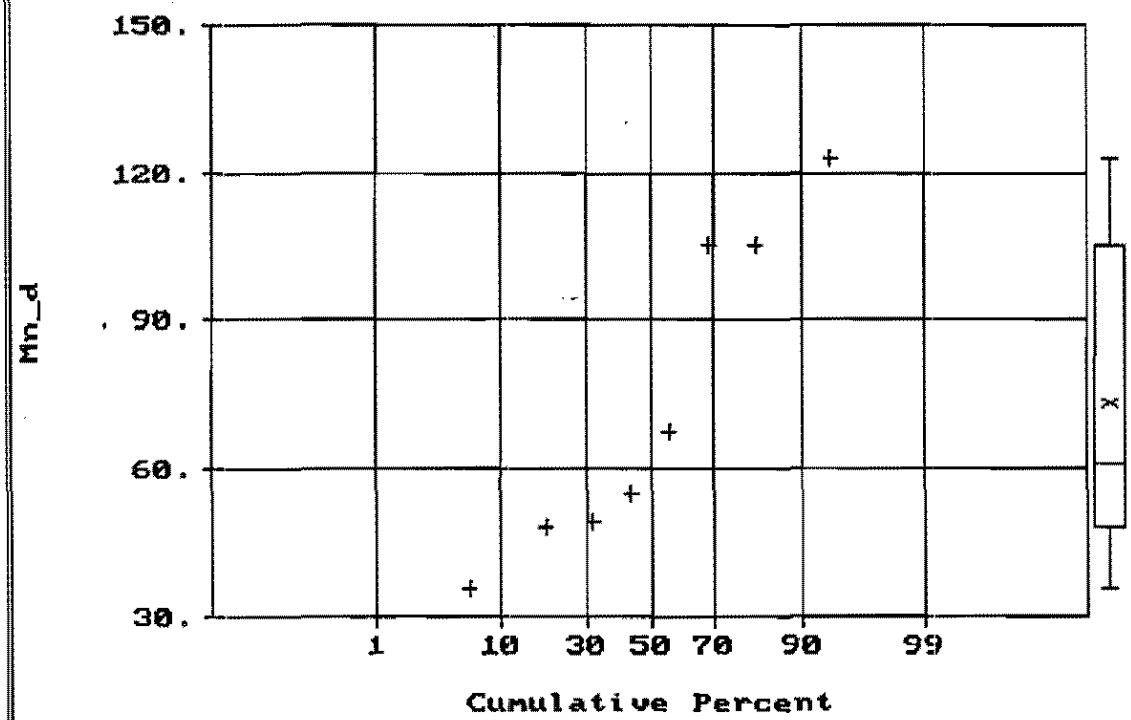


Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	73.450
Variance:	1074.994
Std. Dev:	32.787
% C.V. :	44.639
Skewness:	.397
Kurtosis:	1.555
Minimum :	35.400
25th % :	48.100
Median :	61.050
75th % :	105.000
Maximum :	123.000

16

Normal Probability Plot for Mn_d
Data file: c_bg_gd.dat

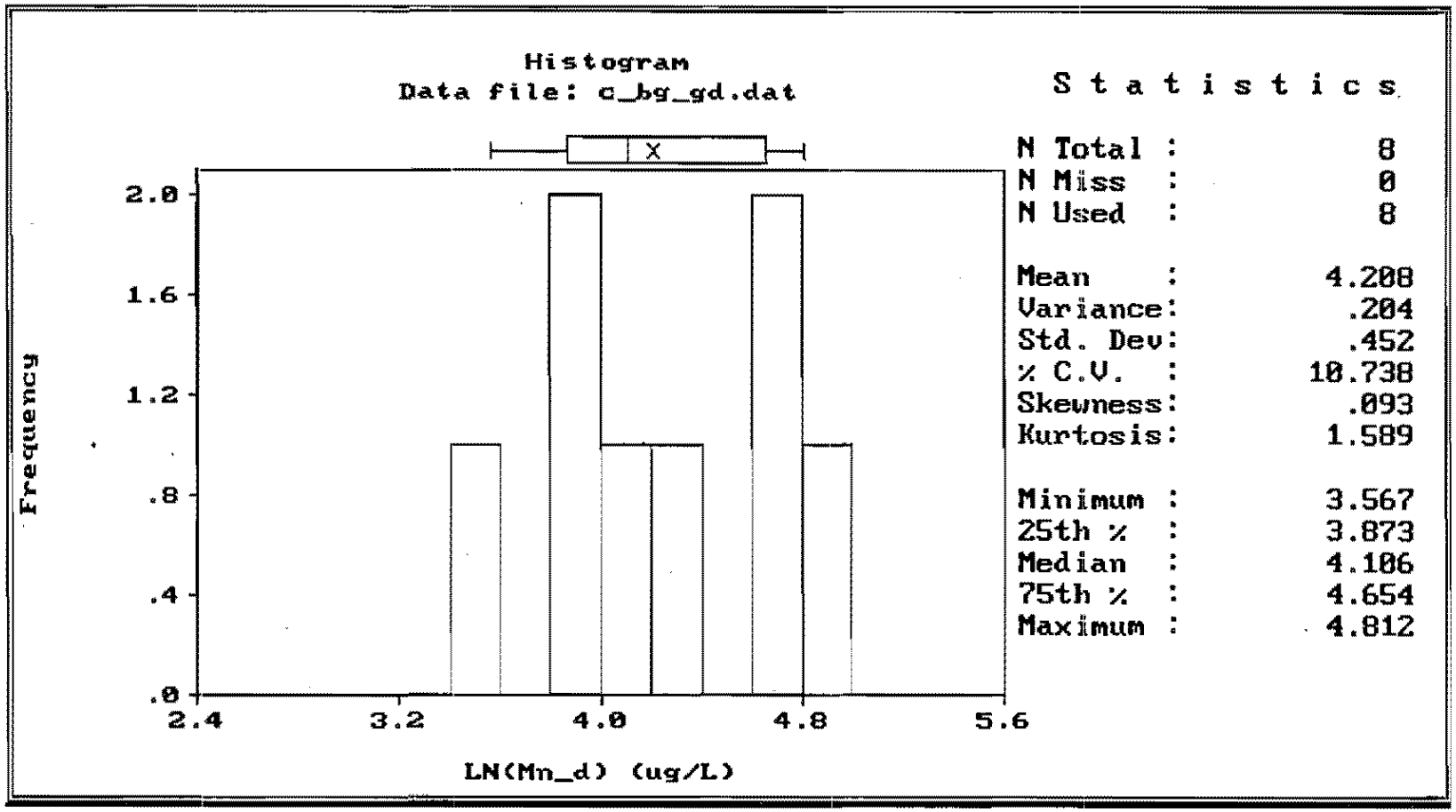


Statistics

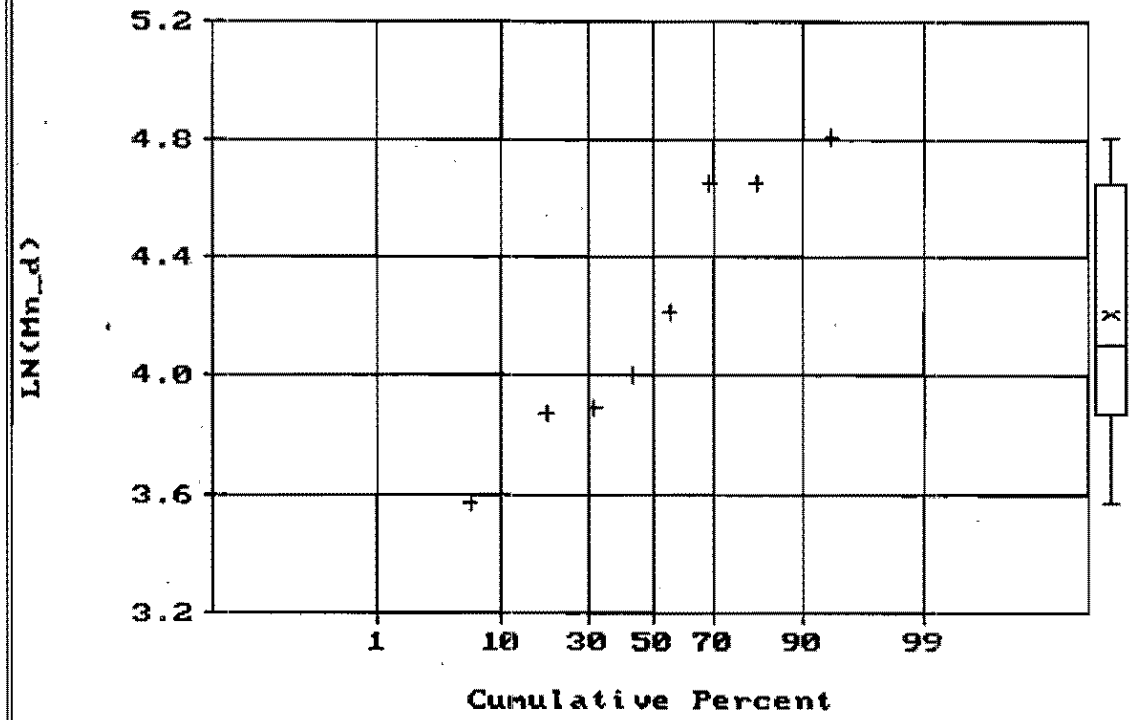
N Total :	8
N Miss :	0
N Used :	8
Mean :	73.450
Variance:	1074.994
Std. Dev:	32.787
% C.V. :	44.639
Skewness:	.397
Kurtosis:	1.555
Minimum :	35.400
25th % :	48.100
Median :	61.050
75th % :	105.000
Maximum :	123.000

Zone C
Manganese in deep GW grid samples
Original dataset (N = 8)
LN-transformed values

2a

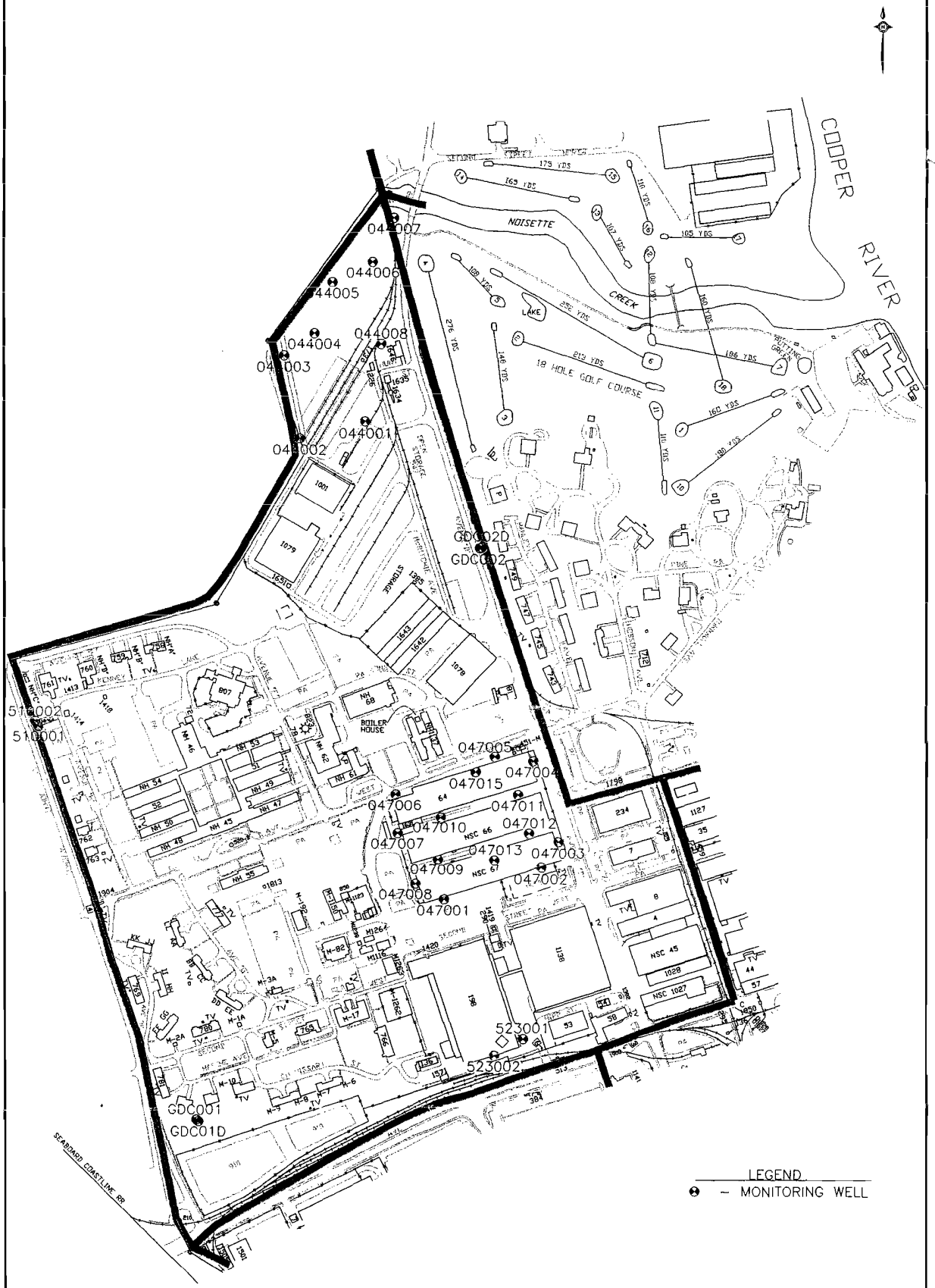


Normal Probability Plot for LN(Mn_d)
Data file: c_bg_gd.dat



Statistics

N Total :	8
N Miss :	0
N Used :	8
Mean :	4.208
Variance:	.204
Std. Dev:	.452
% C.V. :	10.738
Skewness:	.093
Kurtosis:	1.589
Minimum :	3.567
25th % :	3.873
Median :	4.106
75th % :	4.654
Maximum :	4.812



LEGEND

⊖ – MONITORING WELL

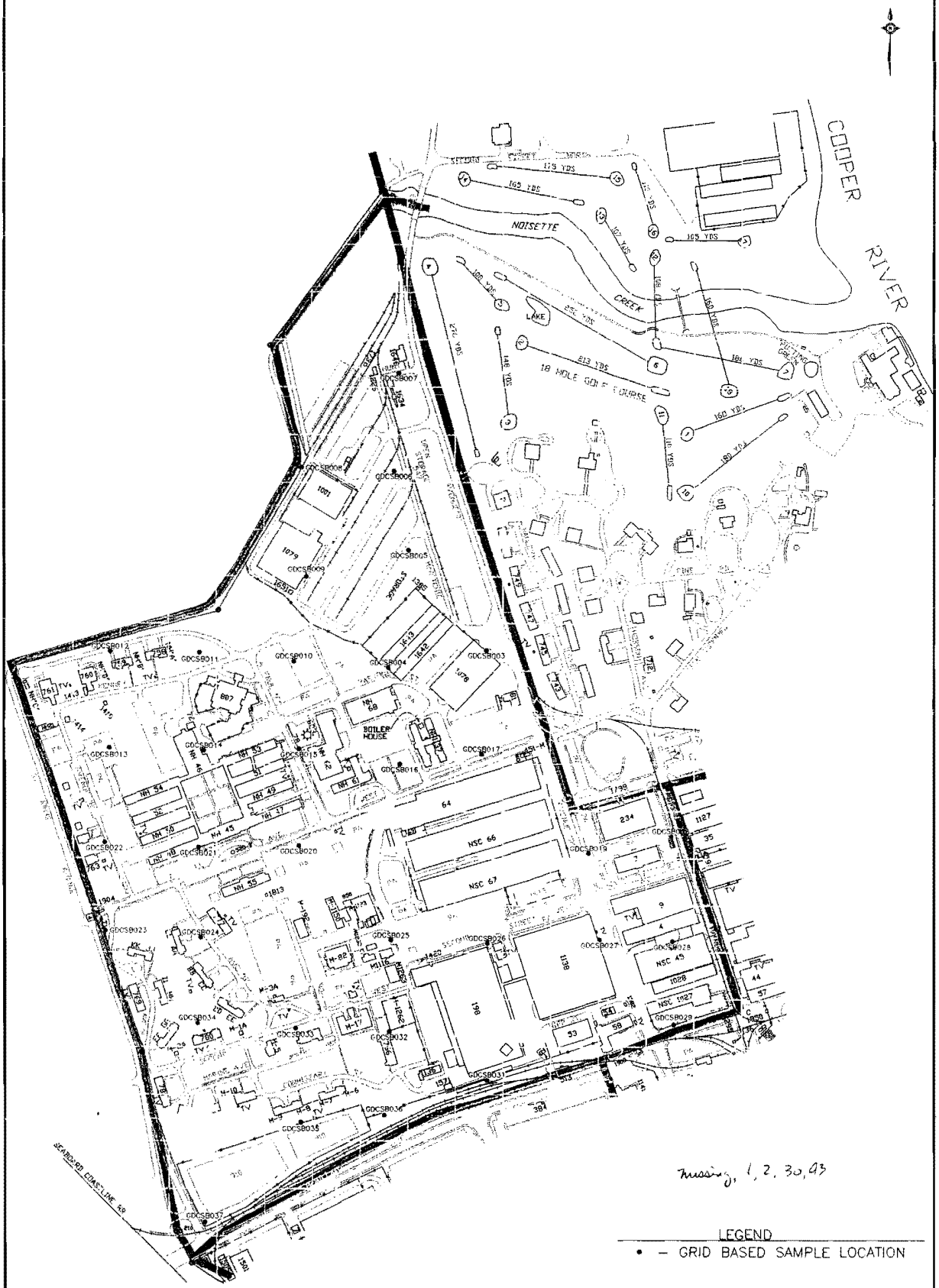
400 0 400

SCALE FEET

ZONE C
DRAFT RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2.1
ZONE C
GROUNDWATER MONITORING WELL
LOCATION MAP

DWG DATE: 01/12/96 | DWG NAME: 29ZNCMW1



missing 1, 2, 30, 43

LEGEND

• – GRID BASED SAMPLE LOCATION

400 0 400

SCALE FEET

ZONE C
DRAFT RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

10.7.1
ZONE C
GRID BASED SAMPLE LOCATIONS

DWG DATE: 01/13/96 | DWG NAME: 29ZNCMW3

APPENDIX C

2000 (PAHs) AND 2001 (INORGANICS) BACKGROUND STUDIES

Evaluation of Background or Reference Value for PAHs in Soils at CNC

PREPARED FOR: CNC Team

PREPARED BY: CH2M HILL- Jones

DATE: November 29, 2000

This revised Technical Memorandum [TM] incorporates suggestions provided by SCDHEC after review of the original TM at the November 2000 BCT meeting.

Introduction

Polycyclic aromatic hydrocarbons (PAHs) are detected in environmental media at the CNC, including areas that did not have site-specific operations involving PAHs. Grid soil samples collected from un-impacted industrial and non-industrial areas also had detectable levels of PAHs. Since human health and ecological protection based criteria (e.g., RBC values) for several PAHs are below typical detection limits, any detection of these PAHs indicates an exceedence of an RBC value. Because PAHs are detected across the CNC, with similar distribution at sites (i.e., SWMU/AOCs) and non-sites, remediation of the PAHs strictly based on RBCs is not technically feasible or defensible.

The RCRA Facility Investigations (RFIs) conducted to date for CNC did not include an evaluation of or establish a "background" or reference PAH concentration. This technical memorandum presents an approach for estimating a reference or base-specific background value for PAHs in soils at the CNC. This approach follows the EPA Region IV guidance for evaluating background values for risk management decisions (EPA, 1998). The approach that is proposed in this paper provides a reference PAH value that may be used as a guide during site-specific risk management decision making by the BCT. The PAH reference value is not proposed as an absolute number to determine when active remediation must be implemented.

PAH Occurrence in the Environment

PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil, gas, wood, garbage, or other organic substances, such as tobacco, and charbroiled meat. PAHs are ubiquitous in the urban environment and generally occur as complex mixtures, not as single compounds. There are more than 100 different PAHs. Table 1 provides typical representative PAH concentrations reported by ATSDR in rural, agricultural and urban soil types.

Calculation of BEQ Values

About 15 PAHs are typically included in analytical list at hazardous waste sites, due to their relatively higher toxicity, and are, hence, part of the EPA's Target Compound List (TCL). Of these, 7 are identified as carcinogenic PAHs. Table 2 presents the TCL PAHs and identifies the seven carcinogenic PAHs. Each of these carcinogenic PAHs is assigned a toxicity

equivalency factor (TEF) relative to benzo(a)pyrene. To calculate a benzo(a) pyrene equivalent (BEQ) value for a sample, the value for each of these seven PAHs is first multiplied by its respective TEF. The sum of the seven resulting values is the BEQ value for that sample.

PAH Sources at CNC

A variety of sources are likely to have contributed PAHs to the environment at CNC. At sites where petroleum products or waste oil handling operations were performed, PAHs in soils could have originated from these site operations. However, a variety of other PAH sources could also have contributed PAHs to the soils. These other potential sources include:

- coal-tar/creosote used in asphalt roads, and railroad ties,
- oil leaks from motor vehicles (automobiles, train engines, buses, tractor trailers),
- exhaust air emissions from motor vehicles,
- air emissions from coal burning facilities (steam plant, steam engines, incinerators)
- air emissions from Naval ships,
- spraying of used oils mixed with pesticide formulations.

The precise source of PAHs detected within CNC can not be established due to ubiquitous occurrence and high variation in the detected concentration levels, age of the source, and varied rates of weathering of the source material in surface and subsurface environments in which it is incorporated.

The relative proportion of the PAHs in various petroleum hydrocarbons, creosote/coal tar materials were reported by several authors. Some of these references are listed here: 1) Millner, James, and Nye, 1992; 2) Heath, Koblis, and Sager, 1993; 3) ATSDR, 1995; 4) ATSDR, 1994- Toxicological Profile for Creosote; and 5) EPA 1982. Table 4 summarizes the PAH content of some representative petroleum, diesel, heating oils, creosote, and coal tar products. When oils are burnt or partially burnt (e.g., crank case oil) the PAH content increases, thus waste oils are reported with higher PAHs (see Table 4).

Additionally, some of the older base maintenance practices may have included use of the waste motor oils in the pesticide formulations leading to widespread distribution of PAHs. This particular practice is not reported for CNC in existing documentation, however it is one that has occurred historically at many similar DOD facilities. Also, areas that are free of industrial activities at the present time may have been impacted by PAH-containing source material, such as asphalt pavements or railroad lines, that are currently not present. All these potential source materials are likely to have contributed to the PAHs detected at the CNC.

