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FINAL SAMPLING AND ANALYSIS PLAN AND RESOURCE CONSERVATION AND
RECOVERY ACT FACILITY INVESTIGATION SOLID WASTE MANAGEMENT UNIT 23 (
SWMU 23) BATTERY SHOP BUILDING 36 NSA CRANE IN
08/01/2012
TETRA TECH

**FINAL
SAMPLING AND ANALYSIS PLAN**

**RESOURCE CONSERVATION AND
RECOVERY ACT FACILITY INVESTIGATION
SWMU 23 - BATTERY SHOP BUILDING 36**

**NAVAL SUPPORT ACTIVITY CRANE
CRANE, INDIANA**



**Naval Facilities Engineering Command
Midwest**

Contract Number N62470-08-D-1001

Contract Task Order F27Q

August 2012

SAP Worksheet No. 1 -- Title and Approval Page
(UFP-QAPP Manual Section 2.1)

**FINAL
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)
August 2012**

**RESOURCE CONSERVATION AND RECOVERY ACT
FACILITY INVESTIGATION**

**SWMU 23 – BATTERY SHOP BUILDING 36
NAVAL SUPPORT ACTIVITY CRANE
CRANE, INDIANA**

Prepared for:

Naval Facilities Engineering Command Midwest
201 Decatur Avenue, Building 1A
Great Lakes, Illinois 60088

Prepared by:

Tetra Tech
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406

Prepared under:

Comprehensive Long-term Environmental Action Navy
Contract No. N62470-08-D-1001
Contract Task Order F27Q

Review Signatures:

 8/30/12
Tom Johnston, PhD/CLEAN Quality Assurance Manager/Date
Tetra Tech

 8/29/12
James Goerd/Project Manager/Date
Tetra Tech

Approval Signatures:

 9/10/12
Thomas J. Brent/Naval RPM/NSA Crane ESRM/Date
NSA Crane

 9/10/12
Doug Griffin/RPM/Date
Indiana Department of Environmental Management

QA/QC/Chemist/Date
NAVFAC QA Review

SAP Worksheet No. 1 -- Title and Approval Page
(UFP-QAPP Manual Section 2.1)

DRAFT
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(Field Sampling Plan and Quality Assurance Project Plan)
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Indiana Department of Environmental Management
NIELSEN.JANICE.L.1069943540
Digitally signed by NIELSEN.JANICE.L.1069943540
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN,
cn=NIELSEN.JANICE.L.1069943540
Date: 2012.07.09 07:32:21 -04'00'

QAO/Chemist/Date
NAVFAC QA Review

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EXECUTIVE SUMMARY

Tetra Tech has prepared this Sampling and Analysis Plan (SAP) that encompasses Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) requirements for the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 23 – Battery Shop Building 36 at Naval Support Activity (NSA) Crane, Crane, Indiana under Contract Task Order (CTO) F27Q, Contract N62470-08-D-1001, Comprehensive Long-term Environmental Action Navy (CLEAN).

The SAP contained herein was generated for and complies with applicable United States (US) Department of the Navy (Navy), US Environmental Protection Agency (USEPA) Region 5, and Indiana Department of Environmental Management (IDEM) requirements, regulations, guidance, and technical standards. This includes the Department of Defense (DoD), Department of Energy (DOE), and USEPA Intergovernmental Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities. To comply with IDQTF requirements, this SAP is presented in the format of standard worksheets specified in the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) guidance documents (IDQTF, 2005).

This SAP outlines the organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigation at SWMU 23. Protocols for sample collection, handling and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are described in this SAP.

SWMU 23 is located in the north-central portion of NSA Crane, and it encompasses approximately 6.5 acres (Figures 10-1 and 10-2). SWMU 23 is bounded on the north and west by heavily wooded areas with steep hillsides. Surface elevations range from approximately 755 feet above mean sea level (msl) in the area of Building 36 to approximately 675 feet above msl in the northwestern area of the Site. Building 36 is the only building located within SWMU 23, and is located in the southeastern area of the Site (Figure 10-2).

Approximately 2,000 gallons of battery acid per year, from about 1940 to 1975, were discharged onto a sloped area behind the Battery Shop Building. In addition, miscellaneous debris and waste oils containing lead, sulfates, and oily water were also discharged in the same area (Naval Energy and Environmental Support Activity [NEESA], 1983). This debris area was situated north of Building 36 as shown on Figure 10-3. The debris area covered an area approximately 400 feet wide and 125 feet long and extended to the bottom of the ravine. A small stream is located at the bottom of that ravine. The area is rugged and densely wooded, with rock formations protruding from the slope causing sudden drops in elevation of 12 to 14 feet. The debris was unevenly scattered throughout the site.

Surface debris was removed in February 1996 as an Interim Measures (IM), and debris was disposed either on-site or off-site, depending upon contaminant concentrations. Soils were left in place and characterized for any future remediation requirements. The IM Report concluded that although the goal of the IM was met (i.e., removal of debris), several contaminants were present in the soil at SWMU 23 at concentrations greater than the generic, interim cleanup level. Therefore, it was recommended that an RFI be performed to determine and delineate the extent of contamination in the soil at the Site.

The objective of the investigation described in this SAP is to provide sufficient data to determine whether remedial action or no further action (NFA) is warranted, based on human health and ecological risk assessments. The field work and sampling are currently scheduled to begin in the summer of 2012. A complete schedule is detailed in SAP [Worksheet #16](#).

The field activities under this SAP will be conducted in accordance with the site-specific health and safety plan (HASP) to be prepared for these activities.

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ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
%D	Percent Difference or Percent Drift
%R	Percent Recovery
%RSD	Percent Relative Standard Deviation
AWQC	Ambient Water Quality Criteria
BFB	Bromofluorobenzene
bgs	Below Ground Surface
CA	Corrective Action
CAS	Chemical Abstracts Service
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CTO	Contract Task Order
DBCP	1,2-Dibromo-3-chloropropane
DFTPP	Decafluorotriphenylphosphine
DL	Detection Limit
DO	Dissolved Oxygen
DoD	Department of Defense
DOE	Department of Energy
DPT	Direct-Push Technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DRO	Diesel Range Organics
DVM	Data Validation Manager
ECD	Electron Capture Detector
Eco SSL	Ecological Soil Screening Level
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Approval Program
Empirical	Empirical Laboratories, LLC
ERA	Ecological Risk Assessment
ERO	Extended Range Organics
ERSM	Environmental Restoration Site Manager
FD	Field Duplicate
FID	Flame Ionization Detector

FOL	Field Operations Leader
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
g	Gram
GC/MS	Gas Chromatography/Mass Spectrometry
GPS	Global Positioning System
GRO	Gasoline Range Organics
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	Hydrochloric Acid
HDOP	Horizontal Dilution of Precision
HH	Human Health
HHRA	Human Health Risk Assessment
HNO ₃	Nitric Acid
HSM	Health and Safety Manager
IAS	Initial Assessment Study
ICAL	Initial Calibration
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectrometry
ICS	Interference Check Standard
ICV	Initial Calibration Verification
IDEM	Indiana Department of Environmental Management
IDEM SW	Indiana Minimum Surface Water Quality Standards
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation-Derived Waste
ILCR	Incremental Lifetime Cancer Risk
IM	Interim Measures
IS	Internal Standard
IUPPS	Indiana Underground Plant Protection Services
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
LUC	Land Use Control
mg/kg	Milligram per Kilogram
mL	Milliliter
MPC	Measurement Performance Criterion

MS	Matrix Spike
MSD	Matrix Spike Duplicate
msl	Mean Sea Level
NA	Not Applicable
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NEESA	Naval Energy and Environmental Support Activity
NFA	No Further Action
NIRIS	Naval Installation Restoration Information Solutions
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NSA	Naval Support Activity
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Unit
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
oz	Ounce
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PM	Project Manager
POC	Point of Contact
ppb	Part Per Billion
PPE	Personal Protective Equipment
PQLG	Project Quantitation Limit Goal
PQO	Project Quality Objective
PSL	Project Screening Level
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
r	Linear Regression Correlation Coefficient
r ²	Coefficient of Determination
R3 BTAG	USEPA Region 3 Biological Technical Assistance Group
R3 SED BTAG	USEPA Region 3 Biological Technical Assistance Group Freshwater Sediment Screening Benchmark

R3 SW BTAG	USEPA Region 3 Biological Technical Assistance Group Freshwater Surface Water Screening Benchmark
R5 ESL	USEPA Region 5 Ecological Screening Level
RBRSL	Risk-Based Regional Screening Level
RBSSL	Risk-Based Soil Screening Level
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFI	Resource Conservation and Recovery Act Facility Investigation
RISC	Risk Integrated System of Closure
RPD	Relative Percent Difference
RPM	Remedial Project Manager
R-RSL	Residential Regional Screening Level
RRT	Relative Retention Time
R-SSL	Risk-Based Migration-to-Groundwater Soil Screening Level
RT	Retention Time
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SPCC	System Performance Check Compound
SSL	Soil Screening Level
SSO	Site Safety Officer
SWMU	Solid Waste Management Unit
TBD	To Be Determined
Tetra Tech	Tetra Tech, Inc.
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
T-RSL	Tapwater Regional Screening Level
UFP-SAP	Uniform Federal Policy for Sampling Analysis Plan
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
µg/L	Microgram per Liter
U.S.	United States
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VISL	Vapor Intrusion Screening Levels
VOC	Volatile Organic Compound

SAP Worksheet No. 2 -- SAP Identifying Information

([UFP-QAPP Manual Section 2.2.4](#))

Site Name/Number: Battery Shop/Building 36
Operable Units: Solid Waste Management Unit (SWMU) 23
Contractor Name: Tetra Tech, Inc. (Tetra Tech)
Contract Number: N62470-08-D-1001
Contract Title: Comprehensive Long-term Environmental Action Navy (CLEAN)
Work Assignment Number: Contract Task Order (CTO) F27Q

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the Intergovernmental Data Quality Task Force (IDQTF) document, *Uniform Federal Policy for Quality Assurance Plans* (UFP-QAPP) (IDQTF, 2005) and the United States Environmental Protection Agency (USEPA) document, *Guidance for Quality Assurance Project Plans, QA/G-5* (USEPA, 2002a).

2. Identify regulatory program: The Indiana Department of Environmental Management (IDEM) Hazardous Waste Closure and Corrective Action Programs, which implement and enforce the Resource Conservation and Recovery Act (RCRA) at Naval Support Activity (NSA) Crane, and related state laws and rules.

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
<u>Site Visit/Meeting</u>	<u>July 13, 2011</u>
<u>Data Quality Objective (DQO) Meeting</u>	<u>September 1, 2011</u>
<u> </u>	<u> </u>

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

Title	Date
<u>None</u>	<u> </u>

6. List organizational partners (stakeholders) and connection with lead organization:

IDEM (regulatory oversight), Naval Facilities Engineering Command (NAVFAC) Midwest (property owner), Tetra Tech (Navy contractor)

7. Lead organization: NAVFAC Midwest (property owner)

8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

Not Applicable (NA), as there are no exclusions.

SAP Worksheet No. 3 -- Distribution List
 (UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address
Tom Brent	Navy Remedial Project Manager (RPM)/Manages Project Activities for the Navy/ Environmental Restoration Site Manager (ERSM)/Facility Point of Contact (POC)	NAVFAC PWD Crane Code PRC42, Building 3245 300 Highway 361 Crane, IN 47522	812-854-6160	thomas.brent@navy.mil
Bonnie Capito (copy of final cover letter only)	Administrative Record Librarian	NAVFAC Atlantic 6506 Hampton Blvd Norfolk, VA 23508	757-322-4785	bonnie.capito@navy.mil
Doug Griffin	State RPM/Provides Regulator Input	IDEM Office of Land Quality 100 North Senate Avenue Indianapolis, IN 46204-2241	317-233-2710	dgriffin@idem.in.gov
John Trepanowski (copy of cover letter only)	Program Manager/Manages Navy Initiatives	Tetra Tech 234 Mall Boulevard Suite 260 King of Prussia, PA 19406	610-382-1532	john.trepanowski@tetrattech.com
Garth Glenn (copy of cover letter only)	Deputy Program Manager/ Manages Program Activities	Tetra Tech 5700 Lake Wright Drive Suite 309 Norfolk, VA 23502	757-461-3926	garth.glenn@tetrattech.com
Ralph Basinski	Activity Coordinator/ Coordinates and oversees Tetra Tech projects at NSA Crane	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-8308	ralph.basinski@tetrattech.com
James Goerd	Project Manager (PM)/ Manages Project Activities	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-8425	james.goerd@tetrattech.com

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address
To Be Determined (TBD)	Field Operations Leader (FOL) and Site Safety Officer (SSO)/Manages Field Operation and Site Safety Issues	Tetra Tech	TBD	TBD
Tom Johnston, PhD (electronic copy only)	Quality Assurance Manager (QAM)/Manages Corporate Quality Assurance (QA) Program and Implementation	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-8615	tom.johnston@tetrattech.com
Matt Soltis [Health and Safety Plan (HASP) only]	Health and Safety Manager (HSM)/Manages Corporate Health and Safety Program	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-8912	matt.soltis@tetrattech.com
Joe Samchuck (electronic copy only)	Data Validation Manager (DVM)/Manages Data Validation	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-8510	joseph.samchuck@tetrattech.com
Kelly Carper (electronic copy only)	Project Chemist/Provides Coordination with Laboratory	Tetra Tech 661 Andersen Drive Foster Plaza 7 Pittsburgh, PA 15220	412-921-7273	kelly.carper@tetrattech.com
Brian Richard (electronic copy only)	Laboratory PM/ Representative for Laboratory and Analytical Issues	Empirical Laboratories, LLC (Empirical) 621 Mainstream Drive Suite 270 Nashville, TN 37228	877-345-1113 ext 249	brichard@empirlabs.com
Driller (TBD) (electronic copy only)	Drilling Subcontractor PM/ Provides Direct-Push Technology (DPT) Services	TBD	TBD	TBD

SAP Worksheet No. 4 -- Project Personnel Sign-Off Sheet
[\(UFP-QAPP Manual Section 2.3.2\)](#)

Certification that project personnel have read the text will be obtained by one of the following methods as applicable:

1. In the case of regulatory agency personnel with oversight authority, approval letters or e-mails will constitute verification that applicable sections of the SAP have been reviewed. Copies of regulatory agency approval letters/e-mails will be retained in the project files and are listed in [Worksheet #29](#) as project records.
2. E-mails will be sent to the Navy, Tetra Tech, and subcontractor project personnel whom will be requested to verify by e-mail that they have read the applicable SAP/sections and the date on which they were reviewed. Copies of the verification e-mail will be included in the project files and are identified in [Worksheet #29](#).

Copies of the signed [Worksheets #1 and #4](#) will be retained in the project files and are identified as a project documents in [Worksheet #29](#).

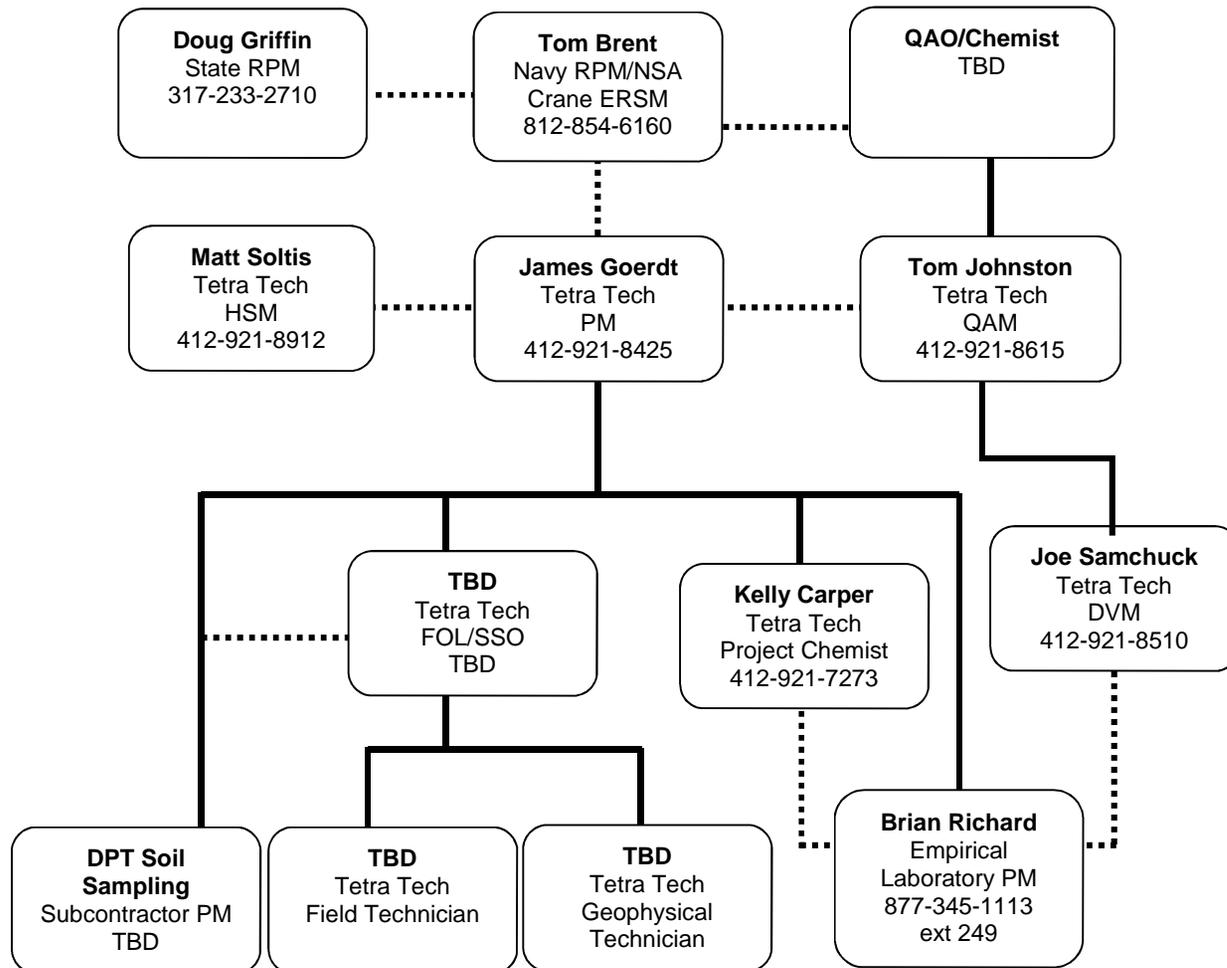
Name ⁽¹⁾	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Navy and Regulator Project Team Personnel					
Tom Brent	Navy RPM/Manages Project Activities for the Navy/NSA Crane ERSM/Facility POC	812-854-6160	See Worksheet #1 for signature	All	
Doug Griffin	IDEM/RPM/Provides Regulator Input	317-233-2710	See Worksheet #1 for signature	All	
Tetra Tech Project Team Personnel					
James Goerd	Tetra Tech/PM/Manages Project Activities	412-921-8425	See Worksheet #1 for signature	All	
TBD	Tetra Tech/FOL/SSO/Manages Field Operation and Site Safety Issues	TBD		All	
Tom Johnston, PhD	Tetra Tech/QAM/Manages Corporate QA Program and Implementation	412-921-8615	See Worksheet #1 for signature	All	
Matt Soltis	Tetra Tech/HSM/Manages Corporate Health and Safety Program	412-921-8912	See HASP for signature	HASP	
Kelly Carper	Tetra Tech/Project Chemist/Provides Coordination with Laboratory	412-921-7273		All	

Name ⁽¹⁾	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Joe Samchuck	Tetra Tech/DVM/Manages Data Validation	412-921-8510		Worksheet #s 12, 14, 15, 19, 20, 23-28, 30, and 34-37	
TBD	Tetra Tech/FOL/Manages Field Operations	TBD		All	
Subcontractor Personnel					
Brian Richard	Empirical/Laboratory PM/Representative for Laboratory and Analytical Issues	877-345-1113 ext 249		Worksheet #s 6, 12, 14, 15, 19, 23-28, 30, and 34-36	
TBD	TBD/Subcontractor PM/Driller for DPT Services	TBD		Worksheet #s 6, 14, 17, and Figures	

1 Persons listed on this worksheet will be responsible for distributing the SAP to the appropriate people within their organization.

