N00164.AR.000828
NSWC CRANE
5090.3a

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE INDIANA 47522-5001

10-1-2003

IN REPLY REFER TO:
5090/S4.7.1
Ser RP3/3338

7 OCT 2003

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NSWC Crane) submits RCRA Facility Investigation (RFI) Quality Assurance Project Plan (QAPP) Addendum No. 1 for Solid Waste Management Units 12/14, 13/14, 16/16, and 19/00 (Mine Fill A, Mine Fill B, Cast High Explosive-Building 146 Incinerator Complex, and Pyrotechnic Test Areas, respectively). One copy was previously submitted to the U. S. EPA by Tetra Tech NUS. Please find another copy of the QAPP Addendum (Volumes I and II) as enclosure (1). The permit required Certification Statement is provided as enclosure (2).

NSWC Crane point of contact is Mr. Thomas J. Brent, Code RP310, telephone 812-854-6160.

Sincerely,

James M. Hunsicker

JAMES M. HUNSICKER
Director, Environmental
Protection Department
By direction of the Commander

Encl:
(1) SWMUs 12, 13, 16, & 19 RFI QAPP Addendum No. 1
(2) Certification Statement

Copy to:
ADMINISTRATIVE RECORD
SOUTHNAVFACENGCOM (Code ES32) (w/o encl)
IDEM (Doug Griffin)
TTNUS (Ralph Basinski) (w/o encl)

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

SIGNATURE

Environmental Protection Department Manager — 10/07/03

TITLE — DATE

Quality Assurance Project Plan Addendum No. 1

for

Mine Fill A (SWMU 12) Mine Fill B (SWMU 13) and Cast High Explosives Fill/ B146 Incinerator (SWMU 16) and Pyrotechnic Test Area (SWMU 19)

RCRA Facility Investigation

VOLUME I OF II - TEXT

Naval Surface Warfare Center Crane

Crane, Indiana

Southern Division Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0166

October 2003

090307/P

QUALITY ASSURANCE PROJECT PLAN
ADDENDUM NO. 1
FOR
MINE FILL A (SWMU 12)
MINE FILL B (SWMU 13)
CAST HIGH EXPLOSIVES FILL/
B146 INCINERATOR (SWMU 16) AND
PYROTECHNIC TEST AREA (SWMU 19)
RCRA FACILITY INVESTIGATION

NAVAL SURFACE WARFARE CENTER, CRANE
CRANE, INDIANA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0166

OCTOBER 2003

RALPH R. BASINSKI, QEP
TASK ORDER MANAGER
TETRA TECH NUS, INC.

DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

for PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

PETER RAMANAUSKAS
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

TOM BRENT
SITE MANAGER
NSWC CRANE

KATHY KREPPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

PAT McLOUGHLIN
QUALITY ASSURANCE OFFICER
MICROSEEPS, INC.

TABLE OF CONTENTS

SECTION **PAGE NO.**

1.0 PROJECT DESCRIPTION 1-1
1.1 RECENT ACTIVITIES 1-2
1.1.1 SWMU 12 Battery Disposal Site Interim Measure Activity 1-2
1.1.2 SWMU 13 Field Investigation Activity 1-5
1.1.3 SWMU 16 Field Investigation 1-6
1.2 SWMU-SPECIFIC CHARACTERISTICS 1-8
1.2.1 SWMU 13, Mine Fill B 1-9
1.2.2 SWMU 16 – B146 Cast High Explosives Incinerator 1-11
1.3 ANALYTICAL RESULTS 1-13
1.3.1 SWMU 13, Mine Fill B 1-13
1.3.2 SWMU 16, Cast High Explosives Fill 1-15
1.4 PROJECT TARGET PARAMETERS AND RATIONALE FOR SELECTION 1-18
1.4.1 SWMU 12 1-18
1.4.2 SWMU 13 1-21
1.4.3 SWMU 16 1-24

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 2-1

3.0 SAMPLING AND ANALYSIS PLAN 3-1
3.1 GENERAL APPROACH 3-1
3.2 SAMPLE IDENTIFICATION SYSTEM 3-1
3.3 UNEXPLODED ORDNANCE AVOIDANCE 3-2
3.4 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES 3-3
3.4.1 Surface and Subsurface Soils 3-3
3.4.2 Ground Water 3-6
3.4.3 Surface Water / Sediment 3-10
3.5 INVESTIGATION EQUIPMENT AND PROCEDURES 3-14
3.5.1 UXO Screening of Selected Drilling Sites 3-14
3.5.2 DPT Sampling for Surface and Subsurface Soil 3-14
3.5.3 Inspection and Repair of Existing Monitoring Wells 3-16
3.5.4 Well Drilling and Installation 3-17
3.5.5 Well Development 3-17
3.5.6 Water-Quality Field Measurements 3-18
3.5.7 Low-Flow Sampling of Monitoring Wells 3-18
3.5.8 Ground-Water-Level Measurements 3-19
3.5.9 Surface Water Sampling 3-20
3.5.10 Sediment Sampling 3-20
3.5.11 Staff Gauge Installation and Estimation of Stream Flow 3-21
3.5.12 Aquifer Testing 3-22
3.6 QUALITY CONTROL SAMPLES 3-22
3.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING 3-23
3.7.1 Sample Preservation 3-23
3.7.2 Sample Labeling 3-23
3.7.3 Sample Packaging 3-24
3.7.4 Sample Shipping 3-24
3.7.5 Sample Custody 3-24

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

3.8 RECORD KEEPING 3-25
3.8.1 Field Log Books 3-25
3.8.2 Drilling and Well Completion Logs 3-25
3.8.3 Well Development Log Sheets 3-25
3.8.4 Equipment Calibration Logs 3-26
3.8.5 Sample Collection Logs 3-26
3.8.6 Chain-of-Custody Forms 3-26
3.8.7 Shipping Forms/Air Bills 3-26
3.8.8 Permanent Record File 3-26
3.9 SURVEYING 3-26
3.10 EQUIPMENT DECONTAMINATION 3-27
3.11 MANAGEMENT OF INVESTIGATION-DERIVED WASTE 3-27
3.12 SAFETY 3-28
3.12.1 Health and Safety Plan 3-28
3.12.2 Health and Safety Training 3-28
3.12.3 Personal Protective Clothing and Equipment 3-29
3.12.4 Safety Meetings 3-29
3.13 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS 3-29
3.13.1 Personnel 3-29
3.13.2 Subcontractors 3-29
3.13.3 Mobilization and Demobilization 3-29

4.0 CUSTODY PROCEDURES 4-1

5.0 CALIBRATION PROCEDURES AND FREQUENCY 5-1

6.0 ANALYTICAL AND MEASUREMENT PROCEDURES 6-1
6.1 FIELD MEASUREMENT PROCEDURES 6-1
6.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES 6-1
6.2.1 List of Project Target Compounds and Detection Limits 6-1
6.2.2 List of Associated Quality Control Samples 6-1

7.0 INTERNAL QUALITY CONTROL CHECKS 7-1

8.0 DATA REDUCTION, VALIDATION, AND REPORTING 8-1

9.0 PERFORMANCE AND SYSTEM AUDITS 9-1

10.0 PREVENTIVE MAINTENANCE PROCEDURES 10-1

11.0 CORRECTIVE ACTION 11-1

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 12-1

REFERENCES R-1

TABLE OF CONTENTS (Continued)

APPENDICES

A SWMU 13 ROUND 1 POSITIVE HITS SUMMARY TABLES
- A.1 SURFACE SOIL
- A.2 SUBSURFACE SOIL
- A.3 GROUND WATER
- A.4 SURFACE WATER
- A.5 SEDIMENT

B SWMU 13 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES
- B.1 SURFACE SOIL
- B.2 SUBSURFACE SOIL
- B.3 GROUND WATER
- B.4 SURFACE WATER
- B.2 SEDIMENT

C SWMU 16 ROUND 1 POSITIVE HITS SUMMARY TABLES
- C.1 SURFACE SOIL
- C.2 SUBSURFACE SOIL
- C.3 GROUND WATER
- C.4 SURFACE WATER
- C.5 SEDIMENT

D SWMU 16 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES
- D.1 SURFACE SOIL
- D.2 SUBSURFACE SOIL
- D.3 GROUND WATER
- D.4 SURFACE WATER
- D.5 SEDIMENT

E FIELD STANDARD OPERATING PROCEDURES

F BORING LOGS
- F.1 SWMU 13
- F.2 SWMU 16

G LABORATORY STANDARD OPERATING PROCEDURES
- G.1 LAUCKS TESTING ANALYTICAL STANDARD OPERATING PROCEDURES
- G.2 MICROSEEPS, INC. ANALYTICAL STANDARD OPERATING PROCEDURES

TABLES

NUMBER

1-1 Monitoring Well Construction Information and Water Level Measurements, SWMU 13
1-2 Summary of Slug Test Hydraulic Conductivity Results
1-3 Monitoring Well Construction Information and Water Level Measurements, SWMU 16
1-4 Specific Fixed-Based Laboratory Analytical Methodologies and Corresponding Target Analyte Lists
1-5 Aqueous Field Target Parameters and Method Detection Limits
1-6 Project Target Parameters and Rationales, Mine Fill A (SWMU 12) Round 1 and Mine Fill B (SWMU 13) Round 2
1-7 Project Target Parameters and Rationales, Cast High Explosives fill/Building 146 Incinerator (SWMU 16), Round 2
2-1 Key Project Personnel for SWMUs 12, 13, and 16, Names, Phone Numbers, and Addresses
3-1 Field Screening and measurements
3-2 Soil Samples and Laboratory Analyses
3-3 Summary of Soil Analyses and Quality Control Samples
3-4 Ground Water Sampling and Laboratory Analyses
3-5 Summary of Ground Water Analyses and Quality Control Samples
3-6 Physical Characteristics of Proposed Monitoring Wells at SWMU 12
3-7 Existing Monitoring Well Construction Information and Water Level measurements for SWMU 13
3-8 Physical Characteristics of Proposed Monitoring Wells at SWMU 13
3-9 Existing Monitoring Well Construction Information and Water Level Measurements at SWMU 16
3-10 Physical Characteristics of Proposed Monitoring Wells at SWMU 16
3-11 Listing of Surface Water Samples and Laboratory Analyses
3-12 Summary of Surface Water Analyses and Quality Control Samples
3-13 Listing of Sediment Samples and Laboratory Analyses
3-14 Summary of Sediment Analyses and Quality Control Samples
3-15 Summary of Sample Analyses, Container Types and Volumes, Preservation Requirements, and Holding times for Soils and Sediments
3-16 Summary of Sample Analyses, Container Types and Volumes, Preservation Requirements, and Holding times for Aqueous Samples
3-17 Non-Calibration Quality Control Sample Usage Frequencies, Acceptance Limits, and Corrective Actions
6-1 Summary of Organic, Inorganic, and Miscellaneous Analytical Procedures for Solid and Aqueous Samples
7-1 Metals Quality Control Limits, Matrix Spike, and Laboratory Duplicate Samples
7-2 Metals Quality Control Limits, Laboratory Control Samples
7-3 Explosives (8330) Quality Control Limits, Matrix Spike/Matrix Spike and Duplicate Samples
7-4 Explosives (8330) Quality Control Limits, Laboratory Control Samples
7-5 Volatile Organic Compounds Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-6 Volatile Organic Compounds Quality Control Limits, Laboratory Control Samples
7-7 Semivolatile Organic Compounds Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-8 Semivolatile Organic Compounds Quality Control Limits, Laboratory Control Samples
7-9 PCB Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-10 PCB Quality Control Limits, Laboratory Control Spike Samples
7-11 Miscellaneous Parameters Quality Control Limits, Matrix Spike/Matrix Spike, and Laboratory Duplicate Samples

TABLES (Continued)

NUMBER

7-12 Miscellaneous Parameters Quality Control Limits, Laboratory Control Samples
7-13 Quality Control Limits, Surrogate Compound Recoveries
7-14 Quality Control Limits, Laboratory Duplicate Sample Precision

FIGURES

NUMBER

1-1 Battery Disposal Site (SWMU 12)
1-2 Bedrock Potentiometric Surface Map (5/11/03), Bedrock Wells and Staff Gauges Mine Fill B (SWMU 13)
1-3 Hydrogeologic Cross Section Map Mine Fill B (SWMU 13)
1-4 Hydrogeologic Cross Section A-A" SWMU 13 - Mine Fill B
1-5 Hydrogeologic Cross Section B-B' SWMU 13 - Mine Fill B
1-6 Hydrogeologic Cross Section C-C' SWMU 13 - Mine Fill B
1-7 Bedrock Potentiometric Surface Map (5/30/03), Bedrock Wells B146 Incinerator/Cast High Explosives Fill (SWMU 16)
1-8 Hydrogeologic Cross Section Map B146 Incinerator/Cast High Explosives Fill (SWMU 16)
1-9 Hydrogeologic Cross Section A-A' SWMU 16 Cast High Explosives/B146 Incinerator
1-10 Hydrogeologic Cross Section B-B' SWMU 16 Cast High Explosives/B146 Incinerator
1-11 Acrclor-1248 Concentrations in Surface Soil (µg/kg) Mine Fill B (SWMU 13)
1-12 Aroclor-1248 Concentrations in Subsurface Soil (µg/kg) Mine Fill B (SWMU 13)
1-13 Total Arsenic Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-14 Total Lead Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-15 RDX Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-16 2,4,6-Trinitrotoluene Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-17 RDX Concentrations in Ground Water (µg/L) B146 Incinerator/Cast High Explosives (SWMU 16)
1-18 Trichloroethene Concentrations in Ground Water (µg/L) B146 Incinerator/Cast High Explosives Fill (SWMU 16)
2-1 Project Organization Chart SWMU 12 (Round 1), SWMU 13 (Round 2), and SWMU 16 (Round 2)
3-1 Soil Boring Locations SWMU 12
3-2 SWMU 12 Battery Disposal Site Soil Boring Locations
3-3 Soil Sampling Locations for PCBs SWMU 13
3-4 Ground Water Sampling Locations SWMU 12
3-5 Ground Water Sampling Locations SWMU 13
3-6 Ground Water Sampling Locations SWMU 16
3-7 Surface Water and Sediment Sampling Locations SWMU 12
3-8 Surface Water and Sediment Sampling Locations SWMU 13
3-9 Surface Water and Sediment Sampling Locations SWMU 16

ACRONYM LIST

°C	Degrees Celsius
amsl	Above Mean Sea Level
AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
bgs	Below Ground Surface
CEC	Cation Exchange Capacity
CMS	Corrective Measures Study
DO	Dissolved Oxygen
DOD	Department of Defense
DPT	Direct-Push Technology
FOL	Field Operations Leader
GC/MS	gas chromatograph/mass spectrometer
GW	ground water
gpm	Gallons per Minute
HASP	Health and Safety Plan
HSA	Hollow-Stem Auger
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HPLC	high-performance liquid chromatograph
IDW	Investigation-Derived Waste
K	Hydraulic Conductivity
MFA	Mine Fill A
MFB	Mine Fill B
mg/kg	Milligrams per Kilogram
mL/minute	Milliliters per Minute
MNA	Monitored Natural Attenuation
MS	Mass spectrometer
MS	Matrix Spike
MSD	Matrix Spike Duplicates
NA	Not Applicable
NAD83	1983 North American Datum
NAVD	North American Vertical Datum
NFESC	Naval Facilities Engineering Service Center
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Unit

OD	Outside Diameter
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
SB	Soil Boring
SD	Sediment
SS	Surface Soil
SW	Surface Water
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCE	Trichloroethene
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Carbon
TOM	Task Order Manager
TtNUS	Tetra Tech NUS, Inc.
UAP	Unidentified Asphalt Pad
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
µS/cm	MicroSiemens per centimeter
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Society
U.S. EPA	U.S. Environmental Protection Agency
UXO	Unexploded Ordnance

VOC	Volatile Organic Compound
WES	Waterways Experiment Station

1.0 PROJECT DESCRIPTION

The Naval Surface Warfare Center (NSWC) Crane prepared a Quality Assurance Project Plan (QAPP) for a Phase III Resource Conservation Recovery Act (RCRA) Investigation (RFI) at the following Solid Waste Management Units (SWMUs):

- SWMU 12 - Mine Fill A (MFA)
- SWMU 13 - Mine Fill B (MFB)
- SWMU 16 - B146 Incinerator, and
- SWMU 19 - Pyrotechnic Test Area

This QAPP was approved by the United States Environmental Protection Agency (U.S. EPA) Region 5. The field program for SWMUs 13 and 16 was conducted in May 2003. The ground water and soils data from samples collected at SWMUs 13 and 16 have the following data gaps:

- Explosives (primarily RDX) contamination is not bounded in ground water at SWMU 13.
- Polychlorinated biphenyl (PCB) contamination is not bounded in soils near the Therminol boiler at SWMU 13.
- Explosives (primarily RDX) and volatile organics [primarily trichloroethane (TCE)] contamination is not bounded at SWMU 16.

SWMUs 12 and 13 both had similar contamination patterns for explosives in soil. The ground water data collected at SWMU 13 indicate a relationship between historical explosives contamination in soil and ground water explosives contamination. A review of these data shows that modifications are necessary to the monitoring well network at SWMU 12 to more completely delineate anticipated explosives contamination in ground water during the initial round of ground water monitoring well installation and sampling.

This document, QAPP Addendum No. 1, addresses the following:

- SWMU 12 (Mine Fill A) – Modification of the ground water monitoring well network to delineate the extent of explosives contamination and determine whether explosives are naturally degrading in ground water.

- SWMU 12 - Complete delineation of soils contamination at Battery Site Area.

- SWMU 13 – Round 2 monitoring well installation and ground water, surface water, and sediment sampling to further delineate the extent of explosives contamination and determine whether explosives may be naturally degrading.

- SWMU 13 – Collection of additional soil, ground water, surface water, and sediment samples to complete the delineation of PCB contamination in the Therminol boiler area.

- SWMU 16 – Round 2 monitoring well installation and sampling to further delineate the extent of ground water contamination and determine whether explosives and chlorinated organics are naturally degrading in ground water.

- Modification of analytical program at SWMU 12, 13, and 16 based on the results of Round 1 monitoring at SWMUs 13 and 16.

This QAPP Addendum No. 1 generally does not repeat information already provided in the approved QAPP. Site-specific geologic and hydrogeologic information collected at SWMUs 13 and 16 during Round 1 field activities is presented. Ground water, soils, sediment, and surface water data collected at SWMUs 13 and 16 are summarized and presented. The Navy conducted an interim removal action at the Battery Disposal Site, which is associated with SWMU 12. Confirmation sampling results indicated that soils contamination may not have been adequately delineated. Information regarding the Battery Disposal Site is presented in this QAPP Addendum No. 1 to serve as the basis for additional sampling at the Battery Disposal Site. The entire sampling and analysis plan is presented in Section 3.0, rather than incorporation of change pages by reference. This was done so that all field procedures would be contained in one document.

1.1 RECENT ACTIVITIES

This section provides a summary of recent field investigations conducted at SWMUs 13 and 16, and the interim measure activity conducted at SWMU 12.

1.1.1 SWMU 12 Battery Disposal Site Interim Measure Activity

The SWMU 12 Battery Site is located on the south end of the MFA approximately 140 feet outside the perimeter fence and is accessed through a gate (See Figure 1-1). The site consists of two areas:

(1) Battery Area - where batteries were dumped on the ground surface; and (2) Soil Area - an adjacent area where soil and construction debris was dumped in small mounds (see Inset A of Figure 1-1).

The Battery Site was discovered early in the 1990s. Further investigation revealed the presence of the battery disposal area. At that time, the batteries were recognizable as AA household type and their numbers were all but unrecognizable and only their inner cores were visible on the ground surface. The size of the Battery Area was approximately 3,500 square feet.

The Soil Area had no apparent unusual characteristics: no staining was present and no odor was detectable. A reasonable assumption was made by personnel from the NSWC Crane Environmental Protection Department that the mounded soil in the Soil Area originated from within MFA, possibly from the installation of road culverts. The size of the Soil Area was approximately 2,355 square feet consisting of several soil mounds, none exceeding four feet in height.

1.1.1.1 Investigative Soil Sampling

Pre-excavation samples (PES) were obtained for the Battery and Soil Areas prior to interim measure activity. Results of the pre-excavation sampling activities at each area are discussed below.

Battery Area

At the Battery Area, five metals (manganese, zinc, cadmium, chromium, and lead) were detected above residential screening levels but below industrial screening levels and three (arsenic, manganese, and lead) were detected above industrial levels. The levels of cadmium, chromium, lead, and mercury were considered to be potentially toxic. None of the samples exhibited toxic characteristics for reactivity, corrosivity, or ignitability. All six Battery Area PES contained metals levels above industrial cleanup goals.

Soil Area

Two samples were contaminated with RDX above industrial cleanup goals. No other contaminants were detected above industrial cleanup goals in any other sample from the Soil Area.

1.1.1.2 Excavation and Disposal Activities

Excavation activities took place at the Battery and Soil Areas on September 27, 2001 and June 18, 2002. The areas of excavation are depicted on Inset B of Figure 1-1. A total of 236.91 tons of contaminated soil

in 12 loads were excavated to a depth of 18 inches at the Battery Area and delivered as non-hazardous special waste to the Waste Management Outer Loop Landfill in Louisville, Kentucky. Excavation of the remaining contaminated soil from the Battery Area was completed on June 18, 2002. A total of 58.97 tons of contaminated soil in four loads were excavated at that time and was delivered as non-hazardous special waste to the Waste Management Outer Loop Landfill in Louisville, Kentucky.

All surface contamination associated with the battery parts had been removed when dark brown to black soil was encountered on the west side of the excavation. The western boundary of the Battery Area is adjacent to an area of rubble consisting of large pieces of concrete, asphalt, and rock. The presence of the discolored soil was revealed when several large stones and concrete pieces were moved. This soil was not previously visible, did not contain any battery parts, and was not previously known to exist.

The two Soil Area mounds were excavated to 18 inches below grade on September 27, 2001 and hauled in a dump truck to the Biofacility. A total of 18.01 tons of soil was excavated from this area. This soil was eventually mixed into Windrow N-214 and processed to residential cleanup levels. Subsequent to processing at the Biofacility, Windrow N-214 was taken to MFB and used as backfill in the Permanent Placement Area.

1.1.1.3 Post-Excavation Sampling and Analysis

Post-excavation confirmatory soil samples (CFS) were obtained from the areas of excavation to document removal of contamination. All samples were grab samples obtained from the surface to 6 inches deep. The locations of CFS are shown in Inset B of Figure 1-1.

Soil Area

The explosive compounds TNT and HMX were detected below Residential cleanup goals. RDX was detected in one sample. Residential cleanup goals were below Industrial cleanup goals.

Battery Area

Eleven samples were obtained from the excavation on September 28, 2001 (six excavation bottom samples and five sidewall samples). Eight samples were obtained from the excavation on June 18, 2002 (four excavation bottom samples and four sidewall samples). Arsenic was found to be above Residential cleanup goals but below industrial cleanup goals in four samples. Arsenic was above industrial cleanup goals in 15 samples. The analytical results for one sample indicated that the level of lead and cadmium could potentially exceed the toxic characteristic leaching procedure (TCLP) regulatory limit. A

subsequent TCLP analysis indicated that cadmium was below the TCLP regulatory level of 1.0 mg/kg. However, lead, detected at 58.8 mg/kg, was above the TCLP regulatory limit of 5.0 mg/kg.

1.1.2 SWMU 13 Field Investigation Activity

RFI field investigation activities were conducted at SWMU 13 from February through May 2003. The investigation at SWMU 13 included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, and sampling
- Water level measurements and aquifer testing
- Surface water/sediment sampling

Analytical data showing the results of all media sampling conducted at SWMU 13 are presented in Appendix A. A summary of positive hits data is also presented in Appendix A, whereas sample summary statistics are presented in Appendix B.

A brief summary of the field activities at SWMU 13 is provided below.

Surface/Subsurface Soil Sampling

A total of 15 surface soil samples were collected at SWMU 13. One surface soil sample was collected from each of the 15 soil borings at a depth of 0 to 2 feet below ground surface (bgs) using DPT methods, Rotosonic drilling, or hand augering. A total of 14 subsurface soil samples were collected from the 15 soil boring locations at SWMU 13. Subsurface samples were collected from a 2-foot interval from depths of 2 to 10 feet bgs using DPT methods, Rotosonic drilling, or hand augering. Refusal was encountered at soil boring 13SB14 before reaching the target depth for subsurface soil sample collection.

Monitoring Well Drilling, Installation, Development, and Sampling

Twenty-six monitoring wells (13MWT01 through 13MWT26) were installed at SWMU 13. One monitoring well boring (13MWT13) at SWMU 13 was drilled using the HSA method. Soil samples were collected continuously from the ground surface to the bottom of this well for lithologic characteristics only. The Rotosonic drilling technique was used to drill 25 borings into the bedrock. Continuous rock corings were collected from 12 borings for lithologic characteristics only. Monitoring wells at SWMU 13 ranged in depth from 15 to 30 feet bgs. Table 1-1 provides construction details for the monitoring wells.

After each boring was completed, a 2-inch diameter polyvinyl chloride (PVC) Schedule 40 well screen and riser pipe was lowered into the boring. All well screens were 10 feet in length with a slot size of 0.20 inch. All new monitoring wells at SWMU 13 were developed in accordance with SOP CTO166-12 as described in Appendix H of the approved QAPP (TtNUS, 2003).

Twenty-eight ground water samples were collected at SWMU 13. The 26 new wells were sampled, and monitoring wells 13MWT09 and 13MWT20 were sampled a second time for semivolatile organic compounds (SVOCs) only due to low surrogate recoveries encountered at the laboratory.

Water Level Measurements and Aquifer Testing

Water level measurements were collected from the SMWU 13 monitoring wells on May 5 and 11, 2003 (see Table 1-1). Ten staff gauges were also installed at SWMU 13, and water levels were measured at these gauges during the May 11 round and the data used to determine the ground water flow direction. Slug tests were performed in eight monitoring wells at SWMU 13.

Surface Water/Sediment Sampling

Samples were collected from all 13 proposed surface water sample locations at SWMU 13. Twenty-three sediment samples were collected at SWMU 13. Originally, 22 locations were proposed. Sample location 13SD23 was added based on field observations (an additional culvert located near the northern corner of the site was discovered and sampled during the field investigation).

1.1.3 SWMU 16 Field Investigation

RFI field investigation activities were conducted at SWMU 16 from February through May 2003. The investigation at SWMU 16 included the following activities:

- Surface/subsurface soil sampling
- Monitoring well drilling, installation, development, repair, and sampling
- Water level measurements and aquifer testing
- Surface water/sediment sampling

Analytical data showing the results of all media sampling conducted at SWMU 16 are presented in Appendix C. A summary of positive hits data is presented in Appendix C.

A brief summary of the field activities at SWMU 16 is provided below.

Surface/Subsurface Soil Sampling

The DPT method was used to complete 36 soil borings at SWMU 16. DPT soil borings 16SB40 and 16SB41 at SWMU 16 were advanced to the bottom of their respective sumps (7 to 8 feet bgs). All other soil borings at SWMU 16 were advanced to refusal (1.5 to 6 feet bgs). The Rotosonic method was used to drill borings for the collection of three soil samples.

A total of 39 surface soil samples were collected from the 41 soil boring locations at SWMU 16. Two soil boring locations at SWMU 16 (16SB40 and 16SB41) did not require surface samples as described in the QAPP. A total of 25 subsurface soil samples were collected from the 41 soil boring locations at SWMU 16. Sixteen subsurface soil samples were unable to be collected due to refusal. The subsurface samples were collected from a 2-foot section within the interval of 2 to 8 feet bgs using DPT or Rotosonic methods.

Monitoring Well Drilling, Installation, Development, Repair, and Sampling

Five Rotosonic borings were drilled and converted into bedrock monitoring wells at SWMU 16. Continuous rock cores were collected from five of the SWMU 16 bedrock well borings for lithologic description purposes. One monitoring well boring was drilled at SWMU 16 using the HSA drilling method. This boring did not require any continuous sampling because an adjacent well was previously installed with continuous sampling.

The six monitoring wells (16MWT01 through 16MWT06) were installed at SWMU 16 to depths ranging from 18 to 39 feet bgs (see Table 1-3 for well construction information). Monitoring well 16MWT06 was installed to replace 16MWT01 due to its low ground water yield. During initial purging activities, 16MWT01 ran dry while being pumped at 200 milliliters per minute and recovered at a rate of 0.01 foot per hour, making it difficult to collect the required sample volume for laboratory analysis.

Five existing wells at SMWU 16 were sampled, inspected, repaired as needed, and redeveloped during RFI activities. The monitoring well repairs made at SWMU 16 included replacing the rusted lock and fixing the locking latch at existing monitoring well WES-14-03-83 and replacing the cement pad at monitoring well WES-14-04-83.

Thirteen ground water samples were collected at SWMU 16. Five of the new wells were sampled once, and one new well (16MWT06) was sampled twice. Monitoring well 16MWT06 was re-sampled for SVOCs only due to low surrogate recoveries encountered at the laboratory. Five existing monitoring wells were

sampled, and one existing monitoring well (WES-14-02-83) was sampled twice. Metals were re-sampled at WES-14-02-83 for statistical background comparison, and SVOCs were re-sampled at this well due to low surrogate recoveries encountered at the fixed-base laboratory.

Water Level Measurements and Aquifer Testing

Water level measurements were collected at SWMU 16 on May 5 and 30, 2003 (see Table 1-3). The May 30 water level measurements, which were considered most representative of static conditions because the wells were allowed to equilibrate prior to development and purging, were used to determine ground water flow direction. Staff gauges were not installed at SWMU 16 due to the lack of surface water. Slug tests were performed in three monitoring wells.

Surface Water/Sediment Sampling

Only three sump samples were collected at SWMU 16. The other four planned surface water sampling locations at SWMU 16 were dry and therefore, no samples were collected. These four locations were checked periodically, and no flow was observed at any time during the field investigation.

Nine of the proposed 11 sediment sample locations were collected at SWMU 16. Three sediment samples were proposed to be collected from the bottom of the three on-site sumps; however, no sediment was found inside any of these sumps. Sediment location 16SD02, which was intended to be sampled from inside the East Sump, was relocated to a nearby drainage ditch just east of the sump. In the past, the aforementioned ditch received discharge from the sump; however, the discharge to the ditch has since been blocked and redirected to the sewer system.

1.2 SWMU-SPECIFIC CHARACTERISTICS

The field investigation activities conducted at SWMUs 13 and 16 from February through May 2003 provided addition information regarding SWMU-specific topography, hydrology, geology, and hydrogeology as discussed in this section. New field investigation activities have not been conducted at SWMU 12. As a result, the reader is referred to the site-specific discussion for SWMU 12 found in the approved QAPP for Mine Fill A (SWMU 12), Mine Fill B (SWMU 13), Cast High Explosives Fill/B146 Incinerator (SWMU 16) and the Pyrotechnic Test Area (SWMU 19) (TtNUS, 2003).

1.2.1 SWMU 13, Mine Fill B

1.2.1.1 Topography/Hydrology

The topography at MFB consists of a ridge running parallel with Highway 45 in a northeast-southwest orientation with gradual slopes to the northwest across MFB and steeper slopes to the southeast into adjacent stream valleys (Figure 1-2). The ground surface elevations at the SWMU range from 661 feet in the southwest to a maximum of approximately 718 feet above mean sea level (amsl) in the northeastern corner near 13MWT03.

Several man-made ditch systems located in the southern, eastern, and northern portions of the site, labeled 1, 2, and 3, respectively on Figure 1-2, convey surface water runoff toward larger tributaries. Ditch systems 1 and 2 ultimately discharge into Turkey Creek east of SWMU 13, and ditch system 3 conveys runoff water towards Boggs Creek to the west. Intermittent streams originating in the central portion of the site flow westward towards stream systems 1, 2, 3, and 4, which ultimately drain into Boggs Creek. Intermittent stream systems 5 and 6, east of Highway 45, flow southeastward and convey water towards Turkey Creek. Ditch systems are defined as man-made controls to divert surface water runoff, whereas stream systems are naturally occurring.

Surface water flow estimates were made based on visual observations during surface water sample collection. It was estimated that stream systems flowed at rates ranging from of 1 to 50 gallons per minute (gpm), and ditch systems flowed at rates of less than 1 to 5 gpm.

1.2.1.2 Geology

The shallow subsurface materials encountered at MFB included fill, natural unconsolidated materials, and bedrock. A description of each of the subsurface materials is included in this section. The maximum depth of investigation at this SWMU was 30 feet bgs (13MWT18).

Fill was encountered in various borings to a maximum depth of 6 feet bgs. In some cases, the fill came into contact with bedrock. Fill material was found in several borings installed near the railroad tracks in the western portion of the SWMU (13MWT12 and 13MWT17) and in borings located near buildings (13MWT02) and areas of excavation (13MWT19 and 13MWT20). The fill material included cinders, gravel, sand, and sandstone fragments. Natural unconsolidated materials, referred to as residual soils of the Raccoon Creek Group, underlie the fill, exist at the ground surface where the fill is not present, and extend to depths of up to 13 feet bgs. The natural unconsolidated materials are predominantly fine-grained, including varying amounts of clay, silt, and sand.

Pennsylvanian bedrock was encountered beneath natural unconsolidated materials and fill and consists of discontinuous layers of siltstones, sandstones, shales, and coal seams. Fractures found in the bedrock were horizontal bedding plane fractures. The Pennsylvanian bedrock beneath SWMU 13 is estimated to be 155 to 205 feet in thickness and to dip to the southwest at approximately 10 to 15 feet per mile (Barnhill, 1993). The bedrock dips towards a paleovalley that lies east of the site. The contact between the Pennsylvanian and underlying Mississippian bedrock at SWMU 13 is estimated to be at an elevation of 500 to 550 feet amsl, roughly 168 to 218 feet bgs.

Figure 1-3 shows the locations of three hydrogeologic cross sections through SWMU 13. Figures 1-4, 1-5, and 1-6 are hydrogeologic cross sections A - A", B - B', and C - C'; respectively.

1.2.1.3 Hydrogeology

The field investigation focused on shallow ground water beneath SWMU 13, which exists in the bedrock and was not found in either fill or the native soils. Shallow ground water is believed to be confined to semi-confined at the MFB site. During drilling activities, ground water was encountered at depths ranging from approximately 7 to 22 feet bgs. Ground water elevations in completed wells rose above the depth at which ground water was encountered in 19 of 26 wells installed (73 percent). The static depth to ground water during Round 1 ranged from 0.5 feet bgs in low-lying areas at 13MWT07 (see Figure 1-1) to 17 feet bgs in the higher elevations to the north at 13MWT02 (see Figure 1-2).

Shallow ground water flow directions were established based on water level and staff gauge measurements collected on May 11, 2003 (Table 1-1 and Figure 1-2). Water elevations from staff gauges located in ditches that were not hydraulically connected to the bedrock ground water flow system were not considered during preparation of the potentiometric surface map.

In general, ground water flows from two high points at the site. Ground water in the northeastern corner of the site flows primarily to the northwest across the site, ultimately discharging into stream systems 1 and 2, which convey water further to the northwest towards Boggs Creek. A smaller component of ground water flows to the south and southeast towards stream system 6, which conveys water southeast beneath Highway 45.

Shallow ground water also flows radially in all directions from a high point in the southern portion of the site in the vicinity of 13MWT20 (see Figure 1-2). Southern and eastern ground water flow components flow toward southeastern ditch system 2 and stream system 5, which convey surface water beneath

Highway 45. Northern and western ground water flow across the site discharges into stream systems 2, 3, and 4, which convey surface water to the northwest.

Based on slug test results (see Table 1-2), the geometric mean hydraulic conductivity (K) for bedrock aquifer wells tested at SWMU 13 is approximately 0.28 feet per day (1×10^{-4} cm/sec). Hydraulic gradients across the site were calculated from ground water elevations as shown on Figure 1-1. The average hydraulic gradients across the western and eastern parts of the site were estimated to be 0.063 and 0.037, respectively. Assuming a fracture-related porosity of about 0.005 for the bedrock, average ground water velocities were then calculated to be approximately 3.53 feet/day and 2.10 feet/day for the western and eastern parts of the site.

1.2.2 SWMU 16 – B146 Cast High Explosives Incinerator

1.2.2.1 Topography/Hydrology

The topography at SWMU 16 is relatively flat with slopes to the east, south, and west. The elevation of the ground surface ranges from 715 feet in the southeast portion of the SWMU to a maximum of approximately 766 feet amsl in the south near WES-14-05-83 (see Figure 1-7). Ditch systems 1 and 2 (see Figure 1-7), located in the northern portion of the site, and systems 3 and 4 located in the southern portion of the site were dry and showed only minor pooling during storm events. Surface runoff encountered during storm events flows across the site to the south, east, and west and into these ditch systems, which ultimately discharge surface water into Turkey Creek.

1.2.2.2 Geology

The encountered subsurface materials consisted of natural unconsolidated materials and bedrock. Natural unconsolidated materials, identified as residual soils of the Raccoon Creek Group, overlie the bedrock. The natural unconsolidated materials are predominantly fine-grained, including varying amounts of clay, silt, and sand. The natural unconsolidated materials extend to up to 8.5 feet bgs, where Pennsylvanian bedrock was encountered. The maximum depth of investigation for this SWMU was 46 feet bgs at WES-14-04-83 (see Figure 1-7).

The Pennsylvanian bedrock consists of siltstones, sandstones, shales, and coal seams. The layers of siltstone and sandstone encountered did not show any lateral continuity; however, the shale layers and coal seams were somewhat continuous. Bedding plane fractures were observed in the bedrock. The Pennsylvanian bedrock beneath SWMU 16 is estimated to be 122 to 134 feet in thickness and dip generally to the southwest at approximately 7 feet per mile (Barnhill, 1993). The contact between the

Pennsylvanian and underlying Mississippian bedrock is estimated to be 640 to 650 feet amsl, roughly 126 to 136 feet bgs (Barnhill, 1993).

Figure 1-8 illustrates the locations of hydrogeologic cross sections through SWMU 16. Borings shown on these figures consist of those installed by TtNUS, as well as borings installed by the United States Army Corps of Engineers (USACE). Figures 1-9 and 1-10 are hydrogeologic cross sections A - A' and B - B', respectively.

1.2.2.3 Hydrogeology

Ground water is present beneath SWMU 16 in bedrock but was not found in the unconsolidated overburden. Ground water was encountered at depths as shallow as 9 feet bgs in low-lying areas (16MWT02) and to depths greater than 30 feet in wells located at higher elevations to the south (16MWT05, WES-14-01-83, WES-14-05-83, and WES-14-04-83). The referenced wells are shown in Figure 1-8.

The shallow ground water flow direction was determined based on water levels collected on May 30, 2003 (Table 1-3). The potentiometric surface map can for SWMU 16 is provided as Figure 1-7. Ground water elevations indicate that shallow ground water predominantly flows in a southwestward direction, ultimately discharging into Turkey Creek southwest of the site (Figure 1-7).

Monitoring well 16MWT01 was not used in developing the SWMU 16 potentiometric surface map. The potentiometric surface elevation for 16MWT01 was approximately 6.78 feet lower than adjacent well 16MWT06. An evaluation of fracturing encountered during drilling activities showed that less frequent fracturing exists in 16MWT01 compared to 16MWT06 and other wells at the site. A very low ground water yield was noted during purging and development of 16MWT01, which may explain the lower water level elevations in this well.

Based on slug test results (see Table 1-2), the geometric mean K for bedrock aquifer wells tested at SWMU 16 is approximately 1.40 feet per day (4.95×10^{-4} cm/sec). The hydraulic gradient across the site was calculated from ground water elevations as shown on Figure 1-7, with the average hydraulic gradient estimated to be 0.05. Assuming a fracture-related porosity of about 0.005 for the bedrock, the ground water velocity was then approximated to be 14 feet per day.

1.3 ANALYTICAL RESULTS

The Round 1 analytical results for SWMUs 13 and 16 are briefly described below. No data were collected in Round 1 for SWMU 12. Because this QAPP Addendum No. 1 is focused on a Round 2 sampling effort that may be followed by additional sampling and analyses, the level of effort expended on descriptions of field activities and analytical results was sufficient only to identify data gaps and to prepare for the second round of work. More detailed descriptions of field activities and analytical results will be provided in the RFI report that will be written upon completion of the field work described in this QAPP Addendum.

1.3.1 SWMU 13, Mine Fill B

Concentrations for a few of the more prominent contaminants in soil and ground water are used in the following discussions to show the spatial contamination patterns in those environmental media. The contamination in these media was the main driving force for the Round 2 sampling effort at SMWU 13. Contamination in surface water and sediment was less significant, although it was evaluated during planning for the Round 2 sampling. A Round 1 positive hits data set and frequencies of detection are provided in Appendices A and B, respectively, for all media sampled at SWMU 13. In the positive hits table, all data for any chemicals detected at least once are presented. Chemicals that were not detected in any sample are not included in the table.

Surface Soil

A total of 15 surface soil samples were collected at SWMU 13 in Round 1. Analyses for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), dioxins, PCBs, and miscellaneous parameters were conducted on all or some of those samples. Figure 1-11 presents the results of Round 1 surface soil sampling at SWMU 13 for PCBs. Only Aroclor-1248 was detected. The Aroclor-1248 concentration exceeds 10 ppm at 5 of the 15 sampling locations, and the greatest concentrations are associated with the southwestern boiler area. The concentrations of other chemicals in surface soil appear to represent little to no risk to humans or ecological receptors, based on a comparison to risk-based criteria.

Subsurface Soil

A total of 14 subsurface soil samples were collected in Round 1 from the 15 soil borings at SWMU 13. Analyses for VOCs, SVOCs, dioxins, PCBs, and miscellaneous parameters were conducted on all or some of those samples. Refusal was encountered at soil boring 13SB14 before reaching the target depth for subsurface soil sample collection. Figure 1-12 presents the results of Round 1 subsurface soil

sampling at SWMU 13 for PCBs. Figures 1-11 and 1-12, when viewed together, show that the PCB contamination generally decreases with depth in the soil, although at least one subsurface sample still had over 210,000 µg/kg of PCBs. Several samples on the perimeter of the sampling pattern had PCB concentrations in excess of risk-based screening levels. The concentrations of other chemicals in subsurface soil appear to represent little to no risk to humans or ecological receptors, based on a comparison to risk-based criteria.

The lateral and vertical extent of PCB contamination near the Therminol boilers was not adequately delineated during Round 1. Based on PCB concentration profiles at the other locations and an operational history of likely surface releases from spilled oil containing PCBs, PCB concentrations in the Therminol boiler area are expected to decrease with depth.

Surface Water

Thirteen surface water samples were collected at SWMU 13 in Round 1. Analyses for SVOCs, explosives, and metals were conducted on these samples. Except for explosives, chemical concentrations were generally low as compared to risk-based criteria and the chemicals were detected infrequently. HMX and/or RDX appeared at concentrations exceeding 10 µg/kg at locations 13SW02, 13SW10, 13SW11, 13SW12, and 13SW13, otherwise the concentrations of these chemicals were approximately 5 µg/kg or less, HMX and RDX were not detected in 8 of 13 samples. The greatest HMX and RDX concentrations were observed at location 13SW11 (RDX = 610 µg/kg; HMX = 93 µg/kg). The concentrations of these chemicals appear to correlate spatially.

HMX and RDX appear to be the most wide spread surface water contaminants, and they exhibit the greatest levels of contamination relative to their risk-based evaluation criteria. These contaminant patterns indicate that explosives contamination in surface water at SWMU 13 was not adequately delineated in the Round 1 field effort.

Sediment

Twenty-three sediment samples were collected in Round 1 at SWMU 13. Originally, 22 locations were proposed, and sample location 13SD23 was added based on field observations (an additional culvert located near the northern corner of the site was discovered and a sampled during the field investigation).

Analyses for explosives, and metals were conducted on these sediment samples. SVOC analyses were conducted on samples 13SD0401, 13SD0501, and 13SD0601. Unlike surface water samples, the

sediment samples did not contain significant levels of explosives contamination. The highest explosives concentration detected was RDX (2.2 mg/kg) at location 13SW11. Concentrations of three industrial metals (e.g., cadmium, copper, lead) appeared to be elevated at one or more locations (e.g., 13SD01, 13SD13, 13SD19, 13SD20 and 13SD22) when compared to typical NSWC Crane background concentrations (TtNUS, 2001). Metals contamination was not completely delineated in sediments during Round 1. Additional, limited sapling in drainage channels would help to bound PAH contamination.

Ground Water

Twenty-eight ground water samples were collected at SWMU 13 during Round 1. All 26 new wells were sampled and monitoring wells 13MWT09 and 13MWT20 were sampled again for SVOCs only due to low surrogate recoveries encountered at the laboratory. Results of the Round 1 ground water sampling at SWMU 13 are presented in Figures 1-13 through 1-16.

Analyses for SVOCs, VOCs, explosives, and metals were conducted on these ground water samples. As shown on Figures 1-13 and 1-14, total arsenic and lead concentrations are greatest in the southwestern perimeter wells 13MWT22 and 13MWT25. RDX concentrations (Figure 1-15) are greatest in areas that are generally downgradient of where mine filling operations occurred. The greatest RDX concentrations are associated with interior well 13MWT08, and the northwestern perimeter wells 13MWT11 and 13MWT21. These concentrations are substantially higher than the 0.61 µg/L risk-based screening value for RDX. The concentrations of 2,4,6-trinitrotoluene (TNT) are elevated in the same general areas as RDX, although the TNT concentrations are much lower (Figure 1-16). These contamination patterns are consistent with the site history and known or expected contaminant release mechanisms. The observed contaminant concentrations indicate that the extent of ground water contamination was not adequately delineated in Round 1 for explosives and metals.

1.3.2 SWMU 16, Cast High Explosives Fill

Concentrations of a few of the more prominent contaminants in soil and ground water are used in the following discussions to represent the spatial contamination patterns in those environmental media. The contamination in these media was the main driving force for the Round 2 sampling effort at SMWU 16. Contamination in surface water and sediment was less significant, although it was evaluated during planning for the Round 2 sampling. A Round 1 positive hits data set and frequencies of detection are provided in Appendices C and D, respectively, for all media sampled at SWMU 16. In the positive hits table, all data for any chemicals detected at least once are presented. Chemicals that were not detected in any sample are not included in Appendix C.

Surface Soil

A total of 39 surface soil samples were collected in Round 1 from the 41 soil boring locations at SWMU 16. Some or all of these samples were analyzed for VOCs, SVOCs, explosives, dioxins and furans, metals, PCBs and miscellaneous parameters. Surface soil samples were not collected from two soil boring locations at SWMU 16 (16SB40 and 16SB41). Surface and subsurface dioxin and furan concentrations were similar in comparison, with relatively few detections overall. The same is true the other organic chemicals, with the exception of polycyclic aromatic hydrocarbon (PAHs) in surface soil at location 16SS09 (Refer to Appendices C and D). Some metal concentrations, e.g., lead at locations 16SB14 (1,240 mg/kg) and 16SB20 (765 mg/kg) and zinc at locations 16SB13 through 17 (438 to 1,560 mg/kg) and 16SB21 (2,510 mg/kg) were high in comparison to typical background concentrations (TtNUS, 2001). Based on these data, surface soil contamination has not been completely delineated for select metals.

Subsurface Soil

A total of 27 subsurface soil samples were collected from the 41 soil boring locations at SWMU 16. Some or all of these samples were analyzed for VOCs, SVOCs, explosives, dioxins and furans, metals, PCBs and miscellaneous parameters. Sixteen subsurface soil samples could not be collected due to the limited soil thickness at these locations. The subsurface samples generally exhibited organic chemical concentrations similar to surface soils although 1,2-cis-dichloroethene and trichloroethene (TCE) concentrations at location 16SB39 were relatively high (200 µg/kg and 280 µg/kg, respectively). Metal concentrations appear to be consistent with subsurface soil background metal concentrations.

Surface Water

Three samples of surface water from sumps were collected at SWMU 16 in Round 1. The other four proposed surface water locations at SWMU 16 were dry and therefore, no samples were collected. These four locations were checked periodically, and no flow was observed at any time during the field investigation.

The explosives HMX and RDX exhibited the greatest levels of contamination relative to their risk-based evaluation criteria. The greatest RDX and HMX concentrations were observed in sump sample 16SW01 (RDX = 88,000 µg/L and HMX = 29,000 µg/L). Most other RDX and HMX concentrations were below detectable levels. The observed contamination concentrations indicate that surface water contamination, if available, should be investigated further in drainage channels for potential migration.

Sediment

Nine of the proposed 11 sediment samples were collected at SWMU 16. Three sediment samples were proposed to be collected from the bottom of the three on-site sumps; however, no sediment was found inside any of these sumps. Sediment location 16SD02, which was intended to be inside the East Sump, was relocated to a nearby drainage ditch just east of the sump. In the past, the aforementioned ditch received discharge from the sump; however, the discharge to the ditch has since been blocked and redirected to the sewer system. Proposed sediment sampling locations 16SD01 and 16SD07 were associated with the North Sump and West Sump, respectively.

The sediment samples were analyzed for SVOCs, explosives, metals, and miscellaneous parameters. Select industrial metal concentrations (e.g., antimony and lead) were significantly greater than background concentrations and risk-based screening levels. These detections, along with the sampling locations, indicate that metals contamination was not adequately delineated in Round 1. The same is true of semivolatile organic contamination, especially polycyclic aromatic hydrocarbons (PAHs), which were present at concentrations greater than 50 µg/kg at two locations (16SD05 and 16SD11).

Ground Water

Thirteen ground water samples were collected at SWMU 16 in Round 1. All six new wells were sampled, and one new well (16MWT06) was sampled twice. Five existing monitoring wells were sampled and one existing monitoring well (WES-14-02-83) was sampled twice. Metals were re-sampled at WES-14-02-83 for statistical background comparison, and SVOCs were re-sampled at this well due to low surrogate recoveries encountered at the laboratory. Monitoring well 16MWT06 was re-sampled for SVOCs only due to low surrogate recoveries encountered at the laboratory.

The ground water samples were analyzed for VOCs, SVOCs, explosives, metals, and miscellaneous parameters. Most organic and many inorganic chemicals were not detectable or exhibited low concentrations (Refer to Appendices C and D). RDX and TCE are the primary site contaminants.

Ground water results for RDX and TCE contamination from Round 1 sampling at SWMU 16 are presented in Figures 1-17 and 1-18, respectively. RDX concentrations (Figure 1-17) are highest in the eastern and southern portions of this SMWU. The maximum TCE concentration was observed near the east sump in the northern portion of the SWMU (Figure 1-18). Well 16MWT06, which is within 20 feet of the sump, had a TCE concentration of 35,000 µg/L. All other ground water TCE concentrations were

orders of magnitude lower. Well 16MWT02, located just 10 feet away from well 16MWT06, had TCE at only 16 µg/L, but that well did not produce water very well and may not be representative of the associated water-bearing geologic unit. Overall, the contaminant distribution patterns are consistent with site operations (sumps containing TCE in the north and explosives storage and use in the central and eastern areas of the SWMU). Based on chemical concentrations that are much greater than risk-based criteria, this ground water contamination was not adequately bounded in Round 1.

1.4 PROJECT TARGET PARAMETERS AND RATIONALE FOR SELECTION

Key target parameters for SWMUs 12, 13, and 16 were selected based on historical activities and recent remedial activities (SWMU 12) and Round 1 sampling results (SWMU 13 and 16). Round 1 results from SWMU 13 were used to modify the analytical program for SWMU 12.

1.4.1 SWMU 12

The SWMU 12 operational history is presented in Section 1.3.2 of the approved QAPP (TtNUS, 2003). The primary contaminant release mechanisms are as follows:

- Explosives powders washed from roof tops onto surface soils
- Leakage of contaminants from sumps
- Direct discharge of contaminants from the wastewater treatment system drainage bypass line

These release mechanisms primarily affect surface soils, subsurface soils, and ground water (especially in locations near sumps). Contaminants in surface soils has migrated into the subsurface. Results of past sampling and analyses at select soil locations demonstrate that this has occurred. Contaminated surface soil also may migrate through erosion into site drainage channels and ultimately into Turkey Creek, which is adjacent to SWMU 12. Surface water may be contaminated via contact with contaminated surface soils and sediments. Ground water may be impacted by infiltration of contaminated water and the releases of contaminants from soil particles.

The chemicals or chemical mixtures potentially released at SMWU 12 fall primarily into two categories: metals and high explosives. Metals concentrations reported previously have not been cause for concern, but explosives concentrations were elevated in soils. The elevated explosives concentrations in soils have been reduced through the remediation activities performed to date. VOCs and SVOCs could also be a concern because of potential use at the unidentified asphalt pad (UAP).

Existing analytical methodologies are sufficient to quantify these chemicals in each of the environmental matrices of interest for delineation of the extent of contamination, comparison to risk-based screening criteria, and risk assessment. Refer to Table 1-4 for specific fixed-base laboratory analytical methodologies and corresponding target analyte lists and Table 1-5 for aqueous field test methods and detection limits. Thus, the following analytical scheme has been selected for specific media:

- Metals (surface and subsurface soils, surface water, sediments, and ground water) - Aluminum and other metals may have been released directly to surface or subsurface soils with subsequent migration to sediments, surface water, and ground water. Soil locations near the UAP Battery Disposal Area and in other areas will be targeted for metals analyses.

- Explosives - Nitroaromatics/nitramines (surface and subsurface soil, surface water, sediments, and ground water) - These compounds may have been released directly to surface or subsurface soils with subsequent migration to sediments, surface water, and ground water. Soils have been remediated to concentrations that are generally less than applicable industrial risk levels, and some soils were remediated to less than residential risk levels. Some exceptions do exist in locations where soil excavation was impeded by utilities and structures. Soils near the UAP and settling basins, Battery Disposal Area (and in other areas of the site) will be sampled and tested for explosives.

- Miscellaneous explosives and explosive degradation products (surface and subsurface soil, sediment, ground water and surface water) - Explosives, which are assumed to be present in soils, sediments, ground water, and surface water at SWMU 12, may be naturally degrading. It is believed that the best opportunity to detect them would be through the analysis of ground water because their short half-lives would result in significant concentration reductions in solid media. Therefore, explosives degradation products will be analyzed in surface water and ground water only.

- VOCs (subsurface soil) - VOCs may have been released to subsurface soils near the UAP and Battery Disposal Area; therefore, analyses for VOCs will be conducted on subsurface soil samples collected from that area.

- SVOCs (surface and subsurface soils, surface water, and sediments) - SVOCs, including PAHs, may have been released into soils and accumulated near the UAP. SVOCs may be present in soils at the Battery Disposal Area. The potential exists for migration toward downstream surface water drainages.

- General surface water and ground water quality parameters [dissolved oxygen, oxidation-reduction potential (ORP), pH, specific conductance, temperature, turbidity, and flow rate (surface water only)] - Information on general water-quality parameters is necessary to evaluate the overall quality of surface water in Turkey Creek tributaries and to provide information on contaminant mass flux (flow rate). This data is also useful in characterizing the ground water flow system. These measurements will be conducted in the field.

- Total organic carbon (TOC), cation exchange capacity (CEC), and pH (soils and sediments) - This provides information for use in corroborating the absence or presence of contamination and potential bioavailability.

- Grain size (sediment, surface soil, and subsurface soil) - This provides information for potential use in the Corrective Measures Study (CMS) and for comparison to background concentrations (for naturally occurring inorganics).

- Acid volatile sulfide/simultaneously extracted metals (AVS/SEM) (sediment) - This provides information for fate and transport of contaminants. AVS/SEM metals will be reported separately from total metals.

- Ammonia (surface water and ground water) - This parameter will be analyzed to determine the impact on surface water and ground water of ammonia that may be leaching from bioremediated soils.

- Nitrate plus Nitrite (ground water and surface water) - This will be analyzed to evaluate the impact of nitrate in ground water and surface water. Nitrate (including nitrite) is a degradation product of certain explosives.

- Chloride and sulfate (ground water) - Chloride is a product of chlorinated VOC degradation, and sulfate data are helpful when evaluating reducing conditions. These analyses will be performed only for ground water.

- Iron(+2), manganese(+2), and sulfide (ground water) - These parameters will be measured in the field to assist with the evaluation of the efficacy of natural attenuation processes.

Table 1-6 summarizes the analytical program for SWMU 12. Data used to determine the nature and extent of contamination will also be used to evaluate human health and ecological risk.

1.4.2 SWMU 13

The SWMU 13 operational history is presented in Section 1.3.3 of the approved QAPP. The primary contaminant release mechanisms are as follows:

- Explosive powders washed from roof tops onto surface soils
- Leakage of contaminants from sumps
- Direct discharge of contaminants from the wastewater treatment system drainage bypass line
- Leakage of oils containing PCBs from Therminol boilers

These deposition mechanisms primarily affect surface soils in locations near sumps, subsurface soils, and ground water. Results of past sampling and analyses at select soil locations demonstrate that contaminants in surface soils have migrated into the subsurface. Contaminated surface soil also may migrate as the result of erosion into site drainage channels and ultimately into Turkey Creek, which is adjacent to SWMU 13. Ground water has been impacted by infiltration of contaminated water from drains, sumps, and by releases of contaminants from soils. Subsurface soils have been shown to have released explosive contaminants into ground water (See Section 1.3 for a summary of Round 1 results). Surface water has been contaminated via ground water discharging along with contaminated surface soils and sediments.

The chemicals or chemical mixtures released at SMWU 13 generally fall into two categories: metals (aluminum) and high explosives (TNT, H-6, HBX, Tritonal, Composition B, and Tetrytol). Existing analytical methodologies are sufficient to quantify these chemicals in each of the environmental matrices of interest for delineation of the extent of contamination, comparison to risk-based screening criteria, and risk assessment. Refer to Table 1-4 for specific analytical methodologies and corresponding target analyte lists and Table 1-5 for field aqueous test methods and detection limits. The following is a discussion of the analytical scheme for Round 2 monitoring including rationales for the deletion of Round 1 analytes from the Round 2 analytical program.

- Metals (sediments, surface water, and ground water) - Aluminum and other metals may have been released directly to surface or subsurface soils with subsequent migration to sediments, surface water, and ground water. Past analyses of soils generally have not shown metals to be cause for concern; therefore, metals analyses will be confined to sediment, surface water, and ground water.

- Explosives - Nitroaromatics/nitramines (sediments, surface water, and ground water) - These compounds were released directly to surface and subsurface soils with subsequent migration to sediments, surface water, and ground water. Soils have been remediated to concentrations that are generally less than applicable industrial risk levels, and some soils were remediated to less than residential risk levels. Some exceptions do exist in locations where soil excavation was impeded by utilities and structures. Round 1 data did not demonstrate any need for additional investigations of explosives in soils; however, Round 1 data demonstrated that additional investigations of explosives in ground water is necessary to delineate the extent of contamination.

- Miscellaneous explosives and explosive degradation products (surface water and ground water) - Explosives present in ground water and other affected media may be naturally degrading. It is believed that the best opportunity to detect them would be through the analysis of ground water and surface water because short half-lives would result in significant concentration reductions in other media. Therefore, explosive degradation products will be analyzed in surface water and ground water during Round 2.

- VOCs - Prior to Round 1 sampling, VOCs were thought to have been potentially released directly to surface or subsurface soils near the Therminol boilers. Round 1 data for surface and subsurface soils and ground water did not indicate any need for further analysis of VOCs; therefore, VOC analyses will not be conducted.

- SVOCs - Prior to Round 1 sampling, SVOCs, including PAHs, were thought to have been potentially released directly to surface or subsurface soils near the Therminol boilers. Round 1 data did not indicate the need for any additional analysis of SVOCs in soils or ground water. Limited additional sampling for PAHs in drainage channels is warranted to bound PAHs in sediments.

- PCBs (surface and subsurface soils near the Therminol boilers) - Existing evidence shows that soils near the Therminol boilers are still contaminated with PCBs. These compounds are not very soluble in water, so water samples were not analyzed for PCBs. Round 1 data demonstrated that further investigation of PCBs in soil is necessary to complete the delineation of PCB contamination.

- Dioxins and furans - These chemicals could have been generated from combustion of PCB oil in the Therminol boilers. The chemicals would have been released via air dispersion to surface soil with migration into subsurface soil. Round 1 data for surface and subsurface soils did not indicate the need for any additional investigation of dioxins in soils.

- General surface water and ground water quality parameters [dissolved oxygen, ORP, pH, specific conductance, temperature, turbidity, and flow rate (surface water only)] - Information on general water-quality parameters is necessary to evaluate the overall quality of surface water in Turkey Creek tributaries surface water and to provide information on contaminant masses (flow rate). This data is also useful in characterizing the ground water flow system. These measurements will be made in the field.

- Ammonia (surface water and ground water) - This parameter will be analyzed to determine the impact on surface water and ground water of ammonia that may be leaching from bioremediated soils.

- Nitrate plus Nitrite (surface water and ground water) - This information is necessary to evaluate the impact of nitrate on ground water and surface water. Nitrates are degradation products of certain explosives.

- TOC, CEC, and pH (soils and sediments) - This provides information for use in corroborating the absence or presence of contamination and potential bioavailability. Adequate data were collected during Round 1, so no additional sampling for these parameters will occur in Round 2.

- Depositional environment and grain size (sediment) - This information can potentially be used in the CMS and for comparison to background concentrations (for naturally occurring inorganics). No surface or subsurface soil samples will be collected during Round 2.

- AVS/SEM - These tests will provide information for fate and transport. AVS/SEM metals results will be reported separately from total metals. Adequate data were collected during Round 1. No additional samples will be collected during Round 2.

- Iron(+2), manganese(+2), and sulfide (ground water) - These parameters will be measured in the field to assist with the evaluation of the efficacy of natural attenuation processes.

Table 1-6 provides the same information for SWMU 13. Data used to determine the nature and extent of contamination will also be sued to evaluate human health and ecological risk. Results from Round 1 sampling are discussed in Section 1.3.

1.4.3 SWMU 16

The SWMU 16 operational history is presented in Section 1.3.4 of the approved QAPP (TtNUS, 2003). The primary contaminant release mechanisms are as follows:

- Incinerator combustion exhaust released to the atmosphere
- Discharge of wastewater from sumps to surface drainages
- Releases from waste ash piles

These deposition mechanisms primarily affect surface soils, sediments, ground water, and surface water. Combustion products would settle on surface features and could be washed into drainage channels by overland flow and wind erosion. However, air migration is no longer a migration pathway of significance because the furnaces and ash piles have been removed. Results from past sampling and analyses, including Round 1 data, at select soil locations demonstrate that contaminants in surface soils have migrated into the subsurface. Contaminated surface soil also may migrate as the result of erosion into site drainage channels and ultimately into Boggs Creek, which is downgradient of SWMU 16. Ground water has been impacted by releases from the site, from infiltration of contaminated water discharges, and/or releases from contaminated soils. Surface water may be contaminated via contact with contaminated surface soils and sediments. Subsurface soils could release contaminants to ground water.

The chemicals or chemical mixtures potentially released at SMWU 16 generally fall into five categories: metals (aluminum, lead, cadmium, chromium, barium, and mercury), PCBs, PCB oxidation products (dioxins and furans), VOCs, and high explosives (Compositions A and B, HBX, and TNT). Existing analytical methodologies are sufficient to quantify these chemicals in each of the environmental matrices of interest for delineation of the extent of contamination, comparison to risk-based screening criteria, and risk assessment. Refer to Table 1-4 for specific analytical methodologies and corresponding target analyte lists and Table 1-5 for field aqueous test methods and detection limits. The following is a discussion of the analytical scheme for Round 2 monitoring, included in the discussions are rationales for the deletion of analytes in Round 2.

- Metals (surface soil, surface water, sediments, and ground water) - Metals have been released directly to surface soil and were thought to have possibly been released to subsurface soils with subsequent potential migration to sediments, surface water, and ground water. In Round 1 of the Phase III RFI, subsurface soil metals concentrations were comparable to background concentrations (TtNUS 2001), even in the shallow subsurface (refer to Appendix A, Tables A-1 and A-2). Therefore, metals will be analyzed in surface soil, surface water, sediment, and ground water in Round 2.

- Explosives - Nitroaromatics/nitramines (surface water, sediments, and ground water) -These compounds may have been released directly to surface or subsurface soils with subsequent migration to sediments, surface water, and ground water. Round 1 data indicate that explosives were released into ground water and that the extent of contamination has not been adequately delineated. Explosives were also detected in surface water and sediments. Therefore, ground water, surface water, and sediment samples will be analyzed for explosives in Round 2 to further delineate the extent of contamination.

- Picrates - Releases of picrates (ammonium picrate in particular) were initially a concern for all media because the relatively soluble picrates would exhibit good migration potential. Round 1 data did not show that picrates were present; therefore, picrates will not be analyzed during Round 2.

- Miscellaneous explosives and explosive degradation products (surface water and ground water) - Explosives present in ground water and other affected media may be naturally degrading. It is believed that the best opportunity to detect them would be through the analysis of ground water and surface water because short half-lives would result in significant concentration reductions in other media. Therefore, explosive degradation products will be analyzed in surface water and ground water during Round 2.

- VOCs (surface and subsurface soil, ground water, surface water, seeps, and sediment) - Contaminants released to soils in the 1980s or to sumps have migrated deeper to subsurface soils and ground water. Round 1 data indicated that VOCs released in soil have migrated into ground water, but little contamination was detected in other media (Refer to Appendices C and D). Therefore, VOCs in ground water samples will be collected during Round 2. Because surface water and sediment can become contaminated by ground water discharging through seeps, surface water, and sediment will also be analyzed for VOCs. Because elevated VOC concentrations were detected near soil boring 16SB39, soils will be analyzed for VOCs near 16SB39.

- SVOCs - Prior to Round 1 sampling, SVOCs, including PAHs, were thought to have been potentially released directly to surface or subsurface soils with subsequent migration to sediments, surface water, and ground water. Round 1 data generally did not show the presence of significant SVOC contamination; therefore, SVOCs will not be analyzed in Round 2 except for some limited sampling for PAHs in drainage channels designed to bound this contamination.

- PCBs - These compounds could have been released directly to surface or subsurface soils with subsequent migration to sediments. The PCBs are not very soluble in water and therefore have limited migration potential. Round 1 soil data did not show significant concentrations of PCBs. Therefore, PCBs will not be analyzed in Round 2.

- Dioxins and furans - These compounds may have been released directly to the air and would have settled on surface soil with limited migration potential. Round 1 soil data did not show significant concentrations of dioxins and furans; therefore, dioxins and furans will not be analyzed during Round 2.

- General surface water and ground water quality parameters [dissolved oxygen, ORP, pH, specific conductance, temperature, turbidity, and flow rate (surface water only)] -Information on general water-quality parameters is necessary to evaluate the overall quality of surface water in Turkey Creek tributaries surface water and provide information on contaminant masses (flow rate). This data is also useful in characterizing the ground water flow system. These measurements will be made in the field.

- Nitrate plus Nitrite (ground water and surface water) - This test is to evaluate the impact of nitrates on the ground water and surface water. Nitrates are degradation products of certain explosives.

- TOC, CEC, and pH (surface and subsurface soils and sediments) - This provides information for use in corroborating the absence or presence of contamination and potential bioavailability. Enough information was collected in Round 1 so that measurement of these parameters in Round 2 is unnecessary.

- Depositional environment and grain size (sediment, surface soil, and subsurface soil) - These observations provide information for potential use in the CMS and for comparison to background concentrations (for naturally occurring inorganics).

- AVS/SEM (sediment) - This test provides information for fate and transport. AVS/SEM metals results will be reported separately from total metals.

- Chloride and sulfate (ground water) - Chloride is a product of chlorinated VOC degradation, and sulfate data as helpful when evaluating reducing conditions.

- Iron(+2), manganese(+2), and sulfide (ground water) - These parameters will be measured in the field to assist with the evaluation of the efficacy of natural attenuation processes.

- Ethane, ethene, and methane (ground water) - These gases are used when evaluating the efficacy of natural attenuation process on degrading chlorinated organic compounds in ground water. This information will be useful for the CMS.

Table 1-7 provides the same information for SWMU 16. Data used to determine the nature and extent of contamination will also be used to evaluate human health and ecological risk. Results from Round 1 sampling are discussed in Section 1.3.

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA
PAGE 1 OF 2

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 11, 2003	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13MWT01	3/30/2003	1310541.574	3025015.943	713.10	715.34	15.00	5.00	15.00	708.10	698.10	Upper Pennyslvanian	6.21	709.13	5.82	709.52
13MWT02	3/29/2003	1310776.555	3024743.547	702.10	704.72	27.00	17.00	27.00	685.10	675.10	Upper Pennyslvanian	17.15	687.57	17.10	687.62
13MWT03	3/30/2003	1310240.946	3024891.661	718.34	721.10	15.00	5.00	15.00	713.34	703.34	Upper Pennyslvanian	8.79	712.31	8.88	712.22
13MWT04	3/30/2003	1310383.396	3024546.113	704.37	706.84	15.00	5.00	15.00	699.37	689.37	Upper Pennyslvanian	12.98	693.86	12.75	694.09
13MWT05	3/29/2003	1310758.927	3024380.025	693.61	696.44	16.00	6.00	16.00	687.61	677.61	Upper Pennyslvanian	5.42	691.02	4.13	692.31
13MWT06	4/7/2003	1309916.177	3024495.270	715.30	717.93	15.00	5.00	15.00	710.30	700.30	Upper Pennyslvanian	15.11	702.82	15.62	702.31
13MWT07	3/29/2003	1310539.322	3024094.128	684.38	687.22	15.00	5.00	15.00	679.38	669.38	Upper Pennyslvanian	3.12	684.10	3.10	684.12
13MWT08	3/30/2003	1310247.860	3024337.560	698.42	700.56	15.00	5.00	15.00	693.42	683.42	Upper Pennyslvanian	3.17	697.39	2.92	697.64
13MWT09	4/1/2003	1309662.066	3024049.030	703.29	705.90	20.00	10.00	20.00	693.29	683.29	Upper Pennyslvanian	7.74	698.16	7.40	698.50
13MWT10	3/27/2003	1309979.693	3024001.262	697.77	700.15	25.00	15.00	25.00	682.77	672.77	Upper Pennyslvanian	13.65	686.50	13.11	687.04
13MWT11	3/28/2003	1310233.721	3023750.087	679.76	682.29	15.00	5.00	15.00	674.76	664.76	Upper Pennyslvanian	7.87	674.42	7.00	675.29
13MWT12	3/27/2003	1310080.207	3023574.945	679.96	682.12	20.00	10.00	20.00	669.96	659.96	Upper Pennyslvanian	7.88	674.24	7.78	674.34
13MWT13	4/23/2003	1309441.270	3024163.605	699.28	701.98	19.00	8.00	18.00	691.28	681.28	Upper Pennyslvanian	3.62	698.36	3.18	698.80
13MWT14	3/31/2003	1309142.232	3024110.167	703.15	705.50	23.00	13.00	23.00	690.15	680.15	Upper Pennyslvanian	13.25	692.25	13.08	692.42
13MWT15	3/25/2003	1309565.518	3023717.803	694.27	696.65	25.00	15.00	25.00	679.27	669.27	Upper Pennyslvanian	12.88	683.77	12.63	684.02
13MWT16	3/27/2003	1309854.276	3023341.916	682.13	684.35	15.00	5.00	15.00	677.13	667.13	Upper Pennyslvanian	8.49	675.86	8.61	675.74
13MWT17	3/26/2003	1309605.272	3023123.966	690.68	693.01	18.00	8.00	18.00	682.68	672.68	Upper Pennyslvanian	8.70	684.31	8.09	684.92
13MWT18	3/26/2003	1309326.980	3023293.416	700.05	702.92	30.00	20.00	30.00	680.05	670.05	Upper Pennyslvanian	19.06	683.86	19.04	683.88
13MWT19	3/31/2003	1308893.971	3023834.565	703.10	705.82	19.00	9.00	19.00	694.10	684.10	Upper Pennyslvanian	8.31	697.51	6.80	699.02
13MWT20	4/1/2003	1309066.757	3023527.233	699.33	702.07	20.00	10.00	20.00	689.33	679.33	Upper Pennyslvanian	4.22	697.85	4.00	698.07
13MWT21	3/28/2003	1309391.009	3022916.218	688.37	690.74	15.00	5.00	15.00	683.37	673.37	Upper Pennyslvanian	7.69	683.05	7.34	683.40
13MWT22	3/28/2003	1308936.338	3022785.672	669.53	671.96	15.00	5.00	15.00	664.53	654.53	Upper Pennyslvanian	7.44	664.52	7.25	664.71
13MWT23	4/1/2003	1308708.016	3023245.117	696.66	699.14	22.00	11.50	21.50	685.16	675.16	Upper Pennyslvanian	7.45	691.69	7.17	691.97

TABLE 1-1

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 13 - MINE FILL B
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 11, 2003	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevation (feet amsl)	Depth to Water (feet btor)	Ground Water Elevation (feet amsl)
13MWT24	4/1/2003	1308397.230	3022916.484	691.33	693.93	22.00	12.00	22.00	679.33	669.33	Upper Pennyslvanian	8.45	685.48	8.23	685.70
13MWT25	3/28/2003	1308625.618	3022677.444	678.87	681.57	15.00	5.00	15.00	673.87	663.87	Upper Pennyslvanian	16.00	665.57	16.61	664.96
13MWT26	3/28/2003	1308232.686	3022690.142	684.86	687.49	20.00	10.00	20.00	674.86	664.86	Upper Pennyslvanian	9.10	678.39	8.93	678.58
STAFF GAUGES															
13SG01[2]	3/29/2003	1310836.894	3024771.436	698.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.73	896.82
13SG02[2]	3/29/2003	1310746.566	3024854.367	701.95	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.64	698.31
13SG03	3/29/2003	1309585.700	3024436.891	696.24	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	1.96	694.28
13SG04	3/29/2003	1309478.258	3024317.864	688.99	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	2.38	686.61
13SG05	3/29/2003	1309341.458	3024185.404	692.94	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	3.89	689.05
13SG06[2]	3/29/2003	1308991.982	3023849.675	704.88	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.37	702.51
13SG07[2]	3/29/2003	1308164.248	3022622.065	680.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.50	878.80
13SG08	3/29/2003	1308846.735	3022744.778	665.95	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	5.05	660.90
13SG09	3/29/2003	1309868.608	3023412.150	675.30	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	4.15	671.15
13SG10	3/29/2003	1310366.976	3023821.247	676.10	NA	NA	NA	NA	NA	NA	Upper Pennyslvanian	NA	NA	4.78	671.32

Notes:
1 = Total depth of boring, total depth of well may be less.
2 = Staff gauges contained perched water not hydraulically connected to the Upper Pennsylvanian Aquifer.
bgs = Below ground surface.
btor = Below top of riser/reference point.
amsl = Above mean sea level (NAVD88).
NA = Not applicable.

TABLE 1-2

SUMMARY OF SLUG TEST HYDRAULIC CONDUCTIVITY RESULTS
SWMU 13 - MINE FILL B AND
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

SWMU	Well	Hydraulic Conductivity			
		Falling Head Test (feet/day)	Rising Head Test (feet/day)	Average	
				(feet/day)	(cm/sec)
13	13MWT02	0.004	0.003	0.003	1.22E-06
	13MWT08	10.900	2.160	6.530	2.30E-03
	13MWT11	0.389	0.159	0.274	9.67E-05
	13MWT14	1.670	1.260	1.465	5.17E-04
	13MWT15	0.195	0.128	0.162	5.70E-05
	13MWT17	10.600	17.300	13.950	4.92E-03
	13MWT20	0.135	0.131	0.133	4.69E-05
	13MWT26	0.019	0.013	0.016	5.61E-06
	Geometric Mean =			**0.28**	**1.00E-04**
16	16MWT02	5.09	3.37	4.23	1.49E-03
	16MWT04	1.09	1.05	1.07	3.77E-04
	16MWT05	0.638	0.584	0.61	2.16E-04
	Geometric Mean =			**1.40**	**4.95E-04**

TABLE 1-3

MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS
SWMU 16 - CAST HIGH EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (feet)	Easting (feet)	Ground Elevation (feet amsl)	Top of Riser Elevation (feet amsl)	Total Depth (feet bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 30, 2003	
							Top (feet bgs)	Bottom (feet bgs)	Top (feet amsl)	Bottom (feet amsl)		Depth to Water (feet btor)	Ground Water Elevaton (feet amsl)	Dept to Water (feet btor)	Ground Water Elevaton (feet amsl)
16MWT01	4/8/2003	1321193.488	3032881.285	762.02	764.50	24.00	14.00	24.00	748.02	738.02	Upper Pennyslvanian	25.19	739.31	22.7	741.80
16MWT02	4/11/2003	1321146.42	3032559.16	757.60	760.36	18.00	8.00	18.00	749.60	739.60	Upper Pennyslvanian	6.55	753.81	12.18	748.18
16MWT03	4/10/2003	1320946.968	3032644.291	761.95	764.41	35.00	25.00	35.00	736.95	726.95	Upper Pennyslvanian	27.20	737.21	28.07	736.34
16MWT04	4/9/2003	1321003.281	3032946.466	763.88	766.14	25.00	15.00	25.00	748.88	738.88	Upper Pennyslvanian	8.05	758.09	13.14	753.00
16MWT05	4/9/2003	1320741.793	3032812.772	764.50	766.88	40.00	29.00	39.00	735.50	725.50	Upper Pennyslvanian	29.77	737.11	30.39	736.49
16MWT06	4/24/2003	1321199.519	3032883.373	761.77	764.44	25.00	15.00	25.00	746.77	736.77	Upper Pennyslvanian	22.33	742.11	15.92	748.52
WES-14-01-83	1983	1320638.353	3032713.383	763.87	766.67	50.70	35.80	45.30	728.07	718.57	Upper Pennyslvanian	31.00	735.67	31.00	735.67
WES-14-02-83	1983	1321319.899	3032647.27	763.69	766.54	25.80	11.35	20.39	752.34	743.30	Upper Pennyslvanian	14.23	752.31	14.56	751.98
WES-14-03-83	1983	1320816.004	3033018.495	761.51	763.93	35.40	20.88	29.99	740.63	731.52	Upper Pennyslvanian	18.80	745.13	19.83	744.10
WES-14-04-83	1983	1320572.345	3032960.959	760.42	762.99	46.00	31.38	40.47	729.04	719.95	Upper Pennyslvanian	26.80	736.19	27.27	735.72
WES-14-05-83	1983	1320584.051	3032850.321	766.60	769.40	50.70	35.80	45.25	730.80	721.35	Upper Pennyslvanian	32.59	736.81	33.05	736.35

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
EXPLOSIVES (SW-846 8330)										
1,3,5-Trinitrobenzene	99-35-4	µg/L	0.5	0.25	1100	mg/kg	0.5	0.25	0.25	0.000121
1,3-Dinitrobenzene	99-65-0	µg/L	0.5	0.25	2.36	mg/kg	0.5	0.25	0.00096	0.000924
2,4,6-Trinitrotoluene	118-96-7	µg/L	0.5	0.25	2.2	mg/kg	0.5	0.25	0.00057	NA
2,4-DA-6-NT	6629-29-4	µg/L	0.5	0.25	2.2	mg/kg	NA	NA	4700	4700
2,4-Dinitrotoluene	121-14-2	µg/L	0.5	0.25	73	mg/kg	0.5	0.25	0.000049	0.07513
2,6-DA-4-NT	59229-75-3	µg/L	0.5	0.25	2.2	mg/kg	NA	NA	4700	4700
2,6-Dinitrotoluene	606-20-2	µg/L	0.5	0.25	36	mg/kg	0.5	0.25	0.000042	0.02062
2-Amino-4,6-dinitrotoluene	35572-78-2	µg/L	0.5	0.25	NA	mg/kg	0.5	0.25	NA	NA
2-Nitrotoluene	88-72-2	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.15	NA
3,5-DNA	618-87-1	µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
3-Nitrotoluene	99-08-1	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.3	NA
DNX		µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	19406-51-0	µg/L	0.5	0.25	NA	mg/kg	0.5	0.25	NA	NA
4-Nitrotoluene	99-99-0	µg/L	0.5	0.25	61	mg/kg	0.5	0.25	0.15	NA
HMX	2691-41-0	µg/L	0.5	0.25	1800	mg/kg	0.5	0.25	3100	NA
MNX		µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
Nitrobenzene	98-95-3	µg/L	0.5	0.25	3.4	mg/kg	0.5	0.25	0.006	0.4876
RDX	121-82-4	µg/L	0.5	0.25	0.61	mg/kg	0.5	0.25	4.4	NA
Tetryl	479-45-8	µg/L	0.5	0.25	360	mg/kg	0.5	0.25	610	NA
TNX		µg/L	0.5	0.25	NA	mg/kg	NA	NA	NA	NA
4,4-'TN-AZOXY		µg/L	1.0	0.65	NA	mg/kg	0.5	0.25	NA	NA
HERBICIDES (SW-846 8151)										
Hexachlorophene	70-30-4	µg/L	0.05	0.025	0.228	µg/kg	1.7	0.85	18000	198.78
Pentachlorophenol	87-86-5	µg/L	0.027	0.013	0.56	µg/kg	0.9	0.45	1.4	119.27

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
METALS (SW-846 6010B)										
Aluminum	7429-90-5	µg/L	50	6.8	50	mg/kg	25	3.4	76000	NA
Antimony	7440-36-0	µg/L	1	0.02	6	mg/kg	0.5	0.01	0.27	0.1423
Arsenic	7440-38-2	µg/L	1	0.03	0.045	mg/kg	0.5	0.015	0.29	5.7
Barium	7440-39-3	µg/L	1	0.04	2000	mg/kg	0.5	0.02	82	1.04
Beryllium	7440-41-7	µg/L	1	0.03	4	mg/kg	0.5	0.015	32	1.06
Cadmium	7440-43-9	µg/L	1	0.04	0.66	mg/kg	0.5	0.02	0.38	0.00222
Calcium	7440-70-2	µg/L	100	3.96	NA	mg/kg	50	1.98	NA	NA
Chromium	7440-47-3	µg/L	1	0.02	42	mg/kg	0.5	0.01	2	0.4
Cobalt	7440-48-4	µg/L	1	0.02	5	mg/kg	0.5	0.01	900	0.14033
Copper	7440-50-8	µg/L	2	0.06	5	mg/kg	1	0.03	560	2.96
Iron	7439-89-6	µg/L	50	2.22	300	mg/kg	25	1.11	23000	NA
Lead	7439-92-1	µg/L	1	0.02	1.3	mg/kg	0.5	0.01	81	0.05373
Magnesium	7439-95-4	µg/L	100	2	NA	mg/kg	50	1	NA	NA
Manganese	7439-96-5	µg/L	5	0.04	50	mg/kg	2.5	0.02	110	NA
Mercury	7439-97-6	µg/L	0.2	0.02	0.0013	mg/kg	0.1	0.002	0.1	0.073
Nickel	7440-02-0	µg/L	1	0.06	29	mg/kg	0.5	0.03	48	13.6
Potassium	7440-09-7	µg/L	100	4.325	NA	mg/kg	50	2.1625	NA	NA
Selenium	7782-49-2	µg/L	1	0.04	5	mg/kg	0.5	0.02	0.26	0.02765
Silver	7440-22-4	µg/L	1	0.03	1	mg/kg	0.5	0.015	1.6	0.5
Sodium	7440-23-5	µg/L	100	4.637	NA	mg/kg	50	2.3185	NA	NA
Thallium	7440-28-0	µg/L	1	0.04	0.56	mg/kg	0.5	0.02	0.04	0.05692
Tin	7440-31-5	µg/L	10	0.09	73	mg/kg	5	0.045	47000	7.62
Titanium	7440-32-6	µg/L	5	0.06	NA	mg/kg	2.5	0.03	NA	NA
Vanadium	7440-62-2	µg/L	2	0.05	19	mg/kg	1	0.025	260	1.59
Zinc	7440-66-6	µg/L	10	0.32	58.9	mg/kg	5	0.16	680	6.62

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
AVS/SEM										
AVS		NA	NA	NA	NA	µmoles/gm	0.008	0.008	NA	NA
Cadmium	7440-43-9	NA	NA	NA	NA	µmoles/gm	0.001	0.001	NA	NA
Copper	7440-50-8	NA	NA	NA	NA	µmoles/gm	0.002	0.002	NA	NA
Lead	7439-92-1	NA	NA	NA	NA	µmoles/gm	0.003	0.003	NA	NA
Mercury	7439-97-6	NA	NA	NA	NA	µmoles/gm	0.0001	0.0001	NA	NA
Nickel	7440-02-0	NA	NA	NA	NA	µmoles/gm	0.006	0.006	NA	NA
Silver	7440-22-4	NA	NA	NA	NA	µmoles/gm	0.001	0.001	NA	NA
Zinc	7440-66-6	NA	NA	NA	NA	µmoles/gm	0.005	0.005	NA	NA
SEM		NA	NA	NA	NA	µmoles/gm	0.017	NA	NA	NA
SEM/AVS ratio		NA	NA	NA	NA	µmoles/gm	2.1	NA	NA	NA
MISCELLANEOUS PARAMETERS										
Ammonia, as N		mg/L	0.02	0.01	NA	µg/kg	NA	NA	NA	NA
Cation Exchange Capacity		NA	NA	NA	NA	meq/100gm	1	1	NA	NA
Chloride	16887-00-6	mg/L	1	0.5	NA	NA	NA	NA	NA	NA
Sulfate	14808-79-8	µg/L	1	0.5	NA	NA	NA	NA	NA	NA
Cyanide	57-12-5	µg/L	10	0.5	5.2	µg/kg	500	250	175	1
Nitrate + Nitrite, as N		mg/L	0.05	0.025	NA	NA	NA	NA	NA	NA
TOC		NA	NA	NA	NA	%	0.1	0.1	NA	NA
pH	pH	NA	NA	NA	NA	Std. Units	1	NA	NA	NA
DISSOLVED GASES										
Ethane	74-84-0	ng/L	5	5	NA	NA	NA	NA	NA	NA
Ethene	74-85-1	ng/L	5	5	NA	NA	NA	NA	NA	NA
Methane	74-82-8	µg/L	0.015	0.008	NA	NA	NA	NA	NA	NA

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
POLYNUCLEAR AROMATIC HYDROCARBONS (SW-846 8270C)										
2-Methylnaphthalene	91-57-6	µg/L	0.1	0.05	6.2	µg/kg	6.7	3.3	16000	20.2
Acenaphthene	83-32-9	µg/L	0.1	0.05	9.9	µg/kg	6.7	3.3	31000	6.71
Acenaphthylene	208-96-8	µg/L	0.1	0.05	370	µg/kg	6.7	3.3	3700000	5.87
Anthracene	120-12-7	µg/L	0.1	0.05	0.029	µg/kg	6.7	3.3	51000	46.9
Benzo(a)anthracene	56-55-3	µg/L	0.1	0.05	0.092	µg/kg	6.7	3.3	80	31.7
Benzo(a)pyrene	50-32-8	µg/L	0.1	0.05	0.0092	µg/kg	6.7	3.3	62	31.9
Benzo(b)fluoranthene	205-99-2	µg/L	0.1	0.05	0.092	µg/kg	6.7	3.3	200	10400
Benzo(g,h,i)perylene	191-24-2	µg/L	0.1	0.05	7.64	µg/kg	6.7	3.3	2300000	170
Benzo(k)fluoranthene	207-08-9	µg/L	0.1	0.05	0.0056	µg/kg	6.7	3.3	2000	240
Chrysene	218-01-9	µg/L	0.1	0.05	0.033	µg/kg	6.7	3.3	8000	57.1
Dibenzo(a,h)anthracene	53-70-3	µg/L	0.1	0.05	0.0016	µg/kg	6.7	3.3	62	6.22
Fluoranthene	206-44-0	µg/L	0.1	0.05	8.1	µg/kg	6.7	3.3	310000	111.3
Fluorene	86-73-7	µg/L	0.1	0.05	3.9	µg/kg	6.7	3.3	41000	21.2
Indeno(1,2,3-cd)pyrene	193-39-5	µg/L	0.1	0.05	0.022	µg/kg	6.7	3.3	620	200
Naphthalene	91-20-3	µg/L	0.1	0.05	6.2	µg/kg	6.7	3.3	700	34.6
Phenanthrene	85-01-8	µg/L	0.1	0.05	2.1	µg/kg	6.7	3.3	2300000	41.9
Pyrene	129-00-0	µg/L	0.1	0.05	0.3	µg/kg	6.7	3.3	230000	53
POLYCHLORINATED BIPHENYLS (SW-846 8082)										
Aroclor-1016	12674-11-2	µg/L	0.5	0.25	NA	µg/kg	33	17	2.8	34.1
Aroclor-1221	11104-28-2	µg/L	0.5	0.25	NA	µg/kg	33	17	220	34.1
Aroclor-1232	11141-16-5	µg/L	0.5	0.25	NA	µg/kg	33	17	220	34.1
Aroclor-1242	53469-21-9	µg/L	0.5	0.25	NA	µg/kg	33	17	2.8	34.1
Aroclor-1248	12672-29-6	µg/L	0.5	0.25	NA	µg/kg	33	17	220	34.1
Aroclor-1254	11097-69-1	µg/L	0.5	0.25	NA	µg/kg	33	17	17	34.1
Aroclor-1260	11096-82-5	µg/L	0.5	0.25	NA	µg/kg	33	17	25	34.1

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
SEMIVOLATILES (SW-846 8270C)										
1,2,4,5-Tetrachlorobenzene	95-94-3	µg/L	5	1	11	µg/kg	333	67	100	2020
1,2,4-Trichlorobenzene	120-82-1	µg/L	5	1	69.2	µg/kg	333	67	260	11100
1,2-Dichlorobenzene	95-50-1	µg/L	5	1	11	µg/kg	333	67	860	231.32
1,3-Dichlorobenzene	541-73-1	µg/L	5	1	5.5	µg/kg	333	67	130	3010
1,4-Dichlorobenzene	106-46-7	µg/L	5	1	0.5	µg/kg	333	67	110	545.59
1,4-Naphthoquinone	130-15-4	µg/L	5	1	0.044	µg/kg	333	67	NA	0.0211
1,4-Phenylenediamine	106-50-3	µg/L	10	1	6900	µg/kg	670	67	1500	0.00568
1-Naphthylamine	134-32-7	µg/L	5	1	0.67	µg/kg	333	67	NA	1.09
2,3,4,6-Tetrachlorophenol	58-90-2	µg/L	5	1	14.06	µg/kg	333	67	110000	198.78
2,4,5-Trichlorophenol	95-95-4	µg/L	5	1	3600	µg/kg	333	67	12000	85.56
2,4,6-Trichlorophenol	88-06-2	µg/L	5	1	2	µg/kg	333	67	7.4	84.84
2,4-Dichlorophenol	120-83-2	µg/L	5	1	18	µg/kg	333	67	54	133.63
2,4-Dimethylphenol	105-67-9	µg/L	5	1	100.17	µg/kg	333	67	450	10
2,4-Dinitrophenol	51-28-5	µg/L	10	1	4.07	µg/kg	670	67	15	1.33
2,6-Dichlorophenol	87-65-0	µg/L	5	1	NA	µg/kg	333	67	NA	3.94
2-Acetylaminofluorene	53-96-3	µg/L	5	1	534.97	µg/kg	333	67	NA	15.32
2-Chloronaphthalene	91-58-7	µg/L	5	1	0.2	µg/kg	333	67	14	12.18
2-Chlorophenol	95-57-8	µg/L	5	1	8.8	µg/kg	333	67	180	11.7
2-Methylphenol	95-48-7	µg/L	5	1	1800	µg/kg	333	67	700	0.826
2-Naphthylamine	91-59-8	µg/L	5	1	NA	µg/kg	333	67	NA	1.74
2-Nitroaniline	88-74-4	µg/L	5	1	1	µg/kg	333	67	11	0.222
2-Nitrophenol	88-75-5	µg/L	5	1	13.5	µg/kg	333	67	NA	7.77
2-Picoline	109-06-8	µg/L	5	1	3790	µg/kg	333	67	NA	753.05
3 & 4-Methylphenol		µg/L	5	1	180	µg/kg	333	67	310000	NA
3,3'-Dichlorobenzidine	91-94-1	µg/L	5	1	0.15	µg/kg	333	67	0.31	28.22
3,3'-Dimethylbenzidine	119-93-7	µg/L	5	1	0.0073	µg/kg	333	67	0.23	2

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
SEMIVOLATILES (SW-846 8270C) (Continued)										
3-Methylcholanthrene	56-49-5	µg/L	5	1	0.0891	µg/kg	333	67	NA	77.94
3-Nitroaniline	99-09-2	µg/L	5	1	1	µg/kg	333	67	1700	0.222
4,6-Dinitro-2-methylphenol	534-52-1	µg/L	5	1	2.3	µg/kg	333	67	NA	10.38
4-Aminobiphenyl	92-67-1	µg/L	5	1	0	µg/kg	333	67	NA	3.05
4-Bromophenyl phenyl ether	101-55-3	µg/L	5	1	1.5	µg/kg	333	67	NA	1680
4-Chloro-3-methylphenol	59-50-7	µg/L	5	1	20	µg/kg	333	67	NA	388.18
4-Chloroaniline	106-47-8	µg/L	5	1	150	µg/kg	333	67	49	146.08
4-Chlorophenyl-phenylether	7005-72-3	µg/L	5	1	NA	µg/kg	333	67	NA	656.112
4-Nitroaniline	100-01-6	µg/L	5	1	1	µg/kg	333	67	1700	0.222
4-Nitrophenol	100-02-7	µg/L	5	1	35	µg/kg	333	67	NA	7.78
4-Nitroquinoline-1-oxide	56-57-5	µg/L	5	1	NA	µg/kg	333	67	NA	1.24
5-Nitro-o-toluidine	99-55-8	µg/L	5	1	2	µg/kg	333	67	15000	NA
7,12-Dimethylbenz(a)anthracene	57-97-6	µg/L	5	1	0.548	µg/kg	333	67	NA	16300
Acetophenone	98-86-2	µg/L	5	1	687.89	µg/kg	333	67	890	246
Aniline	62-53-3	µg/L	5	1	0.44	µg/kg	333	67	3.4	0.0338
Aramite A	140-57-8	µg/L	10	1	2.7	µg/kg	670	67	110	0.00111
Aramite B	140-57-8	µg/L	10	1	2.7	µg/kg	670	67	110	0.00111
Benzyl alcohol	100-51-6	µg/L	5	1	281.24	µg/kg	333	67	3200	33.94
Bis(2-chloroethoxy)methane	111-91-1	µg/L	5	1	6400	µg/kg	333	67	NA	302.09
bis(2-Chloroethyl)ether	111-44-4	µg/L	5	1	0.0098	µg/kg	333	67	0.018	211.96
Bis(2-chloroisopropyl)ether	108-60-1	µg/L	5	1	0.27	µg/kg	333	34.29	0.39	68.78
Bis(2-ethylhexyl)phthalate	117-81-7	µg/L	5	1	2.1	µg/kg	333	67	35000	182
Butylbenzylphthalate	85-68-7	µg/L	5	1	49	µg/kg	333	67	840000	238.89
Chlorobenzilate	510-15-6	µg/L	5	1	0.25	µg/kg	333	67	0.57	860.29
cis-Isosafrole	120-58-1	µg/L	5	1	NA	µg/kg	333	67	NA	4.12
Diallate A	2303-16-4	µg/L	5	1	1.1	µg/kg	333	67	8000	1.51

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
SEMIVOLATILES (SW-846 8270C) (Continued)										
Diallate B	2303-16-4	µg/L	5	1	1.1	µg/kg	333	67	8000	1.51
Dibenzofuran	132-64-9	µg/L	5	1	20	µg/kg	333	67	2400	1520
Diethylphthalate	84-66-2	µg/L	5	1	3	µg/kg	333	67	23000	8.04
Dimethylphthalate	131-11-3	µg/L	5	1	73	µg/kg	333	67	2000000	24.95
Di-n-butylphthalate	84-74-2	µg/L	5	1	3	µg/kg	333	67	250000	110.5
Di-n-octylphthalate	117-84-0	µg/L	5	1	20	µg/kg	333	67	2400000	40600
Diphenylamine	122-39-4	µg/L	5	1	412.51	µg/kg	333	67	5000	34.6
Ethyl methanesulfonate	62-50-0	µg/L	5	1	NA	µg/kg	333	67	NA	0.0161
Hexachlorobenzene	118-74-1	µg/L	5	1	0.00024	µg/kg	333	67	110	20
Hexachlorobutadiene	87-68-3	µg/L	5	1	0.223	µg/kg	333	67	120	39.76
Hexachlorocyclopentadiene	77-47-4	µg/L	5	1	50	µg/kg	333	67	20000	755.37
Hexachloroethane	67-72-1	µg/L	5	1	4.8	µg/kg	333	67	23	596.34
Hexachloropropene	1888-71-7	µg/L	5	1	20	µg/kg	333	67	NA	0.2
Isodrin	465-73-6	µg/L	5	1	0.0309	µg/kg	333	67	NA	3.32
Isophorone	78-59-1	µg/L	5	1	71	µg/kg	333	67	26	422.3
Kepone	143-50-0	µg/L	5	1	0.0084	µg/kg	333	67	61	3.31
Methapyrilene	91-80-5	µg/L	5	1	NA	µg/kg	333	67	NA	0.0144
Methyl methanesulfonate	66-27-3	µg/L	5	1	NA	µg/kg	333	67	NA	0.00474
N-Nitrosodiethylamine	55-18-5	µg/L	5	1	0.00045	µg/kg	333	67	0.00015	22.77
N-Nitrosodimethylamine	62-75-9	µg/L	5	1	0.0013	µg/kg	333	67	0.00036	0.00275
N-Nitroso-di-n-butylamine	924-16-3	µg/L	5	1	0.002	µg/kg	333	67	0.017	267.07
N-Nitroso-di-n-propylamine	621-64-7	µg/L	5	1	0.0096	µg/kg	333	67	0.003	0.217
N-Nitrosodiphenylamine	86-30-6	µg/L	5	1	13	µg/kg	333	67	48	155
N-Nitrosomethylethylamine	10595-95-6	µg/L	5	1	0.0031	µg/kg	333	67	22	0.00485
N-Nitrosomorpholine	59-89-2	µg/L	5	1	NA	µg/kg	333	67	NA	0.0037
N-Nitrosopiperidine	100-75-4	µg/L	5	1	NA	µg/kg	333	67	NA	0.0226

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
SEMIVOLATILES (SW-846 8270C) (Continued)										
N-Nitrosopyrrolidine	930-55-2	µg/L	5	1	0.032	µg/kg	333	67	0.0094	0.000908
O,O,O-Triethyl phosphorothioate	126-68-1	µg/L	5	1	58.25	µg/kg	333	67	NA	188.94
o-Toluidine	95-53-4	µg/L	5	1	0.28	µg/kg	333	67	0.16	0.199
p-Dimethylaminoazobenzene	60-11-7	µg/L	5	1	1.65	µg/kg	333	67	NA	39.76
Pentachlorobenzene	608-93-5	µg/L	5	1	0.47	µg/kg	333	67	3700	496.95
Pentachloroethane	76-01-7	µg/L	5	1	56.42	µg/kg	333	67	NA	689.18
Pentachloronitrobenzene	82-68-8	µg/L	5	1	0.26	µg/kg	333	67	23	7090
Phenacetin	62-44-2	µg/L	5	1	6.3	µg/kg	333	67	NA	2.25
Phenol	108-95-2	µg/L	5	1	100	µg/kg	333	67	2800	27.26
Phentermine	122-09-8	µg/L	10	1	36	µg/kg	670	67	61000	8.9
Pronamide	23950-58-5	µg/L	5	1	160	µg/kg	333	67	16000	1.6
Pyridine	110-86-1	µg/L	5	1	36	µg/kg	333	1.3	7.6	106.17
Safrole	94-59-7	µg/L	5	1	40	µg/kg	333	67	NA	164.86
trans-Isosafrole	120-58-1	µg/L	5	1	NA	µg/kg	333	67	NA	4.12
VOLATILES (SW-846 8260B)										
1,1,1,2-Tetrachloroethane	630-20-6	µg/L	1	0.3	0.43	µg/kg	3	1	7.1	10.89
1,1,1-Trichloroethane	71-55-6	µg/L	1	0.3	88	µg/kg	3	1	97	246.85
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	1	0.3	0.055	µg/kg	3	1	0.17	29.08
1,1,2-Trichloroethane	79-00-5	µg/L	1	0.3	0.2	µg/kg	3	1	0.91	673.51
1,1-Dichloroethane	75-34-3	µg/L	1	0.3	47	µg/kg	3	1	1000	0.575
1,1-Dichloroethene	75-35-4	µg/L	1	0.3	7	µg/kg	3	1	2.9	23.27
1,2,3-Trichloropropane	96-18-4	µg/L	1	0.3	0.0056	µg/kg	3	1	0.0037	8.35
1,2-Dibromo-3-chloropropane	96-12-8	µg/L	1	0.3	0.048	µg/kg	3	1	0.092	19.98
1,2-Dibromoethane	106-93-4	µg/L	1	0.3	0.00076	µg/kg	3	1	0.029	12.37
1,2-Dichloroethane	107-06-2	µg/L	1	0.3	0.12	µg/kg	3	1	1.2	54.18
1,2-Dichloropropane	78-87-5	µg/L	1	0.3	0.16	µg/kg	3	1	1.5	351.61

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
VOLATILES (SW-846 8260B) (Continued)										
1,4-Dioxane	123-91-1	µg/L	100	50	6.1	µg/kg	200	0.1	1.7	0.00543
2-Butanone	78-93-3	µg/L	5	0.5	1900	µg/kg	10	1	4400	136.96
2-Hexanone	591-78-6	µg/L	5	0.5	1710	µg/kg	10	1	NA	1010
3-Chloro-1-propene	107-05-1	µg/L	5	0.5	1800	µg/kg	10	1	1800	0.266
4-Methyl-2-pentanone	108-10-1	µg/L	5	0.5	160	µg/kg	10	1	620	544.37
Acetone	67-64-1	µg/L	5	0.5	610	µg/kg	10	1	730	453.37
Acetonitrile	75-05-8	µg/L	40	20	100	µg/kg	80	40	420000	139.05
Acrolein	107-02-8	µg/L	5	0.5	0.042	µg/kg	10	1	0.23	0.0144
Acrylonitrile	107-13-1	µg/L	5	0.5	0.039	µg/kg	10	1	0.032	0.0157
Benzene	71-43-2	µg/L	1	0.3	0.34	µg/kg	3	1	1.7	141.57
Bromodichloromethane	75-27-4	µg/L	1	0.3	0.18	µg/kg	3	1	32	1.13
Bromoform	75-25-2	µg/L	1	0.3	8.5	µg/kg	3	1	38	996.27
Bromomethane	74-83-9	µg/L	1	0.3	8.7	µg/kg	3	1	12	235.16
Carbon disulfide	75-15-0	µg/L	1	0.3	84.1	µg/kg	3	1	1500	94.12
Carbon tetrachloride	56-23-5	µg/L	1	0.3	0.17	µg/kg	3	1	3.3	35.73
Chlorobenzene	108-90-7	µg/L	1	0.3	10	µg/kg	3	1	65	61.94
Chloroethane	75-00-3	µg/L	1	0.5	4.6	µg/kg	3	1	330	58600
Chloroform	67-66-3	µg/L	1	0.3	6.2	µg/kg	3	1	29	27
Chloromethane	74-87-3	µg/L	1	0.3	1.5	µg/kg	3	1	2	0.0785
Chloroprene	126-99-8	µg/L	5	0.5	14	µg/kg	10	1	560	1.06
cis-1,2-Dichloroethene	156-59-2	µg/L	1	0.3	61	µg/kg	3	1	20	208.94
cis-1,3-Dichloropropene	10061-01-5	µg/L	1	0.3	0.4	µg/kg	3	1	0.3	2.96
Dibromochloromethane	124-48-1	µg/L	1	0.3	0.13	µg/kg	3	1	20	267.61
Dibromomethane	74-95-3	µg/L	1	0.3	61	µg/kg	3	1	77	0.0859
Dichlorodifluoromethane	75-71-8	µg/L	1	0.3	390	µg/kg	3	1	28000	1.33
Ethyl methacrylate	97-63-2	µg/L	5	0.5	550	µg/kg	10	1	810	0.602

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
VOLATILES (SW-846 8260B) (Continued)										
Ethylbenzene	100-41-4	µg/L	1	0.3	2.9	µg/kg	3	1	670	0.1
Iodomethane	74-88-4	µg/L	5	0.5	NA	µg/kg	10	1	NA	0.305
Isobutyl alcohol	78-83-1	µg/L	40	20	1800	µg/kg	80	40	2300	3350
Methacrylonitrile	126-98-7	µg/L	5	0.3	1	µg/kg	10	1	1	0.0297
Methyl methacrylate	80-62-6	µg/L	5	0.5	1400	µg/kg	10	1	12000	167.56
Methylene chloride	75-09-2	µg/L	1	0.3	4.3	µg/kg	3	1	1.2	1260
Propionitrile	107-12-0	µg/L	40	20	6080	µg/kg	80	40	NA	49.83
Styrene	100-42-5	µg/L	1	0.3	56	µg/kg	3	1	180	444.96
Tetrachloroethene	127-18-4	µg/L	1	0.3	0.66	µg/kg	3	1	2.9	195.83
Toluene	108-88-3	µg/L	1	0.3	253	µg/kg	3	1	590	5450
trans-1,2-Dichloroethene	156-60-5	µg/L	1	0.3	100	µg/kg	3	1	34	208.94
trans-1,3-Dichloropropene	10061-02-6	µg/L	1	0.3	0.4	µg/kg	3	1	0.3	2.96
trans-1,4-Dichloro-2-butene	110-57-6	µg/L	5	0.5	NA	µg/kg	10	1	NA	1.82
Trichloroethene	79-01-6	µg/L	1	0.3	0.028	µg/kg	3	1	2.8	179.56
Trichlorofluoromethane	75-69-4	µg/L	1	0.3	1300	µg/kg	3	1	8000	3.07

TABLE 1-4

SPECIFIC FIXED-BASED
LABORATORY ANALYTICAL METHODOLOGIES AND
CORRESPONDING TARGET ANALYTE LISTS[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	CAS#	Aqueous Matrix				Solid Matrix				
		Units	Lab RL	Lab T.V.	Risk-Based Target Level	Units	Lab RL	Lab T.V.	Risk-Based Soil Target Level	Risk-Based Sediment Target Level
VOLATILES (SW-846 8260B) (Continued)										
Vinyl acetate	108-05-4	µg/L	5	0.5	248.03	µg/kg	10	1	2300	12.95
Vinyl chloride	75-01-4	µg/L	1	0.3	0.02	µg/kg	3	1	0.67	2
Xylenes, Total	1330-20-7	µg/L	1	0.3	117	µg/kg	3	1	71000	1880

1 - Risk-based target levels for solid and aqueous matrices are the lowest of the criteria presented in Appendix Tables B-1, B-2, and B-5 (solid matrix), and Appendix Tables B-3 and B-4 (aqueous matrices).
The shaded value exceeds at least one of the associated RBTLs.
AVS = Acid Volatile Sulfides.
CAS # = Chemical abstracts registry service number.
NA = Not applicable.
RBTL = Risk-based target level.
RL = Reporting limit.
SEM = Simultaneously extractable metals.
TOC = Total Organic Carbon.
TV = Threshold Value (realistic estimate of method detection limit after accounting for matrix variability).

TABLE 1-5

AQUEOUS FIELD TARGET PARAMETERS
AND METHOD DETECTION LIMITS
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	Estimated Detection Limit
Dissolved Oxygen (meter)	0.1 mg/L
Flow Rate	NA
Oxidation-Reduction Potential (ORP)	NA
pH	NA
Specific Conductance	0.02 µS/cm
Temperature	0.1°C*
Turbidity	1 NTU
Water Level	0.01 foot*
Dissolved Oxygen (test kit)	0.025 (0 - 1 mg/L range)
Alkalinity	10 (10 - 100 mg/L range) 50 (50 - 500 mg/L range) 100 (100 - 1000 mg/L range)
Carbon Dioxide	10 (10 - 100 mg/L range) 100 (100 - 1000 mg/L range) 250 (250 - 2500 mg/L range)
Nitrite (as N)	0.005 mg/L
Ferrous Iron	0.03 mg/L
Manganese (+2)	0.12 mg/L
Sulfide (S^{-2})	0.01 mg/L
Hydrogen Sulfide (H_2S)	0.1 mg/L

NA – Not applicable.
mg/L = milligrams per liter.
µS/cm = microSiemens per centimeter.
NTU = Nephelometric turbidity unit.
°C = degrees Celsius.
*Stated value is required limit of resolution rather than a detection limit.

TABLE 1-6

PROJECT TARGET PARAMETERS AND RATIONALES
MINE FILL A (SWMU 12) ROUND 1 AND MINE FILL B (SWMU 13) ROUND 2
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL A SWMU 12				MINE FILL B SWMU 13				Rationale/Intended Data Use
	ENVIRONMENTAL MEDIUM				ENVIRONMENTAL MEDIUM				
	SS/SB	SD	SW	GW	SS/SB	SD	SW	GW	
LABORATORY PARAMETERS									
Metals SW-846 6020/7470A/7471A Total	X	X	X	X		X	X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Metals SW-846 6020/7470A/7471A Dissolved			X	X(1)			X	X(1)	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Explosives SW-846 Method 8330	X	X	X	X		X	X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Miscellaneous Explosives and Degradation Products Modified Method 8330			X	X			X	X	To determine whether explosives, present in ground water and surface water, are naturally degrading
VOCs SW-846 8260B/8015B(2)	SB only at UAP BDS								To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
SVOCs SW-846 8270C/SIM/8151A	SB only at UAP BDS	X	X			X (PAHs only on select samples)			To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
PCBs SW-846 8082					X				To complete the delineation of PCB contamination at the Therminol boilers. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Total Organic Carbon	Select Spls	Select Spls							To evaluate fate and transport of contaminants and to corroborate the presence or absence of contamination. Indication of bioavailability of chemicals in sediment.
Cation Exchange Capacity	Select Spls	Select Spls							To evaluate fate and transport of contaminants. Also indication of bioavailability of chemicals in surface soils.
Hardness (Calculation)				X				X	To evaluate water quality and to calculate water-quality standards.

TABLE 1-6

PROJECT TARGET PARAMETERS AND RATIONALES
MINE FILL A (SWMU 12) ROUND 1 AND MINE FILL B (SWMU 13) ROUND 2
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL A SWMU 12				MINE FILL B SWMU 13				Rationale/Intended Data Use
	ENVIRONMENTAL MEDIUM				ENVIRONMENTAL MEDIUM				
	SS/SB	SD	SW	GW	SS/SB	SD	SW	GW	
Cyanide	Near UAP								To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
pH	Select Spls	Select Spls							To obtain information on mobility of chemicals (especially metals).
AVS/SEM		Select Spls							To evaluate fate and transport of contaminants and to corroborate the presence or absence of contamination. Indication of bioavailability of chemicals in sediment.
Nitrate + Nitrite as Nitrogen EPA 353.2			X	X			X	X	To evaluate fate and transport of potential contaminants and natural attenuation.
Ammonia as Nitrogen EPA 350.1	X		X	X			X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Chloride and Sulfate				X				X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
FIELD PARAMETERS									
Grain Size	X	X							To establish which background data set is most appropriate for background comparisons. To evaluate fate and transport of potential contaminants.
Depositional Environment	X	X							To identify soil sampling locations in the horizontal direction for comparison to background concentrations classified according to depositional environment.
Dissolved Oxygen			X	X			X	X	To evaluate water quality, natural attenuation, and fate and transport.
Flow Rate			X				X		To establish transient rate and absence or presence of potential contaminants for interpretation of surface water chemical concentrations. Semi-quantitative parameter only.
Iron(+2)				X				X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
Manganese(+2)				X				X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.

TABLE 1-6

PROJECT TARGET PARAMETERS AND RATIONALES
MINE FILL A (SWMU 12) ROUND 1 AND MINE FILL B (SWMU 13) ROUND 2
NSWC CRANE
CRANE, INDIANA

Parameter	MINE FILL A SWMU 12 ENVIRONMENTAL MEDIUM				MINE FILL B SWMU 13 ENVIRONMENTAL MEDIUM				Rationale/Intended Data Use
	SS/SB	SD	SW	GW	SS/SB	SD	SW	GW	
Oxidation-Reduction Potential (ORP)			X	X			X	X	To evaluate natural attenuation, fate and transport of potential contaminants, and water quality. To establish the reducing/oxidizing tendency of the sample matrix.
pH			X	X			X	X	To establish well stabilization prior to collecting ground water samples. Generally useful for data interpretation and potential future uses.
Sample Depth/ Location	X	X	X	X	X	X	X	X	To identify sample locations in the vertical and horizontal direction.
Specific Conductance			X	X			X	X	To establish well stabilization prior to collecting ground water samples.
Sulfide				X				X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
Temperature			X	X			X	X	To establish well stabilization prior to collecting ground water samples. Also because pH and specific conductivity are temperature dependent.
Turbidity			X	X			X	X	To establish well stabilization prior to collecting ground water samples. To determine if detected concentrations of contaminants caused by suspended solids.
Water Level				X				X	To calculate potentiometric surface, ground water velocity and hydraulic gradient.

1. Ground water samples will be analyzed for dissolved metals if Nephelometric Turbidity Units (NTUs) less than 10 cannot be achieved during sampling.
2. Surface soil samples for VOC analysis will be collected from 1 to 2 feet bgs.

AVS/SEM - Acid Volatile Sulfice/Simultaneously Extracted Metals.
GW - Ground water.
SW - Surface water.
SS - Surface soil.
SB - Subsurface soil.
Select Spls - Select samples.
SD - Sediment.
BDS - Battery Disposal Site
Spls - Samples.
TB - Therminol boiler.
UAP - Unidentified asphalt pad.
bgs - Below ground surface.
VOC - Volatile organic compound.
SVOC - Semivolatile organic compound.
PAHs - Polycyclic Aromatic Hydrocarbons

TABLE 1-7

PROJECT TARGET PARAMETERS AND RATIONALES
CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR (SWMU 16)
ROUND 2
NSWC CRANE
CRANE, INDIANA

Parameter	Environmental Medium					Rationale/Intended Data Use
	SS	SB	SD	SW	GW	
LABORATORY PARAMETERS						
Metals SW-846 6020/7470A Dissolved				X	X(1)	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Metals SW-846 6020/7470A/7471A Total	X		X	X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Explosives SW-846 8330			X	X	X	To further delineate the extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Miscellaneous Explosives and Degradation Products Modified Method 8330				X	X	To determine whether explosives, present in ground water and surface water, are naturally degrading
VOCs (2) SW-846 8260B/8015B	X	X	X	X	X(3)	To further delineate the extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Polycyclic Aromatic Hydrocarbons			X Select Samples			To further delineate the extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site-related contaminants.
Ethane, Ethene, and Methane					X	To evaluate natural attenuation and fate and transport of potential contaminants.
Hardness (Calculation)					X	To evaluate water quality and to calculate water-quality standards.
AVS/SEM			Select Samples			To evaluate fate and transport of contaminants and to establish the presence or absence of contamination. Indication of bioavailability of chemicals in sediment.
Ammonia as Nitrogen EPA 350.1				X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential receptors (human health and ecological) from potentially site related contaminants.
Chloride and Sulfate					X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.

TABLE 1-7

PROJECT TARGET PARAMETERS AND RATIONALES
CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR (SWMU 16)
ROUND 2
NSWC CRANE
CRANE, INDIANA

Parameter	Environmental Medium					Rationale/Intended Data Use
	SS	SB	SD	SW	GW	
Nitrate + Nitrite as Nitrogen EPA 353.2				X	X	To establish absence or presence and extent of contamination. To evaluate risks to potential human receptors from potentially site-related contaminants.
FIELD PARAMETERS						
Grain Size			X			To establish which background data set is most appropriate for background comparisons. To evaluate fate and transport of potential contaminants.
Depositional Environment			X			To identify soil sampling locations in the horizontal direction for comparison to background concentrations classified according to depositional environment.
Dissolved Oxygen				X	X	To evaluate water quality, natural attenuation, and fate and transport.
Flow Rate				X		To establish transient rate and absence or presence of potential contaminants for interpretation of surface water chemical concentrations. Semi-quantitative parameter only.
Iron(+2)				X		To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
Manganese(+2)				X		To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
Oxidation-Reduction Potential (ORP)				X	X	To evaluate natural attenuation, fate and transport of potential contaminants, and water quality.
pH				X	X	Measured to establish well stabilization prior to collecting ground water samples. Generally useful for data interpretation and potential future uses.
Sample Depth/Location			X	X	X	To identify sample locations in the vertical and horizontal direction.
Specific Conductance				X	X	To establish well stabilization prior to collecting ground water samples.

TABLE 1-7

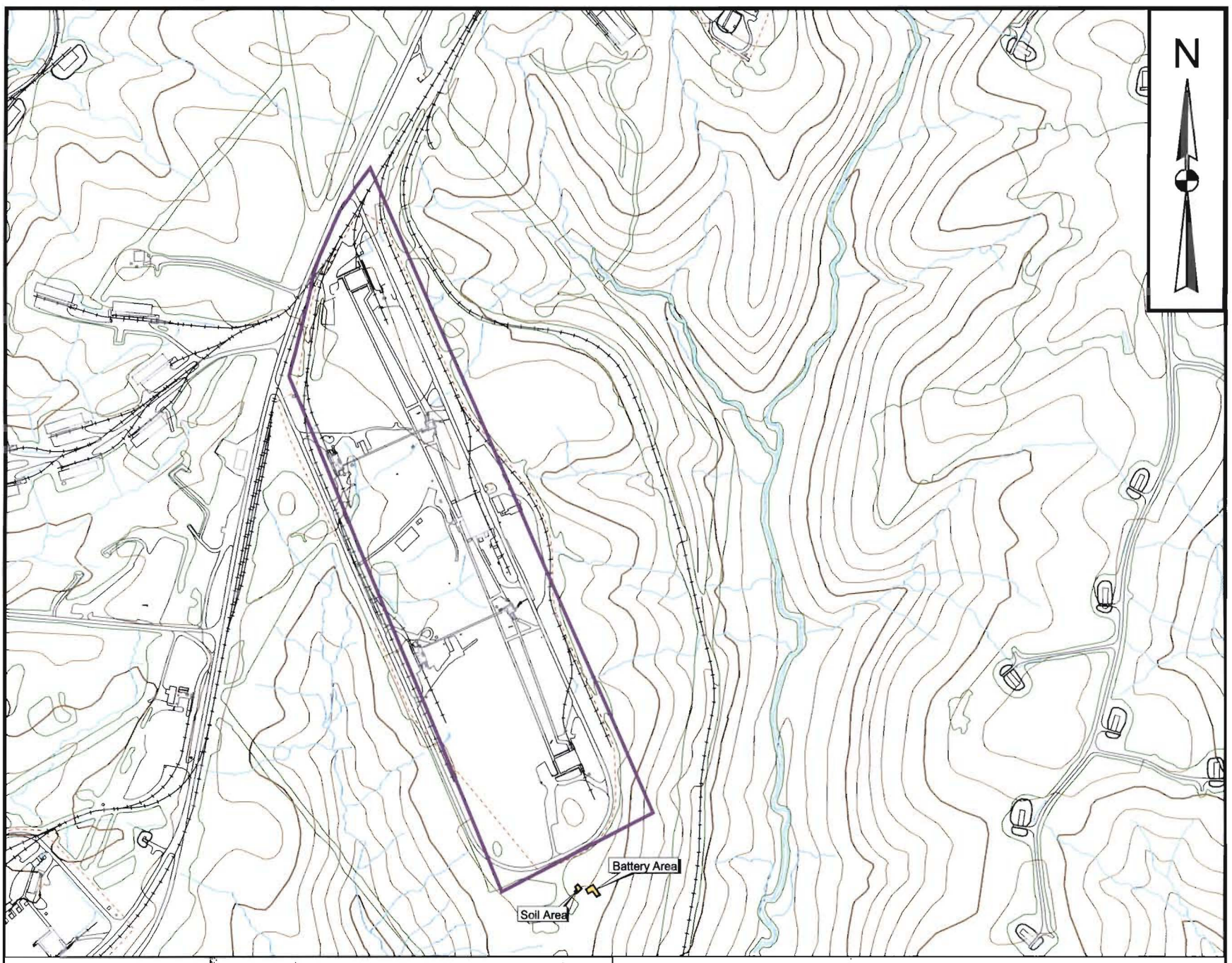
PROJECT TARGET PARAMETERS AND RATIONALES
CAST HIGH EXPLOSIVES FILL/BUILDING 146 INCINERATOR (SWMU 16)
ROUND 2
NSWC CRANE
CRANE, INDIANA

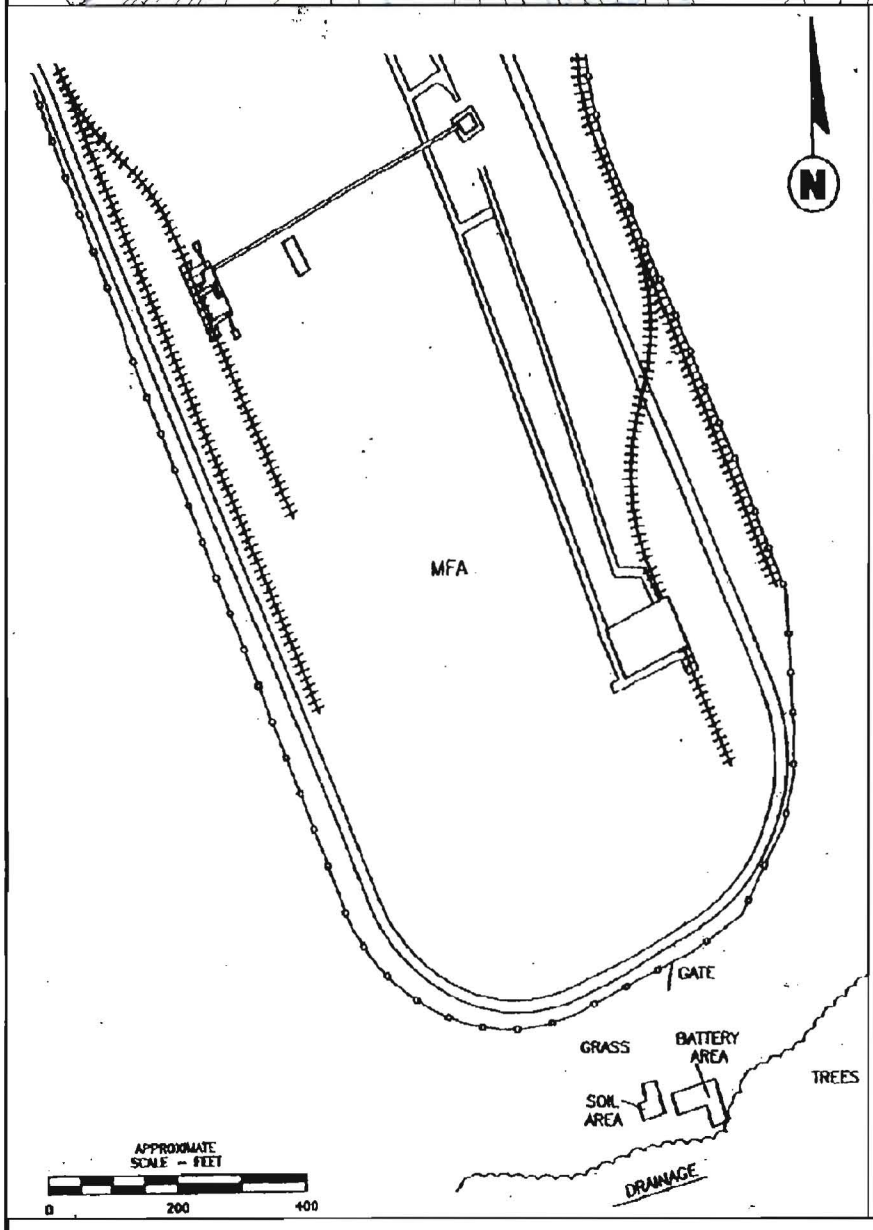
Parameter	Environmental Medium					Rationale/Intended Data Use
	SS	SB	SD	SW	GW	
Sulfide					X	To evaluate natural attenuation and fate and transport of potential contaminants. To establish the reducing/oxidizing tendency of the sample matrix.
Temperature				X	X	To establish well stabilization prior to collecting ground water samples. Also measured because pH and specific conductivity are temperature dependent.
Turbidity				X	X	To establish well stabilization prior to collecting ground water samples. Measured to determine if contaminants caused by suspended solids.
Water Level					X	To calculate potentiometric surface, ground water velocity, and hydraulic gradient.

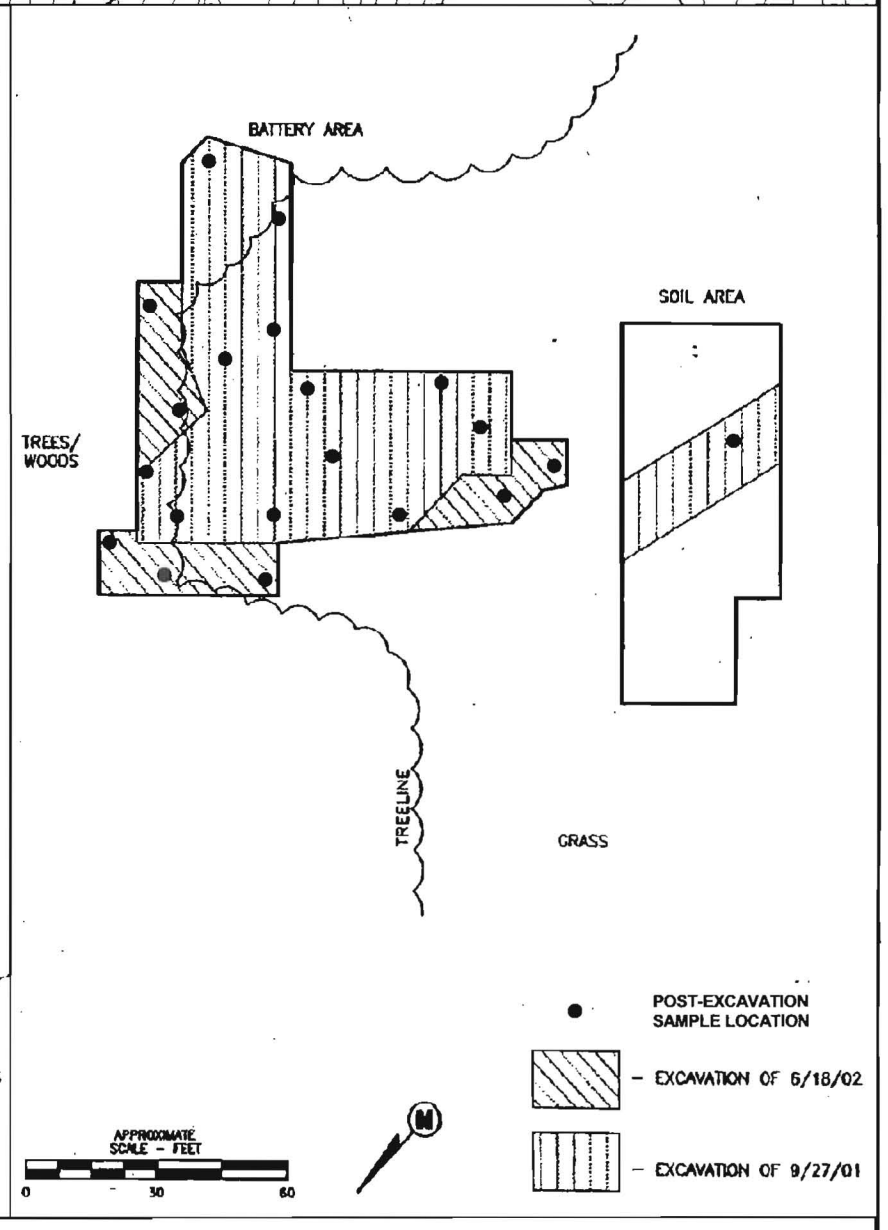
1. Ground water samples will be analyzed for dissolved metals if Nephelometric Turbidity Units (NTUs) less than 10 cannot be achieved during sampling.
2. Surface soil samples for VOC analysis will be collected from 1 to 2 feet bgs.
3. Includes GW discharging via seeps.

AVS/SEM - Acid volatile sulfide/simultaneously extracted metals.
GW - Ground water.
SW - Surface water.
SS - Surface soil.
SB - Subsurface soil.
SD - Sediment.
Spls -Samples.

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR BATTERY DISPOSAL SITE 10/2/03 KMP





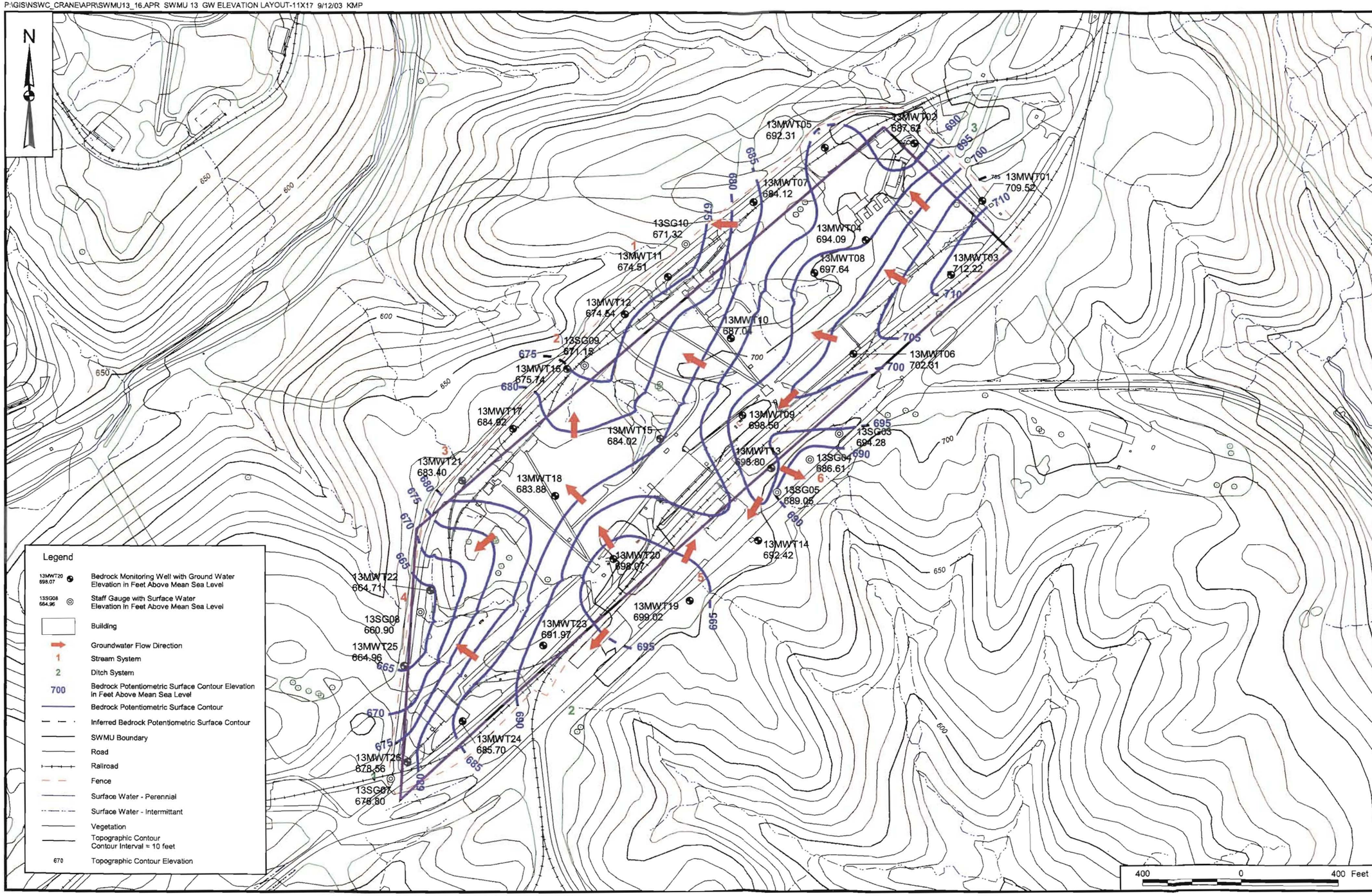


SWMU Boundary | Building | Sump | Road | Railroad | Wall | Fence | Trees | Water | Topographic Contour

700 0 700 Feet

DRAWN BY K. Peila	DATE 10/2/03	BATTERY DISPOSAL SITE SWMU 12 QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. Lucas	DATE 10/2/03		APPROVED BY — DATE —
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. 1-1 REV 0

P:\GIS\NSWC_CRANE\APR\SWMU13_16.APR SWMU 13 GW ELEVATION LAYOUT-11X17 9/12/03 KMP



CONTRACT NO. 9060

APPROVED BY ___ DATE ___

APPROVED BY ___ DATE ___

DRAWING NO. FIGURE 1 - 2

REV 0

BEDROCK POTENTIOMETRIC SURFACE MAP (5/11/03)
BEDROCK WELLS AND STAFF GAUGES
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * NAVAL AIR WARFARE CENTER * SOUTHERN DIVISION

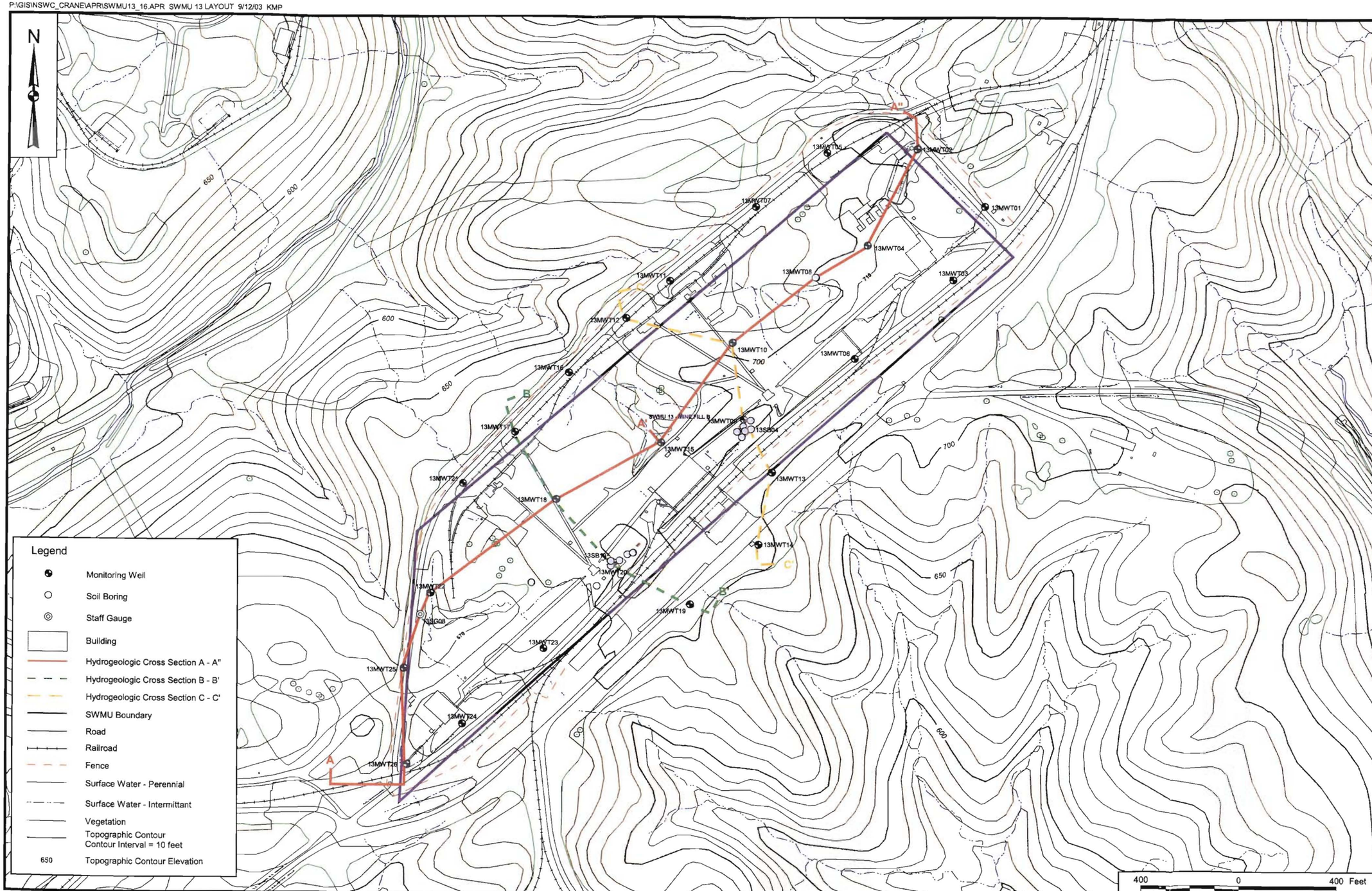
DRAWN BY A. JANOCHA DATE 7/09/03

CHECKED BY B. BALKOVEC DATE 7/22/03

COST/SCHED-AREA

SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\SWMU13_16.APR SWMU 13 LAYOUT 9/12/03 KMP



CONTRACT NO.
9060

APPROVED BY ____ DATE ____

APPROVED BY ____ DATE ____

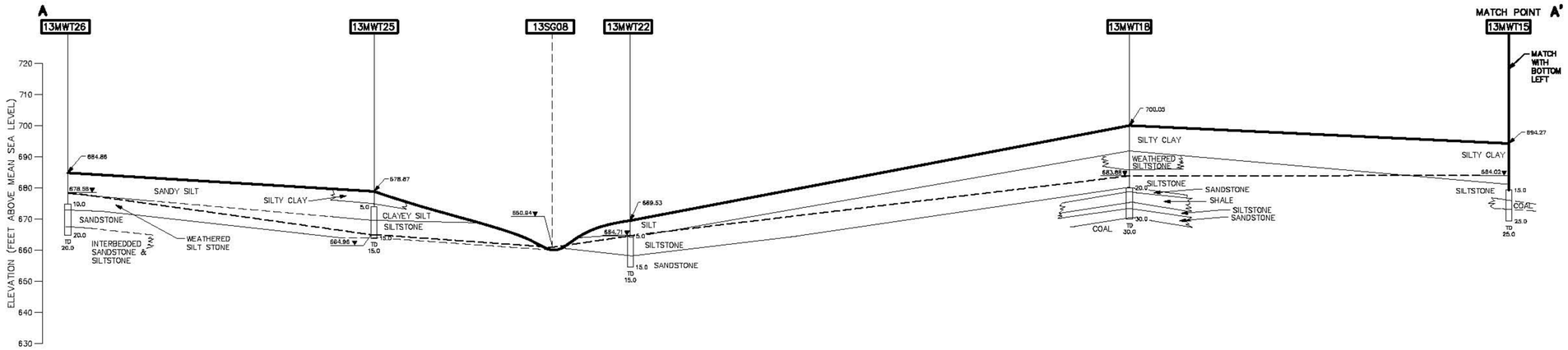
DRAWING NO. FIGURE 1 - 3

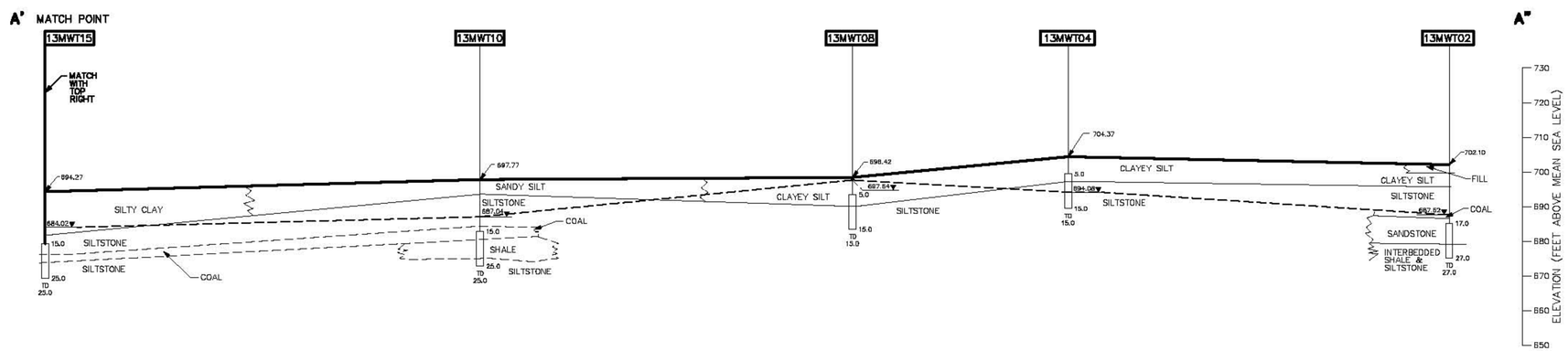
REV 0

HYDROGEOLOGIC CROSS SECTION MAP
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

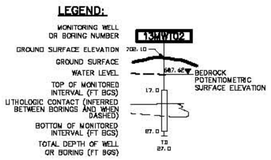
DEPARTMENT OF THE NAVY ★ SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMD ★

DRAWN BY A. JANOCHA	DATE 7/09/03	
CHECKED BY B. BALKOVEC	DATE 7/22/03	
COST/SCHED-AREA		SCALE AS NOTED





LEGEND:



NOTES:

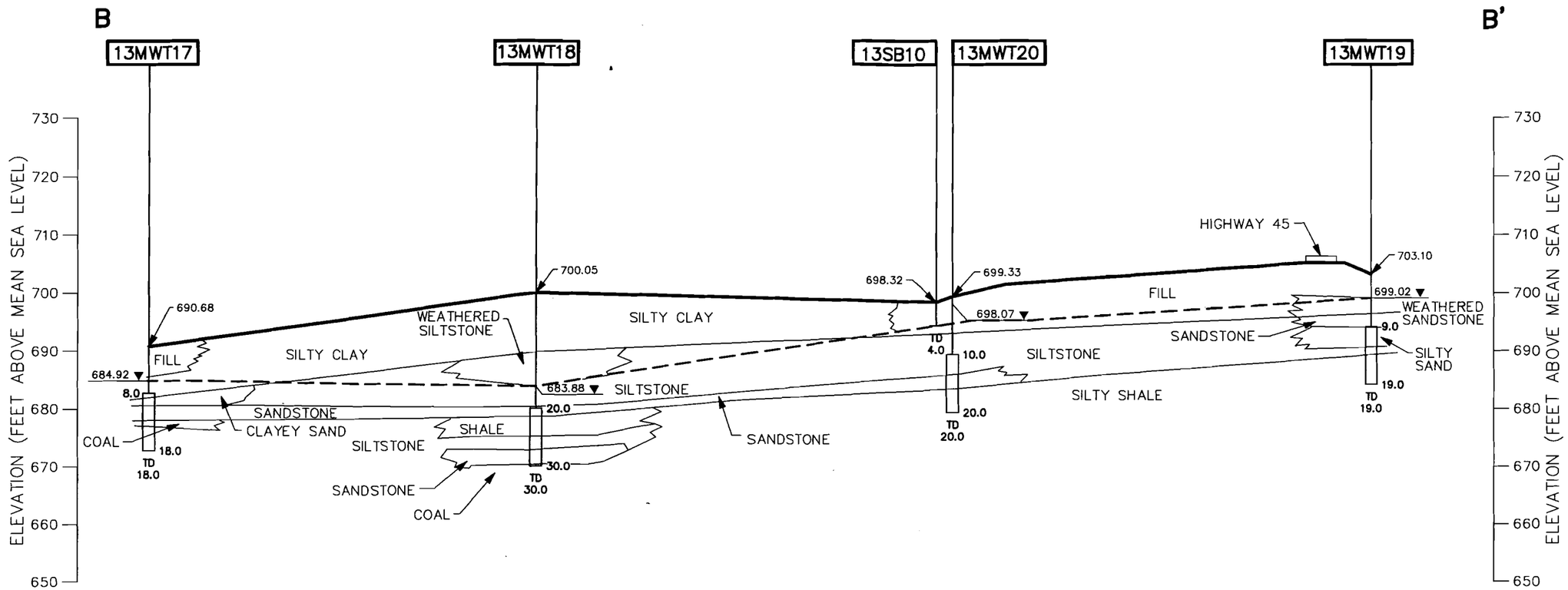
1) BEDROCK WATER LEVEL MEASUREMENTS WERE TAKEN ON 5/11/03 FROM MONITORING WELLS SCREENED IN THE BEDROCK AQUIFER.
2) LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.
3) 13SG08 PROJECTED IN CROSS SECTION.
4) ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL.

0 80 160
HORIZONTAL SCALE IN FEET
0 20 40
VERTICAL SCALE IN FEET

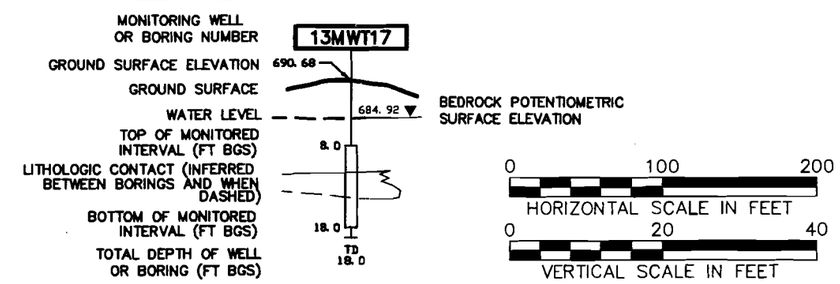
DRAWN BY DM	DATE 8/21/03	HYDROGEOLOGIC CROSS SECTION A–A"	CONTRACT NO. 9060
CHECKED BY JS	DATE 9/12/03	SWMU 13 – MINE FILL B	OWNER NO. ————
REVISED BY ————	DATE ———	NSWC CRANE	APPROVED BY / DATE
SCALE AS NOTED		CRANE, INDIANA	DRAWING NO. FIGURE 1–4 / REV. 0

ACAD: 9060GX10.dwg 09/15/03 MF PIT

ACAD: 9060GX03.dwg 09/15/03 MF PIT



LEGEND:



NOTES:

1) BEDROCK WATER LEVEL MEASUREMENTS WERE TAKEN ON 5/11/03 FROM MONITORING WELLS SCREENED IN THE BEDROCK AQUIFER.

2) LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.

3) ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT. AMSL).

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

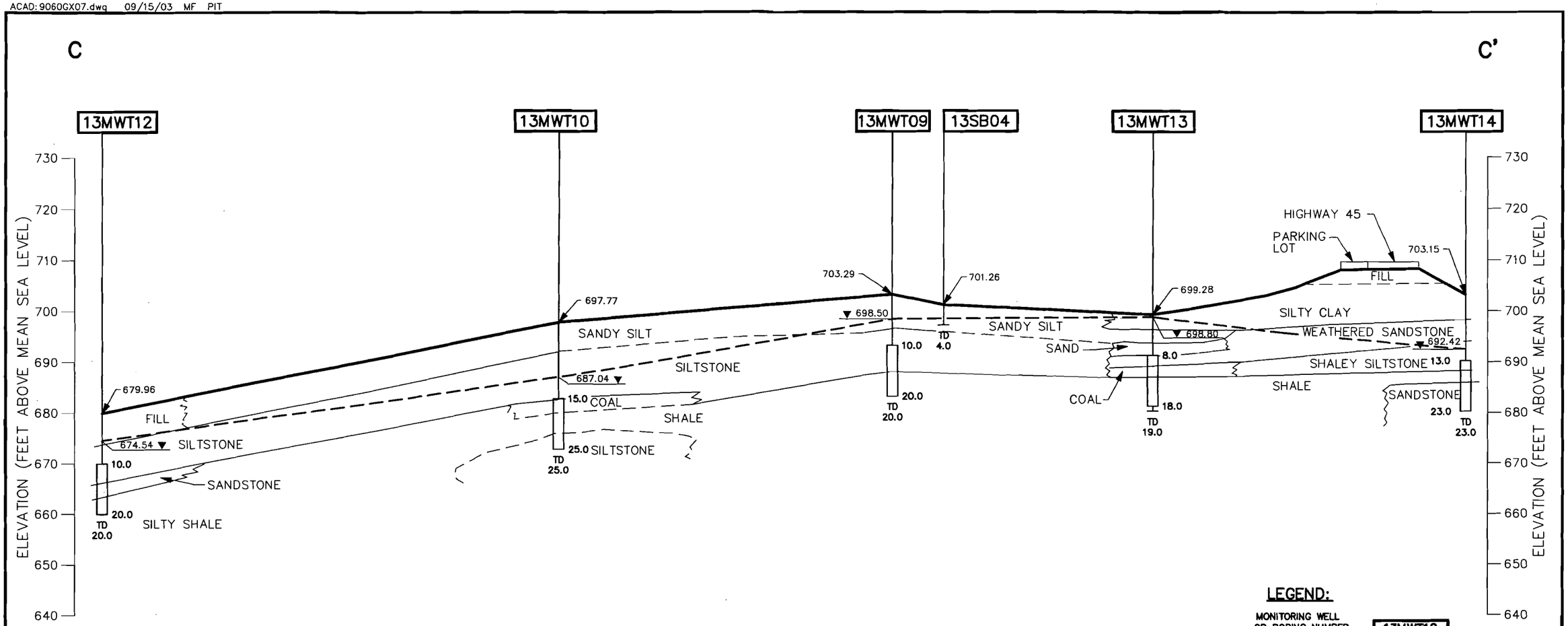
DRAWN BY HJB DATE 6/18/03
CHECKED BY JS DATE 9/12/03
COST/SCHED-AREA
SCALE AS NOTED

HYDROGEOLOGICAL CROSS SECTION B–B'
SWMU 13 – MINE FILL B
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 9060
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1–5
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 9060GX07.dwg 09/15/03 MF PIT



NOTES:

1) BEDROCK WATER LEVEL MEASUREMENTS WERE TAKEN ON 5/11/03 FROM MONITORING WELLS SCREENED IN THE BEDROCK AQUIFER.

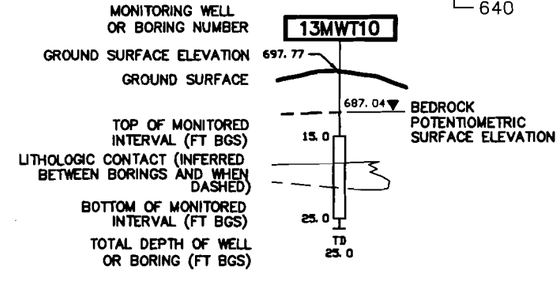
2) LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.

3) ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL.

0 100 200
HORIZONTAL SCALE IN FEET

0 20 40
VERTICAL SCALE IN FEET

LEGEND:



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

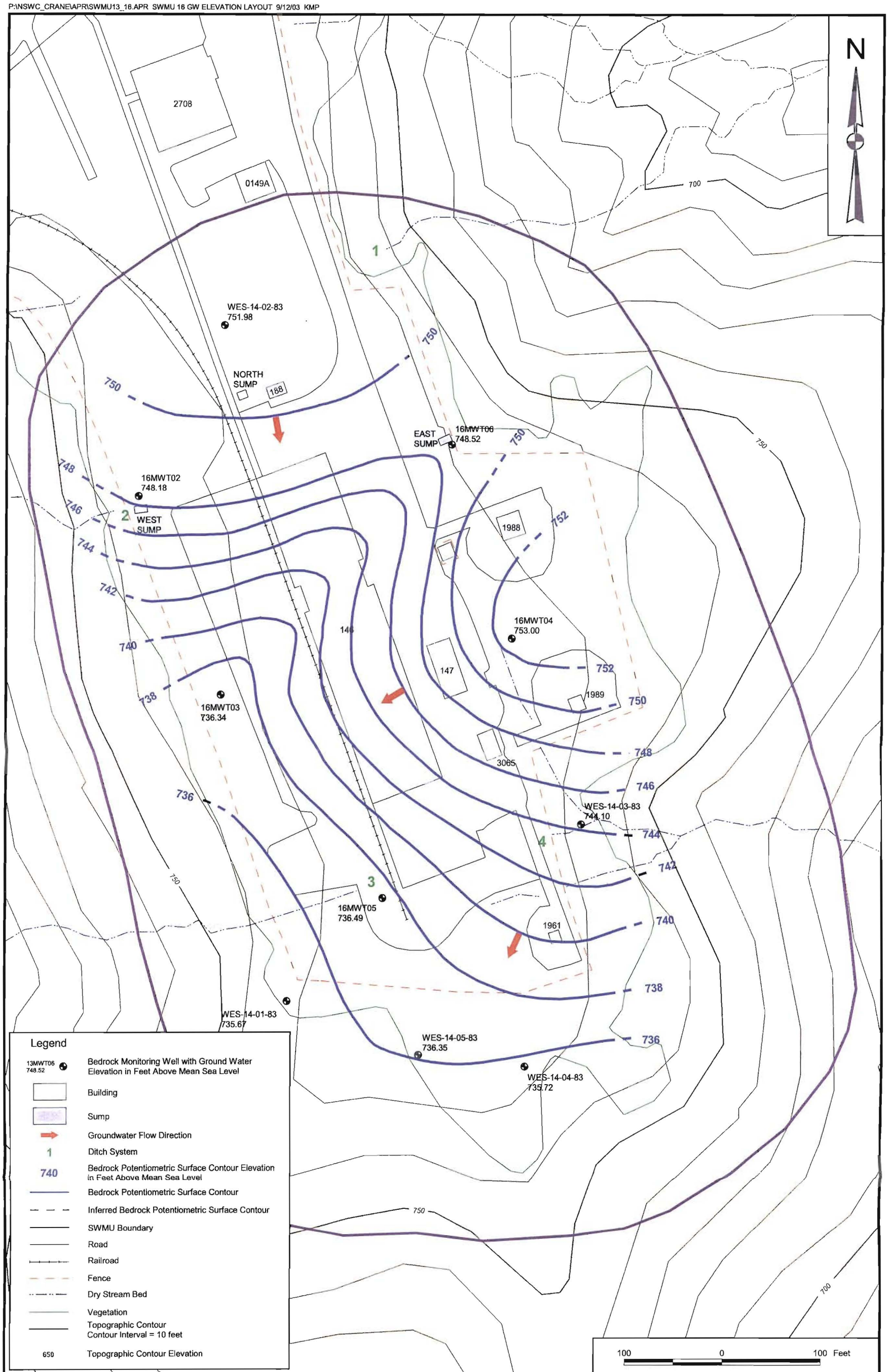
DRAWN BY DM DATE 8/21/03
CHECKED BY JS DATE 9/12/03
COST/SCHED-AREA
SCALE AS NOTED

HYDROGEOLOGIC CROSS SECTION C–C'
SWMU 13 – MINE FILL B
NSWC CRANE
CRANE, INDIANA

CONTRACT NO. 9060
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1–6
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

P:\NSWC_CRANE\APR\SWMU13_16.APR SWMU 16 GW ELEVATION LAYOUT 9/12/03 KMP



DRAWN BY	DATE
A. JANOCHA	6/19/03
CHECKED BY	DATE
B. BALKOVEC	7/23/03
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

BEDROCK POTENTIOMETRIC SURFACE MAP (5/30/03)

BEDROCK WELLS

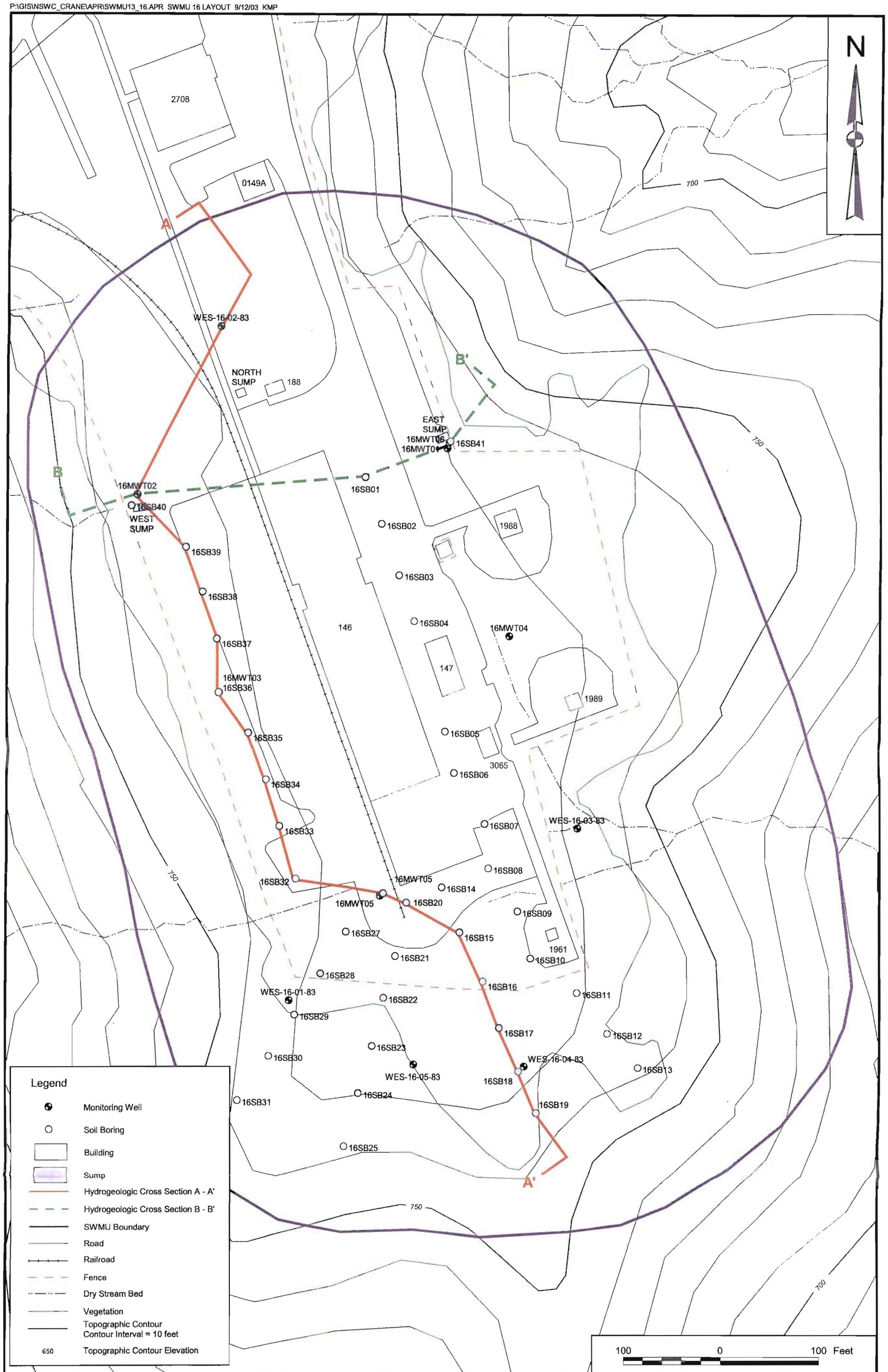
B146 INCINERATOR/CAST HIGH EXPLOSIVES FILL (SWMU 16)

NSWC CRANE

CRANE, INDIANA

CONTRACT NUMBER	
9060	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO.	REV
FIGURE 1 - 7	0

P:\GIS\NSWC_CRANE\APR\SWMU13_16.APR SWMU 16 LAYOUT 9/12/03 KMP

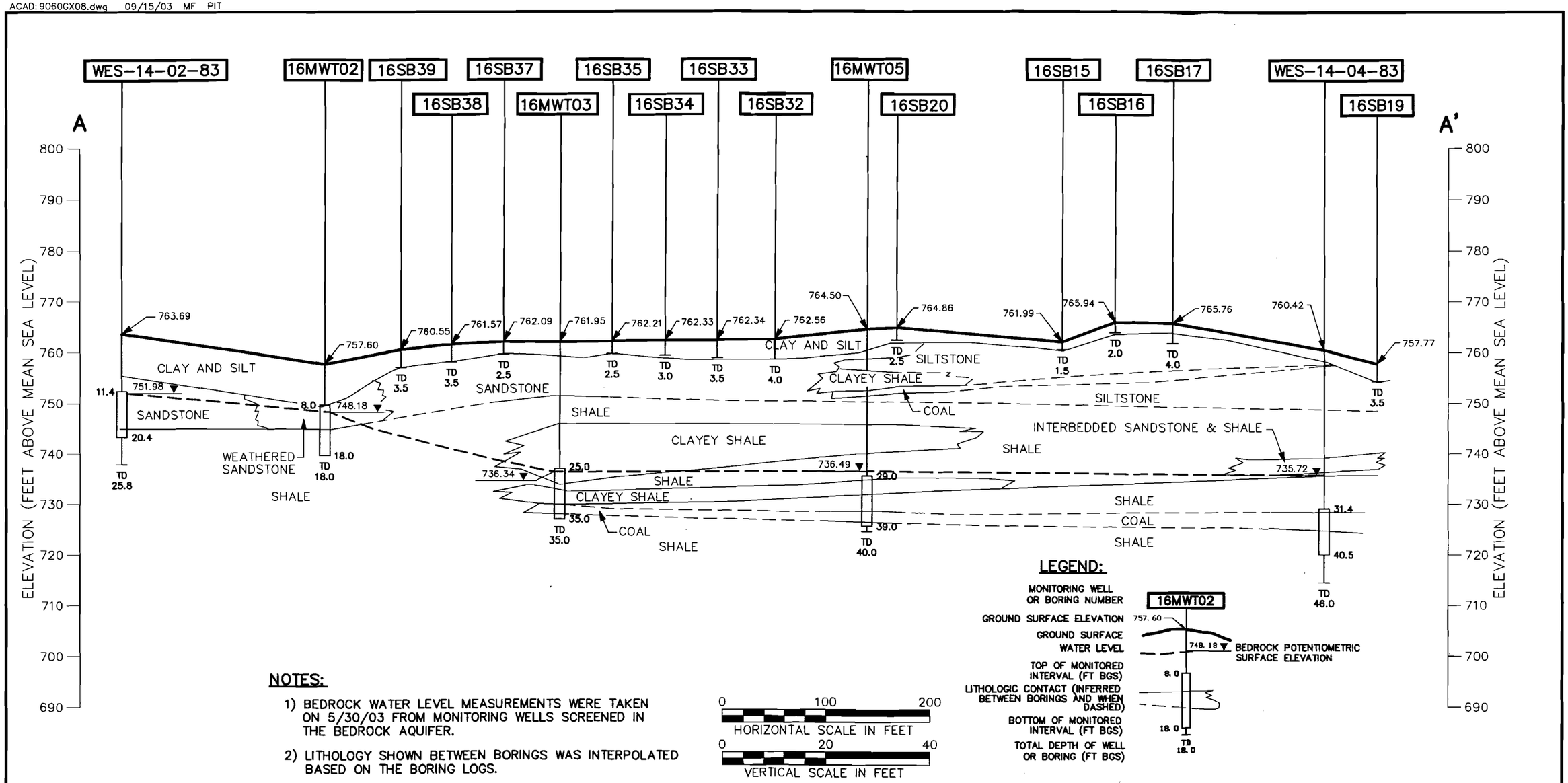


DRAWN BY	DATE
A. JANOCHA	7/09/03
CHECKED BY	DATE
B. BALKOVEC	7/22/03
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

HYDROGEOLOGIC CROSS SECTION MAP
B146 INCINERATOR/ CAST HIGH EXPLOSIVES FILL (SWMU 16)
NSWC CRANE
CRANE, INDIANA

CONTRACT NUMBER	
9060	
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
DRAWING NO.	REV
FIGURE 1 - 8	0

ACAD: 9060GX08.dwg 09/15/03 MF PIT



NOTES:

1) BEDROCK WATER LEVEL MEASUREMENTS WERE TAKEN ON 5/30/03 FROM MONITORING WELLS SCREENED IN THE BEDROCK AQUIFER.
2) LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.
3) ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

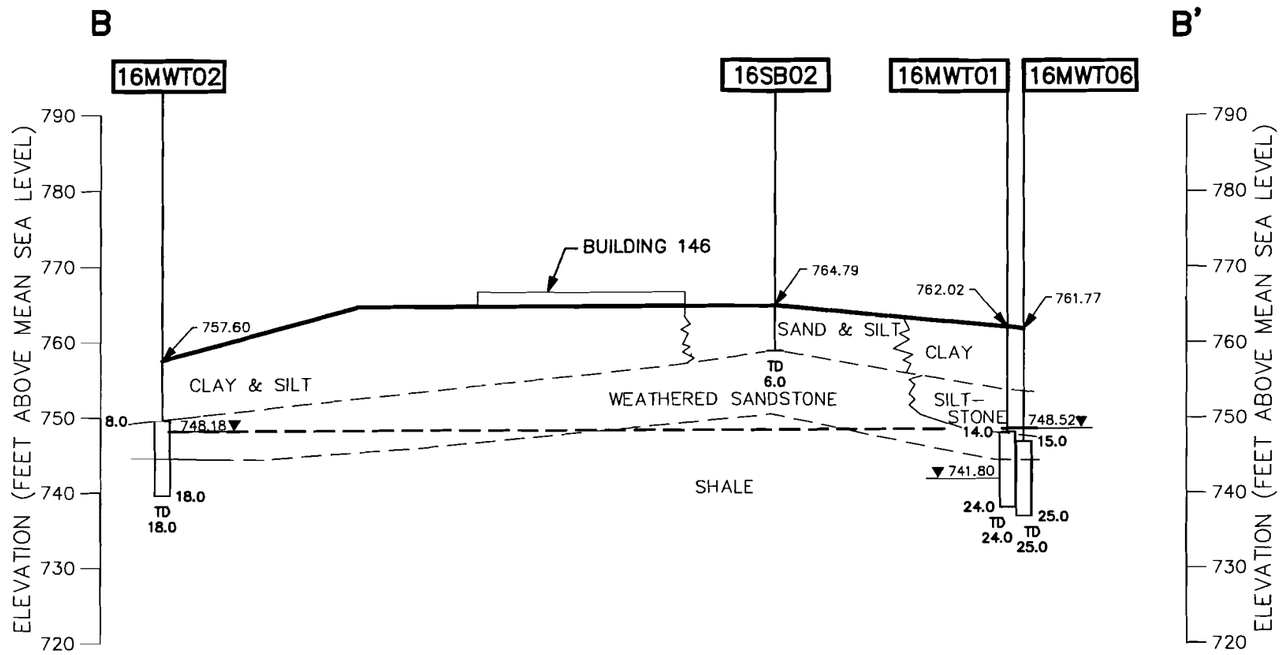
DRAWN BY DM DATE 8/21/03
CHECKED BY JS DATE 9/12/03
COST/SCHED-AREA
SCALE AS NOTED

HYDROGEOLOGIC CROSS SECTION A-A'
SWMU 16 CAST HIGH
EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE, INDIANA

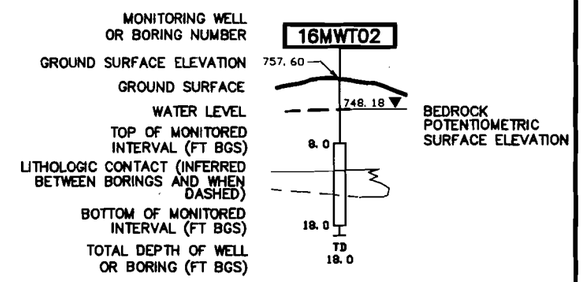
CONTRACT NO. 9060
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1-9
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD:9060GX09.dwg 09/15/03 MF PIT



LEGEND:



0 60 120
HORIZONTAL SCALE IN FEET

0 20 40
VERTICAL SCALE IN FEET

NOTES:

1) BEDROCK WATER LEVEL MEASUREMENTS WERE TAKEN ON 5/30/03 FROM MONITORING WELLS SCREENED IN THE BEDROCK AQUIFER.

2) LITHOLOGY SHOWN BETWEEN BORINGS WAS INTERPOLATED BASED ON THE BORING LOGS.

3) ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 8/21/03
CHECKED BY JS DATE 9/12/03
COST/SCHED-AREA
SCALE AS NOTED

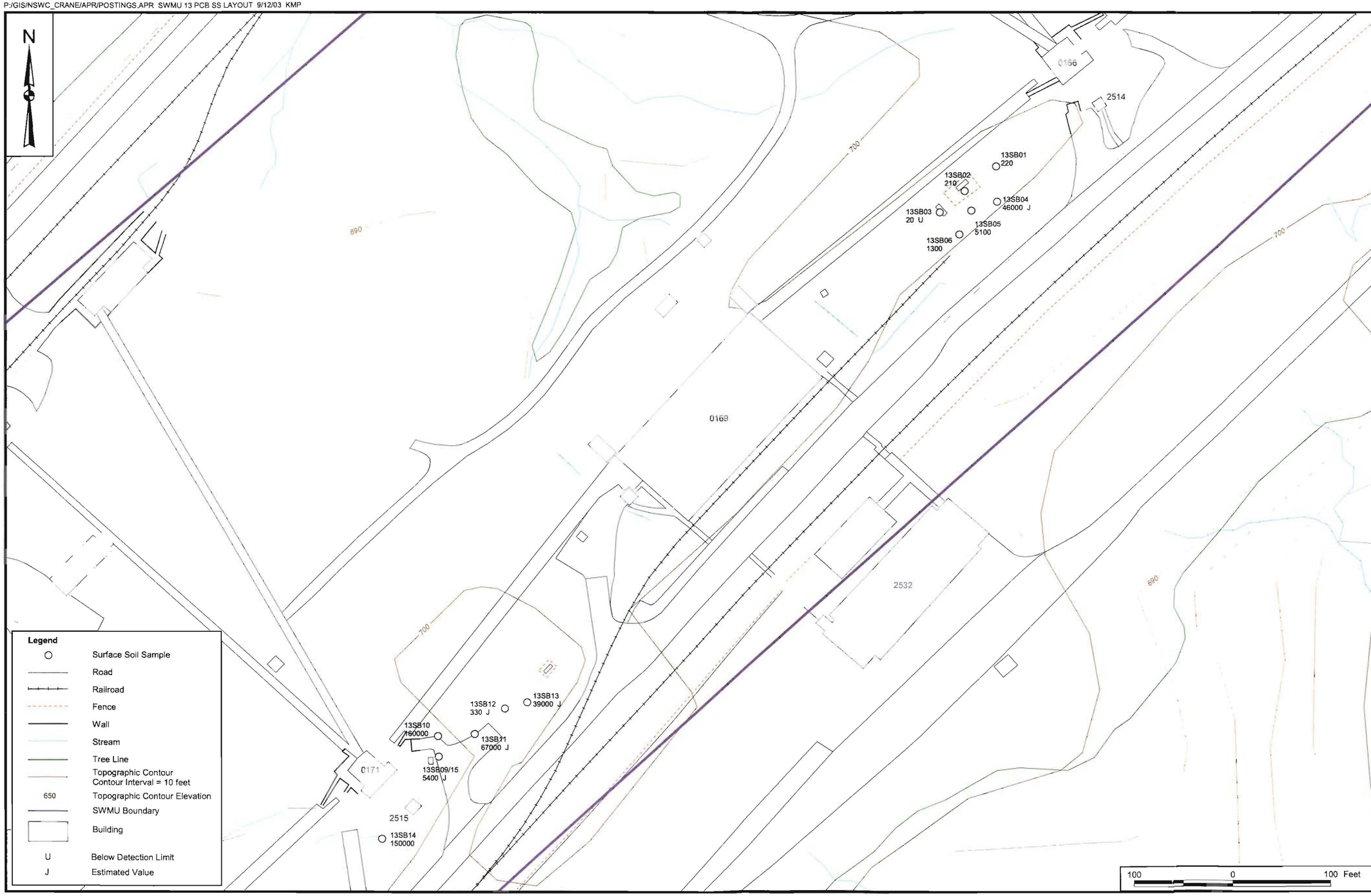
DEPARTMENT OF THE NAVY · SOUTHERN DIV FACILITIES ENGINEERING COMD

HYDROGEOLOGIC CROSS SECTION B–B'
SWMU 16 CAST HIGH
EXPLOSIVES FILL/B146 INCINERATOR
NSWC CRANE
CRANE INDIANA

CONTRACT NO. 9060
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 1–10
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PCB SS LAYOUT 9/12/03 KMP



CONTRACT NO.
3994

APPROVED BY	DATE
T. JOHNSTON	9/05/03
APPROVED BY	DATE

DRAWING NO. 1 - 11

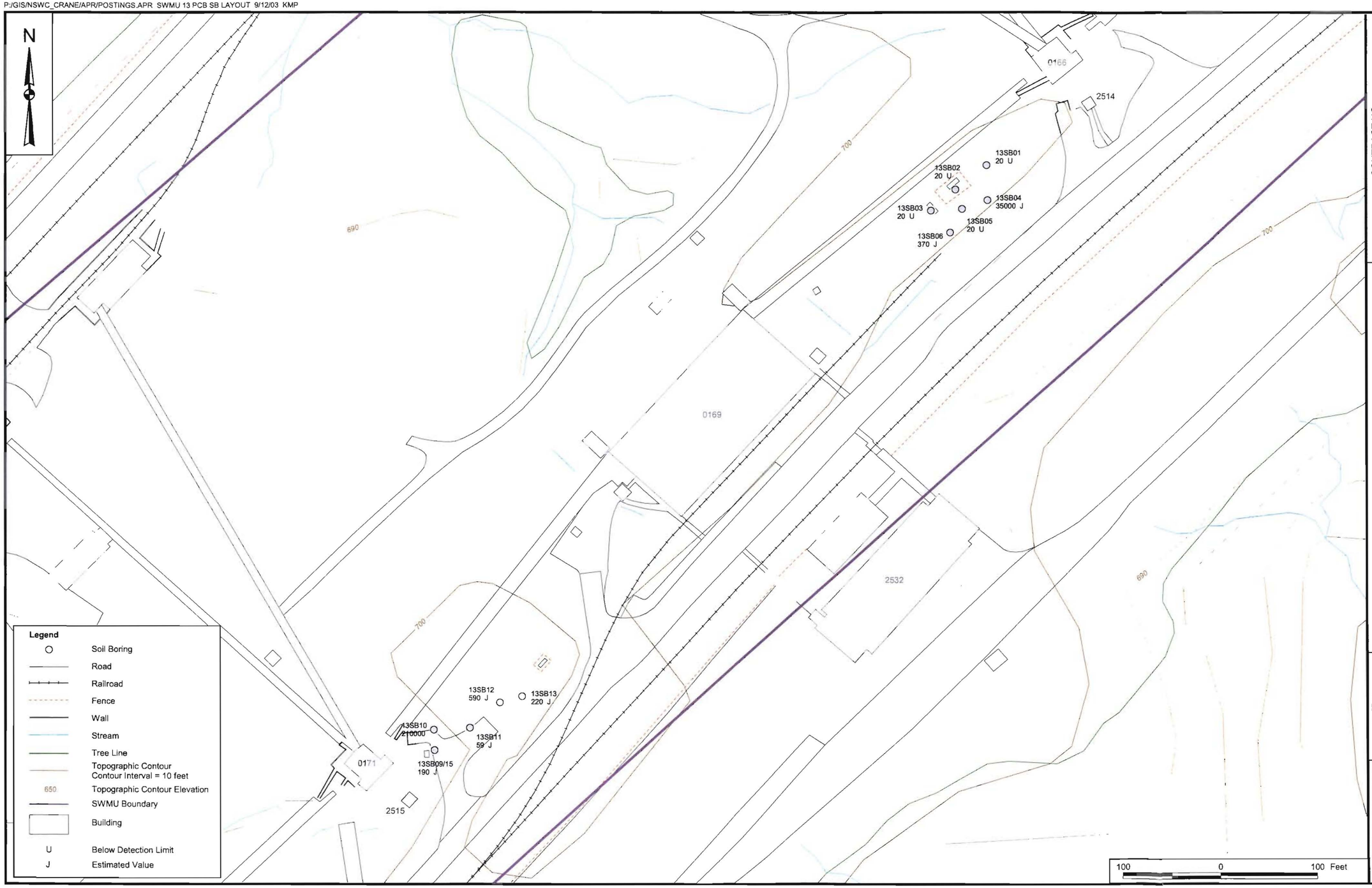
REV 0

AROCLOR-1248 CONCENTRATIONS IN
SURFACE SOIL (ug/kg)
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
T. JOHNSTON	9/05/03
COST/SCHED-AREA	

SCALE
AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PCB SB LAYOUT 9/12/03 KMP



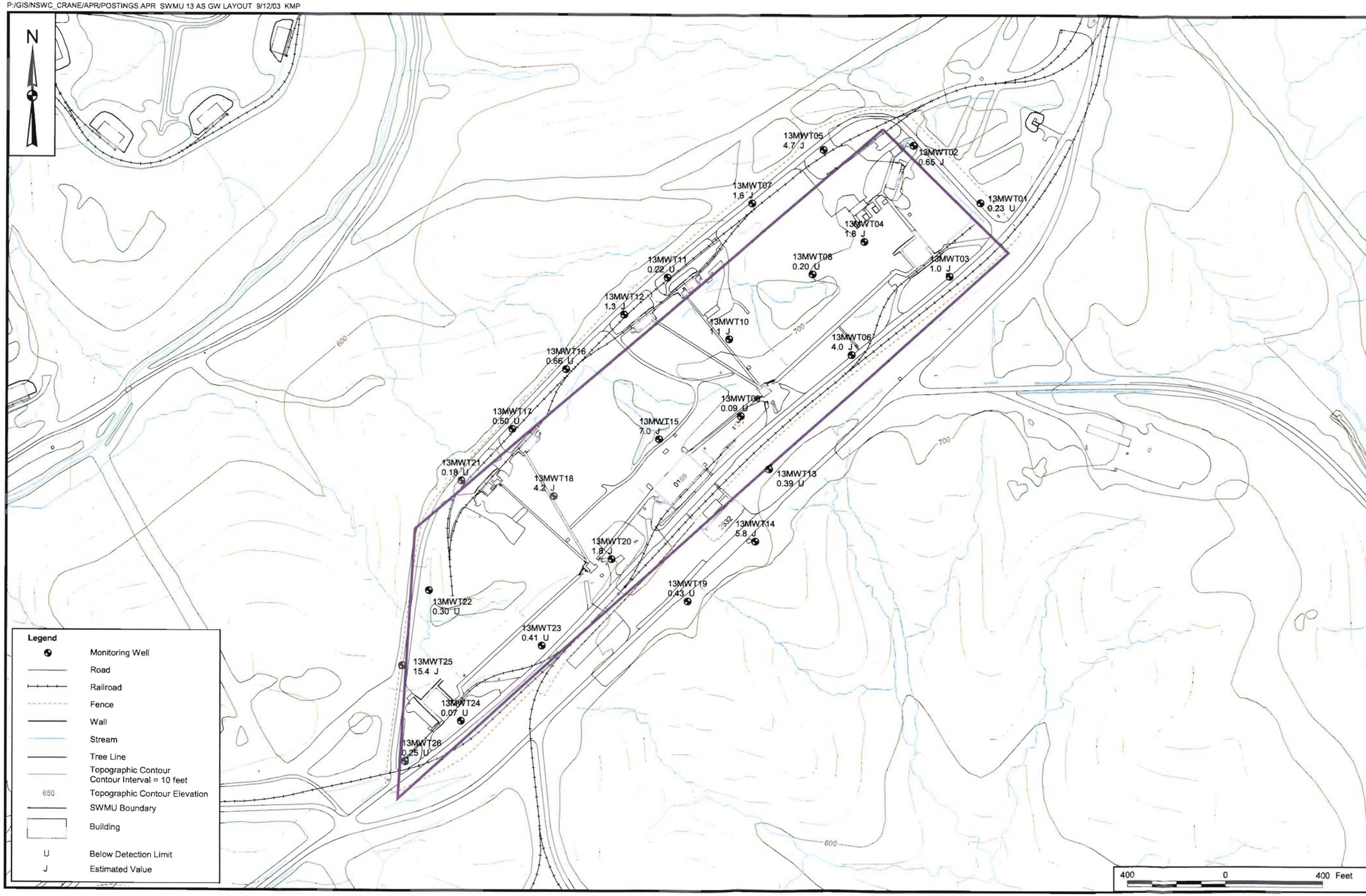
CONTRACT NO.
3994

APPROVED BY T. JOHNSTON	DATE 9/05/03	
APPROVED BY	DATE	
DRAWING NO. 1 - 12		REV 0

AROCLOR-1248 CONCENTRATIONS IN
SUBSURFACE SOIL (ug/kg)
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DRAWN BY A. JANOCHA	DATE 9/05/03	
CHECKED BY T. JOHNSTON	DATE 9/05/03	
COST/SCHED-AREA		SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS APR SWMU 13 AS GW LAYOUT 9/12/03 KMP



CONTRACT NO.
3994

APPROVED BY	DATE
T. JOHNSTON	9/05/03
APPROVED BY	DATE

DRAWING NO. 1 - 13

REV 0

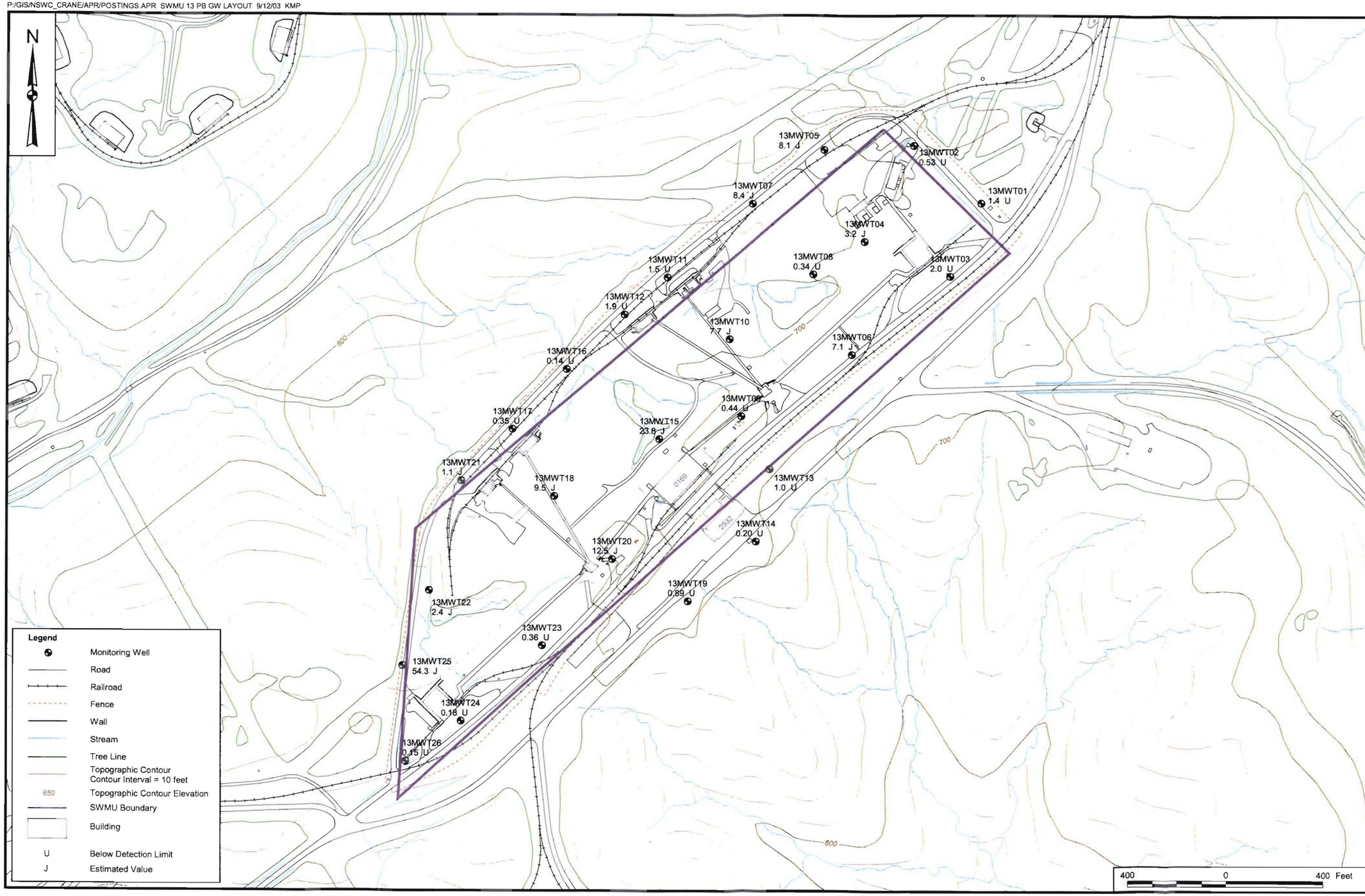
TOTAL ARSENIC CONCENTRATIONS IN
GROUND WATER (ug/L)
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
T. JOHNSTON	9/05/03

COST/SCHED-AREA

SCALE
AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 PB GW LAYOUT 9/12/03 KMP



CONTRACT NO. 3994

APPROVED BY	DATE
T. JOHNSTON	9/05/03
APPROVED BY	DATE

DRAWING NO. 1 - 14

REV 0

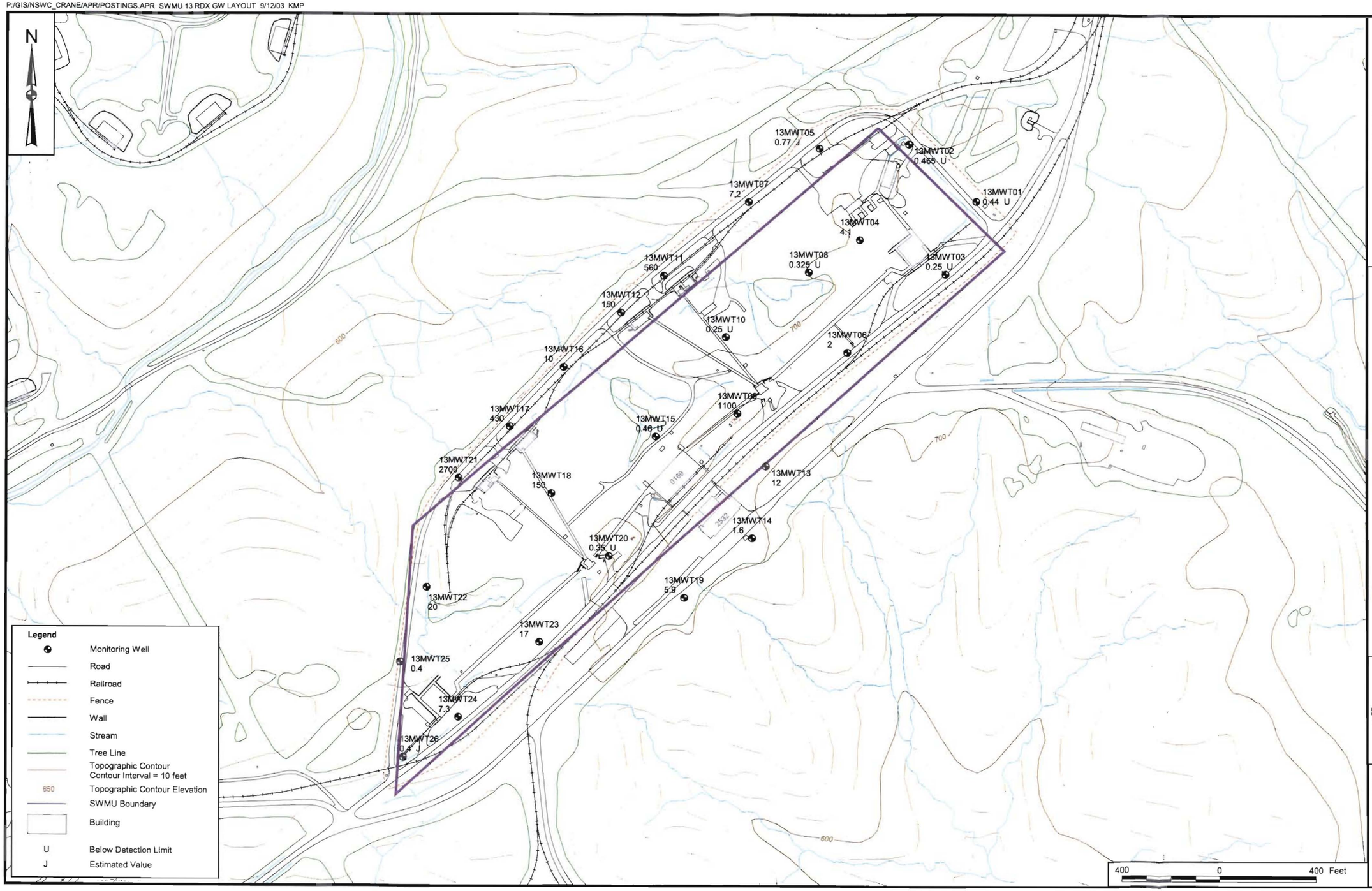
TOTAL LEAD CONCENTRATIONS IN GROUND WATER (ug/L) MINE FILL B (SWMU 13) NSWC CRANE CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIV FACILITIES ENGINEERING COMD *

DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
T. JOHNSTON	9/05/03
COST/SCHED-AREA	

SCALE AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 RDX GW LAYOUT 9/12/03 KMP



CONTRACT NO.
3994

APPROVED BY	DATE
T. JOHNSTON	9/05/03
APPROVED BY	DATE

DRAWING NO. 1 - 15

REV 0

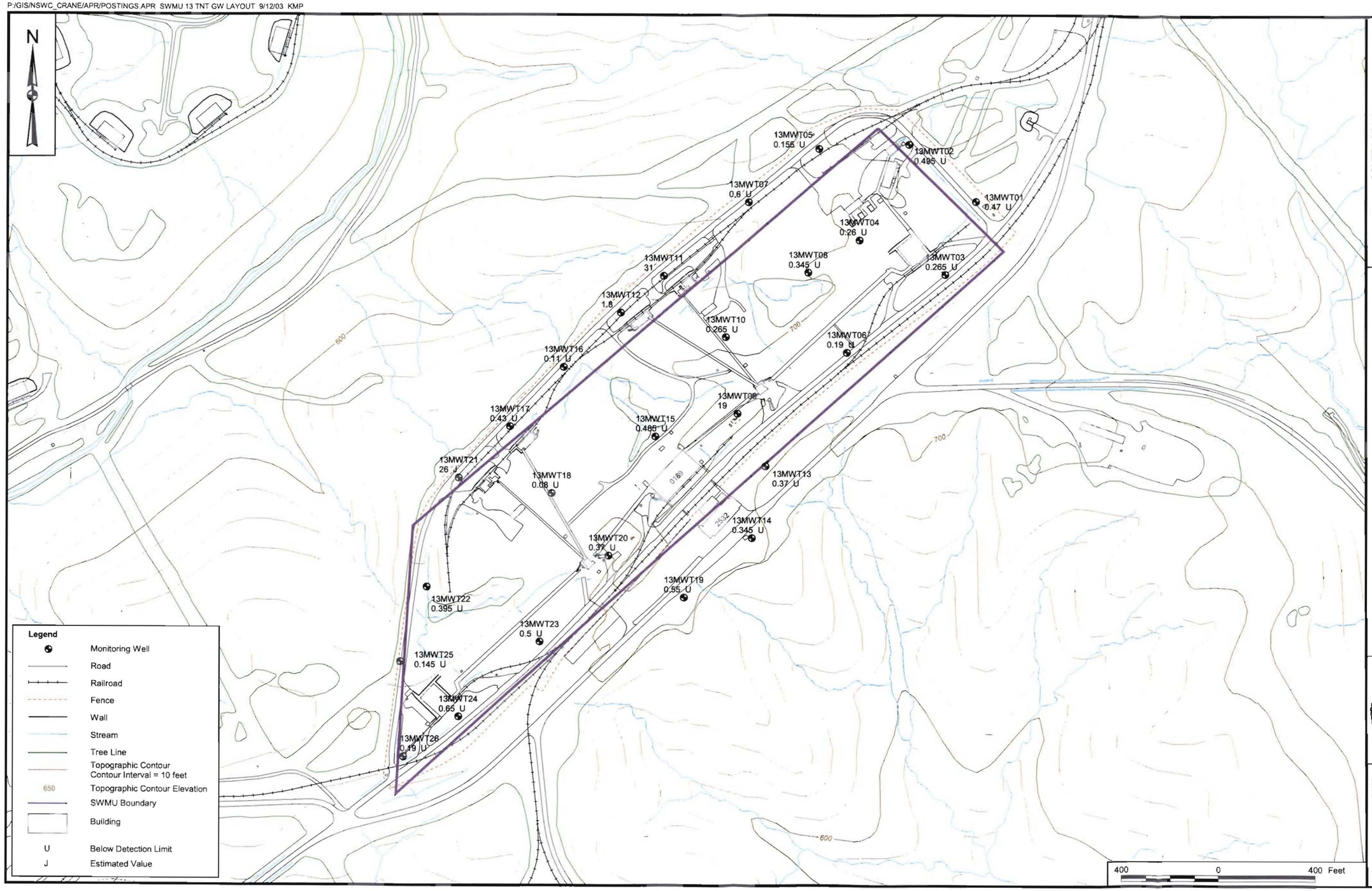
RDX CONCENTRATIONS IN
GROUND WATER (ug/L)
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
T. JOHNSTON	9/05/03

COST/SCHED-AREA

SCALE
AS NOTED

P:/GIS/NSWC_CRANE/APR/POSTINGS.APR SWMU 13 TNT GW LAYOUT 9/12/03 KMP



CONTRACT NO.
3994

APPROVED BY	DATE
T. JOHNSTON	9/05/03
APPROVED BY	DATE

DRAWING NO. 1 - 16

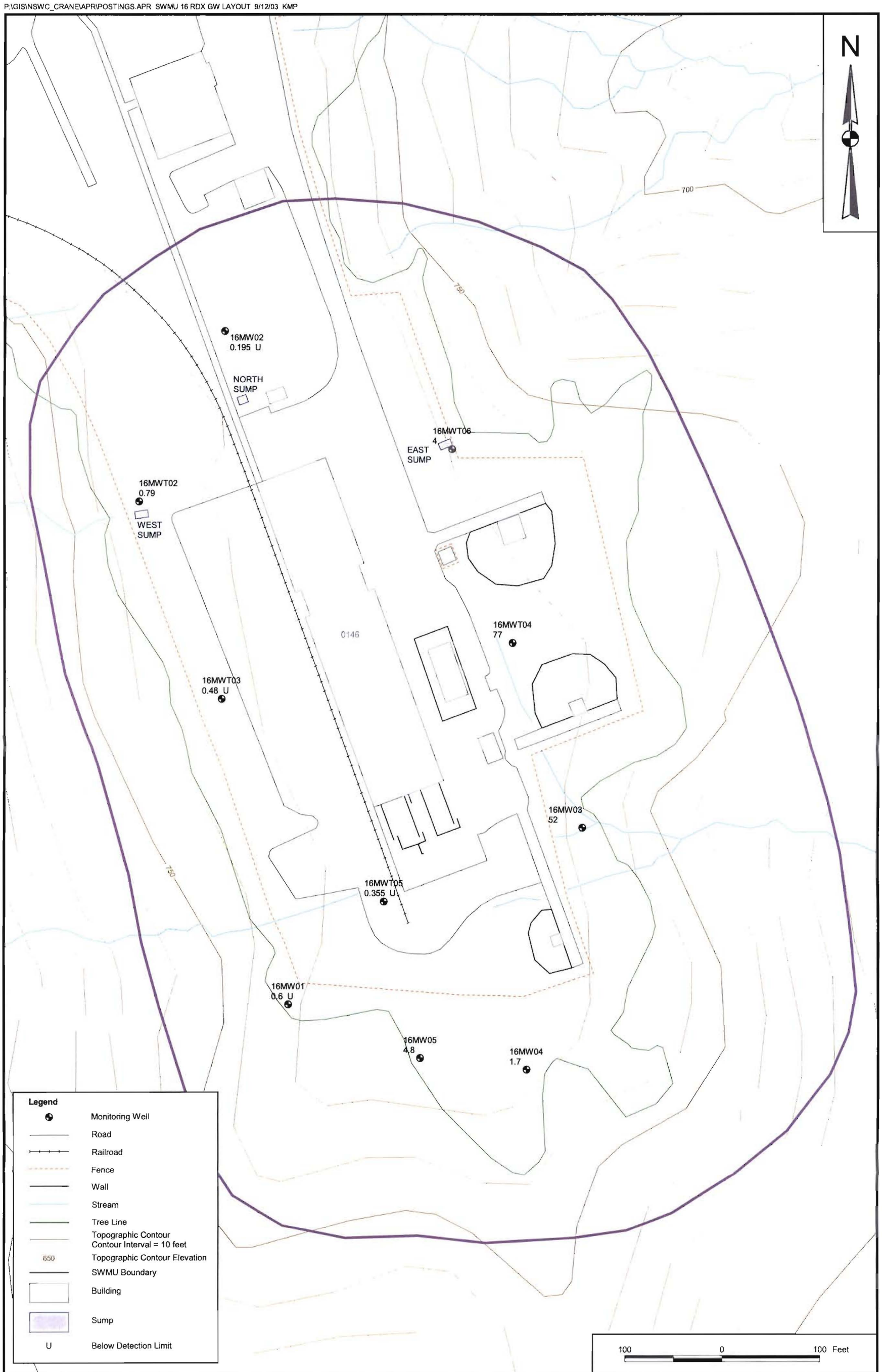
REV 0

2,4,6-TRINITROTOLUENE CONCENTRATIONS IN GROUND WATER (ug/L)
MINE FILL B (SWMU 13)
NSWC CRANE
CRANE, INDIANA

DRAWN BY	DATE
A. JANOCHA	9/05/03
CHECKED BY	DATE
T. JOHNSTON	9/05/03
COST/SCHED-AREA	

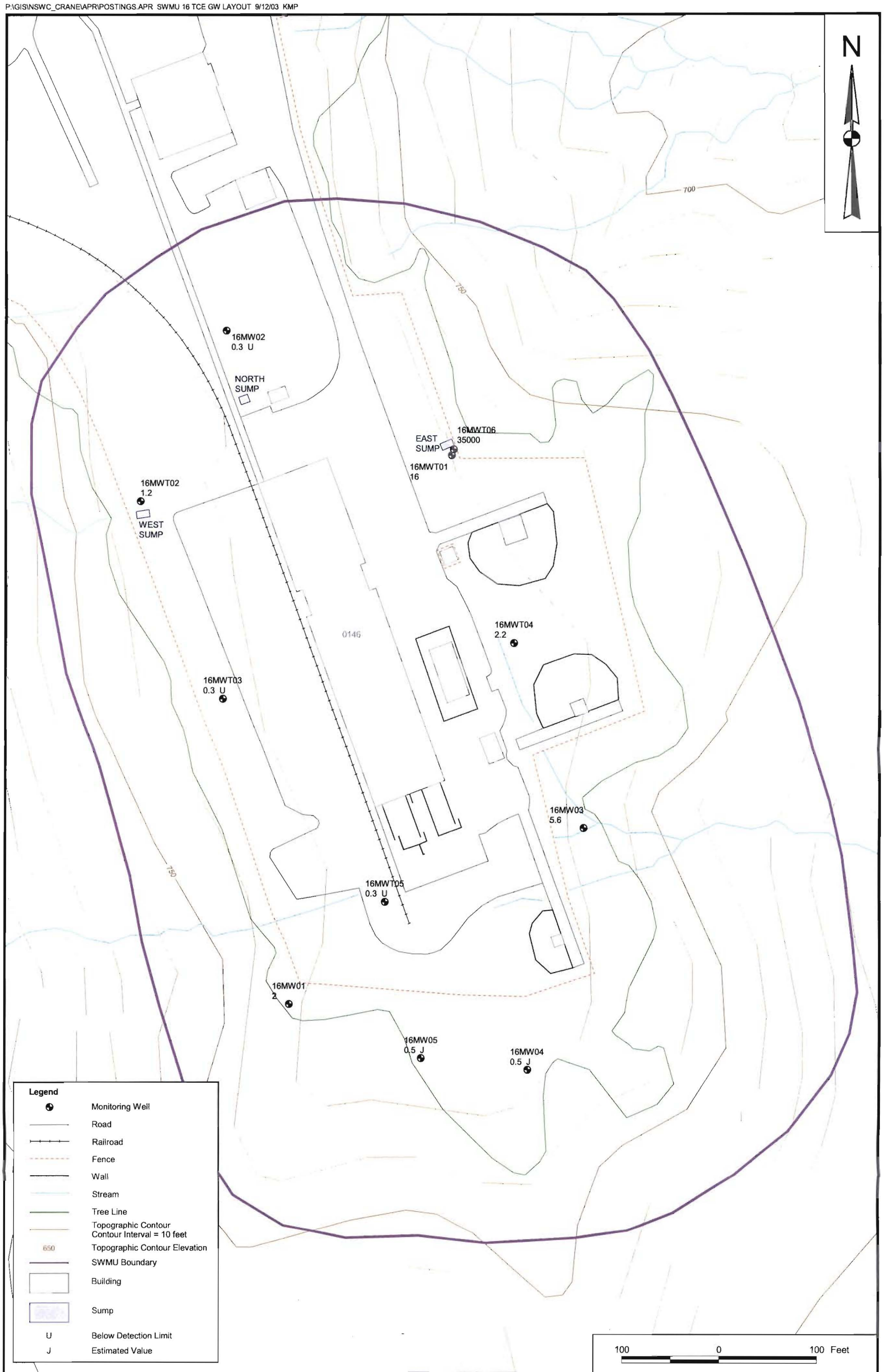
SCALE
AS NOTED

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 RDX GW LAYOUT 9/12/03 KMP



DRAWN BY A. JANOCHA	DATE 9/05/03	RDX CONCENTRATIONS IN GROUND WATER (ug/L)	CONTRACT NUMBER 3994
CHECKED BY T. JOHNSTON	DATE 9/05/03	B146 INCINERATOR/CAST HIGH EXPLOSIVES FILL (SWMU 16)	APPROVED BY T. JOHNSTON — DATE 9/05/03
COST/SCHEDULE-AREA		NWSC CRANE	APPROVED BY — — DATE —
SCALE AS NOTED		CRANE, INDIANA	DRAWING NO. 1 - 17 — REV 0

P:\GIS\NSWC_CRANE\APR\POSTINGS.APR SWMU 16 TCE GW LAYOUT 9/12/03 KMP



DRAWN BY A. JANOCHA	DATE 9/05/03	TRICHLOROETHENE CONCENTRATIONS IN GROUND WATER (ug/L) B146 INCINERATOR/CAST HIGH EXPLOSIVES FILL (SWMU 16) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY T. JOHNSTON	DATE 9/05/03		APPROVED BY T. JOHNSTON — DATE 9/05/03
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. 1 - 18 — REV 0

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the project management and organization for conducting field operations at NSWC Crane SWMUs 12 (Round 1), 13, and 16 (Round 2). Staffing and coordination requirements are described in Section 2.0 of the approved Contract Task Order (CTO) 0166 QAPP (TtNUS, 2003). Table 2-1 and Figure 2-1 were updated to include the most current contact information for the involved parties and are included in this section.

Laucks Testing Laboratories, Inc. of Seattle, Washington will perform all sample analyses for this field activity with the exceptions of the field analyses and the gases ethane, ethene, and methane. These gas analyses will be conducted by Microseeps, Inc. of Pittsburgh, Pennsylvania.

The subcontracted laboratories are responsible for analyzing all samples in accordance with the analytical methods and additional requirements specified in the attendant QAPP. It also will be the analytical laboratory's responsibility to properly dispose of unused sample aliquots. Responsibilities of key laboratory personnel are outlined in Section 2.2.6 of the approved CTO 0166 QAPP (TtNUS, 2003). Although an unexploded ordnance (UXO) specialist is identified in Sections 2.3 and 2.3.4 of the approved CTO 0166 QAPP, no UXO concerns exist for the work conducted under this QAPP Addendum No. 1 and a UXO specialist is not required. All other personnel and training requirements identified in the approved CTO 0166 QAPP apply.

TABLE 2-1

KEY PROJECT PERSONNEL FOR SWMUs 12, 13, AND 16
NAMES, PHONE NUMBERS, AND ADDRESSES
NSWC CRANE
CRANE, INDIANA
PAGE 1 OF 2

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Peter Ramanauskas Project Manager U.S. EPA Region 5	EPA Region 5 77 West Jackson Blvd. Chicago, Illinois 60604	(312) 886-7890 FAX: (312) 353-4788
Allen Debus QA Coordinator U.S. EPA Region 5	EPA Region 5 77 West Jackson Blvd. Chicago, Illinois 60604	(312) 886-6186
Marty Harmless Office of Solid and Hazardous Waste Management IDEM	Office of Solid and Hazardous Waste Management 100 N. Senate Avenue Indianapolis, Indiana 46206-6015	(317) 234-0597
Doug Griffin Corrective Action Section Office of Land Quality Hazardous Waste Permits IDEM	Corrective Action Section Office of Land Quality Hazardous Waste Permits 100 N. Senate Avenue P. O. Box 6015 Indianapolis, Indiana 46206-6015	(317) 233-2710
Bill Gates Remedial Project Manager U.S. Navy SOUTHNAVFACENGCOM	Department of Navy SOUTHNAVFACENGCOM Code 1864 2155 Eagle Drive Charleston, South Carolina 29406	(843) 820-7360 FAX: (843) 820-7465
Tom Brent Environmental Site Manager NSWC Crane	NSWC Crane Code 095 B-3245 300 Highway 361 Crane, Indiana 47522-5009	(812) 854-6160 FAX: (812) 854-3981
Debbie Wroblewski Program Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8968 FAX: (412) 921-4040
Paul Frank Quality Assurance Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8950 FAX: (412) 921-4040
Matt Soltis Health and Safety Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8912 FAX: (412) 921-4040
Ralph Basinski Task Order Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8308 FAX: (412) 921-4040
Terry Rojahn Field Operations Leader Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8857 FAX: (412) 921-4040

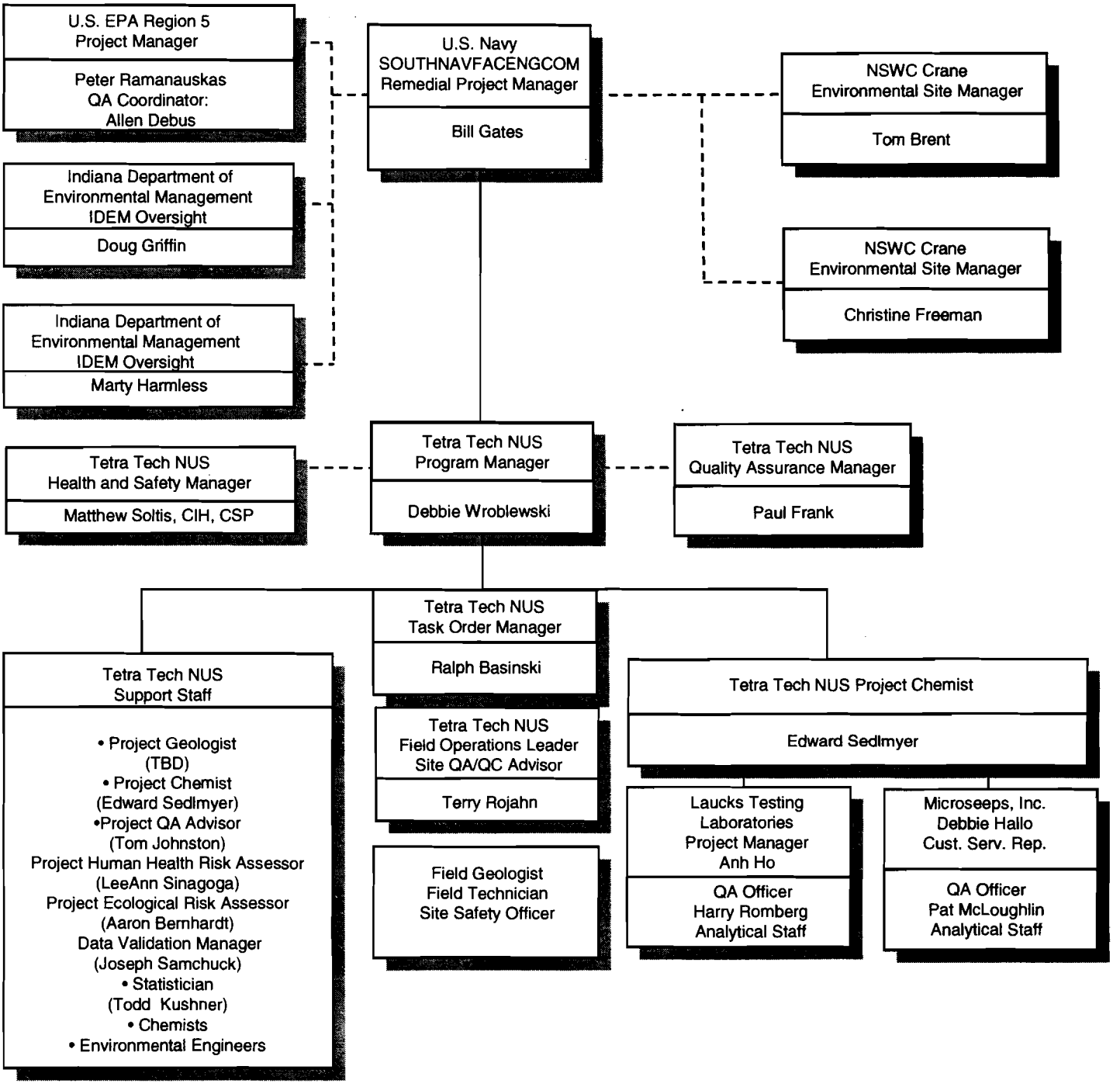
TABLE 2-1

KEY PROJECT PERSONNEL FOR SWMUs 12, 13, AND 16
NAMES, PHONE NUMBERS, AND ADDRESSES
NSWC CRANE
CRANE, INDIANA
PAGE 2 OF 2

PERSON / TITLE / ORGANIZATION	ADDRESS	TELEPHONE
Joseph Samchuck Data Validation Manager Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Anderson Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8510 FAX: (412) 921-4040
Keith Henn Program Geologist Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8146 FAX: (412) 921-4040
Ed Sedlmyer Project Chemist Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-7273 FAX: (412) 921-4040
Tom Johnston Quality Assurance Advisor Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Anderson Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8615 FAX: (412) 921-4040
Todd Kushner Statistician Tetra Tech NUS	Tetra Tech NUS, Inc. 661 Anderson Drive Pittsburgh, Pennsylvania 15220-2745	(412) 921-8539 Fax: (412) 921-4040
Anh Ho Project Manager Laucks Testing	Laucks Testing, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 957-2433 FAX: (206)767-5063
Harry Romberg Lab QA Manager Laucks Testing	Laucks Testing, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 767-5060 FAX: (206)767-5063
Kathy Krepps Lab Operations Manager Laucks Testing	Laucks Testing, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 767-5060 FAX: (206)767-5063
Mike Baxter/Ted Matts Lab Sample Custodian Laucks Testing	Laucks Testing, Inc. 940 South Harney Street Seattle, Washington 98108	(206) 767-5060 FAX: (206)767-5063
Debbie Hallo Customer Service Representative Microseeps, Inc.	Microseeps, Inc. 220 William Pitt Way Pittsburgh, Pennsylvania 15238	(412) 826-5245 FAX: (412) 826-3433
Pat McLoughlin QA Director Microseeps, Inc.	Microseeps, Inc. 220 William Pitt Way Pittsburgh, Pennsylvania 15238	(412) 826-5245 FAX: (412) 826-3433

FIGURE 2-1

PROJECT ORGANIZATION CHART
SWMU 12 (Round 1), SWMU 13 (Round 2), AND
SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA



3.0 SAMPLING AND ANALYSIS PLAN

3.1 GENERAL APPROACH

This section describes sampling locations and rationales for the sampling activities and the equipment and procedures to be used for collecting, handling, preserving, and shipping the samples to the analytical laboratories. The text references standard operating procedures (SOPs) (included in Appendix E) and the Health and Safety Plan (HASP), when applicable.

Prior to sampling, the Task Order Manager (TOM) will ensure that all field personnel read and understand QAPP Addendum No. 1 and the HASP, the Field Operations Leader (FOL) will ensure that all required field equipment for non-health-and-safety-related operations is available and operational, and the Site Safety Officer (SSO) will ensure that all health-and-safety-related equipment is available and operational.

Investigations at the following three SWMUs are described in this Sampling and Analysis Plan:

- Mine Fill A (SWMU 12) – Round 1 Sampling
- Mine Fill B (SWMU 13) – Round 2 Sampling
- Cast High Explosives Fill (SWMU 16) – Round 2 Sampling

One round of drilling, well installation, and multimedia sampling has already been performed at SWMUs 13 and 16. A second round of drilling, sampling, and site characterization work at these two SWMUs is described in this QAPP Addendum No. 1 and is intended to further delineate the areas of contamination identified in the first sampling round.

SWMUs 12 and 13 each had similar patterns of soils contamination from explosives. The results from the initial round of ground water monitoring at SWMU 13 were used to modify the planned monitoring well network and analyses at SWMU 12. In addition, soil sampling at the SWMU 12 Battery Disposal Site has been added.

3.2 SAMPLE IDENTIFICATION SYSTEM

All samples will be properly labeled with an adhesive-backed sample label affixed to and a tag tied to each sample container in accordance with SOP CTO166-01. The sample labels and tags will include the following information: project name, project location, sample tracking number, sampling date, sampling

time, type of analysis required, matrix type, preservative, initials of sampler, and name of the analytical laboratory to which the sample will be submitted.

Each collected sample will be assigned a unique sample tracking number. The sample tracking number for a soil sample is a four-segment, alphanumeric code beginning with the SWMU identification (12, 13, or 16) followed by codes for the sample type, sample location, and sample depth. The sample tracking number for the other media is a five-segment, alphanumeric code identifying the SWMU ID, sample type, sample location, sampling round, and filtering indicator (for aqueous samples only). These numbering schemes are described in SOP CTO166-02. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets.

The sampling time recorded on the chain-of-custody form and labels for duplicate samples will be 0000 so that the duplicate samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

Matrix spike and matrix spike duplicate (MS/MSD) samples will be designated on the field documentation and chain-of-custody forms (see SOP CTO166-03).

3.3 UNEXPLODED ORDNANCE AVOIDANCE

The activities performed at each of the SWMUs, which included ordnance testing, test loading, and manufacturing, were performed using good housekeeping practices. The potential for encountering buried UXO is low, and proposed borings have been located in areas with the least likelihood of encountering UXO while still achieving project objectives. None of the borings, soil excavations, or other intrusive activities to date at the three SWMUs have encountered any UXO material. However, specific boring locations as identified by NSWC Crane may require screening using a magnetometer to check for the presence of UXO in accordance with the HASP. Prior to the initiation of intrusive site activities, a meeting will be held with NSWC Crane staff to determine whether any boring locations may require UXO screening. If potential ordnance is encountered during investigative activities, the activities will stop and the Crane Environmental Site Manager will be notified.

UXO screening is not anticipated to be conducted at SWMUs 12, 13, or 16. At SWMUs 12 and 13, only granular explosives were released, and most soils contaminated with explosives have been remediated. At SWMU 16, no ordnance items were managed on the ground. Released materials consisted only of ash and slag. UXO screening is conducted with a magnetometer, which is sensitive to magnetic material.

Bulk explosives are not magnetic and would not be detected by a magnetometer. Visual inspection will be used to detect whether bulk explosives may be present.

All measurements (listed in Table 3-1) made with field instruments, and visual observations concerning the subsurface materials encountered will be recorded on boring log sheets. Any encounters with metallic objects or discolored soil materials and any above-background measurements of VOCs will be immediately reported to the FOL and the SSO, and appropriate actions will be taken as specified in the HASP.

3.4 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES

This section presents sampling locations, quality assurance/quality control (QA/QC) samples to be collected, analyses to be performed, and rationales for the sampling and analytical program. Details regarding the preserving, packaging, and shipping of the samples are included in Section 3.7. Sampling locations are shown on Figures 3-1 through 3-9.

3.4.1 Surface and Subsurface Soils

Surface and subsurface soil samples will be collected at SWMUs 12, 13, and 16, as described in the remainder of this section. The analyses to be performed on each soil sample are listed in Table 3-2. The rationales for parameter selection are discussed in Sections 1.4.1, 1.4.2, and 1.4.3 and detailed on Tables 1-6 and 1-7.

Surface and subsurface soil sampling will most likely be performed using DPT soil sampling techniques at SWMU 12 and hand augering techniques at SWMUs 13 and 16. However, some borings may be completed using hand augering, hollow-stem auger (HAS) drilling with split-spoon sampling, or other coring technology (e.g., Rotosonic drilling). All soil samples for VOC analyses will be collected with an Encore™ sampler immediately upon opening the split spoon or DPT sampler. Details regarding soil sampling equipment and procedures are included in Section 3.5.2 and SOP CTO166-04.

QA/QC samples will be collected at frequencies listed in Table 3-3. Duplicate samples and rinsate blanks will be collected at a rate of one for every 10 regular soil samples and analyzed for the same analytes as the corresponding soil samples. MS/MSD samples will be collected and analyzed at a rate of one for every 20 soil samples. A trip blank will be placed in every cooler containing samples destined for VOC analyses. The total number of soil analyses for each analyte group is tabulated in Table 3-3.

3.4.1.1 SWMU 12 - Mine Fill A Soil Sampling Activities

Figure 3-1 presents locations of 11 soil borings to be completed within the SWMU 12 fenced area during this investigation.

As previously discussed, investigation and remediation of soils have been performed at Mine Fill A as part of the installation of a bioremediation facility and conformation sampling has been conducted. However, no soil sampling has been performed in the vicinity of a conical-shaped asphalt pad as observed during a site visit performed by TtNUS in June 2001. Therefore, one soil boring (12SB01) is proposed for this area (immediately adjacent to the pad on the downslope edge along a ditch) to determine whether any soil contamination is present as a result of activities performed at this pad. The boring will be sampled at two depth intervals, including one sample at 0 to 2 feet bgs and a second sample immediately above the water table or the bedrock surface (if encountered first).

Two soil borings (12SB02 and 12SB03) will be installed and sampled to establish soil properties (TOC, CEC, and pH) for the soil replacement areas that were treated and returned from the bioremediation facility. Each boring will be sampled at two depth intervals, including one sample at 0 to 2 feet bgs and a second sample immediately above the water table or the bedrock surface (if encountered first).

Four soil borings each will be installed along the edges of settling basins located at structures 3110 (12SB04 through 12SB07) and 3037 (12SB08 through 12SB11) to evaluate whether leakage may have occurred. Each boring will be sampled at one surface (0 to 2 feet bgs) and two subsurface depth intervals (above the water table). Specific subsurface depths will be determined in the field based on whether waste materials or obvious contamination (i.e., soil staining) are observed during drilling. If no waste or obvious contamination is encountered during drilling, then the shallow subsurface sample will be collected from a depth representative of the middle depth of the settling basin. The deep subsurface sample will be collected from a depth representative of the bottom of the settling basin but not below the water table.

Nine additional soil borings (12SB12 through 12SB20) will be collected from the Battery Disposal Site Area, which is located outside the fenced area on the south side of SWMU 12 (Figure 3-2). The soil samples from these borings will be used to determine whether the interim removal action has removed contamination from the disposal of batteries and explosives-contaminated soils. Each soil boring will be sampled at one surface (0-2 feet bgs) and two subsurface depth intervals (see Table 3-2). Specific subsurface depths will be determined in the field based on whether waste materials or obvious contamination (i.e., soil staining) is observed during drilling.

A total of 29 soil samples will be collected and analyzed for VOCs and SVOCs. These same 29 samples plus 24 additional samples will be analyzed for explosives and metals (see Table 3-2). Figures 3-1 and 3-2 show the locations of these samples.

3.4.1.2 SWMU 13 - Mine Fill B Soil Sampling Activities

Figure 3-3 presents locations for 10 soil borings to be completed as part of the Round 2 sampling activities at MFB. The soil samples from these borings will be used to help delineate the extent of PCB contamination around the two former Therminol boilers that were the source of PCBs. As previously discussed in Section 1.0, PCB soil contamination exists in the vicinity of Buildings 166 and 171 due to historical leakage from the Therminol boilers. The boilers and some soil have been removed, but PCBs at concentrations greater that 10 mg/kg still remain in these areas. During Round 1 sampling activities, 12 soil borings (13SB01 through 13SB06 and 13SB10 through 13SB15) were completed immediately outside the known areas of soil removal to determine whether any residual PCBs are present. One surface soil sample (0 to 2 feet bgs) and one subsurface soil sample (2 to 4 feet bgs) was collected from each boring. The results of these soil analyses show that the extent of PCB contamination was not delineated.

Ten new borings (13SB16 through 13SB25) will be completed around the perimeters of the areas where previous borings were installed (see Figure 3-3) to help define the lateral extent of PCB contamination in these two areas. Soils will be cored to a depth of 4 feet, and two samples will be collected from each boring (0 to 2 and 2 to 4 feet bgs) as listed in Table 3-2. If obvious soil staining is observed in any of these borings, it will be described on the boring log. In addition, at the discretion of the site geologist, the boring may be advanced to a depth of 6 feet and a second subsurface soil sample may be collected from a depth of 4 to 6 feet bgs. All soil samples collected at SWMU 13 will be analyzed for PCBs only (Table 3-2).

3.4.1.3 SWMU 16 - Cast High Soil Sampling Activities

Figure 3-6 presents locations for five surface soil and four subsurface soil samples to be collected as part of the Round 2 sampling activities at this SWMU. The soil samples from these borings will be used to help delineate the extent of metals contamination to the south and southeast of the SWMU and VOC contamination downgradient of previous soil boring 16SB39. As previously discussed in Section 1.3, metal contamination exists in surface soils in this area. The metals are expected to have been deposited aerially from incinerator operations but may have been released from former ash piles in this area.

During Round 1 sampling activities, several surface and subsurface soil samples were collected along transects leading away from the incinerators to blanket the area surrounding the incinerators and near the former ash piles. The results of these analyses show that metal concentrations in surface soil on the southeast side of the site are elevated. The origin of VOC contaminants is unknown.

At five new locations (16SB42-16SB46), hand auger samples will be collected around the perimeters of the areas where previous borings were installed (see Figure 3-6) to help define the lateral extent of metals contamination in this area. One surface soil sample will be collected to a depth of 2 feet at each new sampling location, as listed in Table 3-2. These surface soil samples will be analyzed for metals only (Table 3-2). VOC samples will be collected at new soil borings 16SB47 through 16SB50 at the depth where the greatest PID reading is obtained.

3.4.2 Ground Water

Ground water will be evaluated at all three SWMUs. Five monitoring wells were installed previously by the USACE at SWMU 16. During the Round 1 investigations at SWMUs 13 and 16, 26 new monitoring wells were installed at SWMU 13 and six new monitoring wells were installed at SWMU 16. No monitoring wells currently exist at SWMU 12.

The general objectives of the ground water investigation at each of the SWMUs will be to determine whether ground water contamination is present and, if present, to define the magnitude and downgradient and vertical extent of ground water contamination at each site. Additional monitoring wells may be required during subsequent investigative rounds to fully meet the objectives; however, the proposed approach is considered a reasonable effort based on the information currently available for each SWMU. Monitoring wells were initially installed to shallow depths in relative proximity downgradient of potential source areas at SWMUs 13 and 16 during Round 1 investigations.

The total depths and screened intervals for each new monitoring well will be determined in the field. However, screen lengths will be approximately 10 feet. Based on observations and information gathered during the drilling of each well boring, the total depth and the placement of the well screen may be adjusted at the discretion of the field geologist or the FOL. Decisions concerning the monitored intervals and well depths will be based on the following (and possibly other) information collected while the well boring is being drilled and logged:

- The specific depths where the initial (shallow) and deeper water-yielding zones are encountered during drilling.
- The specific depths where above-average rates of ground water yield are observed during drilling.
- The specific depths where moderate to heavily fractured rock is encountered.
- The specific depth interval where potential contamination (i.e., VOCs), if any, is noted during drilling.

All of this information will be recorded on the boring log as each well boring is drilled.

Table 3-4 lists the ground water samples and the analyses that will be performed on each sample. One ground water sample will be collected from each newly installed and existing well. For the newly installed wells, the sample IDs will have a "01" included to signify that the sample is the first one collected for that well. For the existing wells, which have already been sampled once, the new sample IDs will have a "02" included in the ID to identify it as a Round 2 sample.

During low-flow well sampling, the temperature, specific conductance, pH, dissolved oxygen, ORP, and turbidity of the ground water will be measured and recorded for each well. If the turbidity of the ground water samples cannot be reduced to less than 10 nephelometric turbidity units (NTUs) during low-flow sampling, an aliquot of water will be filtered (see SOP CTO166-05) and analyzed for dissolved metals in addition to total metals.

The total number of ground water samples to be analyzed for each analyte group is listed in Table 3-5. The numbers of field QA/QC samples to be collected and analyzed are also listed in Table 3-5. One duplicate sample will be collected for every 10 ground water samples. The duplicate samples will be preferentially collected from monitoring wells that appear to be contaminated (based on visual evidence, odor, screening data, or analytical data from a previous sample). This will provide the greatest opportunity for computing a precision estimate with detectable analyte concentrations. One MS/MSD sample will be collected and analyzed for every 20 ground water samples analyzed. One rinsate sample will be collected and analyzed for every 10 ground water samples analyzed. A trip blank will be included with each cooler containing samples for VOC analysis. Two source water blanks (tap water and distilled water) will be analyzed to establish whether contaminants may be present in the water used for steam cleaning and decontamination of sampling equipment.

3.4.2.1 SWMU 12 - Mine Fill A Ground Water Sampling

SWMUs 12 and 13 are similar units with similar soil explosive contamination profiles. The design of the ground water monitoring program at SWMU 12 is based on the Round 1 results from SWMU 13. A total

of 49 monitoring wells (12MWT01 through 12MWT49) will be installed at Mine Fill A during the Round 1 field activities described in this QAPP Addendum No.1. Figure 3-4 presents the approximate locations of the 49 monitoring wells. Mine Fill A is located on a topographic high, and it is anticipated that shallow ground water flow will be in a radial pattern away from the site toward topographic low areas (i.e., toward the east, west, and south). It is not known which well(s) (if any) will serve as an appropriate background well until a comprehensive round of water-level measurements is collected and a potentiometric surface map is prepared for this SMWU. The wells are located immediately downgradient of structures where historical soil contamination has been detected (see Section 1.0) and along the perimeter of the SWMU to provide adequate spatial coverage. Several wells (12MWT21, 12TMWT22, 12MWT23, and 12MWT28) are located to provide adequate coverage within the interior areas of the SWMU.

Monitoring wells at this SWMU will be installed into the Pennsylvanian-age bedrock because the soil layer on the ridgetop and sideslopes is likely to be less than 15 feet thick and is seldom saturated (based on previous drilling experience at SWMUs 13 and 16). The total depth of most wells will be relatively shallow (25 to 35 feet bgs) and the wells will be installed so that the well screen intersects the uppermost water-bearing unit at each location. It is anticipated that 7 of the 49 monitoring wells will be installed at greater depths (e.g., 70 to 80 feet bgs), which is still within Pennsylvanian bedrock. The purpose of the deeper wells is to determine whether contaminants have migrated downward near each source area. A list of the wells to be installed and their approximate depths is included in Table 3-6.

All newly installed wells (49 total) will be sampled once during this field effort and analyzed for explosives, explosive degradation products, metals, nitrate plus nitrite, and ammonia (Table 3-4). In addition, 24 of the wells will be analyzed for dissolved oxygen, alkalinity, carbon dioxide, nitrite, ferrous iron, manganese (+2), sulfide, and hydrogen sulfide using field test kits. These data will be used to evaluate the potential for monitored natural attenuation (MNA) as a means for ground water remediation.

3.4.2.2 SWMU 13 - Mine Fill B Ground Water Sampling

A total of 26 monitoring wells (13MWT01 through 13MWT26) were installed at MFB during the Round 1 investigation. Construction information for these wells is included on Table 3-7, and boring logs are included in Appendix F. These existing wells were installed along the SWMU perimeter with the exception of wells 13MWT04, 13MWT08, 13MWT10, 13MWT15, and 13MWT18, which were located in the interior of the SWMU. Ground water contaminated with explosives (RDX and TNT) was detected in several shallow bedrock wells during Round 1 sampling. A total of 21 new monitoring wells (13MWT27 to 13MWT47) may be installed during the Round 2 investigation to better define the lateral and vertical

extent of ground water contamination, primarily on the northwestern and southeastern sides of the SWMU (see Table 3-8). The locations of these wells are presented in Figure 3-5.

Of the 21 new wells, 19 (13MWT27 through 13MWT45) are in positions of primary importance. When these have been installed and sampled, and the analytical results have been evaluated, then the locations and depth of the remaining two wells will be determined.

Of the 21 new wells to be installed, six wells (13MWT28, 13MWT36, 13MWT38, 13MWT41, 13MWT45, and 13MWT46) are relatively deep (e.g., 75 to 90 feet bgs total depth) and will be used to determine whether contamination has migrated downward near the potential source areas. Like the shallow wells, the deeper monitoring wells are also screened in Pennsylvanian bedrock, as the base of the Pennsylvanian bedrock is estimated to be about 135 to 200 feet bgs. Based on the current available data and understanding of the site, it is not anticipated that any monitoring wells will need to penetrate deeper through the Pennsylvanian strata into an underlying Mississippian bedrock aquifer. A list of the wells to be installed and the approximate depths of their screened intervals is included in Table 3-8.

All existing and newly-installed wells (47 total) will be sampled once during this field effort and analyzed for explosives, explosive degradation products, metals, nitrate plus nitrite, and ammonia (Table 3-4). In addition, 24 of the wells will be analyzed for dissolved oxygen, alkalinity, carbon dioxide, nitrite, ferrous iron, manganese (+2), sulfide, and hydrogen sulfide using field test kits. These data will be used to evaluate the potential for MNA as a means for ground water remediation.

3.4.2.3 SWMU 16 - Cast High Explosives Fill Ground Water Sampling

Eleven wells are currently located at SWMU 16 (Figure 3-6). Construction information for these wells is included on Table 3-9, and boring logs are included in Appendix F. Results of the Round 1 ground water analyses show that ground water is contaminated with RDX and TCE in a few areas within this SWMU (discussed in more detail in Section 1.0). The ground water contamination is located primarily at the northern end of the SWMU in the vicinity of the sumps (east sump, west sump, and possibly the north sump, see Figures 1-17 and 1-18). Based on the site topography and the ground water levels measured during the initial Round 1 field investigation, shallow ground water flow is to the east, west, and south.

An additional 11 monitoring wells (16MWT07 through 16MWT17) will be installed during the Round 2 field investigation to better delineate the lateral and vertical extent of ground water contamination at this site (Figure 3-6). Nine of the new wells will be located around the eastern, northern, and western sides of the SWMU. Two other wells (16MWT14 and 16MWT16) will be located near the center of the SWMU. Of the

11 wells, seven will be shallow wells (25 to 35 feet total depth) and four will be deeper (75 to 90 feet total depth). Each of the deeper wells will be installed next to a shallow well resulting in four nested well pairs at the site. The deeper wells are intended to determine whether contamination has migrated to deeper strata at the site. A list of the new wells to be installed and the approximate depth of each are included in Table 3-10. Deep wells 16MWT15 and 16MWT16 will only be installed at the locations shown in Figure 3-6, if the ground water samples from the corresponding shallow wells show contamination is present. Shallow well 16MWT17 is located next to the north sump. NSWC Crane intends to conduct an integrity assessment of this sump. If the results of the assessment show that the sump's integrity has been breached, 16MWT17 will be installed.

All existing and newly installed wells (22 total) will be sampled once during this field effort and analyzed for VOCs, explosives, explosive degradation products, metals, nitrate plus nitrite, ammonia, sulfate, and chloride (Table 3-4). In addition, 12 of the well samples will be analyzed for methane, ethane, and ethene in the fixed-base laboratory and dissolved oxygen, alkalinity, carbon dioxide, nitrite, ferrous iron, manganese (+2), hydrogen sulfide, and sulfide using field test kits. These data will be used to evaluate the potential for MNA as a means for ground water remediation.

3.4.3 Surface Water / Sediment

Surface water and sediment sampling is proposed for each of the three SWMUs. For each new sampling location, a surface water sample and a sediment sample will be collected when possible. At sampling stations that have already been sampled once for sediments, only a surface water sample will be collected. Surface water may not be present at some of the sampling locations depending on flow conditions at the time of sampling.

Although not identified as sample locations on sample location maps, up to five seep and spring samples will be collected at each SWMU from the hillsides and down near the lower elevations of each ridge. A search for seep and spring locations will be performed during the field activities. These samples will be analyzed for these same parameters as surface water samples.

More than one full day of searching around the base of the ridges at SWMUs 13 and 16 resulted in the location of one and perhaps two seeps that are not within a major drainage gulley. These seeps were not flowing at a rate that is sufficient to sample (i.e., only very wet soil was evident). Additional searches will be made during the field investigation to locate and sample springs or seeps (outside of drainage gullies) that represent ground water discharge. These searches will extend downhill from all sides of the SWMUs

to where the slopes reach a major drainageway or stream. This search therefore will extend about 1,000 feet outward from each SWMU.

During the initial search for seeps, no rain had fallen for two days. However, small flow rates of water [visually estimated to be one to two gallons per minute (gpm)] were found in most of the major drainage gullies. In the upper portions of the gullies, some of this water was observed to be flowing in the gullies directly on top of exposed bedrock surfaces. In the lower reaches of the gullies; however, the water was mostly flowing just below the surface through the boulders and gravel that are lining the drainage gullies. In several places, the bedrock exposed on the steep banks adjacent to a gulley was wet or very damp. Thus, it appears that the gullies carry mostly surface runoff during storm events, but are also recipients of ground water discharge during and between storm events. Therefore, during the field investigations, the gullies will not be sampled during or immediately after storm events. Instead, sampling in the gullies and drainageways will occur at least three days after a storm event. If possible, small pools of water that have visible inflows will be located and sampled. Otherwise, a shovel (or backhoe in some locations) will be used to excavate small pits in the gravel beds in order to access the water moving down the gullies. Possible sample locations are shown on Figures 3-7 through 3-9 as surface water sample locations. However, if surface water is not flowing at these locations, then a shovel or backhoe will be used to collect seepage water flowing through the gravel bed material. These samples will be labeled as seep samples, but will be interpreted as being a mixture of surface water runoff and ground water seepage. If surface water is not present at each surface water sampling location shown on Figures 3-7 through 3-9, then an attempt will be made to collect a subsurface seepage sample. Therefore, there may be fewer surface water samples and more seep samples collected for each SWMU during the actual field activities. Five seep samples were chosen as a rough estimate for each SWMU in this QAPP Addendum; however, more than five seep samples per SWMU may be collected.

Surface water and sediment samples will be collected using the methods described in Sections 3.5.9 and 3.5.10. Each surface water sample will be analyzed for the analyte groups listed in Table 3-11. Surface water QA/QC samples will be collected as detailed in Table 3-12. No rinsate blanks will be collected because the sample bottles will be filled directly, as discussed in Section 3.5.9. The field duplicate will be analyzed for all parameters. The MS and MSD will be analyzed for all parameters except inorganics, which will have an MS and a lab duplicate. The total number of analyses, including QA samples, for surface water samples is presented in Table 3-12.

Sediment sampling will be concentrated in depositional areas, specifically where finer grained sediments exist. Each of the sediment samples will be analyzed for the analytes listed in Table 3-13. The field duplicate and rinsate blank will be analyzed for all parameters except TOC and geotechnical parameters.

The MS and MSD will be analyzed for all parameters except TOC, metals, and geotechnical parameters. The total number of laboratory analyses, including QA samples, is presented in Table 3-14.

3.4.3.1 Mine Fill A (SWMU 12) Surface Water / Sediment Sampling

A total of 30 surface water / sediment sample locations (12SW/SD01 through 12SW/SD30) are proposed for this SWMU (Figure 3-7). Surface water and sediment samples have not been collected previously at this SWMU. This SWMU is located at a topographically high ridgetop, and all surface water that exists at the SWMU originates within the SWMU boundary. The surface water/sediment samples will primarily be collected from apparent surface water drainageways within the SWMU, along the SWMU boundary, and downslope of the SWMU in order to evaluate contaminants that might be contained in surface runoff from the site and the potential downgradient impacts that might have been caused downgradient by past or present site discharges. Three background surface water/sediment samples (12SW/SD09, 12SW/SD16, and 12SW/SD26) will be collected from small tributary streams unaffected by SWMU 12. In addition, two sampling locations (12SW/SD25 and 12SW/SD27) are located on the main stem of Turkey Creek. A comparison of analytical results from these two locations should provide a means to make a qualitative evaluation of possible impacts to the stream that receives discharge from SWMU 12.

In addition to the surface water samples mentioned above, a search will be performed for seeps and springs emanating from the base and side slopes of the ridge. If found, up to five samples of seeps will be collected and analyzed (Table 3-11).

The surface water samples will be analyzed for explosives, metals (total and dissolved), nitrate plus nitrite, and ammonia (Table 3-11). One sample (12SW/SD03) will be analyzed for SVOCs. The sediment samples will be analyzed for explosives and metals. In addition, three sediment samples will be analyzed for SVOCs and eight samples will be analyzed for CEC, AVS/SEM, TOC, and pH (Table 3-13).

3.4.3.2 SWMU 13 - Mine Fill B Surface Water / Sediment Sampling

The sampling approach at MFB is similar to the approach taken at Mine Fill A. During the initial round of sampling at SWMU 13, samples were collected from a total of 23 surface water/sediment sampling locations (13SW/SD01 through 13SW/SD23) (surface water and sediment samples were not collected at all stations). RDX was detected in several of the surface water samples and some of the sediment samples (see Section 1.0).

For the investigation covered in this QAPP Addendum No.1, surface water samples will be collected from 14 of the original sampling locations (Table 3-11) and from nine new sampling locations (13SW/SD24 through 13SW/SD32). Sediment samples will be collected only from the nine new sampling stations. The sampling locations and the parameters for which surface water and sediment samples will be analyzed are listed in Tables 3-11 and 3-13, respectively. The sampling locations are presented in Figure 3-8. Six of the new sampling stations are located in the drainage gullies southeast of SWMU 13 and three are located northeast of SWMU 13. These locations are downgradient of the SWMU to evaluate how far contaminants may have migrated from the site.

In addition to the surface water samples mentioned above, a search will be performed for seeps and springs emanating from the base and side slopes of the ridge. If found, up to five samples of seeps will be collected and analyzed (Table 3-11).

All surface water samples will all be analyzed for explosives, metals (total and dissolved), nitrate plus nitrite, and ammonia except for sample 13SW3201, which will be analyzed for PAHs only. (Table 3-11). Sediment samples will be analyzed for explosives and metals only, except at two locations, 13SW/SD25 and 13SW/SD32 (Table 3-13).

3.4.3.3 Cast High Explosives Fill (SWMU 16) Surface Water / Sediment Sampling

A total of 11 surface water/sediment sampling stations (16SW/SD01 through 16SW/SD11) were sampled during the Round 1 investigation from ditches and gullies that exit this SWMU (Figure 3-9). Water samples were collected from the three sumps (16SW01, 16SW02, and 16SW07, Figure 3-9) located at the north end of this SWMU. During the Round 2 investigation described in this Addendum, surface water and sediment samples will be collected from 11 new sampling locations (Figure 3-9). These locations are all outside the SWMU boundary and are downgradient of the samples collected during Round 1. The new samples will be used to delineate how far downslope contaminants may have migrated via surface water runoff. The downgradient samples will also be used to identify possible diffuse ground water discharges and evaluate the potential of ground water impacting surface waters near the base of the hillsides.

This SWMU is also located at a topographic high, so no surface water or sediment samples can be collected upgradient of the SWMU. However, two sampling stations (16SW/SD20 and 16SW/SD21) will be located in small tributaries adjacent to, but unaffected by, discharges from SWMU 16 (Figure 3-9). The analytical results from these two locations will be used to compare against site-related contaminants in the same manner as is planned for Mine Fills A and B. In addition, two samples will be collected from

the main stem of Turkey Creek; one location (16SW/SD18) is located upstream of any surface water inputs originating from SWMU 16, and the second location (16SW/SD19) is located downstream of the furthest surface drainage originating from SWMU 16 (Figure 3-9). The analytical results from these two locations will be used to help evaluate whether drainage from SWMU 16 is causing any impacts to Turkey Creek.

In addition to the surface water samples mentioned above, a search will be performed for seeps and springs emanating from the base and side slopes of the ridge. If found, up to five samples of seeps will be collected and analyzed (Table 3-11).

Ten surface water samples collected from SWMU 16 will be analyzed for VOCs, explosives, metals (dissolved and totals), nitrate plus nitrite, and ammonia; one sample (16SW2201) will be analyzed for PAHs only (Table 3-11). The sediment samples will be analyzed for VOCs, explosives, and metals only.

3.5 INVESTIGATION EQUIPMENT AND PROCEDURES

3.5.1 UXO Screening of Selected Drilling Sites

Because of the prior uses of the areas to be investigated, there is a very small possibility that UXO could be encountered during field operations. UXO clearance of drilling sites or other sites where intrusive activities are planned will **not** be performed unless specifically directed to do so by NSWC Crane. If this situation occurs, the activities at the specified location(s) will be conducted consistent with the UXO procedures discussed in the HASP. In addition, all UXO procedures and borehole clearance activities will be documented in the site UXO logbook.

3.5.2 DPT Sampling for Surface and Subsurface Soil

DPT (e.g., Geoprobe®) will be used to collect surface and subsurface soil samples from the unconsolidated overburden. The procedure for soil sampling using DPT is included in SOP CTO166-04. A new acetate liner will be used for each 2-foot section of soil core. Each removed soil core will be scanned for VOCs. The soil core will be visually inspected and logged by the field geologist, and the soil texture, grain size (sand, silt, or clay), color (and any unusual discoloration), moisture content, and the soil type will be identified by the field geologist using the soil type based on the Unified Soil Classification System (USCS).

It may be possible that the local geology at a particular SWMU may differ from the background areas that were previously identified, sampled, and analyzed to establish representative metals concentrations (as

detailed in TtNUS, 2001). For example, the lower Pennsylvanian bedrock (and associated residual soil) may consist locally of thin black shale, carbonaceous shale, and coal beds. These localized beds may contain elevated concentrations of naturally occurring inorganics (e.g., chromium, arsenic). As a result, residual soil in these localized geological environments may have abnormally high inorganic background concentrations. In these instances, it may be appropriate to collect SWMU-specific background soil samples. The site geologist will note any localized geologic environment, similar to that described above, that is unique to a specific SWMU and will notify the TOM to determine whether SWMU-specific background samples are warranted. U.S. EPA Region 5 will be consulted for concurrence in the event that SWMU-specific soil samples are recommended for collection.

After each soil core is retrieved, a photo-ionization detector (PID) will be used to scan the soil core for the presence of VOCs (see SOP CTO 166-06), and the soil cores will be logged by a geologist (see SOP CTO166-07). For samples requiring VOC analysis, the VOC sample will be collected from the point along the soil core that had the greatest PID reading using an Encore™ sampler (see SOP CTO 166-08). If no PID readings are greater than background, the VOC sample will be collected from any discolored area of the soil or from the midpoint of the core. However, VOC aliquots will be confined to depths of 0.5 to 2.0 feet bgs in the case of surface soil samples. The Encore™ samples will be collected from each core immediately after PID readings are collected. After the sample for VOC analysis has been collected, the remaining aliquot will be placed in a decontaminated stainless-steel mixing bowl, rocks, gravel, and other coarse debris will be removed, and the sample will be mixed using a decontaminated stainless-steel spoon. The appropriate sample jars for remaining analyses will then be filled and properly labeled. The bowl and spoon will be decontaminated between each sample. Details regarding the collection and labeling of soil samples are included in SOP CTO166-01.

Up to two subsurface soil samples will be collected from each soil boring. Soil sample analytical information is presented in Table 3-2, and appropriate containers to be used for each sample aliquot are listed in Table 3-15. After the samples are containerized, labeled, tagged, and bagged (see SOPs CTO166-01 and 03), they will be placed in a cooler containing ice until they can be packaged and prepared for shipment (Section 3.7).

For each cooler containing soil samples identified for VOC analysis (i.e., Encore™ samplers), a trip blank will also be stored in the cooler and will continuously accompany the VOC samples until they have been analyzed. As samples are added to a cooler, the chain-of-custody form will be updated to include each new sample (per SOP CTO166-03; see also Section 4.0).

One duplicate soil sample will be collected for every 10 soil samples. Soil duplicates will be collected for those samples that have the greatest probability of containing contaminants (e.g., elevated levels of VOCs as indicated by PID readings). The duplicate samples will be placed in the same type of containers and handled in the same manner as the regular soil samples. The duplicate samples will be given unique QC sample identifications (see SOP CTO166-02). One rinsate blank will be collected for every 10 soil samples. For soil samples, the rinsate blank will consist of running distilled water over a decontaminated sampling spoon into a decontaminated mixing bowl. This water will be used to fill sample bottles for the rinsate blank. This process will continue until all the necessary bottles are filled for the rinsate sample.

Soil borings will be backfilled with either the soil cuttings (if visually uncontaminated) or bentonite pellets (if visually contaminated) in accordance with Section 3.11.

When a boring has been sampled and backfilled, it will be identified by a tall wooden lath driven into the soil near the boring. In addition, a 2 by 2-inch wooden stake will be driven into the center of the backfilled boring. The stake and the lath will both have brightly colored flagging attached to them to increase visibility, and both will be labeled using a waterproof marker with a unique soil boring number corresponding to the boring log.

3.5.3 Inspection and Repair of Existing Monitoring Wells

Existing monitoring wells at SWMUs 13 and 16 (see Tables 3-7 and 3-9) will be sampled as part of this investigation. These wells may have broken casings, bent casings, missing caps, no locks, broken locks, obstructions, or other problems. In addition, it is likely that some of the wells may contain enough sediment at the bottom that the well screen may be partially or totally clogged. Therefore, at the beginning of field activities, the existing wells will be located, inspected, and repaired if possible. For example, broken or bent polyvinyl chloride (PVC) riser pipes above the ground surface will be sawed off and new riser pipes will be added. Caps and locks will be replaced if necessary. The height of casing above ground surface and the depth to the bottom of the well will be measured and recorded. This information will be compared to the boring logs and well construction logs to confirm that the wells are open through the screened interval. These activities are addressed in SOP CTO166-09. Each of the existing wells will be redeveloped, if needed (see SOP CTO166-10) prior to sampling. After sampling, all existing wells will be resurveyed.

3.5.4 Well Drilling and Installation

A total of 83 new monitoring wells will be installed at SWMUs 12, 13, and 16 as part of this investigation. It is anticipated that all new wells installed at SWMUs 12, 13, and 16, will be installed in bedrock. The soil samples and bedrock cores should provide an accurate characterization of stratigraphy, fracture distribution, and other features of the soil and rock units spanning the study area. The bedrock holes will be cored using a rotary rig with coring capabilities or a Rotosonic rig. Procedures for drilling and logging a boring in rock are included in SOP CTO166-11. The holes will be a minimum diameter of 5 inches prior to well installation activities. The rates of water produced during drilling will be carefully observed to identify zones that might be fractured and have above-average permeability characteristics. Drilling standby may be required to monitor for the presence of ground water.

In each of the deep bedrock wells, a 6-inch diameter permanent steel casing will be placed through the overburden and into the bedrock to a depth of about 40 feet bgs to prevent downward vertical contaminant migration during drilling of the deeper portion of the bedrock boring. The steel casings will be installed according to SOP CTO166-12.

A permanent monitoring well will be installed in each of the well borings. The wells will be constructed of 2-inch-diameter, Schedule 40, flush joint, PVC riser pipe and slotted screen (see SOP CTO166-12). In each well, the screen will be 10 feet long and have a slot size of 0.02 inch (factory slotted). All riser pipe and screen sections will be new and certified clean. Each well will consist of slotted screen and enough solid riser pipe so that the riser will extend approximately 2.5 feet above the ground surface.

A sand filter pack, bentonite seal, and cement-bentonite grout will be placed around the annulus of the well screen, from the bottom of the hole upward, according to SOP CTO166-12. An outer, black steel protective casing will be installed around the PVC casing. The outer casing will extend at least 2 feet below the ground surface and no more than 4 inches above the inner PVC well cap. The steel casing will have a hinged cap or removable cap and a padlock. A 6-inch-thick, 3-by-3-foot concrete surface pad will be constructed around the well at the ground surface. In addition, three barrier posts will be installed around the concrete pad. Details regarding well construction sand pack and grout materials, the outer protective casing, the well pad, and the protective barrier posts are included in SOP CTO166-12.

3.5.5 Well Development

All new monitoring wells will be developed in accordance with SOP CTO166-10 to remove fine sediment from inside and around the well screens. The method used to perform well development can be either

vigorous on-and-off pumping or surge block and pumping, depending on which technique is most effective. Field measurements of pH, specific conductance, temperature, and turbidity will be collected at 5- to 10-minute intervals on the water retrieved from the well, in accordance with SOP CTO166-13. Well development will continue until the well water is clear to the unaided eye and until three subsequent consecutive readings of pH, specific conductance, and temperature are within 10 percent of each other and three consecutive turbidity readings are within 5 NTUs of each other. If the water-quality parameter criteria cannot be met after five well volumes of water have been removed, one additional well volume will be removed and well development will be considered complete.

All water removed from the well during the development process will be stored in a portable holding tank (already present at NSWC Crane) and discharged into a designated man-hole for treatment at the NSWC Crane water treatment facility (see SOP CTO166-14).

3.5.6 Water-Quality Field Measurements

Temperature, pH, ORP, dissolved oxygen, specific conductance, and turbidity will be measured for every aqueous sample collected, including all ground water, surface water, and seep samples. Field measurements of water-quality parameters will be collected from ground water in a flow-through cell attached to the pump discharge line. These measurements (except for DO and ORP) will be performed during well development (Section 3.5.5) and all of these measurements will be performed during low-flow well sampling (Section 3.5.7). These field measurements will be made using a YSI 6-Series Environmental Monitoring System or equivalent type of instrument. Turbidity measurements will be made using a LaMotte turbidity meter or equivalent. Calibration and measurements made with the field instruments will be in accordance with Section 6.1 and SOP CTO166-13. These same field water-quality parameters will be measured for each surface water and seep sample using procedures described in SOP CTO166-18.

Each calibration of an instrument will be recorded on an equipment calibration log sheet. Water-quality measurements, along with date, time, instrument operator, and visual and other observations (e.g., weather conditions) will be recorded on well development logs, sample collection logs, or in field notebooks, as appropriate.

3.5.7 Low-Flow Sampling of Monitoring Wells

Low-flow sampling procedures will be used to collect ground water samples from existing and new wells (see SOP CTO166-05 and -15). If the depth to ground water is greater than 25 feet, a compressed air

bladder pump or submersible pump will be used to slowly pump ground water from the well at about 100 milliliters per minute (mL/minute). Low-flow pumping will proceed until readings of temperature, pH, specific conductance, DO, ORP, and turbidity stabilize but for no longer than 4 hours. See SOP CTO166-15 for criteria for well stabilization. Appropriate sample bottles will be filled directly from the pump discharge tube. The bottles will be properly labeled, tagged, bagged, and placed in an ice-filled cooler as quickly as possible (see SOPs CTO166-01 and CTO166-03). A ground water collection log sheet will be completed for each ground water sample collected (see SOP CTO166-05).

The wells will be sampled in order of least contaminated to most contaminated, starting with the upgradient wells, proceeding to the far downgradient wells, and finishing with the source wells. This approach will lessen the possibility of cross contamination between wells. After each ground water sample is collected, the pump will be decontaminated (SOP CTO 166-16). For every 10 ground water samples collected, a rinsate blank sample will be collected to ensure that decontamination of the pump is effectively accomplished. The rinsate blank will be collected by pumping distilled water through the pump and placing the pump discharge water directly into sample jars. The appropriate sample jars and preservatives for each analyte group are listed in Table 3-16.

For each cooler containing ground water samples identified for VOC analysis, a trip blank will be included in the cooler. The trip blank will accompany the VOC samples until they have been analyzed for VOCs. As samples are added to a cooler, the chain-of-custody form should be updated to include each new sample container (see SOP CTO166-03).

3.5.8 Ground Water-Level Measurements

One synoptic round of water-level measurements and total well depth soundings will be obtained at each of the new and existing monitoring wells at the three SWMUs. All water-level measurements at a single SWMU will be taken within a 8-hour period using an electronic water-level meter. Water-level elevations will be recorded to within a 0.01-foot accuracy from a marked reference point on the well riser pipe. Detailed procedures regarding water-level measurements are included in SOP CTO166-17. Water levels will be recorded on a TtNUS water-level form. A blank water-level form is provided in SOP CTO166-17 for reference purposes. The water-level meter will be decontaminated between each well; decontamination procedures are addressed in SOP CTO166-16.

3.5.9 Surface Water Sampling

A total of 62 surface water samples will be collected as grab samples from SWMUs 12, 13, and 16 in accordance with SOP CTO166-18. It will be assumed that the water flowing at the sample locations is thoroughly mixed. Sample bottles will be filled directly in the flowing water. If the depth of water is not sufficient to lower the bottles into the water without disturbing bottom sediment, a decontaminated shovel will be used to dig a depression (i.e., a small pool) about 2 feet deep where the water can accumulate and pass through. After suspended sediment in the pool has settled out or is carried downstream, the unfiltered surface water sample, one sample per pool, will be collected. A filtered water sample will also be collected at each sampling location for dissolved metals analysis (see SOP CTO166-18). The bottles will be properly labeled (see SOP CTO166-01), tagged, bagged, and placed in an ice-filled cooler.

If no water is present at a sampling location or if the water present is not perceptibly flowing, a surface water sample will not be collected from the location.

If water is pooled in a drainage gulley and a small flow rate of water is observed entering the pool, then a surface water sample may be collected from the pool. Several gullies leading down the slope from the northwest side of SWMU 13 are very deeply incised and contain cobbles, boulders, and gravel in the channel ways. Since surface water and ground water may be flowing through the coarse materials, a backhoe will be used to excavate trenches across the channels in order to sample the surface water/ground water mixture in those chemicals. Locations where trenches may be dug in the channel ways include 13SW/SD14, 13SW/SD15, 13SW/SD16, 13SW/SD28, and 13SW/SD29.

Field water-quality measurements (temperature, pH, ORP, dissolved oxygen, specific conductance, and turbidity) will be made at each surface water sampling location immediately after a sample has been collected. These data will be recorded on the surface water sample collection log sheet.

3.5.10 Sediment Sampling

A total of 48 sediment samples will be collected as grab samples from SWMUs 12, 13, and 16, in accordance with SOP CTO166-19. Sampling locations for sediment will be adjusted to positions along stream channels and gullies where surface water is visibly flowing, if possible. At these locations, sediment samples will be collected from beneath the water surface at the water's edge. If water is not visibly present, then the sediment sample will be collected from an area of deposition where the finest sediment is present and the sediment is moist or wet. Sample aliquots for AVS-SEM will be collected in the same manner as aliquots for VOCs. The samples will not be stirred or homogenized, and the

sediment will be placed in a separate container for VOC and AVS-SEM analyses, with a minimum exposure to air. The appropriate sample jars for other parameters (Table 3-15) will then be filled directly from the sediment surface using disposable plastic spoons or trowels. Sample materials will be collected from 0 to 4 inches beneath the sediment surface.

A 2- by 2-inch wooden stake with attached flagging material will be driven into each sediment sampling location, and the sample identification number will be marked on the stake with a black waterproof marker. Alternatively, stakes may be driven into the stream bank to mark the location of the sediment sample. This will be done so that the sampling location can be revisited at a later date, if necessary, for surveying or resampling purposes.

3.5.11 Staff Gauge Installation and Estimation of Stream Flow

Up to eight staff gauges will be installed at surface water/sediment sampling locations at each of the SWMUs. The locations of these gauges will be discretionary and will be determined by the field sampling personnel at the time surface water and sediment samples are collected. Existing permanent structures, such as culverts and bridge abutments, where measurements to the water surface can be taken will be used as staff gauges whenever possible. A mark will be placed on these permanent structures denoting the point where measurements will be taken and the staff gauge number will be noted. If a permanent structure is not available, the staff gauge will consist of a metal pipe that will be pounded into the sediment with a sledgehammer. The measurements will be taken with a weighted tape measure in reference to the established measuring point on the permanent structure denoting the measurement point. All staff gauges will be measured at the same time as water-levels in monitoring wells. Staff gauges and monitoring well water levels will be measured once during the field effort described in this Addendum.

The approximate flow rate of surface water at each surface water sampling and staff gauge location will be estimated at the time when the water samples are collected. These estimates will be approximate and will be accomplished by measuring the cross sectional width of the flowing water, the average depth of the flowing water, and the approximate water velocity, in accordance with SOP CTO 166-20. The information will be used to evaluate surface water flow in relation to each site's drainage system and to help evaluate potential impacts to downstream water bodies (e.g., Turkey Creek).

3.5.12 Aquifer Testing

Aquifer testing in the form of slug tests will be performed in at least 10 shallow wells and four deep wells at each of the three SWMUs. Both rising- and falling-head tests will be performed in wells with submerged well screens; only rising-head tests will be performed in wells for which the screened interval intersects the water table. The slug tests will be performed in accordance with SOP CTO 166-21.

3.6 QUALITY CONTROL SAMPLES

This section focuses on field QC samples that will be collected as part of this environmental investigation including field duplicates, source water blanks, equipment rinsate blanks, and trip blanks. Tables 3-3, 3-5, 3-12, and 3-14 present the types and numbers of required field QC samples to be collected for soil, ground water, surface water, and sediment sampling activities, respectively, during the field investigation. Table 3-17 provides an overview of QC frequencies and corrective action measures. Section 7.0 provides definitions and details for these and all other QC checks to be used during this investigation. Field QC sample requirements for field duplicates, source water blanks, equipment rinsate blanks, and trip blanks required for this project are described below.

Field Duplicates. Field duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Duplicate samples will be collected at a rate of one for every 10 samples of each type of environmental medium. All duplicate samples will be analyzed for the same parameters in the laboratory as their environmental sample counterparts. Duplicate samples will be preferentially collected where field evidence (i.e., PID reading, odor, or analytical data from Round 1) indicates that contamination is likely to be present in the environmental sample.

Equipment Rinsate Blanks. Equipment rinsate blanks will be obtained under representative field conditions by running analyte-free water through sample collection equipment after decontamination and placing it in the appropriate sample containers for analysis. Equipment rinsate blanks will be collected for non-dedicated equipment. For surface and subsurface soil sampling activities, rinsate blanks will be collected by running analyte-free water over the decontaminated stainless-steel bowl and spoon used to mix soil before it is placed in sample jars. For ground water samples, analyte-free water will be pumped through a decontaminated pump and tubing used for ground water sampling. Equipment rinsate blanks will not be required for surface water and sediment samples. Surface water samples will be collected directly from the surface water body, and only new disposable spoons will be used to collect sediment samples.

Source Water Blanks. Source water blanks will be obtained by sampling each water source (e.g., potable water and distilled water) used for decontamination activities during the field investigation. Source water blanks will be used to determine if the water or the laboratory bottles are contributing to sample contamination. Source water blanks will be collected for each type of water used for decontamination and will be submitted at a frequency of one per sampling event. Source water blanks, as applicable, will be analyzed for the entire suite of parameters under investigation. It is anticipated that two source water blanks will be collected during the field investigation: one potable water sample and one sample of distilled water used for decontamination.

Trip Blanks. Trip blank samples are 40-mL glass vials that contain analyte-free water and are prepared by the analytical laboratory prior to the start of field activities. They will be stored in a sealed container until they are needed. During sampling activities, one trip blank, consisting of one vial, will be placed in each cooler that contains environmental samples destined for VOC analysis. The trip blank will be properly labeled and added to the chain-of-custody form for the cooler. Trip blanks are only analyzed for VOCs.

3.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING

3.7.1 Sample Preservation

Preservation requirements for each of the chemicals of interest are provided in Tables 3-15 and 3-16. All soil and sediment samples are to be cooled to 4°C ± 2°C; no chemical preservatives are necessary. Sample bottles for aqueous samples will contain the proper amounts and types of preservatives before they are shipped to NSWC Crane (Table 3-16). The preservatives placed in the sample bottles will be certified that they are free of analytes being tested in the samples. All samples will be promptly chilled with ice to 4°C ± 2°C and packaged in an insulated cooler. Each cooler will include a temperature blank. Ice will be sealed in containers to prevent water leakage. Samples will not be frozen.

3.7.2 Sample Labeling

Before samples are packaged, the sample labels and tags will be checked to ensure that all information on the labels and tags is complete and correct (see SOP CTO166-01) and that it matches the information on the sample collection log sheets and the chain-of-custody form.

3.7.3 Sample Packaging

Each sample container will be placed in a zip-lock bag to prevent cross-contamination and leakage. Each zip-lock bag will be placed in a bubble-wrap sleeve to prevent breakage and cross-contamination. Only shipping containers that meet all applicable State and federal standards for safe shipment will be used. Cube ice will be placed in plastic bags and placed around and between the samples in sufficient quantity to ensure that the samples remain chilled (4°C ± 2°C) during transport to the analytical laboratory.

The completed field chain-of-custody document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container (see SOP CTO166-03).

SOP CTO166-01 provides a detailed description of sample handling, packaging, and shipping procedures required for this project. The FOL will be responsible for ensuring the completion of the following forms:

- Sample labels and tags
- Chain-of-custody forms
- Custody seals for coolers
- Shipping labels for coolers
- Express mail air bills

3.7.4 Sample Shipping

Shipping containers (i.e., coolers) will be sealed with nylon strapping tape in at least two places, and custody seals will be signed, dated, and affixed in a manner that will allow the receiver to quickly identify any tampering that may have occurred during transport to the laboratory (see SOPs CTO166-01 and -03).

Shipment will be made by a public courier at the next scheduled pickup following completion of sample collection. Copies of the air bills should be retained by the FOL for tracking purposes, if needed, and for communications with the laboratory. Air bills will be retained for the permanent record file.

3.7.5 Sample Custody

Custody of samples must be maintained and documented at all times, in accordance with SOP CTO166-03, beginning with the collection of samples in the field. Sample custody procedures are addressed in Section 4.0.

3.8 RECORD KEEPING

Standard forms, field notebooks, and a field logbook will be used to record all sample collection activities, field measurements, observations concerning site conditions, and other project-related information. These records include sample log sheets, daily activity records, field logbooks, drilling and well completion log sheets, and field instrument calibration log sheets, among others. More details regarding record keeping are included in SOP CTO166-03.

3.8.1 Field Log Books

Bound, weatherproof field notebooks will be maintained by sampling personnel. All information related to sampling and other field activities will be recorded in field notebooks. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, and descriptions of photographs.

A bound, weatherproof logbook will be maintained by the FOL. This book will contain a summary of each day's activities and will reference the field notebooks when applicable.

3.8.2 Drilling and Well Completion Logs

A drilling log will be completed for every boring drilled during these field activities. A geologist will complete the drilling log, which will include information regarding date, time, personnel present, drilling and sampling equipment, geologic materials encountered, fracture locations and frequency (where appropriate), water yields, color, texture, odors, and readings made with the screening instruments (see SOPs CTO166-07 and CTO166-11).

A well completion log will be completed for every monitoring well constructed. These logs will include information concerning the date, times of events, quantities of construction materials used, lengths, depths, and diameters of riser pipe and well screen placed in the well, and other information, as described in SOP CTO166-12.

3.8.3 Well Development Log Sheets

During the development or redevelopment of each monitoring well, the date, times of events, development method and equipment, personnel present, amounts of water produced, measurements made by field water-quality meters, and depths to water will be recorded on a well development log sheet, as described in SOP CTO166-10.

3.8.4 Equipment Calibration Logs

An equipment calibration log sheet will be used to record each time an instrument is calibrated, recalibrated, or checked against a standard or background. The procedures and standards to be used for instrument calibration are discussed in Section 5.1 and SOPs CTO166-06 and CTO166-13.

3.8.5 Sample Collection Logs

All sample log sheets will be completed in accordance with SOP CTO166-03.

3.8.6 Chain-of-Custody Forms

A chain-of-custody form will be completed for every cooler that contains samples being shipped to an off-site laboratory for analyses. These forms are a record of the people having custody of the samples from the time the samples are collected to the time they are analyzed and disposed (see SOP CTO166-03). The completed field chain-of-custody document will be signed, placed in a sealed plastic envelope, and taped to the top inside cover of the shipping container before it is shipped. A copy of the chain-of-custody document will be retained by the FOL.

3.8.7 Shipping Forms/Air Bills

Copies of all forms and/or air bills related to the shipment of coolers will be retained by the FOL in order to trace the shipment, if necessary, and to communicate with the receiving laboratory.

3.8.8 Permanent Record File

At the completion of the field activities, the FOL will submit to the TOM all field records, data, field notebooks, logbooks, chain of custody (COC) records, sample log sheets, daily activity logs, and other records concerning the project, including all the forms and log sheets listed above. The FOL will check these records for legibility and completeness before submitting them to the TOM. These forms, data, and field notes will become part of the permanent project record.

3.9 SURVEYING

The location of every soil boring and surface water and sediment sample location will be marked with a wooden lath and flagging, and a boring hole number or sample ID will be marked on the lath. In addition, a 2- by 2-inch wooden stake, 6 inches long, will be driven into the ground at the center of each backfilled

boring. This stake will have a piece of brightly colored flagging tacked onto its top, and the boring hole number will be indelibly marked on the side of the stake.

The horizontal locations and vertical elevations of all new monitoring wells, soil borings, surface water and sediment sampling locations, and staff gauges will be surveyed. Horizontal locations will be surveyed to the Indiana State Plane Coordinates System within the nearest foot and referenced to the 1983 North American Datum (NAD) 83. The vertical elevations of the ground surface and tops of casing for wells, the tops of the staff gauges, and the ground surface for the borings and surface water and sediment sampling locations will be measured to the nearest 0.01 foot and referenced to the North American Vertical Datum (NAVD) of 1988.

3.10 EQUIPMENT DECONTAMINATION

All equipment used to collect soil and ground water samples will be decontaminated in accordance with SOP CTO166-16.

3.11 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

It is anticipated that this investigation will generate five types of potentially contaminated residues or investigation-derived waste (IDW):

- Personal protective equipment (PPE)
- Ground water sample tubing and DPT sample liners
- Well development and purge fluids
- Equipment decontamination fluids
- Waste cuttings from drilling activities

IDW will be handled as described below:

- All PPE, tubing, and DPT sample liners will be decontaminated and double bagged and placed in trash receptacles at NSWC Crane.

- All well development and purge fluids will be collected, stored, and discharged to the NSWC Crane permitted sanitary sewer system in accordance with SOP CTO166-14.

- All drilling equipment decontamination fluids will be combined with well development and purge fluids and handled in the same manner.

- All equipment decontamination fluids will be combined with well development and purge fluids and handled in the same manner.

- For each boring, waste cuttings will be scanned for VOCs. If all readings from screening instruments are at background levels, the soil cuttings from soil borings will be mixed with bentonite, placed back into the hole, and tamped for compaction or spread on the ground adjacent to the borehole. Borings that contain contaminated cuttings or rock cores will be backfilled with bentonite pellets or a cement-bentonite slurry. Contaminated cuttings or rock cores from borings will be placed in black plastic trash bags (or directly in drums if in larger quantities), labeled, and then placed in 55-gallon sealable drums. The bags will be tagged and the drums will be clearly labeled with the dates, locations, and depths from which the soils originated and the personnel (including phone number) placing the cuttings in the drum. When analytical results concerning contaminant concentrations in the soil samples are received from the laboratory, decisions will be made as to how to dispose of the soil materials (see SOP CTO166-14).

3.12 SAFETY

The health and safety activities described in the following sections will ensure that field activities are performed at a high level of safety.

3.12.1 Health and Safety Plan

A separate HASP has been prepared that describes specific health and safety requirements, concerns, and information related to the site activities. This document will be read and understood by each person working at the site. Each worker or visitor to the site must sign an acknowledgment that he or she has read and understands the HASP.

3.12.2 Health and Safety Training

All workers involved with the site investigations shall have successfully completed the Occupational Safety and Health Administration (OSHA)-mandated 40-hour health and safety training and the follow-up annual 8-hour refresher courses when appropriate.

TtNUS and subcontractor personnel will supply OSHA documentation to the FOL before beginning work. Personnel who do not comply with this requirement must receive verbal approval to work from TtNUS corporate health and safety personnel.

3.12.3 Personal Protective Clothing and Equipment

Workers at the site must be part of a medical monitoring program and must be medically approved to perform their duties without physical limitations. Protective clothing and equipment, as specified in the HASP, will be worn while performing site activities.

3.12.4 Safety Meetings

Safety meetings will be held among on-site workers whenever the SSO feels it is appropriate. The SSO will discuss safety issues related to activities being performed and will make site workers aware of any new conditions that could potentially affect health or safety.

3.13 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS

3.13.1 Personnel

The duties, responsibilities, and line of command for each person working on the project are described in Section 2.0 and displayed on Figure 2-1. Persons working on the project will be intimately familiar with their roles and responsibilities. In addition, they will be familiar with the mechanisms and procedures for coordinating tasks, improving communications, and reporting incidences or irregularities. The FOL is responsible for coordinating all on-site personnel and activities (Section 2.3.1). The SSO is responsible for health and safety monitoring and ensures that the HASP is adhered to during all field activities (Section 2.3.3). The SSO has the authority to stop work if an imminent safety hazard is encountered (Section 2.3).

3.13.2 Subcontractors

Subcontractors will perform site activities involving drilling, well installation, and surveying. The FOL will direct all subcontractor activities.

3.13.3 Mobilization and Demobilization

Following approval of the QAPP Addendum No.1, TtNUS will begin mobilization activities. All field team members will review the QAPP Addendum No. 1 (including the HASP) prior to mobilization. In addition, a

field team orientation meeting will be held to familiarize personnel with the scope of the field activities. Items to be presented during that meeting include the following:

- Identification of the QAPP Addendum No. 1, the HASP, and applicable field SOPs (Appendix E).
- Site-specific safety concerns and requirements.
- Project objectives.
- Sampling designs and strategies for soil and ground water (including the relationship of soils data for this project to NSWC Crane background soils data).
- Site-specific particulars of field operations (e.g., locations of utilities, physical access to sampling locations, communication mechanisms, lines of authority and responsibility, scheduling requirements, sample shipping concerns, etc.).
- Laboratory and other subcontractor coordination.
- Site access requirements.
- Travel requirements.

The FOL will coordinate the mobilization activities for this project. The equipment required for the field activities will be mobilized from the TtNUS Pittsburgh office or a third-party vendor. The FOL and crew will demobilize from the site upon completion of the field operations and transport field equipment back to the TtNUS Pittsburgh office, as necessary. All areas will be thoroughly checked, and trash will be removed and disposed properly.

TABLE 3-1

FIELD SCREENING AND MEASUREMENTS
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	Equipment	SOP	Calibration
Volatile Organics	Perkin-Elmer Photovac 2020 Photoionization Detector	SOP CTO166-06	Per Manufacturer
pH Temperature Oxidation-reduction potential Specific Conductance Dissolved Oxygen (water-quality parameters)(1)	YSI 6-Series Environmental Monitoring System	SOP CTO166-13	Per Manufacturer
Turbidity (water-quality parameter)(1)	LaMotte Turbidity Meter	SOP CTO166-13	Per Manufacturer
Water-Level Measurements	Heron Dipper-T (or equivalent)(2)	SOP CTO166-17	Per Manufacturer
Nitrite (as N) Ferrous Iron Manganese (+2) Sulfide	Hach Colorimeter (DR-850)	SOP CTO166-22	Per Manufacturer
Alkalinity Carbon Dioxide Dissolved Oxygen Hydrogen Sulfide	CHEMetrics and Hach Test Kits	SOP CTO166-22	Per Manufacturer

1 Field measurements used to establish well stabilization prior to collecting ground water samples. Field measurements will also be collected at each surface water sample location.
2 Any electronic water-level indicator with the capability of measuring to depths of 100 feet may be used.
SOP = Standard operating procedure.

TABLE 3-2
LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth	Volatiles [2]		Semivolatiles			Explosives	PCBs	Metals		Miscellaneous Parameters				
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	SW-846 8082	Metals SW-846 6020	Mercury SW-846 7471A	Cyanide	TOC	CEC	pH	Ammonia
SWMU 12															
12SB01	0 to 2 ft bgs	1	1	1	1	1	1		1	1	1				
	above water table	1	1	1	1	1	1		1	1	1				
12SB02	0 to 2 ft bgs											1	1	1	1
	above water table											1	1	1	1
12SB03	0 to 2 ft bgs											1	1	1	1
	above water table											1	1	1	1
12SB04	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB05	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB06	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB07	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB08	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB09	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB10	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					
12SB11	0 to 2 ft bgs						1		1	1					
	1st above water table						1		1	1					
	2nd above water table						1		1	1					

TABLE 3-2
LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth	Volatiles [2]		Semivolatiles			Explosives	PCBs	Metals		Miscellaneous Parameters				
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	SW-846 8082	Metals SW-846 6020	Mercury SW-846 7471A	Cyanide	TOC	CEC	pH	Ammonia
12SB12	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB13	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB14	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB15	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB16	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB17	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB18	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB19	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
12SB20	0 to 2 ft bgs	1	1	1	1	1	1		1	1					
	2 to 4 ft bgs	1	1	1	1	1	1		1	1					
	6 to 8 ft bgs	1	1	1	1	1	1		1	1					
Total Soil Samples SWMU 12		29	29	29	29	29	53	0	53	53	2	4	4	4	4

TABLE 3-2
LISTING OF SOIL SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample Depth	Volatiles [2]		Semivolatiles			Explosives	PCBs	Metals		Miscellaneous Parameters				
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	SW-846 8082	Metals SW-846 6020	Mercury SW-846 7471A	Cyanide	TOC	CEC	pH	Ammonia
SWMU 13															
13SB16	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB17	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB18	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB19	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB20	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB21	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB22	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB23	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB24	0-2 ft bgs							1							
	2-4 ft bgs							1							
13SB25	0-2 ft bgs							1							
	2-4 ft bgs							1							
Total Soil Samples SWMU 13		0	0	0	0	0	0	20	0	0	0	0	0	0	0
SWMU 16															
16SB42	0-2 ft bgs								1	1					
16SB43	0-2 ft bgs								1	1					
16SB44	0-2 ft bgs								1	1					
16SB45	0-2 ft bgs								1	1					
16SB46	0-2 ft bgs								1	1					
16SB47	HPD	1	1												
16SB48	HPD	1	1												
16SB49	HPD	1	1												
16SB50	HPD	1	1												
Total Soil Samples SWMU 16		4	4	0	0	0	0	0	5	5	0	0	0	0	0

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Volatile samples will be collected from the 1-2 ft bgs section of all 0-2 ft bgs sampling locations designated for volatile analysis.
HPD - Sample is to be collected from the depth wither the greater PID meter reading is encountered. Soil will be cored down to the bedrock surface.

TABLE 3-3

SUMMARY OF SOIL ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Semivolatiles			Explosives	PCBs	Metals		Miscellaneous				
	SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	SW-846 8082	Metals SW-846 6020	Mercury SW-846 7471A	Cyanide	TOC	CEC	pH	Ammonia
SWMU 12 Samples	29	29	29	29	29	53	0	53	53	2	4	4	4	4
SWMU 13 Samples	0	0	0	0	0	0	20	0	0	0	0.	0	0	0
SWMU 16 Samples	4	4	0	0	0	0	0	5	5	0	0	0	0	0
Total Samples All SWMUs	**33**	**33**	**29**	**29**	**29**	**53**	**20**	**58**	**58**	**2**	**4**	**4**	**4**	**4**
Field Duplicate[2]	4	4	3	3	3	6	2	6	6	1	1	1	1	1
Trip Blank[3]	2	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blank[4]	4	4	3	3	3	6	2	6	6	1	1	1	1	1
Source Water Blank	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ambient Condition Blank[5]	1	1	1	1	1	1	1	1	1	1	NA	NA	NA	1
Matrix Spike[6]	2	2	2	2	2	3	1	3	3	1	1	NA	NA	1
Matrix Spike Duplicate[7]	2	2	2	2	2	3	1	NA	NA	NA	NA	NA	NA	NA

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 10 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated.
4 Rinsate blanks will be collected at a frequency of one per every 10 samples, with a minimum of one per day of sampling per sampling device or instrument. These amounts are estimates and may vary. Rinsates will not be collected for VOC samples that are collected using EnCore samplers.
5 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.

CEC - Cation exchange capacity.
NA - Not applicable.
PCBs - Polychlorinated biphenyl.
TOC - Total organic carbon.

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals [2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 12														
12MWT01	12GWT0101			1	1	1	1	1	1					1
12MWT02	12GWT0201			1	1	1	1	1	1				1	1
12MWT03	12GWT0301			1	1	1	1	1	1					
12MWT04	12GWT0401			1	1	1	1	1	1					1
12MWT05	12GWT0501			1	1	1	1	1	1					
12MWT06	12GWT0601			1	1	1	1	1	1					1
12MWT07	12GWT0701			1	1	1	1	1	1					1
12MWT08	12GWT0801			1	1	1	1	1	1					
12MWT09	12GWT0901			1	1	1	1	1	1					1
12MWT10	12GWT1001			1	1	1	1	1	1					
12MWT11	12GWT1101			1	1	1	1	1	1					1
12MWT12	12GWT1201			1	1	1	1	1	1					1
12MWT13	12GWT1301			1	1	1	1	1	1					
12MWT14	12GWT1401			1	1	1	1	1	1					1
12MWT15	12GWT1501			1	1	1	1	1	1					
12MWT16	12GWT1601			1	1	1	1	1	1					1
12MWT17	12GWT1701			1	1	1	1	1	1					1
12MWT18	12GWT1801			1	1	1	1	1	1					

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals[2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 12 (Continued)														
12MWT19	12GWT1901			1	1	1	1	1	1					1
12MWT20	12GWT2001			1	1	1	1	1	1					
12MWT21	12GWT2101			1	1	1	1	1	1					1
12MWT22	12GWT2201			1	1	1	1	1	1					1
12MWT23	12GWT2301			1	1	1	1	1	1					1
12MWT24	12GWT2401			1	1	1	1	1	1					1
12MWT25	12GWT2501			1	1	1	1	1	1					
12MWT26	12GWT2601			1	1	1	1	1	1				1	1
12MWT27	12GWT2701			1	1	1	1	1	1					1
12MWT28	12GWT2801			1	1	1	1	1	1					
12MWT29	12GWT2901			1	1	1	1	1	1					1
12MWT30	12GWT3001			1	1	1	1	1	1					1
12MWT31	12GWT3101			1	1	1	1	1	1					1
12MWT32	12GWT3201			1	1	1	1	1	1					1
12MWT33	12GWT3301			1	1	1	1	1	1				1	1
12MWT34	12GWT3401			1	1	1	1	1	1					1
12MWT35	12GWT3501			1	1	1	1	1	1					
12MWT36	12GWT3601			1	1	1	1	1	1					

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals [2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 12 (Continued)														
12MWT37	12GWT3701			1	1	1	1	1	1					
12MWT38	12GWT3801			1	1	1	1	1	1					
12MWT39	12GWT3901			1	1	1	1	1	1					
12MWT40	12GWT4001			1	1	1	1	1	1					
12MWT41	12GWT4101			1	1	1	1	1	1					
12MWT42	12GWT4201			1	1	1	1	1	1					
12MWT43	12GWT4301			1	1	1	1	1	1					
12MWT44	12GWT4401			1	1	1	1	1	1					
12MWT45	12GWT4501			1	1	1	1	1	1					
12MWT46	12GWT4601			1	1	1	1	1	1					
12MWT47	12GWT4701			1	1	1	1	1	1					
12MWT48	12GWT4801			1	1	1	1	1	1					
12MWT49	12GWT4901			1	1	1	1	1	1					
SWMU 12 Total Samples		0	0	49	49	49	49	49	49	0	0	0	3	24

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals [2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 13														
13MWT01	13GWT0102			1	1	1	1	1	1					
13MWT02	13GWT0202			1	1	1	1	1	1					1
13MWT03	13GWT0302			1	1	1	1	1	1				1	1
13MWT04	13GWT0402			1	1	1	1	1	1					
13MWT05	13GWT0502			1	1	1	1	1	1					1
13MWT06	13GWT0602			1	1	1	1	1	1					
13MWT07	13GWT0702			1	1	1	1	1	1					
13MWT08	13GWT0802			1	1	1	1	1	1					1
13MWT09	13GWT0903			1	1	1	1	1	1					1
13MWT10	13GWT1002			1	1	1	1	1	1				1	1
13MWT11	13GWT1102			1	1	1	1	1	1					1
13MWT12	13GWT1202			1	1	1	1	1	1					1
13MWT13	13GWT1302			1	1	1	1	1	1					1
13MWT14	13GWT1402			1	1	1	1	1	1					
13MWT15	13GWT1502			1	1	1	1	1	1				1	1
13MWT16	13GWT1602			1	1	1	1	1	1					
13MWT17	13GWT1702			1	1	1	1	1	1					1
13MWT18	13GWT1802			1	1	1	1	1	1					1

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals [2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 13 (Continued)														
13MWT19	13GWT1902			1	1	1	1	1	1					
13MWT20	13GWT2003			1	1	1	1	1	1					1
13MWT21	13GWT2102			1	1	1	1	1	1					1
13MWT22	13GWT2202			1	1	1	1	1	1					1
13MWT23	13GWT2302			1	1	1	1	1	1					1
13MWT24	13GWT2402			1	1	1	1	1	1					1
13MWT25	13GWT2502			1	1	1	1	1	1					
13MWT26	13GWT2602			1	1	1	1	1	1					1
13MWT27	13GWT2701			1	1	1	1	1	1					
13MWT28	13GWT2801			1	1	1	1	1	1					1
13MWT29	13GWT2901			1	1	1	1	1	1					1
13MWT30	13GWT3001			1	1	1	1	1	1					
13MWT31	13GWT3101			1	1	1	1	1	1					
13MWT32	13GWT3201			1	1	1	1	1	1					
13MWT33	13GWT3301			1	1	1	1	1	1					
13MWT34	13GWT3401			1	1	1	1	1	1					1
13MWT35	13GWT3501			1	1	1	1	1	1					1
13MWT36	13GWT3601			1	1	1	1	1	1					1

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals[2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 13 (Continued)														
13MWT37	13GWT3701			1	1	1	1	1	1					
13MWT38	13GWT3801			1	1	1	1	1	1					1
13MWT39	13GWT3901			1	1	1	1	1	1					
13MWT40	13GWT4001			1	1	1	1	1	1					
13MWT41	13GWT4101			1	1	1	1	1	1					
13MWT42	13GWT4201			1	1	1	1	1	1					
13MWT43	13GWT4301			1	1	1	1	1	1					
13MWT44	13GWT4401			1	1	1	1	1	1					
13MWT45	13GWT4501			1	1	1	1	1	1					
13MWT46	13GWT4601			1	1	1	1	1	1					
13MWT47	13GWT4701			1	1	1	1	1	1					
SWMU 13 Total Samples		0	0	47	47	47	47	47	47	0	0	0	3	24

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals [2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 16														
WES-14-01-83	16GW0102	1	1	1	1	1	1	1		1	1			
WES-14-02-83	16GW0203	1	1	1	1	1	1	1		1	1	1	1	1
WES-14-03-83	16GW0302	1	1	1	1	1	1	1		1	1	1		1
WES-14-04-83	16GW0402	1	1	1	1	1	1	1		1	1			
WES-14-05-83	16GW0502	1	1	1	1	1	1	1		1	1	1		1
16MWT01	16GWT0102	1	1	1	1	1	1	1		1	1			
16MWT02	16GWT0202	1	1	1	1	1	1	1		1	1			
16MWT03	16GWT0302	1	1	1	1	1	1	1		1	1			
16MWT04	16GWT0402	1	1	1	1	1	1	1		1	1	1	1	1
16MWT05	16GWT0502	1	1	1	1	1	1	1		1	1			
16MWT06	16GWT0603	1	1	1	1	1	1	1		1	1	1		1
16MWT07	16GWT0701	1	1	1	1	1	1	1		1	1	1		1
16MWT08	16GWT0801	1	1	1	1	1	1	1		1	1	1		1
16MWT09	16GWT0901	1	1	1	1	1	1	1		1	1			
16MWT10	16GWT1001	1	1	1	1	1	1	1		1	1	1		1
16MWT11	16GWT1101	1	1	1	1	1	1	1		1	1			
16MWT12	16GWT1201	1	1	1	1	1	1	1		1	1			
16MWT13	16GWT1301	1	1	1	1	1	1	1		1	1	1		1

TABLE 3-4

GROUND WATER SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Explosives		Metals[2]		Miscellaneous						
		SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[3]
SWMU 16 (Continued)														
16MWT14	16GWT1401	1	1	1	1	1	1	1		1	1	1		1
16MWT15	16GWT1501	1	1	1	1	1	1	1		1	1	1	1	1
16MWT16	16GWT1601	1	1	1	1	1	1	1		1	1	1		1
16MWT17	16GWT1701	1	1	1	1	1	1	1		1	1			
SWMU 16 Total Samples		22	22	22	22	22	22	22	0	22	22	12	3	12

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Dissolved metals analysis will be performed on ground water samples with turbidity >10 NTUs.
3 Monitored Natural Attenuation (MNA) parameters include field measurements of dissolved oxygen, alkalinity, nitrite (as N), ferrous iron, 3-manganese (+2), and sulfide.

TABLE 3-5

SUMMARY OF GROUND WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Explosives		Metals		Miscellaneous						
	SW-846 8260B	SW-846 8015B	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Total Mercury SW-846 7470A	Nitrate + Nitrite (as N) EPA 353.2	Ammonia (as N) EPA 350.1	Sulfate	Chloride	Methane, Ethane, Ethene	Total Organic Carbon	MNA Field Parameters[8]
SWMU 12 Samples	0	0	49	49	49	49	49	49	0	0	0	3	24
SWMU 13 Samples	0	0	47	47	47	47	47	47	0	0	0	3	24
SWMU 16 Samples	22	22	22	22	22	22	22	0	22	22	12	3	12
Total Samples All SWMUs	**22**	**22**	**118**	**118**	**118**	**118**	**118**	**96**	**22**	**22**	**12**	**9**	**60**
Field Duplicate[2]	3	3	12	12	12	12	12	10	3	3	2	1	6
Trip Blank[3]	1	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blank[4]	3	3	12	12	12	12	7	3	3	3	NA	1	NA
Source Water Blank	1	1	1	1	1	1	1	1	1	1	NA	1	NA
Ambient Condition Blank[5]	1	1	1	1	1	1	1	1	1	1	NA	1	NA
Matrix Spike[6]	2	2	6	6	6	6	6	5	3	3	NA	1	NA
Matrix Spike Duplicate[7]	2	2	6	6	NA	NA	NA	NA	NA	NA	NA	NA	NA

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 10 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks are estimated.
4 Rinsate blanks will be collected at a frequency of one per every 10 samples, with a minimum of one per day of sampling per sampling device or instrument. These amounts are estimates and may vary.
5 Amibient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
8 Monitored Natural Attenuation (MNA) parameters include field measurements of dissolved oxygen, alkalinity, carbon dioxide, nitrite (as N), ferrous iron, manganese (+2), sulfide, and hydrogen sulfide.
NA - Not applicable.

TABLE 3-6

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 12
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
12MWT01	TBD	20-35	10	TBD	TBD
12MWT02	TBD	20-35	10	TBD	TBD
12MWT03	TBD	20-35	10	TBD	TBD
12MWT04	TBD	20-35	10	TBD	TBD
12MWT05	TBD	20-35	10	TBD	TBD
12MWT06	TBD	20-35	10	TBD	TBD
12MWT07	TBD	20-35	10	TBD	TBD
12MWT08	TBD	20-35	10	TBD	TBD
12MWT09	TBD	20-35	10	TBD	TBD
12MWT10	TBD	20-35	10	TBD	TBD
12MWT11	TBD	20-35	10	TBD	TBD
12MWT12	TBD	20-35	10	TBD	TBD
12MWT13	TBD	20-35	10	TBD	TBD
12MWT14	TBD	20-35	10	TBD	TBD
12MWT15	TBD	20-35	10	TBD	TBD
12MWT16	TBD	20-35	10	TBD	TBD
12MWT17	TBD	20-35	10	TBD	TBD
12MWT18	TBD	20-35	10	TBD	TBD
12MWT19	TBD	20-35	10	TBD	TBD
12MWT20	TBD	20-35	10	TBD	TBD
12MWT21	TBD	20-35	10	TBD	TBD
12MWT22	TBD	20-35	10	TBD	TBD
12MWT23	TBD	20-35	10	TBD	TBD
12MWT24	TBD	20-35	10	TBD	TBD
12MWT25	TBD	20-35	10	TBD	TBD
12MWT26	TBD	20-35	10	TBD	TBD
12MWT27	TBD	20-35	10	TBD	TBD
12MWT28	TBD	20-35	10	TBD	TBD
12MWT29	TBD	75-90	10	TBD	TBD
12MWT30	TBD	75-90	10	TBD	TBD
12MWT31	TBD	75-90	10	TBD	TBD
12MWT32	TBD	75-90	10	TBD	TBD

TABLE 3-6

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 12
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
12MWT33	TBD	75-90	10	TBD	TBD
12MWT34	TBD	75-90	10	TBD	TBD
12MWT35	TBD	20-35	10	TBD	TBD
12MWT36	TBD	20-35	10	TBD	TBD
12MWT37	TBD	20-35	10	TBD	TBD
12MWT38	TBD	20-35	10	TBD	TBD
12MWT39	TBD	20-35	10	TBD	TBD
12MWT40	TBD	20-35	10	TBD	TBD
12MWT41	TBD	20-35	10	TBD	TBD
12MWT42	TBD	20-35	10	TBD	TBD
12MWT43	TBD	75-90	10	TBD	TBD
12MWT44	TBD	20-35	10	TBD	TBD
12MWT45	TBD	20-35	10	TBD	TBD
12MWT46	TBD	20-35	10	TBD	TBD
12MWT47	TBD	20-35	10	TBD	TBD
12MWT48	TBD	20-35	10	TBD	TBD
12MWT49	TBD	20-35	10	TBD	TBD

amsl - Above mean sea level.
TBD - To Be Determined based on the exact well location and the depth that ground water is encountered during drilling.
bgs - Below ground surface.

1 Well screen elevations will vary depending on the ground surface elevation, the soil and rock types penetrated, and the distribution of fractures encountered in each boring.

TABLE 3-7

EXISTING MONITORING WELL CONSTRUCTION INFORMATION
AND WATER LEVEL MEASUREMENTS FOR SWMU 13
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (ft.)	Easting (ft.)	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 11, 2003	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
13MWT01	3/30/2003	1310541.574	3025015.943	713.10	715.34	15.00	5.00	15.00	708.10	698.10	Upper Pennyslvanian	6.21	709.13	5.82	709.52
13MWT02	3/29/2003	1310776.555	3024743.547	702.10	704.72	27.00	17.00	27.00	685.10	675.10	Upper Pennyslvanian	17.15	687.57	17.10	687.62
13MWT03	3/30/2003	1310240.946	3024891.661	718.34	721.10	15.00	5.00	15.00	713.34	703.34	Upper Pennyslvanian	8.79	712.31	8.88	712.22
13MWT04	3/30/2003	1310383.396	3024546.113	704.37	706.84	15.00	5.00	15.00	699.37	689.37	Upper Pennyslvanian	12.98	693.86	12.75	694.09
13MWT05	3/29/2003	1310758.927	3024380.025	693.61	696.44	16.00	6.00	16.00	687.61	677.61	Upper Pennyslvanian	5.42	691.02	4.13	692.31
13MWT06	4/7/2003	1309916.177	3024495.270	715.30	717.93	15.00	5.00	15.00	710.30	700.30	Upper Pennyslvanian	15.11	702.82	15.62	702.31
13MWT07	3/29/2003	1310539.322	3024094.128	684.38	687.22	15.00	5.00	15.00	679.38	669.38	Upper Pennyslvanian	3.12	684.10	3.10	684.12
13MWT08	3/30/2003	1310247.860	3024337.560	698.42	700.56	15.00	5.00	15.00	693.42	683.42	Upper Pennyslvanian	3.17	697.39	2.92	697.64
13MWT09	4/1/2003	1309662.066	3024049.030	703.29	705.90	20.00	10.00	20.00	693.29	683.29	Upper Pennyslvanian	7.74	698.16	7.40	698.50
13MWT10	3/27/2003	1309979.693	3024001.262	697.77	700.15	25.00	15.00	25.00	682.77	672.77	Upper Pennyslvanian	13.65	686.50	13.11	687.04
13MWT11	3/28/2003	1310233.721	3023750.087	679.76	682.29	15.00	5.00	15.00	674.76	664.76	Upper Pennyslvanian	7.87	674.42	7.00	675.29
13MWT12	3/27/2003	1310080.207	3023574.945	679.96	682.12	20.00	10.00	20.00	669.96	659.96	Upper Pennyslvanian	7.88	674.24	7.78	674.34
13MWT13	4/23/2003	1309441.270	3024163.605	699.28	701.98	19.00	8.00	18.00	691.28	681.28	Upper Pennyslvanian	3.62	698.36	3.18	698.80
13MWT14	3/31/2003	1309142.232	3024110.167	703.15	705.50	23.00	13.00	23.00	690.15	680.15	Upper Pennyslvanian	13.25	692.25	13.08	692.42
13MWT15	3/25/2003	1309565.518	3023717.803	694.27	696.65	25.00	15.00	25.00	679.27	669.27	Upper Pennyslvanian	12.88	683.77	12.63	684.02
13MWT16	3/27/2003	1309854.276	3023341.916	682.13	684.35	15.00	5.00	15.00	677.13	667.13	Upper Pennyslvanian	8.49	675.86	8.61	675.74
13MWT17	3/26/2003	1309605.272	3023123.966	690.68	693.01	18.00	8.00	18.00	682.68	672.68	Upper Pennyslvanian	8.70	684.31	8.09	684.92
13MWT18	3/26/2003	1309326.980	3023293.416	700.05	702.92	30.00	20.00	30.00	680.05	670.05	Upper Pennyslvanian	19.06	683.86	19.04	683.88
13MWT19	3/31/2003	1308893.971	3023834.565	703.10	705.82	19.00	9.00	19.00	694.10	684.10	Upper Pennyslvanian	8.31	697.51	6.80	699.02
13MWT20	4/1/2003	1309066.757	3023527.233	699.33	702.07	20.00	10.00	20.00	689.33	679.33	Upper Pennyslvanian	4.22	697.85	4.00	698.07
13MWT21	3/28/2003	1309391.009	3022916.218	688.37	690.74	15.00	5.00	15.00	683.37	673.37	Upper Pennyslvanian	7.69	683.05	7.34	683.40
13MWT22	3/28/2003	1308936.338	3022785.672	669.53	671.96	15.00	5.00	15.00	664.53	654.53	Upper Pennyslvanian	7.44	664.52	7.25	664.71
13MWT23	4/1/2003	1308708.016	3023245.117	696.66	699.14	22.00	11.50	21.50	685.16	675.16	Upper Pennyslvanian	7.45	691.69	7.17	691.97

TABLE 3-7

EXISTING MONITORING WELL CONSTRUCTION INFORMATION
AND WATER LEVEL MEASUREMENTS FOR SWMU 13
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Well Number	Installation Date	Northing (ft.)	Easting (ft.)	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 11, 2003	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Water Elevation (ft amsl)
13MWT24	4/1/2003	1308397.230	3022916.484	691.33	693.93	22.00	12.00	22.00	679.33	669.33	Upper Pennysivanian	8.45	685.48	8.23	685.70
13MWT25	3/28/2003	1308625.618	3022677.444	678.87	681.57	15.00	5.00	15.00	673.87	663.87	Upper Pennysivanian	16.00	665.57	16.61	664.96
13MWT26	3/28/2003	1308232.686	3022690.142	684.86	687.49	20.00	10.00	20.00	674.86	664.86	Upper Pennysivanian	9.10	678.39	8.93	678.56

Notes:
1 = Total depth of boring, total depth of well may be less.
bgs = Below ground surface.
btor = Below top of riser/reference point.
amsl = Above mean sea level (NAVD88).

TABLE 3-8
PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 13
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
13MWT27	TBD	20-35	10	TBD	TBD
13MWT28	TBD	75-90	10	TBD	TBD
13MWT29	TBD	20-35	10	TBD	TBD
13MWT30	TBD	20-35	10	TBD	TBD
13MWT31	TBD	20-35	10	TBD	TBD
13MWT32	TBD	20-35	10	TBD	TBD
13MWT33	TBD	20-35	10	TBD	TBD
13MWT34	TBD	20-35	10	TBD	TBD
13MWT35	TBD	75-90	10	TBD	TBD
13MWT36	TBD	20-35	10	TBD	TBD
13MWT37	TBD	20-35	10	TBD	TBD
13MWT38	TBD	75-90	10	TBD	TBD
13MWT39	TBD	20-35	10	TBD	TBD
13MWT40	TBD	20-35	10	TBD	TBD
13MWT41	TBD	75-90	10	TBD	TBD
13MWT42	TBD	20-35	10	TBD	TBD
13MWT43	TBD	20-35	10	TBD	TBD
13MWT44	TBD	75-90	10	TBD	TBD
13MWT45	TBD	75-90	10	TBD	TBD
13MWT46	TBD	75-90	10	TBD	TBD
13MWT47	TBD	TBD	10	TBD	TBD

amsl - Above mean sea level.
TBD - To Be Determined based on the exact well location and the depth that ground water is encountered during drilling.
bgs - Below ground surface.

1 Well screen elevations will vary depending on the ground surface elevation, the soil and rock types penetrated, and distribution of fractures encountered in each boring.

TABLE 3-9

EXISTING MONITORING WELL CONSTRUCTION INFORMATION AND WATER LEVEL MEASUREMENTS AT SWMU 16
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Monitoring Well Number	Installation Date	Northing (ft.)	Easting (ft.)	Ground Elevation (ft amsl)	Top of Riser Elevation (ft amsl)	Total Depth (ft bgs)[1]	Screened Interval				Aquifer	May 5, 2003		May 30, 2003	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft amsl)	Bottom (ft amsl)		Depth to Water (ft btor)	Ground Water Elevation (ft amsl)	Depth to Water (ft btor)	Ground Weter Elevation (ft amsl)
WES-14-01-83[2]	1983	1320638.353	3032713.383	763.87	766.67	50.70	35.80	45.30	728.07	718.57	Upper Pennyslvanian	31.00	735.67	31.00	735.67
WES-14-02-83[3]	1983	1321319.899	3032647.27	763.69	766.54	25.80	11.35	20.39	752.34	743.30	Upper Pennyslvanian	14.23	752.31	14.56	751.98
WES-14-03-83[4]	1983	1320816.004	3033018.495	761.51	763.93	35.40	20.88	29.99	740.63	731.52	Upper Pennyslvanian	18.80	745.13	19.83	744.10
WES-14-04-83[5]	1983	1320572.345	3032960.959	760.42	762.99	46.00	31.38	40.47	729.04	719.95	Upper Pennyslvanian	26.80	736.19	27.27	735.72
WES-14-05-83[6]	1983	1320584.051	3032850.321	766.60	769.40	50.70	35.80	45.25	730.80	721.35	Upper Pennyslvanian	32.59	736.81	33.05	736.35
16MWT01	4/8/2003	1321193.488	3032881.285	762.02	764.50	24.00	14.00	24.00	748.02	738.02	Upper Pennyslvanian	25.19	739.31	22.7	741.80
16MWT02	4/11/2003	1321146.42	3032559.16	757.60	760.36	18.00	8.00	18.00	749.60	739.60	Upper Pennyslvanian	6.55	753.81	12.18	748.18
16MWT03	4/10/2003	1320946.968	3032644.291	761.95	764.41	35.00	25.00	35.00	736.95	726.95	Upper Pennyslvanian	27.20	737.21	28.07	736.34
16MWT04	4/9/2003	1321003.281	3032946.466	763.88	766.14	25.00	15.00	25.00	748.88	738.88	Upper Pennyslvanian	8.05	758.09	13.14	753.00
16MWT05	4/9/2003	1320741.793	3032812.772	764.50	766.88	40.00	29.00	39.00	735.50	725.50	Upper Pennyslvanian	29.77	737.11	30.39	736.49
16MWT06	4/24/2003	1321199.519	3032883.373	761.77	764.44	25.00	15.00	25.00	746.77	736.77	Upper Pennyslvanian	22.33	742.11	15.92	748.52

Notes:
1 = Total depth of boring, total depth of well may be less.
2 = WES-14-01-83 numbered as 16MW01 in project database.
3 = WES-14-02-83 numbered as 16MW02 in project database.
4 = WES-14-03-83 numbered as 16MW03 in project database.
5 = WES-14-04-83 numbered as 16MW04 in project database.
6 = WES-14-05-83 numbered as 16MW05 in project database.
bgs = Below ground surface.
btor = Below top of riser.
amsl = Above mean sea level (NAVD88).

TABLE 3-10

PHYSICAL CHARACTERISTICS OF PROPOSED MONITORING WELLS AT SWMU 16 SWMU 12 (Round 1), SWMU 13 (Round 2), SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Monitoring Well Number	Approximate Ground Surface Elevation (feet amsl)	Approximate Total Depth (feet bgs)	Screen Length (feet)	Approximate Desired Well Screen Elevation[1]	
				Top (feet amsl)	Bottom (feet amsl)
16MWT07	TBD	20-35	10	TBD	TBD
16MWT08	TBD	75-90	10	TBD	TBD
16MWT09	TBD	20-35	10	TBD	TBD
16MWT10	TBD	20-35	10	TBD	TBD
16MWT11	TBD	75-90	10	TBD	TBD
16MWT12	TBD	20-35	10	TBD	TBD
16MWT13	TBD	20-35	10	TBD	TBD
16MWT14	TBD	20-35	10	TBD	TBD
16MWT15	TBD	75-90	10	TBD	TBD
16MWT16	TBD	75-90	10	TBD	TBD
16MWT17	TBD	20-35	10	TBD	TBD

amsl - Above mean sea level.
TBD - To Be Determined based on the exact well location and the depth that ground water is encountered during drilling.
bgs - Below ground surface.

1 Well screen elevations will vary depending on the ground surface elevation, the soil and rock types penetrated, and the distribution of fractures encountered in each boring.

TABLE 3-11

LISTING OF SURFACE WATER AND SEEP SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals				Miscellaneous	
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Dissolved Metals SW-846 6020	Total Mercury SW-846 7470A	Dissolved Mercury SW-846 7470A	Nitrate + Nitrite (as N)	Ammonia (as N)
SWMU 12														
12SW/SD01	12SW0101						1	1	1	1	1	1	1	1
12SW/SD02	12SW0201						1	1	1	1	1	1	1	1
12SW/SD03	12SW0301			1	1	1	1	1	1	1	1	1	1	1
12SW/SD04	12SW0401						1	1	1	1	1	1	1	1
12SW/SD05	12SW0501						1	1	1	1	1	1	1	1
12SW/SD06	12SW0601						1	1	1	1	1	1	1	1
12SW/SD07	12SW0701						1	1	1	1	1	1	1	1
12SW/SD08	12SW0801						1	1	1	1	1	1	1	1
12SW/SD09	12SW0901						1	1	1	1	1	1	1	1
12SW/SD10	12SW1001						1	1	1	1	1	1	1	1
12SW/SD11	12SW1101						1	1	1	1	1	1	1	1
12SW/SD12	12SW1201						1	1	1	1	1	1	1	1
12SW/SD13	12SW1301						1	1	1	1	1	1	1	1
12SW/SD14	12SW1401						1	1	1	1	1	1	1	1
12SW/SD15	12SW1501						1	1	1	1	1	1	1	1
12SW/SD16	12SW1601						1	1	1	1	1	1	1	1
12SW/SD17	12SW1701						1	1	1	1	1	1	1	1
12SW/SD18	12SW1801						1	1	1	1	1	1	1	1
12SW/SD19	12SW1901						1	1	1	1	1	1	1	1
12SW/SD20	12SW2001						1	1	1	1	1	1	1	1
12SW/SD21	12SW2101						1	1	1	1	1	1	1	1
12SW/SD22	12SW2201						1	1	1	1	1	1	1	1
12SW/SD23	12SW2301						1	1	1	1	1	1	1	1

TABLE 3-11

LISTING OF SURFACE WATER AND SEEP SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals				Miscellaneous	
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Dissolved Metals SW-846 6020	Total Mercury SW-846 7470A	Dissolved Mercury SW-846 7470A	Nitrate + Nitrite (as N)	Ammonia (as N)
SWMU 12 (Continued)														
12SW/SD24	12SW2401						1	1	1	1	1	1	1	1
12SW/SD25	12SW2501						1	1	1	1	1	1	1	1
12SW/SD26	12SW2601						1	1	1	1	1	1	1	1
12SW/SD27	12SW2701						1	1	1	1	1	1	1	1
12SW/SD28	12SW2801						1	1	1	1	1	1	1	1
12SW/SD29	12SW2901						1	1	1	1	1	1	1	1
12SW/SD30	12SW3001						1	1	1	1	1	1	1	1
12SP01	12SP0101						1	1	1	1	1	1	1	1
12SP02	12SP0201						1	1	1	1	1	1	1	1
12SP03	12SP0301						1	1	1	1	1	1	1	1
12SP04	12SP0401						1	1	1	1	1	1	1	1
12PS05	12SP0501						1	1	1	1	1	1	1	1
SWMU 12 Total Samples		0	0	1	1	1	35	35	35	35	35	35	35	35
SWMU 13														
13SW/SD07	13SW0702						1	1	1	1	1	1	1	1
13SW/SD08	13SW0802						1	1	1	1	1	1	1	1
13SW/SD09	13SW0902						1	1	1	1	1	1	1	1
13SW/SD10	13SW1002						1	1	1	1	1	1	1	1
13SW/SD11	13SW1102						1	1	1	1	1	1	1	1
13SW/SD12	13SW1202						1	1	1	1	1	1	1	1
13SW/SD13	13SW1302						1	1	1	1	1	1	1	1
13SW/SD14	13SW1401						1	1	1	1	1	1	1	1
13SW/SD15	13SW1501						1	1	1	1	1	1	1	1

TABLE 3-11

LISTING OF SURFACE WATER AND SEEP SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals				Miscellaneous	
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Dissolved Metals SW-846 6020	Total Mercury SW-846 7470A	Dissolved Mercury SW-846 7470A	Nitrate + Nitrite (as N)	Ammonia (as N)
SWMU 13 (Continued)														
13SW/SD16	13SW1601						1	1	1	1	1	1	1	1
13SW/SD18	13SW1801						1	1	1	1	1	1	1	1
13SW/SD19	13SW1901						1	1	1	1	1	1	1	1
13SW/SD20	13SW2001						1	1	1	1	1	1	1	1
13SW/SD22	13SW2201						1	1	1	1	1	1	1	1
13SW/SD24	13SW2401						1	1	1	1	1	1	1	1
13SW/SD25	13SW2501				1		1	1	1	1	1	1	1	1
13SW/SD26	13SW2601						1	1	1	1	1	1	1	1
13SW/SD27	13SW2701						1	1	1	1	1	1	1	1
13SW/SD28	13SW2801						1	1	1	1	1	1	1	1
13SW/SD29	13SW2901						1	1	1	1	1	1	1	1
13SW/SD30	13SW3001						1	1	1	1	1	1	1	1
13SW/SD31	13SW3101						1	1	1	1	1	1	1	1
13SW/SD32	13SW3201				1									
13SP01	13SP0101						1	1	1	1	1	1	1	1
13SP02	13SP0201						1	1	1	1	1	1	1	1
13SP03	13SP0301						1	1	1	1	1	1	1	1
13SP04	13SP0401						1	1	1	1	1	1	1	1
13SP05	13SP0501						1	1	1	1	1	1	1	1
SWMU 13 Total Samples		0	0	0	2	0	27	27	27	27	27	27	27	27

TABLE 3-11

LISTING OF SURFACE WATER AND SEEP SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals				Miscellaneous	
		SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Dissolved Metals SW-846 6020	Total Mercury SW-846 7470A	Dissolved Mercury SW-846 7470A	Nitrate + Nitrite (as N)	Ammonia (as N)
SWMU 16														
16SW/SD12	16SW1201	1	1				1	1	1	1	1	1	1	
16SW/SD13	16SW1301	1	1				1	1	1	1	1	1	1	
16SW/SD14	16SW1401	1	1				1	1	1	1	1	1	1	
16SW/SD15	16SW1501	1	1				1	1	1	1	1	1	1	
16SW/SD16	16SW1601	1	1				1	1	1	1	1	1	1	
16SW/SD17	16SW1701	1	1				1	1	1	1	1	1	1	
16SW/SD18	16SW1801	1	1				1	1	1	1	1	1	1	
16SW/SD19	16SW1901	1	1				1	1	1	1	1	1	1	
16SW/SD20	16SW2001	1	1				1	1	1	1	1	1	1	
16SW/SD21	16SW2101	1	1				1	1	1	1	1	1	1	
16SW/SD22	16SW2201	1	1		1									
16SP01	16SP0101	1	1				1	1	1	1	1	1	1	
16SP02	16SP0201	1	1				1	1	1	1	1	1	1	
16SP03	16SP0301	1	1				1	1	1	1	1	1	1	
16SP04	16SP0401	1	1				1	1	1	1	1	1	1	
16SP05	16SP0501	1	1				1	1	1	1	1	1	1	
SWMU 16 Total Samples		16	16	0	1	0	15	15	15	15	15	15	15	0

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.

TABLE 3-12

SUMMARY OF SURFACE WATER ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Semivolatiles			Explosives		Metals				Miscellaneous	
	SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Total Metals SW-846 6020	Dissolved Metals SW-846 6020	Total Mercury SW-846 7470A	Dissolved Mercury SW-846 7470A	Nitrate + Nitrite (as N)	Ammonia (as N)
SWMU 12 Samples	0	0	1	1	1	35	35	35	35	35	35	35	35
SWMU 13 Samples	0	0	0	2	0	27	27	27	27	27	27	27	27
SWMU 16 Samples	16	16	0	1	0	15	15	15	15	15	15	15	0
Total Samples All SWMUs	**16**	**16**	**1**	**4**	**1**	**77**	**77**	**77**	**77**	**77**	**77**	**77**	**62**
Field Duplicate[2]	2	2	1	1	1	8	8	8	8	8	8	8	7
Trip Blank[3]	2	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rinsate Blank[4]	0	0	0	0	0	0	0	0	0	0	0	0	0
Source Water Blank	1	1	1	1	1	1	1	1	1	1	1	1	1
Ambient Condition Blank[5]	1	1	1	1	1	1	1	1	1	1	1	1	1
Matrix Spike[6]	1	1	1	1	1	4	4	4	4	4	4	4	4
Matrix Spike Duplicate[7]	1	1	1	1	1	4	4	NA	NA	NA	NA	NA	NA

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 10 samples per SWMU.
3 Trip blanks will be submitted for analysis at a frequency of one per cooler containing samples for volatile analysis. Because the number of sample coolers shipped may vary, the number of trip blanks is estimated.
4 Environmental samples will be collected by directly filling the sample bottle. Therefore, no rinsate blanks are required for this matrix.
5 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
6 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
7 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
NA - Not Applicable

TABLE 3-13

LISTING OF SEDIMENT SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals		Miscellaneous			
		SW-846 8260B	SW-486 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Metals SW-846 6020	Mercury SW-846 7471A	CEC	AVS/SEM	TOC	pH
SWMU 12														
12SW/SD01	12SD010004						1	1	1	1	1	1	1	1
12SW/SD02	12SD020004						1	1	1	1				
12SW/SD03	12SD030004			1	1	1	1	1	1	1				
12SW/SD04	12SD040004						1	1	1	1	1	1	1	1
12SW/SD05	12SD050004						1	1	1	1				
12SW/SD06	12SD060004						1	1	1	1				
12SW/SD07	12SD070004			1	1	1	1	1	1	1	1	1	1	1
12SW/SD08	12SD080004						1	1	1	1				
12SW/SD09	12SD090004			1	1	1	1	1	1	1				
12SW/SD10	12SD100004						1	1	1	1	1	1	1	1
12SW/SD11	12SD110004						1	1	1	1				
12SW/SD12	12SD120004						1	1	1	1				
12SW/SD13	12SD130004						1	1	1	1	1	1	1	1
12SW/SD14	12SD140004						1	1	1	1				
12SW/SD15	12SD150004						1	1	1	1				
12SW/SD16	12SD160004						1	1	1	1	1	1	1	1
12SW/SD17	12SD170004						1	1	1	1				
12SW/SD18	12SD180004						1	1	1	1				
12SW/SD19	12SD190004						1	1	1	1	1	1	1	1
12SW/SD20	12SD200004						1	1	1	1				
12SW/SD21	12SD210004						1	1	1	1				
12SW/SD22	12SD220004						1	1	1	1	1	1	1	1
12SW/SD23	12SD230004						1	1	1	1				
12SW/SD24	12SD240004						1	1	1	1				
12SW/SD25	12SD250004						1	1	1	1				
12SW/SD26	12SD260004						1	1	1	1				
12SW/SD27	12SD270004						1	1	1	1				
12SW/SD28	12SD280004						1	1	1	1				
12SW/SD29	12SD290004						1	1	1	1				
12SW/SD30	12SD300004						1	1	1	1				
Total Samples SWMU 12		0	0	3	3	3	30	30	30	30	8	8	8	8

TABLE 3-13

LISTING OF SEDIMENT SAMPLES AND LABORATORY ANALYSES[1]
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Location	Sample ID	Volatiles		Semivolatiles			Explosives		Metals		Miscellaneous			
		SW-846 8260B	SW-486 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Metals SW-846 6020	Mercury SW-846 7471A	CEC	AVS/SEM	TOC	pH
SWMU 13														
13SW/SD24	13SD240004						1	1	1	1				
13SW/SD25	13SD250004				1		1	1	1	1				
13SW/SD26	13SD260004						1	1	1	1				
13SW/SD27	13SD270004						1	1	1	1				
13SW/SD28	13SD280004						1	1	1	1				
13SW/SD29	13SD290004						1	1	1	1				
13SW/SD30	13SD300004						1	1	1	1				
13SW/SD31	13SD310004						1	1	1	1				
13SW/SD32	13SD320004				1									
Total Samples SWMU 13		0	0	0	2	0	8	8	8	8	0	0	0	0
SWMU 16														
16SW/SD12	16SD120004	1	1				1	1	1	1				
16SW/SD13	16SD130004	1	1				1	1	1	1				
16SW/SD14	16SD140004	1	1				1	1	1	1				
16SW/SD15	16SD150004	1	1				1	1	1	1				
16SW/SD16	16SD160004	1	1				1	1	1	1				
16SW/SD17	16SD170004	1	1				1	1	1	1				
16SW/SD18	16SD180004	1	1				1	1	1	1				
16SW/SD19	16SD190004	1	1				1	1	1	1				
16SW/SD20	16SD200004	1	1				1	1	1	1				
16SW/SD21	16SD210004	1	1				1	1	1	1				
16SW/SD22	16SD220004	1	1		1									
Total Samples SWMU 16		11	11	0	1	0	10	10	10	10	0	0	0	0

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.

TABLE 3-14

SUMMARY OF SEDIMENT ANALYSES[1] AND QUALITY CONTROL SAMPLES
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Sample Type	Volatiles		Semivolatiles			Explosives		Metals		Miscellaneous			
	SW-846 8260B	SW-846 8015B	SW-846 8270C	Selected Ion Monitoring	SW-846 8151A	SW-846 8330	Miscellaneous Explosives	Metals SW-846 6020	Mercury SW-846 7471A	CEC	AVS/SEM	TOC	pH
Samples SWMU 12	0	0	3	3	3	30	30	30	30	8	8	8	8
Samples SWMU 13	0	0	0	2	0	8	8	8	8	0	0	0	0
Samples SWMU 16	11	11	0	1	0	10	10	10	10	0	0	0	0
Total Samples All SWMUs	**11**	**11**	**3**	**6**	**3**	**48**	**48**	**48**	**48**	**8**	**8**	**8**	**8**
Field Duplicates [2]	2	2	1	1	1	5	5	5	5	1	1	1	1
Rinsate Blanks [3]	1	1	1	1	1	5	5	5	5	NA	NA	1	NA
Ambient Condition Blanks [4]	1	1	1	1	1	1	1	1	1	NA	NA	NA	NA
Matrix Spikes [5]	1	1	1	1	1	3	3	3	3	NA	NA	1	NA
Matrix Spike Duplicates [6]	1	1	1	1	1	3	3	NA	NA	NA	NA	NA	NA

1 See Table 1-4 of this QAPP Addendum No. 1 for specific analysis requirements and analyte lists.
2 Field duplicates will be collected at a frequency of one per every 10 samples per SWMU.
3 Rinsate blanks will be collected at a frequency of one per every 10 samples, with a minimum of one per day of sampling, per sampling device or instrument. These amounts are estimates and may vary. No rinsate blanks are required for VOCs collected with disposable EnCore samplers.
4 Ambient condition blanks are optional samples that may be collected based on the judgment of the FOL.
5 Matrix spikes are collected for all organic and inorganic parameters at a frequency of one per every 20 field samples per matrix.
6 Matrix spike duplicates are collected for all organic parameters. Lab duplicates are analyzed for inorganic parameters in lieu of matrix spike duplicates. Matrix spike duplicates are collected at a frequency of one per every 20 field samples per matrix.
NA - Not Applicable

TABLE 3-15
SUMMARY OF SAMPLE ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR SOILS AND SEDIMENTS
SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2)
NSWC CRANE
CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Explosives	Explosives SW-846 8330	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
	Miscellaneous Explosives Laucks HPLC Method	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
Metals	Metals SW-846 6020, 7471A	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Analysis within 180 days; mercury analysis within 28 days
Volatiles	SW-846 8260B	3 Encore™ samplers[2]	Four 5-gram containers	Cool to 4 °C	48 hours to preservation[3]; 14 days to analysis
	SW-846 8015B	2 Encore™ samplers[2]	Four 5-gram containers	Cool to 4 °C	48 hours to preservation[4]; 7 days to analysis
Semivolatiles	SW-846 8270C	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
	SW-846 8270C Selective Ion Monitoring	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
	PCP and Hexachlorophene SW-846 8151A	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
PCBs	PCBs	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Extraction within 14 days; analysis within 40 days of extraction
Total Organic Carbon	Lloyd Khan	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	28 days
pH	SW-846 9045C	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	Within 24 hours of sample receipt
Cation Exchange Capacity	SW-846 9081	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	As soon as possible

TABLE 3-15

SUMMARY OF SAMPLE ANALYSIS, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR SOILS AND SEDIMENTS SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Cyanide	SW-846 9012A	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	14 days to analysis
AVS/SEM	Draft EPA Method	Wide-mouth jar, Teflon-lined plastic cap	8 ounce (separate container)	Cool to 4 °C	14 days to analysis
Ammonia	EPA 350.1	Wide-mouth jar, Teflon-lined plastic cap	8 ounce	Cool to 4 °C	28 days to analysis

1 All holding times are from date of collection.

2 Sediment samples collected from areas with no standing water will be collected with Encore™ samplers. Sediment samples collected from areas under standing water will be containerized using a 4 ounce clear wide mouth glass jar and cooled to 4°C.

3 One Encore™ extended into 5 mL H_2O and frozen. Second Encore™ frozen as received. Third Encore™ preserved with methanol for medium level analysis.

4 One Encore™ extended into 5 mL H_2O and frozen. Second Encore™ frozen as received.

HPLC = High-performance liquid chromatography.

PCBs = Polychlorinated biphenyl.

AVS/SEM = Acid volatile sulfide/Simultaneously extracted metals.

TABLE 3-16

SUMMARY OF SAMPLE ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR AQUEOUS SAMPLES SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Explosives	Explosives SW-846 8330	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4 °C, dark	Extraction within 7 days; analysis within 40 days of extraction
Metals	Total SW-846 6020, 7470A	Polyethylene, plastic cap w/ plastic liner	2 - 1000 mL (2 bottles each)	HNO_3 to pH <2	Within 180 days; mercury within 28 days
	Dissolved SW-846 6020, 7470A	Polyethylene, plastic cap w/ plastic liner	1000 mL	HNO_3 to pH <2	Within 180 days; mercury within 28 days
Volatiles	SW-846 8260B	Glass, black phenolic plastic screw cap, Teflon-lined septum	40 mL (6 bottles each)	Cool to 4 °C, dark, zero headspace, HCl to pH <2	14 days to analysis
	SW-846 8015B	Glass, black phenolic plastic screw cap, Teflon-lined septum	40 mL (6 bottles each)	Cool to 4 °C, dark, zero headspace, HCl to pH <2	14 days to analysis
Semivolatiles	SW-846 8270C	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4 °C, dark	Extraction within 7 days; analysis within 40 days of extraction
	Selective Ion Monitoring SW-846 8270C	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4 °C, dark	Extraction within 7 days; analysis within 40 days of extraction
	PCP and Hexachlorophene SW-846 8151A	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4 °C, dark	Extraction within 7 days; analysis within 40 days of extraction
PCBs	PCBs SW-846 8082	Amber glass, Teflon-lined cap	1000 mL (2 bottles each)	Cool to 4 °C, dark	Extraction within 7 days; analysis within 40 days of extraction
Nitrate + Nitrite (as N)	EPA Method 353.2	Polyethylene, plastic cap w/ plastic liner	500 mL	Cool to 4 °C, H_2SO_4 to pH < 2	28 days to analysis
Ammonia (as N)	EPA Method 350.1	Polyethylene, plastic cap w/ plastic liner	500 mL	Cool to 4 °C, H_2SO_4 to pH < 2	28 days to analysis
Total Organic Carbon	SW-846 9060	Amber glass, septa cap	125 mL	Cool to 4 °C, H_2SO_4 to pH < 2	28 days to analysis

TABLE 3-16

SUMMARY OF SAMPLE ANALYSES, CONTAINER TYPES AND VOLUMES, PRESERVATION REQUIREMENTS, AND HOLDING TIMES FOR AQUEOUS SAMPLES SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Parameter	Analyte/Methodology	Sample Container	Container Volume	Preservation	Maximum Holding Time[1]
Cyanide	SW-846 9012A	Polyethylene, plastic cap w/ plastic liner	500 mL	Cool to 4° C, NaOH to pH > 12	14 days to analysis
Methane, Ethane, Ethene	Microseeps Method	Amber glass, plastic cap, mylar liner	40 mL	Cool to 4°C	21 days to analysis
Chloride	EPA 300.0	Polyehtylene, plastic cap with plastic liner	250 mL	Cool to 4°C	28 days to analysis
Sulfate	EPA 300.0	Polyethylene, plastic cap with plastic liner	250 mL	Cool to 4°C	28 days to analysis

Note: Aqueous samples include ground water, surface water, seeps, and aqueous QA samples.

1 All holding times are from date of collection.

HCl = Hydrochloric acid.

mL = milliliters.

H_2SO_4 = Sulfuric Acid.

HNO_3 = Nitric Acid.

NaOH = Sodium Hydroxide.

TABLE 3-17

NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS SWMU 12 (Round 1), SMWU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Field Duplicate	1 per 10 investigative samples collected.	Aqueous = 30% RPD Soil/Sediment = 50% RPD	Qualify data according to data validation requirements.
Equipment Rinsate Blank	1 per 10 investigative samples collected, with a minimum of one per day of sampling per non-disposable sampling device/instrument. For pre-cleaned, dedicated, and/or disposable equipment (i.e., disposable plastic trowels, etc.), one rinsate blank will be collected and analyzed at a frequency of one per lot or "batch blank" for a specific equipment type.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Source Water Blank	1 per source of water used for sampling equipment decontamination.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Ambient Condition Blank	At discretion of FOL.	< RL (soil and water)	Identify source of contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Trip Blank	1 per cooler containing samples for volatile organics analysis.	< RL (soil and water)	Identify source of volatiles contamination, if possible. Qualify data according to validation criteria. Qualify use of data if contamination appears to have adversely affected its usability.
Internal Standard	At least one internal standard per sample for GC/MS analysis.	Retention times stable to ±30 seconds; area counts stable to within factor of 2.	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.

TABLE 3-17

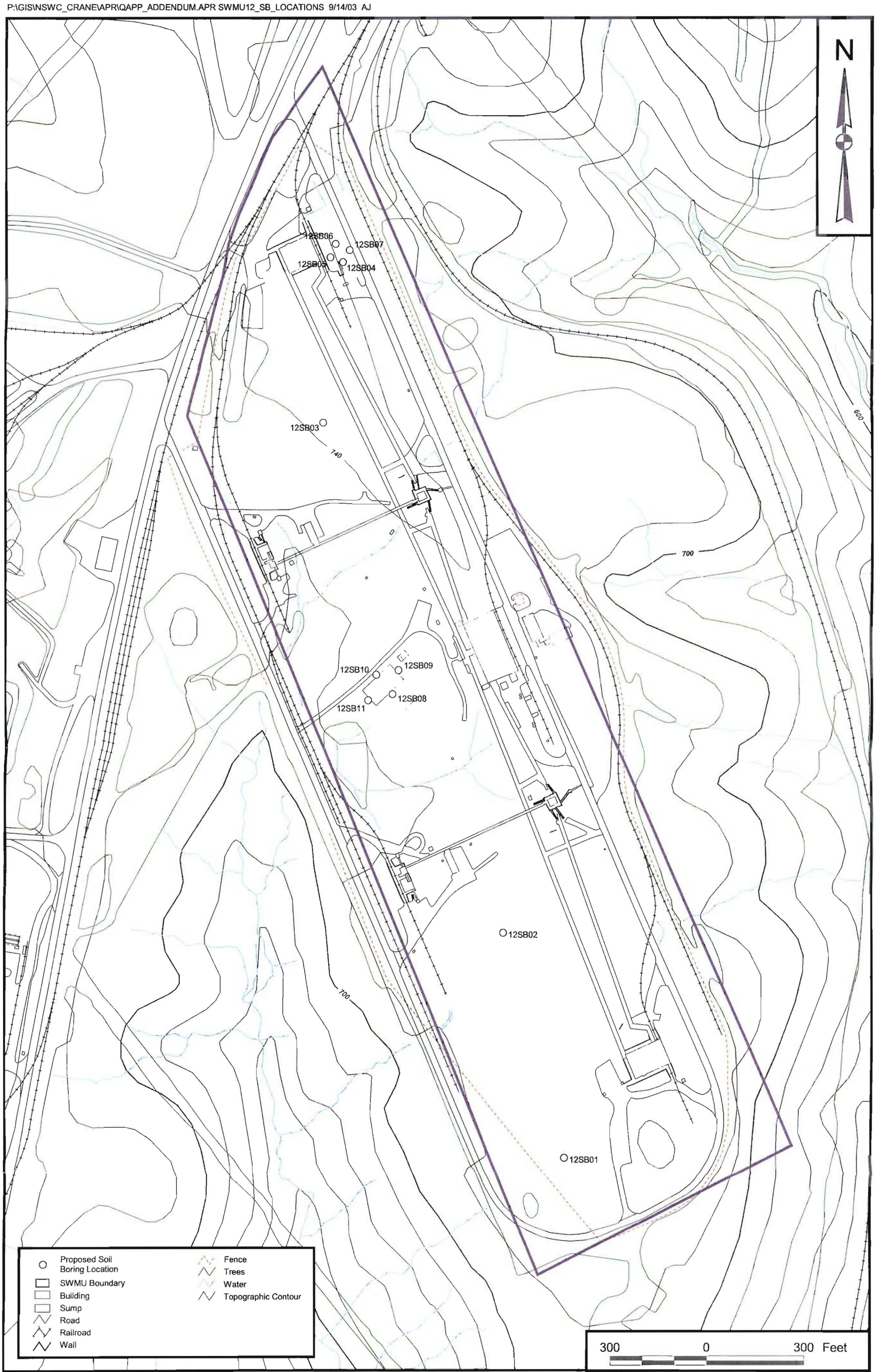
NON-CALIBRATION QUALITY CONTROL SAMPLE USAGE FREQUENCIES, ACCEPTANCE LIMITS, AND CORRECTIVE ACTIONS SWMU 12 (Round 1), SMWU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

QC Sample Type	Collection Frequency	Acceptance Limit	Corrective Action
Laboratory Control Sample	1 per 20 environmental samples per matrix.	See Tables 7-2, 7-4, 7-6, 7-8, 7-10, 7-12, 7-14, 7-16	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Laboratory Duplicate	1 per 20 environmental samples analyzed for inorganic target analytes.	See Tables 7-1, 7-3, 7-5, 7-7, 7-9, 7-11, 7-13, 7-15	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Laboratory Method Blank	1 per 20 environmental samples or per preparation batch, whichever is more frequent.	< RL (soil and water)	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Matrix Spike*	1 per 20 environmental samples.	See Tables 7-1, 7-3, 7-5, 7-7, 7-9, 7-11, 7-13, 7-15	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Matrix Spike Duplicate*	1 per 20 environmental samples analyzed for organic target analytes.	See Tables 7-1, 7-3, 7-7, 7-9, 7-11, 7-13, 7-15	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Post-digestion Spike	Only if out-of-control matrix spike exists (metals only)	100 ± 20%	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Surrogate	At least one per sample for organic chromatographic analyses (GC, GC/MS, and HPLC).	See Tables 7-1, 7-3, 7-7, 7-9, 7-11, 7-13, 7-15	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.
Temperature Blank	One blank per sample cooler.	4°C ± 2 °C	Laboratory action taken per LTL-1008. TtNUS action taken per validation protocols, and Section 11.2.

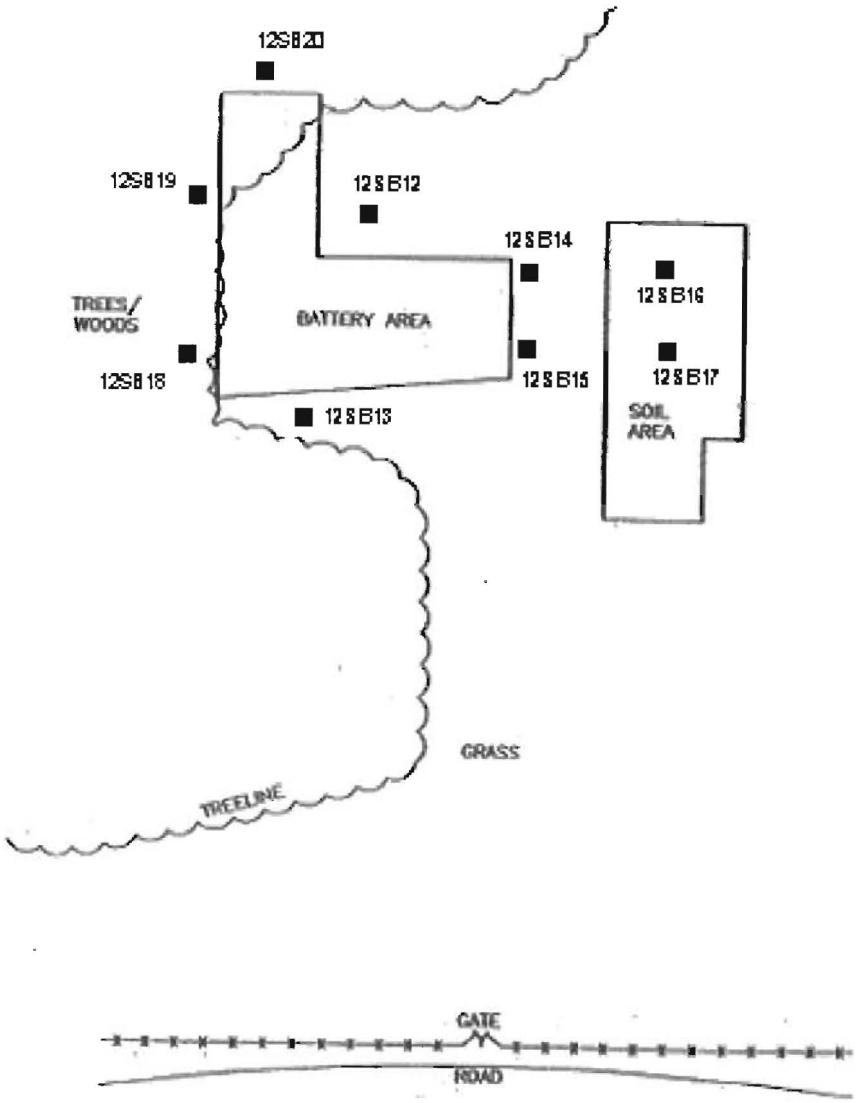
* Matrix spikes and matrix spike duplicates are not analyzed in the field, but additional sample material must be collected in the field to ensure that the laboratory has enough material for spiking and duplicate analysis.

QC = Quality control.
RPD = Relative percent difference.
RL = Reporting limit.
FOL = Field Operations Leader.
GC/MS = Gas chromatograph/mass spectrometer.
HPLC = High-performance liquid chromatography.