Degradation Rates for PAH in Different Media

PAHs originating from different sources tend to degrade with time. The degradation half-life estimates for individual PAH constituents are reported in Howard, et. al., 1991. The lighter PAHs (e.g., naphthalene) degrade faster than heavier (e.g., BaP) PAHs. Aerobic environment (e.g., surface soil) degrades PAHs faster than anaerobic (e.g., sediments) and subsurface environment. Typically, PAHs released into air are likely to degrade within a

very short period of time. Table 3 include the estimated half-lives for individual PAH constituents. The half-lives are estimated for individual chemicals, and these rates are much slower when PAHs are incorporated into matrix of hardened asphaltic material.

Degradation rates of PAHs can be affected by a variety of factors, including the number of aromatic rings, adsorption onto clays, presence of other PAHs, oxygen concentrations, temperature, nutrients, and degradable organic matter. There is extensive technical literature available on this subject that should be consulted for more detail.

PAHs in Grid-based soil samples

PAHs have been analyzed in a significant number of surface and subsurface soils collected at grid locations. The documentation and justification for grid sampling locations were previously discussed in reports prepared by Ensafe.

Approximately 212 surface soil samples, and 153 subsurface soil samples with several duplicate samples were collected from soils across CNC and analyzed for all PAH constituents. A formal DQO process was not described for this soil sampling effort, however it was embodied in the process applied in collection of the data. Based on the available number of samples, analytical quality, and quantity, the data are adequate to make decisions about the general PAH distributions in non-site (unimpacted by SWMU/AOC operations) surface soil and subsurface soils within CNC. The large number of samples available for this background data analysis also minimizes the uncertainty associated with decision errors such as Type I errors (or false negative) or Type II errors (or false positive).

Figures 1a and 1b (previously presented in the initial version of this TM) show grid sample locations and station identification numbers included for the development of a reference value for PAHs at CNC. These grid samples were collected systematically from areas outside of known SWMUs/AOC of CNC. Appendix A (previously provided to BCT members electronically) includes the analytical data for the PAH constituents from these samples. BEQ values were calculated for these samples. Figures 2a and 2b (previously presented in the initial version of this TM) presents the distribution of BEQ concentrations across the CNC at background sample locations.

The BEQ data from these samples were evaluated to determine the nature of the sample concentration distribution. Figures 3a through 3f illustrate different graphing techniques (referred to as descriptive statistics) to assess the nature of the concentration distribution. Figure 3a (surface soil) and 3b (subsurface soil) presents the simple concentration plot of all the samples within background data set. The PAH concentration for non-detect samples was estimated at half the detection limit, which is EPA's preferred method for addressing non-detect values.

Figures 3c through 3f present probability plots for normal and log-transformed data. A straight-line through the XY coordinates would indicate a normal distribution. None of the plots indicates a normal or log-normal distribution.

Because of a large variation in the concentration levels within the data set, an upper confidence limit (UCL) at 95% on the mean could not be established using parametric methods (H-statistic by Land's method). This is because the data did not fit a normal distribution for either normal or log-transformed data, which is essential in estimating a UCL95% concentration. Because of the high variability, further attempts were not made to

fit the data to a particular type of distribution. To keep this reference value assessment simple and avoid extensive statistical exploratory work required to implement an acceptable non-parametric method, a decision was made to proceed following EPA Region IV guidance that is in common practice (and SCDHEC's preferred method) and use a value of 2 times the mean concentration as an estimated reference value for BEQs in surface and subsurface soils.

Development of Reference BEQ Value

Two sets of mean concentrations were estimated using the grid PAH soil data: 1) the mean of detected concentrations only, and 2) a combined mean of the detects and non-detects, using a value of half the detection limit for non-detects. This value is referred to as the adjusted mean value. Table 5 presents the summary statistics of the grid sample data sets for surface and subsurface soils, along with the 2xMean concentration for detect concentrations only, and for detects and non-detects using half the detection limit value. The more conservative (lower) of the two values is proposed as the CNC reference value. Thus, a value of 2 x mean calculated using the adjusted mean value is the proposed PAH reference value. All duplicate sample results were removed from the data set before calculating these values.

Data Evaluation Summary

This section presents several conclusions that can be reached after a review of the data sets for the grid and non-grid (AOC and SMWU related) PAH results.

Variability of Sample Detection Limits

The sample detection limits varied in a similar manner across the data sets (both background and site-related) (See Appendix A for values). The samples from site and background data sets identified with a 'U' qualifier flag were similar in the variability of their reporting limits. The range of 'U' values was between 340 ug/kg and 4000 ug/kg. The highest 'U' value is lower than the maximum detected concentration.

Variability of Sample Results

A review of the data quality indicates that analytical methods were the same for background and onsite data and the techniques and reporting limits met the required data quality. Thus, it can be concluded that the observed high variability in results for both site and background samples is innate to the soil sample PAHs, and is independent of sample location and sampling event.

Discussion of Additional Factors Suggested by SCDHEC

SCDHEC provided recommendations for evaluating the PAH data with regard to its spatial variability at the CNC. This section presents a summary of these data subsets evaluated. The data were separated into several subgroups as per DHEC's suggestion and BEQs were estimated for each subgroup. These subgroups are described below.

Background BEQs per zone

Table 6 presents surface soil grid-sample BEQ results per zone and for all zones. Table 7 presents subsurface soil grid-sample BEQ results per zone and for all zones (last data set) for

comparison. As can be noted from these two tables, there is no particular pattern to the distribution of the PAHs across different zones. Zones A and B have higher levels than all other zones. Zone F, which has a highly industrial area and is adjacent to Zone E, has one of the lowest BEQs reported in the background samples.

One problem in attempting to develop a zone-specific BEQ value is the wide variability in the number of grid samples collected in different zones. For example, in Zone F only 5 grid samples were collected and analyzed for PAHs. Five samples provides a poor statistical data set for this zone and increases the uncertainty regarding decision errors. By contrast, Zone H had 96 surface soil grid samples analyzed for PAHs. Typically, for effectively applying environmental statistics for developing average site concentrations, at least 12 samples is preferred. It can be seen that in addition to Zone F, Zones D and G had fewer than 12 grid samples analyzed for PAHs.

For this reason, CH2M HILL believes that a basewide calculation approach to determining background PAH concentrations is a technically more defensible approach compared to a zone-by-zone calculation.

Background PAH Concentrations Related to Site Features

Background BEQs in surface soil along railroad (RR), roadways, asphalt-paved areas, and all other areas combined are summarized in Table 8. This table includes BEQs estimated for data identified to be within a RR and 10 ft buffer zones, roadways and within 10 ft from roadways, and asphalt paved parking areas and 10 ft buffer zones. There are 3 samples identified within railroad tracks, 19 samples were identified within or near roadways and 62 samples were identified within asphalt paved areas. As can be noted from the table, there is not a significant variability in the calculated values between these different groups.

While the highest calculated values are for the samples collected within 10 ft of railroads, there is a limited number of samples (2) in this set, raising questions about the representativeness of this value.

Impact on BEQ Calculation from Removing 10 Highest Samples

The background BEQs estimated by removing the top 10 highest values are presented in Table 9. As can be noted, removal of the highest concentrations only slighted decreased the overall estimated BEQs. Table 10 includes the individual sample IDs and the associated BEQ concentrations for these top 10 samples.

Summary

Overall BEQ levels do not appear to differ significantly between different ways of looking at the data. Where a difference can be observed, there is no particular readily identified association/reason for the variability observed. For the reasons previously presented, CH2M HILL believes that a basewide value for PAH background will provide the most defensible approach and a consistent basis for remedial decision-making and planning. The values presented in Table 5, calculated using twice the adjusted mean value, are recommended as the surface soil and subsurface soil background BEQ values for CNC.

The proposed reference values could be used for screening evaluations at sites that are being investigated, recommended for no further actions, limited removal action or a CMS study. It should be noted that a single value estimate does not fully describe the internal variability of the data distributions and the occurrence of values well above the 2 x mean values within the reference data sets. Therefore, for sites where the reference value is exceeded, further evaluation may be considered following EPA Region IV guidance for background evaluations (EPA, 1998).

References:

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EPA, 1998. Statistical Tests for Background Comparison at Hazardous Waste Sites. Data Collection and Evaluation, Human Health Risk Assessment, Supplemental Guidance to RAGs: Region 4 Bulletins – Addition #1Background comparison statistical guidance, draft, November, 1998.

TABLE 1:BACKGROUND SOIL PAH CONCENTRATIONS IN UNITED STATES

Chemical	**Concentration (ug/kg)**		
	Rural Soil	**Agricultural Soil**	**Urban Soil**
Acenapththene	1.7	6	-
Acenapththylene	-	5	-
Anthracene	-	11-13	-
Benzo(a)athracene	5-20	56-110	169-59,000
Benzo(a)pyrene	2-1,300	4.6-900	165-220
Benzo(b)fluoranthene	20-30	58-220	1,500-62,000
Benzo(g,h,I)perylene	10-70	66	900-47,000
Benzo(k)fluoranthene	10-110	58-250	300-26,000
Chrysene	38.3	78-120	251-640
Fluoranthene	0.3-40	120-210	200-166,000
Fluorene	-	9.7	-
Indeno(1,2,3-c,d)pyrene	10-15	63-100	8,000-61,000
Phenanthrene	30	48-140	-
Pyrene	1-19.7	99-150	145-147,000

Note: This table is adapted from Table 5-3 from ATSDR's Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs), August 1995.

TABLE 2: LIST OF PAHS COMMONLY REPORTED IN SOIL SAMPLES

PAH	Carcinogen?	TEF for BEQ
Acenaphthene	No	
Anthracene	No	
Benz(a)anthracene	Yes	0.1
Benzo(b)fluoranthene	Yes	0.1
Benzo(k)fluoranthene	Yes	0.01
Benzo(a)pyrene	Yes	1.0
Carbazole*	Yes	
Chrysene	Yes	0.001
Dibenz(a,h)anthracene	Yes	1.0
Dibenzofuran	No	
Fluoranthene	No	
Fluorene	No	
Indeno(1,2,3-c,d)pyrene	Yes	0.1
2-methylnaphthalene	No	
Naphthalene	No	
Pyrene	No	

- Carbazole is included in risk assessment separately; TEF = Toxicity equivalency factor; BEQ = benzo(a)pyrene equivalent concentration.

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TABLE 3
Half-Life Estimates for PAHs (in days)

Media	Naphthalene	Anthracene	Benzo(a)pyrene
Soil (aerobic)	17	50	57
Groundwater	1	100	114
Sediments(anaerobic)	25	200	228
Surface Water	<0.5	<0.1	<0.1
Air	<0.12	<0.1	<0.1

Notes:
Biodegradation half-life estimates in days for surface and subsurface media. Values are the low-end estimates selected for comparison between different PAH constituents.
Surface water attenuation primarily attributed to volatilization and photolysis in the water column. Does not consider sediment partitioning (Howard, 1991).

TABLE 4: PAH CONTENT OF DIFFERENT POTENTIAL SOURCE MATERIAL AT CNC

Potential Source	PAH Content (mg/kg)
Gasoline	7.0
Diesel	>8000*
Fuel Oil No. 2	0.07 – BaP
Used Motor Oil**	BaP – <0.1 to 405
Coal-tar/Creosote	163,000 – 750,000 / (300 to 3600 ppm BaP)
European asphalt cements	10
US asphalt cements (average of 12)	24
European Coaltar	152,647
US Low temperature Coal tar	63,160

- Diesel has mostly di- and trimethyl naphthalenes, with negligible <1 mg/kg of BaP content

**_ From ATSDR, 1995

TABLE 5: PROPOSED PAH REFERENCE VALUES USING 'U' VALUES FOR ADJUSTED MEAN ESTIMATES

Parameter Name	Number of Analysis	Number of Detects	Min Detect	Max Detect	Mean Detect	Adjusted Mean Value*	2X Mean of Detects	2X Adjusted Mean Value*
Surface Soil								
BENZO(a)ANTHRACENE	212	53	34	2100	342	299	683	597
BENZO(a)PYRENE	212	51	45	1500	341	296	681	593
BENZO(b)FLUORANTHENE	212	44	49	1800	383	304	765	607
BENZO(k)FLUORANTHENE	212	48	42	1700	348	295	697	590
CHRYSENE	212	57	40	3000	377	302	754	603
DIBENZ(a,h)ANTHRACENE	212	15	64	440	175	258	351	515
INDENO(1,2,3-c,d)PYRENE	212	36	42	670	215	258	431	516
						BEQ	**1213**	**1258**
Subsurface Soil								
BENZO(a)ANTHRACENE	153	19	55	3400	444	309	888	618
BENZO(a)PYRENE	153	17	52	2600	403	305	805	610
BENZO(b)FLUORANTHENE	153	14	57	2600	384	307	768	613
BENZO(k)FLUORANTHENE	153	13	92	2300	448	303	896	606
CHRYSENE	153	21	57	3400	421	304	841	608
DIBENZ(a,h)ANTHRACENE	153	4	160	780	348	285	695	569
INDENO(1,2,3-c,d)PYRENE	153	10	54	1600	341	289	681	578
						BEQ	**1744**	**1367**

Note: * - Includes non-detects at half of the reported detection limit value
All values in ug/kg

Table 6 : Surface soil background BEQs per zone and combined for all zones

Zone-Medium	Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
A-SS	BENZO(a)ANTHRACENE	UG/KG	13	4	250	660	423	397	720	860	845	793	85	79
A-SS	BENZO(a)PYRENE	UG/KG	13	4	340	830	490	417	720	860	980	835	980	835
A-SS	BENZO(b)FLUORANTHENE	UG/KG	13	4	390	1800	763	501	720	860	1525	1002	153	100
A-SS	BENZO(k)FLUORANTHENE	UG/KG	13	4	390	1100	598	450	720	860	1195	901	12	9
A-SS	CHRYSENE	UG/KG	13	5	190	980	456	412	720	860	912	825	1	1
A-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	13	1	230	230	230	372	720	860	460	744	460	744
A-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	13	4	210	670	333	369	720	860	665	738	67	74
												BEQ	**1756**	**1842**
B-SS	BENZO(a)ANTHRACENE	UG/KG	15	2	160	260	210	372	690	1000	420	743	42	74
B-SS	BENZO(a)PYRENE	UG/KG	15	2	150	210	180	368	690	1000	360	735	360	735
B-SS	BENZO(b)FLUORANTHENE	UG/KG	15	1	220	220	220	382	690	1000	440	764	44	76
B-SS	BENZO(k)FLUORANTHENE	UG/KG	15					391	690	1000		783	0	8
B-SS	CHRYSENE	UG/KG	15	2	160	280	220	373	690	1000	440	746	0	1
B-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	15					391	690	1000		783	0	783
B-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	15	2	130	140	135	362	690	1000	270	723	27	72
												BEQ	**473**	**1750**
C-SS	BENZO(a)ANTHRACENE	UG/KG	12	4	50	260	131	292	720	780	262	585	26	58
C-SS	BENZO(a)PYRENE	UG/KG	12	5	66	330	158	282	720	770	316	564	316	564
C-SS	BENZO(b)FLUORANTHENE	UG/KG	12	5	49	340	192	332	840	900	384	665	38	66
C-SS	BENZO(k)FLUORANTHENE	UG/KG	12	5	52	360	200	287	670	730	401	574	4	6
C-SS	CHRYSENE	UG/KG	12	4	76	200	124	245	590	640	248	490	0	0
C-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	12					242	470	510		483	0	483
C-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	12	2	110	120	115	235	500	540	230	471	23	47
												BEQ	**408**	**1226**
D-SS	BENZO(a)ANTHRACENE	UG/KG	6	2	34	38	36	136	350	400	72	272	7	27
D-SS	BENZO(a)PYRENE	UG/KG	6	1	45	45	45	162	350	400	90	323	90	323
D-SS	BENZO(b)FLUORANTHENE	UG/KG	6	2	57	58	58	143	350	400	115	287	12	29
D-SS	BENZO(k)FLUORANTHENE	UG/KG	6	2	71	77	74	149	350	400	148	298	1	3
D-SS	CHRYSENE	UG/KG	6	2	54	57	56	143	350	400	111	285	0	0
D-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	6					183	340	400		365	0	365
D-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	6					183	340	400		365	0	37
												BEQ	**110**	**784**
E-SS	BENZO(a)ANTHRACENE	UG/KG	28	11	62	2100	463	407	350	4000	926	813	93	81
E-SS	BENZO(a)PYRENE	UG/KG	28	12	82	1500	379	374	350	4000	757	748	757	748
E-SS	BENZO(b)FLUORANTHENE	UG/KG	28	8	69	700	317	333	350	4000	634	667	63	67
E-SS	BENZO(k)FLUORANTHENE	UG/KG	28	12	85	950	398	383	350	4000	797	766	8	8
E-SS	CHRYSENE	UG/KG	28	13	64	3000	540	456	350	4000	1079	912	1	1
E-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	28	5	68	440	190	309	350	4000	379	617	379	617
E-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	28	11	58	450	191	300	350	4000	382	600	38	60
												BEQ	**1339**	**1582**
F-SS	BENZO(a)ANTHRACENE	UG/KG	5	4	58	78	70	93	370	370	140	186	14	19
F-SS	BENZO(a)PYRENE	UG/KG	5	4	72	90	82	103	370	370	165	206	165	206
F-SS	BENZO(b)FLUORANTHENE	UG/KG	5	3	84	110	94	146	370	530	188	293	19	29
F-SS	BENZO(k)FLUORANTHENE	UG/KG	5	4	82	110	97	114	370	370	194	229	2	2
F-SS	CHRYSENE	UG/KG	5	4	91	130	111	126	370	370	222	251	0	0
F-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	5					197	340	530		394	0	394
F-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	5	3	42	69	59	126	370	530	119	251	12	25

Table 6 : Surface soil background BEQs per zone and combined for all zones

Zone-Medium	Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
												BEQ	**211**	**675**
G-SS	BENZO(a)ANTHRACENE	UG/KG	9	6	49	470	183	186	370	400	366	373	37	37
G-SS	BENZO(a)PYRENE	UG/KG	9	6	48	500	185	188	370	400	371	376	371	376
G-SS	BENZO(b)FLUORANTHENE	UG/KG	9	5	64	710	273	238	370	400	546	476	55	48
G-SS	BENZO(k)FLUORANTHENE	UG/KG	9	6	42	390	171	179	370	400	343	357	3	4
G-SS	CHRYSENE	UG/KG	9	6	59	680	243	226	370	400	486	453	0	0
G-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	9	3	64	180	106	169	370	440	212	338	212	338
G-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	9	3	95	300	185	196	370	440	370	391	37	39
												BEQ	**715**	**842**
H-SS	BENZO(a)ANTHRACENE	UG/KG	96	17	48	1900	513	277	340	1700	1025	553	103	55
H-SS	BENZO(a)PYRENE	UG/KG	96	16	81	1400	511	273	340	1700	1023	546	1023	546
H-SS	BENZO(b)FLUORANTHENE	UG/KG	96	12	68	1700	662	280	340	1700	1325	559	132	56
H-SS	BENZO(k)FLUORANTHENE	UG/KG	96	10	88	1700	637	274	340	1700	1274	548	13	5
H-SS	CHRYSENE	UG/KG	96	18	50	1700	503	278	340	1700	1006	556	1	1
H-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	96	6	84	270	189	230	360	1800	378	460	378	460
H-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	96	11	80	650	281	238	340	1700	562	475	56	48
												BEQ	**1706**	**1171**
I-SS	BENZO(a)ANTHRACENE	UG/KG	15	2	43	59	51	381	710	1000	102	762	10	76
I-SS	BENZO(a)PYRENE	UG/KG	15	1	50	50	50	404	710	1000	100	809	100	809
I-SS	BENZO(b)FLUORANTHENE	UG/KG	15	4	81	97	90	381	830	1100	179	761	18	76
I-SS	BENZO(k)FLUORANTHENE	UG/KG	15	4	97	120	104	317	670	920	207	633	2	6
I-SS	CHRYSENE	UG/KG	15	2	40	49	45	312	580	830	89	624	0	1
I-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	15					279	460	660		557	0	557
I-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	15					298	500	700		596	0	60
												BEQ	**130**	**1585**
K-SS	BENZO(a)ANTHRACENE	UG/KG	13	1	110	110	110	187	360	450	220	374	22	37
K-SS	BENZO(a)PYRENE	UG/KG	13					195	360	450		391	0	391
K-SS	BENZO(b)FLUORANTHENE	UG/KG	13					195	360	450		391	0	39
K-SS	BENZO(k)FLUORANTHENE	UG/KG	13	1	200	200	200	194	360	450	400	388	4	4
K-SS	CHRYSENE	UG/KG	13	1	96	96	96	186	360	450	192	372	0	0
K-SS	DIBENZ(a,h)ANTHRACENE	UG/KG	13					195	360	450		391	0	391
K-SS	INDENO(1,2,3-c,d)PYRENE	UG/KG	13					195	360	450		391	0	39
												BEQ	**26**	**901**
SS-BACKG	BENZO(a)ANTHRACENE	UG/KG	212	53	34	2100	342	299	340	4000	683	597	68	60
SS-BACKG	BENZO(a)PYRENE	UG/KG	212	51	45	1500	341	296	340	4000	681	593	681	593
SS-BACKG	BENZO(b)FLUORANTHENE	UG/KG	212	44	49	1800	383	304	340	4000	765	607	77	61
SS-BACKG	BENZO(k)FLUORANTHENE	UG/KG	212	48	42	1700	348	295	340	4000	697	590	7	6
SS-BACKG	CHRYSENE	UG/KG	212	57	40	3000	377	302	340	4000	754	603	1	1
SS-BACKG	DIBENZ(a,h)ANTHRACENE	UG/KG	212	15	64	440	175	258	340	4000	351	515	351	515
SS-BACKG	INDENO(1,2,3-c,d)PYRENE	UG/KG	212	36	42	670	215	258	340	4000	431	516	43	52
												BEQ	**1228**	**1287**