SAP Worksheet No. 5 -- Project Organizational Chart
 (UFP-QAPP Manual Section 2.4.1)

Lines of Authority ————— Lines of Communication



SAP Worksheet No. 6 -- Communication Pathways
[\(UFP-QAPP Manual Section 2.4.2\)](#)

Communication Driver	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
SAP amendments	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM/NSA Crane ERSM	TBD James Goerd Tom Brent	TBD 412-921-8425 812-854-6160	<p>The Tetra Tech FOL will verbally inform the Tetra Tech PM within 24 hours of realizing a need for an amendment.</p> <p>The Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within 5 days and send the Navy RPM\ NSA Crane ERSM a concurrence letter within 7 days of identifying the need for change, if necessary.</p> <p>SAP amendments will be submitted by the Tetra Tech PM and the Navy RPM/ NSA Crane ERSM for review and approval.</p> <p>The Tetra Tech PM will send scope changes to the Project Team via e-mail within 1 business day.</p>
Utility Clearance and Base access	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM/NSA Crane ERSM	TBD James Goerd Tom Brent	TBD 412-921-8425 812-854-6160	<p>At least 3 days prior to intrusive field activities, the Tetra Tech FOL will contact the Indiana Underground Plant Protection Services (IUPPS) to clear utilities in the study area, as discussed in Worksheet #18. The Tetra Tech PM will contact the Navy RPM/ NSA Crane ERSM by phone or e-mail to arrange for site access.</p>
Changes in field work schedule	Tetra Tech PM Navy RPM/NSA Crane ERSM	James Goerd Tom Brent	412-921-8425 812-854-6160	<p>The Tetra Tech PM will verbally inform the Navy RPM/ NSA Crane ERSM on the day that a schedule change is known.</p>

Communication Driver	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Issues in the field that result in changes in scope of field work	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM/NSA Crane ERSM	TBD James Goerd Tom Brent	TBD 412-921-8425 812-854-6160	<p>The Tetra Tech FOL will verbally inform the Tetra Tech PM on the day that the issue is discovered.</p> <p>The Tetra Tech PM will inform the Navy RPM/ NSA Crane ERSM (verbally or via e-mail) within 1 business day of discovery.</p> <p>The Navy RPM\ NSA Crane ERSM will issue a scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed.</p> <p>The Tetra Tech PM will document the change via an FTMR form within 2 days of identifying the need for change and will obtain required approvals within 5 days of initiating the form.</p>
Recommendations to stop work and initiate work upon corrective action	Tetra Tech FOL/SSO Tetra Tech PM Tetra Tech QAM Tetra Tech Project Chemist Tetra Tech HSM Navy RPM/ NSA Crane ERSM	TBD James Goerd Tom Johnston Kelly Carper Matt Soltis Tom Brent	TBD 412-921-8425 412-921-8615 412-921-7273 412-921-8912 812-854-6160	<p>If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform onsite personnel, subcontractor(s), the Navy RPM/ NSA Crane ERSM, and the identified Project Team members within 1 hour (verbally or by e-mail).</p> <p>If a subcontractor is the responsible party, the subcontractor PM must inform the Tetra Tech FOL within 15 minutes, and the Tetra Tech FOL will then follow the procedure listed above.</p>
Corrective action for field program	Tetra Tech PM Tetra Tech QAM Navy RPM/NSA Crane ERSM	James Goerd Tom Johnston Tom Brent	412-921-8425 412-921-8615 812-854-6160	<p>The Tetra Tech QAM will notify the Tetra Tech PM verbally or by e-mail within one business day that the corrective action has been completed.</p> <p>The Tetra Tech PM will then notify the Navy RPM/ NSA Crane ERSM (verbally or by e-mail) within 1 business day</p>
Field data quality issues	Tetra Tech FOL/SSO Tetra Tech PM	TBD James Goerd	TBD 412-921-8425	The Tetra Tech FOL will inform the Tetra Tech PM (verbally or via e-mail) on the same day that a field data quality issue is discovered.

Communication Driver	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Analytical data quality issues	Empirical Laboratory PM Tetra Tech Project Chemist Tetra Tech DVM Tetra Tech PM Navy RPM/ NSA Crane ERSM	Brian Richard Kelly Carper Joseph Samchuck James Goerd Tom Brent	877-345-1113 ext 249 412-921-7273 412-921-8510 412-921-8425 812-854-6160	<p>The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is discovered.</p> <p>The Tetra Tech Project Chemist will notify (verbally or via e-mail) the data validation staff and the Tetra Tech PM within 1 business day.</p> <p>Tetra Tech DVM or Project Chemist notifies Tetra Tech PM verbally or via e-mail within 48 hrs of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Tetra Tech PM verbally advises the Navy RPM\ NSA Crane ERSM within 24 hours of notification from the Project Chemist or DVM. The Navy RPM\ NSA Crane ERSM takes corrective action that is appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed mass spectrometer tune or initial calibration verification. Corrective actions may include a consult with the Navy Chemist.</p>

SAP Worksheet No. 7 -- Personnel Responsibilities and Qualifications Table
 (UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Tom Brent	Navy RPM/NSA Crane ERSM Manages Project Activities and daily site activities related to this project	NSA Crane	Oversees project implementation, including scoping, and evaluation of site activities, conducts data review and evaluation, and reviews the SAP.
Doug Griffin	RPM/Provides Regulator Input	IDEM	Participates in scoping, conducts data review and evaluation, and approves the SAP on behalf of IDEM.
Ralph Basinski	Activity Coordinator/ Oversees project activities	Tetra Tech	Oversees project implementation, including scoping, data review, and evaluation, for all Tetra Tech projects at NSA Crane.
James Goerdts	PM/Manages project on a daily basis	Tetra Tech	Oversees project, financial, schedule, and technical day-to-day management of the project.
TBD	FOL/SSO/Manages field operations and oversees site activities to ensure safety requirements are met	Tetra Tech	FOL supervises, coordinates, and performs field sampling activities. SSO is responsible for on-site project-specific health and safety training and monitoring site conditions. Details of health and safety responsibilities are presented in the HASP.
Tom Johnston	QAM/Oversees program and project QA activities	Tetra Tech	Ensures that quality aspects of the CLEAN Program are implemented.
Matt Soltis	HSM/Oversees health and safety activities	Tetra Tech	Oversees the Tetra Tech CLEAN Program Health and Safety Program.
Kelly Carper	Project Chemist/Conducts project oversight of data validation and reporting	Tetra Tech	Participates in project scoping, prepares laboratory scopes of work, and coordinates laboratory-related functions with laboratory. Oversees data quality reviews and QA of data validation deliverables.
Joseph Samchuck	DVM/Oversees data validation activities	Tetra Tech	Manages data validation activities within Tetra Tech, including ensuring QA of data validation deliverables, providing technical advice on data usability, and coordinating and maintaining the data validation review schedule.
Brian Richard	Laboratory PM/Manages project	Empirical	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.
TBD	Driller	TBD	Performs DPT soil borings according to scope of work. Provides equipment to collect groundwater samples.

In some cases, one person may be designated responsibilities for more than one position. For example, the Tetra Tech FOL will be responsible for SSO duties. This action will be performed only as credentials, experience, and availability permits.

SAP Worksheet No. 8 -- Special Personnel Training Requirements Table

[\(UFP-QAPP Manual Section 2.4.4\)](#)

Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

SAP Worksheet No. 9 -- Project Scoping Session Participants Sheet
 ([UFP-QAPP Manual Section 2.5.1](#))

Project Name: RCRA Facility Investigation (RFI)			Site Name: <u>SWMU 23 – Battery Shop Building 36</u>		
Projected Date(s) of Sampling: <u>Spring 2012</u>			Site Location: <u>Crane, Indiana</u>		
Project Manager: <u>Debra Humbert</u>					
Date of Session: July 13, 2011					
Scoping Session Purpose: Site Walk/Meeting					
Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Ralph Basinski	Crane Activity Coordinator	Tetra Tech	412-921-8308	ralph.basinski@tetrattech.com	Management /Oversight
Tom Brent	RPM/ERSM	NSA Crane	812-854-6160	thomas.brent@navy.mil	Management
Debra Humbert	Initial PM	Tetra Tech	412-921-8968	debra.humbert@tetrattech.com	Management

Comments/Decisions: Discussed SWMU 23 historical use and available data. Conducted site walk.

Action Items: Tetra Tech assigned the task to prepare the draft Uniform Federal Policy for Sampling Analysis Plan (UFP-SAP).

Consensus Decisions: The meeting participants developed the overall strategy for the initial RFI sampling. Consensus decisions included the following:

- RFI will be conducted in phased approach. Initial sampling will be to determine presence/absence of contamination. Subsequent phases will be added to determine nature and extent of contamination and collect data for risk characterization, if necessary.
- For the RFI, surface soil samples will be from 0 to 2 feet below ground surface (bgs) depth intervals.

During the site visit on July 13, 2011:

- Tetra Tech searched the Administrative Record files for documents and drawings related to the site.
- Tom Brent provided Tetra Tech with copies of several pages from historical documents that provided some historical information on SWMU 23.
- Tetra Tech conducted a site walk around the site property. The interior of Building 36 was not inspected.
- Tetra Tech observed the current oil/water separator location.

- Batteries were historically stored in the rear of the building, under a covered area. Records indicate that the area was probably covered and there was a berm around part of the area. Tetra Tech observed this same area during the site visit and batteries are still stored outside in the covered area. Past history indicates that debris was dumped over the hillside, and IMs were conducted.
- There was a small solvent tank mentioned in historical reports. The location was not confirmed during the site visit, and the nature of solvents stored in the tank is unknown. Tetra Tech discussed the need to check around the building as the floor drains may have been a past issue.
- Tetra Tech identified two concrete structures that appear to have been drainage headwalls, located on the hill slope west of the building. The hill slope area is highly vegetated with undergrowth and sizable trees. No significant debris or stressed vegetation was identified.
- Tetra Tech discussed comparing metals data from any past sampling efforts with background levels identified in the Base-wide Background Report.
- A series of photos were taken and very general locations depicted on a rough, hand-drawn sketch.

Project Name: RCRA Facility Investigation (RFI)			Site Name: SWMU 23 – Battery Shop Building 36		
Projected Date(s) of Sampling: <u>Spring 2012</u>			Site Location: <u>Crane, Indiana</u>		
Project Manager: <u>Debra Humbert</u>					
Date of Session: September 1, 2011					
Scoping Session Purpose: Internal DQO Scoping Meeting					
Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Ralph Basinski	Crane Activity Coordinator	Tetra Tech	412-921-8308	ralph.basinski@tetrattech.com	Management /Oversight
Debra Humbert	Initial PM	Tetra Tech	412-921-8968	debra.humbert@tetrattech.com	Management
Ed Sedlmyer	Project Chemist	Tetra Tech	412-921-8704	edward.sedlmyer@tetrattech.com	Project Chemist
John Ducar	Senior Geologist	Tetra Tech	412-921-8089	john.ducar@tetrattech.com	Task Manager
Tom Johnston	QAM	Tetra Tech	412-921-8615	tom.johnston@tetrattech.com	DQO Facilitator

Comments/Decisions: Internal DQO Meeting. Discussed SWMU 23 historical use and available data. Discussed the steps for the initial sampling for the RFI in accordance with the UFP-SAP Tier I format.

Action Items: Tetra Tech assigned the task to prepare the draft UFP-SAP.

Consensus Decisions: The meeting participants developed the overall strategy for the initial RFI sampling. Consensus decisions included the following:

- Media of concern include surface/subsurface soil, groundwater, surface water, and sediment.
- Contaminants that may be present at elevated levels at SWMU 23 based on knowledge of the site history include metals (primarily lead), chlorinated solvents, fuels (i.e, total petroleum hydrocarbons [TPH], diesel range organics/extended range organics [DRO/ERO], gasoline range organics [GRO]) and polychlorinated biphenyls (PCBs).
- Will use a grid pattern of soil samples on the slope down to drainageways at the bottom of the hill.
- Will collect sediment samples from drainageways.
- Locate groundwater wells at the base of the slope adjacent to drainageways. Three downgradient wells and one upgradient.
- Human Health PSLs - USEPA Regions 3, 6, and 9 Regional Screening Levels (RSLs) for residents (R-RSLs), migration-to-groundwater risk-based soil screening levels (RBSSLs), and tapwater (T-RSLs); and IDEM risk-based industrial and residential soil default closure levels (IDCLs and RDCLs, respectively) and groundwater default closure levels (GDCLs).
- Ecological PSLs - In hierarchical order, USEPA Ecological Soil Screening Levels (Eco SSL) (for soil), USEPA Region 5 RCRA Ecological Screening Levels (R5 ESL) (for soil, sediment, and surface water), USEPA Region 3 Biological Technical Assistance Group (R3 BTAG) Freshwater Surface Water (for surface water) and Sediment Screening Benchmarks (for sediment), and National Oceanic and Atmospheric Administration (NOAA) Quick Reference Tables (Buchman, 2008) (for soil).

SAP Worksheet No. 10 -- Conceptual Site Model [\(UFP-QAPP Manual Section 2.5.2\)](#)

NSA Crane is located in the unglaciated Crawford upland physiographic province of southern Indiana ([Figure 10-1](#)). This physiographic province is a rugged, dissected plateau bordered on the west by the Wabash lowland and on the east by the Mitchell plain. The geology at NSA Crane is generally characterized by thin overburden deposits overlying bedrock. The bedrock underlying NSA Crane is Pennsylvanian and Mississippian sandstones, limestones, and shales overlain by Quaternary age deposits. The SWMU 23 area is mapped as being underlain by the Mansfield formation of the Raccoon Group. The Mansfield formation consists of alternating beds of dark shale, sandstone, mudstone, siltstone, and discontinuous coal units. Depth to groundwater at SWMU 23 is unknown, but is expected to be present in the bedrock at less than 20 feet bgs, based on other site investigations at NSA Crane. Groundwater flow under SWMU 23 is assumed to flow to the west and north based on local topography. Drainage of storm water from the area of the Site is to drainage pathways located in the valleys to the west and north of Building 36, which in turn flow to tributaries of Lake Greenwood. The drainage pathways on the ridge slopes tend to have ephemeral flow, with flow in them principally during rain events or following snow melt.

The nearest residences are approximately 0.85 miles northwest of SWMU 23 in Forest City, which is the NSA Crane residential area. There are no known historical or cultural concerns, such as Native American burial grounds, historic landmarks on, or in the vicinity of, the Site. There are no land use controls (LUCs) associated with the Site.

This worksheet presents general background information about SWMU 23. Also presented is a conceptual site model (CSM) that describes potential SWMU 23 contamination sources, contaminant migration routes, human and ecological receptors representative of those that could be exposed to site-related contaminants, if present in environmental media, and pathways by which the receptors could be exposed to contaminants. The CSM served as the basis for developing the sampling and analysis program.

10.1 PHYSICAL SITE DESCRIPTION

SWMU 23 is located in the north-central portion of NSA Crane and encompasses approximately 6.5 acres ([Figures 10-1](#) and [10-2](#)). SWMU 23, as presented in [Figure 10-2](#), is bounded on the north and west by heavily wooded areas with steep hillsides. Nearby Building 34 is located approximately 240 feet to the east, and presumed to be hydraulically upgradient, of SWMU 23 based on topography.

Surface elevations range from approximately 755 feet above mean sea level (msl) in the area of Building 36 to approximately 675 feet above msl in the northwestern area of the Site. Building 36 is the only building located within SWMU 23, and is located in the southeastern area of the Site (Figure 10-2).

Tetra Tech conducted a site walk on July 13, 2011. The site reconnaissance involved visually inspecting the exterior areas of SWMU 23. Building 36 was not entered. The current locations of the oil/water separator and the battery storage area were viewed. The presence of a small solvent tank mentioned in historical reports was not confirmed during the site visit.

The following two photographs show Building 36 and surrounding pavement on the western side of the building. To the right of the forklifts shown in the photos is a steep hillside that is highly vegetated with undergrowth and sizable trees. Photographs of the hillside vegetation are presented in subsequent photographs.



View of rear of Building 36, facing southeast



View of rear of Building 36, facing southwest



View of steep hill slope west of Building 36.

Tetra Tech observed two concrete structures that appear to have been stormwater headwalls along the hill slope west of the building. No significant debris and no stressed vegetation were identified during the visit. A photograph of one of the two headwalls is shown below. The area of the IM debris removal was not inspected.



View of one of the headwalls located along the hill slope west of building 36

10.2 SITE HISTORY

Approximately 2,000 gallons of battery acid (presumably sulfuric acid) per year, from about 1940 to 1975, were discharged onto the sloped area behind the Battery Shop (Building 36). The specific points of discharge are unknown; therefore, the entire edge of the ridge near SWMU 23 and the downslope areas are considered to be potentially affected by these discharges. In addition, miscellaneous debris and waste oils containing lead, sulfates, and oily water were also discharged in the same area (Naval Energy and Environmental Support Activity [NEESA], 1983). This debris area was situated north of Building 36 as shown on [Figure 10-3](#). The debris area covered an area approximately 400 feet wide and 125 feet long and extended to the bottom of the ravine. A small intermittent stream is located at the bottom of the ravine. The area is rugged and densely wooded, with rock formations protruding from the slope causing sudden drops in elevation of 12 to 14 feet. The debris was unevenly scattered throughout the Site.

10.3 PREVIOUS INVESTIGATIONS

Several environmental reports relating to environmental concerns have been prepared previously for SWMU 23. The following discusses these previous studies and investigations.

10.3.1 Initial Assessment Study

The Initial Assessment Study (IAS), conducted in 1983 by NEESA (NEESA, 1983), identified the Battery Shop as Site 1. It states that Battery Shop personnel performed maintenance operations on electric vehicles, primarily forklifts, for use at NSA Crane. Approximately 150 gallons per month (approximately 2,000 gallons per year) of spent battery acid, from 1940 to 1975, were discharged onto a hillside behind the Battery Shop (Building 36). Based on the nature of this operation, it is assumed the battery acid was sulfuric acid. After 1975, the practice was to neutralize the acid in a tank, then discharge the neutralized acid into the sewer system. Visual inspection of the disposal area at the time of the study identified approximately ten 10-gallon barrels and 50 5-gallon barrels at the base of the hill. The report did not state whether the barrels were empty, nor did it identify the nature of actual or potential contents.

Wastewater containing oil originating from the maintenance of non-electric forklifts is processed through an oil/water separator adjacent to the building. Approximately 50 gallons per month of oil is removed from the separator for disposal/recycling.

The report indicated that one small solvent tank of unknown size and type of solvent stored was located in Building 36 at the time of the IAS. It states that prior to 1980, 10 to 20 gallons of solvent were drained out of the tank twice per year and dumped down the hillside behind the building. The specific areas of dumping are unknown.

Surface water drainage from the hillside flows into surface water pathways, which discharge to Lake Greenwood, located approximately 3,200 feet to the north. The report stated that the potential for lead salts to migrate to Lake Greenwood existed. Lake Greenwood is the local drinking water source for NSA Crane. The report recommended that surface soil and sediment be sampled for lead analysis.

10.3.2 Preliminary Review/Visual Site Inspection Report

The Preliminary Review/Visual Site Inspection Report (A.T. Kearney, 1987) identified the "Battery Shop Dump" as an area of concern. The report indicated that this unit consisted of an open hillside north of the Battery Shop (Building 36) with no containment or release control provisions. Spent battery acid and waste oil from forklift servicing were disposed of by allowing them to flow down the hill and into a stream

which flows to Lake Greenwood (NSA Crane's drinking water supply reservoir). The specific areas of disposal are unknown; therefore, the entire edge of the ridge near SWMU 23 is considered to be the disposal area. The wastes disposed in the unit were spent battery acid containing lead and sulfates and waste oil and oily water from forklift servicing within Building 36. A sump was installed in 1980 to replace the open dumping of acids.

The Preliminary Review/Visual Site Inspection Report concluded that the potential for release to soil/groundwater in the past was high due to open dumping of liquid waste on a hillside. However, the NACIP study reports that no significant levels of lead (i.e., associated with battery acid) have been found in the soil of the unit. The potential for release to surface water in the past was high due to the open dumping of liquid wastes on a hillside whose runoff flows into Lake Greenwood. However, the NACIP study reports that no significant levels of lead have been found in the lake water. The potential for release to air in the past was low due to the nature of the wastes disposed and the mechanism of disposal which involved releases of liquids and solids to surface soil. The potential for generation of subsurface gas is low due to the open nature of the unit and the wastes managed. The report recommended soil should be sampled on the hillside to verify the conclusions of the NACIP report.

10.3.3 Interim Measures Report

A voluntary Interim Measures (IM) was conducted at SWMU 23 in February 1996, and documented in the IM Report, SWMU 23/00 Battery Shop (Morrison Knudsen, 2000). This IM was conducted to remove and dispose of surface debris. [Figure 10-3](#) shows the location of the IM debris removal area. Materials were removed using both manual and mechanical methods. A track backhoe was used to clear a path to lower a skid-mounted box down the slope and to extract large pieces of concrete or concrete encased material. The majority of the surface debris was removed by hand and placed into the box. Soil was removed from the materials and left in place prior to placing the debris into the box. The box was then pulled up the slope and the debris was transferred to a roll-off box for transport off-site to Rumpke Landfill in Bloomington, Indiana for disposal. Approximately four and one-half tons of debris, including construction debris such as large sections of preformed concrete slabs, drums, cans, filters, and tires were removed from the Site. A metal detector was used to identify debris covered by leaves or buried at a shallow depth in the area from which debris was removed. There was no soil removed from the site. After all debris was removed from the area, no backfill was placed. The contour of the area was essentially undisturbed.