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR SWMU12_SB_LOCATIONS 9/14/03 AJ



DRAWN BY K. PEILA	DATE 9/8/03	SOIL BORING LOCATIONS SWMU 12 QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. SCHUBERT	DATE 9/12/03		APPROVED BY J. SCHUBERT — DATE 9/8/03
COST/SCHEDULE-AREA			APPROVED BY — — DATE —
SCALE AS NOTED			DRAWING NO. 3-1 — REV 0



APPROXIMATE SCALE (FEET)

0 40 80

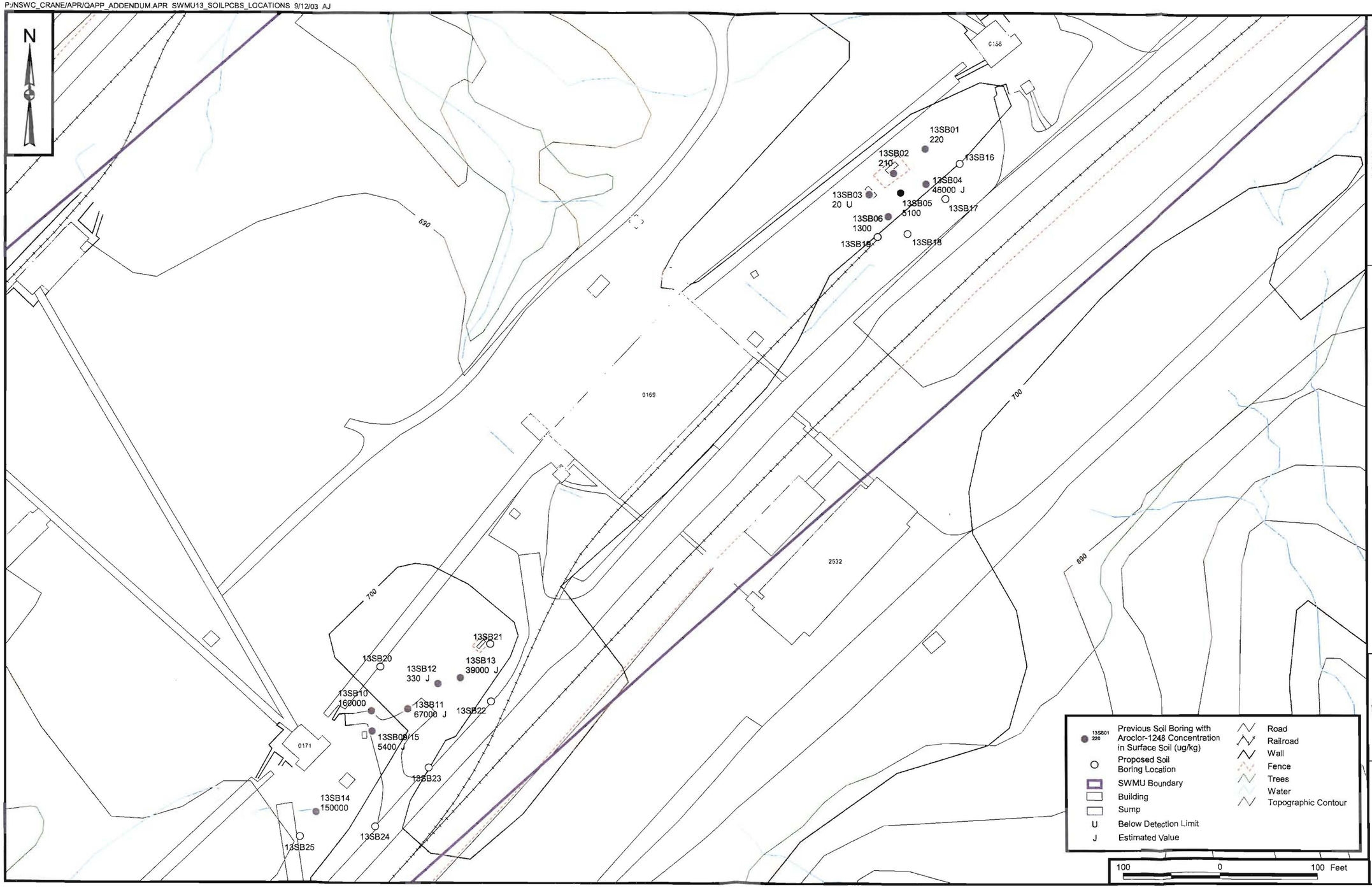
N

■ **PROPOSED SOIL BORING**

DRAWN BY A. JANOCHA	DATE 10/02/03		SWMU 12 BATTERY DISPOSAL SITE SOIL BORING LOCATIONS QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. SCHUBERT	DATE 10/17/03			APPROVED BY J. SCHUBERT / DATE 10/02/03
COST/SCHEDULE-AREA				APPROVED BY — / DATE —
SCALE AS NOTED				DRAWING NO. 3 - 2 / REV. 0

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR BATTERY DISPOSAL SITE SB LOCATIONS LAYOUT 10/17/03 AJ

P:/NSWC_CRANE/APR/QAPP_ADDENDUM.APR SWMU13_SOILPCBS_LOCATIONS 9/12/03 AJ



CONTRACT NO.
3994

APPROVED BY
J. SCHUBERT
DATE
9/8/03

APPROVED BY
DATE

DRAWING NO.
3-3
REV
0

SOIL SAMPLING LOCATIONS FOR PCBs
SWMU 13
QAPP ADDENDUM NO. 1
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2),
AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY * SOUTHERN DIVISION NAVAL FACILITIES ENGINEERING COMD

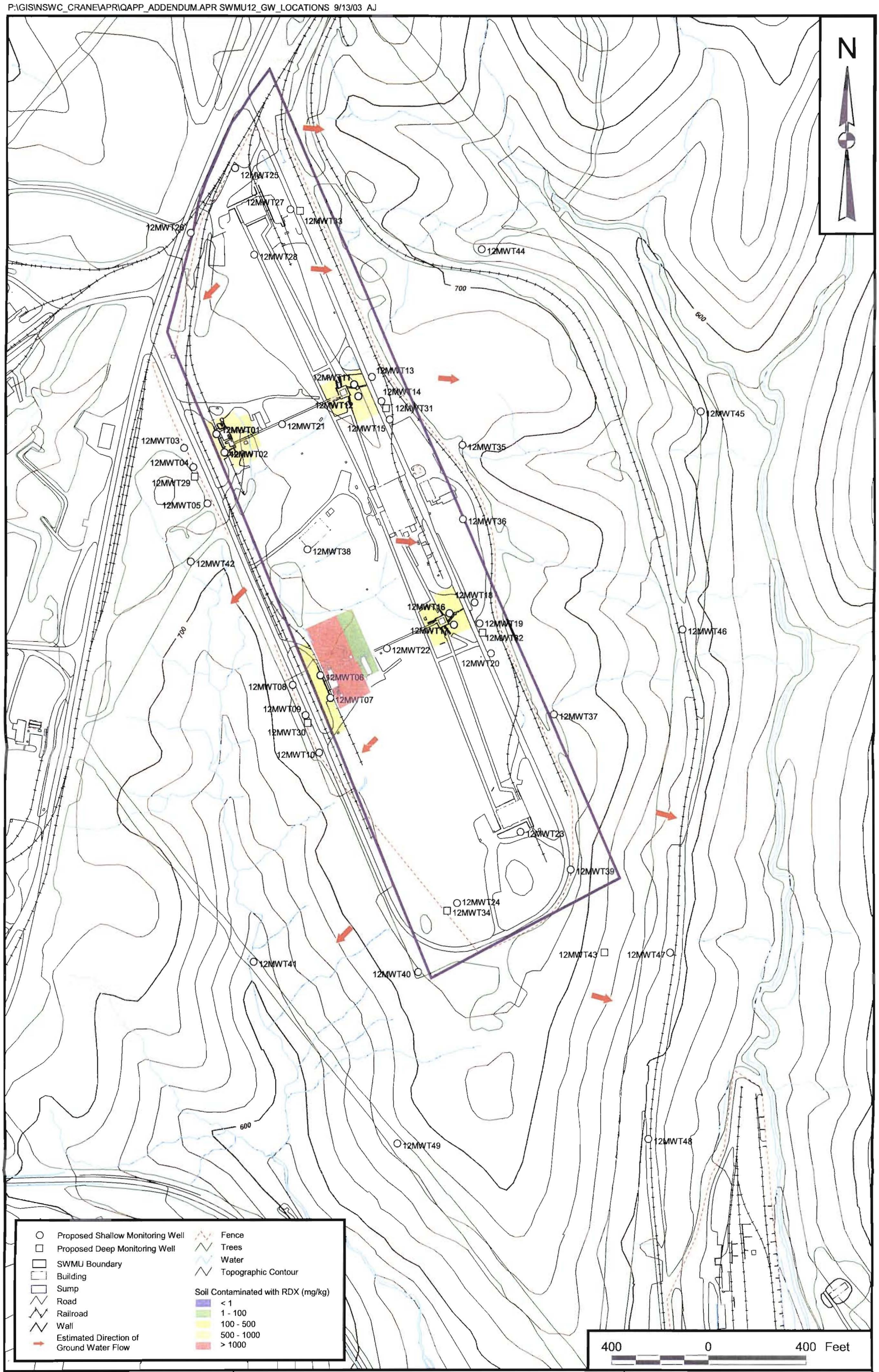
DRAWN BY
K. PEILA
DATE
9/8/03

CHECKED BY
J. SCHUBERT
DATE
9/12/03

COST/SCHED-AREA

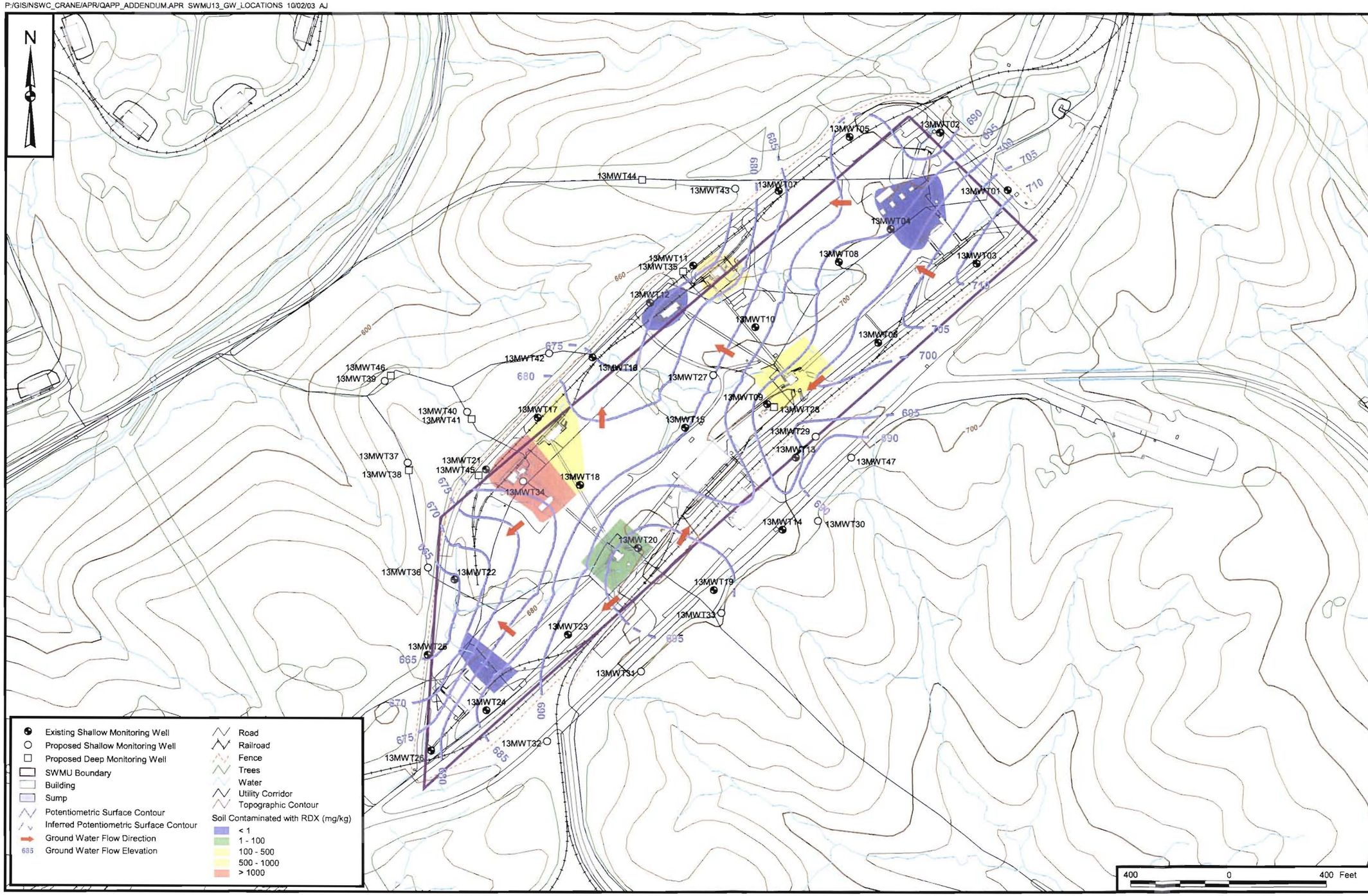
SCALE
AS NOTED

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR SWMU12_GW_LOCATIONS 9/13/03 AJ



DRAWN BY K. PEILA	DATE 9/8/03	GROUND WATER SAMPLING LOCATIONS SWMU 12 QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. SCHUBERT	DATE 9/12/03		APPROVED BY J. SCHUBERT — DATE 9/8/03
COST/SCHEDULE-AREA			APPROVED BY — — DATE —
SCALE AS NOTED			DRAWING NO. 3-4 — REV 0

P:/GIS/NSWC_CRANE/APR/QAPP_ADDENDUM.APR SWMU13_GW_LOCATIONS 10/02/03 AJ



CONTRACT NO. 3994

APPROVED BY J. SCHUBERT — DATE 10/02/03

APPROVED BY ____ — DATE ____

DRAWING NO. 3-5 — REV 0

GROUND WATER SAMPLING LOCATIONS
SWMU 13
QAPP ADDENDUM NO. 1
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2),
AND SWMU 16 (ROUND 2)
NWSC CRANE
CRANE, INDIANA

DEPARTMENT OF THE NAVY ★ SOUTHERN DIV FACILITIES ENGINEERING COMD

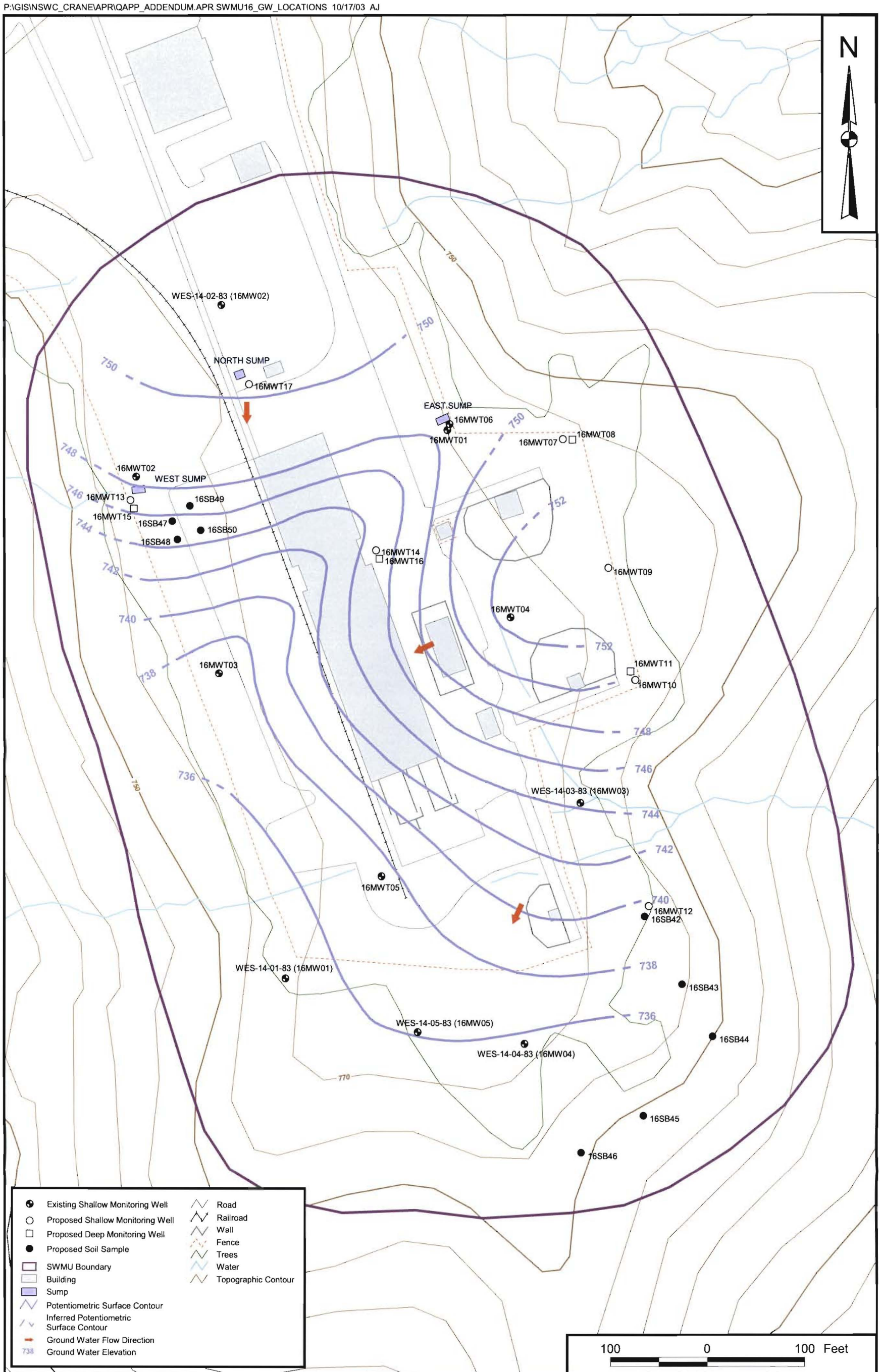
DRAWN BY K. PEILA — DATE 9/8/03

CHECKED BY J. SCHUBERT — DATE 10/02/03

COST/SCHED-AREA

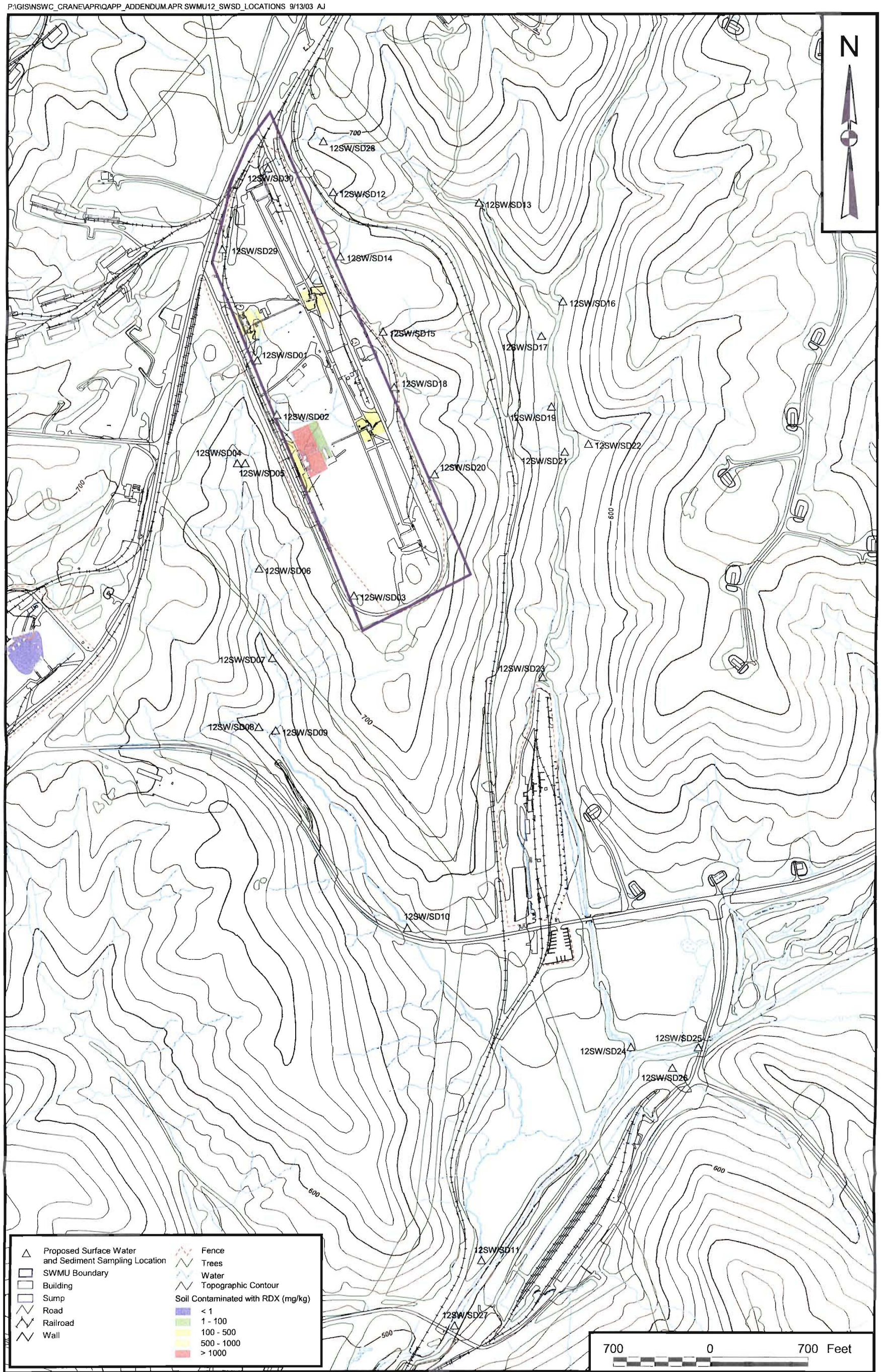
SCALE AS NOTED

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR SWMU16_GW_LOCATIONS 10/17/03 AJ



DRAWN BY A. JANOCHA	DATE 10/09/03	SOIL AND GROUND WATER SAMPLING LOCATIONS SWMU 16 QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. SCHUBERT	DATE 10/17/03		APPROVED BY J. SCHUBERT — DATE 10/17/03
COST/SCHEDULE-AREA			APPROVED BY — — DATE —
SCALE AS NOTED			DRAWING NO. 3-6 — REV 0

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR SWMU12_SWSD_LOCATIONS 9/13/03 AJ

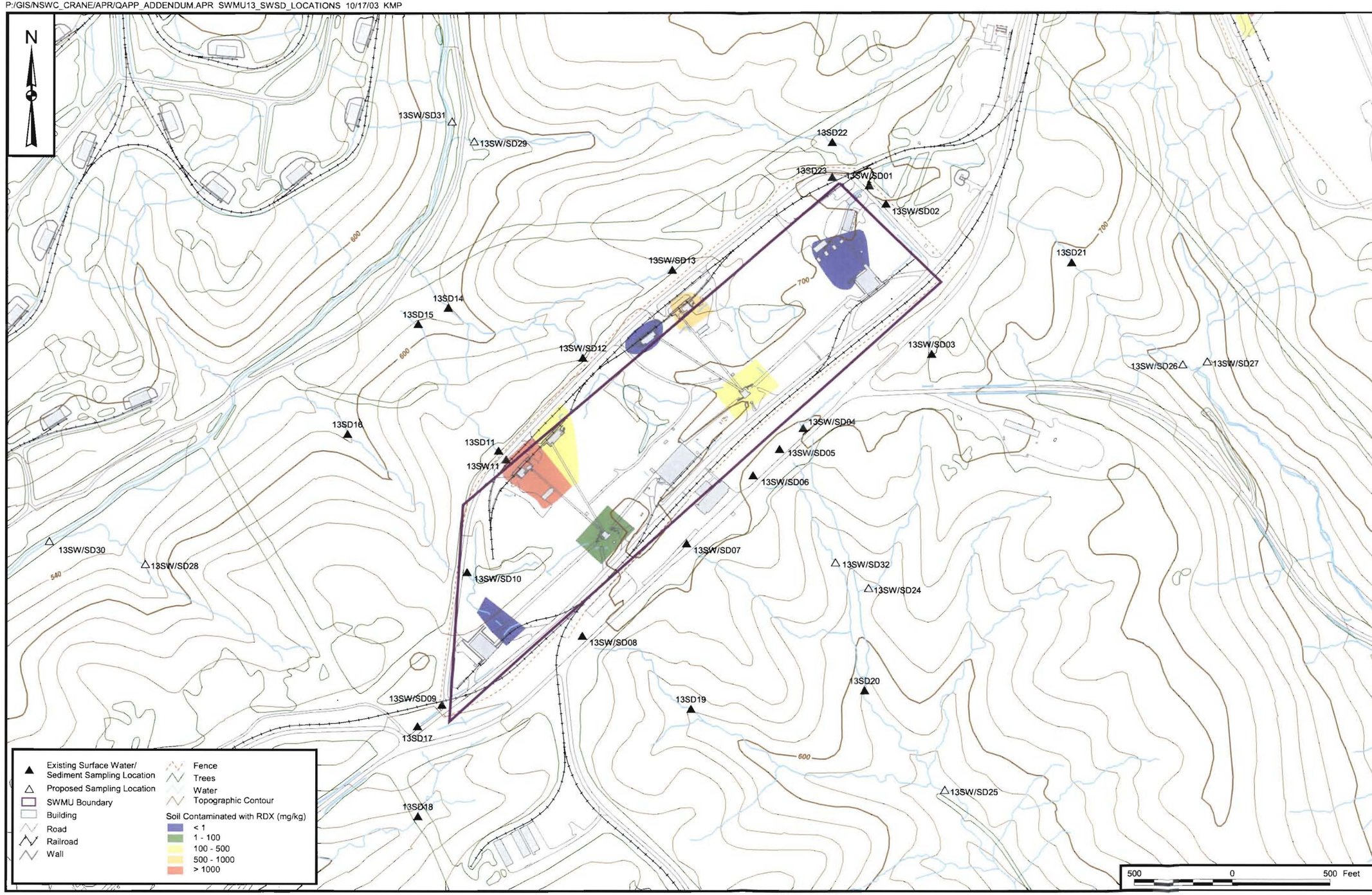


DRAWN BY	DATE
K. PEILA	9/8/03
CHECKED BY	DATE
J. SCHUBERT	9/15/03
COST/SCHEDULE-AREA	
SCALE	
AS NOTED	

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
SWMU 12
QAPP ADDENDUM NO. 1
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2),
AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

CONTRACT NUMBER	
3994	
APPROVED BY	DATE
J. SCHUBERT	9/8/03
APPROVED BY	DATE
—	—
DRAWING NO.	REV
3-7	0

P:/GIS/NSWC_CRANE/APR/QAPP_ADDENDUM.APR SWMU13_SWSD_LOCATIONS 10/17/03 KMP



CONTRACT NO. 3994

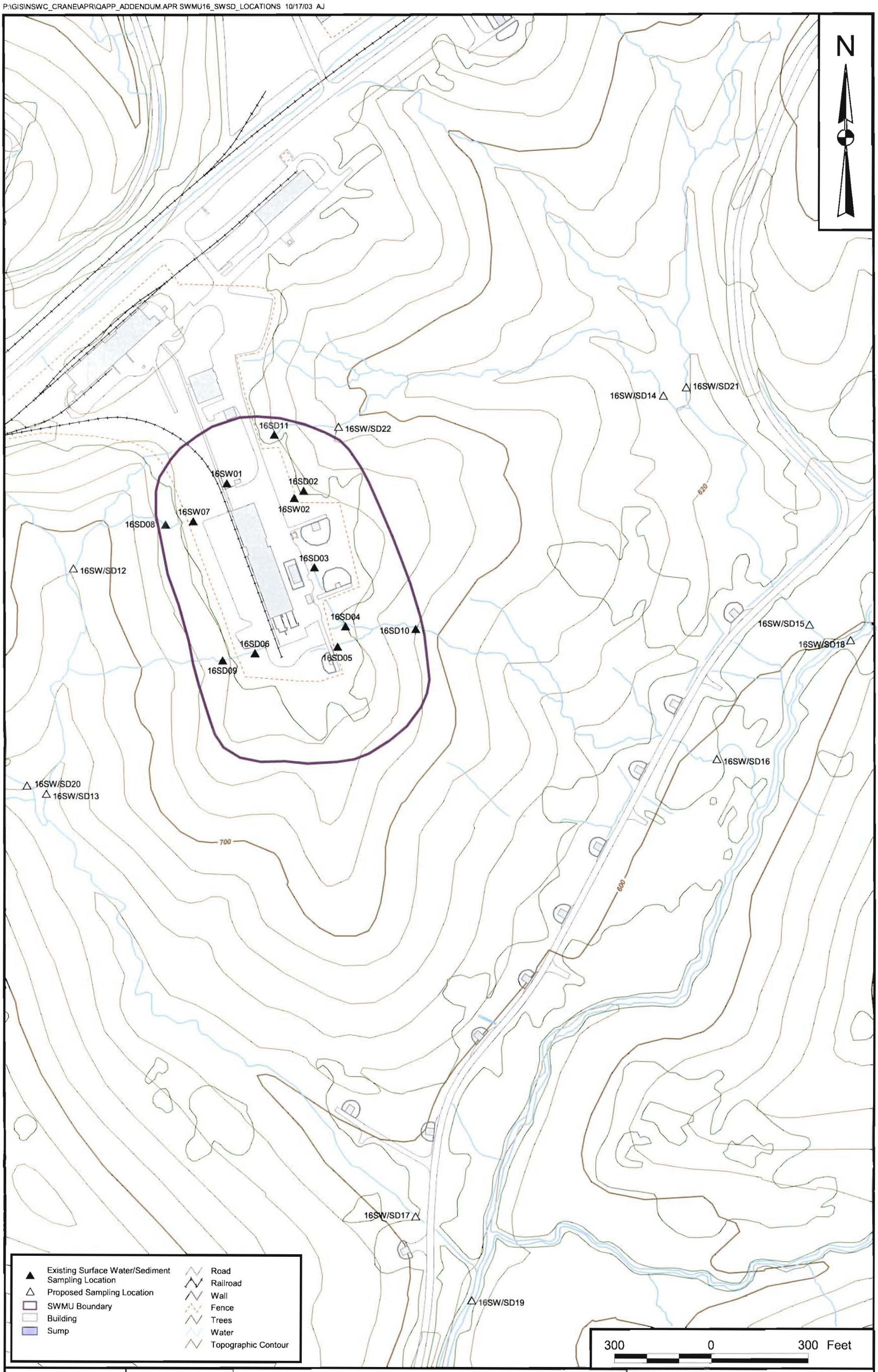
APPROVED BY	DATE
J. SCHUBERT	10/17/03
APPROVED BY	DATE

DRAWING NO. 3-8 REV 0

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
SWMU 13
QAPP ADDENDUM NO. 1
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2),
AND SWMU 16 (ROUND 2)
NWSC CRANE
CRANE, INDIANA

DRAWN BY	DATE
K. PEILA	9/8/03
CHECKED BY	DATE
J. SCHUBERT	10/17/03
COST/SCHED-AREA	SCALE
	AS NOTED

P:\GIS\NSWC_CRANE\APR\QAPP_ADDENDUM.APR SWMU16_SWSD_LOCATIONS 10/17/03 AJ



DRAWN BY K. PEILA	DATE 9/9/03	SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS SWMU 16 QAPP ADDENDUM NO. 1 SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA	CONTRACT NUMBER 3994
CHECKED BY J. SCHUBERT	DATE 10/17/03		APPROVED BY J. SCHUBERT — DATE 10/17/03
COST/SCHEDULE-AREA			APPROVED BY — DATE —
SCALE AS NOTED			DRAWING NO. 3-9 — REV 0

4.0 CUSTODY PROCEDURES

Documented sample custody is one of several factors necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody requirements are presented in Section 4.0 of the approved SWMU 12, 13, 16, 19 QAPP (TtNUS, 2003).

Laucks Testing Laboratory will analyze the samples generated under this QAPP Addendum No. 1 for all but ethane, ethene, and methane. Microseeps, Inc. will perform analyses for ethane, ethane, and methane on ground water samples.

The laboratory contact information, including shipping addresses, is provided in Table 2-1.

5.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results.

Field equipment not listed in the approved CTO 166 QAPP for SWMUs 12, 13, 16, and 19 will be used to measure parameters for evaluating the efficacy of natural attenuation at SWMUs 12, 13, and 16. The necessary equipment lists are identified in the SOPs for field measurement, which are provided in Appendix E to this QAPP Addendum No. 1. The necessary analyte lists are presented in Table 1-3 in Section 1.0 of this QAPP Addendum No. 1.

Instruments used in the field and in the laboratory will be calibrated in accordance with the procedures governing the use of the instruments. Calibration procedures and frequency are described in Section 5.0 of the approved SWMU 12, 13, 16, 19 QAPP (TtNUS, 2003). The additional equipment for specific use in conjunction with this QAPP Addendum No. 1 will be calibrated in accordance with the corresponding SOPs. Chemical test kits do not necessarily require calibration, although when applicable, calibration check standards shall be analyzed in accordance with the test kit instructions. Applicability is indicated in the test kit instructions and the check standards are provided with the test kit.

6.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Field measurements and laboratory analytical procedures are presented in this section.

6.1 FIELD MEASUREMENT PROCEDURES

Parameters to be measured using field instrumentation include sample depth and sample location and the parameters listed in Table 3-1 of Section 3.0. Measurement of field parameters is governed by the applicable SOPs included in Appendix E. Some natural attenuation parameters will also be measured in the field using chemical test kits.

6.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

The laboratory analytical procedures for all but the ethane, ethene, and methane will be performed by Laucks Laboratory. This Laboratory has successfully completed the laboratory evaluation process required as part of the Naval Facilities Engineering Service Center (NFESC) QA Program and described in the Department of Defense (DOD) Environmental Data Quality Systems Manual for Environmental Laboratories (DOD, June 2002). The ethane, ethane, and methane analyses do not require Navy evaluation and Microseeps has not been evaluated; however, a request for Navy evaluation is in the process of being submitted to the Navy. Table 6-1 provides a summary of the laboratory analytical methods and associated laboratory SOPs to be used during this investigation. Laboratory SOPs are included in Appendix I of the approved SWMU 12, 13, 16, 19 QAPP (TtNUS, 2003). Any SOPs that have been updated between the Round 1 and the generation of this QAPP are provided in Appendix G of this QAPP Addendum No. 1.

6.2.1 List of Project Target Compounds and Detection Limits

A list of the laboratory target analytes, project-specific risk-based target levels, and reporting limits (RLs) is provided in Table 1-4 of this QAPP Addendum No. 1. Data reporting conventions will be consistent with the Round 1 reporting conventions and are as described in Section 1.4 of the EPA-approved QAPP for SWMUs 12, 13, 16, and 19 (TtNUS 2003).

6.2.2 List of Associated Quality Control Samples

Field and laboratory QC samples to be analyzed in support of this project are identified in Section 7.0. The analytical SOPs included in Appendix G of this QAPP Addendum No. 1 address minimum QC

requirements for each associated analytical method. The SOPs include calibration QC requirements. Details on QC sample usage are provided in Section 7.0.

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS ANALYTICAL LABORATORY PROCEDURES FOR SOLID AND AQUEOUS SAMPLES SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Analytical Parameter [1]	Preparation Method [2,3]	Analytical Method [2,3]	Preparation/Analytical SOP(s) [4]
EXPLOSIVES AND DEGRADATION PRODUCTS			
Explosives SW-846 8330	Aqueous SW-846 3535/8330 Solid SW-846 8330	Aqueous SW-846 8330 Solid SW-846 8330	Aqueous LTL-3077 / LTL-8330 Solid LTL-3161 / LTL-8330
Miscellaneous Explosives and Degradation Products by modified SW-846 Method 8330	Aqueous SW-846 3535/M8330 Solid SW-846 8330	Aqueous and Solid SW-846 M8330	Aqueous LTL-3077/LTL-8330 Solid LTL-3077/LTL-8330
APPENDIX IX AND TAL METALS			
Metals (except Antimony, Tin, and Mercury), total or dissolved, as applicable (See Table 1-4)	Aqueous SW-846 Methods 3010A (**no** HCl) or 3015 (**no** HCl) Solid SW-846 Method 3050B (include H_2O_2 but **no** HCl)	Aqueous and Solid SW-846 Method 6020	Aqueous LTL-7009 or LTL-7010/ LTL-7202 Solid LTL-7015/ LTL-7202
Antimony and Tin, total or dissolved, as applicable (See Table 1-4)	Aqueous SW-846 Methods 3010A or 3015 (**no** H_2O_2) Solid SW-846 Method 3050B (include HCl but **no** H_2O_2)	Aqueous and Solid SW-846 Method 6020	Aqueous LTL-7009 or LTL-7010/ LTL-7202 Solid LTL-7015/ LTL-7202
Mercury, total or dissolved, as applicable (See Table 1-4)	Aqueous SW-846 Method 7470A Solid SW-846 Method 7471A	Aqueous SW-846 Method 7470A Solid SW-846 Method 7471A	Aqueous LTL-7501 Solid LTL-7501
VOLATILES			
VOCs SW-846 8260B	Aqueous SW-846 Method 5030B (25 mL purge) Solid SW-846 Method 5035 (5 g purge)	Aqueous SW-846 Method 8260B (25 mL purge) Solid SW-846 Method 8260B (5 g purge)	Aqueous LTL-8265 (low level) Solid LTL-8265

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS ANALYTICAL LABORATORY PROCEDURES FOR SOLID AND AQUEOUS SAMPLES SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Analytical Parameter [1]	Preparation Method [2,3]	Analytical Method [2,3]	Preparation/Analytical SOP(s) [4]
VOCs SW-846 8015B	Aqueous SW-846 Method 5030B (10 mL purge) Solid SW-846 Method 5035 (5 g purge)	Aqueous SW-846 Method 8015B Solid SW-846 Method 8015B (5 g purge)	Aqueous LTL-8019 Solid LTL-8019
SEMIVOLATILES			
SVOCs (except PAHs) by SW-8270C	Aqueous SW-846 Method 3520C Solid SW-846 Method 3550B	Aqueous and Solid SW-846 Method 8270C	Aqueous LTL-3000 / LTL-8279 Solid LTL-3101 / LTL-8279
SVOCs (PAHs) by SW-8270C SIM	Aqueous SW-846 Method 3520C Solid SW-846 Method 3545A	Aqueous and Solid SW-846 Methods 8270C-SIM	Aqueous LTL-3001 / LTL-8277 Solid LTL-3451 / LTL-8277
Hexachlorophene and pentachlorophenol by SW-846 8151B	Aqueous SW-846 Method 3510C Solid SW-846 Method M3550B	Aqueous and Solid SW-846 Method 8151B	Aqueous LTL-3510 / LTL-8151 Solid LTL-3011 / LTL-8151
PCBs			
PCBs (Aroclors) SW-846 8082	Solid SW-846 Method 3545A	Solid SW-846 Method 8082	Solid LTL-3303 / LTL-8084
MISCELLANEOUS PARAMETERS			
AVS/SEM	EPA Draft Analytical Method, December 1991	EPA Draft Analytical Method, December 1991	Solid LTL-6008

TABLE 6-1

SUMMARY OF ORGANIC, INORGANIC, AND MISCELLANEOUS ANALYTICAL LABORATORY PROCEDURES FOR SOLID AND AQUEOUS SAMPLES SWMU 12 (Round 1), SWMU 13 (Round 2), AND SWMU 16 (Round 2) NSWC CRANE CRANE, INDIANA

Analytical Parameter [1]	Preparation Method [2,3]	Analytical Method [2,3]	Preparation/Analytical SOP(s) [4]
Ammonia as Nitrogen	Aqueous EPA 350.1 Solid EPA 350.1, DI water leach, 10 g/100 mL	Aqueous and Solid EPA 350.1	Aqueous and Solid LTL-9109
Cation Exchange Capacity (CEC)	Solid SW-846 Method 9081	Solid SW-846 Method 9081	Solid LTL-6006
Chloride and Sulfate	Aqueous SW-846 9056	Aqueous SW-846 9056	Aqueous LTL-9110
Cyanide	Solid SW-846 Method M9012A	Solid SW-846 Method 9012A	Solid LTL-9104
Ethane, Ethene, and Methane	Aqueous Microseeps, Inc. Method	Aqueous Microseeps, Inc. Method	Aqueous DGPM-01/AM20GAx
Nitrate+Nitrite as Nitrogen	Aqueous EPA 353.2	Aqueous EPA 353.2	Aqueous LTL-9125
pH	Solid SW-846 Method 9045C	Solid SW-846 Method 9045C	Solid LTL-9113
Total Organic Carbon	Aqueous SW-846 9060 Solid Lloyd Kahn	Aqueous SW-846 9060 Solid Lloyd Kahn	Aqueous LTL-9115 Solid LTL-9116

AVS = Acid Volatile Sulfides
PAHs = Polycylcic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
SIM = Selected Ion Monitoring
SEM = Simultaneously Extracted Metals
SVOCs = Semivolatile Organic Compounds
TAL = US EPA Contract Laboratory Program Target Analyte List
VOCs = Volatile Organic Compounds

1 Reference Table 1-4 of Section 1 for the specific compounds.
2 U.S. EPA, 1986. Test methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, Third Edition and subsequent updates.
3 U.S. EPA Chemical Analyses of Water and Wastewater, March 1983.
4 Laboratory SOPs are included in Appendix G of this QAPP Addendum No. 1.

7.0 INTERNAL QUALITY CONTROL CHECKS

Field and laboratory QC samples will be analyzed routinely to evaluate overall data quality. Tables 3-3, 3-5, 3-12, and 3-14 of this QAPP Addendum No.1 present the numbers of QC samples that are anticipated to be collected in the field. Section 5.0 of the approved QAPP for SWMUs 12, 13, 16, 19 (TtNUS, 2003) addresses instrument calibrations; and Section 7.0 of the approved QAPP for SWMUs 12, 13, 16, 19 (TtNUS, 2003) describes field and laboratory QC sample types and level of effort associated with them for this project. The QC limits are presented in Tables 7-1 through 7-14 of this section. Tables or portions thereof in Section 7.0 of the approved QAPP (TtNUS, 2003), which are not included in the sampling and analysis program of this QAPP Addendum No.1 are excluded.

Definitions and descriptions of various field and laboratory QC samples are presented in Section 7.0 of the approved QAPP (TtNUS, 2003).

TABLE 7-1

METALS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE, AND LABORATORY DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Aluminum	7429-90-5	75-125	20	75-125	20
Antimony	7440-36-0	75-125	20	75-125	20
Arsenic	7440-38-2	75-125	20	75-125	20
Barium	7440-39-3	75-125	20	75-125	20
Beryllium	7440-41-7	75-125	20	75-125	20
Cadmium	7440-43-9	75-125	20	75-125	20
Calcium	7440-70-2	75-125	20	75-125	20
Chromium	7440-47-3	75-125	20	75-125	20
Cobalt	7440-48-4	75-125	20	75-125	20
Copper	7440-50-8	75-125	20	75-125	20
Iron	7439-89-6	75-125	20	75-125	20
Lead	7439-92-1	75-125	20	75-125	20
Magnesium	7439-95-4	75-125	20	75-125	20
Manganese	7439-96-5	75-125	20	75-125	20
Mercury	7439-97-6	75-125	20	75-125	20
Nickel	7440-02-0	75-125	20	75-125	20
Potassium	7440-09-7	75-125	20	75-125	20
Selenium	7782-49-2	75-125	20	75-125	20
Silver	7440-22-4	75-125	20	75-125	20
Sodium	7440-23-5	75-125	20	75-125	20
Thallium	7440-28-0	75-125	20	75-125	20
Tin	7440-31-5	75-125	20	75-125	20
Titanium	7440-32-6	70-130	25	70-130	25
Vanadium	7440-62-2	75-125	20	75-125	20
Zinc	7440-66-6	75-125	20	75-125	20

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
QC - Quality control.

TABLE 7-2

METALS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Aluminum	7429-90-5	80-120	80-120
Antimony	7440-36-0	80-120	80-120
Arsenic	7440-38-2	80-120	80-120
Barium	7440-39-3	80-120	80-120
Beryllium	7440-41-7	80-120	80-120
Cadmium	7440-43-9	80-120	80-120
Calcium	7440-70-2	80-120	80-120
Chromium	7440-47-3	80-120	80-120
Cobalt	7440-48-4	80-120	80-120
Copper	7440-50-8	80-120	80-120
Iron	7439-89-6	80-120	80-120
Lead	7439-92-1	80-120	80-120
Magnesium	7439-95-4	80-120	80-120
Manganese	7439-96-5	80-120	80-120
Mercury	7439-97-6	75-125	90-110
Nickel	7440-02-0	80-120	80-120
Potassium	7440-09-7	80-120	80-120
Selenium	7782-49-2	80-120	80-120
Silver	7440-22-4	80-120	80-120
Sodium	7440-23-5	80-120	80-120
Thallium	7440-28-0	80-120	80-120
Tin	7440-31-5	80-120	80-120
Titanium	7440-32-6	80-120	80-120
Vanadium	7440-62-2	80-120	80-120
Zinc	7440-66-6	80-120	80-120

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
QC - Quality control.

TABLE 7-3

EXPLOSIVES (8330) QUALITY CONTROL LIMITS[1], MATRIX SPIKE/MATRIX SPIKE AND DUPLICATE SAMPLES SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
1,3,5-Trinitrobenzene	99-35-4	61-132	20	39-167	50
1,3-Dinitrobenzene	99-65-0	68-114	20	51-155	20
2,4,6-Trinitrotoluene	118-96-7	57-138	32	48-160	20
2,4-DA-6-NT	6629-29-4	30-160	30	NA	NA
2,4-Dinitrotoluene	121-14-2	67-116	20	49-152	20
2,6-DA-4-NT	59229-75-3	30-160	30	NA	NA
2,6-Dinitrotoluene	606-20-2	60-137	20	35-168	25
2-Amino-4,6-dinitrotoluene	355-72-78-2	68-117	20	50-157	20
2-Nitrotoluene	88-72-2	66-126	20	35-170	24
3,5-DNA	618-87-1	30-160	30	NA	NA
3-Nitrotoluene	99-08-1	63-125	20	31-164	50
DNX		30-160	30	NA	NA
4-Amino-2,6-dinitrotoluene	1946-51-0	63-125	20	51-152	20
4-Nitrotoluene	99-99-0	64-124	20	50-152	20
HMX	2691-41-0	59-124	28	20-160	50
MNX		30-160	30	NA	NA
Nitrobenzene	98-95-3	69-120	25	33-177	50
RDX	121-82-4	56-132	39	28-163	25
Tetryl	479-45-8	35-149	25	43-154	20
TNX		30-160	30	NA	NA
4,4'-TN-AZOXY		30-160	30	NA	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Qualitiy control.

TABLE 7-4

EXPLOSIVES (8330) QUALITY CONTROL LIMITS[1], LABORATORY CONTROL SAMPLES SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
1,3,5-Trinitrobenzene	99-35-4	66-115	88-117
1,3-Dinitrobenzene	99-65-0	65-115	92-116
2,4,6-Trinitrotoluene	118-96-7	72-119	75-134
2,4-DA-6-NT	6629-29-4	30-160	NA
2,4-Dinitrotoluene	121-14-2	68-114	87-117
2,6-DA-4-NT	59229-75-3	30-160	NA
2,6-Dinitrotoluene	606-20-2	70-116	84-125
2-Amino-4,6-dinitrotoluene	355-72-78-2	68-117	89-120
2-Nitrotoluene	88-72-2	59-120	86-120
3,5-DNA	618-87-1	30-160	NA
3-Nitrotoluene	99-08-1	60-119	84-118
DNX		30-160	NA
4-Amino-2,6-dinitrotoluene	1946-51-0	67-113	85-125
4-Nitrotoluene	99-99-0	64-119	84-118
HMX	2691-41-0	63-120	81-123
MNX		30-160	NA
Nitrobenzene	98-95-3	58-121	91-127
RDX	121-82-4	57-120	82-126
Tetryl	479-45-8	55-119	30-146
TNX		30-160	NA
4,4'-TN-AZOXY		30-160	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-5

VOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
1,1,1,2-Tetrachloroethane	630-20-6	60-140	20	60-140	20
1,1,1-Trichloroethane	71-55-6	60-140	20	54-104	24
1,1,2,2-Tetrachloroethane	79-34-5	60-140	20	22-113	41
1,1,2-Trichloroethane	79-00-5	60-140	20	44-103	30
1,1-Dichloroethane	75-34-3	60-140	20	45-126	33
1,1-Dichloroethene	75-35-4	68-155	20	26-136	34
1,2,3-Trichloropropane	96-18-4	60-140	20	60-140	20
1,2-Dibromo-3-chloropropane	96-12-8	60-140	20	60-140	20
1,2-Dibromoethane	106-93-4	60-140	20	60-140	20
1,2-Dichloroethane	107-06-2	60-140	20	51-115	26
1,2-Dichloropropane	78-87-5	60-140	20	45-123	26
1,4-Dioxane	123-91-1	65-138	20	62-99	37
2-Butanone	78-93-3	60-140	20	20-160	50
2-Hexanone	591-78-6	60-140	20	20-160	50
3-Chloro-1-propene	107-05-1	60-140	20	60-140	20
4-Methyl-2-pentanone	108-10-1	60-140	20	20-160	50
Acetone	67-64-1	60-140	20	20-160	50
Acetonitrile	75-05-8	60-140	20	49-103	46
Acrolein	107-02-8	60-140	20	60-140	20
Acrylonitrile	107-13-1	60-140	20	60-140	20
Benzene	71-43-2	87-128	20	52-112	37
Bromodichloromethane	75-27-4	60-140	20	48-107	30
Bromoform	75-25-2	60-140	20	31-102	47
Bromomethane	74-83-9	60-140	20	20-146	50
Carbon disulfide	75-15-0	60-140	20	20-134	50
Carbon tetrachloride	56-23-5	60-140	20	48-110	21
Chlorobenzene	108-90-7	75-124	20	45-108	45
Chloroethane	75-00-3	60-140	20	38-140	48
Chloroform	67-66-3	60-140	20	59-101	21
Chloromethane	74-87-3	60-140	20	20-158	50
Chloroprene	126-99-8	60-140	20	60-140	20
cis-1,2-Dichloroethene	156-59-2	60-140	20	55-93	24
cis-1,3-Dichloropropene	10061-01-5	60-140	20	33-108	39
Dibromochloromethane	124-48-1	60-140	20	36-108	33
Dibromomethane	74-95-3	60-140	20	60-140	20
Dichlorodifluoromethane	75-71-8	60-140	20	60-140	20
Ethyl methacrylate	97-63-2	60-140	20	60-140	20
Ethylbenzene	100-41-4	60-140	20	40-118	41
Iodomethane	74-88-4	60-140	20	60-140	20
Isobutyl alcohol	78-83-1	68-124	20	51-95	27
Methacrylonitrile	126-98-7	60-140	20	60-140	20

TABLE 7-5

VOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Methyl methacrylate	80-62-6	60-140	20	60-140	20
Methylene chloride	75-09-2	60-140	20	20-160	50
Propionitrile	107-12-0	67-129	20	44-105	45
Styrene	100-42-5	60-140	20	29-114	36
Tetrachloroethene	127-18-4	60-140	20	32-94	34
Toluene	108-88-3	73-136	20	39-120	37
trans-1,2-Dichloroethene	156-60-5	60-140	20	42-97	23
trans-1,3-Dichloropropene	10061-02-6	60-140	20	34-109	39
trans-1,4-Dichloro-2-butene	110-57-6	60-140	20	60-140	20
Trichloroethene	79-01-6	69-119	20	36-124	50
Trichlorofluoromethane	75-69-4	60-140	20	60-140	20
Vinyl acetate	108-05-4	60-140	20	60-140	20
Vinyl chloride	75-01-4	60-140	20	29-138	50
Xylenes, Total	1330-20-7	60-140	20	38-108	31

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-6

VOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
1,1,1,2-Tetrachloroethane	630-20-6	60-140	60-140
1,1,1-Trichloroethane	71-55-6	60-140	60-140
1,1,2,2-Tetrachloroethane	79-34-5	60-140	60-140
1,1,2-Trichloroethane	79-00-5	60-140	60-140
1,1-Dichloroethane	75-34-3	60-140	60-140
1,1-Dichloroethene	75-35-4	80-146	65-129
1,2,3-Trichloropropane	96-18-4	60-140	60-140
1,2-Dibromo-3-chloropropane	96-12-8	60-140	60-140
1,2-Dibromoethane	106-93-4	60-140	60-140
1,2-Dichloroethane	107-06-2	60-140	60-140
1,2-Dichloropropane	78-87-5	60-140	60-140
1,4-Dioxane	123-91-1	41-145	20-142
2-Butanone	78-93-3	60-140	60-140
2-Hexanone	591-78-6	60-140	60-140
3-Chloro-1-propene	107-05-1	60-140	60-140
4-Methyl-2-pentanone	108-10-1	60-140	60-140
Acetone	67-64-1	60-140	60-140
Acetonitrile	75-05-8	60-140	71-111
Acrolein	107-02-8	60-140	60-140
Acrylonitrile	107-13-1	60-140	60-140
Benzene	71-43-2	79-128	72-121
Bromodichloromethane	75-27-4	60-140	60-140
Bromoform	75-25-2	60-140	60-140
Bromomethane	74-83-9	60-140	60-140
Carbon disulfide	75-15-0	60-140	60-140
Carbon tetrachloride	56-23-5	60-140	60-140
Chlorobenzene	108-90-7	77-115	65-121
Chloroethane	75-00-3	60-140	60-140
Chloroform	67-66-3	60-140	60-140
Chloromethane	74-87-3	60-140	60-140
Chloroprene	126-99-8	60-140	60-140
cis-1,2-Dichloroethene	156-59-2	60-140	60-140
cis-1,3-Dichloropropene	10061-01-5	60-140	60-140
Dibromochloromethane	124-48-1	60-140	60-140
Dibromomethane	74-95-3	60-140	60-140
Dichlorodifluoromethane	75-71-8	60-140	60-140
Ethyl methacrylate	97-63-2	60-140	60-140
Ethylbenzene	100-41-4	60-140	72-127
Iodomethane	74-88-4	60-140	60-140
Isobutyl alcohol	78-83-1	74-110	40-117
Methacrylonitrile	126-98-7	60-140	60-140

TABLE 7-6

VOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Methyl methacrylate	80-62-6	60-140	60-140
Methylene chloride	75-09-2	60-140	60-140
Propionitrile	107-12-0	82-110	73-105
Styrene	100-42-5	60-140	60-140
Tetrachloroethene	127-18-4	60-140	60-140
Toluene	108-88-3	77-177	66-124
trans-1,2-Dichloroethene	156-60-5	60-140	60-140
trans-1,3-Dichloropropene	10061-02-6	60-140	60-140
trans-1,4-Dichloro-2-butene	110-57-6	60-140	60-140
Trichloroethene	79-01-6	76-120	61-124
Trichlorofluoromethane	75-69-4	60-140	60-140
Vinyl acetate	108-05-4	60-140	60-140
Vinyl chloride	75-01-4	60-140	60-140
Xylenes, Total	1330-20-7	60-140	60-140

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-7

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
1,2,4,5-Tetrachlorobenzene	95-94-3	20-160	50	20-160	50
1,2,4-Trichlorobenzene	120-82-1	31-67	28	27-82	25
1,2-Dichlorobenzene	95-50-1	20-160	46	23-78	30
1,3-Dichlorobenzene	541-73-1	20-160	50	19-72	32
1,4-Dichlorobenzene	106-46-7	24-63	39	21-73	30
1,4-Naphthoquinone	130-15-4	20-160	50	20-160	50
1,4-Phenylenediamine	106-50-3	20-160	50	20-160	50
1-Naphthylamine	134-32-7	20-160	50	20-160	50
2,3,4,6-Tetrachlorophenol	58-90-2	20-160	50	20-160	50
2,4,5-Trichlorophenol	95-95-4	10-160	26	10-160	50
2,4,6-Trichlorophenol	88-06-2	10-160	50	22-79	44
2,4-Dichlorophenol	120-83-2	10-160	50	26-84	43
2,4-Dimethylphenol	105-67-9	10-160	31	10-160	50
2,4-Dinitrophenol	51-28-5	10-160	50	10-116	33
2,6-Dichlorophenol	87-65-0	20-160	50	20-160	50
2-Acetylaminofluorene	53-96-3	20-160	50	20-160	50
2-Chloronaphthalene	91-58-7	20-160	20	30-60	25
2-Chlorophenol	95-57-8	12-95	50	39-100	20
2-Methylnaphthalene	91-57-6	20-81	50	17-107	50
2-Methylphenol	95-48-7	10-160	50	10-82	50
2-Naphthylamine	91-59-8	20-160	50	20-160	50
2-Nitroaniline	88-74-4	20-160	28	29-92	37
2-Nitrophenol	88-75-5	10-160	50	28-82	50
2-Picoline	109-06-8	20-160	50	20-160	50
3 & 4 - Methylphenol	1319-77-3	10-160	32	10-85	50
3,3'-Dichlorobenzidine	91-94-1	20-160	50	20-160	50
3,3'-Dimethylbenzidine	119-93-7	20-160	50	20-160	50
3-Methylcholanthrene	56-49-5	20-160	50	20-160	50
3-Nitroaniline	99-09-2	20-160	20	10-64	50
4,6-Dinitro-2-methylphenol	534-52-1	10-160	50	13-107	34
4-Aminobiphenyl	92-67-1	20-160	50	20-160	50
4-Bromophenyl phenyl ether	101-55-3	20-160	20	34-81	21
4-Chloro-3-methylphenol	59-50-7	27-109	16	25-128	20
4-Chloroaniline	106-47-8	20-160	36	10-160	50
4-Chlorophenyl-phenylether	7005-72-3	20-160	23	37-98	24
4-Methylphenol	106-44-5	10-160	32	10-85	50
4-Nitroaniline	100-01-6	20-160	20	10-75	50
4-Nitrophenol	100-02-7	10-98	50	10-144	41
4-Nitroquinoline-1-oxide	56-57-5	20-160	50	20-160	50
5-Nitro-o-toluidine	99-55-8	20-160	50	20-160	50
7,12-Dimethylbenz(a)anthracene	57-97-6	20-160	50	20-160	50
Acenaphthene	83-32-9	26-83	42	26-115	50
Acenaphthylene	208-96-8	35-88	45	24-119	50
Acetophenone	98-86-2	20-160	50	20-160	50
Aniline	62-53-3	20-160	50	20-160-	50
Anthracene	120-12-7	20-105	41	20-142	50
Aramite A	140-57-8	20-160	50	20-160	50

TABLE 7-7

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Aramite B	140-57-8	20-160	50	20-160	50
Benzo(a)anthracene	56-55-3	20-119	50	22-140	50
Benzo(a)pyrene	50-32-8	20-106	50	15-150	50
Benzo(b)fluoranthene	205-99-2	20-116	50	20-160	50
Benzo(g,h,i)perylene	191-24-2	20-112	50	17-115	50
Benzo(k)fluoranthene	207-08-9	20-137	50	20-160	50
Benzyl alcohol	100-51-6	20-160	50	20-160	50
Bis(2-chloroethoxy)methane	111-91-1	20-160	38	23-63	57
bis(2-Chloroethyl)ether	111-44-4	20-160	30	29-74	37
Bis(2-chloroisopropyl)ether	108-60-1	20-160	37	10-124	42
Bis(2-ethylhexyl)phthalate	117-81-7	20-160	50	20-160	50
Butylbenzylphthalate	85-68-7	20-160	50	20-160	50
Chlorobenzilate	510-15-6	20-160	50	20-160	50
Chrysene	218-01-9	27-116	50	20-156	50
cis-Isosafrole	120-58-1	20-160	50	20-160	50
Diallate A	2303-16-4	20-160	50	20-160	50
Diallate B	2303-16-4	20-160	50	20-160	50
Dibenzo(a,h)anthracene	53-70-3	20-124	50	10-142	50
Dibenzofuran	132-64-9	20-160	22	35-81	33
Diethylphthalate	84-66-2	20-160	20	35-89	28
Dimethylphthalate	131-11-3	20-160	20	36-78	24
Di-n-butylphthalate	84-74-2	20-160	20	18-100	58
Di-n-octylphthalate	117-84-0	20-160	50	20-160	50
Diphenylamine	122-39-4	20-160	50	20-160	50
Ethyl methanesulfonate	62-50-0	20-160	50	20-160	50
Fluoranthene	206-44-0	29-128	36	12-158	50
Fluorene	86-73-7	35-94	40	28-124	50
Hexachlorobenzene	118-74-1	20-160	20	32-84	22
Hexachlorobutadiene	87-68-3	20-160	24	20-86	31
Hexachlorocyclopentadiene	77-47-4	20-160	50	10-58	50
Hexachloroethane	67-72-1	20-160	50	12-66	38
Hexachlorophene	70-30-4	18-60	36	20-160	50
Hexachloropropene	1888-71-7	20-160	50	20-160	50
Indeno(1,2,3-cd)pyrene	193-39-5	20-117	50	16-134	50
Isodrin	465-73-6	20-160	50	20-160	50
Isophorone	78-59-1	20-160	43	23-68	30
Kepone	143-50-0	20-160	50	20-160	50
Methapyrilene	91-80-5	20-160	50	20-160	50
Methyl methanesulfonate	66-27-3	20-160	50	20-160	50
Naphthalene	91-20-3	20-92	50	19-98	50
N-Nitrosodiethylamine	55-18-5	20-160	50	20-160	50
N-Nitrosodimethylamine	62-75-9	20-160	50	20-160	50
N-Nitroso-di-n-butylamine	924-16-3	20-160	50	20-160	50
N-Nitroso-di-n-propylamine	621-64-7	13-122	31	10-151	28
N-Nitrosodiphenylamine	86-30-6	20-160	20	10-160	50
N-Nitrosomethylethylamine	10595-95-6	20-160	50	20-160	50
N-Nitrosomorpholine	59-89-2	20-160	50	20-160	50

TABLE 7-7

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
N-Nitrosopiperidine	100-75-4	20-160	50	20-160	50
N-Nitrosopyrrolidine	930-55-2	20-160	50	20-160	50
O,O,O-Triethyl phosphorothioate	126-68-1	20-160	50	20-160	50
o-Toluidine	95-53-4	20-160	50	20-160	50
p-Dimethylaminoazobenzene	60-11-7	20-160	50	20-160	50
Pentachlorobenzene	608-93-5	20-160	50	20-160	50
Pentachloroethane	76-01-7	20-160	50	20-160	50
Pentachloronitrobenzene	82-68-8	20-160	50	20-160	50
Pentachlorophenol	87-86-5	20-160	50	20-160	50
Phenacetin	62-44-2	20-160	50	20-160	50
Phenanthrene	85-01-8	39-99	41	20-141	50
Phenol	108-95-2	10-92	45	35-105	20
Phentermine	122-09-8	20-160	50	20-160	50
Pronamide	23950-58-5	20-160	50	20-160	50
Pyrene	129-00-0	20-113	35	20-160	50
Pyridine	110-86-1	20-160	50	20-160	50
Safrole	94-59-7	20-160	50	20-160	50
trans-Isosafrole	120-58-1	20-160	50	20-160	50

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-8

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
1,2,4,5-Tetrachlorobenzene	95-94-3	20-160	20-160
1,2,4-Trichlorobenzene	120-82-1	13-101	57-105
1,2-Dichlorobenzene	95-50-1	12-98	54-102
1,3-Dichlorobenzene	541-73-1	20-95	51-102
1,4-Dichlorobenzene	106-46-7	11-93	52-102
1,4-Naphthoquinone	130-15-4	20-160	20-160
1,4-Phenylenediamine	106-50-3	20-160	20-160
1-Naphthylamine	134-32-7	20-160	20-160
2,3,4,6-Tetrachlorophenol	58-90-2	20-160	20-160
2,4,5-Trichlorophenol	95-95-4	24-123	48-119
2,4,6-Trichlorophenol	88-06-2	13-116	41-126
2,4-Dichlorophenol	120-83-2	35-109	53-117
2,4-Dimethylphenol	105-67-9	42-118	48-98
2,4-Dinitrophenol	51-28-5	10-102	10-80
2,6-Dichlorophenol	87-65-0	20-160	20-160
2-Acetylaminofluorene	53-96-3	20-160	20-160
2-Chloronaphthalene	91-58-7	21-119	51-101
2-Chlorophenol	95-57-8	14-113	53-107
2-Methylnaphthalene	91-57-6	24-118	37-93
2-Methylphenol	95-48-7	52-105	48-116
2-Naphthylamine	91-59-8	20-160	20-160
2-Nitroaniline	88-74-4	52-130	52-115
2-Nitrophenol	88-75-5	29-112	55-120
2-Picoline	109-06-8	20-160	20-160
3 & 4 - Methylphenol	1319-77-3	54-108	49-123
3,3'-Dichlorobenzidine	91-94-1	10-125	10-113
3,3'-Dimethylbenzidine	119-93-7	20-160	20-160
3-Methylcholanthrene	56-49-5	20-160	20-160
3-Nitroaniline	99-09-2	56-119	39-104
4,6-Dinitro-2-methylphenol	534-52-1	10-126	34-106
4-Aminobiphenyl	92-67-1	20-160	20-160
4-Bromophenyl phenyl ether	101-55-3	53-125	56-112
4-Chloro-3-methylphenol	59-50-7	60-104	51-114
4-Chloroaniline	106-47-8	48-114	20-117
4-Chlorophenyl-phenylether	7005-72-3	39-135	52-120
4-Methylphenol	106-44-5	54-108	49-123
4-Nitroaniline	100-01-6	55-120	49-111
4-Nitrophenol	100-02-7	10-119	35-113
4-Nitroquinoline-1-oxide	56-57-5	20-160	20-160
5-Nitro-o-toluidine	99-55-8	20-160	20-160
7,12-Dimethylbenz(a)anthracene	57-97-6	20-160	20-160

TABLE 7-8

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Acenaphthene	83-32-9	50-109	47-92
Acenaphthylene	208-96-8	44-121	47-96
Acetophenone	98-86-2	20-160	20-160
Aniline	62-53-3	20-160	20-160
Anthracene	120-12-7	46-110	48-101
Aramite A	140-57-8	20-160	20-160
Aramite B	140-57-8	20-160	20-160
Benzo(a)anthracene	56-55-3	62-104	20-135
Benzo(a)pyrene	50-32-8	54-105	57-107
Benzo(b)fluoranthene	205-99-2	55-124	55-107
Benzo(g,h,i)perylene	191-24-2	29-115	40-118
Benzo(k)fluoranthene	207-08-9	55-159	45-122
Benzyl alcohol	100-51-6	51-120	17-145
Bis(2-chloroethoxy)methane	111-91-1	31-119	44-101
bis(2-Chloroethyl)ether	111-44-4	43-131	41-116
Bis(2-chloroisopropyl)ether	108-60-1	47-128	45-130
Bis(2-ethylhexyl)phthalate	117-81-7	25-187	49-135
Butylbenzylphthalate	85-68-7	51-124	39-117
Chlorobenzilate	510-15-6	20-160	20-160
Chrysene	218-01-9	69-109	20-144
cis-Isosafrole	120-58-1	20-160	20-160
Diallate A	2303-16-4	20-160	20-160
Diallate B	2303-16-4	20-160	20-160
Dibenzo(a,h)anthracene	53-70-3	32-113	44-128
Dibenzofuran	132-64-9	43-134	61-114
Diethylphthalate	84-66-2	62-124	55-115
Dimethylphthalate	131-11-3	63-121	57-109
Di-n-butylphthalate	84-74-2	59-123	52-112
Di-n-octylphthalate	117-84-0	27-166	15-151
Diphenylamine	122-39-4	20-160	20-160
Ethyl methanesulfonate	62-50-0	20-160	20-160
Fluoranthene	206-44-0	66-113	49-120
Fluorene	86-73-7	50-114	47-99
Hexachlorobenzene	118-74-1	56-125	53-120
Hexachlorobutadiene	87-68-3	10-96	55-106
Hexachlorocyclopentadiene	77-47-4	10-55	21-89
Hexachloroethane	67-72-1	10-91	46-103
Hexachlorophene	70-30-4	20-160	20-160
Hexachloropropene	1888-71-7	20-160	20-160
Indeno(1,2,3-cd)pyrene	193-39-5	33-110	45-127
Isodrin	465-73-6	20-160	20-160

TABLE 7-8

SEMIVOLATILE ORGANIC COMPOUNDS QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Isophorone	78-59-1	39-126	23-125
Kepone	143-50-0	20-160	20-160
Methapyrilene	91-80-5	20-160	20-160
Methyl methanesulfonate	66-27-3	20-160	20-160
Naphthalene	91-20-3	24-111	38-95
N-Nitrosodiethylamine	55-18-5	20-160	20-160
N-Nitrosodimethylamine	62-75-9	43-107	36-104
N-Nitroso-di-n-butylamine	924-16-3	20-160	20-160
N-Nitroso-di-n-propylamine	621-64-7	48-135	43-126
N-Nitrosodiphenylamine	86-30-6	37-108	43-101
N-Nitrosomethylethylamine	10595-95-6	20-160	20-160
N-Nitrosomorpholine	59-89-2	20-160	20-160
N-Nitrosopiperidine	100-75-4	20-160	20-160
N-Nitrosopyrrolidine	930-55-2	20-160	20-160
O,O,O-Triethyl phosphorothioate	126-68-1	20-160	20-160
o-Toluidine	95-53-4	20-160	20-160
p-Dimethylaminoazobenzene	60-11-7	20-160	20-160
Pentachlorobenzene	608-93-5	20-160	20-160
Pentachloroethane	76-01-7	20-160	20-160
Pentachloronitrobenzene	82-68-8	20-160	20-160
Pentachlorophenol	87-86-5	55-99	20-160
Phenacetin	62-44-2	20-160	20-160
Phenanthrene	85-01-8	50-125	51-92
Phenol	108-95-2	23-98	54-110
Phentermine	122-09-8	20-160	20-160
Pronamide	23950-58-5	20-160	20-160
Pyrene	129-00-0	61-123	20-126
Pyridine	110-86-1	20-160	20-160
Safrole	94-59-7	20-160	20-160
trans-Isosafrole	120-58-1	20-160	20-160

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-9

PCB QUALITY CONTROL LIMITS[1],
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Aroclor-1016	12674-11-2	60-132	20	42-128	16
Aroclor-1260	11096-82-5	59-139	21	49-158	31

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
QC - Quality control.

TABLE 7-10

PCB QUALITY CONTROL LIMITS[1],
LABORATORY CONTROL SPIKE SAMPLES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Aroclor-1016	12674-11-2	50-120	62-130
Aroclor-1260	11096-82-5	42-148	58-139

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
QC - Quality control.

TABLE 7-11

MISCELLANEOUS PARAMETERS QUALITY CONTROL LIMITS[1], MATRIX SPIKE/MATRIX SPIKE, AND LABORATORY DUPLICATE SAMPLES SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix		Solid Matrix	
		Accuracy (%R)	Precision (RPD)	Accuracy (%R)	Precision (RPD)
Acid Volatile Sulfide (AVS)		NA	NA	50-150	NA
Ammonia, as N	7727-37-9	53-120	10	NA	NA
Cadmium	7440-43-9	NA	NA	75-125	NA
Chloride	16887-00-6	73-121	11	NA	NA
Copper	7440-50-8	NA	NA	75-125	NA
Cyanide	57-12-5	64-135	11	50-150	30
Ethane	74-84-0	20-160	50	NA	NA
Ethene	74-85-1	20-160	50	NA	NA
Lead	7439-92-1	NA	NA	75-125	NA
Mercury	7439-97-6	NA	NA	75-125	NA
Methane	74-82-8	20-160	50	NA	NA
Nickel	7440-02-0	NA	NA	75-125	NA
Nitrate + Nitrite, as N		68-122	10	NA	NA
Organic Carbon, Total (TOC)		NA	NA	50-150	20
Sulfate	14808-79-8	81-115	10	NA	NA
Silver	7440-22-4	NA	NA	75-125	NA
Zinc	7440-66-6	NA	NA	75-125	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-12

MISCELLANEOUS PARAMETERS QUALITY CONTROL LIMITS[1], LABORATORY CONTROL SAMPLES SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2) NSWC CRANE CRANE, INDIANA

Chemical	CAS #	Aqueous Matrix	Solid Matrix
		Accuracy (%R)	Accuracy (%R)
Acid Volatile Sulfide (AVS)		NA	50-150
Ammonia, as N	7727-37-9	53-120	NA
Cadmium	7440-43-9	NA	75-125
Copper	7440-50-8	NA	75-125
Cyanide	57-12-5	64-135	50-150
Ethane	74-84-0	20-160	NA
Ethene	74-85-1	20-160	NA
Lead	7439-92-1	NA	75-125
Mercury	7439-97-6	NA	75-125
Methane	74-82-8	20-160	NA
Nickel	7440-02-0	NA	75-125
Nitrate + Nitrite, as N		68-122	NA
Organic Carbon, Total		NA	50-150
Silver	7440-22-4	NA	75-125
Zinc	7440-66-6	NA	75-125

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

TABLE 7-13

QUALITY CONTROL LIMITS[1],
SURROGATE COMPOUND RECOVERIES
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Analytical Method	Chemical	CAS #	Aqueous Matrix	Solid Matrix
			Accuracy (%R)	Accuracy (%R)
SW-846 8330	3,4-Dinitrotoluene	610-39-9	40-320	20-160
SW-846 8151	2,4-Dichlorophenyl Acetic Acid	19719-28-9	20-160	20-160
RSK 175 Dissolved Gases	4,6-Dinitro-2-methylphenol	534-52-1	50-150	10-160
SW-846 8270C SIM	1-Fluoronaphthalene	321-38-0	34-108	10-121
	Fluorene-d10	81103-79-9	65-120	19-161
	Pyrene-d10	1718-52-1	72-138	25-151
SW-846 8082	Decachlorobiphenyl	2051-24-3	32-149	20-160
	Tetrachloro-m-xylene	877-09-8	10-129	20-150
SW-846 8270C	1,2-Dichlorobenzene-d4	2199-69-1	21-99	48-102
	2,4,6-Tribromophenol	118-79-6	18-139	54-124
	2-Chlorophenol-d4	93951-73-6	13-111	53-107
	2-Fluorobiphenyl	321-60-8	47-110	59-100
	2-Fluorophenol	367-12-4	10-81	45-109
	Nitrobenzene-d5	4165-60-0	55-110	46-104
	Phenol-d5	4165-62-2	25-96	50-114
	Terphenyl-d14	1718-51-0	37-141	65-164
SW-846 8260B	1,2-Dichloroethane-d4	17060-07-0	60-140	60-140
	4-Bromofluorobenzene	460-00-4	110-290	110-290
	Dibromofluoromethane	1868-53-7	60-140	60-140
	Toluene-d8	2037-26-5	60-140	60-140

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
QC - Quality control.

TABLE 7-14

QUALITY CONTROL LIMITS[1],
LABORATORY DUPLICATE SAMPLE PRECISION
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Analytical Method	Analyte	CAS #	Aqueous Matrix	Solid Matrix
			Accuracy (%R)	Accuracy (%R)
SW-846 6010	Aluminum	7429-90-5	20	20
	Antimony	7440-36-0	20	20
	Arsenic	7440-38-2	20	20
	Barium	7440-39-3	20	20
	Beryllium	7440-41-7	20	20
	Cadmium	7440-43-9	20	20
	Calcium	7440-70-2	20	20
	Chromium	7440-47-3	20	20
	Cobalt	7440-48-4	20	20
	Copper	7440-50-8	20	20
	Iron	7439-89-6	20	20
	Lead	7439-92-1	20	20
	Lithium	7439-93-2	20	20
	Magnesium	7439-95-4	20	20
	Manganese	7439-96-5	20	20
	Mercury	7439-97-6	20	20
	Nickel	7440-02-0	20	20
	Potassium	7440-09-7	20	20
	Selenium	7782-49-2	20	20
	Silver	7440-22-4	20	20
	Sodium	7440-23-5	20	20
	Strontium	7440-24-6	20	20
	Thallium	7440-28-0	20	20
	Tin	7440-31-5	20	20
	Titanium	7440-32-6	20	20
	Vanadium	7440-62-2	20	20
	Zinc	7440-66-6	20	20
Miscellaneous	Acid Volatile Sulfide (AVS)		NA	30
	Ammonia, as N	7727-37-9	10	NA
	Cadmium	7440-43-9	NA	30
	Cation Exchange Capacity		NA	30
	Chloride	16887-00-6	11	NA
	Copper	7440-50-8	NA	30
	Cyanide	57-12-5	20	50
	Ethane	74-84-0	50	NA
	Ethene	74-85-1	50	NA
	Lead	7439-92-1	NA	30
	Mercury	7439-97-6	NA	30
	Methane	74-82-8	50	NA
	Nickel	7440-02-0	NA	30
	Nitrate + Nitrite, as N		10	NA

TABLE 7-14

QUALITY CONTROL LIMITS[1],
LABORATORY DUPLICATE SAMPLE PRECISION
SWMU 12 (ROUND 1), SWMU 13 (ROUND 2), AND SWMU 16 (ROUND 2)
NSWC CRANE
CRANE, INDIANA

Analytical Method	Analyte	CAS #	Aqueous Matrix	Solid Matrix
			Accuracy (%R)	Accuracy (%R)
Miscellaneous (cont'd)	Organic Carbon, Total (TOC)		NA	20
	pH		NA	10
	Silver	7440-22-4	NA	30
	Sodium	7440-23-5	NA	30
	Sulfate	14808-79-8	10	NA
	Zinc	7440-66-6	NA	30

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
NA - Not applicable.
QC - Quality control.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Section 8.0 of the approved QAPP for SWMUs 12, 13, 16, and 19 (TtNUS, 2003) describes the procedures to be used for data reduction, validation, and reporting. Triangle Laboratories and the NSWC Crane laboratory will not be used for this project. The text in Section 8.0 of the QAPP for SWMUs 12, 13, 16, and 19 (TtNUS, 2003) applies to Microseeps, Inc. for the ethane, ethane, and methane analyses on ground water samples, and to Laucks Laboratory for all other analyses.

Concentration measurements in the field will be reported in the units indicated in Table 1-6 of the approved SWMUs 12, 13, 16, 19 QAPP (TtNUS, 2003). Only the analyses listed in Table 1-4 of this QAPP Addendum No. 1 will be conducted for the Round 2 field effort.

Rigorous statistical analyses as described in Section 8.3 of the SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003) will only be conducted if the data Round 1 and Round 2 data are sufficient to warrant the generation of a formal RFI report. If, after the Round 2 field effort, the Navy and EPA decide that additional data collection is necessary to complete the RFI, the level of data analyses is likely to be limited to facilitate rapid movement toward the additional data collection. Therefore, a complete analysis of the data characteristics presented in the bullets of Section 8.3.1 of the approved SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003) will not necessarily be done. The Task Order Manager will make this decision in conjunction with the Navy. The data analysis will be sufficient to assure stakeholders that any pertinent data gaps have been identified. All data reduction calculations for accuracy, precision, and completeness that are presented in Section 8.3 of the approved SWMU 12, 13, 16, and 19 QAPP (TtNUS, 2003) apply to Round 2 data.

9.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be conducted periodically to ensure that work is being implemented in accordance with the approved QAPP and in an overall satisfactory manner. Section 9.0 of the approved SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003) provides examples of pertinent audits.

10.0 PREVENTIVE MAINTENANCE PROCEDURES

Equipment used to collect samples will be maintained in accordance with the manufacturers' operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequencies presented in Section 5.0 of this QAPP Addendum No. 1. The preventive maintenance requirements for field and laboratory equipment are presented in Section 10.0 of the approved SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003). These operations will occur in accordance with the applicable analytical SOPs of Appendix G to this QAPP Addendum No. 1.

11.0 CORRECTIVE ACTION

The TtNUS QA/QC program requires that any and all personnel noting conditions adverse to quality should report these conditions immediately to the TOM and Quality Assurance Manager (QAM). These parties, in turn, are charged with implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed. Corrective action requirements for field, laboratory, and data validation and reporting non-conformances are presented in Section 11.0 of the approved SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003).

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in four primary formats during the course of this investigation: data validation reports, reports summarizing accomplishments and QA/QC issues during the field investigation, project-wide progress reports, and laboratory QA reports. The report frequencies, content, preparers, and recipients are summarized in Section 12.0 of the approved SWMUs 12, 13, 16, and 19 QAPP (TtNUS, 2003).

REFERENCES

Barnhill, Mark, 1993. A Map Showing Structure on Top of the Mississippian Unconformity at NSWC, Crane, Indiana – Base map digitized from the latest U.S. Geological Survey topographic quadrangle maps, scale 1:24,000.

DOD, June 2002. Department of Defense Quality Systems Manual for Environmental Laboratories. Department of Defense Environmental Quality Workgroup, Department of the Navy, Lead service, Version 2.

Tetra Tech NUS, Inc (TtNUS), 2001. Final Basewide Background Soil Investigation Report, Naval Surface Warfare Center, Crane, Indiana, Tetra Tech NUS, Inc., January 2001.

TtNUS, 2003. Quality Assurance Project Plan for Mine Fill A (SWMU 12), Mine Fill B (SWMU 13), Cast High Explosives Fill/B146 Incinerator (SWMU 16), and PyrotechnicTest Area (SWMU 19) RCRA Facility Investigation, Volumes I and II.

Quality Assurance Project Plan Addendum No. 1

for

Mine Fill A (SWMU 12) Mine Fill B (SWMU 13) and Cast High Explosives Fill/ B146 Incinerator (SWMU 16) and Pyrotechnic Test Area (SWMU 19)

RCRA Facility Investigation

VOLUME II OF II - Appendices

Naval Surface Warfare Center Crane

Crane, Indiana

Southern Division Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0166

October 2003

TABLE OF CONTENTS

SECTION **PAGE NO.**

1.0 PROJECT DESCRIPTION 1-1
1.1 RECENT ACTIVITIES 1-2
1.1.1 SWMU 12 Battery Disposal Site Interim Measure Activity 1-2
1.1.2 SWMU 13 Field Investigation Activity 1-5
1.1.3 SWMU 16 Field Investigation 1-6
1.2 SWMU-SPECIFIC CHARACTERISTICS 1-8
1.2.1 SWMU 13, Mine Fill B 1-9
1.2.2 SWMU 16 – B146 Cast High Explosives Incinerator 1-11
1.3 ANALYTICAL RESULTS 1-13
1.3.1 SWMU 13, Mine Fill B 1-13
1.3.2 SWMU 16, Cast High Explosives Fill 1-15
1.4 PROJECT TARGET PARAMETERS AND RATIONALE FOR SELECTION 1-18
1.4.1 SWMU 12 1-18
1.4.2 SWMU 13 1-21
1.4.3 SWMU 16 1-24

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES 2-1

3.0 SAMPLING AND ANALYSIS PLAN 3-1
3.1 GENERAL APPROACH 3-1
3.2 SAMPLE IDENTIFICATION SYSTEM 3-1
3.3 UNEXPLODED ORDNANCE AVOIDANCE 3-2
3.4 SAMPLING LOCATIONS, ANALYSES, AND RATIONALES 3-3
3.4.1 Surface and Subsurface Soils 3-3
3.4.2 Ground Water 3-6
3.4.3 Surface Water / Sediment 3-10
3.5 INVESTIGATION EQUIPMENT AND PROCEDURES 3-13
3.5.1 UXO Screening of Selected Drilling Sites 3-13
3.5.2 DPT Sampling for Surface and Subsurface Soil 3-14
3.5.3 Inspection and Repair of Existing Monitoring Wells 3-15
3.5.4 Well Drilling and Installation 3-16
3.5.5 Well Development 3-17
3.5.6 Water-Quality Field Measurements 3-17
3.5.7 Low-Flow Sampling of Monitoring Wells 3-18
3.5.8 Ground-Water-Level Measurements 3-18
3.5.9 Surface Water Sampling 3-19
3.5.10 Sediment Sampling 3-19
3.5.11 Staff Gauge Installation and Estimation of Stream Flow 3-20
3.5.12 Aquifer Testing 3-21
3.6 QUALITY CONTROL SAMPLES 3-21
3.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING 3-22
3.7.1 Sample Preservation 3-22
3.7.2 Sample Labeling 3-22
3.7.3 Sample Packaging 3-23
3.7.4 Sample Shipping 3-23
3.7.5 Sample Custody 3-23

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

3.8 RECORD KEEPING 3-24
3.8.1 Field Log Books 3-24
3.8.2 Drilling and Well Completion Logs 3-24
3.8.3 Well Development Log Sheets 3-24
3.8.4 Equipment Calibration Logs 3-25
3.8.5 Sample Collection Logs 3-25
3.8.6 Chain-of-Custody Forms 3-25
3.8.7 Shipping Forms/Air Bills 3-25
3.8.8 Permanent Record File 3-25
3.9 SURVEYING 3-26
3.10 EQUIPMENT DECONTAMINATION 3-26
3.11 MANAGEMENT OF INVESTIGATION-DERIVED WASTE 3-26
3.12 SAFETY 3-27
3.12.1 Health and Safety Plan 3-27
3.12.2 Health and Safety Training 3-28
3.12.3 Personal Protective Clothing and Equipment 3-28
3.12.4 Safety Meetings 3-28
3.13 ORGANIZATION AND LOGISTICS OF FIELD INVESTIGATIONS 3-28
3.13.1 Personnel 3-28
3.13.2 Subcontractors 3-29
3.13.3 Mobilization and Demobilization 3-29

4.0 CUSTODY PROCEDURES 4-1

5.0 CALIBRATION PROCEDURES AND FREQUENCY 5-1

6.0 ANALYTICAL AND MEASUREMENT PROCEDURES 6-1
6.1 FIELD MEASUREMENT PROCEDURES 6-1
6.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES 6-1
6.2.1 List of Project Target Compounds and Detection Limits 6-1
6.2.2 List of Associated Quality Control Samples 6-1

7.0 INTERNAL QUALITY CONTROL CHECKS 7-1

8.0 DATA REDUCTION, VALIDATION, AND REPORTING 8-1

9.0 PERFORMANCE AND SYSTEM AUDITS 9-1

10.0 PREVENTIVE MAINTENANCE PROCEDURES 10-1

11.0 CORRECTIVE ACTION 11-1

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 12-1

REFERENCES R-1

TABLE OF CONTENTS (Continued)

APPENDICES

A SWMU 13 ROUND 1 POSITIVE HITS SUMMARY TABLES
- A.1 SURFACE SOIL
- A.2 SUBSURFACE SOIL
- A.3 GROUND WATER
- A.4 SURFACE WATER
- A.5 SEDIMENT

B SWMU 13 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES
- B.1 SURFACE SOIL
- B.2 SUBSURFACE SOIL
- B.3 GROUND WATER
- B.4 SURFACE WATER
- B.2 SEDIMENT

C SWMU 16 ROUND 1 POSITIVE HITS SUMMARY TABLES
- C.1 SURFACE SOIL
- C.2 SUBSURFACE SOIL
- C.3 GROUND WATER
- C.4 SURFACE WATER
- C.5 SEDIMENT

D SWMU 16 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES
- D.1 SURFACE SOIL
- D.2 SUBSURFACE SOIL
- D.3 GROUND WATER
- D.4 SURFACE WATER
- D.5 SEDIMENT

E FIELD STANDARD OPERATING PROCEDURES

F BORING LOGS
- F.1 SWMU 13
- F.2 SWMU 16

G LABORATORY STANDARD OPERATING PROCEDURES
- G.1 LAUCKS TESTING ANALYTICAL STANDARD OPERATING PROCEDURES
- G.2 MICROSEEPS, INC. ANALYTICAL STANDARD OPERATING PROCEDURES

TABLES

NUMBER

1-1 Monitoring Well Construction Information and Water Level Measurements, SWMU 13
1-2 Summary of Slug Test Hydraulic Conductivity Results
1-3 Monitoring Well Construction Information and Water Level Measurements, SWMU 16
1-4 Specific Fixed-Based Laboratory Analytical Methodologies and Corresponding Target Analyte Lists
1-5 Aqueous Field Target Parameters and Method Detection Limits
1-6 Project Target Parameters and Rationales, Mine Fill A (SWMU 12) Round 1 and Mine Fill B (SWMU 13) Round 2
1-7 Project Target Parameters and Rationales, Cast High Explosives fill/Building 146 Incinerator (SWMU 16), Round 2
2-1 Key Project Personnel for SWMUs 12, 13, and 16, Names, Phone Numbers, and Addresses
3-1 Field Screening and measurements
3-2 Soil Samples and Laboratory Analyses
3-3 Summary of Soil Analyses and Quality Control Samples
3-4 Ground Water Sampling and Laboratory Analyses
3-5 Summary of Ground Water Analyses and Quality Control Samples
3-6 Physical Characteristics of Proposed Monitoring Wells at SWMU 12
3-7 Existing Monitoring Well Construction Information and Water Level measurements for SWMU 13
3-8 Physical Characteristics of Proposed Monitoring Wells at SWMU 13
3-9 Existing Monitoring Well Construction Information and Water Level Measurements at SWMU 16
3-10 Physical Characteristics of Proposed Monitoring Wells at SWMU 16
3-11 Listing of Surface Water Samples and Laboratory Analyses
3-12 Summary of Surface Water Analyses and Quality Control Samples
3-13 Listing of Sediment Samples and Laboratory Analyses
3-14 Summary of Sediment Analyses and Quality Control Samples
3-15 Summary of Sample Analyses, Container Types and Volumes, Preservation Requirements, and Holding times for Soils and Sediments
3-16 Summary of Sample Analyses, Container Types and Volumes, Preservation Requirements, and Holding times for Aqueous Samples
3-17 Non-Calibration Quality Control Sample Usage Frequencies, Acceptance Limits, and Corrective Actions
6-1 Summary of Organic, Inorganic, and Miscellaneous Analytical Procedures for Solid and Aqueous Samples
7-1 Metals Quality Control Limits, Matrix Spike, and Laboratory Duplicate Samples
7-2 Metals Quality Control Limits, Laboratory Control Samples
7-3 Explosives (8330) Quality Control Limits, Matrix Spike/Matrix Spike and Duplicate Samples
7-4 Explosives (8330) Quality Control Limits, Laboratory Control Samples
7-5 Volatile Organic Compounds Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-6 Volatile Organic Compounds Quality Control Limits, Laboratory Control Samples
7-7 Semivolatile Organic Compounds Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-8 Semivolatile Organic Compounds Quality Control Limits, Laboratory Control Samples
7-9 PCB Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples
7-10 PCB Quality Control Limits, Laboratory Control Spike Samples
7-11 Miscellaneous Parameters Quality Control Limits, Matrix Spike/Matrix Spike, and Laboratory Duplicate Samples

TABLES (Continued)

NUMBER

7-12 Miscellaneous Parameters Quality Control Limits, Laboratory Control Samples
7-13 Quality Control Limits, Surrogate Compound Recoveries
7-14 Quality Control Limits, Laboratory Duplicate Sample Precision

FIGURES

NUMBER

1-1 Battery Disposal Site (SWMU 12)
1-2 Bedrock Potentiometric Surface Map (5/11/03), Bedrock Wells and Staff Gauges Mine Fill B (SWMU 13)
1-3 Hydrogeologic Cross Section Map Mine Fill B (SWMU 13)
1-4 Hydrogeologic Cross Section A-A" SWMU 13 - Mine Fill B
1-5 Hydrogeologic Cross Section B-B' SWMU 13 - Mine Fill B
1-6 Hydrogeologic Cross Section C-C' SWMU 13 - Mine Fill B
1-7 Bedrock Potentiometric Surface Map (5/30/03), Bedrock Wells B146 Incinerator/Cast High Explosives Fill (SWMU 16)
1-8 Hydrogeologic Cross Section Map B146 Incinerator/Cast High Explosives Fill (SWMU 16)
1-9 Hydrogeologic Cross Section A-A' SWMU 16 Cast High Explosives/B146 Incinerator
1-10 Hydrogeologic Cross Section B-B' SWMU 16 Cast High Explosives/B146 Incinerator
1-11 Acrclor-1248 Concentrations in Surface Soil (µg/kg) Mine Fill B (SWMU 13)
1-12 Aroclor-1248 Concentrations in Subsurface Soil (µg/kg) Mine Fill B (SWMU 13)
1-13 Total Arsenic Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-14 Total Lead Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-15 RDX Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-16 2,4,6-Trinitrotoluene Concentrations in Ground Water (µg/L) Mine Fill B (SWMU 13)
1-17 RDX Concentrations in Ground Water (µg/L) B146 Incinerator/Cast High Explosives (SWMU 16)
1-18 Trichloroethene Concentrations in Ground Water (µg/L) B146 Incinerator/Cast High Explosives Fill (SWMU 16)
2-1 Project Organization Chart SWMU 12 (Round 1), SWMU 13 (Round 2), and SWMU 16 (Round 2)
3-1 Soil Boring Locations SWMU 12
3-2 SWMU 12 Battery Disposal Site Soil Boring Locations
3-3 Soil Sampling Locations for PCBs SWMU 13
3-4 Ground Water Sampling Locations SWMU 12
3-5 Ground Water Sampling Locations SWMU 13
3-6 Ground Water Sampling Locations SWMU 16
3-7 Surface Water and Sediment Sampling Locations SWMU 12
3-8 Surface Water and Sediment Sampling Locations SWMU 13
3-9 Surface Water and Sediment Sampling Locations SWMU 16

ACRONYM LIST

°C	Degrees Celsius
amsl	Above Mean Sea Level
AVS/SEM	Acid Volatile Sulfide/Simultaneously Extracted Metals
bgs	Below Ground Surface
CEC	Cation Exchange Capacity
CMS	Corrective Measures Study
DO	Dissolved Oxygen
DOD	Department of Defense
DPT	Direct-Push Technology
FOL	Field Operations Leader
GC/MS	gas chromatograph/mass spectrometer
GW	ground water
gpm	Gallons per Minute
HASP	Health and Safety Plan
HSA	Hollow-Stem Auger
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HPLC	high-performance liquid chromatograph
IDW	Investigation-Derived Waste
K	Hydraulic Conductivity
MFA	Mine Fill A
MFB	Mine Fill B
mg/kg	Milligrams per Kilogram
mL/minute	Milliliters per Minute
MNA	Monitored Natural Attenuation
MS	Mass spectrometer
MS	Matrix Spike
MSD	Matrix Spike Duplicates
NA	Not Applicable
NAD83	1983 North American Datum
NAVD	North American Vertical Datum
NFESC	Naval Facilities Engineering Service Center
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Unit

OD	Outside Diameter
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
SB	Soil Boring
SD	Sediment
SS	Surface Soil
SW	Surface Water
SOP	Standard Operating Procedure
SSO	Site Safety Officer
SVOC	Semivolatile Organic Compounds
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCE	Trichloroethene
TNT	2,4,6-Trinitrotoluene
TOC	Total Organic Carbon
TOM	Task Order Manager
TtNUS	Tetra Tech NUS, Inc.
UAP	Unidentified Asphalt Pad
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
µS/cm	MicroSiemens per centimeter
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Society
U.S. EPA	U.S. Environmental Protection Agency
UXO	Unexploded Ordnance

VOC	Volatile Organic Compound
WES	Waterways Experiment Station

APPENDIX A

SWMU 13 ROUND 1 POSITIVE HITS SUMMARY TABLES

APPENDIX A.1

SURFACE SOIL DATA

TABLE A-1
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB01	13SB02	13SB03	13SB04	13SB04	13SB05	13SB06	13SB07	13SB08
NSAMPLE	13SS010002	13SS020002	13SS030002	13SS040002	13SS040002-D	13SS050002	13SS060002	13SS070002	13SS080002
SAMPLE	13SS010002	13SS020002	13SS030002	13SS040002	FD03250301	13SS050002	13SS060002	13SS070002	13SS080002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/26/2003	3/30/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD	2240	1910	2810	3310	3580	2910	4140		
1,2,3,4,6,7,8,9-OCDF	0.2 U	0.2 U	0.5 U	2 U	3.4 J	1.6 U	4.6 J		
1,2,3,4,6,7,8-HPCDD	9.8	7.9	18	28.4	37.3	34.3	45.4		
1,2,3,4,6,7,8-HPCDF	0.1 U	0.09 U	0.2 U	0.87 U	1.9 J	0.68 U	2.1 J		
1,2,3,4,7,8,9-HPCDF	0.1 U	0.1 U	0.3 U	0.7 U	0.3 U	0.7 U	0.7 U		
1,2,3,4,7,8-HXCDD	0.2 U	0.1 U	0.3 U	0.6 U	0.5 J	0.7 U	0.6 J		
1,2,3,4,7,8-HXCDF	0.1 U	0.07 U	0.2 U	1 U	1.6 J	1.2 U	1.8 J		
1,2,3,6,7,8-HXCDD	0.1 U	0.1 U	0.3 U	0.54 U	0.77 J	0.86 U	1 U		
1,2,3,6,7,8-HXCDF	0.09 U	0.07 U	0.2 U	0.3 U	0.51 J	0.4 U	0.39 U		
1,2,3,7,8,9-HXCDD	0.2 U	0.1 U	0.3 U	0.6 U	1.4 J	2 U	1.5 J		
1,2,3,7,8,9-HXCDF	0.1 U	0.09 U	0.2 U	0.4 U	0.2 U	0.5 U	0.4 U		
1,2,3,7,8-PECDD	0.2 U	0.1 U	0.5 U	0.5 U	0.3 U	0.8 U	0.6 U		
1,2,3,7,8-PECDF	0.1 U	0.09 U	0.3 U	0.35 U	0.45 J	0.4 U	0.3 U		
2,3,4,6,7,8-HXCDF	0.1 U	0.07 U	0.2 U	0.3 U	0.65 J	0.4 U	0.7 J		
2,3,4,7,8-PECDF	0.1 U	0.1 U	0.4 U	5 J	5	3.7 J	8		
2,3,7,8-TCDD	0.2 U	0.1 U	0.4 U	0.4 U	0.95 J	0.6 U	1.2 U		
2,3,7,8-TCDF	0.64 J	0.46 J	0.3 U	2	2.7	5	5.8		
TOTAL HPCDD	19.8	16.3	36.9	66	95.4	78.5	112		
TOTAL HPCDF	0.1 U	0.1 U	0.3 U	1.9 U	4	1.7 J	4.8 J		
TOTAL HXCDD	1.3 J	1.2 J	1.1 U	5.2 J	11 J	15.7 J	15.1 J		
TOTAL HXCDF	0.1 U	0.07 U	0.2 U	3.9 J	6.7	2.5 J	9.8 J		
TOTAL PECDD	0.2 U	0.1 U	0.5 U	0.5 U	0.3 U	0.8 U	2.8 U		
TOTAL PECDF	0.1 U	0.94 J	0.3 U	48 J	46.3 J	23.1 J	79 J		
TOTAL TCDD	0.2 U	0.1 U	0.4 U	1.8 U	2.9	0.6 U	2.1 J		
TOTAL TCDF	7 J	15.7 J	1.8	238 J	216 J	177 J	328 J		
Volatile Organics (ug/kg)									
TRANS-1,2-DICHLOROETHENE							2 J		
TRICHLOROFLUOROMETHANE							2 J		
Semivolatile Organics (ug/kg)									
ACENAPHTHENE	3.9 U	4 U	3.8 U	4.2 U	4.3 U	4.9 U	4.3 U		
ACETOPHENONE	80 U	80 U	78 U	84 U	87 U	99 U	87 U		
ANTHRACENE	3.9 U	4 U	3.8 U	4.2 U	4.3 U	4.9 U	5 J		
BENZO(A)ANTHRACENE	3.9 U	4 U	3.8 U	20	22	4.9 U	32		
BENZO(A)PYRENE	3.9 U	4 U	3.8 U	27	34	4.9 U	42		
BENZO(B)FLUORANTHENE	3.9 U	4 U	3.8 U	37	40	7 J	58		
BENZO(G,H,I)PERYLENE	3.9 U	4 U	3.8 U	18	32	4.9 U	29		
BENZO(K)FLUORANTHENE	3.9 U	4 U	3.8 U	18	25	5 J	26		

TABLE A-1
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB01	13SB02	13SB03	13SB04	13SB04	13SB05	13SB06	13SB07	13SB08
NSAMPLE	13SS010002	13SS020002	13SS030002	13SS040002	13SS040002-D	13SS050002	13SS060002	13SS070002	13SS080002
SAMPLE	13SS010002	13SS020002	13SS030002	13SS040002	FD03250301	13SS050002	13SS060002	13SS070002	13SS080002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/26/2003	3/30/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BIS(2-ETHYLHEXYL)PHTHALATE	130 J	91 J	78 U	120 J	130 J	99 U	140 J		
CHRYSENE	3.9 U	4 U	3.8 U	28	35	7 J	50		
DIBENZO(A,H)ANTHRACENE	3.9 U	4 U	3.8 U	4.2 U	4.3 U	4.9 U	4.3 U		
FLUORANTHENE	6 J	4 U	3.8 U	34	35	10	75		
FLUORENE	3.9 U	4 U	3.8 U	4.2 U	4.3 U	4.9 U	4.3 U		
INDENO(1,2,3-CD)PYRENE	3.9 U	4 U	3.8 U	16	23	4.9 U	26		
NAPHTHALENE	3.9 U	4 U	3.8 U	4.2 U	4.3 U	4.9 U	4.3 U		
PHENANTHRENE	4 J	4 U	3.8 U	15	19	5 J	23		
PYRENE	7 J	4 U	3.8 U	45	65	10	65		
Pesticides PCBs (ug/kg)									
AROCLOR-1248	220	210	20 U	46000 J	140000 J	5100	1300		
Herbicides (ug/kg)									
PENTACHLOROPHENOL	1.6 R	1.6 R	0.52 U	0.57 U	1.1 J	0.66 U	0.58 U		
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)								14	15
PH (S.U.)								7.4	5.1
TOTAL ORGANIC CARBON (mg/kg)								1000 U	1000 U

TABLE A-1
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB08	13SB09/15	13SB09/15	13SB10	13SB11	13SB12	13SB13	13SB14	13SB09/15
NSAMPLE	13SS080002-D	13SS090002	13SS090002-D	13SS100002	13SS110002	13SS120002	13SS130002	13SS140001	13SS150002
SAMPLE	FD03300301	13SS090002	FD03260301	13SS100002	13SS110002	13SS120002	13SS130002	13SS140001	13SS150002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/30/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	4/10/2003	4/10/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD		1570 J	2070 J	2270 J	828 J	813 J	2390 J	2340	
1,2,3,4,6,7,8,9-OCDF		1.7 J	1.8 J	1.3 U	0.55 J	0.2 UJ	0.3 UJ	9.5 J	
1,2,3,4,6,7,8-HPCDD		13.6	18.4	18.8	6.2	8.1	19.1	22.7	
1,2,3,4,6,7,8-HPCDF		2.3 J	2.4 J	3.1 J	0.18 U	0.1 U	0.57 J	4 U	
1,2,3,4,7,8,9-HPCDF		0.3 U	0.2 U	0.3 U	0.1 U	0.1 U	0.2 U	1.3 J	
1,2,3,4,7,8-HXCDD		0.2 U	0.2 U	0.2 U	0.1 U	0.1 U	0.63 J	0.42 J	
1,2,3,4,7,8-HXCDF		0.46 U	0.5 U	0.41 U	0.33 U	0.08 U	0.51 U	6.4	
1,2,3,6,7,8-HXCDD		0.2 U	0.41 J	0.2 U	0.1 U	0.1 U	0.69 J	0.84 J	
1,2,3,6,7,8-HXCDF		0.3 U	0.1 U	0.1 U	0.07 U	0.08 U	0.41 U	1.6 J	
1,2,3,7,8,9-HXCDD		0.72 J	0.69 J	0.79 J	0.1 U	0.49 U	1.6 J	1.5 J	
1,2,3,7,8,9-HXCDF		0.2 U	0.2 U	0.2 U	0.09 U	0.1 U	0.31 J	0.33 J	
1,2,3,7,8-PECDD		0.34 U	0.2 U	0.3 U	0.2 U	0.2 U	0.71 J	0.2 U	
1,2,3,7,8-PECDF		0.2 U	0.1 U	0.2 U	0.09 U	0.1 U	0.36 J	2.5 J	
2,3,4,6,7,8-HXCDF		0.21 U	0.1 U	0.21 J	0.07 U	0.07 U	0.42 J	1.8 J	
2,3,4,7,8-PECDF		0.53 U	1.1 J	1.2 J	1 J	0.1 U	0.47 J	21.8	
2,3,7,8-TCDD		0.52 J	0.49 U	0.4 U	0.1 U	0.2 U	0.2 U	0.1 U	
2,3,7,8-TCDF		0.35 J	1.1	0.56 J	1.2	0.1 U	0.53 J	21	
TOTAL HPCDD		28	38.4	36.2	11.8	14.5	36.5	56	
TOTAL HPCDF		3.7	4.6 J	5.3	0.38 J	0.1 U	0.57	10.1 J	
TOTAL HXCDD		3.1	4.2 J	3.8	0.77 J	1.1 J	5	8.4 J	
TOTAL HXCDF		3.1 J	3.4 J	4.1 J	0.33	0.08 U	1.6	19.4 J	
TOTAL PECDD		0.34 U	0.2 U	0.3 U	0.2 U	0.2 U	0.71	2.1 U	
TOTAL PECDF		7.6 J	15.3 J	11.8 J	4.6 J	0.1 U	0.83	135 J	
TOTAL TCDD		0.52	1.1 U	0.71 U	0.33 U	0.2 U	0.2 U	2.2 U	
TOTAL TCDF		39.9 J	55.4 J	59.4 J	36.1 J	0.1 U	7.8 J	540 J	
Volatile Organics (ug/kg)									
TRANS-1,2-DICHLOROETHENE									1.4 U
TRICHLOROFLUOROMETHANE									3 J
Semivolatile Organics (ug/kg)									
ACENAPHTHENE		52 J	4.4 UJ	4.1 U	3.9 U	4 U	4 U	4.2 U	
ACETOPHENONE		90 U	150 J	82 U	80 U	82 U	81 U	85 U	
ANTHRACENE		210 J	4.4 UJ	4.1 U	3.9 U	4 U	4 U	4.2 U	
BENZO(A)ANTHRACENE		1100 J	44 J	7 J	5 J	4 J	4 U	8 J	
BENZO(A)PYRENE		1000 J	71 J	7 J	6 J	4 U	4 U	10	
BENZO(B)FLUORANTHENE		1100 J	93 J	14	9	4 U	4 U	14 J	
BENZO(G,H,I)PERYLENE		750 J	57 J	8 J	6 J	4 U	4 U	9	
BENZO(K)FLUORANTHENE		640 J	74 J	8 J	5 J	4 U	4 U	10	

TABLE A-1
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB08	13SB09/15	13SB09/15	13SB10	13SB11	13SB12	13SB13	13SB14	13SB09/15
NSAMPLE	13SS080002-D	13SS090002	13SS090002-D	13SS100002	13SS110002	13SS120002	13SS130002	13SS140001	13SS150002
SAMPLE	FD03300301	13SS090002	FD03260301	13SS100002	13SS110002	13SS120002	13SS130002	13SS140001	13SS150002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/30/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	3/26/2003	4/10/2003	4/10/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BIS(2-ETHYLHEXYL)PHTHALATE		140 J	100 J	110 J	80 U	130 J	81 U	190 BU	
CHRYSENE		1100 J	77 J	13	10	4 U	4 U	11	
DIBENZO(A,H)ANTHRACENE		200 J	16 J	4.1 U	3.9 U	4 U	4 U	4.2 U	
FLUORANTHENE		1800 J	23 J	10	6 J	7 J	4 U	9	
FLUORENE		50 J	4.4 UJ	4.1 U	3.9 U	4 U	4 U	4.2 U	
INDENO(1,2,3-CD)PYRENE		650 J	51 J	7 J	4 J	4 U	4 U	7 J	
NAPHTHALENE		4.4 U	4.4 U	5 J	3.9 U	4 U	4 U	4.2 U	
PHENANTHRENE		1000 J	8 J	5 J	3.9 U	6 J	4 U	4.2 U	
PYRENE		2400 J	26 J	10	6 J	7 J	4 U	12	
Pesticides PCBs (ug/kg)									
AROCLOR-1248		5400 J	6700 J	160000	67000 J	330 J	39000 J	150000	
Herbicides (ug/kg)									
PENTACHLOROPHENOL		0.6 U	0.6 U	0.55 U	0.54 U	0.55 U	0.54 U	0.57 U	
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)	18								
PH (S.U.)	5.2								
TOTAL ORGANIC CARBON (mg/kg)	1300								

APPENDIX A.2

SUBSURFACE SOIL DATA

TABLE A-2
POSITIVE HITS SUBSURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB01	13SB02	13SB03	13SB04	13SB05	13SB06	13SB07	13SB08	13SB09/15
NSAMPLE	13SB010204	13SB020204	13SB030204	13SB040204	13SB050204	13SB060204	13SB070810	13SB080608	13SB090204
SAMPLE	13SB010204	13SB020204	13SB030204	13SB040204	13SB050204	13SB060204	13SB070810	13SB080608	13SB090204
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	8 - 10	6 - 8	2 - 4
SAMPLE DATE	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/26/2003	3/30/2003	3/26/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD	4430	1900	3030	1250	3250	330			923 J
1,2,3,4,6,7,8,9-OCDF	0.2 U	0.2 U	0.3 U	3.4 U	0.6 U	0.7 U			0.4 UJ
1,2,3,4,6,7,8-HPCDD	26.2	8.5	11.8	7.7	23.2	5			8.1
1,2,3,4,6,7,8-HPCDF	0.1 U	0.09 U	0.2 U	1.3 U	0.2 U	0.2 U			0.69
1,2,3,4,7,8-HXCDD	0.2 U	0.1 U	0.2 U	1.5 U	0.2 U	0.2 U			0.2 U
1,2,3,4,7,8-HXCDF	0.1 U	0.07 U	0.1 U	2.7 J	0.1 U	0.1 U			0.73
1,2,3,7,8,9-HXCDD	0.67 J	0.69 J	0.2 U	1.5 U	1.2 U	0.3 U			0.5 U
1,2,3,7,8-PECDD	0.2 U	0.1 U	0.3 U	1.1 U	0.2 U	0.2 U			0.2 U
1,2,3,7,8-PECDF	0.2 U	0.09 U	0.2 U	0.7 U	0.2 U	0.1 U			0.31
2,3,4,6,7,8-HXCDF	0.1 U	0.07 U	0.1 U	0.8 U	0.1 U	0.1 U			0.2 U
2,3,4,7,8-PECDF	0.2 U	0.1 U	0.2 U	15.4	0.2 U	0.2 U			0.66 U
2,3,7,8-TCDF	0.2 U	0.1 U	0.2 U	2.9	0.1 U	0.24 U			0.5 U
TOTAL HPCDD	44.2	16.4	25.1	17.4	52.1	8.7			17
TOTAL HPCDF	0.2 U	0.1 U	0.2 U	1.4 U	0.2 U	0.2 U			1.5 J
TOTAL HXCDD	1.1 J	1.5 J	0.2 U	1.4 U	4.2 J	1.1			2.5 J
TOTAL HXCDF	0.1 U	0.07 U	0.1 U	2.7	0.1 U	0.1 U			2.4 J
TOTAL PECDD	0.2 U	0.1 U	1.4 U	1.1 U	0.2 U	0.2 U			0.2 U
TOTAL PECDF	0.2 U	0.1 U	0.2 U	71.8 J	0.2 U	0.49 U			6.1 J
TOTAL TCDD	0.2 U	0.1 U	0.3 U	5.2 U	0.2 U	0.2 U			0.1 U
TOTAL TCDF	0.2 U	0.1 U	0.94 U	292 J	1.7	1.3 U			24.6 J
Volatile Organics (ug/kg)									
2-BUTANONE						1 U			
4-METHYL-2-PENTANONE						1 U			
ACETONE						1 UJ			
DICHLORODIFLUOROMETHANE						1 U			
TRICHLOROFLUOROMETHANE						2 J			
Semivolatile Organics (ug/kg)									
3&4-METHYLPHENOL	81 U	78 U	79 U	81 U	80 U	87 U			560
BIS(2-ETHYLHEXYL)PHTHALATE	110 J	110 J	79 U	120 J	130 J	90 J			76 U
CHRYSENE	4 U	4 J	3.9 U	4 U	3.9 U	4.3 U			3.7 U
FLUORANTHENE	4 U	7 J	3.9 U	4 U	3.9 U	4.3 U			3.7 U
PHENANTHRENE	4 U	6 J	3.9 U	4 U	3.9 U	4.3 U			3.7 U
PHENOL	81 U	78 U	79 U	81 U	80 U	87 U			110 J
PYRENE	4 U	13	3.9 U	4 U	3.9 U	4.3 U			3.7 U
Pesticides PCBs (ug/kg)									
AROCLOR-1248	20 U	20 U	20 U	35000 J	20 U	370 J			190 J
Herbicides (ug/kg)									
PENTACHLOROPHENOL	0.85 J	0.52 U	0.53 U	0.54 U	0.54 U	0.58 U			0.51 U

TABLE A-2
POSITIVE HITS SUBSURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB01	13SB02	13SB03	13SB04	13SB05	13SB06	13SB07	13SB08	13SB09/15
NSAMPLE	13SB010204	13SB020204	13SB030204	13SB040204	13SB050204	13SB060204	13SB070810	13SB080608	13SB090204
SAMPLE	13SB010204	13SB020204	13SB030204	13SB040204	13SB050204	13SB060204	13SB070810	13SB080608	13SB090204
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4	8 - 10	6 - 8	2 - 4
SAMPLE DATE	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/25/2003	3/26/2003	3/30/2003	3/26/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)							14	13	
PH (S.U.)							5.3	5.8	
TOTAL ORGANIC CARBON (mg/kg)							1100 J	1000 U	

TABLE A-2
POSITIVE HITS SUBSURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB10	13SB11	13SB12	13SB13	13SB09/15
NSAMPLE	13SB100204	13SB110204	13SB120204	13SB130204	13SB150204
SAMPLE	13SB100204	13SB110204	13SB120204	13SB130204	13SB150204
SUBMATRIX	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4
SAMPLE DATE	3/26/2003	3/26/2003	3/26/2003	3/26/2003	4/11/2003
VALIDATED	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)					
1,2,3,4,6,7,8,9-OCDD	1410 J	3460 J	2720 J	3210 J	
1,2,3,4,6,7,8,9-OCDF	2.9 J	0.1 UJ	0.2 UJ	0.3 UJ	
1,2,3,4,6,7,8-HPCDD	10.6	25	15.3	17	
1,2,3,4,6,7,8-HPCDF	1.1 J	0.08 U	0.1 U	0.2 U	
1,2,3,4,7,8-HXCDD	0.2 U	0.09 U	0.1 U	0.44 J	
1,2,3,4,7,8-HXCDF	1.7 J	0.2 U	0.13 U	0.1 U	
1,2,3,7,8,9-HXCDD	0.53 J	1.1 J	0.1 U	0.96	
1,2,3,7,8-PECDD	0.3 U	0.1 U	0.21 J	0.1 U	
1,2,3,7,8-PECDF	0.66 U	0.08 U	0.3 J	0.08 U	
2,3,4,6,7,8-HXCDF	0.59 J	0.09 J	0.07 U	0.1 U	
2,3,4,7,8-PECDF	6.8	0.31 J	0.1 U	0.1 U	
2,3,7,8-TCDF	5.2	0.2 U	0.09 U	0.1 U	
TOTAL HPCDD	21.4	47.3	26.4	44.1	
TOTAL HPCDF	2 J	0.1 U	0.1 U	0.2 U	
TOTAL HXCDD	1.5 J	4 J	0.65 J	3.4 J	
TOTAL HXCDF	5.4 J	0.43	0.13 U	0.1 U	
TOTAL PECDD	0.3 U	0.1 U	0.21	0.1 U	
TOTAL PECDF	40.1 J	1.8	0.3	0.09 U	
TOTAL TCDD	3 J	0.15	0.1 U	0.1 U	
TOTAL TCDF	211 J	12.8 J	0.09 U	0.1 U	
Volatile Organics (ug/kg)					
2-BUTANONE					18
4-METHYL-2-PENTANONE					3 J
ACETONE					89 BJ
DICHLORODIFLUOROMETHANE					7 J
TRICHLOROFLUOROMETHANE					3 J
Semivolatile Organics (ug/kg)					
3&4-METHYLPHENOL	77 U	78 U	76 U	83 U	
BIS(2-ETHYLHEXYL)PHTHALATE	110 J	78 U	76 U	83 U	
CHRYSENE	3.8 U	3.9 U	3.8 U	4.1 U	
FLUORANTHENE	3.8 U	3.9 U	3.8 U	4.1 U	
PHENANTHRENE	3.8 U	3.9 U	3.8 U	4.1 U	
PHENOL	77 U	78 U	76 U	83 U	
PYRENE	3.8 U	3.9 U	3.8 U	4.1 U	
Pesticides PCBs (ug/kg)					
AROCLOR-1248	210000	59 J	590 J	220 J	
Herbicides (ug/kg)					
PENTACHLOROPHENOL	0.52 U	0.53 U	0.67 J	0.55 U	

TABLE A-2
POSITIVE HITS SUBSURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SB10	13SB11	13SB12	13SB13	13SB09/15
NSAMPLE	13SB100204	13SB110204	13SB120204	13SB130204	13SB150204
SAMPLE	13SB100204	13SB110204	13SB120204	13SB130204	13SB150204
SUBMATRIX	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 4	2 - 4	2 - 4	2 - 4	2 - 4
SAMPLE DATE	3/26/2003	3/26/2003	3/26/2003	3/26/2003	4/11/2003
VALIDATED	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB
Miscellaneous Parameters					
CATION EXCHANGE CAPACITY (MEQ/1)					
PH (S.U.)					
TOTAL ORGANIC CARBON (mg/kg)					

APPENDIX A.3

GROUND WATER DATA

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT01	13MWT02	13MWT03	13MWT03	13MWT04	13MWT05	13MWT05	13MWT06
NSAMPLE	13GWT0101	13GWT0201	13GWT0301	13GWT0301-F	13GWT0401	13GWT0501	13GWT0501-F	13GWT0601
SAMPLE	13GWT0101	13GWT0201	13GWT0301	13GWT0301-F	13GWT0401	13GWT0501	13GWT0501-F	13GWT0601
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/26/2003	4/26/2003	4/26/2003	4/26/2003	4/27/2003	4/27/2003	4/27/2003	4/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)								
TRICHLOROETHENE								
Energetics (ug/L)								
1,3-DINITROBENZENE	0.47 U	0.495 U	0.265 U		0.26 U	0.3 J		0.19 U
2,4,6-TRINITROTOLUENE	0.47 U	0.495 U	0.265 U		0.26 U	0.155 U		0.19 U
2-AMINO-4,6-DINITROTOLUENE	0.47 U	0.495 U	0.265 U		0.26 U	0.155 U		0.19 U
4-AMINO-2,6-DINITROTOLUENE	0.47 U	0.495 U	0.265 U		0.26 U	0.155 U		0.19 U
4-NITROTOLUENE	0.47 U	0.495 U	0.265 U		0.26 U	0.155 U		0.19 U
HMX	1	0.495 U	0.29 J		3.3	13		0.97
RDX	0.44 U	0.465 U	0.25 U		4.1	0.77 J		2
Total Metals (ug/L)								
ALUMINUM	598 J	659 J	3990 J		8050 J	21700 J		12300 J
ARSENIC	0.23 U	0.65 J	1.0 J		1.8 J	4.7 J		4.0 J
BARIUM	55.4 J	27.5 J	74.5 J		154 J	126 J		178 J
BERYLLIUM	1.2 U	0.63 U	1.2 U		3.5 J	1.2 U		0.58 U
CADMIUM	0.18 U	0.38 U	0.82 U		1.9 U	0.39 U		0.56 U
CALCIUM	9720 J	94100 J	34800 J		34800 J	40200 J		36700 J
CHROMIUM	0.20 U	1.1 J	7.1 J		1.5 J	36.4 J		18.7 J
COBALT	36.0 J	119 J	48.8 J		111 J	34.2 J		3.6 J
COPPER	2.9 J	2.7 J	5.6 J		3.8 J	10.1 J		7.3 J
IRON	135 J	10500 J	1910 J		5400 J	9860 J		12000 J
LEAD	1.4 U	0.53 U	2.0 U		3.2 J	8.1 J		7.1 J
LITHIUM	21.1 J	208 J	74.0 J		126 J	40.0 J		15.7 J
MAGNESIUM	6790 J	60200 J	17000 J		16700 J	35700 J		17700 J
MANGANESE	689 J	4580 J	302 J		1330 J	172 J		505 J
MERCURY	0.16 J	0.02 U	0.02 U		0.02 U	0.02 U		0.02 U
NICKEL	26.6 J	289 J	99.7 J		314 J	96.2 J		11.7 J
POTASSIUM	494 J	6910 J	2860 J		7760 J	8390 J		10300 J
SELENIUM	0.17 U	0.91 U	0.32 U		0.61 U	0.42 U		0.69 U
SODIUM	24300 J	102000 J	37400 J		22800 J	57900 J		58000 J
STRONTIUM	53.3 J	396 J	97.8 J		101 J	189 J		203 J
TITANIUM	4.0 J	5.8 J	32.0 J		7.8 J	180 J		85.0 J
VANADIUM	0.08 U	0.68 J	5.8 J		0.79 J	34.3 J		15.8 J
ZINC	29.7 J	140 J	161 J		358 J	114 J		30.3 J
Dissolved Metals (ug/L)								
ALUMINUM, FILTERED				226 J			254 J	
ARSENIC, FILTERED				0.50 U			0.80 J	
BARIUM, FILTERED				71.1 J			22.8 J	

(1) Sample, 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT01	13MWT02	13MWT03	13MWT03	13MWT04	13MWT05	13MWT05	13MWT06
NSAMPLE	13GWT0101	13GWT0201	13GWT0301	13GWT0301-F	13GWT0401	13GWT0501	13GWT0501-F	13GWT0601
SAMPLE	13GWT0101	13GWT0201	13GWT0301	13GWT0301-F	13GWT0401	13GWT0501	13GWT0501-F	13GWT0601
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/26/2003	4/26/2003	4/26/2003	4/26/2003	4/27/2003	4/27/2003	4/27/2003	4/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BERYLLIUM, FILTERED				1.1 U			0.46 U	
CALCIUM, FILTERED				30900 J			39800 J	
CHROMIUM, FILTERED				0.48 U			2.6 J	
COBALT, FILTERED				55.7 J			35.0 J	
COPPER, FILTERED				4.5 J			3.4 J	
IRON, FILTERED				344 J			93.8 J	
LEAD, FILTERED				0.25 U			0.21 U	
LITHIUM, FILTERED				78.5 J			27.4 J	
MAGNESIUM, FILTERED				16800 J			32200 J	
MANGANESE, FILTERED				300 J			133 J	
NICKEL, FILTERED				107 J			90.5 J	
POTASSIUM, FILTERED				1890 J			4540 J	
SELENIUM, FILTERED				0.33 U			0.28 U	
SODIUM, FILTERED				35000 J			55000 J	
STRONTIUM, FILTERED				97.1 J			188 J	
TITANIUM, FILTERED				2.6 J			4.5 J	
VANADIUM, FILTERED				0.31 U			0.46 U	
ZINC, FILTERED				178			111 J	
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.01 U	0.13	0.12		0.39	0.05		0.02
NITRITE/NITRATE-N	0.07	0.02 U	0.07		0.24	0.03		0.03
Field Parameters								
DISSOLVED OXYGEN (mg/L)	1.28	1.98	4.5		4.3	0.6		3.15
OXIDATION REDUCTION POTENTIAL (MV)	220	191	152.7		216.1	76		88
PH (S.U.)	4.68	4.61	5.56		4.77	5.83		6.63
SPECIFIC CONDUCTANCE (MS/CM)	0.229	1.244	0.445		0.316	0.632		0.495
TEMPERATURE (C)	12.59	15.28	13.14		13.73	15.18		12.46
TURBIDITY (NTU)	3.8	6.8	38		6	8.8		650

(1) Sample 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT06	13MWT07	13MWT08	13MWT09	13MWT09	13MWT09	13MWT10	13MWT11
NSAMPLE	13GWT0601-F	13GWT0701	13GWT0801	13GWT0901	13GWT0901-D	13GWT0902	13GWT1001	13GWT1101
SAMPLE	13GWT0601	13GWT0701	13GWT0801	13GWT0901	FD04280301	13GWT0902	13GWT1001	13GWT1101
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	---	---	---	---	---	---	---	---
SAMPLE DATE	4/27/2003	4/27/2003	4/26/2003	4/28/2003	4/28/2003	5/9/2003	4/27/2003	4/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)								
TRICHLOROETHENE				0.3 U	0.3 U			
Energetics (ug/L)								
1,3-DINITROBENZENE		0.6 U	0.345 U	1.4 J	1.5 J		0.265 U	0.83 J
2,4,6-TRINITROTOLUENE		0.6 U	0.345 U	19	20 J		0.265 U	31
2-AMINO-4,6-DINITROTOLUENE		0.6 U	0.345 U	8.6 J	8.6 J		0.265 U	6 J
4-AMINO-2,6-DINITROTOLUENE		0.6 U	0.345 U	18	18		0.265 U	19
4-NITROTOLUENE		0.6 U	0.345 U	0.215 U	0.385 U		0.265 U	0.43 U
HMX		0.6 U	0.345 U	84	66		0.265 U	34
RDX		7.2	0.325 U	1100	1100		0.25 U	560
Total Metals (ug/L)								
ALUMINUM		4320 J	907 J	297 J	278 J		1430 J	719 J
ARSENIC		1.6 J	0.20 U	0.09 U	0.07 U		1.1 J	0.22 U
BARIUM		10.4 J	24.5 J	155 J	159 J		18.3 J	27.4 J
BERYLLIUM		8.4 J	0.14 U	0.41 U	0.42 U		4.3 J	1.6 U
CADMIUM		0.64 U	0.05 UJ	0.05 UJ	0.05 U		0.94 U	0.12 U
CALCIUM		69400 J	2580 U	48600 J	50100 J		26700 J	5760 J
CHROMIUM		0.71 U	0.99 J	0.02 U	0.02 U		1.0 J	0.35 U
COBALT		140 J	2.2 J	17.2 J	17.6 J		246 J	26.3 J
COPPER		5.0 J	1.0 J	1.2 J	1.4 J		4.3 J	3.0 J
IRON		128 J	600 J	25.0 U	24.7 U		3560 J	4250 J
LEAD		8.4 J	0.34 U	0.44 U	0.46 U		7.7 J	1.5 U
LITHIUM		154 J	6.6 J	31.1 J	31.8 J		158 J	66.8 J
MAGNESIUM		54300 J	2230 J	38700 J	39900 J		22200 J	4770 J
MANGANESE		1800 J	57.6 U	608 J	624 J		1580 J	250 J
MERCURY		0.16 J	0.02 U	0.034 J	0.026 J		0.02 U	0.032 J
NICKEL		299 J	4.2 J	23.7 J	25.3 J		371 J	66.5 J
POTASSIUM		4380 J	240 J	983 J	1010 J		2570 J	668 J
SELENIUM		0.13 U	0.08 U	0.05 U	0.07 U		0.07 U	0.05 U
SODIUM		82300 J	8360 J	35000 J	36700 J		25500 J	24000 J
STRONTIUM		163 J	14.5 J	229 J	236 J		86.9 J	31.0 J
TITANIUM		4.4 J	16.8 J	2.5 J	2.4 J		5.9 J	6.7 J
VANADIUM		0.14 U	1.4 J	0.05 U	0.05 U		0.58 U	0.29 U
ZINC		382 J	7.4 J	22.0 J	22.9 J		208 J	82.7 J
Dissolved Metals (ug/L)								
ALUMINUM, FILTERED	826 J							
ARSENIC, FILTERED	0.51 U							
BARIUM, FILTERED	41.6 J							

(1) Sample, 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT06	13MWT07	13MWT08	13MWT09	13MWT09	13MWT09	13MWT10	13MWT11
NSAMPLE	13GWT0601-F	13GWT0701	13GWT0801	13GWT0901	13GWT0901-D	13GWT0902	13GWT1001	13GWT1101
SAMPLE	13GWT0601	13GWT0701	13GWT0801	13GWT0901	FD04280301	13GWT0902	13GWT1001	13GWT1101
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/27/2003	4/27/2003	4/26/2003	4/28/2003	4/28/2003	5/9/2003	4/27/2003	4/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BERYLLIUM, FILTERED	0.05 U							
CALCIUM, FILTERED	34900 J							
CHROMIUM, FILTERED	1.3 J							
COBALT, FILTERED	1.3 J							
COPPER, FILTERED	0.63 U							
IRON, FILTERED	772 J							
LEAD, FILTERED	0.30 U							
LITHIUM, FILTERED	9.7 J							
MAGNESIUM, FILTERED	16700 J							
MANGANESE, FILTERED	543 J							
NICKEL, FILTERED	3.2 J							
POTASSIUM, FILTERED	7110 J							
SELENIUM, FILTERED	0.29 U							
SODIUM, FILTERED	49700 J							
STRONTIUM, FILTERED	159 J							
TITANIUM, FILTERED	9.3 J							
VANADIUM, FILTERED	1.1 J							
ZINC, FILTERED	3.6 J							
Miscellaneous Parameters (mg/L)								
AMMONIA-N		0.03	0.01 U	3.3	3.2		0.98	0.1
NITRITE/NITRATE-N		0.07	0.02 U	92	94		0.02 U	0.02 U
Field Parameters								
DISSOLVED OXYGEN (mg/L)		0.34	2.45	1.69		1.21	1.4	0.85
OXIDATION REDUCTION POTENTIAL (MV)		278	206	205.6		148	364	265
PH (S.U.)		3.98	5.06	5.36		5.38	3.01	3.64
SPECIFIC CONDUCTANCE (MS/CM)		1.03	0.74	0.829		0.725	0.582	0.251
TEMPERATURE (C)		15.6	14.65	13.33		14.36	15.6	15.73
TURBIDITY (NTU)		6.8	10	3		0.1	10	10

(1) Sa[illegible] 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT12	13MWT12	13MWT13	13MWT13	13MWT14	13MWT15	13MWT16	13MWT17
NSAMPLE	13GWT1201	13GWT1201-F	13GWT1301	13GWT1301-D	13GWT1401	13GWT1501	13GWT1601	13GWT1701
SAMPLE	13GWT1201	13GWT1201-F	13GWT1301	FD05070301	13GWT1401	13GWT1501	13GWT1601	13GWT1701
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/27/2003	4/27/2003	5/7/2003	5/7/2003	4/29/2003	5/6/2003	5/6/2003	5/7/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)								
TRICHLOROETHENE								
Energetics (ug/L)								
1,3-DINITROBENZENE	0.6 U		0.37 U	0.18 U	0.345 U	0.485 U	0.11 U	0.43 U
2,4,6-TRINITROTOLUENE	1.8		0.37 U	0.18 U	0.345 U	0.485 U	0.11 U	0.43 U
2-AMINO-4,6-DINITROTOLUENE	3.7 J		0.37 U	0.18 U	0.345 U	0.485 U	0.11 U	0.43 U
4-AMINO-2,6-DINITROTOLUENE	5.8 J		0.37 U	0.18 U	0.345 U	0.485 U	0.12 J	0.6 J
4-NITROTOLUENE	0.6 U		0.37 U	0.18 U	0.345 U	0.485 U	0.11 U	0.43 U
HMX	50		9.5	8.4	0.345 U	0.485 U	22 J	92 J
RDX	150		12	10	1.6	0.46 U	10	430
Total Metals (ug/L)								
ALUMINUM	2170 J		1080 J	1060 J	57.1 U	1440 J	123 J	418 J
ARSENIC	1.3 J		0.39 U	0.41 U	5.8 J	7.0 J	0.66 U	0.50 U
BARIUM	36.5 J		43.8 J	43.3 J	31.1 J	43.3 J	72.9 J	19.3 J
BERYLLIUM	0.27 U		2.1 J	2.1 J	0.06 U	4.2 J	0.13 U	0.04 U
CADMIUM	0.10 U		0.09 U	0.12 U	0.35 U	1.0 U	0.14 U	0.05 U
CALCIUM	2800 J		3740 J	3700 J	29700 J	14600 J	27200 J	12100 J
CHROMIUM	4.1 J		0.29 U	0.33 U	0.18 U	0.82 U	0.29 U	0.63 U
COBALT	8.1 J		30.1 J	30.2 J	14.2 J	106 J	5.4 J	1.5 J
COPPER	2.2 J		5.0 J	4.9 J	0.28 U	3.0 J	0.59 U	0.26 U
IRON	2020 J		860 J	846 J	10500 J	9260 J	2570 J	357 J
LEAD	1.9 U		1.0 U	0.99 U	0.20 U	23.8 J	0.14 U	0.35 U
LITHIUM	15.3 J		29.3 J	28.7 J	33.9 J	133 J	2.3 J	5.7 J
MAGNESIUM	2560 J		3660 J	3680 J	26100 J	14300 J	11600 J	9470 J
MANGANESE	216 J		600 J	584 J	1910 J	1300 J	712 J	56.3 U
MERCURY	0.02 U		0.20 U	0.20 U	0.02 U	0.20 U	0.20 U	0.20 U
NICKEL	16.4 J		25.3 J	24.8 J	24.7 J	222 J	7.1 J	2.9 J
POTASSIUM	724 J		649 J	641 J	2080 J	2230 J	576 J	481 J
SELENIUM	0.25 U		0.10 U	0.12 U	0.41 U	1.1 U	0.26 U	0.10 U
SODIUM	21900 J		6030 J	6330 J	48300 J	16000 J	15000 J	8450 J
STRONTIUM	14.6 J		18.5 J	18.3 J	71.7 J	65.5 J	129 J	27.4 J
TITANIUM	34.6 J		3.7 J	3.7 J	1.9 U	4.6 J	3.2 J	7.2 J
VANADIUM	4.2 J		0.07 U	0.10 U	0.08 U	0.32 U	0.27 U	0.72 U
ZINC	14.6 J		35.1 J	34.4 J	17.8 J	266 J	3.9 J	3.0 J
Dissolved Metals (ug/L)								
ALUMINUM, FILTERED		257 J						
ARSENIC, FILTERED		0.37 U						
BARIUM, FILTERED		26.2 J						

(1) Sample, 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT12	13MWT12	13MWT13	13MWT13	13MWT14	13MWT15	13MWT16	13MWT17
NSAMPLE	13GWT1201	13GWT1201-F	13GWT1301	13GWT1301-D	13GWT1401	13GWT1501	13GWT1601	13GWT1701
SAMPLE	13GWT1201	13GWT1201-F	13GWT1301	FD05070301	13GWT1401	13GWT1501	13GWT1601	13GWT1701
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/27/2003	4/27/2003	5/7/2003	5/7/2003	4/29/2003	5/6/2003	5/6/2003	5/7/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BERYLLIUM, FILTERED		0.17 U						
CALCIUM, FILTERED		2980 J						
CHROMIUM, FILTERED		0.63 U						
COBALT, FILTERED		9.0 J						
COPPER, FILTERED		3.4 J						
IRON, FILTERED		203 J						
LEAD, FILTERED		0.31 U						
LITHIUM, FILTERED		14.6 J						
MAGNESIUM, FILTERED		2500 J						
MANGANESE, FILTERED		224 J						
NICKEL, FILTERED		18.3 J						
POTASSIUM, FILTERED		366 J						
SELENIUM, FILTERED		0.26 U						
SODIUM, FILTERED		21800 J						
STRONTIUM, FILTERED		13.6 J						
TITANIUM, FILTERED		8.1 J						
VANADIUM, FILTERED		0.46 U						
ZINC, FILTERED		13.5 J						
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.06		0.03	0.03	0.08	1	0.4	0.01
NITRITE/NITRATE-N	1.3		1.1	1.1	0.13	0.02 U	0.02 U	0.86
Field Parameters								
DISSOLVED OXYGEN (mg/L)	2.35		3.37		1.2	0.53	0.81	0.53
OXIDATION REDUCTION POTENTIAL (MV)	242		268.2		23.2	286.8	-30.4	112
PH (S.U.)	4.83		4.2		5.5	3.74	6.16	5.35
SPECIFIC CONDUCTANCE (MS/CM)	0.135		0.106		0.885	0.391	0.356	0.17
TEMPERATURE (C)	14.46		13.82		14.34	15.89	14.27	15.7
TURBIDITY (NTU)	60		5.8		1.6	7.3	2.7	10

(1) Sample 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT18	13MWT18	13MWT19	13MWT20	13MWT20	13MWT20	13MWT21	13MWT21
NSAMPLE	13GWT1801	13GWT1801-F	13GWT1901	13GWT2001	13GWT2001-F	13GWT2002	13GWT2101	13GWT2101-D
SAMPLE	13GWT1801	13GWT1801-F	13GWT1901	13GWT2001	13GWT2001-F	13GWT2002	13GWT2101	FD04250301
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	5/6/2003	5/6/2003	5/7/2003	4/28/2003	4/28/2003	5/9/2003	4/25/2003	4/25/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)								
TRICHLOROETHENE				1 J				
Energetics (ug/L)								
1,3-DINITROBENZENE	0.08 U		0.55 U	0.37 U			0.28 U	0.345 U
2,4,6-TRINITROTOLUENE	0.08 U		0.55 U	0.37 U			26 J	33 J
2-AMINO-4,6-DINITROTOLUENE	0.08 U		0.55 U	0.37 U			0.28 U	0.345 U
4-AMINO-2,6-DINITROTOLUENE	0.08 U		0.55 U	0.37 U			0.28 U	0.345 U
4-NITROTOLUENE	0.08 U		0.55 U	0.37 U			0.5 J	0.345 U
HMX	8.6		6.4	0.37 U			390	350
RDX	150		5.9	0.35 U			2700	3100
Total Metals (ug/L)								
ALUMINUM	19000 J		195 J	12900 J			354	349
ARSENIC	4.2 J		0.43 U	1.8 J			0.18 U	0.16 U
BARIUM	118 J		401 J	16.7 J			41.7 J	40.5 J
BERYLLIUM	3.0 J		0.77 U	5.8 J			0.97 U	1.0 U
CADMIUM	0.33 U		0.72 U	1.0 U			0.14 U	0.11 U
CALCIUM	19300 J		32500 J	72200 J			12000 J	11600 J
CHROMIUM	25.6 J		0.59 U	3.3 J			0.90 J	0.43 U
COBALT	52.8 J		44.1 J	234 J			16.4 J	16.7 J
COPPER	14.0 J		1.1 U	10.5 J			0.83 J	0.92 J
IRON	15800 J		117 U	143000 J			127 J	109 U
LEAD	9.5 J		0.89 U	12.5 J			1.1 J	1.1 J
LITHIUM	181 J		40.8 J	340 J			45.8 J	49.2 J
MAGNESIUM	25600 J		37800 J	70300 J			8150 J	8100 J
MANGANESE	2170 J		1450 J	11600 J			612 J	628 J
MERCURY	0.20 U		0.20 U	0.02 U			0.02 U	0.02 U
NICKEL	140 J		79.4 J	477 J			35.7 J	35.4 J
POTASSIUM	6390 J		1290 J	6660 J			845 J	848 J
SELENIUM	0.42 U		0.29 U	0.13 U			0.05 U	0.08 U
SODIUM	35200 J		160000 J	53500 J			16000 J	16000 J
STRONTIUM	39.8 J		173 J	72.0 J			45.6 J	44.1 J
TITANIUM	166 J		5.1 J	5.5 J			4.4 J	4.3 J
VANADIUM	26.6 J		0.31 U	0.63 J			0.20 U	0.16 U
ZINC	175 J		57.0 J	661 J			21.9 J	23.0 J
Dissolved Metals (ug/L)								
ALUMINUM, FILTERED		382 J			11800 J			
ARSENIC, FILTERED		1.4 J			1.7 J			
BARIUM, FILTERED		20.9 J			15.6 J			

(1) Sample, 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT18	13MWT18	13MWT19	13MWT20	13MWT20	13MWT20	13MWT21	13MWT21
NSAMPLE	13GWT1801	13GWT1801-F	13GWT1901	13GWT2001	13GWT2001-F	13GWT2002	13GWT2101	13GWT2101-D
SAMPLE	13GWT1801	13GWT1801-F	13GWT1901	13GWT2001	13GWT2001-F	13GWT2002	13GWT2101	FD04250301
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	5/6/2003	5/6/2003	5/7/2003	4/28/2003	4/28/2003	5/9/2003	4/25/2003	4/25/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BERYLLIUM, FILTERED		2.0 J			5.6 J			
CALCIUM, FILTERED		20300 J			70900 J			
CHROMIUM, FILTERED		0.20 U			2.7 J			
COBALT, FILTERED		49.5 J			230 J			
COPPER, FILTERED		6.4 J			10.6 J			
IRON, FILTERED		1980 J			142000 J			
LEAD, FILTERED		0.91 U			11.5 J			
LITHIUM, FILTERED		154 J			322 J			
MAGNESIUM, FILTERED		22700 J			67900 J			
MANGANESE, FILTERED		2090 J			11500 J			
NICKEL, FILTERED		123 J			470 J			
POTASSIUM, FILTERED		2590 J			6520 J			
SELENIUM, FILTERED		0.29 U			0.19 U			
SODIUM, FILTERED		34400 J			52100 J			
STRONTIUM, FILTERED		32.8 J			68.9 J			
TITANIUM, FILTERED		2.8 U			4.2 J			
VANADIUM, FILTERED		0.05 U			0.45 U			
ZINC, FILTERED		138 J			695			
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.02		0.01 U	1.6			0.05	0.04
NITRITE/NITRATE-N	0.09		0.02 U	0.07			0.64	0.65
Field Parameters								
DISSOLVED OXYGEN (mg/L)	2.17		3.51	0.11		0.54	1.45	
OXIDATION REDUCTION POTENTIAL (MV)	324.1		224.1	265		224	193.6	
PH (S.U.)	3.88		5.12	3.48		3.65	5.46	
SPECIFIC CONDUCTANCE (MS/CM)	0.514		1.241	1.504		1.445	0.212	
TEMPERATURE (C)	16.75		13.81	15.78		16.7	13.01	
TURBIDITY (NTU)	450		5.0	19		1.4	8.2	

(1) Sa[illegible] 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT22	13MWT23	13MWT24	13MWT25	13MWT25	13MWT26
NSAMPLE	13GWT2201	13GWT2301	13GWT2401	13GWT2501	13GWT2501-F	13GWT2601
SAMPLE	13GWT2201	13GWT2301	13GWT2401	13GWT2501	13GWT2501	13GWT2601
SUBMATRIX	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—
SAMPLE DATE	5/6/2003	5/6/2003	4/28/2003	4/26/2003	4/26/2003	4/25/2003
VALIDATED	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)						
TRICHLOROETHENE						
Energetics (ug/L)						
1,3-DINITROBENZENE	0.395 U	0.5 U	0.65 U	0.145 U		0.19 U
2,4,6-TRINITROTOLUENE	0.395 U	0.5 U	0.65 U	0.145 U		0.19 U
2-AMINO-4,6-DINITROTOLUENE	0.395 U	0.5 U	0.65 U	0.145 U		0.19 U
4-AMINO-2,6-DINITROTOLUENE	0.395 U	0.5 U	0.65 U	0.145 U		0.19 U
4-NITROTOLUENE	0.395 U	0.5 U	0.65 U	0.145 U		0.19 U
HMX	19	13	2.1	0.34		2.4
RDX	20	17	7.3	0.4		0.4 J
Total Metals (ug/L)						
ALUMINUM	709 J	192 J	47.3 U	39000 J		241
ARSENIC	0.30 U	0.41 U	0.07 U	15.4 J		0.25 U
BARIUM	25.0 J	38.4 J	22.7 J	303 J		21.2 J
BERYLLIUM	3.7 J	0.06 U	0.03 U	2.3 J		0.03 U
CADMIUM	0.40 U	0.13 U	0.05 UJ	2.7 J		0.05 U
CALCIUM	13100 J	10300 J	34300 J	117000 J		22700 J
CHROMIUM	0.44 U	0.55 U	0.37 U	64.9 J		0.76 J
COBALT	80.5 J	5.1 J	3.7 J	33.0 J		5.0 J
COPPER	4.8 J	0.35 U	4.0 J	89.5 J		0.45 U
IRON	434 J	414 J	65.7 U	36000 J		238 J
LEAD	2.4 J	0.36 U	0.18 U	54.3 J		0.15 U
LITHIUM	208 J	12.2 J	18.2 J	74.4 J		35.7 J
MAGNESIUM	11300 J	10800 J	34500 J	19900 J		13700 J
MANGANESE	381 J	404 J	525 J	2080 J		391 J
MERCURY	0.20 U	0.20 U	0.02 U	0.052 J		0.02 U
NICKEL	153 J	5.5 J	6.3 J	82.1 J		8.0 J
POTASSIUM	705 J	796 J	1010 J	11000 J		474 J
SELENIUM	0.05 U	0.24 U	0.29 U	1.8 J		0.09 U
SODIUM	15400 J	37200 J	44200 J	27900 J		29200 J
STRONTIUM	64.9 J	49.9 J	81.0 J	262 J		56.9 J
TITANIUM	5.1 J	6.9 J	2.1 U	285 J		6.8 J
VANADIUM	0.18 U	0.51 U	0.06 U	75.3 J		0.46 U
ZINC	278 J	4.0 J	8.2 J	260 J		4.7 J
Dissolved Metals (ug/L)						
ALUMINUM, FILTERED					344 J	
ARSENIC, FILTERED					0.36 U	
BARIUM, FILTERED					62.6 J	

(1) Sample, 13GWT0902-D, was not detected for any analytes with positive detections.

TABLE A-3
POSITIVE HITS
GROUND WATER
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13MWT22	13MWT23	13MWT24	13MWT25	13MWT25	13MWT26
NSAMPLE	13GWT2201	13GWT2301	13GWT2401	13GWT2501	13GWT2501-F	13GWT2601
SAMPLE	13GWT2201	13GWT2301	13GWT2401	13GWT2501	13GWT2501	13GWT2601
SUBMATRIX	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—
SAMPLE DATE	5/6/2003	5/6/2003	4/28/2003	4/26/2003	4/26/2003	4/25/2003
VALIDATED	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BERYLLIUM, FILTERED					0.09 U	
CALCIUM, FILTERED					64700 J	
CHROMIUM, FILTERED					0.81 U	
COBALT, FILTERED					2.5 J	
COPPER, FILTERED					2.8 J	
IRON, FILTERED					198 J	
LEAD, FILTERED					0.44 U	
LITHIUM, FILTERED					57.3 J	
MAGNESIUM, FILTERED					14100 J	
MANGANESE, FILTERED					460 J	
NICKEL, FILTERED					26.3 J	
POTASSIUM, FILTERED					5560 J	
SELENIUM, FILTERED					2.0 J	
SODIUM, FILTERED					27100 J	
STRONTIUM, FILTERED					135 J	
TITANIUM, FILTERED					7.3 J	
VANADIUM, FILTERED					0.80 U	
ZINC, FILTERED					22.8 J	
Miscellaneous Parameters (mg/L)						
AMMONIA-N	0.01 U	0.01 U	0.02	0.09		0.02
NITRITE/NITRATE-N	0.02 U	0.5	0.39	0.02 U		0.03
Field Parameters						
DISSOLVED OXYGEN (mg/L)	0.64	4.09	2.89	4.21		4.2
OXIDATION REDUCTION POTENTIAL (MV)	264	131	284	219.1		189
PH (S.U.)	3.95	5.19	5.9	6.45		6.05
SPECIFIC CONDUCTANCE (MS/CM)	0.245	0.314	0.671	0.511		0.352
TEMPERATURE (C)	14.15	16.46	16.76	12.0		12.01
TURBIDITY (NTU)	0	0.7	5.2	999 >		7.1

(1) Sa[illegible] 13GWT0902-D, was not detected for any analytes with positive detections.

APPENDIX A.4

SURFACE WATER DATA

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD01	13SW/SD01	13SW/SD02	13SW/SD02	13SW/SD03	13SW/SD03	13SW/SD04	13SW/SD04
NSAMPLE	13SW0101	13SW0101-F	13SW0201	13SW0201-F	13SW0301	13SW0301-F	13SW0401	13SW0401-F
SAMPLE	13SW0101	13SW0101F	13SW0201	13SW0201F	13SW0301	13SW0301F	13SW0401	13SW0401F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/L)								
BENZO(A)ANTHRACENE							0.05 U	
BENZO(A)PYRENE							0.05 U	
BENZO(B)FLUORANTHENE							0.05 U	
BENZO(G,H,I)PERYLENE							0.05 U	
BENZO(K)FLUORANTHENE							0.05 U	
CHRYSENE							0.05 U	
FLUORANTHENE							0.05 U	
INDENO(1,2,3-CD)PYRENE							0.05 U	
PHENANTHRENE							0.05 U	
PYRENE							0.05 U	
Energetics (ug/L)								
2,4,6-TRINITROTOLUENE	2.3		0.53 J		0.265 U		0.5 U	
2-AMINO-4,6-DINITROTOLUENE	0.53 J		0.435 U		0.265 U		0.5 U	
4-AMINO-2,6-DINITROTOLUENE	1.4		0.52 J		0.265 U		0.5 U	
HMX	0.5 U		2.2		0.265 U		0.5 U	
RDX	1.5		14		0.25 U		0.47 U	
Herbicides (ug/L)								
PENTACHLOROPHENOL							0.091	
Total Metals (ug/L)								
ALUMINUM	575 J		4280 J		904 J		10600 J	
ARSENIC	0.51 U		1.5 J		0.67 U		3.4 J	
BARIUM	112 J		71.8 J		57.0 J		94.5 J	
CALCIUM	47200 J		39000 J		32800 J		30100 J	
CHROMIUM	1.2 J		4.6 J		1.0 U		15.6 J	
COBALT	0.16 U		1.6 J		0.69 U		3.2 J	
COPPER	5.2 J		6.1 J		3.3 J		12.2 J	
IRON	467 J		3180 J		700 J		8940 J	
LEAD	3.5 J		3.6 J		0.94 U		7.4 J	
LITHIUM	1.3 U		4.4 J		2.2 U		9.1 J	
MAGNESIUM	6820 J		7180 J		7210 J		6190 J	
MANGANESE	8.2 J		104 J		71.7 J		66.8 J	
NICKEL	0.89 J		3.6 J		3.9 J		7.6 J	
POTASSIUM	855 J		1630 J		2670 J		3760 J	
SELENIUM	0.21 U		0.29 U		0.15 U		0.28 U	
SODIUM	2960 J		18400 J		66800 J		16500 J	
STRONTIUM	105 J		103 J		83.7 J		74.2 J	
TITANIUM	11.1 J		67.5 J		18.4 J		122 J	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD01	13SW/SD01	13SW/SD02	13SW/SD02	13SW/SD03	13SW/SD03	13SW/SD04	13SW/SD04
NSAMPLE	13SW0101	13SW0101-F	13SW0201	13SW0201-F	13SW0301	13SW0301-F	13SW0401	13SW0401-F
SAMPLE	13SW0101	13SW0101F	13SW0201	13SW0201F	13SW0301	13SW0301F	13SW0401	13SW0401F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
VANADIUM	1.3 J		7.5 J		1.8 J		18.8 J	
ZINC	21.9 J		30.5 J		12.7 J		43.7 J	
Filtered Metals (ug/L)								
ALUMINUM, FILTERED		52.7 J		119		82.6		138
ARSENIC, FILTERED		0.35 U		0.36 U		0.45 U		0.47 U
BARIUM, FILTERED		107 J		47.9 J		50.8 J		40.9 J
CALCIUM, FILTERED		46000 J		38500 J		33100 J		28100 J
CHROMIUM, FILTERED		0.40 U		0.57 U		0.40 U		0.48 U
COBALT, FILTERED		0.26 U		0.59 U		0.55 U		0.61 U
COPPER, FILTERED		3.2 J		2.0 J		2.5 J		3.8 J
IRON, FILTERED		35.7 J		119 J		97.0 J		176 J
LITHIUM, FILTERED		0.77 U		0.88 U		1.3 U		1.3 U
MAGNESIUM, FILTERED		6590 J		6690 J		7210 J		4970 J
MANGANESE, FILTERED		2.9 J		14.4 J		28.0 J		5.3 J
NICKEL, FILTERED		0.59 U		0.85 U		3.3 J		1.9 J
POTASSIUM, FILTERED		769 J		1100 J		2560 J		1460 J
SELENIUM, FILTERED		0.28 U		0.32 U		0.15 U		0.15 U
SODIUM, FILTERED		2950 J		18000 J		70600 J		16300 J
STRONTIUM, FILTERED		103 J		101 J		83.5 J		64.3 J
TITANIUM, FILTERED		1.6 J		3.5 J		3.5 J		5.1 J
VANADIUM, FILTERED		0.30 U		0.47 U		0.37 U		0.42 U
ZINC, FILTERED		12.2 J		9.2 J		8.6 J		5.7 U
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.01 U		0.01 U		0.04 J		0.02 J	
NITRITE/NITRATE-N	0.15 J		0.33 J		0.02 U		0.02 U	
Field Parameters								
DISSOLVED OXYGEN (mg/L)	11.7		9.28		9.12		10.41	
OXIDATION REDUCTION POTENTIAL (MV)	95		113		131		174	
PH (S.U.)	7.49		7.24		7.39		7.75	
SPECIFIC CONDUCTANCE (MS/CM)	0.262		0.28		0.496		0.181	
TEMPERATURE (C)	9.29		9.29		11		10.65	
TURBIDITY (NTU)	11		59		16		298	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD05	13SW/SD05	13SW/SD06	13SW/SD06	13SW/SD07	13SW/SD07	13SW/SD08	13SW/SD08
NSAMPLE	13SW0501	13SW0501-F	13SW0601	13SW0601-F	13SW0701	13SW0701-F	13SW0801	13SW0801-F
SAMPLE	13SW0501	13SW0501F	13SW0601	13SW0601F	13SW0701	13SW0701F	13SW0801	13SW0801-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	5/8/2003	5/8/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/L)								
BENZO(A)ANTHRACENE	0.05 U		0.22					
BENZO(A)PYRENE	0.05 U		0.26					
BENZO(B)FLUORANTHENE	0.05 U		0.38					
BENZO(G,H,I)PERYLENE	0.05 U		0.23					
BENZO(K)FLUORANTHENE	0.05 U		0.2					
CHRYSENE	0.05 U		0.35					
FLUORANTHENE	0.05 U		0.96					
INDENO(1,2,3-CD)PYRENE	0.05 U		0.2					
PHENANTHRENE	0.05 U		0.51					
PYRENE	0.05 U		0.65					
Energetics (ug/L)								
2,4,6-TRINITROTOLUENE	0.475 U		0.5 U		0.265 U		0.29 U	
2-AMINO-4,6-DINITROTOLUENE	0.475 U		0.5 U		0.265 U		0.29 U	
4-AMINO-2,6-DINITROTOLUENE	0.475 U		0.5 U		0.265 U		0.29 U	
HMX	3.5		2.8		0.265 U		1.2	
RDX	5.3		3.6		0.29 J		2.8	
Herbicides (ug/L)								
PENTACHLOROPHENOL	0.013 U		0.025 J					
Total Metals (ug/L)								
ALUMINUM	3460 J		1740 J		19100 J		1650 J	
ARSENIC	1.3 J		0.97 U		5.8 J		1.2 J	
BARIUM	56.3 J		84.7 J		247 J		88.4 J	
CALCIUM	28900 J		58800 J		133000 J		59900 J	
CHROMIUM	3.5 J		2.0 J		20.5 J		1.9 J	
COBALT	2.6 J		1.2 J		5.2 J		0.72 U	
COPPER	3.4 J		4.6 J		17.6 J		1.9 J	
IRON	3060 J		1380 J		16200 J		1140 J	
LEAD	1.5 J		1.9 J		29.9 J		1.2 U	
LITHIUM	5.9 J		2.8 J		14.3 J		1.6 U	
MAGNESIUM	7500 J		10900 J		18100 J		10500 J	
MANGANESE	114 J		89.6 J		195 J		118 J	
NICKEL	5.4 J		2.4 J		12.3 J		2.0 J	
POTASSIUM	1220 J		1330 J		4380 J		1430 J	
SELENIUM	0.24 U		0.55 U		0.51 U		0.19 U	
SODIUM	5420 J		55500 J		325000 J		33100 J	
STRONTIUM	94.7 J		149 J		245 J		143 J	
TITANIUM	63.2 J		33.0 J		356 J		24.2 J	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD05	13SW/SD05	13SW/SD06	13SW/SD06	13SW/SD07	13SW/SD07	13SW/SD08	13SW/SD08
NSAMPLE	13SW0501	13SW0501-F	13SW0601	13SW0601-F	13SW0701	13SW0701-F	13SW0801	13SW0801-F
SAMPLE	13SW0501	13SW0501F	13SW0601	13SW0601F	13SW0701	13SW0701F	13SW0801	13SW0801-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	5/8/2003	5/8/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
VANADIUM	6.6 J		3.1 J		38.1 J		3.2 J	
ZINC	14.1 J		9.8 J		79.3 J		7.8 J	
Filtered Metals (ug/L)								
ALUMINUM, FILTERED		108		57.1		56.0		24.8 U
ARSENIC, FILTERED		0.19 U		0.42 U		0.15 U		0.73 U
BARIUM, FILTERED		40.0 J		75.7 J		149 J		78.1 J
CALCIUM, FILTERED		28800 J		56900 J		121000 J		5660 J
CHROMIUM, FILTERED		0.21 U		0.38 U		0.39 U		0.33 U
COBALT, FILTERED		1.3 J		0.70 U		0.43 U		0.32 U
COPPER, FILTERED		3.5 J		2.3 J		2.2 J		1.0 U
IRON, FILTERED		120 J		43.4 J		26.9 U		14.9 U
LITHIUM, FILTERED		3.1 J		1.5 U		0.37 U		0.96 U
MAGNESIUM, FILTERED		7210 J		11000 J		14400 J		9870 J
MANGANESE, FILTERED		64.9 J		63.3 J		20.4 J		84.4 J
NICKEL, FILTERED		2.9 J		1.5 J		0.61 U		1.1 J
POTASSIUM, FILTERED		735 J		1080 J		1080 J		1100 J
SELENIUM, FILTERED		0.21 U		0.59 U		0.17 U		0.36 U
SODIUM, FILTERED		5350 J		55800 J		311000 J		3190 J
STRONTIUM, FILTERED		88.0 J		142 J		219 J		140 J
TITANIUM, FILTERED		3.2 J		1.4 J		1.1 U		1.1 U
VANADIUM, FILTERED		0.27 U		0.23 U		0.34 U		0.38 U
ZINC, FILTERED		19.8 J		5.3 U		3.8 U		3.4 J
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.02 J		0.01 U		0.03 J		0.07	
NITRITE/NITRATE-N	0.02 U		0.54 J		0.18 J		0.64	
Field Parameters								
DISSOLVED OXYGEN (mg/L)	10.8		9.62		8.13		6.91	
OXIDATION REDUCTION POTENTIAL (MV)	109		640		177		150.6	
PH (S.U.)	7.58		7.41		7.32		6.13	
SPECIFIC CONDUCTANCE (MS/CM)	0.203		0.543		1.394		0.462	
TEMPERATURE (C)	10.49		10.44		9.8		15.18	
TURBIDITY (NTU)	36				352		31	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD09	13SW/SD09	13SW/SD10	13SW/SD10	13SW/SD10	13SW/SD10	13SW11	13SW11
NSAMPLE	13SW0901	13SW0901-F	13SW1001	13SW1001-D	13SW1001-F	13SW1001-F-D	13SW1101	13SW1101-F
SAMPLE	13SW0901	13SW0901F	13SW1001	FD03290303	13SW1001F	FD03290303-F	13SW1101	13SW1101-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	5/8/2003	5/8/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/L)								
BENZO(A)ANTHRACENE								
BENZO(A)PYRENE								
BENZO(B)FLUORANTHENE								
BENZO(G,H,I)PERYLENE								
BENZO(K)FLUORANTHENE								
CHRYSENE								
FLUORANTHENE								
INDENO(1,2,3-CD)PYRENE								
PHENANTHRENE								
PYRENE								
Energetics (ug/L)								
2,4,6-TRINITROTOLUENE	0.65 U		0.55 U	0.21 U			0.21 U	
2-AMINO-4,6-DINITROTOLUENE	0.65 U		0.55 U	0.21 U			0.25 R	
4-AMINO-2,6-DINITROTOLUENE	0.65 U		0.55 U	0.4 J			1 J	
HMX	0.65 U		15 J	13			93	
RDX	0.6 U		18	16			610	
Herbicides (ug/L)								
PENTACHLOROPHENOL								
Total Metals (ug/L)								
ALUMINUM	2700 J		2080 J	3260 J			3080 J	
ARSENIC	0.91 U		0.80 U	0.98 U			35.7 J	
BARIUM	38.0 J		44.1 J	50.3 J			25.3 J	
CALCIUM	18900 J		23500 J	23400 J			95400 J	
CHROMIUM	2.5 J		1.9 J	3.0 J			4.5 J	
COBALT	0.65 U		2.6 J	2.7 J			9.4 J	
COPPER	3.6 J		2.2 J	2.6 J			27.1 J	
IRON	2350 J		1740 J	2280 J			2340 J	
LEAD	1.5 J		1.3 J	1.5 J			2.3 J	
LITHIUM	1.8 U		6.6 J	8.1 J			2.9 J	
MAGNESIUM	3600 J		6660 J	7050 J			92200 J	
MANGANESE	25.0 J		231 J	220 J			126 J	
NICKEL	2.1 J		4.5 J	5.2 J			20.4 J	
POTASSIUM	1130 J		7750 J	7850 J			690000 J	
SELENIUM	0.10 U		0.10 U	0.10 U			2.0 J	
SODIUM	3020 J		7780 J	8020 J			72500 J	
STRONTIUM	48.0 J		59.0 J	57.7 J			82.4 J	
TITANIUM	51.0 J		36.4 J	59.4 J			64.6 J	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD09	13SW/SD09	13SW/SD10	13SW/SD10	13SW/SD10	13SW/SD10	13SW11	13SW11
NSAMPLE	13SW0901	13SW0901-F	13SW1001	13SW1001-D	13SW1001-F	13SW1001-F-D	13SW1101	13SW1101-F
SAMPLE	13SW0901	13SW0901F	13SW1001	FD03290303	13SW1001F	FD03290303-F	13SW1101	13SW1101-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	5/8/2003	5/8/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
VANADIUM	4.9 J		3.6 J	5.5 J			43.5 J	
ZINC	27.0 J		13.9 J	17.0 J			67.9 J	
Filtered Metals (ug/L)								
ALUMINUM, FILTERED		822			303	286		212 J
ARSENIC, FILTERED		0.47 U			0.37 U	0.29 U		35.3 J
BARIUM, FILTERED		28.4 J			33.7 J	34.0 J		10.1 J
CALCIUM, FILTERED		18600 J			24300 J	23300 J		94400 J
CHROMIUM, FILTERED		0.89 U			0.55 U	0.46 U		2.0 J
COBALT, FILTERED		0.65 U			1.6 J	1.6 J		8.8 J
COPPER, FILTERED		2.1 J			1.2 U	1.3 U		26.4 J
IRON, FILTERED		750 J			343 J	256 J		337 J
LITHIUM, FILTERED		0.66 U			5.5 J	5.5 J		1.3 U
MAGNESIUM, FILTERED		3440 J			6610 J	6780 J		92900 J
MANGANESE, FILTERED		9.2 J			160 J	155 J		72.5 J
NICKEL, FILTERED		1.1 J			3.3 J	3.3 J		18.6 J
POTASSIUM, FILTERED		846 J			7430 J	7320 J		700000 J
SELENIUM, FILTERED		0.08 U			0.13 U	0.09 U		2.2 J
SODIUM, FILTERED		2920 J			7840 J	7980 J		73200 J
STRONTIUM, FILTERED		45.5 J			56.3 J	54.3 J		79.9 J
TITANIUM, FILTERED		19.5 J			8.0 J	7.0 J		18.6 J
VANADIUM, FILTERED		1.6 J			0.73 U	0.65 U		38.5 J
ZINC, FILTERED		10.1 J			8.6 J	10.4 J		30.6 J
Miscellaneous Parameters (mg/L)								
AMMONIA-N	0.01 J		0.08 J	0.02 J			3.4	
NITRITE/NITRATE-N	0.02 U		0.46 J	0.47 J			23	
Field Parameters								
DISSOLVED OXYGEN (mg/L)	9.81		9.95				4.35	
OXIDATION REDUCTION POTENTIAL (MV)	120		145				152.9	
PH (S.U.)	8.48		7.74				7.67	
SPECIFIC CONDUCTANCE (MS/CM)	0.138		0.199				2.743	
TEMPERATURE (C)	11		9.3				16.45	
TURBIDITY (NTU)	45		150				85	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD12	13SW/SD12	13SW/SD13	13SW/SD13
NSAMPLE	13SW1201	13SW1201-F	13SW1301	13SW1301-F
SAMPLE	13SW1201	13SW1201F	13SW1301	13SW1301F
SUBMATRIX	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—
SAMPLE DATE	3/30/2003	3/30/2003	3/30/2003	3/30/2003
VALIDATED	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/L)				
BENZO(A)ANTHRACENE				
BENZO(A)PYRENE				
BENZO(B)FLUORANTHENE				
BENZO(G,H,I)PERYLENE				
BENZO(K)FLUORANTHENE				
CHRYSENE				
FLUORANTHENE				
INDENO(1,2,3-CD)PYRENE				
PHENANTHRENE				
PYRENE				
Energetics (ug/L)				
2,4,6-TRINITROTOLUENE	1.9 J		6.8	
2-AMINO-4,6-DINITROTOLUENE	0.84 J		1.6 J	
4-AMINO-2,6-DINITROTOLUENE	2 J		3.8 J	
HMX	26		14	
RDX	100		84	
Herbicides (ug/L)				
PENTACHLOROPHENOL				
Total Metals (ug/L)				
ALUMINUM	1330 J		714 J	
ARSENIC	4.2 J		0.95 U	
BARIUM	80.7 J		58.8 J	
CALCIUM	55000 J		38700 J	
CHROMIUM	1.8 J		0.98 U	
COBALT	1.2 J		1.9 J	
COPPER	7.2 J		2.4 J	
IRON	1090 J		673 J	
LEAD	0.92 U		0.77 U	
LITHIUM	2.0 U		3.9 J	
MAGNESIUM	18600 J		7480 J	
MANGANESE	69.9 J		107 J	
NICKEL	4.5 J		3.8 J	
POTASSIUM	97700 J		15100 J	
SELENIUM	0.50 U		0.15 U	
SODIUM	28300 J		8900 J	
STRONTIUM	120 J		94.3 J	
TITANIUM	26.3 J		11.6 J	

TABLE A-4
POSITIVE HITS
SURFACE SOIL
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD12	13SW/SD12	13SW/SD13	13SW/SD13
NSAMPLE	13SW1201	13SW1201-F	13SW1301	13SW1301-F
SAMPLE	13SW1201	13SW1201F	13SW1301	13SW1301F
SUBMATRIX	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—
SAMPLE DATE	3/30/2003	3/30/2003	3/30/2003	3/30/2003
VALIDATED	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB
VANADIUM	5.2 J		1.8 J	
ZINC	16.1 J		21.2 J	
Filtered Metals (ug/L)				
ALUMINUM, FILTERED		137		103
ARSENIC, FILTERED		3.6 J		0.66 U
BARIUM, FILTERED		74.6 J		53.7 J
CALCIUM, FILTERED		51400 J		37900 J
CHROMIUM, FILTERED		0.67 U		0.27 U
COBALT, FILTERED		1.3 J		1.7 J
COPPER, FILTERED		6.6 J		1.9 J
IRON, FILTERED		193 J		82.5 J
LITHIUM, FILTERED		1.2 U		3.5 J
MAGNESIUM, FILTERED		18000 J		7630 J
MANGANESE, FILTERED		52.2 J		88.3 J
NICKEL, FILTERED		3.8 J		3.2 J
POTASSIUM, FILTERED		97700 J		15100 J
SELENIUM, FILTERED		0.44 U		0.18 U
SODIUM, FILTERED		27500 J		9160 J
STRONTIUM, FILTERED		117 J		91.8 J
TITANIUM, FILTERED		7.7 J		3.0 J
VANADIUM, FILTERED		3.4 J		0.67 U
ZINC, FILTERED		8.1 J		13.1 J
Miscellaneous Parameters (mg/L)				
AMMONIA-N	0.88 J		0.14 J	
NITRITE/NITRATE-N	5.8 J		1.6 J	
Field Parameters				
DISSOLVED OXYGEN (mg/L)	11.98		12.32	
OXIDATION REDUCTION POTENTIAL (MV)	162		157	
PH (S.U.)	7.92		8.07	
SPECIFIC CONDUCTANCE (MS/CM)	0.64		0.26	
TEMPERATURE (C)	6.85		6.52	
TURBIDITY (NTU)	17		12.6	

APPENDIX A.5

SEDIMENT DATA

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD01	13SW/SD02	13SW/SD03	13SW/SD04	13SW/SD05	13SW/SD05	13SW/SD06	13SW/SD07	13SW/SD08
NSAMPLE	13SD010004	13SD020004	13SD030004	13SD040004	13SD050004	13SD050004-D	13SD060004	13SD070004	13SD080004
SAMPLE	13SD010004	13SD020004	13SD030004	13SD040004	13SD050004	FD03290301	13SD060004	13SD070004	13SD080004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/kg)									
ACENAPHTHENE				4.1 U	43 J		24		
ANTHRACENE				4.1 U	88		72		
BENZO(A)ANTHRACENE				11	330		290 J		
BENZO(A)PYRENE				15	360 J		390 J		
BENZO(B)FLUORANTHENE				18	420 J		460 J		
BENZO(G,H,I)PERYLENE				10	270 J		380 J		
BENZO(K)FLUORANTHENE				10	250 J		210 J		
CHRYSENE				18	400		430 J		
DI-N-BUTYL PHTHALATE				83 U	87 U		86 J		
DI-N-OCTYL PHTHALATE				83 U	87 U		100 J		
DIBENZO(A,H)ANTHRACENE				4.1 U	66 J		74 J		
FLUORANTHENE				44	860		830		
FLUORENE				4.1 U	42 J		33		
INDENO(1,2,3-CD)PYRENE				8 J	220 J		290 J		
NAPHTHALENE				4.1 U	6 J		6 J		
PHENANTHRENE				27	570		620		
PYRENE				36	1000		1300 J		
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
RDX	0.25 U	0.25 U	0.44 J	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
PENTACHLOROPHENOL				0.56 U	0.58 U		2.1 J		
Inorganics (mg/kg)									
ALUMINUM	9280	8580 J	10900	4250 J	7000 J	4760 J	3920 J	4810	5550 J
ANTIMONY	1.8 J	0.38 U	0.27 U	0.51 U	0.19 U	0.74 U	0.80 J	0.27 U	0.34 U
ARSENIC	6.5 J	6.5 J	8.2 J	10.7 J	5.7 J	6.4 J	5.7 J	3.7 J	9.1 J
BARIUM	364 J	79.7 J	97.4 J	34.4 J	61.4 J	76.4 J	45.1 J	28.5 J	62.5 J
BERYLLIUM	0.52 U	0.79 J	0.67 J	1.3 J	0.63 J	0.38 U	0.37 U	0.18 U	0.71 J
CADMIUM	3.5 J	0.55 J	0.45 U	0.36 U	0.35 U	0.65 J	0.41 J	0.66 J	0.62 J
CALCIUM	38500 J	2140 J	2020 J	1120 J	1490 J	116000 J	71000 J	45700 J	14800 J
CHROMIUM	156 J	12.1 J	15.2 J	18.0 J	9.0 J	18.0 J	11.6 J	9.2 J	14.8 J
COBALT	8.1 J	10.9 J	18.5 J	9.3 J	15.9 J	9.6 J	10.0 J	3.5 J	8.2 J
COPPER	52.1 J	13.9 J	11.7 J	13.7 J	10.6 J	17.4 J	12.7 J	16.6 J	19.2 J
IRON	21300 J	16700 J	22200 J	46100 J	20800 J	15600 J	17500 J	9900 J	26100 J
LEAD	471 J	18.6 J	21.4 J	15.0 J	11.7 J	64.9 J	23.9 J	31.4 J	17.0 J
LITHIUM	8.1 J	7.8 J	8.2 J	2.1 J	6.4 J	5.5 J	4.1 J	4.3 J	3.6 J
MAGNESIUM	3830 J	969 J	1200 J	292 J	908 J	7490 J	4810 J	7540 J	2120 J

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD01	13SW/SD02	13SW/SD03	13SW/SD04	13SW/SD05	13SW/SD05	13SW/SD06	13SW/SD07	13SW/SD08
NSAMPLE	13SD010004	13SD020004	13SD030004	13SD040004	13SD050004	13SD050004-D	13SD060004	13SD070004	13SD080004
SAMPLE	13SD010004	13SD020004	13SD030004	13SD040004	13SD050004	FD03290301	13SD060004	13SD070004	13SD080004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
MANGANESE	204 J	641 J	1580 J	302 J	747 J	570 J	773 J	147 J	591 J
MERCURY	0.16 J	0.044 U	0.037 J	0.010 U	0.024 U	0.022 U	0.015 U	0.015 J	0.036 U
NICKEL	16.1 J	11.3 J	12.8 J	13.5 J	13.5 J	13.6 J	10.4 J	7.9 J	12.0 J
POTASSIUM	614 J	394 J	561 J	417 J	319 J	303 J	252 J	317 J	451 J
SELENIUM	0.56 J	0.51 J	0.55 J	0.11 U	0.27 U	0.26 U	0.16 U	0.18 J	0.33 U
SODIUM	41.9 U	75.9 U	126 U	25.2 U	29.7 U	126 J	81.3 J	334 J	71.4 U
STRONTIUM	39.9 J	7.3 J	6.5 J	4.5 J	5.5 J	122 J	70.2 J	52.5 J	18.1 J
TIN	11.4 J	0.64 U	0.57 U	0.31 U	0.49 U	0.47 U	0.40 U	0.52 J	0.61 U
TITANIUM	68.1 J	93.1 J	92.4 J	27.4 J	91.5 J	84.5 J	67.2 J	78.2 J	52.0 J
VANADIUM	23.3 J	21.5 J	28.2 J	24.8 J	17.4 J	18.7 J	13.9 J	11.8 J	18.7 J
ZINC	541 J	67.8 J	41.4 J	40.0 J	97.2 J	52.9 J	43.1 J	58.1 J	78.0 J
AVS/SEM Parameters (UMO/g)									
ACID VOLATILE SULFIDE		0.49 J			0.88 J	0.85 J			0.62 J
CADMIUM, SEM		0.002 U			0.001 U	0.004			0.004
COPPER, SEM		0.131 J			0.070 J	0.173 J			2.223 J
LEAD, SEM		0.067 J			0.030 J	0.196 J			0.061 J
MERCURY, SEM		0.00007 J			0.00004 J	0.00018 J			0.00004 UJ
NICKEL, SEM		0.048			0.111	0.041			0.028
SEM/AVS S.U.		1.54			0.70	0.49			3.74
ZINC, SEM		0.503 J			0.407 J	0.296 U			0.426 U
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)		15			9.9	10			12
PH (S.U.)		7.2			5	7.6			7.4
TOTAL ORGANIC CARBON (mg/kg)		15000 J			19000 J	3200 J			4400 J

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD09	13SW/SD10	13SD11	13SW/SD12	13SD14	13SD14	13SD15	13SD16	13SD17
NSAMPLE	13SD090004	13SD100004	13SD110004	13SD120004	13SD130004	13SD140004	13SD150004	13SD160004	13SD170004
SAMPLE	13SD090004	13SD100004	13SD110004	13SD120004	13SD130004	13SD140004	13SD150004	13SD160004	13SD170004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/kg)									
ACENAPHTHENE									
ANTHRACENE									
BENZO(A)ANTHRACENE									
BENZO(A)PYRENE									
BENZO(B)FLUORANTHENE									
BENZO(G,H,I)PERYLENE									
BENZO(K)FLUORANTHENE									
CHRYSENE									
DI-N-BUTYL PHTHALATE									
DI-N-OCTYL PHTHALATE									
DIBENZO(A,H)ANTHRACENE									
FLUORANTHENE									
FLUORENE									
INDENO(1,2,3-CD)PYRENE									
NAPHTHALENE									
PHENANTHRENE									
PYRENE									
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	1.9 J	0.8 J	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
RDX	0.25 U	0.25 U	2.2	0.25 U	0.25 U	0.25 U	0.71 J	0.25 U	0.25 U
Herbicides (ug/kg)									
PENTACHLOROPHENOL									
Inorganics (mg/kg)									
ALUMINUM	6430	1480	9260 J	6860	5010	4160 J	10300	9140	10200 J
ANTIMONY	0.45 U	0.16 U	0.52 U	0.55 U	0.47 U	0.13 U	0.26 U	0.25 U	0.24 U
ARSENIC	6.1 J	3.7 J	9.4 J	11.7 J	17.5 J	0.53 U	16.9 J	11.4 J	6.2 J
BARIUM	49.6 J	104 J	67.6 J	257 J	152 J	148 J	65.4 J	113 J	94.1 J
BERYLLIUM	0.74 J	0.88 J	0.63 J	1.0 J	0.96 J	0.53 J	1.4 J	1.4 J	0.70 J
CADMIUM	0.43 J	0.36 U	0.91 J	0.81 J	4.1 J	0.17 U	0.25 U	0.37 U	0.38 U
CALCIUM	6720 J	977 J	33200 J	35400 J	89700 J	998 J	1650 J	767 J	6640 J
CHROMIUM	12.4 J	7.9 J	15.4 J	32.7 J	49.6 J	16.2 J	24.9 J	21.5 J	11.3 J
COBALT	11.7 J	10.3 J	6.8 J	20.6 J	20.0 J	1.8 J	15.0 J	18.9 J	11.8 J
COPPER	11.9 J	7.0 J	12.5 J	10.7 J	11.3 J	8.9 J	24.1 J	13.6 J	11.5 J
IRON	34800 J	1990 J	25900 J	46300 J	83600 J	18400 J	25900 J	26900 J	18300 J
LEAD	17.6 J	11.0 J	20.0 J	21.4 J	38.1 J	4.2 J	14.8 J	20.5 J	13.7 J
LITHIUM	7.3 J	10.1 J	7.2 J	6.5 J	4.0 J	4.3 J	28.4 J	17.5 J	7.7 J
MAGNESIUM	2450 J	983 J	2080 J	1450 J	5620 J	757 J	1840 J	1410 J	1990 J