Table 7 : Subsurface soil background BEQs per zone and combined for all zones

Zone-Medium	Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
A-SB	BENZO(a)ANTHRACENE	UG/KG	12					425	770	1000		850	0	85
A-SB	BENZO(a)PYRENE	UG/KG	12					425	770	1000		850	0	850
A-SB	BENZO(b)FLUORANTHENE	UG/KG	12					425	770	1000		850	0	85
A-SB	BENZO(k)FLUORANTHENE	UG/KG	12					425	770	1000		850	0	9
A-SB	CHRYSENE	UG/KG	12	1	160	160	160	406	780	1000	320	813	0	1
A-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	12					425	770	1000		850	0	850
A-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	12					425	770	1000		850	0	85
												BEQ	**0**	**1964**
B-SB	BENZO(a)ANTHRACENE	UG/KG	14	1	190	190	190	419	680	1600	380	838	38	84
B-SB	BENZO(a)PYRENE	UG/KG	14					437	680	1600		874	0	874
B-SB	BENZO(b)FLUORANTHENE	UG/KG	14					437	680	1600		874	0	87
B-SB	BENZO(k)FLUORANTHENE	UG/KG	14					437	680	1600		874	0	9
B-SB	CHRYSENE	UG/KG	14	1	230	230	230	422	680	1600	460	844	0	1
B-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	14					437	680	1600		874	0	874
B-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	14					437	680	1600		874	0	87
												BEQ	**38**	**2015**
C-SB	BENZO(a)ANTHRACENE	UG/KG	6	3	130	180	150	258	690	800	300	515	30	52
C-SB	BENZO(a)PYRENE	UG/KG	6	2	120	150	135	328	690	1200	270	655	270	655
C-SB	BENZO(b)FLUORANTHENE	UG/KG	6	2	180	240	210	399	800	1400	420	798	42	80
C-SB	BENZO(k)FLUORANTHENE	UG/KG	6	2	96	200	148	320	640	1200	296	640	3	6
C-SB	CHRYSENE	UG/KG	6	3	96	190	149	224	560	660	297	447	0	0
C-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	6					265	450	800		530	0	530
C-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	6	1	82	82	82	255	480	860	164	511	16	51
												BEQ	**362**	**1374**
D-SB	BENZO(a)ANTHRACENE	UG/KG	6					192	350	430		383	0	38
D-SB	BENZO(a)PYRENE	UG/KG	6					192	350	430		383	0	383
D-SB	BENZO(b)FLUORANTHENE	UG/KG	6					192	350	430		383	0	38
D-SB	BENZO(k)FLUORANTHENE	UG/KG	6					192	350	430		383	0	4
D-SB	CHRYSENE	UG/KG	6					192	350	430		383	0	0
D-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	6					192	350	430		383	0	383
D-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	6					192	350	430		383	0	38
												BEQ	**0**	**886**
E-SB	BENZO(a)ANTHRACENE	UG/KG	29	8	130	3400	798	434	350	1100	1595	868	160	87
E-SB	BENZO(a)PYRENE	UG/KG	29	9	120	2600	609	394	350	1100	1218	788	1218	788
E-SB	BENZO(b)FLUORANTHENE	UG/KG	29	7	120	2600	617	380	350	1100	1234	760	123	76
E-SB	BENZO(k)FLUORANTHENE	UG/KG	29	8	92	2300	646	386	350	1100	1292	772	13	8
E-SB	CHRYSENE	UG/KG	29	9	58	3400	731	434	350	1100	1462	867	1	1
E-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	29	4	160	780	348	307	350	1100	695	614	695	614
E-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	29	6	83	1600	498	342	350	1100	995	685	100	68
												BEQ	**2310**	**1642**
F-SB	BENZO(a)ANTHRACENE	UG/KG	5					215	380	530		430	0	43
F-SB	BENZO(a)PYRENE	UG/KG	5					215	380	530		430	0	430
F-SB	BENZO(b)FLUORANTHENE	UG/KG	5					215	380	530		430	0	43
F-SB	BENZO(k)FLUORANTHENE	UG/KG	5					215	380	530		430	0	4
F-SB	CHRYSENE	UG/KG	5					215	380	530		430	0	0
F-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	5					215	380	530		430	0	430
F-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	5					215	380	530		430	0	43
												BEQ	**0**	**994**

Table 7 : Subsurface soil background BEQs per zone and combined for all zones

Zone-Medium	Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
G-SB	BENZO(a)ANTHRACENE	UG/KG	7	3	55	180	112	181	400	630	223	363	22	36
G-SB	BENZO(a)PYRENE	UG/KG	7	2	93	150	122	200	400	630	243	399	243	399
G-SB	BENZO(b)FLUORANTHENE	UG/KG	7	3	57	130	82	169	400	630	165	338	16	34
G-SB	BENZO(k)FLUORANTHENE	UG/KG	7	2	110	120	115	198	400	630	230	396	2	4
G-SB	CHRYSENE	UG/KG	7	3	57	200	119	185	400	630	238	369	0	0
G-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	7					231	400	630		461	0	461
G-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	7	2	54	65	60	182	400	630	119	364	12	36
												BEQ	**296**	**972**
H-SB	BENZO(a)ANTHRACENE	UG/KG	58	3	120	640	317	251	360	910	633	501	63	50
H-SB	BENZO(a)PYRENE	UG/KG	58	3	140	480	267	248	360	910	533	496	533	496
H-SB	BENZO(b)FLUORANTHENE	UG/KG	58	1	270	270	270	249	360	910	540	498	54	50
H-SB	BENZO(k)FLUORANTHENE	UG/KG	58					248	360	910		496	0	5
H-SB	CHRYSENE	UG/KG	58	3	140	580	307	250	360	910	613	500	1	1
H-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	58					249	380	910		498	0	498
H-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	58	1	220	220	220	247	360	910	440	494	44	49
												BEQ	**695**	**1148**
I-SB	BENZO(a)ANTHRACENE	UG/KG	6	1	130	130	130	372	750	980	260	743	26	74
I-SB	BENZO(a)PYRENE	UG/KG	6	1	52	52	52	359	750	980	104	717	104	717
I-SB	BENZO(b)FLUORANTHENE	UG/KG	6	1	120	120	120	423	870	1100	240	847	24	85
I-SB	BENZO(k)FLUORANTHENE	UG/KG	6	1	130	130	130	351	700	920	260	702	3	7
I-SB	CHRYSENE	UG/KG	6	1	140	140	140	309	610	800	280	618	0	1
I-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	6					280	490	640		560	0	560
I-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	6					298	520	680		595	0	60
												BEQ	**157**	**1503**
K-SB	BENZO(a)ANTHRACENE	UG/KG	10					191	350	490		381	0	38
K-SB	BENZO(a)PYRENE	UG/KG	10					191	350	490		381	0	381
K-SB	BENZO(b)FLUORANTHENE	UG/KG	10					191	350	490		381	0	38
K-SB	BENZO(k)FLUORANTHENE	UG/KG	10					191	350	490		381	0	4
K-SB	CHRYSENE	UG/KG	10					191	350	490		381	0	0
K-SB	DIBENZ(a,h)ANTHRACENE	UG/KG	10					191	350	490		381	0	381
K-SB	INDENO(1,2,3-c,d)PYRENE	UG/KG	10					191	350	490		381	0	38
												BEQ	**0**	**880**
SB-BACK(	BENZO(a)ANTHRACENE	UG/KG	153	19	55	3400	444	309	350	1600	888	618	89	62
SB-BACK(	BENZO(a)PYRENE	UG/KG	153	17	52	2600	403	305	350	1600	805	610	805	610
SB-BACK(	BENZO(b)FLUORANTHENE	UG/KG	153	14	57	2600	384	307	350	1600	768	613	77	61
SB-BACK(	BENZO(k)FLUORANTHENE	UG/KG	153	13	92	2300	448	303	350	1600	896	606	9	6
SB-BACK(	CHRYSENE	UG/KG	153	21	57	3400	421	304	350	1600	841	608	1	1
SB-BACK(	DIBENZ(a,h)ANTHRACENE	UG/KG	153	4	160	780	348	285	350	1600	695	569	695	569
SB-BACK(	INDENO(1,2,3-c,d)PYRENE	UG/KG	153	10	54	1600	341	289	350	1600	681	578	68	58
												BEQ	**1744**	**1367**

Table 8 : Surface soil background BEQs Near and Away from Potential Anthropogenic Source Areas

Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
Samples within and near (10ft) Railroad Tracks													
BENZO(a)ANTHRACENE	UG/KG	2	1	530	530	530	360	380	380	1060	720	106	72
BENZO(a)PYRENE	UG/KG	2	1	560	560	560	375	380	380	1120	750	1120	750
BENZO(b)FLUORANTHENE	UG/KG	2					200	380	420		400	0	40
BENZO(k)FLUORANTHENE	UG/KG	2	1	760	760	760	475	380	380	1520	950	15	10
CHRYSENE	UG/KG	2	1	650	650	650	420	380	380	1300	840	1	1
DIBENZ(a,h)ANTHRACENE	UG/KG	2	1	130	130	130	160	380	380	260	320	260	320
INDENO(1,2,3-c,d)PYRENE	UG/KG	2	1	310	310	310	250	380	380	620	500	62	50
												1565	**1242**
Samples within and near (10ft) Apshalt Paved Areas													
BENZO(a)ANTHRACENE	UG/KG	50	8	34	380	179	253	360	860	359	506	36	51
BENZO(a)PYRENE	UG/KG	50	7	45	1400	357	278	360	860	715	556	715	556
BENZO(b)FLUORANTHENE	UG/KG	50	8	57	1700	384	294	360	930	768	589	77	59
BENZO(k)FLUORANTHENE	UG/KG	50	9	71	1200	317	270	360	860	634	540	6	5
CHRYSENE	UG/KG	50	9	54	810	267	254	360	860	534	507	1	1
DIBENZ(a,h)ANTHRACENE	UG/KG	50	2	68	270	169	240	340	860	338	480	338	480
INDENO(1,2,3-c,d)PYRENE	UG/KG	50	6	42	650	214	239	340	860	427	478	43	48
												1215	**1199**
Samples within and near (10ft) Roadways													
BENZO(a)ANTHRACENE	UG/KG	20	7	48	1900	564	389	360	1000	1128	778	113	78
BENZO(a)PYRENE	UG/KG	20	6	82	1200	502	352	360	1000	1004	704	1004	704
BENZO(b)FLUORANTHENE	UG/KG	20	4	68	1400	570	352	360	1100	1139	704	114	70
BENZO(k)FLUORANTHENE	UG/KG	20	4	88	1100	690	356	360	1000	1379	712	14	7
CHRYSENE	UG/KG	20	7	50	1700	561	372	360	1000	1123	745	1	1
DIBENZ(a,h)ANTHRACENE	UG/KG	20	3	130	210	167	229	360	1000	333	459	333	459
INDENO(1,2,3-c,d)PYRENE	UG/KG	20	5	94	380	251	248	360	1000	502	496	50	50
												1629	**1368**
Surface Soil Samples from Other Areas													
BENZO(a)ANTHRACENE	UG/KG	140	38	43	2100	335	301	340	4000	669	602	67	60
BENZO(a)PYRENE	UG/KG	140	38	48	1500	312	294	340	4000	624	588	624	588
BENZO(b)FLUORANTHENE	UG/KG	140	32	49	1800	359	299	340	4000	718	599	72	60
BENZO(k)FLUORANTHENE	UG/KG	140	35	42	1700	317	294	340	4000	635	589	6	6
CHRYSENE	UG/KG	140	41	40	3000	370	308	340	4000	739	616	1	1
DIBENZ(a,h)ANTHRACENE	UG/KG	140	10	64	440	179	267	350	4000	358	535	358	535
INDENO(1,2,3-c,d)PYRENE	UG/KG	140	25	58	670	209	266	340	4000	418	532	42	53
												1170	**1303**
All Surface Soil Background Samples Across CNC													
BENZO(a)ANTHRACENE	UG/KG	212	53	34	2100	342	299	340	4000	683	597	68	60
BENZO(a)PYRENE	UG/KG	212	51	45	1500	341	296	340	4000	681	593	681	593
BENZO(b)FLUORANTHENE	UG/KG	212	44	49	1800	383	304	340	4000	765	607	77	61
BENZO(k)FLUORANTHENE	UG/KG	212	48	42	1700	348	295	340	4000	697	590	7	6
CHRYSENE	UG/KG	212	57	40	3000	377	302	340	4000	754	603	1	1
DIBENZ(a,h)ANTHRACENE	UG/KG	212	15	64	440	175	258	340	4000	351	515	351	515
INDENO(1,2,3-c,d)PYRENE	UG/KG	212	36	42	670	215	258	340	4000	431	516	43	52
											BEQ	**1228**	**1287**

Table 9 : Surface and Subsurface background BEQs after removing top 10 samples

Chemical Name	Units	No. Analysis	No. Detects	Minimum of Detects	Max. of Detects	Mean of Detect	Adjusted Mean	Minimum of Non-Detecs	Maximum of Non-Detects	2x Mean of Detects	2x Adjusted Mean	BEQ (2x Mean Value)	BEQ (2x Adj Mean Value)
Surface Soil													
BENZO(a)ANTHRACENE	UG/KG	202	46	34	860	214	256	340	1000	428	512	43	51
BENZO(a)PYRENE	UG/KG	202	44	45	710	217	256	340	1000	435	511	435	511
BENZO(b)FLUORANTHENE	UG/KG	202	37	49	710	224	260	340	1100	448	520	45	52
BENZO(k)FLUORANTHENE	UG/KG	202	42	42	950	235	255	340	980	470	510	5	5
CHRYSENE	UG/KG	202	50	40	1200	238	253	340	980	476	505	0	1
DIBENZ(a,h)ANTHRACENE	UG/KG	202	9	64	200	119	241	340	980	238	483	238	483
INDENO(1,2,3-c,d)PYRENE	UG/KG	202	30	42	370	154	235	340	980	308	469	31	47
											BEQ	**796**	**1150**
Subsurface Soil													
BENZO(a)ANTHRACENE	UG/KG	143	16	55	640	228	270	350	980	457	539	46	54
BENZO(a)PYRENE	UG/KG	143	15	52	610	217	270	350	980	434	539	434	539
BENZO(b)FLUORANTHENE	UG/KG	143	13	57	620	214	274	350	1100	427	548	43	55
BENZO(k)FLUORANTHENE	UG/KG	143	11	92	440	184	266	350	940	368	532	4	5
CHRYSENE	UG/KG	143	18	57	630	226	264	350	940	452	529	0	1
DIBENZ(a,h)ANTHRACENE	UG/KG	143	2	160	160	160	267	350	940	320	534	320	534
INDENO(1,2,3-c,d)PYRENE	UG/KG	143	8	54	360	157	264	350	940	314	527	31	53
											BEQ	**878**	**1241**

Table 10: Top BEQ Concentrations Removed			
Matrix	**SumOfBEQ**	**SampleID**	**Rank**
SB	4166.4	GDESB01502	1
SB	1848.8	GDBSB00102	2
SB	1519.7	GDESB01402	3
SB	1386.6	GDBSB00202	4
SB	1271.05	GDESB00602	5
SB	1155.5	GDASB00502	6
SB	1155.5	GDASB01102	6
SB	1137.16	GDCSB00402a	8
SB	1120.835	GDESB00702	9
SB	1109.28	GDASB00102	10
SS	4622	GDESB00401	1
SS	2277.5	GDESB01801	2
SS	2014.35	GDHSB08301	3
SS	2006.7	GDHSB02801	4
SS	1955.81	GDHSB00101	5
SS	1790.7	GDHSB02601	6
SS	1761.06	GDHSB08101	6
SS	1384.98	GDASB00601	8
SS	1257.73	GDHSB05601	9
SS	1155.5	GDBSB00101	10

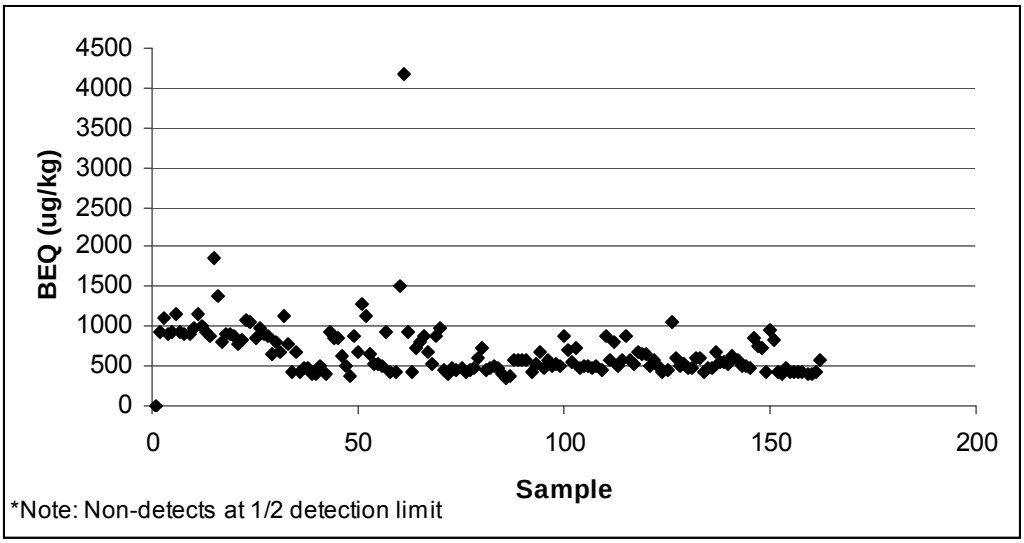

FIGURE 3B
Background **Subsurface Soil** BEQ concentrations plotted against samples
Charleston Navy Complex

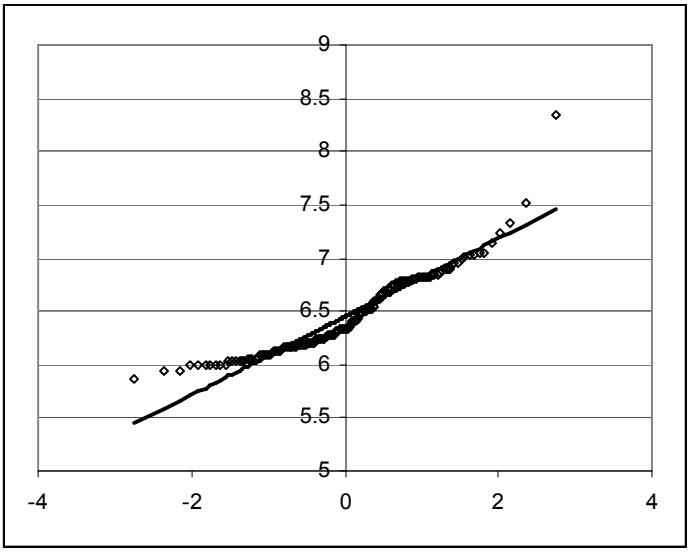

FIGURE 3E
Probability Plot of Background **Subsurface Soil** BEQ concentrations for lognormal transformed data
Charleston Navy Complex

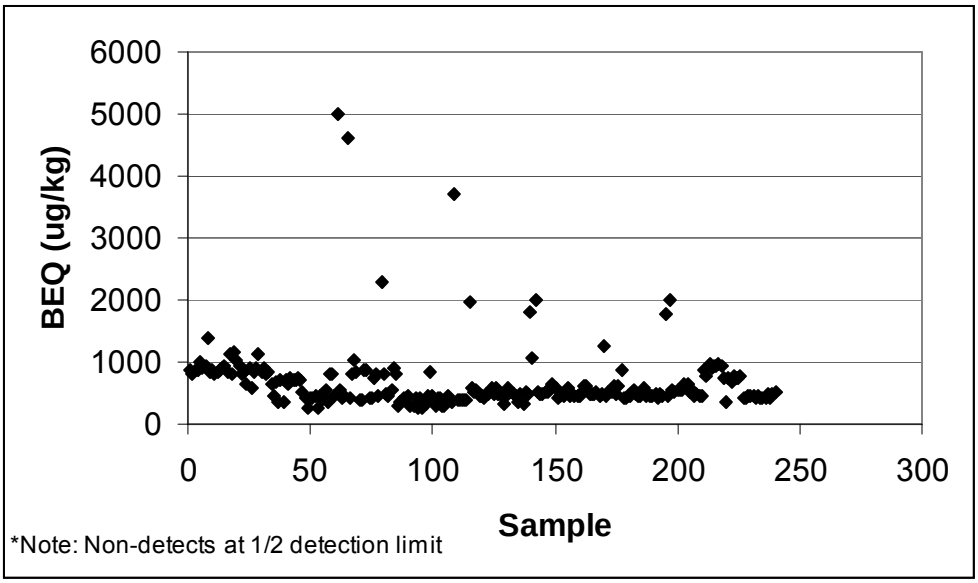

FIGURE 3A
Background **Surface Soil** BEQ concentrations plotted against samples
Charleston Navy Complex

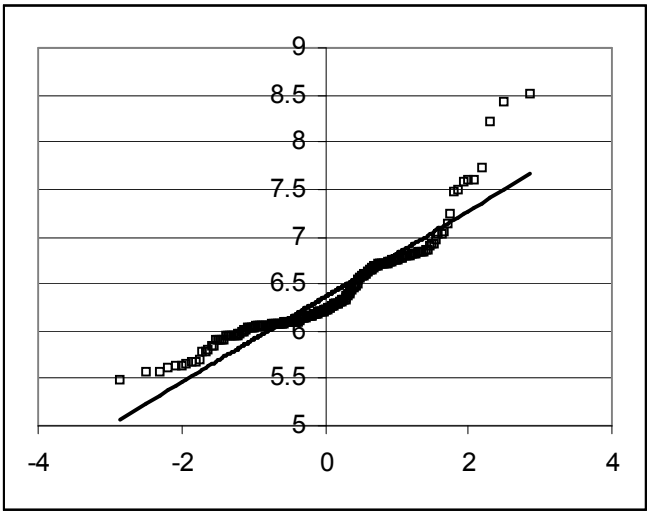

FIGURE 3C
Probability Plot of Background **Surface Soil** BEQ concentrations for lognormal transformed data
Charleston Navy Complex

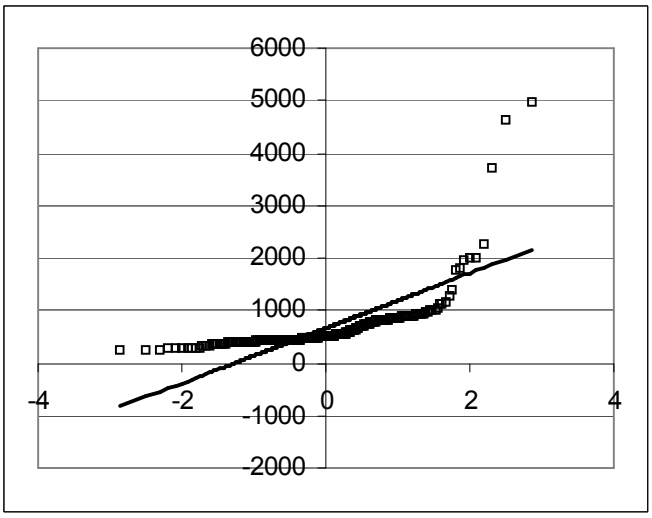

FIGURE 3D
Probability Plot of Background **Surface Soil** BEQ Concentrations of **normal data**.
Charleston Navy Complex