In July and November of 1995, prior to IM removal activities at SWMU 23, four soil samples (001 - 004) were collected for waste characterization purposes from and around the debris removal area for the purpose of evaluating future soil disposal options. In February of 1996, during the debris removal activities, eight soil and two surface water samples (005 - 014) were collected for characterization

purposes. All samples were analyzed by an approved off-site laboratory. Figure 10-4 shows the locations of all samples collected. Tables 10-1 (soil) and 10-2 (surface water) present a summary of the results of all samples collected prior to and during the IM removal activities.

Initial information and laboratory analytical data confirmed that no explosive ordnance was associated with the area of the Battery Shop. The type and condition of surface debris was primarily of a construction or domestic waste nature and included concrete, reinforcement bar (rebar), metal cans, drums, chairs, tires, and battery components.

Following the completion of debris removal, confirmation sampling was performed. Eight soil and two surface water samples were collected and analyzed by an approved off-site laboratory. The confirmation samples were collected on February 22, 1996. The samples were analyzed for Appendix IX parameters.

The IM Cleanup Levels for soil analysis used for the site were taken from USEPA Memo RCRA Corrective Action Guidance: Human Data Quality Levels for RFI Projects by Karl E. Bremer, dated June 18, 1994, and were used as the predetermined cleanup levels for comparison in the absence of site-specific health risk based levels.

The soil samples contained concentrations of various metals at levels greater than the interim cleanup levels. One sample, 23/00-011, also contained the organophosphorus pesticide methyl parathion at a concentration 1 part per billion (ppb) greater than the associated IM cleanup level. The samples did not contain any other target analytes greater than the IM cleanup levels. The two water samples (23/00-012 and 23/00-014) did not show any exceedances of an interim cleanup level.

The report concluded that although the goal of the interim remedial action was met (i.e., removal of debris), based on a review of confirmation sample analytical results several contaminants were present in the soil at SWMU 23 greater than the generic, interim cleanup level. Therefore, it was recommended that an RFI be performed to determine and delineate the extent of contamination in the soil at the Site.

[Table 10-1](#) presents a summary of results of the soil confirmation samples compared against current PSL criteria. [Table 10-2](#) presents a summary of results of the surface water samples collected as part of the IM compared against current PSL criteria.

Based on the screening evaluation against current PSLs, several metals concentrations in soil samples had exceedances. The metals with exceedances in at least one sample included chromium, cobalt, copper, lead, lithium, nickel, selenium, silver, and zinc. In addition, elevated sulfide concentrations were observed in a number of the soil samples. No organic compounds were detected at concentrations

greater than current PSL criteria. However, several organic compounds had detection limits greater than the PSL criteria (see [Table 10-1](#)). This constitutes a data gap that confounds the ability to know whether chemical concentrations exhibited in the historical data exceed current PSL criteria.

Also, based on a screening evaluation utilizing current PSLs, several metals concentrations in the surface water samples now show exceedences. The metals with exceedences in at least one sample include beryllium, copper, lead, nickel, and zinc. In addition, bis(2-ethylhexyl)phthalate and trichlorethene (one sample each) were detected at concentrations greater than PSL criteria. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant that is considered not to be a site-related contaminant because it was detected infrequently and at a concentration below the detection limit. This is often an indication that the chemical is not a site-related contaminant.

10.3.4 Review of Building 36 Site Drawings

Tetra Tech reviewed several Navy drawings of Building 36. Appendix A provides copies of the drawings reviewed. Navy Drawing No. 200997, dated March 7, 1974, entitled “Building 36 – Grit & Oil Separator Neutralization Equip. & Sewer Connect” shows a buried tank located between the fire hydrant and the western side of the building. There is no information on the size or content of the tank. In addition, Navy Drawing No. 2075973, dated July 11, 1984, entitled “New Acid Neutralization Tank, Bldg. 36” shows an existing buried fuel tank located adjacent to the western edge of the building (see [Figure 10-3](#)).

10.4 CONCEPTUAL SITE MODEL

Based on the findings of the SWMU 23 IM Report (Morrison Knudsen, 2000), contamination exists in the soil and surface water of SWMU 23, including drainage channels downgradient of the SWMU. [Figure 10-5](#) illustrates a representative CSM for SWMU 23. The CSM includes the various potential sources of contamination and contaminant migration pathways that may exist at the Site. Further discussion of potential subarea contaminant sources and migration pathways is provided in [Section 10.4.1](#). [Section 10.4.2](#) discusses potential migration pathways, and [Section 10.4.3](#) discusses typical receptors and receptor exposure pathways throughout SWMU 23.

10.4.1 Potential Contaminants

Chemicals that may have been present at SWMU 23 over its operational history, and may have been released to environmental media, include the following:

- Volatile organic chemicals (VOCs): various VOCs not necessarily originating with petroleum-based oils may have been present in materials used at SWMU 23 (e.g., chlorinated degreasing compounds, fuels, and commonly used organic solvents).
- Polycyclic aromatic hydrocarbons (PAHs): various PAHs may have been present in materials used at SWMU 23 (e.g., hydraulic oils and fuels).
- Petroleum-based oils: fuel oils have been used and stored within SWMU 23. Constituents of fuel oils include petroleum hydrocarbons such as DROs and GROs, as well as PAHs. Lubricating oils also may have been released either as pure lubricants or mixed with organic solvents. In these situations DRO, GRO, and extended range organics (ERO) analyses are indicated by the IDEM Risk Integrated System of Closure (RISC) Guidance (IDEM, 2010) for the measurement of TPH.
- Inorganics: various metals may have been present in materials used at SWMU 23 (e.g., batteries, battery acid, or impurities in waste oil). Lead and sulfate, in particular, would have been major components of battery acid. Releases of battery acid would have temporarily depressed pH values at the point of release and these releases could have mobilized metals in the soil by dissolving them until the acid was neutralized and the metals precipitated as sulfates, carbonates, and other chemical salts.
- PCBs: PCBs may have been present in hydraulic oils or dielectric fluids used at SWMU 23 (e.g., transformers, pumps or other hydraulic equipment, etc.).

10.4.2 Potential Contaminant Release and Migration Pathways

The principal potential contaminant release and migration pathways are:

- Documented direct discharge to surface soil (historical dumping);
- Documented direct discharge of contaminants from dumping or spills to surface water drainage pathways;
- Spills from material handling (e.g., solvents) or accidents in Building 36 or near the underground storage tank (UST);
- Direct discharge from building drains or the oil water separator of battery acids, solvents, or oils;

- Leaks from storage tanks (fuel tank, solvent/degreaser) or associated piping; and
- Transport via surface runoff, leaching to deeper soil and groundwater, discharge of contaminated groundwater at hillside seeps, downgradient migration of surface water and sediment in drainage channels, and downgradient migration of groundwater.

10.4.3 Receptors and Exposure Pathways

Persons currently using the site include site personnel and construction workers. However, given that the future land use is unknown, it is customary to evaluate the future use of a property as residential and recreational. Therefore, potential future receptors include residents, persons recreating at the site, and trespassers. Human receptors may be exposed to different media, based on their specific activities. These media include surface and subsurface soil, groundwater, surface water, and sediment. Potential exposure pathways may include dermal contact with, inhalation of, or ingestion of soil, or dermal contact with or ingestion of contaminated media. Currently, groundwater is not used at NSA Crane for potable or agricultural purposes; therefore, no exposure to groundwater is anticipated.

Potential ecological receptors include animal and plant species that could be affected by the contaminants that are present. Typically, ecological receptors can be exposed only to surface media – surface soil, surface water, and upper layers of wetland sediments. Exposure of ecological receptors to groundwater and subsurface soil is not anticipated; however, contamination in subsurface soil or groundwater may serve as a source of contamination to sediments or surface water through subsurface transport or diffuse flow to streams. The soil exposure pathways for ecological receptors is exposure to surface soil by direct contact and ingestion of soil and other food items. Aquatic and semi-aquatic vegetation, benthic invertebrates, and aquatic organisms may be exposed to the surface water and sediment by direct contact and/or ingestion of sediment and surface water and other food items. The benthic invertebrates or other aquatic organisms may be consumed by wildlife. Although terrestrial vertebrates may be exposed to chemicals found in the air via inhalation, this is not considered a significant pathway at SWMU 23. Some of the drainageways leading from SWMU 23 to lower elevations may be dry most of the year. In those cases, the stream bottoms are better characterized as soils than sediments. Until additional site observations are made, however, this determination cannot be made.

SAP Worksheet No. 11 -- Project Quality Objectives/Systematic Planning Process Statements

[\(UFP-QAPP Manual Section 2.6.1\)](#)

This section describes the development of Project Quality Objectives (PQOs) using the USEPA seven-step DQO/Systematic Planning Process.

11.1 PROBLEM DEFINITION

During a 1996 IM conducted at SWMU 23 to cleanup and remove surface debris, subsequent soil and surface water samples collected in the area of the cleanup indicated site-related contaminants present in the environmental media at concentrations that could pose an unacceptable level of human health or ecological risk. Potential site contamination (i.e., battery acid, waste oil) may also exist due to historical operations at Building 36 and from potential releases from a solvent tank located within Building 36 and a UST located near Building 36 which were not investigated during the IM. Therefore, additional sampling is warranted to determine if unacceptable levels of risk to human health and/or environmental receptors are present in site environmental media and if so, to determine if a corrective action or further investigation is necessary. To efficiently and cost effectively utilize resources, the investigation at SWMU 23 will be conducted in two phases. The first phase of work will include the collection of soil, surface water, and sediment samples. The second phase of work will include the installation of groundwater monitoring wells whose placement will be determined based on the phase I analytical results of the soil characterization samples.

11.2 INFORMATION INPUTS

The following physical and chemical data are needed to attain project objectives:

1. Chemical Data: Surface soil, subsurface soil, surface water, sediment, and groundwater concentrations for potentially site-related chemicals (target analytes) are needed to determine if contamination in Site media pose an unacceptable level of risk to human or ecological receptors. The chemicals to be targeted for evaluation (i.e., target analytes) within each group of potential contaminants identified in [Section 10.4.1](#) were from the 40 CFR Part 264 Appendix IX List for organic and metal chemicals. Tin, pentachloroethane, and 1,4-dioxane were excluded from consideration because of the perceived low potential for those chemicals to have been released and the fact that additional sample preparation steps or analyses would be required to obtain data of sufficient quality for those three analytes. The matrix-specific lists of target analytes and the PSLs used to identify individual chemicals for risk evaluations are presented in [Worksheet #15](#). Selection of target analytes was based on Site operational knowledge and the CSM; rationale for sampling is provided in [Worksheet #17](#). Select miscellaneous parameter measurements are also needed and are included in

[Worksheet #15](#). These include sulfate and pH in surface soil, which may be used to identify where battery acid was released; total organic carbon (TOC) in sediment, which is useful for interpreting contaminant fate and transport potential; and hardness concentrations in surface water, which can be used to estimate bioavailability of target analytes. Proposed sampling locations and their respective analyses are presented in [Worksheet #18](#). Analytical methods suitable for measuring target analyte concentrations at levels equal to or less than current PSLs (see next item) are identified in [Worksheet #19](#).

2. Project Screening Levels: USEPA and IDEM residential surface soil, subsurface soil, sediment, surface water, and groundwater risk-based screening criteria are needed to identify chemicals of potential concern (COPCs) so that they can be evaluated in more detail in environmental and human health risk assessments. The relevant environmental and medium-specific risk-based screening levels for the target analytes are the IDEM RISC Default Closure Tables, Residential and Industrial Closure Levels (RDCL and IDCL, respectively) for soil and Groundwater Default Closure Level (GDCL) for groundwater; and USEPA Regions 3, 6, and 9 Residential Regional Screening Levels (R-RSLs), migration-to-groundwater Risk-Based Soil Screening Levels (RBSSLs), and Tapwater Regional Screening Levels (T-RSLs) for human health risk screening and for use in a Human Health Risk Assessment (HHRA) during the RFI. The surface soil, sediment, and surface water ecological benchmarks for ecological risk screening and for use in an Ecological Risk Assessment (ERA) are, in hierarchical order, the USEPA Ecological Soil Screening Levels (Eco SSL) (for soil), USEPA Region 5 RCRA Ecological Screening Levels (R5 ESL) (for soil, sediment, and surface water), USEPA Region 3 Biological Technical Assistance Group (R3 BTAG) Freshwater Surface Water (for surface water) and Sediment Screening Benchmarks (for sediment), National Oceanic and Atmospheric Administration (NOAA) Quick Reference Tables (Buchman, 2008) (for soil). The lowest human health criterion and appropriate ecological screening value selected in hierarchical order for each analyte represents the PSL for each environmental matrix and receptor type (human or ecological) listed in [Worksheet #15](#). There are some cases for which the analyte concentration cannot be measured at values less than the applicable PSL using conventional analytical technology. Those cases are identified in [Worksheet #15](#) and are footnoted to indicate how these situations will be handled during decision making.
3. Background Target Analyte Concentrations: The background upper tolerance limits (UTLs, representing 95 percent coverage of the soil population with 95 percent confidence) for soils must be used to aid the determination as to whether metals are naturally occurring or are site-related contaminants. Background data for the various soil types identified at NSA Crane are described in the *Final Base-Wide Background Soil Investigation Report for NSWC* (Naval Surface Warfare Center

Crane (Tetra Tech, 2001). The applicable soil groups are: Group 3 for all surface soil, Soil Group 8 for subsurface silt and clay, and Soil Group 9 for subsurface sand.

4. Field Data: Direct-push technology (DPT) (e.g., Geoprobe[®]) and hand augers are needed to collect surface and subsurface soil samples from the unconsolidated overburden. Each soil core must 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 soil type must be identified by the Field Geologist based on the Unified Soil Classification System (USCS). Soil samples collected from each proposed 2-foot sample interval must be collected from the most contaminated segment of the sample core, as determined based on field screening and/or visual observation. If no contamination is observed within the sample core, then the sample is to be representative of the entire 2-foot sample interval. The matrix in [Section 11.3](#) must be used to guide sample selection.

The sampling and analysis program is outlined in [Worksheet #18](#), and the sampling requirements for each type of analysis (e.g., bottleware, preservation, holding time) are listed in [Worksheet #19](#). Field and laboratory QC samples will also be collected as outlined in [Worksheet #20](#).

5. Groundwater elevation data are required to establish groundwater flow directions. These elevations must be measured to the nearest 0.01 feet.
6. Well stabilization parameters [i.e., pH, temperature, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity] must be measured during groundwater sampling to ensure that representative groundwater data are collected and to support data interpretation risk calculations. These same parameters must be measured in surface water to help characterize surface water conditions at the time of sampling.
7. Geophysical Data: A geophysical survey must be conducted to determine the presence or absence of a UST on the western side of the building (see [Worksheet #14](#) for details).
8. A bedrock core is required from at least one well location to characterize stratigraphy, fracture distribution, and other features of the bedrock units.
9. Survey Data: Survey coordinate data for monitoring wells must be collected and documented in order to locate the sampling locations with accuracy, both horizontally and vertically. Vertical elevations must be made at a notch made at the top of each well casing. Global positioning system (GPS) measurements must be made to sub-meter accuracy for locating other sampling locations. The

survey coordinates must be expressed in Indiana State Plane Coordinate System (West Zone, see [Worksheet #14](#)).

10. Quality assurance data must be collected as described in [Worksheets #20 and #28](#).

11.3 STUDY AREA BOUNDARIES

The study area is the entire area of SWMU 23 except areas covered by structures. [Figure 10-2](#) provides the horizontal boundaries of SWMU 23, and current structures and features for SWMU 23.

Initial Sampling Event

Populations to be represented by the data are:

- Surface and subsurface soil from areas with the greatest potential for environmental impacts from activities associated within SWMU 23. These include:
 - Areas of the sewer lines, oil/water separator, and/or sumps from the building.
 - Area of the former (or existing) UST.
 - The area of known and potential historic dumping areas, in particular areas which exhibit stressed vegetation (possibly related to environmental conditions) or staining (e.g., hill slope north and west of the building), if present.
 - Areas immediately downgradient of the two headwalls located west of the building, along the hill slope.
- Surface water and collocated sediment from drainage pathways which lead to Lake Greenwood in areas likely to have become contaminated from SWMU 23 activities due to dumping or chemical releases. The top 6 inches of sediment in these drainage channels is the sediment depth of interest because this interval is the most likely to be contaminated.
- Sediment from the base of the oil/water separator.
- Groundwater that is potentially contaminated with solvents and/or petroleum constituents from process, storage, or handling activities.

Note - solid matrices (i.e., soil and sediment) have been identified in this SAP as soil being material in areas outside of watercourses or drainages and sediment being material in watercourses or drainages, whether saturated or dry. The provenance of the sediments must be evaluated during the HHRA or the ERA in order to determine how to incorporate them into the risk assessments. Sediments may be considered to be surface soil during the risk screening and assessments, depending on the stream

channel conditions. For example, bottom material in a steeply pitched drainage channel that is dry at the time of sampling, and which appears to be dry most of the year, must be considered as surface soil to most accurately represent the type of exposures and risks associated with that material.

The following items address the horizontal, vertical, and temporal boundaries for the initial sampling event:

Bedrock may be shallow at the Site, based on known conditions at other NSA Crane sites. The vertical boundary of the initial study for soil is soil from the ground surface to the top of the water table or top of bedrock, whichever is shallower. This represents soil most likely to be contaminated. Surface soil is defined to be 0 to 2 feet bgs and deeper soil is subsurface soil. The greatest likelihood of encountering contamination in subsurface soil is considered to be at depths near the bottom of the UST or the oil/water separator, or near subsurface pipes at depth. Therefore, the interval of interest for representing subsurface soil contamination is a 2-foot interval selected based on field screening with a photoionization detector (PID) and/or visual observations.

When conducting field screening for soil sample collection, the following matrix applies:

Observation	Action
No elevated PID and no staining observed	Collect sample representing entire 2-foot interval. For subsurface samples, collect the sample immediately above bedrock, or from 8-10 feet bgs (if top of bedrock is deeper than 10 feet bgs).
Elevated PID reading and no staining observed	Collect soil sample representing the 2-foot interval exhibiting the greatest PID reading above background PID levels.
No elevated PID reading and staining observed	Collect soil sample representing 2-foot interval containing the staining.
Both an elevated PID reading and staining observed	Collect a sample for VOC analysis representing the 2-foot interval with the greatest PID reading; collect aliquots for all other analyses from the entire 2-foot segment where staining was observed. This selection strategy could result in samples scheduled for VOC and non-VOC analyses being collected from different soil intervals. The intent is to represent the most contaminated intervals for all target analytes.

The Tetra Tech FOL shall use discretion when selecting soil sampling intervals to obtain samples that represent the greatest chance of detecting site-related contamination.

Depth to groundwater is not known, but it is assumed to be less than 20 feet bgs based on other site investigations at NSA Crane. The groundwater population of interest is the shallow groundwater zone (i.e., first encountered water bearing zone) that may have been contaminated by releases from the SWMU 23 site-related activities, including leaks and other releases from operations and disposal activities. This is generally groundwater located downgradient of the operations areas. Upgradient

groundwater is also of interest to provide a reference population to help delineate contamination (see [Section 11.4](#) and associated figures).

Surface water from the drainage pathways located in the northern area of the Site, which ultimately discharge to Lake Greenwood, is the targeted surface water population. Sediment throughout the drainage channels downgradient of Building 36 is also a population of interest; however, if sediment is not widely available, depositional areas must be investigated. Surface water and collocated sediment upgradient and downgradient of the potential source areas must be investigated to distinguish impacts from the site and impacts from other potential sources (see [Section 11.4](#) and associated figures).

It should be noted that SWMU 23 is located in the northeastern portion of NSA Crane, and surface water flow in the vicinity of SWMU 23 is southeast to northwest. Based on the fact that the closest NSA Crane boundary to SWMU 23 is several miles away, and there are no known non-Navy operations within the area of SWMU 23 which could have potentially impacted the streams and/or sediment at SWMU 23, all potential impacts to the surface water and/or sediment at SWMU 23 are believed to be a result of historical operations at the site.

All target analyte concentrations are anticipated to be relatively unchanged (stable) over the course of time needed to conduct the environmental investigations and into the foreseeable future. Except for possible changes in water table elevation caused by rain events, sampling events are not dependent on weather or other temporal factors. To ensure that groundwater elevations represent typical site conditions, synoptic water level measurements must be completed within a 24-hour period and not less than 48 hours after a significant rain event. Subsequent field sampling activities, if deemed necessary based on the initial sampling event results, will be conducted in a timely manner.

11.4 ANALYTIC APPROACH

The decision rules for the initial sampling event for this RFI are presented in graphical form in [Figures 11-1 and 11-2](#) for TPH and non-TPH parameters, respectively.