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SW/SD09	13SW/SD10	13SD11	13SW/SD12	13SD14	13SD14	13SD15	13SD16	13SD17
NSAMPLE	13SD090004	13SD100004	13SD110004	13SD120004	13SD130004	13SD140004	13SD150004	13SD160004	13SD170004
SAMPLE	13SD090004	13SD100004	13SD110004	13SD120004	13SD130004	13SD140004	13SD150004	13SD160004	13SD170004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/30/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
MANGANESE	284 J	67.5 J	372 J	6130 J	1760 J	65.3 J	247 J	1790 J	724 J
MERCURY	0.013 J	0.029 J	0.028 U	0.032 J	0.019 J	0.010 U	0.022 J	0.041 J	0.028 U
NICKEL	13.5 J	19.3 J	8.6 J	14.9 J	13.6 J	8.6 J	35.5 J	33.0 J	12.8 J
POTASSIUM	413 J	442 J	2260 J	1130 J	538 J	1660 J	2390 J	807 J	523 J
SELENIUM	0.21 J	0.30 J	0.29 U	0.30 J	0.22 J	0.02 U	0.34 J	0.51 J	0.27 U
SODIUM	22.6 U	25.8 U	113 J	47.1 U	39.0 U	38.8 U	53.5 U	26.2 U	30.7 U
STRONTIUM	8.5 J	5.5 J	77.1 J	28.2 J	64.2 J	10.3 J	10.1 J	6.3 J	11.0 J
TIN	2.0 J	0.45 U	0.53 U	12.0 J	0.46 U	0.75 J	0.66 J	0.50 U	0.52 U
TITANIUM	42.8 J	68.6 J	62.7 J	60.2 J	67.9 J	72.0 J	13.8 J	45.1 J	110 J
VANADIUM	20.5 J	15.5 J	23.0 J	39.1 J	44.0 J	16.2 J	17.6 J	21.7 J	21.9 J
ZINC	386 U	37.7 J	116 J	138 U	216 U	7.9 J	65.3 J	46.3 J	62.0 J
AVS/SEM Parameters (UMO/g)									
ACID VOLATILE SULFIDE			0.25 J			0.66 J			0.67 J
CADMIUM, SEM			0.002			0.0014 U			0.001 U
COPPER, SEM			0.055 J			0.036 J			0.061 J
LEAD, SEM			0.033 J			0.006 U			0.035 J
MERCURY, SEM			0.00003 UJ			0.00054 J			0.00005 J
NICKEL, SEM			0.021			0.022			0.020
SEM/AVS S.U.			2.60			0.09			0.17
ZINC, SEM			0.538 J			0.031 U			0.285 U
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)			18			13			16
PH (S.U.)			7.9			7.1			7.8
TOTAL ORGANIC CARBON (mg/kg)			2600 J			2500 J			17000 J

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SD17	13SD18	13SD19	13SD20	13SD21	13SD22	13SD23
NSAMPLE	13SD170004-D	13SD180004	13SD190004	13SD200004	13SD210004	13SD220004	13SD230004
SAMPLE	FD03290302	13SD180004	13SD190004	13SD200004	13SD210004	13SD220004	13SD230004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/30/2003	3/30/2003	3/30/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/kg)							
ACENAPHTHENE							
ANTHRACENE							
BENZO(A)ANTHRACENE							
BENZO(A)PYRENE							
BENZO(B)FLUORANTHENE							
BENZO(G,H,I)PERYLENE							
BENZO(K)FLUORANTHENE							
CHRYSENE							
DI-N-BUTYL PHTHALATE							
DI-N-OCTYL PHTHALATE							
DIBENZO(A,H)ANTHRACENE							
FLUORANTHENE							
FLUORENE							
INDENO(1,2,3-CD)PYRENE							
NAPHTHALENE							
PHENANTHRENE							
PYRENE							
Energetics (mg/kg)							
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
RDX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)							
PENTACHLOROPHENOL							
Inorganics (mg/kg)							
ALUMINUM	9800	7650	16200	7090 J	6600	18500	11900
ANTIMONY	0.21 U	0.35 U	0.23 U	0.23 U	0.29 U	1.2 J	0.48 U
ARSENIC	7.0 J	8.2 J	7.5 J	11.0 J	8.0 J	35.6 J	10.2 J
BARIUM	109 J	79.5 J	102 J	77.9 J	102 J	203 J	165 J
BERYLLIUM	0.79 J	0.93 J	1.6 J	0.95 J	0.77 J	4.3 J	0.95 J
CADMIUM	0.50 J	0.39 U	0.45 U	0.46 J	0.52 J	1.8 J	0.82 J
CALCIUM	4220 J	1050 J	2440 J	1360 J	1560 J	2310 J	3400 J
CHROMIUM	16.1 J	24.9 J	13.5 J	36.5 J	10.3 J	140 J	12.7 J
COBALT	13.2 J	17.9 J	107 J	18.2 J	16.0 J	70.2 J	28.5 J
COPPER	14.9 J	11.8 J	12.2 J	14.9 J	13.2 J	32.4 J	17.8 J
IRON	24800 J	24900 J	33100 J	36500 J	14900 J	171000 J	19900 J
LEAD	15.5 J	19.2 J	20.1 J	20.7 J	19.2 J	87.7 J	34.8 J
LITHIUM	7.7 J	6.1 J	38.8 J	9.7 J	5.3 J	10.9 J	9.2 J
MAGNESIUM	1650 J	943 J	1050 J	717 J	825 J	1110 J	1290 J

TABLE A-5
POSITIVE HITS
SEDIMENT
SWMU 13 - MINE FILL B
NSWC CRANE, INDIANA

LOCATION	13SD17	13SD18	13SD19	13SD20	13SD21	13SD22	13SD23
NSAMPLE	13SD170004-D	13SD180004	13SD190004	13SD200004	13SD210004	13SD220004	13SD230004
SAMPLE	FD03290302	13SD180004	13SD190004	13SD200004	13SD210004	13SD220004	13SD230004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	3/29/2003	3/29/2003	3/30/2003	3/30/2003	3/30/2003	3/29/2003	3/29/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
MANGANESE	834 J	1290 J	2960 J	819 J	1440 J	4580 J	4220 J
MERCURY	0.022 J	0.028 J	0.036 J	0.029 U	0.030 J	0.031 J	0.042 J
NICKEL	15.0 J	13.0 J	45.5 J	18.6 J	11.7 J	83.9 J	19.3 J
POTASSIUM	563 J	392 J	599 J	482 J	367 J	482 J	629 J
SELENIUM	0.36 J	0.43 J	0.54 J	0.45 J	0.38 J	0.69 J	0.45 J
SODIUM	29.0 U	43.8 U	63.6 U	48.3 U	62.5 U	58.2 U	26.3 U
STRONTIUM	7.6 J	4.1 J	7.4 J	6.4 J	5.2 J	8.6 J	8.5 J
TIN	0.51 J	0.46 U	0.46 U	0.40 U	0.42 U	0.82 J	0.82 J
TITANIUM	81.4 J	72.3 J	67.0 J	66.6 J	77.4 J	112 J	62.3 J
VANADIUM	25.0 J	26.1 J	21.5 J	26.2 J	19.7 J	115 J	24.6 J
ZINC	77.1 J	31.7 J	75.9 J	40.4 J	33.4 U	273 U	64.5 J
AVS/SEM Parameters (UMO/g)							
ACID VOLATILE SULFIDE				0.23 J			
CADMIUM, SEM				0.001 U			
COPPER, SEM				0.075 J			
LEAD, SEM				0.047 J			
MERCURY, SEM				0.00009 J			
NICKEL, SEM				0.078			
SEM/AVS S.U.				0.87			
ZINC, SEM				0.113 U			
Miscellaneous Parameters							
CATION EXCHANGE CAPACITY (MEQ/1)				12			
PH (S.U.)				7.2			
TOTAL ORGANIC CARBON (mg/kg)				2600 J			

APPENDIX B

SWMU 13 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES

APPENDIX B.1

SURFACE SOIL

TABLE B-1
FREQUENCY OF DETECTION
SURFACE SOIL
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Volatiles								
34	NA	180000	680	69000	783.73	156-60-5	TRANS-1,2-DICHLOROETHENE	2	J	2	J	UG/KG	13SS060002	1/2	1.4
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	13SS150002	2/2	NA
							Semivolatiles								
31000	NA	9500000	130000	3700000	682000	83-32-9	ACENAPHTHENE	52	J	52	J	UG/KG	13SS090002	1/12	3.8 - 4.9
650000	NA	47000000	51000	22000000	1480000	120-12-7	ANTHRACENE	5	J	210	J	UG/KG	13SS090002	2/12	3.8 - 4.9
80	NA	5100	19000	620	5210	56-55-3	BENZO(A)ANTHRACENE	4	J	1100	J	UG/KG	13SS090002	7/12	3.8 - 4.9
410	NA	510	8200	62	1520	50-32-8	BENZO(A)PYRENE	6	J	1000	J	UG/KG	13SS090002	6/12	3.8 - 4.9
200	NA	5100	57000	620	59800	205-99-2	BENZO(B)FLUORANTHENE	7	J	1100	J	UG/KG	13SS090002	7/12	3.8 - 4
NA	NA	NA	NA	2300000	119000	191-24-2	BENZO(G,H,I)PERYLENE	6	J	750	J	UG/KG	13SS090002	6/12	3.8 - 4.9
2000	NA	51000	39000	6200	148000	207-08-9	BENZO(K)FLUORANTHENE	5	J	640	J	UG/KG	13SS090002	7/12	3.8 - 4
180000	NA	310000	3600000	35000	925.94	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	91	J	140	J	UG/KG	13SS060002	7/12	78 - 190
180000	NA	310000	3600000	35000	925.94	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	91	J	140	J	UG/KG	13SS090002	7/12	78 - 190
8000	NA	510000	26000	62000	4730	218-01-9	CHRYSENE	7	J	1100	J	UG/KG	13SS090002	7/12	3.8 - 4
80	NA	510	18000	62	18400	53-70-3	DIBENZO(A,H)ANTHRACENE	200	J	200	J	UG/KG	13SS090002	1/12	3.8 - 4.9
310000	NA	6300000	880000	2300000	122000	206-44-0	FLUORANTHENE	6	J	1800	J	UG/KG	13SS090002	9/12	3.8 - 4
41000	NA	6300000	170000	2600000	122000	86-73-7	FLUORENE	50	J	50	J	UG/KG	13SS090002	1/12	3.8 - 4.9
700	NA	5100	3100	620	109000	193-39-5	INDENO(1,2,3-CD)PYRENE	4	J	650	J	UG/KG	13SS090002	6/12	3.8 - 4.9
3100	170000	3200000	700	56000	99.39	91-20-3	NAPHTHALENE	5	J	5	J	UG/KG	13SS100002	1/12	3.8 - 4.9
NA	NA	NA	NA	2300000	45700	85-01-8	PHENANTHRENE	4	J	1000	J	UG/KG	13SS090002	7/12	3.8 - 4.2
230000	NA	5500000	570000	2300000	78500	129-00-0	PYRENE	6	J	2400	J	UG/KG	13SS090002	9/12	3.8 - 4
							Pesticides/PCBs								
NA	5600000	NA	NA	220	679.71	12672-29-6	AROCLOR-1248	210		160000		UG/KG	13SS100002	11/12	20
							Dioxins/Furans								
NA	NA	NA	NA	39000	0.199	3268-87-9	1,2,3,4,6,7,8,9-OCDD	813	J	4140		NG/KG	13SS060002	12/12	NA
NA	NA	NA	NA	39000	38.6	39001-02-0	1,2,3,4,6,7,8,9-OCDF	0.55	J	9.5	J	NG/KG	13SS140001	4/12	0.2 - 2
NA	NA	NA	NA	390	0.199	35822-46-9	1,2,3,4,6,7,8-HPCDD	6.2		45.4		NG/KG	13SS060002	12/12	NA
NA	NA	NA	NA	390	38.6	67562-39-4	1,2,3,4,6,7,8-HPCDF	0.57	J	3.1	J	NG/KG	13SS100002	4/12	0.09 - 4
NA	NA	NA	NA	390	38.6	55673-89-7	1,2,3,4,7,8,9-HPCDF	1.3	J	1.3	J	NG/KG	13SS140001	1/12	0.1 - 0.7
NA	NA	NA	NA	39	0.199	39227-28-6	1,2,3,4,7,8-HXCDD	0.42	J	0.63	J	NG/KG	13SS130002	3/12	0.1 - 0.7
NA	NA	NA	NA	39	38.6	70648-26-9	1,2,3,4,7,8-HXCDF	1.8	J	6.4		NG/KG	13SS140001	2/12	0.07 - 1.2
NA	NA	NA	NA	39	0.199	57653-85-7	1,2,3,6,7,8-HXCDD	0.69	J	0.84	J	NG/KG	13SS140001	2/12	0.1 - 1
NA	NA	NA	NA	39	38.6	57117-44-9	1,2,3,6,7,8-HXCDF	1.6	J	1.6	J	NG/KG	13SS140001	1/12	0.07 - 0.41
3200	2500000	NA	NA	39	0.199	19408-74-3	1,2,3,7,8,9-HXCDD	0.72	J	1.6	J	NG/KG	13SS130002	5/12	0.1 - 2
NA	NA	NA	NA	39	38.6	72918-21-9	1,2,3,7,8,9-HXCDF	0.31	J	0.33	J	NG/KG	13SS140001	2/12	0.09 - 0.5
NA	NA	NA	NA	3.9	0.199	40321-76-4	1,2,3,7,8-PECDD	0.71	J	0.71	J	NG/KG	13SS130002	1/12	0.1 - 0.8
NA	NA	NA	NA	78	38.6	57117-41-6	1,2,3,7,8-PECDF	0.36	J	2.5	J	NG/KG	13SS140001	2/12	0.09 - 0.4
NA	NA	NA	NA	39	38.6	60851-34-5	2,3,4,6,7,8-HXCDF	0.21	J	1.8	J	NG/KG	13SS140001	4/12	C

TABLE B-1
FREQUENCY OF DETECTION
SURFACE SOIL
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
NA	NA	NA	NA	7.8	38.6	57117-31-4	2,3,4,7,8-PECDF	0.47	J	21.8		NG/KG	13SS140001	7/12	0.1 - 0.53
0.28	43	NA	NA	3.9	0.199	1746-01-6	2,3,7,8-TCDD	0.52	J	0.52	J	NG/KG	13SS090002	1/12	0.1 - 1.2
NA	NA	NA	NA	39	38.6	51207-31-9	2,3,7,8-TCDF	0.35	J	21		NG/KG	13SS140001	10/12	0.1 - 0.3
NA	NA	NA	NA	NA	NA	37871-00-4	TOTAL HPCDD	11.8		112		NG/KG	13SS060002	12/12	NA
NA	NA	NA	NA	NA	NA	38998-75-3	TOTAL HPCDF	0.38	J	10.1	J	NG/KG	13SS140001	7/12	0.1 - 1.9
NA	NA	NA	NA	9.4	NA	34465-46-8	TOTAL HXCDD	0.77	J	15.7	J	NG/KG	13SS050002	11/12	1.1
NA	NA	NA	NA	NA	NA	55684-94-1	TOTAL HXCDF	0.33		19.4	J	NG/KG	13SS140001	8/12	0.07 - 0.2
NA	NA	NA	NA	NA	NA	36088-22-9	TOTAL PECDD	0.71		0.71		NG/KG	13SS130002	1/12	0.1 - 2.8
NA	NA	NA	NA	NA	NA	30402-15-4	TOTAL PECDF	0.83		135	J	NG/KG	13SS140001	9/12	0.1 - 0.3
NA	NA	NA	NA	NA	NA	41903-57-5	TOTAL TCDD	0.52		2.1	J	NG/KG	13SS060002	2/12	0.1 - 2.2
NA	NA	NA	NA	NA	NA	55722-27-5	TOTAL TCDF	1.8		540	J	NG/KG	13SS140001	11/12	0.1
							Miscellaneous Parameters								
NA	NA	NA	NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	14		15		MEQ/1	13SS080002	2/2	NA
NA	NA	NA	NA	NA	NA	TTNUS002	PH	5.1		7.4		S.U.	13SS070002	2/2	NA

Associated Samples:
13SS010002
13SS020002
13SS030002
13SS040002
13SS050002
13SS060002
13SS070002
13SS080002
13SS090002
13SS100002
13SS110002
13SS120002
13SS130002
13SS140001
13SS150002

APPENDIX B.2

SUBSURFACE SOIL

TABLE B-2
FREQUENCY OF DETECTION
SUBSURFACE SOIL
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Volatiles								
4400	9000000	20000000	11000	7300000	89600	78-93-3	2-BUTANONE	18		18		UG/KG	13SB150204	1/2	1
620	490000	1100000	990	790000	443000	108-10-1	4-METHYL-2-PENTANONE	3	J	3	J	UG/KG	13SB150204	1/2	1
730	NA	3900000	3100	1600000	2500	67-64-1	ACETONE	89		89		UG/KG	13SB150204	1/2	1
28000	250000	NA	NA	94000	39500	75-71-8	DICHLORODIFLUOROMETHANE	7	J	7	J	UG/KG	13SB150204	1/2	1
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	13SB150204	2/2	NA
							Semivolatiles								
NA	NA	NA	NA	310000	NA	TTNUS042	3&4-METHYLPHENOL	560		560		UG/KG	13SB090204	1/11	76 - 87
180000	NA	310000	3600000	35000	925.94	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	90	J	130	J	UG/KG	13SB050204	6/11	76 - 83
8000	NA	510000	26000	62000	4730	218-01-9	CHRYSENE	4	J	4	J	UG/KG	13SB020204	1/11	3.7 - 4.3
310000	NA	6300000	880000	2300000	122000	206-44-0	FLUORANTHENE	7	J	7	J	UG/KG	13SB020204	1/11	3.7 - 4.3
NA	NA	NA	NA	2300000	45700	85-01-8	PHENANTHRENE	6	J	6	J	UG/KG	13SB020204	1/11	3.7 - 4.3
2800	NA	88000000	110000	37000000	120000	108-95-2	PHENOL	110	J	110	J	UG/KG	13SB090204	1/11	76 - 87
230000	NA	5500000	570000	2300000	78500	129-00-0	PYRENE	13		13		UG/KG	13SB020204	1/11	3.7 - 4.3
							Pesticides/PCBs								
NA	5600000	NA	NA	220	679.71	12672-29-6	AROCLOR-1248	59	J	210000		UG/KG	13SB100204	7/11	20
							Herbicides								
1.4	NA	20000	28	3000	119.27	87-86-5	PENTACHLOROPHENOL	0.67	J	0.85	J	UG/KG	13SB010204	2/11	0.51 - 0.58
							Dioxins/Furans								
NA	NA	NA	NA	39000	0.199	3268-87-9	1,2,3,4,6,7,8,9-OCDD	330		4430		NG/KG	13SB010204	11/11	NA
NA	NA	NA	NA	39000	38.6	39001-02-0	1,2,3,4,6,7,8,9-OCDF	2.9	J	2.9	J	NG/KG	13SB100204	1/11	0.1 - 3.4
NA	NA	NA	NA	390	0.199	35822-46-9	1,2,3,4,6,7,8-HPCDD	5		26.2		NG/KG	13SB010204	11/11	NA
NA	NA	NA	NA	390	38.6	67562-39-4	1,2,3,4,6,7,8-HPCDF	0.69		1.1	J	NG/KG	13SB100204	2/11	0.08 - 1.3
NA	NA	NA	NA	39	0.199	39227-28-6	1,2,3,4,7,8-HXCDD	0.44	J	0.44	J	NG/KG	13SB130204	1/11	0.09 - 1.5
NA	NA	NA	NA	39	38.6	70648-26-9	1,2,3,4,7,8-HXCDF	0.73		2.7	J	NG/KG	13SB040204	3/11	0.07 - 0.2
3200	2500000	NA	NA	39	0.199	19408-74-3	1,2,3,7,8,9-HXCDD	0.53	J	1.1	J	NG/KG	13SB110204	5/11	0.1 - 1.5
NA	NA	NA	NA	3.9	0.199	40321-76-4	1,2,3,7,8-PECDD	0.21	J	0.21	J	NG/KG	13SB120204	1/11	0.1 - 1.1
NA	NA	NA	NA	78	38.6	57117-41-6	1,2,3,7,8-PECDF	0.3	J	0.31		NG/KG	13SB090204	2/11	0.08 - 0.7
NA	NA	NA	NA	39	38.6	60851-34-5	2,3,4,6,7,8-HXCDF	0.09	J	0.59	J	NG/KG	13SB100204	2/11	0.07 - 0.8
NA	NA	NA	NA	7.8	38.6	57117-31-4	2,3,4,7,8-PECDF	0.31	J	15.4		NG/KG	13SB040204	3/11	0.1 - 0.66
NA	NA	NA	NA	39	38.6	51207-31-9	2,3,7,8-TCDF	2.9		5.2		NG/KG	13SB100204	2/11	0.09 - 0.5
NA	NA	NA	NA	NA	NA	37871-00-4	TOTAL HPCDD	8.7		52.1		NG/KG	13SB050204	11/11	NA
NA	NA	NA	NA	NA	NA	38998-75-3	TOTAL HPCDF	1.5	J	2	J	NG/KG	13SB100204	2/11	0.1 - 1.4
NA	NA	NA	NA	9.4	NA	34465-46-8	TOTAL HXCDD	0.65	J	4.2	J	NG/KG	13SB050204	9/11	0.2 - 1.4
NA	NA	NA	NA	NA	NA	55684-94-1	TOTAL HXCDF	0.43		5.4	J	NG/KG	13SB100204	4/11	0.07 - 0.13
NA	NA	NA	NA	NA	NA	36088-22-9	TOTAL PECDD	0.21		0.21		NG/KG	13SB120204	1/11	0.1 - 1.4
NA	NA	NA	NA	NA	NA	30402-15-4	TOTAL PECDF	0.3		71.8	J	NG/KG	13SB040204	5/11	0.09 - 0.49
NA	NA	NA	NA	NA	NA	41903-57-5	TOTAL TCDD	0.15		3	J	NG/KG	13SB100204	2/11	0.1 - 5.2
NA	NA	NA	NA	NA	NA	55722-27-5	TOTAL TCDF	1.7		292	J	NG/KG	13SB040204	5/11	0.09 - 1.3

TABLE B-2
FREQUENCY OF DETECTION
SUBSURFACE SOIL
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Miscellaneous Parameters								
NA	NA	NA	NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	13		14		MEQ/1	13SB070810	2/2	NA
NA	NA	NA	NA	NA	NA	TTNUS002	PH	5.3		5.8		S.U.	13SB080608	2/2	NA
NA	NA	NA	NA	NA	NA	TTNUS003	TOTAL ORGANIC CARBON	1100	J	1100	J	MG/KG	13SB070810	1/2	1000

Associated Samples:
13SB010204
13SB020204
13SB030204
13SB040204
13SB050204
13SB060204
13SB070810
13SB080608
13SB090204
13SB100204
13SB110204
13SB120204
13SB130204
13SB150204

APPENDIX B.3

GROUND WATER

TA[illegible]-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration
					Volatile Organics						
5	NA	0.028	5	79-01-6	TRICHLOROETHENE	1	J	1	J	UG/L	13GWT2001
					Explosives						
NA	NA	3.6	NA	99-65-0	1,3-DINITROBENZENE	0.3	J	1.4	J	UG/L	13GWT0901
NA	NA	2.2	NA	118-96-7	2,4,6-TRINITROTOLUENE	1.8		31		UG/L	13GWT1101
NA	NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	3.7	J	8.6	J	UG/L	13GWT0901
NA	NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	0.12	J	19		UG/L	13GWT1101
NA	NA	61	NA	99-99-0	4-NITROTOLUENE	0.5	J	0.5	J	UG/L	13GWT2101
NA	NA	1800	NA	2691-41-0	HMX	0.29	J	390		UG/L	13GWT2101
NA	NA	0.61	NA	121-82-4	RDX	0.4	J	2700		UG/L	13GWT2101
					Total Inorganics						
NA	50	36000	NA	7429-90-5	ALUMINUM	123	J	39000	J	UG/L	13GWT2501
10	NA	0.045	50	7440-38-2	ARSENIC	0.65	J	15.4	J	UG/L	13GWT2501
2000	NA	2600	2000	7440-39-3	BARIUM	10.4	J	401	J	UG/L	13GWT1901
4	NA	73	4	7440-41-7	BERYLLIUM	2.1	J	8.4	J	UG/L	13GWT0701
5	NA	18	5	7440-43-9	CADMIUM	2.7	J	2.7	J	UG/L	13GWT2501
NA	NA	NA	NA	7440-70-2	CALCIUM	2800	J	117000	J	UG/L	13GWT2501
100	NA	110	NA	7440-47-3	CHROMIUM	0.76	J	64.9	J	UG/L	13GWT2501
NA	NA	730	NA	7440-48-4	COBALT	1.5	J	246	J	UG/L	13GWT1001
1300	1000	1500	1300	7440-50-8	COPPER	0.83	J	89.5	J	UG/L	13GWT2501
NA	300	11000	NA	7439-89-6	IRON	127	J	143000	J	UG/L	13GWT2001
15	NA	NA	15	7439-92-1	LEAD	1.1	J	54.3	J	UG/L	13GWT2501
NA	NA	730	NA	7439-93-2	LITHIUM	2.3	J	340	J	UG/L	13GWT2001
NA	NA	NA	NA	7439-95-4	MAGNESIUM	2230	J	70300	J	UG/L	13GWT2001
NA	50	880	NA	7439-96-5	MANGANESE	172	J	11600	J	UG/L	13GWT2001
2	NA	11	2	7439-97-6	MERCURY	0.032	J	0.16	J	UG/L	13GWT0101
2	NA	11	2	7439-97-6	MERCURY	0.032	J	0.16	J	UG/L	13GWT0701
NA	NA	730	730	7440-02-0	NICKEL	2.9	J	477	J	UG/L	13GWT2001
NA	NA	NA	NA	7440-09-7	POTASSIUM	240	J	11000	J	UG/L	13GWT2501
50	NA	180	50	7782-49-2	SELENIUM	1.8	J	1.8	J	UG/L	13GWT2501
NA	NA	NA	NA	7440-23-5	SODIUM	6030	J	160000	J	UG/L	13GWT1901
NA	NA	22000	NA	7440-24-6	STRONTIUM	14.5	J	396	J	UG/L	13GWT0201
NA	NA	NA	NA	7440-32-6	TITANIUM	2.5	J	285	J	UG/L	13GWT2501
NA	NA	260	NA	7440-62-2	VANADIUM	0.63	J	75.3	J	UG/L	13GWT2501
NA	5000	11000	11000	7440-66-6	ZINC	3	J	661	J	UG/L	13GWT2001
					Dissolved Inorganics						
NA	50	36000	NA	7429-90-5	ALUMINUM	226	J	11800	J	UG/L	13GWT2001-F
10	NA	0.045	50	7440-38-2	ARSENIC	0.8	J	1.7	J	UG/L	13GWT2001-F
2000	NA	2600	2000	7440-39-3	BARIUM	15.6	J	71.1	J	UG/L	13GWT0301-F
4	NA	73	4	7440-41-7	BERYLLIUM	2	J	5.6	J	UG/L	13GWT2001-F
NA	NA	NA	NA	7440-70-2	CALCIUM	2980	J	70900	J	UG/L	13GWT2001-F
100	NA	110	NA	7440-47-3	CHROMIUM	1.3	J	2.7	J	UG/L	13GWT2001-F
NA	NA	730	NA	7440-48-4	COBALT	1.3	J	230	J	UG/L	13GWT2001-F
1300	1000	1500	1300	7440-50-8	COPPER	2.8	J	10.6	J	UG/L	13GWT2001-F
NA	300	11000	NA	7439-89-6	IRON	93.8	J	142000	J	UG/L	13GWT2001-F

TABLE B-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration
15	NA	NA	15	7439-92-1	LEAD	11.5	J	11.5	J	UG/L	13GWT2001-F
NA	NA	730	NA	7439-93-2	LITHIUM	9.7	J	322	J	UG/L	13GWT2001-F
NA	NA	NA	NA	7439-95-4	MAGNESIUM	2500	J	67900	J	UG/L	13GWT2001-F
NA	50	880	NA	7439-96-5	MANGANESE	133	J	11500	J	UG/L	13GWT2001-F
NA	NA	730	730	7440-02-0	NICKEL	3.2	J	470	J	UG/L	13GWT2001-F
NA	NA	NA	NA	7440-09-7	POTASSIUM	366	J	7110	J	UG/L	13GWT0601-F
50	NA	180	50	7782-49-2	SELENIUM	2	J	2	J	UG/L	13GWT2501-F
NA	NA	NA	NA	7440-23-5	SODIUM	21800	J	55000	J	UG/L	13GWT0501-F
NA	NA	22000	NA	7440-24-6	STRONTIUM	13.6	J	188	J	UG/L	13GWT0501-F
NA	NA	NA	NA	7440-32-6	TITANIUM	2.6	J	9.3	J	UG/L	13GWT0601-F
NA	NA	260	NA	7440-62-2	VANADIUM	1.1	J	1.1	J	UG/L	13GWT0601-F
NA	5000	11000	11000	7440-66-6	ZINC	3.6	J	695		UG/L	13GWT2001-F
					Miscellaneous Parameters						
NA	NA	NA	NA	TTNUS493	AMMONIA-N	0.01		3.3		MG/L	13GWT0901
NA	NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	0.03		92		MG/L	13GWT0901
					Field Parameters						
NA	NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	0.11		4.5		MG/L	13GWT0301
NA	NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	-30.4		364		MV	13GWT1001
NA	0	NA	NA	TTNUS002	PH	3.01		6.63		S.U.	13GWT0601
NA	NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	0.106		1.504		MS/CM	13GWT2001
NA	NA	NA	NA	TTNUS047	TEMPERATURE	12		16.76		C	13GWT2401
NA	NA	NA	NA	TTNUS023	TURBIDITY	0		999	>	NTU	13GWT2501

Associated Samples:

13GWT0101	13GWT1401
13GWT0201	13GWT1501
13GWT0301	13GWT1601
13GWT0301-F	13GWT1701
13GWT0401	13GWT1801
13GWT0501	13GWT1801-F
13GWT0501-F	13GWT1901
13GWT0601	13GWT2001
13GWT0601-F	13GWT2001-F
13GWT0701	13GWT2002
13GWT0801	13GWT2101
13GWT0901	13GWT2201
13GWT0902	13GWT2301
13GWT1001	13GWT2401
13GWT1101	13GWT2501
13GWT1201	13GWT2501-F
13GWT1201-F	13GWT2601
13GWT1301	

TA[illegible]3-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Detection Frequency	Range of Nondetects
				Volatile Organics		
NA	0.028	5	79-01-6	TRICHLOROETHENE	1/2	0.3
				Explosives		
NA	3.6	NA	99-65-0	1,3-DINITROBENZENE	3/26	0.08 - 0.65
NA	2.2	NA	118-96-7	2,4,6-TRINITROTOLUENE	4/26	0.08 - 0.65
NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	3/26	0.08 - 0.65
NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	5/26	0.08 - 0.65
NA	61	NA	99-99-0	4-NITROTOLUENE	1/26	0.08 - 0.65
NA	1800	NA	2691-41-0	HMX	19/26	0.265 - 0.6
NA	0.61	NA	121-82-4	RDX	19/26	0.25 - 0.465
				Total Inorganics		
50	36000	NA	7429-90-5	ALUMINUM	24/26	47.3 - 57.1
NA	0.045	50	7440-38-2	ARSENIC	13/26	0.07 - 0.66
NA	2600	2000	7440-39-3	BARIUM	26/26	NA
NA	73	4	7440-41-7	BERYLLIUM	9/26	0.03 - 1.6
NA	18	5	7440-43-9	CADMIUM	1/26	0.05 - 1.9
NA	NA	NA	7440-70-2	CALCIUM	25/26	2580
NA	110	NA	7440-47-3	CHROMIUM	13/26	0.02 - 0.82
NA	730	NA	7440-48-4	COBALT	26/26	NA
1000	1500	1300	7440-50-8	COPPER	20/26	0.26 - 1.1
300	11000	NA	7439-89-6	IRON	23/26	25 - 117
NA	NA	15	7439-92-1	LEAD	11/26	0.14 - 2
NA	730	NA	7439-93-2	LITHIUM	26/26	NA
NA	NA	NA	7439-95-4	MAGNESIUM	26/26	NA
50	880	NA	7439-96-5	MANGANESE	24/26	56.3 - 57.6
NA	11	2	7439-97-6	MERCURY	5/26	0.02 - 0.2
NA	11	2	7439-97-6	MERCURY	5/26	0.02 - 0.2
NA	730	730	7440-02-0	NICKEL	26/26	NA
NA	NA	NA	7440-09-7	POTASSIUM	26/26	NA
NA	180	50	7782-49-2	SELENIUM	1/26	0.05 - 1.1
NA	NA	NA	7440-23-5	SODIUM	26/26	NA
NA	22000	NA	7440-24-6	STRONTIUM	26/26	NA
NA	NA	NA	7440-32-6	TITANIUM	24/26	1.9 - 2.1
NA	260	NA	7440-62-2	VANADIUM	10/26	0.05 - 0.72
5000	11000	11000	7440-66-6	ZINC	26/26	NA
				Dissolved Inorganics		
50	36000	NA	7429-90-5	ALUMINUM	7/7	NA
NA	0.045	50	7440-38-2	ARSENIC	3/7	0.36 - 0.51
NA	2600	2000	7440-39-3	BARIUM	7/7	NA
NA	73	4	7440-41-7	BERYLLIUM	2/7	0.05 - 1.1
NA	NA	NA	7440-70-2	CALCIUM	7/7	NA
NA	110	NA	7440-47-3	CHROMIUM	3/7	0.2 - 0.81
NA	730	NA	7440-48-4	COBALT	7/7	NA
1000	1500	1300	7440-50-8	COPPER	6/7	0.63
300	11000	NA	7439-89-6	IRON	7/7	NA

TABLE B-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Detection Frequency	Range of Nondetects
NA	NA	15	7439-92-1	LEAD	1/7	0.21 - 0.91
NA	730	NA	7439-93-2	LITHIUM	7/7	NA
NA	NA	NA	7439-95-4	MAGNESIUM	7/7	NA
50	880	NA	7439-96-5	MANGANESE	7/7	NA
NA	730	730	7440-02-0	NICKEL	7/7	NA
NA	NA	NA	7440-09-7	POTASSIUM	7/7	NA
NA	180	50	7782-49-2	SELENIUM	1/7	0.19 - 0.33
NA	NA	NA	7440-23-5	SODIUM	7/7	NA
NA	22000	NA	7440-24-6	STRONTIUM	7/7	NA
NA	NA	NA	7440-32-6	TITANIUM	6/7	2.8
NA	260	NA	7440-62-2	VANADIUM	1/7	0.05 - 0.8
5000	11000	11000	7440-66-6	ZINC	7/7	NA
				Miscellaneous Parameters		
NA	NA	NA	TTNUS493	AMMONIA-N	21/26	0.01
NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	17/26	0.02
				Field Parameters		
NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	28/28	NA
NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	28/28	NA
0	NA	NA	TTNUS002	PH	28/28	NA
NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	28/28	NA
NA	NA	NA	TTNUS047	TEMPERATURE	28/28	NA
NA	NA	NA	TTNUS023	TURBIDITY	28/28	NA

Associated Samples:
13GWT0101
13GWT0201
13GWT0301
13GWT0301-F
13GWT0401
13GWT0501
13GWT0501-F
13GWT0601
13GWT0601-F
13GWT0701
13GWT0801
13GWT0901
13GWT0902
13GWT1001
13GWT1101
13GWT1201
13GWT1201-F
13GWT1301

APPENDIX B.4

SURFACE WATER

TABLE B-4
FREQUENCY OF DETECTION
SURFACE WATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	IDCLRGDF	R9TAPW	R5DQLSW	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
						Semivolatile Organics								
NA	NA	1.2	0.092	0.839	56-55-3	BENZO(A)ANTHRACENE	0.22		0.22		UG/L	13SW0601	1/3	0.05
0.2	NA	0.2	0.0092	0.014	50-32-8	BENZO(A)PYRENE	0.26		0.26		UG/L	13SW0601	1/3	0.05
NA	NA	1.2	0.092	9.07	205-99-2	BENZO(B)FLUORANTHENE	0.38		0.38		UG/L	13SW0601	1/3	0.05
NA	NA	NA	180	7.64	191-24-2	BENZO(G,H,I)PERYLENE	0.23		0.23		UG/L	13SW0601	1/3	0.05
NA	NA	0.8	0.92	0.0056	207-08-9	BENZO(K)FLUORANTHENE	0.2		0.2		UG/L	13SW0601	1/3	0.05
NA	NA	1.6	9.2	0.033	218-01-9	CHRYSENE	0.35		0.35		UG/L	13SW0601	1/3	0.05
NA	NA	210	1500	8.1	206-44-0	FLUORANTHENE	0.96		0.96		UG/L	13SW0601	1/3	0.05
NA	NA	0.022	0.092	4.31	193-39-5	INDENO(1,2,3-CD)PYRENE	0.2		0.2		UG/L	13SW0601	1/3	0.05
NA	NA	NA	180	2.1	85-01-8	PHENANTHRENE	0.51		0.51		UG/L	13SW0601	1/3	0.05
NA	NA	140	180	0.3	129-00-0	PYRENE	0.65		0.65		UG/L	13SW0601	1/3	0.05
						Explosives								
NA	NA	NA	2.2	NA	118-96-7	2,4,6-TRINITROTOLUENE	0.53	J	6.8		UG/L	13SW1301	4/13	0.21 - 0.65
NA	NA	NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	0.53	J	1.6	J	UG/L	13SW1301	3/12	0.265 - 0.65
NA	NA	NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	0.52	J	3.8	J	UG/L	13SW1301	5/13	0.265 - 0.65
NA	NA	NA	1800	NA	2691-41-0	HMX	1.2		93		UG/L	13SW1101	8/13	0.265 - 0.65
NA	NA	NA	0.61	NA	121-82-4	RDX	0.29	J	610		UG/L	13SW1101	10/13	0.25 - 0.6
						Herbicides								
1	NA	1	0.56	5.23	87-86-5	PENTACHLOROPHENOL	0.025	J	0.091		UG/L	13SW0401	2/3	0.013
						Total Inorganics								
10	NA	50	0.045	53	7440-38-2	ARSENIC	1.2	J	35.7	J	UG/L	13SW1101	7/13	0.51 - 0.97
2000	NA	2000	2600	5000	7440-39-3	BARIUM	25.3	J	247	J	UG/L	13SW0701	13/13	NA
NA	NA	NA	NA	NA	7440-70-2	CALCIUM	18900	J	133000	J	UG/L	13SW0701	13/13	NA
100	NA	NA	110	42	7440-47-3	CHROMIUM	1.2	J	20.5	J	UG/L	13SW0701	11/13	0.98 - 1
NA	NA	NA	730	5	7440-48-4	COBALT	1.2	J	9.4	J	UG/L	13SW1101	9/13	0.16 - 0.72
15	NA	15	NA	1.3	7439-92-1	LEAD	1.3	J	29.9	J	UG/L	13SW0701	9/13	0.77 - 1.2
NA	NA	NA	730	NA	7439-93-2	LITHIUM	2.8	J	14.3	J	UG/L	13SW0701	8/13	1.3 - 2.2
NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	3600	J	92200	J	UG/L	13SW1101	13/13	NA
NA	50	NA	880	NA	7439-96-5	MANGANESE	8.2	J	231	J	UG/L	13SW1001	13/13	NA
NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	855	J	690000	J	UG/L	13SW1101	13/13	NA
50	NA	50	180	5	7782-49-2	SELENIUM	2	J	2	J	UG/L	13SW1101	1/13	0.1 - 0.55
NA	NA	NA	NA	NA	7440-23-5	SODIUM	2960	J	325000	J	UG/L	13SW0701	13/13	NA
NA	NA	NA	22000	NA	7440-24-6	STRONTIUM	48	J	245	J	UG/L	13SW0701	13/13	NA
						Dissolved Inorganics								
NA	50	NA	36000	NA	7429-90-5	ALUMINUM	52.7	J	822		UG/L	13SW0901-F	12/13	24.8
10	NA	50	0.045	53	7440-38-2	ARSENIC	3.6	J	35.3	J	UG/L	13SW1101-F	2/13	0.15 - 0.73
2000	NA	2000	2600	5000	7440-39-3	BARIUM	10.1	J	149	J	UG/L	13SW0701-F	13/13	NA
NA	NA	NA	NA	NA	7440-70-2	CALCIUM	5660	J	121000	J	UG/L	13SW0701-F	13/13	NA
100	NA	NA	110	42	7440-47-3	CHROMIUM	2	J	2	J	UG/L	13SW1101-F	1/13	0.21 - 0.89
NA	NA	NA	730	5	7440-48-4	COBALT	1.3	J	8.8	J	UG/L	13SW1101-F	5/13	0.26 - 0.7
1300	1000	1300	1500	5	7440-50-8	COPPER	1.9	J	26.4	J	UG/L	13SW1101-F	11/13	1 - 1.2
NA	300	NA	11000	NA	7439-89-6	IRON	35.7	J	750	J	UG/L	13SW0901-F	11/13	14.9 - 26.9

TABLE B-4
FREQUENCY OF DETECTION
SURFACE WATER
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	IDCLRGDF	R9TAPW	R5DQLSW	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
NA	NA	NA	730	NA	7439-93-2	LITHIUM	3.1	J	5.5	J	UG/L	13SW1001-F	3/13	0.37 - 1.5
NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	3440	J	92900	J	UG/L	13SW1101-F	13/13	NA
NA	50	NA	880	NA	7439-96-5	MANGANESE	2.9	J	160	J	UG/L	13SW1001-F	13/13	NA
NA	NA	730	730	29	7440-02-0	NICKEL	1.1	J	18.6	J	UG/L	13SW1101-F	10/13	0.59 - 0.85
NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	735	J	700000	J	UG/L	13SW1101-F	13/13	NA
50	NA	50	180	5	7782-49-2	SELENIUM	2.2	J	2.2	J	UG/L	13SW1101-F	1/13	0.08 - 0.59
NA	NA	NA	NA	NA	7440-23-5	SODIUM	2920	J	311000	J	UG/L	13SW0701-F	13/13	NA
NA	NA	NA	22000	NA	7440-24-6	STRONTIUM	45.5	J	219	J	UG/L	13SW0701-F	13/13	NA
NA	NA	NA	NA	NA	7440-32-6	TITANIUM	1.4	J	19.5	J	UG/L	13SW0901-F	11/13	1.1
NA	NA	NA	260	19	7440-62-2	VANADIUM	1.6	J	38.5	J	UG/L	13SW1101-F	3/13	0.23 - 0.73
NA	5000	11000	11000	58.9	7440-66-6	ZINC	3.4	J	30.6	J	UG/L	13SW1101-F	10/13	3.8 - 5.7
						Miscellaneous Parameters								
NA	NA	NA	NA	NA	TTNUS493	AMMONIA-N	0.01	J	3.4		MG/L	13SW1101	10/13	0.01
NA	NA	NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	0.15	J	23		MG/L	13SW1101	9/13	0.02
						Field Parameters								
NA	NA	NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	4.35		12.32		MG/L	13SW1301	13/13	NA
NA	NA	NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	95		640		MV	13SW0601	13/13	NA
NA	0	NA	NA	NA	TTNUS002	PH	6.13		8.48		S.U.	13SW0901	13/13	NA
NA	NA	NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	0.138		2.743		MS/CM	13SW1101	13/13	NA
NA	NA	NA	NA	NA	TTNUS047	TEMPERATURE	6.52		16.45		C	13SW1101	13/13	NA
NA	NA	NA	NA	NA	TTNUS023	TURBIDITY	11		352		NTU	13SW0701	12/12	NA

Associated Samples:

13SW0101	13SW0701-F
13SW0101-F	13SW0801
13SW0201	13SW0801-F
13SW0201-F	13SW0901
13SW0301	13SW0901-F
13SW0301-F	13SW1001
13SW0401	13SW1001-F
13SW0401-F	13SW1101
13SW0501	13SW1101-F
13SW0501-F	13SW1201
13SW0601	13SW1201-F
13SW0601-F	13SW1301
13SW0701	13SW1301-F

APPENDIX B.5

SEDIMENT

TABLE B-5
FREQUENCY OF DETECTION
SEDIMENT
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

IDCLRESD	R9SORES	R5DQLSD	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
				Semivolatiles								
9500000	3700000	6.71	83-32-9	ACENAPHTHENE	24		43	J	UG/KG	13SD050004	2/3	4.1
47000000	22000000	46.9	120-12-7	ANTHRACENE	72		88		UG/KG	13SD050004	2/3	4.1
5100	620	31.7	56-55-3	BENZO(A)ANTHRACENE	11		330		UG/KG	13SD050004	3/3	NA
510	62	31.9	50-32-8	BENZO(A)PYRENE	15		390	J	UG/KG	13SD060004	3/3	NA
5100	620	10400	205-99-2	BENZO(B)FLUORANTHENE	18		460	J	UG/KG	13SD060004	3/3	NA
NA	2300000	170	191-24-2	BENZO(G,H,I)PERYLENE	10		380	J	UG/KG	13SD060004	3/3	NA
51000	6200	240	207-08-9	BENZO(K)FLUORANTHENE	10		250	J	UG/KG	13SD050004	3/3	NA
510000	62000	57.1	218-01-9	CHRYSENE	18		430	J	UG/KG	13SD060004	3/3	NA
18000000	6100000	110.5	84-74-2	DI-N-BUTYL PHTHALATE	86	J	86	J	UG/KG	13SD060004	1/3	83 - 87
3700000	2400000	40600	117-84-0	DI-N-OCTYL PHTHALATE	100	J	100	J	UG/KG	13SD060004	1/3	83 - 87
510	62	6.22	53-70-3	DIBENZO(A,H)ANTHRACENE	66	J	74	J	UG/KG	13SD060004	2/3	4.1
6300000	2300000	111.3	206-44-0	FLUORANTHENE	44		860		UG/KG	13SD050004	3/3	NA
6300000	2600000	21.2	86-73-7	FLUORENE	33		42	J	UG/KG	13SD050004	2/3	4.1
5100	620	200	193-39-5	INDENO(1,2,3-CD)PYRENE	8	J	290	J	UG/KG	13SD060004	3/3	NA
3200000	56000	34.6	91-20-3	NAPHTHALENE	6	J	6	J	UG/KG	13SD050004	2/3	4.1
3200000	56000	34.6	91-20-3	NAPHTHALENE	6	J	6	J	UG/KG	13SD060004	2/3	4.1
NA	2300000	41.9	85-01-8	PHENANTHRENE	27		620		UG/KG	13SD060004	3/3	NA
5500000	2300000	53	129-00-0	PYRENE	36		1300	J	UG/KG	13SD060004	3/3	NA
				Explosives								
NA	3100	NA	2691-41-0	HMX	0.8	J	1.9	J	MG/KG	13SD110004	2/23	0.25
NA	4.4	NA	121-82-4	RDX	0.44	J	2.2		MG/KG	13SD110004	3/23	0.25
				Herbicides								
20000	3000	30100	87-86-5	PENTACHLOROPHENOL	2.1	J	2.1	J	UG/KG	13SD060004	1/3	0.56 - 0.58
				Inorganics								
NA	76000	NA	7429-90-5	ALUMINUM	1480		18500		MG/KG	13SD220004	23/23	NA
140	31	NA	7440-36-0	ANTIMONY	0.8	J	1.8	J	MG/KG	13SD010004	3/23	0.13 - 0.55
3.9	0.39	5.9	7440-38-2	ARSENIC	3.7	J	35.6	J	MG/KG	13SD220004	22/23	0.53
24000	5400	NA	7440-39-3	BARIUM	28.5	J	364	J	MG/KG	13SD010004	23/23	NA
680	150	NA	7440-41-7	BERYLLIUM	0.53	J	4.3	J	MG/KG	13SD220004	20/23	0.18 - 0.52
12	37	0.596	7440-43-9	CADMIUM	0.41	J	4.1	J	MG/KG	13SD130004	13/23	0.17 - 0.45
NA	NA	NA	7440-70-2	CALCIUM	767	J	89700	J	MG/KG	13SD130004	23/23	NA
NA	30	26	7440-47-3	CHROMIUM	7.9	J	156	J	MG/KG	13SD010004	23/23	NA
NA	900	50	7440-48-4	COBALT	1.8	J	107	J	MG/KG	13SD190004	23/23	NA
13000	3100	16	7440-50-8	COPPER	7	J	52.1	J	MG/KG	13SD010004	23/23	NA
NA	23000	NA	7439-89-6	IRON	1990	J	171000	J	MG/KG	13SD220004	23/23	NA
400	400	31	7439-92-1	LEAD	4.2	J	471	J	MG/KG	13SD010004	23/23	NA
NA	1600	NA	7439-93-2	LITHIUM	2.1	J	38.8	J	MG/KG	13SD190004	23/23	NA
NA	NA	NA	7439-95-4	MAGNESIUM	292	J	7540	J	MG/KG	13SD070004	23/23	NA
NA	1800	NA	7439-96-5	MANGANESE	65.3	J	6130	J	MG/KG	13SD120004	23/23	NA
55	23	0.174	7439-97-6	MERCURY	0.013	J	0.16	J	MG/KG	13SD010004	14/23	0.01 - 0.044
6900	1600	16	7440-02-0	NICKEL	7.9	J	83.9	J	MG/KG	13SD220004	23/23	NA

TABLE B-5
FREQUENCY OF DETECTION
SEDIMENT
SWMU 13 - MINE FILL A
NSWC CRANE, INDIANA

IDCLRESD	R9SORES	R5DQLSD	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
NA	NA	NA	7440-09-7	POTASSIUM	252	J	2390	J	MG/KG	13SD150004	23/23	NA
1700	390	NA	7782-49-2	SELENIUM	0.18	J	0.69	J	MG/KG	13SD220004	16/23	0.02 - 0.33
NA	NA	NA	7440-23-5	SODIUM	81.3	J	334	J	MG/KG	13SD070004	3/23	22.6 - 126
NA	47000	NA	7440-24-6	STRONTIUM	4.1	J	77.1	J	MG/KG	13SD110004	23/23	NA
NA	47000	NA	7440-31-5	TIN	0.52	J	12	J	MG/KG	13SD120004	8/23	0.31 - 0.64
NA	NA	NA	7440-32-6	TITANIUM	13.8	J	112	J	MG/KG	13SD220004	23/23	NA
NA	550	NA	7440-62-2	VANADIUM	11.8	J	115	J	MG/KG	13SD220004	23/23	NA
100000	23000	120	7440-66-6	ZINC	7.9	J	541	J	MG/KG	13SD010004	18/23	33.4 - 386
				AVS/SEM								
NA	NA	NA	TTNUS010	ACID VOLATILE SULFIDE	0.23	J	0.88	J	UMO/G	13SD050004	7/7	NA
NA	NA	NA	7440-43-9	CADMIUM	0.002		0.004		UMO/G	13SD080004	2/7	0.001 - 0.002
NA	NA	NA	7440-50-8	COPPER	0.036	J	2.223	J	UMO/G	13SD080004	7/7	NA
NA	NA	NA	7439-92-1	LEAD	0.03	J	0.067	J	UMO/G	13SD020004	6/7	0.006
NA	NA	NA	7439-97-6	MERCURY	0.00004	J	0.00054	J	UMO/G	13SD140004	5/7	0.0000 - 0.0000
NA	NA	NA	7440-02-0	NICKEL	0.02		0.111		UMO/G	13SD050004	7/7	NA
NA	NA	NA	TTNUS305	SEM/AVS	0.09		3.74		S.U.	13SD080004	7/7	NA
NA	NA	NA	7440-66-6	ZINC	0.407	J	0.538	J	UMO/G	13SD110004	3/7	0.031 - 0.426
				Miscellaneous Parameters								
NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	9.9		18		MEQ/1	13SD110004	7/7	NA
NA	NA	NA	TTNUS002	PH	5		7.9		S.U.	13SD110004	7/7	NA
NA	NA	NA	TTNUS003	TOTAL ORGANIC CARBON	2500	J	19000	J	MG/KG	13SD050004	7/7	NA

Associated Samples:

13SD010004	13SD130004
13SD020004	13SD140004
13SD030004	13SD150004
13SD040004	13SD160004
13SD050004	13SD170004
13SD060004	13SD180004
13SD070004	13SD190004
13SD080004	13SD200004
13SD090004	13SD210004
13SD100004	13SD220004
13SD110004	13SD230004
13SD120004	

APPENDIX C

SMWU 16 ROUND 1 POSITIVE HITS SUMMARY TABLES

APPENDIX C.1

SURFACE SOIL

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB01	16SB02	16SB03	16SB04	16SB05	16SB06	16SB07	16SB08	16SB09
NSAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD						4660	89.4 U	396 J	1600 J
1,2,3,4,6,7,8,9-OCDF						1.9 U	2.6 UJ	1.8 UJ	1.4 UJ
1,2,3,4,6,7,8-HPCDD						151	4.2 J	4.2 J	14.7
1,2,3,4,6,7,8-HPCDF						0.5 U	0.6 U	0.5 U	0.81 U
1,2,3,4,7,8,9-HPCDF						0.7 U	0.8 U	0.7 U	0.5 U
1,2,3,4,7,8-HXCDD						0.6 U	0.7 U	0.6 U	0.6 U
1,2,3,4,7,8-HXCDF						0.3 U	0.3 U	0.3 U	0.2 U
1,2,3,6,7,8-HXCDD						0.92 U	0.7 U	0.6 U	0.5 U
1,2,3,6,7,8-HXCDF						0.3 U	0.3 U	0.3 U	0.2 U
1,2,3,7,8,9-HXCDD						2.2 J	0.7 U	0.6 U	0.6 U
1,2,3,7,8,9-HXCDF						0.4 U	0.4 U	0.4 U	0.3 U
1,2,3,7,8-PECDD						0.6 U	0.7 U	0.6 U	0.6 U
2,3,4,6,7,8-HXCDF						0.3 U	0.4 U	0.3 U	0.3 U
2,3,7,8-TCDF						0.3 U	0.3 U	0.3 U	0.3 U
TOTAL HPCDD						208	4.2	9.7	32.7
TOTAL HPCDF						0.6 U	0.7 U	0.6 U	1.4 U
TOTAL HXCDD						18.2 J	0.7 U	0.6 U	2 U
TOTAL HXCDF						0.3 U	0.4 U	0.3 U	1.5
TOTAL PECDD						0.6 U	0.7 U	0.6 U	0.6 U
TOTAL PECDF						0.5 U	0.5 U	0.4 U	3.7 J
TOTAL TCDF						0.3 U	0.3 U	0.86	7.9 U
Volatile Organics (ug/kg)									
ACETONE	7 J	1.1 UJ	1.1 UJ	3 J	1.2 UJ	1.2 UJ	1.1 UJ	1.1 UJ	1.1 UJ
CIS-1,2-DICHLOROETHENE	1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U	2 J	1.1 U	1.1 U
DICHLORODIFLUOROMETHANE	1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U
STYRENE	1 U	1.1 U	1.1 U	1 J	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U
TOLUENE	1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U
TRANS-1,2-DICHLOROETHENE	1 U	1 J	2 J	1 J	1.2 U	1.2 U	1.1 U	1.1 U	1.1 U
TRICHLOROETHENE	1 U	1.1 U	1.1 U	1.2 U	1.2 U	1.2 U	3	1.1 U	1.1 U
TRICHLOROFLUOROMETHANE	1 U	2 J	1.1 U	2 J	2 J	1.2 U	1.1 U	2 J	2 J
VINYL ACETATE	1 U	1.1 UJ	1.1 UJ	1.2 UJ	1.2 U	1.2 U	1.1 UJ	1.1 UJ	1.1 UJ
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	3.4 U	3.8 U	94	3.9 U	3.8 U	4 U	3.7 U	3.6 U	3.8 U
ACENAPHTHENE	5 J	3.8 U	1800	3.9 U	3.8 U	4 U	3.7 U	3.6 U	3.8 U
ACENAPHTHYLENE	13	3.8 U	680	3.9 U	3.8 U	4 U	3.7 U	3.6 U	3.8 U
ANTHRACENE	27	3.8 U	3500	3.9 U	3.8 U	4 U	10	3.6 U	5 J
BENZO(A)ANTHRACENE	100	3.8 U	9600	15	3.8 U	4 U	25	4 J	28 J

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB01	16SB02	16SB03	16SB04	16SB05	16SB06	16SB07	16SB08	16SB09
NSAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BENZO(A)PYRENE	94	3.8 U	8400	12	3.8 U	4 U	17	4 J	32
BENZO(B)FLUORANTHENE	110	3.8 U	9200	17	3.8 U	4 U	19	5 J	50 J
BENZO(G,H,I)PERYLENE	48	3.8 U	5100	8	6 J	4 U	7 J	4 J	28
BENZO(K)FLUORANTHENE	58	3.8 U	5000	11	3.8 U	4 U	13	4 J	22
BIS(2-ETHYLHEXYL)PHTHALATE	69 U	76 U	150 U	92 J	77 U	160 J	75 U	73 U	76 U
CHRYSENE	130	4 J	11000	34	3.8 U	4 U	22	3.6 U	36
DIBENZO(A,H)ANTHRACENE	15	3.8 U	1600	3.9 U	3.8 U	4 U	3.7 U	3.6 U	8
DIBENZOFURAN	69 U	76 U	560 J	78 U	77 U	81 U	75 U	73 U	76 U
FLUORANTHENE	220	3.8 U	19000	41	3.8 U	4 U	58	5 J	64 J
FLUORENE	23	3.8 U	2300	4 J	3.8 U	4 U	11	3.6 U	3.8 U
INDENO(1,2,3-CD)PYRENE	41	3.8 U	4400	6 J	3.8 U	4 U	6 J	3.6 U	23
NAPHTHALENE	3.4 U	3.8 U	180	3.9 U	3.8 U	4 U	3.7 U	3.6 U	3.8 U
PHENANTHRENE	140	3.8 U	8700	24	3.8 U	4 U	49	3.6 U	28
PYRENE	200	6 J	35000	44	3.8 U	4 U	54	4 J	60
SAFROLE	69 U	76 U	150 U	78 U	77 U	81 U	75 U	73 U	76 U
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	0.62 U	0.68 U	2.6 J	0.7 U	0.69 U	0.72 U	0.67 U	0.66 U	0.68 U
PENTACHLOROPHENOL	0.46 U	0.51 U	0.49 U	0.53 U	14	0.54 U	0.5 U	0.49 U	0.51 U
Inorganics (mg/kg)									
ALUMINUM	10500 J	13600 J	3610 U	18800 J	2740 J	16000 J	7590 J	4230 J	5010 J
ANTIMONY	0.43 U	0.40 U	0.36 U	0.62 U	0.95 U	0.75 U	0.29 U	2.9 U	8.9 J
ARSENIC	6.0 J	4.0 J	1.3 J	9.0 J	1.2 J	4.0 J	1.3 J	0.94 J	1.6 J
BARIUM	48.1 J	52.0 J	19.7 J	69.8 J	18.0 J	84.5 J	25.3 J	53.1 J	95.0 J
BERYLLIUM	0.36 J	0.43 J	0.12 U	0.59 J	0.25 U	0.47 J	0.54 J	0.49 J	0.49 J
CADMIUM	0.35 U	0.57 U	0.48 U	0.57 U	0.20 U	0.29 U	0.19 U	0.66 U	1.9 J
CALCIUM	56500 J	40000 J	246000 J	7760 J	20800 J	8910 J	4040 J	10400 J	17300 J
CHROMIUM	15.5 J	18.8 J	11.9 J	20.5 J	8.3 J	20.5 J	19.3 J	12.1 J	12.1 J
COBALT	3.2 J	3.6 J	1.1 J	5.9 J	0.87 J	5.7 J	3.8 J	4.4 J	3.6 J
COPPER	10.4 J	9.9 J	3.5 J	12.7 J	13.9 J	12.1 J	13.8 J	52.5 J	84.0 J
IRON	15800 J	18600 J	4230 J	22200 J	8590 J	20900 J	7890 J	14400 J	13600 J
LEAD	8.8 J	12.3 J	4.7 J	11.4 J	15.9 J	15.0 J	16.0 J	195 J	311 J
LITHIUM	7.7 J	10.7 J	9.9 J	14.1 J	3.0 J	13.5 J	17.1 J	7.2 J	6.1 J
MAGNESIUM	2860 J	6350 J	62500 J	4650 J	8230 J	2980 J	1970 J	830 J	2490 J
MANGANESE	97.0 J	140 J	78.2 J	147 J	28.2 J	75.0 J	31.0 J	108 J	132 J
MERCURY	0.027 J	0.008 U	0.007 U	0.026 J	0.22 J	0.029 J	0.002 U	0.018 J	0.016 J
NICKEL	7.9 J	9.3 J	9.9 J	13.3 J	4.2 J	11.5 J	16.7 J	13.0 J	9.4 J

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB01	16SB02	16SB03	16SB04	16SB05	16SB06	16SB07	16SB08	16SB09
NSAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SAMPLE	16SS010002	16SS020002	16SS030002	16SS040002	16SS050002	16SS060002	16SS070002	16SS080002	16SS090002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
POTASSIUM	982 J	1180 J	1160 J	1690 J	807 J	1120 J	1510 J	1140 J	919 J
SELENIUM	0.23 U	0.22 U	0.22 U	0.41 U	0.14 U	0.17 U	0.20 U	0.04 U	0.12 U
SILVER	0.13 U	0.04 U	0.04 U	0.05 U	0.03 U	0.03 U	0.04 U	0.03 U	0.04 U
SODIUM	162 J	178 J	496 J	84.9 U	66.0 U	49.6 U	69.5 U	45.7 U	36.2 U
STRONTIUM	93.8 J	51.2 J	252 J	20.8 J	26.5 J	50.2 J	16.6 J	33.6 J	41.5 J
THALLIUM	0.18 U	0.15 U	0.06 U	0.23 U	0.05 U	0.17 U	0.12 U	0.06 U	0.08 U
TIN	0.43 U	0.47 U	0.38 U	0.57 U	0.33 U	0.63 U	0.42 U	12.3 J	2.4 U
TITANIUM	128 J	121 J	39.1 J	239 J	61.8 J	125 J	68.2 J	82.7 J	53.6 J
VANADIUM	27.1 J	29.3 J	13.9 J	37.1 J	10.8 J	32.3 J	12.3 J	11.1 J	10.6 J
ZINC	24.2 J	24.0 J	33.6 J	40.7 J	24.2 J	33.6 J	48.1 J	271 J	552 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)		20					7.4		
PH (S.U.)		8					7.7		
TOTAL ORGANIC CARBON (mg/kg)		3800 J					1000 U		

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB09	16SB10	16SB11	16SB12	16SB13	16SB14	16SB15	16SB16	16SB17
NSAMPLE	16SS090002-D	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SAMPLE	FD03270301	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/28/2003	3/28/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD	1110 J	815 U	3840	4980	3070	735	282 J	731 J	935
1,2,3,4,6,7,8,9-OCDF	2.1 UJ	2 UJ	1.1 U	1 U	20.1	1.8 J	1.8 UJ	2.1 UJ	1.4 U
1,2,3,4,6,7,8-HPCDD	10.4	7	29.2	45.2	42.4	9.3	4.1 J	7.4	10.4
1,2,3,4,6,7,8-HPCDF	1.2 J	0.73 J	0.5 U	0.9 UJ	8	0.81 J	0.4 U	0.5 U	0.5 U
1,2,3,4,7,8,9-HPCDF	0.6 U	0.6 U	0.7 U	1.2 UJ	1.8 J	0.6 U	0.6 U	0.7 U	0.8 U
1,2,3,4,7,8-HXCDD	0.4 U	0.5 U	0.5 U	0.5 U	0.69 J	0.4 U	0.5 U	0.6 U	0.5 U
1,2,3,4,7,8-HXCDF	0.3 U	0.3 U	0.3 U	0.4 U	0.98 J	0.2 U	0.3 U	0.72 J	0.3 U
1,2,3,6,7,8-HXCDD	0.4 U	0.5 U	0.5 U	0.5 U	1.4 J	0.4 U	0.5 U	0.6 U	0.5 U
1,2,3,6,7,8-HXCDF	0.3 U	0.2 U	0.3 U	0.4 U	0.64 J	0.2 U	0.3 U	0.3 U	0.3 U
1,2,3,7,8,9-HXCDD	0.5 U	0.5 U	1.1 J	0.5 U	1.8 J	0.86 J	0.5 U	0.6 U	0.5 U
1,2,3,7,8,9-HXCDF	0.4 U	0.3 U	0.4 U	0.5 U	0.3 U	0.3 U	0.4 U	0.81 J	0.4 U
1,2,3,7,8-PECDD	0.4 U	0.6 U	0.5 U	0.4 U	0.4 U	0.3 U	0.6 U	0.8 U	0.5 U
2,3,4,6,7,8-HXCDF	0.3 U	0.3 U	0.3 U	0.4 U	0.7 J	0.2 U	0.3 U	0.3 U	0.3 U
2,3,7,8-TCDF	0.3 U	0.3 U	0.4 U	0.4 U	0.51 J	0.2 U	0.3 U	0.3 U	0.4 U
TOTAL HPCDD	20.9	15.1 J	52.2	82.4	86.1	16.4	9 J	15.9 J	22.2
TOTAL HPCDF	3	0.73	0.6 U	1 UJ	27.5 J	1.4 J	0.5 U	0.6 U	1.3
TOTAL HXCDD	2.8	0.5 U	2.8	2.3	13.5	3.4	0.5 U	0.6 U	2
TOTAL HXCDF	0.3 U	0.3 U	0.3 U	0.4 U	10.3 J	0.46	0.3 U	1.5	0.4 U
TOTAL PECDD	0.4 U	0.6 U	0.5 U	0.4 U	0.79 U	0.3 U	0.6 U	0.8 U	0.5 U
TOTAL PECDF	0.3 U	0.4 U	0.3 U	0.3 U	7.6 J	0.87 U	0.4 U	0.5 U	0.3 U
TOTAL TCDF	1.2 J	0.51 U	0.4 U	0.4 U	7 U	2.7 U	0.3 U	0.3 U	0.4 U
Volatile Organics (ug/kg)									
ACETONE	1.2 UJ	1.2 UJ	1.3 UJ	1.3 UJ	1.3 UJ	1.2 UJ	1.1 UJ	1.2 UJ	1.2 UJ
CIS-1,2-DICHLOROETHENE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 U	1.2 U	1.2 U
DICHLORODIFLUOROMETHANE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 U	1.2 U	1.2 U
STYRENE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 UJ	1.2 U	1.2 U
TOLUENE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 U	1 J	1.2 U
TRANS-1,2-DICHLOROETHENE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 U	1.2 U	1.2 U
TRICHLOROETHENE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.1 U	1.2 U	1.2 U
TRICHLOROFLUOROMETHANE	2 J	1.2 U	1.3 U	2 J	3 J	2 J	1.1 U	2 J	2 J
VINYL ACETATE	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 UJ	1.1 UJ	1.2 UJ	1.2 UJ
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
ACENAPHTHENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
ACENAPHTHYLENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
ANTHRACENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
BENZO(A)ANTHRACENE	16 J	3.8 U	4.1 U	4.2 U	4.3 U	4 U	5 J	6 J	3.8 U

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB09	16SB10	16SB11	16SB12	16SB13	16SB14	16SB15	16SB16	16SB17
NSAMPLE	16SS090002-D	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SAMPLE	FD03270301	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/28/2003	3/28/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BENZO(A)PYRENE	20	3.8 U	4.1 U	4.2 U	4.3 U	4 U	4 J	10	3.8 U
BENZO(B)FLUORANTHENE	24 J	9	4.1 U	4.2 U	4 J	4 U	11	12	3.8 U
BENZO(G,H,I)PERYLENE	20	3.8 U	4.1 U	4.2 U	4.3 U	6 J	6 J	10	3.8 U
BENZO(K)FLUORANTHENE	17	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	8 J	3.8 U
BIS(2-ETHYLHEXYL)PHTHALATE	140 J	98 J	170	85 U	180 BU	96 J	97 J	110 J	130 J
CHRYSENE	22	5 J	4.1 U	4.2 U	4.3 U	4 U	6 J	10	3.8 U
DIBENZO(A,H)ANTHRACENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
DIBENZOFURAN	81 U	77 U	84 U	85 U	87 U	80 U	77 U	81 U	78 U
FLUORANTHENE	34 J	6 J	4.1 U	4.2 U	4.3 U	6 J	8	15	3.8 U
FLUORENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
INDENO(1,2,3-CD)PYRENE	16	3.8 U	4.1 U	4.2 U	4.3 U	5 J	5 J	8	3.8 U
NAPHTHALENE	4 U	3.8 U	4.1 U	4.2 U	4.3 U	4 U	3.8 U	4 U	3.8 U
PHENANTHRENE	17	3.8 U	4.1 U	4.2 U	4.3 U	4 U	4 J	7 J	3.8 U
PYRENE	42	6 J	4.1 U	4.2 U	4.3 U	7 J	8	15	3.8 U
SAFROLE	81 U	77 U	84 U	85 U	15000	80 U	77 U	81 U	78 U
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	0.72 U	0.69 U	0.75 U	1.1 U	1.1 U	0.72 U	0.69 U	0.72 U	0.7 U
PENTACHLOROPHENOL	0.54 U	0.52 U	0.56 U	0.57 U	0.58 U	0.54 U	0.51 U	0.54 U	0.52 U
Inorganics (mg/kg)									
ALUMINUM	7230 J	7410 J	23800 J	12000 J	11000 J	13900 J	12900 J	11900 J	9880 J
ANTIMONY	13.6 J	7.3 J	3.4 U	3.6 J	13.0 J	27.2 J	4.4 J	6.6 J	1.4 U
ARSENIC	3.3 J	1.4 J	10.9 J	6.7 J	7.0 J	4.7 J	5.9 J	4.7 J	2.7 J
BARIUM	194 J	203 J	76.2 J	134 J	303 J	144 J	177 J	148 J	119 J
BERYLLIUM	0.50 J	0.80 J	0.73 J	0.64 U	0.49 U	0.45 J	0.68 J	0.63 J	1.4 J
CADMIUM	1.9 J	1.0 J	0.38 U	1.3 J	2.4 J	0.60 U	2.8 J	0.94 J	0.75 J
CALCIUM	34900 J	548 J	818 J	985 J	1580 J	63000 J	6860 J	2570 J	219 J
CHROMIUM	14.0 J	17.7 J	28.9 J	12.9 J	11.8 J	16.0 J	19.2 J	16.7 J	26.0 J
COBALT	5.5 J	7.4 J	5.6 J	11.5 J	13.7 J	4.5 J	9.4 J	9.0 J	25.9 J
COPPER	190 J	127 J	16.9 J	62.6 J	122 J	231 J	413 J	66.9 J	39.5 J
IRON	16000 J	23600 J	28900 J	18900 J	17200 J	15700 J	22500 J	17900 J	31000 J
LEAD	480 J	345 J	15.2 J	258 J	405 J	1240 J	211 J	154 J	140 J
LITHIUM	8.0 J	9.8 J	19.2 J	9.7 J	8.7 J	10.7 J	12.1 J	10.1 J	21.5 J
MAGNESIUM	6490 J	957 J	1560 J	1520 J	1400 J	2940 J	1890 J	1420 J	2330 J
MANGANESE	371 J	311 J	231 J	706 J	1040 J	301 J	575 J	566 J	536 J
MERCURY	0.024 J	0.040 J	0.16 J	0.073 J	0.070 J	0.042 J	0.015 J	0.009 U	0.026 J
NICKEL	11.3 J	19.9 J	15.1 J	12.4 J	13.4 J	9.9 J	15.0 J	12.1 J	41.3 J

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB09	16SB10	16SB11	16SB12	16SB13	16SB14	16SB15	16SB16	16SB17
NSAMPLE	16SS090002-D	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SAMPLE	FD03270301	16SS100002	16SS110002	16SS120002	16SS130002	16SS140002	16SS150002	16SS160002	16SS170002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/28/2003	3/28/2003	3/27/2003	3/27/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
POTASSIUM	996 J	1240 J	2240 J	707 J	595 J	791 J	1340 J	1280 J	1440 J
SELENIUM	0.21 U	0.12 U	0.26 U	0.43 U	0.54 U	0.22 U	0.31 U	0.24 U	0.25 U
SILVER	0.07 U	0.09 U	0.08 U	0.04 U	0.26 U	0.18 U	0.10 U	0.05 U	0.05 U
SODIUM	55.3 U	48.5 U	53.2 U	20.4 U	24.5 U	68.8 U	40.3 U	38.5 U	40.7 U
STRONTIUM	80.8 J	55.0 J	14.1 J	58.8 J	145 J	81.8 J	46.5 J	47.0 J	34.8 J
THALLIUM	0.10 U	0.10 U	0.32 J	0.15 U	0.26 U	0.17 U	0.20 U	0.18 U	0.17 U
TIN	2.2 U	1.1 U	0.83 U	0.98 U	2.3 U	1.9 U	2.1 U	2.2 U	0.58 U
TITANIUM	81.2 J	22.9 J	348 J	113 J	71.7 J	99.9 J	123 J	119 J	67.0 J
VANADIUM	16.6 J	14.1 J	52.8 J	23.3 J	22.8 J	25.7 J	30.3 J	26.0 J	21.6 J
ZINC	1320 J	972 J	55.9 J	603 J	1560 J	575 J	1150 J	563 J	438 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)				17					
PH (S.U.)				5.7					
TOTAL ORGANIC CARBON (mg/kg)				6200 J					

(1) Du[illegible]e sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB17	16SB18	16SB19	16SB20	16SB21	16SB22	16SB23	16SB23	16SB24
NSAMPLE	16SS170002-D	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	16SS230002-D	16SS240002
SAMPLE	FD03270302	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	FD03280301	16SS240002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD	859	2350	2510	49.4	1370	1290	1490 J	2410	2070 J
1,2,3,4,6,7,8,9-OCDF	1 U	0.62 J	0.5 U	0.79 J	0.5 U	0.2 U	0.8 UJ	1.4 U	1.3 J
1,2,3,4,6,7,8-HPCDD	7	13.1	13.5	1.5 U	9.7	8.8	20.3	22	16.9 J
1,2,3,4,6,7,8-HPCDF	0.7 U	0.33 J	0.1 U	0.27 U	0.2 U	0.07 U	0.76 U	0.1 U	0.56 J
1,2,3,4,7,8,9-HPCDF	0.6 U	0.08 U	0.2 U	0.08 U	0.2 U	0.09 U	0.3 U	0.2 U	0.2 UJ
1,2,3,4,7,8-HXCDD	0.4 U	0.2 J	0.2 U	0.1 U	0.2 U	0.1 U	0.4 U	0.2 U	0.37 J
1,2,3,4,7,8-HXCDF	0.2 U	0.13 U	0.38 J	0.12 U	0.31 U	0.05 U	0.43 J	0.2 U	0.35 J
1,2,3,6,7,8-HXCDD	0.3 U	0.27 J	0.42 J	0.09 U	0.2 U	0.09 U	0.64 J	0.43 J	0.48 U
1,2,3,6,7,8-HXCDF	0.2 U	0.06 U	0.09 U	0.04 U	0.09 U	0.04 U	0.2 U	0.1 U	0.1 UJ
1,2,3,7,8,9-HXCDD	0.4 U	0.47 J	0.9 U	0.1 U	0.2 U	0.1 U	0.81 J	0.9 J	0.71 J
1,2,3,7,8,9-HXCDF	0.3 U	0.06 U	0.1 U	0.06 U	0.1 U	0.06 U	0.2 U	0.1 U	0.2 UJ
1,2,3,7,8-PECDD	0.3 U	0.14 J	0.3 U	0.1 U	0.2 U	0.1 U	0.4 UJ	0.3 U	0.3 UJ
2,3,4,6,7,8-HXCDF	0.2 U	0.12 J	0.1 U	0.05 U	0.1 U	0.05 U	0.2 U	0.1 U	0.21 U
2,3,7,8-TCDF	0.2 U	0.06 U	0.1 U	0.05 U	0.1 U	0.05 U	0.2 U	0.1 U	0.1 UJ
TOTAL HPCDD	13.4	25.6	26.3	3.3 U	20.1	20.2	42.8	44	34.2 J
TOTAL HPCDF	0.7 U	0.48 J	0.1 U	0.53 U	0.2 U	0.08 U	0.76 U	0.1 U	0.56 J
TOTAL HXCDD	1.3	3.5 J	2.8 J	0.94 U	1.6	2 J	6.2 J	4 J	3.7 J
TOTAL HXCDF	0.2 U	0.42 J	0.67	0.51 U	0.5 J	0.05 U	1 J	0.2 U	0.83 J
TOTAL PECDD	0.3 U	0.34	0.3 U	0.1 U	0.2 U	0.1 U	0.4 UJ	0.3 U	0.3 UJ
TOTAL PECDF	0.2 U	0.07 U	0.36 U	0.07 U	0.2 U	0.07 U	0.2 UJ	0.1 U	0.2 UJ
TOTAL TCDF	0.2 U	0.06 U	0.1 U	0.26	0.1 U	0.05 U	2.4 J	0.1 U	0.1 UJ
Volatile Organics (ug/kg)									
ACETONE	1.1 UJ	1.2 UJ	8 J	1.1 UJ	1.1 UJ	3 J	30 J	1.3 UJ	1.3 UJ
CIS-1,2-DICHLOROETHENE	1.1 U	1.2 U	1.2 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.3 U
DICHLORODIFLUOROMETHANE	1.1 U	1.2 U	1.2 UJ	1.1 U	1.1 U	1.2 UJ	1.3 UJ	1.3 UJ	1.3 U
STYRENE	1.1 U	1.2 U	1.2 U	1.1 U	1.1 UJ	1.2 U	1.3 U	1.3 U	1.3 U
TOLUENE	1.1 U	1.2 U	1.2 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.3 U
TRANS-1,2-DICHLOROETHENE	1.1 U	1.2 U	1.2 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.3 U
TRICHLOROETHENE	1.1 U	1.2 U	1.2 U	2 J	1.1 U	1.2 U	1.3 U	1.3 U	1.3 U
TRICHLOROFLUOROMETHANE	2 J	2 J	2 J	2 J	2 J	2 J	3 J	2 J	3 J
VINYL ACETATE	1.1 U	1.2 U	1 J	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.3 U
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	3.8 U	3.9 U	3.8 U	4 J	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
ACENAPHTHENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
ACENAPHTHYLENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
ANTHRACENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
BENZO(A)ANTHRACENE	8	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB17	16SB18	16SB19	16SB20	16SB21	16SB22	16SB23	16SB23	16SB24
NSAMPLE	16SS170002-D	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	16SS230002-D	16SS240002
SAMPLE	FD03270302	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	FD03280301	16SS240002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BENZO(A)PYRENE	7 J	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
BENZO(B)FLUORANTHENE	8	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
BENZO(G,H,I)PERYLENE	7 J	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
BENZO(K)FLUORANTHENE	6 J	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
BIS(2-ETHYLHEXYL)PHTHALATE	77 U	78 UJ	730 BU	130 BU	110 BU	180 BU	270 BU	140 BU	89 BU
CHRYSENE	8	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
DIBENZO(A,H)ANTHRACENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
DIBENZOFURAN	77 U	78 UJ	77 U	74 U	77 U	78 U	85 U	85 U	84 U
FLUORANTHENE	6 J	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
FLUORENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
INDENO(1,2,3-CD)PYRENE	6 J	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
NAPHTHALENE	3.8 U	3.9 U	3.8 U	5 J	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
PHENANTHRENE	3.8 U	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
PYRENE	9	3.9 U	3.8 U	3.6 U	3.8 U	3.9 U	4.2 U	4.2 U	4.2 U
SAFROLE	77 U	78 UJ	77 U	74 U	77 U	78 U	1200 J	450 J	84 U
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	0.69 U	0.99 U	0.98 U	0.94 U	0.97 U	1 U	1.1 U	1.1 U	1.1 U
PENTACHLOROPHENOL	0.51 U	0.53 U	0.52 U	0.5 U	0.52 U	0.53 U	0.57 U	0.57 U	0.57 U
Inorganics (mg/kg)									
ALUMINUM	9250 J	4690 J	8340 J	3170 J	2510 J	9330 J	17300 J	8480 J	8940 J
ANTIMONY	3.6 U	0.59 U	0.29 U	7.7 J	14.8 J	2.0 U	1.3 U	9.1 J	2.0 J
ARSENIC	2.1 J	1.5 J	3.4 J	1.2 J	1.1 J	3.3 J	10.5 J	4.9 J	5.6 J
BARIUM	45.2 J	48.2 J	36.2 J	159 J	243 J	61.3 J	85.2 J	162 J	91.7 J
BERYLLIUM	0.95 J	0.59 U	0.22 U	0.86 J	0.23 U	0.79 J	0.60 J	0.48 U	0.51 U
CADMIUM	0.32 U	0.16 U	0.21 U	0.66 J	0.56 U	0.57 U	0.43 U	0.64 J	0.30 U
CALCIUM	468 J	316 J	152 U	3290 J	3890 J	478 J	236 U	668 J	888 J
CHROMIUM	21.3 J	13.6 J	10.9 J	13.8 J	6.7 J	17.0 J	18.5 J	9.0 J	10.0 J
COBALT	10.3 J	8.7 J	2.9 J	15.6 J	8.3 J	6.6 J	7.8 J	12.9 J	6.6 J
COPPER	22.4 J	12.8 J	6.9 J	65.4 J	391 J	28.3 J	23.0 J	42.2 J	15.3 J
IRON	22500 J	19800 J	14200 J	43000 J	15800 J	42000 J	28500 J	12900 J	13900 J
LEAD	27.8 J	9.8 J	8.1 J	765 J	211 J	69.9 J	43.0 J	95.8 J	18.0 J
LITHIUM	18.8 J	8.0 J	5.6 J	5.7 J	3.4 J	8.3 J	12.8 J	8.3 J	8.0 J
MAGNESIUM	989 J	854 J	1030 J	989 J	851 J	1190 J	2320 J	1210 J	1250 J
MANGANESE	238 J	155 J	130 J	945 J	244 J	208 J	275 J	809 J	205 J
MERCURY	0.030 J	0.002 U	0.011 U	0.015 U	0.026 J	0.006 U	0.047 J	0.033 J	0.047 J
NICKEL	18.1 J	15.9 J	5.6 J	23.6 J	15.7 J	13.5 J	15.0 J	10.2 J	8.4 J

(1) Du[illegible]e sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB17	16SB18	16SB19	16SB20	16SB21	16SB22.	16SB23	16SB23	16SB24
NSAMPLE	16SS170002-D	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	16SS230002-D	16SS240002
SAMPLE	FD03270302	16SS180002	16SS190002	16SS200002	16SS210002	16SS220002	16SS230002	FD03280301	16SS240002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/27/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
POTASSIUM	1800 J	484 J	360 J	750 J	696 J	514 J	893 J	593 J	535 J
SELENIUM	0.19 U	0.11 U	0.09 U	0.16 U	0.05 U	0.17 U	0.49 U	0.37 U	0.28 U
SILVER	0.02 U	0.02 U	0.02 U	0.04 U	0.06 U	0.02 U	0.03 U	0.05 U	0.03 U
SODIUM	40.7 U	19.3 U	18.1 U	36.0 U	64.2 U	27.1 U	19.7 U	17.3 U	14.5 U
STRONTIUM	22.8 J	6.8 J	7.1 J	22.4 J	140 J	30.4 J	14.8 J	86.5 J	48.8 J
THALLIUM	0.13 U	0.10 U	0.07 U	0.22 U	0.08 U	0.09 U	0.21 U	0.19 U	0.12 U
TIN	1.3 U	0.53 U	0.46 U	0.65 U	2.2 U	0.68 U	0.64 U	0.91 U	0.47 U
TITANIUM	55.5 J	26.7 J	73.3 J	16.1 J	7.5 J	33.7 J	179 J	44.9 J	82.4 J
VANADIUM	13.6 J	10.0 J	16.1 J	8.2 J	5.8 J	23.8 J	32.1 J	17.8 J	17.5 J
ZINC	132 U	47.8 J	17.6 U	132 U	2510 U	197 U	102 J	786 J	174 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)		13							22
PH (S.U.)		5.3							6.5
TOTAL ORGANIC CARBON (mg/kg)		3800 J							5800 J

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB25	16SB26	16SB26	16SB27	16SB28	16SB29	16SB30	16SB31	16SB32
NSAMPLE	16SS250002	16SS260002	16SS260002-D	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002 (1)
SAMPLE	16SS250002	16SS260002	FD04090302	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/28/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	4/9/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)									
1,2,3,4,6,7,8,9-OCDD	3250	79.1		3300	2210	3950	3920	972	3130
1,2,3,4,6,7,8,9-OCDF	0.5 U	0.3 U		17.7	14.2	0.7 U	0.4 U	1.1 U	7.5 J
1,2,3,4,6,7,8-HPCDD	32.9	1.1 J		90.9	63.2	48.4	38.4	18	36.1
1,2,3,4,6,7,8-HPCDF	0.49 J	0.2 U		6.2 U	3.6 J	0.28 U	0.2 U	0.72 J	2.7 J
1,2,3,4,7,8,9-HPCDF	0.2 U	0.1 U		0.49 U	0.45 U	0.3 U	0.2 U	0.1 U	0.3 UJ
1,2,3,4,7,8-HXCDD	0.34 U	0.1 U		1.5 J	0.82 U	0.56 U	0.2 U	0.35 J	1.2 J
1,2,3,4,7,8-HXCDF	0.17 J	0.06 U		0.88 J	0.4 U	0.2 U	0.1 U	0.44 U	0.36 J
1,2,3,6,7,8-HXCDD	0.52 U	0.1 U		2.5 J	1.6 J	0.86 U	0.2 U	0.49 J	1.8 J
1,2,3,6,7,8-HXCDF	0.1 U	0.05 U		0.45 J	0.32 U	0.2 U	0.1 U	0.21 U	0.41 J
1,2,3,7,8,9-HXCDD	0.72 J	0.1 U		4.7 J	2.4 J	1.1 U	0.59 J	0.61 J	2.8 J
1,2,3,7,8,9-HXCDF	0.1 U	0.07 U		0.25 J	0.1 U	0.2 U	0.1 U	0.09 U	0.57 J
1,2,3,7,8-PECDD	0.2 U	0.2 U		0.88 J	0.2 U	0.4 U	0.2 U	0.2 U	1.5 J
2,3,4,6,7,8-HXCDF	0.1 U	0.06 U		0.75 J	0.28 U	0.2 U	0.1 U	0.27 J	0.33 J
2,3,7,8-TCDF	0.1 U	0.08 U		0.75 J	0.29 U	0.2 U	0.1 U	0.09 U	0.1 U
TOTAL HPCDD	68.4	2.3		302	235	87	66	34.4	73.1
TOTAL HPCDF	0.49	0.2 U		17.9 J	11.7 J	0.28 U	0.2 U	1.2	6.5
TOTAL HXCDD	6.1 J	0.1 U		45.9	32.9 J	8.3 J	4.4 J	5.9 J	14.7 J
TOTAL HXCDF	0.17	0.2 U		11.7 J	4.5 J	0.2 U	0.1 U	1.7 J	5.5 J
TOTAL PECDD	0.2 U	0.2 U		4.4 J	0.59	0.4 U	0.2 U	0.87	3.1 J
TOTAL PECDF	0.2 U	2.3 J		5.1 J	1.3 J	0.3 U	0.2 U	1.5 J	6.3 J
TOTAL TCDF	0.1 U	3.9 U		4.5 J	1.9 J	0.2 U	0.1 U	1 U	13.3 J
Volatile Organics (ug/kg)									
ACETONE	34 J	8 BU	6 BU	1.1 UJ	1.2 UJ	71 J	32 J	1.2 UJ	1.2 UJ
CIS-1,2-DICHLOROETHENE	1.2 U	1.1 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
DICHLORODIFLUOROMETHANE	1.2 UJ	1.1 UJ	1.1 UJ	1.1 U	1.2 U	1.3 UJ	1.3 U	1.2 U	1.2 UJ
STYRENE	1.2 U	1.1 UJ	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
TOLUENE	1.2 U	1.1 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
TRANS-1,2-DICHLOROETHENE	1.2 U	1.1 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
TRICHLOROETHENE	1.2 U	1.1 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
TRICHLOROFLUOROMETHANE	2 J	1.1 U	2 J	2 J	2 J	3 J	2 J	2 J	2 J
VINYL ACETATE	1.2 U	1.1 U	1.1 U	1.1 U	1.2 U	1.3 U	1.3 U	1.2 U	1.2 U
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
ACENAPHTHENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
ACENAPHTHYLENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
ANTHRACENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
BENZO(A)ANTHRACENE	4 U	10 J	3.7 UJ	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB25	16SB26	16SB26	16SB27	16SB28	16SB29	16SB30	16SB31	16SB32
NSAMPLE	16SS250002	16SS260002	16SS260002-D	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002 (1)
SAMPLE	16SS250002	16SS260002	FD04090302	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/28/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	4/9/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BENZO(A)PYRENE	4 U	9 J	3.7 UJ	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
BENZO(B)FLUORANTHENE	4 U	13 J	3.7 UJ	3.7 U	5 J	4.2 U	4.2 U	4 U	4.1 UJ
BENZO(G,H,I)PERYLENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
BENZO(K)FLUORANTHENE	4 U	8 J	3.7 UJ	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
BIS(2-ETHYLHEXYL)PHTHALATE	150 BU	87 BU	74 U	110 BU	140 BU	410 BU	240 BU	140 BU	83 U
CHRYSENE	4 U	7 J	3.7 U	3.7 U	6 J	4.2 U	4.2 U	4 U	4.1 U
DIBENZO(A,H)ANTHRACENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
DIBENZOFURAN	82 U	74 U	74 U	76 U	78 U	85 U	85 U	81 U	83 U
FLUORANTHENE	4 U	4 J	3.7 U	3.7 U	7 J	4.2 U	4.2 U	4 U	4.1 U
FLUORENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
INDENO(1,2,3-CD)PYRENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
NAPHTHALENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
PHENANTHRENE	4 U	3.7 U	3.7 U	3.7 U	3.9 U	4.2 U	4.2 U	4 U	4.1 U
PYRENE	4 U	5 J	3.7 U	3.7 U	7 J	4.2 U	4.2 U	4 U	4.1 U
SAFROLE	4600	74 U	74 U	76 U	78 U	1500	340 J	81 U	83 U
Energetics (mg/kg)									
HMX	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	1 U	0.94 U	0.94 U	0.96 U	0.99 U	1.1 U	1.1 U	1 U	1.1 U
PENTACHLOROPHENOL	0.55 U	0.5 U	0.5 U	0.51 U	0.53 U	2.5 J	8 J	0.55 U	0.56 U
Inorganics (mg/kg)									
ALUMINUM	13800 J	4060 J	3720 J	4230 J	9480 J	16900 J	16200 J	5750 J	12000 J
ANTIMONY	1.5 U	0.19 U	0.38 J	0.27 U	0.66 U	2.8 U	1.2 U	1.6 U	0.79 J
ARSENIC	7.6 J	1.6 J	1.3 J	1.4 J	7.3 J	10.4 J	11.2 J	3.0 J	8.5 J
BARIUM	57.8 J	44.4 J	40.0 J	33.7 J	69.5 J	138 J	59.6 J	134 J	41.8 J
BERYLLIUM	0.46 U	0.81 J	0.76 J	0.37 U	0.63 J	0.53 J	0.52 J	0.28 U	0.38 J
CADMIUM	0.41 U	0.48 J	0.38 J	0.27 U	1.2 J	0.64 J	0.39 U	0.47 U	0.33 J
CALCIUM	496 J	831 J	4120 J	858 J	1650 J	821 J	198 U	898 J	1100 J
CHROMIUM	17.0 J	11.8 J	11.0 J	6.9 J	18.3 J	17.8 J	19.2 J	7.0 J	16.6 J
COBALT	4.1 J	20.0 J	18.1 J	1.4 J	4.1 J	7.2 J	5.1 J	1.9 J	4.2 J
COPPER	19.0 J	13.0 J	11.1 J	5.1 J	19.8 J	35.0 J	18.8 J	42.5 J	15.9 J
IRON	25000 J	19700 J	20100 J	9380 J	23500 J	26300 J	29400 J	8870 J	22600 J
LEAD	24.9 J	14.8 U	15.7 U	8.3 J	31.8 J	85.7 J	16.9 J	150 J	17.2 J
LITHIUM	10.5 J	10.7 J	9.9 J	4.3 J	9.7 J	13.1 J	12.7 J	5.6 U	9.0 J
MAGNESIUM	1440 J	687 J	2250 J	793 J	1320 J	2080 J	2320 J	794 J	1910 J
MANGANESE	141 J	794 J	620 J	5.1 J	51.6 J	277 J	108 J	183 J	139 J
MERCURY	0.034 J	0.002 U	0.013 U	0.003 U	0.008 U	0.053 J	0.084 J	0.033 J	0.035 J
NICKEL	9.8 J	24.8 J	19.9 J	3.5 J	12.1 J	15.5 J	13.2 J	5.0 J	10.4 J

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB25	16SB26	16SB26	16SB27	16SB28	16SB29	16SB30	16SB31	16SB32
NSAMPLE	16SS250002	16SS260002	16SS260002-D	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002 (1)
SAMPLE	16SS250002	16SS260002	FD04090302	16SS270002	16SS280002	16SS290002	16SS300002	16SS310002	16SS320002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	3/28/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003	4/9/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
POTASSIUM	664 J	751 J	685 J	466 J	462 J	827 J	807 J	400 J	496 J
SELENIUM	0.44 U	0.07 U	0.07 U	0.10 U	0.14 U	0.51 U	0.43 U	0.24 U	0.31 J
SILVER	0.04 U	0.09 U	0.19 U	0.14 U	0.03 U	0.06 U	0.06 U	0.06 U	0.11 U
SODIUM	16.2 U	27.6 U	34.4 U	29.3 U	26.0 U	19.4 U	22.3 U	28.5 U	33.8 U
STRONTIUM	21.8 J	13.5 J	16.5 J	48.0 J	136 J	82.8 J	10.4 J	86.2 J	18.7 J
THALLIUM	0.15 U	0.13 U	0.15 U	0.14 U	0.09 U	0.23 U	0.19 U	0.10 U	0.14 U
TIN	0.70 U	0.87 J	0.70 J	0.32 U	0.49 U	0.85 U	0.63 U	0.58 U	1.7 J
TITANIUM	99.9 J	29.6 J	26.0 J	10.2 J	32.0 J	147 J	210 J	57.3 J	145 J
VANADIUM	27.7 J	9.3 J	8.4 J	8.4 J	25.4 J	32.9 J	32.2 J	11.6 J	28.1 J
ZINC	97.2 J	49.0 J	45.7 J	24.3 U	144 U	401 U	68.2 J	633 J	40.6 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)								15	
PH (S.U.)								5.8	
TOTAL ORGANIC CARBON (mg/kg)								4700 J	

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB33	16SB34	16SB35	16SB36	16SB37	16SB38	16SB39
NSAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	4/9/2003	4/9/2003	3/28/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Dioxins (ng/kg)							
1,2,3,4,6,7,8,9-OCDD	11500						
1,2,3,4,6,7,8,9-OCDF	4.2 J						
1,2,3,4,6,7,8-HPCDD	34						
1,2,3,4,6,7,8-HPCDF	2.1 J						
1,2,3,4,7,8,9-HPCDF	0.2 UJ						
1,2,3,4,7,8-HXCDD	0.2 U						
1,2,3,4,7,8-HXCDF	0.33 J						
1,2,3,6,7,8-HXCDD	0.2 U						
1,2,3,6,7,8-HXCDF	0.24 J						
1,2,3,7,8,9-HXCDD	0.95 J						
1,2,3,7,8,9-HXCDF	0.2 U						
1,2,3,7,8-PECDD	0.3 U						
2,3,4,6,7,8-HXCDF	0.1 U						
2,3,7,8-TCDF	0.1 U						
TOTAL HPCDD	83.1						
TOTAL HPCDF	3.8 J						
TOTAL HXCDD	2.6						
TOTAL HXCDF	2.7						
TOTAL PECDD	0.3 U						
TOTAL PECDF	2.5 J						
TOTAL TCDF	2.4 U						
Volatile Organics (ug/kg)							
ACETONE	1.1 UJ	1.1 UJ	1.1 UJ	1.2 UJ	1.1 UJ	1.1 UJ	1.2 UJ
CIS-1,2-DICHLOROETHENE	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1.1 U	23
DICHLORODIFLUOROMETHANE	10 J	1.1 UJ	1.1 U	1.2 UJ	1.1 U	1.1 U	1.2 UJ
STYRENE	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1.1 U	1.2 U
TOLUENE	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1.1 U	1.2 U
TRANS-1,2-DICHLOROETHENE	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1.1 U	2 J
TRICHLOROETHENE	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	6	86
TRICHLOROFLUOROMETHANE	3 J	2 J	3 J	2 J	2 J	2 J	2 J
VINYL ACETATE	1.1 U	1.1 U	1 J	1.2 U	1.1 U	1.1 U	1.2 U
Semivolatile Organics (ug/kg)							
2-METHYLNAPHTHALENE	3.8 U	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
ACENAPHTHENE	3.8 U	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
ACENAPHTHYLENE	4 J	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
ANTHRACENE	3.8 U	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
BENZO(A)ANTHRACENE	36	3.5 U	8	3.8 U	5 J	3.8 U	3.8 U

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB33	16SB34	16SB35	16SB36	16SB37	16SB38	16SB39
NSAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	4/9/2003	4/9/2003	3/28/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
BENZO(A)PYRENE	45	3.5 U	10	3.8 U	5 J	3.8 U	4 J
BENZO(B)FLUORANTHENE	62 J	3.5 UJ	12	3.8 UJ	5 J	3.8 U	9
BENZO(G,H,I)PERYLENE	23	3.5 U	5 J	3.8 U	3.7 U	3.8 U	3.8 U
BENZO(K)FLUORANTHENE	46	3.5 U	8	3.8 U	4 J	3.8 U	3.8 U
BIS(2-ETHYLHEXYL)PHTHALATE	76 U	72 U	220 BU	1200 BJ	74 U	160 BU	170 BU
CHRYSENE	42	3.5 U	9	3.8 U	4 J	3.8 U	7 J
DIBENZO(A,H)ANTHRACENE	3.8 U	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
DIBENZOFURAN	76 U	72 U	76 U	78 U	74 U	76 U	78 U
FLUORANTHENE	50	3.5 U	6 J	3.8 U	4 J	3.8 U	3.8 U
FLUORENE	3.8 U	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
INDENO(1,2,3-CD)PYRENE	24	3.5 U	5 J	3.8 U	3.7 U	3.8 U	3.8 U
NAPHTHALENE	4 J	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
PHENANTHRENE	12	3.5 U	3.8 U	3.8 U	3.7 U	3.8 U	3.8 U
PYRENE	55	3.5 U	10	3.8 U	5 J	3.8 U	5 J
SAFROLE	76 U	72 U	76 U	78 U	74 U	76 U	78 U
Energetics (mg/kg)							
HMX	0.34 J	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
Herbicides (ug/kg)							
HEXACHLOROPHENE	0.97 U	0.91 U	0.97 U	0.99 U	0.94 U	0.97 U	0.99 U
PENTACHLOROPHENOL	0.51 U	0.48 U	0.51 U	0.52 U	0.5 U	0.79 J	0.52 U
Inorganics (mg/kg)							
ALUMINUM	8020 J	1780 J	6760 J	11900 J	5470 J	10900 J	13800 J
ANTIMONY	1.1 J	0.51 J	0.75 U	0.55 J	0.44 U	0.36 U	0.78 U
ARSENIC	4.8 J	0.75 J	2.6 J	4.8 J	1.9 J	5.4 J	8.8 J
BARIUM	55.6 J	11.9 J	33.7 J	39.4 J	17.6 J	81.9 J	83.4 J
BERYLLIUM	0.43 J	0.06 U	0.20 U	0.23 J	0.27 U	0.27 U	0.42 U
CADMIUM	0.45 J	0.19 J	0.21 U	0.20 J	0.13 U	0.30 U	0.28 U
CALCIUM	1980 J	212 J	727 J	1010 J	347 J	6750 J	808 J
CHROMIUM	13.7 J	4.3 J	9.0 J	12.8 J	7.6 J	13.0 J	15.9 J
COBALT	2.5 J	1.5 J	1.3 J	2.7 J	1.1 J	3.6 J	4.7 J
COPPER	33.5 J	2.4 J	9.3 J	11.4 J	5.3 J	13.9 J	13.1 J
IRON	23100 J	2170 J	11500 J	17100 J	8360 J	18100 J	24000 J
LEAD	123 J	3.5 J	11.9 J	9.6 J	4.2 J	14.0 J	13.4 J
LITHIUM	4.0 J	0.81 J	4.2 J	6.0 J	4.3 U	7.6 J	10.7 J
MAGNESIUM	765 J	105 J	801 J	1210 J	553 J	2160 J	2130 J
MANGANESE	132 J	3.8 J	10.4 J	49.8 J	6.8 J	91.6 J	256 J
MERCURY	0.030 J	0.002 U	0.008 U	0.030 J	0.004 U	0.021 U	0.048 J
NICKEL	5.2 J	0.71 J	3.5 J	6.5 J	2.9 J	10.4 J	11.1 J

(1) Dup" e sample, 16SS320002-D, had no data for any analytes found to be positively detected.

TABLE C-1
POSITIVE HITS
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB33	16SB34	16SB35	16SB36	16SB37	16SB38	16SB39
NSAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SAMPLE	16SS330002	16SS340002	16SS350002	16SS360002	16SS370002	16SS380002	16SS390002
SUBMATRIX	SS	SS	SS	SS	SS	SS	SS
DEPTH RANGE	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2	0 - 2
SAMPLE DATE	4/9/2003	4/9/2003	3/28/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
POTASSIUM	266 J	312 J	311 J	378 J	206 J	470 J	672 J
SELENIUM	0.11 U	0.03 U	0.10 U	0.16 J	0.06 U	0.14 U	0.47 U
SILVER	0.28 J	0.16 U	0.02 U	0.07 U	0.02 U	0.02 U	0.13 U
SODIUM	23.0 U	12.7 U	20.6 U	20.5 U	22.7 U	39.7 U	43.7 U
STRONTIUM	39.8 J	4.5 J	27.1 J	38.6 J	7.0 J	48.8 J	13.5 J
THALLIUM	0.16 J	0.03 U	0.07 U	0.10 U	0.06 U	0.10 U	0.19 U
TIN	0.45 J	0.25 J	0.45 U	0.38 J	0.39 U	0.40 U	0.60 U
TITANIUM	54.8 J	12.2 J	24.8 J	84.1 J	29.0 J	135 J	143 J
VANADIUM	19.5 J	3.6 J	11.2 J	20.6 J	10.2 J	20.1 J	27.3 J
ZINC	193 U	5.2 U	23.5 U	24.1 J	7.6 U	42.6 U	42.1 U
Miscellaneous Parameters							
CATION EXCHANGE CAPACITY (MEQ/1)					21		
PH (S.U.)					5.2		
TOTAL ORGANIC CARBON (mg/kg)					1000 J		

(1) Duplicate sample, 16SS320002-D, had no data for any analytes found to be positively detected.

APPENDIX C.2

SUBSURFACE SOIL

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB01	16SB02	16SB11	16SB12	16SB13	16SB17	16SB18	16SB19	16SB22
NSAMPLE	16SB010406	16SB020406	16SB110204	16SB120204	16SB130204	16SB170204	16SB180203	16SB190203	16SB220203
SAMPLE	16SB010406	16SB020406	16SB110204	16SB120204	16SB130204	16SB170204	16SB180203	16SB190203	16SB220203
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	4 - 6	4 - 6	2 - 4	2 - 4	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/28/2003	3/28/2003	3/27/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/kg)									
ACETONE	1.2 UJ	1.1 UJ							
CIS-1,2-DICHLOROETHENE	1.2 U	1.1 U							
TRANS-1,2-DICHLOROETHENE	1.2 U	1.1 U							
TRICHLOROETHENE	1.2 U	1.1 U							
TRICHLOROFLUOROMETHANE	2 J	2 J							
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
ANTHRACENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BENZO(A)ANTHRACENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BENZO(A)PYRENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BENZO(B)FLUORANTHENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BENZO(G,H,I)PERYLENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BENZO(K)FLUORANTHENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
BIS(2-ETHYLHEXYL)PHTHALATE	80 U	130 J	77 U	83 U	80 U	250 BU	390 BU	260 BU	77 U
CHRYSENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
DIBENZO(A,H)ANTHRACENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
FLUORANTHENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
FLUORENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
INDENO(1,2,3-CD)PYRENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
ISOSAFROLE	80 U	76 U	77 U	83 U	80 U	74 U	80 U	76 U	77 U
NAPHTHALENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
PHENANTHRENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
PYRENE	3.9 U	3.7 U	3.8 U	4.1 U	3.9 U	3.7 U	3.9 U	3.8 U	3.8 U
SAFROLE	80 U	76 U	77 U	83 U	80 U	74 U	80 U	76 U	77 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	1 U	0.68 U	0.98 U	1 U	1 U	0.94 U	1 U	0.97 U	0.98 U
PENTACHLOROPHENOL	0.54 U	0.51 U	0.52 U	0.55 U	0.54 U	0.5 U	0.54 U	0.51 U	0.52 U
Inorganics (mg/kg)									
ALUMINUM	8090 J	13800 J	7110 J	13500 J	12900 J	5160 J	3520 J	6040 J	2120 J
ANTIMONY	0.52 U	0.31 U	0.39 U	0.71 U	0.41 U	0.31 U	0.51 U	0.24 U	0.14 U
ARSENIC	2.7 J	3.2 J	3.3 J	8.3 J	3.5 J	1.8 J	5.9 J	2.3 J	0.63 J
BARIUM	20.6 J	76.3 J	34.8 J	40.2 J	91.8 J	23.0 J	32.6 J	33.2 J	20.0 J
BERYLLIUM	0.38 U	0.50 J	0.33 U	0.53 U	0.88 J	0.87 J	2.4 J	0.41 U	0.40 U
CADMIUM	0.16 U	0.18 U	0.17 U	0.19 U	0.22 J	0.24 U	0.74 J	0.13 U	0.10 U
CALCIUM	468 J	602 J	334 J	143 J	380 U	607 J	1510 J	234 J	218 J
CHROMIUM	11.9 J	17.8 J	11.3 J	16.0 J	25.1 J	11.8 J	20.2 J	10.7 J	6.0 J
COBALT	1.7 J	2.2 J	3.0 J	3.7 J	2.9 J	15.7 J	7.0 J	3.0 J	2.4 J
COPPER	6.7 J	6.7 J	8.7 J	13.2 J	19.3 J	15.5 J	34.8 J	6.8 J	3.6 J

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB01	16SB02	16SB11	16SB12	16SB13	16SB17	16SB18	16SB19	16SB22
NSAMPLE	16SB010406	16SB020406	16SB110204	16SB120204	16SB130204	16SB170204	16SB180203	16SB190203	16SB220203
SAMPLE	16SB010406	16SB020406	16SB110204	16SB120204	16SB130204	16SB170204	16SB180203	16SB190203	16SB220203
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	4 - 6	4 - 6	2 - 4	2 - 4	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3
SAMPLE DATE	3/27/2003	3/27/2003	3/27/2003	3/28/2003	3/28/2003	3/27/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
IRON	14800 J	15100 J	15900 J	24600 J	13400 J	20500 J	8520 J	12500 J	12800 J
LEAD	6.0 J	7.2 J	8.1 J	10.3 J	9.5 J	6.1 J	14.2 J	6.3 J	3.4 J
LITHIUM	5.9 U	11.8 J	7.0 J	9.9 J	12.4 J	23.6 J	6.9 J	5.6 U	2.0 U
MAGNESIUM	939 J	1070 J	1250 J	1970 J	1260 J	1330 J	910 J	849 J	535 J
MANGANESE	28.8 J	10.0 J	82.0 J	111 J	7.3 J	254 J	47.2 J	64.4 J	87.9 J
MERCURY	0.012 U	0.023 J	0.003 U	0.069 J	0.013 J	0.031 J	0.079 J	0.003 U	0.004 U
NICKEL	4.8 J	6.8 J	7.2 J	10.2 J	14.7 J	35.6 J	25.1 J	6.3 J	6.5 J
POTASSIUM	245 J	621 J	366 J	646 J	2070 J	867 J	413 J	325 J	350 J
SELENIUM	0.06 U	0.11 U	0.10 U	0.38 U	0.24 U	0.07 U	0.63 J	0.10 U	0.02 U
SILVER	0.11 U	0.03 U	0.04 U	0.14 U	0.14 U	0.03 U	0.05 U	0.02 U	0.05 U
SODIUM	70.8 U	75.8 U	34.3 U	28.4 U	46.2 U	32.5 U	52.5 U	23.1 U	29.6 U
STRONTIUM	4.9 J	13.6 J	4.6 J	5.6 J	21.8 J	5.3 J	9.9 J	4.0 J	7.9 J
TIN	0.67 U	0.57 U	0.52 U	0.56 U	0.50 U	0.47 U	0.34 U	0.31 U	0.36 U
TITANIUM	75.9 J	58.5 J	82.1 J	162 J	43.5 J	36.7 J	13.8 J	43.1 J	12.2 J
VANADIUM	17.5 J	24.0 J	15.6 J	25.8 J	21.3 J	7.9 J	6.9 J	12.3 J	5.5 J
ZINC	10.2 J	11.8 U	20.6 J	35.9 J	15.2 U	59.0 J	17.8 J	14.0 J	15.6 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)		24		25			24		
PH (S.U.)		5		5.1			5.8		
TOTAL ORGANIC CARBON (mg/kg)		3400 J		5300 J			14000 J		

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB23	16SB23	16SB24	16SB25	16SB26	16SB26	16SB27	16SB28	16SB29
NSAMPLE	16SB230203	16SB230203-D	16SB240203	16SB250203	16SB260204	16SB260204-D	16SB270203	16SB280203	16SB290203
SAMPLE	16SB230203	FD03280302	16SB240203	16SB250203	16SB260204	FD04090303	16SB270203	16SB280203	16SB290203
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 3	2 - 3	2 - 3	2 - 3	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3
SAMPLE DATE	3/28/2003	3/28/2003	3/28/2003	3/28/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/kg)									
ACETONE									
CIS-1,2-DICHLOROETHENE									
TRANS-1,2-DICHLOROETHENE									
TRICHLOROETHENE									
TRICHLOROFLUOROMETHANE									
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	3.9 U	3.8 U	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
ANTHRACENE	3.9 U	5 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
BENZO(A)ANTHRACENE	3.9 UJ	38 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
BENZO(A)PYRENE	3.9 UJ	41 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
BENZO(B)FLUORANTHENE	3.9 UJ	47 J	3.8 U	3.9 U	3.5 UJ	3.5 UJ	3.6 U	3.7 U	4 U
BENZO(G,H,I)PERYLENE	3.9 UJ	17 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
BENZO(K)FLUORANTHENE	3.9 UJ	22 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
BIS(2-ETHYLHEXYL)PHTHALATE	81 BU	86 BU	130 BU	480 BU	70 U	71 U	91 BU	150 BU	82 U
CHRYSENE	3.9 UJ	41 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
DIBENZO(A,H)ANTHRACENE	3.9 U	6 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
FLUORANTHENE	3.9 UJ	49 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
FLUORENE	3.9 U	5 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
INDENO(1,2,3-CD)PYRENE	3.9 U	15	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
ISOSAFROLE	79 U	78 U	76 U	80 U	70 U	71 U	73 U	75 U	82 U
NAPHTHALENE	3.9 U	3.8 U	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
PHENANTHRENE	3.9 UJ	16 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
PYRENE	3.9 UJ	58 J	3.8 U	3.9 U	3.5 U	3.5 U	3.6 U	3.7 U	4 U
SAFROLE	480	78 U	76 U	80 U	70 U	71 U	73 U	75 U	82 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	1 U	0.99 U	0.97 U	1 U	0.96 J	0.89 J	0.93 U	0.96 U	1 U
PENTACHLOROPHENOL	0.53 U	0.52 U	0.51 U	0.53 U	0.47 U	0.47 U	0.49 U	0.51 U	0.55 U
Inorganics (mg/kg)									
ALUMINUM	8380 J	4740 J	6110 J	9170 J	3610 J	3370 J	1540 J	2540 J	9780 J
ANTIMONY	0.24 U	0.33 U	0.28 U	0.57 U	0.14 U	0.18 U	0.97 U	0.19 U	0.41 U
ARSENIC	4.1 J	2.0 J	2.2 J	3.5 J	1.6 J	1.6 J	0.35 J	1.0 J	5.6 J
BARIUM	30.9 J	21.3 J	26.5 J	33.2 J	24.1 J	27.0 J	9.4 J	9.1 J	42.5 J
BERYLLIUM	0.31 U	0.18 U	0.32 U	0.53 U	0.62 J	0.69 J	0.17 U	0.75 J	0.37 U
CADMIUM	0.16 U	0.10 U	0.12 U	0.20 U	0.32 J	0.37 J	0.09 U	0.17 U	0.18 U
CALCIUM	68.7 J	58.7 U	139 J	312 J	420 J	343 J	204 J	199 J	184 J
CHROMIUM	12.4 J	6.7 J	9.4 J	15.4 J	9.1 J	9.1 J	5.1 J	8.0 J	11.6 J
COBALT	3.0 J	1.8 J	2.4 J	2.5 J	13.9 J	22.6 J	0.54 J	7.9 J	3.2 J
COPPER	8.6 J	5.2 J	7.8 J	10.0 J	10.8 J	10.7 J	3.9 J	6.8 J	11.5 J

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB23	16SB23	16SB24	16SB25	16SB26	16SB26	16SB27	16SB28	16SB29
NSAMPLE	16SB230203	16SB230203-D	16SB240203	16SB250203	16SB260204	16SB260204-D	16SB270203	16SB280203	16SB290203
SAMPLE	16SB230203	FD03280302	16SB240203	16SB250203	16SB260204	FD04090303	16SB270203	16SB280203	16SB290203
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 3	2 - 3	2 - 3	2 - 3	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3
SAMPLE DATE	3/28/2003	3/28/2003	3/28/2003	3/28/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
IRON	16900 J	9670 J	13500 J	21500 J	8210 J	8250 J	3630 J	21800 J	15400 J
LEAD	7.3 J	4.0 J	5.8 J	7.4 J	7.9 U	8.8 J	4.4 J	6.4 J	6.5 J
LITHIUM	6.3 U	4.2 U	4.6 U	7.1 J	11.6 J	11.4 J	2.1 U	4.1 U	6.3 U
MAGNESIUM	1350 J	786 J	955 J	1010 J	737 J	707 J	279 J	628 J	1930 J
MANGANESE	81.3 J	33.4 J	44.6 J	9.8 J	286 J	520 J	3.2 J	35.9 J	55.9 J
MERCURY	0.003 U	0.034 J	0.005 U	0.010 U	0.004 J	0.006 U	0.002 U	0.006 U	0.074 J
NICKEL	6.8 J	4.0 J	5.6 J	5.7 J	16.6 J	18.1 J	2.0 J	20.8 J	8.5 J
POTASSIUM	407 J	245 J	334 J	383 J	752 J	769 J	487 J	333 J	487 J
SELENIUM	0.15 U	0.08 U	0.08 U	0.10 U	0.04 U	0.08 U	0.03 U	0.06 U	0.12 U
SILVER	0.02 U	0.02 U	0.02 U	0.03 U	0.14 U	0.22 J	0.02 U	0.06 U	0.03 U
SODIUM	18.9 U	12.8 U	13.9 U	30.3 U	26.0 U	28.9 U	23.6 U	15.8 U	26.9 U
STRONTIUM	3.8 J	2.7 J	4.3 J	5.4 J	11.0 J	11.3 J	2.8 J	3.1 J	5.8 J
TIN	0.36 U	0.41 U	0.36 U	0.60 U	0.31 J	0.42 J	0.22 U	0.32 U	0.49 U
TITANIUM	106 J	56.3 J	63.5 J	47.7 J	25.1 J	24.0 J	16.7 J	15.3 J	131 J
VANADIUM	17.5 J	9.9 J	12.0 J	18.0 J	5.9 J	5.6 J	2.9 J	7.4 J	16.7 J
ZINC	20.2 J	12.1 J	17.5 J	11.5 J	48.9 J	49.2 J	4.5 U	59.6 J	29.1 J
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)			18						
PH (S.U.)			4.9						
TOTAL ORGANIC CARBON (mg/kg)			4700 J						

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB30	16SB32	16SB33	16SB34	16SB36	16SB38	16SB39	16SB40	16SB40
NSAMPLE	16SB300203	16SB320204	16SB330204	16SB340203	16SB360203	16SB380203	16SB390203	16SB400506	16SB400608
SAMPLE	16SB300203	16SB320204	16SB330204	16SB340203	16SB360203	16SB380203	16SB390203	16SB400506	16SB400608
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 3	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3	2 - 3	5 - 6	6 - 8
SAMPLE DATE	3/28/2003	4/9/2003	4/9/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/kg)									
ACETONE					1.2 UJ	1.1 UJ	1.2 UJ	1.2 UJ	1.2 UJ
CIS-1,2-DICHLOROETHENE					1.2 U	1.1 U	200	1.2 U	1.2 U
TRANS-1,2-DICHLOROETHENE					1.2 U	1.1 U	12	1.2 U	1.2 U
TRICHLOROETHENE					1.2 U	4	280	1.2 U	1.2 U
TRICHLOROFLUOROMETHANE					1.2 U	2 J	2 J	2 J	2 J
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
ANTHRACENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
BENZO(A)ANTHRACENE	4 U	3.9 U	4 J	7 J	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
BENZO(A)PYRENE	4 U	3.9 U	6 J	10	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
BENZO(B)FLUORANTHENE	4 U	3.9 UJ	8 J	16 J	3.8 UJ	3.7 U	4.1 U	3.9 U	3.9 U
BENZO(G,H,I)PERYLENE	4 U	3.9 U	3.8 U	6 J	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
BENZO(K)FLUORANTHENE	4 U	3.9 U	6 J	13	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
BIS(2-ETHYLHEXYL)PHTHALATE	420 BU	80 U	80 BU	74 U	110 BU	150 BU	1000 BU	1400 BJ	660 BU
CHRYSENE	4 U	3.9 U	6 J	10	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
DIBENZO(A,H)ANTHRACENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
FLUORANTHENE	4 U	3.9 U	6 J	9	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
FLUORENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
INDENO(1,2,3-CD)PYRENE	4 U	3.9 U	3.8 U	6 J	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
ISOSAFROLE	81 U	80 U	76 U	74 U	77 U	75 U	82 U	80 U	80 U
NAPHTHALENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	5 J	3.9 U	3.9 U
PHENANTHRENE	4 U	3.9 U	3.8 U	3.7 U	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
PYRENE	4 U	3.9 U	7 J	12	3.8 U	3.7 U	4.1 U	3.9 U	3.9 U
SAFROLE	81 U	80 U	76 U	74 U	77 U	75 U	82 U	80 U	80 U
Herbicides (ug/kg)									
HEXACHLOROPHENE	1 U	1 U	0.97 U	0.94 U	0.98 U	0.96 U	1 U	1 U	1 U
PENTACHLOROPHENOL	1.6 J	0.54 U	0.51 U	0.5 U	0.52 U	0.51 U	0.55 U	0.54 U	0.54 U
Inorganics (mg/kg)									
ALUMINUM	9080 J	10300 J	5330 J	4790 J	7450 J	4530 J	12600 J	9140 J	8330 J
ANTIMONY	0.48 U	0.51 J	0.25 U	0.33 J	0.62 J	0.40 U	1.5 U	0.54 U	0.57 U
ARSENIC	5.6 J	10.2 J	2.1 J	2.8 J	2.6 J	2.4 J	7.9 J	5.7 J	4.6 J
BARIUM	37.6 J	119 J	30.2 J	34.7 J	45.3 J	26.7 J	58.2 J	58.2 J	72.2 J
BERYLLIUM	0.33 U	0.75 J	0.20 J	0.25 J	0.37 J	0.25 U	0.39 U	0.35 U	0.42 U
CADMIUM	0.18 U	0.43 J	0.19 J	0.57 J	0.24 J	0.19 U	0.28 U	0.21 U	0.22 U
CALCIUM	122 J	1040 J	146 J	2150 J	408 J	192 U	528 J	601 J	1130 J
CHROMIUM	11.9 J	13.6 J	6.7 J	8.0 J	10.9 J	10.0 J	14.5 J	13.5 J	11.4 J
COBALT	3.3 J	7.8 J	0.89 J	1.6 J	1.8 J	1.5 J	6.7 J	7.1 J	7.9 J
COPPER	11.2 J	17.1 J	5.4 J	12.4 J	15.5 J	5.5 J	13.7 J	8.7 J	17.2 J

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB30	16SB32	16SB33	16SB34	16SB36	16SB38	16SB39	16SB40	16SB40
NSAMPLE	16SB300203	16SB320204	16SB330204	16SB340203	16SB360203	16SB380203	16SB390203	16SB400506	16SB400608
SAMPLE	16SB300203	16SB320204	16SB330204	16SB340203	16SB360203	16SB380203	16SB390203	16SB400506	16SB400608
SUBMATRIX	SB	SB	SB	SB	SB	SB	SB	SB	SB
DEPTH RANGE	2 - 3	2 - 4	2 - 4	2 - 3	2 - 3	2 - 3	2 - 3	5 - 6	6 - 8
SAMPLE DATE	3/28/2003	4/9/2003	4/9/2003	4/9/2003	4/9/2003	3/28/2003	3/28/2003	3/28/2003	3/28/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
IRON	16900 J	18200 J	8650 J	9870 J	13300 J	12800 J	23900 J	17900 J	13600 J
LEAD	8.3 J	20.1 J	12.9 J	30.0 J	34.0 J	6.9 J	11.6 J	14.1 J	12.3 J
LITHIUM	5.9 U	8.3 J	3.4 J	3.7 J	4.6 J	4.3 J	9.7 J	7.9 J	7.3 J
MAGNESIUM	1740 J	1440 J	495 J	630 J	710 J	593 J	2000 J	1100 J	1010 J
MANGANESE	77.8 J	143 J	8.1 J	16.7 J	15.6 J	24.7 J	415 J	314 J	229 J
MERCURY	0.007 U	0.017 J	0.007 J	0.002 U	0.003 J	0.002 U	0.047 J	0.032 J	0.026 J
NICKEL	7.6 J	10.4 J	3.6 J	3.4 J	4.3 J	3.8 J	11.0 J	7.6 J	8.4 J
POTASSIUM	458 J	461 J	282 J	270 J	285 J	225 J	610 J	429 J	448 J
SELENIUM	0.19 U	0.22 J	0.07 U	0.11 U	0.05 U	0.06 U	0.31 U	0.36 U	0.30 U
SILVER	0.03 U	0.05 U	0.05 U	0.42 J	0.08 U	0.02 U	0.05 U	0.05 U	0.07 U
SODIUM	23.1 U	50.5 J	20.8 U	19.3 U	27.1 U	27.9 U	44.2 U	19.9 U	38.2 U
STRONTIUM	4.7 J	19.6 J	7.8 J	15.9 J	16.6 J	4.0 J	8.2 J	7.3 J	9.4 J
TIN	0.50 U	1.3 J	0.31 J	0.35 J	0.46 J	0.30 U	0.66 U	0.49 U	0.50 U
TITANIUM	121 J	74.4 J	23.0 J	29.4 J	42.2 J	30.1 J	99.3 J	82.0 J	70.3 J
VANADIUM	17.9 J	21.6 J	9.5 J	11.2 J	14.5 J	12.1 J	24.3 J	20.1 J	17.7 J
ZINC	27.9 J	31.2 J	8.6 U	54.5 J	83.3 J	11.6 U	39.7 U	26.7 U	33.3 U
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)									
PH (S.U.)									
TOTAL ORGANIC CARBON (mg/kg)									

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB40	16SB41	16SB41
NSAMPLE	16SB400608-D	16SB410305	16SB410507
SAMPLE	FD03280303	16SB410305	16SB410507
SUBMATRIX	SB	SB	SB
DEPTH RANGE	6 - 8	3 - 5	5 - 7
SAMPLE DATE	3/28/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB
Volatile Organics (ug/kg)			
ACETONE	1.2 UJ	4 J	14 J
CIS-1,2-DICHLOROETHENE	1.2 U	1.2 U	1.2 U
TRANS-1,2-DICHLOROETHENE	1.2 U	1.2 U	1.2 U
TRICHLOROETHENE	1.2 U	1.2 U	1.2 U
TRICHLOROFLUOROMETHANE	3 J	1.2 U	2 J
Semivolatile Organics (ug/kg)			
2-METHYLNAPHTHALENE	4 U	4 U	4 J
ANTHRACENE	4 U	4 U	4.1 U
BENZO(A)ANTHRACENE	4 U	4 U	4.1 U
BENZO(A)PYRENE	4 U	4 U	4.1 U
BENZO(B)FLUORANTHENE	4 U	4 U	4.1 U
BENZO(G,H,I)PERYLENE	4 U	4 U	4.1 U
BENZO(K)FLUORANTHENE	4 U	4 U	4.1 U
BIS(2-ETHYLHEXYL)PHTHALATE	350 BU	81 U	86 J
CHRYSENE	4 U	4 U	8
DIBENZO(A,H)ANTHRACENE	4 U	4 U	4.1 U
FLUORANTHENE	4 U	4 U	4.1 U
FLUORENE	4 U	4 U	4.1 U
INDENO(1,2,3-CD)PYRENE	4 U	4 U	4.1 U
ISOSAFROLE	81 U	81 U	150 J
NAPHTHALENE	4 U	4 U	6 J
PHENANTHRENE	4 U	4 U	6 J
PYRENE	4 U	4 U	6 J
SAFROLE	81 U	81 U	67000
Herbicides (ug/kg)			
HEXACHLOROPHENE	1 U	0.73 U	0.74 U
PENTACHLOROPHENOL	0.55 U	0.55 U	0.56 U
Inorganics (mg/kg)			
ALUMINUM	11300 J	18600 J	11800 J
ANTIMONY	0.74 U	0.75 U	0.33 U
ARSENIC	7.2 J	6.0 J	9.4 J
BARIUM	68.6 J	76.8 J	36.5 J
BERYLLIUM	0.44 U	0.47 J	0.34 J
CADMIUM	0.27 U	0.27 U	0.25 U
CALCIUM	1740 J	1540 J	586 J
CHROMIUM	14.7 J	20.0 J	21.8 J
COBALT	7.2 J	4.4 J	4.0 J
COPPER	12.5 J	11.5 J	7.0 J

TABLE C-2
POSITIVE HITS
SUBSURFACE SOIL
SWMU 16 - CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SB40	16SB41	16SB41
NSAMPLE	16SB400608-D	16SB410305	16SB410507
SAMPLE	FD03280303	16SB410305	16SB410507
SUBMATRIX	SB	SB	SB
DEPTH RANGE	6 - 8	3 - 5	5 - 7
SAMPLE DATE	3/28/2003	3/27/2003	3/27/2003
VALIDATED	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB
IRON	22100 J	20800 J	30300 J
LEAD	12.6 J	9.7 J	8.6 J
LITHIUM	9.7 J	13.5 J	8.4 J
MAGNESIUM	1550 J	2620 J	1290 J
MANGANESE	443 J	298 J	167 J
MERCURY	0.060 J	0.058 J	0.020 J
NICKEL	9.9 J	11.5 J	6.5 J
POTASSIUM	635 J	1550 J	810 J
SELENIUM	0.42 U	0.28 U	0.26 U
SILVER	0.03 U	0.04 U	0.03 U
SODIUM	38.6 U	69.4 U	62.0 U
STRONTIUM	15.7 J	17.1 J	8.0 J
TIN	0.59 U	0.55 U	0.49 U
TITANIUM	123 J	177 J	173 J
VANADIUM	25.1 J	33.9 J	32.4 J
ZINC	34.2 U	31.8 J	17.6 J
Miscellaneous Parameters			
CATION EXCHANGE CAPACITY (MEQ/1)		22	15
PH (S.U.)		7.5	5.3
TOTAL ORGANIC CARBON (mg/kg)		1400 J	3400 J

APPENDIX C.3

GROUND WATER

TABLE C-3
POSITIVE HITS
GROUND WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16MW01	16MW02	16MW02	16MW03	16MW04	16MW05	16MWT01	16MWT02	16MWT03	16MWT04
NSAMPLE	16GW0101	16GW0201	16GW0202	16GW0301	16GW0401	16GW0501	16GWT0101	16GWT0201	16GWT0301	16GWT0401
SAMPLE	16GW0101	16GW0201	16GW0202	16GW0301	16GW0401	16GW0501	16GWT0101	16GWT0201	16GWT0301	16GWT0401
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—
SAMPLE DATE	4/23/2003	4/24/2003	5/11/2003	5/11/2003	4/23/2003	4/22/2003	4/22/2003	4/22/2003	4/25/2003	4/22/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)										
1,1,2-TRICHLOROETHANE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
1,1-DICHLOROETHENE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
4-METHYL-2-PENTANONE	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
ACETONE	0.5 UR	0.5 UR		0.5 UR	0.5 UR	0.5 UR	1.3 J	0.5 UR	0.5 UR	0.5 UR
BENZENE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
BROMODICHLOROMETHANE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CARBON DISULFIDE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CARBON TETRACHLORIDE	0.3 U	0.3 U		15	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CHLOROFORM	0.3 U	0.3 U		5.6	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
CIS-1,2-DICHLOROETHENE	0.3 U	0.3 U		0.4 J	0.3 J	0.3 U	1.9	0.3 U	0.3 U	0.3 U
TETRACHLOROETHENE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
TOLUENE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
TRANS-1,2-DICHLOROETHENE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
TRICHLOROETHENE	2	0.3 U		5.6	0.5 J	0.5 J	16	1.2	0.3 U	2.2
VINYL CHLORIDE	0.3 U	0.3 U		0.3 U	0.3 U	0.3 U	0.3 J	0.3 U	0.3 U	0.3 U
Semivolatile Organics (ug/L)										
2-METHYLNAPHTHALENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
ACENAPHTHENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
BENZO(B)FLUORANTHENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
CHRYSENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
DIETHYL PHTHALATE	1 U	1 U	1 U	1 U	1 U	1 U		1 U	1 U	1 U
FLUORANTHENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
FLUORENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
PHENANTHRENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
PYRENE	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U		0.05 U	0.05 U	0.05 U
PYRIDINE	1 U	1 U	1 U	1 U	1 U	1 U		1 U	1 U	1 U
Energetics (ug/L)										
2-AMINO-4,6-DINITROTOLUENE	0.65 U	0.21 U		0.48 J	0.165 U	0.42 U		0.385 U	0.5 U	0.55 U
4-AMINO-2,6-DINITROTOLUENE	0.65 U	0.21 U		0.86 J	0.165 U	0.42 U		0.385 U	0.5 U	0.55 U
HMX	0.65 U	0.21 U		5.7	0.39	1.2 J		0.385 U	0.5 U	7.8
RDX	0.6 U	0.195 U		52	1.7	4.8		0.79	0.48 U	77
Inorganics (ug/L)										
ALUMINUM	19.2 J	85.6	60.6 U	1050	9680	5030		168	140	1050
ARSENIC	2.7 J	0.16 U	0.33 U	0.10 U	1.5 J	1.6 J		0.81 J	1.6 J	0.41 U
BARIUM	5.0 J	21.6 J	18.0 J	13.5 J	9.4 J	12.0 J		107 J	18.1 J	68.7 J
BERYLLIUM	0.16 U	0.42 U	0.34 U	0.48 U	2.0 J	1.1 U		0.06 U	0.28 U	0.16 U
CADMIUM	0.05 U	0.31 U	0.22 U	0.17 U	0.83 J	1.1 J		0.13 U	0.20 U	0.16 U

TABLE C-3
POSITIVE HITS
GROUND WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16MW01	16MW02	16MW02	16MW03	16MW04	16MW05	16MWT01	16MWT02	16MWT03	16MWT04
NSAMPLE	16GW0101	16GW0201	16GW0202	16GW0301	16GW0401	16GW0501	16GWT0101	16GWT0201	16GWT0301	16GWT0401
SAMPLE	16GW0101	16GW0201	16GW0202	16GW0301	16GW0401	16GW0501	16GWT0101	16GWT0201	16GWT0301	16GWT0401
SUBMATRIX	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—	—	—	—	—	—	—
SAMPLE DATE	4/23/2003	4/24/2003	5/11/2003	5/11/2003	4/23/2003	4/22/2003	4/22/2003	4/22/2003	4/25/2003	4/22/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
CALCIUM	194000 J	99400 J	97300 J	48900 J	66900 J	72800 J		47200 J	39500 J	22600 J
CHROMIUM	0.27 U	0.43 U	0.29 U	0.44 U	0.55 U	0.51 U		0.56 U	0.41 U	0.68 J
COBALT	154 J	12.9 J	9.2 J	15.1 J	51.7 J	34.4 J		3.9 J	40.9 J	7.1 J
COPPER	0.06 U	0.87 J	0.15 U	0.82 J	0.12 U	0.11 U		2.8 J	2.1 J	3.4 J
IRON	52700 J	287 J	415 J	698 J	4870 J	2190 J		5850 J	39400 J	568 J
LEAD	0.03 U	0.21 U	0.28 U	0.12 U	0.43 U	0.89 J		0.51 U	1.1 J	0.43 U
LITHIUM	328 J	32.7 J	33.6 J	33.2 J	120 J	92.7 J		0.72 U	101 J	8.5 J
MAGNESIUM	84500 J	6240 J	6480 J	14000 J	29000 J	30600 J		10900 J	25000 J	8270 J
MANGANESE	29300 J	916 J	864 J	1960 J	3710 J	2550 J		2590 J	3930 J	353 J
NICKEL	198 J	34.2 J	27.0 J	43.1 J	186 J	134 J		1.5 J	93.4 J	21.1 J
POTASSIUM	9390 J	738 J	3390 U	2780 J	3240 J	3760 J		1400 J	4260 J	1360 J
SELENIUM	0.05 U	0.05 U	0.06 U	0.36 U	0.05 U	0.05 U		0.20 U	0.32 U	0.43 U
SODIUM	25900 J	18000 J	17900 J	7190 J	13400 J	13500 J		26900 J	26700 J	18200 J
STRONTIUM	197 J	88.4 J	98.4 J	254 J	199 J	279 J		387 J	158 J	278 J
TITANIUM	1.2 J	3.8 J	3.0 J	1.0 J	2.0 J	2.0 J		4.3 J	2.9 J	8.4 J
VANADIUM	0.05 U	0.30 U	0.35 U	0.05 U	0.86 J	0.60 J		0.36 U	0.14 U	0.51 J
ZINC	157 J	50.0 J	42.9 J	69.5 J	244 J	222 J		31.9 J	108 J	15.9 J
Miscellaneous Parameters (mg/L)										
AMMONIA-N	0.41	0.04		0.02	0.08	0.03		0.53	0.33	0.03
NITRITE/NITRATE-N	0.02 U	0.02 U		0.54	0.02 U	0.02 U		0.03	0.02 U	0.6
Field Parameters										
DISSOLVED OXYGEN (mg/L)	0.32	0.64	1.18	1.63	0.29	0.9	4.51	0.82	0.64	5.41
OXIDATION REDUCTION POTENTIAL (MV)	-130	7.1	-46.1	154.2	207.4	152	63.1	-7.1	35	79.7
PH (S.U.)	6.4	6.65	6.69	5.84	3.68	4.38	6.51	6.33	5.23	6.28
SPECIFIC CONDUCTANCE (MS/CM)	1.606	0.568	0.496	0.483	0.72	0.625	1.061	0.4	0.607	0.225
TEMPERATURE (C)	13.79	11.8	12.84	14.17	13.31	12.95	13.01	11.51	12.26	12.41
TURBIDITY (NTU)	0.05	2.2	0.4	2.8	0.5	0	999 >	3.4	10	9.2

TABLE C-3
POSITIVE HITS
GROUND WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16MWT05	16MWT05	16MWT06	16MWT06
NSAMPLE	16GWT0501	16GWT0501-D	16GWT0601	16GWT0602
SAMPLE	16GWT0501	FD04240301	16GWT0601	16GWT0602
SUBMATRIX	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—
SAMPLE DATE	4/24/2003	4/24/2003	4/28/2003	5/11/2003
VALIDATED	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB
Volatile Organics (ug/L)				
1,1,2-TRICHLOROETHANE	0.3 U	0.3 U	38 J	
1,1-DICHLOROETHENE	0.3 U	0.3 U	26 J	
4-METHYL-2-PENTANONE	0.5 U	0.5 U	3.5 J	
ACETONE	0.5 UR	0.5 UR	10 U	
BENZENE	0.3 U	0.3 U	0.9 J	
BROMODICHLOROMETHANE	0.3 U	0.3 U	0.8 J	
CARBON DISULFIDE	0.3 U	0.3 U	0.8 J	
CARBON TETRACHLORIDE	0.3 U	0.3 U	0.3 UJ	
CHLOROFORM	0.3 U	0.3 U	12 J	
CIS-1,2-DICHLOROETHENE	0.3 U	0.3 U	600	
TETRACHLOROETHENE	0.3 U	0.3 U	13 J	
TOLUENE	0.3 U	0.3 U	32 J	
TRANS-1,2-DICHLOROETHENE	0.3 U	0.3 U	3.1 J	
TRICHLOROETHENE	0.3 U	0.3 U	35000	
VINYL CHLORIDE	0.3 U	0.3 U	65 J	
Semivolatile Organics (ug/L)				
2-METHYLNAPHTHALENE	0.05 U	0.05 U	0.11	
ACENAPHTHENE	0.05 U	0.05 U	0.07 J	
BENZO(B)FLUORANTHENE	0.05 U	0.05 U	0.09 J	
CHRYSENE	0.05 U	0.05 U	0.1 J	
DIETHYL PHTHALATE	1 U	1 U	1 J	1 U
FLUORANTHENE	0.05 U	0.05 U	0.11	
FLUORENE	0.05 U	0.05 U	0.1 J	
PHENANTHRENE	0.05 U	0.05 U	0.54	
PYRENE	0.05 U	0.05 U	0.2	
PYRIDINE	1 U	1 U	1 U	9
Energetics (ug/L)				
2-AMINO-4,6-DINITROTOLUENE	0.375 U	0.135 U	0.34 U	
4-AMINO-2,6-DINITROTOLUENE	0.375 U	0.135 U	0.34 U	
HMX	0.375 U	0.135 U	0.34 U	
RDX	0.355 U	0.13 U	4	
Inorganics (ug/L)				
ALUMINUM	6020	6120	222 J	
ARSENIC	3.5 J	3.3 J	4.5 J	
BARIUM	14.2 J	14.7 J	36.9 J	
BERYLLIUM	4.7 J	4.2 J	0.03 U	
CADMIUM	0.21 U	0.22 U	0.05 UJ	

TABLE C-3
POSITIVE HITS
GROUND WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16MWT05	16MWT05	16MWT06	16MWT06
NSAMPLE	16GWT0501	16GWT0501-D	16GWT0601	16GWT0602
SAMPLE	16GWT0501	FD04240301	16GWT0601	16GWT0602
SUBMATRIX	GW	GW	GW	GW
DEPTH RANGE	—	—	—	—
SAMPLE DATE	4/24/2003	4/24/2003	4/28/2003	5/11/2003
VALIDATED	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB
CALCIUM	57000 J	56800 J	96800 J	
CHROMIUM	0.58 U	0.73 J	0.93 J	
COBALT	92.1 J	93.4 J	2.0 J	
COPPER	1.4 J	1.5 J	4.9 J	
IRON	29700 J	30400 J	171 J	
LEAD	1.8 J	1.9 J	0.40 U	
LITHIUM	310 J	318 J	21.9 J	
MAGNESIUM	27200 J	27900 J	19700 J	
MANGANESE	6510 J	6680 J	482 J	
NICKEL	304 J	301 J	8.1 J	
POTASSIUM	3590 J	3660 J	11900 J	
SELENIUM	0.19 U	0.19 U	1.2 J	
SODIUM	14300 J	14700 J	37100 J	
STRONTIUM	106 J	109 J	186 J	
TITANIUM	3.2 J	3.1 J	4.0 J	
VANADIUM	0.60 J	0.58 J	0.80 J	
ZINC	329 J	294 J	6.2 J	
Miscellaneous Parameters (mg/L)				
AMMONIA-N	0.32	0.33	0.57	
NITRITE/NITRATE-N	0.02 U	0.02 U	0.5	
Field Parameters				
DISSOLVED OXYGEN (mg/L)	0.2		0.48	6.94
OXIDATION REDUCTION POTENTIAL (MV)	185		-106	-117.1
PH (S.U.)	4.42		7.7	6.93
SPECIFIC CONDUCTANCE (MS/CM)	0.684		0.516	0.96
TEMPERATURE (C)	14.47		15	14.2
TURBIDITY (NTU)	6.8		8.8	43.1

APPENDIX C.4

SURFACE WATER

TABLE C-4
POSITIVE HITS
SURFACE WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SW01	16SW01	16SW02	16SW02	16SW07	16SW07	16SW07	16SW07
NSAMPLE	16SW0101	16SW0101-F	16SW0201	16SW0201-F	16SW0701	16SW0701-D	16SW0701-F	16SW0701-F-D
SAMPLE	16SW0101	16SW0101F	16SW0201	16SW0201F	16SW0701	FD04100301	16SW0701F	FD04100301-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/1/2003	4/1/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/L)								
2-METHYLNAPHTHALENE	0.67 J		0.05 U		0.05 U	0.05 U		
ACENAPHTHENE	0.9 J		0.05 UJ		0.05 UJ	0.05 UJ		
ANTHRACENE	0.31 J		0.05 U		0.05 U	0.05 U		
BENZO(A)ANTHRACENE	0.31 J		0.05 U		0.05 U	0.05 U		
BIS(2-ETHYLHEXYL)PHTHALATE	86 BJ		2 BU		3 BU	2 BU		
CHRYSENE	0.78 J		0.05 U		0.05 U	0.05 U		
FLUORANTHENE	1.09 J		0.05 U		0.05 U	0.05 U		
FLUORENE	0.59 J		0.05 U		0.05 U	0.05 U		
NAPHTHALENE	1.3 J		0.05 U		0.05 U	0.05 U		
PHENANTHRENE	1.26 J		0.05 U		0.05 U	0.05 U		
PYRENE	2.34 J		0.05 U		0.05 U	0.05 U		
Energetics (ug/L)								
2,4,6-TRINITROTOLUENE	0.455 U		0.8 U		2.1	2.1		
2-AMINO-4,6-DINITROTOLUENE	0.455 U		0.8 U		0.89 J	0.86 J		
4-AMINO-2,6-DINITROTOLUENE	0.455 U		0.8 U		2.2 J	2.2 J		
HMX	29000		1.5 J		0.55 U	0.42 U		
RDX	88000		9.2		2.9	2.9		
Herbicides (ug/L)								
HEXACHLOROPHENE	0.082 J		0.025 U		0.025 U	0.025 U		
PENTACHLOROPHENOL	0.19 J		0.02 J		0.015 R	0.016 J		
Total Metals (ug/L)								
ALUMINUM	7.6 U		82.4 U		298 J	228 J		
ARSENIC	0.38 U		3.4 J		2.9 J	2.9 J		
BARIUM	66.3 J		91.0 J		73.4 J	72.9 J		
CALCIUM	30300 J		30400 J		37100 J	36500 J		
CHROMIUM	0.25 U		3.4 J		2.0 J	1.8 J		
COPPER	2.0 J		17.2 J		10.7 J	11.0 J		
IRON	60.5 J		77.1 U		194 U	167 U		
LEAD	0.15 U		13.1 J		4.6 J	4.6 J		
MAGNESIUM	5190 J		5700 J		6560 J	6540 J		
MANGANESE	44.3 J		10.6 J		5.2 J	4.9 J		
MERCURY	2.0		0.020 U		0.020 U	0.020 U		
NICKEL	1.8 J		0.61 U		0.95 J	0.97 J		
POTASSIUM	1640 J		839 J		2430 J	2380 J		
SODIUM	12400 J		29300 J		84800 J	83300 J		
STRONTIUM	190 J		213 J		226 J	233 J		
TITANIUM	0.24 U		2.2 J		10.2 J	4.3 J		

TABLE C-4
POSITIVE HITS
SURFACE WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SW01	16SW01	16SW02	16SW02	16SW07	16SW07	16SW07	16SW07
NSAMPLE	16SW0101	16SW0101-F	16SW0201	16SW0201-F	16SW0701	16SW0701-D	16SW0701-F	16SW0701-F-D
SAMPLE	16SW0101	16SW0101F	16SW0201	16SW0201F	16SW0701	FD04100301	16SW0701F	FD04100301-F
SUBMATRIX	SW	SW	SW	SW	SW	SW	SW	SW
DEPTH RANGE	—	—	—	—	—	—	—	—
SAMPLE DATE	4/1/2003	4/1/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003	4/10/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
VANADIUM	0.05 U		0.39 U		1.2 J	1.0 J		
ZINC	3.2 U		178 J		80.1 J	79.7 J		
Dissolved Metals (ug/L)								
ALUMINUM, FILTERED		575		22.3 U			49.4 U	40.4 U
ANTIMONY, FILTERED		2.1 U		2.8 U			2.5 U	3.2 J
ARSENIC, FILTERED		0.60 U		3.2 J			2.8 J	2.8 J
BARIUM, FILTERED		70.5 J		91.5 J			71.8 J	71.4 J
CADMIUM, FILTERED		3.3 J		0.40 U			0.15 U	0.41 U
CALCIUM, FILTERED		31000 J		29200 J			37700 J	38200 J
CHROMIUM, FILTERED		1.7 J		3.2 J			1.5 J	1.6 J
COPPER, FILTERED		17.9 J		16.2 J			9.1 J	9.3 J
IRON, FILTERED		4100 J		36.6 U			42.3 U	42.5 U
LEAD, FILTERED		26.2 J		8.4 J			1.9 U	2.3 J
MAGNESIUM, FILTERED		5310 J		5620 J			6560 J	6530 J
MANGANESE, FILTERED		23.4 J		10.1 J			2.8 U	2.9 U
NICKEL, FILTERED		2.2 J		0.50 U			0.84 J	0.80 U
POTASSIUM, FILTERED		1940 J		842 J			2370 J	2360 J
SODIUM, FILTERED		12100 J		28200 J			87000 J	89000 J
STRONTIUM, FILTERED		196 J		207 J			234 J	237 J
TITANIUM, FILTERED		3.9 J		1.3 U			3.2 J	2.2 J
ZINC, FILTERED		78.6 J		170 J			68.0 J	68.3 J
Miscellaneous Parameters (mg/L)								
AMMONIA-N	2.8 J		0.01 U		0.01 U	0.02		
NITRITE/NITRATE-N	3.3 J		0.22		1.5	1.5		
Field Parameters								
DISSOLVED OXYGEN (mg/L)			10.51		10.63			
OXIDATION REDUCTION POTENTIAL (MV)			90.9		89.1			
PH (S.U.)			8.13		8.4			
SPECIFIC CONDUCTANCE (MS/CM)			0.281		0.591			
TEMPERATURE (C)			9.14		11.78			
TURBIDITY (NTU)			2.1		4.2			

APPENDIX C.5

SEDIMENT

TABLE C-5
POSITIVE HITS
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SD02	16SD03	16SD04	16SD05	16SD06	16SD06	16SD08	16SD09	16SD10
NSAMPLE	16SD020004	16SD030004	16SD040004	16SD050004	16SD060004	16SD060004-D	16SD080004	16SD090004	16SD100004
SAMPLE	16SD020004	16SD030004	16SD040004	16SD050004	16SD060004	FD04010302	16SD080004	16SD090004	16SD100004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
SACODE	NORMAL	NORMAL	NORMAL	NORMAL	ORIG	DUP	NORMAL	NORMAL	NORMAL
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
Semivolatile Organics (ug/kg)									
2-METHYLNAPHTHALENE	4.4 U	5 J	4.3 U	4 U	4.1 U	4.2 U	4.4 U	4.3 U	4.3 U
ACENAPHTHENE	4.4 U	3.9 U	4.3 U	8 J	4.1 U	4.2 U	4.4 U	4.3 U	4.3 U
ACENAPHTHYLENE	4.4 U	8	5 J	4 J	4.1 U	4.2 U	4.4 U	4.3 U	4.3 U
ANTHRACENE	4.4 U	3.9 U	5 J	15	4.1 U	4.2 U	4.4 U	4.3 U	5 J
BENZO(A)ANTHRACENE	6 J	13 J	7 J	66	5 J	5 J	4.4 UJ	4.3 U	15
BENZO(A)PYRENE	8 J	3.9 UJ	12	84	7 J	7 J	4.4 UJ	4.3 U	21
BENZO(B)FLUORANTHENE	20	3.9 UJ	32	120	10	9	4.4 UJ	6 J	30
BENZO(G,H,I)PERYLENE	11	62 J	33	65	5 J	7 J	4.4 UJ	4.3 U	29
BENZO(K)FLUORANTHENE	9	3.9 UJ	8 J	65	7 J	5 J	4.4 UJ	4.3 U	18
CHRYSENE	19	60 J	18	100	12	7 J	4.4 UJ	5 J	31
DI-N-BUTYL PHTHALATE	89 U	79 U	86 U	82 U	84 U	85 U	130 J	87 U	87 U
DIBENZO(A,H)ANTHRACENE	4.4 U	3.9 UJ	4.3 U	18	4.1 U	4.2 U	4.4 UJ	4.3 U	4.3 U
DIPHENYLAMINE	89 U	170 J	86 U	82 U	84 UJ	460 J	90 U	140 J	87 U
FLUORANTHENE	25	22	12	160	11	8 J	5 J	6 J	30
FLUORENE	4.4 U	3.9 U	4.3 U	8 J	4.1 U	4.2 U	4.4 U	4.3 U	4.3 U
INDENO(1,2,3-CD)PYRENE	7 J	43 J	24	55	4.1 U	6 J	4.4 UJ	4.3 U	19
NAPHTHALENE	4.4 U	6 J	4.3 U	5 J	4.1 U	4.2 U	4.4 U	4.3 U	4.3 U
PHENANTHRENE	14	14	8 J	100	6 J	6 J	4 J	4.3 U	18
PYRENE	20	44 J	17	170	13	10	9 J	6 J	39
Energetics (mg/kg)									
RDX	0.25 U	0.27 J	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Herbicides (ug/kg)									
PENTACHLOROPHENOL	0.6 U	2.9 J	7.6	0.55 U	0.56 U	0.57 U	0.6 U	2.6 J	9.4 J
Inorganics (mg/kg)									
ALUMINUM	11800	6060 J	12900 J	6620 J	5560	6950	8190 J	9830	6940 J
ANTIMONY	7.8 J	69.6 J	42.0 J	35.3 J	174 J	4.8 J	4.3 J	15.1 J	25.5 J
ARSENIC	11.2 J	3.4 J	8.7 J	6.6 J	3.9 J	2.6 J	8.8 J	9.8 J	14.1 J
BARIUM	1240 J	2820 J	231 J	1460 J	1680 J	357 J	143 J	572 J	257 J
BERYLLIUM	0.63 J	0.39 U	0.56 J	0.43 J	0.52 J	0.41 U	0.59 J	0.56 J	0.88 J
CADMIUM	4.8 J	18.1 J	7.1 J	18.1 J	19.5 J	4.5 J	0.80 J	11.1 J	6.8 J
CALCIUM	2980 J	54200 J	2450 J	59800 J	28600 J	6760 J	1520 J	4240 J	1480 J
CHROMIUM	20.5 J	15.4 J	19.6 J	24.7 J	23.8 J	12.9 J	13.3 J	19.6 J	68.5 J
COBALT	12.4 J	3.4 J	11.2 J	9.3 J	6.3 J	4.3 J	12.8 J	11.6 J	14.0 J
COPPER	172 J	1980 J	68.7 J	1790 J	2570 J	274 J	85.3 J	332 J	250 J
IRON	30600 J	21000 J	25500 J	25800 J	30500 J	20900 J	18200 J	25700 J	65100 J
LEAD	770 J	4990 J	229 J	3570 J	15200 J	2510 J	336 J	1480 J	1010 J

TABLE C-5
POSITIVE HITS
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SD02	16SD03	16SD04	16SD05	16SD06	16SD06	16SD08	16SD09	16SD10
NSAMPLE	16SD020004	16SD030004	16SD040004	16SD050004	16SD060004	16SD060004-D	16SD080004	16SD090004	16SD100004
SAMPLE	16SD020004	16SD030004	16SD040004	16SD050004	16SD060004	FD04010302	16SD080004	16SD090004	16SD100004
SUBMATRIX	SD	SD	SD	SD	SD	SD	SD	SD	SD
SACODE	NORMAL	NORMAL	NORMAL	NORMAL	ORIG	DUP	NORMAL	NORMAL	NORMAL
DEPTH RANGE	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3
SAMPLE DATE	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003	4/1/2003
VALIDATED	Y	Y	Y	Y	Y	Y	Y	Y	Y
COLLECTION METHOD	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
LITHIUM	8.8 J	2.9 J	10.4 J	4.7 J	4.1 J	5.1 J	7.2 J	8.1 J	4.5 J
MAGNESIUM	1620 J	4820 J	2100 J	6080 J	2220 J	1320 J	1310 J	1540 J	677 J
MANGANESE	893 J	175 J	300 J	790 J	376 J	63.9 J	966 J	596 J	918 J
MERCURY	0.17 J	2.7 J	0.35 J	0.18 J	0.22 J	0.006 J	0.080 J	0.10 J	1.1 J
NICKEL	13.5 J	12.5 J	13.2 J	17.6 J	16.5 J	8.8 J	10.6 J	12.1 J	12.1 J
POTASSIUM	606 J	282 J	645 J	350 J	438 J	581 J	492 J	605 J	328 J
SELENIUM	0.55 J	0.17 U	0.46 J	0.33 J	0.14 U	0.12 U	0.50 J	0.47 J	0.39 J
SODIUM	40.2 U	43.8 U	23.6 U	34.4 U	20.6 U	18.5 U	44.0 U	16.3 U	11.7 U
STRONTIUM	51.0 J	2740 J	109 J	791 J	886 J	196 J	62.2 J	227 J	57.8 J
TIN	2.2 J	12.3 J	3.2 J	12.5 J	19.0 J	1.1 J	1.1 J	2.4 J	2.8 J
TITANIUM	82.5 J	35.7 J	156 J	64.3 J	9.4 J	20.6 J	112 J	60.7 J	95.3 J
VANADIUM	34.9 J	12.8 J	35.8 J	21.0 J	17.1 J	16.1 J	25.0 J	29.5 J	48.9 J
ZINC	1700 J	23400 J	952 J	14300 J	7700 J	826 J	573 J	1570 J	2330 J
AVS/SEM Parameters (UMO/g)									
ACID VOLATILE SULFIDE	0.53				0.56	0.54		0.59	
CADMIUM, SEM	0.024 J				0.145 J	0.084 J		0.075 J	
COPPER, SEM	1.83				18.3	17.4		4.98	
LEAD, SEM	2.6				16.3	14.6		4.14	
MERCURY, SEM	0.00011				0.00014	0.00009		0.00015	
NICKEL, SEM	0.028				0.068	0.063		0.035	
SEM/AVS S.U.	51				220	190		50	
ZINC, SEM	22.4 J				91 J	72.6 J		20.6 J	
Miscellaneous Parameters									
CATION EXCHANGE CAPACITY (MEQ/1)	25 J				5.7 J	17 J		18 J	
PH (S.U.)	7.4				8	8		7.8	
TOTAL ORGANIC CARBON (mg/kg)	8600				1600	1000 U		3900	

TABLE C-5
POSITIVE HITS
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SD11	16SD11
NSAMPLE	16SD110004	16SD110004-D
SAMPLE	16SD110004	FD04010301
SUBMATRIX	SD	SD
SACODE	ORIG	DUP
DEPTH RANGE	0 - 0.3	0 - 0.3
SAMPLE DATE	4/1/2003	4/1/2003
VALIDATED	Y	Y
COLLECTION METHOD	GRAB	GRAB
Semivolatile Organics (ug/kg)		
2-METHYLNAPHTHALENE	5.8 U	6 J
ACENAPHTHENE	5.8 U	5.9 U
ACENAPHTHYLENE	5.8 U	6 J
ANTHRACENE	6 J	9 J
BENZO(A)ANTHRACENE	31 J	52 J
BENZO(A)PYRENE	43 J	69 J
BENZO(B)FLUORANTHENE	57 J	87 J
BENZO(G,H,I)PERYLENE	63 J	110 J
BENZO(K)FLUORANTHENE	28 J	59 J
CHRYSENE	52	74 J
DI-N-BUTYL PHTHALATE	120 U	120 U
DIBENZO(A,H)ANTHRACENE	5.8 UJ	5.9 UJ
DIPHENYLAMINE	120 U	120 U
FLUORANTHENE	55	85
FLUORENE	5.8 U	5.9 U
INDENO(1,2,3-CD)PYRENE	38 J	73 J
NAPHTHALENE	5.8 U	5.9 U
PHENANTHRENE	30	42
PYRENE	88	130 J
Energetics (mg/kg)		
RDX	0.25 U	0.25 U
Herbicides (ug/kg)		
PENTACHLOROPHENOL	19 J	24 J
Inorganics (mg/kg)		
ALUMINUM	10300 J	9650 J
ANTIMONY	8.1 J	7.6 J
ARSENIC	10.3 J	8.4 J
BARIUM	171 J	351 J
BERYLLIUM	0.80 J	0.64 J
CADMIUM	3.0 J	3.4 J
CALCIUM	7740 J	9750 J
CHROMIUM	27.0 J	17.7 J
COBALT	10.2 J	13.1 J
COPPER	266 J	282 J
IRON	28500 J	20900 J
LEAD	1120 J	991 J

TABLE C-5
POSITIVE HITS
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

LOCATION	16SD11	16SD11
NSAMPLE	16SD110004	16SD110004-D
SAMPLE	16SD110004	FD04010301
SUBMATRIX	SD	SD
SACODE	ORIG	DUP
DEPTH RANGE	0 - 0.3	0 - 0.3
SAMPLE DATE	4/1/2003	4/1/2003
VALIDATED	Y	Y
COLLECTION METHOD	GRAB	GRAB
LITHIUM	8.1 J	8.4 J
MAGNESIUM	1700 J	1870 J
MANGANESE	976 J	1630 J
MERCURY	0.25 J	0.26 J
NICKEL	22.5 J	22.6 J
POTASSIUM	589 J	672 J
SELENIUM	0.90 J	0.98 J
SODIUM	160 J	203 J
STRONTIUM	58.0 J	79.0 J
TIN	5.3 J	4.3 J
TITANIUM	100 J	103 J
VANADIUM	40.3 J	35.3 J
ZINC	2680 J	2250 J
AVS/SEM Parameters (UMO/g)		
ACID VOLATILE SULFIDE		
CADMIUM, SEM		
COPPER, SEM		
LEAD, SEM		
MERCURY, SEM		
NICKEL, SEM		
SEM/AVS S.U.		
ZINC, SEM		
Miscellaneous Parameters		
CATION EXCHANGE CAPACITY (MEQ/1)		
PH (S.U.)		
TOTAL ORGANIC CARBON (mg/kg)		

APPENDIX D

SWMU 16 ROUND 1 FREQUENCY OF DETECTION SUMMARY TABLES

APPENDIX D.1

SURFACE SOIL

TABLE D-1
FREQUENCY OF DETECTION
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Volatiles								
730	NA	3900000	3100	1600000	2500	67-64-1	ACETONE	3	J	71	J	UG/KG	16SS290002	8/39	1.1 - 8
20	NA	110000	400	43000	783.73	156-59-2	CIS-1,2-DICHLOROETHENE	2	J	23		UG/KG	16SS390002	2/39	1 - 1.3
28000	250000	NA	NA	94000	39500	75-71-8	DICHLORODIFLUOROMETHANE	10	J	10	J	UG/KG	16SS330002	1/39	1 - 1.3
180	1500000	11000000	3500	1700000	4690	100-42-5	STYRENE	1	J	1	J	UG/KG	16SS040002	1/39	1 - 1.3
590	650000	1700000	12000	520000	5450	108-88-3	TOLUENE	1	J	1	J	UG/KG	16SS160002	1/39	1 - 1.3
34	NA	180000	680	69000	783.73	156-60-5	TRANS-1,2-DICHLOROETHENE	1	J	2	J	UG/KG	16SS030002	4/39	1 - 1.3
34	NA	180000	680	69000	783.73	156-60-5	TRANS-1,2-DICHLOROETHENE	1	J	2	J	UG/KG	16SS390002	4/39	1 - 1.3
2.8	4600	45000	57	53	12400	79-01-6	TRICHLOROETHENE	2	J	86		UG/KG	16SS390002	4/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS130002	31/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS230002	31/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS240002	31/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS290002	31/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS330002	31/39	1 - 1.3
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	3	J	UG/KG	16SS350002	31/39	1 - 1.3
7800	990000	1100000	2300	430000	12700	108-05-4	VINYL ACETATE	1	J	1	J	UG/KG	16SS190002	2/39	1 - 1.3
7800	990000	1100000	2300	430000	12700	108-05-4	VINYL ACETATE	1	J	1	J	UG/KG	16SS350002	2/39	1 - 1.3
							Semivolatiles								
NA	NA	3700000	16000	56000	3240	91-57-6	2-METHYLNAPHTHALENE	4	J	94		UG/KG	16SS030002	2/39	3.4 - 4.3
31000	NA	9500000	130000	3700000	682000	83-32-9	ACENAPHTHENE	5	J	1800		UG/KG	16SS030002	2/39	3.5 - 4.3
NA	NA	NA	NA	3700000	682000	208-96-8	ACENAPHTHYLENE	4	J	680		UG/KG	16SS030002	3/39	3.5 - 4.3
650000	NA	47000000	51000	22000000	1480000	120-12-7	ANTHRACENE	5	J	3500		UG/KG	16SS030002	4/39	3.5 - 4.3
80	NA	5100	19000	620	5210	56-55-3	BENZO(A)ANTHRACENE	4	J	9600		UG/KG	16SS030002	12/39	3.5 - 4.3
410	NA	510	8200	62	1520	50-32-8	BENZO(A)PYRENE	4	J	8400		UG/KG	16SS030002	13/39	3.5 - 4.3
200	NA	5100	57000	620	59800	205-99-2	BENZO(B)FLUORANTHENE	4	J	9200		UG/KG	16SS030002	16/39	3.5 - 4.2
NA	NA	NA	NA	2300000	119000	191-24-2	BENZO(G,H,I)PERYLENE	4	J	5100		UG/KG	16SS030002	12/39	3.5 - 4.3
2000	NA	51000	39000	6200	148000	207-08-9	BENZO(K)FLUORANTHENE	4	J	5000		UG/KG	16SS030002	11/39	3.5 - 4.3
180000	NA	310000	3600000	35000	925.94	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	92	J	1200		UG/KG	16SS040002	9/39	69 - 730
8000	NA	510000	26000	62000	4730	218-01-9	CHRYSENE	4	J	11000		UG/KG	16SS030002	15/39	3.5 - 4.3
80	NA	510	18000	62	18400	53-70-3	DIBENZO(A,H)ANTHRACENE	8		1600		UG/KG	16SS030002	3/39	3.5 - 4.3
2400	NA	730000	9700	290000	NA	132-64-9	DIBENZOFURAN	560	J	560	J	UG/KG	16SS030002	1/39	69 - 87
310000	NA	6300000	880000	2300000	122000	206-44-0	FLUORANTHENE	4	J	19000		UG/KG	16SS030002	15/39	3.5 - 4.3
41000	NA	6300000	170000	2600000	122000	86-73-7	FLUORENE	4	J	2300		UG/KG	16SS030002	4/39	3.5 - 4.3
700	NA	5100	3100	620	109000	193-39-5	INDENO(1,2,3-CD)PYRENE	5	J	4400		UG/KG	16SS030002	10/39	3.5 - 4.3
3100	170000	3200000	700	56000	99.39	91-20-3	NAPHTHALENE	4	J	180		UG/KG	16SS030002	3/39	3.4 - 4.3
NA	NA	NA	NA	2300000	45700	85-01-8	PHENANTHRENE	4	J	8700		UG/KG	16SS030002	8/39	3.5 - 4.3
230000	NA	5500000	570000	2300000	78500	129-00-0	PYRENE	4	J	35000		UG/KG	16SS030002	17/39	3.5 - 4.3
NA	NA	NA	NA	NA	403.98	94-59-7	SAFROLE	340	J	15000		UG/KG	16SS130002	5/39	69 - 150
							Explosives								
NA	NA	NA	NA	3100	NA	2691-41-0	HMX	0.34	J	0.34	J	MG/KG	16SS330002	1/39	0.25
							Herbicides								
570000	NA	NA	NA	18000	198.78	70-30-4	HEXACHLOROPHENE	2.6	J	2.6	J	UG/KG	16SS030002	1/39	0.62 - 1.1
1.4	NA	20000	28	3000	119.27	87-86-5	PENTACHLOROPHENOL	0.79	J	14		UG/KG	16SS050002	4/39	0.46 - 0.58

TABLE D-1
FREQUENCY OF DETECTION
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Dioxins/Furans								
NA	NA	NA	NA	39000	0.199	3268-87-9	1,2,3,4,6,7,8,9-OCDD	49.4		11500		NG/KG	16SS330002	26/28	89.4 - 815
NA	NA	NA	NA	39000	38.6	39001-02-0	1,2,3,4,6,7,8,9-OCDF	0.62	J	20.1		NG/KG	16SS130002	9/28	0.2 - 2.6
NA	NA	NA	NA	390	0.199	35822-46-9	1,2,3,4,6,7,8-HPCDD	1.1	J	151		NG/KG	16SS060002	27/28	1.5
NA	NA	NA	NA	390	38.6	67562-39-4	1,2,3,4,6,7,8-HPCDF	0.33	J	8		NG/KG	16SS130002	10/28	0.07 - 6.2
NA	NA	NA	NA	390	38.6	55673-89-7	1,2,3,4,7,8,9-HPCDF	1.8	J	1.8	J	NG/KG	16SS130002	1/28	0.08 - 1.2
NA	NA	NA	NA	39	0.199	39227-28-6	1,2,3,4,7,8-HXCDD	0.2	J	1.5	J	NG/KG	16SS270002	6/28	0.1 - 0.82
NA	NA	NA	NA	39	38.6	70648-26-9	1,2,3,4,7,8-HXCDF	0.17	J	0.98	J	NG/KG	16SS130002	9/28	0.05 - 0.44
NA	NA	NA	NA	39	0.199	57653-85-7	1,2,3,6,7,8-HXCDD	0.27	J	2.5	J	NG/KG	16SS270002	8/28	0.09 - 0.92
NA	NA	NA	NA	39	38.6	57117-44-9	1,2,3,6,7,8-HXCDF	0.24	J	0.64	J	NG/KG	16SS130002	4/28	0.04 - 0.4
3200	2500000	NA	NA	39	0.199	19408-74-3	1,2,3,7,8,9-HXCDD	0.47	J	4.7	J	NG/KG	16SS270002	14/28	0.1 - 1.1
NA	NA	NA	NA	39	38.6	72918-21-9	1,2,3,7,8,9-HXCDF	0.25	J	0.81	J	NG/KG	16SS160002	3/28	0.06 - 0.5
NA	NA	NA	NA	3.9	0.199	40321-76-4	1,2,3,7,8-PECDD	0.14	J	1.5	J	NG/KG	16SS320002	3/28	0.1 - 0.8
NA	NA	NA	NA	39	38.6	60851-34-5	2,3,4,6,7,8-HXCDF	0.12	J	0.75	J	NG/KG	16SS270002	5/28	0.05 - 0.4
NA	NA	NA	NA	39	38.6	51207-31-9	2,3,7,8-TCDF	0.51	J	0.75	J	NG/KG	16SS270002	2/28	0.05 - 0.4
NA	NA	NA	NA	NA	NA	37871-00-4	TOTAL HPCDD	2.3		302		NG/KG	16SS270002	27/28	3.3
NA	NA	NA	NA	NA	NA	38998-75-3	TOTAL HPCDF	0.48	J	27.5	J	NG/KG	16SS130002	12/28	0.08 - 1.4
NA	NA	NA	NA	9.4	NA	34465-46-8	TOTAL HXCDD	1.6		45.9		NG/KG	16SS270002	20/28	0.1 - 2
NA	NA	NA	NA	NA	NA	55684-94-1	TOTAL HXCDF	0.17		11.7	J	NG/KG	16SS270002	15/28	0.05 - 0.51
NA	NA	NA	NA	NA	NA	36088-22-9	TOTAL PECDD	0.34		4.4	J	NG/KG	16SS270002	5/28	0.1 - 0.8
NA	NA	NA	NA	NA	NA	30402-15-4	TOTAL PECDF	1.3	J	7.6	J	NG/KG	16SS130002	8/28	0.07 - 0.87
NA	NA	NA	NA	NA	NA	55722-27-5	TOTAL TCDF	0.26		13.3	J	NG/KG	16SS320002	6/28	0.05 - 7.9
							Inorganics								
NA	NA	NA	NA	76000	NA	7429-90-5	ALUMINUM	1780	J	23800	J	MG/KG	16SS110002	38/39	3610
0.27	NA	140	5.4	31	0.1423	7440-36-0	ANTIMONY	0.51	J	27.2	J	MG/KG	16SS140002	14/39	0.19 - 3.4
0.29	770	3.9	29	0.39	5.7	7440-38-2	ARSENIC	0.75	J	11.2	J	MG/KG	16SS300002	39/39	NA
82	710000	24000	1700	5400	1.04	7440-39-3	BARIUM	11.9	J	303	J	MG/KG	16SS130002	39/39	NA
32	1400	680	63	150	1.06	7440-41-7	BERYLLIUM	0.23	J	1.4	J	MG/KG	16SS170002	23/39	0.06 - 0.64
0.38	1800	12	7.5	37	0.00222	7440-43-9	CADMIUM	0.19	J	2.8	J	MG/KG	16SS150002	15/39	0.13 - 0.66
NA	NA	NA	NA	NA	NA	7440-70-2	CALCIUM	212	J	246000	J	MG/KG	16SS030002	36/39	152 - 236
2	280	NA	NA	30	0.4	7440-47-3	CHROMIUM	4.3	J	28.9	J	MG/KG	16SS110002	39/39	NA
NA	NA	NA	NA	900	0.14033	7440-48-4	COBALT	0.87	J	25.9	J	MG/KG	16SS170002	39/39	NA
560	NA	13000	580	3100	2.96	7440-50-8	COPPER	2.4	J	413	J	MG/KG	16SS150002	39/39	NA
NA	NA	NA	NA	23000	NA	7439-89-6	IRON	2170	J	43000	J	MG/KG	16SS200002	39/39	NA
NA	NA	400	81	400	0.05373	7439-92-1	LEAD	3.5	J	1240	J	MG/KG	16SS140002	38/39	14.8
NA	NA	NA	NA	1600	NA	7439-93-2	LITHIUM	0.81	J	21.5	J	MG/KG	16SS170002	37/39	4.3 - 5.6
NA	NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	105	J	62500	J	MG/KG	16SS030002	39/39	NA
110	69000	NA	NA	1800	NA	7439-96-5	MANGANESE	3.8	J	1040	J	MG/KG	16SS130002	39/39	NA
0.1	2.9	55	2.1	23	0.073	7439-97-6	MERCURY	0.015	J	0.22	J	MG/KG	16SS050002	24/39	0.002 - 0.021
48	NA	6900	950	1600	13.6	7440-02-0	NICKEL	0.71	J	41.3	J	MG/KG	16SS170002	39/39	NA
NA	NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	206	J	2240	J	MG/KG	16SS110002	39/39	NA
0.26	NA	1700	5.2	390	0.02765	7782-49-2	SELENIUM	0.16	J	0.31	J	MG/KG	16SS320002	2/39	0.03 - 0.54
1.6	NA	1700	31	390	4.04	7440-22-4	SILVER	0.28	J	0.28	J	MG/KG	16SS330002	1/39	0.02 - 0.26