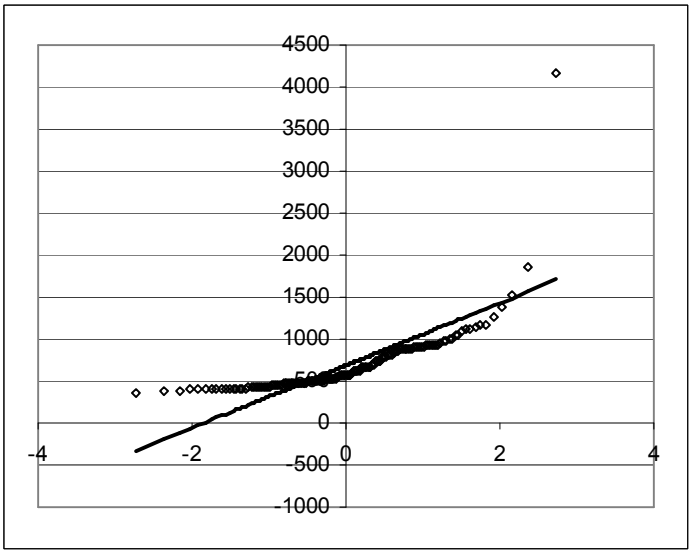

FIGURE 3F
Probability Plot of Background **Subsurface Soil** BEQs assuming a **normal data distribution**
Charleston Navy Complex

TABLE 1
Statistical Summary of the Analytical Results for Surface Soil Background Samples for Each Zone
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)	RR Lines*
Aluminum	Detects	13	15	44	6	31	6	9	97	13	9	4	
Aluminum	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Aluminum	Maximum Detect	11,800	55,500	9,850	6,510	20,500	19,400	17,800	32,700	27,400	8,320	24,700	
Aluminum	Minimum Detect	3,640	6,320	2,110	3,560	261	3,610	2,190	1,090	3,470	4,050	5,020	
Aluminum	Mean	7,468	15,695	4,988	4,312	5,930	8,842	9,302	8,688	13,362	5,578	14,655	
Aluminum	Std Dev	2,216	13,890	1,876	1,139	5,036	6,698	5,391	6,227	9,544	1,267	8,691	
Antimony	Detects	0	1	15	1	9	3	5	6	0	1	3	
Antimony	No. Analyzed	13	15	44	6	36	6	9	96	13	9	4	
Antimony	Maximum Detect	NA	13	1.4	1.7	7.4	0.71	5.7	2.2	NA	0.59	2.2	
Antimony	Minimum Detect	NA	13	0.26	1.7	0.50	0.50	0.79	1.1	NA	0.59	0.48	
Antimony	Mean	6.0	6.5	0.22	0.46	0.86	0.40	1.4	1.7	1.3	0.23	0.85	
Antimony	Std Dev	0.37	1.9	0.22	0.61	1.3	0.25	1.8	2.1	1.2	0.14	0.92	
Arsenic	Detects	16	14	31	6	29	6	9	84	12	15	4	21
Arsenic	No. Analyzed	16	15	44	6	36	6	9	97	13	15	4	21
Arsenic	Maximum Detect	30	29	39	7.4	68	30	25	18	20	92	14	92
Arsenic	Minimum Detect	1.7	1.7	0.40	0.84	0.95	3.0	3.1	0.64	0.46	0.60	7.2	1.9
Arsenic	Mean	7.0	8.1	4.2	2.8	8.5	13	12	6.1	6.6	11	11	26
Arsenic	Std Dev	6.9	8.0	7.4	2.6	14	11	8.1	4.3	5.7	26	3.6	27
Barium	Detects	13	15	44	6	31	6	9	85	13	9	4	
Barium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Barium	Maximum Detect	47	95	193	20	1,980	47	129	73	43	20	51	
Barium	Minimum Detect	6.5	15	4.4	9.7	1.8	13	11	3.6	7.8	6.6	17	
Barium	Mean	23	47	28	15	76	30	51	15	27	13	29	
Barium	Std Dev	9.4	20	33	4.7	327	14	36	11	11	4.6	16	

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TABLE 1
Statistical Summary of the Analytical Results for Surface Soil Background Samples for Each Zone
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)	RR Lines*
Beryllium	Detects	1	13	4	1	27	6	6	85	8	5	4	
Beryllium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Beryllium	Maximum Detect	0.32	1.7	0.26	0.13	1.6	1.3	1.1	1.4	0.95	0.32	0.99	
Beryllium	Minimum Detect	0.32	0.28	0.11	0.13	0.13	0.19	0.47	0.040	0.34	0.060	0.31	
Beryllium	Mean	0.13	0.56	0.095	0.11	0.42	0.53	0.58	0.39	0.46	0.083	0.65	
Beryllium	Std Dev	0.057	0.42	0.056	0.033	0.39	0.46	0.36	0.31	0.34	0.096	0.29	
Cadmium	Detects	1	0	6	1	14	4	7	21	5	1	2	
Cadmium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Cadmium	Maximum Detect	2.8	NA	0.65	0.11	1.5	0.22	1.7	1.6	0.61	0.080	0.42	
Cadmium	Minimum Detect	2.8	NA	0.16	0.11	0.060	0.12	0.12	0.12	0.13	0.080	0.29	
Cadmium	Mean	0.75	0.59	0.089	0.037	0.32	0.13	0.53	0.26	0.28	0.064	0.23	
Cadmium	Std Dev	0.62	0.076	0.14	0.036	0.41	0.074	0.53	0.32	0.18	0.040	0.15	
Calcium	Detects	13	15	43	6	31	6	9	97	13	9	4	
Calcium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Calcium	Maximum Detect	78,900	115,000	85,600	15,500	182,000	27,800	52,300	333,000	59,500	2,960	59,000	
Calcium	Minimum Detect	797	406	484	344	167	2,080	8,920	169	1,670	275	8,100	
Calcium	Mean	17,673	16,822	15,713	4,062	23,015	10,265	23,391	52,482	24,108	934	39,950	
Calcium	Std Dev	24,601	31,516	19,694	5,673	39,261	9,757	14,051	66,613	18,266	933	22,061	
Chromium IV	No. Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	
Chromium IV	Mean	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.13	
Chromium IV	Std Dev	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.012	
Chromium, Total	Detects	13	15	44	6	35	6	9	96	13	9	4	
Chromium, Total	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Chromium, Total	Maximum Detect	34	74	32	9.7	567	35	39	114	54	6.3	46	

TABLE 1
Statistical Summary of the Analytical Results for Surface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)	RR Lines*
Chromium, Total	Minimum Detect	5.7	6.0	2.7	4.5	2.3	6.3	7.0	3.4	7.5	2.8	21	
Chromium, Total	Mean	16	24	9.8	6.1	33	17	21	27	29	4.2	31	
Chromium, Total	Std Dev	7.9	20	6.2	1.9	93	12	11	21	17	1.1	12	
Cobalt	Detects	5	12	41	6	30	6	9	72	9	3	4	
Cobalt	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Cobalt	Maximum Detect	4.4	11	2.9	17	111	36	6.2	7.9	5.8	0.46	4.5	
Cobalt	Minimum Detect	1.6	1.4	0.18	0.34	0.35	0.94	1.1	0.49	0.64	0.16	0.35	
Cobalt	Mean	1.3	3.4	1.0	4.7	6.4	7.5	3.3	2.0	3.0	0.17	2.9	
Cobalt	Std Dev	1.1	3.2	0.61	6.8	18	14	1.8	1.5	2.1	0.12	1.8	
Copper	Detects	13	15	43	1	31	6	7	82	13	8	4	21
Copper	No. Analyzed	13	15	44	6	36	6	9	97	13	15	4	21
Copper	Maximum Detect	71	122	40	116	866	56	431	126	556	4.8	95	109
Copper	Minimum Detect	2.2	3.8	0.81	116	0.47	5.7	23	0.94	2.4	0.90	11	5.0
Copper	Mean	18	31	11	20	60	25	130	12	67	1.6	47	37
Copper	Std Dev	19	33	9.6	47	154	17	154	16	149	1.4	35	28
Iron	Detects	13	15	44	6	31	6	9	97	13	9	4	
Iron	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Iron	Maximum Detect	15,700	48,700	12,000	3,600	30,600	28,200	32,700	38,800	22,700	7,990	23,400	
Iron	Minimum Detect	1,530	2,630	841	966	1,050	3,570	4,300	695	1,730	1,200	10,400	
Iron	Mean	7,461	12,682	3,848	2,239	8,710	11,755	14,577	9,484	11,267	3,529	16,575	
Iron	Std Dev	3,659	14,134	2,229	841	8,885	10,008	8,714	8,629	8,047	2,075	5,775	
Lead	Detects	13	15	44	6	31	6	9	82	13	9	4	
Lead	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Lead	Maximum Detect	93	310	588	21	400	231	275	172	203	259	71	
Lead	Minimum Detect	4.1	13	2.7	2.2	1.0	49	3.5	1.8	5.0	8.9	16	

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Lead	Mean	36	70	69	9.4	61	91	91	27	57	46	41	
Lead	Std Dev	29	70	111	8.3	101	69	78	30	58	80	23	
Magnesium	Detects	13	15	44	6	31	6	9	97	13	9	4	
Magnesium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Magnesium	Maximum Detect	3,150	6,990	2,390	850	14,800	4,000	5,280	7,850	3,820	251	4,240	
Magnesium	Minimum Detect	231	226	130	157	31	323	766	131	424	66	2,110	
Magnesium	Mean	822	1,767	574	345	2,060	1,504	2,008	2,035	1,956	136	3,125	
Magnesium	Std Dev	851	2,014	506	260	3,153	1,603	1,409	1,681	1,443	55	873	
Manganese	Detects	13	15	44	6	31	6	9	97	13	9	4	
Manganese	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Manganese	Maximum Detect	66	454	101	23	508	436	359	1,200	426	45	1,050	
Manganese	Minimum Detect	8.7	27	10	5.0	0.93	32	39	5.3	15	3.2	229	
Manganese	Mean	36	213	43	14	100	161	163	146	163	13	511	
Manganese	Std Dev	18	134	22	6.2	114	182	114	194	155	13	367	
Mercury	Detects	4	8	15	1	22	6	8	69	7	0	3	
Mercury	No. Analyzed	13	15	44	6	35	6	9	97	13	9	4	
Mercury	Maximum Detect	0.30	1.5	0.75	0.060	2.7	0.61	2.0	3.8	0.47	NA	0.52	
Mercury	Minimum Detect	0.12	0.12	0.11	0.060	0.030	0.090	0.060	0.020	0.13	NA	0.17	
Mercury	Mean	0.10	0.34	0.10	0.026	0.22	0.30	0.55	0.19	0.17	0.026	0.24	
Mercury	Std Dev	0.082	0.47	0.11	0.017	0.47	0.19	0.63	0.48	0.13	0.0022	0.21	
Nickel	Detects	11	15	40	6	30	4	9	86	12	5	4	
Nickel	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Nickel	Maximum Detect	15	29	28	4.7	72	16	27	92	18	2.0	16	
Nickel	Minimum Detect	3.2	3.4	0.54	1.2	0.60	2.4	2.0	0.63	1.5	0.39	4.6	

TABLE 1
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Nickel	Mean	7.3	12	3.7	2.4	10	6.2	10	9.9	9.7	0.85	11	
Nickel	Std Dev	4.6	7.0	4.4	1.4	16	6.0	7.6	13	6.0	0.82	6.2	
Potassium	Detects	12	13	44	0	25	4	8	80	9	6	4	
Potassium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Potassium	Maximum Detect	675	3,570	836	NA	2,620	1,580	1,730	2,960	2,730	112	2,010	
Potassium	Minimum Detect	128	145	65	NA	46	202	280	65	493	42	859	
Potassium	Mean	282	796	258	112	642	595	777	657	1,267	58	1,290	
Potassium	Std Dev	157	979	188	8.7	606	594	514	632	1,036	27	519	
Selenium	Detects	2	5	25	4	11	4	6	25	9	3	3	
Selenium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Selenium	Maximum Detect	0.88	2.8	1.3	1.0	4.0	0.95	1.4	2.6	1.1	0.71	1.1	
Selenium	Minimum Detect	0.70	0.78	0.48	0.40	0.57	0.44	0.45	0.28	0.50	0.63	0.46	
Selenium	Mean	0.42	0.82	0.50	0.44	0.59	0.52	0.61	0.41	0.68	0.42	0.58	
Selenium	Std Dev	0.17	0.79	0.29	0.31	0.75	0.27	0.39	0.51	0.33	0.22	0.37	
Silver	Detects	0	6	3	3	2	1	0	2	1	2	1	
Silver	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Silver	Maximum Detect	NA	1.7	0.060	0.42	0.91	5.0	NA	0.74	1.5	0.88	0.31	
Silver	Minimum Detect	NA	0.72	0.050	0.26	0.75	5.0	NA	0.55	1.5	0.24	0.31	
Silver	Mean	0.35	0.72	0.030	0.21	0.16	0.92	0.12	0.31	0.26	0.22	0.19	
Silver	Std Dev	0.022	0.54	0.0083	0.13	0.17	2.0	0.010	0.39	0.39	0.25	0.084	
Sodium	Detects	13	15	18	1	28	2	5	95	12	6	4	
Sodium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Sodium	Maximum Detect	653	6,670	729	170	28,200	415	1,150	1,660	2,030	21	2,530	
Sodium	Minimum Detect	195	165	99	170	12	226	394	10	181	11	150	

TABLE 1
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Sodium	Mean	290	759	173	101	1,077	202	602	339	621	12	1,350	
Sodium	Std Dev	124	1,648	161	46	4,668	133	407	360	552	5.7	1,175	
Thallium	Detects	0	0	0	0	4	0	3	7	0	0	0	
Thallium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Thallium	Maximum Detect	NA	NA	NA	NA	2.8	NA	0.91	1.1	NA	NA	NA	
Thallium	Minimum Detect	NA	NA	NA	NA	0.61	NA	0.55	0.12	NA	NA	NA	
Thallium	Mean	0.47	0.48	0.25	0.19	0.44	0.22	0.43	0.24	0.36	0.45	0.66	
Thallium	Std Dev	0.031	0.070	0.031	0.014	0.52	0.063	0.25	0.20	0.044	0.15	0.075	
Tin	Detects	0	6	33	0	20	1	4	NA	6	3	1	
Tin	No. Analyzed	13	15	44	6	36	6	9	NA	13	9	4	
Tin	Maximum Detect	NA	14	8.1	NA	45	22	26	NA	7.5	32	46	
Tin	Minimum Detect	NA	8.2	0.70	NA	0.77	22	2.6	NA	0.98	11	46	
Tin	Mean	4.3	6.9	1.4	0.95	6.1	4.7	4.9	NA	1.9	9.7	16	
Tin	Std Dev	0.27	3.5	1.2	1.2	10	8.3	8.1	NA	2.4	8.8	20	
Vanadium	Detects	13	15	44	6	32	6	9	96	13	9	4	
Vanadium	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Vanadium	Maximum Detect	28	101	25	9.1	60	60	57	75	53	13	51	
Vanadium	Minimum Detect	4.9	6.5	2.7	2.2	1.1	6.8	7.2	4.1	8.5	5.3	19	
Vanadium	Mean	16	26	8.8	4.9	15	24	30	24	28	7.9	35	
Vanadium	Std Dev	5.8	28	5.5	2.6	14	22	17	16	17	2.4	15	
Zinc	Detects	13	15	44	4	30	6	8	89	13	1	4	
Zinc	No. Analyzed	13	15	44	6	36	6	9	97	13	9	4	
Zinc	Maximum Detect	168	266	779	41	855	202	1,650	431	150	24	145	
Zinc	Minimum Detect	4.5	18	3.4	6.8	1.9	33	18	5.0	5.9	24	37	
Zinc	Mean	75	106	76	13	129	99	414	55	58	7.4	98	

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Zinc	Std Dev	49	74	128	14	229	60	549	54	44	6.5	48	

* Only Arsenic and Copper were sampled near the railroad lines as part of the base-wide PAH background study.

Results for the PAH analysis can be found in the Railroad Line/Zone K Annex PAH Background Study Technical Memorandum (CH2M-Jones, 2001).

All units are in milligrams per kilogram (mg/kg) (parts per million [ppm]).

Ag - Silver, Al - Aluminum, As-Arsenic, Ba-Barium, Be-Beryllium, Ca-Calcium, Cd- Cadmium, Co- Cobalt, Cr-Chromium, Cu-Copper, Fe-Iron, Hg-Mercury, K-Potassium, Mg-Magnesium, Mn-Manganese, Na-Sodium, Ni-Nickel, Pb-Lead, Sb-Antimony, Se-Selenium, Sn-Tin, Tl-Thallium, V-Vanadium, Zn-Zinc

NA Not applicable/not available

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Aluminum	Detects	12	14	30	6	23	6	7	58	4	9	1
Aluminum	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Aluminum	Maximum Detect	17,500	55,600	25,400	12,800	29,900	23,500	36,800	45,300	11,700	12,000	14,200
Aluminum	Minimum Detect	3,850	1,970	1,450	2,850	1,220	3,300	2,630	798	4,590	3,090	14,200
Aluminum	Mean	9,083	12,661	6,481	5,130	7,767	8,550	11,783	11,915	7,428	5,167	14,200
Aluminum	Std Dev	3,972	14,881	5,358	3,835	7,195	7,482	11,411	10,301	3,022	2,837	NA
Antimony	Detects	0	1	3	0	7	0	0	4	0	0	0
Antimony	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Antimony	Maximum Detect	NA	23	0.92	NA	1.6	NA	NA	19	NA	NA	NA
Antimony	Minimum Detect	NA	23	0.22	NA	0.52	NA	NA	1.5	NA	NA	NA
Antimony	Mean	6.5	7.7	0.16	0.22	0.73	0.21	0.21	2.5	1.4	0.18	0.20
Antimony	Std Dev	0.66	4.7	0.17	0.055	0.71	0.039	0.037	3.7	1.3	0.027	NA
Arsenic	Detects	11	10	13	6	22	6	7	54	4	11	1
Arsenic	No. Analyzed	12	14	30	6	27	6	7	58	4	12	1
Arsenic	Maximum Detect	6.9	34	32	5.8	26	30	36	136	4.4	5.8	14
Arsenic	Minimum Detect	1.1	1.2	0.36	0.74	0.83	3.3	1.4	0.78	0.88	0.28	14
Arsenic	Mean	3.9	6.5	3.3	2.0	7.8	9.1	13	10	3.2	1.3	14
Arsenic	Std Dev	2.2	9.3	6.6	1.9	7.8	10	12	18	1.6	1.6	NA
Barium	Detects	12	14	30	6	23	6	7	42	4	9	1
Barium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Barium	Maximum Detect	31	65	65	29	91	47	63	60	19	7.2	24
Barium	Minimum Detect	5.7	12	3.6	7.7	6.1	14	7.7	2.4	9.5	1.8	24
Barium	Mean	16	28	17	15	24	26	32	15	13	3.3	24
Barium	Std Dev	7.0	17	13	7.4	19	15	20	13	4.5	1.9	NA

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Beryllium	Detects	0	7	4	3	22	5	6	55	3	6	1
Beryllium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Beryllium	Maximum Detect	NA	1.7	0.98	0.96	1.6	1.4	2.4	1.6	0.51	0.20	0.62
Beryllium	Minimum Detect	NA	0.28	0.24	0.12	0.15	0.22	0.45	0.060	0.33	0.030	0.62
Beryllium	Mean	0.13	0.40	0.14	0.37	0.48	0.60	0.82	0.61	0.32	0.062	0.62
Beryllium	Std Dev	0.013	0.46	0.24	0.41	0.41	0.44	0.73	0.41	0.20	0.060	NA
Cadmium	Detects	0	0	3	2	10	1	6	6	1	0	0
Cadmium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Cadmium	Maximum Detect	NA	NA	0.28	0.76	0.96	0.080	0.52	1.2	0.48	NA	NA
Cadmium	Minimum Detect	NA	NA	0.13	0.30	0.13	0.080	0.080	0.14	0.48	NA	NA
Cadmium	Mean	0.64	0.66	0.051	0.19	0.26	0.043	0.24	0.27	0.26	0.054	0.13
Cadmium	Std Dev	0.064	0.20	0.072	0.30	0.28	0.025	0.17	0.31	0.18	0.039	NA
Calcium	Detects	12	14	25	6	23	6	7	58	4	2	1
Calcium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Calcium	Maximum Detect	262,000	182,000	40,300	82,400	229,000	11,700	127,000	320,000	63,900	57	18,200
Calcium	Minimum Detect	491	279	181	142	323	1,040	6,390	346	528	50	18,200
Calcium	Mean	59,132	17,400	4,636	14,457	20,586	5,547	41,363	58,904	31,505	21	18,200
Calcium	Std Dev	99,812	48,153	9,188	33,294	45,732	4,720	46,311	79,424	33,479	18	NA
Chromium IV	No. Analyzed	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
Chromium IV	Mean	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15
Chromium IV	Std Dev	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium, Total	Detects	12	14	30	6	26	6	7	58	4	9	1
Chromium, Total	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Chromium, Total	Maximum Detect	63	76	40	41	75	40	65	95	41	8.5	26
Chromium, Total	Minimum Detect	6.3	2.5	2.0	2.5	1.6	8.7	7.4	2.9	7.6	2.4	26