11.5 PERFORMANCE OR ACCEPTANCE CRITERIA

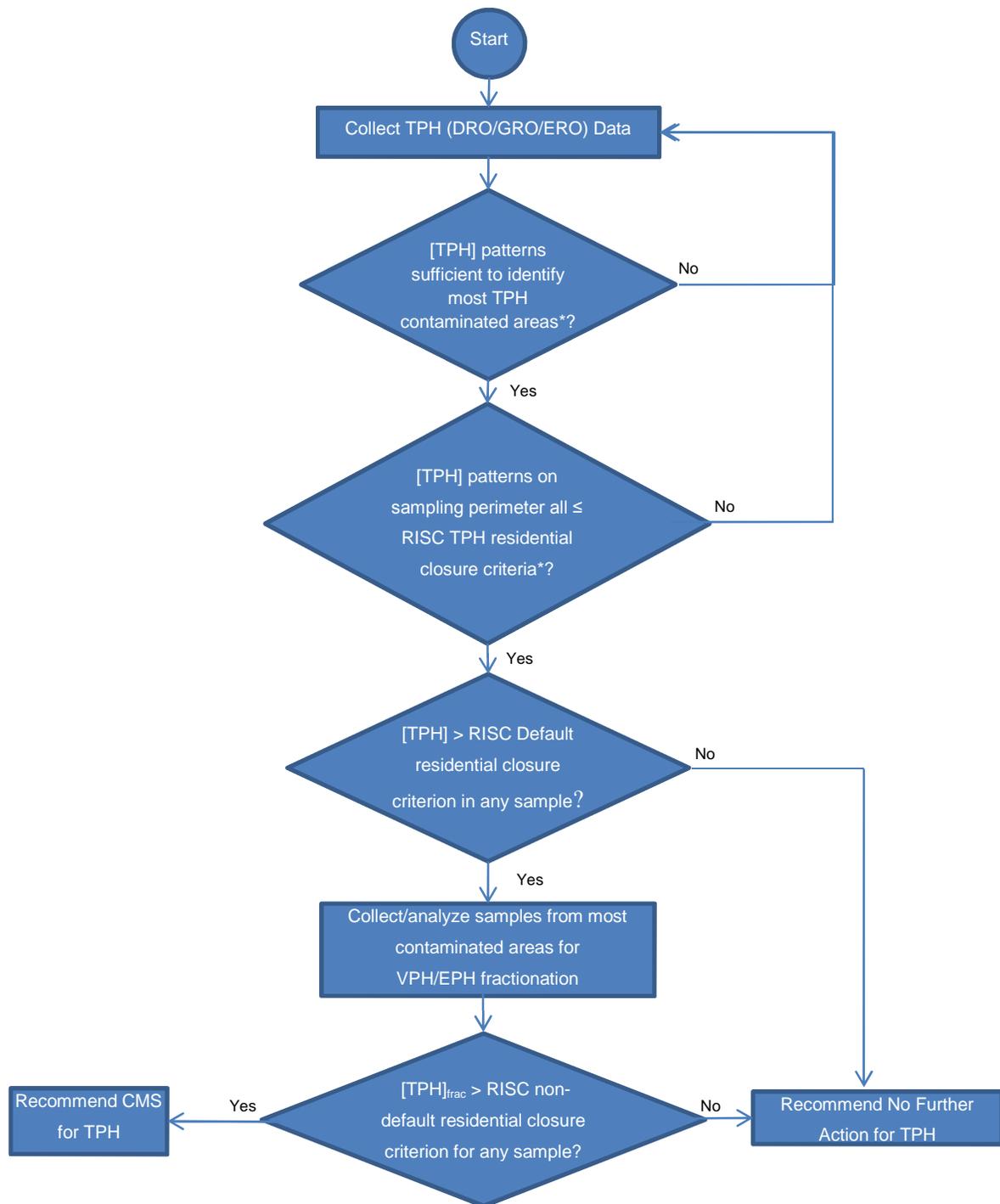
Simple comparisons of measured concentrations to background concentrations (metals only) and PSLs are planned for the initial investigation. The Project Team will use the results of the initial sampling investigation to determine whether the amount and type of data collected are sufficient to support the attainment of project objectives in accordance with [Figures 11-1 and 11-2](#). For any particular round of sampling, if all data have been collected as planned and no data usability deficiencies exist, the data will

be considered sufficient to meet project objectives. Refer to [Worksheet #37](#) for a discussion of the data usability process.

11.6 PLANS FOR OBTAINING DATA

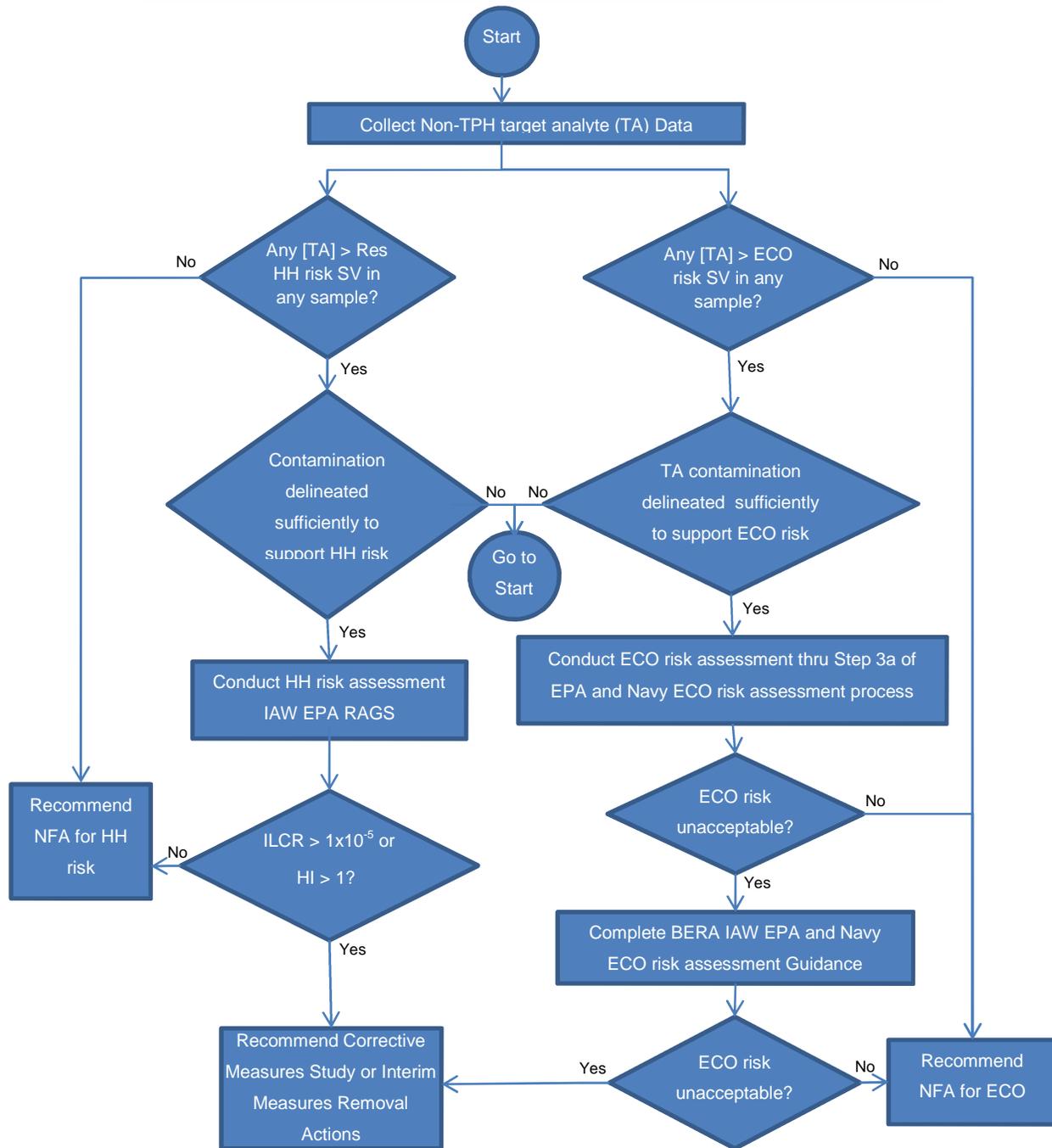
Based on the information presented above, a detailed plan was developed to obtain the necessary data to answer the problem. The sampling design and rationale for all samples that will be collected are provided in [Worksheet #17](#).

FIGURE 11-1. DECISION FLOW FOR TOTAL PETROLEUM HYDROCARBONS



CMS = Corrective Measures Study
 DRO/GRO/ERO = Diesel/Gasoline/Extended Range Organics
 RISC = Risk Integrated System of Closure
 TPH = Total Petroleum Hydrocarbons
 [TPH] = TPH concentration
 [TPH]frac = Fractionated [TPH]
 *This determination must be made in accordance with the IDEM RISC Technical Guide – June 15, 2006 Ch. 8, rev. June 14, 2010.

FIGURE 11-2. DECISION FLOW FOR NON-PETROLEUM TARGET ANALYTES



*The Project Team will strive to obtain Target Analyte (TA) concentrations less than screening values at the perimeters of media-specific sampling patterns. **When evaluating extent of contamination, however, the Project Team will consider lines of evidence they feel are appropriate when assessing whether contamination is adequately delineated to support the risk assessments. This means that the extent of contamination may be deemed sufficient even if some samples on the perimeter of the sampling patterns exhibit exceedances of SVs.** When making this determination, the Project Team will use the 95 percent Upper Tolerance Limit with 95 percent coverage of the sampled population (95/95 UTL) for soil (as defined in the NSWCrane Basewide Background Soil Study) for the Soil Group corresponding to the soil being evaluated. For surface water, sediment, and groundwater, the maximum TA concentration measured for upgradient locations sampled for this project will be compared to site concentrations.

- BERA = Baseline ecological risk assessment
- ECO = Ecological
- EPA = United States Environmental Protection Agency
- HH = Human Health
- HI = Hazard Index for common target organ/effect
- IAW = In Accordance With
- ILCR = Cumulative incremental Lifetime Cancer Risk
- NFA = No further action
- RAGS = Risk Assessment Guidance for Superfund
- SV = Screening Value

SAP Worksheet No. 12 -- Measurement Performance Criteria Table – Field Quality Control Samples

([UFP-QAPP Manual Section 2.6.2](#))

Quality Control (QC) Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPCs)	QC Sample Assesses Error for Sampling, Analytical, or Both
Equipment Rinsate Blank	All analytical groups	One per 20 field samples per matrix per non-dedicated sampling equipment ¹ .	Accuracy/Bias/Contamination	No analytes \geq ½ limit of quantitation (LOQ), except common laboratory contaminants, which must be < LOQ.	Sampling & Analytical
Field Duplicate (FD)	All analytical groups	One per 20 field samples collected per matrix.	Precision	Values > 5X LOQ: Relative Percent Difference (RPD) must be ≤ 30 ^{2,3} (aqueous), ≤ 50 ^{2,3} (solid).	Sampling & Analytical
Cooler Temperature Indicator	All analytical groups	One per cooler.	Representativeness	Temperature must be above freezing and less than or equal to 6 degrees Celsius (°C).	Sampling

1 Equipment rinsate blanks will be collected if non-dedicated sampling equipment is used.

2 If duplicate values for non-metals are < 5x LOQ, the absolute difference should be < 2x LOQ.

3 If duplicate values for metals are < 5x LOQ, the absolute difference should be < 4x LOQ.

SAP Worksheet No. 13 -- Secondary Data Criteria and Limitations Table

[\(UFP-QAPP Manual Section 2.7\)](#)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/ collection dates)	How Data Will Be Used	Limitations on Data Use
Background Soil Data	NAVFAC Southern Division. Final Base-Wide Background Soil Investigation Report for Naval Surface Warfare Center Crane, Crane, Indiana. January 2001.	NAVFAC Southern Division. The data includes soil type identification and associated representative metals concentrations for those soil types. The data was collected in November 1999 through October 2000.	The background data set for soils at NSA Crane will be used to determine whether metals present on-site are naturally occurring or are site-related.	No limitations are identified for data use.

SAP Worksheet No. 14 -- Summary of Project Tasks ([UFP-QAPP Manual Section 2.8.1](#))

14.1 FIELD INVESTIGATION TASK PLAN

Site-specific Standard Operating Procedures (SOPs) have been developed for field activities at NSA Crane and are located in [Appendix B](#). Field tasks are summarized below with a short description for each task.

- Utility Clearance
- Mobilization/Demobilization
- Site-Specific Health and Safety Training
- Geophysical Investigation
- Monitoring Equipment Calibration
- Sample Collection Tasks
- Surface and Subsurface Soil Sampling
- Surface Water Sampling
- Sediment Sampling (Surface Water Pathways and Subsurface Structures)
- Monitoring Well Drilling and Installation (if required)
- Well Surveying
- Well Development
- Groundwater Level Measurements
- Low Flow Purging and Sampling of Monitoring Wells
- GPS Locating
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Field Documentation Procedures
- Sample Handling
- Quality Control (QC) Tasks

Utility Clearance

At least three days prior to the commencement of any subsurface intrusive activities, the Tetra Tech FOL or designee will contact IUPPS to complete a utility clearance ticket for the areas under investigation. Work permits, if required by the facility, will be obtained prior to conducting field activities. The Tetra Tech FOL will be responsible for coordinating these activities.

Mobilization/Demobilization

Mobilization will consist of the delivery of all equipment, materials, and supplies to the site, complete assembly in satisfactory working order of all such equipment at the site, and satisfactory storage at the site of all such materials and supplies. The Tetra Tech FOL or designee will coordinate with the NSA Crane ERSM to identify appropriate locations for the storage of equipment and supplies. Site-specific health and safety training for all Tetra Tech field personnel and subcontractors will be provided as part of site mobilization.

Demobilization will consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization includes the cleanup and removal of waste generated during the performance of the investigation.

Site-Specific Health and Safety Training

There are no specialized/non-routine project-specific training requirements or certifications needed by personnel to successfully complete the project or tasks. All field personnel will have appropriate training to conduct the field activities to which they are assigned. Each site worker will be required to have completed the OSHA 40-hour course (and 8-hour refresher, if applicable) in health and safety training (See [Worksheet #18](#)). Safety requirements are addressed in greater detail in the site-specific HASP.

Geophysical Investigation

A buried tank is depicted on a 1974 engineering drawing for Building 36 (Drawing PW38205015). This buried tank is also shown in the location on a 1984 engineering drawing as an existing buried fuel tank (Drawing PW46125002). The depicted buried tank is shown on the drawings by a rectangular symbol with dimensions that suggest a large capacity (size) for the buried tank. It is unknown whether a UST is currently present at this location. If the buried tank from 1974 is still present, its age would imply steel construction. No buried tank records are available. Currently, the drawing's location for the buried tank is an open asphalt area next to Building 36.

A geophysical survey to search for the possible buried tank will be conducted using ground penetrating radar (GPR) and a magnetic locator instrument (i.e., Schonstedt). The geophysical survey will be conducted prior to any intrusive site investigation activities (i.e., soil borings and monitoring well installations). The GPR survey will be supplemented at FOL discretion, by an EM61 survey, and possible use of a pipe and cable locator instrument if potentially contaminated tank piping is observed during the survey. The GPR and magnetic locator instruments will be used to survey a 30- by 50- foot area approximately centered on the buried tank's location shown on the engineering drawings. The longer

dimension of the survey area (50 feet) will be along the long dimension of the buried tank shown on the drawings (long dimension is in a northeast-southwest direction). The GPR survey will be performed along parallel lines spaced 2.5 feet apart in two mutually perpendicular directions across accessible portions of the specified survey area. Survey line spacing was determined given the survey objective (potential target size) and the survey area size. Surveying using 2.5-foot line spacing provides dense data coverage to provide thorough survey coverage for small to large UST investigations. The magnetic locator survey will be conducted along parallel lines spaced 2.5 feet apart in one direction across accessible portions of the specified survey area. If GPR signal penetration into the ground appears potentially limiting and no buried tank appears evident from the GPR data, then an EM61 survey over the same area using 2.5 foot survey line spacing in one direction may be performed to augment the geophysical survey interpretation. If tank piping is observed during the survey, then a pipe and cable locator will be utilized to trace the piping in order to help determine where the potential tank may be located to help focus the other proposed geophysical methods. Standard operating procedures for the planned geophysical survey are provided in [SOP-11](#) (Geophysical Survey for Underground Storage Tanks).

Monitoring Equipment Calibration

Monitoring equipment calibration procedures are described in [Worksheet #22](#).

Sample Collection Tasks

The sampling and analysis program is outlined in [Worksheet #18](#). Sample collection will be in accordance with the site-specific SOPs listed in [Worksheet #21](#) and provided in [Appendix B](#). The sampling requirements for each type of analysis (e.g., bottleware, preservation, holding time) are listed in [Worksheet #19](#). Field and laboratory QC samples will also be collected as outlined in [Worksheet #20](#).

Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected in accordance with [SOP-08](#) (Borehole Advancement and Soil Coring Using DPT and Hand Auger Techniques). Surface and subsurface soil samples will be collected with a hand auger where DPT access may be limited (e.g., steep hill slope). Combined surface soil and subsurface soil samples (all other locations) will be collected using a DPT. The soil borings will be described by the field personnel in accordance with [SOP-09](#) (Soil Sample Logging). Any qualitative visual signs of potential contamination (such as soil staining) will be noted on the soil boring log. The surface and subsurface soil samples will be collected in accordance with [SOP-10](#) (Surface and Subsurface Soil Sampling). Samples for VOC analyses will be collected from 0.5 to 2 feet below the ground surface.

Surface Water Sampling

The surface water sampling procedures discussed in [SOP-05](#) (Surface Water Sampling) will be followed. If surface water is deep enough to accommodate the necessary instrumentation, water quality parameters will be measured in situ and recorded during the collection of each surface water sample using a multi-parameter water quality meter in accordance with [SOP-06](#) (Measurement of Water Quality Parameters). The PM or FOL will coordinate with NSA Crane regarding the timing of and locations where samples are collected for surface water sampling so as not to conflict with regulatory National Pollutant Discharge Elimination System (NPDES) permit sampling activities (if applicable).

Sediment Sampling (Surface Water Pathways and Subsurface Structures)

During sediment sampling the procedures discussed in [SOP-07](#) (Sediment Sampling) will be followed. Sampling locations from surface water drainages for the sediment samples will be at the same location as surface water samples. Sample materials will be collected from 0 to 6 inches beneath the sediment surface, which is the interval most likely to be contaminated.

In addition, a sediment sample will be collected from the base of the oil/water separator located within SWMU 23. The sediment samples will be collected in accordance with [SOP-07](#).

Monitoring Well Drilling and Installation

Should the site characterization soil samples indicate elevated concentrations of constituents having the potential to reach the shallow groundwater at the site, groundwater monitoring wells will be subsequently installed in accordance with [SOP-12](#) (Monitoring Well Installation) within the area of SWMU 23 as part of the RFI. The wells at SWMU 23 will be installed within the shallowest waterbearing zone in bedrock. One bedrock well location will be cored to characterize stratigraphy, fracture distribution, and other features of the bedrock units in SWMU 23. Procedures for drilling and logging a boring in soil are included in [SOP-08](#), and in rock in [SOP-13](#) (Drilling and Geologic Logging of Boreholes in Bedrock).

If installed, the permanent monitoring wells will be constructed of 2-inch-diameter, Schedule 40, flush-joint, polyvinyl chloride (PVC) riser pipe and slotted screen (see [SOP-12](#) Monitoring Well Installation). In each well, the screen will be 10 feet long and have a slot size of 0.010-inch (factory slotted). 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-12](#) (Monitoring Well Installation).

Well Surveying

Any newly installed monitoring wells will be surveyed for horizontal and vertical location by an Indiana-licensed surveyor. The ground surface, the top of the protective casing, and the top of the well riser will be surveyed. Horizontal locations will be surveyed to 0.1-foot, and vertical elevations will be surveyed to 0.01 foot. Horizontal coordinates will be relative to the Indiana State Plane Coordinate System (West Zone), and the vertical elevations will be relative to North American Vertical Datum (NAVD) 88.

Well Development

Any monitoring wells installed at the site will be developed in accordance with [SOP-14](#) (Monitoring Well Development) to remove fine sediment from inside and around the well screens.

All groundwater removed from the well during the development process will be stored in a portable holding tank (already present at NSA Crane) and discharged into a designated man-hole for treatment at the NSA Crane water treatment facility (see [SOP-19](#) - Management of Investigation Derived Waste).

Groundwater Level Measurements

Prior to sampling, one synoptic round of water level measurements and total well depth soundings will be obtained at each of the monitoring wells installed at SWMU 23. All groundwater level measurements collected within SWMU 23 will be taken within an 8-hour period using an electronic water-level meter. Water level elevations will be recorded to within 0.01-foot accuracy from a marked reference point on the well riser pipe. Detailed procedures regarding water level measurements are included in [SOP-15](#) (Measurement of Water Levels in Monitoring Wells). Water levels will be recorded on a groundwater level measurement form, provided in [SOP-15](#). The water level meter will be decontaminated between each well measurement; decontamination procedures are addressed in [SOP-20](#).

Low-Flow Purging and Sampling of Monitoring Wells

Low-flow sampling procedures will be used to collect groundwater samples from the monitoring wells [see [SOP-16](#) (Low Flow Well Purging and Stabilization), [SOP-17](#) (Groundwater Sampling), and [SOP-18](#) (Calibration and Care of Water Quality Meters)].