TABLE D-1
FREQUENCY OF DETECTION
SURFACE SOIL
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
NA	NA	NA	NA	NA	NA	7440-23-5	SODIUM	162	J	496	J	MG/KG	16SS030002	3/39	12.7 - 84.9
770	NA	NA	NA	47000	NA	7440-24-6	STRONTIUM	4.5	J	252	J	MG/KG	16SS030002	39/39	NA
0.04	NA	31	2.9	5.2	0.05692	7440-28-0	THALLIUM	0.16	J	0.32	J	MG/KG	16SS110002	2/39	0.03 - 0.26
NA	NA	NA	NA	47000	7.62	7440-31-5	TIN	0.25	J	12.3	J	MG/KG	16SS080002	6/39	0.32 - 2.4
NA	NA	NA	NA	NA	NA	7440-32-6	TITANIUM	7.5	J	348	J	MG/KG	16SS110002	39/39	NA
260	NA	NA	NA	550	1.59	7440-62-2	VANADIUM	3.6	J	52.8	J	MG/KG	16SS110002	39/39	NA
680	NA	100000	14000	23000	6.62	7440-66-6	ZINC	24	J	1560	J	MG/KG	16SS130002	26/39	5.2 - 2510
							Miscellaneous Parameters								
NA	NA	NA	NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	7.4		22		MEQ/1	16SS240002	7/7	NA
NA	NA	NA	NA	NA	NA	TTNUS002	PH	5.2		8		S.U.	16SS020002	7/7	NA
NA	NA	NA	NA	NA	NA	TTNUS003	TOTAL ORGANIC CARBON	1000	J	6200	J	MG/KG	16SS120002	6/7	1000

Associated Samples:

16SS010002	16SS210002
16SS020002	16SS220002
16SS030002	16SS230002
16SS040002	16SS240002
16SS050002	16SS250002
16SS060002	16SS260002
16SS070002	16SS270002
16SS080002	16SS280002
16SS090002	16SS290002
16SS100002	16SS300002
16SS110002	16SS310002
16SS120002	16SS320002
16SS130002	16SS330002
16SS140002	16SS340002
16SS150002	16SS350002
16SS160002	16SS360002
16SS170002	16SS370002
16SS180002	16SS380002
16SS190002	16SS390002
16SS200002	

APPENDIX D.2

SUBSURFACE SOIL

TABLE D-2
FREQUENCY OF DETECTION
SUBSURFACE SOIL
SMWU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
							Volatiles								
730	NA	3900000	3100	1600000	2500	67-64-1	ACETONE	4	J	14	J	UG/KG	16SB410507	2/9	1.1 - 1.2
20	NA	110000	400	43000	783.73	156-59-2	CIS-1,2-DICHLOROETHENE	200		200		UG/KG	16SB390203	1/9	1.1 - 1.2
34	NA	180000	680	69000	783.73	156-60-5	TRANS-1,2-DICHLOROETHENE	12		12		UG/KG	16SB390203	1/9	1.1 - 1.2
2.8	4600	45000	57	53	12400	79-01-6	TRICHLOROETHENE	4		280		UG/KG	16SB390203	2/9	1.1 - 1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB010406	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB020406	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB380203	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB390203	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB400506	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB400608	7/9	1.2
8000	1100000	NA	NA	390000	16400	75-69-4	TRICHLOROFLUOROMETHANE	2	J	2	J	UG/KG	16SB410507	7/9	1.2
							Semivolatiles								
NA	NA	3700000	16000	56000	3240	91-57-6	2-METHYLNAPHTHALENE	4	J	4	J	UG/KG	16SB410507	1/27	3.5 - 4.1
80	NA	5100	19000	620	5210	56-55-3	BENZO(A)ANTHRACENE	4	J	7	J	UG/KG	16SB340203	2/27	3.5 - 4.1
410	NA	510	8200	62	1520	50-32-8	BENZO(A)PYRENE	6	J	10		UG/KG	16SB340203	2/27	3.5 - 4.1
200	NA	5100	57000	620	59800	205-99-2	BENZO(B)FLUORANTHENE	8	J	16	J	UG/KG	16SB340203	2/27	3.5 - 4.1
NA	NA	NA	NA	2300000	119000	191-24-2	BENZO(G,H,I)PERYLENE	6	J	6	J	UG/KG	16SB340203	1/27	3.5 - 4.1
2000	NA	51000	39000	6200	148000	207-08-9	BENZO(K)FLUORANTHENE	6	J	13		UG/KG	16SB340203	2/27	3.5 - 4.1
180000	NA	310000	3600000	35000	925.94	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	86	J	1400		UG/KG	16SB410507	3/27	70 - 1000
8000	NA	510000	26000	62000	4730	218-01-9	CHRYSENE	6	J	10		UG/KG	16SB340203	3/27	3.5 - 4.1
310000	NA	6300000	880000	2300000	122000	206-44-0	FLUORANTHENE	6	J	9		UG/KG	16SB340203	2/27	3.5 - 4.1
700	NA	5100	3100	620	109000	193-39-5	INDENO(1,2,3-CD)PYRENE	6	J	6	J	UG/KG	16SB340203	1/27	3.5 - 4.1
NA	NA	NA	NA	NA	9940	120-58-1	ISOSAFROLE	150	J	150	J	UG/KG	16SB410507	1/27	70 - 83
3100	170000	3200000	700	56000	99.39	91-20-3	NAPHTHALENE	5	J	6	J	UG/KG	16SB410507	2/27	3.5 - 4.1
NA	NA	NA	NA	2300000	45700	85-01-8	PHENANTHRENE	6	J	6	J	UG/KG	16SB410507	1/27	3.5 - 4.1
230000	NA	5500000	570000	2300000	78500	129-00-0	PYRENE	6	J	12		UG/KG	16SB340203	3/27	3.5 - 4.1
NA	NA	NA	NA	NA	403.98	94-59-7	SAFROLE	480		67000		UG/KG	16SB410507	2/27	70 - 83
							Herbicides								
570000	NA	NA	NA	18000	198.78	70-30-4	HEXACHLOROPHENE	0.96	J	0.96	J	UG/KG	16SB260204	1/27	0.68 - 1
1.4	NA	20000	28	3000	119.27	87-86-5	PENTACHLOROPHENOL	1.6	J	1.6	J	UG/KG	16SB300203	1/27	0.47 - 0.56
							Inorganics								
NA	NA	NA	NA	76000	NA	7429-90-5	ALUMINUM	1540	J	18600	J	MG/KG	16SB410305	27/27	NA
0.27	NA	140	5.4	31	0.1423	7440-36-0	ANTIMONY	0.33	J	0.62	J	MG/KG	16SB360203	3/27	0.14 - 1.5
0.29	770	3.9	29	0.39	5.7	7440-38-2	ARSENIC	0.35	J	10.2	J	MG/KG	16SB320204	27/27	NA
82	710000	24000	1700	5400	1.04	7440-39-3	BARIUM	9.1	J	119	J	MG/KG	16SB320204	27/27	NA
32	1400	680	63	150	1.06	7440-41-7	BERYLLIUM	0.2	J	2.4	J	MG/KG	16SB180203	12/27	0.17 - 0.53
0.38	1800	12	7.5	37	0.00222	7440-43-9	CADMIUM	0.19	J	0.74	J	MG/KG	16SB180203	7/27	0.09 - 0.28
NA	NA	NA	NA	NA	NA	7440-70-2	CALCIUM	68.7	J	2150	J	MG/KG	16SB340203	25/27	192 - 380
2	280	NA	NA	30	0.4	7440-47-3	CHROMIUM	5.1	J	25.1	J	MG/KG	16SB130204	27/27	NA
NA	NA	NA	NA	900	0.14033	7440-48-4	COBALT	0.54	J	15.7	J	MG/KG	16SB170204	27/27	NA

TABLE D-2
FREQUENCY OF DETECTION
SUBSURFACE SOIL
SMWU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

SSLDAF1	SSLINH	IDCLRESD	IDCLRSGW	R9SORES	R5DQLSO	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
560	NA	13000	580	3100	2.96	7440-50-8	COPPER	3.6	J	34.8	J	MG/KG	16SB180203	27/27	NA
NA	NA	NA	NA	23000	NA	7439-89-6	IRON	3630	J	30300	J	MG/KG	16SB410507	27/27	NA
NA	NA	400	81	400	0.05373	7439-92-1	LEAD	3.4	J	34	J	MG/KG	16SB360203	26/27	7.9
NA	NA	NA	NA	1600	NA	7439-93-2	LITHIUM	3.4	J	23.6	J	MG/KG	16SB170204	18/27	2 - 6.3
NA	NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	279	J	2620	J	MG/KG	16SB410305	27/27	NA
110	69000	NA	NA	1800	NA	7439-96-5	MANGANESE	3.2	J	415	J	MG/KG	16SB390203	27/27	NA
0.1	2.9	55	2.1	23	0.073	7439-97-6	MERCURY	0.003	J	0.079	J	MG/KG	16SB180203	15/27	0.002 - 0.012
48	NA	6900	950	1600	13.6	7440-02-0	NICKEL	2	J	35.6	J	MG/KG	16SB170204	27/27	NA
NA	NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	225	J	2070	J	MG/KG	16SB130204	27/27	NA
0.26	NA	1700	5.2	390	0.02765	7782-49-2	SELENIUM	0.22	J	0.63	J	MG/KG	16SB180203	2/27	0.02 - 0.38
1.6	NA	1700	31	390	4.04	7440-22-4	SILVER	0.42	J	0.42	J	MG/KG	16SB340203	1/27	0.02 - 0.14
NA	NA	NA	NA	NA	NA	7440-23-5	SODIUM	50.5	J	50.5	J	MG/KG	16SB320204	1/27	13.9 - 75.8
770	NA	NA	NA	47000	NA	7440-24-6	STRONTIUM	2.8	J	21.8	J	MG/KG	16SB130204	27/27	NA
NA	NA	NA	NA	47000	7.62	7440-31-5	TIN	0.31	J	1.3	J	MG/KG	16SB320204	5/27	0.22 - 0.67
NA	NA	NA	NA	NA	NA	7440-32-6	TITANIUM	12.2	J	177	J	MG/KG	16SB410305	27/27	NA
260	NA	NA	NA	550	1.59	7440-62-2	VANADIUM	2.9	J	33.9	J	MG/KG	16SB410305	27/27	NA
680	NA	100000	14000	23000	6.62	7440-66-6	ZINC	10.2	J	83.3	J	MG/KG	16SB360203	19/27	4.5 - 39.7
							Miscellaneous Parameters								
NA	NA	NA	NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	15		25		MEQ/1	16SB120204	6/6	NA
NA	NA	NA	NA	NA	NA	TTNUS002	PH	4.9		7.5		S.U.	16SB410305	6/6	NA
NA	NA	NA	NA	NA	NA	TTNUS003	TOTAL ORGANIC CARBON	1400	J	14000	J	MG/KG	16SB180203	6/6	NA

Associated Samples:

16SB010406	16SB280203
16SB020406	16SB290203
16SB110204	16SB300203
16SB120204	16SB320204
16SB130204	16SB330204
16SB170204	16SB340203
16SB180203	16SB360203
16SB190203	16SB380203
16SB220203	16SB390203
16SB230203	16SB400506
16SB240203	16SB400608
16SB250203	16SB410305
16SB260204	16SB410507
16SB270203	

APPENDIX D.3

GROUND WATER

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration
					Volatile Organics						
5	NA	0.2	5	79-00-5	1,1,2-TRICHLOROETHANE	38	J	38	J	UG/L	16GWT0601
7	NA	340	7	75-35-4	1,1-DICHLOROETHENE	26	J	26	J	UG/L	16GWT0601
NA	NA	160	210	108-10-1	4-METHYL-2-PENTANONE	3.5	J	3.5	J	UG/L	16GWT0601
NA	NA	610	770	67-64-1	ACETONE	1.3	J	1.3	J	UG/L	16GWT0101
5	NA	0.34	5	71-43-2	BENZENE	0.9	J	0.9	J	UG/L	16GWT0601
80	NA	0.18	100	75-27-4	BROMODICHLOROMETHANE	0.8	J	0.8	J	UG/L	16GWT0601
NA	NA	1000	1300	75-15-0	CARBON DISULFIDE	0.8	J	0.8	J	UG/L	16GWT0601
5	NA	0.17	5	56-23-5	CARBON TETRACHLORIDE	15		15		UG/L	16GW0301
80	NA	6.2	100	67-66-3	CHLOROFORM	5.6		12	J	UG/L	16GWT0601
70	NA	61	70	156-59-2	CIS-1,2-DICHLOROETHENE	0.3	J	600		UG/L	16GWT0601
5	NA	0.66	5	127-18-4	TETRACHLOROETHENE	13	J	13	J	UG/L	16GWT0601
1000	NA	720	1000	108-88-3	TOLUENE	32	J	32	J	UG/L	16GWT0601
100	NA	120	100	156-60-5	TRANS-1,2-DICHLOROETHENE	3.1	J	3.1	J	UG/L	16GWT0601
5	NA	0.028	5	79-01-6	TRICHLOROETHENE	0.5	J	35000		UG/L	16GWT0601
2	NA	0.02	2	75-01-4	VINYL CHLORIDE	0.3	J	65	J	UG/L	16GWT0601
					Semivolatile Organics						
NA	NA	6.2	150	91-57-6	2-METHYLNAPHTHALENE	0.11		0.11		UG/L	16GWT0601
NA	NA	370	460	83-32-9	ACENAPHTHENE	0.07	J	0.07	J	UG/L	16GWT0601
NA	NA	0.092	1.2	205-99-2	BENZO(B)FLUORANTHENE	0.09	J	0.09	J	UG/L	16GWT0601
NA	NA	9.2	1.6	218-01-9	CHRYSENE	0.1	J	0.1	J	UG/L	16GWT0601
NA	NA	29000	29000	84-66-2	DIETHYL PHTHALATE	1	J	1	J	UG/L	16GWT0601
NA	NA	1500	210	206-44-0	FLUORANTHENE	0.11		0.11		UG/L	16GWT0601
NA	NA	240	310	86-73-7	FLUORENE	0.1	J	0.1	J	UG/L	16GWT0601
NA	NA	180	NA	85-01-8	PHENANTHRENE	0.54		0.54		UG/L	16GWT0601
NA	NA	180	140	129-00-0	PYRENE	0.2		0.2		UG/L	16GWT0601
NA	NA	36	NA	110-86-1	PYRIDINE	9		9		UG/L	16GWT0602
					Explosives						
NA	NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	0.48	J	0.48	J	UG/L	16GW0301
NA	NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	0.86	J	0.86	J	UG/L	16GW0301
NA	NA	1800	NA	2691-41-0	HMX	0.39		7.8		UG/L	16GWT0401
NA	NA	0.61	NA	121-82-4	RDX	0.79		77		UG/L	16GWT0401
					Total Inorganics						
NA	50	36000	NA	7429-90-5	ALUMINUM	19.2	J	9680		UG/L	16GW0401
10	NA	0.045	50	7440-38-2	ARSENIC	0.81	J	4.5	J	UG/L	16GWT0601
2000	NA	2600	2000	7440-39-3	BARIUM	5	J	107	J	UG/L	16GWT0201
4	NA	73	4	7440-41-7	BERYLLIUM	2	J	4.7	J	UG/L	16GWT0501
5	NA	18	5	7440-43-9	CADMIUM	0.83	J	1.1	J	UG/L	16GW0501
NA	NA	NA	NA	7440-70-2	CALCIUM	22600	J	194000	J	UG/L	16GW0101

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration
100	NA	110	NA	7440-47-3	CHROMIUM	0.68	J	0.93	J	UG/L	16GWT0601
NA	NA	730	NA	7440-48-4	COBALT	2	J	154	J	UG/L	16GW0101
1300	1000	1500	1300	7440-50-8	COPPER	0.82	J	4.9	J	UG/L	16GWT0601
NA	300	11000	NA	7439-89-6	IRON	171	J	52700	J	UG/L	16GW0101
15	NA	NA	15	7439-92-1	LEAD	0.89	J	1.8	J	UG/L	16GWT0501
NA	NA	730	NA	7439-93-2	LITHIUM	8.5	J	328	J	UG/L	16GW0101
NA	NA	NA	NA	7439-95-4	MAGNESIUM	6240	J	84500	J	UG/L	16GW0101
NA	50	880	NA	7439-96-5	MANGANESE	353	J	29300	J	UG/L	16GW0101
NA	NA	730	730	7440-02-0	NICKEL	1.5	J	304	J	UG/L	16GWT0501
NA	NA	NA	NA	7440-09-7	POTASSIUM	738	J	11900	J	UG/L	16GWT0601
50	NA	180	50	7782-49-2	SELENIUM	1.2	J	1.2	J	UG/L	16GWT0601
NA	NA	NA	NA	7440-23-5	SODIUM	7190	J	37100	J	UG/L	16GWT0601
NA	NA	22000	NA	7440-24-6	STRONTIUM	88.4	J	387	J	UG/L	16GWT0201
NA	NA	NA	NA	7440-32-6	TITANIUM	1	J	8.4	J	UG/L	16GWT0401
NA	NA	260	NA	7440-62-2	VANADIUM	0.51	J	0.86	J	UG/L	16GW0401
NA	5000	11000	11000	7440-66-6	ZINC	6.2	J	329	J	UG/L	16GWT0501
					Miscellaneous Parameters						
NA	NA	NA	NA	TTNUS493	AMMONIA-N	0.02		0.57		MG/L	16GWT0601
NA	NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	0.03		0.6		MG/L	16GWT0401
					Field Parameters						
NA	NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	0.2		6.94		MG/L	16GWT0602
NA	NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	-130		207.4		MV	16GW0401
NA	0	NA	NA	TTNUS002	PH	3.68		7.7		S.U.	16GWT0601
NA	NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	0.225		1.606		MS/CM	16GW0101
NA	NA	NA	NA	TTNUS047	TEMPERATURE	11.51		15		C	16GWT0601
NA	NA	NA	NA	TTNUS023	TURBIDITY	0		999	>	NTU	16GWT0101

Associated Samples:
16GW0101
16GW0201
16GW0202
16GW0301
16GW0401
16GW0501
16GWT0101
16GWT0201
16GWT0301
16GWT0401
16GWT0501

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration
					16GWT0601						
					16GWT0602						

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Detection Frequency	Range of Nondetects
					Volatile Organics		
5	NA	0.2	5	79-00-5	1,1,2-TRICHLOROETHANE	1/11	0.3
7	NA	340	7	75-35-4	1,1-DICHLOROETHENE	1/11	0.3
NA	NA	160	210	108-10-1	4-METHYL-2-PENTANONE	1/11	0.5
NA	NA	610	770	67-64-1	ACETONE	1/2	10
5	NA	0.34	5	71-43-2	BENZENE	1/11	0.3
80	NA	0.18	100	75-27-4	BROMODICHLOROMETHANE	1/11	0.3
NA	NA	1000	1300	75-15-0	CARBON DISULFIDE	1/11	0.3
5	NA	0.17	5	56-23-5	CARBON TETRACHLORIDE	1/11	0.3
80	NA	6.2	100	67-66-3	CHLOROFORM	2/11	0.3
70	NA	61	70	156-59-2	CIS-1,2-DICHLOROETHENE	4/11	0.3
5	NA	0.66	5	127-18-4	TETRACHLOROETHENE	1/11	0.3
1000	NA	720	1000	108-88-3	TOLUENE	1/11	0.3
100	NA	120	100	156-60-5	TRANS-1,2-DICHLOROETHENE	1/11	0.3
5	NA	0.028	5	79-01-6	TRICHLOROETHENE	8/11	0.3
2	NA	0.02	2	75-01-4	VINYL CHLORIDE	2/11	0.3
					Semivolatile Organics		
NA	NA	6.2	150	91-57-6	2-METHYLNAPHTHALENE	1/10	0.05
NA	NA	370	460	83-32-9	ACENAPHTHENE	1/10	0.05
NA	NA	0.092	1.2	205-99-2	BENZO(B)FLUORANTHENE	1/10	0.05
NA	NA	9.2	1.6	218-01-9	CHRYSENE	1/10	0.05
NA	NA	29000	29000	84-66-2	DIETHYL PHTHALATE	1/12	1
NA	NA	1500	210	206-44-0	FLUORANTHENE	1/10	0.05
NA	NA	240	310	86-73-7	FLUORENE	1/10	0.05
NA	NA	180	NA	85-01-8	PHENANTHRENE	1/10	0.05
NA	NA	180	140	129-00-0	PYRENE	1/10	0.05
NA	NA	36	NA	110-86-1	PYRIDINE	1/12	1
					Explosives		
NA	NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	1/10	0.165 - 0.65
NA	NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	1/10	0.165 - 0.65
NA	NA	1800	NA	2691-41-0	HMX	4/10	0.21 - 0.65
NA	NA	0.61	NA	121-82-4	RDX	6/10	0.195 - 0.6
					Total Inorganics		
NA	50	36000	NA	7429-90-5	ALUMINUM	10/11	60.6
10	NA	0.045	50	7440-38-2	ARSENIC	7/11	0.1 - 0.41
2000	NA	2600	2000	7440-39-3	BARIUM	11/11	NA
4	NA	73	4	7440-41-7	BERYLLIUM	2/11	0.03 - 1.1
5	NA	18	5	7440-43-9	CADMIUM	2/11	0.05 - 0.31
NA	NA	NA	NA	7440-70-2	CALCIUM	11/11	NA

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Detection Frequency	Range of Nondetects
100	NA	110	NA	7440-47-3	CHROMIUM	2/11	0.27 - 0.58
NA	NA	730	NA	7440-48-4	COBALT	11/11	NA
1300	1000	1500	1300	7440-50-8	COPPER	7/11	0.06 - 0.15
NA	300	11000	NA	7439-89-6	IRON	11/11	NA
15	NA	NA	15	7439-92-1	LEAD	3/11	0.03 - 0.51
NA	NA	730	NA	7439-93-2	LITHIUM	10/11	0.72
NA	NA	NA	NA	7439-95-4	MAGNESIUM	11/11	NA
NA	50	880	NA	7439-96-5	MANGANESE	11/11	NA
NA	NA	730	730	7440-02-0	NICKEL	11/11	NA
NA	NA	NA	NA	7440-09-7	POTASSIUM	10/11	3390
50	NA	180	50	7782-49-2	SELENIUM	1/11	0.05 - 0.43
NA	NA	NA	NA	7440-23-5	SODIUM	11/11	NA
NA	NA	22000	NA	7440-24-6	STRONTIUM	11/11	NA
NA	NA	NA	NA	7440-32-6	TITANIUM	11/11	NA
NA	NA	260	NA	7440-62-2	VANADIUM	5/11	0.05 - 0.36
NA	5000	11000	11000	7440-66-6	ZINC	11/11	NA
					Miscellaneous Parameters		
NA	NA	NA	NA	TTNUS493	AMMONIA-N	10/10	NA
NA	NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	4/10	0.02
					Field Parameters		
NA	NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	13/13	NA
NA	NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	13/13	NA
NA	0	NA	NA	TTNUS002	PH	13/13	NA
NA	NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	13/13	NA
NA	NA	NA	NA	TTNUS047	TEMPERATURE	13/13	NA
NA	NA	NA	NA	TTNUS023	TURBIDITY	13/13	NA

Associated Samples:
16GW0101
16GW0201
16GW0202
16GW0301
16GW0401
16GW0501
16GWT0101
16GWT0201
16GWT0301
16GWT0401
16GWT0501

TABLE D-3
FREQUENCY OF DETECTION
GROUNDWATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	R9TAPW	IDCLRGDF	CAS Number	Chemical	Detection Frequency	Range of Nondetects
					16GWT0601		
					16GWT0602		

APPENDIX D.4

SURFACE WATER

TA D-4

FREQUENCY OF DETECTION
SURFACE WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	IDCLRGDF	R9TAPW	R5DQLSW	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
						Semivolatile Organics								
NA	NA	150	6.2	329.55	91-57-6	2-METHYLNAPHTHALENE	0.67	J	0.67	J	UG/L	16SW0101	1/3	0.05
NA	NA	460	370	9.9	83-32-9	ACENAPHTHENE	0.9	J	0.9	J	UG/L	16SW0101	1/3	0.05
NA	NA	43	1800	0.029	120-12-7	ANTHRACENE	0.31	J	0.31	J	UG/L	16SW0101	1/3	0.05
NA	NA	1.2	0.092	0.839	56-55-3	BENZO(A)ANTHRACENE	0.31	J	0.31	J	UG/L	16SW0101	1/3	0.05
6	NA	6	4.8	2.1	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	86		86		UG/L		1/3	2 - 3
NA	NA	1.6	9.2	0.033	218-01-9	CHRYSENE	0.78	J	0.78	J	UG/L	16SW0101	1/3	0.05
NA	NA	210	1500	8.1	206-44-0	FLUORANTHENE	1.09	J	1.09	J	UG/L	16SW0101	1/3	0.05
NA	NA	310	240	3.9	86-73-7	FLUORENE	0.59	J	0.59	J	UG/L	16SW0101	1/3	0.05
NA	NA	8.3	6.2	44	91-20-3	NAPHTHALENE	1.3	J	1.3	J	UG/L	16SW0101	1/3	0.05
NA	NA	NA	180	2.1	85-01-8	PHENANTHRENE	1.26	J	1.26	J	UG/L	16SW0101	1/3	0.05
NA	NA	140	180	0.3	129-00-0	PYRENE	2.34	J	2.34	J	UG/L	16SW0101	1/3	0.05
						Explosives								
NA	NA	NA	2.2	NA	118-96-7	2,4,6-TRINITROTOLUENE	2.1		2.1		UG/L	16SW0701	1/3	0.455 - 0.8
NA	NA	NA	NA	NA	35572-78-2	2-AMINO-4,6-DINITROTOLUENE	0.89	J	0.89	J	UG/L	16SW0701	1/3	0.455 - 0.8
NA	NA	NA	NA	NA	19406-51-0	4-AMINO-2,6-DINITROTOLUENE	2.2	J	2.2	J	UG/L	16SW0701	1/3	0.455 - 0.8
NA	NA	NA	1800	NA	2691-41-0	HMX	1.5	J	29000		UG/L	16SW0101	2/3	0.55
NA	NA	NA	0.61	NA	121-82-4	RDX	2.9		88000		UG/L	16SW0101	3/3	NA
						Herbicides								
NA	NA	NA	11	0.228	70-30-4	HEXACHLOROPHENE	0.082	J	0.082	J	UG/L	16SW0101	1/3	0.025
1	NA	1	0.56	5.23	87-86-5	PENTACHLOROPHENOL	0.02	J	0.19	J	UG/L	16SW0101	2/2	NA
						Total Inorganics								
NA	50	NA	36000	NA	7429-90-5	ALUMINUM	298	J	298	J	UG/L	16SW0701	1/3	7.6 - 82.4
10	NA	50	0.045	53	7440-38-2	ARSENIC	2.9	J	3.4	J	UG/L	16SW0201	2/3	0.38
2000	NA	2000	2600	5000	7440-39-3	BARIUM	66.3	J	91	J	UG/L	16SW0201	3/3	NA
NA	NA	NA	NA	NA	7440-70-2	CALCIUM	30300	J	37100	J	UG/L	16SW0701	3/3	NA
100	NA	NA	110	42	7440-47-3	CHROMIUM	2	J	3.4	J	UG/L	16SW0201	2/3	0.25
1300	1000	1300	1500	5	7440-50-8	COPPER	2	J	17.2	J	UG/L	16SW0201	3/3	NA
NA	300	NA	11000	NA	7439-89-6	IRON	60.5	J	60.5	J	UG/L	16SW0101	1/3	77.1 - 194
15	NA	15	NA	1.3	7439-92-1	LEAD	4.6	J	13.1	J	UG/L	16SW0201	2/3	0.15
NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	5190	J	6560	J	UG/L	16SW0701	3/3	NA
2	NA	2	11	0.0013	7439-97-6	MERCURY	2		2		UG/L	16SW0101	1/3	0.02
NA	NA	730	730	29	7440-02-0	NICKEL	0.95	J	1.8	J	UG/L	16SW0101	2/3	0.61
NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	839	J	2430	J	UG/L	16SW0701	3/3	NA
NA	NA	NA	NA	NA	7440-23-5	SODIUM	12400	J	84800	J	UG/L	16SW0701	3/3	NA
NA	NA	NA	22000	NA	7440-24-6	STRONTIUM	190	J	226	J	UG/L	16SW0701	3/3	NA
NA	NA	NA	NA	NA	7440-32-6	TITANIUM	2.2	J	10.2	J	UG/L	16SW0701	2/3	0.24
NA	NA	NA	260	19	7440-62-2	VANADIUM	1.2	J	1.2	J	UG/L	16SW0701	1/3	0.05 - 0.39
NA	5000	11000	11000	58.9	7440-66-6	ZINC	80.1	J	178	J	UG/L	16SW0201	2/3	3.2
						Dissolved Inorganics								
NA	50	NA	36000	NA	7429-90-5	ALUMINUM	575		575		UG/L	16SW0101-F	1/3	22.3 - 49.4
10	NA	50	0.045	53	7440-38-2	ARSENIC	2.8	J	3.2	J	UG/L	16SW0201-F	2/3	0.6

TABLE D-4
FREQUENCY OF DETECTION
SURFACE WATER
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

FEDMCL	FEDSMCL	IDCLRGDF	R9TAPW	R5DQLSW	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
2000	NA	2000	2600	5000	7440-39-3	BARIUM	70.5	J	91.5	J	UG/L	16SW0201-F	3/3	NA
5	NA	5	18	0.66	7440-43-9	CADMIUM	3.3	J	3.3	J	UG/L	16SW0101-F	1/3	0.15 - 0.4
NA	NA	NA	NA	NA	7440-70-2	CALCIUM	29200	J	37700	J	UG/L	16SW0701-F	3/3	NA
100	NA	NA	110	42	7440-47-3	CHROMIUM	1.5	J	3.2	J	UG/L	16SW0201-F	3/3	NA
1300	1000	1300	1500	5	7440-50-8	COPPER	9.1	J	17.9	J	UG/L	16SW0101-F	3/3	NA
NA	300	NA	11000	NA	7439-89-6	IRON	4100	J	4100	J	UG/L	16SW0101-F	1/3	36.6 - 42.3
15	NA	15	NA	1.3	7439-92-1	LEAD	8.4	J	26.2	J	UG/L	16SW0101-F	2/3	1.9
NA	NA	NA	NA	NA	7439-95-4	MAGNESIUM	5310	J	6560	J	UG/L	16SW0701-F	3/3	NA
NA	50	NA	880	NA	7439-96-5	MANGANESE	10.1	J	23.4	J	UG/L	16SW0101-F	2/3	2.8
NA	NA	730	730	29	7440-02-0	NICKEL	0.84	J	2.2	J	UG/L	16SW0101-F	2/3	0.5
NA	NA	NA	NA	NA	7440-09-7	POTASSIUM	842	J	2370	J	UG/L	16SW0701-F	3/3	NA
NA	NA	NA	NA	NA	7440-23-5	SODIUM	12100	J	87000	J	UG/L	16SW0701-F	3/3	NA
NA	NA	NA	22000	NA	7440-24-6	STRONTIUM	196	J	234	J	UG/L	16SW0701-F	3/3	NA
NA	NA	NA	NA	NA	7440-32-6	TITANIUM	3.2	J	3.9	J	UG/L	16SW0101-F	2/3	1.3
NA	5000	11000	11000	58.9	7440-66-6	ZINC	68	J	170	J	UG/L	16SW0201-F	3/3	NA
						Miscellaneous Parameters								
NA	NA	NA	NA	NA	TTNUS493	AMMONIA-N	2.8	J	2.8	J	MG/L	16SW0101	1/3	0.01
NA	NA	NA	NA	NA	TTNUS494	NITRITE/NITRATE-N	0.22		3.3	J	MG/L	16SW0101	3/3	NA
						Field Parameters								
NA	NA	NA	NA	NA	TTNUS034	DISSOLVED OXYGEN	10.51		10.63		MG/L	16SW0701	2/2	NA
NA	NA	NA	NA	NA	TTNUS033	OXIDATION REDUCTION POTENTIAL	89.1		90.9		MV	16SW0201	2/2	NA
NA	0	NA	NA	NA	TTNUS002	PH	8.13		8.4		S.U.	16SW0701	2/2	NA
NA	NA	NA	NA	NA	TTNUS038	SPECIFIC CONDUCTANCE	0.281		0.591		MS/CM	16SW0701	2/2	NA
NA	NA	NA	NA	NA	TTNUS047	TEMPERATURE	9.14		11.78		C	16SW0701	2/2	NA
NA	NA	NA	NA	NA	TTNUS023	TURBIDITY	2.1		4.2		NTU	16SW0701	2/2	NA

Associated Samples:
16SW0101
16SW0101-F
16SW0201
16SW0201-F
16SW0701
16SW0701-F

APPENDIX D.5

SEDIMENT

TABLE D-5
FREQUENCY OF DETECTION
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

IDCLRESD	R9SORES	R5DQLSD	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
				Semivolatiles								
3700000	56000	3240	91-57-6	2-METHYLNAPHTHALENE	5	J	5	J	UG/KG	16SD030004	1/9	4 - 5.8
9500000	3700000	682000	83-32-9	ACENAPHTHENE	8	J	8	J	UG/KG	16SD050004	1/9	3.9 - 5.8
NA	3700000	682000	208-96-8	ACENAPHTHYLENE	4	J	8		UG/KG	16SD030004	3/9	4.1 - 5.8
47000000	22000000	1480000	120-12-7	ANTHRACENE	5	J	15		UG/KG	16SD050004	4/9	3.9 - 4.4
5100	620	5210	56-55-3	BENZO(A)ANTHRACENE	5	J	66		UG/KG	16SD050004	7/9	4.3 - 4.4
510	62	1520	50-32-8	BENZO(A)PYRENE	7	J	84		UG/KG	16SD050004	6/9	3.9 - 4.4
5100	620	59800	205-99-2	BENZO(B)FLUORANTHENE	6	J	120		UG/KG	16SD050004	7/9	3.9 - 4.4
NA	2300000	119000	191-24-2	BENZO(G,H,I)PERYLENE	5	J	65		UG/KG	16SD050004	7/9	4.3 - 4.4
51000	6200	148000	207-08-9	BENZO(K)FLUORANTHENE	7	J	65		UG/KG	16SD050004	6/9	3.9 - 4.4
510000	62000	4730	218-01-9	CHRYSENE	5	J	100		UG/KG	16SD050004	8/9	4.4
18000000	6100000	149.79	84-74-2	DI-N-BUTYL PHTHALATE	130	J	130	J	UG/KG	16SD080004	1/9	79 - 120
510	62	18400	53-70-3	DIBENZO(A,H)ANTHRACENE	18		18		UG/KG	16SD050004	1/9	3.9 - 5.8
NA	1500000	1010	122-39-4	DIPHENYLAMINE	140	J	170	J	UG/KG	16SD030004	2/9	82 - 120
6300000	2300000	122000	206-44-0	FLUORANTHENE	5	J	160		UG/KG	16SD050004	9/9	NA
6300000	2600000	122000	86-73-7	FLUORENE	8	J	8	J	UG/KG	16SD050004	1/9	3.9 - 5.8
5100	620	109000	193-39-5	INDENO(1,2,3-CD)PYRENE	7	J	55		UG/KG	16SD050004	6/9	4.1 - 4.4
3200000	56000	99.39	91-20-3	NAPHTHALENE	5	J	6	J	UG/KG	16SD030004	2/9	4.1 - 5.8
NA	2300000	45700	85-01-8	PHENANTHRENE	4	J	100		UG/KG	16SD050004	8/9	4.3
5500000	2300000	78500	129-00-0	PYRENE	6	J	170		UG/KG	16SD050004	9/9	NA
				Explosives								
NA	4.4	NA	121-82-4	RDX	0.27	J	0.27	J	MG/KG	16SD030004	1/9	0.25
				Herbicides								
20000	3000	119.27	87-86-5	PENTACHLOROPHENOL	2.6	J	19	J	UG/KG	16SD110004	5/9	0.55 - 0.6
				Inorganics								
NA	76000	NA	7429-90-5	ALUMINUM	5560		12900	J	MG/KG	16SD040004	9/9	NA
140	31	0.1423	7440-36-0	ANTIMONY	4.3	J	174	J	MG/KG	16SD060004	9/9	NA
3.9	0.39	5.7	7440-38-2	ARSENIC	3.4	J	14.1	J	MG/KG	16SD100004	9/9	NA
24000	5400	1.04	7440-39-3	BARIUM	143	J	2820	J	MG/KG	16SD030004	9/9	NA
680	150	1.06	7440-41-7	BERYLLIUM	0.43	J	0.88	J	MG/KG	16SD100004	8/9	0.39
12	37	0.00222	7440-43-9	CADMIUM	0.8	J	19.5	J	MG/KG	16SD060004	9/9	NA
NA	NA	NA	7440-70-2	CALCIUM	1480	J	59800	J	MG/KG	16SD050004	9/9	NA
NA	30	0.4	7440-47-3	CHROMIUM	13.3	J	68.5	J	MG/KG	16SD100004	9/9	NA
NA	900	0.14033	7440-48-4	COBALT	3.4	J	14	J	MG/KG	16SD100004	9/9	NA
13000	3100	2.96	7440-50-8	COPPER	68.7	J	2570	J	MG/KG	16SD060004	9/9	NA
NA	23000	NA	7439-89-6	IRON	18200	J	65100	J	MG/KG	16SD100004	9/9	NA
400	400	0.05373	7439-92-1	LEAD	229	J	15200	J	MG/KG	16SD060004	9/9	NA
NA	1600	NA	7439-93-2	LITHIUM	2.9	J	10.4	J	MG/KG	16SD040004	9/9	NA

TABLE D-5
FREQUENCY OF DETECTION
SEDIMENT
SWMU 16 - B146 CAST HIGH EXPLOSIVES INCINERATOR
NSWC CRANE, INDIANA

IDCLRESD	R9SORES	R5DQLSD	CAS Number	Chemical	Minimum Concentration	Minimum Qualifier	Maximum Concentration	Maximum Qualifier	Units	Sample Containing Maximum Concentration	Detection Frequency	Range of Nondetects
NA	NA	NA	7439-95-4	MAGNESIUM	677	J	6080	J	MG/KG	16SD050004	9/9	NA
NA	1800	NA	7439-96-5	MANGANESE	175	J	976	J	MG/KG	16SD110004	9/9	NA
55	23	0.073	7439-97-6	MERCURY	0.08	J	2.7	J	MG/KG	16SD030004	9/9	NA
6900	1600	13.6	7440-02-0	NICKEL	10.6	J	22.5	J	MG/KG	16SD110004	9/9	NA
NA	NA	NA	7440-09-7	POTASSIUM	282	J	645	J	MG/KG	16SD040004	9/9	NA
1700	390	0.02765	7782-49-2	SELENIUM	0.33	J	0.9	J	MG/KG	16SD110004	7/9	0.14 - 0.17
NA	NA	NA	7440-23-5	SODIUM	160	J	160	J	MG/KG	16SD110004	1/9	11.7 - 44
NA	47000	NA	7440-24-6	STRONTIUM	51	J	2740	J	MG/KG	16SD030004	9/9	NA
NA	47000	7.62	7440-31-5	TIN	1.1	J	19	J	MG/KG	16SD060004	9/9	NA
NA	NA	NA	7440-32-6	TITANIUM	9.4	J	156	J	MG/KG	16SD040004	9/9	NA
NA	550	1.59	7440-62-2	VANADIUM	12.8	J	48.9	J	MG/KG	16SD100004	9/9	NA
100000	23000	6.62	7440-66-6	ZINC	573	J	23400	J	MG/KG	16SD030004	9/9	NA
				AVS/SEM								
NA	NA	NA	TTNUS010	ACID VOLATILE SULFIDE	0.53		0.59		UMO/G	16SD090004	3/3	NA
NA	NA	NA	7440-43-9	CADMIUM	0.024	J	0.145	J	UMO/G	16SD060004	3/3	NA
NA	NA	NA	7440-50-8	COPPER	1.83		18.3		UMO/G	16SD060004	3/3	NA
NA	NA	NA	7439-92-1	LEAD	2.6		16.3		UMO/G	16SD060004	3/3	NA
NA	NA	NA	7439-97-6	MERCURY	0.00011		0.00015		UMO/G	16SD090004	3/3	NA
NA	NA	NA	7440-02-0	NICKEL	0.028		0.068		UMO/G	16SD060004	3/3	NA
NA	NA	NA	TTNUS305	SEM/AVS	50		220		S.U.	16SD060004	3/3	NA
NA	NA	NA	7440-66-6	ZINC	20.6	J	91	J	UMO/G	16SD060004	3/3	NA
				Miscellaneous Parameters								
NA	NA	NA	TTNUS014	CATION EXCHANGE CAPACITY	5.7	J	25	J	MEQ/1	16SD020004	3/3	NA
NA	NA	NA	TTNUS002	PH	7.4		8		S.U.	16SD060004	3/3	NA
NA	NA	NA	TTNUS003	TOTAL ORGANIC CARBON	1600		8600		MG/KG	16SD020004	3/3	NA

Associated Samples:
16SD020004
16SD030004
16SD040004
16SD050004
16SD060004
16SD080004
16SD090004
16SD100004
16SD110004

APPENDIX E

FIELD STANDARD OPERATING PROCEDURES

APPENDIX E

FIELD SOP TABLE OF CONTENTS

CTO166-01	Sample Labeling
CTO166-02	Sample Identification Nomenclature
CTO166-03	Sample Custody and Documentation of Field Activities
CTO166-04	Borehole Advancement and Soil Coring Using Direct-Push Technology and Hand Auger Techniques
CTO166-05	Monitoring Well Sampling
CTO166-06	Calibration and Use of Photoionization Detector
CTO166-07	Borehole and Soil Sample Logging
CTO166-08	Surface and Subsurface Soil Sampling
CTO166-09	Inspection and Rehabilitation of Existing Monitoring Wells
CTO166-10	Monitoring Well Development
CTO166-11	Drilling and Geologic Logging of Boreholes in Rock
CTO166-12	Monitoring Well Installation
CTO166-13	Calibration and Care of Water Quality Meters
CTO166-14	Management of Investigation-Derived Waste
CTO166-15	Low-Flow Well Purging and Stabilization
CTO166-16	Decontamination of Field Sampling Equipment
CTO166-17	Measurement of Water Levels in Monitoring Wells
CTO166-18	Surface Water Sampling
CTO166-19	Sediment Sampling
CTO166-20	Estimating Flow in Small Streams
CTO166-21	Hydraulic Conductivity Testing
CTO166-22	Field Test Kit Analyses

STANDARD OPERATING PROCEDURE
NUMBER CTO166-01

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling and tagging sample containers. Sample labels and tags are used to document the sample ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label and a sample tag will be attached to each sample container. The label and tag for each container will contain identical information.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil
Disposable medical-grade gloves (e.g. latex, nitrile)
Sample logsheets
Required sample containers: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory.
Preprinted sample labels and sample tags
Chain-of-custody records
Sealable polyethylene bags
Heavy-duty cooler
Ice

3.0 PROCEDURES

3.1 The following information will be printed on the labels and tags prior to field activities.

- Project number (CTO 166)
- Project location (NSWC Crane)
- Sample ID
- Preservative

- Analysis to be performed
- Matrix type
- Laboratory name

3.2 Preprinted sample labels and tags will be prepared before the team mobilizes to the field. Check to determine if

- One sample label and tag exists for each sample container that is to be collected for all media during the field activities.
- The information printed on each tag and label is correct.
- Extra blank labels and tags are brought to the site in case additional environmental samples or QA samples are collected that are not anticipated in the QAPP. Additional blank labels and tags should also be brought to the site in case a sample container is broken or some of the preprinted labels or tags are accidentally lost before they are attached to a container.

3.3 Once at the field site, sample containers should have labels affixed before sampling activities begin.

3.4 Select the labeled containers that are appropriate for a given sample and fill in the date, time, and sampler's initials just before sampling begins. Use a black waterproof marker or pen.

3.5 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.6 Write the same date, time, and sampler's initials on the sample tag as written on the label.

3.7 Place the sample container in a ziplock plastic bag and place in a cooler containing ice.

3.8 Fill in appropriate information on the Sample Collection Log Form and the Chain-of-Custody Form.

Example sample labels and tags are attached at the end of this SOP.

4.0 ATTACHMENTS

1. Sample Label and Tag

ATTACHMENT 1

SAMPLE LABEL AND TAG

SAMPLE LABEL AND TAG

Tetra Tech NUS, Inc.
661 Andersen Drive
Pittsburgh, 15220
(412)921-7090

Project: CTO-~~205~~ 166
Location: NSWC CRANE

Sample No:		Tag # : A0001
Date:	Time:	Preserve:
Analysis: ~~PCBs~~		Matrix: SOIL
Sampled By:		Laboratory: LAUCKS

STRING

STANDARD OPERATING PROCEDURE
NUMBER CTO166-02

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Surface Warfare Center (NSWC). The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of identification and direct link to site and year

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Pen with indelible ink
Sample tags
Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Monitoring Samples

All monitoring samples collected at NSWC Crane will be properly labeled with a sample label affixed to the sample container and a tag tied around the neck of the sample container. Each sample will be assigned a unique sample tracking number. The sample tracking number will consist of a four- or five-segment alpha-numeric code that identifies the sample's associated solid waste management unit (SWMU) or

associated site, sample type, location, and, for aqueous samples, where applicable, whether a sample is filtered, and/or the sample round number. For soil or sediment samples, the final four tracking numbers will identify the depth at which the soil or sediment sample was collected.

The alpha-numeric coding to be used in the NSWC Crane sample system is explained in the diagram and the subsequent definitions:

NN	**AA**	**A or N** **2 to 5-Characters**	**NN and/or A** **Aqueous only**	**NNNN** **Soils and Sediment only**
SWMU or Site Number	Sample Type	Location	Round Identifier and/or Filtered	Depth Interval

Character Type:

A = Alpha
N = Numeric

SWMU or Site Number:

12 = Mine Fill A
13 = Mine Fill B
16 = Cast High Explosives Fill/B146 Incinerator
19 = Pyrotechnic Test Area

Sample Type:

GW - Groundwater Sample from a Permanent Monitoring Well
ID - Investigation-Derived Waste Sample
SB - Soil Boring Sample
SD - Sediment Sample
SP - Seep Sample or Spring Sample
SS - Surface Soil Sample
SW - Surface Water Sample

Location:

The sample location code is the well number, soil sample location, sediment sample location, or the stream sample location (i.e., surface water, springs, or seeps). The location code for each sample is listed on figures and tables in the site-specific work plan. Existing well numbers are used when unique.

New wells will be designated by a SWMU or site number, followed by "MW" for permanent monitoring well, "TW" for temporary well, etc.; a "T" for Tetra Tech NUS; and numbered sequentially, by SWMU, beginning with zero one (MWT01).

Well clusters that are newly installed by TtNUS (two or more wells in close proximity) in the same investigative effort will be designated with the letter P followed by the number 2, 3, 4, etc. The number signifies the well depth in relation to other wells in that cluster. This two-digit code will follow the well identification. Using well T02 as an example of a three-well cluster, the well identification will be as follows:

T02	=	The deepest well in the cluster.
T02P2	=	Intermediate well
T02P3	=	Shallowest well in the cluster

Note: To keep the sample identification nomenclature to a minimum number of characters and to avoid redundancy, "MW" (monitoring well) is used for text, figures, and tables and replaced with "GW" (groundwater) in the sample identification. For example, MWT01 would be GWT01.

Round Identifier and/or Filtered:

This code section will be used for aqueous samples only.

Round Identifier:

A two-digit round identifier will be used to track the number of aqueous samples (GW, SW) taken from a particular aqueous sample location. The first sample collected from a location will be assigned round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Filtered:

Water samples that are field filtered (dissolved analysis) will be identified with an "F" in the last code section. No entry in this segment signifies an unfiltered (total) sample.

Depth Interval:

This code section will be used for soil and sediment samples only.

The depth code is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and

fourth specify the bottom interval in feet bgs (soil) or inches bgs (sediment) of the sample. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

Depth (for soils, in feet bgs)

0002 = soil collected from 0 to 2 feet bgs

0204 = soil collected from 2 to 4 feet bgs

0810 = soil collected from 8 to 10 feet bgs

Depth (for sediments, in inches bgs)

0006= sediment collected from 0 to 6 inches bgs

0612= sediment collected from 6 to 12 inches bgs

3.1.1 Examples of Sample Nomenclature

The first groundwater sample collected from existing monitoring well 01 at the Cast High Explosives Fill/B146 Incinerator (SWMU 16) for a filtered sample would be designated as 16GW0101F.

The second groundwater sample collected from existing monitoring well C20P2 at SWMU 16 for an unfiltered sample would be designated as 16GWC20P202.

The first unfiltered groundwater sample collected from new monitoring well MWT01 at SWMU 13 would be designated as 13GWT0101.

The second surface water sample collected from point 01 at SWMU 13 for an unfiltered sample would be designated as 13SW0102.

A surface soil sample collected from soil boring 03 at SWMU 16 at the 0- to 2-foot interval would be designated as 16SS030002.

A subsurface soil sample from the same soil boring 03 at an interval of 4 to 5 feet bgs would be designated as 16SB030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 19SD140006.

3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the approved field sampling plan and QAPP. They will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

AA	NNNNNN	NN	F
QC Type	Date	Sequence Number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

TB = Trip Blank
RB = Rinsate Blank (Equipment Blank)
FD = Field Duplicate
AB = Ambient Conditions Blank
SB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

3.2.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-03

SAMPLE CUSTODY AND DOCUMENTATION OF FIELD ACTIVITIES

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for sample custody and documentation of field sampling and field analyses activities.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following logbooks, forms, and labels are required.

Site logbook
Field logbook
Sample label
Chain-of-Custody Form
Custody seals
Equipment calibration log
Monitoring Well Inspection Form
Water-Level Measurement Form
Low-Flow Purge Data Sheet
Ground Water Sample Log Sheet
Surface Water Sample Log Sheet
Soil and Sediment Log Sheet

3.0 PROCEDURES

This section describes custody and documentation procedures. All entries made into the logbooks, custody documents, logs, and log sheets described in this SOP must be made in indelible ink (black is preferred). No erasures are permitted. If an incorrect entry is made, the entry will be crossed out with a single strike mark, initialed, and dated.

3.1 Site Logbook

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, the following activities and events will be recorded (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Arrival/departure of equipment
- Start or completion of sampling activities
- Daily on-site activities performed each day
- Sample pickup information
- Health and safety issues
- Weather conditions

The site logbook is initiated at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day that on-site activities take place.

The following information must be recorded on the cover of each site logbook:

- Project name
- Project number
- Book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). At the completion of each day's entries, the site logbook must be signed and dated by the field operations leader (FOL).

3.2 Field Logbooks

The field logbook is a separate dedicated notebook used by field personnel to document his or her activities in the field. This notebook is hardbound and paginated.

3.3 Sample Labels

Adhesive sample container labels must be completed and applied to every sample container. Information on the label includes the project name, location, sample number, date, time, preservative, analysis, matrix, sampler's initials, and the name of the laboratory performing the analysis.

3.4 Chain-of-Custody Form

The Chain-of-Custody Form (COC) is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as it is transferred from person to person. Each COC is numbered. This form must accompany any samples collected for laboratory chemical analysis. A copy of a blank COC form is attached at the end of this SOP.

The FOL must include the name of the laboratory in the "Remarks" section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the FOL will indicate "Page __ of __" on each COC. The original (top) signed copy of the COC will be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. Once the samples are received at the laboratory, the sample custodian checks the contents of the cooler(s) against the enclosed COC(s). Any problems are noted on the enclosed COC Form (bottle breakage, discrepancies between the sample labels, COC form, etc.) and will be resolved through communication between the laboratory point-of-contact and the Task Order Manager (TOM). The COC Form is signed and retained by the laboratory and becomes part of the sample's corresponding analytical data package.

3.5 Custody Seal

The custody seal is an adhesive-backed label with a number on each seal. It is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. The custody seals are signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the TOM if evidence of tampering is observed.

3.6 Equipment Calibration Log

The Equipment Calibration Log is used to document calibration of measuring equipment (e.g., multi-parameter water-quality meter) used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device requiring calibration. Entries must be made for each day the equipment is used.

3.7 Monitoring Well Inspection Form

The Monitoring Well Inspection Form is used to document the inspection of existing monitoring wells in accordance with SOP CTO166-09.

3.8 Water-Level Measurement Form

The Water-Level Measurement Form is used to document the determination of water levels in monitoring wells in accordance with SOP CTO166-17.

3.9 Low-Flow Purge Data Sheet

The Low-Flow Purge Data Sheet is used to document field measurements made while purging wells to stabilization in accordance with SOP CTO166-15.

3.10 Ground Water Sample Log Sheet

The Ground Water Sample Log Sheet is used to document the samples taken from a monitoring well at the end of low-flow well purging. This sheet is used in conjunction with SOP CTO166-05.

3.11 Surface Water Sample Log Sheet

The Surface Water Sample Log Sheet is used to document the samples collected from surface waters. This sheet is used in conjunction with SOP CTO166-18.

3.12 Soil and Sediment Sample Log Sheet

The Soil and Sediment Sample Log Sheets are used to document the sampling of soils and sediments. This sheet is used in conjunction with SOP CTO166-08 and SOP CTO166-19.

4.0 ATTACHMENTS

1. Chain-of-Custody Record

ATTACHMENT 1
CHAIN-OF-CUSTODY RECORD

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE ____ OF _____

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
		CARRIER/WAYBILL NUMBER	CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

CONTAINER TYPE PLASTIC (P) or GLASS (G)

PRESERVATIVE USED

TYPE OF ANALYSIS

DATE YEAR ____	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS									COMMENTS

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

3/99
FORM NO. TtNUS-001

STANDARD OPERATING PROCEDURE
NUMBER CTO166-04

BOREHOLE ADVANCEMENT AND SOIL CORING USING DIRECT-PUSH TECHNOLOGY AND HAND AUGER TECHNIQUES

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for collecting surface and subsurface soil cores from unconsolidated overburden materials using direct-push technology (DPT) and hand augering techniques at the NSWC Crane facility. For this investigation, a Geoprobe® rig with a Macrocore Sampler will be the type of DPT used.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Cut-resistant non-latex Impermeable Gloves
Cotton gloves
Disposable medical-grade gloves (e.g., latex, nitrile)
Writing utensil
Boring log sheets: A copy of this form is included in SOP CTO166-07
Photoionization detector (PID) (see SOP CTO 166-06)
Geoprobe® or equivalent DPT equipment
Geoprobe® Macrocore Sampler or equivalent
Geoprobe® Sampling Kit or equivalent
Clear acetate liners: one new liner for each soil core
Stainless Steel Auger Buckets
Stainless Steel Extension Rods
Cross Handle
Required decontamination materials (see SOP CTO166-16)
Bentonite pellets

3.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A GEOPROBE®

DPT will be employed to collect soil cores. DPT refers to sampling tools and sensors that are driven directly into the ground without the use of conventional rotary drilling equipment. DPT typically utilizes hydraulic pressure and/or percussion hammers to advance the sampling tools. Geoprobe® is a manufacturer of a hydraulically powered, percussion/probing machine utilizing DPT to collect subsurface environmental samples.

3.1 Clear the area to be sampled of any surface debris (herbaceous vegetation, twigs, rocks, litter, etc.).

3.2 Place a new clear acetate liner in the detachable Macrocore core barrel and attach the coring device to the Geoprobe® rig.

3.3 Drive the macrocore sampler (lined with acetate) into the ground to a depth of 2 feet using hydraulic pressure. The 0- to 2-foot depth soil interval is considered to be the surface soil.

3.4 Retract the sampler from the borehole and remove the acetate liner and the soil core from the Macrocore barrel.

3.5 Attach the metal trough from the Geoprobe® Sampling Kit firmly to the tailgate of a vehicle. If a vehicle with a tailgate is not available, secure the trough on another suitable surface.

3.6 Place the acetate liner containing the soil core in the trough.

3.7 While wearing cut-resistant gloves (constructed of non-latex over cotton), cut the acetate liner through its entire length using the double-bladed knife that accompanies the Geoprobe® Sampling Kit. Then remove the strip of acetate from the trough to gain access to the collected soils. **CAUTION:** Do not attempt to cut the acetate liner while holding it in your hand.

3.8 Scan the entire length of the soil core for VOCs using the PID. Record the specific depth interval and the associated PID reading on the Boring Log Sheet. Collect a soil VOC sample using Encore samplers from the soil interval that had the highest PID reading. If no above-background PID readings were detected, collect the VOC sample from an interval that is discolored or displays other visual signs of being contaminated. If no visual sign of contamination is evident, collect the

soil VOC sample from the center of the core interval (i.e., 1-foot depth). Details for collecting a VOC sample using the Encore sampler are included in SOP CTO166-08.

3.9 Log the soil core on the Boring Log Sheet (see SOP CTO166-07).

3.10 Place the soil core in a stainless-steel mixing bowl, homogenize, and collect the remainder of the soil sample aliquots, as described in SOP CTO 166-08.

3.11 Repeat steps 3.2 through 3.11 for the next depth intervals.

3.12 The depth to bedrock should be recorded on the Boring Log and the estimated moisture content of the soil and the presence or absence of water in the boring should be noted.

3.13 If readings from the PID are all at background levels below field screening criteria, then excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole.

3.14 If screening instruments indicate that contaminants may be present in the soil materials, then all excess soil core materials will be placed in a plastic bag (or drum if larger quantities). The bag will be tagged identifying the locations and depths from where the soils came from and the date. The bag will then be placed in a 55-gallon drum and stored on site until laboratory analyses of the soil are completed and classification of the soil waste materials can be determined (see SOP CTO166-14).

3.15 If soil materials from the boring are suspected of being contaminated (see 3.14 above), the soil boring will be backfilled with bentonite pellets up to the ground surface.

3.16 Decontaminate all soil sampling equipment in accordance with SOP CTO166-16 before collecting the next sample.

4.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A HAND AUGER

Hand Augers may be employed to collect soil cores where non-VOC samples will be collected. A hand augering system generally consists of a variety of all stainless steel bucket bits (i.e. cylinders 6-1/2" long and 2-3/4", 3-1/4", and 4" in diameter), a series of extension rods (available in 2', 3', 4' and 5' lengths), a

cross handle. A larger diameter bucket bit is commonly used to bore a hole to the desired sampling depth and then withdrawn. In turn, the larger diameter bit is replaced with a smaller diameter bit, lowered down the hole, and slowly turned into the soil at the completion depth or refusal. The apparatus is then withdrawn and the soil sample collected.

The hand auger can be used in a wide variety of soil conditions. It can be used to sample soil, both from the surface, or to depths in excess of 12 feet. However, the presence or rock layers and the collapse of the borehole normally contribute to its limiting factors.

4.1 Attach a properly decontaminated bucket bit into a clean extension rod and further attach the cross handle to the extension rod.

4.2 Clear the area to be sampled of any surface debris (vegetation, twigs, rocks, letter, etc.)

4.3 Begin augering (periodically removing accumulated soils from the bucket bit) and add additional rod extensions as necessary. Also, note (in a field notebook or on standardized data sheets) and changes in the color, texture or odor of the soil.

4.4 After reaching the desired depth, slowly and carefully withdraw the apparatus from the borehole.

4.5 Remove the soiled bucket bit from the extension rod extension and replace it with another properly decontaminated bucket bit. The bucket bit used for sampling is commonly smaller in diameter than the bucket employed to initiate the borehole.

4.6 Carefully lower the apparatus down the borehole. Care must be taken to avoid scraping the borehole sides.

4.7 Slowly turn the apparatus until the bucket bit is advanced approximately 6 inches.

4.8 Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.

4.9 Scan the soil core using the PID. Record the specific depth interval and the associated PID reading on the Boring Log Sheet.

4.10 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the remaining sample containers, as described in SOP CTO 166-8.

4.11 Log the soil core on the Boring Log Sheet (see SOP CTO166-07).

4.12 If readings from the PID are all at background levels below field screening criteria, then excess soil core materials will be returned to the hole and tamped. If insufficient soil is available to fill the hole to the ground surface, then bentonite pellets mixed with the soil will be used to backfill the hole.

4.13 If screening instruments indicate that contaminants may be present in the soil materials, then all excess soil core materials will be placed in a plastic bag (or drum if larger quantities). The bag will be tagged identifying the locations and depths from where the soils came from and the date. The bag will then be placed in a 55-gallon drum and stored on site until laboratory analyses of the soil are completed and classification of the soil waste materials can be determined (see SOP CTO166-15).

4.14 If soil materials from the boring are suspected of being contaminated (see 4.12 above), the soil boring will be backfilled with bentonite pellets up to the ground surface.

4.15 Decontaminate all soil sampling equipment in accordance with SOP CTO166-16 before collecting the next sample.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-05

MONITORING WELL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for monitoring well sampling. Low-flow sampling techniques will be used for ground water sampling at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

Ground Water Sample Log Form: A copy of this form is attached at the end of this SOP

Bound field log book

Chain-of-Custody Form

Bladder pump

Peristaltic Pump

Surgical gloves

Labeled sample containers: Sample containers are certified clean by the laboratory supplying the sample containers.

Tag for each sample container

Plastic storage bags

Shipping containers with ice

3.0 MONITORING WELL SAMPLING PROCEDURES

3.1 Ground water sampling may be initiated when the monitoring well has been purged and stabilized in accordance with SOP CTO166-15.

3.2 Record the sample start time (using military time) on the Ground Water Sample Log Sheet. Record the field measurements for pH, (ORP), specific conductance, temperature, dissolved oxygen, and turbidity.

3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.

3.4 Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled. Sample containers for volatile constituents (VOCs) must be completely filled so that no headspace exists in the container. The VOC vials will be filled to the top so that a convex meniscus is formed. Gently secure the cap, turn the vial upside down, and check to see if any air has been trapped inside the vial. If so, open the cap, reform the meniscus, and attempt again to secure the lid without trapping air in the sample. All other sample containers can have air space included when the container lid is secured.

3.5 Cap each container immediately after filling.

3.6 Record the sample time on the Ground Water Sample Log Form, the sample tag, and the sample label.

3.7 Secure the associated tag to each sample container.

3.8 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.

3.9 Enter the proper information on the Chain-of-Custody Form for each sample container (see SOP CTO166-03).

3.10 Repeat steps 3.3 through 3.9 for each sample container collected.

3.11 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Ground Water Sample Log Form.

3.12 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence (where applicable):

- Volatile organic compounds (VOCs)
- Other organics
- Appendix IX Metals plus Sn (totals)
- Nitrate
- Nitrite

3.13 If the last turbidity measurement prior to the commencement of sampling showed turbidity to be greater than 10 nephelometric turbidity units (NTUs), then filtered aliquots of ground water will be collected and analyzed for dissolved metals. Without turning off the pump, attach a disposable, inline, 0.45-um filter cartridge at the end of the discharge tube. Fill sample containers marked for dissolved metals so that the laboratory knows that these aliquots are distinct sample fractions and that the results should be reported as dissolved analytes.

3.14 Repeat steps 3.5 through 3.9 for the filtered sample containers.

3.15 After completion of sample collection, remove the bladder pump from the well and decontaminate following the procedures in SOP CTO166-16.

3.16 Replace the outer protective well cap and lock the well.

3.17 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves and other equipment should be placed in a plastic trash bag and handled as investigation-derived waste (SOP CTO166-14).

4.0 ATTACHMENTS

1. Ground Water Sample Log Sheet

ATTACHMENT 1

GROUND WATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Time:	(Visual)	(S.U.)	(mS/cm)	(^{0}C)	(NTU)	(mg/l)	(%)	
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp.	Turbidity	DO	Salinity	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO166-06

CALIBRATION AND USE OF PHOTOIONIZATION DETECTOR

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for the maintenance, calibration, and use of a photoionization detector (PID). The Photovac 2020 Photoionization Air Monitor will be used during the NSWC Crane facility investigation. The procedures for its use are discussed in detail in the following sections.

2.0 GLOSSARY

Electron-volt (eV) - A unit of energy equal to the energy acquired by an electron when it passes through a potential difference of 1 volt in a vacuum.

Intrinsically Safe (I.S.) - Based on wiring, configuration, design, operation, gasketing, construction, this instrument may be employed within locations where flammable gases and/or vapors may exist.

Ionization Potential (I.P.) - The energy required to remove an electron from a molecule yielding a positively charged ion and a negatively charged free electron. The instrument measures this energy level.

Photoionization Detector (PID) - Photoionization detector is employed as the general reference to air monitors of this type. PID's detection method employs ultraviolet (UV) radiation as an energy source. As air and contaminants are drawn through the ionization chamber, the UV light source causes the contaminant with ionization potentials equal to or less than the UV source to break into positive and negatively charge ions. The created ions are subjected to an electrostatic field. The voltage difference is measured in proportion to the calibration reference and the concentration of the contaminant.

Ultraviolet Radiation (UV) Lamp - Ultraviolet radiation is the energy source employed by the instrument to ionize collected sample gas streams. The UV lamp source is required to be equal to or greater than the ionization potential of the substance drawn through the instrument in order to create separate ionized species.

3.0 REQUIRED EQUIPMENT

Pen
Equipment Calibration Form
Photoionization detector
Isobutylene calibration gas (i.e., span gas)
Regulator

4.0 PROCEDURES

4.1 Principle of Operation

The Photovac portable photoionizer detects many organic (and a few inorganic) species. The basis for detection of this instrument is the ionization of components in gaseous streams. The incoming gas molecules are subjected to ultraviolet (UV) radiation, which is energetic enough to ionize many compounds associated with industrial activities. Molecules are transformed into charged-ion pairs, creating a current between two electrodes. Each molecule has a characteristic ionization potential, which is the energy required to remove an electron from the molecule, yielding a positively charged ion and a free electron. The instrument measures this energy level.

This instrument measures the concentration of airborne photoionizable gases and vapors and automatically displays and records these concentrations. It does not distinguish between individual substances. Readings displayed represent the total concentration of all photoionizable chemicals present in the sample. This instrument is factory-set to display concentration in units of ppm or mg/m^3. The meter display updates itself once per second.

The 2020 also performs short-term exposure limit (STEL), time-weighted average (TWA), and PEAK calculations. Any of these results can be viewed, but only one mode may be viewed at a time.

The 2020 has six keys for alphanumeric entry and for accessing multiple functions. The keys are used to set up and calibrate 2020. They allow the user to manipulate the concentration data in various ways.

All information entered with the keys and stored in the 2020's memory is retained when the instrument is switched off. The clock and calendar continue to operate and do not need to be set each time the 2020 is turned on.

4.1.1 Displays

The 2020 has a meter display for reporting detected concentration and a display used for status/ information to guide you through configuration options. All functions of the 2020 will be controlled or reported using one of these displays.

4.1.1.1 Meter Display

The meter display is four digits. It will always be used for reporting detected concentration. When the detector and pump are off, the meter display will be blank.

In order to accommodate the range of concentrations the 2020 can detect, the meter reading will be reported using one of two resolutions. A resolution of 0.1 will be used for concentrations below 100 ppm, and a resolution of 1 will be used for concentrations above 100 ppm.

4.1.1.2 Status Display

The status display is a two- line by 16-character display. The top line is used to display status information and prompts the user for inputs. The bottom line is used for soft key names. Up to three names can be displayed for the three soft keys. If a name does not appear for a soft key, then the soft key has no associated function.

4.1.2 Keys

4.1.2.1 Fixed Keys

The three round keys below the soft keys each have a fixed function. The first key is the ON/OFF key, the middle key is the EXIT key, and the last key is the ENTER key.

The ON/OFF key is used to both turn power on and off. To turn on the 2020, press the ON/OFF key. To turn the power off, press the ON/OFF key and hold it down for 2 seconds, and then release it. This is done to prevent accidental power off.

The EXIT key provides a way of returning to the default display. In the functional map, the soft keys allow the user to advance and the EXIT key provides a way to go back. If the user is at the initial entry of the menu, EXIT will return you to the default display.

The ENTER key has a context sensitive function. When the user is operating or navigating through the function map, the ENTER key is used to exit the functions and return to the default display. When entering data such as a name, number, date, or time, ENTER is used to confirm the entry.

4.1.2.2 Soft Keys

The three soft keys on the 2020 are located directly below the status display. Each key has varying functions for configuring the 2020, editing the data logger, and controlling the display. Because only three soft keys are available, each function is broken down into a path.

4.1.2.3 Entering Text with the Soft Keys

For all information that is entered, the left, center, and right soft keys correspond to the up, down, and right arrow.

The up and down arrows are used to change the character highlighted by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right most character, it wraps around to the first character again. To accept the changes, press the ENTER key. To ignore the change, press EXIT.

Formatting characters, such as the colon (:) in the time, the decimal (.) in a concentration, and the slash (/) in the date, are skipped when advancing the cursor.

All inputs are an eight-character input, which is displayed on the right side of the top line of the status display. The prompt, describing the input, occupies the left half of the top line. The soft keys are defined on the bottom line of the status display.

4.2 Default Display

The meter display shows the detected concentration. The resolution of the display changes with the magnitude of the reading. A reading of 0 to 99.9 will be displayed with a resolution of 0.1 ppm. A reading greater than 99.9 will be shown with a resolution of 1 ppm or 1 mg/m^3. The meter will display concentrations up to 2000 ppm or 2(99) mg/m^3.

The status display is used to display the instrument status, date, time, units, and active soft keys.

The default display provides the following information: instrument status, current detected concentration, time, date, and measurement units. The status display toggles between showing time and units and then the date.

When the display mode is MAX, the date and time correspond to the date and time the MAX concentration was recorded. In TWA mode, the time represents the number of hours and minutes during which the TWA has been accumulating. For PEAK and STEL monitoring, the date and time correspond to the current date and time.

4.3 Monitoring

4.3.1 Instrument Status

The instrument status is shown on the left of the first line of the status display and on the Table and Graph outputs. Each status has a priority assigned to it. If more than one status is in effect, then the status with the highest priority is displayed until the condition is corrected or until the option is turned off.

4.3.2 Alarms

While operating the instrument, any one of three alarm conditions can occur. To accurately identify the source of the alarm, each type of alarm has been given a unique status.

In addition to the status, the 2020 also has an audible alarm and a visual alarm LED. To conserve power, the 2020 alternates between these two alarm indicators, rather than operating both concurrently. Different alarms are identified by the frequency at which the 2020 alternates as follows: PEAK alarm, 5 times per second; STEL alarm, 2.5 times per second; and TWA alarm, 1.25 times per second.

The left soft key is used for acknowledging alarms, and is labeled "Ack." If no alarm exists, then the "Ack" key is not shown. To clear the alarm, press the "Ack" key. Once acknowledged, the alarm indicators are cleared. The alarm status will remain until the alarm condition clears.

The 2020 updates the peak concentration once every second. Following every update, the peak concentration is compared to the peak alarm level, and, if exceeded, an alarm is triggered.

If a 15-minute average concentration exceeds the selected STEL, a STEL alarm is generated.

The TWA alarm is generated when the current average concentration over an 8-hour period, since the TWA was last cleared, has exceeded the TWA exposure limit.

During calibration, all alarms are disabled. Once the calibration is complete, the alarms are re-enabled.

4.4 STEL, TWA, MAX, and PEAK Operation

The 2020's meter display can be configured to show one of four values: STEL, TWA, PEAK, and MAX.

4.4.1 Short-term Exposure Limit Mode

The STEL mode displays the concentration as a 15-minute moving average. The 2020 maintains 15 samples, each representing a 1-minute averaging interval.

Once every minute, the oldest of the 15 samples is replaced with a new 1-minute average. This moving average provides a 15-minute average of the last 15 minutes with a 1-minute update rate. Because the average is calculated using 15 one-minute averages, the meter display will only update once every minute.

The STEL is set to zero each time the instrument is turned on. Because STEL is a 15-minute moving average, there is no need to clear or reset the STEL.

STEL calculations are always being performed by the 2020. The user can display the results of the calculations by selecting "STEL" as the Display mode.

4.4.2 Time-weighted Average (TWA) Mode

The TWA accumulator sums concentrations every second until 8 hours of data have been combined. If this value exceeds the TWA alarm setting, a TWA alarm is generated. The TWA is not calculated using a moving average. Once 8 hours of data have been summed, the accumulation stops. In order to reset the TWA accumulator, press the "Clr" key.

This sum will only be complete after 8 hours, so the meter displays the current sum divided by 8 hours. While in TWA mode, the time on the status display will show the number of minutes and hours of data that TWA has accumulated. When this reaches 8 hours, the 2020 stops accumulating data and the TWA is complete.

TWA calculations are always being performed by the 2020. The user can display the results of the calculations by selecting TWA as the Display mode.

4.4.3 MAX Mode

The MAX mode displays the maximum signal, with the date and time that it was recorded. The 2020 continues to log data according to the selected averaging interval, but only the maximum detected concentration is displayed on the meter display.

The right soft key is used to clear the meter when displaying MAX. The "Clr" key only affects the reading that the meter is displaying. For example, if the MAX reading is displayed, and "Clr" is pressed, only the MAX value is cleared. The TWA is still accumulating in the background.

4.4.4 PEAK Mode

The PEAK mode displays the current detected concentration. The reading is updated once a second. In the background, the 2020 data logger is sampling the concentration and measuring minimum, maximum, and average concentrations for the selected averaging interval. At the end of every interval, one entry is placed in the data logger until the data logger is full. For CTO 166, the instrument should be operated in this mode. Operation within the other specialized modes is the responsibility of the SSO.

4.5 Set Functions

Set functions are used to set up the 2020. Three functions can be set on the 2020: Pump, Clock, and Calibration.

4.5.1 Pump

The Pump function is used to control the pump. After selecting "Set Pump," the 2020 responds by displaying the new pump status.

The detector is also turned off when the pump is turned off. This prevents the detector from being damaged when there is no sample flowing through the detector.

When the pump and the detector are off, the meter display will be blank. Turn the pump and detector off when concentration measurements are not necessary, and the 2020 will only be used for reviewing data

or generating reports. By operating the instrument with the pump and detector off when they are not needed, the lives of the battery and ultraviolet (UV) lamp will be conserved.

To set the pump:

1. Press the ENTER key. The top line of the status display changes to "Select?" The bottom line displays three soft key names: "Set," "Log," and "Disp."

2. Press the soft key below "Set."

3. The names of the soft keys change to reflect the Set options. The display now shows three devices that can be set: "Clock," "Pump," and "Cal." Press the "Pump" key.

4. The 2020 turns the pump off. If the pump was off, pressing "Pump" will turn the pump on.

5. A message will be displayed to show the status of the pump. The 2020 reverts back to the previous menu after a few seconds.

6. To return to the default display, press the ENTER key.

4.5.2 Clock

The Clock function is used to set both the current date and time.

To set the clock:

1. Press the ENTER key.

2. Press the "Set" key.

3. When the names of the soft keys change, press the "Clock" key.

   The up and down arrows are used to change the character underlined by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced past the right-most character, it wraps around to the first character again.

Formatting characters, such as the colon (:) in the time and the slash (/) in the date are skipped when advancing the cursor.

4. Use the "arrow keys" to enter the correct time. The time is formatted as Hour:Minute:Second.

5. Press the ENTER key to confirm the time and move to the date option.

6. When setting the date, the 2020 prompts for the current date formatted as Year/Month/Day. Use the "arrow keys" to enter the correct date.

7. Press the ENTER key to confirm the date and return to the Set options. Wait for the display to timeout or press ENTER to return to the default display.

4.5.3 Calibration (Cal)

"Cal" allows the user to set up and calibrate the 2020. There are three options under the Cal function: "Zero," "Span," and "Mem."

A calibration memory consists of a name, a response factor, and PEAK, TWA, and STEL alarm levels.

The "Zero" and "Span" keys are covered in detail in the manufacturer's operations manual for the instrument.

To edit the calibration memory, select "Mem" and then "Chng." The 2020 prompts the user with two new soft keys: "User" and "Lib."

4.5.4 Library (Lib)

Library selections simplify Cal Memory programming and provide standard response factors for approximately 70 applications. "Lib" allows the user to select an entry from a pre-programmed library. The name, response factor, and three alarm levels are all set from the library. To select a library entry to program the selected Cal Memory:

1. Select "Set," "Cal," "Mem," "Chng," and "Lib."
2. Use the "Next" and "Prev" keys to scroll through the list. See the manufacturer's manual Appendix 8.7 for a list of the library entries.

4.6 Preparing for Field Operation of the Photovac 2020

Turning The 2020 On

1. Turn the 2020 on by pressing the ON/OFF key.

2. The 2020 will display the software version number. Wait for the 2020 to proceed to the default display.

3. Allow 10 minutes for the instrument to warm up and stabilize.

4. Press the Enter Key. The default display will provide three soft key selections, "Set," "Log," and "Display."

5. Press "Set." From this option, three other soft key selections will be offered: "Pump," "Clock," and "Cal."

6. Press "Cal." This will begin the calibration sequence. The first selection is to zero the instrument.

7. Press Enter; zeroing will begin. (Note: When employing zero gas, attach and activate zero gas supply at this time.)

8. The next selection offered will be Span. Press Enter, at which time the concentration will be requested. The isobutylene calibration gas employed under general service will be marked on the side of the container. Use the soft keys to toggle into position and to log the concentration. Once the concentration is logged, press "Enter." The direction on the status display will indicate spanning. At this time, hook up the span gas with a regulator to the Photovac 2020 and open it to supply enough flow to elevate the flow rate indicator to the green indicator line (1/8 inch from the rest position).

9. Once spanning is complete, the alarms, which have been disabled during calibration, will activate, indicating that calibration is complete.

10. Document this calibration procedure using a Document of Calibration form (included in Appendix A).

This instrument is ready for general purpose application.

Calibration is to be performed daily or prior to each use, in accordance with this section.

4.7 Maintenance and Calibration Schedule

Function	Frequency
Routine Calibration	Prior to each use.
Factory Inspection and Calibration	Once a year, or when malfunctioning.
Wipe Down the Outer Casing of the Unit	After each use.
Clean UV Light Source	Every 24 hours of operation.
Sample Inlet Filter	Change on a weekly basis or as required by level of use.
Battery charging	After each use.
Clean ionization chamber	Monthly.

4.7.1 Cleaning the UV Light Source Window

1. Turn the FUNCTION switch to the OFF position. Use the 2020 multi-tool and remove the lamp housing cover. CAUTION: The UV lamp is delicate and expensive; handle carefully.

2. Tilt the lamp housing with one hand over the opening; slide the lamp out of the housing.

3. The lamp window may now be cleaned with any of the following compounds using lens paper:
   a. 11.7 eV Lamp - Dry Aluminum Oxide Powder (3.0 micron powder)
   b. All other lamps-HPLC Grade Methanol

4. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace the o-ring as necessary, reinstall the lamp housing cover, and tighten it using the 2020 multi-tool. (Do not over tighten.)

5. Recalibrate the instrument as per Section 4.6.

4.7.2 Cleaning the Ionization Chamber

1. Turn the FUNCTION switch to the OFF position and remove the lamp housing cover and lamp as per Section 4.7.1.

2. Using a gentle jet of compressed air, gently blow out any dust or dirt.

3. Following cleaning, reassemble by first sliding the lamp back into the lamp housing. Replace the o-ring as necessary, reinstall the lamp housing cover, and tighten it using the 2020 multi-tool. (Do not over tighten.)

4. Recalibrate the instrument as per Section 4.6.

4.8 Instrument Advantages

The Photovac 2020 is easy to use in comparison to many other types of monitoring instrumentation. Its detection limit range is in the low parts-per-million range. Response rapidly reaches 90 percent scale of the indicated concentration (less than 3 seconds for benzene). This instrument's automated performance covers multiple monitoring functions simultaneously, incorporating data logging capabilities.

4.9 Limitations of the Photovac 2020 Photoionization Monitor

- Because the 2020 is a nonspecific total gas/vapor detector, it cannot be used to identify unknown chemicals; it can only quantitate them in relationship to a calibration standard (relative response ratio).

- For appropriate application of the 2020, ionization potentials of suspected contaminants must be known.

- Because the types of compounds that the 2020 can potentially detect are only a fraction of the chemicals possibly present at a hazardous waste site or incident, a background or zero reading on this instrument does not necessarily signify the absence of air contaminants.

- The 2020 instrument can only monitor certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates, and other toxic gases and vapors cannot be detected.

- PIDs are generally not specific. Their response to different compounds is relative to the calibration gas used. This is referred to as relative response ratio. Instrument readings may be higher or lower than the true concentration. This can be an especially serious problem when monitoring for total contaminant concentrations if several different compounds are being detected at once.

- The 2020 is a small, portable instrument that cannot be expected to yield results as accurately as laboratory instruments.

4.9.1 Variables Affecting Monitoring Data

Monitoring a hazardous waste site environment can pose a significant challenge in assessing airborne concentrations and the potential threats to site personnel. Several variables may influence both dispersion and the instrument's ability to detect actual concentrations. Some of the variables, which may impact these conditions, are as follows:

- Temperature - Changes in temperature or pressure will influence volatization and affect airborne concentrations. Additionally, an increase or decrease in temperature ranges may have an adverse effect on the instrument's ability to detect airborne concentrations.

- Humidity - Excessive levels of humidity may interfere with the accuracy of monitoring results.

- Rainfall - Through increased barometric pressure and water, rainfall may influence dispersion pathways affecting airborne emissions.

- Electromagnetic interference - High voltage sources, generators, other electrical equipment may interfere with the operation and accuracy of direct-reading monitoring instruments.

5.0 TROUBLESHOOTING

5.1 <u>Fault Messages</u>

When the "Fault" status is displayed, the 2020's operation is compromised.

Fault 1: Signal from zero gas is too high.

Cause: If another fault occurred while the 2020 was setting its zero point, then this fault is displayed.
Action: Ensure no faults are occurring and calibrate the 2020 again.

Cause: Contamination of sample line, sample probe, or fittings before the detector.

Action: Clean or replace the sample line, sample probe, or the inlet filter.

Cause: Span gas and zero air are switched.

Action: Ensure clean air is used to zero the 2020. If you are using gas bags, mark the calibration and zero gas bags clearly.

Cause: Ambient air is contaminated.

Action: If you are unsure about the quality of ambient air, use a supply of commercial zero grade air to zero the 2020.

Fault 2: Signal from span gas is too small.

Cause: Operator may have switched the span gas and zero air.

Action: Ensure clean air is used to zero the 2020. If you are using gas bags, mark the calibration and zero gas bags clearly.

Action: Ensure the span gas is of a reliable concentration.

Cause: UV lamp window is dirty.

Note: Do not remove the detector lamp in a hazardous location.

Action: Clean the UV lamp window.

Cause: UV lamp is failing.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a new UV lamp.

Cause: Incompatible application.

Action: The concentration and sample gas are incompatible for use with the 2020.

Fault 3: UV lamp fault. UV lamp has not started.

Cause: The UV lamp has not started immediately.

Action: This fault may be seen momentarily when 2020 is first turned on. Allow 30 to 60 seconds for the UV lamp to start and the fault to clear.

Cause: The UV lamp serial number label is blocking the photocell.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the label is blocking the photocell. Rotate the lamp approximately 90 degrees and then try to start the 2020 again. If the fault persists, replace the lamp.

Cause: the UV lamp is not installed.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a UV lamp.

Cause: The UV lamp has failed.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: Install a new UV lamp.

Cause: Electronic problem.

Action: If a new UV lamp still generates this fault, then contact the Photovac Service Department.

Fault 4: Pump current too low or too high.

Cause: If the pump sounds labored, then the pump is operating beyond normal operating parameters.

Action: Check for an obstruction in the sample line. Make sure sample line, sample probe, or inlet filter are not plugged.

Note: Do not replace the inlet filter in a hazardous location.

Action: Replace the inlet filter.

Action: Ensure the sample outlet, located on the underside of the 2020, is not obstructed.

Cause: The UV lamp is too wide, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS equipment manager.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter and liquid has been aspirated.

Action: Contact the TtNUS equipment manager.

Cause: The pump has failed.

Action: Contact the TtNUS equipment manager.

5.2 Specific Problems

Problem: Very low or no instrument response detected, yet compounds are known to be present.

Cause: The 2020 has not been calibrated properly.

Action: Ensure the calibration gas is of a reliable concentration and then calibrate the instrument as outlined in Section 4.6 of the User's Manual. After the instrument has been calibrated, sample the bag of calibration gas. A reading equivalent to the calibration gas should be displayed. If not, contact the TtNUS equipment manager.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Disconnect the battery charger before calibrating the 2020.

Cause: Calibration memories have not been programmed correctly.

Action: Program all the calibration memories you require for your application. You must use the correct calibration gas and concentration for each Cal Memory.

Cause: The response factor has been set to zero.

Action: Enter the correct response factor. Refer to Appendix 8.6 for a list of response factors. If the compound is not listed in Appendix 8.6 or you are measuring gas mixtures, then enter a value of 1.0. See User's Manual provided by the manufacturer.

Cause: You are not using the correct Cal Memory.

Action: Select the correct Cal Memory for your application.

Note: It does not matter which Cal Memory is selected or which response factor is entered. The 2020's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

Cause: Detector is leaking. A decrease in sensitivity may be due to a leak in the detector.

Note: Do not remove or replace the detection lamp in a hazardous location.

Action: Ensure the UV lamp has been installed correctly.

Action: Ensure the lamp cover has been tightened down. Do not overtighten the cover.

Action: Ensure the o-ring seal on the lamp cover is positioned correctly.

Cause: The UV lamp is too long, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too long for the lampholder. Replace the lamp and contact the TtNUS equipment manager.

Cause: UV lamp is too wide, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS equipment manager.

Cause: The sampling environment is extremely humid.

Action: Water vapor is not ionized by the PID, but it does scatter and absorb the light and results in a lower reading. The 2020 detector has been designed to operate under high humidity conditions. Under extreme conditions, you may notice decreased response due to humidity.

Cause: The UV lamp is failing.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: High concentration of non-ionizable compounds. Chemical compounds, such as methane, with IPs greater than the 10.6 eV scatter and absorb the UV light. Sensitivity may be decreased significantly. Application with high backgrounds of such materials may be incompatible with the 2020. Contact the Photovac Applications Group for more information.

Problem: Erroneously high readings.

Cause: Sampling environment is extremely humid.

Action: Water vapor may contain mineral salts, which carry a charge. The water vapor becomes an electrolytic solution, which becomes ionized when it enters the detector. Atmospheric water in areas around the sea or stagnant water may produce a response in the absence of contaminants. The same effect may be seen when conducting ground water investigations in areas where the water is hard because it contains a significant concentration of minerals.

Cause: The 2020 has not been calibrated properly.

Action: Ensure the calibration gas is of a reliable concentration and then calibrate the instrument as outlined in Section 4.6. After the instrument has been calibrated, sample the bag of calibration gas. A reading equivalent to the calibration gas should be displayed. If not, contact the TtNUS equipment manager.

Cause: Cal Memories have not been programmed correctly.

Action: Program all the Cal Memories you require for your application. You must use the correct calibration gas and concentration for each Cal Memory. See Section 3.4 of the User's Manual.

Cause: You are not using the correct Cal Memory.

Action: Select the correct Cal Memory for your application. See Section 3.2.2 or 3.3.2 of the User's Manual.

Note: It does not matter which Cal Memory is selected or which response factor is entered. The 2020's response is not specific to any one compound. The reading displayed represents the total concentration of all ionizable compounds in the sample.

Cause: The detector has been short circuited by foreign matter in the detector cell.

Note: Do not service the 2020 in a hazardous location.

Action: Do not touch the wire grid inside the detector cell. Use a gentle jet of compressed air to remove any dust in the detector cell.

Warning: Do not insert any object, other than the UV lamp, into the lampholder.

Cause: There is an undetermined problem.

Action: Contact the TtNUS equipment manager.

Problem: Date and time settings are not retained.

Cause: The battery pack was removed before the 2020 was turned off.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Replace the battery pack and reset the time and date. Ensure that the 2020 has been turned off before removing the battery pack.

Cause: The 2020 has not been used for 3 months or more and the internal battery (not the external battery pack) has discharged.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Connect the 2020 to the AC adapter and turn the 2020 on. Turn the pump off. While the 2020 is running, the internal battery is charging. Leave the instrument running for approximately 24 hours.

Problem: Instrument status shows "Over."

Cause: High concentrations of gases and vapors will cause a rapid change in signal level. The detector and associated electronics may become temporarily saturated.

Action: Wait a few seconds for the status to return to normal. PIDs are designed to detect relatively low concentrations of gases and vapors. Exposure to very high concentrations may result in a very high or maximum response.

Cause: The detector has become saturated.

Action: Move the 2020 to a location where it can sample clean air. Sample clean air until the reading stabilizes around 0.

Cause: Detector has been short circuited by foreign matter in the detector cell.

Note: Do not service the 2020 in a hazardous location.

Action: Do not touch the wire grid inside the detector cell. Use a gentle jet of compressed air to remove any dust or dirt in the detector cell.

Warning: Do not insert any object, other than the UV lamp, into the lampholder.

Cause: There is an undetermined problem.

Action: Contact the TtNUS equipment manager.

Problem: Display is blank.

Cause: Battery pack is critically low.

Note: Do not remove or recharge the battery pack in a hazardous location.

Action: Replace the battery pack or connect the 2020 to the AC adapter.

Cause: The battery pack is not connected to the instrument correctly.

Action: Ensure the battery pack connector is securely attached to the connector on the 2020.

Cause: There is an undetermined problem.

Action: Reset the 2020. You must leave the instrument on while you disconnect the battery pack. This will reset the instrument. Reconnect the battery pack and close the battery hatch. Turn on the 2020, set the time and date, and program all the calibration memories that you are using.

Action: Contact the TtNUS equipment manager.

Problem: Sample flow rate is less than 300 ml/min.

Cause: The inlet filter is plugged.

Note: Do not replace the inlet filter in a hazardous location.

Action: Replace the inlet filter.

Cause: The inlet filter has not been installed properly.

Action: Ensure that the inlet filter has been installed correctly.

Cause: The UV lamp is too long, causing flow to be restricted.

Note: Do not remove or replace the detector lamp in a hazardous location.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too long for the lampholder. Replace the lamp and contact the TtNUS equipment manager.

Cause: The UV lamp is too wide, causing flow to be restricted.

Action: If you have a UV lamp with a white serial number label, it is possible that the lamp is too wide for the lampholder. Contact the TtNUS Equipment Manager.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter and liquid has been aspirated.

Action: Contact the TtNUS equipment manager.

Cause: Sample outlet is obstructed.

Action: Ensure the sample outlet is not obstructed in any way.

Cause: Pump has been damaged.

Action: Contact the TtNUS equipment manager.

Problem: Liquid has been aspirated.

Cause: The 2020 has been exposed to a solvent that can pass through the inlet filter.

Action: Contact the TtNUS equipment manager.

Problem: Corrosive gases and vapors have been sampled.

Cause: The 2020 has been exposed to corrosive gases and vapors.

Action: Corrosive gases and vapors can affect the electrodes within the detector as well as the lamp window. Prolonged exposure to corrosive materials may result in permanent fogging or etching

of the window. If the 2020 is exposed to corrosive material, contact the TtNUS equipment manager.

6.0 SHIPPING

The Photovac may be shipped as cargo or carried on as luggage if there is no calibration gas cylinder accompanying the kit. When shipping or transporting the calibration gas, a Hazardous Airbill must be completed.

7.0 REFERENCES

Photovac 2020 Photoionization Monitor User's Manual, 1995.

8.0 ATTACHMENTS

1. Equipment Calibration Log

ATTACHMENT 1

EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____

INSTRUMENT NAME/MODEL: LaMotte 2020

SITE NAME: _____

MANUFACTURER: _____

PROJECT No.: _____

SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

STANDARD OPERATING PROCEDURE
NUMBER CTO166-07

BOREHOLE AND SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil cores collected at the NSWC Crane facility.

2.0 FIELD FORMS AND EQUIPMENT

Knife
Ruler (marked in tenths and hundredths of feet)
Boring Log: An example of this form is attached.
Photoionization detector (PID) (see SOP 166-06)
Writing utensil

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all boring activities and assuring that each borehole is properly and completely logged.

4.0 PROCEDURES FOR BOREHOLE AND SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Soil colors will be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

The term "mottled" will be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist.
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb.
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail.
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. The sample will be broken in half and the thumb pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. One of the other methods will be used in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

4.4 Weight Percentages

In nature, soils are consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., sandy)	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, the following table will be used.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	inorganic clays of high plasticity, fat clays.
	OH	organic clays of medium to high plasticity, organic silts.
Silt	ML	inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity.
	OL	organic silts and organic silty clays of low plasticity..
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Sand	SW	well graded sands, gravelly sands, little or no fines.
	SP	poorly graded sands, gravelly sands, little or no fines.
	SM	silty sands, sand-silt mixtures.
	SC	clayey sands, sand-clay mixtures.

4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

4.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

ATTACHMENT 1

FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

Unified Soil Classification System

Coarse Grained Soils (more than half of soil > No. 200 sieve)	Gravels (More than half of coarse fraction > no. 4 sieve size)	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Sandy gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
Fine Grained Soils (more than half of soil < No. 200 sieve)	Silts and Clays LL = < 50	ML	Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays LL = > 50	MH	Inorganic silts, micaceous or diatomaceous fine sanc or silty soils, elastic silts
		CH	Inorganic silts of high plasticity, fat clays
		OH	Organic clays of high plasticity, organic silty clays, organic silts
Highly Organic Soils		Pt	Peat and other highly organic soils

Grain Size Chart

Classification	Range of Grain Sizes	
	U.S. Standard Sieve Size	Grain Size In Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 7.76
coarse	3" to 3/4"	76.2 to 4.76
fine	3/4"to No.4	19.1 to 4.76
Sand	No. 4 to No. 200	4.76 to 0.074
coarse	No.4 to No. 10	4.76 to 2.00
medium	No. 10 to No. 40	2.00 to 0.420
fine	No. 40 to No. 200	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Relative Density (SPT)

SANDS AND GRAVELS	BLOWS/FOOT
VERY LOOSE	0 – 4
LOOSE	4 – 10
MEDIUM DENSE	10 – 30
DENSE	32 – 50
VERY DENSE	OVER 50

Consistency (SPT)

SILTS AND CLAYS	BLOWS/FOOT
VERY SOFT	0 – 2
SOFT	2 – 4
MEDIUM STIFF	4 – 8
STIFF	8 – 16
VERY STIFF	16 – 22
HARD	OVER 32

ATTACHMENT 2

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area _____

Remarks: _____ Background (ppm): _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

STANDARD OPERATING PROCEDURE
NUMBER CTO166-08

SURFACE AND SUBSURFACE SOIL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for surface and subsurface soil sampling using direct-push technology (DPT) , split-barrel samplers, or hand augers during field activities at the NSWC Crane facility. This procedure also describes the collection of samples for analysis of volatile organic compounds (VOCs) using EnCore samplers and the use of field screening [i.e., photoionization detector (PID)] to select the most appropriate subsurface soil interval for VOC sampling.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil with indelible ink

Disposable medical-grade gloves (i.e. latex, nitrile)

Boring log

Soil sample logsheets

Stainless-steel mixing bowls

Stainless-steel trowel or soup spoon

Disposable trowels

EnCore handle and samplers

Required sample containers: All sample containers including shipping coolers for analysis by fix-based laboratories will be supplied and certified clean by the laboratory.

Required decontamination materials

Chain-of-custody records

Required personnel protective equipment (PPE)

Photoionization detector (PID) (see SOP 166-06)

Wooden stakes or pin flags

Survey tape

Marking Paint

Sealable polyethylene bags

Heavy-duty cooler

Ice

Razor knife

Geoprobe® and sampling equipment

Sample labels and tags

3.0 COLLECTION OF SOIL SAMPLES FOR VOLATILE ORGANIC COMPOUNDS (VOCs)

When soil cores are collected using DPT such as Geoprobe®, 2-foot soil intervals will be collected in clear acetate tubes, which can be extracted from the Geoprobe® core barrel (see SOP CTO166-04) upon retrieval at the surface.

3.1 Slit the acetate liner lengthwise with a razor knife, remove a section of the liner, and expose the length of the soil interval (see SOP CTO166-04).

3.2 Scan the soil core interval with a PID, slowly moving the intake nozzle along the length of the core where the acetate liner has been slit open. Note on the boring log the range of PID readings that are detected and the specific location(s) along the sample interval where above-background readings are encountered. If elevated volatile organics are measured via the PID, collect the VOC samples from the specific interval where the highest PID reading is measured. If no above-background PID readings are measured, then the VOC sample will be collected from a specific interval where visual signs of contamination (staining, etc.) are observed. If no above-background PID reading is measured and no discoloration or odor in the soil core indicates potential contamination, then collect the VOC sample from near the center of a core.

3.3 The 0- to 2-foot core interval will be collected as a surface soil sample. Determine where in this core interval the highest PID reading was encountered. Soil samples collected for volatile organics will be obtained directly from soil cores using four EnCore samplers for each VOC sample. These samples are to be collected by pushing the EnCore samplers directly into the soil core where the highest PID readings were measured, ensuring that the sampler is packed tight with soil and leaving no headspace between cap and container. All four EnCore sample containers will be collected as close to each other as possible. Make sure that all caps are securely fastened to the samplers and locked in place with both clips (see instructions that come with samplers). Write the sample identification on the strip labels that come with the samplers and place a label on each of the four samplers.

3.4 Place the four EnCore samplers in the ziplock pouches that come with the samplers and fill in appropriate information, including sample identification, date, time, and other information on the label. Place the four pouches in a plastic bag and place the tag on the bag, identifying the sample identification and other necessary information (see SOP CTO166-01).

3.5 Once the samples are properly labeled, bagged, and tagged, place the sample into the cooler containing ice and a trip blank. The cooler should be kept at 4°C and shipped to the analytical laboratory for preservation or extraction within 48 hours.

3.6 Fill in the required information on the Soil Sample Log Sheet (attached at the end of this SOP) and fill in the required information on the Chain-of-Custody (COC) Form.

3.7 Up to two additional subsurface soil samples will be collected from each boring. For these subsurface soil samples, the collected cores will be scanned with the PID before a specific depth is selected for VOC sampling. Choose the specific location within the collected cores that had the highest PID reading and proceed to collect four EnCore samples, as described above in 3.2 through 3.6. If readings are not elevated, samples will be collected from the center of each cored interval using the default sample depths identified in the QAPP. Place the samples in the cooler containing ice, after they have been properly labeled, bagged, and tagged.

4.0 COLLECTION OF OTHER SOIL SAMPLE ALIQUOTS

Note: A surface soil sample is collected from the 0- to 2-foot depth (i.e., one core length). Additional subsurface soil samples each consist of two 2-foot core segments.

4.1 After the VOC sample has been collected for the soil interval of interest (see 3.0 above), the remainder of the soil interval will be composited and used to fill the remainder of the sample containers. Any surface debris (e.g., herbaceous vegetation, twigs, rocks, litter, etc.) should first be removed from the top of the surface soil core. For other core intervals, the top 2 inches of each core should be discarded because it often contains material scraped from the side of the borehole and not fresh material from the bottom of the borehole.

4.2 Slide the remaining core material out of the acetate liner and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

- Containers for organic analyses
- Container for metals
- Container for Nitrate
- Container for Nitrite

4.3 Complete all required information on the sample labels (see SOP CTO166-01).

4.4 Fill in all required information on the sample tag and secure the tag to the sample container.

4.5 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4 ± 2°C.

4.6 Record the required information on the Soil Sample Log Sheet and the COC Record form.

5.0 COLLECTION OF SOIL SAMPLES FOR PCBS USING A HAND AUGER

5.1 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the sample material from the bucket bit and place into a properly decontaminated stainless steel mixing bowl . Mix the soil thoroughly and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers for PCB analysis.

5.2 Complete all required information on the sample labels (see SOP CTO166-01).

5.3 Fill in all required information on the sample tag and secure the tag to the sample container.

5.4 Place the sample container in a ziplock plastic bag and seal shut. Place the bag in a cooler containing ice and cool to 4 ± 2°C.

5.5 Record the required information on the Soil Sample Log Sheet and the COC Record form.

6.0 PACKAGING AND SHIPPING OF SAMPLES

Samples will be packaged and shipped according to SOP CTO166-04.

7.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO166-09

INSPECTION AND REHABILITATION OF EXISTING MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for the inspection and repair of existing monitoring wells at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for inspection of existing monitoring wells.

Monitoring well inspection form: A copy of the monitoring well inspection form is attached.
Writing utensil with indelible ink
Bound field logbook
Well keys
Disposable medical-grade gloves (e.g., latex, nitrile)
Photoionization detector (PID)
Electronic water-level indicator
Steel rod (about 1 inch in diameter with eye bolt at one end)
100 feet of nylon rope
Internal pipe cutter
File, v notch

3.0 INSPECTION PROCEDURES

3.1 Record the well identification information (ID), date, and time on the Monitoring Well Inspection Form.

3.2 Record the condition of the well ID tag. Is the tag in place and legible? If not, note the discrepancies on the Monitoring Well Inspection Form.

3.3 Record the condition of the protective casing, caps, and lock. Has the casing, cap, and/or lock been tampered with or damaged? Has the well been damaged in any way or does it show signs of deterioration?

3.4 Record the condition of the concrete or gravel pads, if a pad is present. Check the condition of the pad (or the area around the well if no pad exists) and note any abnormalities. Are concrete pads cracking or heaving? If a gravel pad is present, is there any erosion or plant growth in the pad area?

3.5 Record the condition of the cement seal surrounding the protective casing. Has the seal cracked or pulled away from the protective casing? Record any visible signs of deterioration in the area of the seal.

3.6 Record the presence of depressions and/or standing water around the casing or pad.

3.7 Unlock the well cap and open the protective cover, if one exists.

3.8 Inspect and record the condition of the polyvinyl chloride (PVC) riser pipe and the surveyed reference point. The surveyed reference point is a V-notch on the top of the PVC riser pipe.

3.9 Measure the height of the protective casing and riser pipe above the ground surface. Record these readings on the inspection form to the nearest 0.01foot.

3.10 Check the existing well log to verify the total original depth of the monitoring well being inspected.

3.11 Open the well cap and use the PID to screen the air within the well opening to determine whether above-background levels of VOCs are present within the well. Refer to the Health & Safety Plan (HASP) for procedures to follow for the presence of VOCS in a well.

3.12 Lower the electronic water-level indicator probe down the well casing. If an obstruction is encountered, record the depth of the obstruction and whether the obstruction is partial or complete.

3.13 If no obstruction is encountered, continue lowering the water-level indicator down the well casing until ground water is encountered. Measure the depth to water to the nearest 0.01 foot (see SOP CTO166-17) and record the depth on the Inspection Log.

3.14 Continue lowering the indicator probe down the casing until a solid bottom is reached or an obstruction is encountered. Record the depth to the bottom of the well (from top of casing) on the Inspection Log.

3.15 If an obstruction is encountered in the casing before the well bottom is reached, record the depth of obstruction on the Inspection Log and whether the obstruction is partial or complete.

3.16 Remove the water-level indicator from the well.

3.17 If an obstruction was encountered during steps 3.12 or 3.14, lower a heavy steel rod slowly down the well casing until the obstruction is encountered. Attempt to loosen the obstruction by raising and dropping the steel rod, letting it hit the obstruction with gradually increasing force. Record whether the obstruction could be loosened.

3.18 If step 3.17 is performed, remove the steel rod from the well and remeasure the depth to the obstruction. If the obstruction has been knocked loose and settles to the bottom, then the well may still be used as a piezometer but will not be used for ground water sampling.

3.19 Close the well cap and lock, if lock is present.

3.20 Decontaminate the water-level indicator and steel rod, if used, per SOP CTO166-16.

3.21 Make recommendations on the Inspection Log, if necessary, for repair of the monitoring well. Replace lock, if needed, as soon as possible.

3.22 Perform repair of well as soon as possible.

4.0 Field Repairs to Monitoring Wells

Field repairs to monitoring wells, for the most part, will be limited to the repair of the PVC riser (inter case). If a monitoring well is damaged beyond the repair capabilities of the field crew, the NSWC Crane Environmental Department will be notified and a decision will be made to repair or replace the well using a drilling contractor.

4.1 Remove a short section of the top of the PVC riser that is broken, using an inside pipe cutter. Before the riser is cut, a clean rag will be inserted into the riser to just below the cut to prevent

cuttings from entering the well. Insert the cutter just below the damaged area and remove only the damaged section of riser. Carefully remove the rag, measure and record the length of riser removed and mark the top of the riser for water-level measurement (filing a V notch is the preferred method).

4.2 If the riser damage indicates that a riser must be added, a section of PVC may be attached to the existing riser. After removing the damaged riser (see 4.1 above), cut a new section of riser to the needed length and attach a slip coupler to one end. In most cases, the coupler will fit securely to the pipe without the need for mechanical fasteners (pop-rivets/screws). If needed, fasteners may be used, but in no case will glue be used to attach the coupler. Attach the new coupler and PVC pipe to the existing riser, mark the top for measurement purposes, and document the length of pipe added. All new materials (pipe and couplers) will be decontaminated prior to installation.

5.0 ATTACHMENTS

1. Monitoring Well Inspection Sheet

ATTACHMENT 1

MONITORING WELL INSPECTION SHEET

MONITORING WELL INSPECTION SHEET

Well ID: _____

Time: _____ **Date:** _____ **Inspector's Name:**

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible			
Well security	Condition protective case, cap, lock			
Well pad	Concrete or gravel & condition			
Well seal	Condition of…			
Area Immediately around well pad	Record any evidence of/or standing water in area of well			
Dedicated sampling equipment	Condition of…			
PVC Riser	Condition of riser & survey reference point			

Comments:

Signature(s)_____

Note: S= Satisfactory, U= Unsatisfactory
Check one, if unsatisfactory explain

STANDARD OPERATING PROCEDURE
NUMBER CTO166-10

MONITORING WELL DEVELOPMENT

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper development of new and existing monitoring wells. The methods described herein are specific for monitoring wells located at the NSWC Crane facility. Guidelines by South Division, Naval Facilities Engineering Command, (SOUTHDIV NAVFAC, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) should be consulted.

2.0 RESPONSIBILITIES

The drilling contractor will provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of developing monitoring wells. The drilling contractor personnel must have all the health and safety training required to perform the work, as specified in the health and safety plan (HASP).

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the site safety officer.

Well development equipment with associated materials (typically supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water-level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).

4.0 WELL DEVELOPMENT METHODS

The development of new wells will not occur until at least 48 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen and to restore the permeability of the formation that may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Sequential measurements of pH, specific conductance, turbidity, and temperature taken during development yield information (stabilized values) that sufficient development is reached. Development should proceed until criteria are met as stated in Navy Guidelines.

A surge plunger (also called a surge block) that is approximately the same diameter as the well casing will be used to agitate the water. There are two basic types of surge plungers, solid and valved surge plungers. Site-specific conditions will dictate which type will be used. In formations with low yields, a valved surge plunger may be preferred because solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

Surging causes water to move in and out of the screens. This movement of water pulls fine materials into the well, preventing bridging of sand particles in the gravel pack. These fine materials can then be removed by any of several methods such as submersible pumps (i.e. whale pumps), bailers, or even peristaltic pumps. Whale pumps can be used to surge and sweep the well screen as it pumps. Another alternative method for development would be to utilize a waterra (i.e. check valve method). This method allows for surging and purging of the well by moving the tubing in an up and down motion. On the downward stroke, the ball in the foot valve lifts and the tubing fills with water; and on the upward stroke the ball is set and surged ground water is forced out of the tubing and into a purge bucket.

Development should proceed until the following criteria are met:

- The well water is clear to the unaided eye.

and

- A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated borehole annulus, assuming 30% annular porosity).

or

- When pH measurements remain constant within 0.1 Standard Units and specific conductance and temperature vary no more than plus or minus 3 percent for at least three consecutive readings. Turbidity should also show stabilization and ideally be below 10 nephelometric turbidity units (NTUs).

or

- If the well has been purged dry at least three times while waiting 15 to 20 minutes to allow the well to recharge between pumping intervals. Recharge rates will be documented while the well is allowed to recover.

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Task Order Manager regarding an alternate plan of action.

Well development must be completed at least 24 hours before well sampling. The intent of this hiatus is to provide time for the newly installed well and backfill materials to sufficiently equilibrate to their new environment and for the new environment to re-stabilize after the disturbance of drilling. All development water should be handled in accordance with SOP CTO166-14.

5.0 ATTACHMENTS

1. Monitoring Well Development Record

ATTACHMENT 1

MONITORING WELL DEVELOPMENT RECORD

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Page ___ of ____

Well: _____
Site: _____
Date Installed: _____
Date Developed: _____
Dev. Method: _____
Pump Type: _____

Depth to Bottom (ft.): _____
Static Water Level Before (ft.): _____
Static Water Level After (ft.): _____
Screen Length (ft.): _____
One Well Volume (gal/L): _____
Casing ID (in.): _____

Responsible Personnel: _____
Drilling Company: _____
Project Name: _____
Project Number: _____
PID Readings: Bore Hole_____ppm
PID Readings: Breathing Zone_____ppm

Time	Cumulative Water Volume (Gal.)	Flow Rate (mL/min.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units _____)	Turbidity (NTU)	Remarks (odor, color, etc.)

STANDARD OPERATING PROCEDURE
NUMBER CTO166-11

DRILLING AND GEOLOGIC LOGGING OF BOREHOLES IN ROCK

1.0 PURPOSE

This procedure describes the methods and equipment necessary to drill rock borings and identify the equipment, sequence of events, and appropriate methods necessary to obtain rock cores and prepare boring logs during drilling activities. Up to five types of drilling methods will be used to drill boreholes at the NSWC Crane facility:

- Auger drilling may be used to drill through the overburden material and weathered bedrock.

Diamond bit coring techniques may be used to core through the bedrock. NX or similar size diamond core barrels will be used to collect 2- to 3-inch-diameter continuous rock core. These cores will be used to describe the lithologic characteristics and fracture distributions in the bedrock.

- Air-rotary drilling may be used to drill through the bedrock or to ream out core holes to a larger diameter to accommodate well installation.

- Rotary drilling with a water wash may be used to drill through the bedrock or to ream out core holes to a larger diameter to accommodate well installation.

- Rotosonic drilling and coring may be used to core through the bedrock. Four inch diameter rock core will be collected from these boreholes. These cores will also be used to describe the lithologic characteristics and fracture distributions in the bedrock.

2.0 RESPONSIBILITIES

Field Operations Leader (FOL) - The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all activities and will ensure the availability and maintenance of all materials and equipment. The FOL is responsible for the completion of all field activities and field and chain-of-custody documentation. The

FOL will assume custody of all samples and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS Task Order Manager (TOM). Specific FOL responsibilities include the following:

- Function as a communications link among field staff members, the site quality assurance/quality control advisor, site safety officer, the site manager, and the TOM.
- Oversee the mobilization and demobilization of all field equipment and subcontractors.
- Coordinate and manage the field technical staff.
- Adhere to the work schedules provided by the TOM.
- Maintain the site logbook and field recordkeeping.
- Initiate field task modification requests, when necessary.
- Identify and resolve problems in the field, resolve difficulties in consultation with the NSWC Crane Site Manager, implement and document corrective action procedures, and provide communication between the field team and upper management.

Field Geologist - The field geologist is responsible for ensuring that standard and approved drilling procedures are followed. The field geologist will generate a detailed boring log for each borehole. This log will include a description of geologic materials, samples (if any), method of sampling, and other pertinent information and observations that may be obtained during drilling.

Drilling Subcontractor - The subcontractor operates under the supervision of the FOL. He or she is responsible for performing all work in accordance with the procedures outlined in the executed subcontract agreement.

Site Safety Officer – The site safety officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 PROCEDURES

3.1 General

The purpose of drilling boreholes is

- To determine the type, thickness, and certain physical and chemical properties of the soil, water, and rock strata that underlie the site.
- To install monitoring wells or piezometers.

All drilling and sampling equipment will be cleaned between samples and borings using appropriate decontamination procedures as outlined in SOP CTO166-17. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first and at the most contaminated locations last to reduce the risk of spreading contamination between locations. All borings must be logged by the site geologist as they proceed.

3.2 Rock Coring

Rock is cored by rotating and applying downward pressure hydraulically or with vibratory means using either diamond bit coring methods or Rotosonic techniques. A continuous core is collected in a core barrel in five to ten foot length sections called runs. Care should be taken during drilling to maximize recovery, and if necessary, shorter runs may be used to achieve this goal. Core diameter can be any size, but must be large enough to adequately evaluate the core. Reaming of the borehole may be necessary to accommodate well installation and backfill materials. After drilling the desired run length, remove the core barrel from the hole and take out the core.

Since rock structures and the occurrence of bedding planes, porosity type and distribution, and fracture patterns are among the most important items to be detected and described, take special care to obtain and record these features.

3.3 Rock Core Management and Labeling

When the core barrel has been recovered, the rock core will be carefully removed from the barrel, placed in a core tray (previously labeled "top" and "bottom" to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). Each core will be described, classified, and logged using a uniform system (Section 3.5 of this SOP).

Rock cores will be placed in the sequence of recovery in well-constructed wooden or cardboard boxes provided by the drilling contractor. Rock cores from two different borings will not be placed in the same core box. Partitions will be placed at the end of each core run. The depth from the surface of the boring to the top and bottom of the drill run and run number will be marked on the partitions with indelible ink. The partitions will serve to separate successive core runs and indicate depth intervals for each run. The order of placing cores will be the same in all core boxes. Rock core will be placed in the box so that, when the box is open, with the inside of the lid facing the observer, the top of the cored interval contained within the box is in the upper left corner of the box and the bottom of the cored interval is in the lower right corner of the box. The top and bottom of each core obtained and their true depths will be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly, an empty space in a row will be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

The inside and outside of the core-box lid will be marked by indelible ink to show all pertinent data about the box's contents. At a minimum, the following information will be included:

Project name

- Project number
- Boring number
- Run numbers
- Footage (depths)
- Recovery
- RQD (%)
- Box number and total number of boxes for that boring (Example: Box 5 of 7)
-

For easy retrieval when core boxes are stacked, the sides and ends of the box will also be labeled and will include project name, number, boring number, top and bottom depths of core, and box number.

Before final closing of the core box, a photograph will be taken of the recovered core and the labeling on the inside cover will be taken. If moisture content is not critical, the core shall be wetted and wiped clean for the photograph. (This will help to show true colors and bedding features in the cores.)

3.4 Drilling Techniques that Generate Drill Cuttings

Some drilling methods may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that will be followed when logging cuttings are as follows:

- Obtain cutting samples at approximately 5-foot intervals and sieve and wash the cuttings to obtain a cleaner sample. Cuttings will be closely examined to determine general lithology.
- Note any change in color of drilling fluid or cuttings to estimate changes in lithology.
- Note drop or chattering of drilling tools or a change in the rate of drilling to determine fracture locations or lithologic changes.
- Observe loss or gain of drilling fluids or air (if air rotary methods are used) to identify potential fracture zones.
- Record this and any other useful information onto the boring log.

This logging provides a general description of subsurface lithology, and adequate information can be obtained through careful observation of the drilling process. It is recommended that rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less-detailed data generated through borings drilled that generate drill cuttings.

3.5 Drill Cuttings Management and Labeling

Each 5 foot run of drill cuttings will be collected in plastic bags and logged for lithologic description. Each bag will be labeled with a magic marker with the boring number and depth interval. The cuttings will be retained for future correlation purposes and field reference until project completion, then will be discarded.

4.0 GEOLOGIC DESCRIPTION OF BOREHOLES IN ROCK

These procedures provide descriptions of the standard techniques for borehole and sample logging. These logging techniques will be used for each boring to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of

soil and rock, the field geologist or engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

The classification of soil and rocks is one of the most important jobs of the field geologist or engineer. To maintain a consistent flow of information, it is imperative that the field geologist or engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 Required Field Forms and Equipment

When logging soil and rock samples, the geologist or engineer should be equipped with the following:

Rock hammer
Knife
Camera
10% Dilute hydrochloric acid (HCl)
Ruler (marked in tenths and hundredths of feet)
Hand lens
Writing utensil with indelible ink
Field logbook
Disposable medical-grade gloves (e.g., latex, nitrile)
Soil/rock classification sheets
Strainer
Shovel

4.2 Classification of Rocks

Claystone - Very fine-grained rock made up of particle less than 1/256 mm in diameter. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

Shale - A fissile, very fine-grained rock with particles less than 1/256 mm in diameter. Fractures along bedding planes.

Limestone - Rock made up predominantly of calcite ($CaCO_3$, which is mainly fossilized animal and plant debris). Effervesces strongly upon the application of dilute hydrochloric acid.

Coal – A very dark colored rock consisting mainly of organic (mainly fossilized plant debris) remains.

Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record.

The local abundance of any of these rock types is dependent upon the depositional history of the area. Conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock, the following hierarchy will be noted: Rocks are grouped into three main divisions: sedimentary, igneous, and metamorphic. Sedimentary rocks are by far the predominant type exposed at the earth's surface and are the only type present at NSWC Crane. The following basic names are applied to the types of rocks found in sedimentary sequences:

Sandstone - Made up predominantly of granular materials ranging between 1/16 to 2 mm in diameter.

Siltstone - Made up of granular materials between 1/16 to 1/256 mm in diameter. Fractures irregularly. Medium thick to thick bedded.

4.2.1 Rock Type

As described above, there are numerous types of sedimentary rocks. In most cases, a rock will be a combination of several grain types; therefore, a modifier such as "sandy siltstone" or a "silty sandstone" can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifying descriptions can include carbonaceous, calcareous, siliceous, fossiliferous, etc.

Grain size is the basis for the classification of clastic (sandstones, siltstones, and shales) sedimentary rocks. The Udden-Wentworth classification will be assigned to sedimentary rocks (shown below). The individual boundaries are slightly different than the USGS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse-grained rocks. Alternatively, the division between siltstone and shale may be measurable in the field by the use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a shale.

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 0.25 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm
After Wentworth, 1922	

4.2.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples will be classified while wet, when possible, and drill cuttings will be cleaned with water prior to color classifications. Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

4.2.3 Bedding Thickness

The bedding thickness designations listed below will also be used for rock classification.

BEDDING THICKNESS CLASSIFICATION

Thickness (metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' – 3.3'	Thick bedded
10 cm - 30 cm	4" - 1.0'	Medium bedded
3 cm - 10 cm	1" – 4"	Thin bedded
1 cm - 3 cm	2/5" - 1"	Very thin bedded
3 mm - 1 cm	1/8" – 2/5"	Laminated
1 mm - 3 mm	1/32" – 1/8"	Thinly laminated
< 1 mm	<1/32"	Micro laminated

(Ingram, 1954)

4.2.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock that occupies the zone between the lowest soil horizon and firm bedrock).

Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage of the words "scratch" and "gouge." A scratch will be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), and a gouge is much deeper.

4.2.5 Fracturing

Method of Calculating RQD
(After Deere, 1966)

Fractures should also be noted.

$$RQD\ \% = r/l \times 100$$

r = Total length of all pieces of the lithologic unit being measured that are greater than 4 inches in length and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

4.2.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

Fresh - The rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

Slight - The rock has some staining that may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration. Oxidation and weathering may affect the degree of fracturing or brokenness of a rock. After eliminating drilling breaks, the average spacing of natural breaks is calculated and the fracturing is described by the following terms:

Very broken (V. BR.) - Less than 2-inch spacing between fractures
Broken (BR.) - 2-inch to 1-foot spacing between fractures
Blocky (BL.) - 1- to 3-foot spacing between fractures
Massive (M.) - 3- to 10-foot spacing between fractures

The structural integrity of the rock can be approximated by calculating the rock quality designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run to obtain a percentage.

Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with a hammer.

Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

4.2.7 Other Characteristics

The following items will be included in the rock description:

Description of contact between two rock units. These can be sharp or gradational.

- Stratification (parallel, cross stratified).
- Description of any filled cavities or vugs.
- Cementation (calcareous, siliceous, hematitic).
- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs will be neat so it can be reproduced on a copy machine for report presentation. The data will be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

4.2.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

Seam - Thin (12 inches or less), probably continuous layer.

Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams of sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

4.2.9 Abbreviations

Abbreviations may be used in the description of a rock. However, they will be kept at a minimum. Following are some of the abbreviations that may be used:

C	-	Coarse	Lt	-	Light	Yl	-	Yellow
Med	-	Medium	BR	-	Broken	Or	-	Orange
F	-	Fine	BL	-	Blocky	SS	-	Sandstone
V	-	Very	M	-	Massive	Sh	-	Shale
Sl	-	Slight	Br	-	Brown	LS	-	Limestone
Occ	-	Occasional	Bl	-	Black	Fgr	-	Fine-grained
Tr	-	Trace						

5.0 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceding sections will be used to complete the logs. A sample boring log is attached at the end of this SOP.

The field geologist or engineer will use this example as a guide in completing each boring log. Each boring log will be fully described by the geologist or engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided either on the back of the boring log or on a separate sheet, for field use. All data will be written directly on the boring log. Additional notes may be entered in a field notebook if more space is needed.

5.1 Remarks Column

The following information will be entered under the "Remarks" column and will include, but is not limited to, the following:

- Moisture - Estimate moisture content using the following terms: dry, moist, wet, and saturated. These terms are determined by the individual. Whatever method is used to determine moisture should be consistent throughout the log.

- Angularity - Describe angularity of coarse-grained particles using the terms angular, subangular, subrounded, or rounded. Refer to ASTM D 2488 or the Earth Manual for criteria for these terms.

- Particle shape - flat, elongated, or flat and elongated.

- Maximum particle size or dimension.

- Water-level observations.

- Reaction with HCl - none, weak, or strong.

Additional comments:

- Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.

- Indicate odor and photoionization detector (PID) readings.

- Indicate any change in lithology by drawing a line through the lithology change column and indicate the depth. This will help when cross-sections are subsequently constructed.

- At the bottom of the page, indicate type of rig, drilling method, hammer size and drop, and any other useful information (i.e., borehole size, casing set, changes in drilling method).

- Vertical lines shall be drawn in the Material Description column from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines will be drawn if there is a change in lithology, then vertical lines will be drawn to that point.

- Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.2 Review

Upon completion of the borings logs, copies will be made and reviewed. Items to be reviewed include

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

Originals of the boring logs will be retained in the project files.

6.0 ATTACHMENTS

1. Boring Log

ATTACHMENT 1

BORING LOG

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: _____ BORING No.: _____
PROJECT NUMBER: _____ DATE: _____
DRILLING COMPANY: _____ GEOLOGIST: _____
DRILLING RIG: _____ DRILLER: _____

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: _____

Converted to Well: Yes _____ No _____ Well I.D. #: _____

References

Deere, D.U. and Miller, R.P., (1966). Engineering Classification and Index Properties for Intact Rock, Air Force Weapons Lab. Tech. Report AFWL-TR-65-116, Kirtland Base, New Mexico.

Wentworth, C.K., 1922. A Scale of Grade and Class Terms for Caustic Sediments: Jour. Geology, v. 30, p. 377-392.

Ingram, R.L., 1954. Terminology for the Thickness of Stratification and Parting Units in Sedimentary Rocks: Geological Society of America Bulletin, v. 65. p. 937-938.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-12

MONITORING WELL INSTALLATION

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper design and installation of ground water monitoring wells. The methods described herein are specific for monitoring well construction at the NSWC Crane facility. Guidelines by South Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM, 1997) and the State of Indiana regulatory requirements in Article 16 Water Well Drillers of Chapter 310 of the Indiana Annotated Codes (310 IAC 16) were consulted during development of this procedure.

2.0 RESPONSIBILITIES

Field Operations Leader (FOL) - The FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The FOL, or designee, will coordinate and lead all activities and will ensure the availability and maintenance of all materials and equipment. The FOL is responsible for the completion of all field activities and field and chain-of-custody documentation. The FOL will assume custody of all samples and will ensure the proper handling and shipping of samples. The FOL is a highly experienced environmental professional who will report directly to the TtNUS Task Order Manager (TOM). Specific FOL responsibilities include the following:

- Function as a communications link among field staff members, the site quality assurance/quality control advisor, site safety officer, the site manager, and the TOM.
- Oversee the mobilization and demobilization of all field equipment and subcontractors.
- Coordinate and manage the field technical staff.
- Adhere to the work schedules provided by the TOM.
- Maintain the site logbook and field recordkeeping.

- Initiate field task modification requests, when necessary.

- Identify and resolve problems in the field, resolve difficulties in consultation with the NSWC Crane Site Manager, implement and document corrective action procedures, and provide communication between the field team and upper management.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller and ensures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

Drilling Subcontractor - The subcontractor operates under the supervision of the FOL. He or she is responsible for performing all work in accordance with the procedures outlined in the executed subcontract agreement.

Site Safety Officer – The site safety officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the site safety officer.

Well drilling and installation equipment with associated materials (typically supplied by the drilling subcontractor).

Hydrogeologic equipment (weighted engineer's tape, water-level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, boring logs, soil sample log forms, chain-of-custody records, sample coolers with ice, and a field notebook).

4.0 WELL DESIGN AND CONSTRUCTION

Two basic types of wells may be drilled at NSWC Crane (Shallow and deep). Shallow wells include any well that is installed into the first water yielding zone encountered during drilling at a particular well

location. Deep wells include any wells that are installed below the first water yielding zone encountered during drilling at a particular well location. Typically, deep wells will be installed adjacent to shallow wells in cases when a vertical profile of groundwater contamination is desired at a particular location. The well construction techniques are identical between deep and shallow wells, however, all deep wells will have a minimum 6 inch inside diameter steel isolation casing placed to the bottom of the first water yielding zone that will be cemented in place with a cement-bentonite slurry and allowed to cure for a minimum of 24 hours. Drilling will resume inside the isolation casing after the grout cures. In this manner, the potential for shallow contamination in the first water yielding zone to migrate deeper is minimized.

Monitoring well borings will be drilled using a variety of techniques including hollow stem auger, rotary, rotosonic. Specific techniques are determined based on numerous issues including expected materials encountered during drilling, well depth, diameter, access, sampling requirements, etc.

Boreholes drilled in materials that tend to collapse drilling (overburden and / or weathered or highly fractured bedrock) may require the advancing of a hollow drilling tool (hollow stem auger, temporary casing, etc) to ensure that the borehole stays open during well installation. If this is the case, the hollow drilling tool will have a minimum inside diameter of 4 inches to accommodate the installation of the well construction materials, and will be retracted as well construction materials are installed to ensure adequate backfill of materials. In all cases, the final outside diameter of all well borings will be a minimum of 5 ½ inches.

All monitoring wells will be constructed of Schedule 40, flush-joint-threaded, 2-inch inside diameter polyvinyl chloride (PVC) riser pipe and flush joint threaded, factory slotted well screen with a threaded end cap. The well screens will be factory slotted to 0.020-inch size. Each section of well casing and screen will be National Sanitation Foundation (NSF) approved. Well screens will be 10 feet long but may be longer or shorter based on the subsurface conditions that are encountered. A PVC cap will be placed on the bottom and will also be flush threaded. Other means of joining casings using glue, gaskets, pop rivets, or screws are not allowed. The screen will pass no more than 10 percent of the pack material or in-situ aquifer material.

Monitoring wells will be installed immediately upon completion of drilling, A well screen section with bottom cap and the proper amount of riser pipe will be assembled and lowered down the borehole. Centralizers will be used as necessary to ensure that the casing and screen are centered and are aligned straight. The sand pack will be extended from 0.5 foot below the well screen to at least 1 foot above the top of the well screen. Clean silica sand of U.S. Standard Sieve Size No. 20 to 40 will be used.

A minimum 3-foot-thick bentonite pellet seal will be installed above the filter pack and allowed to hydrate for a minimum of 3 hours before grout is added above the seal. Only 100 percent, certified pure sodium bentonite will be used for well construction. As an alternative, a high solids bentonite grout can be used in lieu of the bentonite pellet to minimize downtime to allow for bentonite pellet seal hydration. The depths of backfill materials will be constantly monitored during well installation using a weighted stainless-steel or fiberglass tape measure.

The remaining annulus above the hydrated bentonite seal will be backfilled to the surface using a tremie pipe, with a 20:1 cement/bentonite grout. A maximum of 10 gallons of water per 94-pound bag of Type 1 cement will be used. The grout mixture should be blended in an above-ground rigid container or mixer to produce a thick lump-free mixture. This grout mixture will also be used for placement of steel casings in deep wells. A tremie grout will be used to install all grout unless the borehole is open and contains no standing water above the sand pack.

When the well is completed and grouted to the surface, a protective steel surface casing is placed over the top of the riser pipe. The finished well casing will extend at least 2 feet above the ground level. This casing will have a cap that can be locked to prevent vandalism. In addition, one hole is drilled just above the cement collar through the protective casing, which acts as a weep hole for the flow of water that may enter the annulus during well development, purging, or sampling. A 4 foot square and 6 inch thick concrete apron will be installed around each well. Four safety yellow barrier posts (nominal 4-inch diameter, 5 foot long steel pipes buried 2 feet deep and filled with concrete) will be cemented just outside the four corners of the concrete apron.

5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and in a field logbook. Details of borehole logging are contained in SOP CTO166-11.

6.0 ATTACHMENTS

1. Bedrock Monitoring Well Sheet
2. Overburden Monitoring Well Sheet

ATTACHMENT 1

BEDROCK MONITORING WELL SHEET

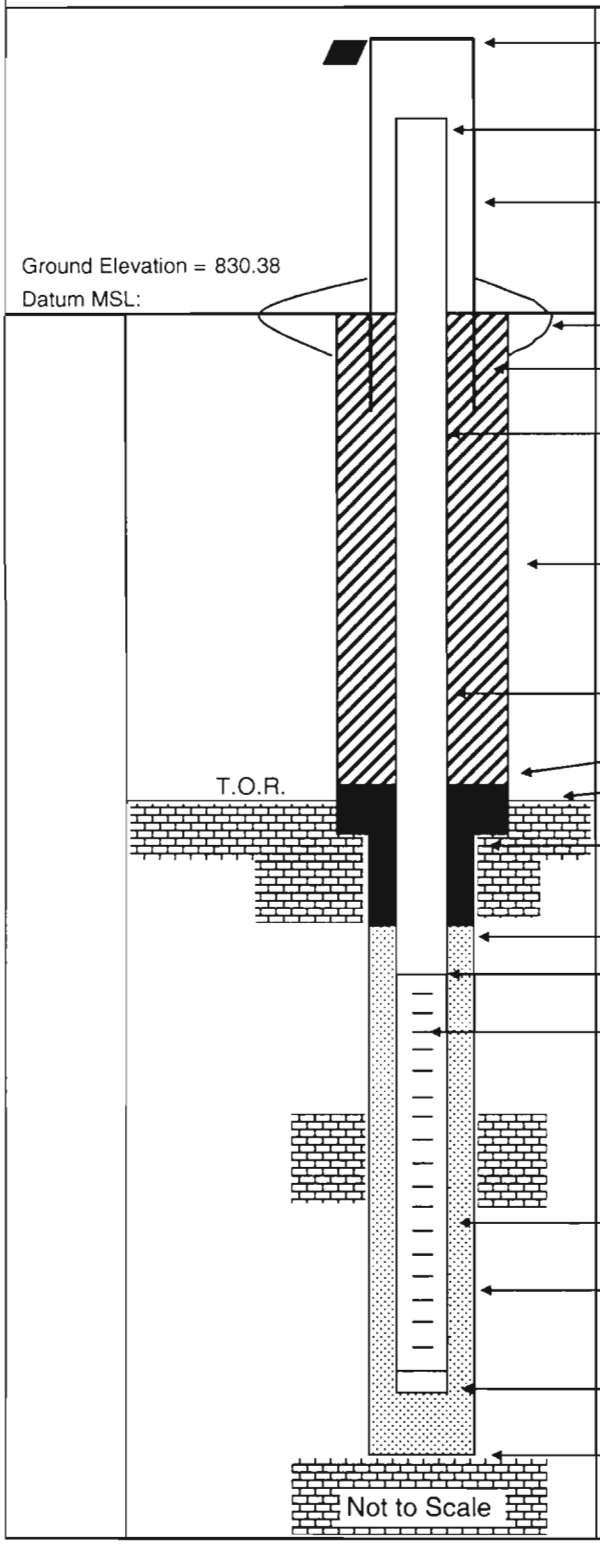
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: MS-53PC

PERMIT No: 638659

PROJECT:	NIROP FRIDLEY	DRILLING Co.:	BOART LONGYEAR	BORING No.:	MS-53PC
PROJECT No.:	7842 CTO 057	DRILLER:	K. SMITH	DATE COMPLETED:	10/25/99
SITE:	ANOKA PARK	DRILLING METHOD:	ROTOSONIC	NORTHING:	1077365.0
GEOLOGIST:	B. HOWZE	DEV. METHOD:	NITROGEN AIR LIFT	EASTING:	2811070.6



Elevation of Top of Casing:		
Stick Up of Casing Above Ground Surface:		
Elevation of Top of Riser:	832.64	
I.D. of Surface Casing:	6"	
Type of Surface Casing:	STEEL	
Type of Surface Seal:	CONCRETE	
I.D. of Permanent Casing:	6"	
I.D. of Riser:	2"	
Type of Riser:	CARBON STEEL	
Borehole Diameter:	9 5/8"	
Type of Backfill:	CEMENT GROUT	
Elevation / Depth Top of Seal:	830.38/	0.0
Elevation / Depth Top of Bedrock:	696.88/	133.5
Type of Seal:	CEMENT GROUT	
Elevation / Depth of Top of Fine Sand:	685.38/	145.0
Elevation / Depth of Top of Filter Pack:	681.38/	149.0
Elevation / Depth of Top of Screen:	678.98/	151.4
Type of Screen:	STAINLESS STEEL	
Slot Size x Length:	10 SLOT X 15.5'	
I.D. of Screen:	2"	
Type of Filter Pack:	No. 10-20 SAND	
Diameter of Hole in Bedrock: Core / Ream:	CORE = 5.5"	
Elevation / Depth of Bottom of Screen:	663.48/	166.9
Elevation / Total Depth of Borehole:	660.38/	170.0

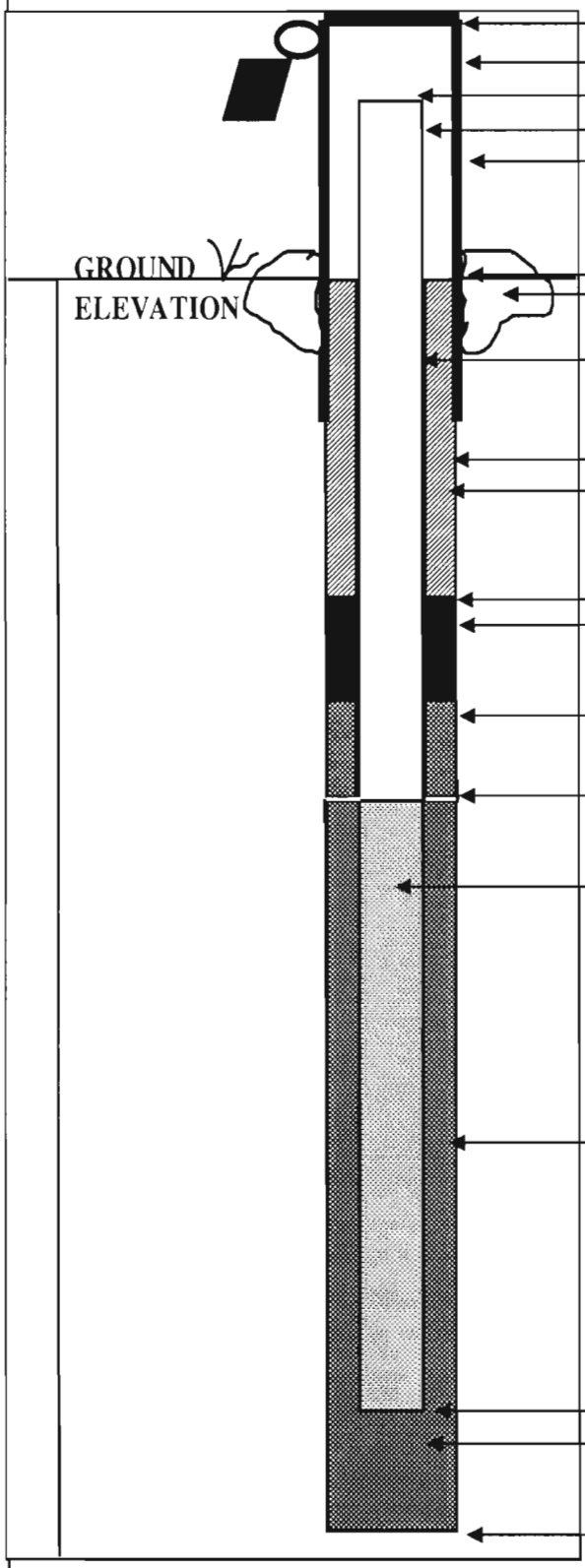
ATTACHMENT 2

OVERBURDEN MONITORING WELL SHEET

BORING NO.: _____

Tetra Tech NUS, Inc. **OVERBURDEN MONITORING WELL SHEET**

PROJECT:	NIROP FRIDLEY	DRILLING Co.:		BORING No.:	
PROJECT No.:	7842 CTO 0057	DRILLER:		DATE COMPLETED:	
SITE:	ANOKA PARK	DRILLING METHOD:		NORTHING:	
GEOLOGIST:		DEV. METHOD:		EASTING:	



ELEVATION OF TOP OF SURFACE CASING: _____

STICK -UP TOP OF SURFACE CASING: _____

ELEVATION OF TOP OF RISER PIPE: _____

RISER STICK-UP ABOVE GROUND SURFACE: _____

I.D. OF SURFACE CASING: _____

TYPE OF SURFACE CASING: _____

GROUND ELEVATION: _____

TYPE OF SURFACE SEAL: _____

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: CARBON STEEL

BOREHOLE DIAMETER: _____

TYPE OF SEAL: _____

ELEVATION / DEPTH OF SEAL: /

TYPE OF SEAL: BENTONITE CHIPS

ELEVATION / DEPTH TOP OF FILTER PACK: /

ELEVATION / DEPTH TOP OF SCREEN: /

TYPE OF SCREEN: CARBON STEEL

SLOT SIZE X LENGTH: 10 SLOT x

I.D. OF SCREEN: 2"

TYPE OF FILTER PACK: SILICA SAND
(No. 10-20 U.S. STANDARD SEIVE SIZE)

ELEVATION / DEPTH BOTTOM OF SCREEN: /

ELEVATION / DEPTH BOTTOM OF FILTER PACK: /

TYPE OF BACKFILL BELOW WELL: _____

ELEVATION / DEPTH OF BOREHOLE: /

STANDARD OPERATING PROCEDURE
NUMBER CTO166-13

CALIBRATION AND CARE OF WATER QUALITY METERS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance. The YSI 600-Series Environmental Monitoring System will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), dissolved oxygen (DO), and turbidity in water. A LaMotte turbidity meter will be used in conjunction with the YSI to measure turbidity. The YSI meter has a multiprobe sensor that can be used in conjunction with a flow-through cell attached to a pump discharge tube to measure water-quality parameters in a ground water discharge or can be immersed in a surface water body such as a stream, pond, or drainage ditch. The LaMotte is a hand held meter that uses a multi-detector optical configuration to assure long term stability and minimize stray light and color interferences.

2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

Site logbook
Equipment calibration log sheet
YSI Model 600 Serien and Sonde: multi-parameter water-quality meter with flow through cell
LaMotte Turbidity Meter
Equipment manual
Calibration kit
Deionized water, paper towels, spray bottle, etc.
Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES

This section describes the calibration procedures for the YSI Model 600 series and the LaMotte. Each meter is supplied with an instruction manual and will be on site and will be used as the calibration guidance documents. These procedures will list requirements for frequency of calibration and checks to be performed on the meter.

3.1 YSI Model 600 Series

The YSI Model 600 series and Sonde is a multi-parameter, water-quality meter that may be used to measure open water bodies (streams, ponds, springs, etc.) with the probe guard installed. With the flow through cell attached, the meter has the ability to measure water-quality parameters in ground water via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the ground water comes in contact with the atmosphere. The parameters measured by the YSI for this field effort are as follows:

- DO
- SC
- Temperature
- pH
- ORP
- Turbidity

3.1.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.1.2 Calibration

All the parameters listed in Section 3.0 must be calibrated prior to the start of each field effort. After this initial calibration, the YSI will be checked each day that it is used. If the check shows any out-of-

specification readings, the specific probe will be recalibrated. Meter specifications can be found in the equipment manual, starting on page 248. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.1.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.

- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.

- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.

- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.

- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

3.2 Lamotte Turbidity Meter

The Lamotte turbidity meter is a hand held meter that measures the amount of suspended matter in water using the Nephelometric method.

3.2.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.2.2 Calibration

Turbidity must be calibrated prior to the start of each field effort. After this initial calibration, the LaMotte will be calibrated each day that it is used. If the check shows any out-of-specification readings, the meter will be recalibrated. Meter specifications can be found in the equipment manual. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.2.2 Tips for Good Calibration

- Thoroughly clean the standard vial with a chem wipe to remove finger prints.
- Make sure that the vial is properly aligned according the manual recommendations.

4.0 MAINTENANCE

The YSI Meter and LaMotte will be rented for the duration of each brief field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

4.1 Meter Storage for the YSI

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. During these breaks, the meter will be charged. One-half inch of tap or distilled water will be placed in the meter calibration cup and the cup threaded onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Multi-parameter short term storage key points:

- Use enough water to provide humidity but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, consult Section 2.10 on page 89 of the equipment manual.

Note: Reagents that are used to calibrate and check the YSI may be hazardous. Review the health and safety plan, Appendix A of the equipment manual, and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

4.3 Meter Storage for the LaMotte

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. Proper storage of the meter between usage will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Short term storage key points:

- Make sure the storage vessel is moisture free and sealed.

4.4 Sample Vial Cleaning

- Rinse the vial thoroughly with potable water to remove sediments.
- Wipe with chem.-wipes or cotton swabs.

5.0 ATTACHMENTS

1. Documentation of Field Calibration
2. Equipment Calibration Log

ATTACHMENT 1

DOCUMENTATION OF FIELD CALIBRATION

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : _____

SITE NAME: _____

PROJECT No.: _____

INSTRUMENT NAME/MODEL: HORIBA U-22

MANUFACTURER: _____

SERIAL NUMBER: _____

Date of Calibration	Person Performing Calibration	INITIAL READINGS						FINAL READINGS						Calibration Standard (Lot No.)	Remarks and Comments
		PH	COND	TURB	DO	TEMP	SAL	PH	COND	TURB	DO	TEMP	SAL		

ATTACHMENT 2

EQUIPMENT CALIBRATION LOG

STANDARD OPERATING PROCEDURE
NUMBER CTO166-14

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at the NSWC Crane facility. The following types of IDW will be generated during this investigation:

- Excess soil and rock materials remaining from subsurface drilling activities
- Well development water and purge water related to monitoring well installation and sampling
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)
Decontamination equipment
Field logbook and indelible ink pen
Plastic sheeting and/or tarps
55-gallon drums with sealable lids
IDW labels for drums
Wastewater container tanks
Plastic garbage bags

3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities.

3.1 Liquid Wastes

Liquid wastes that will be generated during the site activities include well development water, well purge water (collected during low-flow sampling), and decontamination solutions from drilling and sampling equipment. As they are collected, these wastewaters will be placed in a 300-gallon (or smaller) portable tank attached to a truck. Whenever the portable tank approaches full, it will be transported to a central location at NSWC Crane (adjacent to a Crane-designated sanitary sewer manhole). The water in the portable tank will be discharged to the sewer by gravity draining.

An accurate record will be kept by the FOL of all wastewaters that have been placed in the large holding tank. At a minimum, this information will include the following:

- The location and type of each water that has been placed in the tank (e.g., purge water from wells)
- The quantity of water from each source
- The date the wastewater was generated
- The date and time the wastewater was placed in the tank
- The person(s) present when the wastewaters were discharged to the sewer

3.2 Drill Cuttings and Cores

As cuttings are removed from borings, they will be screened for VOCs. If these results do not show above-background levels of VOCs, the cuttings materials will be mixed with bentonite and returned to the borehole when sampling activities in the hole are completed or spread on the ground in the area of the borehole. The backfill materials will be tamped as they are placed in the hole to increase density and reduce permeability of the backfill material.

If any soil materials from a screened borehole interval show evidence of contamination (based on the field screening results), then the soil material from the screened interval will be placed in a plastic trash bag (or directly in a drum if a larger quantity) and the bag will be tagged. Information included on the tag will consist of the hole from which the material came, the depth interval from which the material came, the date, and the name of the person filling out the tag. The bag will then be placed in a 55-gallon drum and sealed (more than one bag may be placed in a drum). The waste drums will be stored on site temporarily until laboratory results have been received concerning the soil samples that were collected from the suspect borehole. If the results indicate that no contamination is present in the soil samples, then the soils will be disposed on site. If the levels of contamination of any of the samples from a borehole exceed Toxicity Characteristic Leaching Procedure (TCLP) limits (using the total soil concentrations), then all

excess soil from the borehole will be considered as RCRA-hazardous and disposed off site in accordance with RCRA waste disposal regulations. Alternatively, the toxicity characteristic leaching procedure may be conducted for any constituent that could exceed the TC limits based on total concentrations.

Cuttings from well borings will be handled in the same manner as soil boring cuttings.

3.3 PPE, Pump Discharge Tubing, Direct-Push Technology (DPT) Sample Liners, and Incidental Trash

All PPE wastes, pump discharge tubes, DPT sample liners, and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSWC Crane.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-15

LOW-FLOW WELL PURGING AND STABILIZATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

Low-Flow Purge Data Sheet: A copy of this form is attached at the end of this SOP.

Ground Water Sample Log Sheet: A copy of this form and instructions for its completion are included in SOP CTO166-05.

Bound field logbook

Writing utensil

Photoionization detector (PID): The procedures for the operation of the PID are found in the health and safety plan and SOP CTO166-06.

Well key

Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot (see SOP CTO166-17).

Electronic Programmable Controller, model 400: This controller regulates air flow in a bladder pump.

Cylinder of compressed nitrogen with regulator: Compressed gas serves as the power source for the bladder pump.

Multiple parameter water-quality meter: This unit measures and displays field parameters measured in the field including pH, dissolved oxygen, oxidation-reduction potential (ORP), temperature, and specific conductance (see SOP CTO166-13).

Flow-through cell adapter for water-quality meter

LaMotte Turbidity Meter: Used to measure turbidity (see SOP CTO166-13).

Purge water containers

Graduated cylinder and stopwatch: Used to calculate flow rate.

Decontamination supplies: SOP CTO166-16 describes required decontamination supplies.

Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES FOR WELL PURGING

3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate above equipment in accordance with manufacturer requirements as necessary.

3.2 Follow the steps outlined in SOP CTO166-17 to obtain a static water-level measurement of the well to be purged. Record the information on the Ground Water Sample Log Sheet and the Low-Flow Purge Data Sheet. Leave the water-level meter suspended in the well casing.

3.3 Calculate one well casing volume as follows:

1. Obtain the total depth of the well by measurement.

2. Using the static water level determined in Step 3.2 of this SOP and the total depth of the well, calculate the well casing volume using the following formula:

$$V = (0.163)(T)(r^2)$$

where:

V	=	Static casing volume of well (in gallons).
T	=	Vertical height of water column (linear feet of water).
0.163	=	A constant conversion factor that compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.
r	=	Inside radius of the well casing (in inches).

Note: For wells of 1-inch radius (2-inch diameter), V = 0.163 gallons per foot of water column.

3.4 Connect the pump controller to the well pump air supply (at the well cap) by following the instructions in the pump control manual. The pump controller must be turned off when it is being connected.

3.5 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (psi) when it is being connected.

3.6 Following the instructions found in the water-quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).

3.7 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge water container.

3.8 Following the instructions in the pump controller manual, start pumping water from the well.

3.9 Start with the initial pump rate set at approximately 0.1 liters per minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If ground water is drawn down below the top of the well screen, purging will cease and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same 8-hour workday and no later than 24 hours after the start of purging.

The time to sample any given well will vary greatly due to the many variables associated with low flow purging and sampling:

- Stabilization of parameters
- Possible drawdown
- Analytical changes from quarter to quarter
- Varying QA sample requirements from quarter to quarter
- Variable pump rates

Normally, the time from the start of purging to the end of sampling will be between 1 and 4 hours.

3.10 Measure the well water level using the water-level meter every 5 minutes. Record the well water level on the Low-Flow Purge Data Form (attached at the end of this SOP).

3.11 Every 5 to 10 minutes, record on the Low-Flow Purge Data Form the water-quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, and dissolved oxygen) measured by the water-quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

3.12 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

3.13 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

3.14 Stabilization is achieved and sampling can begin when a minimum of one casing volume has been removed and three consecutive readings, taken at 5- to 10-minute intervals, are within the following limits:

- pH ± 0.1 standard units
- Specific conduct ± 3%
- Temperature ± 5%
- Turbidity less than 10 NTUs
- Dissolved oxygen ± 10%
- Oxidation-Reduction Potential (ORP) ± 10 mV

If the above conditions have still not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data From onto the Ground Water Sample Log Form.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear line of sight to the well, the sampler may leave the pump running and watch the well from a distance until he or she is able to return to the well.

- Two, if for whatever reason, the sampler must stop purging for an extended period of time or a clear line of sight cannot be maintained, the pump and cell will be shut down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before the sampler departs.

In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Form.

3.15 Rinse the flow-through cell, the water-quality meter probes, and the turbidity cell with analyte-free water and pack the cell and meters for transport.

4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

ATTACHMENT 1

LOW-FLOW PURGE DATA SHEET

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT : _____
PROJECT NUMBER: _____
PROJECT SITE NAME: _____

WELL ID.: _____
DATE: _____
WEATHER: _____

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments

Water Quality Meter (S/N) _____
Control Box Type (S/N) _____
Turbidity Meter (S/N) _____

Pump Intake Depth _____

SIGNATURE(S): _____

PAGE___OF___

STANDARD OPERATING PROCEDURE
NUMBER CTO166-16

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Waterproof pens
Non-latex rubber or plastic gloves
Cotton gloves
Field logbook
Potable water
Deionized water
LiquiNox detergent
Brushes, spray bottles, paper towels, etc.
55-gallon drum or other container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution into a container. Use brushes or sprays as appropriate for the equipment. If oily residue has

accumulated on the sampling equipment, remove the residue with a isopropanol wash and repeat the Liquinox wash.

3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the deionized water rinsate into a container.

3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.

3.7 Document decontamination by recording it in the field logbook.

3.8 Containerized decontamination solutions will be managed in accordance with the procedures described in SOP CTO166-14 and the QAPP.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-17

MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

Ground Water Level Measurement Form: A copy of the Ground Water Level Measurement Form is attached.
Bound field logbook
Photoionization detector (PID): Operation and calibration of the PID is discussed in SOP CTO166-06.
Well key
Writing utensil
Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.
Decontamination supplies: SOP CTO166-16 describes decontamination procedures including decontamination supplies.

3.0 WATER-LEVEL MEASUREMENT PROCEDURES

3.1 Check the operation of the electronic water-level indicator or interface meter.

3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form.

3.3 Unlock the well and remove the well cap.

3.4 Place the well cap on a clean piece of plastic.

3.5 Check the well for the presence of organic vapors in the 2-inch polyvinyl chloride (PVC) riser pipe as follows:

1. Calibration of the PID shall be done in accordance with the calibration procedures described in SOP CTO166-06. Calibration of the PID shall be done at the field office prior to entering the field.

2. Insert the PID sample inlet straw approximately 3 inches into the riser pipe.

3. Record the PID reading on the Ground Water Level Measurement Form. If the reading is less than concentrations specified in the site-specific HASP, proceed to step 3.6. If the reading is greater than the concentration specified in the HASP, measure the concentration in the breathing zone. If the concentration in the breathing zone is less than the concentration specified in the HASP, proceed to Step 3.6. If the reading is greater than the specified concentration, allow the riser pipe to ventilate for 10 minutes and repeat the measurement of breathing zone concentrations until the concentrations fall below the level specified in the HASP before proceeding to step 3.6.

3.6 Ensure that the water-level indicator probe has been decontaminated before use, in accordance with the procedures outlined in SOP CTO166-16.

3.7 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.

3.8 Read the ground water-level measurement from the top of the inner casing at the surveyed reference point to the nearest 0.01 foot.

3.9 Record the water-level measurement on the Ground Water Level Measurement Form.

3.10 Wind the meter cable measuring tape back onto the spool.

3.11 Replace the well cap and lock.

3.12 Decontaminate the meter's probe and cable following the procedures outlined in SOP CTO166-16.

3.13 Containerize any decontamination fluids and PPE in accordance with the procedures described in SOP CTO166-15.

4.0 ATTACHMENTS

1. Ground Water Level Measurement Sheet

ATTACHMENT 1

GROUND WATER LEVEL MEASUREMENT SHEET

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____

Location: _____ **Personnel:** _____

Weather Conditions: _____ **Measuring Device:** _____

Tidally Influenced: Yes ____ No ____ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth From TOC (feet)*	Water Level Indicator Reading (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

STANDARD OPERATING PROCEDURE
NUMBER CTO166-18

SURFACE WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting surface water samples at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Surface Water Sample Log Sheet: A copy of this form is attached at the end of this SOP.

Field logbook

Writing utensil

Multi-parameter water-quality meter: The water-quality meter is used for the measurement of dissolved oxygen, pH, specific conductance, temperature, oxidation-reduction potential, and turbidity (see SOP CTO166-13).

LaMotte Turbidity Meter: Used to measure turbidity in the field (see SOP CTO166-13)..

Disposable sample containers: Disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering.

Labeled sample containers: Prelabeled, certified-clean sample containers will be provided by the laboratory that performs the analyses.

Sample tags: One tag is to be completed and attached to each sample container.

0.45-micron filter assembly: These are single-use filter cartridges used to filter samples scheduled for dissolved metals or dissolved thorium isotope analyses. The filters become investigation-derived waste (IDW) after one use.

Peristaltic pump

Silicon tubing

Ziploc-type plastic storage bags

Shipping containers (coolers)

Trip blank sample (if VOC samples are being collected)

Temperature blank

3.0 SURFACE WATER SAMPLING PROCEDURES

3.1 The same methods will be used to collect surface water and seep samples. Sampling will start at the downstream end of a stream and proceed to the farthest upstream location.

3.2 While standing downstream or from the bank, gently remove any floating leaves or twigs that may be present in a sample pool area in a manner that will not disturb the bottom sediment.

3.3 While standing downstream or from the bank, place the sample container in the water at the sampling location at a 45-degree angle and lower it to approximately half the sample pool depth. With the mouth of the container facing upstream, fill the container with water, being careful not to disturb the sediment.

3.4 All samples will be collected into certified-clean, pre-preserved bottles (if preservation is required for the analysis to be performed) supplied by the laboratory performing the analyses. Sample containers for volatile constituents (VOCs) must be completely filled so no headspace exists in the container. Other sample containers should <u>not</u> be filled completely; a small amount of air should be left at the top. Sample containers will be collected in the following sequence:

Volatile organic compounds (VOCs)
Other Organics
Total metals
Nitrate
Nitrite
Total suspended solids (TSS)
Dissolved metals

3.5 Record the date and time that the sample containers are filled on the Surface Water Sample Log Sheet, the sample labels, the sample tags, and the Chain-of-Custody Form.

3.6 After the sample label and sample tag are completed and checked, place the sample container into a ziploc-type plastic storage bag and place the plastic storage bag holding the sample container into a cooler containing ice.

3.7 Repeat steps 3.3 through 3.6 until all the sample bottles containing unfiltered samples have been filled.

3.8 Fill two 1-liter unpreserved polyethylene bottles. Use these bottles to transfer the sample for field filtering. Set up a peristaltic pump for filtering of the dissolved metals samples. Using new, clean, disposable silicone tubing and a 0.45-micron filter, place the intake tubing from the pump into the transfer bottle with the filter attached to the discharge end and start the pump. Pre-rinse the filter with approximately 50-mL of sample water prior to filling the sample containers.

3.9 Using the discharge from the filter cartridge, fill one 1-liter polyethylene sample bottle for dissolved metals. Repeat steps 3.8 and 3.9 for these sample containers.

3.10 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential using the multi-parameter water-quality meter and LaMotte Turbidity Meter (see SOP CTO166-13). Record the readings in the appropriate fields on the Surface Water Sample Log Sheet.

3.11 Estimate the flow rate of the stream or spring in accordance with SOP CTO166-20. This is an estimate only. Round the flow rate to the nearest 5 gallons and record this number on the Surface Water Sample Log Sheet.

3.12 Decontaminate all equipment and load the equipment and the sample cooler in the sample vehicle for transport.

4.0 ATTACHMENTS

1. Surface Water Sample Log Sheet

ATTACHMENT 1

SURFACE WATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SURFACE WATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Stream
[] Spring
[] Pond
[] Lake
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP
Date:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	%	mV
Time:								
Depth:								
Method:								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO166-19

SEDIMENT SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for sediment sampling.

Sediment Sample Log Forms: A copy of this form is attached at the end of this SOP.
Bound field logbook
Tags for each sample container
Disposable plastic trowels
Survey stakes and flagging: Used to mark sampling locations after completion of sampling.
Labeled sample containers: See SOP CTO166-01 for sample identification procedures. Sample containers are certified clean by the laboratory supplying the containers.
Plastic storage bags
Shipping containers (containing ice)
Surgical gloves
Indelible marker
Chain-of-Custody Form

3.0 SEDIMENT SAMPLE LOCATION SELECTION

In general, sediments composed of fine-grained materials with greater surface area available for adsorption are more desirable for sample selection. The fined-grained materials may act as a sink or reservoir for adsorbing heavy metals and organic contaminants even if surface runoff concentrations are below detection limits. Therefore, it is important to locate the specific sampling points where the sediment has the greatest percentage of fine particles. The sampling personnel will determine specific sampling locations with these goals in mind.

4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The sampler will wear clean, disposable, surgical gloves during sampling activities.

4.2 Sampling locations for sediment will be chosen along stream channels and gullies where surface water is visibly flowing, if possible. At these locations, sediment samples will be collected from beneath the water surface at the water's edge. If water is not visibly present, then the sediment sample will be collected from an area of deposition where the finest sediment is present and the sediment is moist or wet.

4.3 A disposable plastic trowel or spoon will be used to clear vegetative matter, cobbles, and gravel from the surface of the sediment.

4.4 All sediment samples will be collected from a depth of 0 to 4 inches below the sediment surface. Sample jars for VOCs and AVS-SEM will be collected first by placing exposed sediment material directly in the appropriate sample jars. The sediment will not be stirred or homogenized prior to placement in the jars, and the sediment will be transferred to the jars with a minimum exposure to air. The jars will be filled to capacity in order to minimize the amount of residual air space in the containers. Separate jars will be used for VOCs and AVS-SEM analysis.

4.5 Use the trowel to dig up and homogenize the sediment in an 18-inch-diameter circular area that is 4 inches deep. Stir the sediment within the circular area; do not move the sediment outside the circle. Also, do not dig or stir sediment that is deeper than 4 inches below the sediment surface.

4.6 Use the same trowel or spoon to scoop the homogenized sediment into the requisite labeled sample containers.

4.7 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels and tags. Record all other information required on the labels and tags as specified by SOP CTO166-01.

4.8 Secure the tag to the neck of the sample container using a wire tie.

4.9 Place the tagged sample container into a plastic storage bag and then place the plastic storage bag holding the sample container into a cooler containing ice.

4.10 Record date, sampling site, site conditions, location map, and other information (e.g., presence and flow rate of water in channel) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody Form in accordance with SOP CTO166-04.

4.11 Using an indelible marker, write the sample identification on a survey stake, and drive the stake into the ground at the sample location. Tack a piece of brightly colored flagging to the stake. In addition, tie a piece of flagging to an overhead tree branch or other eye-level object to improve the ability to relocate the sampling site in the future.

5.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1

SOIL AND SEDIMENT SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____

Type of Sample:
[] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date:	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time:			
Method:			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s):

STANDARD OPERATING PROCEDURE
NUMBER CTO166-20

ESTIMATING FLOW IN SMALL STREAMS

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides technical guidance on the measurement of stream channel cross-section and flow in a small stream. Stream flow measurements will be obtained to evaluate the migration potential of contaminants in a stream channel. This method is applicable for free-flowing streams with uniform flow and widths greater than 3 feet and depths greater than about 6 inches. Stream flow rates will be measured at the same time as water-level measurements are collected.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Measuring rod or yardstick
Measuring tape
Waders or rubber boots
Colored flagging tape
2x2 inch wooden stakes
Bound field logbook
Waterproof pen
Orange, apple, or small piece of wood
Surface Water Sample Log Sheet
Indelible marker
Stopwatch

3.0 PROCEDURES

3.1 Establish a transect across the stream, along a straight reach where the stream is relatively narrow and velocity across the stream is relatively uniform. Orient the transect perpendicular to the flow.

3.2 Mark both ends of the transect with colored plastic flagging tape. Tie the flagging to a tree branch or other elevated (about eye level) object. Drive wooden stakes into the ground at both ends of

transect and tack a short piece of brightly colored flagging to the stakes. Use a black marker to identify the transect number, which will be the same as the surface water sample location.

3.3 Measure the total distance across the stream with a measuring tape and record the stream width (in feet) in the field logbook.

3.4 Measure the depth of water in the stream at three or four points across the stream. Record these measurements and calculate an average depth. Record the average depth (in feet) in the field logbook.

3.5 Measure a distance of 20 feet upstream of the transect. Tie a piece of flagging on a tree branch or other visible location above the stream.

3.6 Go another 20 feet upstream and place the orange or apple in the center of the stream or where the water current is fastest.

3.7 Using a watch with a timer or a stopwatch, measure the length of time it takes the orange (or apple) to travel from the first marker flag to the transect location (distance of 20 feet). Record the time.

3.8 Repeat step 3.7 two more times. Record the readings and calculate an average time.

3.9 Calculate approximate flow rate in the stream channel by multiplying the stream width (from step 3.3) times the average depth (from step 3.4) times the average velocity (from step 3.8). Record the estimated flow rate (in ft^3/s) in the field logbook and on the Surface Water Sample Collection Log Sheet.

STANDARD OPERATING PROCEDURE
NUMBER CTO166-21

HYDRAULIC CONDUCTIVITY TESTING

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides technical guidance for the performance and evaluation of an in-situ hydraulic conductivity testing (slug testing) in monitoring wells at the NSWC Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Solid slug
Pressure transducers and data recorder, including instruction manual
Manual water-level indicator
Hydraulic Conductivity Testing Data Sheet
Watch
Decontamination equipment and supplies
Field logbook
Measuring tape

3.0 PROCEDURES

Slug tests are short-term tests designed to provide approximate hydraulic conductivity values for the portion of a formation immediately surrounding the screened/open interval of a well or boring. These tests are much less accurate than pumping tests, because a much more localized area is involved. Therefore, a number of slug tests are typically performed and averaged to determine a representative hydraulic conductivity value for the formation tested. Performance of slug tests may be preferable to pumping tests in situations where handling of large volumes of contaminated water is a concern or when time or budget constraints preclude the more expensive and time-consuming setup and performance of a pumping test.

The procedure is summarized below:

3.1 Determine the total depth of the well using a weighted tape or other measuring device. A pressure transducer attached to a data logger will be placed in the well approximately 1 foot from the bottom of the well. The transducer will be positioned so that it is about 5 to 10 feet lower than the slug.

3.2 Record the well number, the transducer probe identification number being used, the PSI rating for each probe, the depth below top of casing where each probe is positioned, the static water level in the well, and any other information relative to the setup and performance of the slug test. Data and information should be recorded in a bound field notebook and on the Pumping Test Data Sheet.

3.3 A falling-head test can be performed where the slug is lowered into the well and the rate of water-level fall with respect to time is recorded until equilibrium is reached. A rising-head test can be performed where a slug is lowered into the well and the water is allowed to equilibrate, then the slug is removed and the rate of water-level rise is measured with respect to time. Falling head slug tests should only be performed in wells with fully submerged screens, and rising head slug tests can be performed in wells with either partially or fully submerged screens or open intervals.

3.4 Remove or insert the slug and immediately start the data logger. Record the starting time for the data logger on the hydraulic conductivity testing data sheet.

3.5 Manually measure the depth to water with a water depth indicator to estimate the rate of recovery while the data logger is in the sleep mode. Enter the reading onto the form sheet, along with the corresponding transducer reading from the same time.

3.6 Observe the water-level readings when the data logger can be read. Record the times and the readings on the form sheet.

3.7 Rate of recovery measurements shall be obtained from time zero (maximum change in water level) until water-level recovery exceeds 90 percent of the initial change in water level. In low-permeability formations, the test may be cut-off short of 90 percent recovery due to time constraints. Time intervals between water level readings will vary according to the rate of recovery of the well. For a moderately fast recovering well, water-level readings at 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1.0, 1.25, 1.5, 2.0, 2.5, 3.0, 4.0, . . . minutes may be required. With practice, readings at down to 0.05-minute (3 seconds) time intervals can be obtained with reasonable

accuracy, using a pressure transducer and hand-held readout. For wells that recover very fast, the pressure transducer and data logger can be set on a logarithmic recording interval. Time intervals between measurements can be extended for slow recovering wells. A typical schedule for measurements for a slow recovering well would be 0, 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0, 10.0, 15.0, 20.0, 30.0, . . . minutes from the beginning the test. Measurements will be taken from the top of the well casing.

3.8 Stop the test when equilibrium is reached and repeat as necessary to ensure reproducibility.

3.9 Remove the pressure transducer, the slug, and the cables from the well and thoroughly decontaminate, in accordance SOP CTO166-16.

3.10 Check all field notes, copy, and place into one file for each test. Download the data recorder as soon as possible and check data. Make an electronic file and paper file of all data and place with the file for evaluation later. Confirm that the data are usable for the intended analysis prior to leaving the field. Time and recovery should be field plotted on semilog graph paper to determine the data quality. The data set should plot along a sloped, straight line. If excessive data scatter is observed, the test should be rerun until acceptable results are obtained.

4.0 PERSONNEL

A qualified geologist or hydrogeologist, with experience with these test procedures and equipment, will be needed for each sampling team to carry out the hydraulic conductivity tests.

5.0 ATTACHMENTS

1. Hydraulic Conductivity Testing Data Sheet

ATTACHMENT 1

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET

Tetra Tech NUS, Inc.

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET

PROJECT NAME: ..... WELL/BORING NO.: .....

PROJECT NO.: ..... GEOLOGIST: .....

WELL DIAMETER: ..... SCREEN LENGTH/DEPTH: ..... TEST NO.: .....

STATIC WATER LEVEL (Depth/Elevation): ..... DATE: .....

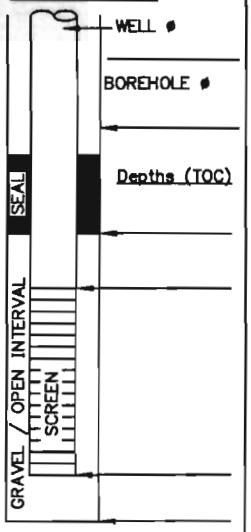
TEST TYPE (Rising/Falling/Constant Head): ..... CHECKED: .....

METHOD OF INDUCING WATER LEVEL CHANGE: ..... PAGE ..... OF .....