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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Chromium, Total	Mean	25	20	9.6	11	19	16	28	32	24	4.2	26
Chromium, Total	Std Dev	20	23	10	15	19	12	19	21	15	1.9	NA
Cobalt	Detects	2	6	25	5	23	6	7	44	2	4	1
Cobalt	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Cobalt	Maximum Detect	1.7	11	7.1	5.9	15	9.0	15	12	2.2	1.0	3.1
Cobalt	Minimum Detect	1.6	1.9	0.14	0.30	0.41	0.94	0.90	0.27	2.1	0.40	3.1
Cobalt	Mean	0.92	2.4	1.2	1.4	3.4	3.4	4.1	3.1	1.5	0.31	3.1
Cobalt	Std Dev	0.35	3.1	1.8	2.2	4.1	2.9	4.9	2.6	0.80	0.31	NA
Copper	Detects	12	14	23	0	23	3	5	46	4	3	1
Copper	No. Analyzed	12	14	30	6	27	4	7	58	4	12	1
Copper	Maximum Detect	13	47	32	NA	192	55	46	35	12	0.51	22
Copper	Minimum Detect	1.1	0.80	0.35	NA	1.3	2.5	4.5	0.53	1.2	0.23	22
Copper	Mean	5.3	9.4	4.6	1.1	24	15	16	10	6.1	0.20	22
Copper	Std Dev	4.1	15	7.3	1.0	42	27	15	9.0	5.4	0.20	NA
Iron	Detects	12	14	30	6	23	6	7	58	4	9	1
Iron	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Iron	Maximum Detect	37,400	49,100	36,700	11,100	35,800	34,800	58,100	54,300	7,250	10,900	17,200
Iron	Minimum Detect	2,550	1,470	726	916	924	7,850	3,110	1,210	3,730	560	17,200
Iron	Mean	10,153	11,667	5,639	3,134	9,424	12,998	17,913	14,463	5,640	2,550	17,200
Iron	Std Dev	9,895	14,104	8,348	3,920	9,205	10,715	18,571	18,586	1,708	3,401	NA
Lead	Detects	12	14	30	6	23	6	7	45	4	9	1
Lead	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Lead	Maximum Detect	26	145	95	9.2	322	123	76	39	7.2	4.4	18
Lead	Minimum Detect	2.4	1.4	1.9	1.4	1.8	4.3	2.4	2.1	3.1	2.1	18
Lead	Mean	8.3	21	14	3.9	46	26	33	15	4.8	3.1	18

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Lead	Std Dev	6.6	41	19	3.3	69	48	23	12	1.7	0.77	NA
Magnesium	Detects	12	14	30	6	23	6	7	58	4	9	1
Magnesium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Magnesium	Maximum Detect	10,200	9,070	3,940	5,290	9,140	4,240	7,040	12,700	3,990	225	2,960
Magnesium	Minimum Detect	245	147	62	102	77	399	1,040	80	196	28	2,960
Magnesium	Mean	2,468	1,872	590	1,067	1,571	1,353	3,187	3,237	2,164	81	2,960
Magnesium	Std Dev	3,629	2,755	1,013	2,070	2,057	1,445	1,908	2,557	1,837	70	NA
Manganese	Detects	12	14	30	6	23	6	7	58	4	9	1
Manganese	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Manganese	Maximum Detect	91	744	520	51	625	1,120	409	966	55	6.8	355
Manganese	Minimum Detect	7.5	8.6	3.2	4.6	4.9	22	20	5.6	8.6	1.4	355
Manganese	Mean	26	129	54	15	103	234	146	204	40	2.8	355
Manganese	Std Dev	23	192	125	18	146	435	141	240	22	1.8	NA
Mercury	Detects	0	3	6	1	19	2	6	33	0	0	1
Mercury	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Mercury	Maximum Detect	NA	2.0	8.5	0.050	0.90	0.57	0.37	1.3	0	0	0.20
Mercury	Minimum Detect	NA	0.18	0.14	0.050	0.040	0.040	0.050	0.020	0	0	0.20
Mercury	Mean	0.064	0.26	0.36	0.025	0.15	0.11	0.16	0.17	0.066	0.024	0.20
Mercury	Std Dev	0.0070	0.53	1.5	0.012	0.20	0.22	0.12	0.29	0.0063	0.0022	NA
Nickel	Detects	8	9	20	6	22	4	7	49	3	8	1
Nickel	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Nickel	Maximum Detect	35	25	13	12	20	13	22	78	16	4.7	7.2
Nickel	Minimum Detect	3.4	4.6	0.60	0.84	0.85	3.3	1.9	0.74	3.5	0.23	7.2
Nickel	Mean	9.2	8.3	2.3	3.4	6.4	4.4	9.2	11	8.1	1.2	7.2
Nickel	Std Dev	11	7.6	2.9	4.3	6.0	4.5	6.9	12	7.0	1.5	NA

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Potassium	Detects	9	9	30	1	17	6	6	49	3	2	1
Potassium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Potassium	Maximum Detect	1,470	4,720	2,460	1,240	3,440	1,800	3,790	2,800	2,230	91	1,430
Potassium	Minimum Detect	248	176	41	1,240	106	195	670	60	930	64	1,430
Potassium	Mean	487	760	346	302	923	775	1,450	1,031	1,143	35	1,430
Potassium	Std Dev	445	1,284	616	460	823	620	1,172	765	884	27	NA
Selenium	Detects	9	4	11	4	6	3	5	22	4	1	0
Selenium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Selenium	Maximum Detect	2.6	3.8	2.9	1.9	2.4	1.7	1.0	3.9	1.4	0.51	NA
Selenium	Minimum Detect	0.75	0.72	0.49	0.34	0.59	0.40	0.54	0.36	0.59	0.51	NA
Selenium	Mean	0.95	0.87	0.55	0.73	0.51	0.62	0.63	0.63	1.0	0.25	0.31
Selenium	Std Dev	0.61	1.0	0.61	0.69	0.51	0.59	0.28	0.73	0.35	0.099	NA
Silver	Detects	1	7	0	1	0	0	0	1	0	2	0
Silver	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Silver	Maximum Detect	1.0	1.8	NA	0.50	NA	NA	NA	1.7	NA	0.57	NA
Silver	Minimum Detect	1.0	1.2	NA	0.50	NA	NA	NA	1.7	NA	0.41	NA
Silver	Mean	0.44	0.95	0.029	0.18	0.13	0.13	0.14	0.39	0.16	0.20	0.17
Silver	Std Dev	0.18	0.56	0.0055	0.16	0.021	0.017	0.027	0.48	0.14	0.17	NA
Sodium	Detects	12	14	12	1	20	3	5	56	3	2	1
Sodium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Sodium	Maximum Detect	1,550	12,600	2,160	179	1,430	624	3,890	2,110	1,770	10	2,430
Sodium	Minimum Detect	195	159	107	179	21	289	1,070	11	226	9.9	2,430
Sodium	Mean	591	1,280	175	224	356	308	1,825	579	802	5.2	2,430
Sodium	Std Dev	526	3,286	384	319	415	251	1,368	492	794	2.9	NA

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)
Thallium	Detects	0	0	1	1	0	4	1	9	0	0	0
Thallium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Thallium	Maximum Detect	NA	NA	0.93	0.68	NA	1.2	1.0	1.9	NA	NA	NA
Thallium	Minimum Detect	NA	NA	0.93	0.68	NA	0.40	1.0	0.36	NA	NA	NA
Thallium	Mean	0.51	0.53	0.29	0.28	0.31	0.62	0.48	0.32	0.36	0.44	0.75
Thallium	Std Dev	0.058	0.16	0.13	0.20	0.065	0.38	0.28	0.34	0.038	0.15	NA
Tin	Detects	1	2	16	0	11	0	3	NA	0	0	0
Tin	No. Analyzed	12	14	30	6	27	6	7	NA	4	9	1
Tin	Maximum Detect	9.2	20	2.0	NA	24	NA	2.9	NA	NA	NA	NA
Tin	Minimum Detect	9.2	8.2	0.64	NA	2.8	NA	1.1	NA	NA	NA	NA
Tin	Mean	5.1	6.0	0.97	0.59	4.1	0.99	1.5	NA	0.52	5.0	6.9
Tin	Std Dev	1.4	4.3	0.50	0.19	5.1	0.64	0.92	NA	0.060	0.69	NA
Vanadium	Detects	12	12	30	6	24	6	7	58	4	9	1
Vanadium	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Vanadium	Maximum Detect	49	102	57	29	71	72	112	103	24	16	29
Vanadium	Minimum Detect	5.5	3.3	1.5	1.9	1.6	12	5.9	2.7	11	2.7	29
Vanadium	Mean	23	22	11	7.6	20	25	36	31	17	5.9	29
Vanadium	Std Dev	14	29	15	10	20	23	35	24	5.6	4.2	NA
Zinc	Detects	12	14	30	5	23	5	6	51	4	0	1
Zinc	No. Analyzed	12	14	30	6	27	6	7	58	4	9	1
Zinc	Maximum Detect	66	238	168	40	438	195	198	233	29	NA	58
Zinc	Minimum Detect	6.0	3.7	1.3	10	5.8	9.3	20	1.8	4.7	NA	58
Zinc	Mean	26	47	30	15	82	42	73	48	17	1.4	58
Zinc	Std Dev	20	76	42	13	103	75	64	42	11	0.70	NA

All units are in milligrams per kilogram (mg/kg) (parts per million [ppm]).

TABLE 2
Statistical Summary of the Analytical Results for Subsurface Soil Background Samples for Each Zone
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Chemical	Statistic	Zone A	Zone B	Zone C	Zone D	Zone E	Zone F	Zone G	Zone H	Zone I	Zone K (Annex)	Zone K (Clouter Isl.)

Ag-Silver, Al-Aluminum, As-Arsenic, Ba-Barium, Be-Beryllium, Ca-Calcium, Cd- Cadmium, Co- Cobalt, Cr-Chromium, Cu-Copper, Fe-Iron, Hg-Mercury, K-Potassium, Mg-Magnesium, Mn-Manganese, Na-Sodium, Ni-Nickel, Pb-Lead, Sb-Antimony, Se-Selenium, Sn-Tin, Tl-Thallium, V-Vanadium, Zn-Zinc

NA Not applicable/not available

TABLE 3
Statistical Summary of the Analytical Results for Shallow Groundwater Background Samples by Zone for CNC Main Base
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
A	Shallow	7429905	Aluminum	3	12	9	66	5,220	1,622
A	Shallow	7440360	Antimony	3	10	1	4	4	4
A	Shallow	7440382	Arsenic	3	12	5	3	68	18
A	Shallow	7440393	Barium	3	12	9	21	102	52
A	Shallow	7440417	Beryllium	3	12	0	NA	NA	NA
A	Shallow	7440439	Cadmium	3	12	1	1	1	1
A	Shallow	7440702	Calcium	3	12	12	43,100	151,000	93,600
A	Shallow	7440473	Chromium, Total	3	12	4	5	10	7
A	Shallow	7440484	Cobalt	3	12	1	10	10	10
A	Shallow	7440508	Copper	3	10	4	3	10	8
A	Shallow	7439896	Iron	3	12	12	7,320	72,100	17,420
A	Shallow	7439921	Lead	3	10	3	2	3	3
A	Shallow	7439954	Magnesium	3	12	12	15,600	91,900	39,950
A	Shallow	7439965	Manganese	3	12	12	80	577	211
A	Shallow	7439976	Mercury	3	12	0	NA	NA	NA
A	Shallow	7440020	Nickel	3	12	1	9	9	9
A	Shallow	7440097	Potassium	3	12	12	4,130	36,800	19,035
A	Shallow	7782492	Selenium	3	10	0	NA	NA	NA
A	Shallow	7440224	Silver	3	12	1	1	1	1
A	Shallow	7440280	Thallium	3	8	0	NA	NA	NA
A	Shallow	7440315	Tin (Sn)	3	9	0	NA	NA	NA
A	Shallow	7440622	Vanadium	3	12	5	1	14	7
A	Shallow	7440666	Zinc	3	10	3	8	89	42
B	Shallow	7429905	Aluminum	4	16	10	87	2,840	655
B	Shallow	7440360	Antimony	4	16	0	NA	NA	NA
B	Shallow	7440382	Arsenic	4	16	4	8	16	11

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
B	Shallow	7440393	Barium	4	16	13	18	90	42
B	Shallow	7440417	Beryllium	4	16	1	5	5	5
B	Shallow	7440439	Cadmium	4	16	0	NA	NA	NA
B	Shallow	7440702	Calcium	4	16	16	12,000	46,7000	197,463
B	Shallow	7440473	Chromium, Total	4	16	3	8	128	49
B	Shallow	7440484	Cobalt	4	16	1	75	75	75
B	Shallow	7440508	Copper	4	16	2	7	105	56
B	Shallow	7439896	Iron	4	16	16	231	18,500	4,812
B	Shallow	7439921	Lead	4	16	1	7	7	7
B	Shallow	7439954	Magnesium	4	16	16	6,740	1,010,000	264,631
B	Shallow	7439965	Manganese	4	16	16	21	3,430	1,119
B	Shallow	7439976	Mercury	4	16	0	NA	NA	NA
B	Shallow	7440020	Nickel	4	16	2	17	56	36
B	Shallow	7440097	Potassium	4	16	15	1,270	517,000	108,986
B	Shallow	7782492	Selenium	4	16	0	NA	NA	NA
B	Shallow	7440224	Silver	4	16	1	112	112	112
B	Shallow	7440280	Thallium	4	16	1	3	3	3
B	Shallow	7440315	Tin (Sn)	4	12	1	46	46	46
B	Shallow	7440622	Vanadium	4	16	4	4	13	9
B	Shallow	7440666	Zinc	4	16	3	6	17	10
C	Shallow	7429905	Aluminum	2	8	5	64	620	289
C	Shallow	7440360	Antimony	2	8	0	NA	NA	NA
C	Shallow	7440382	Arsenic	2	8	3	3	6	4
C	Shallow	7440393	Barium	2	8	5	5	16	11
C	Shallow	7440417	Beryllium	2	8	1	0.36	0.36	0.36
C	Shallow	7440439	Cadmium	2	8	0	NA	NA	NA

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
C	Shallow	7440702	Calcium	2	8	8	25,700	152,000	82,450
C	Shallow	7440473	Chromium, Total	2	8	1	2	2	2
C	Shallow	7440484	Cobalt	2	8	1	2	2	2
C	Shallow	7440508	Copper	2	8	0	NA	NA	NA
C	Shallow	7439896	Iron	2	8	8	288	4,660	1,719
C	Shallow	7439921	Lead	2	8	2	3	4	4
C	Shallow	7439954	Magnesium	2	8	7	697	9,250	5,108
C	Shallow	7439965	Manganese	2	8	7	18	789	346
C	Shallow	7439976	Mercury	2	8	0	NA	NA	NA
C	Shallow	7440020	Nickel	2	8	2	2	5	3
C	Shallow	7440097	Potassium	2	8	3	560	6,400	4,113
C	Shallow	7782492	Selenium	2	8	0	NA	NA	NA
C	Shallow	7440224	Silver	2	8	0	NA	NA	NA
C	Shallow	7440280	Thallium	2	8	0	NA	NA	NA
C	Shallow	7440315	Tin (Sn)	2	8	0	NA	NA	NA
C	Shallow	7440622	Vanadium	2	8	2	1	2	2
C	Shallow	7440666	Zinc	2	8	4	6	15	10
D	Shallow	7429905	Aluminum	1	4	4	262	707	485
D	Shallow	7440360	Antimony	1	4	0	NA	NA	NA
D	Shallow	7440382	Arsenic	1	4	4	2	4	3
D	Shallow	7440393	Barium	1	4	4	4	11	7
D	Shallow	7440417	Beryllium	1	4	2	0.20	0.40	0.30
D	Shallow	7440439	Cadmium	1	4	0	NA	NA	NA
D	Shallow	7440702	Calcium	1	4	4	11,600	22,600	17,350
D	Shallow	7440473	Chromium, Total	1	4	3	1	2	2
D	Shallow	7440484	Cobalt	1	4	0	NA	NA	NA

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
D	Shallow	7440508	Copper	1	4	1	4	4	4
D	Shallow	7439896	Iron	1	4	4	210	2,270	812
D	Shallow	7439921	Lead	1	4	1	2	2	2
D	Shallow	7439954	Magnesium	1	4	4	1,390	1,680	1,495
D	Shallow	7439965	Manganese	1	4	3	2	15	8
D	Shallow	7439976	Mercury	1	4	0	NA	NA	NA
D	Shallow	7440020	Nickel	1	4	2	2	2	2
D	Shallow	7440097	Potassium	1	4	4	2,220	2,960	2,503
D	Shallow	7782492	Selenium	1	4	1	5	5	5
D	Shallow	7440224	Silver	1	4	0	NA	NA	NA
D	Shallow	7440280	Thallium	1	4	0	NA	NA	NA
D	Shallow	7440315	Tin (Sn)	1	4	0	NA	NA	NA
D	Shallow	7440622	Vanadium	1	4	4	4	8	6
D	Shallow	7440666	Zinc	1	4	1	14	14	14
E	Shallow	7429905	Aluminum	31	123	97	19	16,100	891
E	Shallow	7440360	Antimony	31	123	6	2	5	3
E	Shallow	7440382	Arsenic	31	123	66	3	316	36
E	Shallow	7440393	Barium	31	123	97	6	398	54
E	Shallow	7440417	Beryllium	31	123	21	0.3	0.9	0.4
E	Shallow	7440439	Cadmium	31	123	1	1.4	1.4	1
E	Shallow	7440702	Calcium	31	123	119	1170	260,000	87,887
E	Shallow	7440473	Chromium, Total	31	123	35	0.8	31	5
E	Shallow	7440484	Cobalt	31	123	17	0.9	44	10
E	Shallow	7440508	Copper	31	123	15	0.9	8	3
E	Shallow	7439896	Iron	31	123	119	144	76,600	9,023
E	Shallow	7439921	Lead	31	123	22	2	47	9

TABLE 3
Statistical Summary of the Analytical Results for Shallow Groundwater Background Samples by Zone for CNC Main Base
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
E	Shallow	7439954	Magnesium	31	123	119	790	1,160,000	65,403
E	Shallow	7439965	Manganese	31	123	114	2	2650	442
E	Shallow	7439976	Mercury	31	123	7	0.14	0.6	0.30
E	Shallow	7440020	Nickel	31	123	45	0.9	17	4
E	Shallow	7440097	Potassium	31	123	109	1,320	289,000	31,171
E	Shallow	7782492	Selenium	31	123	5	3	5	5
E	Shallow	7440224	Silver	31	123	2	2	4	3
E	Shallow	7440280	Thallium	31	123	13	3	6	4
E	Shallow	7440315	Tin (Sn)	31	123	7	3	10	4
E	Shallow	7440622	Vanadium	31	123	82	0.6	26	4
E	Shallow	7440666	Zinc	31	123	22	5	141	24
F	Shallow	7429905	Aluminum	1	4	4	185	470	296
F	Shallow	7440360	Antimony	1	4	0	NA	NA	NA
F	Shallow	7440382	Arsenic	1	4	4	3	9	6
F	Shallow	7440393	Barium	1	4	4	29	38	32
F	Shallow	7440417	Beryllium	1	4	1	0.4	0.4	0.4
F	Shallow	7440439	Cadmium	1	4	2	0.6	4.4	2.5
F	Shallow	7440702	Calcium	1	4	4	29,700	97,000	48,275
F	Shallow	7440473	Chromium, Total	1	4	0	NA	NA	NA
F	Shallow	7440484	Cobalt	1	4	4	8	10	9
F	Shallow	7440508	Copper	1	4	0	NA	NA	NA
F	Shallow	7439896	Iron	1	4	4	51,600	62,300	55,075
F	Shallow	7439921	Lead	1	4	0	NA	NA	NA
F	Shallow	7439954	Magnesium	1	4	4	34,600	46,600	38,425
F	Shallow	7439965	Manganese	1	4	4	984	1,560	1,141
F	Shallow	7439976	Mercury	1	4	1	0.17	0.17	0.17

TABLE 3
Statistical Summary of the Analytical Results for Shallow Groundwater Background Samples by Zone for CNC Main Base
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
F	Shallow	7440020	Nickel	1	4	2	2	3	3
F	Shallow	7440097	Potassium	1	4	4	8,820	12,200	10,005
F	Shallow	7782492	Selenium	1	4	0	NA	NA	NA
F	Shallow	7440224	Silver	1	4	0	NA	NA	NA
F	Shallow	7440280	Thallium	1	4	1	5	5	5
F	Shallow	7440315	Tin (Sn)	1	4	0	NA	NA	NA
F	Shallow	7440622	Vanadium	1	4	0	NA	NA	NA
F	Shallow	7440666	Zinc	1	4	0	NA	NA	NA
G	Shallow	7429905	Aluminum	2	9	7	136	1,770	663
G	Shallow	7440360	Antimony	2	9	4	3	6	5
G	Shallow	7440382	Arsenic	2	9	9	8	166	76
G	Shallow	7440393	Barium	2	9	9	14	937	424
G	Shallow	7440417	Beryllium	2	9	0	NA	NA	NA
G	Shallow	7440439	Cadmium	2	9	2	0.40	2	1.0
G	Shallow	7440702	Calcium	2	9	9	85,600	294,000	143,300
G	Shallow	7440473	Chromium, Total	2	9	6	2	14	5
G	Shallow	7440484	Cobalt	2	9	4	1.2	8	3
G	Shallow	7440508	Copper	2	9	5	12	87	34
G	Shallow	7439896	Iron	2	9	9	2,000	35,700	14,683
G	Shallow	7439921	Lead	2	9	5	6	52	19
G	Shallow	7439954	Magnesium	2	9	9	70,100	533,000	188,811
G	Shallow	7439965	Manganese	2	9	9	149	7980	1904
G	Shallow	7439976	Mercury	2	9	2	0.14	0.17	0.16
G	Shallow	7440020	Nickel	2	9	8	1.2	20	6
G	Shallow	7440097	Potassium	2	9	9	15,400	180,000	72,267
G	Shallow	7782492	Selenium	2	9	2	4	4	4

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
G	Shallow	7440224	Silver	2	9	1	2	2	2
G	Shallow	7440280	Thallium	2	9	0	NA	NA	NA
G	Shallow	7440315	Tin (Sn)	2	9	1	3	3	3
G	Shallow	7440622	Vanadium	2	9	8	3	30	12
G	Shallow	7440666	Zinc	2	9	6	18	124	57
H	Shallow	7429905	Aluminum	11	45	6	57	1,140	413
H	Shallow	7440360	Antimony	11	49	0	NA	NA	NA
H	Shallow	7440382	Arsenic	11	53	30	0.8	50	20
H	Shallow	7440393	Barium	11	45	15	3	115	26
H	Shallow	7440417	Beryllium	11	51	1	1.0	1.0	1.0
H	Shallow	7440439	Cadmium	11	45	1	5	5	5
H	Shallow	7440702	Calcium	11	45	45	8,510	720,000	208,862
H	Shallow	7440473	Chromium, Total	11	49	3	2	6	4
H	Shallow	7440484	Cobalt	11	45	3	1.0	3	2
H	Shallow	7440508	Copper	11	45	2	0.7	4	2
H	Shallow	7439896	Iron	11	45	42	317	28,700	9,944
H	Shallow	7439921	Lead	11	49	8	1.1	3	2
H	Shallow	7439954	Magnesium	11	45	45	10,000	1,090,000	201,349
H	Shallow	7439965	Manganese	11	45	41	17	4,570	1,005
H	Shallow	7439976	Mercury	11	49	2	0.12	0.13	0.13
H	Shallow	7440020	Nickel	11	45	4	1.0	36	15
H	Shallow	7440097	Potassium	11	45	44	5,010	297,000	65,602
H	Shallow	7782492	Selenium	11	45	7	1.1	5	2
H	Shallow	7440224	Silver	11	45	1	1.4	1.4	1.4
H	Shallow	7440280	Thallium	11	49	8	2	105	16
H	Shallow	7440315	Tin (Sn)	11	12	4	3	4	3