Global Positioning System Locating

A GPS unit will be used to locate all soil, surface water, and sediment sampling points in accordance with [SOP-21](#) (Global Positioning System). The GPS equipment will be checked on control monuments before

and after each day's use; these checks will be documented in the field notebook. To ensure sub-meter accuracy, the GPS SOP requires a minimum of six satellites to capture a position.

Investigation-Derived Waste Management

Solid or semi-solid IDW in the form of soil or water will be generated during field activities, including during collection of subsurface samples using DPT and monitoring well installation using a rotary drill rig and split-spoon samplers. Soil will be replaced into the DPT boring from which it was removed.

IDW generated, including personal protective equipment (PPE) and decontamination fluids will be handled in accordance with [SOP-19](#) (Management of Investigation-Derived Waste).

Field Decontamination Procedures

Decontamination of sampling equipment will not be necessary for dedicated and disposable hand trowels. Decontamination of reusable sampling equipment (e.g., non-disposable hand trowels, hand augers, split-spoon-samplers, DPT sampling equipment, drill rods and bits, or groundwater sampling equipment) will be conducted prior to sampling and between samples at each location. Decontamination of equipment will be conducted according to the sequence established in [SOP-20](#) (Decontamination of Field Sampling Equipment).

Field Documentation Procedures

Field documentation will be performed in accordance with [SOP-03](#) (Sample Custody and Documentation of Field Activity).

Sample Handling

Methods for sample handling will be in accordance with [SOP-03](#) (Sample Custody and Documentation of Field Activities). Sample containers will be provided certified-clean (I-Chem 300 or equivalent) from Empirical Laboratories (Empirical). Sample labeling will be in accordance with [SOP-01](#) (Sample Labeling), and the sample numbering scheme will be in accordance with [Worksheet #27](#) and [SOP-02](#) (Sample Identification and Nomenclature). The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with [Worksheet #19](#) and [SOP-04](#) (Sample Preservation, Packaging, and Shipping).

Quality Control Tasks

QA/QC samples will be collected at frequencies listed in [Worksheets #12 and #20](#).

14.2 ADDITIONAL PROJECT-RELATED TASKS

Additional project-related tasks include:

- Analytical Tasks
- Data Management
- Assessment and Oversight
- Data Review
- Project Reports

Analytical Tasks

Chemical analyses for VOCs, PAHs, PCBs, TPH (GRO, DRO, and ERO), metals, and miscellaneous parameters will be performed by Empirical, which is a Department of Defense (DoD) Environmental Laboratory Approval Program (ELAP)-accredited laboratory. A copy of the laboratory accreditation for Empirical is included in [Appendix C](#). Analyses will be performed in accordance with the analytical methods identified in [Worksheet #30](#). Empirical will meet the PSLs specified in [Worksheet #15](#) and will perform the chemical analyses following laboratory-specific SOPs (see [Worksheets #19 and #23](#)) developed based on the methods listed in [Worksheets #19 and #30](#).

All soil and sediment results will be reported by the laboratory on an adjusted dry-weight basis for all parameters, except pH. Results of percent moisture will be reported in each analytical data package and associated electronic data files. This information will also be captured in the project database, which will eventually be uploaded to the Naval Installation Restoration Information Solutions (NIRIS) database. Percent moisture information will also be captured in the RFI Report.

The analytical data packages provided by Empirical will be in a Contract Laboratory Program-like format and will be fully validatable and contain raw data, summary forms for all sample and laboratory method blank data, and summary forms containing all method-specific QC (results, recoveries, RPDs, relative standard deviations, and/or percent differences, etc.).

Data Management

The data generated for this project will be from field data and laboratory analytical data. After the RFI field work is completed, field sampling log sheets will be organized by date and environmental medium, and filed in the project files. The field logbooks for this project will be used only for this site and will also be categorized and maintained in the project files after the completion of the field program. Project

personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity.

The data handling procedures to be followed by Empirical will meet the requirements of the technical specifications. Electronic data results will be automatically downloaded into the Tetra Tech database in accordance with the proprietary Tetra Tech processes.

The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- **Data Tracking.** Data are tracked from generation to archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to Empirical. Upon receipt of the data packages from Empirical, the Tetra Tech Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by Empirical.
- **Data Storage, Archiving, and Retrieval.** The data packages received from Empirical are tracked in the data validation logbook. After the data are validated, the data packages are entered into the Tetra Tech Navy CLEAN file system and archived in secure files. The field records including field log books, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. The project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Tetra Tech. Electronic data will be uploaded to NIRIS as indicated in [Worksheet #29](#).
- **Data Security.** Access to Tetra Tech project files is restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data Manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.
- **Electronic Data.** All electronic data will be compiled into a NIRIS Electronic Data Deliverable (NEDD) and loaded into NIRIS.

Assessment and Oversight

Refer to [Worksheet #32](#) for assessment findings and corrective actions and to [Worksheet #33](#) for QA Management Reports.

Data Review - Data verification is described in [Worksheet #34](#), data validation is described in [Worksheets #35 and #36](#), and usability assessment is described in [Worksheet #37](#).

Project Reports – Draft and final versions of the RFI Report will be prepared and submitted to the Navy and IDEM for review. The reports will include the following sections:

- Executive Summary – will include a brief description of the work conducted and the findings.
- Introduction and Background – will include a description of the history of operations and activities at the site and a summary of any previous investigations and removal actions.
- Description of Field Investigations – will include a summary of the work performed in accordance with the approved UFP-SAP and any field modifications as documented by the Tetra Tech FOL. This section will include maps showing the sampling locations and tables summarizing the data collected. A description of geophysical methods utilized, and a summary of the geophysical investigation results will be provided, including figures depicting the survey area and survey findings.
- Data Quality – will include a summary of quantitative analytical performance indicators such as completeness, precision, bias, and sensitivity and qualitative indicators such as representativeness and comparability. This section includes a reconciliation of project data with the DQOs and an identification of deviations from this UFP-SAP.

A data usability assessment will be used to identify significant deviations in analytical performance that could affect the ability to meet project objectives. The elements of this review are presented in [Worksheet #37](#).

- Nature and Extent of Contamination – will include a discussion of the contamination detected in each medium sampled in relation to the CSM of the site. This section will note the removals previously conducted (if applicable), contamination addressed, and any additional contaminants found during this field effort. Detected contaminant concentrations will be tabulated for each medium and depicted on maps.

- Contaminant Fate and Transport – will include a description of the contaminants detected and their behavior in soil, bedrock, groundwater, surface water, and sediment, particularly with emphasis on the future migration of these contaminants to any possible exposure areas.
- Summary and Conclusions – includes a summary of the findings, conclusions as to whether delineation of contamination is adequate, and recommendations for further investigations, if needed.

Tetra Tech will submit the draft report and respond to comments received on the draft report before any additional sampling begins. The final version of the report will be submitted in hardcopy and electronic format to the project stakeholders.

SAP Worksheet No. 15 -- Reference Limits and Evaluation Table
 (UFP-QAPP Manual Section 2.8.1)

Matrix: Surface Soil (depth: 0 to 2 feet) and Subsurface Soil (depth: greater than 2 feet)

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	630-20-6	0.0038	225	RBSSL	Reg 5	0.0013	0.005	0.0025	0.00125
1,1,1-Trichloroethane	71-55-6	1.4	29.8	RBSSL	Reg 5	0.47	0.005	0.0025	0.00125
1,1,2,2-Tetrachloroethane	79-34-5	0.00052	0.127	RBSSL	Reg 5	0.00017	0.005	0.0025	0.00125
1,1,2-Trichloroethane	79-00-5	0.0015	28.6	RBSSL	Reg 5	0.00052	0.005	0.0025	0.00125
1,1-Dichloroethane	75-34-3	0.014	20.1	RBSSL	Reg 5	0.0047	0.005	0.0025	0.00125
1,1-Dichloroethene	75-35-4	0.050	8.28	RBSSL	Reg 5	0.017	0.005	0.0025	0.00125
1,2,3-Trichloropropane	96-18-4	0.0000056	3.36	RBSSL	Reg 5	0.0000021	0.005	0.0025	0.00125
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	2.8E-06	0.0352	RBSSL	Reg 5	0.00000093	0.01	0.005	0.0025
1,2-Dibromoethane (EDB)	106-93-4	0.000036	1.23	RBSSL	Reg 5	0.000012	0.005	0.0025	0.00125
1,2-Dichloroethane	107-06-2	0.00084	21.2	RBSSL	Reg 5	0.00028	0.005	0.0025	0.00125
1,2-Dichloropropane	78-87-5	0.0026	32.7	RBSSL	Reg 5	0.00087	0.005	0.0025	0.00125
2-Butanone (MEK)	78-93-3	20	89.6	RBSSL	Reg 5	6.7	0.01	0.005	0.0025
2-Hexanone	591-78-6	0.16	12.6	RBSSL	Reg 5	0.073	0.005	0.0025	0.00125
4-Methyl-2-pentanone (MIBK)	108-10-1	4.6	443	RBSSL	Reg 5	1.5	0.005	0.0025	0.00125
Acetone	67-64-1	28	2.5	IDEM-RDCL	Reg 5	0.83	0.02	0.01	0.005
Acetonitrile	75-05-8	0.52	1.37	RBSSL	Reg 5	0.17	0.05	0.025	0.01
Acrolein	107-02-8	0.00017	5.27	RBSSL	Reg 5	0.000056	0.02	0.01	0.005
Acrylonitrile	107-13-1	0.000198	0.0239	RBSSL	Reg 5	0.000066	0.02	0.01	0.005
Allyl Chloride	107-05-1	0.0040	0.0134	RBSSL	Reg 5	0.0013	0.005	0.0025	0.00125
Benzene	71-43-2	0.0040	0.255	RBSSL	Reg 5	0.0013	0.005	0.0025	0.00125
Bromodichloromethane	75-27-4	0.00064	0.54	RBSSL	Reg 5	0.00021	0.005	0.0025	0.00125
Bromoform	75-25-2	0.042	15.9	RBSSL	Reg 5	0.014	0.005	0.0025	0.00125
Bromomethane	74-83-9	0.036	0.235	RBSSL	Reg 5	0.012	0.01	0.005	0.0025

Matrix: Surface Soil (depth: 0 to 2 feet) and Subsurface Soil (depth: greater than 2 feet)

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Carbon disulfide	75-15-0	4.2	0.0941	RBSSL	Reg 5	0.031	0.005	0.0025	0.00125
Carbon tetrachloride	56-23-5	0.0030	2.98	RBSSL	Reg 5	0.0010	0.005	0.0025	0.00125
Chlorobenzene	108-90-7	0.98	13.1	RBSSL	Reg 5	0.33	0.005	0.0025	0.00125
Chloroethane	75-00-3	0.65	NC	IDEM-RDCL	None	0.22	0.01	0.005	0.0025
Chloroform	67-66-3	0.0011	1.19	RBSSL	Reg 5	0.00035	0.005	0.0025	0.00125
Chloromethane	74-87-3	0.98	10.4	RBSSL	Reg 5	0.33	0.01	0.005	0.0025
Chloroprene	126-99-8	0.00017	0.0029	RBSSL	Reg 5	0.000057	0.005	0.0025	0.00125
cis-1,2-Dichloroethene	156-59-2	0.16	0.784	IDEM-RDCL	Reg 5	0.053	0.005	0.0025	0.00125
cis-1,3-Dichloropropene	10061-01-5	0.0030	0.398	RBSSL	Reg 5	0.0010	0.005	0.0025	0.00125
Dibromochloromethane	124-48-1	0.00078	2.05	RBSSL	Reg 5	0.00026	0.005	0.0025	0.00125
Dichlorodifluoromethane	75-71-8	6.0	39.5	RBSSL	Reg 5	2.0	0.01	0.005	0.0025
Ethyl methacrylate	97-63-2	2.0	30	RBSSL	Reg 5	0.67	0.005	0.0025	0.00125
Ethylbenzene	100-41-4	0.030	5.16	RBSSL	Reg 5	0.010	0.005	0.0025	0.00125
Iodomethane	74-88-4	NC	1.23	None	Reg 5	0.41	0.02	0.01	0.005
Isobutyl alcohol	78-83-1	19	20.8	RBSSL	Reg 5	6.3	0.1	0.04	0.02
Methacrylonitrile	126-98-7	0.0034	0.057	RBSSL	Reg 5	0.0011	0.05	0.025	0.01
Methyl methacrylate	80-62-6	6.0	984	RBSSL	Reg 5	2.0	0.005	0.0025	0.00125
Methylene bromide	74-95-3	0.038	65	RBSSL	Reg 5	0.013	0.005	0.0025	0.00125
Methylene chloride	75-09-2	0.023	4.05	IDEM-RDCL	Reg 5	0.0077	0.01	0.005	0.0025
Propionitrile	107-12-0	NC	0.0498	None	Reg 5	0.017	0.05	0.025	0.01
Styrene	100-42-5	2.2	4.69	IDEM-RDCL	Reg 5	0.73	0.005	0.0025	0.00125
Tetrachloroethene	127-18-4	0.058	9.92	IDEM-RDCL	Reg 5	0.00033	0.005	0.0025	0.00125
Toluene	108-88-3	12	5.45	IDEM-RDCL	Reg 5	1.8	0.005	0.0025	0.00125
trans-1,2-Dichloroethene	156-60-5	0.50	0.784	RBSSL	Reg 5	0.17	0.005	0.0025	0.00125
trans-1,3-Dichloropropene	10061-02-6	0.0030	0.398	IDEM-RDCL	Reg 5	0.0010	0.005	0.0025	0.00125
trans-1,4-Dichloro-2-butene	110-57-6	0.000011	1000	RBSSL	NOAA	0.0000036	0.005	0.0025	0.00125
Trichloroethene	79-01-6	0.0032	12.4	RBSSL	Reg 5	0.0011	0.005	0.0025	0.00125
Trichlorofluoromethane	75-69-4	14	16.4	RBSSL	Reg 5	4.7	0.01	0.005	0.0025

Matrix: Surface Soil (depth: 0 to 2 feet) and Subsurface Soil (depth: greater than 2 feet)

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Vinyl acetate	108-05-4	1.7	12.7	RBSSL	Reg 5	0.57	0.01	0.005	0.0025
Vinyl chloride	75-01-4	0.00011	0.646	RBSSL	Reg 5	0.000037	0.005	0.0025	0.00125
Xylenes (total)	1330-20-7	3.8	10	RBSSL	Reg 5	1.3	0.005	0.0025	0.00125

Polycyclic Aromatic Hydrocarbons

2-Methylnaphthalene	91-57-6	2.8	29	RBSSL	Eco SSL	0.93	0.00667	0.00333	0.00167
Acenaphthene	83-32-9	82	29	RBSSL	Eco SSL	9.7	0.00667	0.00333	0.00167
Acenaphthylene	208-96-8	18	29	IDEM-RDCL	Eco SSL	6.0	0.00667	0.00333	0.00167
Anthracene	120-12-7	840	29	R-RSL	Eco SSL	9.7	0.00667	0.00333	0.00167
Benzo(a)anthracene	56-55-3	0.15	1.1	R-RSL	Eco SSL	0.050	0.00667	0.00333	0.00167
Benzo(a)pyrene	50-32-8	0.015	1.1	R-RSL	Eco SSL	0.0050	0.00667	0.00333	0.00167
Benzo(b)fluoranthene	205-99-2	0.15	1.1	R-RSL	Eco SSL	0.050	0.00667	0.00333	0.00167
Benzo(g,h,i)perylene	191-24-2	170	1.1	R-RSL	Eco SSL	0.37	0.00667	0.00333	0.00167
Benzo(k)fluoranthene	207-08-9	1.5	1.1	R-RSL	Eco SSL	0.37	0.00667	0.00333	0.00167
Chrysene	218-01-9	15	1.1	R-RSL	Eco SSL	0.37	0.00667	0.00333	0.00167
Dibenzo(a,h)anthracene	53-70-3	0.015	1.1	R-RSL	Eco SSL	0.0050	0.00667	0.00333	0.00167
Fluoranthene	206-44-0	230	29	R-RSL	Eco SSL	9.7	0.00667	0.00333	0.00167
Fluorene	86-73-7	80	29	RBSSL	Eco SSL	9.7	0.00667	0.00333	0.00167
Indeno(1,2,3-c,d)pyrene	193-39-5	0.15	1.1	R-RSL	Eco SSL	0.050	0.00667	0.00333	0.00167
Naphthalene	91-20-3	0.0094	29	RBSSL	Eco SSL	0.0031	0.00667	0.00333	0.00167
Phenanthrene	85-01-8	13	29	IDEM-RDCL	Eco SSL	4.3	0.00667	0.00333	0.00167
Pyrene	129-00-0	170	1.1	R-RSL	Eco SSL	0.37	0.00667	0.00333	0.00167

Polychlorinated Biphenyls

Aroclor-1016	12674-11-2	0.39	0.000332	R-RSL	Reg 5	0.00011	0.00334⁽³⁾	0.001666⁽³⁾	0.000834⁽³⁾
Aroclor-1221	11104-28-2	0.0015	0.000332	RBSSL	Reg 5	0.00011	0.00334⁽³⁾	0.001666⁽³⁾	0.000834⁽³⁾
Aroclor-1232	11141-16-5	0.0015	0.000332	RBSSL	Reg 5	0.00011	0.00334⁽³⁾	0.001666⁽³⁾	0.000834⁽³⁾
Aroclor-1242	53469-21-9	0.11	0.000332	RBSSL	Reg 5	0.00011	0.00334⁽³⁾	0.001666⁽³⁾	0.000834⁽³⁾
Aroclor-1248	12672-29-6	0.104	0.000332	RBSSL	Reg 5	0.00011	0.00334⁽³⁾	0.001666⁽³⁾	0.000834⁽³⁾

Matrix: Surface Soil (depth: 0 to 2 feet) and Subsurface Soil (depth: greater than 2 feet)

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Aroclor-1254	11097-69-1	0.11	0.000332	R-RSL	Reg 5	0.00011	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1260	11096-82-5	0.22	0.000332	R-RSL	Reg 5	0.00011	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Total PCBs	1336-36-3	0.22	0.000332	R-RSL	Reg 5	0.00011	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾

Metals

Antimony	7440-36-0	3.1	0.27	R-RSL	Eco SSL	0.090	0.50	0.4	0.25
Arsenic	7440-38-2	0.026	18	RBSSL	Eco SSL	0.0087	0.5	0.3	0.15
Barium	7440-39-3	1500	330	R-RSL	Eco SSL	110	8	4	1
Beryllium	7440-41-7	16	21	R-RSL	Eco SSL	5.3	1	0.4	0.2
Cadmium	7440-43-9	7.0	0.36	R-RSL	Eco SSL	0.12	0.25	0.1	0.05
Chromium	7440-47-3	0.012	26	RBSSL	Eco SSL	0.0040	0.5	0.2	0.1
Cobalt	7440-48-4	2.3	13	R-RSL	Eco SSL	0.77	0.625	0.5	0.25
Copper	7440-50-8	310	28	R-RSL	Eco SSL	9.3	2	1.6	0.8
Lead	7439-92-1	81	11	IDEM-RDCL	Eco SSL	3.7	1	0.6	0.3
Mercury	7439-97-6	0.78	0.1	R-RSL	Reg 5	0.033	0.033	0.033	0.0130
Nickel	7440-02-0	150	38	R-RSL	Eco SSL	12.7	2	1.2	0.6
Selenium	7782-49-2	5.2	0.52	IDEM-RDCL	Eco SSL	0.17	0.5	0.25	0.15
Silver	7440-22-4	12	4.2	RBSSL	Eco SSL	1.4	0.5	0.1	0.05
Thallium	7440-28-0	0.078	0.0569	R-RSL	Reg 5	0.019	0.4	0.2	0.15
Vanadium	7440-62-2	39	7.8	R-RSL	Eco SSL	2.6	2.5	2	1
Zinc	7440-66-6	2300	46	R-RSL	Eco SSL	15	4	2	1

Miscellaneous

Total Petroleum Hydrocarbons (As determined using DRO/GRO/ERO analysis or fractionation in accordance with decision rules)	NA	NC	None	NC	None	6.67	6.67	6.67	6.67
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Matrix: Surface Soil (depth: 0 to 2 feet) and Subsurface Soil (depth: greater than 2 feet)

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
pH (surface soil only)	NA	NC	None	NC	None	(pH units)	NA	NA	NA
Sulfate	14808-79-8	NC	None	NC	None	20	20	10	3.3

- 1 HH PSL References: The R-RSL and RBSSL were taken from the USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, May 2012, available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.html. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens divided by 10 (denoted in the USEPA tables with an "N" flag) or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted in the USEPA tables with a "C" flag). For non-carcinogens, the division by 10 renders the adjusted criterion equal to a hazard quotient of 0.1 and represents an assumption that 10 compounds having the same target organ effect may be present. IDEM-RDCL (Residential Default Closure Levels) were taken from IDEM RISC Technical Guide, January 31, 2006, Appendix 1, revised May 1, 2009.
- 2 Eco PSL Reference: Of the reference used to select ecological criteria, not all references have a criterion for every chemical. These criteria represent the first available criterion in the following hierarchy of references: Eco SSL - USEPA Ecological Soil Screening Levels (USEPA, 2005a-e, 2006d, 2007a,b, 2008b); Reg 5 - USEPA Region 5 Ecological Screening Levels (USEPA, 2003); and NOAA - NOAA's Quick Reference Tables (Buchman, 2008).
- 3 Value reflects a five times lower detection limit obtained by concentrating the extract from 5 milliliter (mL) to 1 mL. Samples will be concentrated to attain the documented LOQs, LODs, and DLs.