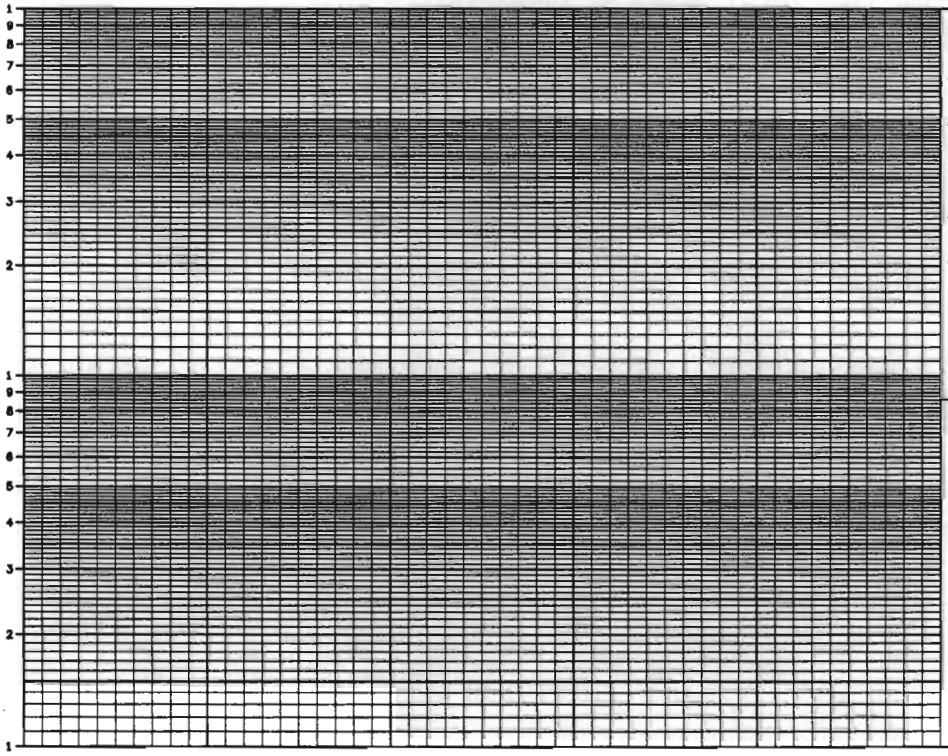
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): .....

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)

WELL SCHEMATIC



Indicate SWL Depth on Drawing



REMARKS:

.....

.....

.....

.....

.....

.....

.....

CALCS,SKETCH MAPS, ETC.:

ACAD:FORM_HYDCONTST.dwg 07/06/99 INL

STANDARD OPERATING PROCEDURE
NUMBER CTO166-22
FIELD TEST KIT ANALYSIS

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish the procedure for the field chemical analysis of parameters in ground water using field test kits. The following parameters are included in this SOP:

- Alkalinity
- Carbon Dioxide
- Dissolved Oxygen
- Ferrous Iron
- Hydrogen Sulfide
- Manganese
- Nitrite
- Sulfide

The NSWC Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Field Chemical Analytical Log Form: A copy of the Field Chemical Analytical Log Form can be found in Attachment 1 of this SOP.

Field analytical test kits, methods, and reagents: The following table presents the required an al test kits to be used for field analysis. Specific reagents and bottle requirements are included in each procedure. Current copies of the procedures will be maintained on-site during the field program. They will be accessible during use of the Field Test Kits.

Parameter	Make	Model	Method Number	Equipment/ Method Chemistry
Alkalinity	CHEMetrics	K-9810 K-9815 K-9820	ASTM D 1067-92	CHEMets vacuum vials/HCL Titrant w/pH indicator
Carbon Dioxide	CHEMetrics	K-1910 K-1920 K-1925	ASTM D 513-82	CHEMets vacuum vials/Rhodazine D and Indigo Carmine Sodium Hydroxide w/pH indicator
Dissolved Oxygen	CHEMetrics	K-7501 K-7512	ASTM D 5543-94	CHEMets vacuum vials/Rhodazine D and Indigo Carmine
Ferrous Iron	HACH	DR-850	HACH 8146	Colorimeter / 1,10 Phenanthrolein
Hydrogen Sulfide	HACH	HS-C	HACH Proprietary/ Mod. SM 426C	Color Chart/ Effervescence through Sulfide reactive paper
Manganese	HACH	DR-850	HACH 8304	Colorimeter / Cadmium Reduction
Nitrite	HACH	DR-850	HACH 8507 Mod EPA 354.1	Colorimeter / Diazotization
Sulfide	HACH	DR-850	HACH 8131 EPA 376.2	Colorimeter / Methylene Blue

3.0 FIELD ANALYTICAL PROCEDURES

3.1 General

The procedures for each of the individual analyses will be maintained in the field during the entire sampling program. The procedures give a detailed explanation on how to perform each particular method, and include information on sampling/storage, accuracy checks, interference, reagents, and apparatus.

3.2 Quality Assurance/Quality Control Procedures

Accuracy checks shall be performed to check the performance of the reagents, the apparatus, and the analytical procedure. These accuracy checks include standard solutions, field duplicates, and reagent blank correction. The field test kit procedures detail how to perform each of the accuracy checks for each parameter.

Prior to analysis, the expiration dates of reagents will be checked. If the reagents have exceeded their shelf life, the reagents will be replaced. If deviations from the applicable analytical procedure are identified, the deviations will be corrected and the associated samples re-analyzed. If no problems are

identified with the reagents, apparatus, or procedures, interference may be present. Associated data will be qualified as estimated in the 'notes' section on the sample logsheet. Field duplicate results will be evaluated for relative percent difference (RPD). If the RPD exceeds 30 percent, the associated data will be qualified as estimated.

The following table describes the type and frequency of accuracy checks required for each parameter.

Parameter	Standard Solution	Field Duplicate	Reagent Blank Correction
Alkalinity	None	1 per 10	None
Carbon Dioxide	None	1 per 10	None
Dissolved Oxygen	None	1 per 10	None
Ferrous Iron	None	1 per 10	None
Hydrogen Sulfide	None	1 per 10	None
Manganese	None	1 per 10	None
Nitrite	1 per round	1 per 10	1 per lot
Sulfide	None	1 per 10	None

3.3 Sample Handling and Storage

Each of the field parameters requires slightly different sampling procedures and storage limitations. In order to compile these procedures and limitations into one location for reference in the field, the following table has been prepared that presents parameter-specific requirements for sampling and storage.

Parameter	Handling	Storage
Alkalinity	Avoid agitation and exposure to air	May hold for 1 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Carbon Dioxide	Avoid agitation and exposure to air	May hold for 24 hr. at 4°C with zero headspace; warm to room temperature before analysis.
Dissolved Oxygen	Avoid agitation and exposure to air	Analyze immediately.
Hydrogen Sulfide	Avoid agitation and exposure to air	Analyze immediately.
Ferrous Iron	Avoid agitation and exposure to air; filter if visibly turbid	Analyze immediately; keep out of sunlight.
Manganese	Avoid agitation and exposure to air; filter if visibly turbid	Analyze immediately.

Parameter	Handling	Storage
Nitrite	Utilize standard sampling techniques	May hold for 24 hr. at 4°C; warm to room temperature before analysis.
Sulfide	Avoid agitation and exposure to air	Analyze immediately.

4.0 ATTACHMENTS

1 Field Analytical Log Sheet Geochemical Parameters

ATTACHMENT 1

FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLING DATA:

Date: / Time:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (^{0}C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	ORP (Eh) (+/- mv)
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: _____

Equipment: HACH Digital Titrator OX-DT

Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier		Concentration
_____	x 0.01	=	mg/L
_____	x 0.02	=	mg/L

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: _____

Equipment: HACH Digital Titrator CA-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count			Concentration
_____	x 0.1	=	mg/L
_____	x 0.2	=	mg/L
_____	x 1.0	=	mg/L
_____	x 2.0	=	mg/L

Standard Additions: ☐ Titrant Molarity: _____ Digits Required: 1st.: _____ 2nd.: _____ 3rd.: _____

Notes:

Hydrogen, dissolved

Equipment: Bubble strip sampling field method

Start stripper at _____ (time)

End stripper at _____ (time)

Total stripper time _____

Pump rate _____ milliliters/minute

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Alkalinity:

Equipment: Chemetrics Test Kit Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: _____

Filtered: ☐

Equipment: HACH Digital Titrator AL-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	= mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	= mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 3.00 mg/L Concentration: _____ ppm

Program/Module: 500nm 33

Analysis Time: _____

Equipment: IR-18C Color Wheel Range: 0 - 10 mg/L

Notes:

Filtered: ☐

Hydrogen Sulfide (H_2S):

Range: 0 - 5 mg/L

Equipment: HS-C Other: _____ Concentration: _____ ppm

Exceeded 5.0 mg/L range on color chart: ☐ Analysis Time: _____

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics Test Kit Range: 0 - 10 mg/L Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-9510	
☐	1 to 10 ppm	K-9510	

Analysis Time: _____

Filtered: ☐

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.70 mg/L

Program/Module: 610nm 93

Notes:

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Sulfate (SO_4^{2-}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 70 mg/L Concentration: _____ ppm

Program/Module: _____ 91 Analysis Time: _____

Standard Solution: ☐ Results: _____ Filtered: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

Nitrate (NO_3^--N):

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.50 mg/L (1) Concentration: _____ ppm

Program/Module: 55 Analysis Time: _____ Filtered: ☐

Standard Solution: ☐ Results: _____ Nitrite Interference Treatment: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Alternate forms: NO_2 _____ $NaNO_2$ _____ mg/L

Notes (1): If results are over limit use dilution method at step 3, 5ml sample 10ml DI result X3, range upto 1.5mg/L

Notes:

Nitrite (NO_2^--N): Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.350 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}): Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 20.0 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 525nm 41

Standard Solution: ☐ Results: _____ Digestion: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Equipment: HACH MN-5 Range: 0 - 3 mg/L

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐

Mulitplication is correct for each *Multiplier* table: ☐

Final calulated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

APPENDIX F

BORING LOGS

APPENDIX F.1

SWMU 13

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT01
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	2" TOPSOIL	ML	5" 0-6"	0.0			
	2					↓	↓	↓		↓			
	3				DRY	YELL	2'-6' CLAYEY SILT						
	4					OR ↓							
S-1 1125	5		4.9' / 5'			LT. GRAY	↓			↓		0.0	0.0
	6					YELLOW + LT. GRAY	CLAYEY SILT	↓		0.0			
	7				MOIST	BR +	6'-9.5' SILTY SAND	SM	WEATHERED S.S.	↓			
	8				↓	YELL OR	↓	↓	↓				
	9					↓							
S-2 1145	10		4.8' / 5'		HARD DRY	↓	.5' SANDSTONE	BX	ROCK @ 9.5'	↓			
↓	11					LT GRAY	WL @ 6' BGS	↓					
	12					↓	5" REAM TO 15'						
R-1	13						SANDY MATERIAL						
	14					↓	IN CUTTINGS						
↓	15					OR GRAY	SILTY MATERIAL	↓					
				T.D. 15'			WELL SET @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 3'						
							BENT TO 1'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MWT01

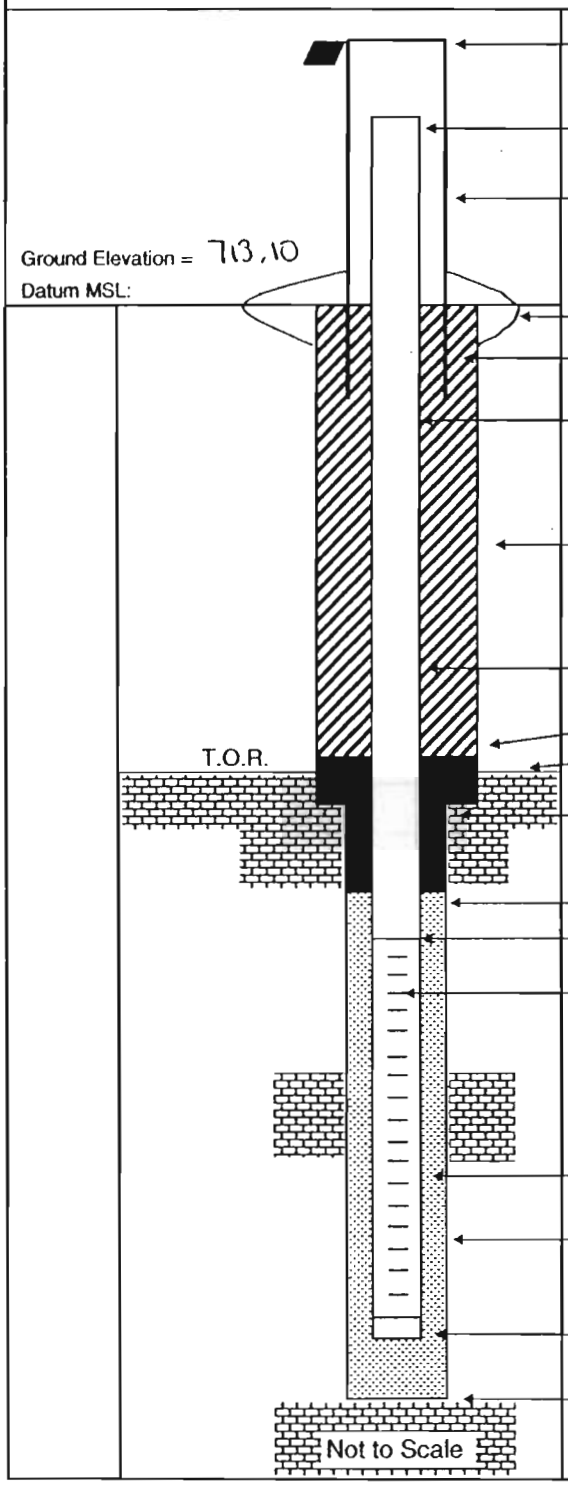
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MWT01

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT01
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310541.574
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3025015.943



Elevation of Top of Casing: 715.91

Stick Up of Casing Above Ground Surface: 2.24'

Elevation of Top of Riser: 715.34

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 712.1 / 1'

Elevation / Depth Top of Bedrock: 702.6 / 9.5'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 710.1 / 3'

Elevation / Depth of Top of Screen: 708.1 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 698.10 / 15'

Elevation / Total Depth of Borehole: 698.10 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Roto Sonic
BORING NUMBER: 13MWT02
DATE: 3/29/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	TOP .5' TOP SOIL	ML	6" TO 7'	0.0			
	2						.5-5' SANDY SILT W/ S.S		FILL				
	3						FRAGS						
	4					YELL OR	3'-5' CLAYEY SILT		MOTTLED				
S-1 1030	5		4.7 / 5'			LT. GRAY						0.0	0.0
	6				DRY +		5'-7' SILT W/ SOME	ML		0.0			
S-2 1035	7		2' / 2'		STIFF		CLAY		REFUSAL @ 7'				
	8				HARD +	GRAY	7'-12' SILT STONE		THIN LAM.				
	9		70% RQD		DRY	+ BR							
C-1	10		@1130			GRAY			ROCK @ 7'				
	11				SOFT +				POSS H2O @ 11'				
	12		5' / 5'		MOIST								
	13				SOFT	GRAY	SHALE 12-13.5'						
	14		60% RQD				SILTSTONE 13.5'-15.5'		THIN LAM.				
C2	15		@1149	COAL			COAL SEAM (14'-14.5')						
	16				HARD		SANDSTONE 15.5'	BR					
	17		4.9' / 5'						@ 17' WL=16.7' BGS				
	18								AFTER 2 HRS.				
	19		68% RQD						FRACT 17'-18'				
C3	20		@1137						STATIONING @ 19.5'				
	21								FRACT 19.5'-20'				
	22		5' / 5'						FRACT 22'-23.5'				
	23						22'-23.5' SANDSTONE	BR					
	24												
C4	25		@1452		SOFT	DK GRAY	INTERBEDDED SHALE SS	BR	POSS WATER ZONE				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes X No

Well I.D. #: 13MWT02

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Roto Sonic

BORING NUMBER: 13MW102
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
G4	26		50%		SOFT	DK	INTERBEDDED	VAR		0.0	0.0		
↓	27		RQD		↓	GRAY	SHALE + S.S	↓		↓	↓		
				T.D. 27'									
							WELL SET @ 27' 2" PVC						
							SCREENED 17'-27'						
							SAND TO 15'						
							BENT TO 13'						
							VOL. CLAY TO 4'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes x No _____ Well I.D. #: 13MW102

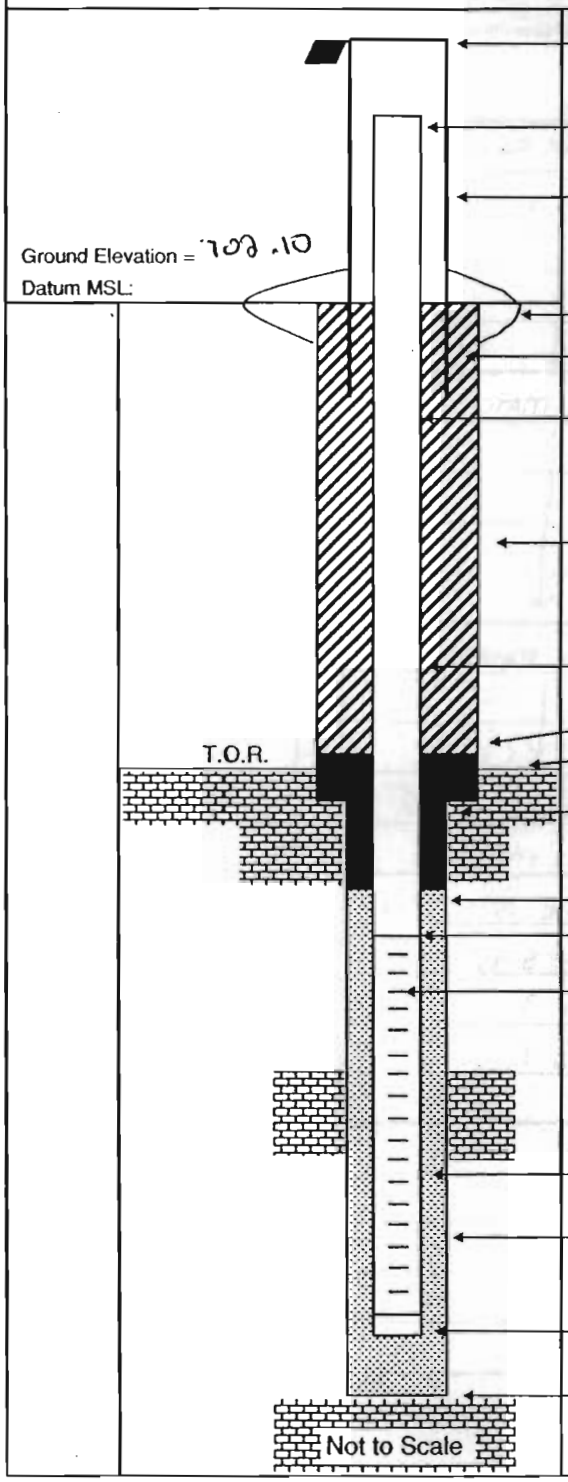
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW102

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW102
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/24/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310776.555
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	BAILER S. STEEL	EASTING:	3024743.547



Elevation of Top of Casing: 705.28

Stick Up of Casing Above Ground Surface: 2.62'

Elevation of Top of Riser: 704.72

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5" (7'-9') 6" (0-7')

Type of Backfill: VOL CLAY TO 4'

Elevation / Depth Top of Seal: 689.1 / 13'

Elevation / Depth Top of Bedrock: 695.1 / 7.0'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 687.1 / 15'

Elevation / Depth of Top of Screen: 685.1 / 17'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 675.1 / 27'

Elevation / Total Depth of Borehole: 675.1 / 27'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC
BORING NUMBER: BMWT03
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1						SEE BMWT01 FOR LITHOLOGY		5" 0-15'				
						YELLOW	SILTY MATERIAL						
						↓	↓						
1515	5					↓	↓						
							SANDY MATERIAL						
							↓						
1520	10						↓		HARDER @ 10'				
							SANDY MATERIAL						
							↓						
						↓	↓						
						GRAY	COLOR CHANGE @ 13'						
1530	15					↓	SILTY MATERIAL						
				T.D. 15'			WELL SET @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 3'						
							BENT TO 1'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): —

Converted to Well: Yes X No ____ Well I.D. #: BMWT03

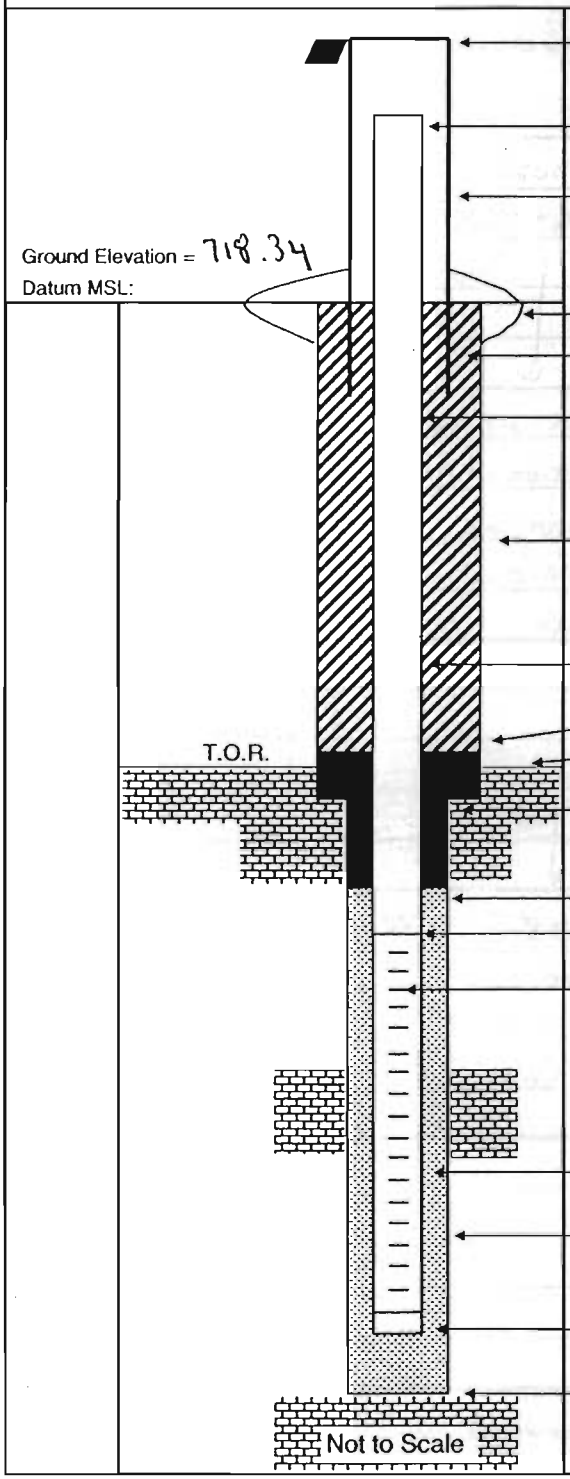
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MWT03

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT03
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310240.946
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024891.661



Elevation of Top of Casing:	721.60
Stick Up of Casing Above Ground Surface:	2.86'
Elevation of Top of Riser:	721.10
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	5"
Type of Backfill:	GROUT
Elevation / Depth Top of Seal:	717.34 / 1'
Elevation / Depth Top of Bedrock:	708.34 / 10'
Type of Seal:	BENT. CHIPS
Elevation / Depth of Top of Filter Pack:	715.34 / 3'
Elevation / Depth of Top of Screen:	713.34 / 5'
Type of Screen:	PVC
Slot Size x Length:	10' x .20
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	703.34 / 15'
Elevation / Total Depth of Borehole:	703.34 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT04
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MUSSY & SOFT	BR	.4' TOP SOIL	ML		0.0			
	2				MUSSY &	YELL OR	.4'-7.5' CLAYEY SILT						
	3				M-STIFF	LT.	(MOTTLED)						
	4					GRAY							
S-1 0.4'-3.4'	5		5' / 5'										
	6				MUSSY &		CLAYEY SILT SOME			0.0			
	7			▼?	M-STIFF		SOLUTION CAVITIES						
S-2 0.4'-3.4'	8		3' / 3'		HARD & DRY	BRN GRAY	SANDY SILTSTONE		REFUSAL @ 8'				
	9						SILTY MATERIAL IN		6" TO 5'				
	10						CUTTINGS		5" 5'-15'				
	11						5" REAM						
	12												
	13												
	14												
	15												
				TD.15'			SET WELL @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 4'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 6" TO 5' 5" 5'-15'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 13MWT04

Tetra Tech NUS, Inc.

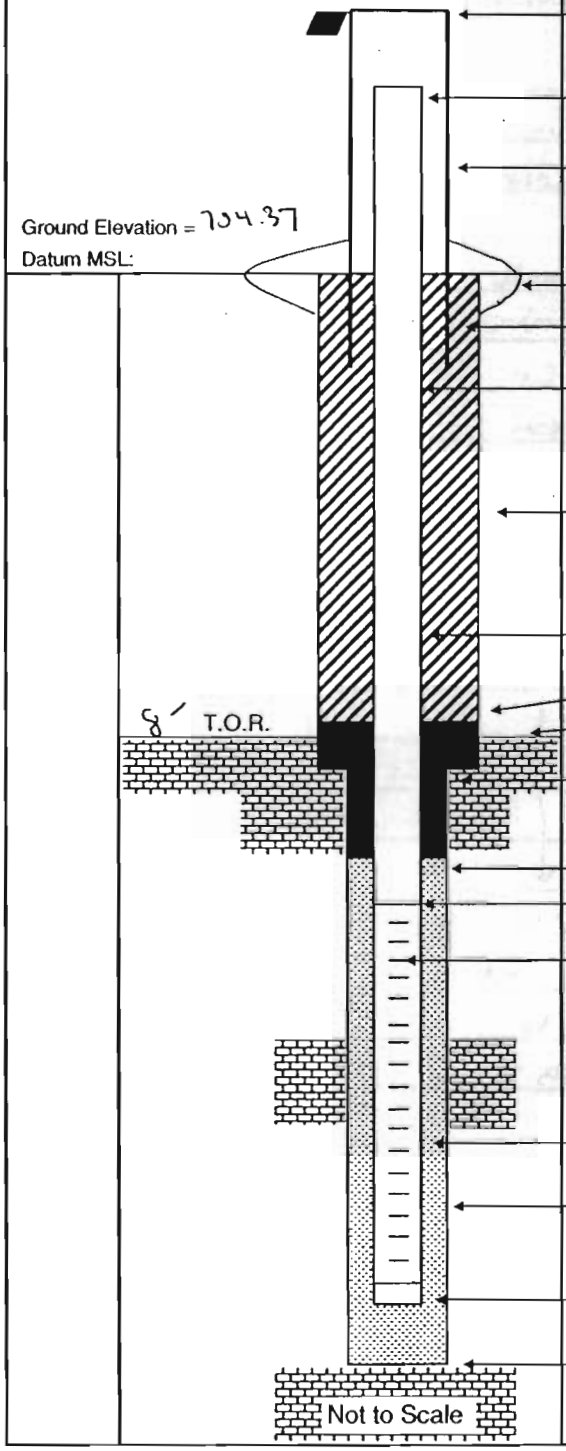
BEDROCK

MONITORING WELL SHEET

WELL No.: 13MW704

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW704
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310383.396
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024546.113



Elevation of Top of Casing: 707.32

Stick Up of Casing Above Ground Surface: 2.47'

Elevation of Top of Riser: 706.84

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 700.37 / 2'

Elevation / Depth Top of Bedrock: 696.37 / 8'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 700.37 / 4'

Elevation / Depth of Top of Screen: 694.37 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 684.37 / 15'

Elevation / Total Depth of Borehole: 684.37 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: BMW105
DATE: 3/29/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVES

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	SEE BORING LOG BMW107						
						↓	FOR LITHOLOGY						
						LT							
						GRAY	5" REAM TO 6'						
0920	5					↓	SILTY MATERIAL						
						YELL	SILT + CLAY						
						OR	MATERIAL						
						↓	↓						
	10					GRAY	SILTY MATERIAL		HARDER @ 9'				
						↓	↓						
	15												
0928	16					↓	↓						
				TD 16'			SET WELL @ 16' 2" PVC						
							SCREENED 6'-16'						
							SAND TO 4'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): —

Converted to Well: Yes X No ____ Well I.D. #: BMW105

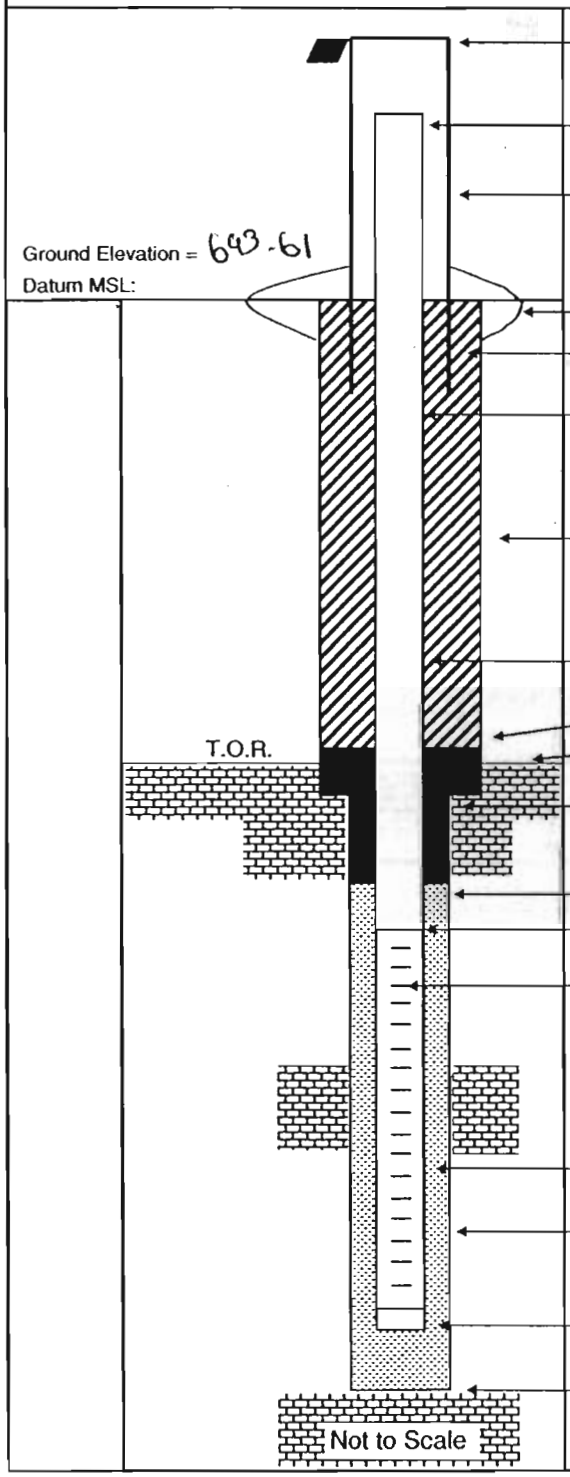
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW105

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW105
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/29/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1360758.427
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024380.025



Elevation of Top of Casing: 697.12

Stick Up of Casing Above Ground Surface: 2.83'

Elevation of Top of Riser: 696.44

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4' x 4' x 6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 691.61 / 2'

Elevation / Depth Top of Bedrock: 684.61 / 9'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 689.61 / 4'

Elevation / Depth of Top of Screen: 687.61 / 6'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 677.61 / 16'

Elevation / Total Depth of Borehole: 677.61 / 16'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC
BORING NUMBER: 13MW T06
DATE: 4/7/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST & SOFT	BR	.5' TOP SOIL	ML		0.0			
	2				MOIST &	BR &	.5'-4' CLAYEY SILT		MOTTLED				
	3				M-STIFF	LT GRAY							
S-1 1705	4		4' / 4'										
	5						CLAYEY SILT 4-7'	ML		0.0			
	6												
	7			?			SANDY 6.5'-7'		POSS. SAT @ 6.5'				
	8				DRY &	LT	7'-15' SILTSTONE						
S-2 1710	9		4.9' / 5'		SOFT	GRAY							
	10				SOFT &	BR &	SILTSTONE W/ SOME			0.0			
	11				MOIST	LT GRAY	SAND (FINE)						
	12				HARD &	LT	SILTSTONE						
	13				DRY	GRAY							
	14					LT GRAY							
S-3 1729	15		5.5' / 6'		V. HARD & DRY	& RUSTY							
				15' T.D.			WELL SET @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 3'						
							BENT TO 1'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 5" 0-15'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 13MW T06

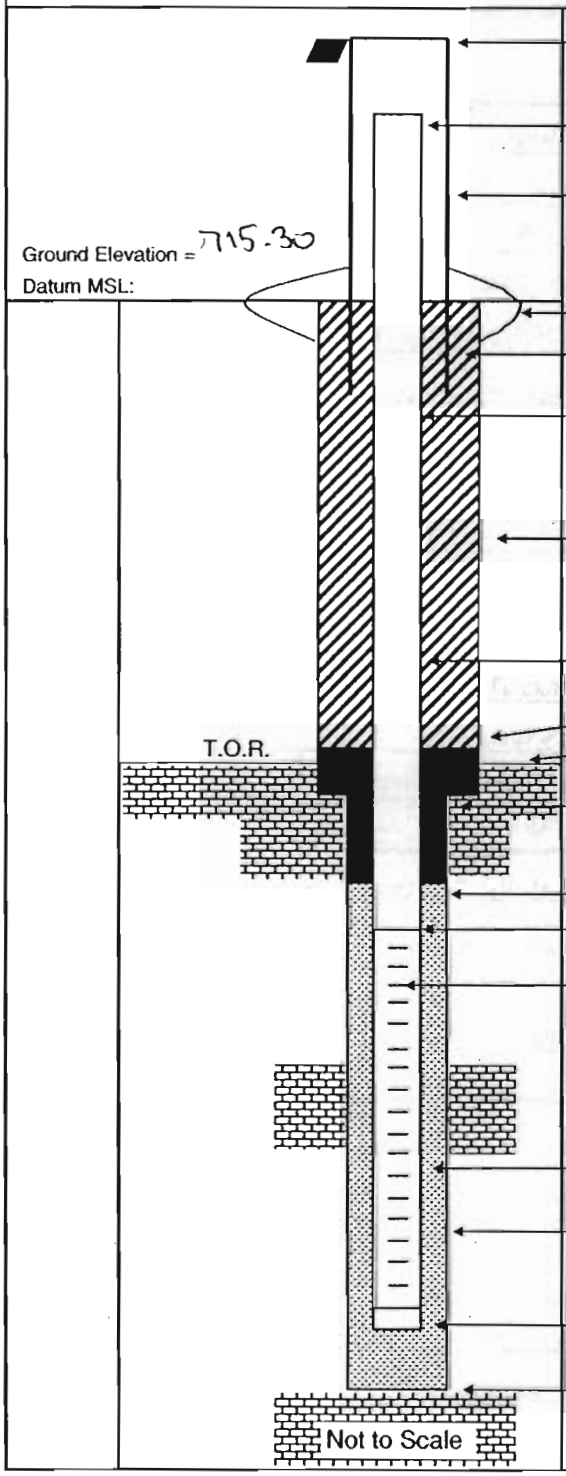
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: BMW706

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	BMW706
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	4/7/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309916.177
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024445.270



Elevation of Top of Casing: 718.47

Stick Up of Casing Above Ground Surface: 2.63'

Elevation of Top of Riser: 717.93

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 714.3 / 1'

Elevation / Depth Top of Bedrock: 708.3 / 7.0

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 712.3 / 3'

Elevation / Depth of Top of Screen: 710.3 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 700.3 / 15'

Elevation / Total Depth of Borehole: 700.3 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW107
DATE: 3/29/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST +	BR	TOP 1' TOP SOIL	ML	4'-to 5'	0.0			
	2				M-STIFF	YELL OR	1'-3' SANDY SILT	↓	WELL SET 6'-to 5'	↓			
	3				↓	LT GRAY	(MOTTLED)	↓	CORE 5'-	↓			
	4				DRY +	LT	3'-5' SILTSTONE		WEATHERED 3'-4'	↓			
SH 0807	5		4.5' / 5'		SOFT	GRAY	ROCK @ 4' (COMPETENT)	DK		↓			
	6				MOIST +	YELL OR	5'-7' SANDY SILT W/ SOME	ML	MOTTLED	0.0			
	7				M-STIFF	GRAY	CLAY	↓	↓	↓			
	8		70%		SOFT + WET	BR	7-8.5' SILTY CLAY	CL		↓			
	9		RQD		DRY +	LT	SILTSTONE W/ T. SAND	BR	ROCK @ 8.5'	↓			
CH	10		@ 84%		SOFT	GRAY	↓	↓		↓			
	11				↓	↓	↓	↓		0.0			
	12				DRY + HARD	YELL OR	11.5'-13' SANDSTONE	↓		↓			
	13				MOIST +	LT + DK	SILTSTONE	↓		↓			
	14				SOFT	GRAY	↓	↓		↓			
	15		9.5' / 10'		↓	↓	↓	↓		↓			
				T.D. 15'			SET WELL @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 4'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes X No ____ Well I.D. #: 13MW107

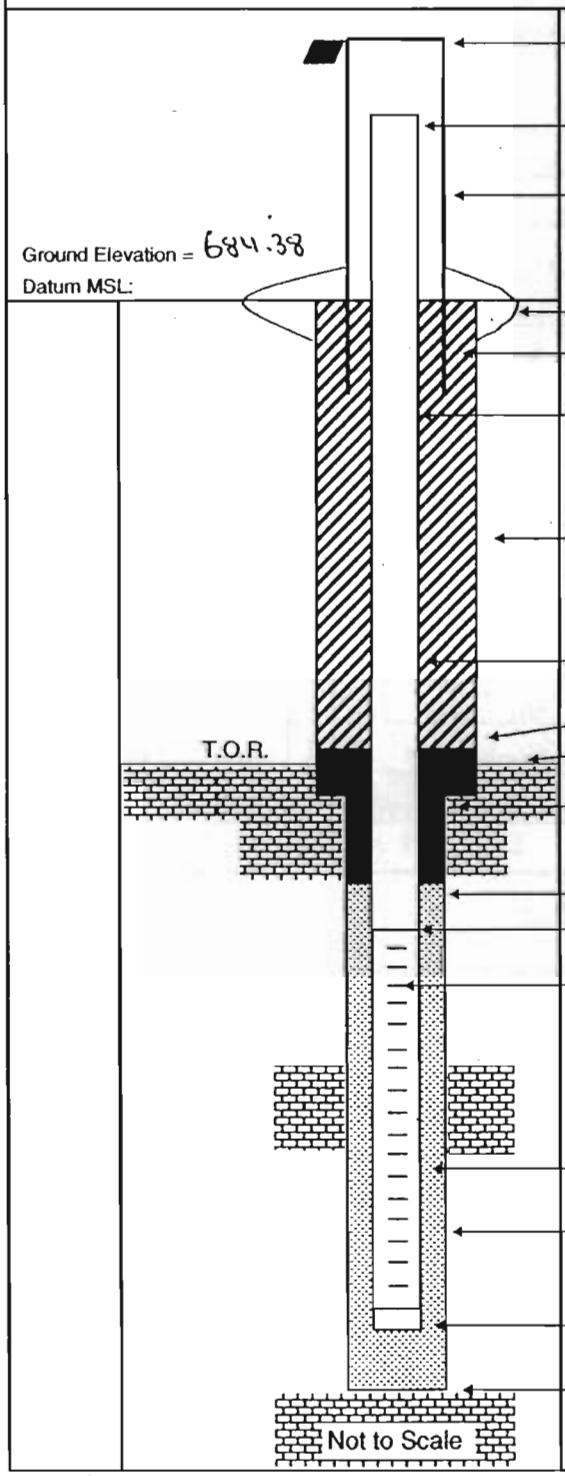
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW707

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW707
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/24/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310534.322
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024094.128



Elevation of Top of Casing: 687.70

Stick Up of Casing Above Ground Surface: 2.84

Elevation of Top of Riser: 687.22

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 682.38 / 2'

Elevation / Depth Top of Bedrock: 676.88 / 8.5'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 680.38 / 4'

Elevation / Depth of Top of Screen: 679.38 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 669.38 / 15'

Elevation / Total Depth of Borehole: 669.38 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: BMW T08 / SB08
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST & SOFT	BR	TOP .5' TOP SOIL	ML		0.0			
	2				DRY &	YELL BR	CLAYEY SILT		0-2 @ 0745				
	3				MOISTIFF	GRAY	(MOTTLED)		DUP F0030304				
	4												
S-1 0943	5		4.5'/5'										
	6					BR	5-6.5' CLAYEY SILT W/ S.S. FRAGS	ML		0.0			
	7					YELL BR	6.5-8' CLAYEY SILT		6-8' @ 0800				
	8			?			(MOTTLED)		MS/MSD				
	9				SOFT &	LT GRAY	8-10' SILTSTONE	DK	POSS. WATER @ 8'				
S-2 1254	10		4.4'/5'		DRY			BR					
	11				HARD	YELL BR	SANDSTONE 10-10.5'			0.0			
	12				HARD &	LT GRAY	10.5'-13.5' SILTSTONE						
	13				DRY	YELL BR	(MOTTLED)		MOISTURE ALONG				
	14				HARD &	LT/DK	THIN LAMINATED SILTSTONE		SOIL WALLS				
S-3 0810	15		5'/5'		DRY	GRAY	13.5'-15'		6" TO 5' 5" REAM				
				TD 15'			WELL SET @ 15'		5'-15'				
							SCREENED 5'-15'		DRILLER LOSING				
							SAND TO 4'		WATER.				
							BENT TO 2'		HOLE 9 1/2" DIA				
									AFTER BLOWOUT				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: BMW T08

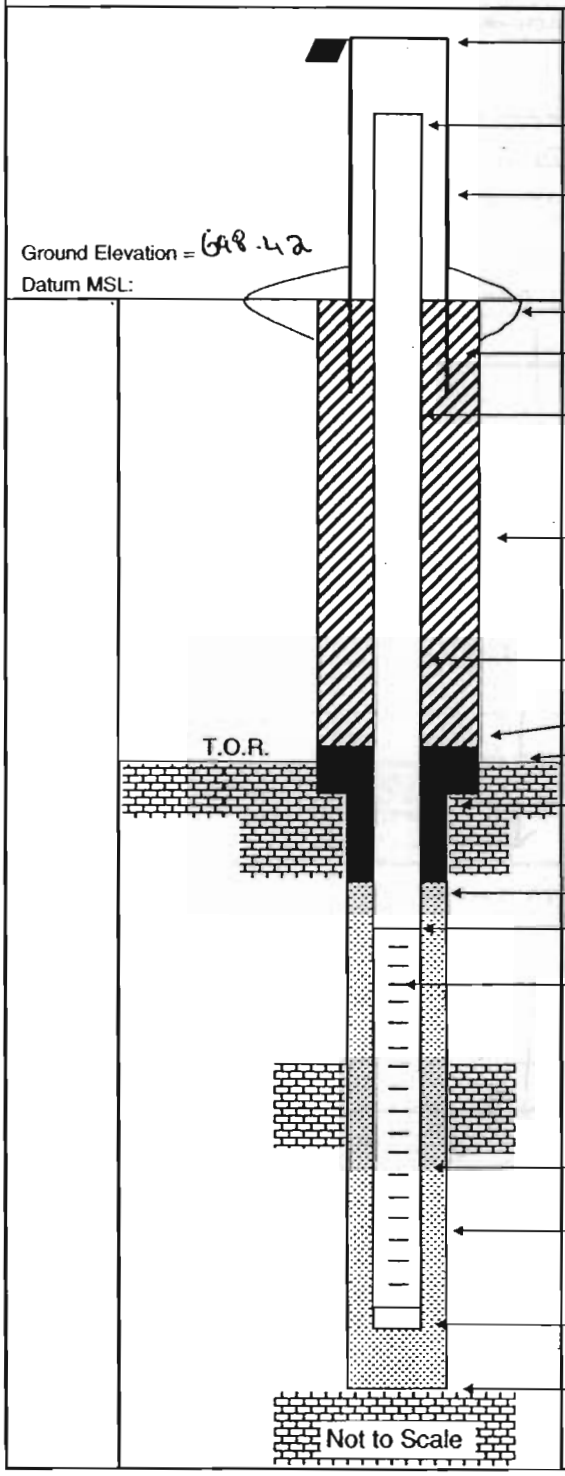
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW108

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW108/SB08
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES	DATE COMPLETED:	3/30/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310247.860
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3024337.560



Elevation of Top of Casing: 701.11

Stick Up of Casing Above Ground Surface: 2.14

Elevation of Top of Riser: 700.56

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" (0-5')
5" (5'-15')

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 696.42 / 2'

Elevation / Depth Top of Bedrock: 690.42 / 8'

Type of Seal: BENTONITE

Elevation / Depth of Top of Filter Pack: 694.42 / 4'

Elevation / Depth of Top of Screen: 693.42 / 5'

Type of Screen: PVC

Slot Size x Length: .020 x 40'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 683.42 / 15'

Elevation / Total Depth of Borehole: 683.42 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW709
DATE: 4/1/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVES.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						YELL	FOR COMPLETE LITHOLOGY						
						OR	SEE 13MWT10						
							5" REAM TO 20'						
							SILTY MATERIAL						
	5												
									HARDER DRILLING				
									@ 6'				
						LT			COLOR CHANGE				
						GRAY			@ 7'				
	10												
						DK	SILTY MATERIAL						
						GRAY							
	15												
							SHALEY MATERIAL						
	20												
							WELL SET @ 20' 2" PVC						
							SCREENED 10'-20'						
							SAND TO 8'						
							BENT TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 7

Remarks:

Converted to Well: Yes X No

Well I.D. #: 13MW709

Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

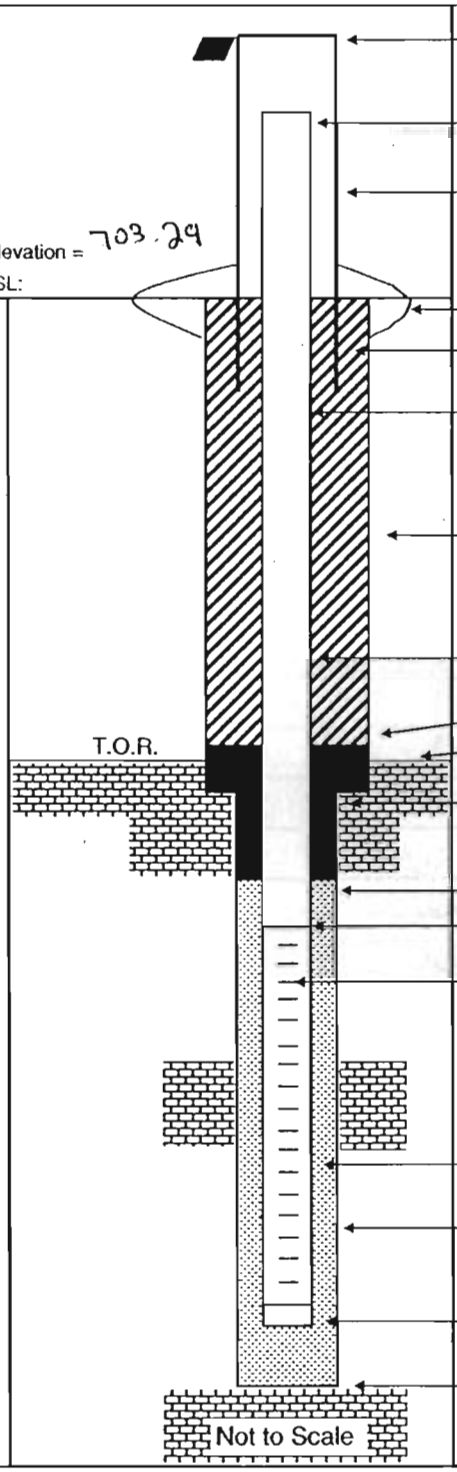
WELL No.: 13MWT09

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT09
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES.	DATE COMPLETED:	4/1/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309662.066
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3024049.030

Ground Elevation = 703.29

Datum MSL:



Elevation of Top of Casing:	706.37
Stick Up of Casing Above Ground Surface:	2.61'
Elevation of Top of Riser:	705.40
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	5"
Type of Backfill:	GROUT
Elevation / Depth Top of Seal:	701.29 / 2'
Elevation / Depth Top of Bedrock:	697.29 / ≈6'
Type of Seal:	BENT CHIPS
Elevation / Depth of Top of Filter Pack:	695.29 / 8'
Elevation / Depth of Top of Screen:	693.29 / 10'
Type of Screen:	PVC
Slot Size x Length:	.20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	683.29 / 20'
Elevation / Total Depth of Borehole:	683.29 / 20'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC
BORING NUMBER: 13MWTW
DATE: 3/27/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST &	BR	TOP .5' TOP SOIL		HIT CONCRETE @	0.0	0.0		
	2				MOIST	↓	.5' CLAY & SILT W/ S.S. GRAV.	ML	3' WITH OFFSET				
	3					LT BR	2-5.5' SANDY SILT W/ SOME	ML	HIT CONCRETE AGAIN				
	4					+ GRAY	↓ CLAY	↓					
S-1 1337	5		4.5 / 5'			↓	↓	↓		↓		0.0	0.0
	6					YELL BR	SANDY SILT	ML		0.0			
	7			11:11-11:5	SOFT & DRY	LT	SILTSTONE 5.5'-14.5'	RF	ROCK @ 5.5'				
	8				↓	GRAY	↓	BR					
	9					↓							
S-2 1351	10		5' / 5'			DK GRAY	↓ (COLOR CHANGE)			↓			
	11			?	MOIST?		SILTSTONE		COLD TO THE	0.0			
	12				& STIFF				TOUCH. (14.2')				
	13				↓								
	14					↓	↓						
S-3 1403	15		4.9' / 5'		DRY & LOOSE	BLK	.5' COAL SEAM		6" TO 15'	↓			
	16					BLK	BLACK MATERIAL IN		5" REAM 15'				
	17					↓	CUTTINGS (COAL)						
	18					GRAY	SHALEY MATERIAL						
	19					↓	↓						
R-1 1520	20					↓	↓		BLOW OUT HOLE				
	21					GRAY	SHALEY MATERIAL		WATER @ 19' BGS				
	22					↓	↓						
	23					DK GRAY	SILTY MATERIAL						
	24					↓	↓						
R-2 1530	25					↓	↓	↓	BLOW OUT HOLE W/ 19' BGS		↓		

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: 6' OFFSET SET WELL @ 25' 10' SCREEN
SAND TO 13'
BENT TO 11' VOL CLAY TO 4'

Converted to Well: Yes X No ___ Well I.D. #: 13MWTW

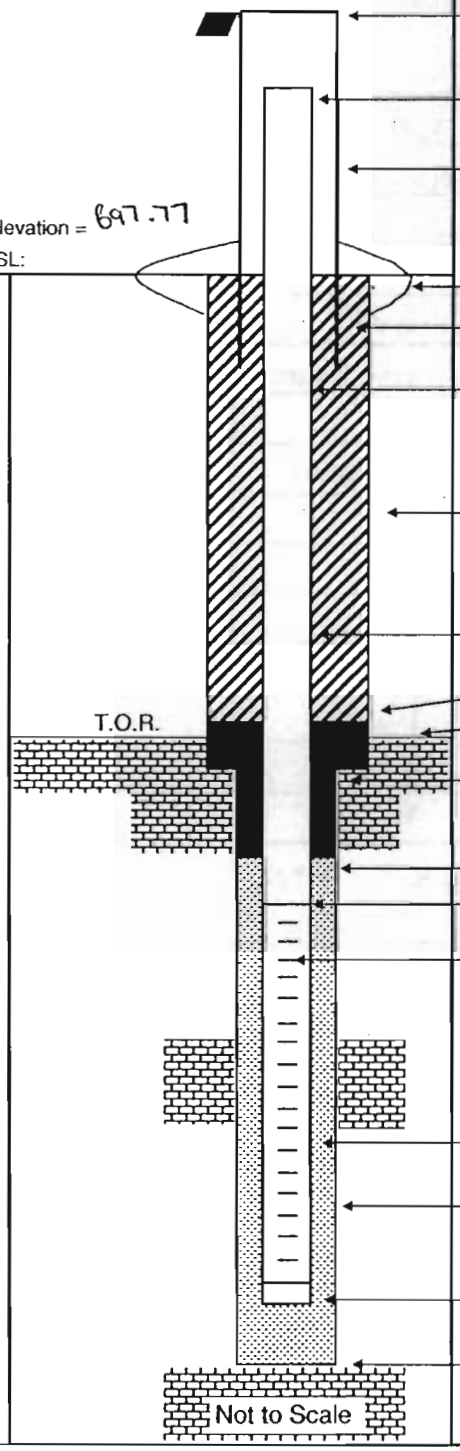
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MWT10

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT10
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/27/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309479.643
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3034001.262



Elevation of Top of Casing: 700.64

Stick Up of Casing Above Ground Surface: 2.38

Elevation of Top of Riser: 700.15

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" (0-15') 5" (15'-25')

Type of Backfill: VOL CLAY TO 4'

Elevation / Depth Top of Seal: 686.77 / 11'

Elevation / Depth Top of Bedrock: 692.77 / 5.5'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 684.77 / 13'

Elevation / Depth of Top of Screen: 682.77 / 15'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 672.77 / 25'

Elevation / Total Depth of Borehole: 672.77 / 25'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13 MW T11
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
						BR	REFER TO 13 MW T12						
							FOR COMPLETE LITHOLOGY						
							6" CASING TO 5'						
	5						5" REAM TO 15'						
							0-7' SILTY MATERIAL						
									HARDER DRILLING				
						GRAY	SANDY MATERIAL		@ 7'				
	10												
	15												
				TD. 15'			SET WELL @ 15' 2" PVC						
							SCREEN 5'-15'						
							SAND TO 4'						
							BENT CHIPS 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): —

Remarks:

Converted to Well: Yes X No ____ Well I.D. #: 13 MW T11

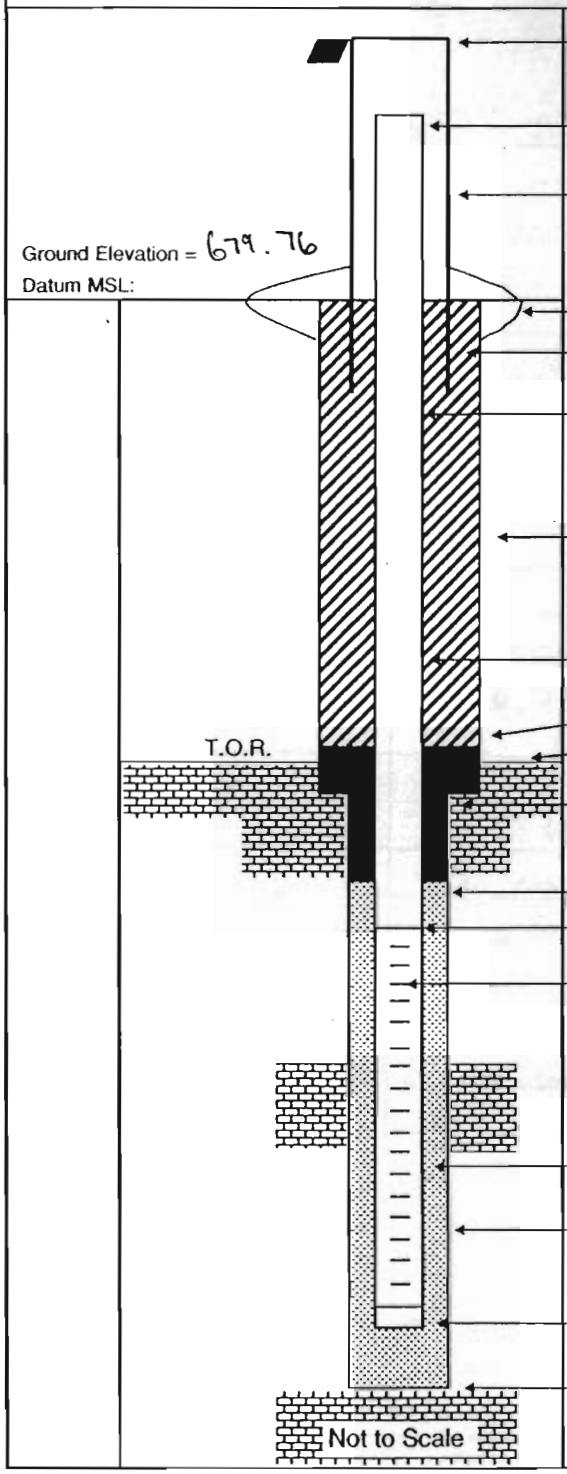
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW711

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW711
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/28/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310233.721
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3023750.087



Elevation of Top of Casing: 682.82

Stick Up of Casing Above Ground Surface: 2.53

Elevation of Top of Riser: 682.29

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" (0-5') 5" (5'-15')

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 677.76 / 2'

Elevation / Depth Top of Bedrock: 672.76 / 7'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 675.76 / 4'

Elevation / Depth of Top of Screen: 674.76 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 664.76 / 15'

Elevation / Total Depth of Borehole: 664.76 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Rotosonic

BORING NUMBER: 13MWT12
DATE: 3/27/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sample BZ	Borehole**	Driller BZ**
	1			1 1 1	MOIST	BR	TOP .5' TOPSOIL	ML	16" 0-10'	0.0			
	2				M. STIFF	LT.	5'-7' STIFF CLAY W/S.S. FRAGS	CL	FILL .5'-5'				
	3				DRY	BR	SOME SAND						
	4												
S-1 0930	5		4.7' / 5'									0.0	0.0
	6					BRL	NO S.S. OR SAND	CL		0.0			
	7					RED							
	8				HARD	YELL &	7-10' SANDSTONE W/	MBR	ROCK @ 7'				
	9				&	GRAY	CLAYSTONE SEAMS						
S-2 0939	10		5' / 5'		DRY								
	11					GR	SANDSTONE 10-10.5'	BR		0.0			
	12		70% RQD			GRAY	SILTSTONE 10.5'-11.5'						
C-1	13		@ 1014		SOFT & WET				POSSIBLE WATER @ 13'				
	14												
	15		5' / 5'			YELL							
	16				HARD	GR	SANDSTONE 14.5'-16'			0.0			
	17		64% RQD			GRAY	16'-18.5' SILTSTONE		MODERATE FRACT. 16'-19.5'				
C-2	18		@ 1027										
	19												
	20		4.9' / 5'				18.5'-20' SANDSTONE						
				T.D. 20'			WELL SET @ 20' 2" PVC						
							SCREENED 10'-20'						
							SAND 8'						
							BENT ~ 4'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes X No ____ Well I.D. #: 13MWT12

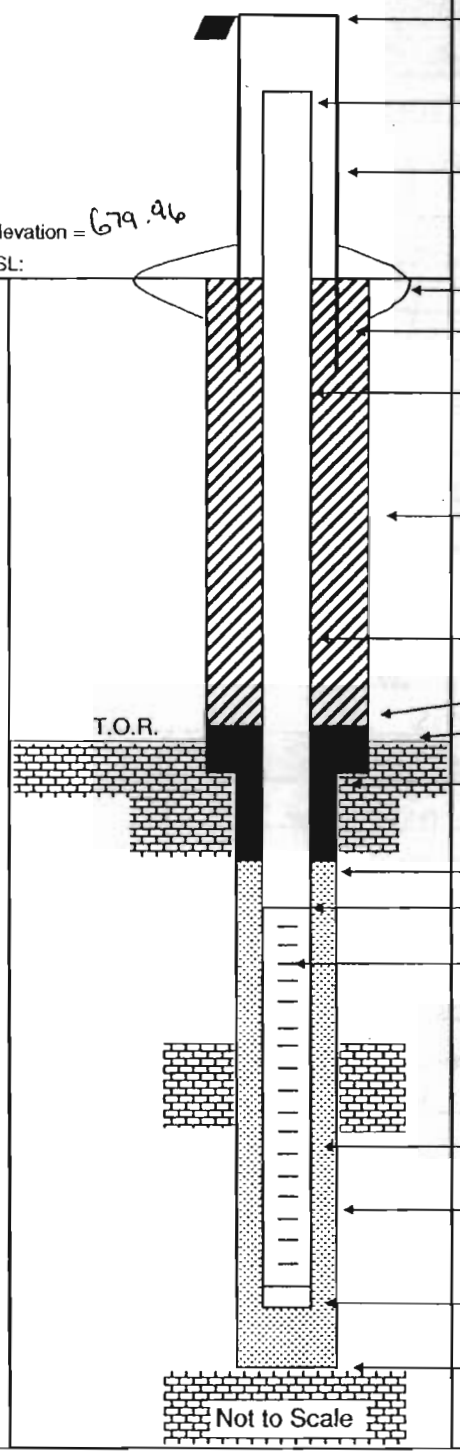
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW712

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW712
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S	DATE COMPLETED:	3/27/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1310080.207
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3023574.945



Elevation of Top of Casing: 682.66

Stick Up of Casing Above Ground Surface: 2.16

Elevation of Top of Riser: 682.12

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" (0-10') 5" (10'-20')

Type of Backfill: GROUT/CEMENT

Elevation / Depth Top of Seal: 675.96 / 4'

Elevation / Depth Top of Bedrock: 672.96 / 7'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 671.96 / 8'

Elevation / Depth of Top of Screen: 669.96 / 10'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 659.96 / 20'

Elevation / Total Depth of Borehole: 659.96 / 20'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: [redacted] HSA R26

BORING NUMBER: 13MW713
DATE: 4/23/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DENNIS SZAK

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1	3 / 3				BR	.5' TOP SOIL	ML			0.0		
S-1 1240	2	3 / 4	1.8' / 2'				.5'-3.5' STIFF CLAY	CL		0.0			
	3	3 / 5											
S-2 1242	4	7 / 7	2' / 2'			YEL	3.5'-6' SANDY SILT	ML		0.0		0.0	0.0
	5	1 / 3				OR + GRAY							
S-3 1248	6	3 / 5	1.6' / 2'							0.0			
	7	14 / 25			MOIST + V. DENSE	YEL OR	6'-8' F-SAND	SP		0.0			
S-4 1302	8	27 / 31	2' / 2'										
	9	22 / 20			WET + DENSE		F-SAND W/ SOME SILT + S.S. FRAGS. (8'-10.5')	SM	WATER @ 10'	0.0			
S-5 1304	10	7 / 5	2' / 2'										
	11	17 / 22				BLK	COAL 10.5-12.5'						
S-6 1321	12	36 / 21	2' / 2'		DRY					0.0			
	13	22 / 30			HARD	GRAY	12.5'-13' SHALE		REFUSAL @ 13'	0.0			
S-7 1335	14	50/.4	.5' / .8'				SHALE @ 13'		ROCK @ 13.5'				
	15						WELL AUGER TO 19'						
	16						SHALE MATERIAL IN						
	17						CUTTINGS						
	18												
1350	19												
				T.D. 19'			WELL SET @ 18' 2" PVC						
							SCREENED 8'-18'						
							SAND 6'						
							BENT 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MW713

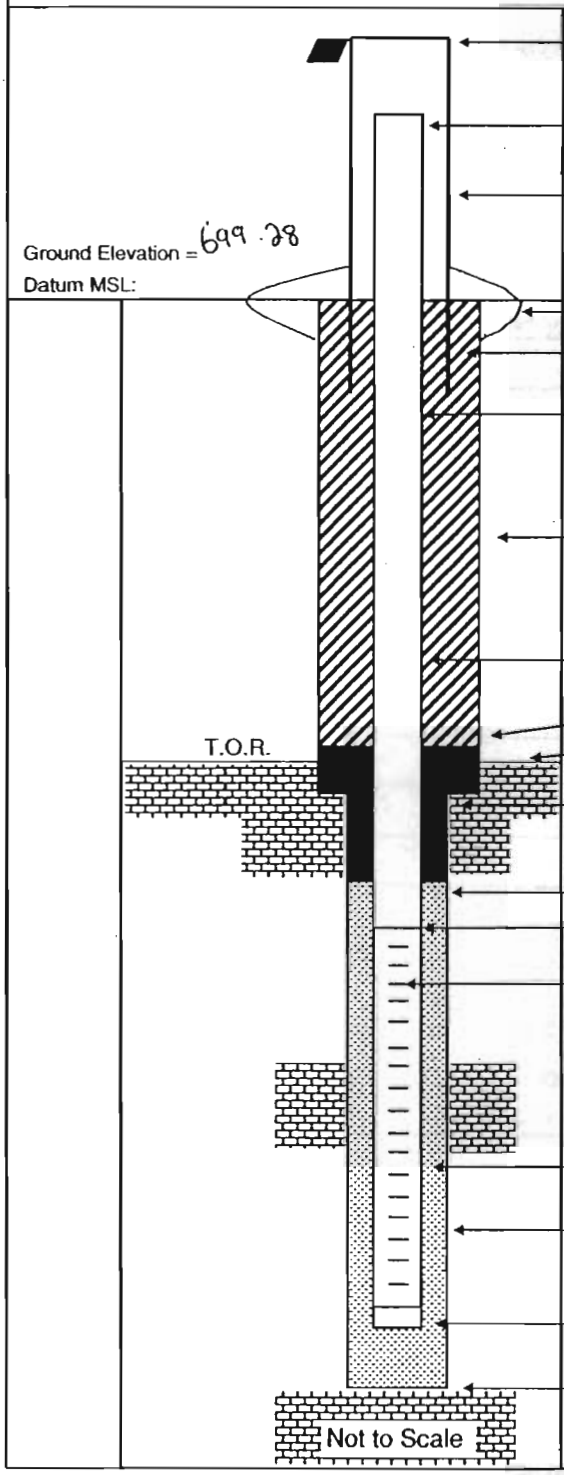
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW713

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW713
PROJECT No.:	9060 CTO 0279	DRILLER:	DENNIS SZWK	DATE COMPLETED:	4/23/03
SITE:	SWMU 13	DRILLING METHOD:	HSA ~~ROTOSONIC~~	NORTHING:	1304441.770
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATERRA	EASTING:	3024163.605



Elevation of Top of Casing:	702.40
Stick Up of Casing Above Ground Surface:	2.70
Elevation of Top of Riser:	701.98
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	6"
Type of Backfill:	CEMENT
Elevation / Depth Top of Seal:	697.28 / 2'
Elevation / Depth Top of Bedrock:	686.78 / 12.5'
Type of Seal:	BENTONITE
Elevation / Depth of Top of Filter Pack:	693.28 / 6'
Elevation / Depth of Top of Screen:	691.28 / 8'
Type of Screen:	PVC
Slot Size x Length:	.20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	6"
Elevation / Depth of Bottom of Screen:	681.28 / 18'
Elevation / Total Depth of Borehole:	680.28 / 19'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT14
DATE: 3/31/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	5' TOP SOIL	ML	4" SAMPLE TO 17.5'	0.0			
	2					↓	.5'-3' CLAY & SILT	↓		↓			
	3					↓							
	4					YELL BR.	3-5' SANDY SILT W/ SOME						
S-1 0814	5		4.5'/5'			LT. GRAY	CLAY	↓		↓			
	6				MOIST & MOTTLED	BR	5-6.5' SANDY SILT W/ S.S FRAGS	ML	WEATHERED S.S.	0.0			
	7				SOFT	LT GRY.	6.5'-7' SILT	ML		↓			
	8				WET &	BR	7-9.5' SILT & SAND W/ S.S	SM	THIN LAMINATION				
	9			▼?	MOTTLED	↓	FRAGS	↓	POSSIBLE @ 9'				
S-2 0821	10		4.5'/5'			LT GRAY	9.5-10' SILTSTONE	ML	ROCK @ 9.5'	↓			
	11				SOFT &	DK	10-15' SHALEY SILTSTONE			0.0			
	12				DRY	& LT							
	13				↓	GRAY							
	14												
S-3 0835	15		5'/5'		↓	↓	↓			↓			
	16				↓	LT & DK	15-17' SHALE						
	17				↓	GRAY	↓						
S-4 0844	17.5		2'/2.5'	▼	HARD	GRAY	17-17.5' SANDSTONE		REFUSAL @ 17.5'				
	18					↓	SAND & SILT						
	19						MATRIX						
R-1	20					↓	↓						
	21												
	22												
1015	23					↓	↓	↓					
				TD 23'									

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: 5' TO 23' SET WELL @ 23' SCREENED 13'-23'
SAND TO 11'
BENT TO 9' VOL CLAY TO 8'

Converted to Well: Yes X No ___ Well I.D. #: 13MWT14

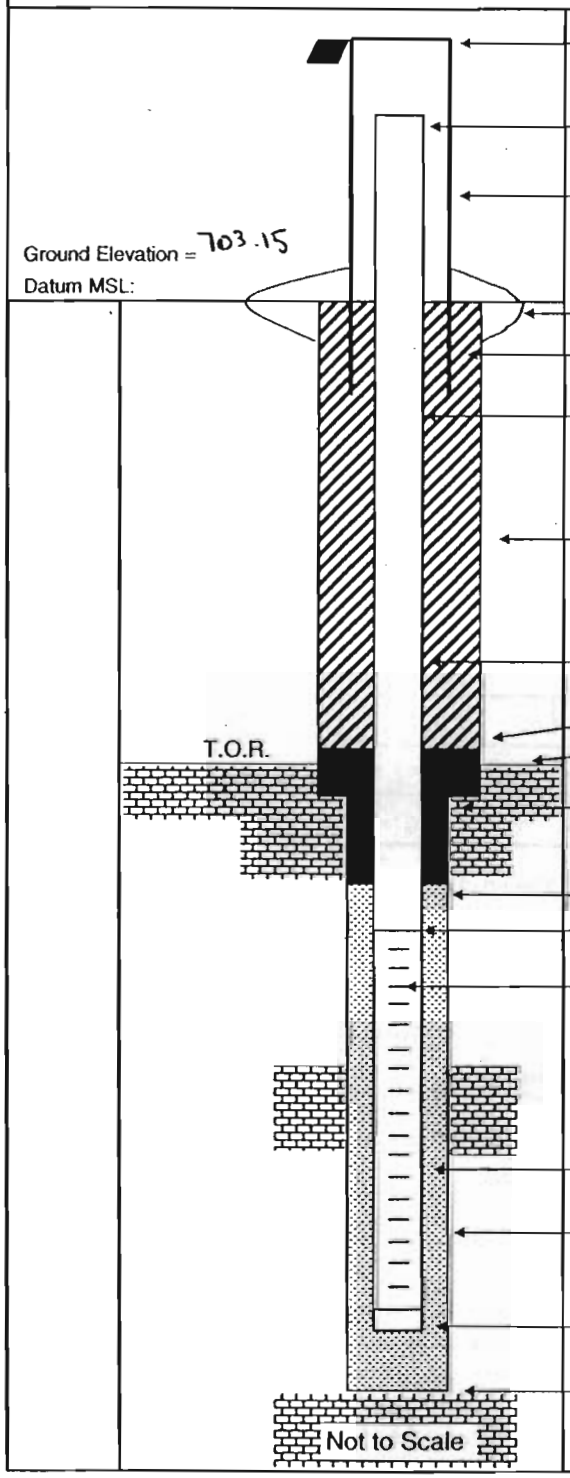
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MWT14

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT14
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/31/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309142.732
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3024110.167



Elevation of Top of Casing: 705.98

Stick Up of Casing Above Ground Surface: 2.35

Elevation of Top of Riser: 705.50

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: VOL CLAY (2'-4')

Elevation / Depth Top of Seal: 694.15 / 9'

Elevation / Depth Top of Bedrock: 693.65 / 9.5'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 692.15 / 11'

Elevation / Depth of Top of Screen: 690.15 / 13'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 680.15 / 23'

Elevation / Total Depth of Borehole: 680.15 / 23'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW T15
DATE: 3/25/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				DRY M.STIFF	BR	SILTY CLAY 0-2.5'	CL	6" GRAVEL 0-1.5'	0.0			
	2						T-SAND						
	3					YELL	CLAY W/ SILT 2.5-7.5'						
	4					OR				1.7			
S1 0237	5		4.5 / 5'							0.0			
	6					YELL OR		CL	MOTTLED	0.0			
	7					LT							
	8					GRAY							
	9						CLAY W/ INTERBEDDED						
S2 1236	10		5' / 5'				SILT SEAMS (HARD FINGS)						
	11							CL		0.0			
	12												
	13												
	14				SOFT +	GRAY	SILTSTONE 15'-18'	RK	RK				
S3 1245	15		5' / 5'		DRY				6" TO 15'				
	16						SILTY MATERIAL		5" TO 25'				
	17								WL @ 17' @ 1341				
	18								AFTER FLUSHING				
	19					BLACK	BLACK MATERIAL COMING		@ 25'				
R-1	20						OUT OF THE HOLE						
	21					GRAY	SILTY MATERIAL						
	22												
	23					LT							
	24					GRAY							
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 4" TO 15' FOLLOWED BY 6" WELL SET @ 25' 15-25' SAND TO 13 BENT TO 11 WELL CLAY TO 4'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ___ Well I.D. #: ___

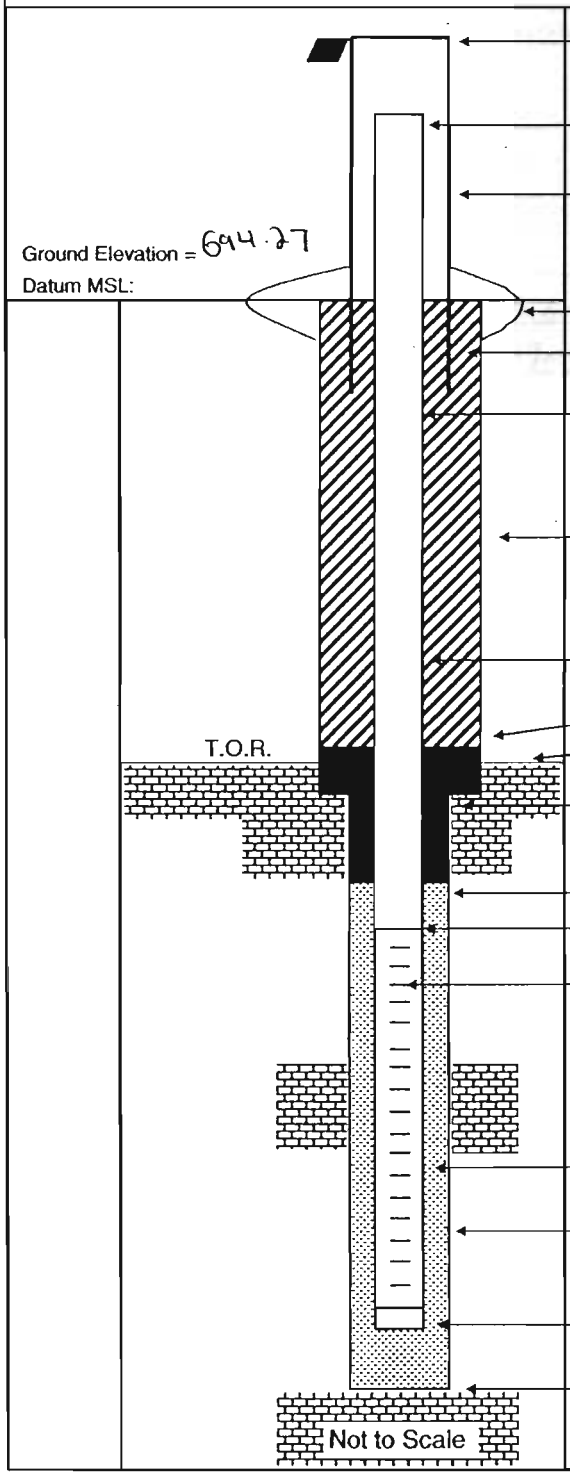
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW T15

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW T15
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/25/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1304565.518
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3023717.803



Elevation of Top of Casing: 697.16

Stick Up of Casing Above Ground Surface: 2.38'

Elevation of Top of Riser: 696.65

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" (0-15') 5" (15'-25')

Type of Backfill: VOL-CLAY (4'-11')

Elevation / Depth Top of Seal: 683.27 / 11'

Elevation / Depth Top of Bedrock: 681.27 / 13'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 681.27 / 13'

Elevation / Depth of Top of Screen: 679.27 / 15'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 669.27 / 25'

Elevation / Total Depth of Borehole: 669.27 / 25'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT16
DATE: 3/27/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0						DRILL 6" CASING TO 15'				0.0		0.0
							WASHED OUT HOLE						
							-REFER TO 13MWT17						
							FOR COMPLETE						
							LITHOLOGY						
							0-5' SANDY MATERIAL						
							5'-10' CLAYEY MATERIAL						
									HARD DRILLING				
							10-15' SILTY MATERIAL		@ 10'				0.0
	15												
				T.D. 15'			SET WELL @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 4'						
							BENT TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 13MWT16

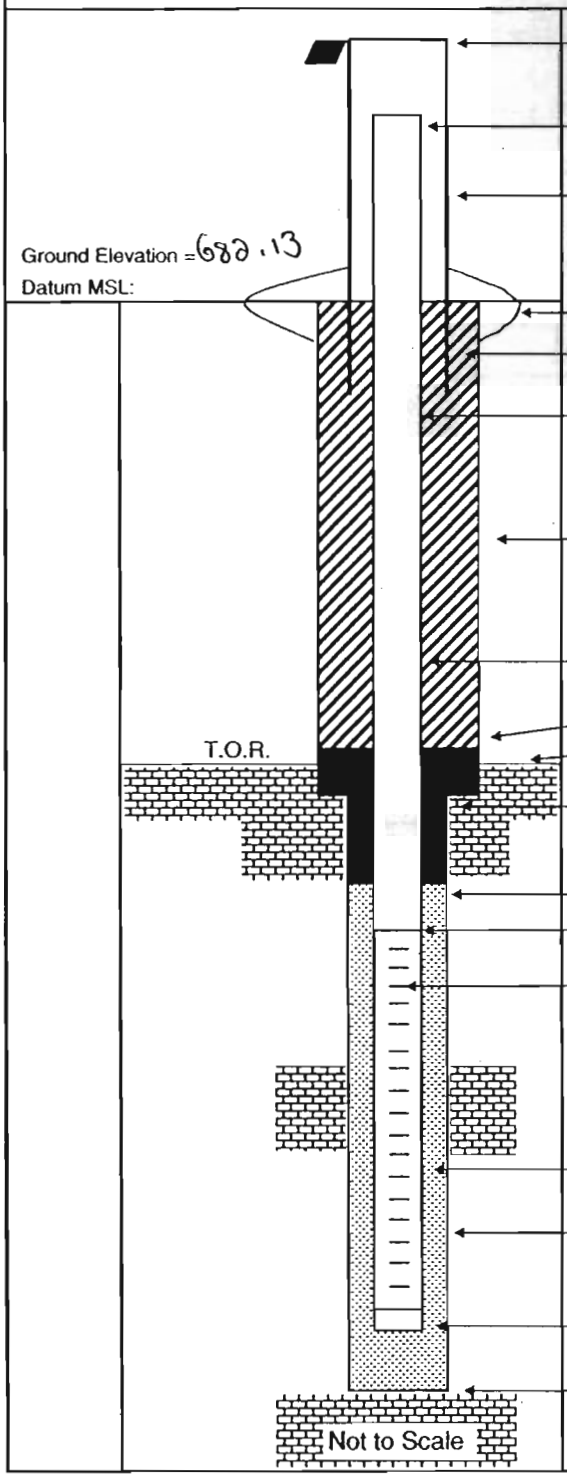
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MWT16

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT16
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/27/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1304854.276
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3023341.916



Elevation of Top of Casing: 684.83

Stick Up of Casing Above Ground Surface: 2.22

Elevation of Top of Riser: 684.35

I.D. of Surface Casing: 4' SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: GROUT

Elevation / Depth Top of Seal: 680.13 / 2'

Elevation / Depth Top of Bedrock: 672.13 / 10'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 678.13 / 4'

Elevation / Depth of Top of Screen: 677.13 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 667.13 / 15'

Elevation / Total Depth of Borehole: 667.13 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT17
DATE: 3/26/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				DRY & LOSE	BLK	CINDERS + GRAVEL .5'	GM	4" SAMPLE 0-.5'	0.0			
	2				↓	↓	↓	↓	.5'-2' FILL	↓			
	3					BR	SANDSTONE FRAGS						
	4					↓	↓						
S-1 1506	5		1.5'/5'		↓	↓	↓	↓		↓			
	6				DRY M. STIFF	YELL BR & LT	SILTY CLAY 5-8.5	CL	MED PLASTICITY	0.0			
	7				↓		↓	↓		↓			
	8				↓	GRAY	↓	↓					
	9				STIFF	↓	CLAYEY SILT 8.5-10'	ML					
S-2 1510	10		5'/5'	▼	↓	↓	↓ T-SAND	↓		↓			
	11			WET	↓	YELL BR	SILT + SANDSTONE	PX	WET 10-11.5'	0.0			
	12				↓	LT GRAY	FRAGS 10-13'	↓	WELL SET 6" TO 8'	↓			
	13				DRY & LOSE	BLK	COAL SEAM 13-13.5'		+ BEAM 8'-15'				
	14				↓	GRAY	13.5'-15' SILT STONE		POSS. WATER 10'				
S-3 1517	15		5'/5'		↓	↓	HIGH WEATHERED			↓			
	16					GRAY	15'-18' SILTY MATERIAL	↓					
	17					↓	COMING OUT OF THE						
	18					↓	CASING	↓					
				T.D. 18'									
							WATER TO 11 @ 1558						
							WELL SET @ 18' 2" PVC						
							SCREENED 8'-18'						
							SAND TO 6'						
							BENT TO 3'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 1

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ___ Well I.D. #: 13MWT17

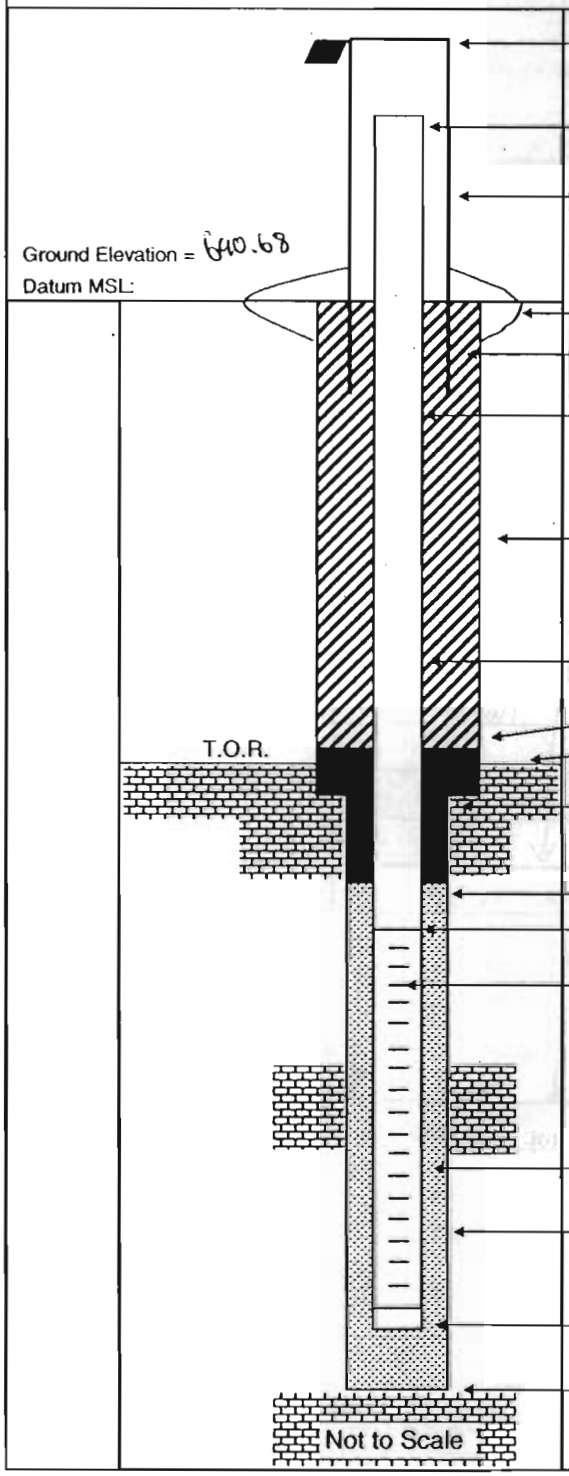
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW717

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW717
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/26/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309605.272
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3023123.466



Elevation of Top of Casing: 643.68

Stick Up of Casing Above Ground Surface: 2.37'

Elevation of Top of Riser: 643.01

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" 0-8'
5" 8'-18'

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 687.68 / 3'

Elevation / Depth Top of Bedrock: 680.68 / 10'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 684.68 / 6'

Elevation / Depth of Top of Screen: 682.68 / 8'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5" CORE 10'-15'
5" REAM 15'-18'

Elevation / Depth of Bottom of Screen: 672.68 / 18'

Elevation / Total Depth of Borehole: 672.68 / 18'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Rotosonic

BORING NUMBER: 13MW718
DATE: 3/25/03 - 3/26/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1				M.STIFF	YELL	0-8' SILTY CLAY	CL	MOTTLED	0.0			
	2				DRY	OR			6" CASING 0-20'				
	3					LT GRAY							
	4												
S-1 1634	5		4.5" / 5"										
	6									0.0		0.0	0.0
	7												
	8												
1/25	9				M.STIFF		8-10' INTERBEDDED	ML					
S-2 1638	10		5" / 5"				CLAY & SILT						
	11				M.STIFF	YELL	WEATHERED SILTSTONE	WR		0.0			
	12				MOIST	OR	(10'-15')						
	13					GRAY							
	14					PURPLE							
S-3 1654	15		4.5" / 5"										
	16				HARD	LT	SILTSTONE 15'-20'	BR	COMPETENT ROCK	0.0			
	17					GRAY			@ 15'				
	18												
	19								DRY 0-20'				
S-4 1716	20		5" / 5"										
	21				HARD	LT	SANDSTONE 20-21.5'	MS		0.0			
	22		22' / RQD			BR							
1/26 C.1	23		0804	▼	WET	LT GRAY	SHALE 21.5'-25'	BR	POSSIBLE WATER				
	24								ZONE.				
	25		5" / 5"										

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MW718

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: RUTH SONIC

BORING NUMBER: 13 MW718
DATE: 3/26/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26				SOFT	LT GRAY	25'-27' SILTSTONE	VAR		0.0			
	27				↓	↓	↓	↓		↓			
	28					LT BR	27'-29.5' SANDSTONE	BR		↓			
	29					↓		↓		↓			
↓	30		9.5' / 10'			BLK	29.5'-30' COAL	-					
				T.D. 30'									
							WELL SET @ 30' 2" PVC						
							SCREENED 20'-30'						
							SAND TO 18'						
							BENT TO 16'						
							VOL CLAY TO 3'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ✓ No _____ Well I.D. #: BMW718

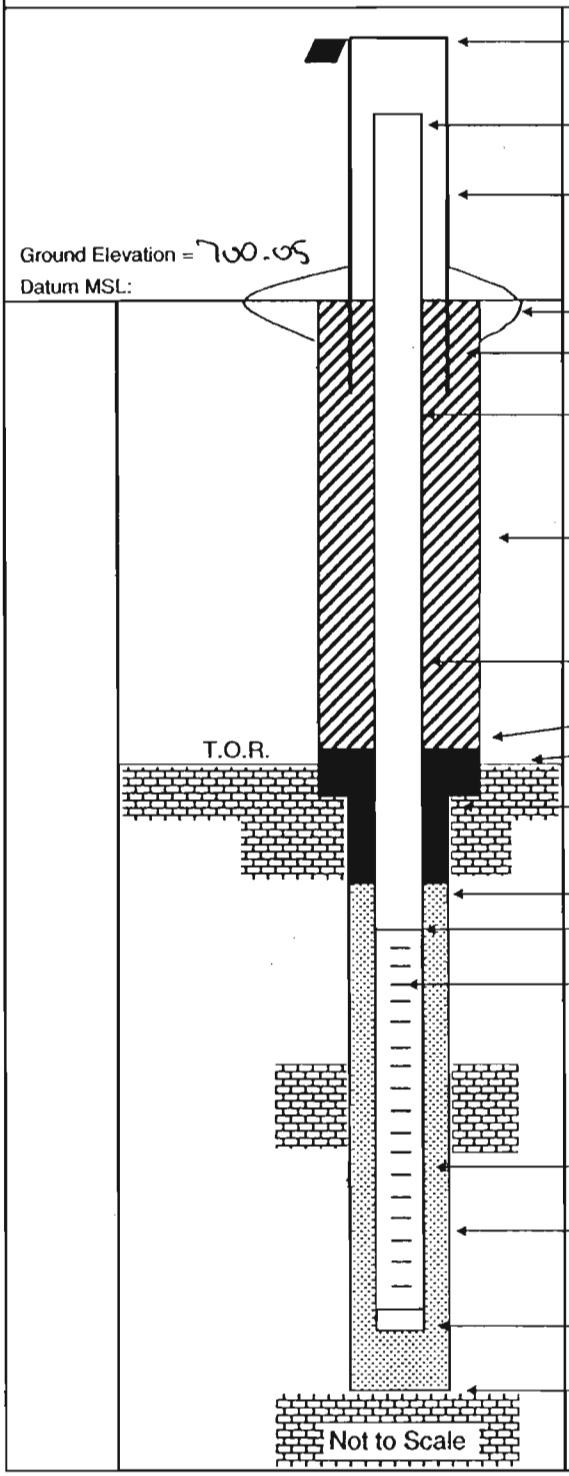
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW718

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW718
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S	DATE COMPLETED:	3/26/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309326.480
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	3023243.416



Elevation of Top of Casing: 703.43

Stick Up of Casing Above Ground Surface: 3.87'

Elevation of Top of Riser: 702.92

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" 0-15' / 5" 15'-30'

Type of Backfill: VOL CLAY (3'-16')

Elevation / Depth Top of Seal: 684.05 / 16'

Elevation / Depth Top of Bedrock: 685.05 / 15'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 682.05 / 18'

Elevation / Depth of Top of Screen: 680.05 / 20'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 670.05 / 30'

Elevation / Total Depth of Borehole: 670.05 / 30'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW719
DATE: 3/31/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST + SOFT	BR	.5' TOP SOIL	ML		0.0			
	2				MOIST M.STIFF	PALE LT	.5'-4' CLAYEY SILT + GRAVEL		(MOTTLED)				
	3					GRAY			FILL				
S-1 1344	4		3.9' / 4'				4-5.5' SANDY SILT W/ SOME CLAY		WEATHERED S.S.				
	5				DRY + M.STIFF		SANDY SILT + SS CHUNKS		6" TO 5'	0.0			
	6				HARD		5.5'-6' CLAYSTONE SEAM						
	7				DRY + M.DENSE	BR + TAN	SANDY SILT 6'-7'						
	8			?	MOIST +		SANDSTONE 7'-9'		WEATHERED @ 7.4'				
S-2 1252	9		5' / 5'		M.DENSE	YELL BR		BL	HARD 8-9'				
	10				MOIST +		SANDY SILT 9-11'	ML	5" CORE 9-19'				
	11		61% RQD		M.STIFF								
C-1	12		@1346		WET + SOFT		.5' SILT 11-11.5'	ML					
	13			?	WET + M.DENSE		11.5'-13' SILTY SAND + SS FRAGS	SM	POSS. WATER @ 13'				
	14		4.9' / 5'		STIFF + DRY		SILTSTONE	BL	THIN LAM.				
	15					GRAY	SILTY SHALE	DR					
	16												
C-2	17		50% RQD										
	18		@1420										
	19		4.7' / 5'										
				T.D. 19'			WELL SET @ 19' 2" PVC						
							SCREENED 9'-19'						
							SAND TO 7'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes X No ____ Well I.D. #: 13MW719

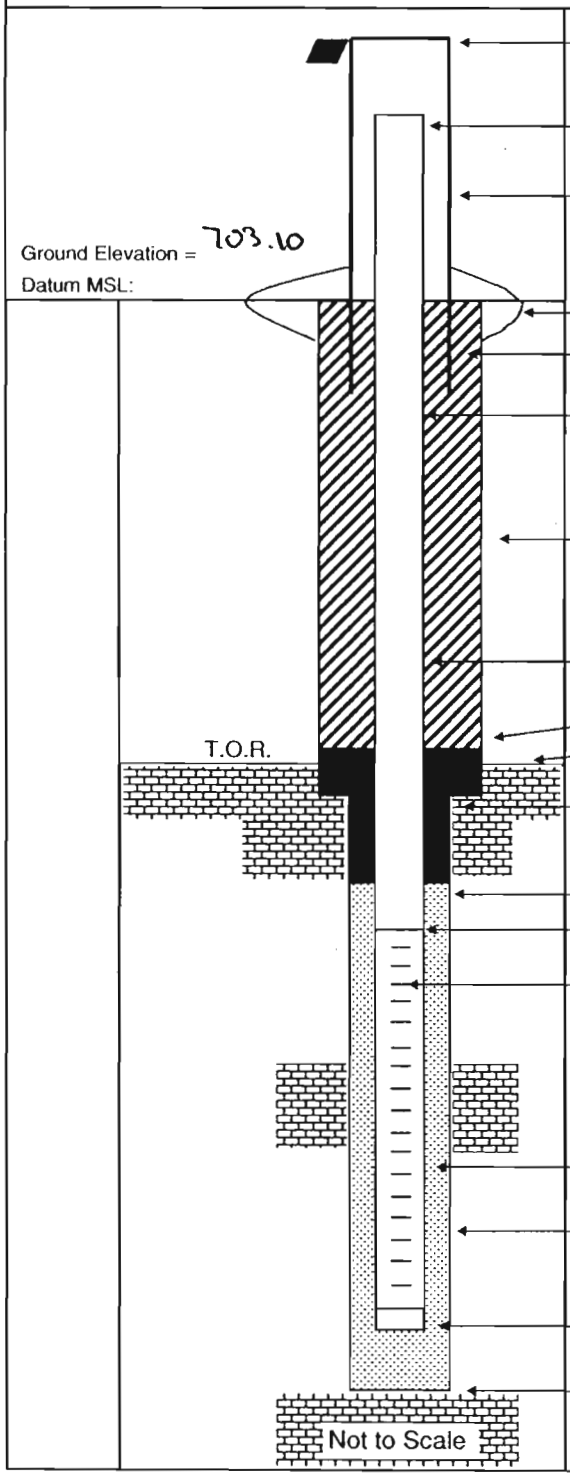
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW714

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW714
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/31/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308893.471
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3023834.565



Elevation of Top of Casing: 706.32

Stick Up of Casing Above Ground Surface: 2.72'

Elevation of Top of Riser: 705.82

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" to 5'
5" 5'-19'

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 701.1 / 2'

Elevation / Depth Top of Bedrock: 690.1 / 13'

Type of Seal: BENT-CHIPS

Elevation / Depth of Top of Filter Pack: 696.1 / 7'

Elevation / Depth of Top of Screen: 694.1 / 9'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
(Core) / Ream: 5"

Elevation / Depth of Bottom of Screen: 684.1 / 19'

Elevation / Total Depth of Borehole: 684.1 / 19'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW720
DATE: 7/1/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVES

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MUSSY SOFT	DB	.5' TOP SOIL	ML		0.0			
	2				MUSSY	YELL OR	5'-6' CLAYEY SILT + SAND	ML / SC					
	3				MSTIFF	LT	(FILL)						
	4					GRAY			MOTTLED (3'-5')				
5.1 0917	5		4.7' / 5'										
	6					YELL OR	CLAYEY SILT	ML		0.0			
	7			11'-11'	HARD	LT	6'-13.5' SILTSTONE	BR	THIN LAMINATION				
	8					DK GRAY							
	9												
5.2 0835	10		4.4' / 5'				SHALEY 9'-10'						
	11						SILTSTONE 10'-13.5'			0.0			
	12												
	13				WET + SOFT								
	14												
5.3 0847	15		4.8' / 5'		HARD +	WHITE	SANDSTONE 13.5'-15.5'	BR	WATER @ BTTM of				
	16				DRY				HOLE 13.5' @ 0909	0.0			
	17				SOFT +	LT DK	15.5'-20' SILTY SHALE	HARD					
	18				DRY	GRAY							
	19												
5.4 0924	20		5' / 5'										
				T.D. 20'			WELL SET @ 20' 2" PVC						
							SCREENED 10'-20'						
							SAND TO 8'						
							BENT TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MW720

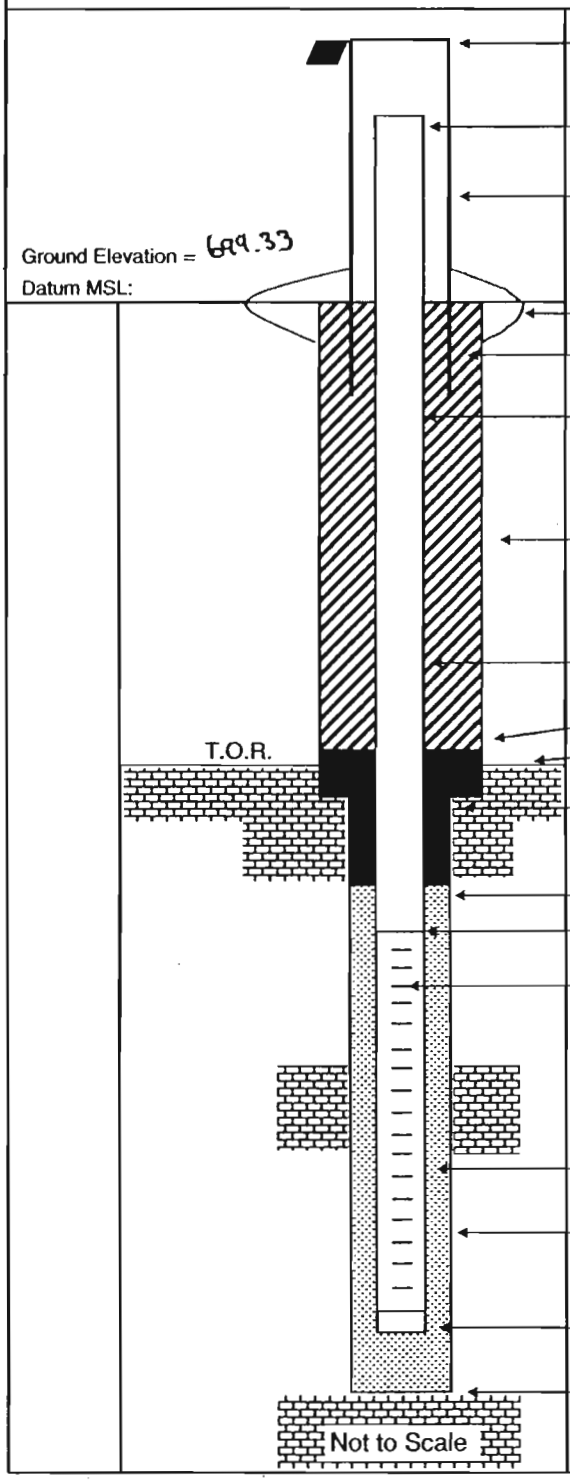
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW720

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW720
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	4/1/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1304066.757
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERRA	EASTING:	3023527.233



Elevation of Top of Casing: 702.65

Stick Up of Casing Above Ground Surface: 2.74

Elevation of Top of Riser: 702.07

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: N/A

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 692.33 / 2'

Elevation / Depth Top of Bedrock: 683.33 / 6'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 681.33 / 8'

Elevation / Depth of Top of Screen: 689.33 / 10'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 679.33 / 20'

Elevation / Total Depth of Borehole: 679.33 / 20'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT21
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVES

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	SEE 13MWT17 FOR		5" 0-15'				
							COMPLETE LITHOLOGY						
							SILTY MATERIAL						
1051	5												
						GRAY							
1100	10								HARD DRILLING				
							SILTY MATERIAL		@ 10'				
1105	15												
				T.D 15'			WELL SET @ 15' 2" PVC						
							SCREENED 5'-15'						
							SAND TO 4'						
							BENT 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MWT21

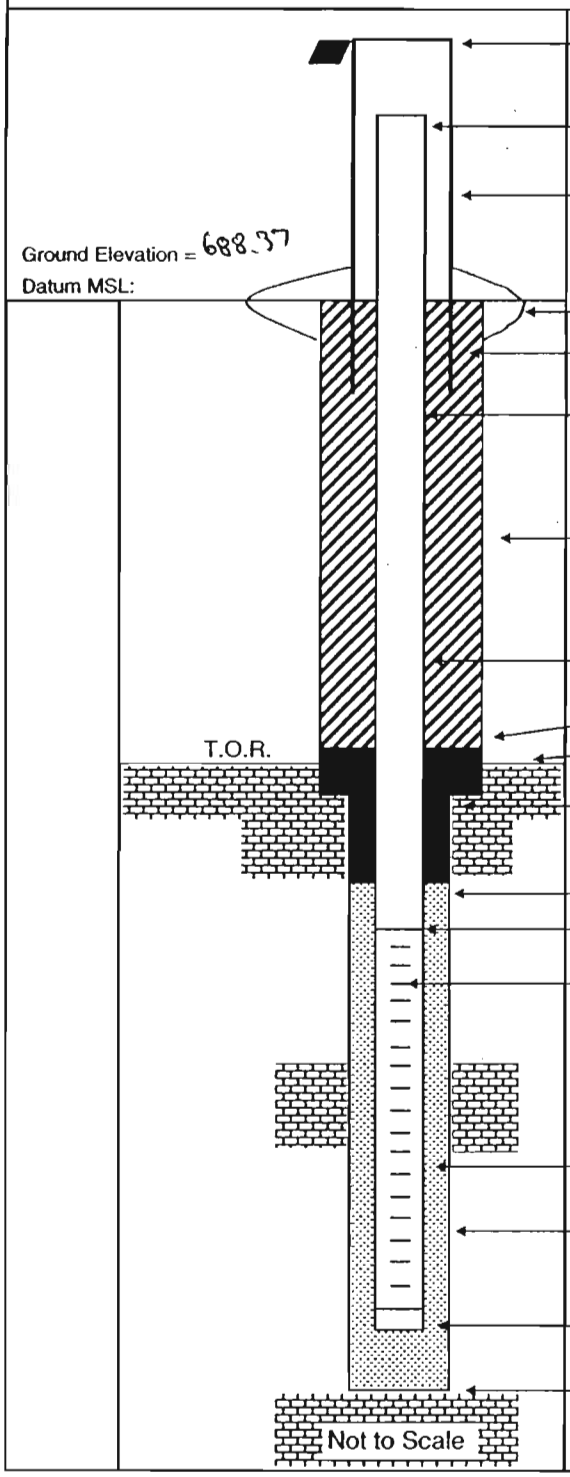
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MWT21

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT21
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES.	DATE COMPLETED:	3/28/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1309341.009
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERRA	EASTING:	3022916.218



Elevation of Top of Casing: 691.26

Stick Up of Casing Above Ground Surface: 2.37

Elevation of Top of Riser: 690.74

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 686.37 / 2'

Elevation / Depth Top of Bedrock: 678.37 / 10'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 684.37 / 4'

Elevation / Depth of Top of Screen: 683.37 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 673.37 / 15'

Elevation / Total Depth of Borehole: 673.37 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT22
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	.5' TOP SOIL	ML		0.0	0.0		
	2					YELL BR	CLAYEY SILT .5-3'						
	3					↓	↓						
	4					YELL BR	SANDY SILT 3'-5'		MOTTLED				
S-1 0813	5		5'/5'			+ GRAY	↓ SOME WEATHERED QZ	↓		↓			0.0
	6					↓	5-6' ↓	ML		0.0			
	7				SOFT +	YELL BR	6'-11' SILT STONE	BR	COAL TO THE				
	8				DRY	+ GRAY	↓		TOUCH. PASS				
	9				HARD +	LT GRAY			WATER @ 7'	↓			
S-2 0819	10		4.5'/5'		DRY	↓	↓			0.0			
	11					↓	SILT STONE			0.0			
	12					LT GRAY	11-15' S.S						
	13					↓							
	14					BR			WATER UP TO 14'				
S-3 0829	15		4.9'/5'		↓	BLK	↓	↓	@ 0848	↓	↓		0.0
-				T.D. 15'			SET WELL @ 15' 2" PVC		6" TO 5' REAM				
							SCREENED 5'-15'		5'-15' (5")				
							SAND TO 4'						
							BEAD CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 13MWT22

Tetra Tech NUS, Inc.

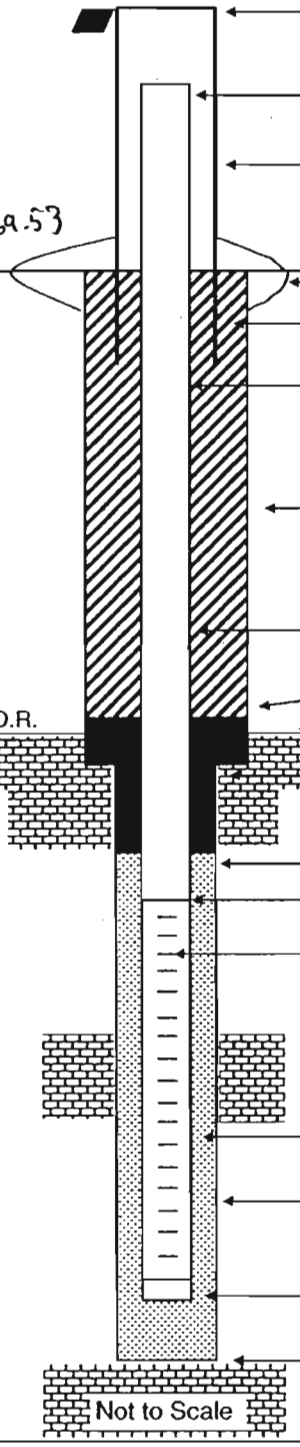
BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW-722

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW-722
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/28/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308436.338
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3022785.672

Ground Elevation = 669.53
Datum MSL:



Elevation of Top of Casing:	672.38
Stick Up of Casing Above Ground Surface:	2.43
Elevation of Top of Riser:	671.96
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	6" 0-5' 5" 5'-15'
Type of Backfill:	CEMENT
Elevation / Depth Top of Seal:	667.53 / 2'
Elevation / Depth Top of Bedrock:	663.53 / 6'
Type of Seal:	BENT CHIPS
Elevation / Depth of Top of Filter Pack:	665.53 / 4'
Elevation / Depth of Top of Screen:	664.53 / 5'
Type of Screen:	PVC
Slot Size x Length:	.20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	654.53 / 15'
Elevation / Total Depth of Borehole:	654.53 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW723
DATE: 4/1/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				DAMP	BR	TOP .5' TOP SOIL	ML		0.0			
	2				MOIST	BR	.5'-5.5' CLAYEY SILT						
	3				M-STIFF	↓							
	4					LT GRAY			MOTTLED (3'-5')				
S-1 1225	5		4.5'/5'			↓							
	6					BR	CLAYEY SILT	ML		0.0			
	7				MOIST M-STIFF	YELL	5.5'-10.8' SANDY SILT						
	8					OR							
	9					LT GRAY							
S-2 1233	10		5'/5'			↓			WET SAND SEAM @ 10'				
	11				DAMP M-STIFF	↓	SANDY SILT	ML	ROCK @ 10.8'	0.0			
	12					DK GRAY	SILTSTONE 10.8'-13.2'	RX	THIN LAM				
	13												
	14					LT GRAY	13.2'-25' SILTSTONE W/SS						
S-3 1242	15		4.9'/5'			LT GRAY	SEAMS 3 1" THICK						
	16			▼?		↓	SILTSTONE W/SS						
	17			STAIN		BR	SANDSTONE		POSS WATER @ 16				
	18					LT. GRAY							
	19												
S-4 1252	20		4.8'/5'										
	21				WET -								
S-5 1312	22		1.5'/2'			↓							
				TD. 22'			WELL SET @ 21.5' 2" PVC		.5' OF SAND FELL				
							SCREENED 11.5'-21.5'		BACK 20.				
							SAND TO 9.5' BENT TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: 5" TO 22'

Converted to Well: Yes X No _____ Well I.D. #: 13MW723

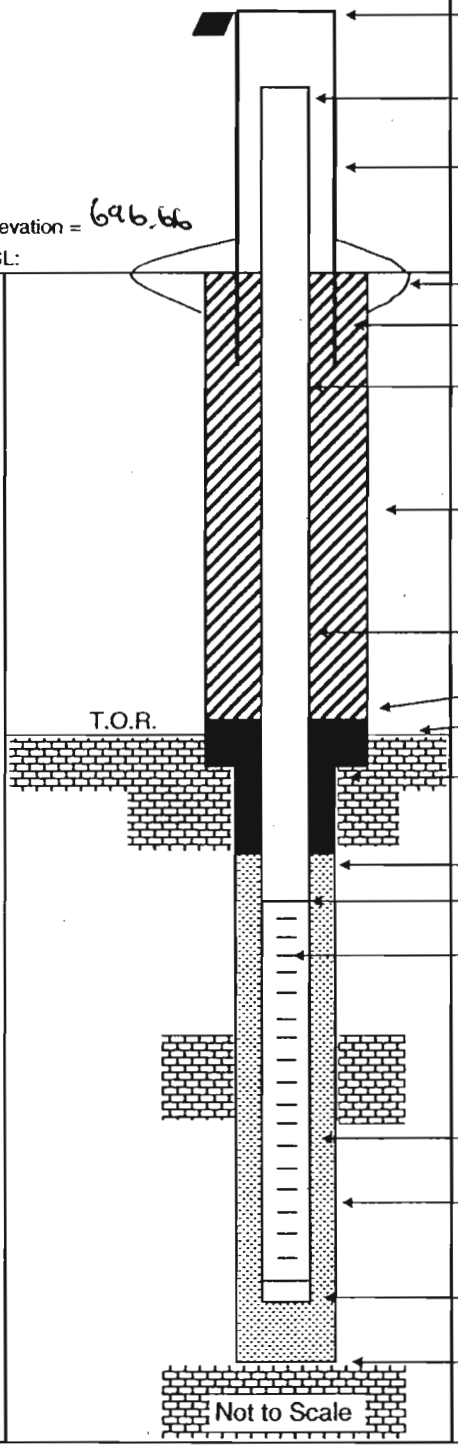
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: BMW723

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	BMW723
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES.	DATE COMPLETED:	4/1/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308708.016
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3023245.117



Elevation of Top of Casing: 699.69

Stick Up of Casing Above Ground Surface: 2.48

Elevation of Top of Riser: 699.14

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: VOL CLAY (2-7.5')

Elevation / Depth Top of Seal: 689.16 / 7.5'

Elevation / Depth Top of Bedrock: 685.86 / 10.5'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 687.16 / 9.5'

Elevation / Depth of Top of Screen: 685.16 / 11.5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 675.16 / 21.5'

Elevation / Total Depth of Borehole: 674.66 / 22.0'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MW724
DATE: 4/1/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1					YELL	SEE BORING LOG 13MW724	ML	LOGGED SOIL				
						OR	+ 13MW723 FOR COMPLETE		CUTTINGS				
							LITHOLOGIC DETAILS						
							5" REAM 0-22'						
	5						- SILTY CUTTINGS						
						YELL							
						OR							
	10												
						GRAY	SILTY MATERIAL	ML	ROCK @ 10'±				
							SILTSTONE?		HARDER TO				
									REAM: SLOWER				
									PROGRESS				
	15												
	20												
						GRAY			FLUSHED OUT				
	22								HOLE. WATER				
				TD 22'			WELL SET @ 22' 2" PVC		@ 19.0'				
							SCREENED 12'-22'						
							SAND TO 10'						
							BENT TO 8' VOL CLAY TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): –

Remarks: 5" REAM 0-22'

Converted to Well: Yes X No ___ Well I.D. #: 13MW724

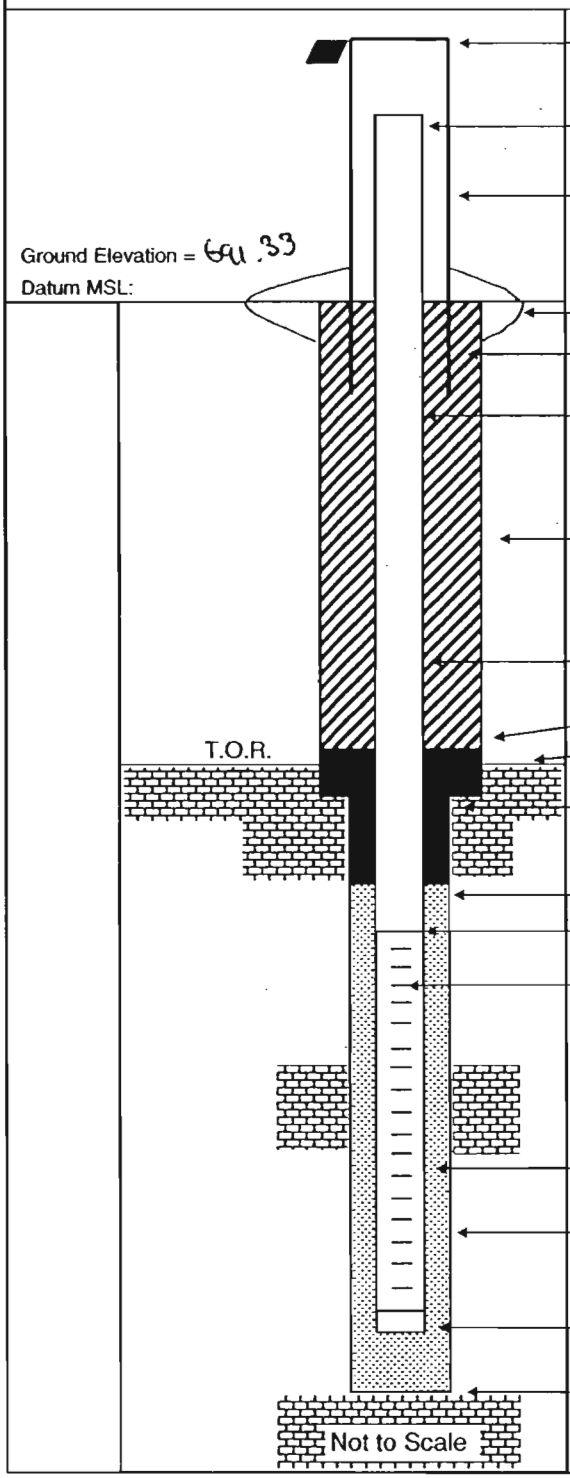
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MW724

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW724
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES.	DATE COMPLETED:	4/1/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308397.230
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	302296.484



Elevation of Top of Casing: 694.39

Stick Up of Casing Above Ground Surface: 2.6

Elevation of Top of Riser: 693.93

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: VOL CLAY (2'-8')

Elevation / Depth Top of Seal: 683.33 / 8'

Elevation / Depth Top of Bedrock: 680.33 / 11'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 681.33 / 10'

Elevation / Depth of Top of Screen: 679.33 / 12'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 669.33 / 22'

Elevation / Total Depth of Borehole: 669.33 / 22'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC
BORING NUMBER: BMWT25
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	TOP .5' TOPSOIL	ML		0.0			
	2					LT	.5'-4' SILTY CLAY W/	CL					
	3					BR	F-C SAND						
	4												
S1 1302	5		4.5' / 5'			YELLOW BROWN	SANDY SILT W/ T-CLAY	ML	MOTTLED				
	6				MOIST +		CLAYEY SILT			0.0			
	7				STIFF		4-8'						
	8				SOFT + WET				WET @ 8'				
	9				STIFF + DRY	YELLOW BROWN	SAND + SILT 8-9'	ML	WEATHERED RK				
S2 1316	10		4.9' / 5'		DRY + SOFT	LT GRAY	SILTSTONE 9-15'	RK	BLACK CLAY LAYER @ 9' x 2" WIDE				
	11									0.0			
	12												
	13												
S3 1323	14		4 / 4'						REFUSAL @ 14'				
	15						5" REAM TO 15'		RUN 5" TO 15'				
				T.D. 15									
							SET WELL @ 15' 2" PVC						
							SCREENED FROM 5'-15'						
							SAND TO 4'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: SAMPLED 0-14' 1' OF REAM.

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: BMWT25

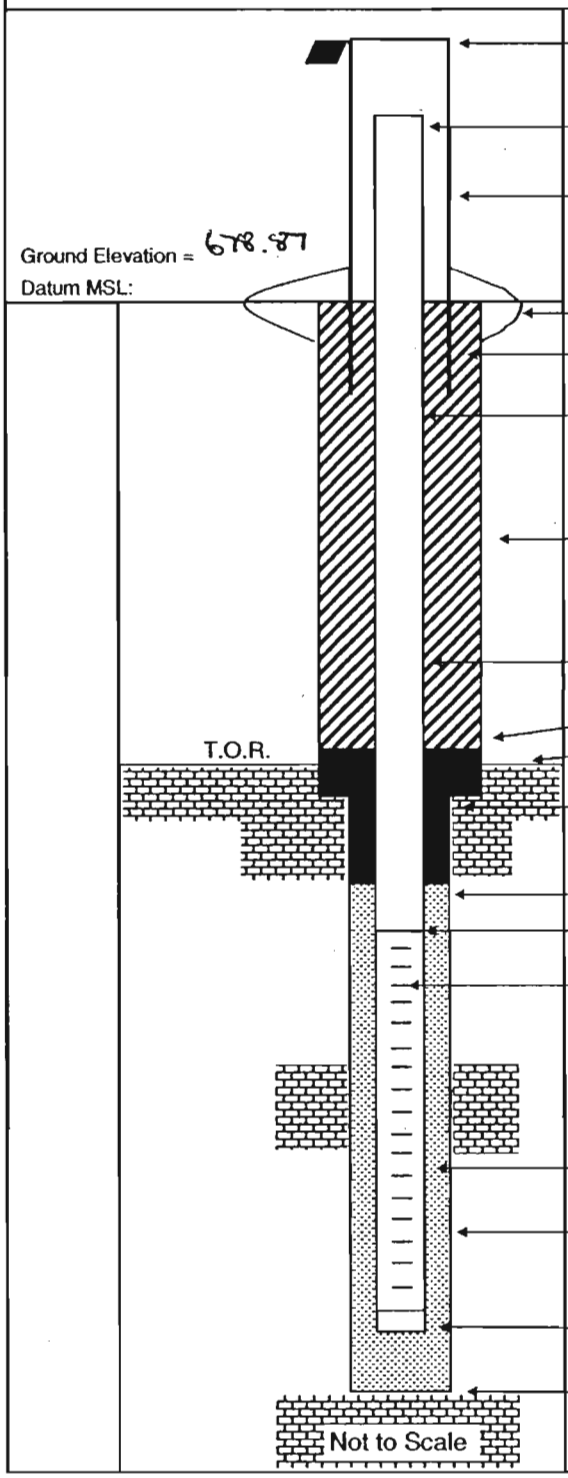
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 13MWT25

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MWT25
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	7/28/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308635.618
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	302267.444



Elevation of Top of Casing: 682.00

Stick Up of Casing Above Ground Surface: 2.70

Elevation of Top of Riser: 681.57

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 676.87 / 2'

Elevation / Depth Top of Bedrock: 669.87 / 9'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 674.87 / 4'

Elevation / Depth of Top of Screen: 673.87 / 5'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 663.87 / 15'

Elevation / Total Depth of Borehole: 663.87 / 15'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 13MWT26
DATE: 3/28/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST	BR	TOP .5 TOP SOIL	ML		0.0	0.0		
	2				M STIFF		.5'-6.5' SANDY SILT						
	3												
	4												
S-1 1452	5		4.7 / 5'									0.0	0.0
	6					BR	SANDY SILT			0.0			
	7					YELL BR	6.5'-8.5' SANDY SILT W/ SOME						
	8					GRAY	CLAY & S.S. FRAGS		SOME MOISTURE				
	9								@ 8' NOT				
S-2 1456	10		5' / 5'				MORE S.S. @ 10'		MUCH				
	11			?			CASING PLUGGED UP						
	12						SANDY SILT W/ SOME						
	13						CLAY & SS FRAGS						
	14			?		LT GRAY	12.5-17' SANDSTONE		SS @ 12.5'				
S-3 1524	15		2' / 5'						DRILLER OBSERV.				
	16				HARD	BR		MS	SET 6" TO 10'				
	17		@1543										
C-1	18		40%		SOFT +	LT. DK	ALTERNATING BEDS OF	VFR	CLAYEY 17-19'				
	19		RQD		HARD.	GRAY	SANDSTONE & SILTSTONE						
	20		5' / 5'		SOFT	LT GRAY	1' SANDSTONE BRITTLE						
				T.D. 20'			WELL SET @ 20' 2" PVC						
							SCREENED 10'-20'						
							SAND TO 8'						
							BENT CHIPS TO 3'						
							NO VOC CLAY.						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DRY @ 15' AFTER REAMING. WL @ 19' AFTER BLOW OUT

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 13MWT26

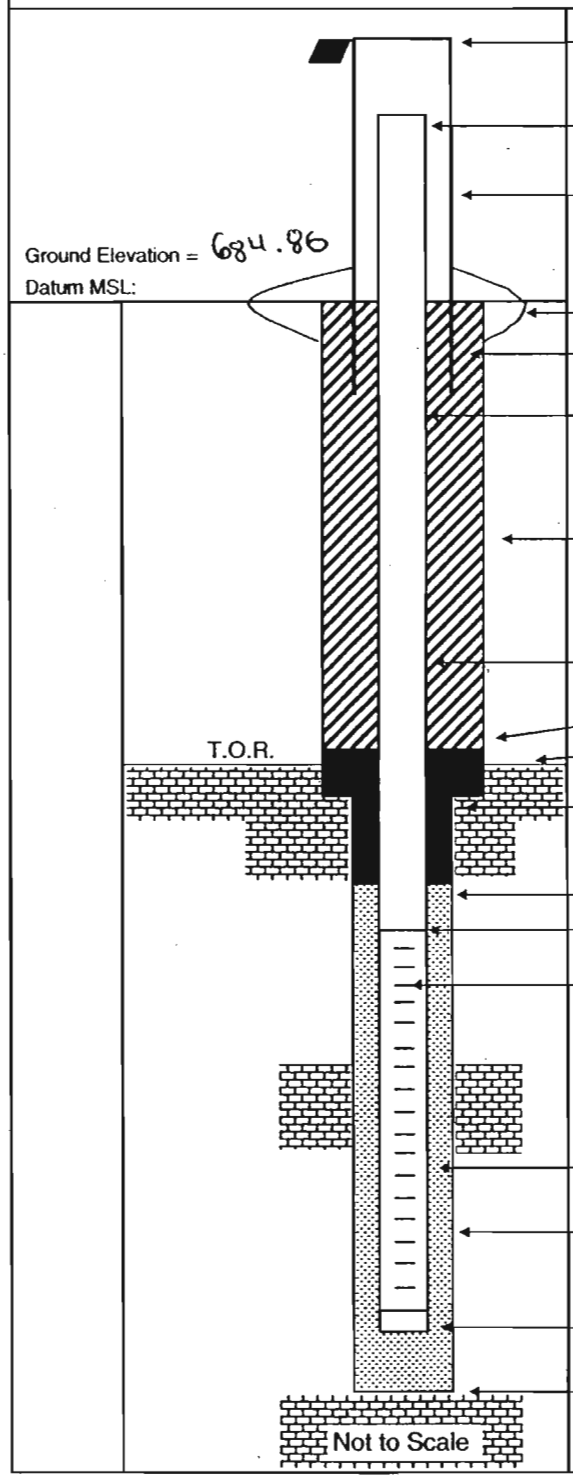
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 13MW726

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	13MW726
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	3/28/03
SITE:	SWMU 13	DRILLING METHOD:	ROTOSONIC	NORTHING:	1308232.686
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE	EASTING:	302260.142



Elevation of Top of Casing: 687.42

Stick Up of Casing Above Ground Surface: 2.63'

Elevation of Top of Riser: 687.49

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6" 0-10' 5" 10-20'

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 681.86 / 3'

Elevation / Depth Top of Bedrock: 672.36 / 12.5

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 676.86 / 8'

Elevation / Depth of Top of Screen: 674.86 / 10'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 664.86 / 20'

Elevation / Total Depth of Borehole: 664.86 / 20'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 13SB01
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sample Bz	Borehole**	Driller Bz**
0	1		2.3/		—	GR-BRN	SANDY SILT	SM	MOIST	3.6	3.6	3.6	3.6
	2		4.0						FE STAINED	↓	↓	↓	↓
	3								FILL				
4	4								MORE FE				
	5						TD 4.0'		BTM. BTM DAMP				
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS010002						
						@	1240						
						SAMPLED	13SB010204						
						@	1245						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 3.6

Converted to Well: Yes _____ No ✓ Well I.D. #: —

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13SB02
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sample BZ	Borehole**	Driller BZ**
0	1		2.5/		—	GR BRN	SANDY SILT	SM	MOIST	2.1	2.1	2.1	2.1
	2		4.0						FE STAINED	↓	↓	↓	↓
	3								FILL				
4	4								DAMP @ BTM				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS020002						
						@	1255						
						SAMPLED	13SB020204						
						@	1300						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 2.1

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13SB03
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Drillers BZ**
	1		2.8/			GR BRN	SANDY SILT	SM	MOIST @ TOP	1.8	1.8	1.8	1.8
	2		4.0						FILL	↓	↓	↓	↓
	3								DAMP @ BTM				
	4								Fe STAINED @				
	5						TD 4.0		HARD @ BTM BTM				
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS030002						
						@	1310						
						SAMPLED	13SB030204						
						@	1315						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 1.8

Converted to Well: Yes ____ No ✓ Well I.D. #: —

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 13SB04
DATE: 3-25-03
GEOLOGIST: M.G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		1.8/			GR BRN	SANDY SILT	SM	MOIST @ TOP	2.2	2.2	2.2	2.2
	2		4.0							↓	↓	↓	↓
	3								FILL				
	4								FE STAINED @ BTM				
	5						TD 4.0		DAMP @ BTM				
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 13SB040002 @ 1415							
						SAMPLED 13SB040204 @ 1420							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 2.2

Converted to Well: Yes ____ No ✓ Well I.D. #: —

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13 SB05
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		1.2/			GR BRN	SANDY SILT	SM	SAT @ TOP	1.8	1.8	1.8	1.8
	2		4.0							↓	↓	↓	↓
	3								FILL				
	4								DAMP @ BTM FE STAINED				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS050002						
						@	1350						
						SAMPLED	13SB050209						
						@	1355						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 1.8

Converted to Well: Yes ____ No ✓ Well I.D. #: —

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13SB06
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKER

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
0	1		2.5/			GR. BRN	SILTY SAND	SM	MOIST @ TOP	1.9	1.9	1.9	1.9
	2		4.0						FILL				
	3												
4	4								DAMP @ BTM FE STAINED				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 13SS060002 @ 1330							
						SAMPLED 13SB060204 @ 1335							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DPT W/ MACRO CORE

Drilling Area Background (ppm): 1.9

Converted to Well: Yes ____ No ✓ Well I.D. #: —

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13 SB07
DATE: 3-26-03
GEOLOGIST: M G COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
0	1		3.8/			DK BRN	TOPSOIL - .5' SILT, LITTLE	SM	DAMP	1.7	1.7	1.7	1.7
	2		4.0				SAND		FILL - 5.5'?	↓	↓	↓	↓
	3												
4	4												
	5		3.3/						SATURATED				
	6		4.0						S.S. FRAG				
	7			5.5		RD BRN	SILT, [illegible]		GREY MOTTLING	1.7	1.7	1.7	1.7
8	8								DAMP				
	9												
	10								WEATHERED RK				
11	11						REFUSAL @ 11'		SHALY @ BTM				
	12												
	13												
	14												
	15												
						SAMPLED	13SS070002						
						@	1320						
						SAMPLED	13SB070810						
						@	1330						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 1.7

Remarks: GEOPROBE MACRO CORE
HOLE BACK FILLED W/ HOLEPLUG

Converted to Well: Yes _____ No ✓ Well I.D. #: _____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: BMW108 / SB08
DATE: 3/30/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST & SOFT	BR	TOP .5' TOP SOIL	ML		0.0			
	2				DRY &	YELL OR	CLAYEY SILT		0-2 @ 0745				
	3				M. STIFF	GRAY	(MOTTLED)		DUP F0030304				
	4												
S-1 0943	5		4.5' / 5'										
	6					BR	5-6.5' CLAYEY SILT W/ S.S. FRAGS	ML		0.0			
	7					YELL OR	6.5-8' CLAYEY SILT		6-8' @ 0800				
	8			?			(MOTTLED)		MS/MSD				
	9				SOFT &	LT GRAY	SILTSTONE	MX	POSS. WATER @ 8'				
S-2 1154	10		4.9' / 5'		DRY			BR					
	11				HARD	YELL OR	SANDSTONE 10-10.5'			0.0			
	12				HARD &	LT GRAY	10.5'-13.5' SILTSTONE						
	13				DRY	YELL OR	(MOTTLED)		MOISTURE ALONG				
	14				HARD &	G/DK	THIN LAMINATED SILTSTONE		SOIL WALLS				
S-3 0810	15		5' / 5'		DRY	GRAY	13.5'-15'		6" TO 5' 5" REAM				
				TD 15'			WELL SET @ 15'		5'-15'				
							SCREENED 5'-15'		BOTTOM LOSING				
							SAND TO 4'		WATER.				
							BEAD TO 2'		WL @ 4' BGS				
									AFTER BLOWOUT				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: BMW108

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13SB09/15
DATE: 3-26-03
GEOLOGIST: M.G COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
0	1		1.7/			BL	COMPOST		MANURE ODOR, MOIST	2.1	2.1	2.1	2.1
	2		4.0			BRN	SILTY SAND		FILL				
	3												
4	4								DAMP @ BTM				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS090002						
						@	945						
						SAMPLED	13SB090204						
						@	950						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEO PROBE MACRO CORE
BACKFILLED W HOLE PLUG

Drilling Area Background (ppm): 2.1

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 13SB10
DATE: 3-26-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BL BRN	TOPSOIL .5' SANDY SILT	SM	MO MOIST	1.9	1.9	1.9	1.9
	2								FILL				
	3												
	4								DAMP @ BTM				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS100002						
						@	930						
						SAMPLED	13SB100204						
						@	935						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACRO CORE

Drilling Area Background (ppm): 1.9

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEO PROBE 54LT

BORING NUMBER: 13 SB 11
DATE: 3-26-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
0	1		2.6/		RO	BL-BRN	TOPSOIL SILTY SAND	SM	MOIST@TOP	1.9	1.9	1.9	1.9
	2		4.0						FILL				
	3								DAMP@BTM				
4	4								HARD@BTM				
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13 SS 11 0002						
						@	915						
						SAMPLED	13 SB 110204						
						@	920						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACRO CORE

Drilling Area Background (ppm): 1.9

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEO PROBE 54LT

BORING NUMBER: 13SB12
DATE: 3-26-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
G	1		2.3/			BRN	SANDY SILT	SM	DAMP	2.1	2.1	2.1	2.1
	2		4.0						FILL	↓	↓	↓	↓
	3								BLACK @ 1.5-2.0,				
4	4								RK FRAG IN				
	5						TD 4.0		BTM				
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS12 0002						
						@	830						
						SAMPLED	13SB12 0204						
						@	835						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACRO CORE

Drilling Area Background (ppm): 2.1

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 13SB13
DATE: 3-25-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
0	1		3.1/			BRN	SANDY SILT	SM	DAMP	0	0	0	0
	2		4.0						FILL				
	3												
4	4												
	5						TD 4.0						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	13SS130002						
						@	750						
						SAMPLED	13SB130204						
						@	755						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACRO CORE

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: HAND AUGER
BORING NUMBER: 13SB14
DATE: 4/10/03
GEOLOGIST: BOB BALMOVE
DRILLER: Jeff Akers

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		1' / 1'			BR	SANDY SILT w/ SOME TOPSOIL	ML	MOIST	00			
	2			T.D. 1'									
	3						REFUSAL @ 1'						
	4						2 OFFSETS						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 13SB140001							
						@ 1210							
						SAMPLED							
						@							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks:

Converted to Well: Yes _____ No ✓ Well I.D. #: _____

APPENDIX F.2

SWMU 16

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Rotosonic

BORING NUMBER: 16MW701 / SB41
DATE: 4/8/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MUSSY & SOFT	BR	.5' TOP SOIL	ML		0.0			
	2				MUSSY &		.5'-7' CLAY	CL					
	3				M. STIFF								
S-1 1024	4		3.9' / 4'										
	5				DRY &				MED PLASTICITY				
	6				M. STIFF				4'-7'	0.0			
	7												
	8					YELL OR	7'-8' SANDY CLAY		6" CASING TO 9'				
S-2 1040	9		4.9' / 5'		DRY & SOFT		SILTSTONE 8'-14'	BR	THIN LAM				
	10				DRY &								
	11				M. STIFF					0.0			
	12					LT							
	13					BR							
S-3 1103	14		4.8' / 5'		DRY & HARD	LT GRAY	SHALEY 13'-14'						
	15				MUSSY &	YELL	SANDY CLAY W/ 14'-18'		WEATHERED				
	16				M. STIFF	OR	S.S. FRAGS		SANDSTONE	0.0			
	17								POSS SATURATION				
	18								@ 16'-16.5'				
S-4 1147	19		4.8' / 5'		WET &	LT GRAY	SHALEY SILTSTONE 18'-19'	MS					
	20					DK	SHALE 19'-24'	VBR					
	21					GRAY				0.0			
	22												
	23												
S-5 1400	24		4.9' / 5'										

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: 6" 0-4' WELL SET @ 24' 10' SCREEN
5" 4'-24' SAND TO 12'
BENT TO 15' VER. CLAY TO 2'

Converted to Well: Yes X No ____ Well I.D. #: 16MW701

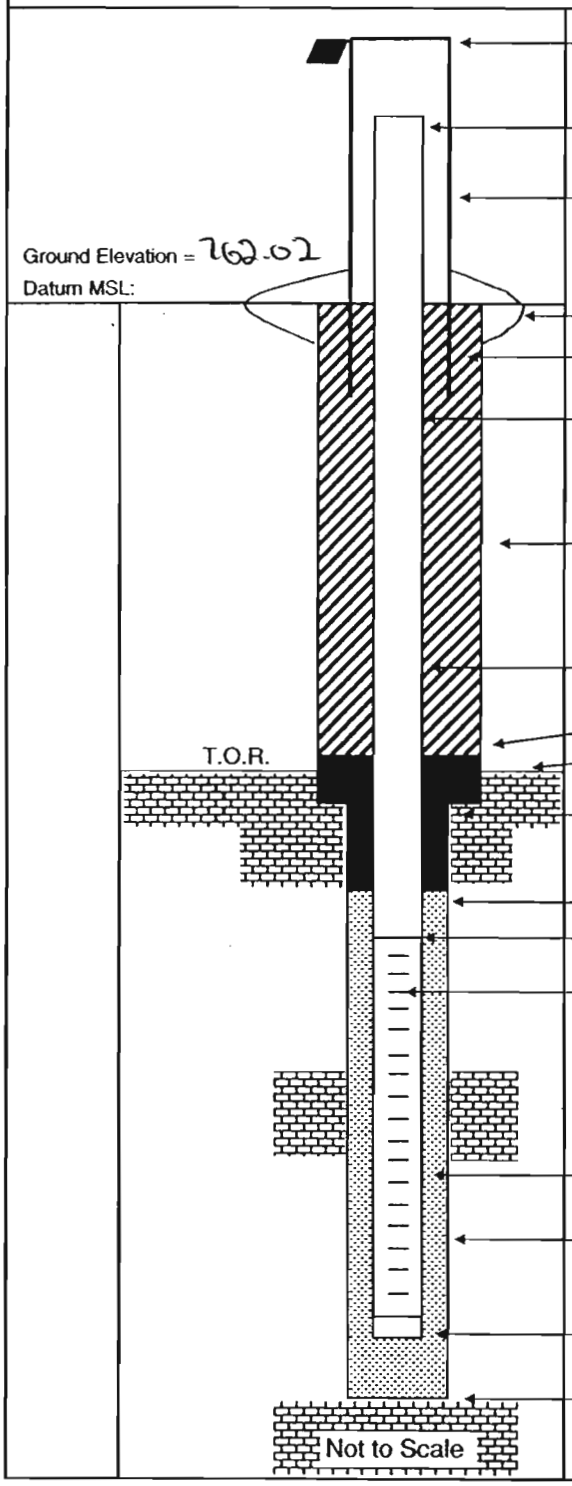
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 16MW101

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MW101/SB41
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	4/8/03
SITE:	SWMU 16	DRILLING METHOD:	ROTOSONIC	NORTHING:	1371193.488
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3032881.785



Elevation of Top of Casing: 765.00

Stick Up of Casing Above Ground Surface: 2.48

Elevation of Top of Riser: 764.5

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: VOL CLAY

Elevation / Depth Top of Seal: 752.02 / 10'

Elevation / Depth Top of Bedrock: 754.02 / 8'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 750.02 / 12'

Elevation / Depth of Top of Screen: 748.02 / 14'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 738.02 / 24'

Elevation / Total Depth of Borehole: 738.02 / 24'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW102
DATE: 4/11/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST	BR	.5' TOP SOIL			0.0			
	2				MOIST		CLAYEY SILT	ML					
	3				M. STIFF								
S-1 0807	4		1.5' / 4'										
	5					BR	4-4.5 CLAYEY SILT			0.0	0.0	0.0	0.0
	6				SOFT +	GRAY	4.5-8' SILTY CLAY	CL					
	7				MOIST				V. SOFT @ 7'-8'				
S-2 0811	8		4" / 4"										
	9				STIFF +	YELL	8-10.5' SILTY SAND W/ SS		WEATHERED SS				
	10					GR	FRAGS		8'-13'				
	11			▼?	HARD		SAND SEAM 10.5'-13'		POSS WATER @ 10.5'				
	12				STIFF +								
S-3 0817	13		4.5' / 5'		MOIST								
	14					DK	SHALE 13'-18'	VAR					
	15					GRAY							
	16												
	17								WELL @ 16' @ 0838				
S-4 0838	18		5' / 5'						WATER RUNNING				
				T.D. 18'			WELL SET @ 18 2" PVC		INTO HOLE.				
							SCREENED 8'-18'						
							SAND 6'						
							BENT CHIPS TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 5" 0-18'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No _____ Well I.D. #: 16MW102

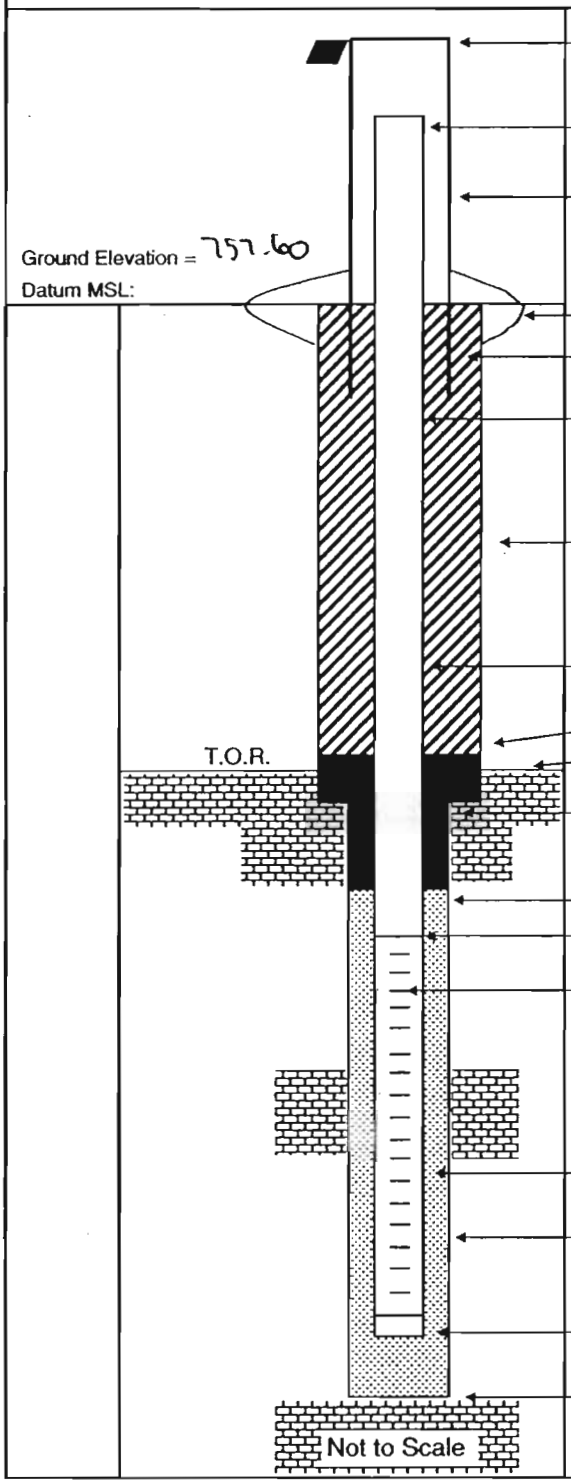
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 16MW702

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MW702
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES	DATE COMPLETED:	4/1/03
SITE:	SWMU 16	DRILLING METHOD:	ROTOSONIC	NORTHING:	1371146.42
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3032554.16



Elevation of Top of Casing: 760.98

Stick Up of Casing Above Ground Surface: 2.76

Elevation of Top of Riser: 760.36

I.D. of Surface Casing: 4' SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT

Elevation / Depth Top of Seal: 755.6 / 2'

Elevation / Depth Top of Bedrock: 744.6 / 13'

Type of Seal: BENT. CHIPS

Elevation / Depth of Top of Filter Pack: 751.6 / 6'

Elevation / Depth of Top of Screen: 749.6 / 8'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 739.6 / 18'

Elevation / Total Depth of Borehole: 739.6 / 18'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW103 / SB36
DATE: 4/20/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					LT.	CLAY 0-1'	CL	6" TO 3"	0.0			
	2					BR	SILTY SAND W/SS FRAGS	SM		↓			
	3					↓	(1'-3')	↓					
	4		2 OSSA		HARD	YELL	3'-10.5' SANDSTONE	BR	THIN BEDDING	0.0			
	5				↓	OR	↓	↓					
C-1	6				↓	↓	↓	MS	MASSIVE 5-8'				
C-1	7		71% RQD					↓	↓				
	8												
	9		5.5'/6'		↓	↓	↓	BR					
	10				HARD	YELL OR	SANDSTONE	↓		0.0			
	11				BRITTLE	DK GRAY	10.5'-16' SHALE	VBR	HIGHLY FRACTURED				
	12				↓	↓	↓	↓	V.BR				
	13								↓				
	14		51% RQD										
C-2	15		0845										
	16				↓	↓	↓						
	17				SOFT TO	GRAY	16'-27' CLAYEY SHALE						
	18				BRITTLE	↓	↓						
	19		9.7'/10'		-DRY-	↓	↓						
	20				↓	DK GRAY	CLAYEY SHALE		↓	0.0			
	21				V.SOFT	↓	↓						
	22		47%		TO BRITTLE								
	23		RQD		↓				V.WET FROM 24'				
C-3	24								TO 27'				
	25				WET - SOFT	↓	↓	↓	WATER @ 25.5' AFTER BLOW OUT				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 6" 0-3' 5" 3'-34'

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 16MW103

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MWT03 / SB36
DATE: 4/10/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVES.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26		C0910		WET +	DK	CLAYEY SHALE	VAR	WET	0.0			
	27				SOFT	GRAY							
	28				MOIST +	DK GRAY	27-29' SHALE						
	29		9.5'/10'		STIFF	↓	↓						
	30						29-32 SHALE-CLAYEY						
	31		46% RQD										
C-4	32		C0943			↓	↓						
	33					BLK	COAL SEAM 32-33'						
	34		4.0'/5'			DK GRAY	SHALE	↓					
				T.D. 34'			WELL SET @ 35 2" PVC		DRILLER SET				
							SCREENED 25-35'		WELL @ 35'				
							SAND TO 23'		OVERDRILLED.				
							BENT CHIPS TO 20'		DURING CLEANOUT				
							VOL. CLAY TO 2'						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No

Well I.D. #: 16MWT03

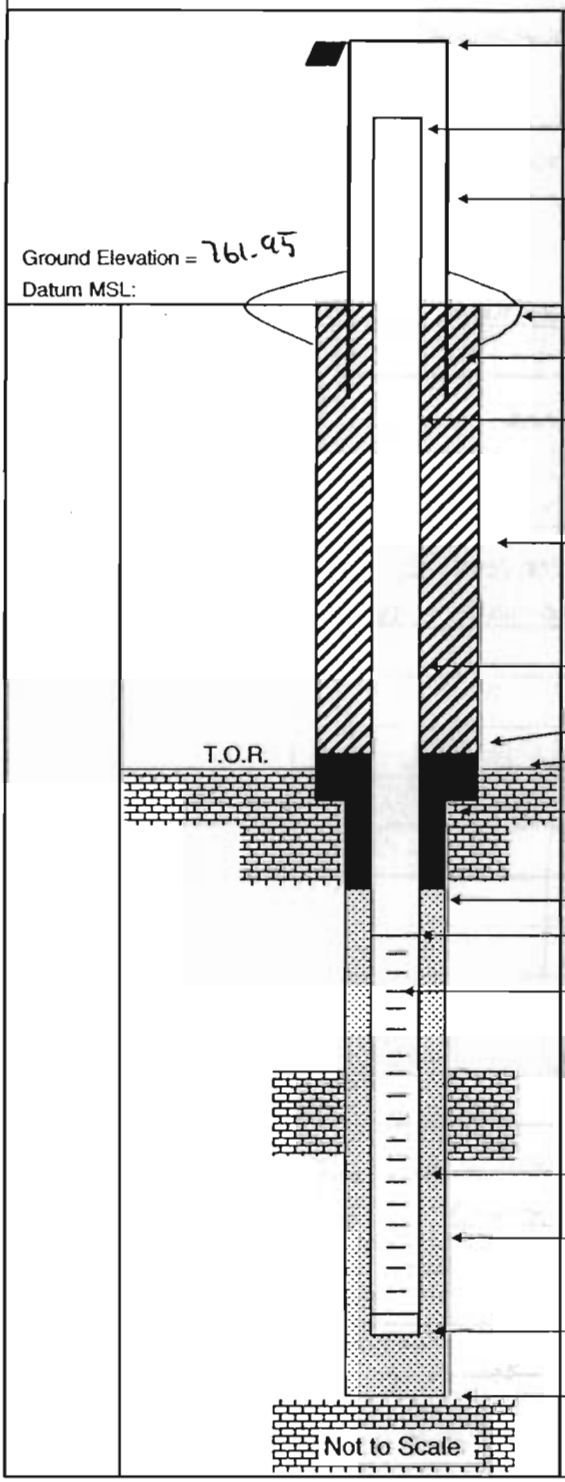
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 16MW03

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MW03/5036
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	4/10/03
SITE:	SWMU 16	DRILLING METHOD:	ROTOSONIC	NORTHING:	1320946.468
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3032559.16



Elevation of Top of Casing: 764.96

Stick Up of Casing Above Ground Surface: 2.46

Elevation of Top of Riser: 764.41

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: VOL CLAY

Elevation / Depth Top of Seal: 741.95 / 20'

Elevation / Depth Top of Bedrock: 758.95 / 3'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 738.45 / 23'

Elevation / Depth of Top of Screen: 736.95 / 25'

Type of Screen: PVC

Slot Size x Length: .20 x 60'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 726.95 / 35'

Elevation / Total Depth of Borehole: 726.95 / 35'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW704
DATE: 4/8/03 - 4/9/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST & SOFT	BR	.5' TOP SOIL	ML		0.0			
	2				MOIST &	LT GRAY	.5'-3' CLAY	CL					
	3				STIFF	& YELLOW	↓						
S-1 1540	4		4' / 4'		DRY & SOFT		3'-8.5' SANDSTONE	BR	ROCK @ 3'				
S-2 1546	5		1' / 7'		HARD		↓		REFUSAL @ 5'	0.0			
	6					RED	SANDSTONE		MODERATE WEATH.				
	7		64% RQD						LIGHT. FRACT.				
C-1	8		@ 1615										
	9				SOFT	RED &	SILTY SANDSTONE 8.5'-9'	VBR	HIGHLY FRACTURED				
	10		47" / 5		HARD	LT GRAY	SANDSTONE 9'-18'						
	11				HARD &	RED			HIGHLY FRACT.				
4/8	12					& BR							
	13												
	14		47% RQD										
C-2	15		1628										
	16												
	17												
	18								POS. SAT @ 18'				
	19				SOFT	DK GRAY	SHALE 18'-25'		FLUSH OUT HOLE.				
	20		96" / 10"						LET SIT OVERNIGHT				
	21					DK	SHALY MATERIAL	BR	CONTINUOUS TO 20'				
4/9	22					GRAY	IN CUTTINGS						
R-1	23								WL = 15' BGS				
	24								@ 0738				
	25		0800	TD 25									

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: 6" 0-4' 5" CORE 4'-20' 5" REAM 20'-25'
WELL SET @ 25' SAND TO 13' BENT TO 12' VOLCLAY TO 2'

Converted to Well: Yes X No ___ Well I.D. #: 16MW704

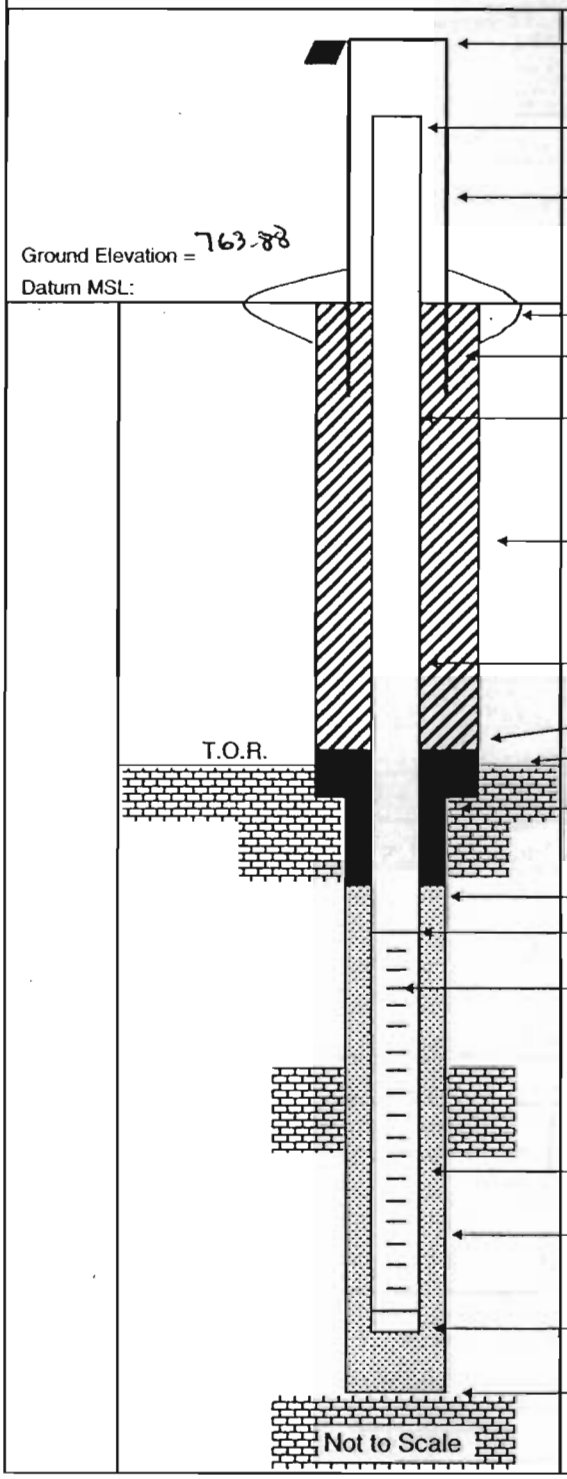
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 16MWT04

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MWT04
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVE S.	DATE COMPLETED:	4/9/03
SITE:	SWMU 16	DRILLING METHOD:	ROTOSONIC	NORTHING:	1321003.781
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3032946.4660



Elevation of Top of Casing: 766.71

Stick Up of Casing Above Ground Surface: 2.76

Elevation of Top of Riser: 766.14

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: STEEL

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 5"

Type of Backfill: CEMENT 0-2' VOL & CLAY 2-12'

Elevation / Depth Top of Seal: 751.88 / 12'

Elevation / Depth Top of Bedrock: 760.88 / 3'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 750.88 / 13'

Elevation / Depth of Top of Screen: 748.88 / 15'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock: Core / Ream: 5"

Elevation / Depth of Bottom of Screen: 738.88 / 25'

Elevation / Total Depth of Borehole: 738.88 / 25'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW105 / SB26
DATE: 4/9/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DANES

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST	BR	0-1' CLAY	CL		0.0			
	2				M. STIFF		1'-4' SILTY SAND W/	SM					
	3						S.S FRAGS						
S1	4								6" TO 4'				
	5				HARD	LT BR	4'-6' SANDSTONE	BR		0.0			
	6				DRY								
C-1	7		60% RQD		HARD	LT	6'-8.5' SILTY STONE	VBR					
	8		C1320			GRAY							
	9		4.8' / 5'			GRAY	8.5'-9' SANDSTONE	MS					
	10				SOFT TO	LT	9'-13' CLAYEY SHALE	BR		0.0			
	11				STIFF	GRAY							
	12												
	13				LOOSE	BLK	COAL SEAM 12-12.5'						
C-2	14		C1335		HARD	LT GRAY	SANDSTONE 12.5'-14'	MS					
	15				SOFT TO	DK GRAY	SHALE (14'-40')	VBR		0.0			
	16		47%		BRITTLE	BR	SANDY FROM 15'-16.5'						
	17		RQD										
	18					BLK	SHALE 16.5'-19'						
	19		9.8' / 10'			DK GRAY							
	20				SOFT TO	LT	19-25' SHALE & CLAYEY - 14			0.0			
	21				BRITTLE	DK							
	22					GRAY							
	23												
C-3	24												
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No _____ Well I.D. #: 16MW105

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW105/SB26
DATE: 4/9/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color*	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26		@1354		SOFT TO	GY	SHALE 25'-40'	BR		0.0			
	27		37%		BRITTLE	DK							
	28		RQD			GRAY							
	29												
	30		4.7'/5'										
	31				SOFT TO		SHALE:	BR	V. SOFT @ 31'				
	32				BRITTLE		- CLAYEY 30-32'		POSS WATER				
	33		45%						V. WET 30-35'				
	34		RQD										
C-4	35		@1445										
	36												
	37												
	38						THIN COAL SEAM 37'-37.4'						
	39							VBR					
	40		2.7/10'										
							WELL SET @ 39' 2" PVC						
							SAND TO 27'						
							BENT CHIPS TO 25'						
							VOL-CLAY TO "						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes X No ____ Well I.D. #: 16MW105

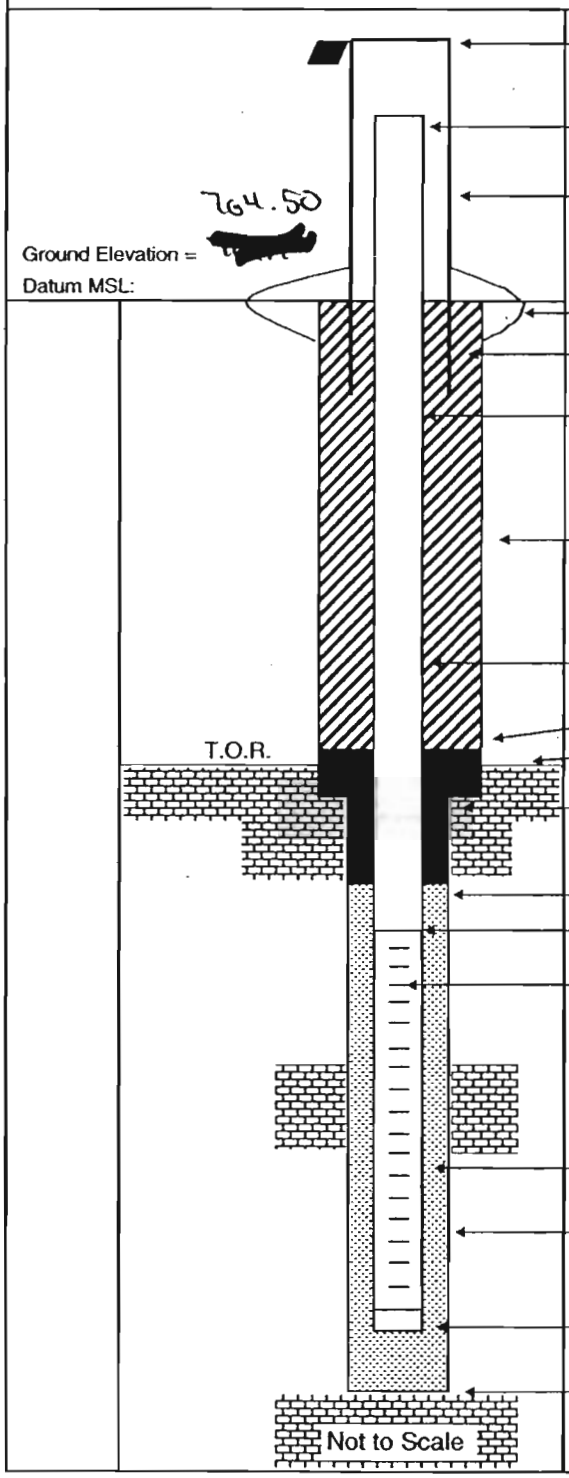
Tetra Tech NUS, Inc.

BEDROCK MONITORING WELL SHEET

WELL No.: 16MW705

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MW705/SB26
PROJECT No.:	9060 CTO 0279	DRILLER:	DAVES	DATE COMPLETED:	4/9/03
SITE:	SWMU 16	DRILLING METHOD:	ROTOSONIC	NORTHING:	[redacted] 1320741.797
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WHALE PUMP	EASTING:	[redacted] 3032812.77



Elevation of Top of Casing:	[redacted] 767.45
Stick Up of Casing Above Ground Surface:	2.38
Elevation of Top of Riser:	[redacted] 766.88
I.D. of Surface Casing:	4" SQUARE
Type of Surface Casing:	STEEL
Type of Surface Seal:	4'x4'x6" PAD
I.D. of Permanent Casing:	NA
I.D. of Riser:	2"
Type of Riser:	PVC
Borehole Diameter:	5"
Type of Backfill:	VOL CLAY (0-25')
Elevation / Depth Top of Seal:	739.5 / 25'
Elevation / Depth Top of Bedrock:	760.5 / 4'
Type of Seal:	BENT CHIPS
Elevation / Depth of Top of Filter Pack:	737.5 / 27'
Elevation / Depth of Top of Screen:	735.5 / 29'
Type of Screen:	PVC
Slot Size x Length:	.20 x 10'
I.D. of Screen:	2"
Type of Filter Pack:	No. 20-40 SAND
Diameter of Hole in Bedrock: Core / Ream:	5"
Elevation / Depth of Bottom of Screen:	725.5 / 39'
Elevation / Total Depth of Borehole:	724.5 / 40'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTOSONIC

BORING NUMBER: 16MW106
DATE: 4/24/03
GEOLOGIST: BOB BALKOVEC
DRILLER: DENNIS SZNAK.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1						REFER TO 16MW101						
							FOR COMPLETE						
							LITH. DETAILS						
	5												
	10												
	15												
							16 FT U-WET						
							CUTTINGS						
	20						SET WELL @ 25' 2" PVC						
							SCREENED 15'-25'						
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated response read.

Remarks:

Drilling Area Background (ppm):

Converted to Well: Yes X No

Well I.D. #: 16MW106

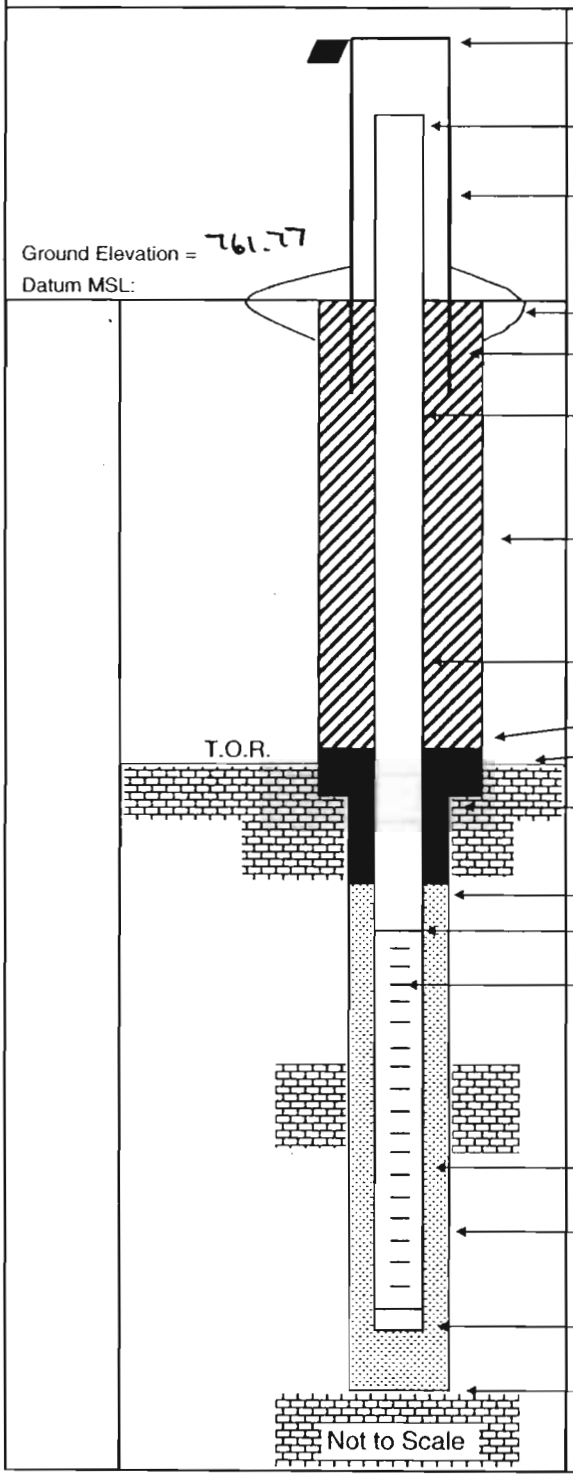
Tetra Tech NUS, Inc.

BEDROCK
MONITORING WELL SHEET

WELL No.: 16MW06

PERMIT No:

PROJECT:	NSWC CRANE	DRILLING Co.:	BOWSER MORNER	BORING No.:	16MW06
PROJECT No.:	9060 CTO 0279	DRILLER:	DENNIS SAUK	DATE COMPLETED:	4/24/03
SITE:	SWMU 16	DRILLING METHOD:	[redacted]	NORTHING:	1321199.519
GEOLOGIST:	B. BALKOVEC	DEV. METHOD:	WATTERA	EASTING:	3032883.373



Elevation of Top of Casing: 764.85

Stick Up of Casing Above Ground Surface: 2.67

Elevation of Top of Riser: 764.44

I.D. of Surface Casing: 4" SQUARE

Type of Surface Casing: NA

Type of Surface Seal: 4'x4'x6" PAD

I.D. of Permanent Casing: NA

I.D. of Riser: 2"

Type of Riser: PVC

Borehole Diameter: 6"

Type of Backfill: VOL CUT 11'-2'

Elevation / Depth Top of Seal: 750.77 / 11'

Elevation / Depth Top of Bedrock: 753.77 / 8'

Type of Seal: BENT CHIPS

Elevation / Depth of Top of Filter Pack: 748.77 / 13'

Elevation / Depth of Top of Screen: 746.77 / 15'

Type of Screen: PVC

Slot Size x Length: .20 x 10'

I.D. of Screen: 2"

Type of Filter Pack: No. 20-40 SAND

Diameter of Hole in Bedrock:
Core / Ream: 6"

Elevation / Depth of Bottom of Screen: 736.77 / 25'

Elevation / Total Depth of Borehole: 736.77 / 25'

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB01
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		1.0/1.0			BL	ASPHALT + GRAVEL			1.7	1.7	1.7	1.7
S2	2		2.8/			GR BRN	CLAYEY SILT		DAMP, FILL MOTTLED 2-4'	1.7	1.7	1.7	1.7
	3		3.0										
	4					BRN	CLAYEY SILT			1.7	1.7	1.7	1.7
S3	5												
	6						REFUSAL @ 6'						
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS010002						
						@	0845						
						SAMPLED	16SB010406						
						@	0900						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACRO CORE

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB02
DATE: 3-27-03
GEOLOGIST: M G COCHRAN
DRILLER: JAKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		3.7/	1.0		BL	ASPHALT			1.7	1.7	1.7	1.7
	2		4.0			BRN	CLAYEY SILT	ML	DAMP				
	3								FILL				
	4												
S2	5		2.6/			GR-BRN	SILTY SAND	SM	DAMP	1.7	1.7	1.7	1.7
	6		2.0						SS FRAG IN BTM.				
	7						REFUSAL @ 6'		WEATHERED SS IN BTM.				
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS020002						
						@	905						
						SAMPLED	16SB020406						
						@	915						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEO PROBE 54LT

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LI

BORING NUMBER: 16SB03
DATE: 3-27-03
GEOLOGIST: M G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S-1	1		1.7/			BL	ASPHALT		REFUSAL @ 2' FIRST TRY	1.7	1.7	1.7	1.7
	2		2.0			RD BRN	CLAYEY SILT		REFUSAL 2ND TRY SS FRAG				
	3						TD 2.0		IN BTM - MOVE HOLE 2'				
	4								REFUSAL @ 2' DAMP @ BTM FILL				
	5								NO SUB. SPL TAKEN				
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED @	16SS03000Z 940						
						SAMPLED @	NO SUB SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB04
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		1.7/	1.0		BL	ASPHALT + GRAVEL			1.7	1.7	1.7	1.7
	2		2.5			BRN	CLAYEY SILT	ML	DAMP, FILL	↓	↓	↓	↓
	3						REFUSAL @ 2.5						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS040002							
						@ 1000							
						SAMPLED NO SUB SURFACE							
						@ SPL TAKEN							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB05
DATE: 3-27-03
GEOLOGIST: M. GCOCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
SI	1			1.0		BL	ASPHALT		TOOK 2 CORES FOR	1.7	1.7	1.7	1.7
	2					RD BRN	CLAYEY SILT	ML	DAMP	↓	↓	↓	↓
	3						REFUSAL @ 2'						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS050002						
						@	1035						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 165B06
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1			1.0		BL	ASPHALT		TOOK 3 CORES FOR SPL. VOL.	1.7	1.7	1.7	1.7
	2					BRN	CLAYEY SILT	ML	DAMP, FILL	↓	↓	↓	↓
	3						REFUSAL @ 2.5'						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	165506.0002						
						@	1055						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB07
DATE: 3-27-03
GEOLOGIST: M.G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		1.4/	1.0		BL	ASPHALT		TOOK 3 CORES FOR SPL. VOL.	1.7	1.7	1.7	1.7
	2		2.0			BRN	CLAYEY SILT	ML	DAMP. FILL	↓	↓	↓	↓
	3						REFUSAL @ 2.0						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS070002						
						@	1100						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB08
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1			1.0		GR.	GRAVEL.		TOOK 3 CORES FOR SPL. VOL	1.7	1.7	1.7	1.7
	2					BRN	SILTY SAND	SM	SS FRAGS IN SPL. DAMP,	↓	↓	↓	↓
	3						REFUSAL @ 1.5'		FILL				
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS080002						
						@	1330						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.7

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB09
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		1.31	.5		DK BR RDBRN	TOPSOIL CLAYEY SILT	ML	TOOK 4 CORES FOR SPL VOL	1.6	1.6	1.6	1.6
	2		2.0						SS FRAGS BTM	↓	↓	↓	↓
	3						REFUSAL @ 2'		DAMP, FILL				
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS090002						
						@	1355						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 1.6

Remarks: FD 03270301 COLLECTED

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB10
DATE: 3-27-03
GEOLOGIST: MG COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		1.3/	.5		DKBR	TOPSOIL		TOOK 3 CORES				
						RDBRN	CLAYEY SILT	ML	FOR SPL VOL.	1.6	1.6	1.6	1.6
	2		2.0						DAMP. FILL SS FRAG BTM	↓	↓	↓	↓
	3						REFUSAL @ 2'						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS100002						
						@	1400						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.6

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB11
DATE: 3-27-03
GEOLOGIST: M.G. COCHRAN
DRILLER: JAKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		3.1/			RD BRN	CLAYEY SILT	ML	DAMP, FILL	1.5	1.5	1.5	1.5
S1	2		4.0							↓	↓	↓	↓
	3												
	4		0/						NO RECOVERY				
S2	5		1				REFUSAL @ 5'						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS110002							
						@ 1515							
						SAMPLED 16SB110204							
						@ 1520							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 1.5

Remarks:

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB12
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.5/			DK BRN	CLAYEY SILT	ML	FILL, DAMP	0	0	0	0
	2		3.5			BRN	CLAYEY SILT			↓	↓	↓	↓
	3												
	4			T.D. 3.5'			REFUSAL @ 3.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS120002						
						@	820						
						SAMPLED	16SB120204						
						@	825						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT.