TABLE 3
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
H	Shallow	7440622	Vanadium	11	45	5	2	8	6
H	Shallow	7440666	Zinc	11	45	4	7	123	37
I	Shallow	7429905	Aluminum	19	81	25	25	1,550	319
I	Shallow	7440360	Antimony	19	83	6	3	6	4
I	Shallow	7440382	Arsenic	19	83	38	3	66	16
I	Shallow	7440393	Barium	19	81	69	3	278	52
I	Shallow	7440417	Beryllium	19	81	10	0.3	1.2	0.9
I	Shallow	7440439	Cadmium	19	81	3	0.5	2	1.2
I	Shallow	7440702	Calcium	19	81	81	39,000	980,000	266,479
I	Shallow	7440473	Chromium, Total	19	81	35	0.9	24	5
I	Shallow	7440484	Cobalt	19	81	8	0.7	4	1.5
I	Shallow	7440508	Copper	19	81	9	1.2	5	3
I	Shallow	7439896	Iron	19	81	77	49	3,1900	6,745
I	Shallow	7439921	Lead	19	83	22	2	16	5
I	Shallow	7439954	Magnesium	19	81	81	8,580	1,410,000	338,399
I	Shallow	7439965	Manganese	19	81	80	23	4,850	817
I	Shallow	7439976	Mercury	19	81	2	0.1	1.1	0.6
I	Shallow	7440020	Nickel	19	81	40	1.0	16	4
I	Shallow	7440097	Potassium	19	81	80	7,060	550,000	122,848
I	Shallow	7782492	Selenium	19	81	1	27	27	27
I	Shallow	7440224	Silver	19	81	1	1.3	1.3	1.3
I	Shallow	7440280	Thallium	19	83	9	3	8	5
I	Shallow	7440315	Tin (Sn)	19	81	4	3	3	3
I	Shallow	7440622	Vanadium	19	81	41	0.7	19	4
I	Shallow	7440666	Zinc	19	81	30	4	316	25
K-Annex	Shallow	7429905	Aluminum	2	9	3	391	9,490	3,571

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
K-Annex	Shallow	7440360	Antimony	2	9	0	NA	NA	NA
K-Annex	Shallow	7440382	Arsenic	2	9	0	NA	NA	NA
K-Annex	Shallow	7440393	Barium	2	9	8	6.2	65	22
K-Annex	Shallow	7440417	Beryllium	2	9	0	NA	NA	NA
K-Annex	Shallow	7440439	Cadmium	2	9	0	NA	NA	NA
K-Annex	Shallow	7440702	Calcium	2	9	8	1,630	8,640	3,388
K-Annex	Shallow	7440473	Chromium, Total	2	9	1	11	11	11
K-Annex	Shallow	7440484	Cobalt	2	9	1	1.5	1.5	1.5
K-Annex	Shallow	7440508	Copper	2	9	3	0.98	4.8	2.4
K-Annex	Shallow	7439896	Iron	2	9	6	64	2,800	638
K-Annex	Shallow	7439921	Lead	2	9	2	1.9	6.1	4.0
K-Annex	Shallow	7439954	Magnesium	2	9	8	132	1,830	700
K-Annex	Shallow	7439965	Manganese	2	9	5	1.3	67	19
K-Annex	Shallow	7439976	Mercury	2	9	0	NA	NA	NA
K-Annex	Shallow	7440020	Nickel	2	9	1	6.4	6.4	6.4
K-Annex	Shallow	7440097	Potassium	2	9	5	423	2,670	1,174
K-Annex	Shallow	7782492	Selenium	2	9	0	NA	NA	NA
K-Annex	Shallow	7440224	Silver	2	9	0	NA	NA	NA
K-Annex	Shallow	7440280	Thallium	2	9	0	NA	NA	NA
K-Annex	Shallow	7440315	Tin (Sn)	2	9	2	54	196	125
K-Annex	Shallow	7440622	Vanadium	2	9	3	0.76	9.4	3.7
K-Annex	Shallow	7440666	Zinc	2	9	0	NA	NA	NA
K-Clouter Isl.	Shallow	7429905	Aluminum	1	4	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440360	Antimony	1	6	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440382	Arsenic	1	6	6	5	9	7
K-Clouter Isl.	Shallow	7440393	Barium	1	4	4	29	62	48

TABLE 3
Statistical Summary of the Analytical Results for Shallow Groundwater Background Samples by Zone for CNC Main Base
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
K-Clouter Isl.	Shallow	7440417	Beryllium	1	6	2	0	0	0
K-Clouter Isl.	Shallow	7440439	Cadmium	1	4	1	0	0	0
K-Clouter Isl.	Shallow	7440702	Calcium	1	4	4	332,000	485,000	423,000
K-Clouter Isl.	Shallow	7440473	Chromium, Total	1	6	1	2	2	2
K-Clouter Isl.	Shallow	7440484	Cobalt	1	4	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440508	Copper	1	4	2	5	6	5
K-Clouter Isl.	Shallow	7439896	Iron	1	4	4	2,580	6,250	4,585
K-Clouter Isl.	Shallow	7439921	Lead	1	6	0	NA	NA	NA
K-Clouter Isl.	Shallow	7439954	Magnesium	1	4	4	163,000	327,000	265,000
K-Clouter Isl.	Shallow	7439965	Manganese	1	4	4	311	976	607
K-Clouter Isl.	Shallow	7439976	Mercury	1	6	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440020	Nickel	1	4	1	4	4	4
K-Clouter Isl.	Shallow	7440097	Potassium	1	4	4	55,800	99,900	81,350
K-Clouter Isl.	Shallow	7782492	Selenium	1	4	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440224	Silver	1	4	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440280	Thallium	1	6	0	NA	NA	NA
K-Clouter Isl.	Shallow	7440315	Tin (Sn)	1	4	1	40	40	40
K-Clouter Isl.	Shallow	7440622	Vanadium	1	4	4	3	6	5
K-Clouter Isl.	Shallow	7440666	Zinc	1	4	0	NA	NA	NA

All units are in micrograms per liter (µg/L).

NA Not applicable/not available

TABLE 4
Statistical Summary of the Analytical Results for Deep groundwater Background Samples by Zone for CNC Main Base
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
A	Deep	7429905	Aluminum	3	12	6	49	1,580	552
A	Deep	7440360	Antimony	3	10	1	7	7	7
A	Deep	7440382	Arsenic	3	11	3	4	11	8
A	Deep	7440393	Barium	3	12	9	36	182	93
A	Deep	7440417	Beryllium	3	12	1	3	3	3
A	Deep	7440439	Cadmium	3	12	0	NA	NA	NA
A	Deep	7440702	Calcium	3	12	12	45,100	524,000	229,108
A	Deep	7440473	Chromium, Total	3	12	3	2	136	64
A	Deep	7440484	Cobalt	3	12	4	10	29	19
A	Deep	7440508	Copper	3	11	6	6	445	82
A	Deep	7439896	Iron	3	12	9	187	22,700	12,901
A	Deep	7439921	Lead	3	8	1	19	19	19
A	Deep	7439954	Magnesium	3	12	12	93,200	1,610,000	696,475
A	Deep	7439965	Manganese	3	12	12	183	2,660	1,377
A	Deep	7439976	Mercury	3	12	0	NA	NA	NA
A	Deep	7440020	Nickel	3	12	2	20	74	47
A	Deep	7440097	Potassium	3	12	12	23,500	606,000	207,550
A	Deep	7782492	Selenium	3	10	0	NA	NA	NA
A	Deep	7440224	Silver	3	12	3	6	31	16
A	Deep	7440280	Thallium	3	9	3	17	163	68
A	Deep	7440315	Tin (Sn)	3	9	2	82	111	96
A	Deep	7440622	Vanadium	3	12	1	10	10	10
A	Deep	7440666	Zinc	3	11	4	6	1,440	385
B	Deep	7429905	Aluminum	2	8	2	57	1,910	983
B	Deep	7440360	Antimony	2	8	0	NA	NA	NA
B	Deep	7440382	Arsenic	2	8	0	NA	NA	NA

TABLE 4
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
B	Deep	7440393	Barium	2	8	6	7	154	70
B	Deep	7440417	Beryllium	2	8	1	5	5	5
B	Deep	7440439	Cadmium	2	8	0	NA	NA	NA
B	Deep	7440702	Calcium	2	8	8	48,600	381,000	190,125
B	Deep	7440473	Chromium, Total	2	8	1	102	102	102
B	Deep	7440484	Cobalt	2	8	1	69	69	69
B	Deep	7440508	Copper	2	8	2	6	88	47
B	Deep	7439896	Iron	2	8	4	32	184	96
B	Deep	7439921	Lead	2	8	1	3	3	3
B	Deep	7439954	Magnesium	2	8	8	4,900	425,000	195,881
B	Deep	7439965	Manganese	2	8	8	32	894	363
B	Deep	7439976	Mercury	2	8	0	NA	NA	NA
B	Deep	7440020	Nickel	2	8	3	14	47	26
B	Deep	7440097	Potassium	2	8	8	2,270	203,000	69,434
B	Deep	7782492	Selenium	2	8	0	NA	NA	NA
B	Deep	7440224	Silver	2	8	1	136	136	136
B	Deep	7440280	Thallium	2	8	0	NA	NA	NA
B	Deep	7440315	Tin (Sn)	2	6	0	NA	NA	NA
B	Deep	7440622	Vanadium	2	8	1	5	5	5
B	Deep	7440666	Zinc	2	8	1	9	9	9
C	Deep	7429905	Aluminum	2	8	1	18	18	18
C	Deep	7440360	Antimony	2	8	0	NA	NA	NA
C	Deep	7440382	Arsenic	2	8	0	NA	NA	NA
C	Deep	7440393	Barium	2	8	4	12	70	37
C	Deep	7440417	Beryllium	2	8	1	0.33	0.33	0.33
C	Deep	7440439	Cadmium	2	8	0	NA	NA	NA

TABLE 4
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
C	Deep	7440702	Calcium	2	8	8	44,800	179,000	104,813
C	Deep	7440473	Chromium, Total	2	8	0	NA	NA	NA
C	Deep	7440484	Cobalt	2	8	0	NA	NA	NA
C	Deep	7440508	Copper	2	8	0	NA	NA	NA
C	Deep	7439896	Iron	2	8	8	213	788	421
C	Deep	7439921	Lead	2	8	0	NA	NA	NA
C	Deep	7439954	Magnesium	2	8	8	1,420	22,400	10,580
C	Deep	7439965	Manganese	2	8	8	35	123	73
C	Deep	7439976	Mercury	2	8	0	NA	NA	NA
C	Deep	7440020	Nickel	2	8	0	NA	NA	NA
C	Deep	7440097	Potassium	2	8	4	918	11,200	8,255
C	Deep	7782492	Selenium	2	8	0	NA	NA	NA
C	Deep	7440224	Silver	2	8	0	NA	NA	NA
C	Deep	7440280	Thallium	2	8	0	NA	NA	NA
C	Deep	7440315	Tin (Sn)	2	8	0	NA	NA	NA
C	Deep	7440622	Vanadium	2	8	1	0.43	0.43	0.43
C	Deep	7440666	Zinc	2	8	0	NA	NA	NA
D	Deep	7429905	Aluminum	1	4	0	NA	NA	NA
D	Deep	7440360	Antimony	1	4	0	NA	NA	NA
D	Deep	7440382	Arsenic	1	4	4	3	6	4
D	Deep	7440393	Barium	1	4	4	13	16	14
D	Deep	7440417	Beryllium	1	4	0	NA	NA	NA
D	Deep	7440439	Cadmium	1	4	0	NA	NA	NA
D	Deep	7440702	Calcium	1	4	4	51,300	54,900	52,825
D	Deep	7440473	Chromium, Total	1	4	0	NA	NA	NA
D	Deep	7440484	Cobalt	1	4	0	NA	NA	NA

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
D	Deep	7440508	Copper	1	4	0	NA	NA	NA
D	Deep	7439896	Iron	1	4	4	384	547	470
D	Deep	7439921	Lead	1	4	0	NA	NA	NA
D	Deep	7439954	Magnesium	1	4	4	3,290	3,460	3,398
D	Deep	7439965	Manganese	1	4	4	125	160	142
D	Deep	7439976	Mercury	1	4	0	NA	NA	NA
D	Deep	7440020	Nickel	1	4	0	NA	NA	NA
D	Deep	7440097	Potassium	1	4	3	1,090	1,270	1,183
D	Deep	7782492	Selenium	1	4	0	NA	NA	NA
D	Deep	7440224	Silver	1	4	0	NA	NA	NA
D	Deep	7440280	Thallium	1	4	0	NA	NA	NA
D	Deep	7440315	Tin (Sn)	1	4	0	NA	NA	NA
D	Deep	7440622	Vanadium	1	4	0	NA	NA	NA
D	Deep	7440666	Zinc	1	4	0	NA	NA	NA
E	Deep	7429905	Aluminum	33	125	23	19	461	90
E	Deep	7440360	Antimony	33	127	3	3	7	5
E	Deep	7440382	Arsenic	33	127	65	3	132	21
E	Deep	7440393	Barium	33	125	104	12	322	85
E	Deep	7440417	Beryllium	33	127	30	0.2	1.3	0.6
E	Deep	7440439	Cadmium	33	125	2	0.6	0.6	0.6
E	Deep	7440702	Calcium	33	125	124	44,400	391,000	163,977
E	Deep	7440473	Chromium, Total	33	127	27	0.8	27	4
E	Deep	7440484	Cobalt	33	125	26	1.1	14	6
E	Deep	7440508	Copper	33	125	10	0.6	6	2
E	Deep	7439896	Iron	33	125	105	19	26,000	3,529
E	Deep	7439921	Lead	33	127	2	2	3	3

TABLE 4
Statistical Summary of the Analytical Results for Deep groundwater Background Samples by Zone for CNC Main Base
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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
E	Deep	7439954	Magnesium	33	125	124	3,190	1,370,000	307,875
E	Deep	7439965	Manganese	33	125	123	1.3	1,660	288
E	Deep	7439976	Mercury	33	127	12	0.11	0.20	0.14
E	Deep	7440020	Nickel	33	125	55	0.8	46	9
E	Deep	7440097	Potassium	33	125	120	1,720	351,000	88,609
E	Deep	7782492	Selenium	33	125	2	3	4	3
E	Deep	7440224	Silver	33	125	3	2	3	2
E	Deep	7440280	Thallium	33	127	17	3	7	5
E	Deep	7440315	Tin (Sn)	33	125	4	3	3	3
E	Deep	7440622	Vanadium	33	125	42	0.5	8	3
E	Deep	7440666	Zinc	33	125	12	4	21	10
F	Deep	7429905	Aluminum	1	4	0	NA	NA	NA
F	Deep	7440360	Antimony	1	4	0	NA	NA	NA
F	Deep	7440382	Arsenic	1	4	4	7	10	9
F	Deep	7440393	Barium	1	4	4	129	137	132
F	Deep	7440417	Beryllium	1	4	1	0.23	0.23	0.23
F	Deep	7440439	Cadmium	1	4	2	0.46	0.5	0.5
F	Deep	7440702	Calcium	1	4	4	182,000	191,000	186,750
F	Deep	7440473	Chromium, Total	1	4	1	1.0	1.0	1.0
F	Deep	7440484	Cobalt	1	4	4	49	61	55
F	Deep	7440508	Copper	1	4	0	NA	NA	NA
F	Deep	7439896	Iron	1	4	4	311	1,150	805
F	Deep	7439921	Lead	1	4	0	NA	NA	NA
F	Deep	7439954	Magnesium	1	4	4	22,000	24,200	23,150
F	Deep	7439965	Manganese	1	4	4	4,260	4,820	4,530
F	Deep	7439976	Mercury	1	4	1	0.32	0.32	0.32

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Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
F	Deep	7440020	Nickel	1	4	4	22	25	23
F	Deep	7440097	Potasslum	1	4	4	5,930	6,660	6,273
F	Deep	7782492	Selenium	1	4	0	NA	NA	NA
F	Deep	7440224	Silver	1	4	0	NA	NA	NA
F	Deep	7440280	Thallium	1	4	2	6	7	6
F	Deep	7440315	Tin (Sn)	1	4	0	NA	NA	NA
F	Deep	7440622	Vanadium	1	4	0	NA	NA	NA
F	Deep	7440666	Zinc	1	4	0	NA	NA	NA
G	Deep	7429905	Aluminum	2	8	3	20	147	87
G	Deep	7440360	Antimony	2	8	1	5	5	5
G	Deep	7440382	Arsenic	2	8	5	3	58	34
G	Deep	7440393	Barium	2	8	7	65	223	140
G	Deep	7440417	Beryllium	2	8	1	0.33	0.33	0.33
G	Deep	7440439	Cadmium	2	8	2	0.34	3	2
G	Deep	7440702	Calcium	2	8	8	794	338,000	176,824
G	Deep	7440473	Chromium, Total	2	8	5	1	8	4
G	Deep	7440484	Cobalt	2	8	4	2	10	7
G	Deep	7440508	Copper	2	8	1	2	2	2
G	Deep	7439896	Iron	2	8	8	38	16,900	7,591
G	Deep	7439921	Lead	2	8	0	NA	NA	NA
G	Deep	7439954	Magnesium	2	8	8	225	624,000	335,503
G	Deep	7439965	Manganese	2	8	8	21	9,030	3,331
G	Deep	7439976	Mercury	2	8	2	0.14	0.18	0.16
G	Deep	7440020	Nickel	2	8	6	0.8	21	12
G	Deep	7440097	Potassium	2	8	7	14,700	198,000	113,529
G	Deep	7782492	Selenium	2	8	1	4	4	4

TABLE 4
Statistical Summary of the Analytical Results for Deep groundwater Background Samples by Zone for CNC Main Base
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
G	Deep	7440224	Silver	2	8	1	4	4	4
G	Deep	7440280	Thallium	2	8	0	NA	NA	NA
G	Deep	7440315	Tin (Sn)	2	8	0	NA	NA	NA
G	Deep	7440622	Vanadium	2	8	0	NA	NA	NA
G	Deep	7440666	Zinc	2	8	2	6	51	29
H	Deep	7429905	Aluminum	11	44	10	16	3,620	1,197
H	Deep	7440360	Antimony	11	48	2	12	12	12
H	Deep	7440382	Arsenic	11	52	12	2	8	3
H	Deep	7440393	Barium	11	44	15	30	871	121
H	Deep	7440417	Beryllium	11	50	5	0.7	1.0	0.9
H	Deep	7440439	Cadmium	11	44	15	2	6	4
H	Deep	7440702	Calcium	11	44	44	7,650	228,000	142,497
H	Deep	7440473	Chromium, Total	11	48	16	0.8	12	4
H	Deep	7440484	Cobalt	11	44	5	1.0	3	2
H	Deep	7440508	Copper	11	44	3	0.7	118	46
H	Deep	7439896	Iron	11	44	36	289	7,180	3,281
H	Deep	7439921	Lead	11	48	9	1.2	6	3
H	Deep	7439954	Magnesium	11	44	44	1,290	1,150,000	823,688
H	Deep	7439965	Manganese	11	44	39	3	821	323
H	Deep	7439976	Mercury	11	48	5	0.10	0.17	0.12
H	Deep	7440020	Nickel	11	44	4	2	13	6
H	Deep	7440097	Potassium	11	44	44	9,050	384,000	219,297
H	Deep	7782492	Selenium	11	44	5	0.9	1.4	1.0
H	Deep	7440224	Silver	11	44	2	1.3	2	2
H	Deep	7440280	Thallium	11	48	3	6	6	6
H	Deep	7440315	Tin (Sn)	11	11	5	3	4	3

TABLE 4
Statistical Summary of the Analytical Results for Deep groundwater Background Samples by Zone for CNC Main Base
Technical Memorandum: Summary of Inorganic Chemical Concentrations in Background Soil and Groundwater, Charleston Naval Complex

Zone	Aquifer	CAS Number	Parameter Name	Wells	Samples	Detects	Min Detect (µg/L)	Max Detect (µg/L)	Mean Detect (µg/L)
H	Deep	7440622	Vanadium	11	44	12	1.0	9	5
H	Deep	7440666	Zinc	11	44	5	62	1,180	328
I	Deep	7429905	Aluminum	19	81	11	29	235	83
I	Deep	7440360	Antimony	19	87	6	4	9	6
I	Deep	7440382	Arsenic	19	87	15	2	25	8
I	Deep	7440393	Barium	19	81	72	28	942	146
I	Deep	7440417	Beryllium	19	85	14	0.8	1.2	1.0
I	Deep	7440439	Cadmium	19	81	7	0.30	3	1.2
I	Deep	7440702	Calcium	19	81	81	78,600	1,030,000	220,500
I	Deep	7440473	Chromium, Total	19	85	34	0.8	50	5
I	Deep	7440484	Cobalt	19	81	9	0.7	4	2
I	Deep	7440508	Copper	19	81	7	0.8	15	4
I	Deep	7439896	Iron	19	81	50	34	12,200	2,269
I	Deep	7439921	Lead	19	87	9	2	51	12
I	Deep	7439954	Magnesium	19	81	81	8,550	1,460,000	871,812
I	Deep	7439965	Manganese	19	81	63	0.42	690	135
I	Deep	7439976	Mercury	19	85	3	0.21	2	0.8
I	Deep	7440020	Nickel	19	81	18	0.9	454	28
I	Deep	7440097	Potassium	19	81	81	1,960	495,000	289,579
I	Deep	7782492	Selenium	19	81	1	6	6	6
I	Deep	7440224	Silver	19	81	0	NA	NA	NA
I	Deep	7440280	Thallium	19	87	16	3	15	6
I	Deep	7440315	Tin (Sn)	19	81	11	3	365	172
I	Deep	7440622	Vanadium	19	81	32	1.0	19	6
I	Deep	7440666	Zinc	19	81	13	7	116	26

There are no deep wells in Zone K.
All units are in micrograms per liter (µg/L).
NA Not applicable/not available

APPENDIX D

SCDHEC APPROVAL LETTER OF THE ZONE C RFI REPORT

2903-12240

E H E C

PROMOTE PROTECT PROSPER

ull Street
Columbia, SC 29201-1708

COMMISSIONER:
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CERTIFIED MAIL

May 5, 1998

Henry Shepard II, P.E.
Caretaker Site Office
NAVFACENGCOM, Southern Division
1690 Turnbull Avenue
Building NH-51
Charleston, SC 29405

Re: Zone C Final RCRA Facility Investigation (RFI) Report
Dated November 14, 1997
Charleston Naval Complex
SC0 170 022 560

Dear Mr. Shepard:

The South Carolina Department of Health and Environmental Control (Department) has reviewed the above referenced Zone C Final RFI Report, the response to comments and additional information received on April 27, 1998. The review was performed according to applicable State and Federal Regulations and the Charleston Naval Base Hazardous Waste Permit effective June 5, 1990. The units (AOCs/SWMUs) located at Zone C are classified as follows:

SWMU 44	CMS
SWMU 47 / AOC 516	CMS
AOC 508 / AOC 511	CMS
AOC 512	CMS
AOC 517	CMS (Lead dust removal is necessary since there are no regulations governing this kind of exposure. Most of zone C is planned to have a residential reuse)
AOC 518	CMS (Candidate for Interim Measures)
AOC 700	CMS (To be addressed as part of SWMU 44 CMS effort)
AOC 515 / AOC 519	NFA
AOC 510	NFA
AOC 513	NFA
AOC 520	NFA
AOC 522	NFA
AOC 523	(Decision Pending verification that the UST program has or will address the unit, and the base-wide thallium study by the RCRA Subtitle C program.
Ecological subzone C1	Further evaluation required under the Zone J (water bodies) RFI investigation.
Ecological subzone C2	No further evaluation required
Ecological subzone C3	No further evaluation required

In addition, at grid location 001 high DDT concentrations were detected. Limited soil removal is recommended.