General Notes:

Bolded rows indicate that the PSL is between the laboratory LOQ and LOD. Results less than the LOQ will be "J" flagged to indicate a greater level of imprecision than results greater than the LOQ and these data will be accepted for decision making. The effect of these J-qualified results on the contaminant delineation and risk assessment will be described in an uncertainty section of the RFI report.

Bolded and Shaded rows indicate that the PSL is less than the LOD. In these cases, the Project Team has agreed to report non-detected results at the LOD. Any limitations on data use resulting from having detection limits greater than PSLs will be described in the RFI Report.

CAS – Chemical Abstracts Service

DL – Detection limit

Eco – Ecological

LOD - Limit of Detection

mg/kg – Milligram per kilogram

PQLG - Project Quantitation Limit Goal

RBSSL - Risk-Based Soil Screening Level

Matrix: Sediment

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Volatile Organic Compounds									
1,1,1,2-Tetrachloroethane	630-20-6	1.9	NC	R-RSL	None	0.63	0.005	0.0025	0.00125
1,1,1-Trichloroethane	71-55-6	870	0.213	R-RSL	Reg 5	0.071	0.005	0.0025	0.00125
1,1,2,2-Tetrachloroethane	79-34-5	0.56	0.85	R-RSL	Reg 5	0.19	0.005	0.0025	0.00125
1,1,2-Trichloroethane	79-00-5	0.16	0.518	R-RSL	Reg 5	0.053	0.005	0.0025	0.00125
1,1-Dichloroethane	75-34-3	3.3	0.000575	R-RSL	Reg 5	0.00019	0.005	0.0025	0.00125
1,1-Dichloroethene	75-35-4	24	0.0194	R-RSL	Reg 5	0.0065	0.005	0.0025	0.00125
1,2,3-Trichloropropane	96-18-4	0.0050	NC	R-RSL	None	0.0017	0.005	0.0025	0.00125
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	0.0054	NC	R-RSL	None	0.0018	0.01	0.005	0.0025
1,2-Dibromoethane (EDB)	106-93-4	0.034	NC	R-RSL	None	0.011	0.005	0.0025	0.00125
1,2-Dichloroethane	107-06-2	0.43	0.26	R-RSL	Reg 5	0.087	0.005	0.0025	0.00125
1,2-Dichloropropane	78-87-5	0.94	0.333	R-RSL	Reg 5	0.11	0.005	0.0025	0.00125
2-Butanone (MEK)	78-93-3	2800	0.0424	R-RSL	Reg 5	0.014	0.01	0.005	0.0025
2-Hexanone	591-78-6	21	0.0582	R-RSL	Reg 5	0.019	0.005	0.0025	0.00125
4-Methyl-2-pentanone (MIBK)	108-10-1	530	0.0251	R-RSL	Reg 5	0.0084	0.005	0.0025	0.00125
Acetone	67-64-1	6100	0.0099	R-RSL	Reg 5	0.0033	0.02	0.01	0.005
Acetonitrile	75-05-8	87	0.056	R-RSL	Reg 5	0.019	0.05	0.025	0.01
Acrolein	107-02-8	0.015	0.0000015₂	R-RSL	Reg 5	0.00000051	0.02	0.01	0.005
Acrylonitrile	107-13-1	0.24	0.0012	R-RSL	Reg 5	0.00040	0.005	0.0025	0.00125
Allyl Chloride	107-05-1	0.18	NA	R-RSL	NA	0.060	0.005	0.0025	0.00125
Benzene	71-43-2	1.1	0.142	R-RSL	Reg 5	0.047	0.005	0.0025	0.00125
Bromodichloromethane	75-27-4	0.27	NA	R-RSL	NA	0.090	0.005	0.0025	0.00125
Bromoform	75-25-2	62	0.492	R-RSL	Reg 5	0.16	0.005	0.0025	0.00125
Bromomethane	74-83-9	0.73	0.00137	R-RSL	Reg 5	0.00046	0.01	0.005	0.0025
Carbon disulfide	75-15-0	82	0.0239	R-RSL	Reg 5	0.0077	0.005	0.0025	0.00125
Carbon tetrachloride	56-23-5	0.61	1.45	R-RSL	Reg 5	0.20	0.005	0.0025	0.00125
Chlorobenzene	108-90-7	29	0.291	R-RSL	Reg 5	0.097	0.005	0.0025	0.00125

Matrix: Sediment

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Chloroethane	75-00-3	80	NC	IDEM-RDCL	None	27	0.01	0.005	0.0025
Chloroform	67-66-3	0.29	0.121	R-RSL	Reg 5	0.040	0.005	0.0025	0.00125
Chloromethane	74-87-3	12	NC	R-RSL	None	4.0	0.01	0.005	0.0025
Chloroprene	126-99-8	0.0094	NC	R-RSL	None	0.0031	0.005	0.0025	0.00125
cis-1,2-Dichloroethene	156-59-2	16	0.20894	R-RSL	Reg 5	0.070	0.005	0.0025	0.00125
cis-1,3-Dichloropropene	10061-01-5	1.7	0.0000509	R-RSL	R3 SED BTAG	1.7E-5	0.005	0.0025	0.00125
Dibromochloromethane	124-48-1	0.68	NC	R-RSL	None	0.23	0.005	0.0025	0.00125
Dichlorodifluoromethane	75-71-8	9.4	NC	R-RSL	None	3.1	0.01	0.005	0.0025
Ethly methacrylate	97-63-2	150	NC	R-RSL	None	50	0.005	0.0025	0.00125
Ethylbenzene	100-41-4	5.4	0.175	R-RSL	Reg 5	0.058	0.005	0.0025	0.00125
Iodomethane	74-88-4	NC	NC	None	None	None	0.02	0.01	0.005
Isobutyl alcohol	78-83-1	1800	NC	R-RSL	None	600	0.1	0.04	0.02
Methacrylonitrile	126-98-7	0.32	NC	R-RSL	None	0.11	0.05	0.025	0.01
Methyl methacrylate	80-62-6	480	0.168	R-RSL	Reg 5	0.056	0.005	0.0025	0.00125
Methylene bromide	74-95-3	2.5	NC	R-RSL	None	0.83	0.005	0.0025	0.00125
Methylene chloride	75-09-2	56	0.159	R-RSL	Reg 5	0.053	0.01	0.005	0.0025
Propionitrile	107-12-0	NC	NC	None	None	0.05	0.05	0.025	0.00125
Styrene	100-42-5	630	0.254	R-RSL	Reg 5	0.085	0.005	0.0025	0.00125
Tetrachloroethene	127-18-4	9.9	0.99	IDEM-RDCL	Reg 5	0.33	0.005	0.0025	0.00125
Toluene	108-88-3	500	1.22	R-RSL	Reg 5	0.41	0.005	0.0025	0.00125
trans-1,2-Dichloroethene	156-60-5	15	0.654	R-RSL	Reg 5	0.22	0.005	0.0025	0.00125
trans-1,3-Dichloropropene	10061-02-6	1.7	0.0000509	R-RSL	R3 SED BTAG	1.7E-5	0.005	0.0025	0.00125
trans-1,4-Dichloro-2-Butene	110-57-6	0.0069	NC	R-RSL	None	0.0023	0.005	0.0025	0.00125
Trichloroethene	79-01-6	0.25	0.112	R-RSL	Reg 5	0.037	0.005	0.0025	0.00125
Trichlorofluoromethane	75-69-4	79	NC	R-RSL	None	26	0.01	0.005	0.0025
Vinyl acetate	108-05-4	97	0.013	R-RSL	Reg 5	0.0043	0.01	0.005	0.0025

Matrix: Sediment

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Vinyl chloride	75-01-4	0.060	0.202	R-RSL	Reg 5	0.020	0.005	0.0025	0.00125
Xylenes (total)	1330-20-7	63	0.433	R-RSL	Reg 5	0.14	0.005	0.0025	0.00125

Polycyclic Aromatic Hydrocarbons

2-Methylnaphthalene	91-57-6	23	0.0202	R-RSL	Reg 5	0.0067	0.00667	0.00333	0.00167
Acenaphthene	83-32-9	340	0.00671	R-RSL	Reg 5	0.0022	0.00667	0.00333	0.00167
Acenaphthylene	208-96-8	340	0.00587	R-RSL	Reg 5	0.0020	0.00667	0.00333	0.00167
Anthracene	120-12-7	1700	0.0572	R-RSL	Reg 5	0.019	0.00667	0.00333	0.00167
Benzo(a)anthracene	56-55-3	0.15	0.108	R-RSL	Reg 5	0.036	0.00667	0.00333	0.00167
Benzo(a)pyrene	50-32-8	0.015	0.15	R-RSL	Reg 5	0.0050	0.00667	0.00333	0.00167
Benzo(b)fluoranthene	205-99-2	0.15	10.4	R-RSL	Reg 5	0.050	0.00667	0.00333	0.00167
Benzo(g,h,i)perylene	191-24-2	170	0.17	R-RSL	Reg 5	0.057	0.00667	0.00333	0.00167
Benzo(k)fluoranthene	207-08-9	1.5	0.24	R-RSL	Reg 5	0.080	0.00667	0.00333	0.00167
Chrysene	218-01-9	15	0.166	R-RSL	Reg 5	0.055	0.00667	0.00333	0.00167
Dibenzo(a,h)anthracene	53-70-3	0.015	0.033	R-RSL	Reg 5	0.0050	0.00667	0.00333	0.00167
Fluoranthene	206-44-0	230	0.423	R-RSL	Reg 5	0.14	0.00667	0.00333	0.00167
Fluorene	86-73-7	230	0.0774	R-RSL	Reg 5	0.026	0.00667	0.00333	0.00167
Indeno(1,2,3-c,d)pyrene	193-39-5	0.15	0.2	R-RSL	Reg 5	0.050	0.00667	0.00333	0.00167
Naphthalene	91-20-3	3.6	0.176	R-RSL	Reg 5	0.059	0.00667	0.00333	0.00167
Phenanthrene	85-01-8	170	0.204	R-RSL	Reg 5	0.068	0.00667	0.00333	0.00167
Pyrene	129-00-0	170	0.195	R-RSL	Reg 5	0.065	0.00667	0.00333	0.00167

Polychlorinated Biphenyls

Aroclor-1016	12674-11-2	0.39	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1221	11104-28-2	0.14	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1232	11141-16-5	0.14	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1242	53469-21-9	0.22	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1248	12672-29-6	0.22	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1254	11097-69-1	0.11	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾
Aroclor-1260	11096-82-5	0.22	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾

Matrix: Sediment

Analyte	CAS Number	HH PSL (mg/kg)	Eco PSL (mg/kg)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Total PCBs	1336-36-3	0.22	0.0598	R-RSL	Reg 5	0.020	0.00334 ⁽³⁾	0.001666 ⁽³⁾	0.000834 ⁽³⁾

Metals

Antimony	7440-36-0	3.1	2	R-RSL	R3 SED BTAG	0.67	0.5	0.4	0.25
Arsenic	7440-38-2	0.39	9.79	R-RSL	Reg 5	0.13	0.5	0.3	0.15
Barium	7440-39-3	1500	NC	R-RSL	None	500	8	4	1
Beryllium	7440-41-7	16	NC	R-RSL	None	5.3	1	0.4	0.2
Cadmium	7440-43-9	7	0.99	R-RSL	Reg 5	0.33	0.25	0.1	0.05
Chromium	7440-47-3	0.29	43.4	R-RSL	Reg 5	0.097	0.5	0.2	0.1
Cobalt	7440-48-4	2.3	50	R-RSL	Reg 5	0.77	0.625	0.5	0.25
Copper	7440-50-8	310	31.6	R-RSL	Reg 5	10.5	2	1.6	0.8
Lead	7439-92-1	400	35.8	R-RSL	Reg 5	11.9	1	0.6	0.3
Mercury	7439-97-6	0.78	0.174	R-RSL	Reg 5	0.058	0.033	0.033	0.013
Nickel	7440-02-0	150	22.7	R-RSL	Reg 5	7.6	2	1.2	0.6
Selenium	7782-49-2	39	2	R-RSL	R3 SED BTAG	0.67	0.5	0.25	0.15
Silver	7440-22-4	39	0.5	R-RSL	Reg 5	0.17	0.5	0.1	0.05
Thallium	7440-28-0	0.078	NC	R-RSL	None	0.026	0.4	0.2	0.15
Vanadium	7440-62-2	39	NC	R-RSL	None	13.0	2.5	2	1
Zinc	7440-66-6	2300	121	R-RSL	Reg 5	40.3	4	2	1

Miscellaneous

Total Organic Carbon	NA	NA	NA	NA	NA	800	800	400	200
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1 HH PSL References: The residential direct contact screening value (R-RSL) was taken from the USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, May 2012 available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.html. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens divided by 10 (denoted in the EPA tables with an "N" flag) or an incremental lifetime cancer risk (ILCR) of 1E-6 for carcinogens (denoted in the USEPA tables with a "C" flag). For non-carcinogens, the division by 10 renders the adjusted criterion equal to a hazard quotient of 0.1 and represents an assumption that 10 compounds having the same target organ effect may be present. The IDEM residential soil direct contact screening level (IDEM-RDCL) was taken from the IDEM RISC Technical Guide, January 31, 2006, Appendix 1, revised May 1, 2009.

- 2 Eco PSL Reference: Of the references used to select ecological criteria, not all references have a criterion for every chemical. These criteria represent the first available criterion in the following hierarchy of references: Reg 5 - USEPA Region 5 Ecological Screening Levels (USEPA, 2003); and Reg 3 – USEPA Region 3 BTAG Freshwater Sediment Screening Levels (USEPA, 2006b).
- 3 Value reflects a five times lower detection limit obtained by concentrating the extract from 5 milliliter (mL) to 1 mL. Samples will be concentrated to attain the documented LOQs, LODs, and DLs.

General Notes:

Bolded rows indicate that the PSL is between the laboratory LOQ and LOD. Results less than the LOQ will be “J” flagged to indicate a greater level of imprecision than results greater than the LOQ and these data will be accepted for decision making. The effect of these J-qualified results on the contaminant delineation and risk assessment will be described in an uncertainty section of the RFI report.

Bolded and Shaded rows indicate that the PSL is less than the LOD. In these cases, the Project Team has agreed to report non-detected results at the LOD. Any limitations on data use resulting from having detection limits greater than PSLs will be described in the RFI Report.

Matrix: Groundwater

Analyte	CAS Number	HH PSL (µg/L)	HH PSL Reference ⁽¹⁾	PQLG (µg/L)	Empirical		
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)

Volatile Organic Compounds

1,1,1,2-Tetrachloroethane	630-20-6	0.5	T-RSL	0.17	1	0.5	0.25
1,1,1-Trichloroethane	71-55-6	200	IDEM-DCL	67	1	0.5	0.25
1,1,2,2-Tetrachloroethane	79-34-5	0.066	T-RSL	0.022	1	0.5	0.25
1,1,2-Trichloroethane	79-00-5	0.041	T-RSL	0.014	1	0.5	0.25
1,1-Dichloroethane	75-34-3	2.4	T-RSL	0.80	1	0.5	0.25
1,1-Dichloroethene	75-35-4	7	IDEM-DCL	2.3	1	0.5	0.25
1,2,3-Trichloropropane	96-18-4	0.00065	T-RSL	0.00022	2	1	0.5
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	0.00032	T-RSL	0.00011	2	1	0.5
1,2-Dibromoethane (EDB)	106-93-4	0.0065	T-RSL	0.0022	1	0.5	0.25
1,2-Dichloroethane	107-06-2	0.15	T-RSL	0.050	1	0.5	0.25
1,2-Dichloropropane	78-87-5	0.38	T-RSL	0.13	1	0.5	0.25
2-Butanone (MEK)	78-93-3	490	T-RSL	160	10	5	2.5
2-Hexanone	591-78-6	3.4	T-RSL	1.1	5	2.5	1.25
4-Methyl-2-pentanone (MIBK)	108-10-1	100	T-RSL	33	5	2.5	1.25
Acetone	67-64-1	1200	T-RSL	400	10	5	2.5
Acetonitrile	75-05-8	13	T-RSL	4.3	10.0	5.00	2.50
Acrolein	107-02-8	0.0041	T-RSL	0.0014	5.00	2.50	1.25
Acrylonitrile	107-13-1	0.045	T-RSL	0.015	10.0	5.00	2.50
Allyl Chloride	107-05-1	0.21	T-RSL	0.070	1.00	0.50	0.25
Benzene	71-43-2	0.39	T-RSL	0.14	1	0.5	0.25
Bromodichloromethane	75-27-4	0.12	T-RSL	0.040	1	0.5	0.25
Bromoform	75-25-2	7.9	T-RSL	2.6	1	0.5	0.25
Bromomethane	74-83-9	0.70	T-RSL	0.23	2	1	0.5
Carbon disulfide	75-15-0	72	T-RSL	24	1	0.5	0.25
Carbon tetrachloride	56-23-5	0.36	RBSL-VISL	0.12	1	0.5	0.25
Chlorobenzene	108-90-7	7.2	T-RSL	2.4	1	0.5	0.25
Chloroethane	75-00-3	62	IDEM-DCL	21	2	1	0.5

Matrix: Groundwater

Analyte	CAS Number	HH PSL (µg/L)	HH PSL Reference ⁽¹⁾	PQLG (µg/L)	Empirical		
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Chloroform	67-66-3	0.19	T-RSL	0.063	1	0.5	0.25
Chloromethane	74-87-3	19	T-RSL	6.3	1	0.5	0.25
Chloroprene	126-99-8	0.0035	RBSL-VISL	0.0012	1.00	0.50	0.25
cis-1,2-Dichloroethene	156-59-2	2.8	T-RSL	0.93	1	0.5	0.25
cis-1,3-Dichloropropene	10061-01-5	0.41	T-RSL	0.14	1	0.5	0.25
Dibromochloromethane	124-48-1	0.15	T-RSL	0.050	1	0.5	0.25
Dichlorodifluoromethane	75-71-8	0.74	RBSL-VISL	0.24	2	1	0.5
Ethly methacrylate	97-63-2	42	T-RSL	14	1.00	0.50	0.25
Ethylbenzene	100-41-4	1.3	T-RSL	0.43	1	0.5	0.25
Iodomethane	74-88-4	NC	None	None	1.00	0.50	0.25
Isobutyl alcohol	78-83-1	460	T-RSL	150	100.0	50.0	10.0
Methacrylonitrile	126-98-7	0.075	T-RSL	0.025	10.0	5.00	2.50
Methyl methacrylate	80-62-6	140	T-RSL	47	1.00	0.50	0.25
Methylene Bromide	74-95-3	0.79	T-RSL	0.27	1.00	0.50	0.25
Methylene chloride	75-09-2	5	IDEM-DCL	1.6	2	1	0.5
Propionitrile	107-12-0	NC	NC	None	10.0	5.00	2.50
Styrene	100-42-5	100	IDEM-DCL	33	1	0.5	0.25
Tetrachloroethene	127-18-4	0.57	RBSL-VISL	0.19	1	0.5	0.25
Toluene	108-88-3	86	T-RSL	29	1	0.5	0.25
trans-1,2-Dichloroethene	156-60-5	8.6	T-RSL	2.9	1	0.5	0.25
trans-1,3-Dichloropropene	10061-02-6	0.41	T-RSL	0.14	1	0.5	0.25
trans-1,4-Dichloro-2-Butene	110-57-6	0.0012	T-RSL	0.00040	1.00	0.50	0.25
Trichloroethene	79-01-6	0.44	T-RSL	0.15	1	0.5	0.25
Trichlorofluoromethane	75-69-4	18	RBSL-VISL	6.0	2	1	0.5
Vinyl acetate	108-05-4	41	T-RSL	13.7	2	1	0.5
Vinyl chloride	75-01-4	0.015	T-RSL	0.0050	1	0.5	0.25
Xylenes (total)	1330-20-7	19	T-RSL	6.7	1	0.5	0.25

Matrix: Groundwater

Analyte	CAS Number	HH PSL (µg/L)	HH PSL Reference ⁽¹⁾	PQLG (µg/L)	Empirical		
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)