BORING NUMBER: 16SB13
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1			.5		DK BRN	TOPSOIL		DAMP, FILL	0	0	0	0
S1	2					DK BRN	CLAYEY SILT	ML		↓	↓	↓	↓
	3												
	4						REFUSAL @ 3.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS130002 @ 800						
						SAMPLED	16SB130204 @ 805						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB14
DATE: 3-27-03
GEOLOGIST: M.G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					DKBR	TOPSOIL						
						BRN	CLAYEY SILT		DAMP, FILL	1.6	1.6	1.6	1.6
	2												
	3			T.D. 7'			REFUSAL @ 2'						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS140002						
						@	1500						
						SAMPLED	NO SUBSURFACE						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.6

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB15
DATE: 3-27-03
GEOLOGIST: M.G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		1.5/			DK BRN	TOPSOIL CLAYEY SILT	ML	TOOK 3 CORES SPL VOLUME DAMP, FILL	1.6	1.6	1.6	1.6
	2		1.5				REFUSAL @ 1.5'	↓		↓	↓	↓	↓
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS150002						
						@	1440						
						SAMPLED	NO SPL						
						@	TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: MS/MSD SAMPLE TAKEN

Drilling Area Background (ppm): 1.6

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16 SB 16
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sample BZ	Borehole**	Driller BZ**
S1	1		1.0	.5		DK BRN BRN	TOPSOIL. CLAYEY SILT	ML	TOOK 3 CORES FOR SPL VOL	1.5	1.5	1.5	1.5
	2		2.0					↓		↓	↓	↓	↓
	3						REFUSAL @ 2'						
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS160002						
						@	1415						
						SAMPLED	NO SUBSURF.						
						@	SPL TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 1.5

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16 SB 17
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sample BZ	Borehole**	Driller BZ**
S1	1		3.5/	.5		BL RD-BRN	TOPSOIL CLAYEY SILT	ML	TOOK 2 CORES FOR SPL. VOL	1.5	1.5	1.5	1.5
	2		4.0	2.0				↓	DAMP, FILL	↓	↓	↓	↓
	3					RD BN	SHALY SILTSTONE		SOFT, WEATHERED				
	4												
	5						REFUSAL @ 4'						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED*	16SS170002						
						@	1540						
						SAMPLED	16SB170204						
						@	1545						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: *DUPLICATE SPL. FD 032703 02

Drilling Area Background (ppm): 1.5

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB18
DATE: 3-28-03
GEOLOGIST: M G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ*
	1	/	2.9			BN	CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
	2	/	3.5					↓					
	3	/		3.0									
	4	/		3.5		BL			BLACK SMEAR @ BTM, 5'	0	0	0	0
	5	/					REFUSAL @ 3.5'		POSSIBLE WASTE MTL?				
	6	/											
	7	/											
	8	/											
	9	/											
	10	/											
	11	/											
	12	/											
	13	/											
	14	/											
	15	/											
		/				SAMPLED 16SS180002							
		/				@ 1030							
		/				SAMPLED 16SB180203							
		/				@ 1035							
		/											

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB19
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.3			GR. BRN	CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
	2		3.5	2.0						↓	↓	↓	↓
	3					RED BRN			RK FRAGS IN SPL.				
	4						REFUSAL @ 3.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS19 0002 @ 1040							
						SAMPLED 16SB19 0203 @ 1045							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 165B20
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1			1.0		GR BRN	CLAYEY SILT + GRAVEL	ML	TOOK 2 CORES FOR SPL. VOL	0	0	0	0
S-1	2						WEATHERED SS	↓	DAMP, FILL	↓	↓	↓	↓
	3												
	4						REFUSAL @ 2.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	165S200002						
						@	1140						
						SAMPLED	NO SPL						
						@	TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16 SB 21
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.1			BRN	CLAYEY SILT + GRAVEL	ML	TOOK 3 CORES FOR SPL. VOL	0	0	0	0
S1	2		2.5	2.0		-			DAMP, FILL	↓	↓	↓	↓
	3			2.5		BRN	WEATHERED SS						
	4						REFUSAL @ 2.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED* 16 SS 21 0002							
						@ 1100							
						SAMPLED No SUB SAMPLE							
						@ Collected							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: * MS/MSD collected @ this location.

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB22
DATE: 3/28/03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		2.5/	.5		DK BR BRN	TOPSOIL CLAYEY SILT	ML	DAMP. FILL	0	0	0	0
	2		3.5					↓		↓	↓	↓	↓
	3					LT BRN	WEATHERED S. STONE						
	4						REFUSAL @ 3.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS220002 @ 910							
						SAMPLED 16SB220203 @ 915.							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB23
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.5'			DKBRN	TOPSOIL		TOOK 2 CORES				
						RDBRN	CLAYEY SILT	ML	FOR SPL. VOL	0	0	0	0
S1	2		3.5					↓	DAMP, FILL	↓	↓	↓	↓
	3												
	4						REFUSAL @ 3.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS230002(1)						
						@	1000						
						SAMPLED	16SB230203						
						@	1005 (2)						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0

Remarks: (1) FD0328 0301
(2) FD0328 0302

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB24
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.2	.5		DKBRN	TOPSOIL						
						RD BRN	CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
	2		3.5					↓		↓	↓	↓	↓
	3								SS. FRAG BTM				
	4						REFUSAL @ 3.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS240002						
						@	940						
						SAMPLED	16SB240203						
						@	945						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: GEOPROBE MACROCORE

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB25
DATE: 3.28.03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.4/	.5		DK BRN	TOPSOIL						
						RD BRN	CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
51	2		3.5						RK FRAGS IN SPL.	↓	↓	↓	↓
	3												
	4						REFUSAL @ 3.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS250002						
						@	930						
						SAMPLED	16SB250203						
						@	935						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG:

BORING NUMBER: 16SB26 / MW05
DATE: 4/9/03
GEOLOGIST: B Dawver
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BR	1' CLAY	CL		00			
	2					YELL OR	1½' SILTY SAND W/S.S	SM					
	3					LT GRAY	FRAGS						
S1 W35	4		4" / 4"										
	5						ROCK @ 4'						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS260002			FD040903 02				
						@ 1038			MS/MSD				
						SAMPLED 16SB260004			FD040903 03				
						@ 1045			MS/MSD				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm):

Converted to Well: Yes ____ No X Well I.D. #:

NOT AT TIME OF INITIAL SAMPLING

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 165B27
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.9'	.5		PROB BRN	TOPSOIL CLAYEY SILT W	ML	DAMP, FILL	0	0	0	0
S1	2		3.5				GRAVEL FRAGS	↓		↓	↓	↓	↓
	3			2.5			WEATHERED SS						
	4			3.5									
	5						REFUSAL @ 3.5'						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	165S270002						
						@	1120						
						SAMPLED	165B270203						
						@	1125						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: MACROCORE

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB28
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1			.5		DKBR	TOPSOIL						
						BRN	CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
	2			1.5				↓		↓	↓	↓	↓
	3					BRN	SANDY SILT						
	4			3.5									
	5						REFUSAL @ 3.5						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS280002						
						@	1130						
						SAMPLED	16SB280203						
						@	1135						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0-0

Converted to Well: Yes ____ No X Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB29
DATE: 3/28/03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ*	Borehole**	Driller BZ**
	1		3.0/			DKBR	TOPSOIL						
						RDBR	CLAYEY SILT	ML	DAMP	0	0	0	0
	2		3.5					↓		↓	↓	↓	↓
	3												
	4						REFUSAL @ 3.5						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS290002						
						@	900						
						SAMPLED	16SB290203						
						@	905						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB30
DATE: 3-28-03
GEOLOGIST: MG COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		3.1/	.5		DKBRN ROGRN	TOPSOIL CLAYEY SILT	ML	DAMP, FILL	0	0	0	0
	2		3.0							↓	↓	↓	↓
	3								SS FRAGS @ BTM.				
	4						REFUSAL @ 3'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS300002 @ 840							
						SAMPLED 16SB300203 @ 845							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB31
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		2.0/	.5		DKBR RDBN	TOPSOIL CLAYEY SILT	ML	DAMP	0	0	0	0
	2		3.0					↓		↓	↓	↓	↓
	3						REFUSAL @ 3'		SS FRAG @ BTM				
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS310002						
						@	830						
						SAMPLED	NO SPL						
						@	TAK						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG:

BORING NUMBER: 16SB32
DATE: 4/9/03
GEOLOGIST: B. BALLOUZ
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				moist mstiff	BR	CLAY	CL		00			
	2				↓	↓	↓	↓		↓			
	3					↓	↓	↓					
SI 1010	4		3.9 / 4'		↓	LT Gray	SANDY CLAY	CL		↓			
	5			T.D. 4'									
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS320002 @ 1015			FD040903 01 For PCBs				
						SAMPLED 16SB320204 @ 1020							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm):

Converted to Well: Yes ____ No X Well I.D. #:

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTO SONIC

BORING NUMBER: 16SB33
DATE: 4/4/03
GEOLOGIST: R BALKOVEC
DRILLER: DAVES.

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1				MOIST SOFT	BR	.5' CLAY	CL		0.0			
	2				DRY	YELL OR	SILTY SAND W/	SM		↓			
	3				HARD	↓	S.S. FRAGS	↓		↓			
S1 0457	4		3.4'/3.5	T.D. 3.5'									
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS330002							
						@ 1000							
						SAMPLED 16SB330204							
						@ 1005							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No X Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: Roto Sonic

BORING NUMBER: 16SB34
DATE: 4/9/03
GEOLOGIST: R. Balkovec
DRILLER: Dave S.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler 12"	Borehole**	Driller 12"**
	1				MOIST + SOFT	BR	5' CLAY	CL		0.0			
	2				DRY +	YELL OR	SILTY SAND	SM		↓			
S-1 0245	3		3'/3'		STIFF	↓	W/S.S. FRAGS	↓		↓			
	4			T.D. 3'			REFUSAL @ 3'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS340002						
						@	0947						
						SAMPLED	16SB340203						
						@	0953						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No X Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB35
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		1.9/	1.0		LT GREY	CLAYEY SILT + GRAVEL		FILL, DAMP	0	0	0	0
	2		2.5			BRN	CLAYEY SILT	ML		↓	↓	↓	↓
	3												
	4						REFUSAL @ 2.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS350002						
						@	1440						
						SAMPLED	NO SPL.						
						@	TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: _____

Drilling Area Background (ppm): 0

Converted to Well: Yes _____ No ✓ Well I.D. #: _____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: ROTO SONIC

BORING NUMBER: 16SB36/MW03
DATE: 4/9/03
GEOLOGIST: B. BALKOVEC
DRILLER: DAVE S.

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Drillor BZ**
	1				DRY - STIFF	BR	CLAY	CL		aw			
	2				↓	↓	↓	↓		↓			
S-1 0925	3		2.4'/3'		DRY	YELLOW	SILTY SAND W/ S.S. FRAGS	SM		↓			
	4						REFUSAL @ 3'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS36 0002							
						@ 0930							
						SAMPLED 16SB36 0203							
						@ 0940							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm):

Converted to Well: Yes ____ No X Well I.D. #:

NOT DURING INITIAL SAMPLING

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB37
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
S1	1		2.1			LT GREY	CLAYEY SILT+GRAVEL	ML-GP	DAMP, FILL	0	0	0	0
	2		2.5			OR BRN	CLAYEY SILT	ML		↓	↓	↓	↓
	3												
	4						REFUSAL @ 2.5'						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SS370002						
						@	1435						
						SAMPLED	NO SPL						
						@	TAKEN						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes ___ No ✓ Well I.D. #: ___

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB38
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (FL) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /FL) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		3.3/	1.0		GREY	CLAYEY SILT +	ML-GP	DAMP, FILL	0	0	0	0
S1	2		3.5				GRAVEL	ML		↓	↓	↓	↓
	3					BR	CLAYEY SILT						
	4												
	5						REFUSAL @ 3.5'						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS380002							
						@ 1410							
						SAMPLED 16SB380203							
						@ 1415							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks:

Drilling Area Background (ppm): 0

Converted to Well: Yes _____ No _____ Well I.D. #: _____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT.

BORING NUMBER: 16SB39
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1		2.91	1.0		BRN	CLAYEY SILT +	GP-ML	DAMP, FILL	0	0	0	0
S-1	2		3.5			BRN	GRAVEL FRAGS	ML		↓	↓	↓	↓
	3						CLAYEY SILT		BLACK SMEAR IN BTM, POSSIBLE WASTE				
	4												
	5						REFUSAL @ 3.5						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SS390002							
						@ 1400							
						SAMPLED 16SB390203							
						@ 1405							

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0

Remarks:

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54LT

BORING NUMBER: 16SB40
DATE: 3-28-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ:	Borehole**	Driller BZ**
	1		1.1/	1.0		DK BRN	TOPSOIL	ML	DAMP, FILL TO TD.	0	0	0	0
S1	2		4.0			BRN	CLAYEY SILT,						
	3												
	4												
S2	5		2.0/			BRN	CLAYEY SILT		DAMP-MOIST	0	0	0	0
	6		4.0						TOOK 2 CORES FOR SPL.				
	7								VOL.				
	8								MOIST				
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED	16SB400506						
						@	1340						
						SAMPLED*	16SB400608						
						@	1345 DUP						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: H_2O LEVEL IN SUMP 5' BGS TD 8' BGS
* FD032803 DUPLICATE SPL.

Drilling Area Background (ppm): 0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NSWC CRANE
PROJECT NUMBER: N9060 CTO 0279
DRILLING COMPANY: BOWSER MORNER
DRILLING RIG: GEOPROBE 54 LT

BORING NUMBER: 16SB41
DATE: 3-27-03
GEOLOGIST: M. G. COCHRAN
DRILLER: J. AKERS

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth /Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler B.Z.	Borehole**	Driller B.Z.*
S1	1		3.1/	1.0		BL	TOPSOIL		DAMP	1.7	1.7	1.7	1.7
	2		4.0			BRN	CLAYEY SILT.	ML	BRICK MTL. IN SPL.				
	3							↓	FILL				
	4		1.8/						moist	1.7	1.7	1.7	1.7
S2	5		4.0										
	6			7.0									
	7					GREY	SILTY CLAY		SATURATED				
	8						TD 8.0						
	9												
	10												
	11												
	12												
	13												
	14												
	15												
						SAMPLED 16SB41 0305 @ 1010							
						SAMPLED 16SB410507 @ 1015							

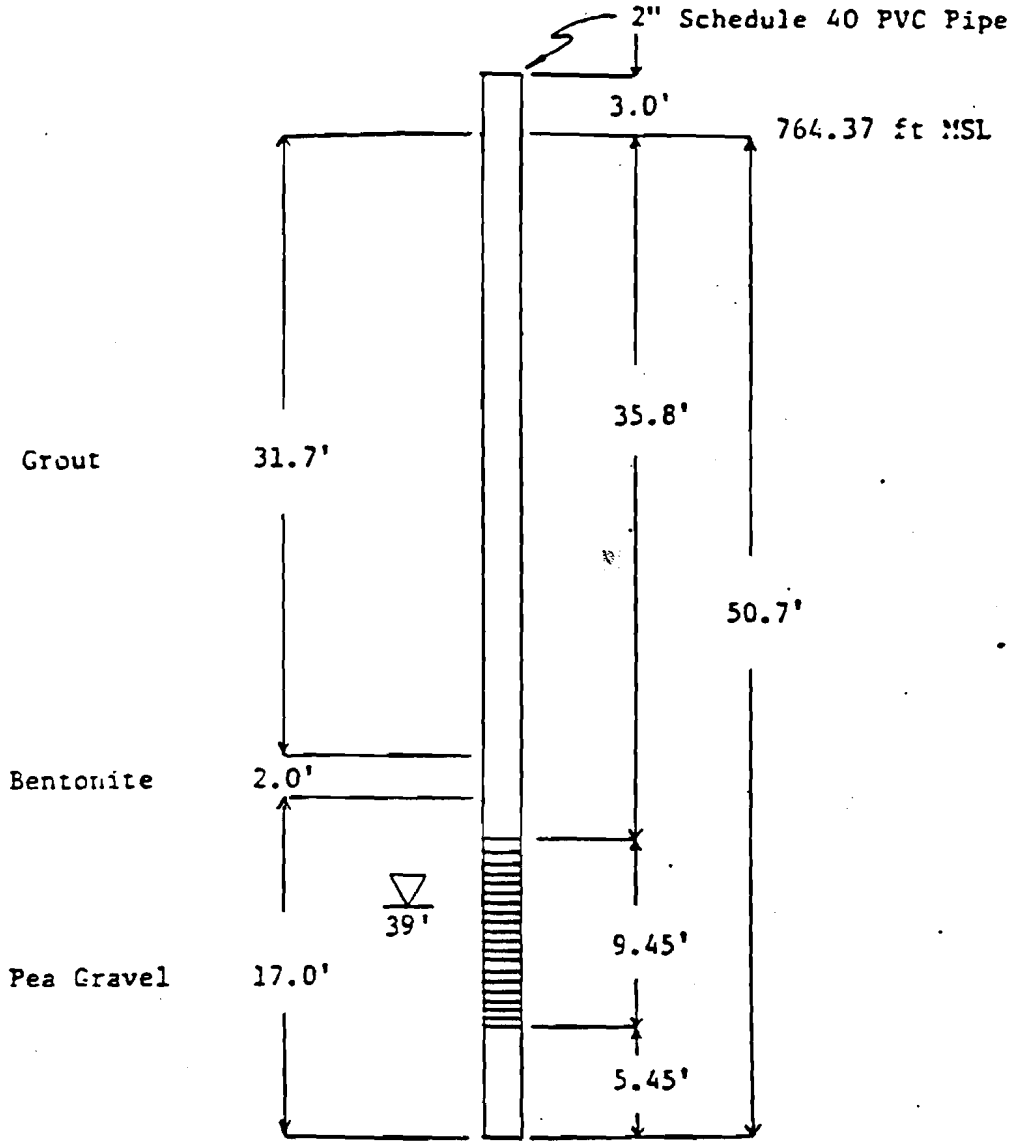
* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks: HOLE NEAR SUMP. SUMP H2O LEVEL 4' BGS. SUMP BTM 8' BGS.

Converted to Well: Yes ____ No ____ Well I.D. #: ____



Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-1-83

764.37 ft MSL - 28.5 = 735.87

Depth, ft

0.0

Sandy clay(CL): brown, soft, damp, very fine-grained sand, gravelly (sandstone).

5.0

Siltstone: brown to light grey, uniform, composition (quartz), soft to stiff, highly weathered damp.

10.0

Clay Shale: red, brown, black, orange brown, very thinly bedded (1/16"-1/4") highly weathered, soft to very stiff, brittle, and contains iron concreations or lenses.

15.0

Shale: dark grey to black, weathered and oxidized in regions, very thinly bedded, contains micro subhedral grains of calcite.

20.0

25.0

Coal: black, soft to moderately hard, earth bituminous, brittle, blocky, contains limoni and approximately 5% sulfides (pyrite and chalcopyrite).

30.0

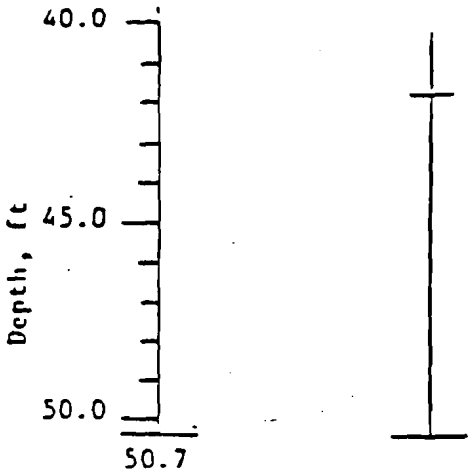
Sandstone: white to light grey, red, and brown, thinly bedded, fractured, oxidized, uniform, predominantly very fine-grained quartz sand, moderately to slightly friable, bedding dips approximately 15 degrees from horizontal with cross-bedding visible.

35.0

40.0

continued

NWSC, Crane, Indiana
Building 146-Ordnance Demil Facility
Lithology
Boring Number: MES-14-1-83

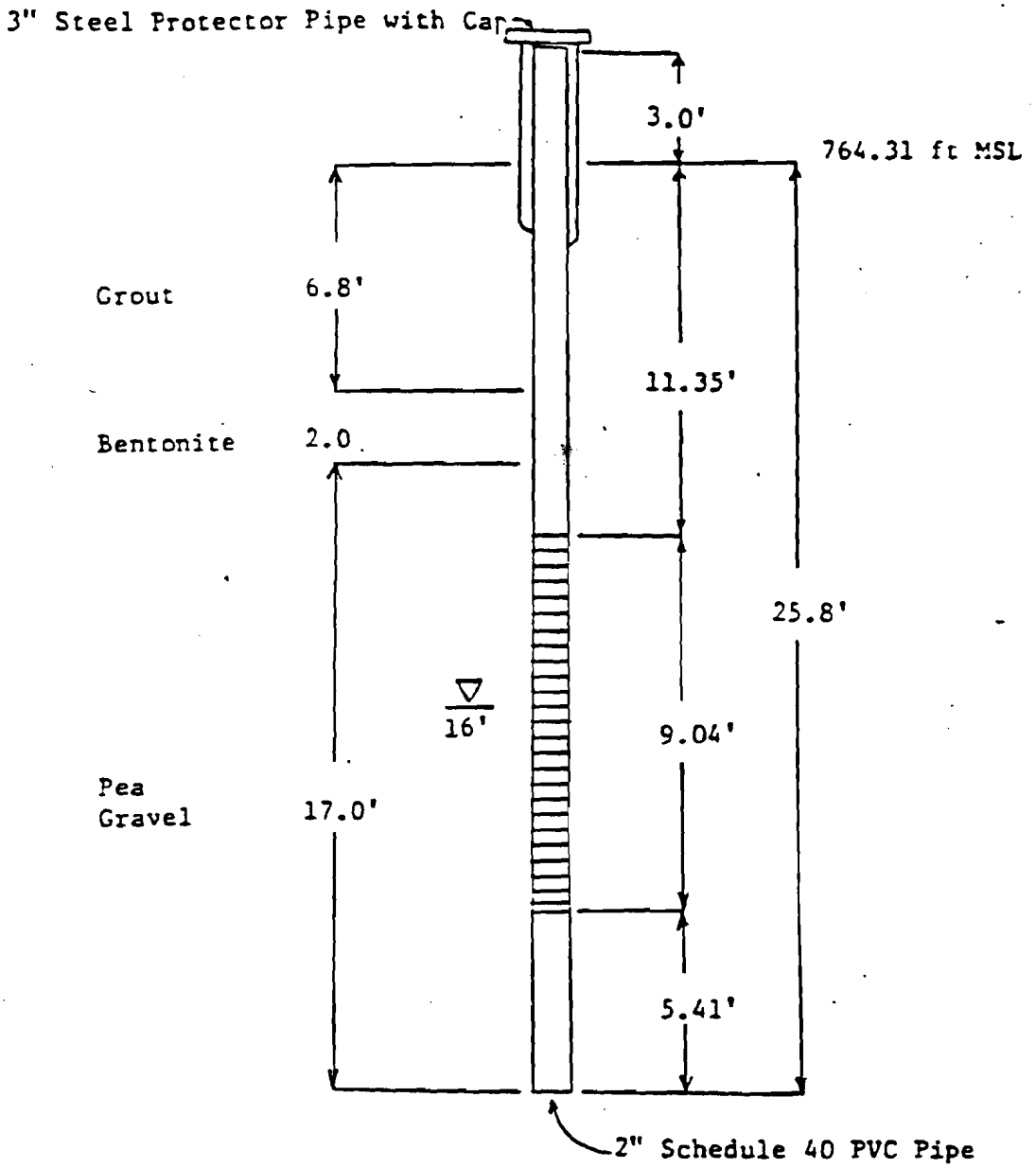


724.37 ft MSL

Sandstone (60%) and shale (40%): very fine sandstone interbedded with black soft shale ding consists of very fine lamina, randomly displaying irregular near shore deposition.

Shale: dark grey, sandy, uniform, soft

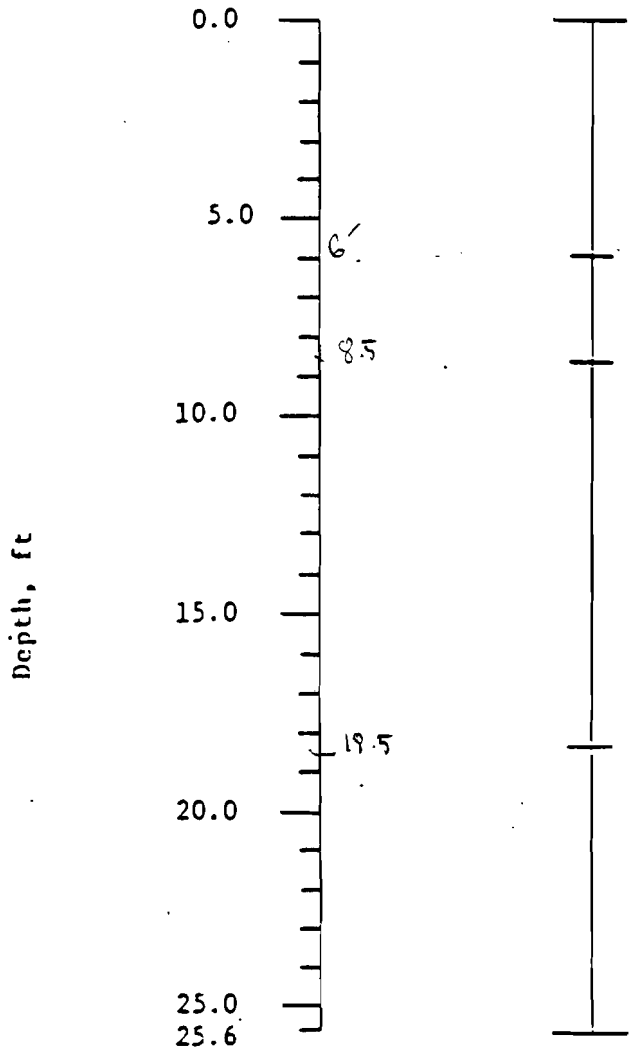
NWSC, Crane, Indiana
Building 146 Ordnance Demil Faci
Lithology
Boring Number: WES-14-1-83



▽ Water Depth at Time of Drilling

▤ Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-2-8



764.31 ft MSL

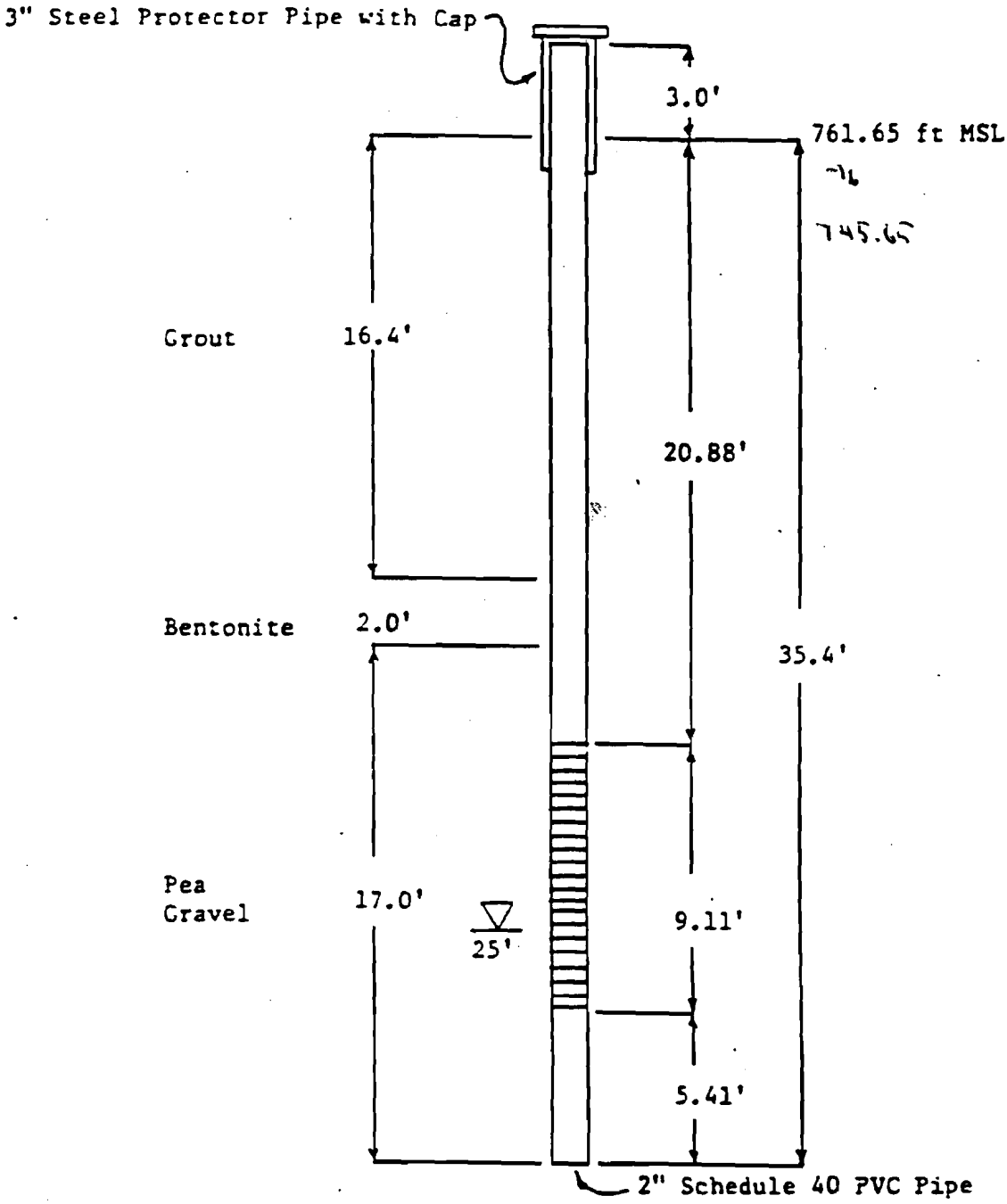
Clay(CL): brown, soft, damp, organic matte:

Clayey sand(SC): brown, soft to stiff, ver: fine-grained sand, uniform, slightly damp.

Sandstone: brown, dark brown, very fine-grained sand (quartz), wet from 15 to 16 ft

Shale: dark grey and brown, soft.

NWSC, Crane, Indiana
Building 146-Ordnance Demil Facility
Lithology
Boring Number: WES-14-2-83

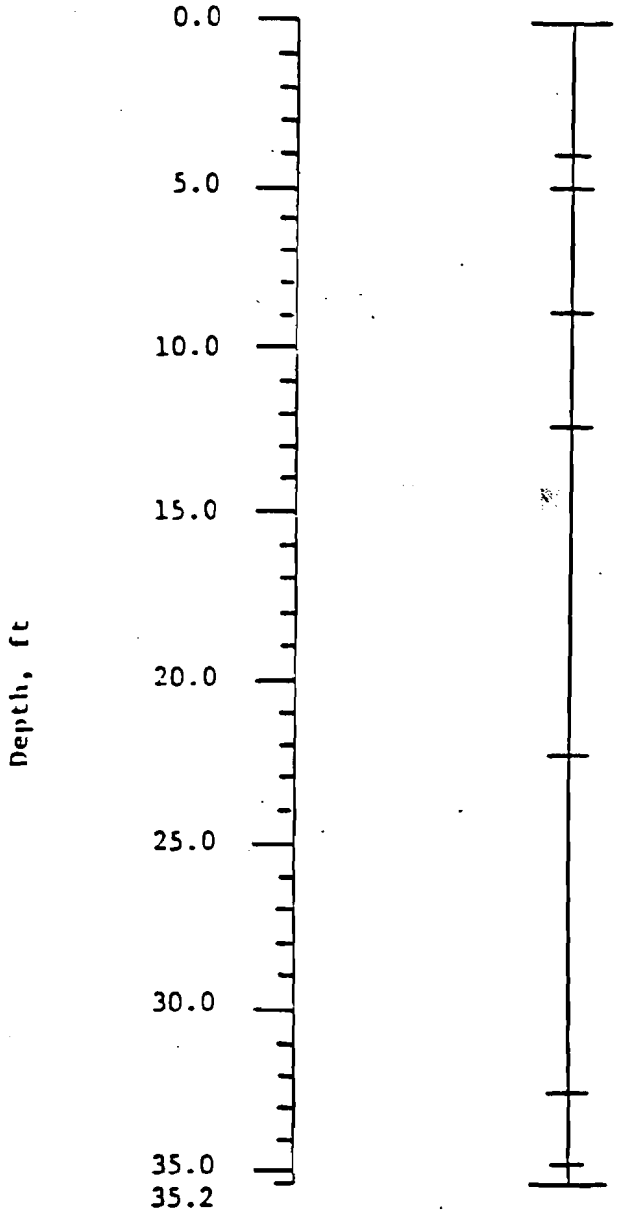


Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-3-83

James May *Ralph knows he will call
(601) 634-3395



761.65 ft MSL

Clay (CL): brown, soft, sandy, damp, organic matter (roots)

Clay (CL): greenish grey, very soft,

Sandstone: brown, soft, very fine-gra: clay lenses

Shale: brown, weathered, hard from 8.1 11 ft (iron)

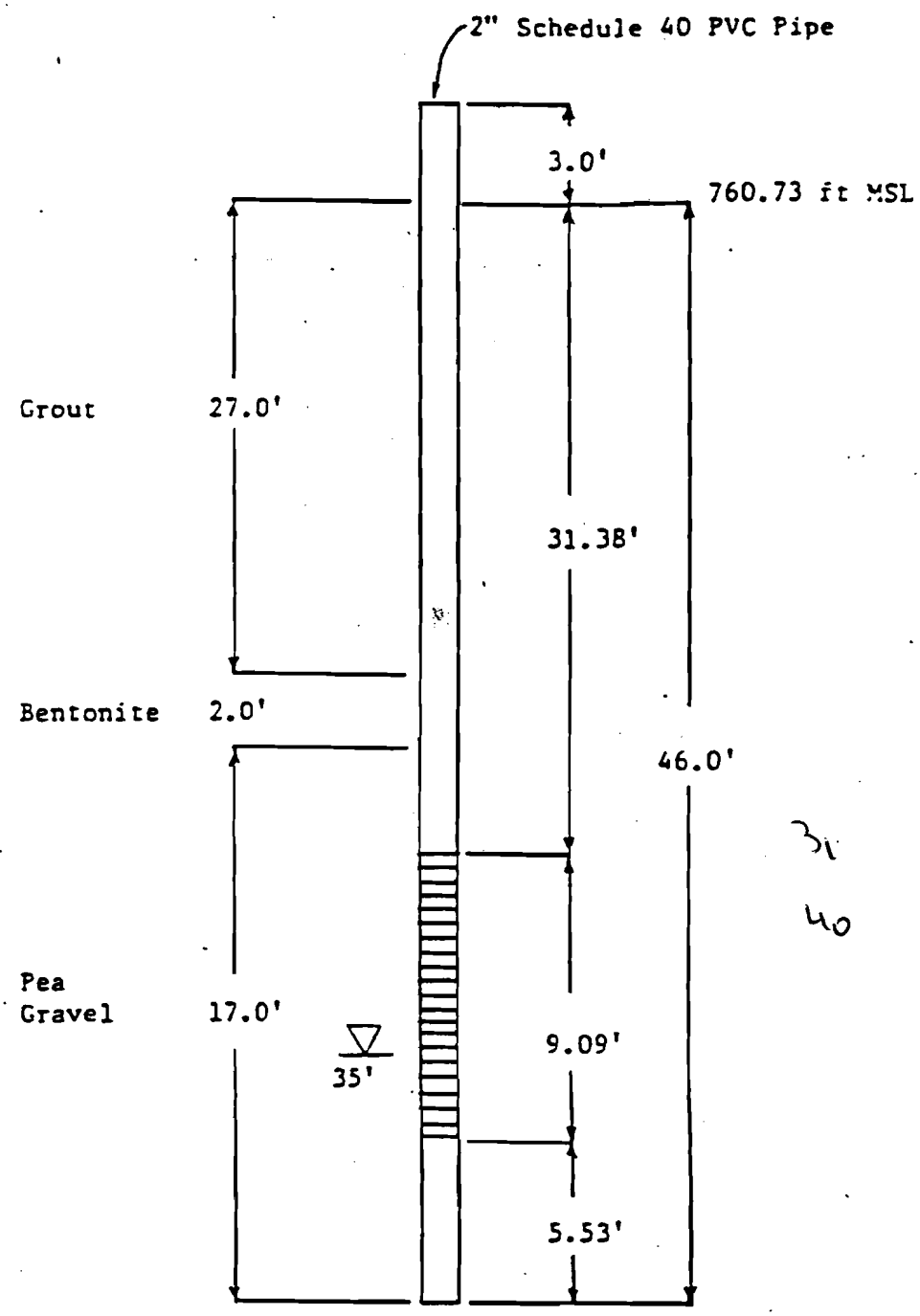
Sandstone: brown, grey (beginning at 15 ft), very fine-grained, soft

Shale: grey, dark grey, soft, water a 25 ft

Coal: black, soft (bituminous)

Shale: see above

NWSC, Crane, Indiana
Building 146-Ordnance Demil Fa
Lithology
Boring Number: WES-14-3-C3

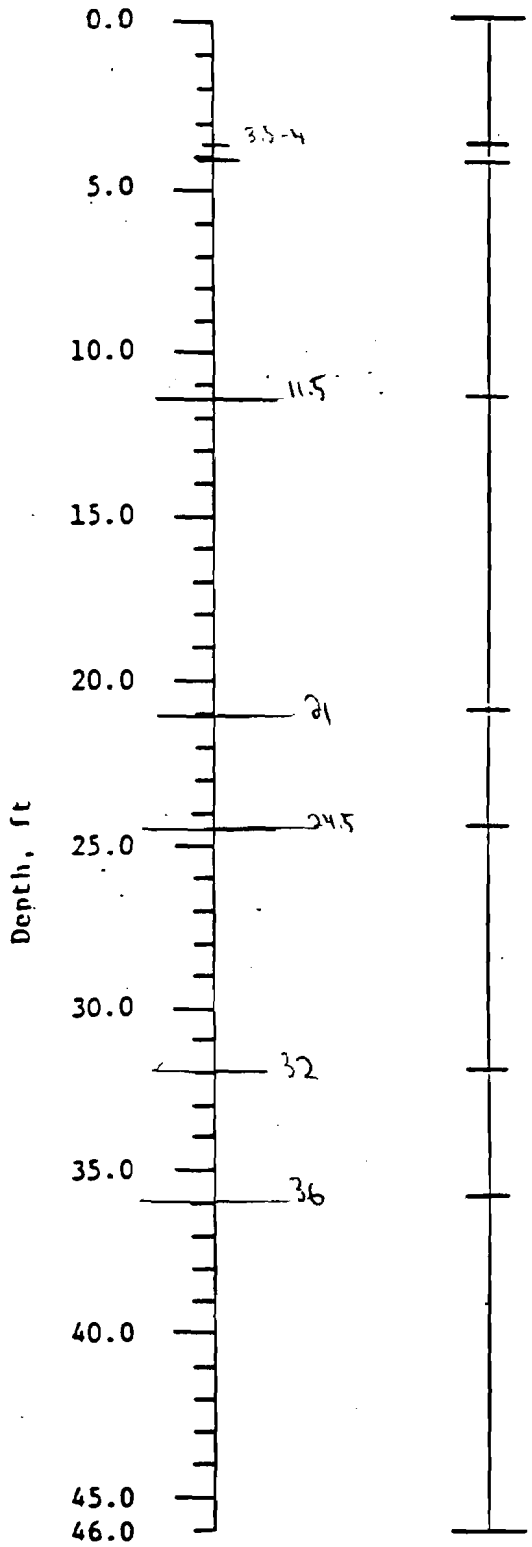


31
40

Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-4-B3



760.73 ft MSL

Sandy silt (ML): brown with grey streaks, soft, damp, very fine-grained sand.

Coal: black, soft, earthy

Siltstone: light to dark grey, light brown, soft.

Shale: grey, red (13.3 - 13.8 ft), soft

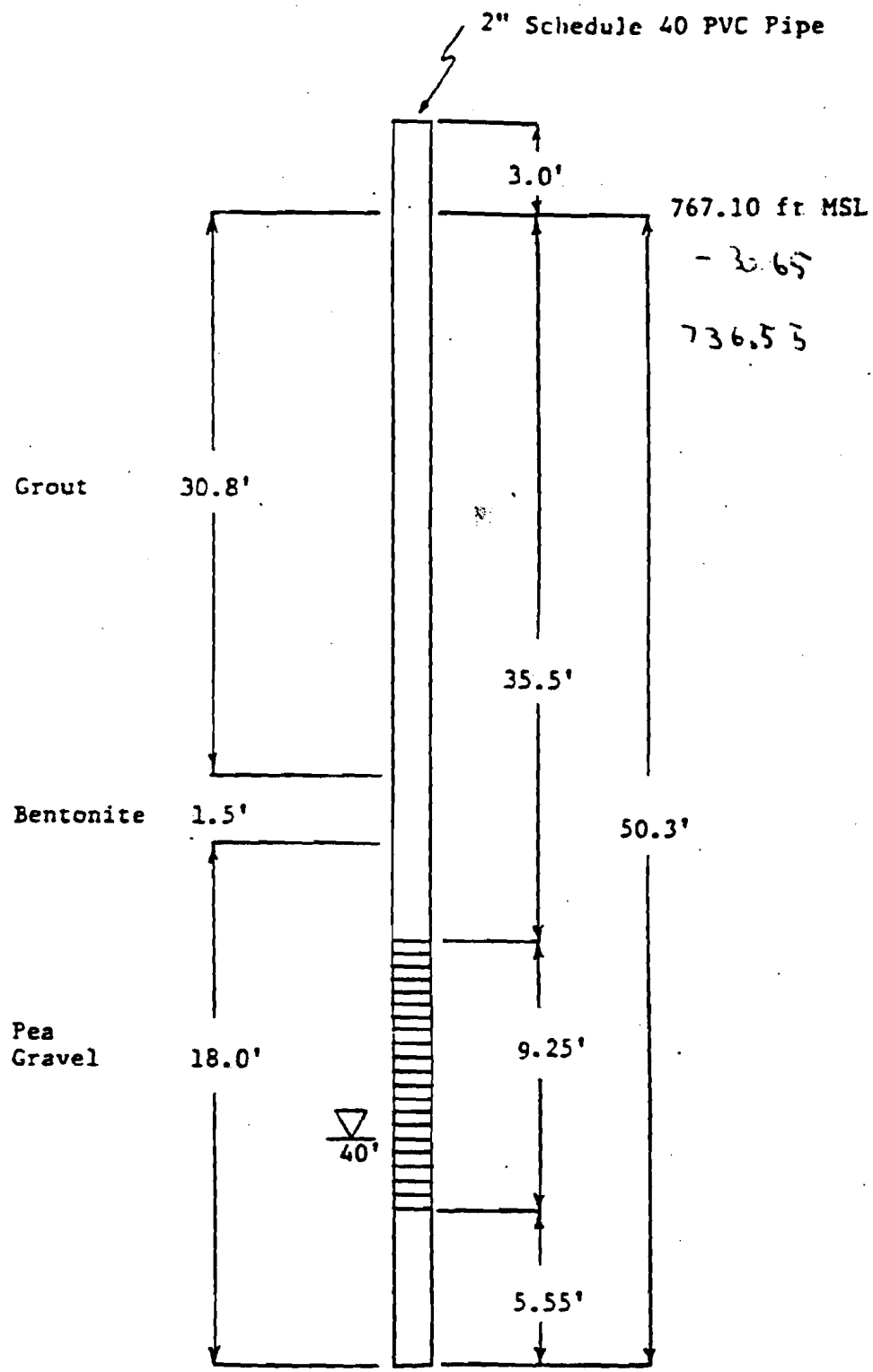
Sandstone and shale: grey to dark grey, sof thinly bedded, soft.

Shale: dark grey, soft

Coal: black, soft, wet between 35-36 ft (bituminous)

Sandstone and/or shale (?)- no cuttings, very wet

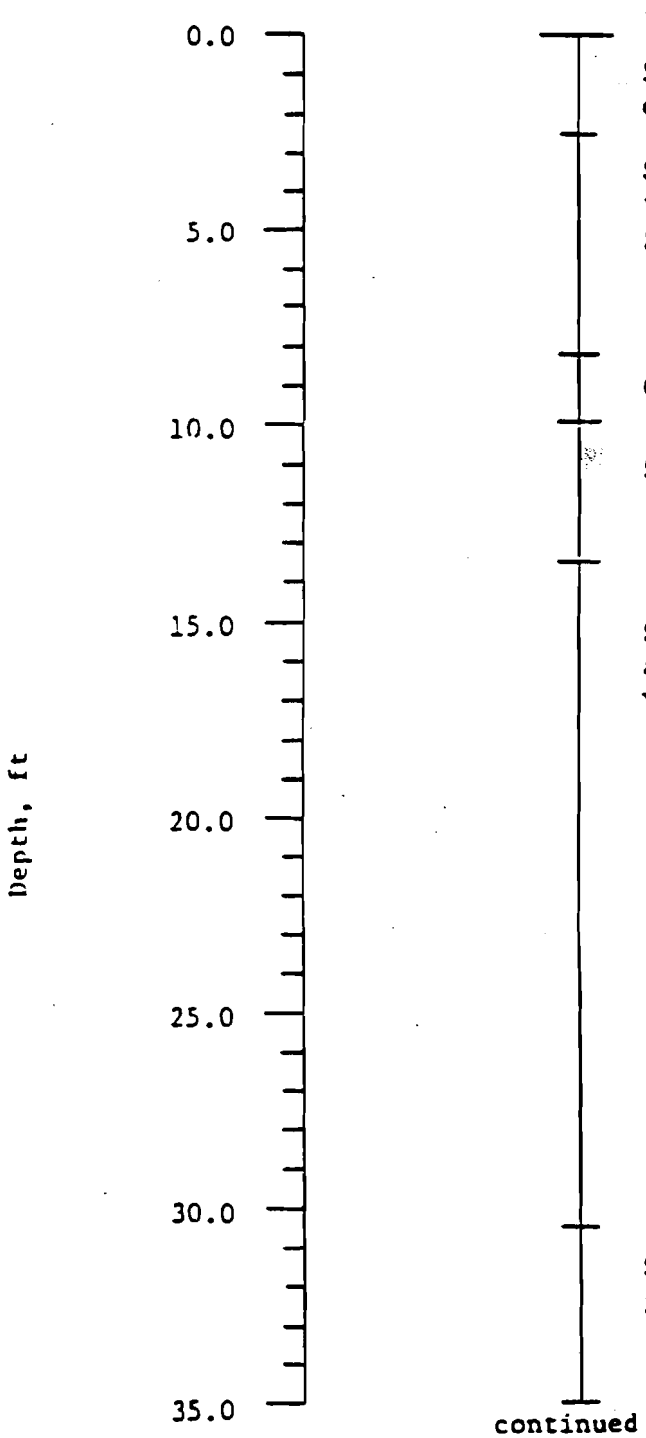
NWSC, Crane, Indiana
Building 146-Ordnance Demil Facility
Lithology
Boring Number: WES-14-4-83



Water Depth at Time of Drilling

Well Screen

NWSC, Crane, Indiana
Building 146-Ordnance
Demil Facility
Well Completion
Boring Number: WES-14-5-83



767.10 ft MSL

Sandy clay(CL): brown, soft to very stiff dry, sandy- very fine-grained sand.

Sandstone and clay: brown, reddish brown, thinly bedded, weathered, soft, very fine-grained sandstone.

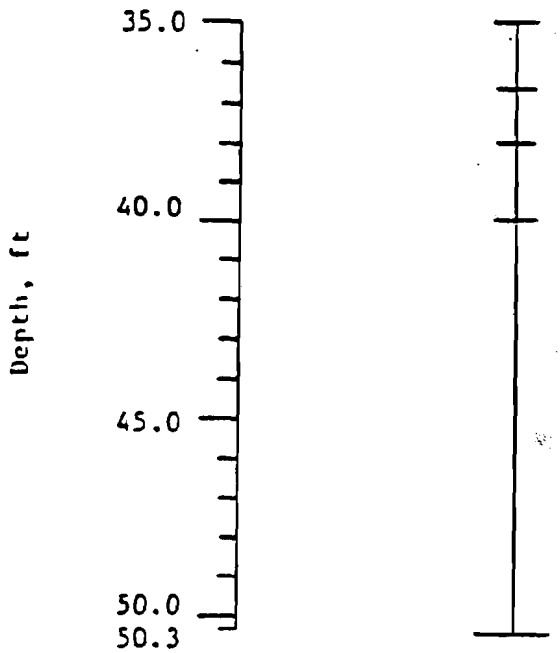
Coal: black, soft

Shale: light grey, soft, uniform

Sandstone and shale: light brown to brown and light grey to dark grey thinly bedded very fine-grained sandstone, soft.

Shale: grey, soft, uniform, sandy - fine grained.

NWSC, Crane, Indiana
Building 146-Ordnance Demil Facility
Lithology
Boring Number: WES-14-5-83



732.10 ft MSL

Coal: black, soft, brittle, uniform - bituminous.

Shale: grey, soft, thinly bedded with very fine-grained sandstone.

Sandstone: grey, shaley, very fine-grained

Shale: grey, soft, thinly bedded with very fine-grained sandstone.

NWSC, Crane, Indiana
Building 146-Ordnance Demil Facility
Lithology
Boring Number: WES-14-5-83

APPENDIX G

ANALYTICAL STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE SUBMITTALS

Laucks Testing Laboratory, Triangle Laboratory, and NSWC Crane Laboratory Analytical Standard Operating Procedures (SOPs) have previously been submitted as part of other QAPPs. All SOPs for Microseeps Laboratory have not appeared in any previous Crane QAPPs and are presented here for the first time. Laucks Testing Laboratory and Triangle Laboratory SOPs were submitted as part of the approved Quality Assurance Project Plan for Ammunition Burning Grounds Little Sulphur Creek and Jeep Trail Resource Conservation and Recovery Act Phase III RCRA Facility Investigation. NSWC Crane Laboratory analytical SOPs were submitted as part of the approved Work Plan for RCRA Facility Investigation Corrective Measures Study and Risk Assessment at Solid Waste Management Unit 2-Dye Burial Grounds. All analytical SOPs utilized for analysis of samples collected at SWMUs 12, 13, 16, and 19 are listed. However, analytical SOPs which have not changed are incorporated by reference and only SOPs which have been changed are included in this submission and are shown in italics in the Appendix I Table of Contents.

APPENDIX G.1

LAUCKS TESTING

ANALYTICAL STANDARD OPERATING PROCEDURES

LABORATORY STANDARD OPERATING PROCEDURES (SOPs)
TABLE OF CONTENTS

SOP No.	REV No.	QAPP/WP	TITLE
LAUCKS TESTING LABORATORIES			
LTL-1001	4	126[1]	Elements of SOP and Method Formats
LTL-1002	5	126[1]	Document Tracking and Control
LTL-1003	2	126[1]	Chain-of-Custody and Documentation Procedures
LTL-1004	4	126[1]	Documentation of Analyst Competence and Training
LTL-1005	5	126[1]	Analytical Balances
LTL-1006	3	126[1]	Refrigerator, Freezer, and Oven Thermometer Calibration and Maintenance
LTL-1007	3	126[1]	Use of Instrument Records and Logbooks
LTL-1008	6	126[1]	QC Corrective Action
LTL-1009	3	126[1]	Blind Spike Program
LTL-1011	4	126[1]	Procedures for the Determination and Reporting of Detection Limits, Reporting Limits, Precision and Accuracy Studies, and Control Limits
LTL-1012	2	126[1]	Solvent QC Monitoring for Trace Residue Analysis
LTL-1013	4	126[1]	Preparation, Storage, Shelf Life and Traceability Documentation of Standards and Reference Materials
LTL-1017	1	126[1]	Internal Audit Procedures
LTL-1018	1	126[1]	Overview of Review and Approval Practices for Validatable Data Packages
LTL-1019	2	166[2]	Controlling, Maintaining, and Monitoring Laboratory Logbooks
LTL-1020	2	166[2]	Integration of IC, GC, HPLC and GCMS Peaks
LTL-2001	6	166[2]	Waste Segregation and Disposal
LTL-3000	12	166[2]	Extraction Method for Base, Acid and Neutral Compounds in Water (8270C by 3520C)
LTL-3001	4	166[2]	Extraction Method for Polynuclear Aromatics in Water (8270C by 3520C)
LTL-3011	2	166[2]	Extraction Method for Chlorinated Herbicides in Soil (8151A by 3550B)
LTL-3077	5	166[2]	Extraction Method for Ordnance Compounds in Water
LTL-3100	11	126[1]	Extraction Method for Base, Acid and Neutral Compounds in Soils (8270C by 3550B)
LTL-3101	2	166[4]	Extraction Method for Base, Acid and Neutral Compounds in Soil (8270D by 3545A)
LTL-3161	5	166[2]	Extraction Method for Ordnance Compounds in Soils (8330)
LTL-3202	3	166[2]	Extraction Method for Organochlorine Pesticides and Polychlorinated Biphenyls in Water (8081A/8082 by 3510C)

LABORATORY STANDARD OPERATING PROCEDURES (SOPs)
TABLE OF CONTENTS

SOP No.	REV No.	QAPP/WP	TITLE
LTL-3302	2	126[1]	Extraction Method for Organochlorine Pesticides and Polychlorinated Biphenyls in Soil (8081A/8082 by 3550B)
LTL-3303	2	166[4]	Extraction Method for Organochlorine Pesticides and Polychlorinated Biphenyls in Soil (8081B/8082A by 3545A)
LTL-3450	1	126[1]	Extraction Method for Polynuclear Aromatics in Soil (8270C by 3550B)
LTL-3451	3	166[4]	Extraction Method for Polynuclear Aromatics in Soil (8270D by 3545A)
LTL-3510	8	166[2]	Extraction Method for Chlorinated Herbicides in Water (8151A by 3510C)
LTL-3550	5	166[2]	Extraction Method for Picric and Picramic Acids in Water (3510C)
LTL-3555	4	166[2]	Extraction Method for Piciric and Picramic Acids in Soil (3550B)
LTL-4002	6	126[1]	Electronic Sample Entry and Log-In
LTL-4103	0	126[1]	Reviewing a Sample Delivery Group (SDG) and Updating Projects in the LIMS
LTL-4201	0	126[1]	Package Deliverables for all Reporting Levels
LTL-6006	0	166[2]	Cation –Exchange Capacity of Soils (Sodium Acetate) by SW 846 Method 9081
LTL-6008	0	166[2]	The Determination of Acid Volatile Sulfides and Simultaneously Extracted Metals in Sediment
LTL-7003	2	126[1]	Inorganic Glass Cleaning Procedure
LTL-7009	3	126[1]	Microwave Assisted Acid Digestion of Aqueous Samples and Extracts Using SW846 Method 3015
LTL-7010	3	166[2]	Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy by SW846 Method 3010A
LTL-7012	1	126[1]	Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils Using SW846 Method 3015
LTL-7015	1	126[1]	Acid Digestion of Sediments, Sludges, and Soils Using SW846 Method 3050B
LTL-7202	4	126[1]	Metals Analysis Using Inductively Coupled Plasma – Mass Spectrometry (ICP/MS) SW846 Method 6020
LTL-7501	2	166[2]	Operation of the PE FIMS 400 for the Analysis of Hg.
LTL-8000	2	126[1]	Determination of Retention Time Windows
LTL-8019	4	166[2]	Determination of Non-Halogenated Volatile Organics by SW 8015B
LTL-8084	5	166[2]	Analysis of Organochlorine Pesticides and PCBs by SW 846 Methods SW 8081A and 8082
LTL-8151	4	166[2]	Analysis of Chlorinated Herbicides by 8151A

LABORATORY STANDARD OPERATING PROCEDURES (SOPs)
TABLE OF CONTENTS

SOP No.	REV No.	QAPP/WP	TITLE
LTI-8265	4	166[2]	Determination of Volatile Organic Compounds by Method 8260B
LTL-8277	2	166[2]	Determination of Polynuclear Aromatic Hydrocarbon Compounds by Selective Ion Monitoring (SIM) Method 8270C
LTL-8279	7	166[2]	Determination of Semivolatile Organic Compounds by Method 8270C and 8270D
LTL-8302	1	126[1]	HPLC Ordnance 8330 Data Review
LTL-8303	5	166[2]	Determination of Picric and Picramic Acid
LTL-8330	11	166[2]	Determination of Nitroaromatics and Nitramines by SW-846 Method 8330
LTL-9104	3	166[2]	Preparation and Analysis of Total and Amenable Cyanide According to EPA Methods 335.1, 335.3, and SW 846 9012A
LTL-9109	4	166[4]	Ammonia Analysis by Lachet Auto-Analyzer, EPA Method 350.1
LTL-9110	8	166[2]	Determination of Anions by Ion Chromatography by Method 300.0A or 9056
LTL-9113	2	166[2]	pH in Soil and Waste Samples Using SW846 Method 9045C
LTL-9115	3	166[2]	The Determination of Total Organic Carbon in Water Samples by EPA415.1 and SW-846 9060
LTL-9116	6	166[2]	The Determination of Total Organic Carbon in Soil/Sediment Samples Using Modified SW-846 Method 9060
LTL-9125	3	166[4]	Nitrate/Nitrite as Non-Lachet by EPA Method 353.2
LTL-9136	0	166[2]	Determination of Perchlorate by Ion Chromatography by EPA Method 314.0
LTL-9202	3	166[2]	Total Suspended Solids (Non-Filterable Residue) Using EPA Method 160.2
TRIANGLE LABORATORY			
2.04	6	166[2]	Nonconformance
5.01	10	166[2]	Sample Receipt, Identification, Handling, and Storage
DSP 105	16	166[2]	Extraction of PCDD/PCDF from Solids (not tissue) – 8290
DSP 161	18	166[2]	Extraction of PCDD/PCDF from Water for Methods 1613, 8290, and 551
DHR 182	9	166[2]	PCDDs and PCDFs by HRGC/HRMS – Method 8290
DPA 104	12	166[2]	Data Package Assembly and Shipping

LABORATORY STANDARD OPERATING PROCEDURES (SOPs)
TABLE OF CONTENTS

SOP No.	REV No.	QAPP/WP	TITLE
NSWC CRANE LABORATORY			
CR4052-PD-0001	1	166[2]	Quality Assurance and Control Plan
CR4052-PD-0100	3	166[2]	Document Control
CR4052-PD-0150	4	166[2]	Record Retention
CR4052-PD-0200	3	166[2]	Preventive Maintenance
CR4052-PD-0220	0	166[2]	Chemical/Supply Management
CR4052-PD-0250	1	166[2]	Calibration
CR4052-PD-0300	0	166[2]	Training Overview
CR4052-PD-0450	0	166[2]	Performance Evaluation
CR4052-PD-0500	1	166[2]	Chain of Custody: Soil and Water Samples
CR4052-PD-0600	2	166[2]	Customer Reports
CR4052-PD-0700	0	166[2]	Glassware Cleaning Procedure
CR4052-PD-2500	0	010[3]	Determination of Organic Colorants in Environmental Matrices by HPLC
MICROSEEPS LABORATORY			
SOP-ADM10	1	166[4]	Standard Operating Procedure for Glassware Washing
SOP-AM20GAx	2.1	166[4]	Analytical Method AM20GAx Standard Operating Procedure for the Analysis of Biodegradation Indicator Gases
SOP-PM01G	1.2	166[4]	Standard Operating Procedure for the Preparation of Samples for the Analysis of Biodegradatoin Indicator Gases

Shading indicates SOPs that have been revised or that have not been included in previous QAPPs.

1 "Quality Assurance Project Plan for Ammunition Burning Grounds Little Sulphur Creek and Jeep Trail Resource Conservation and Recovery Act Phase III RCRA Facility Investigation," NSWC Crane, April 2001.

2 "Quality Assurance Project Plan for Mine Fill A (SWMU 12), Mine Fill B (SWMU 13), Cast High Explosives Fill/B146 Incinerator (SWMU 16), and Pyrotechnic Test Area (SWMU 19) RCRA FRI Investigation," NSWC Crane, February 2002.

3 Risk Assessment Work Plan for Risk Assessment at SWMUs 4, 5, 9, and 10," August 2000.

4 "Quality Assurance Project Plan Addendum No. 1 for Mine Fill A (SWMU 12), Mine Fill B (SWMU 13), Cast High Explosives fill/B146 Incinerator (SWMU 16), and Pyrotechnic Test Area (SWMU 19) RCRA RFI Investigation," NSWC Crane, September 2003.

SOP No.—standard operating procedure number.
REV No.—SOP revision number.
QAPP—quality assurance project plan.
WP—work plan.

Extraction Method for Base, Acid and Neutral Compounds in Soil (8270D by 3545A)

Method # LTL-3101

May 28, 2002

Revision Number: #2

Written by: B. O'Neill Date: 5-28-02

Reviewed by: Harry Romberg Date: 6-21-02

Approved by: Kathy E Greps Date: 6-21-02

Controlled Document

No. 20 Assigned to: TETC

1. **PURPOSE** - In this method base, acid and neutral compounds are extracted from neutral soils with a mixture of methylene chloride and acetone. The extract is dehydrated, concentrated in a Kuderna-Danish (K-D) apparatus and GPC cleaned prior to analysis by GC Mass Spectrometer. This method provides for soils of low and medium levels of contamination.

2. **SAFETY** - During the conduct of this method, the analyst will be exposed to a number of reagent chemicals and solvents. The health effects of these various chemicals may be ascertained by reading the material safety data sheets (MSDS) available in the general files. Additionally, the samples, by their very nature may contain significant levels of hazardous materials. It is incumbent on each analyst to exercise due care and caution executing this method. The company will provide any protective equipment or clothing needed to assure employee safety.

3. **REAGENTS**

3.1. All reagents are to be AR grade or better.

3.2. All solvents are to be distilled in glass, unless otherwise noted.

3.3. The following special reagents should be prepared:

3.3.1. 1:1 methylene chloride/acetone (v/v)- prepared by mixing equal volumes of the solvents.

3.3.2. Anhydrous sodium sulfate - prepared by muffling AR grade sodium sulfate for four hours at 400°C.

3.3.3. Ottawa Sand - prepared by soxhleting for 8 hours with methylene chloride, air dry for two hours in a hood, followed by two hours in a 100°C oven.

3.3.4. Surrogate solution prepared in methanol:

Base/Neutrals	Nitrobenzene-d5	200 ug/ml
	p-Terphenyl-d14	200 ug/ml
	2- Fluorobiphenyl	200 ug/ml
	1,2-Dichlorobenzene-d4	200 ug/ml
Acids	Phenol-d5	300 ug/ml
	2,4,6-Tribromophenol	300 ug/ml
	2-Fluorophenol	300 ug/ml
	2-Chlorophenol-d4	300 ug/ml

3.3.5. Matrix spiking solution prepared in methanol.

Base/Neutrals	1,2,4-Trichlorobenzene	100 ug/ml
	Acenaphthene	100 ug/ml
	2,4-Dinitrotoluene	100 ug/ml
	Pyrene	100 ug/ml
	n-Nitroso-di-n-propylamine	100 ug/ml
	1,4-Dichlorobenzene	100 ug/ml
Acids	Pentachlorophenol	150 ug/ml
	Phenol	150 ug/ml
	2-Chlorophenol	150 ug/ml
	4-Chloro-3-methyl phenol	150 ug/ml
	4-Nitrophenol	150 ug/ml

4. EQUIPMENT

4.1. Dionex Accelerated Solvent Extractor - Model ASE 200 - Maintain per manufacture's instructions.

4.1.1. 33 ml sample cells

4.1.2. Cellulose filters

4.2. Analytical Biochemical Laboratories, Inc. (ABC) Model 1002B or Model 1000 Gel-Permeation Chromatography (GPC)

4.3. Organomations Assoc., Inc. - N-EVAP (nitrogen evaporator), Model 112

4.4. Standard laboratory glassware to include:

4.4.1. 8 ounce extraction bottles

4.4.2. Small filling funnels

4.4.3. 60 ml collection vials

4.4.4. K-D apparatus: 250 ml. K-D flask, 10 ml or 25 ml ampule and three-ball snyder column.

4.5. All glassware to be rinsed as follows, prior to use:

4.5.1. Technical grade acetone (if the glassware is wet).

4.5.2. Triple rinsed with methylene chloride.

4.6. Volumetric measurements are to be made with a calibrated fixed or adjustable volume microdispenser and individually calibrated vials.

5. **QUALITY CONTROL** - The normal level of quality control will consist of blanks, blank spikes, matrix spikes and matrix spike duplicates (MS and MSD). This is performed on a per batch basis to include no more than 20 samples. The level of quality control will be indicated to the extractionist at the time the job is assigned. These samples serve to provide a measure of the recovery efficiency for the analyte and to provide data for statistical evaluation of the sample. In those instances that a client requires additional or different quality control measures, the extractionist will be directed accordingly in writing.

6. **METHODOLOGY**

NOTE: It is necessary to make an intuitive decision as to which level extraction procedure to follow. If the soil appears clean with little odor, do a low level extraction. If the soil has appreciable odor, is tar-like, partially miscible, or has an oily appearance, prep both a low and a medium level extraction. Totally miscible samples may only have a medium level extraction. Remember it is important that holding times be met. If you are in doubt, prep and store a medium level sample simultaneously.

6.1. Sample Extraction

6.1.1. Mix sample thoroughly in its original container if there is space available otherwise mix in solvent rinsed aluminum tray.

6.1.2. Weigh 15.0 grams of soil (wet weight) into a extraction bottle. (Medium Level: 2.00 grams)

6.1.3. Prepare two additional aliquots of a sample if Quality Control is required.

6.1.4. Add 10 grams sodium sulfate and mix well to give the soil a sandy texture.

6.1.5. Insert cellulose filter into bottom of sample cell.

6.1.6. Using a small filling funnel, add approximately one gram sand to bottom of sample cell

6.1.7. Transfer sample to cell.

6.1.8. Prepare a blank and a blank spike with sodium sulfate.

6.1.9. Pipet 250 ul surrogate solution to each cell.

6.1.10. Pipet 250 ul matrix spiking solution to each QC cell.

6.1.11. Fill cell to within 1 cm of top with sand or sodium sulfate and cap.

6.1.12. Fill solvent reservoir with 1:1 methylene chloride/acetone.

6.1.13. Align trays and start.

6.2. Solvent dehydration

6.2.1. Prepare a glass funnel by plugging with glass wool, and filling 1/4 full with sodium sulfate.

6.2.2. Pre-rinse the sodium sulfate by passing 40 ml methylene chloride through the prepared funnel.

6.2.3. Pass the extract from step 6.1.13. through the funnel and collect in an assembled K-D apparatus.

6.2.4. Rinse the collection vessel with several 10 ml methylene chloride rinses.

6.2.5. Rinse the sodium sulfate with 25 ml of methylene chloride.

6.3. Solvent evaporation

6.3.1. Assemble the full K-D apparatus with a snyder column prewet with 2-3 ml of methylene chloride.

6.3.2. Immerse K-D apparatus into a hot water bath, using a bath temperature of 90° C, with a long ampule immersed to a depth of 12 ml. Regulate the evaporation time to take approx. 30 minutes.

6.3.3. Reduce the volume to 4-5 ml, remove the apparatus from the water bath and cool to room temperature.

6.3.4. Rinse joint and remove snyder column. Allow rinse solvent to drain into ampule.

6.3.5. Remove the ampule clamp, and wipe the joint with a Kimwipe. Separate the ampule and rinse the joint with a small amount of solvent.

6.3.6. Reduce the extract volume to less than 8 ml on a nitrogen blowdown. Transfer extract to a 16 x 100 mm culture tube, and adjust to 10.0 ml intermediate volume (as compared to a measured volume) with methylene chloride.

6.3.7. At this point the extract will be GPC cleaned -- see Method # LTL-3692.

6.3.8. K-D the GPC cleaned extract. Reduce the extract to 0.5 ml in a warm water bath with nitrogen. Rinse internal walls of ampule several times during blowdown.

6.3.9. Transfer the extract to a 1.8 ml vial. The final volume is then adjusted to 0.5 ml (as compared to a measured volume) in methylene chloride.

6.3.10. Label the extract and deliver to 940.

6.3.11. Complete all paperwork and bench sheet. Bench sheet to include the cleanup method #, date of GPC, date and time of transfer to 940 and extract location. Clip the T-Card on the folder and place in GC/MS room extraction folder box. The file folder color will be blue and the blank name will be ____MSV.SL_. (Medium Level: ____MSV.SM_.)

8. **REFERENCES** - The following USEPA methods are the official methods on which this Laucks Testing Laboratory method is based. The primary methods are those which most closely parallel the Laucks procedure and are referenced by their USEPA series and number. In those instances for which there are no official EPA methods, the most suitable reference is given under the miscellaneous references section. The additional reference section cites those methods which contain additional information. These methods will frequently be official methods, which apply in part to, or support the Laucks method.

PRIMARY REFERENCES:

Test Methods for Evaluating Solid Waste, USEPA, SW-846

8270D (1998), 3545A (1998), 3640A (1996)

Extraction Method for Organochlorine Pesticides and Polychlorinated Biphenyls in Soil (8081B/8082A by 3545A)

Method # LTL-3303

November 13, 2002

Revision Number: #2

Written by: B. O'Quill Date: 11-13-02

Reviewed by: Harry Romberg Date: 11-13-02

Approved by: Kathy Grepp Date: 11-13-02

Controlled Document

No. 870 Assigned to: TETA

1. **PURPOSE** - In this method organochlorine pesticides and polychlorinated biphenyls are extracted from neutral with a mixture of methylene chloride and acetone. The extract is dehydrated and concentrated in a Kuderna-Danish (K-D) apparatus. Pesticide/PCB extracts are GPC cleaned prior to analysis by GC. The PCB only extracts are sulfuric acid cleaned prior to analysis by GC.

2. **SAFETY** - During the conduct of this method, the analyst will be exposed to a variety of reagent chemicals and solvents. The health effects of these various chemicals may be ascertained by reading the material safety data sheets (MSDS) available in the general files. Additionally, the samples, by their very nature, may contain significant levels of hazardous materials. It is incumbent on each analyst to exercise due care and caution executing this method. The company will provide any protective equipment or clothing needed to assure employee safety.

3. **DEFINITIONS**

Method Blank – An analytical control consisting of all reagents and surrogate standards that is carried throughout the entire analytical procedure. The method blank is used to define the level of laborataory, background, and reagent contamination.

Method Blank Spike - An analytical control consisting of all reagents, target analytes, and surrogate standards that is carried throughout the entire analytical procedure.

Matrix Spike – Aliquot of a matrix spiked with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

Matrix Spike Duplicate – A second aliquot of the same matrix as the matrix spike that is spiked in order to determine the precision of the method.

Surrogates – Compounds added to each blank, blank spike, sample, matrix spike and spike duplicate to evaluate analytical efficiency by measuring recovery.

4 **REAGENTS**

4.1. All reagents are to be AR grade or better.

4.2. All solvents are to be distilled in glass, unless otherwise noted.

4.3. The following special reagents should be prepared:

4.3.1. 1:1 methylene chloride/acetone (v/v)- prepared by mixing equal volumes of the solvents.

4.3.2. Anhydrous sodium sulfate - prepared by muffling AR grade sodium sulfate for four hours at 400°C.

4.3.3. Ottawa Sand - prepared by soxhleting for 8 hours with methylene chloride, air dry for two hours in a hood, followed by two hours in a 100°C oven.

4.3.4. Surrogate solution prepared in acetone:

2,4,5,6-Tetrachloro-m-xylene	1.0 ug/ml
Decachlorobiphenyl	1.0 ug/ml

4.3.5 Pesticide/PCB matrix spiking solution prepared in acetone:

Gamma-BHC	2.5 ug/ml
Heptachlor	2.5 ug/ml
Aldrin	2.5 ug/ml
Aroclor 1260	25.0 ug/ml

4.3.6. PCB Only (AR1660) matrix spiking solution prepared in acetone:

Aroclor 1016	25 ug/ml
Aroclor 1260	25 ug/ml

5. **EQUIPMENT**

5.1. Dionex Accelerated Solvent Extractor - Model ASE 200 - Maintain per manufacture's instructions.

5.1.1. 33 ml sample cells

5.1.2. Cellulose filters

5.2. Analytical Biochemical Laboratories, Inc. (ABC) Model 1002B or - Model 1000 Gel-Permeation Chromatography (GPC)

5.3. Organomations Assoc., Inc. - N-EVAP (nitrogen evaporator), Model 112

5.4. Standard laboratory glassware to include:

5.4.1. 8 ounce extraction bottles

5.4.2. Small filling funnels

5.4.3. 60 ml collection vials

5.4.4. K-D apparatus: 250 ml. K-D flask, 10 ml or 25 ml ampule and three-ball snyder column.

5.5. All glassware and sample cells to be rinsed as follows, prior to use:

5.5.1. Technical grade acetone (if the glassware is wet).

5.5.2. Triple rinsed with methylene chloride.

5.6. Volumetric measurements are to be made with a calibrated fixed or adjustable volume microdispenser and individually calibrated vials.

6. **SAMPLE COLLECTION & PRESERVATION** – Samples are normally collected in glass containers with Teflon-lined caps. All samples and sample extracts are stored at 4°C ± 2°C. Soil samples must be extracted within 14 days of collection.

7. **POLLUTION PREVENTION & WASTE MANAGEMENT** – Sample extracts, standards and solvent rinses are disposed of by depositing them in the hazardous waste container located in the solvent locker. Waste segregation and disposal from the point of collection is further covered in LTL-2001.

8. **PERSONNEL QUALIFICATIONS** – This method is restricted to use by, or under the supervision of, experienced chemist/extractionists who have demonstarated the ability to perform the described extraction procedures and techniques.

9. **QUALITY CONTROL** - The normal level of quality control will consist of blanks, blank spikes, matrix spikes and matrix spike duplicates (MS and MSD). This is performed on a per batch basis to include no more than 20 samples. The level of quality control will be indicated to the extractionist at the time the job is assigned. These samples serve to provide a measure of the recovery efficiency for the analyte and to provide data for statistical evaluation of the sample. In those instances that a client requires additional or different quality control measures, the extractionist will be directed accordingly in writing.

10. METHODOLOGY

10.1. Sample Extraction

10.1.1. Mix sample thoroughly in its original container if there is space available otherwise mix in solvent rinsed aluminum tray.

10.1.2. Weigh 15.0 grams of soil (wet weight) into a extraction bottle.

10.1.3. Prepare two additional aliquots of a sample if Quality Control is required.

10.1.4. Add 10 grams sodium sulfate and mix well to give the soil a sandy texture.

10.1.5. Insert cellulose filter into bottom of sample cell.

10.1.6. Using a small filling funnel, add approximately one gram sand to bottom of sample cell

10.1.7. Transfer sample to cell.

10.1.8. Prepare a blank and a blank spike with sodium sulfate.

10.1.9. Pipet 100 ul surrogate solution to each cell.

10.1.10. Pipet 100 ul matrix spiking solution to each QC cell.

10.1.11. Fill cell to within 1 cm of top with sand or sodium sulfate and cap.

10.1.12. Fill solvent reservoir with 1:1 methylene chloride/acetone.

10.1.13. Align trays and start.

10.2. Solvent dehydration

10.2.1. Prepare a stainless steel funnel by plugging with glass wool, and filling 1/4 full with sodium sulfate.

10.2.2. Pre-rinse the sodium sulfate by passing 40 ml methylene chloride through the prepared funnel.

10.2.3. Pass the extract from 10.1.13. through the funnel and collect in an assembled K-D apparatus.

10.2.4. Rinse the collection vessel with several 10 ml methylene chloride rinses.

10.2.5. Rinse the sodium sulfate with 25 ml of methylene chloride.

10.3. Solvent evaporation

10.3.1. Assemble the full K-D apparatus with a snyder column prewet with 2-3 ml of methylene chloride.

10.3.2. Immerse K-D apparatus into a hot water bath, using a bath temperature of 90°C, with a long ampule immersed to a depth of 12 ml. Regulate the evaporation time to take approx. 30 minutes.

10.3.3. Reduce the volume to 4-5 ml, remove the apparatus from the water bath and cool to room temperature.

NOTE: PCB Only: Reduce the volume to 4-5 ml and proceed to solvent exchange, 10.3.8.1. Bring to final volume. The solvent exchange step must be tested. Take 1 ml extract, 1 ml sulfuric acid and vortex. Check for volume changes between layers. If exchange is complete, proceed to 10.4.

10.3.4. Rinse joint and remove snyder column. Allow rinse solvent to drain into ampule.

10.3.5. Remove the ampule clamp, and wipe the joint with a Kimwipe. Separate the ampule and rinse the joint with a small amount of solvent.

10.3.6. Pesticides/PCB: Reduce the extract volume to less than 8 ml on a nitrogen blowdown. Transfer extract to a 16 x 100 mm culture tube, and adjust to 10.0 ml intermediate volume (as compared to a measured volume) with methylene chloride.

10.3.7. At this point the extract will be GPC cleaned -- see Method # LTL-3692.

10.3.8. K-D the GPC cleaned extract to 4-5 ml and exchange into hexane as follows:

10.3.8.1. Add 2-3 ml hexane through the top of the snyder column while the ampule is still immersed in the water bath. Reduce to 4-5 ml.

10.3.8.2. Repeat 10.3.8.1. two additional times.

10.3.9. Remove the apparatus from the water bath and cool to room temperature.

10.3.10. Rinse joint with hexane and remove snyder column. Allow rinse solvent to drain into ampule.

10.3.11. Remove the ampule clamp, and wipe the joint with a Kimwipe. Separate the ampule and rinse the joint with a small amount of hexane.

10.3.12. Reduce the extract to less than 2 ml in a nitrogen blowdown. Transfer extract to a 4.0 ml vial and adjust to a final volume of 2.5 ml (as compared to a measured volume) in hexane. Proceed to 10.4.4. PCB only final volume will be 5.0 ml in a 16 x 100 mm culture tube.

10.4. Sulfuric Acid Cleanup (PCBs only)

10.4.1. Add 2.0 mls concentrated sulfuric acid and vortex for 30 - 60 seconds.

10.4.2. Let stand for a few minutes to allow layers to separate. May be centrifuged.

10.4.3. Transfer extract to a 1.8 ml vial.

10.4.4. Label the extract and deliver to 940.

10.4.5. Complete all necessary paperwork and bench sheet. Bench sheet to include cleanup method #, the date of GPC, date and time of transfer to 940 and extract location. Clip the T-card on the folder and place in the GC room extraction folder box. The file folder color will be purple and the blank name will be ____GPX.SL_. PCB only will be a tan folder and the blank name will be ___GPB.SL_.

11. **REFERENCES** - The following USEPA methods are the official methods on which this Laucks Testing Laboratory method is based. The primary methods are those which most closely parallel the Laucks procedure and are referenced by their USEPA series and number. In those instances for which there are no official EPA methods, the most suitable reference is given under the miscellaneous references section. The additional reference section cites those methods which contain additional information. These methods will frequently be official methods, which apply in part to, or support the Laucks method.

PRIMARY REFERENCES:

Test Methods for Evaluating Solid Waste, USEPA, SW-846

8081B (2001), 8082A (2001), 3545A (1998), 3640A (1994), 3665A (1996)

Yakima

EXTRACTIONS BENCH SHEET FORM

LAUCKS TESTING LABORATORIES INC.	EXTRACTION	DATE	METHOD	ANALYST	CHECKER	ANALYSIS
JOB NUMBER: 0107011	PCB	7.2.01	3545A	BDD/SO	BDD 7.3.01	8082A
MATRIX: Soil						

Sample #	wt./vol.	7.0mO	To Acid	To 940			STD#	Bal#
0107011-1	15.0g	5.0mL	5.0mO	~1.0mL			AK046	1
2								2
3								3
4								4
4MS								1
4MSD								1
5								5
6								6
S070201GPXSLG								
B070201GPXSLG								

BDD 7-2-01

COMMENTS:

Ext Sol: MeCl2/Acetone - BGJ# CA561/EM# 39022
Wind Sol: Hexane - EM# 40163
3665A - acid cleanup
Remaining extract at 921

SURROGATES:
100 ul of: Ex 8-45-9
ul of:

SPIKES:
100 ul of: Ex 8-47-9
ul of:

STANDARDS:
ul of:
ul of:
ul of:

Fraction and Method	Extraction		Transferred from 921 to 940		Extract Location	Analysis	
PCB	Time out 0920	Time in 0950	Time out 1635	Time in —	Tray# 2-169	Time out	Time in
	Date 7.2.01	Initials JL	Date 7.5.01	Initials AGH	FS-F14	Date	Initials
	Time out	Time in	Time out —	Time in 1635		Time out	Time in
	Date	Initials	Date	Initials		Date	Initials

Yakima

EXTRACTIONS BENCH SHEET FORM

LAUCKS TESTING LABORATORIES INC.	EXTRACTION	DATE	METHOD	ANALYST	CHECKER	ANALYSIS
JOB NUMBER: 0107011	Pest / PCB	7-2-01	3545A	BDD / SO	BDD 7-3-01	8081B / 8082A
MATRIX: Soil						

To GPC

Sample #	wt./vol.	7.0	940				SOW#	Bottle #
0107011-1	15.0 g	5.0 ml	2.5 ml				AK046	1
2								2
3								3
4								4
4MS								1
4MSD								1
5								5
6								6
S070201GPXSLG								
B070201GPXSLG								

BDD 7-3-01

COMMENTS:

Ext Sol: MeCl2/Acetone - BGJ# CA561 | EM# 39023
Final Sol: Hexane - EM# 40163
3640A - GPC Date - 7-3-01

SURROGATES:
100 ul of: Eq 8.45.9
ul of:

SPIKES:
100 ul of: Eq 8.47.9
ul of:

STANDARDS:
ul of:
ul of:
ul of:

Fraction and Method	Extraction		Transferred from 921 to 940		Extract Location	Analysis	
Pest / PCB	Time out: 0920	Time in: 0950	Time out: 1635	Time in: —	Tray# 2-169	Time out:	Time in:
	Date: 7-2-01	Initials: JL	Date: 7-5-01	Initials: AGH	FS-#14	Date:	Initials:
	Time out:	Time in:	Time out: —	Time in: 1635		Time out:	Time in:
	Date:	Initials:	Date:	Initials:		Date:	Initials:

Extraction Method for Polynuclear Aromatics in Soil
(8270D by 3545A)

Method # LTL-3451

November 13 2002

Revision Number: #3

Written by: B. O'Neill Date: 11.13.02

Reviewed by: Harry Pombey Date: 11-13-02

Approved by: Kathy Greps Date: 11-13-02

Controlled Document

No. 20 Assigned to: IETR

1. **PURPOSE** - In this method polynuclear aromatics are extracted from neutral soils with a mixture of methylene chloride and acetone. The extract is dehydrated, concentrated in a Kuderna-Danish (K-D) apparatus and alumina cleaned prior to analysis by GC Mass Spectrometer. This method also includes low concentration (SIM).

2. **SAFETY** - During the conduct of this method, the analyst will be exposed to a number of reagent chemicals and solvents. The health effects of these various chemicals may be ascertained by reading the material safety data sheets (MSDS) available in the general files. Additionally, the samples, by their very nature may contain significant levels of hazardous materials. It is incumbent on each analyst to exercise due care and caution executing this method. The company will provide any protective equipment or clothing needed to assure employee safety.

3. **DEFINITIONS**

Method Blank – An analytical control consisting of all reagents and surrogate standards that is carried throughout the entire analytical procedure. The method blank is used to define the level of laborataory, background, and reagent contamination.

Method Blank Spike - An analytical control consisting of all reagents, target analytes, and surrogate standards that is carried throughout the entire analytical procedure.

Matrix Spike – Aliquot of a matrix spiked with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

Matrix Spike Duplicate – A second aliquot of the same matrix as the matrix spike that is spiked in order to determine the precision of the method.

Surrogates – Compounds added to each blank, blank spike, sample, matrix spike and spike duplicate to evaluate analytical efficiency by measuring recovery.

4. **REAGENTS**

4.1. All reagents are to be AR grade or better.

4.2. All solvents are to be distilled in glass, unless otherwise noted.

4.3. The following special reagents should be prepared:

4.3.1. 1:1 methylene chloride/acetone (v/v)- prepared by mixing equal volumes of the solvents.

4.3.2. Anhydrous sodium sulfate - prepared by muffling AR grade sodium sulfate for four hours at 400°C.

4.3.3. Alumina, Neutral, Brockman Activity I - activate 60-325 mesh alumina by heating for 16 hours at 130°C.

4.3.4. Surrogate solution prepared in methanol:

1-Fluoronaphthalene	250 ug/ml
Fluorene-d10	250 ug/ml
Pyrene-d10	250 ug/ml

Low Concentration (SIM) surrogate solution prepared in methanol:

1-Fluoronaphthalene	12.5 ug/ml
Fluorene-d10	12.5 ug/ml
Pyrene-d10	12.5 ug/ml

4.3.5. Matrix spiking solution and Low Concentration (SIM) matrix spiking solution prepared in methanol:

Acenaphthene	50 ug/ml

Acenaphthylene	50 ug/ml
Anthracene	50 ug/ml
Benzo(a)anthracene	50 ug/ml
Benzo(a)pyrene	50 ug/ml
Benzo(b)fluoranthene	50 ug/ml
Benzo(ghi)perylene	50 ug/ml
Benzo(k)fluoranthene	50 ug/ml
Chrysene	50 ug/ml
Dibenzo(a,h)anthracene	50 ug/ml
Fluoranthene	50 ug/ml
Fluorene	50 ug/ml
Indeno(1,2,3-cd)pyrene	50 ug/ml
Naphthalene	50 ug/ml
Phenanthrene	50 ug/ml
Pyrene	50 ug/ml
2-Methylnaphthalene	50 ug/ml

5. **EQUIPMENT**

5.1. Dionex Accelerated Solvent Extractor - Model ASE 200 - Maintain per manufacture's instructions.

5.1.1. 33 ml sample cells

5.1.2. Cellulose filters

5.2. Organomations Assoc., Inc. - N-EVAP (nitrogen evaporator), Model 112

5.3. Standard laboratory glassware to include:

5.3.1. 8 ounce extraction bottles

5.3.2. Small filling funnels

5.3.3. 60 ml collection vials

5.3.4. K-D apparatus: 250 ml. K-D flask, 10 ml or 25 ml ampule and three-ball snyder column.

5.4. All glassware to be rinsed as follows, prior to use:

5.4.1. Technical grade acetone (if the glassware is wet).

5.4.2. Triple rinsed with methylene chloride.

5.5. Volumetric measurements are to be made with a calibrated fixed or adjustable volume microdispenser and individually calibrated vials.

5.6. Teflon thistle tubes

5.7. Disposable Monstr-pette (large pasteur pipets)

6. **SAMPLE COLLECTION & PRESERVATION** – Samples are normally collected in glass containers with Teflon-lined caps. All samples and sample extracts are stored at 4°C ± 2°C. Soil samples must be extracted within 14 days of collection.

7. **POLLUTION PREVENTION & WASTE MANAGEMENT** – Sample extracts, standards and solvent rinses are disposed of by depositing them in the hazardous waste container located in the solvent locker. Waste segregation and disposal from the point of collection is further covered in LTL-2001.

8. **PERSONNEL QUALIFICATIONS** – This method is restricted to use by, or under the supervision of, experienced chemist/extractionists who have demonstarated the ability to perform the described extraction procedures and techniques.

9. **QUALITY CONTROL** - The normal level of quality control will consist of blank, blank spike, matrix spike and matrix spike duplicate (MS and MSD). This is performed on a per batch basis to include no more than 20 samples. The level of quality control will be indicated to the extractionist at the time the job is assigned. These samples serve to provide a measure of the recovery efficiency for the analyte and to provide data for statistical evaluation of the sample. In those instances that a client requires additional or different quality control measures, the extractionist will be directed accordingly in writing.

10. **METHODOLOGY**

10.1. Sample Extraction:

10.1.1. Mix sample thoroughly in its original container if there is space available otherwise mix in solvent rinsed aluminum tray.

10.1.2. Weigh 15.0 grams of soil (wet weight) into a extraction bottle.

10.1.3. Prepare two additional aliquots of a sample if Quality Control is required.

10.1.4. Add 10 grams sodium sulfate and mix well to give the soil a sandy texture.

10.1.5. Insert cellulose filter into bottom of sample cell.

10.1.6. Using a small filling funnel, add approximately one gram sand to bottom of sample cell

10.1.7. Transfer sample to cell.

10.1.8. Prepare a blank and a blank spike with sodium sulfate.

10.1.9. Pipet 100 ul surrogate solution to each cell.
(SIM: 100 ul of low conc. surrogate solution.)

10.1.10. Pipet 250 ul matrix spiking solution to each QC cell.
(SIM: 25 ul of matrix spiking solution.)

10.1.11. Fill cell to within 1 cm of top with sand or sodium sulfate and cap.

10.1.12. Fill solvent reservoir with 1:1 methylene chloride/acetone.

10.1.13. Align trays and start.

10.2. Solvent dehydration

10.2.1. Prepare a stainless steel funnel by plugging with glass wool, and filling 1/4 full with sodium sulfate.

10.2.2. Pre-rinse the sodium sulfate by passing 40 ml methylene chloride through the prepared funnel.

10.2.3. Pass the extract from 10.1.13. through the funnel and collect in an assembled K-D apparatus.

10.2.4. Rinse the collection vessel with several 10 ml methylene chloride rinses.

10.2.5. Rinse the sodium sulfate with 40 ml of methylene chloride.

10.3. Solvent Evaporation

10.3.1. Assemble the full K-D apparatus with a snyder column prewet with 2-3 ml of methylene chloride.

10.3.2. Immerse K-D apparatus into a hot water bath, using a bath temperature of 90°C, with a long ampule immersed to a depth of 12 ml. Regulate the evaporation time to take approx. 30 minutes.

10.3.3. Reduce the volume to 4-5 ml and remove the apparatus from the water bath. Cool to room temperature.

10.3.4. Rinse joint and remove snyder column. Allow rinse solvent to drain into ampule.

10.3.5. Remove the ampule clamp, and wipe the joint with a Kimwipe. Separate the ampule and rinse the joint with a small amount of solvent.

10.3.6. Reduce the extract to 1.0 ml in a warm water bath with nitrogen. Rinse internal walls of ampule several times during blowdown.

10.4. Alumina Cleanup

10.4.1. Prepare a Monstr-pette column by plugging with a small amount of glass wool.

10.4.2. Pack column with a minimum of 3 gm. of activated alumina. Top with 1/2 cm of sodium sulfate.

10.4.3. Attach Teflon thistle tube and pre-elute column with 10 ml methylene chloride.

10.4.4. Add extract directly to top of the sodium sulfate and allow to elute onto the column.

10.4.5. Rinse the ampule twice with a small amount of methylene chloride and add to top of column.

10.4.6. Re-attach the Teflon thistle tube to the column and add a minimum of 10 ml methylene chloride

10.4.7. Elute into a 16 x 125 mm culture tube.

10.4.8. Reduce the extract volume to 1.0 ml in a warm water bath with nitrogen. Rinse internal walls of the culture tube several times during blowdown.

10.4.9. Transfer extract to a 1.8 ml vial. The final volume is then adjusted to 0.5 ml (as compared to a measured volume) in methylene chloride. (SIM: Final volume adjusted to 0.5 ml. in methylene chloride.)

10.4.10. Label the extract and deliver to 940.

10.4.11. Complete all paperwork and bench sheet. Bench sheet to include cleanup method #, alumina lot #, the date of transfer to 940 and extract location. Clip the T-Card on the folder and place in GC/MS room extraction folder box. The file folder color will be blue and the blank name will be ____MPN.SL_.

11. **REFERENCES** - The following USEPA methods are the official methods on which this Laucks Testing Laboratory method is based. The primary methods are those which most closely parallel the Laucks procedure and are referenced by their USEPA series and number. In those instances for which there are no official EPA methods, the most suitable reference is given under the miscellaneous references section. The additional reference section cites those methods which contain additional information. These methods will frequently be official methods, which apply in part to, or support the Laucks method.

PRIMARY REFERENCES:

Test Methods for Evaluating Solid Waste, USEPA, SW-846.

8270D (1998), 3545A (1998), 3611B (1996)

LAUCKS TESTING LABORATORIES INC.	EXTRACTION	DATE	METHOD	ANALYST	CHECKER	ANALYSIS
JOB NUMBER: 0105096	PNA	5-8-01	3545A	SJ / DN	PJP 5-10-01	8270D PNA
MATRIX: Soil						

Sample #	wt./vol.	To Alumina	Z vol				SDG#	Bottle #
0105096-1	15.0g	0.5ml	0.5ml				LL 071	1
2								2
3								3
3MS								1
3MSD								1
4								4
5								5
S050801MPNSLA								
B050801MPNSLA								

5-8-01

COMMENTS:

Ext Sol: MeCl2/Acetone - BGJ # CA561 / EM# 34022
Final Sol: MeCl2 - BGJ # CA561
3611B - Alumina # 0206398

SURROGATES:

100 ul of: Ex 10-9-8
ul of: 250ug/ml

SPIKES:

250 ul of: Ex 10-11-2
ul of: 50 ug/ml

STANDARDS:

ul of:
ul of:
ul of:

Fraction and Method	Extraction		Transferred from 921 to 940		Extract Location	Analysis	
PNA	Time out 0850	Time in 1120	Time out 0845	Time in —	Tray # 1587	Time out	Time in
	Date 5-8-01	Initials SJ	Date 5-10-01	Initials AGH	F4-F12	Date	Initials
	Time out	Time in	Time out	Time in		Time out	Time in
	Date	Initials	Date	Initials		Date	Initials

LAUCKS TESTING LABORATORIES INC.
Seattle, Washington

SOP #:LTL-8279

Determination of Semivolatile Organic Compounds by SW-846 Methods 8270C and 8270D

Revision history:

Number	Date
0	02/05/01
1	09/11/01
2	3/20/02
3	5/28/02
4	7/8/02
5	10/21/02
6	11/22/02
7	04/08/03

Revised by: Loreena May, GC/MS Analyst Date: 4/16/03

Approved by: Harry Romberg, QA Officer Date: 4-16-03

Approved by: Kathy Kreps, Laboratory Director Date: 4/16/03

Controlled Document

No. 20 Assigned to: Tetra

TABLE OF CONTENTS

1. INTRODUCTION AND SCOPE **4**

1.1 METHOD DESCRIPTION 4
1.2 METHOD DEVIATIONS & COMMENTS 4
1.3 SAMPLE COLLECTION, SAMPLE STORAGE, HOLDING TIMES 5
1.4 DEFINITION OF TERMS 5

2. EQUIPMENT LIST AND STANDARDS **8**

2.1 CHROMATOGRAPHIC SYSTEM 8
2.2 STANDARDS 8

3. SAFETY PRECAUTIONS **11**

3.1 ROUTINE SAFETY PRECAUTIONS 11
3.2 WASTE DISPOSAL 11

4. OPERATION PROCEDURES **12**

4.1 ANALYTICAL CONDITIONS 12
4.2 METHOD DETECTION LIMIT STUDY 12
4.3 METHOD REPORTING LIMITS 12
4.4 METHOD VALIDATION 13
4.5 DAILY INSTRUMENT MAINTENANCE 13
4.6 INSTRUMENT TUNING 13
4.7 INITIAL MULTI-POINT CALIBRATION 14
4.8 LINEAR CALIBRATION 15
4.9 NON-LINEAR CALIBRATION 15
4.10 CONTINUING CALIBRATION STANDARD AND INITIAL CALIBRATION VERIFICATION 16
4.11 SAMPLE ANALYSIS 17
4.12 COMPOUND IDENTIFICATION 18
4.13 COMMON ANALYTICAL PROBLEMS 18
4.14 COMPOUND QUANTIFICATION 20

5. REPORTS **21**

5.1 DATA PACKET ORGANIZATION 21
5.2 QUALITY CONTROL REPORTS 21
5.3 SAMPLE RESULT REPORTS 22

6. QUALITY CONTROL **22**

6.1 GENERAL ISSUES 22
6.2 INITIAL CALIBRATION 22
6.3 CONTINUING CALIBRATION VERIFICATION 23
6.4 METHOD BLANK 24
6.5 QC CHECK SAMPLE (LCS) 25
6.6 MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLE 27
6.7 SURROGATE RECOVERY 29

7. REFERENCES **31**

APPENDIX I **32**

CALIBRATION STANDARD SOLUTION CONCENTRATIONS, NG/µL 32

APPENDIX II **34**
DFTPP TUNING CRITERIA 34
APPENDIX III **35**
DATA PACKET ORDER LIST 35
APPENDIX IV **36**
INITIAL CALIBRATION CRITERIA 36
APPENDIX V **37**
CONTINUING CALIBRATION VERIFICATION CRITERIA 37
APPENDIX VI **37**
METHOD BLANK CORRECTIVE ACTION LIMITS 37
APPENDIX VII **38**
METHOD 8270D FLOW CHART 38
APPENDIX VIII **39**
METHOD 8270D QC REQUIREMENTS AND CORRECTIVE ACTIONS 39
APPENDIX IX **42**
APPENDIX IX CALIBRATION STANDARD SOLUTION CONCENTRATIONS, NG/µL 42
APPENDIX X **44**
ANALYTES AMENABLE TO ANALYSIS BY METHOD 8270D 44
APPENDIX XI **48**
SEMIVOLATILE INTERNAL STANDARDS WITH CORRESPONDING ANALYTES ASSIGNED FOR QUANTITATION 48
APPENDIX XIV **50**
CALCULATION OF PEAK TAILING FACTORS 50

1. Introduction and Scope

1.1 Method Description

1.1.1 This method is used for the determination of semivolatile organic analytes in aqueous, soil, sediment, and other matrices. This SOP follows SW-846 Method 8270D except for the specific deviations listed below or outlined in a project's specific QAPP. This SOP is also applicable to SW-846 Method 8270C as all differences between the two revisions are clerical in nature. There are no technical differences.

1.1.2 This method is restricted to use by, or under the supervision of, analysts experienced in the use of gas/liquid/chromatography/mass spectroscopy and in the interpretation of chromatograms and mass spectra. Each analyst performing this method must have demonstrated the ability to perform the described chromatographic analysis and/or data interpretation.

1.2 Method Deviations & Comments

1.2.1 The following items represent deviations and comments of Method 8270D, as published, which are followed as standard operating procedure in the performance of this method at Laucks:

1.2.1.1 Method 3640A (Gel Permeation Chromatography cleanup) is utilized routinely for all soil/sediment sample extracts. GPC cleanup is performed on aqueous sample extracts as deemed necessary.

1.2.1.2 The initial calibration has been increased from five to six concentration levels in order to demonstrate linearity for all target analytes and to provide a low-level standard that will act as the reporting limit as outlined in the method.

1.2.1.3 The concentration of internal standards added to all sample extracts and calibration standards have been decreased from 40 ng/µL per compound to 20 ng/µL in order to accommodate 2 µL injection volumes as allowed by the method. This adjustment keeps the total nanograms injected the same and prevents overloading the analytical column.

1.2.1.4 Laucks uses a relative response factor for all analytes. The method specifies that if the average RSD of all analytes for the initial calibration is ≤15%, then the RRF may be used for individual analytes with RSDs >15%.

1.2.1.5 For Appendix IX and TCLP analyses, the compound 3-methylphenol (m-Cresol) coelutes with 4-methylphenol (p-Cresol). Since the spectrum and retention time for these two compounds are the same, these two compounds will be reported together as

the sum of these two compounds and with the assumption that 3-methylphenol has the same response factor as the 4-methylphenol present in the standards.

1.2.1.6 All standards are stored at less than -10°C or by the manufacturer's recommendation. Sample extracts are stored at 4°C ±2°C.

1.2.1.7 The surrogate and matrix spikes will be added to the sample such that the final amount injected from normally concentrated samples is 100 ng for the base/neutral compounds and 150 ng for the acids. Acids will not be injected at 200 ng per injection to prevent exceeding the highest calibration standard of 160 ng.

1.3 Sample Collection, Sample Storage, Holding Times

1.3.1 Samples are normally collected in glass containers with Teflon-lined caps. All samples and sample extracts are stored at 4°C ± 2°C. Water samples must be extracted within 7 days of collection. Soil samples must be extracted within 14 days of collection. All sample extracts must be analyzed within 40 days of sample preparation.

1.4 Definition of Terms

1.4.1 This section defines terms and acronyms as they are used in this SOP. Other terms, such as MS/MSD or method blank, are not defined here since it is assumed that the user of this SOP already understands their more general meaning.

Method Blank Spike	A background free matrix (DIW for water, clean sand for soils/sediments) to which known amounts or target analytes and surrogates are added each time sample extracts are prepared. Blank spikes are required on NFESC work. In the context of this SOP, a blank spike is the same as a QC check standard.
CCC	Calibration Check Compound. A compound of analytical interest whose RRF in the CCV is compared to the average RRF from the initial calibration. The % difference must be less than the value specified in the method for the CCV to be considered valid. CCCs must also meet maximum %RSD criteria in an initial calibration.
CCV	Continuing calibration verification. This is the same acronym used in the CLP program. This is a standard injected at some prescribed frequency during the analysis sequence to determine whether the instrument has remained in calibration.

ICV	Initial continuing verification. A calibration standard obtained from a different manufacturer than the standards used for the initial and continuing calibrations that is analyzed after a compliant initial calibration.
CLP	Contract Laboratory Program. The USEPA program that contracts with laboratories to provide laboratory services. The term has come to mean a much broader set of methods and deliverables. In the context of this SOP, CLP means procedures or operations which are detailed in the CLP contract and which are extended to a broader working definition.
DIW	Deionized water. Lab reagent water. Organic-free water. Since the systems used to provide DIW at Laucks all contain carbon polishing filters, they are capable of providing organic-free water for use in method blanks and method blank spikes.
DFTPP	A solution containing DFTPP, pentachlorophenol, benzidine, and p,p'-DDT. An aliquot of this solution is analyzed at the start of a 12-hour QC period in order to verify DFTPP tuning criteria.
Internal Standard	A compound added to every standard, blank, matrix spike, matrix spike duplicate, and sample extract at a know concentration, prior to analysis. Internal standards are used as the basis for quantitation of target compounds.
MDL	Method detection limit. The lowest concentration in a sample which will yield a positive result that is greater than zero at a known level of confidence. MDLs are empirically determined by Laucks.
MDL Standard	Method detection limit standard. A standard prepared so that the concentrations of the target analytes are approximately 4x the empirically determined MDLs on an extract basis. This standard is used to verify that the instrument is capable of detecting the target analytes on an ongoing basis.
QC Period	Quality control period. An analysis sequence initiated by the injection of one or more standards, followed by sample extracts. A QC period is 12 hours starting with the injection of the DFTPP performance evaluation solution.

RF	Response Factor. The measure of the mass spectral response of an analyte compared to its internal standard. Response factors are determined by analysis of standards and are used in the calculation of concentrations of analytes in samples. RF is determined by the following equation: $RF = \frac{A_x \times C_{is}}{A_{is} \times C_x}$ where: A_x - Area of target analyte primary ion C_{is} - Concentration of internal standard A_{is} - Area of internal standard primary ion C_x - Concentration of target analyte
RSD or %RSD	Relative standard deviation or percent relative standard deviation. The ratio of the standard deviation of a set of values to the mean of the set of values. A measure of the similarity of the values one to another.
RT	Retention time. The time (in minutes) at which a target analyte elutes from the GC column.
Sequence	A set of sample extracts and standard solutions injected into an instrument in a chronologically continuous group. See also QC period.
SPCC	System Performance Check Compound. A compound of analytical interest whose relative response factor (RRF) is monitored in the CCV for signs of chromatographic degradation. SPCCs generally have low RRFs and tend to decrease in response as the chromatographic system begins to deteriorate. They must meet a minimum RRF for initial and continuing calibrations.
EICP	Extracted ion current profile-a plot of ion abundance versus time (or scan number) for ion(s) of specified mass(es).
Surrogate	Compounds added to every standard, blank, matrix spike, matrix spike duplicate, and sample extract at a known concentration; used to evaluate extraction and analytical efficiency by measuring recovery. Surrogates are brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental samples.

2. Equipment List and Standards

2.1 Chromatographic System

Gas Chromatograph:	Hewlett Packard 5890 I or II
Carrier Gas:	Helium 99.999% (ultra purity) or better
Column:	30 m x 0.25 mm x 0.25 μ capillary column (Restek RTX5SIL-MS or equivalent)
Automatic Sampler:	Hewlett Packard 7673A or 7673 with 19405A and 3396A controllers
GC/MS Interface:	Capillary direct to the ion source of the mass spectrometer, fixed temperature
Mass Spectrometer:	Hewlett Packard 5970B or 5972
Data System:	PC based Teknivent with ENVIROLINK data acquisition and processing software or HP Chemstation.
Miscellaneous:	Assorted syringes, vials, caps, septa, injection port liners, ferrules, etc.
Note:	All of the above equipment may be substituted with equivalent or better equipment

2.2 Standards

2.2.1 Preparation of Semivolatile Standards

2.2.1.1 All standards prepared from this operating procedure must be logged into the iLIMS standards logbook under GC/MS ABNs. When a standard is made, a solution number is assigned to it. This solution number is unique and will be used to track and identify the standard every time it is analyzed.

2.2.1.2 The following is an example of the solution nomenclature used for a semivolatile standard. The solution number assigned was MS9-10-19. This label represents the following:

MS	Solution was made and used as Mass Spec Standard
9	Solution was logged into standard book #9
10	Page number on which solution has been recorded
19	This denotes the nineteenth entry on page 10

2.2.1.3 All standards must also be verified both qualitatively and quantitatively in order to satisfy EPA requirements for traceability. This may be accomplished by purchasing solutions that have been fully documented by a commercial vendor.

2.2.2 Preparation of Internal Standard Solution (ABN IS MIX @ 2000 ug/mL).

Internal Standards
1,4-Dichlorobenzene-d4
Naphthalene-d8
Acenaphthene-d10
Phenanthrene-d10
Chrysene-d12
Perylene-d12

2.2.2.1 Commercially prepared and certified internal standard solution is purchased at a concentration of 2000 µg/mL and is used undiluted. This standard is kept at less than -10°C until put into use. Once opened, the standard is kept at room temperature to avoid having the less soluble compounds fall out of solution. A new ampule of internal standard is opened on a weekly basis.

2.2.3 Preparation of DFTPP solution:

2.2.3.1 Prepare a 25 µg/mL tuning solution which consists of DFTPP, pentachlorophenol, benzidine, and 4,4'-DDT in methylene chloride. This solution is kept at temperature of less than -10°C.

2.2.4 Preparation of Calibration Standards

2.2.4.1 Calibration standards are prepared in methylene chloride from stock solutions that are purchased from a commercial source (e.g., Supelco or Crescent). If an analyte required for calibration is not present in an available mixed solution, laboratory-prepared stock solutions that have been verified by GC/MS may be used. Laboratory prepared stock solutions should be tested against independent reference standards when they are available.

2.2.4.2 Calibration standards are prepared at six concentration levels (5, 10, 25, 40, 60 and 80 ng/µL). Each calibration standard contains all compounds of interest, surrogates, and internal standards. The internal standards are added so that they are present in all calibration standards at a concentration of 20 ng/µL each.

2.2.5 Preparation of ABN200 stock solution

2.2.5.1 Assemble the following solutions in order to prepare a combined stock solution which will contain all analytes of interest at a concentration of 200 µg/mL each:

Analyte Mix	Vendor	Stock #
Benzidines Mix 2	Crescent	CC2410
Base/Neutrals Mix 1	Crescent	CC2458

Acids Mix 3	Crescent	CC2471R
SV Mix w/ Pyridine & Carbazole	Crescent	CC2473
Acid Surrogate Mix	Supelco	4-7261
B/N Surrogate Mix	Supelco	4-7262

Note: 1,2-diphenylhydrazine is detected as azobenzene. Azobenzene may be substituted for 1,2-diphenylhydrazine as it is in many commercially purchased calibration mixes.

2.2.6 Preparation of APPEND200 stock solution

2.2.6.1 Assemble the following solutions in order to prepare a combined stock solution which will contain all analytes of interest at a concentration of 200 µg/mL each:

Analyte Mix	**Vendor**	**Stock #**
Appendix IX Semivolatiles (15)	Crescent	CC2289
Appendix IX Semivolatiles (9)	Crescent	CC2289A
Appendix IX Semivolatiles (10)	Crescent	CC2289B
Appendix IX 1,3,5-TNB	Crescent	CC2289C
Semivolatiles Mix 5	Crescent	8SM-008A
Pentachlorethane	Crescent	3347D.20
EPA CLP SOW OLM04.2 Semivolatile Mix for Additional Compounds	Supelco	47514-U

2.2.6.2 The vendor and catalog numbers provided are for reference only. Other vendor's certified solutions may be substituted.

2.2.6.3 Combine appropriate amounts of all solutions in a clean, 10 mL volumetric flask so that all analytes are present at 200 µg/mL. Dilute to volume with methylene chloride, stopper the flask and mix well. Record all information in the iLIMS standards logbook and transfer the contents of the volumetric flask into an amber screw-cap vial. Store this solution in the freezer when not in use. The vial must be marked with the logbook name, standard type, preparation date, solvent used, expiration date, and preparer's initials.

2.2.7 Preparation of working calibration standards

2.2.7.1 To prepare working calibration standards, add the amounts listed below (in µL) of ABN200 stock solution, internal standard solution (ABN IS MIX @ 2000 ug/mL) and methylene chloride to clean vial inserts and use within one week.

	Amount of Standard ABN200 in µl	Amount of Standard APPEND200 in µl	Amount of Internal Standard in µl	Amount of CH_2Cl_2 in µl

Working ABN 5	5	5	2	190
Working ABN 10	10	10	2	180
Working ABN 25	25	25	2	150
Working ABN 40	40	40	2	120
Working ABN 60	60	60	2	80
Working ABN 80	80	80	2	40

2.2.7.2 Log into the working solutions logbook all of the above information as the standards are made. Store all standards at less than -10°C for up to one week when not in use.

2.2.7.3 The ABN 25 standard is the continuing calibration standard and it will need to be prepared on a weekly basis.

2.2.7.4 Calibration stock solutions, which are received sealed in ampules from the manufacturer, are useable up to their manufacturer's expiration date. The mixed ABN200 and APPEND200 stock solution must be prepared once every twelve months, or sooner, if standards have degraded or concentrated.

3. Safety precautions

3.1 Routine Safety Precautions

3.1.1 All standards and sample extracts should be handled as if they are hazardous substances.

3.1.2 Refer to the instrument manufacturer's manual for routine instrument precautions.

3.1.3 Routine precautions include an awareness of the moving parts on the instrument you're using. These parts are often charged with power from an electrical component or with high pressure gas and have the potential to do harm if not used properly.

3.1.4 Electrical shock - All instruments present the possibility of electrical shock. The operator should take all precautions including ensuring that all instruments are operated with fully grounded power outlets, turning off the instrument and disconnecting the instrument from the electrical power supply before working on any electrical components, etc.

3.1.5 Almost all of the analytes under consideration are known or suspected carcinogens. Analysts should wash their hands after using any standard, solvent or sample extract. Additionally, a respirator should be worn or a fume hood utilized for extremely hazardous compounds or very dirty extracts.

3.2 Waste disposal

3.2.1 All waste solvents, expired standards and old extracts should be disposed of in the solvent waste can located in the prep area fume hood. Consult the laboratory SOP for more detail on waste disposal.

4. Operation procedures

4.1 Analytical Conditions

4.1.1 Chromatographic Conditions

Initial Temperature:	45°C
Initial Time:	4 minutes
Column Temperature Program:	8°C/minute
Final Temperature:	320°C
Final Time:	8 minutes
Injector Temperature:	250-300°C (instrument dependent)
Transfer Line Temperature:	280-310°C (instrument dependent)
Injector Purge Time Off:	0.15 minutes
Injection Volume:	2 µL
Column Linear Velocity:	30-40 cm/sec (nominal 35 cm/sec measured at 30°C)

4.1.2 Mass Spectrometer Conditions

Electron Energy:	70 volts
Mass Range:	35 to 500 AMU
Scan Time:	Not to exceed 1 second per scan

4.2 Method Detection Limit Study

4.2.1 MDL studies are performed on an annual basis. This procedure is fully described in Laucks SOP on Determination of MDLs.

4.2.2 MDLs for this method are in the range of 0.27 – 2.5 µg/L for waters and 29.0 – 201 µg/kg for soils.

4.3 Method Reporting Limits

4.3.1 The method reporting limit for this method shall be set as described by method 8000B by using the lowest calibration standard as the method report limit. Values detected below this level will be reported but will be "J" flagged as outlined in Section 5.3 of this SOP.

4.3.2 Reporting limits for aqueous samples are 5 µg/L with the exception of benzoic acid and 2,4-dinitrophenol which are 10 µg/L. Reporting limits for non-aqueous samples are 330 µg/kg with the exception of benzoic acid and 2,4-dinitrophenol, which are 670 µg/kg.

4.3.3 For the additional Append IX analytes, the reporting limit for aqueous samples is 5 µg/L with the exception of a,a-dimethylphenylethylamine and famphur where the reporting limit is 10 µg/L. Reporting limits for non-aqueous samples are 330 µg/kg and 670 µg/kg respectively.

4.4 Method Validation

4.4.1 Prior to the analysis of any samples, it is necessary to validate the method. A method validation study is performed in a similar manner to an MDL study with the exception that a minimum of 4 replicates is required and the concentration levels are typically higher. This procedure is fully described in Laucks SOP on Determination of QC limits.

4.5 Daily Instrument Maintenance

4.5.1 Instrument maintenance may be required for good chromatography and proper calibration. The following steps may be undertaken if needed before the analysis of any standard or sample:

A. Cool the GC oven to 30°C.
B. Check the background for the instrument using manual tune to determine the operating status of the instrument.
C. Remove the injector septum and quartz liner.
D. Remove the column from the injector.
E. Install a new column ferrule.
F. Clip off 10 cm of the column. Check for a proper cut.
G. Reinstall the column and adjust the alignment.
H. Install a clean quartz liner.
I. Reinstall the O-ring or replace it if worn.
J. Install a new septum.
K. Clean and reinstall the autosampler syringe.

4.5.2 After any of these steps have been taken, recheck background, correct any leaks by tightening fittings, then ramp the GC oven twice from 50° to 310°C at 20° /minute for 10 minutes

4.6 Instrument Tuning

4.6.1 The HP mass spectrometers use FC-43 (PFTBA) as a mass calibration compound. Each instrument will require different ion ratios to pass the required DFTPP performance criteria. See Appendix II for the DFTPP tuning criteria. The following ratios are therefore approximate.

Ion	% of ion 69
69	100%

131	25-35%
219	25-35%
414	1-3%

4.6.2 Ion peak widths should be in the 0.5 to 0.6 AMU range. Excessive peak width can lead to loss of minor isotope peaks. Insufficient peak width can result in the loss of sensitivity. Ions for water, nitrogen, and oxygen should be <5% of ion 69. A copy of the PFTBA spectrum and tabular listing should be kept with the instrument historical file.

4.6.3 The DFTPP tuning solution should also be used to assess GC column performance and injection port inertness. Degradation of DDT to DDE and DDD should not exceed 20%. Benzidine and pentachlorophenol should be present at their normal responses, with no visible peak tailing, as demonstrated by the peak-tailing factor. A copy of the peak tailing factors and degradation of DDT is kept with the instrument historical file. The calculation of peak tailing factors is illustrated in Appendix XIV. The acceptance criteria for benzidine is <3.0 and pentachlorophenol is <5.0. If degradation is excessive and/or poor chromatography is noted, the injection port may require cleaning. It may also be necessary to break off the first 6-12 inches of the capillary column.

4.6.4 Analysis of the DFTPP must meet the ion abundance criteria listed in Appendix II before initiation of initial or continuing calibration standard analysis.

4.7 Initial Multi-Point Calibration

4.7.1 After demonstrating compliance with the DFTPP tuning criteria, analyze the calibration standards within 12 hours.

4.7.2 Check the integration and retention times of all compounds in each standard. Examine the peaks to ensure that peak saturation and/or chromatographic overload has not occurred in the upper calibration standard.

4.7.3 SW 846 allows the use of both linear and non-linear models for the calibration data. The option for non-linear calibration may be necessary to achieve low detection limits or to address specific instrumental techniques.

4.7.4 The choice of a specific calibration model should be made in one of two ways. The first option is to begin with the simplest approach, the linear model through the origin using RSDs, as described in section 7.5 of 8000B. In methods where this method is not appropriate, because the calibration acceptance criteria cannot be met, the next option of calibration (linear regression) is used. This calibration option is typically used in fuels because of the elevated response obtained in these analyses. The requirements for the linear regression model is that R^2 be greater than or equal to 0.99. The more complex calibration option is use of the quadratic curve. This calibration option requires a minimum of 6 points and is used in cases where the detector doesn't meet calibration

criteria over a wide range. The difficulty with the quadratic is that the intercept may be greater than the detection limit. This calibration option exhibits a greater accuracy in the mid-range, and may demonstrate more extreme responses at the low and high end of the calibration, and therefore, it is important to dilute samples and extracts so that they are in the mid-range of the calibration.

4.7.5 For linear calibrations using the RSD, analyze standard solutions using a minimum of 5 different concentration levels. (Six calibration levels are typically used for 8270D.) The lowest concentration should establish the reporting limit. The highest concentration should define the upper usable working range of the detector. Criteria for evaluating these standards are detailed in Section 6.

4.8 Linear Calibration

4.8.1 Internal standard calibration data is evaluated by determining the %RSD of the response factors.

4.8.1.1 Calculate the individual and average RFs for each compound.

4.8.1.2 RFs are calculated using the equation

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:

A_s = Response of target analyte
A_{is} = Response of internal standard
C_s = Amount of target analyte (ng/µL)
C_{is} = Amount of internal standard (ng/µL)

4.9 Non-linear Calibration

4.9.1 In situations where the analyst knows that the instrument response does not follow a linear model over a sufficiently wide working range, or when the other approaches described here have not met the acceptance criteria, a non-linear calibration model may be employed.

4.9.2 When using a calibration model for quantitation, the curve must be continuous, continuously differentiable and monotonic (the successive members of which either consistently increase or decrease but do not oscillate in relative value. Each member of a monotone increasing sequence is greater than or equal to the preceding member; each member of a monotone decreasing sequence is less than or equal to the preceding

member) over the calibration range. The model chosen should have no more than four parameters, i.e., if the model is polynomial, it may be no more than third order, as in the equation:

$$y = ax^3 + bx^2 + cx + d$$

4.9.3 The statistical considerations in developing a non-linear calibration model require more data than the more traditional linear approaches. A quadratic (second order) requires a minimum of six standards, and a third order polynomial requires seven standards. Do not force the line through the origin, i.e., do not set the intercept as 0, and do not include the origin (0,0) as a calibration point.

4.9.4 Whichever option is employed, a surrogate concentration must fall within the calibration range.

4.9.5 Criteria for evaluating these standards are detailed in Section 6.

4.10 Continuing Calibration Standard and Initial Calibration Verification

4.10.1 Concentration and/or RF Criteria

4.10.2 After demonstrating compliance with the DFTPP tuning criteria and the completion of a compliant initial calibration curve, analyze the continuing calibration standard within 12 hours.

4.10.2.1 After completion of a compliant initial calibration curve, an initial calibration verification (ICV) will be analyzed. This standard is from a source different than that of the calibration standards. At the time of the writing of this SOP, Laucks uses a commercially prepared and certified standard solution purchased from Cerilliant (Catalog # ERS072). This solution contains the analytes that are most commonly reported on a routine basis. This ICV standard is analyzed at a concentration range of 32-64 µg/mL, which is higher than the CCV analyzed on a routine basis. There are no compound-specific criteria. The %D results should be within ±30% of the average RF or expected concentration from the initial calibration for each analyte. See below for initial calibration verification criteria.

Initial Calibration Verification Criteria

Army Corps	**DoD**	**AFCEE**
All analytes %D ≤30%	All analytes %D ≤25%	All analytes %D ≤25%

4.10.2.2 Using the appropriate calculation technique (average RF) compute either RFs or concentration values. For linear calibrations the CCV standard can be verified by

calculating either the percent difference or the percent drift.

4.10.2.2.1 The percent difference calculation compares the CCV RFs to the mean RFs from the initial multi-point calibration. The percent difference is calculated as follows:

$$\%D = \frac{RF_V - \overline{RF}}{\overline{RF}} \times 100$$

where:

RF_V = Response Factor

$\overline{RF}$ = Mean Response Factor

4.10.2.2.2 The percent drift calculation compares the CCV calculated concentrations to the theoretical (or actual) concentration of the CCV standard. The percent drift is calculated as follows:

$$\%D = \frac{C_c - C_T}{C_T} \times 100$$

where:

C_c= Calculated Concentration
C_T = Theoretical Concentration

4.10.3 The standard analysis must meet the %D and minimum RRF criteria detailed in Section 7.

4.11 Sample Analysis

4.11.1 After completion of a compliant continuing calibration standard, sample analysis may be performed.

4.11.2 Remove the sample extracts from the refrigerator and allow to warm to room temperature.

4.11.3 Transfer 200 µL of extract to a vial insert.

4.11.4 Add 2 µL of IS solution (ABN IS MIX @ 2000 µg/mL).

4.11.5 Cap the vial and mix well.

4.11.6 Place the vial onto the autosampler for analysis.

4.11.7 For dilutions, decide what dilution is necessary from previous data or analyst judgment. Make dilution and then add 2 µL of ABN IS solution prior to capping vial. Mix well prior

to analysis.

4.11.8 In general, the method blank accompanying the samples is injected prior to the analysis of the samples. This is not a requirement, however. Samples are then injected until the end of the 12 hour clock.

4.12 Compound Identification

4.12.1 Compounds are tentatively identified if a peak elutes within 0.5 minute of that compound in the CCV standard. In addition, the internal standard for that compound should also be within 0.5 minute of its counterpart in the CCV standard. To confirm the presence of that compound in the sample extract, the mass spectrum of the peak must be evaluated. Spectra are compared against standard spectra of each compound generated on the instrument used for analysis.

4.12.2 The following criteria are used to evaluate mass spectra.

4.12.2.1 The intensities of the characteristic ions of a compound maximize within one scan of each other. Searches performed based on the presence of a target compound at a compound-specific retention time will be accepted as meeting this criterion.

4.12.2.2 All ions present in the standard mass spectra at a relative intensity greater than 30% (most abundant ion in the spectrum equals 100%) or the three ions of greatest intensity must be present in the sample spectrum.

4.12.2.3 The relative intensities of ions specified must agree within 30% between the standard and sample spectra. Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample ion abundance must be between 20 and 80 percent.

4.12.2.4 If a compound cannot be verified by all of these criteria, but in the technical judgment of the analyst, the identification is correct, then report that identification and proceed with quantification.

4.12.2.5 The experienced analyst's judgment weighs heavily in evaluating chromatograms and mass spectra for compound identification. For instance, the retention times of surrogate compounds may be outside their expected windows due to sample matrix effects. If this has occurred, it must be fully documented in the appropriate report notes.

4.13 Common Analytical Problems

4.13.1 An analyst's professional judgment plays a large role in how data are interpreted. The following guidelines should be followed in order to facilitate consistency between analysts. Any anomalies not addressed in this SOP must be discussed with the supervisor

prior to implementation. All anomalies and corrective actions must be documented.

4.13.2 Interferences

4.13.2.1 Problems have been associated with the following compounds analyzed by this method.

4.13.2.2 Dichlorobenzidine and 4-chloroaniline can be subject to oxidative losses during solvent concentration.

4.13.2.3 Hexachlorocyclopentadiene is subject to thermal decomposition in the inlet of the gas chromatograph, chemical reactions in acetone solution, and photochemical decomposition.

4.13.2.4 N-nitrosodiphenylamine decomposes in the gas chromatograph inlet forming diphenylamine and, consequently, may be detected as diphenylamine.

4.13.3 Carryover

4.13.3.1 In some cases, if analytes in a sample are very high, there may be carryover from one analysis to the next. If a sample is suspected of being high due to historical data or extract color, the sample should be diluted prior to analysis or one or more blanks should be analyzed after the sample to insure that there is no carryover between analyses.

4.13.3.2 However, in the case where high levels were not expected, and do appear in a sample analysis, the analysis after it should be examined carefully for carryover. Any sample analyte whose concentration exceeds 250 ng/µL in the extract may be considered a candidate for carryover.

4.13.4 Manual Peak Integrations

4.13.4.1 Manual peak integration should be used only when necessary to correct for matrix interference, tangent peaks, and rising baselines. Manual integrations are not to be used in an attempt to meet calibration, surrogate recovery, or spike recovery criteria. Refer to LTL-1020, *The Integration of IC, GC, HPLC, and GC/MS Peaks* for more detail.

4.13.4.2 If the chromatogram shows degradation due to sample loading e.g. split peaks, lift off, or severe tailing, the sample should be diluted and reanalyzed if required detection limits permit.

4.13.4.3 If a manual integration is necessary, use the following guidelines:

- Integrate only the peak. Start where the peak lifts from the baseline and end as soon as it returns to the baseline. Do not integrate extra baseline in an attempt to increase peak area.
- Do not "peak shave". Do not cut off legitimate parts of the peak in order to reduce peak area.
- In cases of tangent skims, do not increase or decrease peak areas or heights by skimming extra long baselines or drawing the baseline too low.
- Initial and date all manual integrations.

4.14 Compound Quantification

4.14.1 Target compound concentrations are calculated using the following equations:

4.14.2 The equation for internal standard calculations using a linear model is

$$Extract\ Concentration(ng / \mu L) = \frac{A_x \times C_{is}}{A_{is} \times RF_{average}}$$

where:

A_x	= Response for the target analyte
A_{is}	= Response for the internal standard
C_{is}	= Concentration of internal standard, in ng/µL
$RF_{average}$	= Average Response Factor (calculated from the initial calibration)

4.14.3 If the %RSD of a compound's relative response factor is 15% or less, than the concentration may be determined using the average response factor from the initial calibration. If the %RSD of any analyte is greater than 15%, then alternative calibration options must be performed.

4.14.4 The above equation is used directly by the HP computer to yield the extract concentration.

4.14.5 Aqueous samples

4.14.5.1 To calculate the actual sample concentration, the following calculation must be used.

$$\text{Extract Concentration } (\mu g/L) = \frac{F \times D \times V_f \times GPC}{V_i}$$

where:

F = Amount found from HP quantitation report (ng/µL)
D = Dilution factor of extract
V_f = Final extract volume (µL)
GPC = GPC dilution factor. Use 1 if GPC was not performed, 2 if GPC was used
V_i = Initial sample volume (mL)

4.14.5.2 Any sample extracts that exceed the upper calibration range for any analytes of interest must be diluted and reanalyzed to bring the analytes into the working range of the calibration.

4.14.6 Non-aqueous samples

4.14.6.1 The result calculation for non-aqueous samples is very similar to that for aqueous samples. The only difference is the inclusion of a total solids term to calculate the dry weight equivalent of the initial sample size.

$$\text{Sample Concentration}(\mu g/kg) = \frac{F \times D \times V_f \times GPC}{W_s \times T_s}$$

where:

W_s = Sample size extracted in grams.
T_s = Total Solids in decimal format (i.e. 0.76 not 76).

4.14.6.2 Any sample extracts that exceed the upper calibration range for any analytes of interest must be diluted and reanalyzed to bring the analytes into the working range of the calibration.

5. Reports

5.1 Data Packet Organization

5.1.1 See Appendix III for a checklist detailing data packet organization.

5.2 Quality Control Reports

5.2.1 All results for quality control tests are entered into the lab database. Printouts of all data entered must be included in the data packet. The routine minimum is a method blank report, a method blank spike report, and an MS/MSD report.

5.3 Sample Result Reports

5.3.1 Data Qualifying Flags

5.3.1.1 Sample report results are qualified with data qualifying flags. These flags have the following definitions:

U: The analyte of interest was not detected, to the limit of detection indicated.

B: The analyte of interest was detected in the method blank associated with the sample, as well as in the sample itself. The B flag is applied without regard to the relative concentrations detected in the blank and sample.

J: The analyte of interest was detected below the practical quantitation limit. This value should be regarded as an estimate.

D: The value reported is derived from the analysis of a diluted sample or sample extract.

X: Indicates an unresolvable isomeric pair. This flag indicates that calculated results are the sum of the two isomers.

E: The value reported is based on a sample or sample extract in which the target analyte concentration exceeded the calibration range. The value reported should be considered an estimate.

6. Quality Control

6.1 General Issues

6.1.1 See Appendices VII and VIII for flow chart and QA/QC limit and corrective action tables.

6.2 Initial Calibration

6.2.1 Criteria

6.2.1.1 Calculate the %RSD for all compounds. CCC criteria are listed in Appendix IV.

6.2.1.2 The calculated RFs are tabulated and the %RSD calculated. Initial calibration data are evaluated using %RSD of the relative response factors as well as minimum average RRFs. The average RRF for all SPCC analytes must be ≥ 0.05. The %RSD must be ≤ 30% for each individual Calibration Check Compound (CCC). The %RSDs must be ≤15% for all other analytes.

6.2.1.3 Laucks has established an additional criterion by requiring a minimum acceptable average RRF for all non SPCC analytes of 0.010. At this time the Appendix IX

compounds have no minimum RRF. See Appendix IV for a listing of all SPCCs.

6.2.2 If the %RSD of any analyte is greater than 15%, then alternative calibration options must be considered. The second approach to a linear model is to use *a priori* knowledge of the detector response to choose the calibration model. Such knowledge may come from previous experience, knowledge of physics of the detector, or specific manufacturer's recommendations. See section 7.5 in Method 8000B and section 4.7.4 in this SOP for more details.

6.2.3 Corrective action

6.2.3.1 If the criteria are not met, other standards may be analyzed or appropriate instrument maintenance and analysis of new standards must be performed. Failure to achieve the required minimum average RRF for the SPCC compounds may indicate the need to perform instrument maintenance or prepare fresh calibration standards.

6.2.3.2 Some compounds, including but not limited to the nitroanilines, the nitrophenols and some additional Appendix IX analytes, tend to show poor or erratic response at the lower calibration levels.

6.2.3.3 For routine analyte lists the lowest standard may be omitted from the initial calibration as long as the %RSD does not exceed 30% for any which are CCCs. Additionally, those compounds, which are omitted from the lower calibration levels, will also have an elevated reporting level equivalent to that of the lowest standard.

6.3 Continuing Calibration Verification

6.3.1 Criteria

6.3.1.1 At the beginning of each 12-hour QC period, a CCV standard at a concentration level of 25 µg/mL is analyzed. The RF or concentration for each analyte is calculated and the percent difference or percent drift is calculated as shown above.

6.3.1.2 The RF for each compound is calculated and the percent difference is calculated as follows:

$$\%Difference = \frac{RF_c - RF_i}{RF_i} \times 100$$

where:

RF_i = Average RF from Initial Calibration.
RF_c = RRF from CCV standard.

6.3.1.3 According to the US ACOE Shell, Section I.9.2.5.4: "Evaluate the concentration of each target analyte and surrogate in the CCV. Verify that the percent drift or percent difference for the CCCs and all project-specified contaminants of concern are within ± 20 percent of their expected values. Evaluate remaining target analytes to assess instrument stability and survey the need for performing instrument maintenance." It is recommended that the list of project-specified contaminants of concern be made available to the laboratory.

6.3.1.4 According to the Department of Defense Quality Systems manual, Table B-3 Calibration Verification (CV) "all calibration analytes within ±20%D of expected value from the ICAL with no individual analytes (except CCCs) > 25%".

6.3.1.5 According to the Air Force Center for Environmental Excellence QAPP, Table 7.2.10-3 Continuing Calibration Verification "all calibration analytes within ±20%D of expected value".

6.3.1.6 The internal standard area responses must be within a factor of two (-50% to +100%) from that of the mid-point standard level of the most recent initial calibration. In addition, the retention time must fall within 30 seconds from that in the mid-point standard level of the most recent calibration sequence.

6.3.1.7 In addition, all compounds (with the exception of the Appendix IX analytes) must have a minimum RRF of at least 0.010 compounds. See Appendix V for all CCV criteria.

6.3.2 Corrective action

6.3.2.1 Check that all peaks have been properly integrated. Check the calculations. If the %D or the internal standard area criteria are still not met, perform corrective instrument maintenance or re-tuning, and reanalyze the standard. If the %D, internal standard area response, or minimum RF criteria are still not met, a new CCV standard may need to be prepared, a new initial calibration performed, a new column installed, or other instrument maintenance performed in order to meet the CCV criteria.

6.4 Method Blank

6.4.1 Criteria

6.4.1.1 A method blank is used to verify contamination-free reagents and apparatus. A method blank is prepared with every set of samples extracted at the same time, at a frequency of at least one blank per 20 samples.

6.4.1.2 Laucks criterion for a method blank is less than one-half the RL for each analyte. Method blank corrective action limits are detailed in Appendix VI.

6.4.2 Corrective action

6.4.2.1 When these criteria are exceeded, corrective action should be taken to find/reduce/eliminate the source of this contamination in the method blank. Sample corrective action may be limited to qualification for blank contamination. When the concentrations of any target analytes within the method blank are above one-half of the reporting limit, the effect this may have had on the samples will be assessed.

1) If any analyte is found only in the method blank, but not in any batch samples, no further corrective action may be necessary. Steps shall be taken to find/reduce/eliminate the source of this contamination in the method blank. The case narrative should also discuss the situation.

2) Reanalysis of the method blank and any samples containing the same contaminant(s) which exceeded the corrective action limit(s) is performed if an analyte is found in the method blank and some, or all, of the other batch samples. If the contamination remains, the contaminated samples of the batch would be re-prepared and reanalyzed with a new method blank and batch specific QC samples.

3) Sporadic cases of contamination may be difficult to control, however daily contamination would not be acceptable.

4) Out-of-control surrogate recoveries in the method blank require reanalysis of the method blank.

5) If common lab contaminants such as phthalates are present, the associated sample results for these compounds are flagged appropriately. Analytes may be present as long as they are less than 5 percent of the regulatory limit associated with that analyte, or less than 5 percent of the sample result for the same analyte, whichever is greater, for the method blank to be acceptable. Typically, the regulatory limits for these compounds are well above normal sporadic contamination levels however, in order to make appropriate determinations in accordance with the DoD QSM and SW 846, the lab must have the specific regulatory limit for the common lab contaminants provided by the contractor or oversight agency.

6.4.3 Documentation

6.4.3.1 Copies of all method blank analyses are stored with the sample analyses raw data. In addition, the raw data for the method blank analyses are stored in the laboratory for an extended period of time. The results for the method blank analyses are reported electronically via the laboratory's iLIMS database. If criteria are not met, reanalysis of additional blank(s) are noted in the instrument run log. Outliers are discussed in the case narrative.

6.5 QC Check Sample (LCS)

6.5.1 The LCS is used to determine whether a method is in control during sample preparation and analysis. A LCS follows the same protocol as the matrix spike analysis except that the spiking solution is added to a blank matrix (deionized water for water or sea sand for soil/sediments) instead of an actual sample. A Lab Control Sample is prepared with every set of samples extracted at the same time, at a frequency of at least one LCS per 20 samples.

6.5.2 The USACOE requires at a minimum that all target analytes be spiked into the LCS. According to the USACOE Shell Document I.10.2.2: "The LCS is spiked with all single-component target analytes before it is carried through the preparation, cleanup, and determinative procedures. ***A subset of the single-component target analytes containing the specific analytes of interest can be substituted for the full list of target analytes if specified in project-specific contracts or work plans."***

6.5.3 It is also recommended that all target analytes of concern be spiked into the LCS for non-USACOE projects. NELAP specifies in D.1.1.b.4.: "if the test method has an extremely long list of components or components are incompatible, a representative number (at a minimum 10%) of the listed components may be used to control the test method." The DOD QSM Final Version I specifies, in clarification Box D-5: ""an extremely long list of components" means greater than 50 components. If a percentage of the component list is used, those analytes must be representative of each chemical class covered by the test method and include any project-specific analytes of concern."

6.5.4 The LCS may fill the requirements for the performance of an initial calibration and continuing calibration verification standard as specified in Sections 9.4.2.1 and 9.4.2.2 in the DoD Quality Systems Manual – Final Version 1, October 2000. The spiking levels vary from 20µg/mL to 30µg/mL.

6.5.5 Criteria

6.5.5.1 At the time of the writing of this SOP, the established control limits are as follows:

TABLE 1
Blank Spike Recovery Limits

Compound	%Recovery Water	%Recovery Soil/Sediment
Phenol	18-109	25-121
2-Chlorophenol	23-114	31-117
1,4-Dichlorobenzene	13-85	40-102
N-Nitroso-di-n-propylamine	36-120	27-118
1,2,4-Trichlorobenzene	19-91	43-107
4-Chloro-3-methylphenol	28-120	35-121
Acenaphthene	35-119	33-123
4-Nitrophenol	10-134	10-148
2,4-Dinitrotoluene	19-132	18-135
Pentachlorophenol	12-127	14-120
Pyrene	52-118	45-112

6.5.6 Corrective action

6.5.6.1 Check all peak integrations and sample calculations.

6.5.6.2 If the analyte recoveries still exceed the control limits, the blank spike extract may be reanalyzed.

6.5.6.3 If the analyte recoveries are still out of control, re-extraction of the associated samples is required.

6.6 Matrix Spike/Matrix Spike Duplicate Sample

6.6.1 A sample is chosen from the samples to be analyzed, and an aliquot of spiking solution is added to this sample prior to extraction. It is not required that a matrix spike analysis be performed with each extraction batch unless the project QAPP requires it. However, the minimum frequency for MS analysis is 1 each per 20 samples per matrix. This matrix spike sample is used to evaluate the matrix effect of the sample upon recovery of Calculate the recovery of each matrix spike compound using the equation below.

$$\%\text{Recovery} = \frac{\textit{Spiked sample result} - \textit{sample result}}{\textit{Spike added}} \times 100$$

6.6.2 Calculate the relative percent difference (RPD) of the recoveries of each compound in the

matrix spike and matrix spike duplicate as follows:

$$RPD = \frac{|Matrix\ spike\ recovery - Matrix\ spike\ duplicate\ recovery|}{1/2(Matrix\ spike\ recovery + Matrix\ spike\ duplicate\ recovery)} \times 100$$

The vertical bars in the formula above indicate the absolute value of the difference, therefore RPD is always expressed as a positive value.

6.6.3 Criteria

6.6.3.1 At the time of the writing of this SOP, the established control limits are as follows:

TABLE 2
Matrix Spike Recovery and Relative Percent Difference Limits

Compound	%Recovery Water	RPD Water	%Recovery Soil/Sediment	RPD Soil/Sediment
Phenol	10-92	45	35-105	20
2-Chlorophenol	12-95	50	39-100	20
1,4-Dichlorobenzene	24-63	39	21-73	30
N-Nitroso-di-n-propylamine	13-122	31	10-151	28
1,2,4-Trichlorobenzene	31-67	28	27-82	25
4-Chloro-3-methylphenol	27-109	16	25-128	20
Acenaphthene	42-93	22	41-107	20
4-Nitrophenol	10-98	50	10-144	41
2,4-Dinitrotoluene	35-111	20	38-91	20
Pentachlorophenol	10-137	50	10-108	50
Pyrene	44-116	20	32-127	44

6.6.4 Corrective action

6.6.4.1 Samples with spike recoveries outside control limits will be reviewed for possible corrective action. Corrective action may involve recalculation, re-extraction, and/or reanalysis. This process should also look at the recovery of surrogate compounds in the MS sample and at the recovery of matrix spiking compounds from the extraction batch blank spike analysis. In all cases, a narrative explanation of the condition is required to detail the corrective actions taken.

6.6.4.2 If any analyte recovery exceeds the control limits the following action must be taken:

6.6.4.2.1 If the blank spike analysis yielded recoveries outside the control limits then re-extract and reanalyze all samples extracted with the MS/MSD.

6.6.4.2.2 If the blank spike analysis was in control then recoveries outside the control limits can be attributed to matrix effect and sample results are processed as normal. The report comments or narrative section must include comments about the out-of-control recoveries.

6.6.4.3 Corrective action for RPD values that exceed the control limits follows the corrective action for MS/MSD recoveries. If more than one RPD exceeds the control limit, re-extraction may not be required if it can be demonstrated that the sample is non-homogeneous and all MS/MSD recoveries are within the control limits.

6.7 Surrogate Recovery

6.7.1 Surrogates are chemically similar compounds added to every sample, method blank and QC sample prior to sample processing. They are used to monitor for potential sample processing errors and matrix effects.

6.7.2 Surrogate compound recoveries are calculated as follow:

$$\%Recovery = \frac{S_m}{S_a} \times 100$$

where:
S_m = Concentration of surrogate measured in extract.
S_a = Concentration of surrogate added.

6.7.3 Criteria

6.7.4 The semivolatile surrogates can be divided into two groups: base/neutral compounds (nitrobenzene-d5, 2-fluorobiphenyl, 1,2-dichlorobenzene-d4, and terphenyl-d14); acid compounds (phenol-d5, 2-fluorophenol, 2,4,6-tribromophenol, and 2-chlorophenol-d4). At the time of the writing of this SOP, the established control limits are follows:

TABLE 3
SURROGATE RECOVERY LIMITS

Compound	%Recovery Water	%Recovery Soil
Nitrobenzene-d5	39-104	41-101
2-Fluorobiphenyl	34-104	43-107
Terphenyl-d14	37-141	14-164
Phenol-d5	25-105	27-115
2-Fluorophenol	14-108	31-110
2,4,6-Tribromophenol	18-139	16-140
2-Chlorophenol-d4	37-105 (advisory)	35-112 (advisory)
1,2-Dichlorobenzene-d4	20-91 (advisory)	44-102 (advisory)

6.7.5 Corrective Action

6.7.5.1 Check calculations for possible error.

6.7.5.2 Check instrument performance, if necessary correct the problem and re-analyze the extract.

6.7.5.3 Some samples may require dilution in order to bring one or more target analytes within the calibration range or to overcome significant matrix interference. This may result in the dilution of the surrogate response to the point that the recoveries can not be measured. If the surrogate recoveries are available from a less-diluted or undiluted aliquot of the sample or sample extract, those recoveries may be used to demonstrate that the surrogates were within the QC limits, and no further action is required. For all package work both the diluted and undiluted analyses will be provided.

6.7.5.4 Re-extraction is not necessary in the case where a sample is chosen for MS/MSD analyses and the same recovery pattern is present in all three analyses. In this case, matrix effects may be assumed and re-extraction is not required for this sample.

6.7.5.5 If only one fraction is being analyzed and surrogates that relate to the other fraction are out-of-control, then re-extraction and reanalysis for the target fraction is not required.

6.7.5.6 All other circumstances require re-extraction and reanalysis of the affected sample(s).

6.7.5.7 Out of control surrogate recoveries in the method blank require that all the samples in the associated batch be re-extracted and reanalyzed. In any case, it is imperative to identify the problem associated with low recovery so that it can be corrected. It is a requirement that all out of control surrogate recoveries and the corrective action taken be discussed in the narrative.

7. References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 4th Edition, Method 8270D, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS): Capillary Column Technique," Revision 4, January 1998, U.S. EPA.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, 2nd Update, Method 3640A, "Gel-Permeation Cleanup," Revision 1, November 1992, US EPA.

US EPA Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, Document Number OLM04.2, May 1999.

SW846 Test Methods for Evaluating Solid Waste, Method 8141A Organophosphorus Compounds by GC: Capillary Column Technique, US EPA Office of Solid Waste and Emergency Response, Revision 2, December 1996.

APPENDIX I
Calibration Standard Solution Concentrations, ng/µL

Compound	STD1	STD2	STD3	STD4	STD5	STD6
Phenol	5	10	25	40	60	80
bis(2-Chloroethyl)ether	5	10	25	40	60	80
2-Chlorophenol	5	10	25	40	60	80
1,3-Dichlorobenzene	5	10	25	40	60	80
1,4-Dichlorobenzene	5	10	25	40	60	80
Benzyl Alcohol	5	10	25	40	60	80
1,2-Dichlorobenzene	5	10	25	40	60	80
2-Methylphenol	5	10	25	40	60	80
Bis(2-chloroisopropyl)ether	5	10	25	40	60	80
4-Methylphenol	5	10	25	40	60	80
N-Nitroso-di-n-propylamine	5	10	25	40	60	80
Hexachloroethane	5	10	25	40	60	80
Nitrobenzene	5	10	25	40	60	80
Isophorone	5	10	25	40	60	80
2-Nitrophenol	5	10	25	40	60	80
2,4-Dimethylphenol	5	10	25	40	60	80
Benzoic Acid	5	10	25	40	60	80
bis(2-Chloroethoxy)methane	5	10	25	40	60	80
2,4-Dichlorophenol	5	10	25	40	60	80
1,2,4-Trichlorobenzene	5	10	25	40	60	80
Naphthalene	5	10	25	40	60	80
4-Chloroaniline	5	10	25	40	60	80
Hexachlorobutadiene	5	10	25	40	60	80
4-Chloro-3-methylphenol	5	10	25	40	60	80
2-Methylnaphthalene	5	10	25	40	60	80
Hexachlorocyclopentadiene	5	10	25	40	60	80
2,4,6-Trichlorophenol	5	10	25	40	60	80
2,4,5-Trichlorophenol	5	10	25	40	60	80
2-Chloronaphthalene	5	10	25	40	60	80
2-Nitroaniline	5	10	25	40	60	80
Dimethylphthalate	5	10	25	40	60	80
Acenaphthylene	5	10	25	40	60	80
2,6-Dinitrotoluene	5	10	25	40	60	80
3-Nitroaniline	5	10	25	40	60	80
Acenaphthene	5	10	25	40	60	80
2,4-Dinitrophenol	5	10	25	40	60	80

Compound	STD1	STD2	STD3	STD4	STD5	STD6
4-Nitrophenol	5	10	25	40	60	80
Dibenzofuran	5	10	25	40	60	80
2,4-Dinitrotoluene	5	10	25	40	60	80
Diethylphthalate	5	10	25	40	60	80
4-Chlorophenyl-phenylether	5	10	25	40	60	80
Fluorene	5	10	25	40	60	80
4-Nitroaniline	5	10	25	40	60	80
4,6-Dinitro-2-methylphenol	5	10	25	40	60	80
N-Nitrosodiphenylamine	5	10	25	40	60	80
4-Bromophenyl-phenylether	5	10	25	40	60	80
Hexachlorobenzene	5	10	25	40	60	80
Pentachlorophenol	5	10	25	40	60	80
Phenanthrene	5	10	25	40	60	80
Anthracene	5	10	25	40	60	80
Carbazole	5	10	25	40	60	80
Di-n-butylphthalate	5	10	25	40	60	80
Fluoranthene	5	10	25	40	60	80
Pyrene	5	10	25	40	60	80
Butylbenzylphthalate	5	10	25	40	60	80
3,3'-Dichlorobenzidine	5	10	25	40	60	80
Benzo(a)anthracene	5	10	25	40	60	80
Chrysene	5	10	25	40	60	80
bis(2-Ethylhexyl)phthalate	5	10	25	40	60	80
Di-n-octylphthalate	5	10	25	40	60	80
Benzo(b)fluoranthene	5	10	25	40	60	80
Benzo(k)fluoranthene	5	10	25	40	60	80
Benzo(a)pyrene	5	10	25	40	60	80
Indeno(1,2,3-cd)pyrene	5	10	25	40	60	80
Dibenzo(a,h)anthracene	5	10	25	40	60	80
Benzo(g,h,i)perylene	5	10	25	40	60	80
N-Nitrosodimethylamine	5	10	25	40	60	80
2-Fluorophenol	5	10	25	40	60	80
Phenol-d5	5	10	25	40	60	80
2-Chlorophenol-d4	5	10	25	40	60	80
1,2-Dichlorobenzene-d4	5	10	25	40	60	80
Nitrobenzene-d5	5	10	25	40	60	80
2-Fluorobiphenyl	5	10	25	40	60	80
2,4,6-Tribromophenol	5	10	25	40	60	80
1,2-Diphenylhydrazine	5	10	25	40	60	80
Benzidine	5	10	25	40	60	80
Terphenyl-d14	5	10	25	40	60	80

APPENDIX II

DFTPP Tuning Criteria

SW 846 states that the following approach has been shown to be useful: the mass spectrum of DFTPP may be acquired in the following manner. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is required, and must be accomplished using a single scan no more than 20 scans prior to the elution of DFTPP. Do not background subtract part of the DFTPP peak.

Mass	Relative Abundance
51	30-60% of mass 198
68	less than 2% of 69
69	present
70	less than 2% of 69
127	40-60% of mass 198
197	less than 1% of 198
198	100%
199	5-9% of mass 198
275	10-30% of mass 198
365	greater than 1% of mass 198
441	0-100 % of mass 443
442	40-100% of mass 198
443	17-23% of mass 442

The above listed tuning criteria will be used for all USACOE and AFCEE work unless otherwise specified on a project specific basis.
As per SW846 any alternate tuning criteria such as the one below from the OLM04.2 contract may use used or any other published tuning criteria.

Mass	Relative Abundance
51	30-80% of mass 198
68	less than 2% of 69
69	present
70	less than 2% of 69
127	25-75% of mass 198
197	less than 1% of 198
198	100%
199	5-9% of mass 198
275	10-30% of mass 198
365	greater than 0.75% of mass 198
441	0-100 % of mass 443
442	40-110% of mass 198
443	15-24% of mass 442

CLP requires that the three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is required, and must be accomplished using a single scan no more than 20 scans prior to the elution of DFTPP. Do not background subtract part of the DFTPP peak.

APPENDIX III

Data Packet Order List

QC Summary
Surrogate Recovery Summary Report
Blank Spike Recovery Report
MS/MSD Recovery Report
Method Blank Summary
GC/MS Instrument Performance Check
Internal Standard Area and RT Summary Report

Sample Data
Target Compound Results (Organics Analysis Data Sheet)
Tentatively Identified Compound (TIC) Results (if required)
Sample Chromatograms, quantitation reports and spectra for all samples

Standards Data
Initial Calibration Summary Report
Chromatograms and quantitation reports for all initial calibration standards
Continuing Calibration Summary Reports
Chromatograms and quantitation reports for all CCV Standards

Raw QC Data
Bar Graph Spectrum, mass listing and chromatogram for every DFTPP injection
Method Blank Data
Target Compound Results (Organics Analysis Data Sheet)
Tentatively Identified Compound (TIC) Results (if required)
Chromatograms, quantitation reports and spectra for all method blanks
Blank Spike Data
Target Compound Results (Organics Analysis Data Sheet)
Chromatograms, quantitation reports and spectra for all blank spikes
Matrix Spike/Matrix Spike Duplicate Data
Target Compound Results (Organics Analysis Data Sheet)
Chromatograms, quantitation reports and spectra for all MS analyses
Control Charts

Bench Sheets
All extraction bench sheets, analysis log book pages, chains of custody, and any other pertinent information

APPENDIX IV

Initial Calibration Criteria

Calibration Check Compound	%RSD Limit
Phenol	≤30%
1,4-Dichlorobenzene	≤30%
2-Nitrophenol	≤30%
2,4-Dichlorophenol	≤30%
Hexachlorobutadiene	≤30%
4-Chloro-3-methylphenol	≤30%
2,4,6-Trichlorophenol	≤30%
Acenaphthene	≤30%
N-Nitrosodiphenylamine	≤30%
Pentachlorophenol	≤30%
Fluoranthene	≤30%
Di-n-octylphthalate	≤30%
Benzo(a)pyrene	≤30%

System Performance Check Compound	Minimum Average RF
N-Nitroso-di-n-propylamine	0.050
Hexachlorocyclopentadiene	0.050
2,4-Dinitrophenol	0.050
4-Nitrophenol	0.050

APPENDIX V

Continuing Calibration Verification Criteria

Calibration Check Compound	%D Limit
Phenol	≤20%
1,4-Dichlorobenzene	≤20%
2-Nitrophenol	≤20%
2,4-Dichlorophenol	≤20%
Hexachlorobutadiene	≤20%
4-Chloro-3-methylphenol	≤20%
2,4,6-Trichlorophenol	≤20%
Acenaphthene	≤20%
N-Nitrosodiphenylamine	≤20%
Pentachlorophenol	≤20%
Fluoranthene	≤20%
Di-n-octylphthalate	≤20%
Benzo(a)pyrene	≤20%

System Performance Check Compound	Minimum RF
N-Nitroso-di-n-propylamine	0.050
Hexachlorocyclopentadiene	0.050
2,4-Dinitrophenol	0.050
4-Nitrophenol	0.050

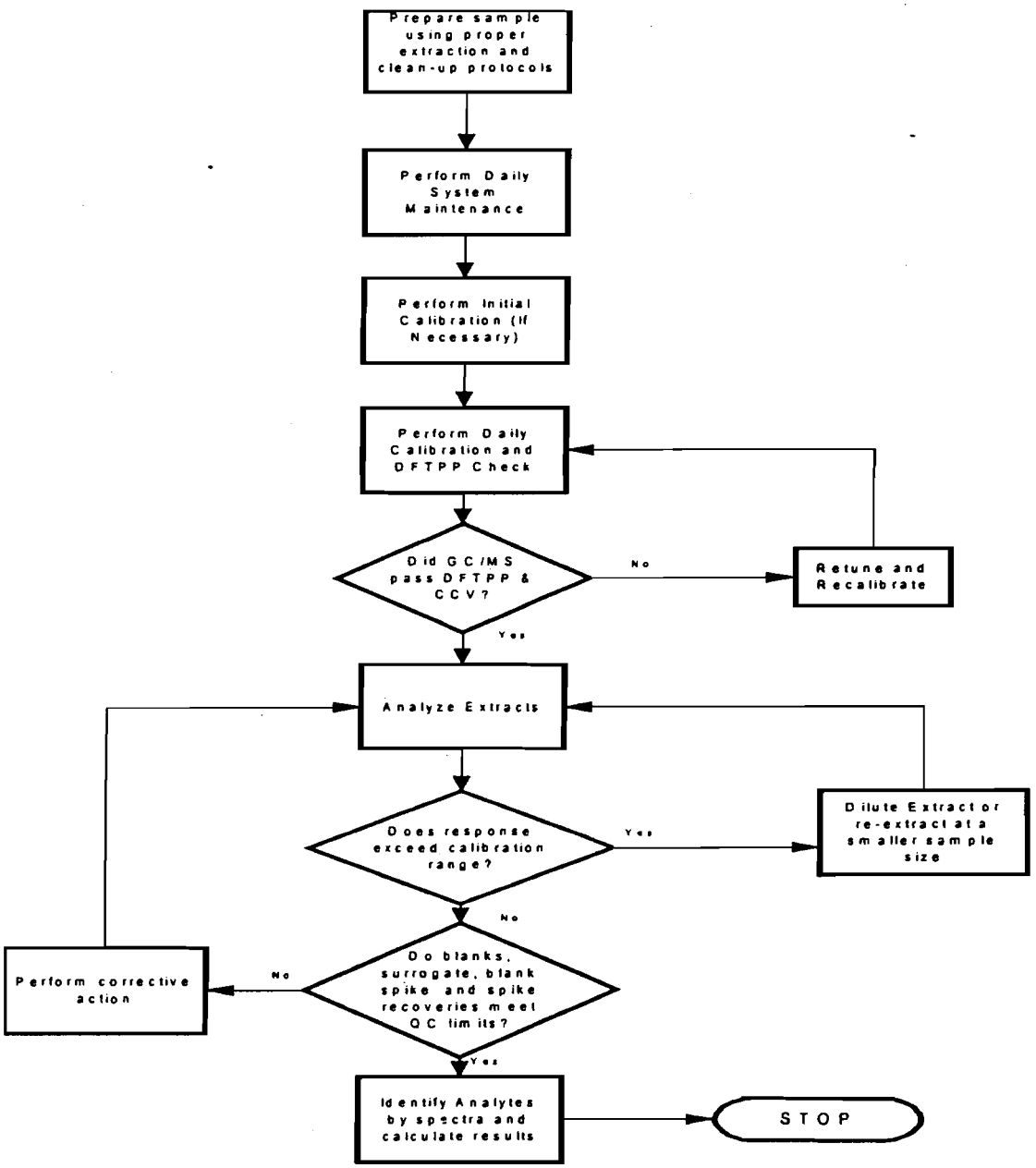
APPENDIX VI

Method Blank Corrective Action Limits

	Control Limits	
Compound	Water	Soil
All compounds	1/2 RL	1/2 RL

APPENDIX VII

Method 8270D Flow Chart



APPENDIX VIII

Method 8270D QC Requirements and Corrective Actions

QA Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
DFTPP Tuning Verification (50 ng)	Mass Abundance 51 30-60% of 198 68 <2% of 69 69 present 70 <2% of 69 127 40-60% of 198 197 <1% of 198 198 100% 199 5-9% of 198 275 10-30% of 198 365 >.75% of 198 441 present but < 443 442 40-100% of 198 443 17-23% of 442	Mass Abundance 51 30-60% of 198 68 <2% of 69 69 present 70 <2% of 69 127 40-60% of 198 197 <1% of 198 198 100% 199 5-9% of 198 275 10-30% of 198 365 >.75% of 198 441 present but < 443 442 40-100% of 198 443 17-23% of 442 Alternatively, for non-ACOE or AFCEE work any published tuning criteria may be used. Peak tailing factors; benzidine ≤5% pentachlorophenol ≤3% and 4,4'-DDT degradation breakdown ≤20%	Every 12 hours: CLP Criteria is used as allowed by the method.	Retune instrument to pass criteria.	Copy of tailing factor and degradation breakdown check stored with instrument historical file.
Initial Calibration	Minimum of 5 levels, lowest near but above MDL, %RSD for CCC ≤30, All others should be ≤15%. RF for SPCC >0.05.	Minimum of 5 levels, %RSD for CCC ≤30, All others ≤15%, All RFs >0.010. Alternate calibration models may be used for analytes with %RSD >15%.	As necessary due to major instrument maintenance or continuing difficulties meeting the CCV requirements.	Re-analysis of out of control standards.	Copies of all raw data, mass calibration, tune, and Form VI.
Initial Calibration Verification		Mid-range standard; concentrations range from 32-64µg/mL. Army Corps all analytes ≤30%, DoD all analytes ≤25%, AFCEE all analytes ≤25%	Once after initial calibration.	Re-analysis of initial calibration.	

QA Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
Continuing Calibration Verification	Mid-level standard every 12 hours. %D ≤20% for CCCs SPCCs >0.05. IS Area must be -50% to +100% of the IS in the ICV. RT of IS must be within ±30 seconds of the RT of the IS in the IC.	25 ng/µl standard every 12 hours. %D for CCC ≤20. All RFs >0.010. 40% as an upper limit. IS Area must be -50% to +100% of the IS in the IC. No RT limits for IS in the CCV.	Every 12 hours.	Perform system maintenance, re-analyze CCV standard.	
Internal Standards	1,4-Dichlorobenzene-d4, Naphthalene-d8, Acenaphthene-d10, Phenanthrene-d10, Chrysene-d12, Perylene-d12, All @ 40 ng/uL ea.	1,4-Dichlorobenzene-d4, Naphthalene-d8, Acenaphthene-d10, Phenanthrene-d10, Chrysene-d12, Perylene-d12, all @ 20 ng/µl ea. Area must be -50% to +100% of the area of the IS in the CCV. RT must be within 0.5 minutes of RT in CCV.	All standards, blanks, matrix spikes, matrix spike duplicates, blank spikes, SRMs, and sample re-extracts.	Re-analyze any sample which IS areas or RTs are out of range.	Notation in case narrative if applicable.
Method Blank	Analytes must be <MDL except phthalates which must be <5X the MDL.	All analytes <1/2 RL.	One method blank per 20 samples or each extraction batch of samples, whichever is more frequent.	Re-analyze blank. If still out of control, re-extract the entire batch of samples unless the offending analyte(s) are not detected in the associated samples.	Notation in case narrative if any analytes >1/2 reporting limit is present.

QA Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
Surrogate Recovery	Nitrobenzene-d5, 2-Fluorobiphenyl, Terphenyl-d14, Phenol-d6, 2-Fluorophenol, & 2,4,6-Tribromophenol. Upper and lower recovery limits determined by 3X standard deviation of at least twenty samples. To be performed at least semi-annually.	Nitrobenzene-d5, 2-Fluorobiphenyl, Terphenyl-d14, Phenol-d6, 2-Fluorophenol, & 2,4,6-Tribromophenol. Upper and lower recovery limits determined by 3X standard deviation of at least twenty samples. To be performed at least semi-annually.	All samples, method blanks, LCSs.	RE-EXTRACTION OF THE SAMPLE IS REQUIRED IF ANY SURROGATE IS OUT. ALL SURROGATES MUST BE IN CONTROL IN THE METHOD BLANK; OTHERWISE ALL ASSOCIATED SAMPLES MUST BE RE-EXTRACTED.	Notation in case narrative if applicable.
Blank Spike Recovery	MS/MSD Recovery criteria	Empirically derived from five or more blank spikes. QC limit equals 3X standard deviation. See QC database.	One per batch of twenty.	Re-extract batch unless MS/MSD is perfect.	Narrate in case narrative.
MS/MSD Recovery & RPD	Empirically derived from five or more MS/MSD pairs. QC interval equals 3X standard deviation.	Empirically derived from five or more MS/MSD pairs. QC interval equals 3X standard deviation. See QC database.	One per batch of twenty.	Re-extract batch unless blanks spike is perfect or documentable matrix effect is present.	Narrate problems in case narrative.

APPENDIX IX

Appendix IX Calibration Standard Solution Concentrations, ng/µL

Compound	STD1	STD2	STD3	STD4	STD5	STD6
Aniline	5	10	25	40	60	80
2,6-Dichlorophenol	5	10	25	40	60	80
1,2,4,5-Tetrachlorobenzene	5	10	25	40	60	80
2,3,4,6-Tetrachlorophenol	5	10	25	40	60	80
Dinoseb	5	10	25	40	60	80
Methanesulfonate, methyl	5	10	25	40	60	80
Methanesulfonate, ethyl	5	10	25	40	60	80
Phosphorothiotic Acid	5	10	25	40	60	80
Safrole	5	10	25	40	60	80
Isosafrole, cis & trans	5	10	25	40	60	80
1,4-Naphthoquinone	5	10	25	40	60	80
1,3-Dinitrobenzene	5	10	25	40	60	80
Thionazin	5	10	25	40	60	80
2,4-D, methyl ester	5	10	25	40	60	80
Diallate	5	10	25	40	60	80
Phorate	5	10	25	40	60	80
Dimethoate	5	10	25	40	60	80
Silvex, methyl ester	5	10	25	40	60	80
2,4,5-T, methyl ester	5	10	25	40	60	80
Pronamide	5	10	25	40	60	80
Disulfoton	5	10	25	40	60	80
Methyl parathion	5	10	25	40	60	80
Ethyl parathion	5	10	25	40	60	80
Isodrin	5	10	25	40	60	80
Chlorobenzilate	5	10	25	40	60	80
Kepone	5	10	25	40	60	80
Famphur	5	10	25	40	60	80
3-Methylcholanthrene	5	10	25	40	60	80
Ethanamine,N-methyl-N-nitroso	5	10	25	40	60	80
N-nitrosomorpholine	5	10	25	40	60	80
Butanamine, N-butyl-N-nitroso	5	10	25	40	60	80
2-Naphthalenamine	5	10	25	40	60	80
Diphenylamine	5	10	25	40	60	80
1,3,5-Trinitrobenzene	5	10	25	40	60	80
4-Aminobiphenyl	5	10	25	40	60	80
Methyapyrilene, HCL	5	10	25	40	60	80

Compound	STD1	STD2	STD3	STD4	STD5	STD6
p-Dimethylaminoazobenzene	5	10	25	40	60	80
2-Acetylaminofluorene	5	10	25	40	60	80
7,12-Dimethylbenz(a)anthracene	5	10	25	40	60	80
2-Picoline	5	10	25	40	60	80
Pentachloroethane	5	10	25	40	60	80
Acetophenone	5	10	25	40	60	80
N-Nitrosopyrrolidine	5	10	25	40	60	80
N-Nitrosopiperidine	5	10	25	40	60	80
Hexachloropropene	5	10	25	40	60	80
1,4-Phenylenediamine	5	10	25	40	60	80
Pentachlorobenzene	5	10	25	40	60	80
1-Naphthylamine	5	10	25	40	60	80
5-Nitro-o-toluidine	5	10	25	40	60	80
Pentachloronitrobenzene	5	10	25	40	60	80
N-Nitroquinoline-N-oxide	5	10	25	40	60	80
3,3-Dimethylbenzidine	5	10	25	40	60	80
Hexachlorophene	5	10	25	40	60	80
N-Nitrosodiethylamine	5	10	25	40	60	80
o-Toluidine	5	10	25	40	60	80
Phentermine	5	10	25	40	60	80
Sulfotep	5	10	25	40	60	80
Aramite	5	10	25	40	60	80
Phenacetin	5	10	25	40	60	80
Benzaldehyde	5	10	25	40	60	80
Atrazine	5	10	25	40	60	80
1,1'-Biphenyl	5	10	25	40	60	80
Caprolactam	5	10	25	40	60	80

Appendix X

Analytes Amenable to Analysis by Method 8270D

Current 8270D Target Analytes:

Compound	Primary Ion	Secondary Ion(s)
Phenol	94	65, 66
bis(2-Chloroethyl)ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 111
1,4-Dichlorobenzene	146	148, 111
Benzyl Alcohol	108	79, 77
1,2-Dichlorobenzene	146	148, 111
2-Methylphenol	107	108, 77
Bis(2-chloroisopropyl)ether	45	77, 121
4-Methylphenol	107	108, 77
N-Nitroso-di-n-propylamine	70	42, 101
Hexachloroethane	117	201, 199
Nitrobenzene	77	123, 65
Isophorone	82	195, 138
2-Nitrophenol	139	109, 65
2,4-Dimethylphenol	122	107, 121
Benzoic Acid	122	105, 77
bis(2-Chloroethoxy)methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
4-Chloroaniline	127	129, 65
Hexachlorobutadiene	225	223, 227
4-Chloro-3-methylphenol	107	144, 142
2-Methylnaphthalene	142	141
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 97
2-Chloronaphthalene	162	127, 164
2-Nitroaniline	65	92, 138
Dimethylphthalate	163	194, 164
Acenaphthylene	152	151, 153
2,6-Dinitrotoluene	165	63, 89
Atrazine	200	173, 215
Benzaldehyde	77	105, 106
1,1'-Biphenyl	154	153, 76
4,6-Dinitro-2-methylphenol	198	182, 77
Caprolactam	113	55, 56

Current 8270D Target Analytes:

Compound	Primary Ion	Secondary Ion(s)
3-Nitroaniline	138	108, 92
Acenaphthene	154	153, 152
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	139	109, 65
Dibenzofuran	168	139
2,4-Dinitrotoluene	167	
4-Nitroaniline	138	65, 108
4,6-Dinitro-2-methylphenol	198	51, 105
N-Nitrosodiphenylamine	169	168, 167
4-Bromophenyl-phenylether	248	250, 141
4-Chlorophenyl-phenylether	204	206, 141
Fluorene	166	165, 167
Diethylphthalate	149	177, 150
Hexachlorobenzene	284	142, 249
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Anthracene	178	176, 179
Carbazole	167	84
Di-n-butylphthalate	149	150
Fluoranthene	202	101
Pyrene	202	200, 203
Butylbenzylphthalate	149	91
3,3'-Dichlorobenzidine	252	254, 126
Benzo(a)anthracene	228	229, 226
Chrysene	228	226, 229
bis(2-Ethylhexyl)phthalate	149	167, 279
Di-n-octylphthalate	149	167, 43
Benzo(b)fluoranthene	252	253, 125
Benzo(k)fluoranthene	252	253, 125
Benzo(a)pyrene	252	253, 125
Indeno(1,2,3-cd)pyrene	276	138, 227
Dibenzo(a,h)anthracene	278	139, 279
Benzo(g,h,i)perylene	276	138, 277
N-Nitrosodimethylamine	74	42
2-Fluorophenol	112	64
Aniline	93	66, 65

Current 8270D Target Analytes:

Compound	Primary Ion	Secondary Ion(s)
Phenol-d5	99	42, 71
2-Chlorophenol-d4	132	68
1,2-Dichlorobenzene-d4	152	115
Nitrobenzene-d5	82	128, 54
2-Fluorobiphenyl	172	171
2,4,6-Tribromophenol	330	332, 141
1,2-Diphenylhydrazine	77	182, 105
Benzidine	184	92, 185
Terphenyl-d14	244	122, 212

Current Appendix IX Analytes:

Compound	Primary Ion	Secondary Ion(s)
2,6-Dichlorophenol	162	164, 63
1,2,4,5-Tetrachlorobenzene	216	214, 218
2,3,4,6-Tetrachlorophenol	230	232, 234
Dinoseb	211	163, 117
Methanesulfonate, methyl	80	79, 95
Methanesulfonate, ethyl	109	97
Phosphorothiotic Acid	97	121, 198
Safrole	162	104, 131
Isosafrole, cis & trans	162	104, 131
1,4-Naphthoquinone	158	102, 104
1,3-Dinitrobenzene	168	76, 122
Thionazin	97	96, 107
2,4-D, methyl ester	199	175, 234
Diallate	86	234, 236
Phorate	260	231, 121
Dimethoate	87	93, 125
Silvex, methyl ester	196	225, 282
2,4,5-T, methyl ester	233	235, 268
Pronamide	173	175, 255
Disulfoton	88	274, 142
Methyl parathion	263	125, 109
Ethyl parathion	291	235, 186
Isodrin	193	195, 230

Current Appendix IX Analytes:

Compound	Primary Ion	Secondary Ion(s)
Chlorobenzilate	139	251, 253
Kepone	272	274, 355
Famphur	218	125, 217
3-Methylcholanthrene	268	252, 253
Ethanamine,N-methyl-N-nitroso	42	88, 43
N-nitrosomorpholine	56	86, 116
Butanamine, N-butyl-N-nitroso	84	41, 57
2-Naphthalenamine	143	144, 115
Diphenylamine	169	168, 167
1,3,5-Trinitrobenzene	213	75, 74
4-Aminobiphenyl	169	168, 170
Methyapyrilene, HCL	58	97, 191
p-Dimethylaminoazobenzene	120	225, 226
2-Acetylaminofluorene	181	180, 223
7,12-Dimethylbenz(a)anthracene	256	241, 239
2-Picoline	93	92, 78
Pentachloroethane	167	165, 119
Acetophenone	105	77, 51
N-Nitrosopyrrolidine	100	41, 42
N-Nitrosopiperidine	42	114, 55
Hexachloropropene	213	215, 211
1,4-Phenylenediamine	108	80, 81
Pentachlorobenzene	250	252, 248
1-Naphthylamine	143	144, 115
5-Nitro-o-toluidine	152	77, 106
Pentachloronitrobenzene	237	214, 295
N-Nitroquinoline-N-oxide	190	160, 89
3,3-Dimethylbenzidine	212	213, 211
Hexachlorophene	196	198, 209
N-Nitrosodiethylamine	74	42
o-Toluidine	106	107
Phentermine	58	91, 134
Sulfotep	97	322, 202
Aramite	135	193, 208
Phenacetin	108	109, 179

APPENDIX XI

Semivolatile Internal Standards With Corresponding Analytes Assigned For Quantitation

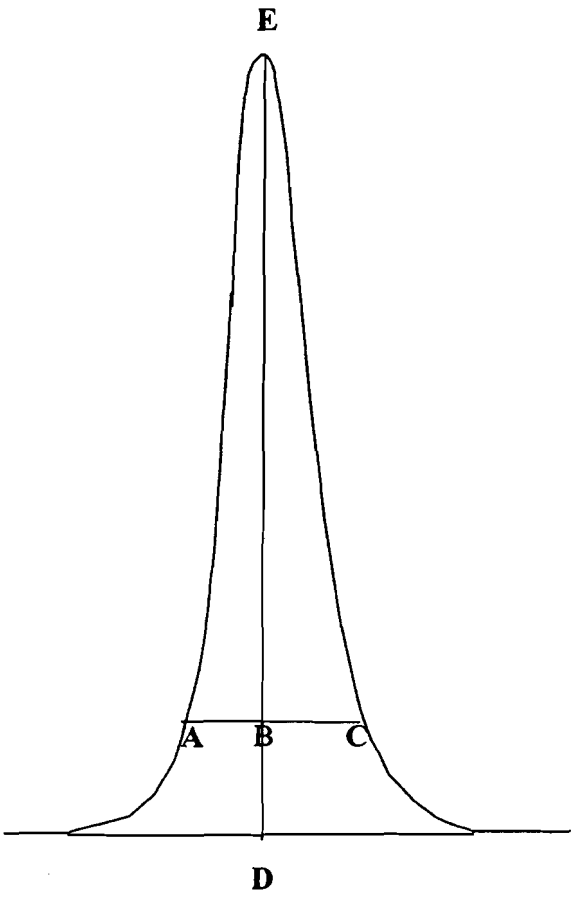
1,4-Dichlorobenzene-d4	Naphthalene-d8	Acenaphthene-d10
Phenol	Nitrobenzene	Hexachlorocyclopentadiene
Bis(2-Chloroethyl)ether	Isophorone	2,4,6-Trichlorophenol
2-Chlorophenol	2-Nitrophenol	2,4,5-Trichlorophenol
1,3-Dichlorobenzene	2,4-Dimethylphenol	2-Chloronaphthalene
1,4-Dichlorobenzene	Benzoic Acid	2-Nitroaniline
Benzyl Alcohol	bis(2-Chloroethoxy)methane	Dimethylphthalate
1,2-Dichlorobenzene	2,4-Dichlorophenol	Acenaphthylene
2-Methylphenol	1,2,4-Trichlorobenzene	2,6-Dinitrotoluene
Bis(2-chloroisopropyl)ether	Naphthalene	3-Nitroaniline
4-Methylphenol	4-Chloroaniline	Acenaphthene
N-Nitroso-di-n-propylamine	Hexachlorobutadiene	2,4-Dinitrophenol
Hexachloroethane	4-Chloro-3-methylphenol	4-Nitrophenol
Aniline	2-Methylnaphthalene	Dibenzofuran
Pyridine	Nitrobenzene-d5	2,4-Dinitrotoluene
Phenol-d5	2,6-Dichlorophenol	4-Nitroaniline
2-Chlorophenol-d4	Safrole	Fluorene
1,2-Dichlorobenzene-d4	Isosafrole, cis & trans	4-Chlorophenyl-phenylether
N-Nitrosodimethylamine	1,4-Naphthoquinone	Diethylphthalate
2-Fluorophenol	Butanamine, N-methyl-N-nitroso	1,2,4,5-Tetrachlorobenzene
Methanesulfonate methyl	Hexachloropropene	2,3,4,6-Tetrachlorophenol
Methanesulfonate ethyl	1,4-phenylenediamine	1,3-Dinitrobenzene
Phosphorothiotic acid	Phentermine	Thionazin
Ethanamine, N-methyl-N-nitroso	Caprolactam	2,4-D methyl ester
N-Nitrosomorpholine		Diallate
2-Picoline		Phorate
Pentachloroethane		Dimethoate
Acetophenone		Silvex methyl ester
N-Nitrosopyrrolidine		2,4,5-T methyl ester
N-Nitrosopiperidine		2-Naphthaleneamine
Benzaldehyde		1,1'-Biphenyl

1,4-Dichlorobenzene-d4	Naphthalene-d8	Acenaphthene-d10
N-Nitrosodiethylamine O-Toluidine		Pentachlorobenzene 1-Naphthylamine 5-Nitro-o-toluidine Pentachloronitrobenzene Sulfotep Aramite

Phenanthrene-d10	Chrysene-d12	Perylene-d12
4,6-Dinitro-2-methylphenol N-Nitrosodiphenylamine 4-Bromophenyl-phenylether Hexachlorobenzene Pentachlorophenol Phenanthrene Anthracene Carbazole Di-n-butylphthalate Fluoranthene 2,4,6-Tribromophenol 1,2-Diphenylhydrazine Dinoseb Pronamide Disulfoton Methyl parathion Ethyl parathion Isodrin Diphenylamine 1,3,5-Trinitrobenzene 4-Aminobiphenyl Methapyrilene, HCL N-Nitroquinoline-n-oxide 3,3-Dimethylbenzidine Phenacetin Atrazine	Pyrene Butylbenzylphthalate 3,3'-Dichlorobenzidine Benzo(a)anthracene Chrysene bis(2-Ethylhexyl)phthalate Benzidine Terphenyl-d14 Chlorobenzilate Kepone Famphur P-Dimethylaminoazobenzene 2-Acetylaminofluorene 7,12- Dimethylbenz(a)anthracene Hexachlorophene	Di-n-octylphthalate Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene Dibenzo(a,h)anthracene Benzo(g,h,i)perylene 3-Methylcholanthrene

Appendix XIV

Calculation of Peak Tailing Factors



Peak Tailing Factor = BC/AB

Sample calculation: Peak Height = DE =100mm
10% Peak Height = BD = 10mm
Peak Width at 10% Peak Height = AC = 23mm
AB = 11mm
BC = 12mm
Tailing Factor = 12/11 = 1.1

LAUCKS TESTING LABORATORIES INC.