The Department made the comment and confirmed with EPA, that screening total dioxin detections (TEQs) against the EPA's recommended cleanup level of 1 ppb is not appropriate. This approach departs from the Department's approved use of RBCs for soil ingestion for screening purposes, which if exceeded should be carried out into the risk assessment. Considering that detections of TEQs did not exceed EPA's recommended 1 ppb cleanup level, the Navy is not required to recalculate the risk at units were TEQs were present, however, a qualitative discussion related to dioxins (TEQs) is required for all units at Zone C. This discussion shall be included in a modified Section 11 of the Final RFI Report, that upon receipt of this letter shall be prepared and submitted to the Department.

Based on this review, and contingent that the above conditions are met the Department approves the Zone C final RFI report with minor deviations from the decisions reached at the Project Team meeting of April 1998.

It should be noted that according to condition IV.E.2. the permit shall be modified pursuant to R.61-79.270.41. The permit modifications can be made as part of the permit renewal, currently underway. The US EPA has not provided written comments or an approval letter to date.

The Department's concurrence is based on the information provided by the Navy to date. Any new information contradicting the basis for this concurrence may require further investigation or action.

Should you have any questions regarding this issue, please contact Johnny Tapia at (803) 896-4179 or Paul Bergstrand at (803) 896-4016.

Sincerely,

Joan Hartley

Joan Hartley, Manager
Corrective Action Engineering Section
Bureau of Land & Waste Management

cc: Paul Bergstrand, Hydrogeology
Rick Richter, Trident EQC
Tony Hunt, SOUTHNAVFACENGNCOM
Dann Spariosu, EPA Region IV

APPENDIX E

MEMORANDUM - RE: ZONE C, AOC 517 AND AOC 523, NFA STATUS INVESTIGATION

MEMORANDUM

To: Chris Pike, P.E., Tetra Tech

From: Ronald J. Kotun, Ph.D., Tetra Tech

CC:

Date: July 31, 2008

Re: **Zone C, AOC 517 and AOC 523, NFA Status Investigation**
Charleston Naval Complex
Charleston, South Carolina

Introduction

The purpose of this memo is to present my opinion regarding whether data from previous investigations sufficiently warrant that No Further Action (NFA) is needed at Zone C, AOC 517 and AOC 523.

Upon reviewing the documents provided from the Naval Facilities Engineering Command (NAVFAC), there appears to be some residual issues at Sites AOC 517 and AOC 523 that have yet to be addressed in an approach that is satisfactory to the regulating agencies. This conclusion has been drawn from the reluctance that the SCDEH and the United States Environmental Protection Agency (USEPA) have to granting a NFA for these Sites.

AOC 517

AOC 517 is the site of building M-192 that was used as a firing range from 1959 until 1974 and then it subsequently served as classrooms and storage facilities. While there were no exceedances of lead detected in the soils surrounding the former firing range, lead dust was discovered on surfaces inside the building. A remediation effort of lead dust was performed on the interior of Building M-192 in January of 1999. Following the remediation of the inside surfaces of the building it was found that the remediation had addressed the residual lead dust to levels less than 25 $\mu g/ft^2$, which is the method detection limit. As an outcome of the remediation measures on the inside surfaces of Building M-192, a No Further Action was requested. It was also recommended that any impact to the environment that was potentially caused through the migration of lead dust in sanitary or storm sewers would be addressed in an RFI for Zone J.

It appears that the primary risk at this AOC was attributable to the inside of the building. Apparently, this has been rectified; therefore, it could be concluded that NFA would be required for the inside of the building. Five soil borings were collected in the area surrounding building M-192 and no constituents of potential concern (COPC) were identified, i.e., concentrations were less than risk-based screening concentrations. Therefore, it could be concluded that no further action would be needed for soil in this area. No groundwater samples were collected for this area

beneath this building. It is the Navy's decision in concurrence with the regulatory agencies how they would choose to evaluate groundwater with respect to this AOC. Specifically, is the groundwater being treated as its own operable unit with Zone C? Overall, NFA could be granted for the soil for AOC 517.

AOC 523

AOC 523 is the existing location of Building 198 that is currently in use. The Site formerly contained a gas station and Building M-1234 that was operated from 1958 until 1962. In the Zone C RFI submitted in November 1997, COCs were detected above the screening or reference levels in the soil and groundwater for: TPH, arsenic chromium, barium mercury, and vanadium.

Two surface soil samples provided the basis for the risk assessment at this AOC. No subsurface soil samples were collected. The potential primary source of contamination would have been the USTs that would have been associated with the gas station, yet no subsurface soil samples were collected to determine if there was any potential contamination associated with these USTs. The lack of subsurface soil data in combination with an inadequate number of surface soil samples provides uncertainty associated with evaluation of soil risks. Moreover, with regards to soil, benzo[a]pyrene was not identified as a constituent of potential concern. However, using current screening levels, it now would be considered a COPC and would be retained in the risk assessment.

The determination of NFA was based on the most likely receptors and the most likely exposure pathways that were identified in the RFI. However, risks calculated for the potential future receptors associated with groundwater exceeded 1×10^{-4}. The risks are primarily attributed to groundwater exposure, which is not identified as a likely exposure pathway. Nonetheless, it may be difficult to render a NFA decision with unacceptable groundwater risks. As identified for AOC 517, a determination of whether groundwater is being treated as its own operable unit must be made.

APPENDIX F

SCDHEC WELL STANDARD R.61-71

SOUTH CAROLINA DEPARTMENT OF
HEALTH AND ENVIRONMENTAL CONTROL

R.61-71
South Carolina Well Standards

Effective Date: April 26, 2002

Bureau of Water
2600 Bull Street
Columbia, S.C. 29201

DISCLAIMER

This copy of the regulation is provided by DHEC for the convenience of the public. Every effort has been made to ensure its accuracy; however, it is not the official text. DHEC reserves the right to withdraw or correct this text if deviations from the official text as published in the State Register are found.

SOUTH CAROLINA WELL STANDARDS
REGULATION 61-71

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(Statutory Authority: 1976 Code Section 44-55-40)

A. PURPOSE AND SCOPE.

These regulations establish minimum standards for the construction, maintenance, and operation of the following wells: individual residential, irrigation, monitoring (including non-standard installations), and boreholes to ensure that underground sources of drinking water are not contaminated and public health is protected. These regulations do not apply to public water wells as those standards are stated in R.61-58. Additional requirements may be found for injection wells in R.61-87; for water wells which produce greater than 3 million gallons per month in capacity use areas as stated in the regulations promulgated under the Groundwater Use and Reporting Act; for oil and gas exploration and production wells as required under the Oil & Gas Exploration, Drilling, Transportation and Production Act as stated in regulation R.121-8; and for monitoring and remediation wells required under the State Hazardous Waste Management Regulations (R.61-79). Permitting requirements for Individual Residential Wells and Irrigation Wells are found in R.61-44.

B. DEFINITIONS.

For the purpose of this regulation, the following terms are defined:

1. Annular Space - the space between the drill string or casing and the wall of the borehole.
2. Bored Well - a large diameter individual residential well or irrigation well, commonly equal to or greater than 24 inches in diameter, that is typically installed at a shallow depth and with casing constructed of rock, concrete, or ceramic material.
3. Borehole - a bored, drilled or driven shaft, or a dug hole, whose depth is greater than the largest surface dimension.
4. Borehole Completion - the date the total depth of the borehole has been reached.
5. Boring – a borehole for the purpose of sampling sub-surface materials such as environmental soil sampling borings, geotechnical borings, or exploration borings, but does not include boreholes completed as wells.
6. Casing - a pipe or tubing of appropriate material, of varying diameter and weight, lowered into a borehole during or after drilling in order to support the sides of the hole and thus prevent the sides of the hole from caving, to prevent loss of drilling mud into permeable strata, or to prevent fluids from entering or leaving the borehole.
7. Certified Well Driller - a driller duly and currently registered in South Carolina by the Department of Labor, Licensing, and Regulation.
8. Confining Layer - a geologic formation, group of formations, or part of a formation that is capable of significantly limiting fluid movement between hydrogeologic units.
9. Consolidated Formation or Material – crystalline, metamorphic, limestone, or otherwise competent rock.

10. Conventionally Installed Monitoring Well – a monitoring well where an annular space is created during the well construction process.

11. Development - the removal of formation cuttings, fine-grained sediments, drilling fluids, or additives from the borehole.

12. Direct Push Monitoring Well - a type of monitoring well constructed by pushing casing or other sampling device into the subsurface to obtain water samples for groundwater quality analysis, or to measure groundwater levels, where little or no annular space is created.

13. Environmental Soil Sampling Boring - a borehole used to obtain a soil sample for contamination investigations.

14. Exploration Boring - any borehole for the purpose of sub-surface mineral investigation and exploration.

15. Forced Injection of Grout - the emplacing of grout through a tremie pipe by pumping as opposed to pouring by gravity.

16. Filter Pack - an artificial filter material that is placed in the annular space around the well screen.

17. Geotechnical Boring – a typically shallow borehole for determining physical properties of the soil and subsurface, including foundation or general geotechnical borings and other such shallow borings incidental to construction activities.

18. Geothermal System Well – a type of well that is used to provide heat exchange for heating and cooling systems where the piping is below ground; includes, but is not limited to, closed loop and open loop systems.

19. Individual Residential Well - a well intended to produce potable water for human consumption at a single residence or a family.

20. Irrigation Well - a well intended to produce water for uses other than human consumption, to include, but not be limited to, lawn and landscape watering and agricultural uses.

21. Monitoring Well - any well constructed specifically to obtain a sample of groundwater for analysis, or any well used to measure groundwater levels. These wells include, but are not limited to, wells constructed using conventional drilling techniques and direct push methods.

22. Permanent Monitoring Well – any monitoring well that is intended for multiple sampling events over time.

23. Sanitary Cover - a removable seal to prevent the entrance of contaminants or foreign matter into the well.

24. Sanitary Seal - a removable seal at the top of the casing, between the casing and pipe, wire, tool, or device, capable of supporting such tools or devices, having no opening that would enable the entrance of contaminants or foreign matter into the well.

25. Screen – a filtering device that serves as the intake portion of a well that allows water to enter the well while preventing sediment from entering the well.

26. Surface Water – all water, which is open to the atmosphere and is subject to surface runoff that includes lakes, streams, ponds, ditches, and reservoirs.

27. Temporary Monitoring Well – a monitoring well where a one-time groundwater sample or groundwater level measurement is obtained.

28. Thermoplastic - materials composed of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) plastics.

29. Tremie - the use of a small diameter pipe inserted into the borehole through which the filter pack or grout is placed at the desired depth to either complete construction of the well or to abandon the boring.

30. Unconsolidated Formation or Material - layers or sequences of sands, silts, or clays.

31. Vent – a device to keep foreign matter out of the well and that allows the well to be vented to the atmosphere.

32. Well – any borehole completed for the purpose of extracting or injecting fluid. This shall include, but not be limited to, wells used for irrigation, individual residential drinking water, environmental restoration, geothermal well systems, or environmental sampling. Wells fall into one of the following types:

    a. Type I - open hole in bedrock aquifers;

    b. Type II - screened with natural filter in unconsolidated aquifers;

    c. Type III - screened with artificial filter in unconsolidated aquifers;

    d. Type IV - open hole in consolidated limestone aquifers;

    e. Type V - bored or dug well having a large diameter.

33. Well Completion Date – the date the casing has been grouted.

C. VARIANCES.

Any requests for variances to these regulations shall be directed in writing to the Department and shall be considered on a well-specific basis by the Department. A variance can be issued as an alternative construction method that ensures the equivalent protection of the groundwater resource and public health when the standards in this regulation cannot otherwise be met. The Department may revoke issued variances as determined to be appropriate by the Department.

D. GENERAL.

1. All wells shall be drilled, constructed, and abandoned by a South Carolina certified well driller per 40-23-10 et seq.

2. Analytical data submitted to the Department shall be from a South Carolina Certified Laboratory per R.61-81.

E. LOCATION OF WELLS.

1. Wells outlined in Section F and G shall be located the specified minimum distance from all of the following existing potential sources of contamination:

   a. Sewer lines .....20 feet

   b. Lakes, streams, surface-water bodies .....50 feet

   c. Septic tank/tile fields .....50 feet

   d. Animal feedlots, barns, stables .....50 feet

   e. Waste disposal--land application sites ..... 100 feet

   f. Waste treatment lagoons ..... 100 feet

   g. Chemical, herbicide, pesticide and petroleum storage or handling sites ..... 100 feet

   h. Landfills ..... 100 feet

   i. Hazardous waste landfills/surface impoundments ..... 100 feet

   j. Radioactive waste landfills ..... 100 feet

   k. Property lines and buildings .....5 feet

2. Certain conditions may require increased distances of certain wells from potential contamination sources or known contamination and the decision shall be made in consultation with the Department. These include but are not limited to:

   a. Type I and IV wells with less than twenty feet of casing

   b. Type I wells where fractured rock is at the surface

   c. Type II or III wells with no confining layers between the screened zone(s) and the ground surface

   d. Type IV wells where no confining layers overlie the open-hole limestone or the limestone is at shallow depth

   e. Type V wells because they are under water-table conditions

3. At the time of construction, all wells shall be accessible for cleaning, treatment, repair, inspection, and other attention as may be necessary.

F. INDIVIDUAL RESIDENTIAL AND IRRIGATION WELLS.

1. Drilling.

   a. The drilling process or use of drilling fluid additives shall not contaminate any aquifer.

   b. Water used in the drilling process shall be obtained from a source that will not result in chemical or biological contamination of any aquifer. Water taken directly from ponds, lakes, streams or other surface water sources shall not be used.

2. Grouting.

a. The diameter of the drilled hole shall be large enough to allow for a minimum of 1.5 inches of annular space on all sides of the casing for forced injection of grout through a tremie pipe.

b. Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.

(1) Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturer's specifications.

(2) Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturer's specifications.

(3) High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturer's specifications with water and/or other required additives.

c. Grout shall fill the entire annular space from a minimum depth of twenty feet from the land surface at the time of well completion, unless otherwise approved by the Department. While the Department discourages wells less than 20 feet to be used for human consumption, it is recognized that due to differing hydrogeologic conditions across the state, some wells may need to be screened or completed at depths less than 20 feet to obtain potable water in the shallow aquifer. Therefore, wells less than 20 feet in depth, but no less than 15 feet in depth, are allowed. In these cases, in Type II and Type III wells, grout shall extend from one foot above the screen to the land surface and, in Type I and Type IV wells, the entire annular space shall be filled with grout. Any other minimum well depths may only be allowed per the variance procedure outlined in this regulation.

d. All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.

e. Wells shall be grouted in-place within five (5) days after borehole completion.

f. When high solids sodium bentonite grouts are used, a vapor barrier at the land surface at least the width of the annular space made of suitable materials, as approved by the Department, such as native soils, gravel,

sand, or thermoplastic material, is required for public safety and structural stability of the well.

3. Plumbness and Alignment.

Wells shall be constructed sufficiently plumb and straight so as to cause no interference with intended use.

4. Development.

a. Wells shall be properly developed. In a screened well, development shall be by a method that ensures that water is forced to flow into and out of the screen.

b. Development shall be complete when the well produces water typical of the aquifer being utilized.

5. Well Tested for Yield.

If a yield test is conducted, it shall be by a standard method and accurately measure flow. Results are to be included with the well record to be sent to the Department.

6. Backflow Prevention.

Approved backflow prevention devices are required on all wells that utilize a chemical feed system for any purpose other than water treatment. The backflow prevention device shall be installed so as to preclude any direct pathway for any contaminant to enter an underground source of drinking water.

7. Disinfection.

All individual residential wells and irrigation wells shall be disinfected upon well completion. The well shall also be disinfected upon any well maintenance, repair, pump repair, pump installation, or testing. Disinfectants shall be placed in the well in order to provide a chlorine residual from 50 ppm (milligrams per liter) to 250 ppm for a minimum of four hours before being flushed from the well. The method of chlorination shall be one that insures that the chlorine is uniformly distributed in the well. The well shall be flushed sufficiently after disinfection to remove the disinfectant and to condition the well for use.

8. Well Identification.

These wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible. The identification plate shall be permanently marked to show:

a. Company name and certification number of the driller who installed the well;

b. Date well was completed;

c. Total depth (feet); and,

d. Casing depth (feet).

9. Materials.

a. Casing.

(1) Casing may be driven, lowered, or installed in any manner that will effect a continuous water tight and plumb installation.

(2) A well point, drive pipe, or drive shoe shall be structurally suitable to prevent rupture during the driving of the casing.

(3) Permanent well casing shall be new, seamless, or electric-resistance welded steel or galvanized pipe or thermoplastic pipe.

(4) Casing shall have watertight joints that shall be glued or threaded and coupled if plastic, or electrically welded or threaded and coupled with heavy recessed-type couplings of steel, if metal.

(5) Casing shall be of standards classified by the American Society for Testing and Materials (ASTM) and shall be NSF approved.

(6) New steel casing which bears mill markings and which conforms to the standard and specifications ASTM A-53, ASTM A-120, or American Petroleum Institute (API-5L) for water well pipe shall be used.

(7) Casing weighing less than "standard weight" steel pipe is allowed by the Department for water wells when the following requirements are met:

(a) The casing shall have a minimum nominal wall thickness of 0.188 inches;

(b) Casing meets the requirements of American National Standards Institute and ASTM (ANSI/ASTM) for water well casing.

(8) In consolidated formations, the well casing shall be set into the formation so as to provide a watertight seal between the casing and the top of the consolidated formation.

(9) In unconsolidated material, well casing shall be set into the first confining layer or to twenty feet, whichever is greater.

(10) Casing installed shall extend a minimum of one foot above the land surface at the time of construction. If an above ground pump is used, the casing may extend less than one foot above the land surface or below the land surface with a protective wellhead cover that allows access to the wellhead if the piping connecting the well casing to the pump is glued or threaded and is watertight.

(11) Thermoplastic casing may be used provided the casing:

(a) Conforms to requirements of American National Standards Institute/American Society of Testing and Materials (ANSI/ASTM), specification F480-77 for thermoplastic water well casing pipe and couplings made in standard dimension ratios (SDR);

(b) Has minimum wall thickness and tolerances to meet or exceed requirements for SDR 26 thermoplastic water well casing pipe and couplings made in standard dimension ratios;

(c) Has wall thickness and tolerances to meet or exceed requirements for Schedule 40 thermoplastic water well casing pipe for nominal sizes three inches or smaller;

(d) Can be installed without interference from formational material or other objects that may cause physical damage to the casing during emplacement.

b. Screens.

(1) The well, if constructed to obtain water from an unconsolidated formation, shall be equipped with a screen that will prevent the entrance of formation material into the well after the well has been developed and completed.

(2) The well screen shall meet standards classified by the American Society for Testing and Materials (ASTM) and shall be National Sanitation Foundation (NSF) approved material, and shall be of a strength to satisfactorily withstand chemical or physical forces applied to it during and after installation.

(3) Thermoplastic well screens shall:

(a) Have a minimum wall thickness and tolerance which meet or exceed requirements for schedule 40 thermoplastic water well casing pipe for nominal sizes three inches and smaller;

(b) Have a minimum wall thickness and tolerance which meet or exceed requirements for SDR 26 thermoplastic water well casing for nominal sizes greater than three inches, and;

(c) Be installed in wells without interference from formation material or other objects that may cause physical damage during emplacement and do not exceed manufacturers recommendations for depth placement.

(d) Multi-screened wells shall not connect aquifers or zones that have documented differences:

(1) In water quality that would result in contamination of any aquifer or zone such that any State Primary Drinking Water standard is exceeded;

(2) In static water levels that would result in depletion of water from any aquifer or zone, or significant loss of head in any aquifer or zone.

(e) The bottom of the lower-most well screen shall be plugged or capped.

10. Filter Pack.

When a filter pack is used, the following criteria shall apply:

a. The filter pack shall be composed of uniformly sized, quartz sand or gravel being free from clay, silt, or other deleterious material.

b. The filter pack shall be installed using a method that ensures placement into the annular space around the screens.

c. The filter pack shall be disinfected prior to or during installation.

d. The filter pack shall not connect aquifers or zones that have documented differences:

(1) In water quality that would result in contamination of any aquifer or zone such that any State Primary Drinking Water standard is exceeded;

(2) In static water levels that would result in depletion of water from any aquifer or zone, or significant loss of head in any aquifer or zone.

11. Sanitary Seal.

a. A sanitary seal shall be provided on the top of the well casing.

b. If a vent is used, it shall be of a type to prevent the entrance of contaminants, insects, or rainwater into the well.

12. Reporting.

a. The Water Well Record Form 1903, or other approved form, shall be completed and submitted to the Department by the contractor within thirty days after well completion. In addition to the water well record, the driller shall submit additional information as available such as chemical or bacterial results, if taken, and pumping information.

b. A Form 1903 shall also be submitted for individual residential and irrigation wells that are abandoned.