Polycyclic Aromatic Hydrocarbons

2-Methylnaphthalene	91-57-6	2.7	T-RSL	0.90	0.2	0.1	0.05
Acenaphthene	83-32-9	40	T-RSL	13	0.2	0.1	0.05
Acenaphthylene	208-96-8	40	T-RSL	13	0.2	0.1	0.05
Anthracene	120-12-7	130	T-RSL	43	0.2	0.1	0.05
Benzo(a)anthracene	56-55-3	0.029	T-RSL	0.0097	0.2	0.1	0.05
Benzo(a)pyrene	50-32-8	0.0029	T-RSL	0.00097	0.2	0.1	0.05
Benzo(b)fluoranthene	205-99-2	0.029	T-RSL	0.0097	0.2	0.1	0.05
Benzo(g,h,i)perylene	191-24-2	8.7	T-RSL	2.9	0.2	0.1	0.05
Benzo(k)fluoranthene	207-08-9	0.29	T-RSL	0.097	0.2	0.1	0.05
Chrysene	218-01-9	2.9	T-RSL	0.97	0.2	0.1	0.05
Dibenzo(a,h)anthracene	53-70-3	0.0029	T-RSL	0.00097	0.2	0.1	0.05
Fluoranthene	206-44-0	63	T-RSL	21	0.2	0.1	0.05
Fluorene	86-73-7	22	T-RSL	7.3	0.2	0.1	0.05
Indeno(1,2,3-c,d)pyrene	193-39-5	0.029	T-RSL	0.0097	0.2	0.1	0.05
Naphthalene	91-20-3	0.14	T-RSL	0.047	0.2	0.1	0.05
Phenanthrene	85-01-8	8.7	T-RSL	2.9	0.2	0.1	0.05
Pyrene	129-00-0	8.7	T-RSL	2.9	0.2	0.1	0.05

Metals, Total (If Turbidity > 10 NTU, include Dissolved Metals)

Antimony	7440-36-0	0.60	T-RSL	0.20	0.63 ⁽²⁾	0.5 ⁽²⁾	0.3125 ⁽²⁾
Arsenic	7440-38-2	0.045	T-RSL	0.015	0.63⁽²⁾	0.38⁽²⁾	0.1875⁽²⁾
Barium	7440-39-3	290	T-RSL	97	10	2.5	1.25
Beryllium	7440-41-7	1.6	T-RSL	0.53	1.25 ⁽²⁾	0.5 ⁽²⁾	0.25 ⁽²⁾
Cadmium	7440-43-9	0.69	T-RSL	0.23	1.25 ⁽²⁾	0.5 ⁽²⁾	0.25 ⁽²⁾
Chromium	7440-47-3	0.031	T-RSL	0.010	2.5⁽²⁾	1⁽²⁾	0.5⁽²⁾
Cobalt	7440-48-4	0.47	T-RSL	0.16	3.13⁽²⁾	2.5⁽²⁾	1.25⁽²⁾
Copper	7440-50-8	62	T-RSL	21	10	8	4
Lead	7439-92-1	15	T-RSL	5.0	3	3	1.5
Mercury	7439-97-6	0.43	T-RSL	0.14	0.20	0.20	0.0800

Matrix: Groundwater

Analyte	CAS Number	HH PSL (µg/L)	HH PSL Reference ⁽¹⁾	PQLG (µg/L)	Empirical		
					LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Nickel	7440-02-0	30	T-RSL	10	10	6	3
Selenium	7782-49-2	7.8	T-RSL	2.6	2.50 ⁽²⁾	1.25 ⁽²⁾	0.75 ⁽²⁾
Silver	7440-22-4	7.1	T-RSL	2.4	10	2	1
Thallium	7440-28-0	0.016	T-RSL	0.0053	2⁽²⁾	1⁽²⁾	0.75⁽²⁾
Vanadium	7440-62-2	7.8	T-RSL	2.6	3.13 ⁽²⁾	2.5 ⁽²⁾	1.25 ⁽²⁾
Zinc	7440-66-6	470	T-RSL	160	20	10	5

- 1 HH PSL References: The tapwater screening levels from the USEPA Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites, May 2012 is available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.html. The vapor intrusion screening levels are from USEPA Vapor Intrusion Screening Level (VISL) Calculator, Version 1.0 November, 2011 RSLs. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag) or an ILCR of 1E-6 for carcinogens (denoted with a "C" flag).
 The USEPA tapwater screening levels (May, 2012) and vapor intrusion screening levels for noncarcinogens were adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1.
 USEPA Maximum Contaminant Level (MCLs) were taken from the 2011 Edition of the Drinking Water Standards and Health Advisories, January 2011.
 IDEM Groundwater Default Closure Levels (GDCLs) were taken from the IDEM RISC Technical Guide, January 31, 2006, Appendix 1, revised May 1, 2009.
- 2 Samples will be concentrated four times to attain the documented LOQs, LODs, and DLs. This sample concentration technique is referenced in USEPA Method 200.7. SW-846 sample preparation techniques will be utilized (3005/3010).

General Notes:

Bolded rows indicate that the PSL is between the laboratory LOQ and LOD. Results less than the LOQ will be "J" flagged to indicate a greater level of imprecision than results greater than the LOQ and these data will be accepted for decision making. The effect of these J-qualified results on the contaminant delineation and risk assessment will be described in an uncertainty section of the RFI report.

Bolded and Shaded rows indicate that the PSL is less than the LOD. In these cases, the Project Team has agreed to report non-detected results at the LOD. Any limitations on data use resulting from having detection limits greater than PSLs will be described in the RFI Report.

µg/L - Microgram per liter
 NTU - Nephelometric Turbidity Unit

Matrix: Surface Water

Analyte	CAS Number	HH PSL (µg/L)	Eco PSL (µg/L)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
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Polycyclic Aromatic Hydrocarbons

2-Methylnaphthalene	91-57-6	2.7	330	T-RSL	Reg 5	5.0	0.2	0.1	0.05
Acenaphthene	83-32-9	40	38	T-RSL	Reg 5	137	0.2	0.1	0.05
Acenaphthylene	208-96-8	40	4840	T-RSL	Reg 5	13	0.2	0.1	0.05
Anthracene	120-12-7	130	0.035	T-RSL	Reg 5	0.012	0.2	0.1	0.05
Benzo(a)anthracene	56-55-3	0.029	0.025	T-RSL	Reg 5	0.0083	0.2	0.1	0.05
Benzo(a)pyrene	50-32-8	0.0029	0.014	T-RSL	Reg 5	0.00097	0.2	0.1	0.05
Benzo(b)fluoranthene	205-99-2	0.029	9.07	T-RSL	Reg 5	0.0097	0.2	0.1	0.05
Benzo(g,h,i)perylene	191-24-2	8.7	7.64	T-RSL	Reg 5	2.5	0.2	0.1	0.05
Benzo(k)fluoranthene	207-08-9	0.29	NC	T-RSL	None	0.097	0.2	0.1	0.05
Chrysene	218-01-9	2.9	NC	T-RSL	None	0.97	0.2	0.1	0.05
Dibenzo(a,h)anthracene	53-70-3	0.0029	NC	T-RSL	None	0.00097	0.2	0.1	0.05
Fluoranthene	206-44-0	63	1.9	T-RSL	Reg 5	0.63	0.2	0.1	0.05
Fluorene	86-73-7	22	19	T-RSL	Reg 5	6.3	0.2	0.1	0.05
Indeno(1,2,3-c,d)pyrene	193-39-5	0.029	4.31	T-RSL	Reg 5	0.0097	0.2	0.1	0.05
Naphthalene	91-20-3	0.14	13	T-RSL	Reg 5	0.047	0.2	0.1	0.05
Phenanthrene	85-01-8	8.7	3.6	T-RSL	Reg 5	1.2	0.2	0.1	0.05
Pyrene	129-00-0	8.7	0.3	T-RSL	Reg 5	0.10	0.2	0.1	0.05

Metals (Total and Dissolved, regardless of Turbidity)

Antimony	7440-36-0	0.60	80	T-RSL	Reg 5	0.20	2.5	2	1.25
Arsenic	7440-38-2	0.045	150	T-RSL	AWQC	0.015	2.5	1.5	0.75
Barium	7440-39-3	290	220	T-RSL	Reg 5	73	10	2.5	1.25
Beryllium	7440-41-7	1.6	3.6	T-RSL	Reg 5	1.2	1.25	0.5	0.25
Cadmium	7440-43-9	0.69	0.25	T-RSL	AWQC	0.083	1.25⁽³⁾	0.5⁽³⁾	0.25⁽³⁾
Calcium	7440-70-2	NC	116000	None	Reg 3	38700	5000	2000	1000
Chromium	7440-47-3	0.031	11	T-RSL	AWQC	0.010	2.5⁽³⁾	1⁽³⁾	0.5⁽³⁾
Cobalt	7440-48-4	0.47	24	T-RSL	Reg 5	0.16	3.125⁽³⁾	2.5⁽³⁾	1.25⁽³⁾
Copper	7440-50-8	62	9	T-RSL	AWQC	3.0	2.5 ⁽³⁾	2 ⁽³⁾	1 ⁽³⁾

Matrix: Surface Water

Analyte	CAS Number	HH PSL (µg/L)	Eco PSL (µg/L)	HH PSL Reference ⁽¹⁾	Eco PSL Reference ⁽²⁾	PQLG (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
Lead	7439-92-1	15	2.5	T-RSL	AWQC	0.83	0.75 ⁽³⁾	0.75 ⁽³⁾	0.375 ⁽³⁾
Magnesium	7439-96-5	NC	120	None	Reg 3	40	1250	750	250
Mercury	7439-97-6	0.43	0.77	T-RSL	AWQC	0.14	0.2	0.2	0.08
Nickel	7440-02-0	30	52	T-RSL	AWQC	17	10	6	3
Selenium	7782-49-2	7.8	5	T-RSL	AWQC	1.7	2.5 ⁽³⁾	1.25 ⁽³⁾	0.75 ⁽³⁾
Silver	7440-22-4	7.1	0.12	T-RSL	Reg 5	0.040	2.5⁽³⁾	0.5⁽³⁾	0.25⁽³⁾
Thallium	7440-28-0	0.016	10	T-RSL	Reg 5	0.0053	2⁽³⁾	1⁽³⁾	0.75⁽³⁾
Vanadium	7440-62-2	7.8	12	T-RSL	Reg 5	4.0	3.125 ⁽³⁾	2.5 ⁽³⁾	1.25 ⁽³⁾
Zinc	7440-66-6	470	120	T-RSL	AWQC	40	20	10	5

Miscellaneous

Hardness (computed from Ca and Mg concentrations)	TTNUS022	NC	NC	None	None	7500	7500	5000	2500
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- 1 HH PSL References: The tapwater screening levels were taken from the USEPA Regional Screening Levels (T-RSLs) for Chemical Contaminants at Superfund Sites, May 2012 available online at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.html. The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted with a "N" flag) or an ILCR of 1E-6 for carcinogens (denoted with a "C" flag).
 The USEPA tapwater screening levels (May, 2012) for noncarcinogens were adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1.
 USEPA MCLs were taken from the 2011 Edition of the Drinking Water Standards and Health Advisories, January 2011.
 IDEM groundwater screening levels for direct contact and Groundwater Default Closure Levels (GDCLs) were taken from the IDEM RISC Technical Guide, January 31, 2006, Appendix 1, revised May 1, 2009.
- 2 Eco PSL References: Of the reference used to select ecological criteria, not all references have a criterion for every chemical. These criteria represent the first available criterion in the following hierarchy of references: Ambient Water Quality Criteria (AWQC) - National Recommended Water Quality Criteria, Freshwater Chronic Effects (USEPA, 2009), followed by Reg 5 - USEPA Region 5 Ecological Screening Levels for surface water (USEPA, 2003), and Reg 3 – USEPA Region 3 BTAG Freshwater Surface Water Screening Levels (USEPA, 2006a).
- 3 Samples will be concentrated four times to attain the documented LOQs, LODs, and DLs. This sample concentration technique is referenced in USEPA Method 200.7. SW-846 sample preparation techniques will be utilized (3005/3010).

General Notes:

Bolded and Shaded rows indicate that the PSL is less than the LOD. In these cases, the Project Team has agreed to report non-detected results at the LOD. Any limitations on data use resulting from having detection limits greater than PSLs will be described in the RFI Report.

AWQC = Ambient Water Quality Criteria

SAP Worksheet No. 16 -- Project Schedule/Timeline Table
[\(UFP-QAPP Manual Section 2.8.2\)](#)

Activities	Organization	Dates (MM/DD/YYYY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Initial Sampling - Soil, Sediment, Groundwater, and Surface Water	Tetra Tech	09/17/2012	09/21/2012 ⁽¹⁾	RFI Report, SWMU 23	12/28/2012 (Draft) ⁽¹⁾ 03/25/2013 (Final) ⁽¹⁾

(1) Dates will be revised as necessary if groundwater monitoring well installation is required based on initial soil sample results.

SAP Worksheet No. 17 -- Sampling Design and Rationale ([UFP-QAPP Manual Section 3.1.1](#))

The sampling strategy for SWMU 23 is based on a judgmental (biased) sampling design. The objectives of the sampling is to determine if residual contamination related to historical use of the Site is present at levels of concern and to delineate site-related contamination. Areas known to have been contaminated or that are likely to be contaminated if a release has occurred were targeted for sampling. This will yield an overestimate of risks, but is considered to be a suitable first step. If additional site characterization is warranted after the first round of sampling, the Project Team will plan for the additional data collection as indicated on [Figures 11-1 and 11-2](#). In that case, the Project Team will consider and incorporate into the sampling strategy for subsequent investigations a less biased sampling design.

Chemicals that may have been present at SWMU 23 over its operational history, and may have been released to environmental media, are described in [Section 10.4.1](#) and a detailed target analyte list is presented in [Worksheet #15](#) for each of the environmental media being investigated.

The study boundaries for the RFI are identified in [Worksheet #11](#). Sampling locations within the study boundaries were selected to investigate areas of potential releases, thus representing locations most likely to be contaminated if releases had occurred at the Site.

The following text describes the sampling locations, media to be sampled, and analyses. Sampling locations are illustrated on [Figures 17-1, 17-2, and 17-3](#), and a list of samples is provided in [Worksheet #18](#). Details of field activities, including but not limited to soil boring, hand augering, well installation, decontamination, and IDW, are described in [Worksheet #14](#). Soil selection matrix is presented in [Worksheet #14](#) to help the FOL select vertical soil sampling intervals for VOC and non-VOC analyses.

Surface soil samples will be collected from 0 to 2 feet bgs at targeted locations along drainage pathways and other potentially impacted areas. Soil borings will consist of two soil samples to be collected from each soil boring location; one surface soil (0 to 2 feet bgs for all target analytes except VOCs which will be collected at 0.5 to 2 feet bgs) and one subsurface soil (depth is location-specific). If refusal on bedrock is encountered before the desired subsurface sample depth, the sample will be collected from the 2-foot soil interval directly above the bedrock surface.

Groundwater generally occurs in bedrock at NSA Crane. Based on surface and subsurface soil sample results, permanent groundwater monitoring wells may be installed, and the upper water-bearing zone will be monitored in select subareas to determine whether the groundwater is contaminated.

17.1 SOIL SAMPLING

Fifty-two soil samples will be collected from 26 locations (23SB001 through 23SB026) ([Figure 17-1](#)).

Soil Borings

Twenty-three soil borings (23SB001 through 23SB023) will be advanced within SWMU 23 ([Figure 17-1](#)). The boring locations were selected to target areas in which releases may have occurred, based on current and historical site activities and information. Two soil samples will be collected from each soil boring location: one surface soil (0 to 2 feet bgs) and one subsurface soil sample. The surface soil samples for VOC analyses will be collected from 0.5 to 2 feet bgs. The subsurface soil sample will be collected as indicated in the matrix near the end of [Section 11.3](#). Both the surface and subsurface soil samples from these borings will be analyzed for VOCs, metals, TPH (GRO, DRO, and ERO), and PAHs. In addition, the surface soil samples will be analyzed for PCBs, pH, and sulfate, as presented in [Worksheet #18](#).

In addition, two borings (23SB024 and 23SB025) will be completed hydraulically downgradient of the UST located near the western portion of Building 36. Two soil samples will be collected from each boring: one surface soil (0 to 2 feet bgs) and one subsurface soil. The subsurface soil sample will be collected from a depth as indicated in the matrix near the end of [Section 11.3](#). The soil boring samples will be analyzed for VOCs, TPH (GRO, DRO, and ERO), metals, PCBs, and PAHs, as presented in [Worksheet #18](#). The surface soil samples will also be analyzed for pH and sulfate.

Finally, one boring (23SB026) will be completed hydraulically downgradient of the oil/water separator located in the southwest corner of Building 36. Two soil samples will be collected from the boring: one surface soil (0 to 2 feet bgs) and one subsurface soil. The subsurface soil sample will be collected from a depth as indicated in the matrix near the end of [Section 11.3](#). The soil boring samples will be analyzed for VOCs, metals, PCBs, TPH (GRO, DRO, and ERO), and PAHs. The surface soil samples will also be analyzed for pH and sulfate.

Surface Water and Sediment Sample from Drainage Channels

Seven surface water and seven sediment samples will be collected at locations 23SW/SD001 through 23SW/SD007 ([Figure 17-2](#)). The locations are along the drainage pathways located in the northern and southern areas of SWMU 23. The samples will be collected to assess residual contamination from the historical disposal practices.

The surface water samples will be analyzed for metals (total and dissolved), PAHs, and hardness (based on calcium and magnesium concentrations), as presented in [Worksheet #18](#). PCBs were eliminated from surface water sample analyses because they are not soluble and the only PCB transport mechanism of significant concern would be in migration of sediment.

The sediment samples will be analyzed for VOCs, metals, PCBs, PAHs, and TOC, as presented in [Worksheet #18](#).

Sediment Samples (Oil/Water Separator)

One sediment sample at location 23SD008 will be collected from the bottom of the oil/water separator located in the southwestern corner of the building ([Figure 17-2](#)).

This sample will be analyzed for VOCs, metals, PCBs, TPH (GRO, DRO, and ERO), and PAHs, as presented in [Worksheet #18](#).

Groundwater

Seven monitoring wells (23MWT001 through 23MWT007) will be installed within SWMU 23 ([Figure 17-3](#)). No monitoring wells currently exist within the SWMU, and groundwater flow direction is not known. Therefore, some of the wells will be strategically located within the SWMU in order to identify groundwater flow direction. Additionally, placement of the wells to evaluate any potential groundwater contamination will be based on the soil characterization analytical data. Should the site characterization soil samples indicate that elevated concentrations of constituents have the potential to reach the shallow groundwater at the site, the groundwater monitoring wells will be subsequently installed in locations that will attempt to characterize potential groundwater contamination; otherwise, the monitoring wells will be placed in the current default locations as shown on [Figure 17-3](#).

Groundwater samples would be collected from any newly installed monitoring wells, and would be analyzed for VOCs, PAHs, and total metals. If groundwater is highly turbid (>10 NTUs), a filtered sample will also be collected for dissolved metals analysis, as presented in [Worksheet #18](#).

17.2 FIELD QUALITY CONTROL SAMPLES

Field QC samples will be collected as part of the investigation, including field duplicates and equipment rinsate blanks (if non-dedicated sampling equipment is used). [Worksheet #20](#) presents the field QC sample summary. Also, additional sample volume will be collected as necessary for the laboratory QC of matrix spike/matrix spike duplicate (MS/MSD) analyses for organics and MS/duplicate sample analyses for metals.