Seattle, Washington

SOP #:LTL-8330

Determination of Nitroaromatics and Nitramines by SW-846 Method 8330A & 8332

Revision history:

Number	Date
1	06/19/95
2	01/11/96
3	04/10/96
4	04/15/96
5	07/09/96
6	12/18/97
7	4/30/98
8	10/28/98
9	01/25/99
10	03/16/00
11	05/09/02
12	09/26/02
13	09/30/03

Revised by: Elizabeth Leps, Chemist Date: 10/1/03

Approved by: Harry Romberg, QA Officer Date: 10-1-03

Approved by: Kathy Kreps, Laboratory Director Date: 10-1-03

TABLE OF CONTENTS

1.1 METHOD DESCRIPTION 4
1.2 METHOD DEVIATIONS & COMMENTS 5
1.3 INTERFERENCES 7
1.4 SAMPLE COLLECTION, SAMPLE STORAGE, HOLDING TIMES 7
1.5 DEFINITION OF TERMS 7

2. EQUIPMENT LIST AND STANDARDS 9

2.1 CHROMATOGRAPHIC SYSTEM 9
2.2 STANDARDS 10

VENDOR 12

3. SAFETY PRECAUTIONS 14

3.1 ROUTINE SAFETY PRECAUTIONS 14
3.2 WASTE DISPOSAL 14

4. OPERATION PROCEDURES 14

4.1 ANALYTICAL CONDITIONS 14

5. CALIBRATION AND QUALITY CONTROL 16

5.1 METHOD DETECTION LIMIT STUDY 16
5.2 METHOD VALIDATION 17
5.3 RETENTION TIME WINDOWS 17
5.4 INITIAL CALIBRATION 17
5.5 NON-LINEAR CALIBRATION 18
5.6 SECOND SOURCE STANDARDS (ICV) 19
5.7 INITIAL CONTINUING CALIBRATION VERIFICATION (ICCV) 19
5.8 CONTINUING CALIBRATION VERIFICATION 20
5.9 SAMPLE ANALYSIS 20

6. REPORTS 23

6.1 DATA PACKET ORGANIZATION 23
6.2 QUALITY CONTROL REPORTS 23

7. QUALITY CONTROL 24

7.1 METHOD BLANK 24
7.2 BLANK SPIKE OR QC CHECK SAMPLE (LCS) 25
7.3 MATRIX SPIKE 25
7.4 MATRIX SPIKE DUPLICATE 26
7.5 SURROGATE RECOVERY 26

8. REFERENCES 28

APPENDIX I 29

CALIBRATION STANDARD SOLUTION CONCENTRATIONS, µG/ML 29

COMPOUND 30

CONCENTRATION 30

APPENDIX II 31

ANALYSIS SEQUENCE 31

APPENDIX III 32

DATA PACKET ORDER LIST 32

APPENDIX IV 34

METHOD 8330 REQUIREMENTS AND CORRECTIVE ACTIONS 34

APPENDIX V 36

ELUTION ORDER OF TARGET ANALYTES 36

APPENDIX VI 37

MDLS/PQLS 37

APPENDIX VII 38

METHOD 8330 FLOW CHART 38

APPENDIX VIII 39

CONTROL LIMITS* 39

LCS 39

SURROGATE 39

WATER 39

SOIL 39

INTRODUCTION AND SCOPE

1.1 Method Description

1.1.1 This method is used for the trace analysis of ordnance compounds in water, soil, and sediment samples by high performance liquid chromatography. The concentrated water sample extracts are diluted 1:1 (v/v) with reagent grade water prior to analysis. The sample extracts are analyzed using a C18 (octadecyl) reverse phase column, and target analyte concentrations are measured at either 254 nm or 210 nm using a UV detector. All positive measurements observed on the C18 column are confirmed by a second analysis that uses a CN (cyano) column.

1.1.2 The C18 column is considered the primary column and is used for quantitation of all target analytes.

1.1.3 This method is used to determine part per billion levels of the ordnance analytes listed below:

Compound	Acronym
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	HMX
Hexahydro-1,3,5-trinitro-1,3,5-triazine	RDX
1,3,5-Trinitrobenzene	1,3,5-TNB
1,3-Dinitrobenzene	1,3-DNB
Methyl-2,4,6-trinitrophenylnitramine	Tetryl
Nitrobenzene	NB
2,4,6-Trinitrotoluene	2,4,6-TNT
4-Amino-2,6-dinitrotoluene	4-Am-DNT
2-Amino-4,6-dinitrotoluene	2-Am-DNT
2,4-Dinitrotoluene	2,4-DNT
2,6-Dinitrotoluene	2,6-DNT
2-Nitrotoluene	2-NT
3-Nitrotoluene	3-NT
4-Nitrotoluene	4-NT

6 Additional Compounds
(Separate Analysis at 254 nm)

Compound	Acronym
2,4-Diamino-6-nitrotoluene	2,4-DA-6-NT
2,6-Diamino-4-nitrotoluene	2,6-DA-4-NT
3,5-Dinitroaniline	3,5-DNA
1-Nitroso-3,5-dinitro-1,3,5-hexahydrotriazine	MNX
1,3,5-Trinitroso-1,3,5-hexahydrotriazine	TNX
2,2',6,6'-Tetranitro-4,4'-azoxytoluene	4,4'-TN-AZOXY

PETN/NG Compounds
(Separate Analysis at 210 nm)

Compound	Acronym
Nitroglycerin	NG
Pentaerythritoltetranitrate	PETN

1.1.4 Aqueous samples of higher concentration can be directly analyzed by diluting 1:1 (v/v) with methanol or acetonitrile, filtering, separating on a C18 reverse phase column, and determined at either 254 nm or 210 nm, and confirmed on a CN column.

1.1.5 This method is restricted to use by, or under the supervision of, analysts experienced in the use of high-pressure liquid chromatography and in the interpretation of chromatograms. Each analyst performing this method must have demonstrated the ability to perform the described chromatographic analysis and/or data interpretation.

1.2 Method Deviations & Comments

1.2.1 The following items represent deviations from the published version of method SW 8330 and SW 8332 that are followed as standard operating procedure in the performance of this method at Laucks.

1. Single injections of calibration standards are analyzed rather than triplicate injections in a random order. It has been determined at Laucks that single injections of these standards yield acceptable calibration and linearity data as evidenced by the calculated percent RSDs used to evaluate the initial calibration data.

2. Method SW 8330 and SW 8332 specifies that all analyses are to be performed using a mobile phase that consists of a 50:50 mixture of methanol/water under isocratic conditions.

3. According to Method 8330 and 8332, all working standards are to be prepared daily in a methanol/calcium chloride solution. The practice at Laucks for 8330/8332 and the 6 additional compounds is to prepare working standards using acetonitrile and diluting 50/50 with water just prior to analysis. NG/PETN are prepared in a 50/50 mixture of acetonitrile and water. These working solutions have been demonstrated to be stable for at least 6 months. The stability of target analyte responses in the working solutions in use (especially that of tetryl) is used to determine whether new solutions should be prepared.

4. Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. Laucks has experienced erratic recovery of tetryl from spiked sample extracts.

5. Currently, the confirmation column will not demonstrate full separation for the ordnance compounds. The following target analytes will co-elute: 2-nitrotoluene, 3-nitrotoluene, and 4-nitrotoluene and 4-amino-2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene. Therefore, positive confirmation can not be made when these peaks have been tentatively identified on the primary column.

6. At the time of this writing, analysis of the 6 additional compounds (not including PETN/NG) requires a separate analysis on both the primary and confirmation columns using a wavelength at 254 nm. However, when only MNX is added to the 14 ordnance compounds, complete separation is achieved on the primary column (C18) and a separate analysis is not required.

7. Although the compounds NG and PETN are not listed in SW 846 Method 8330/8332, Laucks has found that adequate recovery of these compounds can be achieved using this method by modifying the wavelength from 254 nm to 210 nm.

1.2.2 In order to attain lab-wide consistency among staff members for decision-making processes with regard to laboratory anomalies, several common items have been addressed in this SOP. Any occurrences that are not covered in this SOP should be discussed with the supervisor, prior to implementing a solution.

1.2.3 One example is the determination of potential carry-over in sample analyses. Any samples analyzed after a high level sample (which is defined by yielding one or more target analytes above the calibration range) should be thoroughly examined for potential carry-over of the same target

analyte(s). Corrective action in the form of reanalysis for possible carry-over should be performed and documented in the narrative, if required.

1.2.4 Another example is the review of all sample chromatograms for analytes that may not show up on the sample quantitation report due to data system error or retention time shift. All peaks should be examined and evaluated based on the retention times and sample concentration in order to prevent reporting false negatives.

1.3 Interferences

1.3.1 When there is a significant discrepancy between analytical columns, the analyst needs to take special care to review data for possible matrix interference on one or both columns. While the majority of results are reported from the primary column (C18), there may be times when reporting results from the confirmation may be more appropriate. This anomaly should also be noted in the case narrative.

1.4 Sample Collection, Sample Storage, Holding Times

1.4.1 Samples are collected in amber glass containers with Teflon-lined caps. All samples and sample extracts are stored at 4°C ±2°C. According to guidelines listed in SW-846 for the extraction of semivolatile compounds, water samples must be extracted within 7 days of collection, and soil samples must be extracted within 14 days of collection. All extracts must be analyzed within 40 days of sample preparation.

1.4.2 Although not a routine sampling practice, a soil holding time study performed by the U.S. Army Cold Regions Research and Engineering Laboratory recommends a maximum holding time of eight weeks when samples are frozen.

1.4.3 A similar study performed for water samples recommends a maximum holding time of 50 days for relatively sterile samples that are refrigerated. Surface waters, or samples likely to have significant microbial activity, may suffer significant losses of nitroaromatic compounds (particularly trinitrobenzene and trinitrotoluene) within 1-2 days, even under refrigeration. If microbial activity is suspected, water samples should be extracted as soon after collection as is practical.

1.5 Definition of Terms

1.5.1 This section defines terms and acronyms as they are used in this SOP. Other terms, such as MS/MSD or method blank, are not defined here since it is assumed that the user of this SOP already understands their more general meaning.

Method Blank Spike	A background free matrix (DIW for water, clean sand for soils/sediments) to which known amounts of target analytes and surrogates are added each time sample extracts are prepared. In the context of this SOP, a blank spike is the same as a QC check standard. See also QC check standard.
CCV	Continuing calibration verification. This is the same acronym used in the CLP program. This is a standard injected at some prescribed frequency during the analysis sequence to determine whether the instrument has remained in calibration.
CF	Calibration factor. The ratio of peak response to nanograms injected. This term is defined in the same way in both the CLP contract and SW-846.
DIW	Deionized water. Lab reagent water. Organic-free water
IBLK	An instrument blank is solvent containing the method surrogates. It may be used to monitor the instrument conditions.
ICCV	Initial continuing calibration verification. A standard that is injected at the start of each QC period that is compared to the initial multi-point calibration to determine whether the instrument is still in calibration.
ICV	Initial calibration verification standard. This standard is analyzed after the initial calibration using a second source.
IDL	Instrument detection limit. The lowest concentration of a target analyte that will yield a signal:noise ratio of at least 3:1. Used as a starting point for selecting MDL study spiking levels.
MDL	Method detection limit. The lowest concentration in a sample which will yield a positive result that is greater than zero at a known level of confidence. MDLs are empirically determined at Laucks.

QC Check Standard	Quality control check standard. Referred to in this SOP as a blank spike. A QC check standard is a requirement of SW-846 method 8000 and is used to determine whether the analytical system is in control if MS/MSD recoveries are out of control. See also blank spike.
QC Period	Quality control period. An analysis sequence initiated by the injection of one or more standards, followed by sample extracts, and terminated with a standard injection. A QC period can be open-ended chronologically, but calibration verification must be documented using the procedures in this SOP.
Reporting Limit	Also known as PQL, or Practical Quantitation Limit, is determined by the low-level standard concentration.
RSD or %RSD	Relative standard deviation or percent relative standard deviation. The ratio of the standard deviation of a set of values to the mean of the set of values. A measure of the similarity of the values one to another.
RT	Retention time. The time (in minutes) at which a target analyte elutes from the LC column.
RT Window	Retention time window. The ± value that is applied to the ICV to establish the time range used to make tentative compound identifications.
Sequence	A set of sample extracts and standard solutions injected into an instrument in a chronologically continuous group. See also QC period.

2. Equipment List and Standards

2.1 Chromatographic System

Primary Column:	8330 compounds: C18 (octadecyl) reverse phase HPLC column, 25 cm x 4.6 mm, 5 µm particle size, (Restek 9164575-700 or equivalent). 8332 compounds: C18 (octadecyl) reverse phase HPLC column, 15 cm x 4.6 mm, 5 µm particle size, (Varian R0089200D5 or equivalent)

Secondary Column:	CN (cyano) reverse phase HPLC column, 25 cm x 4.6 mm, 5 µm particle size or Phenomenex Synergy 4µm Polar-RP 80A, 250 mm x 4.6 mm (Supelco 46207-05, Phenomenex 00G-4336-E0 or equivalent).
Mobile Phase:	C18 column: methanol (EM Science high purity solvent or equivalent) and water (EM Science HPLC Grade or equivalent). CN column: acetonitrile (EM Science high purity solvent or equivalent), methanol, and 0.01 % phosphoric acid.
UV Detector:	254 nm (210 nm for NG and PETN).
Hewlett Packard System:	HP 1313A Autosampler. HP G1311A Quaternary Pump. HP G1322A In-line degasser. HP G1316A Thermostat column compartment. HP 1314A Variable wavelength detector. Acquisition Software: EZChrom.

2.1.1 Column Temperature Control:

2.1.2 Column temperature is controlled through the use of a column heater, which is maintained at a temperature of 25°C.

2.2 Standards

2.2.1 Target Analyte Stock Solution

2.2.1.1 The stock solution used contains the 14 standard compounds in the mix at a concentration of 1000 µg/mL and is generally purchased from AccuStandard Inc. (25 Science Park, New Haven CT 06511). Equivalent solutions from this or other vendors are also acceptable.

2.2.1.2 The NG and PETN stock solutions are purchased individually from AccuStandard, Inc. (25 Science Park, New Haven, CT 06511). The NG solution comes in 1 mL ampules at 4000 µg/mL in ethanol. The PETN solution comes in 1 mL ampules at 1000 µg/mL in methanol. Equivalent solutions from this or other vendors are also acceptable.

2.2.1.3 The 3,5-Dinitroaniline, 2,4-diamino-6-nitrotoluene, 2,6-diamino-4-nitrotoluene and 2,2',6,6'-tetranitro-4,4'-azoxytoluene standards stock solutions are obtained from AccuStandard, Inc. (25 Science Park, New Haven, CT 06511). The 1-nitroso-3,5-dinitro-1,3,5-

hexahydrotriazine and 1,3,5-Trinitroso-1,3,5-hexahydrotriazine standards are made from standard analytical reference materials obtained from Stanford Research.

2.2.1.4 Calibration standard surrogate solutions are detailed in Appendix I.

2.2.2 Surrogate Stock Solution

2.2.2.1 The surrogate stock solution is received in a methanol solution at a concentration of 1000 µg/mL. The surrogate can also be prepared by weighing 100 mg of 3,4-dinitrotoluene into a 100 mL volumetric flask and diluting to volume with methanol to yield a concentration of 1000 µg/mL. (3,4-Dinitrotoluene replaced the surrogate 1,2-dinitrotoluene in June 2002, in order to eliminate co-elution.)

2.2.3 IBLK Working Solution

2.2.3.1 The working instrument blank solution contains only the surrogate compound.

2.2.4 Calibration Standards

Analyte Mix	Concentration	Vendor	Stock #
8330 Calibration Mix 1	1000µg/mL	Restek	31450
8330 Calibration Mix 2	1000µg/mL	Restek	31451
8330 Internal Standard Mix	1000µg/mL	Restek	31452

8330 Calibration Mix 1	**8330 Calibration Mix 2**
1,3,5-Trinitrobenzene	2,6-Dinitrotoluene
2,4,6-Trinitrotoluene	2-Amino-4,6-dinitrotoluene
2,4-Dinitrotoluene	2-Nitrotoluene
HMX	3-Nitrotoluene
m-Dinitrobenzene	4-Amino-2,6-dinitrotoluene
Nitrobenzene	4-Nitrotoluene
RDX	Tetryl

2.2.4.1 To prepare the 8330 stock solution, take a 200µl aliquot of each of the above listed solutions and put into a 10ml volumetric and dilute to volume with acetonitrile. Invert and transfer to an amber vial. The final concentration is 20 ppm. This solution is good for 6 months from the preparation date.

2.2.4.2 Prepare an intermediate stock solution; take 250µl of the stock solution at 20 ppm and dilute it to 1ml with 1:1 Acetonitrile and water. This solution is at a concentration of 5µg/mL. This solution is made up at the time it is needed. It is not stored.

Standard Name	Amount of Intermediate 8330 Stock Solution in µl	Amount of 1:1 Acetonitrile /Water in µl
Working 0.05	2	198
Working 0.1	4	196
Working 0.5	20	180
Working 1.0	40	160
Working 5.0	An aliquot of the intermediate solution	0

2.2.4.3 A continuing calibration standard is prepared fresh daily at the same level as the working 1.0 standard (1000ppb). This is usually made in a 2ml volumetric by taking 100 µl of 8330 stock solution at 20µg/mL into 2ml of 1:1 acetonitrile and water.

2.2.4.4 To prepare the standard for the attenuation compounds, take a 20µl aliquot of each of the solutions listed below and put into a 1 ml volumetric, dilute to volume with acetonitrile. Invert and transfer to an amber vial. This solution is good for 6 months from the preparation date.

Standard	**Concentration**	**Vendor**	**Catalog #**
8330 Int. Std Mix	1000 µg/mL	Restek	31452
2,4-DA-6-NT	1000 µg/mL	AccuStandard	M-8330-ADD-12-10X
2,6-DA-4-NT	1000 µg/mL	AccuStandard	M-8330-ADD-13-10X
3,5-DNA	1000 µg/mL	AccuStandard	M-8330-ADD-14-10X
MNX	Neat	SRI	Custom order
TNX	Neat	SRI	Custom order
4,4'-TN-AZOXY	1000 µg/mL	AccuStandard	M-8330-ADD-15-10X

2.2.5 Preparation of PETN/NG Stock Solution

2.2.5.1 To prepare the PETN/NG stock solution, take a 200µl aliquot of nitroglycerin and 100ul each of PETN and the Internal Standard mix and put into a 10ml volumetric and dilute to volume with acetonitrile. Invert and transfer to an amber vial. This solution is good for 1 year from the preparation date.

2.2.5.2 Prepare an intermediate stock solution; take 250µl of the stock solution and dilute it to 1ml with 1:1 Acetonitrile and water. This solution is at a concentration of 5µg/mL. This solution is made up at the time it is needed. It is not stored.

Standard	Concentration	Vendor	Catolog #
Nitroglycerin	1000 µg/mL	Accustandard	M-8330-ADD-1-10x
PETN	1000 µg/mL	AccuStandard	M-8330-ADD-2-10x
8330 Internal Standard Mix	1000 µg/mL	Restek	31452

	Amount of Intermediate PETN/NG Stock Solution in µl	Amount of 1:1 Acetonitrile /Water in µl
Working 0.25/0.125	10	190
Working 0.5/0.25	20	180
Working 1.0/0.5	40	160
Working 2.5/1.25	100	100
Working 5.0/2.5	An aliquot of the intermediate solution	0

2.2.5.3 A continuing calibration standard is prepared fresh daily at the same level as the Working 1.0/0.5 standard (1000ppb/500ppb). This is usually made in a 2ml volumetric - 100ul of PETN/NG stock solution at 20µg/mL into 2ml of 1:1 acetonitrile and water.

2.2.5.4 Note: Store all standard and surrogate solutions in amber glass vials with screw caps and Teflon-lined septa. Minimize headspace in these vials and store them in a refrigerator kept at 4°C ±2°C. Allow standards to come to room temperature prior to use.

2.2.5.5 Stock solutions may be used for up to one year, and working solutions are good for six months or the expiration date of the parent standard, whichever is sooner.

2.2.5.6 All standards are assigned a unique identifier to enable cross-referencing of each individual standard back to the supplier's lot number. In addition, all standards are labeled with the standard concentration, the solvent, date prepared, expiration date, analyst's initials, and the standard reference number. Refer to Laucks' SOP on the traceability, documentation and preparation of standards.

3. Safety precautions

3.1 Routine Safety Precautions

3.1.1 All standards and sample extracts should be handled as if they are hazardous substances.

3.1.2 All compounds analyzed by this method are used either in the manufacture of explosives or are the degradation products of these compounds. When making stock solutions for calibration, treat each explosive compound with caution.

3.1.3 Refer to the instrument manufacturer's manual for routine instrument precautions.

3.1.4 Routine precautions include an awareness of the moving parts on the instrument you're using. These parts are often charged with power from an electrical component or with high-pressure gas and have the potential to do harm if not used properly.

3.1.5 Electrical shock - All instruments present the possibility of electrical shock. The operator should take all precautions including ensuring that all instruments are operated with fully grounded power outlets, turning off the instrument and disconnecting the instrument from the electrical power supply before working on any electrical components, etc.

3.1.6 Almost all of the analytes under consideration are known or suspected carcinogens. Analysts should wash their hands after using any standard, solvent or sample extract. Additionally, a respirator should be worn or a fume hood utilized for extremely hazardous compounds or very dirty extracts.

3.2 Waste disposal

3.2.1 Out of date standards and sample extracts are disposed of in the designated organic waste container located in the organic preparation area.

3.2.2 HPLC liquid waste is disposed of by pouring into the designated organic waste container located in the solvent storage area.

4. Operation procedures

4.1 Analytical Conditions

4.1.1 Current C18 Column Conditions for the 14 Compounds:

Oscar:

Pump A Solvent:	Methanol
Pump B Solvent:	Water
Flow:	0.75 mL/minute:
Gradient:	Linear
Run Time:	35 minutes
Acquisition Time:	35 minutes
Injection Volume:	50 µL inj.

4.1.2 Current CN Column Conditions for the 14 Compounds:

Felix:

Pump B Solvent:	Water/0.01% H_3PO_4 buffer
Pump C Solvent:	Acetonitrile
Pump D Solvent:	Methanol
Flow:	1.0 mL/minute
Gradient:	Linear
Run Time:	35 minutes
Acquisition Time:	35 minutes

Initial %B	70
Initial %C	15
Initial %D	15

4.1.3 Current Synergy Column Conditions for the 14 Compounds:

Felix:

Pump B Solvent:	Water
Pump C Solvent:	Acetonitrile
Flow:	0.75 mL/minute
Gradient:	Linear
Run Time:	25 minutes
Acquisition Time:	25 minutes
Initial %B	50
Initial %C	50

4.1.4 Current Column Conditions for NG/PETN:

C18		**CN**	
Pump A Solvent:	Methanol	Pump A Solvent:	Methanol
Pump B Solvent:	0.01% H_3PO_4	Pump B Solvent	Water
Flow:	0.6 mL/minute:	Flow: 0.7 mL/min	1.2 mL/minute
Gradient:	Linear	Gradient:	Linear (1:1)
Run Time:	25 minutes	Run Time:	5 minutes
Acquisition Time:	25 minutes	Acq. Time:	5 minutes
Injection Volume:	50 µL inj.	Time:	50 µL

4.1.5 Current Column Conditions for the 6 Additional Compounds:

C18		**CN**	
Pump A Solvent:	Water	Pump B Solvent:	Methanol
Pump B Solvent:	Methanol	Pump C Solvent:	Acetonitrile
Flow:	0.75 mL/minute:	Pump D Solvent:	0.01%H3PO4
Time = 0 minutes	85% A, 15% B	Flow:	1.0 mL/minute
Time = 15 minutes	40% A, 60% B	Time: 0 minutes	15% B, 12% C, 73% D
Time = 25 minutes	10% A, 90% B	Time: 19 minutes	15% B, 12% C, 73% D
Time = 33 minutes	10% A. 90% B	Time: 20 minutes	30% B, 30% C, 40% D
Time = 35 minutes	85% A. 15% B	Time: 35 minutes	30% B, 30% C, 40% D
Run Time:	40 minutes	Time: 36 minutes	15% B, 12% C, 73% D
Acquisition Time:	35 minutes	Run Time:	45 minutes
Injection Volume:	50 µL inj.	Acq. Time:	35 minutes
		Injection Volume:	50 µL inj.

5. Calibration and Quality Control

5.1 Method Detection Limit Study

5.1.1 Prior to the analysis of any samples, it is necessary to establish method detection limits. This procedure is fully described in the Laucks SOP on determination of detection limits. Briefly, it involves the analysis of 7 replicate samples spiked at a concentration near the anticipated

method detection limit. A Student's T-test is then applied to these measured values to calculate the MDL. MDL studies are performed on both columns. Refer to Appendix VI for MDLs.

5.2 Method Validation

5.2.1 Prior to the analysis of any samples, it is necessary to validate the method. A method validation study is performed in a similar manner to an MDL study with the exception that a minimum of 4 replicates is required and the concentration levels are typically higher.

5.3 Retention Time Windows

5.3.1 It is necessary to establish retention time windows for the method by analyzing standards for all target analytes over at least a 72-hour period. At least 3 standards must be injected during the 72-hour period, at about equal time intervals. These standards should be interspersed with real sample extracts in order to mimic actual instrument operating conditions. Tabulate the retention times for all standard compounds and compute the sample (n-1) standard deviations of all the retention times.

5.3.2 The retention time window half-width is set at 3 times the above-calculated standard deviation. This operation must be repeated for each new column, whenever major equipment changes are made, or whenever the chromatographic method is modified.

5.3.3 In some cases, the retention time window may be modified in order to take into account any pattern shifting. This shift is acknowledged by observation of the surrogate peak behavior and the surrounding CCV standards. If retention time shift has occurred and the possibility of misidentifying peaks exists, the sample is reanalyzed.

5.3.4 See the Laucks SOP on determination of retention time windows for more specifics on their determination and use.

5.4 Initial Calibration

5.4.1 Analyze the working standard solutions (which include the surrogate) using at least 5 different concentration levels. Inject the standard solutions from the lowest concentration to the highest. The lowest concentration defines the reporting limit. The highest concentration should define the upper useable working range of the detector.

5.4.2 SW 846 allows the use of both linear and non-linear models for the calibration data. The option for non-linear calibration may be necessary to achieve low detection limits or to address specific instrumental techniques. If the %RSD from the initial calibration is less than or equal to 20% when averaged across all compounds, the calibration is considered valid according to SW 846. However, for DOD clients, the use of alternative calibration methods should be employed in

order to eliminate the need for using the average. At the time of this writing, the laboratory can meet SW 846 and DOD calibration requirements using the %RSD criterion of less than or equal to 20% without averaging across all compounds. The alternative calibration methods are discussed below.

5.4.3 The choice of a specific calibration model should be made in one of two ways. The first is to begin with the simplest approach, the linear model through the origin, and progressing through the other options until the calibration acceptance criteria are met, or until the analyte is best represented by a calibration model. The second approach is to use *a priori* knowledge of the detector response to choose the calibration model. Such knowledge may come from previous experience, knowledge of physics of the detector, or specific manufacturer's recommendations.

5.4.4 External standard initial calibration data are evaluated by determining the %RSD of the calibration factors. CFs are calculated using the equation:

$$CF = \frac{\text{response}}{\text{ng injected}}$$

<u>%RSDs are calculated using the equation:</u>

$$\%RSD = \frac{SD}{\overline{CF}} \times 100$$

where:

SD = External calibration standard deviation
CF = Average CF

5.4.5 Corrective action

5.4.5.1 If the criteria are not met, the instrument must be re-calibrated or if appropriate, an alternative calibration model employed.

5.5 Non-linear Calibration

5.5.1 In situations where the analyst knows that the instrument response does not follow a linear model over a sufficiently wide working range, or when the other approaches described here have not met the acceptance criteria, a non-linear calibration model may be employed.

The model chosen should have no more than four parameters, i.e., if the model is polynomial, it may be no more than third order, as in the equation:

$$y = ax^3 + bx^2 + cx + d$$

5.5.2 The statistical considerations in developing a non-linear calibration model require more data than the more traditional linear approaches. A quadratic (second order) requires a minimum of six standards, and a third order polynomial requires seven standards. Do not force the line through the origin, i.e., do not set the intercept as 0, and do not include the origin (0,0) as a calibration point. The r^2 value must be ≥ 0.990.

5.5.3 Whichever option is employed, the surrogate concentration must fall within the calibration range.

5.5.4 Corrective action

5.5.4.1 If the criteria are not met, the instrument must be re-calibrated.

5.6 Second Source Standards (ICV)

5.6.1 A standard prepared from a source separate from the primary source must be analyzed with each initial calibration. The %D for each analyte must be within 15%.

5.6.2 Corrective action

5.6.2.1 If this criterion is not met, an investigation should be made into the discrepancies between vendors. Appropriate action should be taken such as possibly obtaining a third source standard.

5.7 Initial Continuing Calibration Verification (ICCV)

5.7.1 At the beginning of each analysis sequence, an initial calibration verification standard is analyzed. The initial calibration standard is comprised of either a mid-point calibration standard (STD 2) or STD 3 or STD 4. (The use of varied concentrations is required for DOD clients.)

5.7.2 Since the retention time windows, which were established by the retention time study are relative and not absolute, the windows are anchored by the ICV. This allows the retention times from the ICV to become the mid-point of the retention time windows.

5.7.3 Criteria

5.7.3.1 Using the average CF calculation technique, compute the CFs for each compound. The calibration factors for the ICV standard are compared to the mean CFs for the initial multi-point calibration. The percent difference for these calibration factors is calculated as follows:

$$\%\,Difference = \frac{CF_a - CF_i}{CF_a} \times 100$$

where:
CF_a = .Average CF from the initial multi-point calibration
CF_i = Calibration Factor of the calibration verification standard.

5.7.3.2 The %D cannot exceed 15% for any target analytes or surrogates.

5.7.4 Corrective action

5.7.4.1 If the ICV criteria are not met, no sample extracts can be analyzed. Determine the cause of the ICV failure and correct. Reanalyze the ICV and if it is still out of control, a new calibration curve must be analyzed.

5.8 Continuing Calibration Verification

5.8.1 Criteria

5.8.1.1 A CCV standard is analyzed every 10 injections, and after the last sample of the sequence. The CF for each compound is calculated and the percent difference is calculated as shown above.

5.8.1.2 The %D cannot exceed 15% for any target analytes or surrogates.

5.8.1.3 The retention times for all target analytes must fall within the RT windows established by the ICCV.

5.8.2 Corrective action

5.8.2.1 Determine the cause of failure and correct. All samples bracketed by an out of control CCV must be reanalyzed unless the CCV demonstrates an increase in response and no analytes are detected above the reporting limit in the associated samples.

5.9 Sample Analysis

5.9.1 Analysis sequence

See Appendix II for a detailed analysis injection sequence.

5.9.2 Sample Preparation

5.9.2.1 Prior to injection on the instrument water sample extracts are diluted 1:1 with water. Any extract that exceeds the instrument calibration range is diluted with 1:1 acetonitrile and water with a dilution factor necessary to quantitate the analytes within the calibration range. The lot number of acetonitrile used in the dilution will be noted on the bench sheet.

5.9.3 Compound Identification

5.9.3.1 Compounds are tentatively identified if a peak elutes in the retention time window characteristic of that compound on the primary column. To confirm the presence of that compound in the sample extract, the peak must also elute in its retention time window on a second column. When analyte co-elute on the secondary column, the responses are summed. Sample results are reported using the C18 column. Retention time windows are established as previously described and are updated each QC period. Compounds can only be identified if the ICV and CCV criteria detailed in Section VI are strictly adhered to. Due to constraints of the software, the RT of co-eluting compounds is determined by assigning the RT to the highest point within a given window. For co-eluting compounds that may have a slight but not complete separation, such as: 2-nitrotoluene, 3-nitrotoluene and 4-nitrotoluene, this determination of RT can result in RT windows which exceed those identified by the standard (due to the changes in peak heights with concentration values). In order to avoid potential problems with RT windows, and in order to accurately identify these co-eluting target analytes, the retention time windows may be administratively set for the co-eluting compounds.

5.9.3.2 The experienced analyst's judgment weighs heavily in evaluating chromatograms for compound identification. For instance, the retention times of surrogate compounds may be outside their expected windows due to sample matrix effects. The analyst may decide to re-adjust target analytes' retention time windows on an ad hoc basis based on such an observed shift. This can occur only on a sample-specific basis and is used when the analyst examining the data suspects that a retention time shift has occurred. If this is done, it must be fully documented in the case narrative. If the concentration of any target analyte exceeds the calibration range, the sample extract must be diluted and reanalyzed.

5.9.4 Compound Quantification

5.9.4.1 Target compound concentrations are calculated using the following equations:

5.9.4.2 Aqueous samples

The external standard equation, as expressed in SW-846 is

$$Concentration(\mu g / L) = \frac{A_x \times A \times V_t \times D}{A_s \times V_i \times V_s}$$

where:

A_x = Response for the analyte in the extract, in area or height units.
A = Amount of standard injected (in nanograms).
A_s = Response for the external standard, same units as A_x.
V_i = Volume of extract injected, µL.
D = Dilution factor of extract. The final result of an algebraic multiplication of the ratio of all dilution final volumes to initial volumes. For example, if an extract is diluted 10 µL to 1000 µL and subsequently diluted an additional 10 µL to 1000 µL, the expression is: (1000/10) * (1000/10) = 100 * 100 = 10,000. If no dilution was made, D = 1.
V_t = Final volume of total extract, µL.
V_s = Initial sample size, mL.

5.9.4.3 In routine use at Laucks, the equation reduces as follows.

5.9.4.4 First, CF is used directly in the equation. Since Cf = A_s/A, this substitution is made. Next, since Laucks routinely measures all final extract volumes in mL, a conversion factor for µL to mL must be made in the numerator of the expression - i.e., V_t = 1000 * mL. Finally, the sample preparation process is represented as the algebraic ratio of initial sample size to final extract volume.

5.9.4.5 The equation then becomes

$$Concentration(\mu g / L) = \frac{1000 \times Ax \times D}{CF \times Vi \times (Vs / Vt)}$$

5.9.4.6 This expression is completely equivalent to the SW-846 equation, yielding the same result. To report concentrations in alternate units, apply an appropriate factor:

mg/L = µg/L * 0.001

5.9.4.7 Non-aqueous samples

5.9.4.8 The calculation for non-aqueous samples is very similar to that for aqueous samples. The only difference is the inclusion of a total solids term to calculate the dry weight equivalent of the initial sample size. (Under normal conditions 8330 soil samples are air-dried prior to extraction and this term is 1.)

$$Concentration(\mu g / kg) = \frac{1000 \times A_x \times D}{CF \times V_i \times (W / V_t) \times T_s}$$

where:

W_s = Sample size extracted in grams.
T_s = Total Solids in decimal format (i.e. 0.76 not 76).

6. Reports

6.1 Data Packet Organization

See Appendix III for a checklist detailing data packet organization.

6.2 Quality Control Reports

6.2.1 All results for quality control tests are entered into the lab database. Printouts of all data entered must be included in the data packet. The routine minimum is a method blank report, a method blank spike report, and an MS/MSD report.

6.2.2 Data Qualifying Flags

6.2.3 Sample report results are qualified with data qualifying flags. These flags have the following definitions:

U:	The analyte of interest was not detected, to the limit of detection indicated.
B:	The analyte of interest was detected in the method blank associated with the sample, as well as in the sample itself. The B flag is applied without regard to the relative concentrations detected in the blank and sample.
J:	The analyte of interest was detected below the practical quantitation limit. This value should be regarded as an estimate.

D: The value reported is derived from the analysis of a diluted sample or sample extract.

P: When a dual column technique is employed, this flag indicates that calculated results from the two columns differ by more than 25 percent.

E: The value reported is based on a sample or sample extract in which the target analyte concentration exceeded the calibration range. The value reported should be considered an estimate.

X: The sample has been analyzed at several dilutions. The value reported has been determined to be the most appropriate quantitative value.

Z: The value reported is from the C18 column and there is coelution with another target analyte on the CN or CN/C8 columns in series.

7. Quality Control

7.1 Method Blank

7.1.1 Criteria

7.1.1.1 Method blanks are used to verify contamination free reagents and apparatus. They are prepared with every set of samples extracted at the same time or at least one blank for every 20 samples, whichever is more frequent. Analytes of interest should not be detected at levels greater than half the current reporting limit or less than 5% the regulatory limit, or less than 5% of the sample result for the same analyte. If any analytes are detected above half the reporting limit, corrective action must be taken.

7.1.2 Corrective action

7.1.2.1 Steps shall be taken to find/reduce/eliminate the source of the contamination. Sample corrective action may be limited to qualification for blank contamination. When the concentrations of any target analytes in the method blank are above 1/2 the reporting limit for the majority of target analytes or above the reporting limit for target analytes known to be common laboratory contaminants, the effect this may have had on the samples will be assessed. If any analyte is found only in the method blank, but not in any samples associated with the method blank, no further corrective action may be necessary. The case narrative should discuss the situation. If an analyte is found in the method blank and some, or all, of the other batch samples,

additional corrective action is required to reanalyze the method blank and any samples containing the same contaminant. If the contamination remains, the contaminated samples of the batch would be re-extracted and reanalyzed with a new method blank and batch specific QC samples. Sporadic cases of contamination may be difficult to control; however, daily contamination would not be acceptable.

7.2 Blank Spike or QC Check Sample (LCS)

7.2.1 Criteria

7.2.1.1 A blank spike follows the same protocol as the matrix spike analysis except that the spiking solution is added to a method blank solution instead of an actual sample.

7.2.2 Corrective action

7.2.2.1 The blank spike is used to determine whether a method is in control during sample preparation and analysis. Sample re-extraction and reanalysis would be triggered by any analytes falling outside of control limits in the blank spike sample unless all sample surrogate recoveries and MS/MSD spike recoveries are in control.

7.3 Matrix Spike

7.3.1 Criteria

7.3.1.1 A sample is chosen at random (unless designated by project-specific requirements) from the samples to be analyzed, and an aliquot of spiking solution is added to this sample prior to extraction. It is required that a matrix spike analysis be performed with each extraction batch. However, the minimum frequency for MS analysis is 1 each per 20 samples per matrix. This frequency may be changed on a project specific basis. This matrix spike sample is used to evaluate the matrix effect of the samples upon recovery of the analytes. This spiking solution is supplied from a source other than the calibration standards. The use of a second source for the spiking standards is employed in order to verify the calibration standards. The recovery of spike analytes is calculated as follows:

$$\%Recovery = \frac{SSR - SR}{SA} \times 100$$

where:
SSR = Concentration in spiked sample.
SR = Native concentration in unspiked sample.
SA = Concentration of spike added.

7.3.2 Corrective action

7.3.2.1 MS samples with spike recoveries outside control limits will be reviewed for possible corrective action. Corrective action may involve recalculation, re-extraction and/or reanalysis. This process should also look at the recovery of surrogate compounds in the MS sample and at the recovery of matrix spiking compounds from the extraction batch blank spike analysis. In all cases, a narrative explanation of the condition is required to detail the corrective actions taken.

7.4 Matrix Spike Duplicate

7.4.1 Criteria

7.4.1.1 The compound recovery criteria are identical to those for the matrix spike sample. In addition, the matrix spike duplicate is used to measure method precision. This is done by computing the relative percent difference (RPD) between the matrix spike and matrix spike duplicate recovery values. This calculation is as follows:

$$RPD = \frac{S1 - S2}{(S1 + S2)/2} \times 100$$

where:
S1 = Measured concentration for MS sample.
S2 = Measured concentration for MSD sample.

7.4.2 Corrective action

7.4.2.1 If a trend in out of control RPD values is observed, the methods used must be examined to determine the source of variance. Once this source is identified, the method must be changed so that samples can be analyzed with predictable reproducibility.

7.5 Surrogate Recovery

7.5.1 Criteria

7.5.1.1 Surrogates are chemically similar compounds added to every sample, method blank, and QC sample prior to sample extraction. They are used to monitor potential sample processing errors and matrix effects. Surrogate compound recoveries are calculated as follows:

$$\%Recovery = \frac{S_m}{S_a} \times 100$$

where:

S_m = Concentration of surrogate measured in sample.
S_a = Concentration of surrogate added.

7.5.1.2 At the time this SOP was written the surrogate recovery control limits were 20 to 160 percent. These control limits are updated periodically.

7.5.2 Corrective Action

7.5.2.1 Reanalyze the sample. Low surrogate recoveries are better indicators of poor method performance than high surrogate recoveries since non-GC/MS methods cannot separate co-eluting interferences. In instances where high surrogate recoveries are attributable to matrix effects, no corrective action is taken. However, if elevated surrogate recoveries are attributable to preparation error, re-extraction and reanalysis is performed.

7.5.2.2 Check calculations for possible error. Re-extract the sample if surrogate recovery is less than the lower control limit. If a poor injection is suspected, reanalyze the sample.

7.5.2.3 Low surrogate recoveries in the method blank may require that all the samples in the associated batch be re-extracted and reanalyzed. In any case, it is imperative to identify the problem associated with low recovery so that it can be corrected. It is a requirement that all out of control surrogate recoveries and the corrective action taken be discussed in the narrative.

8. References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition, Method 8000B, "Gas Chromatography," Revision 1, July 1992, U.S.E.P.A.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 4th Update, Method 8330A, "Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)," Revision 1, January 1998, U.S.E.P.A.

40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984, U.S.E.P.A.

Special Report 93-11, "Experimental Assessment of Analytical Holding Times for Nitroaromatic and Nitroamine Explosives in Soil," Clarence L. Grant et al, June 1993, U.S. Army Cold Regions Research and Engineering Laboratory.

Special Report 93-24, "Evaluation of Pre-extraction Analytical Holding Times for Nitroaromatic and Nitroamine Explosives in Water," Clarence L. Grant et al, August 1993, U.S. Army Cold Regions Research and Engineering Laboratory.

APPENDIX I

Calibration Standard Solution Concentrations, µg/mL

Compound	STD1	STD2	STD3	STD4	STD5
HMX	0.05	0.1	0.5	1.0	5.0
RDX	0.05	0.1	0.5	1.0	5.0
1,3,5-TNB	0.05	0.1	0.5	1.0	5.0
1,3-DNB	0.05	0.1	0.5	1.0	5.0
Tetryl	0.05	0.1	0.5	1.0	5.0
NB	0.05	0.1	0.5	1.0	5.0
2,4,6-TNT	0.05	0.1	0.5	1.0	5.0
4-Am-DNT	0.05	0.1	0.5	1.0	5.0
2-Am-DNT	0.05	0.1	0.5	1.0	5.0
2,4-DNT	0.05	0.1	0.5	1.0	5.0
2,6-DNT	0.05	0.1	0.5	1.0	5.0
2-NT	0.05	0.1	0.5	1.0	5.0
3-NT	0.05	0.1	0.5	1.0	5.0
4-NT	0.05	0.1	0.5	1.0	5.0
Surrogate					
3,4-Dinitrotoluene	0.05	0.1	0.5	1.0	5.0

Calibration Standard Solution Concentrations, µg/mL

Compound	STD1	STD2	STD3	STD4	STD5
TNX	0.05	0.1	0.5	1.0	5.0
2,6-DA-4-NT	0.05	0.1	0.5	1.0	5.0
2,4-DA-4-NT	0.05	0.1	0.5	1.0	5.0
MNX	0.05	0.1	0.5	1.0	5.0
3,5-DNA	0.05	0.1	0.5	1.0	5.0
4,4'-TN-AZOXY	0.05	0.1	0.5	1.0	5.0
Surrogate					
3,4-Dinitrotoluene	0.05	0.1	0.5	1.0	5.0

Calibration Standard Solution Concentrations, µg/mL

Compound	STD1	STD2	STD3	STD4	STD5
NG	0.25	0.5	1.0	2.5	5.0
PETN	0.125	0.25	0.5	1.25	2.5
Surrogate					
3,4-Dinitrotoluene	0.25	0.5	2.5	5.0	10.0

Surrogate Stock Solution

Compound	Concentration
3,4-Dinitrotoluene	1000 µg/mL

APPENDIX II

Analysis Sequence

Injection	Sample
1	Standard #1
2	Standard #2
3	Standard #3
4	Standard #4
5	Standard #5
6	ICCV
	injections (total of 10 injections between CCVs
17	CCV Standard
	injections (total of 10 injections between CCVs)
28	CCV Standard
	injections (total of 10 injections between CCVs)
last	CCV Standard

APPENDIX III

Data Packet Order List

I. QC SUMMARY

Surrogate Recovery Summary Report
Blank Spike Report
MS/MSD Report
Method Blank Summary

II. SAMPLE DATA:

Organic Analysis Data Sheet
Sample Confirmation Worksheet
Chromatogram, primary column
Quantitation Report, primary column
Chromatogram, secondary column
Quantitation Report, secondary column

III. STANDARD DATA:

Linearity Report
ICAL Data
ICAL Response, ICAL std concentrations
ICCV reports
CCV reports
Other Standards Used to Support Sample Data and Instrument Blanks

V. Raw QC Data:

Method Blank
Chromatograms
Quantitation Report

Blank Spike
Chromatograms,
Quantitation Report

Matrix Spike
Chromatograms
Quantitation Report

Matrix Spike Duplicate
Chromatograms
Quantitation Report

V. Bench Sheets

SDG Report
Extraction Bench Sheets
Injection Sequence (logbook copy)
Miscellaneous Work Sheets. (HTVRs)
Standards Logs

VI. Reject Data:

Data not used to support reported sample results.
Non-routine standards used to support sample data should be placed at the last of the Standard Data section.

APPENDIX IV

Method 8330 Requirements and Corrective Actions					
QA Element	**Method Criterion**	**Laucks Criterion**	**Frequency**	**Corrective Action**	**Documentation**
Initial Calibration	Minimum of 5 levels. %RSD ≤ 20%	Minimum of 5 levels. Must demonstrate an RSD (or average RSD) of ≤ 20%.	As necessary due to major instrument maintenance or difficulties meeting the CCV requirements.	Reanalyze out of control standard. If still out, determine cause of curve failure and correct. Re-analyze curve and any samples analyzed with curve.	Target forms and raw data.
Second Source Standard		+/- 15% of the initial calibration response factor (or average).	After each initial calibration	Investigate third source if 2 existing sources do not match.	Stored with data.
Initial Continuing Calibration Verification	+/- 15% of the initial calibration response factor.	+/- 15% of the initial calibration response factor (or average).	Every 24 hr. or at the beginning of an analytical sequence, which ever is more frequent, or as necessary.	Determine cause of ICCV failure and correct. Reanalyze ICCV and if out of control a new calibration curve must be analyzed.	Target form and raw data.
Continuing Calibration Verification	+/- 15% of the initial calibration response factor. Analyze singly every 10 injections and after the final sample.	+/- 15% of the initial calibration response factor (or average).	Every 10 injections and at the end of an analytical sequence.	Determine cause of failure and correct. Reanalyze calibration curve. All samples bracketed by an out of control CCV must be reanalyzed unless the CCV demonstrates an increase in response and no analytes are detected above the reporting limit.	Target form and raw data.
Method Blank	All analytes must be < MDL	All analytes must be less than half the Reporting Limit, or ≤ 5% regulatory limit, or ≤ 5% of the sample result, whichever is greater.	One method blank per 20 samples or each extraction batch, whichever is more frequent.	Reanalyze blank. If still out of control, re-extract the entire batch of samples unless the detected analyte(s) are not present in the associated samples.	Method Blank Summary and raw data. Narrative comment when necessary.
Surrogate Recovery	Minimum of 1 surrogate. Recoveries must fall within the labs established windows.	See latest version of Laucks Testing Labs control limits database. All surrogate recoveries must fall within the generated limits.	All samples, method blanks, and QC samples.	Re-extract if surrogate recovery is < the lower control limit. If a poor injection is suspected, reanalyze the sample.	Target Surrogate Summary form or special test results. Narrative comment when necessary.

Method 8330 Requirements and Corrective Actions					
QA Element	**Method Criterion**	**Laucks Criterion**	**Frequency**	**Corrective Action**	**Documentation**
MS/MSD	One per 20 samples or extraction batch which ever is more frequent. Must be per matrix.	See latest version of Laucks control limits located in the QC database.	1 MS/MSD pair per 20 samples or every extraction batch which ever is more frequent.	Per SW 846, if analyte recoveries are out of control in the MS/MSD but are in control in the associated blank spike, no further action is required.	MS/MSD report and raw data. Narrative comment when necessary.
Blank Spike	N/A	See latest version of Laucks Testing Labs control limits in the QC database. All recoveries must fall within the generated limits.	1 per 20 samples or every extraction batch which ever is more frequent.	Re-extract if analyte recoveries are outside of control limits.	Blank Spike report and raw data. Narrative comment when necessary.

APPENDIX V

Elution Order of Target Analytes

Compound	Order of Elution on Primary (C18) Column	Order of Elution on Confirmation (CN) Column
HMX	1	12
RDX	2	8
1,3,5-TNB	3	2
1,3-DNB	4	3
Tetryl	6	11
NB	5	1
2,4,6-TNT	8	7
4-Am-DNT	9	9
2-Am-DNT	10	9
2,4-DNT	12	5
2,6-DNT	11	6
2-NT	13	4
3-NT	15	4
4-NT	14	4
Surrogate		
3,4-Dinitrotoluene	7	10

Compound	Order of Elution on Primary (C18) Column	Order of Elution on Confirmation (C8/CN) Column
TNX	3	1
2,6-DA-4-NT	2	2
2,4-DA-6-NT	1	3
MNX	4	4
3,5-DNA	5	5
4,4'-TN-AZOXY	7	6
Surrogate		
3,4-Dinitrotoluene	6	5

Compound	Order of Elution on Primary (C18) Column	Order of Elution on Confirmation (CN) Column
NG	1	2
PETN	3	3
Surrogate		
3,4-Dinitrotoluene	2	1

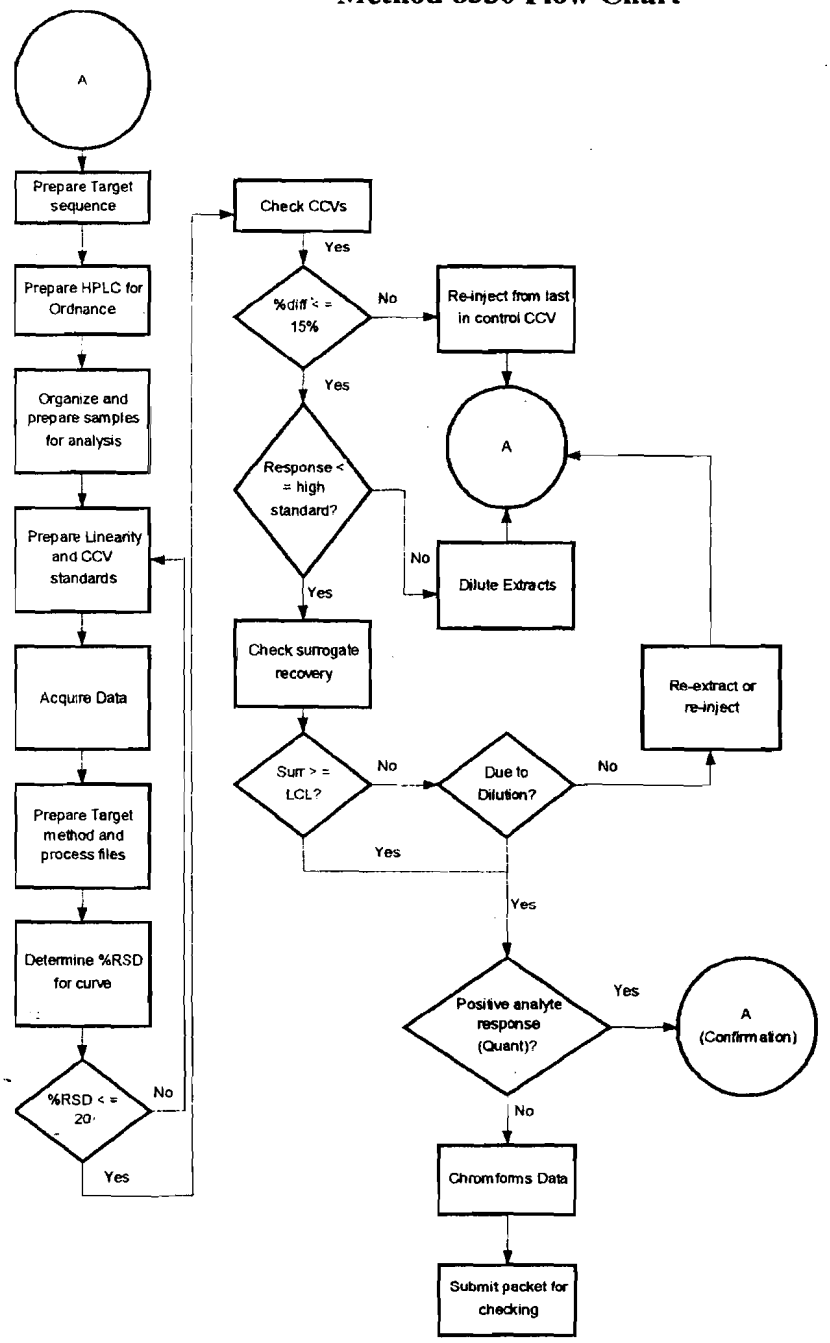
APPENDIX VI

MDLs/PQLs

Compound	MDL (µg/L)	MDL (mg/Kg)	PQL (µg/L)	PQL (mg/Kg)
HMX	0.0427	0.0261	0.65	0.5
RDX	0.0564	0.0418	0.65	0.5
1,3,5-TNB	0.0222	0.0237	0.65	0.5
1,3-DNB	0.0647	0.2438	0.65	0.5
Tetryl	0.0720	0.0238	0.65	0.5
NB	0.0413	0.0627	0.65	0.5
2,4,6-TNT	0.0243	0.0406	0.65	0.5
4-Am-DNT	0.0382	0.0479	0.65	0.5
2-Am-DNT	0.0344	0.0147	0.65	0.5
2,4-DNT	0.0476	0.0319	0.65	0.5
2,6-DNT	0.0297	0.0087	0.65	0.5
2-NT	0.0780	0.0479	0.65	0.5
3-NT	0.1322	0.0519	0.65	0.5
4-NT	0.0517	0.0415	0.65	0.5

APPENDIX VII

Method 8330 Flow Chart



12-18-97

APPENDIX VIII

Control Limits*

Compound	LCS Water	LCS Soil	MS Water	MS Soil
HMX	70–115	81-123	59-124	20-160
RDX	66-128	82-126	56-132	28-163
1,3,5-TNB	77-118	88-117	61-132	61-132-
1,3-DNB	73-110	92-116	68-114	68-114
Tetryl	81-127	30-146	35-149	43-154
NB	74-112	91-127	69-120	33-177
2,4,6-TNT	79-124	75-134	57-138	48-160
4-Am-DNT	74-117	85-125	63-125	51-152
2-Am-DNT	72-115	89-120	68-117	50-157
2,4-DNT	74-118	87-117	67-116	49-152
2,6-DNT	71-131	84-125	60-137	35-168
2-NT	76-119	86-120	66-126	35-170
3-NT	73-117	84-118	63-125	31-164
4-NT	70-117	84-118	64-124	50-152

Surrogate	Water	Soil
3,4-Dinitrotoluene	20-160	20-160

*At the time of this writing.

LAUCKS TESTING LABORATORIES INC.
Seattle, Washington

SOP #: LTL-9109

Title: Ammonia Analysis by Lachat Auto-Analyzer, EPA Method 350.1

Revision history:

Number	Date
1	3/30/94
2	4/26/01
3	3/19/02
4	5/28/02

Revised by: _____ Date: 5/28/02
Joan Phillips, Inorganics Manager

Reviewed by: _____ Date: 5/29/02
Bill Ambacher, Chemist

Approved by: _____ Date: 5/30/02
Harry Romberg, QA Officer

Approved by: _____ Date: 05/30/02
Kathy Kreps, Laboratory Director

Controlled Document
No. 20 Assigned to: Tetr

Table of Contents

1 INTRODUCTION AND SCOPE 3
1.1 OVERVIEW 3
1.2 SAMPLE PRESERVATION, STORAGE, AND HOLDING TIMES 3
1.3 DEFINITION OF TERMS 3
2 INTERFERENCES 5
3 SAFETY AND WASTE DISPOSAL 6
3.1 SAFETY 6
3.2 WASTE DISPOSAL 6
4 REAGENTS AND STANDARDS 6
4.1 REAGENTS 6
4.2 STANDARDS 7
5 EQUIPMENT 7
6 QUALITY CONTROL 8
6.1 METHOD DETECTION LIMIT STUDY 8
6.2 INITIAL MULTI-POINT CALIBRATION 8
6.3 INITIAL CALIBRATION VERIFICATION 9
6.4 INITIAL CALIBRATION BLANK 9
6.5 METHOD DETECTION LIMIT 9
6.6 METHOD BLANK/PREP BLANK 10
6.7 CONTINUING CALIBRATION 10
6.8 MATRIX SPIKE 11
6.9 MATRIX SPIKE DUPLICATE 11
6.10 SAMPLE DUPLICATE 12
7 PROCEDURE 13
7.1 INSTRUMENT SET-UP 13
7.2 ANALYSIS SEQUENCE 13
7.3 SOIL PREPARATION 14
7.4 SAMPLE ANALYSIS 14
7.5 CALCULATIONS 14
7.6 ANALYSIS TIME 15
8 REFERENCES 15

1 Introduction and Scope

1.1 Overview

1.1.1 This method is for the measurement of ammonia as nitrogen in drinking, surface, and saline waters, domestic and industrial wastes in the range of 0.01 to 2.0 mg/L NH_3 as N by EPA Method 350.1. Higher concentrations can be determined by sample dilution. Soil leachates and distillates may also be analyzed by this method.

1.1.2 This analysis is based on the Berthelot reaction. Ammonia reacts with alkaline phenol, then with sodium hypochlorite to form indophenol blue. Sodium nitroprusside (nitroferricyanide) is added to enhance sensitivity. The absorbance of the reaction product is measured at 630 nm, and is directly proportional to the original ammonia concentration.

1.2 Sample preservation, storage, and holding times

1.2.1 Preserve aqueous samples by the addition of sulfuric acid - 2 mL / liter sample.

1.2.2 Refrigerate all samples at 4±2 °C.

1.2.3 Recommended holding time from date of collection is 28 days.

1.3 Definition of Terms

1.3.1 This section defines terms and acronyms as they are used in this SOP. Other terms, such as MS/MSD or method blank, are not defined here since it is assumed that the user of this SOP already understands their more general meaning. This section or parts of it may be deleted if the analysis is basic and has no terminology that may be confusing to anyone likely to read the procedure.

1.3.2 **Batch Identifier** - A number given to each preparation or analysis group which uniquely identifies that batch. This number is generally the blank ID for preparation batches and either a sequence number for organic analyses or an analysis number which is similar to the blank ID, only preceded by an "A" rather than a "B" for inorganic batches. The preparation batch IDs are discussed in other documentation

1.3.3 **Blank spike** - A background free matrix (DIW for water, clean sand for soils/sediments) to which known amounts of target analytes are added each time samples are prepared. Blank spikes are required on all NFESC work. Note that an LCS or SRM (see below) will substitute as a blank spike for most inorganic analyses. In the context of this SOP, a blank spike is the same as a QC check standard. See also QC check standard.

1.3.4 **CCB - Continuing Calibration Blank** - This is the same acronym used in the CLP program. This is a blank which is analyzed immediately after the CCV (almost always after every 10 samples and at the end of the analytical run) during the analysis sequence to determine whether the instrument or system has maintained a stable baseline.

1.3.5 **CCV - Continuing calibration verification.** - This is the same acronym used in the CLP program. This is a standard analyzed at some prescribed frequency (almost always after every 10 samples and at the end of the analytical run) during the analysis sequence to determine whether the instrument or system has remained in calibration.

1.3.6 **CLP - Contract Laboratory Program** - The USEPA program that contracts with laboratories to provide laboratory services. The term has come to mean a much broader set of methods and deliverables. In context of this SOP, CLP means procedures or operations which are detailed in the CLP contract and which are extended to a broader working definition.

1.3.7 **Corr Coef, CC - Correlation coefficient** - A measure of the "goodness of fit" of a set of data to a regression model. The closer the value is to 1, the higher the degree of confidence in the correlation

1.3.8 **DIW - Deionized water** - Lab reagent water. This water should be free of virtually all analytes.

1.3.9 **ICB - Initial calibration blank** - This term is borrowed from CLP. An instrument blank is made up in the same way as calibration standards, without target analytes.

1.3.10 **ICV - Initial calibration verification** - This term is borrowed from the CLP protocol. It is a standard which is analyzed at the start of each analytical run that is compared to the initial multi-point calibration to determine whether the instrument calibration is accurate. For most inorganic methods, this verification standard is from a source different from that used to make the calibration standards.

1.3.11 **IDL - Instrument detection limit** - The lowest concentration of a target analyte that will yield a signal noise ratio of least 3x. Used as a starting point for selecting MDL study spiking levels.

1.3.12 **MDL - Method detection limit** - The lowest concentration a sample which will yield a positive result that is greater zero at a known level of confidence. MDLs are empirically determined by Laucks.

1.3.13 **MDL standard - Method detection limit standard** - A standard prepared so that the concentrations of the target analytes are no greater than 4x the empirically determined MDLs. This standard is used to verify that the instrument or system is capable of

detecting the target analytes on an ongoing basis.

1.3.14 **QC check standard - Quality control check standard** - Referred to in this SOP as a blank spike. A QC check standard is used to determine whether the analytical system is in control if MS/MSD recoveries are out of control. See also blank spike.

1.3.15 **SRM or LCS - Standard Reference Material or Laboratory Control Sample** - This is a material of approximately the same matrix as the samples, containing a known and usually certified amount of target analyte and which is prepared and analyzed in the same manner as a typical sample. This sample is used to demonstrate that the analytical system is in control. It may be considered to be a blank spike for most inorganic analyses and is preferred over artificially spiking blank materials.

1.3.16 **QC period - Quality control period** - An analysis sequence initiated by the analysis of one or more standards, followed by samples, and terminated with a standard and blank analysis. A QC period can be open-ended chronologically, but calibration verification must be documented using the procedures in this SOP

1.3.17 **RSD or %RSD** - Relative standard deviation or percent relative standard deviation - The ratio of the standard deviation of a set of values to the mean of the set of values. A measure of the similarity of the values one to another.

1.3.18 **Sequence** - A set of sample extracts and standard solutions injected into an instrument in a chronologically continuous group. See also QC period.

2 Interferences

2.1.1 Calcium and magnesium ions may be present in concentration sufficient to cause precipitation problems during analysis. The 5% EDTA solution is used to prevent the precipitation of calcium and magnesium ions from river water and industrial waste.

2.1.2 Sample turbidity may interfere with this method. Turbidity must be removed by pressure filtration through a 0.45 µm filter prior to analysis.

2.1.3 Sulfide interference, if present, may be removed by acidifying the sample to pH<3 with dilute HCL and aerating vigorously until the sulfide odor can no longer be detected.

2.1.4 Sample color that absorbs in the photometric detection range used will also interfere.

2.1.5 Cyanate, which may be encountered in certain industrial effluents, will hydrolyze to some extent even at the pH of 9.5 at which distillation is carried out.

2.1.6 Residual Chlorine must be removed by pretreatment of the sample with sodium

thiosulfate before distillation.

3 Safety and Waste Disposal

3.1 Safety

3.1.1 Care should be taken when working laboratory reagents and acids.

3.1.2 Wear a lab coat and safety glasses while in the lab and especially during any type of analysis.

3.1.3 Gloves offer protection from reagents while degassing and handling samples.

3.1.4 If it is necessary to open the back of the instrument, disconnect the power first.

3.2 Waste Disposal

3.2.1 Waste products from this process are not considered harmful or of sufficient volume to be considered hazardous.

4 Reagents and Standards

4.1 Reagents

4.1.1 Ammonia-free de-ionized water.

4.1.2 Sodium phenolate - Dissolve 83.0g crystalline phenol and 32.0g sodium hydroxide in DIW. Dilute to 1.0L and mix until dissolved.

4.1.3 Sodium hypochlorite - Dilute 500 mL of 5.25% NaOCl (bleach) to 1.0 L with DIW.

4.1.4 Buffer - Dissolve 50.0g of Disodium salt of EDTA and 5.5g of NaOH with DIW. Dilute to 1.0 L with DIW and mix until dissolved (about one hour).

4.1.5 Sodium nitroferricyanide - Dissolve 3.50 g of sodium nitroferricyanide in DIW. Dilute to 1.0 L. Make this reagent before it is needed. Greater sensitivity is achieved with 2-day old reagent.

4.1.6 Carrier (0.02% H_2SO_4) - Dilute 3.0 mL H_2SO_4 to 1.5 L with DIW.

4.1.7 Concentrated H_2SO_4 (for soil distillation)

4.1.8 Phenolphthalein indicator (for soils) – Dissolve 1 g phenolphthalein in 100 mL isopropanol.

4.1.9 Sodium borate buffer (for soils) - Dissolve 9.5 g sodium borate in DIW, add 88 mL 0.1N NaOH, and dilute to 1.0L. Keep in an amber glass bottle.

4.1.10 Anti-foam solution, prepared (for soils)

4.1.11 50 % NaOH (for soils)

4.1.12 Sodium thiosulfate: Dissolve 3.5 g $Na_2S_2O_3$ (CASRN 10102-17-7) in reagent water and dilute to 1 L. One mL of this solution will remove 1 mg/L or residual chlorine in 500 mL of sample.

4.2 Standards

4.2.1 All standards should be stored at 4 ± 2°C.

4.2.2 Stock NH_3 solution - Dissolve 0.3819g of anhydrous ammonium chloride, NH_4Cl, dried at 105 °C, in DIW, add 2 mL H_2SO_4 and dilute to 1.0 L. 1.0 mL of stock standard equals 0.1 mg NH_3-N (100 ppm solution.). Expires after one year.

4.2.3 2 ppm working standard - Dilute 2 mL of the 100 ppm stock NH_3 standard up to 100 mL with 0.02%H_2SO_4 in a volumetric flask. Prepared weekly.

4.2.4 10,000 ppm NH_3 standard for spiking soils - Dissolve 38.19 g of anhydrous ammonium chloride, NH_4Cl, dried at 105 °C, in DIW, add 2 mL H_2SO_4 and dilute to 1.0 L. Expires after one year.

5 Equipment

5.1.1 Lachat Automatic Flow Injection Ion Analyzer

5.1.2 Automatic sampler

5.1.3 Peristaltic pump

5.1.4 Injection module: 150 cm, 0.81 mm I.D., sample loop

5.1.5 Colorimeter: 10 mm flow cell, 630 nm filter

5.1.6 Heating block: 60 °C

5.1.7 Reaction manifold 10-107-06-1-B or equivalent

5.1.8 Sample and calibration racks, with calibration vials

5.1.9 Helium for degassing reagents

5.1.10 Fritted gas dispersion tube

5.1.11 PC with keyboard and printer (IBM compatible)

5.1.12 Various micropipettes with tips

5.1.13 13 x 100 borosilicate disposal test tubes

5.1.14 100 mL volumetric flask

5.1.15 Kjeldahl flasks (for soil distillations)

5.1.16 250 mL beakers (for soils)

5.1.17 Any laboratory PC equipped with Excel and the ammonia template may be used for calculation or the calculations may be done by hand, requiring no computer except for entry into the LIMS database.

6 Quality Control

6.1 Method Detection Limit Study

6.1.1 Prior to the analysis of any samples, it is necessary to establish method detection limits. This procedure is fully described in Laucks SOP on MDL studies. Briefly, it involves the analysis of seven replicate samples spiked at a concentration near the anticipated method detection limit. A Student's t-test is then applied to these measured values to calculate the MDL. The LTL estimated MDL is 0.01 mg/L.

6.2 Initial Multi-Point Calibration

6.2.1 Calibration Curve:

mL intermediate ammonia intermediate solution, diluted to 20mLs with carrier	Ammonia concentration (mg/L)
20	2.0
5	0.5
1	0.1
0.5	0.05
0	0

6.2.2 Prior to the analysis of any samples, a calibration curve must be analyzed in order of decreasing concentrations. A minimum of a four point curve plus a zero standard should be analyzed.

6.2.3 Criteria

6.2.3.1 Initial calibration data is evaluated using the correlation coefficient of a linear regression analysis. The correlation coefficient must be 0.995 or greater for a 4-point calibration.

6.2.4 Corrective action

6.2.4.1 If the criteria are not met, the instrument must be recalibrated.

6.3 Initial Calibration Verification

6.3.1 One initial calibration verification (ICV) sample must be analyzed at the beginning of each analytical sequence and be repeated with every 20 samples. The value must fall be within the control limits set by the manufacturer or within recovery limits of 90-110%. This sample must be traceable to an NIST primary standard, and must be of different origin from the calibration/spiking standard. This check sample serves as the LCS/SRM when required. Failure to meet recovery criteria requires recalibration.

6.4 Initial Calibration Blank

6.4.1 An initial calibration blank (ICB) must follow the ICV, and must be less than ½ the RL (0.01 mg/L). Failure to meet criteria requires recalibration and reanalysis.

6.5 Method detection limit

6.5.1.1 A method detection limit (MDL) sample must be analyzed with each analytical run. The minimum requirement for the MDL is that it be detectable, although it is desirable that it be within the range of 64% to 220% of the true value (0.01 mg/L). No corrective action is indicated should the value fall outside this range.

6.5.2 Corrective Action

6.5.2.1 If NH_3 is not detected, the analysis must be terminated until the problem has been solved. Alternatively, if the affected samples are well above the detection limit (i.e. bracketed by appropriate standards), they may be reported. No undetected values should be reported if the MDL standard for that analyte(s) is undetected.

6.6 Method Blank/Prep Blank

6.6.1 Method blanks are used to verify contamination free reagents and apparatus. They are prepared with every set of samples prepared at the same time or at least one blank every 20 samples whichever is more frequent. The reporting limits are considered to be 0.02 mg/L for water and 0.2 mg/kg for soil. Any analyte response above ½ the reporting limit (0.01 mg/L for waters, 0.10 mg/kg for soils) is reported.

6.6.2 . Waters

6.6.2.1 The method blank is carrier reagent. Preparation instructions are located in 4.1.6.

6.6.3 Soils

6.6.3.1 Distill 2.5 g of sand as preparation blank.

6.6.4 Corrective action

6.6.4.1 Corrective action may necessitate re-preparation and re-analysis of the sample set. For example if an analyte were found in the blank but not in any of the associated samples then sample group may not require re-analysis. In addition, if sample levels exceed 10 times the blank, the level of contamination may be considered insignificant. In any case, if re-preparation and re-analysis is not being undertaken, the analyst must first discuss the issue with the Quality Assurance Officer. It is the laboratory's responsibility to ensure that method interferences caused by contaminants in acids, solvents, reagents, glassware, and other sample processing hardware leading to discrete artifacts and/or elevated baselines in the analytical run be minimized. In the extreme case of chronic contamination, blanks may have to be analyzed from each stage of the sample processing to determine the contamination source so it can be eliminated. In all cases where blank contamination exceeds the control limit, a narrative comment must be made which documents the corrective actions taken.

6.7 Continuing Calibration

6.7.1 A continuing calibration verification (CCV) sample must be analyzed after every ten samples and at the end of the run, and must be ±10% of the true value. A suggested value would be 0.5 mg/L. If the CCV sample exceeds the recovery criterion but the samples are non-detects the data may be reported. If the CCV sample recovery falls below 90% the instrument must be recalibrated and all affected samples reanalyzed.

6.7.2 A continuing calibration blank (CCB) must follow each CCV, and must be less than ½ the RL (≤.01 mg/L). If the blank sample response exceeds this level and the sample concentrations exceed 20-times the blank level then the data may be reported. Otherwise,

the blank sample may be repoured and reanalyzed. Should this fail, the instrument must be recalibrated and all affected samples reanalyzed.

6.8 Matrix Spike

6.8.1 A sample is chosen at random from the samples to be analyzed, and an aliquot of spiking solution is added to this sample prior to analysis such that the final solution is fortified at 0.500 mg/L. The analyst should attempt to avoid selecting samples which are identified by the client as blanks. As the purpose of the matrix spike is to test the system under "typical" conditions, the analyst may also avoid selecting the most difficult sample of the batch for spiking. It is always required that a matrix spike analysis be performed with each preparation/analysis batch, however, the minimum frequency for MS analysis is 1 each per 20 samples per matrix.. This matrix spike sample is used to evaluate the matrix effect of the sample upon recovery of the analytes. The recovery of spike analytes is calculated as follows:

$$\% \text{ recovery} = \frac{(SS - S) * 100}{SA}$$

where:
SS = concentration in spiked sample
S = native concentration in unspiked sample
SA = spiked added, the amount of spiking material actually added to the sample calculated on the sample basis

6.8.2 The recovery criteria are detailed in the Quality Control Database and will change from time to time. Currently, the LTL recovery criteria for matrix spike recovery is 53-120% for water samples and 50-128% for soil samples.

6.8.3 Corrective action

6.8.3.1 Samples with spike recoveries outside control limits will be reviewed for possible corrective action. Corrective action will first involve recalculation, followed by possible re-preparation, and/or reanalysis. This process should also look at the recovery of the matrix spiking compounds from the SRM and/or blank spike analysis. If the SRM is in control, the out of control recovery is due to matrix interference and probably does not warrant reanalysis. In all cases a narrative explanation of the condition is required to detail the corrective actions taken.

6.9 Matrix Spike Duplicate

6.9.1 The compound recovery criteria are identical to those for the matrix spike sample. In

addition, the matrix spike duplicate is used measure method precision. This is done by computing the relative percent difference (RPD) between the matrix spike and matrix spike duplicate recovery values. MS/MSD is the preferred method for measuring precision, however if the client requests, or if it is to reported in CLP format, MS/DUP is performed. This calculation is as follows:

$$RPD = \frac{|S1 - S2| * 100}{(S1 + S2)/2}$$

where:
S1 = measured concentration for MS sample
S2 = measured concentration for MSD sample

6.9.2 RPD control limits are detailed in the Quality Control Database and will change from time to time. Currently, the LTL RPD criteria is 10% for water samples and 30% for soil samples.

6.10 Sample Duplicate

6.10.1 Criteria

6.10.1.1 Sample duplicates are required only when the client requests, when CLP practices are employed, or when the method specifically calls for duplicates. At least one duplicate sample per 20 samples per matrix is required when matrix spikes/duplicates are being performed. RPD values are calculated in a manner similar to MS/MSD RPDs:

$$RPD = \frac{|S1 - S2| * 100}{(S1 + S2)/2}$$

where:
S1 = measured concentration in the initial analysis
S2 = measured concentration in the duplicate analysis

6.10.2 The RPD control limits are detailed in the Quality Control Database and will change from time to time. Currently, the LTL RPD criteria is 10% for water samples and 30% for soil samples.

7 Procedure

(Note - additional operational instructions may be found in the Lachat Operations Manual)

7.1 Instrument set-up

7.1.1 Turn on power and all modules, and allow heating block to warm up to 60 °C

7.1.2 Degas all reagents (except phenolate reagent) by sparging with helium at low flow for 20 minutes.

7.1.3 Place reagent feed lines into proper containers, and raise tension levers on pump tube cassettes.

7.1.4 Allow reagents to pump through system until a stable baseline in obtained.

7.2 Analysis sequence

7.2.1 A typical analysis sequence is as follows:

2.0 ppm standard
0.50 ppm standard
0.10 ppm standard
0.05 ppm standard
0.00 ppm standard
SRM
ICB
MDL
PBW
Sample 1
Sample 1MS (or D, depending on client needs)
Sample 1MSD (or S, depending on client needs)
Sample 2
Sample 3
Etc
after 10 samples
CCV1
CCB1
Sample 11
etc...
CCV2
CCB2

7.3 Soil preparation

7.3.1 Though soil samples can be prepared by either distillation or by leaching them with 0.2% H_2SO_4, distillation is the preferred method, and is what is discussed here.

7.3.2 Into a Kjeldahl flask place 2.5g of sample (1.0g for biosolids), 300 mL of DIW, some boiling stones, 3 drops of phenolphthalein indicator, 25 mL of sodium borate solution, and a squirt of anti-foam solution.

7.3.3 Samples should be pink. If they are not, add 50% NaOH drop wise until color forms.

7.3.4 Also distill a preparation blank, a matrix spike sample, and a matrix spike duplicate.

7.3.5 Spike MS/MSD with 0.5 mL of the 10,000 ppm solution, for an NH_3 spiking value of 5 ppm at the instrument.

7.3.6 Place 50 mL DIW and 0.500 mL conc. H_2SO_4 into 250 mL sample bottles (cubes).

7.3.7 Distill flasks into cubes until distillate levels reach approximately 175-195 mL, about the shoulder of the cube.

7.3.8 Turn off heat and pull beakers down so as not to draw distillate up the condenser.

7.3.9 Dilute distillates to 235 mL each (to the neck of the cube), and analyze the same as waters.

7.4 Sample analysis

7.4.1 Place all prepared samples in test tubes and on the autosampler, and start tray analysis.

7.4.2 Dilute samples as needed, and re-analyze.

7.5 Calculations

7.5.1 The soil calculation to reach a final mg/L value is incorporated in the spreadsheet, and is as follows:

$$\text{mg/Kg AR} = \frac{\text{Instrument concentration} * \text{mL final volume}}{\text{g sample weight}}$$

$$\text{mg/Kg DB} = \frac{\text{mg/Kg AR}}{\text{TS}}$$

7.6 Analysis Time

7.6.1 Barring any problems or excessive dilutions, approximately 20 samples with their corresponding QC can be analyzed in 90 minutes.

8 References

Determination of Ammonia-Nitrogen by Semi-Automated Colorimetry, EPA Method 350.1, Rev. 2.0, August 1993.

QuikChem AE Automated Ion Analyzer Operating Manual, Lachat Instruments

Appendix I

QC Summary Table
Laucks Testing Laboratories
Method 350.1 / LTL-9109 QC Requirements and Corrective Actions

QC Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
Initial Calibration	Multi-point	Multi-point R>0.995 (4 points plus blank)	One per run	Recalibrate	Printout of calibration
Standard Reference Material (SRM) Recovery		Limits set by Manufacturer or 90 - 110 %	One per twenty samples	Reanalyze or recalibrate	Printout of QC database
Method Blank	<MDL	<½ RL (<0.01 mg/L)	One per twenty samples	Reanalyze	Printout of QC database
Continuing Calibration Verification	90 - 110 % recovery	90 - 110 % recovery	One after every ten samples and at the end of the run.	Recalibrate	Printout of result
Continuing Calibration Blank		<½ Reporting Limit (<0.01 mg/L)	One after every ten samples and at the end of the run.	Recalibrate	Printout of result
MDL standard recovery		Detectable	One per run	Recalibrate	Printout of result
Matrix Spike Recovery	90 - 110 % rec. but if sample fails, may be due to matrix if SRM / blank spike passes	See QC database. Currently, Water 53-120% Soil 50-128%	One MS/MSD or one MS/Dup per 20 samples	Dilute and reanalyze	Printout of QC database
MS/MSD RPD		See QC database. Currently, Water 10% Soil 30%	One MS/MSD or one MS/Dup per 20 samples	Dilute and reanalyze	Printout of QC database

QC Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
Duplicate % Difference		See QC database. Currently, Water 10% Soil 30%	One MS/MSD or one MS/Dup per 20 samples	Dilute and reanalyze	Printout of QC database

Appendix II

Sample Bench Sheet

Laucks Testing Laboratories, Inc.

0104323 KCH011 0104406
327 412
358 541
359 549
387 581
405 582

0104587

Ammonia as N
EPA 350.1

Matrix: Water
Analyst: German N.
Reviewer:

Calibration Tray Info: Ammonia as N: 01050801 05/08/01 16:53

m(A-B)= 0.04756 m(B-E)= 0.04747 r(A-B)= 0.99999 r(B-E)= 0.99962 y0(A-B)= -0.00005 y0(B-E)= 0.00003

Cup #	Calibration Standard	Dilution of Intermediate Std.	Absorbance	Determined Conc. (mg/L)	% Residual		Standards Log ID	T.V. (mg/L)
1	Std. A (tv=2.00mg/L)	20.0mL / 20.0mL	0.0951	2.000	0.00	Intermediate Std:	TE6-27-8	2.00
2	Std. B (tv=0.500mg/L)	5.00mL / 20.0mL	0.0237	0.500	0.00	Stock Std:	TE6-15-1	100.
3	Std. C (tv=0.100mg/L)	1.00mL / 20.0mL	0.0051	0.107	-7.00	LCSW:	TE6-18-6	13.00
4	Std. D (tv=0.050mg/L)	0.50mL / 20.0mL	0.0023	0.047	5.53	CCV:	Std. B	0.500
5	Std. E (tv=0.000mg/L)	0mL / 20.0mL	-0.0001	-0.003	0.00			

Spikes = 25.µL Stock Std in 5.00mL of diluted sample: 0.50 mg/L @ Instrument

Sample Tray Info: Ammonia as N: 01050801.RS 05/08/01 17:47 min. rep. limit (mg/L): 0.01

Cup #	Laucks ID		PIF	Absorbance	Dilution Factor	Conc. @ Instrument	Conc. in Sample	NH_3 as N mg/L	Rep. Lim.	
101	ICV/LCSW1 tv=13.mg/L		0.97	0.0638	10	1.3431	13.4310	13.	0.1	103.%
102	ICB		0.00	-0.0001	1	-0.0023	-0.0023	0.01 U	0.01	
103	MDL tv=0.01mg/L		0.77	0.0003	1	0.0060	0.0060	0.01 U	0.01	60.%
104	B050801NH3W01		0.00	0.0000	1	-0.0014	-0.0014	0.01 U	0.01	
105	0104323-2	37 (b.+k.#)	0.28	0.0002	1	0.0044	0.0044	0.01 U	0.01	
106	0104327-1	48	0.44	0.0003	1	0.0048	0.0048	0.01 U	0.01	
107	0104327-2	49	0.14	0.0002	1	0.0043	0.0043	0.01 U	0.01	
108	0104327-2ms	49	0.99	0.0254	1	0.5353	0.5353	0.54	0.01	106.%
109	0104327-2msd	49	0.99	0.0257	1	0.5412	0.5412	0.54	0.01	107.%
110	0104358-1	19	0.00	-0.0002	1	-0.0053	-0.0053	0.01 U	0.01	
2	CCV1		0.99	0.0238	1	0.5006	0.5006	0.50	0.01	100.%
5	CCB1		0.00	0.0001	1	0.0013	0.0013	0.01 U	0.01	
111	0104359-1	16	0.19	-0.0005	1	-0.0120	-0.0120	0.01 U	0.01	
112	0104387-1	17	0.84	0.0011	1	0.0233	0.0233	0.02	0.01	
113	0104405-1	34	0.00	0.0001	1	0.0006	0.0006	0.01 U	0.01	
114	0104405-2	35	0.00	0.0002	1	0.0032	0.0032	0.01 U	0.01	
115	0104406-1	18	0.71	-0.0003	1	-0.0071	-0.0071	0.01 U	0.01	
116	0104412-1	21	0.94	0.0029	1	0.0611	0.0611	0.06	0.01	
117	0104541-1	7	0.69	-0.0005	1	-0.0108	-0.0108	0.01 U	0.01	
118	0104541-2	8	0.72	-0.0007	1	-0.0157	-0.0157	0.01 U	0.01	
119	0104541-3	9	0.00	-0.0002	1	-0.0048	-0.0048	0.01 U	0.01	
120	0104549-1	1	0.99	0.0862	20	1.8141	36.2820	36.	0.2	
2	CCV2		0.99	0.0240	1	0.5059	0.5059	0.51	0.01	101.%
5	CCB2		0.00	0.0000	1	0.0002	0.0002	0.01 U	0.01	
121	0104549-2	2	0.95	0.0109	1	0.2294	0.2294	0.23	0.01	
122	0104581-1	4	0.61	0.0005	1	0.0094	0.0094	0.01 U	0.01	
123	0104581-2	5	0.56	0.0012	1	0.0242	0.0242	0.02	0.01	
124	0104581-3	6	0.00	-0.0002	1	-0.0053	-0.0053	0.01 U	0.01	
125	0104582-1	2	0.96	0.0152	1	0.3205	0.3205	0.32	0.01	
~~126~~	~~0104587-1~~	1	~~0.55~~	~~1.1640~~	~~1~~	~~24.2670~~	~~24.2670~~	~~>dilute>~~	~~0.01~~	
~~127~~	~~CCV3~~		~~0.85~~	~~0.0293~~	~~1~~	~~0.6163~~	~~0.6163~~	~~0.62~~	~~0.01~~	~~123.%~~
~~128~~	~~0104587-1~~	1	~~0.08~~	~~0.1068~~	~~50~~	~~4.1388~~	~~206.0400~~	~~>dilute>~~	~~0.5~~	
129	0104587-1	1	0.99	0.0585	250	1.2307	307.6750	310.	2.	
~~130~~	~~blank~~		~~0.08~~	~~0.0005~~	~~1~~	~~0.0005~~	~~0.0005~~	~~0.01 U~~	~~0.01~~	
2	CCV3		0.99	0.0241	1	0.5073	0.5073	0.51	0.01	101.%
5	CCB3		0.00	0.0001	1	0.0011	0.0011	0.01 U	0.01	

LAUCKS TESTING LABORATORIES INC.
Seattle, Washington

SOP #: LTL-9125

Nitrate/Nitrite as N on Lachat by EPA Method 353.2

Revision history:

Number	Date
0	04/23/96
1	10/28/98
2	5/10/01
3	11/07/02

Revised by: Bill Ambacher Date: 11/7/02
Bill Ambacher, Chemist

Reviewed by: Joan Phillips Date: 11/7/02
Joan Phillips, Inorg. Div. Manager

Approved by: Harry Romberg Date: 11/12/02
Harry Romberg, QC Officer

Approved by: Kathy Kreps Date: 11/12/02
Kathy Kreps, Laboratory Director

Controlled Document
No. 20 Assigned to: TETR

Table of Contents

1. INTRODUCTION AND SCOPE 4

1.1. METHOD DESCRIPTION 4
1.2. SAMPLE COLLECTION, SAMPLE STORAGE, HOLDING TIMES 4
1.3. DEFINITION OF TERMS 4
1.4. INTERFERENCES 6

2. EQUIPMENT LIST AND STANDARDS 7

2.1. INSTRUMENT 7
2.2. STANDARDS 7
2.3 REAGENTS 8

3. SAFETY PRECAUTIONS AND WASTE DISPOSAL 9

3.1. SAFETY PRECAUTIONS 9
3.2. WASTE DISPOSAL 9

4. CALIBRATION AND QUALITY CONTROL 9

4.1. METHOD DETECTION LIMIT STUDY 9
4.2. INITIAL MULTI-POINT CALIBRATION 10
4.3. INITIAL CALIBRATION VERIFICATION 10
4.4. INITIAL CALIBRATION BLANK 10
4.5. METHOD DETECTION LIMIT STANDARD 11
4.6. CONTINUING CALIBRATION VERIFICATION (CCV) AND BLANK (CCB) 11
4.7. METHOD BLANKS 12
4.8. MATRIX SPIKE 12
4.9. MATRIX SPIKE DUPLICATE 13
4.10. SAMPLE DUPLICATE 14
4.11. CADMIUM COLUMN EFFICIENCY CHECK 15

5. OPERATION PROCEDURES 15

5.1. SAMPLE ANALYSIS 15
5.2. INSTRUMENTAL CONDITIONS 16
5.3 ANALYTICAL OPERATION 16
5.4 COMPOUND QUANTIFICATION 17

6. REPORTS 17

6.1. DATA PACKET ORGANIZATION 17
6.2. QUALITY CONTROL REPORTS 18
6.3. SAMPLE RESULT REPORTS 18

7. REFERENCES **18**

APPENDIX I **19**

QC REQUIREMENTS AND CORRECTIVE ACTIONS 19

APPENDIX II **21**

MANIFOLD SCHEMATIC FROM CURRENT INSTRUMENT MANUAL 21

APPENDIX III **22**

SAMPLE DATA SHEET 22

1. Introduction and Scope

1.1. Method Description

1.1.1. This method is applicable to the determination of nitrate/nitrite in drinking, surface and saline waters, domestic and industrial wastes. The method is applicable in the range from 0.05 to 2.0 mg/L as N. Higher nitrate/nitrite concentrations can be determined by diluting the sample. Some clients may require a reporting limit of 0.01 mg/L. If a client requests this reporting limit, Laucks will analyze a standard at 0.01 mg/L at the beginning of an analysis.

1.1.2. The nitrate in the sample is quantitatively reduced to nitrite by passing it over a cadmium reduction column. The diazonium compound formed by diazotation of sulfanilamide by nitrite in water under acid conditions is coupled with N-(1-napthyl)-ethylenediamine dihydrochloride to produce a reddish-purple color, which is measured in a spectrophotometer at 520 nm.

1.1.3. This method is restricted to use by, or under the supervision of analysts experienced in the technique described. Each analyst performing this method must have demonstrated the ability to perform the described analysis.

1.2. Sample Collection, Sample Storage, Holding Times

1.2.1. Samples are collected in plastic 500 mL bottles. They are preserved with H_2SO_4 to pH <2. The samples should be held at 4±2°C until analysis. The holding time is 28 days, based on time of collection.

1.3. Definition of Terms

1.3.1. This section defines terms and acronyms as they are used in this SOP. Other terms, such as MS/MSD or method blank, are not defined here since it is assumed that the user of this SOP already understands their more general meaning.

1.3.2. **Batch Identifier** - A number given to each preparation or analysis group which uniquely identifies that batch. This number is an analysis number, which is similar to the blank ID, only preceded by an "A" rather than a "B" for inorganic batches. The preparation batch IDs are discussed in other documentation. The batch identifier for the third batch of waters run on Feb 29,1996 would be: A022996LANNW03.

1.3.3. **Blank spike** - A background free matrix (DIW for water, clean sand for soils/sediments) to which known amounts of target analytes are added each time samples are prepared. Note that an LCS or SRM (see below) will substitute as a blank spike for most inorganic analyses. In the context of this SOP, a blank spike is the same as a QC check standard. See also QC check standard.

1.3.4. **CCB** - Continuing Calibration Blank - This is the same acronym used in the CLP program. This is a blank, which is analyzed immediately after the CCV (almost always after every 10 samples and at the end of the analytical run) during the analysis sequence to determine whether the instrument or system has maintained a stable baseline.

1.3.5. **CCV** - Continuing calibration verification. - This is the same acronym used in the CLP program. This is a standard analyzed at some prescribed frequency (after every 10 samples and at the end of the analytical run) during the analysis sequence to determine whether the instrument or system has remained in calibration.

1.3.6. **CLP** - Contract Laboratory Program - The USEPA program that contracts with laboratories to provide laboratory services. The term has come to mean a much broader set of methods and deliverables. In context of this SOP, CLP means procedures or operations which are detailed in the CLP contract and which are extended to a broader working definition.

1.3.7. **Corr Coef, CC** - Correlation coefficient - A measure of the "goodness of fit" of a set of data to a regression model. The closer the value is to 1, the higher the degree of confidence in the correlation.

1.3.8. **DIW** - Deionized water - Lab reagent water. This water should be free of virtually all analytes.

1.3.9. **ICB** - Initial calibration blank - This term is borrowed from CLP. An instrument blank is made up in the same way as calibration standards, without target analytes.

1.3.10. **ICV** - Initial calibration verification - This term is borrowed from the CLP protocol. It is a standard, which is analyzed at the start of each analytical run and that is compared to the initial multi-point calibration to determine whether the instrument calibration is accurate. For most inorganic methods, this verification standard is from a source different from that used to make the calibration standards.

1.3.11. **IDL** - Instrument detection limit. The lowest concentration of a target analyte that will yield a signal:noise ratio of least 3x. Used as a starting point for selecting MDL study spiking levels.

1.3.12. **MDL** - Method detection limit - The lowest concentration of a sample, which will yield a positive result, that is greater than zero at a known level of confidence. MDLs are empirically determined by Laucks.

1.3.13. **MDL standard** - Method detection limit standard - A standard prepared so that the concentrations of the target analytes are no greater than 4x the empirically determined MDLs. This standard is used to verify that the instrument or system is capable of detecting the target analytes on an ongoing basis.

1.3.14. **QC check standard** - Quality control check standard. Referred to in this SOP as a blank spike. A QC check standard is used to determine whether the analytical system is in control if MS/MSD recoveries are out of control. See also blank spike.

1.3.15. **SRM or LCS** - Standard Reference Material or Laboratory Control Sample. This is a material of approximately the same matrix as the samples, containing a known and usually certified amount of target analyte and which is prepared and analyzed in the same manner as a typical sample. This sample is used to demonstrate that the analytical system is in control.

1.3.16. **QC period** - Quality control period - An analysis sequence initiated by the analysis of one or more standards, followed by samples, and terminated with a standard and blank analysis. A QC period can be open-ended chronologically, but calibration verification must be documented using the procedures in this SOP.

1.3.17. **RSD or %RSD** - Relative standard deviation or percent relative standard deviation - The ratio of the standard deviation of a set of values to the mean of the set of values. A measure of the similarity of the values one to another.

1.3.18. **Sequence** - A set of sample extracts and standard solutions injected into an instrument in a chronologically continuous group. See also QC period.

1.4. Interferences

1.4.1. Build up of suspended matter in the reduction column will restrict sample flow. Since nitrate and nitrite are found in a soluble state, samples may be filtered.

1.4.2. Low results might be obtained for samples that contain high concentrations of iron, copper or other metals. EDTA is added to the samples to eliminate this interference.

1.4.3. Residual chlorine can produce a negative interference by limiting reduction efficiency. Before analysis, samples should be checked and if required, dechlorinated with sodium thiosulfate.

1.4.4. Samples that contain large concentrations of oil and grease will coat the surface of the cadmium. Pre-extracting the sample with an organic solvent eliminates this interference.

1.4.5 Sample color that absorbs at about 520 nm will interfere.

2. Equipment List and Standards

2.1. Instrument

2.1.1 Lachat QuickChem AE-200,

2.1.2 QuikChem AE Software, Release 3, October 1994

2.1.2 Reaction Module 10-107-04-1-C

2.1.3 Cd/Cu column. This is purchased pre-packed from Lachat.

2.1.4 Autosampler

2.1.5 Proportioning Pump

2.1.6 IBM PC with keyboard and printer (IBM compatible) that is equipped with Excel and the NN template may be used for calculation or calculation may be done by hand.

2.1.7 Orbit shaker: for leaching soil samples

2.2. Standards

2.2.1 Stock Nitrate solution: Dissolve 0.7218g of potassium nitrate (KNO_3) to 1 L in a volumetric flask with 0.02 % H_2SO_4. This produces a 100. mg/L NO_3 stock solution. This stock is prepared annually and stored at 4±2°C. Alternatively, dilute 10.0 mL of 1000 mg/L NO_3 standard to 100 mL in volumetric flask with 0.02% H_2SO_4. This

produces a 100. mg/L NO_3 stock solution. This stock is prepared every six months and is stored at 4±2°C.

2.2.2 Intermediate Nitrate Standard: Dilute 2.0 mL of 2.2.1 (or 0.2 mL of 1000 mg/L NO_3 standard) to 100 mLs in a volumetric flask with 0.02 % H_2SO_4. The concentration of this solution is 2.0 mg/L. This solution should be prepared weekly and stored at 4±2°C. (The nitrate and ammonia intermediate standards are prepared in the same 100 mL volumetric flask from their respective stock solutions.)

2.2.3 Working standards: These solutions should be made fresh daily:

mL intermediate standard (2.2.2) diluted to 20.0 mL with Carrier (2.3.3)	Concentration (mg/L)
0	0
0.500	0.050
1.00	0.100
5.0	0.500
20.0	2.000

2.2.4 Cadmium column reduction efficiency standards: Two standards at the same concentration (e.g. 5.0 ppm), one of NO_3 and the other NO_2, are used to test the cadmium column efficiency to reduce nitrate to nitrite. These could be made up from the stock solutions (see LTL-9135, Nitrite by EPA 354.1, 2.2 for nitrite stock solutions).

2.3 Reagents

2.3.1 Ammonium chloride buffer: Dissolve 85g of NH_4Cl and 1.0g EDTA into approximately 900 mL of DIW. Adjust the pH to 8.5 with 50% NaOH solution. Dilute to 1L and mix. (Usually, it is convenient to prepare 2 L of buffer at a time.) Stored at room temperature.

2.3.2 Sulfanilamide color reagent: In a 1L volumetric flask, combine 600 mL of DIW, 100 mL of 85% H_3PO_4, and 40.0 g of sulfanilamide. Stir on a stir plate and add 1.0 g N-1-napthylethylenediamine dihydrochloride (NED) when all of the sulfanilamide is dissolved. Dilute to 1L and mix. Store in a dark bottle at room temperature. This solution is stable for one month.

2.3.3 Carrier: Dilute 3 mL of conc. H_2SO_4 to 1.5 L with DIW. Prepare daily.

2.3.4 Sodium thiosulfate: Dissolve 3.5 g $Na_2S_2O_3$ (CASRN 10102-17-7) in reagent water and dilute to 1 L. One mL of this solution will remove 1 mg/L of residual chlorine in 500 mL of sample.

* Degas ammonium chloride buffer and carrier with helium for 2-3 minutes before analysis.

3. Safety precautions and Waste Disposal

3.1. Safety Precautions

3.1.1. All standards, samples and sample solutions should be handled as if they are hazardous substances.

3.1.2. Refer to the instrument manufacturer's manual for routine instrument precautions.

3.1.3. Routine precautions include an awareness of the moving parts on the instrument you're using. These parts are often charged with power from an electrical component or with high-pressure gas and have the potential to do harm if not used properly.

3.1.4. Electrical shock - All instruments present the possibility of electrical shock. The operator should take all precautions including ensuring that all instruments are operated with fully grounded power outlets, turning off the instrument and disconnecting the instrument from the electrical power supply before working on any electrical components, etc.

3.1.5 Sodium hydroxide and sulfuric acid are extreme irritants if they come in contact with skin or eyes. When using these chemicals, the analyst should wear gloves and safety glasses.

3.2. Waste Disposal

3.2.1. Waste from the instrument is carried by a drain to the sink. Leftover sample aliquots are also disposed of into the sink.

3.2.2. Waste segregation and disposal from the point of collection is further covered in the Laucks SOP on Waste Segregation and Disposal.

4. Calibration and Quality Control

4.1. Method Detection Limit Study

4.1.1. Prior to the analysis of any samples, it is necessary to establish method detection limits. This procedure is fully described in Laucks SOP on MDL studies. Briefly, it involves the analysis of 7 replicate samples spiked at a concentration near the anticipated method detection limit. A Student's T-test is then applied to these measured values to calculate the MDL. The LTL estimated MDL is 0.014 mg/L.

4.2. Initial Multi-Point Calibration

4.2.1. Analyze standard solutions using at least 4 different concentration levels. The calibration curve was described in the Standards section 2.2.3. The lowest standard is at 0.050 mg/L. The highest standard is 2.00 mg/L. The calibration solutions are analyzed from the highest concentration to the lowest

4.2.2. Criteria

4.2.2.1. Initial calibration data is evaluated using the correlation coefficient of a linear regression analysis. The correlation coefficient must be 0.995 or greater for a 4-point calibration. All CCVs and sample concentrations must be computed using the regression equation.

4.2.3. Corrective action

4.2.3.1. If the criteria are not met, the instrument must be recalibrated.

4.3. Initial Calibration Verification

4.3.1. Immediately after the calibration curve, analyze a standard from a source other than that from which the calibration material was obtained. For this analysis, the ICV is also the LCS.

4.3.2. Criteria

4.3.2.1. The calculated concentration of the ICV must be 90%-110% of the true value.

4.3.3. Corrective action

4.3.3.1. If the ICV criteria are not met, no samples can be analyzed. Perform system maintenance and re-check the ICV. If the criteria still cannot be met, the system must be recalibrated.

4.4. Initial Calibration Blank

4.4.1. After the analysis of the ICV standard, an instrument blank (ICB) is analyzed. The absolute value of NO_2/NO_3 in the ICB should not exceed one-half of the reporting limit of 0.05 mg/L.

4.4.2. Corrective action

4.4.2.1. If the ICB contains target analyte levels above one-half of the reporting limit of 0.05 mg/L, the system is out of control. The source of contamination must be identified and corrected before proceeding with the analysis.

4.5. Method Detection Limit Standard

4.5.1. After the analysis of the ICV and the ICB, but before the analysis of any samples, an MDL standard at 0.01 mg/L is to be analyzed. The MDL standard is used to provide on-going verification of the ability of the system to detect analytes at a concentration near the method detection limit. The MDL standard should give a positive result. It must be detected for the system to be considered in control.

4.5.2. The MDL solution is prepared by diluting 25 µl of 2.2.2 into 5.0 mLs of carrier (2.3.3).

4.5.3 Corrective Action

4.5.3.1 If NO_3/NO_2 is not detected, the analysis must be terminated until the problem has been solved. Alternatively, if the affected samples are well above the detection limit (i.e. bracketed by appropriate standards), they may be reported. No undetected values should be reported if the MDL standard for that analyte(s) is undetected.

4.6. Continuing Calibration Verification (CCV) and Blank (CCB)

4.6.1. A mid-range calibration standard is analyzed after every 10 samples. The CCV solution is the 0.500 mg/L standard. Immediately following the CCV, a blank solution is analyzed. In addition, this standard and blank must be the last samples analyzed in the run.

4.6.2. The CCV must fall within ± 10% of the true value.

4.6.3. The levels of NO_3/NO_2 in the CCB should not exceed one-half of the reporting limit of 0.05 mg/L.

4.6.4. Corrective action

4.6.4.1 If CCV limits are exceeded, check calculations or perform instrument maintenance. Recalibrate and reanalyze. No sample results may be reported that are not bracketed by a successful calibration and a CCV, which is in control or by preceding and following CCVs, which are within limits.

4.6.4.2 If the CCB contains target analyte levels above one-half of the reporting limit of 0.05 mg/L, the system is out of control. The source of contamination must be identified and corrected and the affected samples re-analyzed unless the samples are more than 20 times the blank level. As with the CCVs, no sample results may be reported that are not bracketed by a successful initial and continuing calibration blank, which are in control or by preceding and following CCBs, which are within limits.

4.7. Method Blanks

4.7.1. Method blanks are used to verify contamination free reagents and apparatus. They are prepared with every set of samples prepared at the same time or at least one blank every 20 samples, which ever is more frequent. Any analyte response above the reporting limit of 0.05 mg/L is reported. Method blank control limits are that contamination should not exceed ½ the reporting limit

4.7.2. Corrective action

4.7.2.1 Corrective action may necessitate re-preparation and re-analysis of the sample set. For example, if an analyte were found in the blank but not in any of the associated samples, then sample group may not require re-analysis. In addition, if sample levels exceed 20-times the blank, the level of contamination may be considered insignificant. In any case, if re-preparation and re-analysis is not being undertaken, the analyst must first discuss the issue with the Quality Control Officer. It is the laboratory's responsibility to ensure that method interferences caused by contaminants in acids, solvents, reagents, glassware, and other sample processing hardware leading to discrete artifacts and/or elevated baselines in the analytical run be minimized. In the extreme case of chronic contamination, blanks may have to be analyzed from each stage of the sample processing to determine the contamination source so it can be eliminated. In all cases where blank contamination exceeds the control limit, a narrative comment must be made which documents the corrective actions taken.

4.8. Matrix Spike

4.8.1. A sample is chosen at random from the samples to be analyzed, and an aliquot of spiking solution is added to this sample prior to analysis, such that the final solution is fortified at 0.500 mg/L. The analyst should attempt to avoid selecting samples, which are identified by the client as blanks. As the purpose of the matrix spike is to test the system under "typical" conditions, the analyst may also avoid selecting the most difficult sample of the batch for spiking. It is always required that a matrix spike analysis be performed with each preparation/analysis batch, however, the minimum frequency for MS analysis is 1 each per 20 samples per matrix. This matrix spike sample is used to evaluate the matrix effect of the sample upon recovery of the analytes. The recovery of spike analytes is calculated as follows:

$$\% \text{ recovery} = \frac{(SS - S) * 100}{SA}$$

where:

SS = concentration in spiked sample
S = native concentration in unspiked sample
SA = spiked added, the amount of spiking material actually added to the sample calculation the sample basis

4.8.2. MS/MSD samples are prepared by diluting 25µl of nitrate stock solution (2.2.1) to 5.0 mL with the sample.

4.8.3. The recovery criteria are detailed in the Quality Control Database and will change from time to time. Currently, the recovery control limit for water is 68-122% and for soil is 57-109%.

4.8.4. Corrective action

4.8.4.1 Samples with spike recoveries outside control limits will be reviewed for possible corrective action. Corrective action will first involve recalculation, followed by possible re-preparation, and/or reanalysis. This process should also look at the recovery of the matrix spiking compounds from the SRM and/or blank spike analysis. If the SRM is in control, the out of control recovery is due to matrix interference and probably does not warrant reanalysis. In all cases, a narrative explanation of the condition is required to detail the corrective actions taken.

4.9. Matrix Spike Duplicate

4.9.1. The compound recovery criteria are identical to those for the matrix spike sample. In addition, the matrix spike duplicate is used to measure method precision. This is done by computing the relative percent difference (RPD) between the matrix spike and matrix spike duplicate recovery values. MS/MSD is the preferred method for measuring precision. However, if the client requests, or if it is to be reported in CLP format, MS/DUP is performed. This calculation is as follows:

$$RPD = \frac{|S1 - S2| * 100}{(S1 + S2)/2}$$

where:
S1 = measured concentration for MS sample
S2 = measured concentration for MSD sample

4.9.2. RPD control limits are detailed in the Quality Control Database and will change from time to time. Currently the RPD control limit for water is 10% and for soil is 18%.

4.10. Sample Duplicate

4.10.1. Sample duplicates are required only when the client requests, when CLP practices are employed, or when the method specifically calls for duplicates. At least one duplicate sample per 20 samples per matrix is required when matrix spikes/duplicates are being performed. RPD values are calculated in a manner similar to MS/MSD RPDs:

$$RPD = \frac{|S1 - S2| * 100}{(S1 + S2)/2}$$

where:
S1 = measured concentration in the initial analysis
S2 = measured concentration in the duplicate analysis

4.10.1. The RPD control limits are detailed in the Quality Control Database and will change from time to time. Currently the RPD control limit for water is 10% and for soil is 18%.

4.10.3. Corrective action

4.10.3.1 If a trend in out of control RPD values is observed, the methods used must be examined to determine the source of variance. Once this source is identified, the method must be changed so that samples can be analyzed with a predictable reproducibility. Generally, if recoveries are in control and no analyte of interest was detected in any of the samples, no

immediate action will be taken on that sample set. If integrity of reported sample values is in doubt, re-analysis may be called for. Corrective actions should be discussed with the Quality Control Officer.

4.11. Cadmium Column Efficiency Check

4.11.1 Two standard solutions, one of nitrate and the other nitrite, are made up at the same concentration (e.g. 5.0 mg/L, diluted to fall into the range of analysis) and run on the LACHAT just before analysis of the first NO_3/NO_2 sample. This is to test the efficiency of the cadmium column for reducing nitrate to nitrite. This efficiency test should be performed once during every NO_3/NO_2 analysis.

4.11.2 Criteria: The percent difference between the NO_3 solution and the NO_2 solution should be less than 10%.

4.11.3 Corrective Action: If the cadmium column shows reduced efficiency (<10% difference), then it should be replaced with a newly packed column. Old columns must be sent to LACHAT instruments to be repacked.

5. Operation procedures

5.1. Sample Analysis

5.1.1. Analysis sequence

S0
S1
S2
S3
S4
ICV/LCSW
ICB
MDL
PBW
Cadmium column efficiency check standard NO3
Cadmium column efficiency check standard NO2
Sample A
Sample A Spike
Sample A Spike Dup (or Dup)
Sample B

etc.
after 10 samples
CCV1
CCB1

A CCV and CCB must be the last samples analyzed.

5.2. Instrumental Conditions

5.2.1. Proportioning pump set at 35.

5.2.2 Injection valve with 17 cm of 0.8 mm i.d. tubing.

5.2.3 Reaction Module 10-107-04-1-C

5.2.4 Colorimeter with 520 nm filter, and 10 mm flow cell.

5.3 Analytical Operation

5.3.1 Turn on the system at the instrument, and allow to warm up for 5-10 mins.

5.3.2 Download the method by selecting "NN" in the Analysis Select and Download screen.

5.3.3 Place reagent feed tubes into the wash water container.

5.3.4 Lock pump tube cassettes down on the pump, and raise the tension levers to vertical.

5.3.5 Pump water until all air is expelled from the tubing. Then place reagent lines into their proper containers and pump reagents through all tubing.

5.3.6 Stop the pump, place the cadmium column in line on the manifold, and restart the pump.

5.3.7 Make up the standards as described in the standards section.

5.3.8 Begin calibration by selecting "Calibrate Now" under the "Submit" menu. Follow instructions on the screen to begin calibration.

5.3.9 After calibration approval, verify that the correlation coefficient is >0.995.

5.3.10 Submit the tray by choosing "Submit Current Tray". Give the appropriate responses to the prompted fields.

5.3.11 After analysis is complete, move to the "Results/Approval" field. To print the report, choose Tray selection, Sample tray, Reports, Print reports.

5.3.12 After analysis is completed, stop pump, remove the Cadmium column, place the reagent tubes in DIW, and pump for 5 mins. to clean the system.

5.3.13 Remove the tubes from the DIW, pump air until all liquid is expelled, unlatch the pump tubes, and turn off the instrument.

5.3.14 Soil Analysis: 10.0 g of soil must be leached in 100.0 mL of 0.02% H_2SO_4 and placed on the orbit shaker for a half-hour. Leachate is analyzed as a water sample and NN concentration calculated to mg/Kg.

5.4 Compound Quantification

5.4.1 The instrument report is in mg/L. This value is corrected for any dilution input into the software. Any external dilutions need to be accounted for on the report.

5.4.2 Soil samples are reported in mg/Kg DB using the following equation:

$$\text{Nitrate/Nitrite, mg/Kg DB} = \frac{\text{N/N in extract (mg/L)* mL final volume of leachate / g sample}}{\text{\% TS/100}}$$

5.4.3 Any samples having concentrations above the high standard are diluted with carrier and reanalyzed.

5.4.4 Any samples having concentrations less than -0.05 mg/L will have the pH treated to approximately 7 and will be reanalyzed.

6. Reports

6.1. Data Packet Organization

6.1.1. A data package will consist of a copy of the calibration, a copy of the quantitation report for the samples, a data summary showing any external calculations (i.e., TS corrections), and a QC summary report showing where the records are located in the QC database. A

CLP like package will also require a runlog showing all the standards preparation, standard and QC solution references, and the analytical sequence and its timing.

6.2. Quality Control Reports

6.2.1. All results for quality control tests are entered into the lab database. A report of all data entered must be included in the data packet. The routine minimum is a method blank report, and an MS/MSD or MS/duplicate report. Many analyses will also require an SRM, blank spike or other report.

6.3. Sample Result Reports

6.3.1. Data Qualifying Flags

6.3.1.1 Sample report results are qualified with data qualifying flags. These flags have the following definitions:

CODE	Definition
U:	The analyte of interest was not detected, to the limit of detection indicated.

7. References

'Determination of Nitrate-Nitrite by Automated Colorimetry,' EPA method 353.2, rev. 2.0, August 1993.

'Determination of Nitrate/Nitrite by Flow Injection Analysis Colorimetry,' QuikChem Method 10-107-04-1-C, Sept. 1996.

Appendix I

Laucks Testing Laboratories

Method 353.2 NO_3/NO_2
QC Requirements and Corrective Actions

QA Element	Method Criterion	Laucks Criterion	Frequency	Corrective Action	Documentation
Initial Calibration	3 pt calibration plus a blank	4 pt calibration plus a blank r≥0.995	Daily	Recalibrate	Copy of calibration in package
Initial Calibration Verification/ LCS	90-110%	90-110%	1/20	Recalibrate	Included in raw data
Initial Calibration Blank	< MDL	Less than ½ the reporting limit of 0.05 mg/L	Once per run	Reanalyze or recalibrate	Included in raw data
Continuing Calibration Verification	90-110%	90-110 %	Every 10 samples and at the end of the run	Recalibrate	Included in raw data
Continuing Calibration Blank	<MDL	Less than ½ the reporting limit of 0.05 mg/L	Every 10 samples and at the end of the run	Recalibrate	Included in raw data
MDL standard recovery	None required	Must be detectable	Once per run	Recalibrate	Included in raw data
Method Blank	1/ batch < MDL	Less than ½ the reporting limit of 0.05 mg/L	One per 20 samples	Reanalyze or recalibrate unless sample>20X MB	Included in raw data
Matrix Spike	10% frequency 90-110%	See QC database; Currently, Water 68-122%, Soil 57-109%	*One per 20 samples	Discuss with the QC officer. May require reanalysis.	QC database

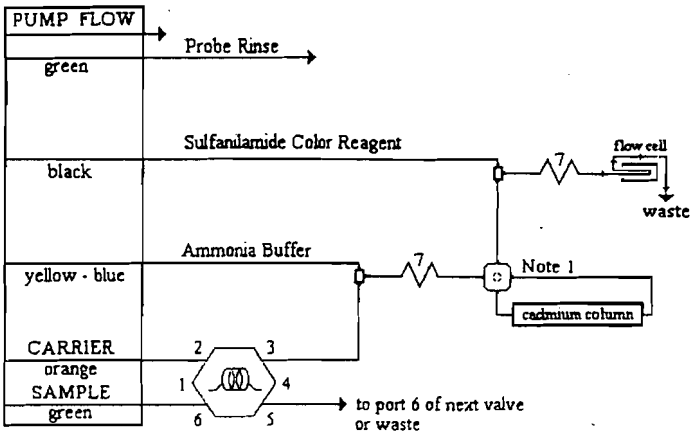
Matrix Spike Duplicate	None required	See Matrix Spike	*One per 20 samples	Discuss with the QC officer. May require reanalysis.	QC database.
Duplicate % Difference	None required	See QC database; Currently, Water 10% Soil 18 %	*One per 20 samples	Discuss with the QC officer. May require reanalysis.	QC database
Lab Fortified Blank	1/ batch 90-110%	See ICV	See ICV	See ICV	See ICV
Cadmium column reduction efficiency check.	Once per day	Concentration of NO_3 and concentration of NO_2 must be within 10% of their true value.	Once per day	Replace cadmium column and recalibrate.	Included in raw data

* Either a MS/MSD or a MS/DUP will be run with every batch

Appendix II

Manifold Schematic from Current Instrument Manual

NITRATE MANIFOLD DIAGRAM



Sample Loop = 17 cm
QC8000 Sample Loop = 22.5 cm

Interference Filter = 520 nm

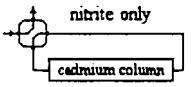
CARRIER is DI Water.

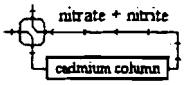
All manifold tubing is **0.8 mm (0.032 in) i.d.** This is **5.2 uL/cm.**

7 is 135 cm of tubing on a 7 cm coil support

APPARATUS: An injection valve, a 10 mm path length flow cell , and a colorimetric detector module is required.

Note 1: This is a 2 state switching valve used to place the cadmium column in-line with the manifold.





Appendix III

Sample data sheet

Laucks Testing Laboratories, Inc.

Nitrate/Nitrite as N
EPA 353.2

Matrix: Water
Analyst: Bill A.
Reviewer:

Calibration Tray Info: NO3/NO2 as N: 02110602 11/06/02 13:52

m(A-E)= 0.03956 r(A-E)= 0.99943 y0(A-E)= -0.00047

Cup #	Calibration Standard	Dilution of Intermediate Std.	Absorbance	Determined Conc. (mg/L)	% Resi-dual		Standards Log ID	T.V. (mg/L)
1	Std. A (tv=2.000mg/L)	20.0mL / 20.0mL	0.0788	2.004	-0.21	Intermediate Std:	TE7-3-19	2.00
2	Std. B (tv=0.500mg/L)	5.00mL / 20.0mL	0.0186	0.483	3.49	Stock Std:	TE7-2-12	100.
3	Std. C (tv=0.100mg/L)	1.00mL / 20.0mL	0.0036	0.102	-2.06	LCSW:	TE6-43-1	5.22
4	Std. D (tv=0.050mg/L)	0.50mL / 20.0mL	0.0019	0.059	-18.90	CCV:	Std. B	0.500
5	Std. E (tv=0.000mg/L)	0mL / 20.0mL	0.0001	0.015	0.00			

Spikes = 25uL Stock Std in 5.00mL of diluted sample: **0.50** mg/L @ Instrument

Sample Tray Info: NO3/NO2 as N: 02110603.RS 11/06/02 15:27 min. rep. limit (mg/L): **0.01**

Cup #	Laucks ID		PIF	Absorbance	Dilution Factor	Conc. @ Instrument	Conc. in Sample	NO_3/NO_2 as N mg/L	Rep. Lim.		
101	ICV/LCSW3 tv=5.22mg/L		0.99	0.0330	5	0.8464	4.2320	4.2	0.05	81.%	
102	b110602nnw03		0.41	-0.0003	1	0.0049	0.0049	0.01 U	0.01		
103	0210437-1		0.26	-0.0011	1	-0.0162	-0.0162	0.01 U	0.01		
104	0210476-1		0.97	0.0262	500	0.6749	337.4500	340.	5.		
105	0210483-1		0.98	0.0571	1	1.4551	1.4551	1.5	0.01		
106	b110502nns01		0.75	0.0012	1	0.0421	0.0421	0.04	0.01		
107	s110502nns01		0.97	0.0205	1	0.5306	0.5306	0.53	0.01		
108	0210182-1		0.98	0.0465	1	1.1886	1.1886	1.2	0.01		
~~109~~	~~0210182-2~~		~~0.99~~	~~0.0935~~	~~1~~	~~2.3763~~	~~2.3763~~	~~>dilute>~~	~~0.01~~		
~~110~~	~~0210182-3~~		~~0.99~~	~~0.1967~~	~~1~~	~~4.9849~~	~~4.9849~~	~~>dilute>~~	~~0.01~~		
1	CCV1		0.98	0.0193	1	0.4996	0.4996	0.50	0.01	100.%	
5	CCB1		0.28	-0.0001	1	0.0097	0.0097	0.01 U	0.01		
111	0210182-3d		0.97	0.0362	5	0.9270	4.6350	4.6	0.05		
112	0210182-3s		0.99	0.0362	5	0.9258	4.6290	4.6	0.05	-4.%	
113	0210182-2		0.97	0.0356	2	0.9114	1.8228	1.8	0.02		
114	0210182-3		0.98	0.0370	5	0.9462	4.7310	4.7	0.05		
~~115~~	~~0210527-1~~		~~0.92~~	~~-0.0012~~	~~1~~	~~-0.0171~~	~~-0.0171~~	~~0.01 U~~	~~0.01~~		
116	0210527-2		0.98	0.0524	1	1.3370	1.3370	1.3	0.01		
117	0210535-1		0.98	0.0361	1	0.9245	0.9245	0.92	0.01		
118	0210554-1		0.98	0.0116	1	0.3040	0.3040	0.30	0.01		
119	0210555-1		0.97	0.0274	1	0.7035	0.7035	0.70	0.01		
~~120~~	~~0210555-2~~		~~0.89~~	~~-0.0019~~	~~1~~	~~-0.0358~~	~~-0.0358~~	~~<<<<<~~	~~0.01~~		
2	CCV2		0.98	0.0192	1	0.4970	0.4970	0.50	0.01	99.%	
~~5~~	~~CCB2~~		~~0.00~~	~~0.0000~~	~~1~~	~~0.0128~~	~~0.0128~~	~~0.01~~	~~0.01~~		
~~121~~	~~ccb~~		~~0.00~~	~~0.0000~~	~~1~~	~~0.0122~~	~~0.0122~~	~~0.01~~	~~0.01~~		
~~122~~	~~0210558-1~~		~~0.56~~	~~-0.0003~~	~~1~~	~~0.0047~~	~~0.0047~~	~~0.01 U~~	~~0.01~~		
123	0210568-1		0.00	-0.0001	1	0.0094	0.0094	0.01 U	0.01		For QC
124	0210568-1ms		0.96	0.0186	1	0.4820	0.4820	0.48	0.01	95.%	For QC
125	0210568-1msd		0.97	0.0167	1	0.4348	0.4348	0.43	0.01	85.%	For QC
~~126~~	~~0210571-1~~		~~0.83~~	~~-0.0010~~	~~1~~	~~-0.0121~~	~~-0.0121~~	~~0.01 U~~	~~0.01~~		
~~127~~	~~0210571-2~~		~~0.80~~	~~-0.0006~~	~~1~~	~~-0.0034~~	~~-0.0034~~	~~0.01 U~~	~~0.01~~		
~~128~~	~~0210571-3~~		~~0.38~~	~~-0.0003~~	~~1~~	~~0.0052~~	~~0.0052~~	~~0.01 U~~	~~0.01~~		
~~129~~	~~0210602-1~~		~~0.98~~	~~0.1560~~	~~1~~	~~3.9561~~	~~3.9561~~	~~>dilute>~~	~~0.01~~		
~~130~~	~~0210603-1~~		~~0.95~~	~~0.0137~~	~~1~~	~~0.3570~~	~~0.3570~~	~~0.36~~	~~0.01~~		
~~2~~	~~CCV3~~		~~0.97~~	~~0.0189~~	~~1~~	~~0.4898~~	~~0.4898~~	~~0.49~~	~~0.01~~	~~98.%~~	
	~~CCB3~~		~~0.51~~	~~-0.0003~~	~~1~~	~~0.0049~~	~~0.0049~~	~~0.01 U~~	~~0.01~~		

APPENDIX G.2

MICROSEEPS, INC

ANALYTICAL STANDARD OPERATING PROCEDURES

MICROSEEPS, INC.

Standard Operating Procedure for Glassware Washing

Controlled Copy No.

Mary Ellen Tenney
QA/QC Coordinator
Primary Author

Dominick Frollini Ph.D
Primary Reviewer

Carl Martin
Laboratory Director

Signature of Final Approval:

Patrick McLoughlin Ph.D.
Technical Director

Date: 8-25-99

1. Purpose and Applicability

The purpose of this standard operating procedure is to define the steps necessary to prevent contamination of analytical results that may result from the use of dirty glassware.

This procedure is applicable to all types of glassware used in the laboratory. Specific washing and rinsing steps particular to the type of glassware and the analytical method that will be used are defined in section 4 of this SOP.

2. Summary of Method

Cleaning of glassware methods should be considered both for substances to be removed and the analysis to be determined. Water-soluble items for general glassware uses are washed with hot soapy water and rinsed with tap water, then distilled water. Difficult residues may require more intense cleaning solutions such as detergents, organic solvents, acids, and dichromate cleaning solutions.

Analyst should dispose of materials properly and rinse glassware with tap water soon after use. Allowing residue to dry on glassware makes it more difficult to remove and may destroy the life of the vessels.

2. Responsibility

The analysts using the glassware are responsible for proper washing. Cleaning of glassware methods should be considered both for substances to be removed and the analysis to be determined. Water-soluble items for general glassware uses are washed with hot soapy water and rinsed with tap water and then de-ionized water. Difficult residues may require more intense cleaning solutions such as detergents, organic solvents, acids, and dichromate cleaning solutions.

3.1 It is the responsibility of the analyst to insure that all glassware being used is labeled.
3.2 Chemicals and samples shall be disposed of properly by the analyst, according to its waste type - hazardous or non-hazardous waste.

3.3 All persons using glassware shall rinse the vessels before placing them on the counter to be washed. Labels shall be read carefully, not only for safety considerations but also to make sure the glassware is being washed for its proper components.

4. Procedure
Specific cleaning techniques are outlined below for each type of glassware to be washed:

4.1 Ordinary Glassware

a. Wash with detergent (Alconox, Sparkleen or Citranox) and hot water
b. Rinse with tap water
c. Rinse with 1:1 HCl
d. Rinse with tap water
e. Rinse with de-ionized water three times

4.2 Evaporating Dishes

a. Scour out residue with a scrounge
b. Wash with (Alconox, Sparkleen or Citranox) and hot water
c. Rinse three times with tap water
d. Rinse three times with de-ionized water
e. Burn out in a 180°C oven
f. Cool in a desicator

4.3 Biochemical Oxygen Demand Bottles

a. Wash with detergent (Sparkleen Alconox, or Citranox) and hot water
b. Rinse once with tap water
c. Rinse with 1:1 HCl
d. Rinse with tap water three times
e. Rinse with de-ionized water three times
f. Burn out in a 180°C oven
g. Cool in a desicator

4.4 Chemical Oxygen Demand Flask

a. Rinse once with tap water
b. Wash with detergent (Sparkleen, Alconox, or Citranox) and hot water
c. Rinse with tap water three times
d. Rinse with de-ionized water three times
e.

4.5 Phenolics Flask

a. Wash with detergent Sparkleen, Alconox, or Citranox) and hot water
b. Rinse with tap water three times
c. Rinse with 1:1 HCl
d. Rinse with tap water.
e. Rinse with de-ionized water three times

4.6 Phosphate Flask

a. Rinse with tap water
b. Wash with detergent (Citranox)and hot water
c. Rinse with tap water three times
d. Rinse with 1:1 HCl
e. Rinse with de-ionized water three times

4.7 Surfactants Glassware

a. Rinse with tap water
b. Rinse with 1:1 HCl
c. Rinse with tap water three times
d. Rinse with deionized water three times

4.8 Metals Glassware

a. Wash with detergent (Citranox) and hot water
b. Rinse with tap water three times
c. Rinse with 1:1 HNO_3
d. Rinse with de-ionized water three times

4.9 Mercury Bottles

For bottles containing less than 0.01 ppm Hg:

a. Wash with detergent (Citranox) and hot water
b. Rinse with 1:1 NHO_3
c. Rinse with tap water
d. Rinse with de-ionized water three times

For bottles containing greater than 0.01 ppm Hg:

a. Soak in aqua regia for 1 hour
b. Rinse with tap water
c. Wash with detergent (Citrranox) and hot water
d. Rinse with 1:1 NHO_3
e. Rinse with tap water
f. Rinse with de-ionized water three times
g. Check the bottle for contamination prior to use for samples by using it to run an extra blank through the mercury procedure to ensure that it is non-contaminated.

4.10 Organic Glassware

a. Wash with detergent (Sparkleen, Alconox, or Citranox) and hot water
b. Rinse with tap water three times
c. Rinse with de-ionized water three times
e. Rinse with acetone three times

4.11 Oil and Grease Flask

a. Rinse with acetone
b. Wash with detergent (Sparkleen, Alconox, or Citranox) and hot water
h. Rinse with tap water three times
i. Rinse with de-ionized water three times
j. Rinse with acetone
f. Place in 105°C oven
g. Place in dessicator for storage

4.12 Cyanide Flask

a. Wash with detergent (Sparkleen, Alconox, or Citranox) and hot water
b. Rinse with tap water three times

c. Rinse with 1:1 HCl
d. Rinse with de-ionized water three times

4.13 Hard to clean residues and General Comments

4.13.1 More extensive cleaning procedures for hard-to-clean residues and general comments for cleaning are as follows:

4.13.2 Volumetric glassware can be thoroughly cleaned by mixing 4 grams (g) of sodium hydroxide, 4 g of sodium hexametaphosphate, and 8 g of trisodium phosphate into a liter of water.

4.13.3 Chromic acid solution is a powerful cleaning agent; however, it is extremely dangerous and should be handled with care. Chromic acid is made by adding 1 liter of concentrated sulfuric acid to 35 milliliters (ml) of saturated sodium dichromate. This solution is placed into the vessel to be cleaned for approximately 15 to 30 minutes and then poured back into the storage bottle. After treatment with chromic acid, the glassware is then rinsed with tap water and then distilled water.

4.13.4 Persistent greasy layers or spots may be removed with acetone or with a warm solution of sodium hydroxide. Removal of oil and grease from glassware can be achieved by adding 1 g of sodium hydroxide into 50 ml of warm water and allowing the solution to stand for about 15 minutes to react. Rinse glassware with water followed by diluted hydrochloric acid. Rinsing usually removes stubborn spots. Alcoholic potassium hydroxide is also effective in removing grease.

4.13.5 Burets can be washed with detergents and rinsed with distilled water. Under no circumstances should burets be dried; they should only be conditioned with the titrant before use. As a general rule, solutions should not be stored in burets.

4.13.6 Spectrophotometric cells should be kept free of fingerprints, smudges, and film residues. Detergents can be used for cleaning but do not allow soaking for long periods of time. Absorption cells can be rinsed with either nitric acid or organic

solvents prior to use. Rinsing with acetone or alcohol for storage is preferred. Scratched cells should be replaced and taken from service.

4.13.7 Glassware used for phosphorus analysis should never be washed with detergents containing phosphate additives, whereas glassware used for ammonia or total kjeldahl nitrogen should be rinsed with ammonia-free water.

4.13.8 Glassware used for the determination of organics can be cleaned by washing with chromic acid for 15 minutes and rinsing with tap water and then distilled water. The glassware then can be dried by either an acetone rinse for immediate use or in an oven prior to storage.

4.13.9 When hazardous or heavily contaminated samples are encountered, disposable glassware may be preferred.

4.13.10 Following any of the washing procedure described in this section, the glassware should then be washed according to the appropriate method described in section 4.

5. Quality Control

Volumetric glassware is glassware that has been accurately calibrated for precise measurement of volume. The accuracy by which volumes of solutions are measured depends on the precision of the volumetric glassware. Volumetric glassware is calibrated "to contain" (TC) or "to deliver" (TD) a definite volume of liquid. TD volumetric pipets are routinely used in the laboratory. Volumetric pipet (TC) tips are held against the wall of the receiving vessel until flow has stopped. Do not ever blow out the remaining liquid left in the tip of the pipet. All apparatus used for delivering liquids should be volumetrically clean(no beading of liquids on the apparatus walls), this will ensure accurate volume dispensing.

Analysts should dispose of materials properly and rinse the glassware with tap water soon after use. Allowing residue to dry on glassware makes it more difficult ot remove and may destroy the life of the vessel.

Final disposal of disposable containers, wastes, spent chemicals and chemical containing wastes are handled in accordance with the Microseeps Chemical Hygiene Plan and the Microseeps Waste Disposal Plan.

6. Safety

Safety is a major concern throughout the laboratory environment, not only at the analytical bench, but also for the consideration of the dishwasher.

Anyone providing analytical cleaning support shall wear a lab coat, safety glasses, and protective gloves before handling any glassware.

7. Equipment and Reagents

7.1 Equipment
- 7.1.1 Sinks
- 7.1.2 Scrub brushes
- 7.1.3 Drying rack

7.2 Reagents
- 7.2.1 Tap water
- 7.2.2 Detergents
- 7.2.3 Deionized water
- 7.2.4 Nitric acid (1:1)
- 7.2.5 Aqua Regia (25% by volume conc. HNO_3 in concentrated HCl). To prepare Aqua Regia: mix 3 parts of concentrated HCL and 1 part of concentrated HNO_3. Prepare just before use.
- 7.2.6 Acetone
- 7.2.7 Dichromate solution (chromic acid)
- 7.2.8 Hydroxide solution

8. Documentation and References

Not Applicable

Microseeps, Incorporated

Analytical Method AM20GAx
Standard Operating Procedure for the Analysis of Biodegradation Indicator Gases

Controlled Copy No. ____

Controlled Doc
Confiden

Dominic Nestasie
Laboratory Director

Signature of Final Approval:

Patrick McLoughlin, Ph.D.
Author and Technical Director

3-17-03
Date

1.0 Scope and Application

Method AM20GAx is used to determine the concentration of biodegradation indicator gases in vapor samples. Specifically, Method AM20GAx is used to determine the dissolved concentration of the following gases:

Gases	CAS Number
Carbon dioxide	124-38-9
Oxygen	7782-44-7
Nitrogen	7727-37-9
Hydrogen	1333-74-0
Methane	74-82-8
Ethane	74-84-0
Ethene	74-85-1
Propane	74-98-6
Propene	115-07-1
n-Butane	106-97-8
i-Butane	75-28-5
Carbon Monoxide	630-08-0

This method is recommended for use by, or under the supervision of, analysts experienced in sample preparation, the operation of gas chromatographs and in the interpretation of chromatograms.

2.0 Method Summary

The sample gas is analyzed with a gas chromatograph capable of simultaneous analysis of all of the target analytes from a single 10 mL gas sample. A single injection of gas from integral, simultaneously filled sample loops is used to assure consistent injection volume. The permanent gases are analyzed using a thermal conductivity detector (TCD). The light hydrocarbons are analyzed using a flame ionization detector (FID). Hydrogen is analyzed using a reduction gas detector (RGD). The data are transferred to a microcomputer, converted to digital format, stored, and processed using a chromatography data system.

2.1 Definitions

Instrument Flush: The front end of the sample loop is flushed with ultra high purity helium injected into the loop directly from the cylinder to remove possible interference by ambient air and to avoid cross contamination between samples.

Method Blank: A sample analyzed by all three detectors that consists of ultra high purity helium. The method blank is free from the analytes of interest

Laboratory Control Sample: A sample spiked with verified known amounts of analytes. A LCS is used to assess the performance of the measurement system.

Matrix Spike and Matrix Spike Duplicate: A sample prepared by adding a known concentration of target analyte to a specific amount of sample. Matrix spikes are used to determine the effect of sample matrix on a method's recovery efficiency.

3.0 Apparatus and Materials and Operating Conditions

3.1 Apparatus

Gas Chromatograph: The chromatograph designed and built by Microseeps is equipped with multiple packed columns and multi-port valves, a TCD, a FID, a RGD, and multiple sample loops. The FID, which is also built by Microseeps, is of a special design that allows considerably more sensitivity than commercially available models. To increase the working range of the system, there are two outputs to the FID. Thus, it is a four-channel system: (1) FID low; (2) TCD; (3) RGD; and (4) FID high. As discussed in Section 5.3, each channel is calibrated separately. This instrument provides rapid turn-around for consecutive analyses and a clean baseline for accurate, reproducible results.

3.2 Materials

- Sample vials (Supelco, Inc, Bellefonte, PA or equivalent)
- Syringe: locking gas tight

3.3 Operating Conditions

Gas Chromatograph:

• Sample Loop Temperature:	ambient
• Thermal Conductivity Detector Temperature:	100°C
• Flame Ionization Detector Temperature:	ambient
• Reduction Gas Detector Temperature:	280°C
• Oven Temp.:	100 °C. isothermal
• TCD Signal Range:	1
• FID Signal Range:	variable depending on concentrations
• RGD Signal Range:	1
• He Carrier Gas Regulator Pressure:	60 psig
• Sample carrier flow:	30 mL/min.
• Reference flow:	30 mL/min.
• N2 Carrier Gas Regulator Pressure:	25 psig

- Sample carrier flow: 25 mL/min
- Valve Air Pressure: 60 psig.

3.3.1 Interferences

The most likely source of "interference" is ambient air. Due to the relatively high concentrations of oxygen and nitrogen, a very small amount of air as a contaminant will dramatically affect the results. The analyst must take great care to ensure that air is flushed from the gas tight syringe before sample preparation and that no air has entered the syringe or needle prior to injection of the sample into the gas chromatograph.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. An unrestricted flow (Instrument flush) of pure carrier gas from a 10 psig source should be allowed to flow through each sample loop for 30 seconds prior to each analysis.

As required, the analyst should demonstrate the absence of carryover contamination by analysis of the contents of the sample loop when purged with carrier gas. This demonstration should be performed when carryover contamination is suspected (after high samples). In the event that 'ghost peaks' (peaks similar to previous sample) appear when a pure carrier gas sample is analyzed (method blank), measures should be taken to eliminate the carryover contamination.

4.0 Reagents

- Helium (UHP Gas)
- Nitrogen (UHP Gas)
- Certified Commercial Gas Standards

4.1 Standard Preparation Procedures

Calibration standards are prepared by using the procedures below:

4.1.1 Vial Preparation

Headspace vials used for instrument calibration standards for this method are prepared as follows:

- Crimp and cap each vial, with stopper septa.
- Evacuate each vial to vacuum below 100 millitorr.
- Flush each vial to atmospheric pressure with the vial preparation gas. The gas used depends upon the detector that is being calibrated and is specified in Table 4.1 below:

Table 4-1

Detector	Vial Preparation Gas	Standard Mix Vendor
FID	Nitrogen	Spectra
TCD	Helium	Scotty
RGD	Nitrogen	Spectra and Scotty

4.1.1 Preparing Calibration Standards

Instrumentation is calibrated using dilutions of custom certified gas mixes. (Refer to Table 4-2 for the correct amounts of standard mix and vial preparation gas to inject into prepared vials.)

- Prepare the correct number of vials as specified above for the detector being calibrated.
- Inject the specified amount of standard by extracting it from the standard mix gas cylinder using a gas-tight syringe and injecting it into a prepared vial.
- Then the specified amount of vial preparation gas is added to the same vial.

The dilution factor of one is achieved by directly injecting the standard gas mix from the cylinder into the GC.

Table 4-2

Dilution Factor	FID		TCD		RGD	
	Standard Gas Mix	Prep. Gas	Standard Gas Mix	Prep. Gas	Standard Gas Mix	Prep. Gas
1	Direct inject mix into GC		Direct inject mix into GC		Direct inject Spectra mix into GC	
2	21cc	0 cc	21cc	0cc	21cc Scotty	0cc
3	15cc	9cc	N/A	N/A	N/A	N/A
10	4cc	15cc	4cc	15cc	4cc Spectra	15cc
100	0.5cc	28.5cc	0.5cc	28.5cc	0.5cc Spectra	28.5cc

4.2 Quality Control Sample Preparation

Quality control samples are prepared as indicated below.

4.2.1 Laboratory Control Sample (LCS) and LCS Duplicate (LCSD)

The LCS and LCSD are directly injected into the sample port from a second source certified standard gas mix. A needle is plumbed to the cylinder and used to inject the gas into the sample loop.

4.2.2 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

MS and MSDs are prepared when clients' request and send sufficient numbers of aliquots to prepare them (e.g. one 40 ml vial each for the MS and the MSD). They are prepared, one at a time, as follows:

- Using a clean 50ml gas-tight locking syringe, withdraw a volume of water from the bottom of the sample vial.
- Withdraw 10 cc of the certified standard gas used for preparing the LCSs and lock the syringe.
- Shake the syringe by hand (for use a wrist action shaker) for five minutes.
- The equilibrated MS and/or MSD is/are now ready to be analyzed.

4.2.3 Method Blank

Method blanks are made up of ultra high purity helium injected into a vial and then into the instrument.

4.3 Glassware and Storage Requirements for Reagents and Standards

Reagents are stored at ambient room temperature and all standards are prepared shortly before analyses.

5.0 Procedure

The sample must be received and processed via Microseeps SOP for those procedures. Gas samples are shipped and received at a positive pressure, which eliminates a cross-contamination issue during sample shipment. They are stored at ambient temperature to avoid creating a pressure reduction in the samples upon cooling. Such a pressure reduction could lead to a drawing of atmospheric gas into the sample. A sample batch consists of twenty or fewer samples run during an eight-hour work shift.

Analysts who use this method have been certified for the method by running Initial Demonstration of Proficiency Samples. The IDOPs are an identical set of 4 samples (PM01/AM20Gax uses tap water and AM20Gax uses known standard concentrations) run

consecutively. IDOPs are run any time there is significant change to an instrument, method, or in the Training procedure for training a new analyst.

The percent relative standard deviation (%RSD) is calculated for the IDOPs by:

$$\%RSD = \frac{\sigma_{n-1}}{S} \times 100\%$$

Where:

% RSD = the percent relative standard deviation.
σ_{n-1} = the standard deviation about the mean.
S = the mean response $(X_1 + X_2 + X_3 + X_4)/4$

The %RSD must be less than 20%. If this criterion is not met, the system is checked and the IDOP samples are re-analyzed.

5.1 Sample Preparation

Samples that are collected using the Bubble Strip Sampling Technique, Microseeps Sampling Method SM9, do not require additional preparation prior to analysis.

Samples that are collected as waters and are to be analyzed for dissolved gases (CO_2, N_2, O_2) must be prepared using Microseeps Standard Operating Procedure PM01G.

Samples that are collected as gases, for example from a soil gas survey or from the headspace of a microcosm sample, need not be collected by a Microseeps sampling method, nor do they require additional preparation.

5.2 Analysis

5.2.1 If the sample is prepared via DGPM 01, it can be injected from the gastight syringe in which it is prepared by inserting the needle of the syringe through the septum on the "sample in" port. If the sample is a calibration standard, a bubble strip sample (SM9), or a gas, the septum inlet to the "sample in" port of the GC must be removed and a luer-lock needle receptacle is plumbed to the "sample in" port in place of the needle. A needle is attached to the luer-lock receptacle and inserted through the septa of the calibration standard, bubble stripped sample, or gas sample.

In order to initiate analysis and introduce the sample into the GC sample loop, a needle is attached to the entry port on the GC and inserted through the sample septum. The flow through the sample loop is monitored by a flow meter connected to the sample-loop vent-port on the gas

chromatograph. If the loop is not properly pressurized, this is reflected on the flow meter immediately.

5.2.2 If the flow is insufficient the vial is rapidly removed. A clean, gas-tight syringe is flushed with He, the plunger of that syringe is completely depressed, and the needle of that syringe is inserted through the sample septum. The plunger of that syringe is allowed to expand completely. The syringe is removed from the sample and its contents are discharged into an appropriate receptacle. 22 ml. of nitrogen are then used to pressurize the sample vial, the dilution is noted, and the sample is injected onto the GC as though it were a properly over-pressurized sample.

5.2.3 Once the flow out of the sample loop ceases (3 seconds if DGPM 01 is used) the sample loop valves are activated.

5.2.4 Once the sample loop valves are activated, the ports to and from the sample loop are flushed with ultra high purity helium injected into the loop directly from the cylinder to remove any interference from ambient air and to avoid cross contamination between samples.

5.3 Calibration and Results

5.3.1 The standard calibration gas should be introduced in the same manner as described in section 5.2.1 above. Measured peak areas are converted to concentrations using certified commercial gas standards. Dilutions are made to achieve multi-point calibration curves for each detector.

5.3.2 Initial calibration is accomplished by analyzing multiple standards of appropriate calibration ranges. Table 5.1 specifies the approximate concentrations of calibration standards for each detector.

Note: Due to the nature of preparing custom gas standards, the component concentration can fluctuate between purchased lots. This is accounted for during method/calibration development. These results will be used to establish a multi-point calibration curve.

Acceptance Criteria: A linear fit to an area response versus concentration plot is formed with the origin forced to zero, and the calibration is accepted for use if r^2, the coefficient of determination is ≥ 0.995.

Corrective Action: If the acceptance criteria specified above is not met, the reason is determined and a new set of calibration standards are analyzed.

5.3.3 An Initial Calibration Verification (ICV) standard immediately follows the initial calibration. The ICV is made up separately from the same stock standards used to make up the ICAL. (Second source requirement in LCS) Acceptance criterion for the ICV is an instrument response of $\leq$ (less than or equal to) 20% (%D).

Acceptance Criteria and Corrective Action: If the instrument response for the ICV standard varies by more than 20% (%D), the analyst will not analyze samples until either the reason is determined and the problem is corrected, or a new multi-point calibration is analyze

Table 5.1

COMPOUND	FID-LOW (ppmv)	FID-HIGH (ppmv)	TCD (% V)	RGD (ppmv)
carbon dioxide	-	-	15, 7.5, 0.15	-
oxygen	-	-	7, 3.5, 0.07	-
nitrogen	-	-	66.5, 33.3, 0.665	-
hydrogen	-	-	-	100, 25, 2.5, 0.25
methane	300, 100, 30, 3	1000, 300, 100, 30	4.5, 2.25, 0.045	-
ethane	100, 33.3, 10, 1	1000, 100, 33.3, 10	-	-
ethene				
propane	100, 33, 10, 1	100, 33.3, 10	-	-
propene				
i-butane				
n-butane				

5.3.4 An initial calibration blank follows the ICV. The blank is made up of the carrier gas. Compounds must not be detected above the reporting limits.

Corrective Action: If the blank does not meet the acceptance criterion, another blank is injected until the results are within the acceptance criterion.

5.3.5 The analytes of this method are indicators. Every attempt to achieve and deliver precise results is made. However, it is realized that for indicator parameters measuring the range of the analyte concentration (*i.e.* is the concentration of methane gas >1 mg/l or < 0.1 mg/l?) is the primary goal of employing these analyses. The calibration range is chosen to extend over the entire useful bio-indicator concentration range. If the concentration of an analyte exceeds that of the highest calibration standard, the concentration is calculated by assuming detector response linearity and using an extrapolation of the calibration plot.

5.3.6 The unique combination of analytes used in this method makes it impractical to find a second source for the calibration mix. To insure that the calibration is accurate, the first use of a new standard is as a CCV against a calibration prepared with the old standard. If this CCV passes the standard CCV criteria, the new standard is placed into routine use. This insures that as the original source of the master mix from which our standards are prepared is switched,

Microseeps checks the reported calibration of the new against the old. If the client requests a formalized check of the standard, a calibration check standard can be analyzed and included in the clients report provided that the request for this service is made prior to collection of the samples.

5.4 Quality Control

The following quality control samples shall be analyzed with each analytical batch of twenty or fewer samples.

5.4.1 A Continuing Calibration Verification: The CCV is made up separately from the same stock standards used to make up the initial calibration. The acceptance criterion for the CCV is a percent drift of ± 20%.

Corrective Action: If the CCV fails, the instrument shall be recalibrated, and all samples since the last acceptable calibration shall be reanalyzed, provided sufficient sample volume is present and the samples have not been compromised by exposure to air.

5.4.2 A Continuing Calibration Blank: A CCB follows each CCV. The blanks are made up of the carrier gas. The acceptance criterion for the blank is the result must be less than the reporting limits for all compounds.

Corrective Action: If the blank does not meet the acceptance criterion, another blank is injected until the results are within the acceptance criterion.

5.4.3 Laboratory Control Sample and Laboratory Control Sample Duplicate: The LCS and LCSD are prepared at a mid-calibration range and comes from a source other than the calibration standards. The acceptance criterion is a percent recovery between 75% and 125% and a Relative Percent Difference of less than or equal to 20%.

$$Percent\,Recovery = \frac{MeasuredValue}{TrueValue} \times 100\%$$

$$RPD = \frac{|C1 - C2|}{\frac{C1 + C2}{2}} \times 100\%$$

Where: C1=LCS
C2=LCSD

Corrective Action: If the LCS fails, a new LCS is prepared and analyzed. If the new LCS falls within the acceptance criterion, analysis continues. If the new LCS fails, analysis is stopped and the instrument is checked with a series of standards to determine the cause. Once the cause is determined and the instrument repaired, calibration is conducted and analysis continues.

5.4.4 Matrix Spike and Matrix Spike Duplicate: Matrix spikes and spike duplicates are analyzed for water samples only when requested by a client and sufficient sample aliquots are provided. Acceptance criterion is a percent recovery between 70% and 130%, and a relative percent difference of less than or equal to 20%.

Corrective Action: If the matrix spike and spike duplicate fails but all the other quality control samples are within the acceptance criteria, a matrix interference is noted in the Case Narrative.

5.4.5 Method Blank: A method blank is analyzed with each sample batch. The blanks are made up of UHP helium. The acceptance criterion for the blank is the result must be less than the reporting limits for all compounds.

Corrective Action: If the blank does not meet the acceptance criterion, another blank is injected until the results are within the acceptance criterion.

5.4.6 Contingency for Handling Out of Control or Unacceptable Data

If the requirements set forth in section 5.4 are not met, the analytical program will be terminated until the cause is determined and a solution is affected. All samples associated with out of control quality control samples (with the exception of matrix interference) must be reanalyzed provided another vial of sample has been provided by the client. If quality control acceptance criteria cannot be met using the corrective action above, a detailed check of the analytical system is made. Reagents, standards, and other quality control samples are re-prepared and analyzed. If problems persist, sample analysis will be halted and the Technical Director shall be contacted immediately to determine the cause and implement corrective action.

Any data submitted with unacceptable quality control sample results shall be qualified in a case narrative. The narrative should indicate the out of control event that occurred, the corrective action that was taken, and any other pertinent information to inform the client of exactly what occurred.

5.4.7 An experienced analyst shall examine all chromatograms.

5.4.8 Through out analysis the gas samples are injected mechanically into the GC flow path utilizing a sample loop to achieve a uniform sample size from a flow directly from the sample preparation syringe. The uniform sample size achieved using the sample loop assures consistent and accurate results. Table 5.2 (see next page) gives example data from a study performed via this analysis. That data can also be used for accuracy and precision estimates.

Table 5.2
Example Data for Precision and Accuracy Studies

	Carbon Dioxide	Oxygen	Nitrogen	Methane	Hydrogen	Methane	Ethane	Ethylene	Propane	Propylene	Iso-Butane	N-Butane
REP. #	(%v)	(%v)	(%v)	(%v)	(PPMV)	(PPMV)	(PPMV)	(PPMV)	(PPMV)	(PPMV)	(PPMV)	(PPMV)
1	0.1221	0.0670	0.5744	0.0410	0.1118	0.2512	0.0525	0.0453	0.0461	0.0581	0.0473	0.0358
2	0.1267	0.0690	0.6020	0.0428	0.1122	0.2608	0.0518	0.0468	0.0521	0.0465	0.0439	0.0407
3	0.1207	0.0657	0.5838	0.0446	0.1247	0.2812	0.0509	0.0485	0.0529	0.0588	0.0436	0.0405
4	0.1193	0.0667	0.6036	0.0444	0.1244	0.2779	0.0549	0.0460	0.0461	0.0536	0.0549	0.0476
5	0.1261	0.0703	0.5860	0.0439	0.1120	0.2894	0.0551	0.0497	0.0520	0.0549	0.0417	0.0460
6	0.1193	0.0665	0.5861	0.0478	0.0943	0.2970	0.0515	0.0467	0.0458	0.0542	0.0435	0.0514
7	0.1227	0.0732	0.5748	0.0353	0.1296	0.3053	0.0532	0.0473	0.0485	0.0584	0.0483	0.0535
AVERAGE	0.1224	0.0683	0.5872	0.0428	0.1156	0.2804	0.0528	0.0472	0.0491	0.0549	0.0462	0.0451
KNOWN	0.1500	0.0700	0.6649	0.0450	0.0999	0.1500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
STD. DEV.	0.003	0.003	0.012	0.004	0.012	0.019	0.002	0.001	0.003	0.004	0.004	0.006

5.4.9 The gas matrix for this analysis minimizes the opportunity for matrix effects. If the gas is prepared from a matrix other than that which is injected into the GC (*e.g.* prepared through headspace extraction via Microseeps SOP-PM01), the client should request that matrix spike (MS) and matrix spike duplicate (MSD) analyses be conducted and should supply sufficient sample volume. Since matrix effects are extremely site dependent, the MS and MSD are not part of the regular analytical quality assurance program.

In order to determine analytical precision, relative percent difference (RPD) is calculated between the matrix spike and matrix spike duplicate results using the following formula:

$$\%RPD = \frac{|C_1 - C_2|}{\left|\frac{C_1 + C_2}{2}\right|} x100$$

Where: C_1= Matrix Spike Result
C_2= Matrix Spike Duplicate Result

In order to determine accuracy, percent recovery of the matrix spike is calculated using the following formula:

$$\% \text{ Recovery} = \frac{\text{concentration found}}{\text{concentration added}} \text{ X } 100$$

5.4.10 All of the target analytes are gases at room temperature so the opportunity for carry over is negligible. Because of the configuration of the GC used in this analysis, any possible carryover would only manifest itself as a ghost peak, well out of the RT windows of any analytes and thus never misinterpreted. For these reasons, samples that have high concentrations of analytes do not need to be followed by a blank analysis.

5.5 Capturing and Submitting Data

5.5.1 The output of the chromatograph is directed to a microcomputer where the signal is converted to digital format, stored, and processed using a chromatography data system.

5.5.2 Automated valve control: Digital control is provided by the microcomputer though the chromatography data-system software. This control provides constant start and stop times for directing carrier gas flow. The event times are programmed and saved using the method editor module of the software.

5.5.3 Calibration records are generated in electronic and hard copy formats and stored. All such records will be maintained in the laboratory during the course of the project and thereafter as determined by the client.

5.5.4 The instrument produces four channels of data, and an output is generated from each sample for each channel. Each channel is used for a distinct set of analytes, in a distinct range. The channel designations are listed in Table 5.3 below, as are the analytes and range specification for each analyte.

Table 5.3

FID	FID/10	TCD	RGD *
iso-butane (low)	iso-butane (high)	carbon dioxide	hydrogen
n-butane (low)	n-butane (high)	nitrogen	
propene (low)	propene (high)	oxygen	
propane (low)	propane (high)	methane (high)	
ethane (low)	ethane (high)	carbon monoxide	
ethene (low)	ethene (high)		
methane (low)	methane (high)		

* If hydrogen is not a required analyte, the GC may be run without this channel activated. This reduces the generation of unused records and the consumption of power.

If an analyte is not detected on the most sensitive channel, it is recorded as a non-detect. That channel, designated low, is used until the detector output as read from the chromatograph of the channel, exceeds 2V. At that point the next most sensitive detector ("mid" if available, or "high" otherwise) is used. If that saturates, the "high" detector is used if available. Otherwise, the sample is diluted and re-analyzed. The saturation limit, in terms of concentration, varies machine to machine and calibration-to-calibration, so universal cut-offs cannot be supplied here. The final choice of which channel to use when reporting results is up to the experienced analyst and depends upon the sample response, the calibration, and the history of the instrument.

5.5.5 This analysis produces concentration of the analyzed gas in PPMV or % V. If the sample was collected via the bubble-strip method (Microseeps SOP SM9) or prepared through static headspace preparation (Microseeps SOP DGPM 01), the gas phase concentrations can be used to specify sample water concentrations via the calculations presented in those Standard Operating Procedures.

6.0 Secondary Data Review

All analytical data must undergo a minimum of a two-tiered review. The analyst first reviews the data for completeness and accuracy. The data is then submitted to the Group Lead Analyst for final review and the data is entered into the LIMS. Once approved at this level, the data is released as a final report.

7.0 Reporting Limits

The reporting limits for this analysis are listed in table 7.1 below. The method detection limits for this procedure must be determined by conducting annual MDL Studies. Those MDLs must be less than the reporting limits specified below. MDL studies are also performed when there is reason to suspect that method sensitivity has changed. MDLs are determined by analyzing seven aliquots of a known standard (estimated to be 3 to 5 times the lowest concentration that can be seen above noise level) through the procedure, and calculating the mean and standard deviation. Once the seven aliquots are run the results are given to the Quality Systems Coordinator. The MDL studies are kept on file in the Quality Systems Office.

Reporting Limits
Table 7.1

Parameter	Reporting Limit	Units
Carbon Dioxide	0.02	%V
Oxygen	0.02	%V
Nitrogen	0.04	%V
Hydrogen	0.02	ppmv
Methane	0.06	ppmv
Ethane	0.01	ppmv
Ethene	0.01	ppmv
Propane	0.01	ppmv
Propene	0.01	ppmv
n-butane	0.01	ppmv
i-butane	0.02	ppmv

7.2 Conversion Factors

This procedure is used to measure the volume concentration of the analytes in a gas. Two methods are used to extract that gas from the groundwater. The conversion factors that are used to convert the concentration of the analytes in the water from the concentration of the analytes as they are measured using this method, are specific to the collection or preparation method and can be found in either SOP-SM9 or SOP-DGPM 01.

8.0 Safety

Gloves, proper eye protection, and a laboratory coat shall be worn when handling samples and standards. The major hazard in this laboratory area is stick from needles. All needles must be capped when not in use and when moving about the laboratory. The proper way of capping a needle is to place the cap on the laboratory bench and direct the needle into the cap. A needle is never to be directed into a cap while the cap is being held.

All compressed gases are to be moved using a dolly made for transporting gases and shall be chained in place when in the laboratory. The chain shall be tightened sufficiently to keep the cylinder upright if jostled.

9.0 Laboratory Waste

Samples are kept for 30 days following analysis. There is no hazardous waste generated during this analytical process. The analysts dispose of the sample vials in the general laboratory trash according to Microseeps Standard Operation Procedure for Waste Disposal (SOP-ADM 14).

9.1 Waste Minimization

Where possible, Microseeps takes steps to minimize the amount of waste generated in the laboratory by using substitution, where possible, and good chemical handling procedures. For specific information on waste minimization consult SOP-ADM 14.

10.0 References

U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste. SW-846, 3rd ed., Office of Solid Waste and Emergency Response, Washington, DC. 1986.

Newel, B.S., RSKSOP-175, Sample Preparation and Calculations for Dissolved Gas Analysis in Water Samples using a GC Headspace Equilibration Technique. Revision No. 0, August 1994.

Newel, B.S., RSK-SOP-147, Gas Chromatographic Analysis of Gaseous Samples for Part-Per-Million Levels of Nitrous Oxide, Methane, Ethylene, and Ethane. Revision No. 0, August 1993.

American Society for Testing and Materials, Standard Practice for Analysis of Reformed Gas by Gas Chromatography. Annual Book of ASTM Standards. Vol. 14.02, 1994.

Kampbell, D.H. and Vandegrift, S.A., Analysis of Dissolved Methane, Ethane, and Ethylene in Ground Water by a Standard Gas Chromatographic Technique. Journal of Chromatographic Science. Vol. 36, May 1998.

Microseeps, Inc.

Standard Operating Procedure for the Preparation of Samples for the Analysis of Biodegradation Indicator Gases

Controlled Copy No. _____

Controlled Copy

Dominic Nestasie
Laboratory Director
Primary Reviewer

Signature of final Approval:

Dr. Patrick McLoughlin
Technical Director and Author

2-6-03
Date

1.0 Purpose and Application

Method PM01G is used to prepare a chemically equilibrated gas-phase (*i.e.* vapor) headspace above a fixed volume of aqueous sample. The composition of that headspace can then be analyzed by Microseeps' AM20GAX and the results can be used to calculate the concentration of gases in the sample water. Conceptually, this method can be used for any substance that can be detected in the gas phase, but practical considerations of sensitivity, vapor pressure and air/water partitioning limit the technique. Method DGPM 01 is used for the following gases:

Gases	CAS Number
Carbon dioxide	124-38-9
Oxygen	7782-44-7
Nitrogen	7727-37-9
Methane	74-82-8
Ethane	74-84-0
Ethene	74-85-1
Propane	74-98-6
Propene	115-07-1
n-Butane	106-97-8
i-Butane	75-28-5

This method is recommended for use by, or under the supervision of, analysts experienced in sample preparation, the operation of gas chromatographs, and in the interpretation of chromatograms.

2.0 Method Summary

A water sample is transferred from a 40 mL vial into a gas-tight syringe and an analyte-free; inert gas is used to create headspace above that water. At equilibrium, the headspace should contain each of the analytes in proportion to the air/water-partitioning coefficient of the analyte. Agitation of the syringe accelerates the onset of equilibrium. Following that agitation, the equilibrated sample is ready for analysis (*e.g.* by method AM20GAX) or storage.

3.0 Apparatus, Materials and Operating Conditions

3.1 Apparatus

- Sample vials (Supelco, Inc, Bellefonte, PA or equivalent).
- Syringe: locking gas tight
- Luer lock valve

3.2 Materials

- Ultra-pure Helium supply.

3.3 Operating Conditions

The following situations are cases where sample "interference" could occur.

3.3.1 Ambient Air

The most likely source of "interference" is ambient air. Due to the relatively high concentrations of oxygen and nitrogen, a very small amount of air as a contaminant will seriously affect the results. The analyst must take great care to ensure that air is flushed from the gas tight syringe before sample preparation and that no air has entered the syringe or needle prior to injection of the sample into the gas chromatograph.

3.3.2 Equipment not supplied by Microseeps

Upon occasion a sample will be collected in a vial that was not supplied by Microseeps. In such cases, the needle on the gas-tight syringe sometimes gouges the septum of the sample vial, rather then simply tearing it. This gouged out portion may occlude the needle and frustrate further use of it. As such, the gas-tight syringe should be fit with the water collection needle before the plunger is inserted into it and depressed.

3.3.3 Cross Contamination

The gases that are the analytes are extremely volatile. Carryover is generally not a problem. However, agents, such as surfactants, may be present in some samples and those agents can alter the partitioning coefficient and even present some chance of carryover. All syringes and re-useable needles should be cleaned thoroughly between sample preparations.

4.0 Reagents

Not Applicable

5.0 Procedure

The sample must be received and processed via Microseeps SOP for those procedures. Samples are stored in a refrigerator at 4 °C and allowed to equilibrate to room temperature prior to sample preparation.

5.1 Sample Preparation Steps.

1. Using a clean 50ml gas-tight locking syringe, withdraw a volume of water from the bottom of the sample vial.

2. Withdraw a volume of an inert gas from a reservoir and lock the syringe.

3. Shake the syringe by hand (or use a wrist action shaker) for five minutes.

4. The equilibrated sample is now ready to be analyzed or injected into a vial for storage for analysis at a later date.

5.2 Calibration and Results

Not Applicable.

5.3 Sample Analysis

Not Applicable.

5.4 Quality Control

Most of the quality control sample analyses that are "typical" of EPA methods, are not applicable to this analytical method due to the target analytes being naturally occurring substances in water. The most likely result of any analytical error is compromising the sample through exposure to ambient air. Since two of the analytes (nitrogen and oxygen) make up nearly 80% and 20% respectively, of the air all around us, it is virtually impossible to generate a truly inert "prep-blank". The best way to detect procedural error is through careful review of all analytical results, insuring that the oxygen and nitrogen concentration, and their ratio, truly reflects groundwater geochemistry. The concentration of nitrogen is typically between 10 and 20 mg/l, but the oxygen concentration can be much lower. In anoxic waters the nitrogen/oxygen ratio is typically above five. Ratios below this suggest significant sample contamination. A reanalysis should be performed to insure that the source of the contamination was not simple unsystematic error in the preparation.

5.4.1 Matrix Spikes/Matrix Spike Duplicates

To insure that there are no matrix effects in a client's samples and to produce client specific accuracy and precision data, clients should request matrix spike (MS) and matrix spike duplicate (MSD) analyses during the bottle order process, collect those samples while on site, and submit them as separate samples on the chain of custody to the laboratory. These analyses involve the analysis of an analyte-fortified client sample. The recovery efficiency of that fortification can reveal matrix effects, and the reproducibility of the result of the analysis of the fortified sample reveals client sample-specific precision information. Since matrix effects are extremely site dependent, the MS and MSD are not part of the batch analytical quality assurance program.

5.5 Capturing and Submitting Data

Not Applicable.

6.0 Secondary Data Review

Not Applicable.

7.0 Reporting Limits

Reporting limits for this method are specified below in Table 7.1.

Table 7.0
Reporting Limits

Analyte	Reporting Limit	Water Units
Carbon dioxide	0.6	mg/L
Oxygen	0.15	mg/L
Nitrogen	0.4	mg/L
Methane	0.015	µg/L
Ethane	5	ng/L
Ethene	5	ng/L
Propane	25	ng/L
Propene	25	ng/L
i-butane	25	ng/L
n-butane	25	ng/L

7.1 Calculations

The headspace prepared through this procedure can be analyzed to give the vapor, or gas phase concentration of the analytes. That concentration can then be used to calculate the concentration of the analytes in the original water samples. This is done by multiplying the gas phase (vapor units) concentrations by the units specified in Table 7.1 below.

Table 7.1
Conversion Factors

Analyte	Vapor Units	Factor	Units
Carbon dioxide	% by volume	21.3	mg/L
Oxygen	% by volume	4.85	mg/L
Nitrogen	% by volume	4.06	mg/L
Methane	ppmv	0.243	µg/L
Ethane	ppmv	472	ng/L
Ethene	ppmv	525	ng/L
Propane	ppmv	672	ng/L
Propene	ppmv	782	ng/L
i-butane	ppmv	854	ng/L
n-butane	ppmv	865	ng/L

8.0 Safety

The primary concern with this preparation method is the use of sharps. Needles should always be capped when not in use. The proper method for capping a needle is to insert the needle into the cap while the cap is lying on the bench top. Never attempt to cap a needle by holding the cap.

The other safety concern is handling compressed gas cylinders. Cylinders should always be stored upright and chained in place. Cylinders should only be moved using a dolly designed for cylinder transport. Safety glasses shall be worn in the laboratory at all times. Consult Microseeps Chemical Hygiene Plan for more specific information on laboratory safety.

9.0 Waste

Samples are kept for 30 days following analysis. There is no hazardous waste generated during the analytical process. The analysts dispose of the sample vials in the general laboratory trash.

10.0 References

U.S. Environmental Protection Agency, Test Methods for Evaluating Solid Waste. SW-846, 3rd ed., Office of Solid Waste and Emergency Response, Washington, DC. 1986.

Newel, B.S., RSKSOP-175, Sample Preparation and Calculations for Dissolved Gas Analysis in Water Samples using a GC Headspace Equilibration Technique. Revision No. 0, August 1994.

Newel, B.S., RSK-SOP-147, Gas Chromatographic Analysis of Gaseous Samples for Part-Per-Million Levels of Nitrous Oxide, Methane, Ethylene, and Ethane. Revision No. 0, August 1993.

American Society for Testing and Materials, Standard Practice for Analysis of Reformed Gas by Gas Chromatography. Annual Book of ASTM Standards. Vol. 14.02, 1994.

Kampbell, D.H. and Vandegrift, S.A., Analysis of Dissolved Methane, Ethane, and Ethylene in Ground Water by a Standard Gas Chromatographic Technique. Journal of Chromatographic Science. Vol. 36, May 1998.