13. Operations and Maintenance.

    a. All wells shall be operated and maintained at all times in such a manner so as to protect underground sources of drinking water from contamination and to protect public health. The well owner may be required to provide additional security against vandalism as appropriate. The well owner is responsible for routine maintenance and operation of the well.

    b. The well driller is responsible for ensuring wells are constructed in accordance with this regulation. Once the well driller has provided a properly constructed well to the well owner, the well driller is not responsible for normal wear of the well.

    c. A sampling spigot shall be installed on the wellhead.

14. Abandonment.

    a. When any well is removed from service or prior to putting in service, the well shall be sealed with a watertight cap or seal. The well shall be maintained such that it is not a source or channel of contamination while it is not in service. Until a well is abandoned, all provisions for protection of the water against contamination and for maintaining sanitary conditions around the well shall be carried out to the same extent as though the well were in routine use. This goal shall be met when conducting repair or maintenance on the well, surrounding structures, or pumps.

    b. Any well removed from service for longer than thirty-six months shall be permanently abandoned unless a variance from the Department is requested.

    c. Any well that acts as a source of contamination shall be repaired or permanently abandoned immediately after receipt of notice from the Department.

    d. Abandonment shall be by forced injection of grout or pouring through a tremie pipe starting at the bottom of the well or fill material and proceeding to the surface in one continuous operation.

    e. When an individual residential well or irrigation well is permanently abandoned, at a minimum, the well may be filled with either bentonite-cement, neat cement, 20% high solids sodium bentonite grout, sand, or gravel to no closer than twenty feet below the ground surface. The remaining twenty feet to the ground surface shall be filled with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout.

G. BORED INDIVIDUAL RESIDENTIAL AND IRRIGATION WELLS.

The construction of bored wells shall meet the following minimum requirements:

1. Drilling.

a. The drilling process or use of drilling fluid additives shall not contaminate any aquifer.

b. Water used in the drilling process shall be obtained from a source that will not result in chemical or biological contamination of any aquifer. Water taken directly from ponds, lakes, streams or other surface water sources shall not be used.

2. Grouting.

a. The diameter of the borehole shall be large enough to allow for a minimum of 1.5 inches of annular space on all sides of the casing for forced injection of grout through a tremie pipe.

b. Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.

(1) Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturers specifications

(2) Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturers specifications.

(3) High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturers specifications with water and/or other required additives.

c. When high solids sodium bentonite grouts are used, a vapor barrier at the land surface made of suitable natural materials as approved by the Department, such as native soils, gravel, or sand, is required.

d. Grout shall fill the entire annular space from a minimum depth of fifteen feet from the land surface at the time of well completion to ensure that water does not enter the well from the joints in the well casing. Bored wells shall be greater than 15 feet in depth.

e. Grouting shall be done by forced injection of grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.

f. Grouting shall take place within five (5) days after borehole completion.

3. Development.

Development shall be complete when the well produces water typical of the aquifer being utilized.

4. Well Tested for Yield.

If a yield test is conducted, it shall be by a standard method and accurately measure flow. Results are to be included in the well record to be sent to the Department.

5. Backflow Prevention.

Approved backflow prevention devices are required on all wells that utilize a chemical feed system for any purpose other than water treatment. The backflow prevention device shall be installed so as to preclude any direct pathway for any contaminant to enter an underground source of drinking water.

6. Disinfection.

All individual residential wells shall be disinfected upon the initial installation of the pump and sanitary cover. The well shall also be disinfected upon any subsequent well maintenance, repair, pump repair, pump installation, or testing. Disinfectants shall be placed in the well in order to provide a chlorine residual from 50 ppm (milligrams per liter) to 250 ppm for a minimum of four hours before being flushed from the well. The method of chlorination shall be one that insures that the chlorine is uniformly distributed in the well. The well shall be flushed sufficiently after disinfection to remove the disinfectant and to condition the well for use.

7. Well Identification.

All wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible. The identification plate shall be permanently marked to show:

a. Company name and driller's certification number who installed the well;

b. Date well was completed;

c. Total depth (feet);

d. Casing depth (feet).

8. Casing.

a. Casing may be driven, lowered, or installed in any manner that will effect a continuous water tight and plumb installation.

b. Any piping connecting through the well casing shall be watertight.

9. Filter Pack.

When a filter pack is used, the following criteria shall apply:

a. The filter pack shall be composed of uniformly sized, quartz sand or gravel being free from clay, silt, or other deleterious material.

b. The filter pack shall be installed using a method approved by the Department into the annular space.

c. The filter shall be disinfected prior to or during installation.

10. Sanitary Cover.

A sanitary cover shall be provided on the top of the well casing.

11. Reporting.

a. The Water Well Record Form 1903, or other approved form, shall be completed and submitted to the Department by the contractor within thirty days after well completion. In addition to the water well record, the driller shall submit additional information as available such as chemical or bacterial results, if taken, and pumping information.

b. A Form 1903 shall also be submitted for bored wells that are abandoned.

12. Operations and Maintenance.

Bored wells shall be operated and maintained at all times in such a manner so as to protect underground sources of drinking water from contamination and to protect public health. The well owner may be required to provide additional security against vandalism as appropriate. The well driller is responsible for ensuring wells are constructed in accordance with this regulation. Once the well driller has provided a properly constructed well to the well owner, the well driller is not responsible for normal wear of the well. The well owner is responsible for maintenance and operation of the well.

13. Abandonment.

a. When a bored well is removed from service or prior to putting in service, the well shall be covered with a cap or seal. The well shall be maintained such that it is not a source or channel of contamination while not in service. Until a well is abandoned, all provisions for protection of the water against contamination and for maintaining sanitary conditions around the well shall be carried out to the same extent as though the well were in routine use. This goal shall be met when conducting repair or maintenance on the well, surrounding structures, or pumps.

b. Any well removed from service for longer than thirty-six months shall be permanently abandoned unless a variance from the Department is requested.

c. Any well that acts as a source of contamination shall be repaired or permanently abandoned immediately after receipt of notice from the Department.

d. Abandonment shall be by forced injection of grout or pouring through a tremie pipe starting at the bottom of the well or fill material and proceeding to the surface in one continuous operation, unless compacted clay is used.

e. The bored well shall be abandoned immediately upon being permanently taken out of service. The well may be filled with either bentonite-cement, neat cement, 20% high solids sodium bentonite grout, sand, or gravel to no closer than twenty feet below the ground surface. The remaining twenty feet to the ground surface shall be filled with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout, or compacted clay.

H. MONITORING WELLS

1. Requirements For All Permanent and Temporary Monitoring Wells.

a. Due to the nature and purpose of a monitoring well, the depth and location requirements in respect to surface water bodies, potential contamination sources, etc., are variable, and shall be approved on a case-by-case basis by the Department. All monitoring wells shall have Department approval prior to installation or abandonment. Prior to the construction of any monitoring well, the following information shall be completed on a form provided and/or approved by the Department and shall be submitted to the Department:

(1) Proposed well location(s) on a scaled map or plat;

(2) Proposed well construction details;

(3) Intended purpose of the well(s);

(4) Well owner's name and mailing address;

(5) Property owner's name and mailing address, if different from the well owner;

(6) Mailing address and county of location where monitoring wells are to be installed, if different from the well owner's or property owner's address;

(7) Proposed parameters to be analyzed; and,

(8) Proposed drilling date.

If any of the information provided to the Department changes, the Department shall be notified at least 24 hours prior to well construction.

b. All monitoring wells shall be drilled, constructed, maintained, operated, and/or abandoned to ensure that underground sources of drinking water are not contaminated.

c. All monitoring wells shall yield water samples and water levels that are representative of the zone monitored.

d. The well owner shall submit all analytical data and water levels obtained from each monitoring well to the Department within 30 days of receipt of laboratory results unless another schedule has been approved by the Department.

e. Any monitoring well which is destroyed, rendered unusable, or abandoned, shall be reported to the Department, and shall be properly abandoned, revitalized, or replaced as appropriate or as required by permit or regulation.

f. A Water Well Record Form 1903 or other form provided and/or approved by the Department shall be completed and submitted to the Department within 30 days after well completion or abandonment. At a minimum, the form shall contain the following information:

(1) Name and address of facility/owner;

(2) Surveyed or global positioning system location, in latitude and longitude or Universal Transverse Mercator coordinates, of monitoring well(s) on a scaled map or plat;

(3) Driller and certification number;

(4) Date drilled;

(5) Driller's or Geologist's log;

(6) Total depth;

(7) Screened interval;

(8) Diameter and construction details;

(9) Depth to groundwater with date and time measured;

(10) Surveyed elevation of measuring point with respect to an established benchmark.

(11) Monitoring well approval number issued by the Department.

g. Monitoring wells constructed and reported to satisfy permitting or other regulatory requirements are not required to submit duplicate reports under this regulation.

h. Any well that acts as a source of contamination shall be repaired or permanently abandoned immediately after receipt of notice from the Department.

2. Additional Requirements for Permanent Conventionally Installed Monitoring Wells

a. Grouting.

(1) These monitoring wells shall be grouted from the top of the bentonite seal to the land surface.

(2) Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.

(a) Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven (7) gallons of clean water per bag (one cubic

foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturer's specifications

(b) Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturer's specifications.

(c) High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturer's specifications with water and/or other required additives.

(3) The diameter of the drilled hole shall be large enough to allow for a minimum of 1.5 inches of annular space on all sides of the casing for forced injection of grout through a tremie pipe.

(4) All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.

(5) A cement or aggregate reinforced concrete pad at the ground surface of appropriate durability and strength, considering the setting and location of each well, that extends six inches beyond the borehole diameter and six inches below ground surface is required. The pad shall be capable of preventing infiltration between the surface casing and the borehole to the subsurface.

b. Construction and Materials

(1) Casing shall be of sufficient strength to withstand normal forces encountered during and after well installation and be composed of material so as to minimally affect water quality analyses.

(2) Casing shall have a sufficient diameter to provide access for sampling equipment.

(3) A properly hydrated bentonite seal with a minimum thickness of twelve inches directly above the filter pack shall be used, if the well has a filter pack.

(4) The monitoring well intake or screen design shall minimize formational materials from entering the well. The filter pack

shall be utilized opposite the well screen as appropriate so that parameter analyses will be minimally affected.

(5) A locking cap or other security devices to prevent damage and/or vandalism shall be used.

(6) Monitoring wells completed below grade shall be in a watertight vault with a well cap to prevent infiltration of surface water into the well.

c. Well Identification.

All monitoring wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible. The identification plate shall be permanently marked to show:

(1) Company name and certification number of the driller who installed the well;

(2) Date well was completed;

(3) Total depth (feet);

(4) Casing depth (feet);

(5) Screened interval;

(6) Designator and/or identification number.

d. Development.

Development shall be complete when the well produces water typical of the aquifer being utilized.

e. Abandonment

Abandonment shall be by forced injection of grout or pouring through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation. The well shall be filled with either with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout, from the bottom of the well to the land surface.

3. Additional Requirements for Permanent Direct Push Monitoring Wells

a. Direct Push Wells cannot be installed below a confining layer unless it can be demonstrated to the satisfaction of the Department that cross-contamination of the aquifer systems can be prevented.

b. Grouting.

(1) These monitoring wells shall be grouted from the top of the bentonite seal to the land surface.

(2) Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.

(a) Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturer's specifications

(b) Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturer's specifications.

(c) High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturer's specifications with water and/or other required additives.

(3) The diameter of the annular space shall be large enough to allow for forced injection of grout through a tremie pipe.

(4) All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.

(5) A cement or aggregate reinforced concrete pad at the ground surface of appropriate durability and strength, considering the setting and location of each well, that extends six inches beyond the borehole diameter and six inches below ground surface is required. The pad shall be capable of preventing infiltration between the surface casing and the borehole to the subsurface.

c. Construction and Materials

(1) Casing shall be of sufficient strength to withstand normal forces encountered during and after well installation and be composed of material so as to minimally affect water quality analyses.

(2) Casing shall have a sufficient diameter to provide access for sampling equipment.

(3) The monitoring well intake or screen design shall minimize formational materials from entering the well. The well screen or intake shall be designed so that parameter analyses will be minimally affected.

(4) A locking cap or other security devices to prevent damage and/or vandalism shall be used.

(5) Monitoring wells completed below grade shall be in a watertight vault with a well cap to prevent infiltration of surface water into the well.

d. Well Identification.

All monitoring wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible. The identification plate shall be permanently marked to show:

(1) Company name and certification number of the driller who installed the well;

(2) Date well was completed;

(3) Total depth (feet);

(4) Casing depth (feet);

(5) Screened Interval;

(6) Designator and/or identification number.

e. Development.

Development shall be complete when the well produces water typical of the aquifer being utilized.

f. Abandonment

(1) Permanent Direct Push Wells that do not penetrate a confining layer shall be abandoned by removing all casing from the subsurface and be grouted by forced injection through a tremie pipe from the total depth to the land surface, or by forced injection or pouring of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation.

(2) Direct Push Wells that penetrate a confining layer shall be abandoned by forced injection or pouring of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation.

4. Additional Requirements For Temporary Monitoring Wells

a. Construction and Materials

(1) Casing shall be of sufficient strength to withstand normal forces encountered during and after well installation and be

composed of material so as to minimally affect water quality analyses.

(2) Casing shall have a sufficient diameter to provide access for sampling equipment.

(3) The monitoring well intake or screen design shall minimize formational materials from entering the well. The filter pack or intake shall be utilized opposite the well screen as appropriate so that parameter analyses will be minimally affected.

b. Operation and Maintenance

All temporary monitoring wells shall be sealed with a watertight cap or seal until abandoned. Temporary monitoring wells shall be maintained such that they are not a source or channel of contamination before they are abandoned.

c. Abandonment.

(1) All temporary monitoring wells shall be abandoned within 5 days of borehole completion.

(2) A conventionally drilled temporary well shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe starting at the bottom of the well and proceeding to the surface in one continuous operation.

(3) A Temporary Direct Push Well that does not penetrate a confining layer shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through a tremie pipe after the sampling device has been removed.

(4) A Temporary Direct Push Well that penetrates a confining layer shall be abandoned by forced injection of neat cement, bentonite-cement, or 20% high solids sodium bentonite grout through the sampling device as the sampling device is removed from the sub-surface. Abandonment shall occur during the initial withdrawal from the original push borehole and not by a separate tremie tool after the sampling device has been removed to ensure the breech in the confining layer is permanently sealed.

5. Use of Water Wells as Monitoring Wells.

Due to the variability involved, the use of a potable water well as a monitoring well shall be approved by the Department on a case-by-case basis.

6. Non-Standard Monitoring Wells

Due to the variability involved, the use of construction methods, techniques, or monitoring well designs not covered in this regulation shall be approved by the Department on a case-by-case basis.

I. BORINGS.

1. Geotechnical Borings.

   a. Geotechnical borings shall be abandoned within five days of borehole completion.

   b. Geotechnical borings shall be backfilled with a suitable material, such as the native material removed from the boring, to eliminate safety hazards and infiltration of runoff into the boring.

2. Exploration Borings

   a. Exploration borings shall be abandoned or cased to observe groundwater levels within five days of borehole completion or completion of geophysical logging. When cased, the casing shall be grouted per the requirements of R.61-71.F.2. and shall be capped for safety when not in use.

   b. Exploration borings in near surface unconsolidated formations or saprolite shall be backfilled with a suitable material, such as the native material removed from the boring, to eliminate safety hazards and infiltration of runoff into the boring.

   c. Exploration borings in indurated or consolidated formations shall be abandoned by filling with either bentonite-cement, neat cement, 20% high solids sodium bentonite grout, sand, or gravel to within no less than twenty feet of the surface and the remainder shall be filled with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout.

   d. Exploration borings in indurated or consolidated formations shall be abandoned by forced injection of grout or pouring through a tremie pipe starting at the bottom of the borehole and proceeding to the surface in one continuous operation.

   e. Special precautions shall be used to abandon exploration borings if natural voids, such as solution cavities in limestone, significant fractures, and shear zones, are encountered. Suitable grout and grouting methods shall be used when such conditions exist to ensure the long-term integrity of the grout in the abandoned borehole.

   f. Exploration borings constructed on property that is included in an active mine permit shall be exempt from this Section of this regulation.

   g. A form provided and/or approved by the Department shall be completed and submitted to the Department within 30 days after completion of the exploration project, or phase in exploration drilling, whichever occurs first. The Department shall treat the approved form

completed and submitted for exploration boring abandonment as confidential trade secrets and proprietary business information and not subject to public disclosure under the Freedom of Information Act.

3. Environmental Soil Sampling Borings

   a. All analytical data obtained from each environmental soil sampling boring shall be submitted to the Department within 30 days of receipt of laboratory results unless another schedule has been approved by the Department.

   b. The boring shall be abandoned within five days of borehole completion.

   c. Borings five feet in depth or shallower may be abandoned by backfilling with native fill material.

   d. Borings greater than five feet in depth shall be completely filled from the bottom of the borehole to the land surface with bentonite-cement, neat cement, or 20% high solids sodium bentonite grout.

   e. The boring shall be abandoned by forced injection of grout or pouring through a tremie pipe starting at the bottom of the borehole and proceeding to the surface in one continuous operation.

   f. A Water Well Record Form 1903 or other form provided and/or approved by the Department shall be completed and submitted to the Department within 30 days after abandonment.

4. Horizontal Borings.

   a. Horizontal borings shall be backfilled with a suitable material, such as the native material removed from the boring, to eliminate safety hazards and infiltration of runoff into the boring.

J. GEOTHERMAL SYSTEM WELLS.

1. Drilling.

   a. The drilling process or use of drilling fluid additives shall not contaminate any aquifer.

   b. Water used in the drilling process shall be obtained from a source that will not result in chemical or biological contamination of any aquifer. Water taken directly from ponds, lakes, streams or other surface water sources shall not be used.

   c. Geothermal system wells shall not connect aquifers or zones that have documented differences:

      (1) In water quality that would result in contamination of any aquifer or zone such that any State Primary Drinking Water standard is exceeded;

(2) In static water levels that would result in depletion of water from any aquifer or zone, or significant loss of head in any aquifer or zone.

2. Grouting.

a. If the geothermal system well is to be cased, the diameter of the drilled hole shall be large enough to allow for a minimum of 1.5 inches of annular space on all sides of the casing for forced injection of grout through a tremie pipe. Grout shall fill the entire annular space from a minimum depth of twenty feet from the land surface at the time of well completion, unless otherwise approved by the Department.

b. If the geothermal system well will not be cased, the borehole may be filled with either bentonite-cement, neat cement, 20% high solids sodium bentonite grout, sand, or gravel to no closer than twenty feet below the ground surface. The remaining twenty feet to the ground surface shall be filled with neat cement, bentonite-cement, or 20% high solids sodium bentonite grout.

c. Grout is to be composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.

(1) Neat cement grout shall be composed of Class A, Type I Portland Cement mixed with not more than seven (7) gallons of clean water per bag (one cubic foot or 94 pounds) of cement with a density of 15 to 16 pounds per gallon, or to manufacturer's specifications.

(2) Bentonite-cement grout shall be composed of powdered bentonite (less than 5% by weight) mixed at not more than 8 gallons of water to the bag, with a density of 14 to 15 pounds per gallon, or to manufacturer's specifications.

(3) High solids sodium bentonite grout shall have a minimum of 20% solids and be mixed per manufacturer's specifications with water and/or other required additives.

d. All grouting shall be accomplished using forced injection to emplace the grout. When emplacing the grouting material, the tremie pipe shall be lowered to the bottom of the zone to be grouted. The tremie pipe shall be kept full continuously from start to finish of the grouting procedure, with the discharge end of the tremie pipe being continuously submerged in the grout until the zone to be grouted is completely filled.

e. Geothermal system wells shall be grouted in-place within five (5) days after borehole completion.

f. When high solids sodium bentonite grouts are used, a vapor barrier at the land surface at least the width of the annular space made of suitable materials, as approved by the Department, such as native soils, gravel,

sand, or thermoplastic material, is required for public safety and structural stability of the well.

3. Well Identification.

These wells shall be properly labeled with an identification plate immediately upon well completion. The identification plate shall be constructed of a durable, weatherproof, rustproof, material. The identification plate shall be permanently secured to the well casing or enclosure floor around the casing where it is readily visible. The identification plate shall be permanently marked to show:

a. Company name and certification number of the driller who installed the well;

b. Date well was completed;

c. Total depth (feet); and

d. Casing depth (feet).

4. Reporting.

The Water Well Record Form 1903, or other approved form, shall be completed and submitted to the Department by the contractor within thirty days after well completion.

K. VIOLATIONS AND PENALTIES.

1. Violations of this regulation shall be subject to penalties as provided in Sections 48-1-320, 44-55-90 and 48-1-330 of the 1976 S.C. Code of Laws.

2. Whenever the Department finds that a well driller is in violation of a requirement under this regulation, the Department will issue a written notice of violation with a requirement to correct all violations within a specified time period. Whether the noted violation(s) is properly corrected within the specified time period, the extent of deviation from the regulation, the potential for harm, and the historical record of violations by that well driller, shall be considered by the Department in determining additional enforcement actions, if any, and any associated penalties.

3. Should a violation be determined by the Department to have occurred despite the well driller following all applicable regulations and manufacturer's specifications, the Department shall direct the well driller to correct the noted violation within a specified time period. If this violation is corrected within the specified time period, no monetary penalty will be assessed for that violation.

4. After written notice of violation, the Department may issue an order or commence an action in court requiring the well driller to comply with the permit, regulation, standard, or requirement, or may request the Attorney General to commence an action under this subsection in the appropriate court. The Department may also assess civil penalties as provided in this section for violations of the provisions of this regulation or for violating any order, permit, regulation, or standard.

5. A well driller who fails to take appropriate corrective action, after receiving written notice of violation of a provision of this regulation, is liable for civil penalties or criminal prosecution.

6. The Department shall have full access to a well driller's bond as required by the Department of Labor, Licensing, and Regulation to correct a violation of this regulation where, as part of a Department enforcement action, a well driller is unwilling or unable to take required corrective actions.

7. If the Department finds a person not certified by the Department of Labor, Licensing, and Regulation in the act of drilling a well, the Department may issue an order or field citation requiring the person to immediately cease and desist operations, or seek a court order enjoining further drilling.

L. SEVERABILITY.

Should any section, paragraph, sentence, clause, phrase, or other part of this regulation be declared invalid for any reason, the remainder shall not be affected thereby.