SAP Worksheet No. 18 -- Sampling Locations and Methods/SOP Requirements Table
 ([UFP-QAPP Manual Section 3.1.1](#))

Sample Location	Sample ID ⁽¹⁾	Analyses							
		VOCs	Metals	PAHs	PCBs	TPH (GRO/DRO/ERO)	Sulfate/pH	Hardness	TOC
SOIL									
23SB001	23SB001-0002	1	1	1	1	1	1	---	---
	23SB001-XXXX	1	1	1	---	1	---	---	---
23SB002	23SB002-0002	1	1	1	1	1	1	---	---
	23SB002-XXXX	1	1	1	---	1	---	---	---
23SB003	23SB003-0002	1	1	1	1	1	1	---	---
	23SB003-XXXX	1	1	1	---	1	---	---	---
23SB004	23SB004-0002	1	1	1	1	1	1	---	---
	23SB004-XXXX	1	1	1	---	1	---	---	---
23SB005	23SB005-0002	1	1	1	1	1	1	---	---
	23SB005-XXXX	1	1	1	---	1	---	---	---
23SB006	23SB006-0002	1	1	1	1	1	1	---	---
	23SB006-XXXX	1	1	1	---	1	---	---	---
23SB007	23SB007-0002	1	1	1	1	1	1	---	---
	23SB007-XXXX	1	1	1	---	1	---	---	---
23SB008	23SB008-0002	1	1	1	1	1	1	---	---
	23SB008-XXXX	1	1	1	---	1	---	---	---
23SB009	23SB009-0002	1	1	1	1	1	1	---	---
	23SB009-XXXX	1	1	1	---	1	---	---	---
23SB010	23SB010-0002	1	1	1	1	1	1	---	---
	23SB010-XXXX	1	1	1	---	1	---	---	---

Sample Location	Sample ID ⁽¹⁾	Analyses							
		VOCs	Metals	PAHs	PCBs	TPH (GRO/DRO/ERO)	Sulfate/pH	Hardness	TOC
23SB011	23SB011-0002	1	1	1	1	1	1	---	---
	23SB011-XXXX	1	1	1	---	1	---	---	---
23SB012	23SB012-0002	1	1	1	1	1	1	---	---
	23SB012-XXXX	1	1	1	---	1	---	---	---
23SB013	23SB013-0002	1	1	1	1	1	1	---	---
	23SB013-XXXX	1	1	1	---	1	---	---	---
23SB014	23SB014-0002	1	1	1	1	1	1	---	---
	23SB014-XXXX	1	1	1	---	1	---	---	---
23SB015	23SB015-0002	1	1	1	1	1	1	---	---
	23SB015-XXXX	1	1	1	---	1	---	---	---
23SB016	23SB016-0002	1	1	1	1	1	1	---	---
	23SB016-XXXX	1	1	1	---	1	---	---	---
23SB017	23SB017-0002	1	1	1	1	1	1	---	---
	23SB017-XXXX	1	1	1	---	1	---	---	---
23SB018	23SB018-0002	1	1	1	1	1	1	---	---
	23SB018-XXXX	1	1	1	---	1	---	---	---
23SB019	23SB019-0002	1	1	1	1	1	1	---	---
	23SB019-XXXX	1	1	1	---	1	---	---	---
23SB020	23SB020-0002	1	1	1	1	1	1	---	---
	23SB020-XXXX	1	1	1	---	1	---	---	---
23SB021	23SB021-0002	1	1	1	1	1	1	---	---
	23SB021-XXXX	1	1	1	---	1	---	---	---

Sample Location	Sample ID ⁽¹⁾	Analyses							
		VOCs	Metals	PAHs	PCBs	TPH (GRO/DRO/ERO)	Sulfate/pH	Hardness	TOC
23SB022	23SB022-0002	1	1	1	1	1	1	---	---
	23SB022-XXXX	1	1	1	---	1	---	---	---
23SB023	23SB023-0002	1	1	1	1	1	1	---	---
	23SB023-XXXX	1	1	1	---	1	---	---	---
23SB024	23SB024-0002	1	1	1	1	1	1	---	---
	23SB024-XXXX	1	1	1	---	1	---	---	---
23SB025	23SB025-0002	1	1	1	1	1	1	---	---
	23SB025-XXXX	1	1	1	---	1	---	---	---
23SB026	23SB026-0002	1	1	1	1	1	1	---	---
	23SB026-XXXX	1	1	1	---	1	---	---	---
SEDIMENT									
23SW/SD001	23SD001-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD002	23SD002-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD003	23SD003-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD004	23SD004-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD005	23SD005-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD006	23SD006-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD007	23SD007-0006 ⁽²⁾	1	1	1	1	---	---	---	1
23SW/SD008	23SD008-0006 ⁽²⁾	1	1	1	1	1	---	---	---
SURFACE WATER⁽³⁾⁽⁴⁾									
23SW/SD001	23SW001	---	1	1	---	---	---	1	---
23SW/SD002	23SW001	---	1	1	---	---	---	1	---
23SW/SD003	23SW001	---	1	1	---	---	---	1	---

Sample Location	Sample ID ⁽¹⁾	Analyses							
		VOCs	Metals	PAHs	PCBs	TPH (GRO/DRO/ERO)	Sulfate/pH	Hardness	TOC
23SW/SD004	23SW001	---	1	1	---	---	---	1	---
23SW/SD005	23SW001	---	1	1	---	---	---	1	---
23SW/SD006	23SW001	---	1	1	---	---	---	1	---
23SW/SD007	23SW001	---	1	1	---	---	---	1	---
GROUNDWATER⁽³⁾⁽⁴⁾⁽⁵⁾									
23MW001	23GW001	1	1	1	---	---	---	---	---
23MW002	23GW002	1	1	1	---	---	---	---	---
23MW003	23GW003	1	1	1	---	---	---	---	---
23MW004	23GW004	1	1	1	---	---	---	---	---
23MW005	23GW005	1	1	1	---	---	---	---	---
23MW006	23GW006	1	1	1	---	---	---	---	---
23MW007	23GW007	1	1	1	---	---	---	---	---

- (1) "XXXX" represents a specific 2-foot depth interval of the sample from below 2 feet bgs and above the top of bedrock. Depth will be determined in the field based on visual and olfactory observations and where bedrock is encountered. For example, if sample is collected from 8 to 10 feet bgs, the depth will be recorded as 0810.
- (2) Sediment samples will be collected at a depth of 0 to 6-inches bgs.
- (3) Select water sample parameters (e.g., pH, temperature, etc.) will be collected in the field at the time of sampling.
- (4) For filtered surface water or groundwater samples, "-F" will be added to the end of the ID number (e.g., 23SW001-F).
- (5) Groundwater monitoring wells only installed if deemed necessary based on soil characterization values.

Notes:

- Field duplicate and MS/MSD samples will be collected at a frequency of 1 per 20 samples per media per analyte for fixed-base laboratory samples.
- Soil samples will be collected in accordance with SOPs -08, -09, and -10.
- Sediment samples will be collected in accordance with SOP-07.
- Surface water samples will be collected in accordance with SOP-05.
- Groundwater samples will be collected in accordance with SOPs -16 and -17.

SAP Worksheet No. 19 -- Analytical SOP Requirements Table
 (UFP-QAPP Manual Section 3.1.1)

MATRIX	ANALYTICAL GROUP	ANALYTICAL AND PREPARATION METHOD/ SOP REFERENCE ⁽¹⁾	CONTAINERS (number, size, and type)	SAMPLE VOLUME (units)	PRESERVATION REQUIREMENTS (chemical, temperature, light protected)	MAXIMUM HOLDING TIME (preparation/ analysis)
Groundwater, surface water, and aqueous QC samples	VOCs	SW-846 5030/8260B Empirical SOP-202	Three 40-mL glass vials	5 mL	Hydrochloric acid (HCl) to pH<2; cool to ≤ 6 °C; no headspace	14 days to analysis
Soil and sediment	VOCs	SW-846 5035/8260B Empirical SOP-202/225	Three 5-gram (g) Encore samplers or terracores	5 g	Sodium bisulfate in water, cool to ≤ 6 °C; methanol, freeze to < -10°C	48 hours from sampling to preparation, 14 days to analysis
Groundwater, surface water, and aqueous QC samples	PAHs	SW-846 3510C/3520/8270D-Low Empirical SOP-201/300	Two 1-liter (L) glass amber bottles	1,000 mL	Cool to ≤ 6 °C	7 days until extraction, 40 days to analysis
Soil and sediment	PAHs	SW-846 3546/8270D-Low Empirical SOP-201/343	One 4-ounce (oz) glass jar with a Teflon-lined lid	30 g	Cool to ≤ 6 °C	14 days until extraction, 40 days to analysis
Aqueous QC samples	PCBs	SW-846 3546/3550/8082A Empirical SOP-211/343	One 4-oz glass jar with a Teflon-lined lid	30 g	Cool to ≤ 6 °C	14 days until extraction, 40 days to analysis
Soil and sediment	PCBs	SW-846 3546/3550/8082A Empirical SOP-211/343	One 4-oz glass jar with a Teflon-lined lid	30 g	Cool to ≤ 6 °C	14 days until extraction, 40 days to analysis
Groundwater, surface water, and aqueous QC samples	Metals (and Dissolved Metals)	SW-846 3010A/6010C,7470A Empirical SOP-100/103/104/105	One 500-mL plastic bottle	50 mL	Nitric acid (HNO ₃) to pH <2; Cool to ≤ 6 °C	180 days to analysis except mercury, 28 days for mercury
Aqueous QC samples	TPH (GRO)	SW-846 5030B/8015B, Empirical SOP-219	Two 40-ml volatile vials	5 mL	HCl to pH<2; cool to ≤6 °C	14 days until extraction/analysis
Aqueous QC samples	TPH (DRO/ERO)	SW-846 3510C/8015B, Empirical SOP-219/322	Two 1-L glass amber bottle	1,000 mL	HCl or H ₂ SO ₄ to pH<2; cool to ≤6 °C	7 days until extraction 40 days until analysis
Soil and sediment	Metals	SW-846 3050B/6010C, 7471B Empirical SOP-100/103/104/105	One 4-oz glass jar with a Teflon-lined lid	1 to 2 g	Cool to ≤ 6 °C	180 days to analysis except mercury, 28 days for mercury

MATRIX	ANALYTICAL GROUP	ANALYTICAL AND PREPARATION METHOD/ SOP REFERENCE ⁽¹⁾	CONTAINERS (number, size, and type)	SAMPLE VOLUME (units)	PRESERVATION REQUIREMENTS (chemical, temperature, light protected)	MAXIMUM HOLDING TIME (preparation/ analysis)
Soil and sediment	TPH (GRO)	SW-846 5035A, 8015B/ Empirical SOP-219	One 5-g Encore sampler or terracore	5 g	Preserve in methanol in the field and cool to ≤ 6 °C or sample in 5 g Encore and cool to ≤ 6 °C. Lab to freeze or prepare within 48 hours of sampling	Freeze or prepare in methanol within 48 hours of sampling. 14 days from sampling to analysis
Soil and Sediment	TPH (DRO/ERO)	SW-846 3546/8015B Empirical SOP-219/343	One 4-oz glass jar with a Teflon-lined lid	25 g	Cool to ≤ 6°C	14 days until extraction, 40 days to analysis
Soil	Sulfate	SW-846 9056 Empirical SOP-145/145A	One 4-oz glass jar with Teflon-lined lid	5 g	Cool to ≤ 6°C	28 days to analysis
Soil	pH	SW-846 9045D Empirical SOP-187	One 4-oz glass jar with Teflon-lined lid	10 g	Cool to ≤ 6 °C	Analyze as soon as possible
Sediment	TOC	Lloyd Kahn Empirical SOP-221	One 4-oz glass jar with Teflon-lined lid	5 g	Cool to ≤ 6°C	14 days to analysis

Notes:

- 1 Specifies the appropriate reference letter or number from the Analytical SOP References table ([Worksheet #23](#)).

SAP Worksheet No. 20 -- Field Quality Control Sample Summary Table
 (UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Samples	No. of Field Duplicates	No. of MS/MSDs ⁽¹⁾	No. of Equip. Blanks	No. of VOC Trip Blanks	Total No. of Samples to Lab
Soil	VOCs	52	3	3/3	2	2	59
	Metals	52	3	3/3	2	0	57
	PCBs	26	2	2/2	2	0	30
	PAHs	52	3	3/3	2	0	57
	TPH (DRO/GRO/ERO)	52	3	3/3	2	0	57
	pH	26	2	2/2	2	0	30
	Sulfate	26	2	2/2	2	0	30
Sediment	VOCs	8	1	1/1	0	1	10
	Metals	8	1	1/1	0	0	9
	PCBs	8	1	1/1	0	0	9
	PAHs	8	1	1/1	0	0	9
	TOC	7	1	1/1	0	0	8
	TPH (DRO/GRO/ERO)	1	1	1/1	0	0	2
Surface water	PAHs	7	1	1/1	0	0	8
	Total Metals	7	1	1/1	0	0	8
	Dissolved Metals ⁽²⁾	7	1	1/1	0	0	8
	Hardness (Calc'd) ⁽³⁾	7	1	1/1	0	0	8
Groundwater	VOCs	7	1	1/1	0	1	9
	PAHs	7	1	1/1	0	0	8
	Total Metals	7	1	1/1	0	0	8
	Dissolved Metals ⁽²⁾	7	1	1/1	0	0	8

- 1 Although MS/MSDs are not typically considered field QC samples, they are included here because location determination is often established in the field. The MS/MSDs are not included in the total number of samples sent to the laboratory. For total and dissolved metals, a duplicate sample will be collected in place of an MSD.
- 2 As needed.
- 3 A separate sample will not be collected for this calculated value, but the calculation will be performed on both the original and duplicate sample.

SAP Worksheet No. 21 -- Project Sampling SOP References Table
 ([UFP-QAPP Manual Section 3.1.2](#))

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-01	Sample Labeling, 05/22/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-02	Sample Identification Nomenclature, 05/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-03	Sample Custody and Documentation of Field Activities, 05/12, Revision 0.	Tetra Tech	Field logbook, sample log sheets, boring logs	Y (project-specific SOP)	Contained in Appendix B
SOP-04	Sample Preservation, Packaging, and Shipping, 05/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-05	Surface Water Sampling, 05/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-06	Measurement of Water Quality Parameters, 05/12, Revision 0.	Tetra Tech	Multi-parameter water quality meter, such as a Horiba U-22	Y (project-specific SOP)	Contained in Appendix B
SOP-07	Sediment Sampling, 05/12, Revision 0.	Tetra Tech	Stainless steel or disposable trowel, long-handled sampling device	Y (project-specific SOP)	Contained in Appendix B
SOP-08	Borehole Advancement and Soil Coring Using Direct-Push Technology (DPT) and Hand Auger Techniques, 05/12, Revision 0.	Tetra Tech	DPT rig, stainless steel augers, extension rods, and T-handle	Y (project-specific SOP)	Contained in Appendix B
SOP-09	Soil Sample Logging, 05/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-10	Surface and Subsurface Soil Sampling, 05/12, Revision 0.	Tetra Tech	Stainless steel auger bucket, extension rods, and T-handle, PID	Y (project-specific SOP)	Contained in Appendix B
SOP-11	Geophysical Survey for Underground Storage Tanks, 05/12, Revision 0.	Tetra Tech	Geophysical instruments	Y (project-specific SOP)	Contained in Appendix B
SOP-12	Monitoring Well Installation, 05/12, Revision 0.	Tetra Tech	Air rotary or rotosonic drill rig	Y (project-specific SOP)	Contained in Appendix B
SOP-13	Drilling and Geologic Logging of Boreholes in Bedrock, 05/12, Revision 0.	Tetra Tech	Air rotary or rotosonic drill rig	Y (project-specific SOP)	Contained in Appendix B
SOP-14	Monitoring Well Development, 05/12, Revision 0.	Tetra Tech	Pump, surge block, Multi-parameter water quality meter, such as a Horiba U-22	Y (project-specific SOP)	Contained in Appendix B
SOP-15	Measurement of Water Levels in Monitoring Wells; 05/12, Revision 0.	Tetra Tech	Electronic Water Level Indicator	Y (project-specific SOP)	Contained in Appendix B
SOP-16	Low-Flow Well Purging and Stabilization; 05/12, Revision 0.	Tetra Tech	Bladder or Peristaltic Pump, Multi-parameter water quality meter, such as a Horiba U-22, turbidity meter, PID	Y (project-specific SOP)	Contained in Appendix B
SOP-17	Groundwater Sampling; 05/12, Revision 0.	Tetra Tech	Bladder or Peristaltic Pump, Multi-parameter water quality meter, such as a Horiba U-22, turbidity meter, PID	Y (project-specific SOP)	Contained in Appendix B
SOP-18	Calibration and Care of Water Quality Meters; 05/12, Revision 0.	Tetra Tech	Multi-parameter water quality meter, such as a Horiba U-22, turbidity meter	Y (project-specific SOP)	Contained in Appendix B

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-19	Management of Investigation-Derived Waste, 05/12, Revision 0.	Tetra Tech	NA	Y (project-specific SOP)	Contained in Appendix B
SOP-20	Decontamination of Field Sampling Equipment, 05/12, Revision 0.	Tetra Tech	Decontamination equipment, scrub brushes, 5-gallon buckets, spray bottles, phosphate free detergent, de-ionized water	Y (project-specific SOP)	Contained in Appendix B
SOP-21	Global Positioning System, 05/12, Revision 0.	Tetra Tech	GPS unit	Y (project-specific SOP)	Contained in Appendix B

SAP Worksheet No. 22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table
 (UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity ⁽¹⁾	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference ⁽²⁾	Comments
GPS	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision (HDOP) <3, number of satellites at least six.	Wait for better signal, replace unit, or choose alternate location technique	Tetra Tech FOL or designee	SOP-21	SOP located in Appendix B .
Multi-Parameter Water Quality Meter (YSI 600 Series or similar)	Visual Inspection	Daily	Manufacturer's guidance.	Operator correction or replacement	Tetra Tech FOL or designee	SOP-06, SOP-18	SOP located in Appendix B .
	Calibration/ Verification	Beginning and end of day					
Photo-Ionization Detector or Flame Ionization detector	Visual Inspection	Daily	Manufacturer's guidance	Operator correction or Replacement	Tetra Tech FOL or designee	Operation according to manufacturer's instructions	SOP located in Appendix B .
	Calibration/ Verification	Beginning and end of day					
Turbidity Meter (LaMotte 2020 or similar)	Visual Inspection	Daily	Manufacturer's guidance; calibrations must bracket expected values. Initial Calibration Verification (ICV) must be <10 nephelometric turbidity units (NTUs).	Operator correction or replacement	Tetra Tech FOL or designee	SOP-06, SOP-18	SOP located in Appendix B .
	Calibration/ Verification	Beginning and end of day					

- 1 Activities may include calibration, verification, testing, maintenance, and/or inspection.
- 2 From the Project Sampling SOP References table ([Worksheet #21](#)).

SAP Worksheet No. 23 -- Analytical SOP References Table
 (UFP-QAPP Manual Section 3.2.1)

LAB SOP NUMBER	TITLE, REVISION DATE, AND/OR NUMBER	DEFINITIVE OR SCREENING DATA	MATRIX AND ANALYTICAL GROUP	INSTRUMENT	ORGANIZATION PERFORMING ANALYSIS	VARIANCE TO QSM? (Y/N)	MODIFIED FOR PROJECT WORK? (Y/N)
Empirical SOP-100	Metals Digestion/Preparation, Methods 3005A/USEPA CLP ILMO 4.1 Aqueous, 3010A, 3030C, 3050B, USEPA CLP ILMO 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C (Revision 22, 11/17/11)	Definitive	Soil, sediment, groundwater, surface water, and aqueous QC samples/Metals Digestion	NA/ Preparation	Empirical	NA	N
Empirical SOP-103	Mercury Analysis in Water by Manual Cold Vapor Technique Methods SW846 7470A and 245.1, CLP-M 4.1 (Revision 20, 05/16/11)	Definitive	Groundwater, surface water, and aqueous QC samples/ Mercury	Flow Injection Mercury Analyzer	Empirical	N	N
Empirical SOP-104	Mercury Analysis in Soil/Sediment by Manual Cold Vapor Technique Methods SW846 7471A, 7471B, 245.5, and CLP-ILM 4.1 (Revision 20, 05/16/11)	Definitive	Soil and sediment/ Mercury	Flow Injection Mercury Analyzer	Empirical	N	N
Empirical SOP-105	Metals by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) Technique, SW-846 Methods 6010B, 6010C, USEPA Method 200.7, Standard Methods 19 th Edition 2340B, USEPA CLP ILMO 4.1 (Revision 17, 05/16/11)	Definitive	Soil, sediment, groundwater, surface water, and aqueous QC samples/ Metals	ICP-AES	Empirical	N	N
Empirical SOP-145A	Anion Leaching Procedure	Definitive	Soil/ Sulfate leaching	NA/ Preparation	Empirical	NA	N
Empirical SOP-145	Determination of Inorganic Anions in Water by Ion Chromatography using Dionex DX-500 Ion Chromatographs with Hydroxide Eluent and Dionex Column AS18, Method 300.0 Guidance (Revision 7, 03/25/10)	Definitive	Soil/Sulfate	Ion Chromatography (IC)	Empirical	N	N

LAB SOP NUMBER	TITLE, REVISION DATE, AND/OR NUMBER	DEFINITIVE OR SCREENING DATA	MATRIX AND ANALYTICAL GROUP	INSTRUMENT	ORGANIZATION PERFORMING ANALYSIS	VARIANCE TO QSM? (Y/N)	MODIFIED FOR PROJECT WORK? (Y/N)
Empirical SOP-187	Electrometric Determination of pH, Methods 150.1, Standard Method 4500-H+B, and 9040B for Waters, Liquids, and Liquid Wastes, and 9045C for Soils and Soild Wastes (Revision 8, 07/12/10).	Definitive	Soil/pH	pH meter	Empirical	NA	N
Empirical SOP-201	Gas Chromatography Mass Spectrometry (GC/MS) semivolatiles and Low-Concentration PAHs using USEPA Method 625 and SW846 Method 8270C and 8270D, Including Appendix IX Compounds (Revision 20, 04/26/10)	Definitive	Soil, sediment, groundwater, surface water, and aqueous QC samples/PAHs	GC/MS	Empirical	N	N
Empirical SOP-202	GC/MS Volatiles using USEPA Method 624 and SW846 Method 8260B, Including Appendix IX Compounds (Revision 23, 09/09/10)	Definitive	Soil, sediment, groundwater, surface water, and aqueous QC samples/VOCs	GC/MS	Empirical	N	N
Empirical SOP-211	Gas Chromatography/Electron Capture Detector (GC/ECD) Organochlorine Pesticides/PCBs using USEPA Method 608608.2 or SW846 Method 8081A/8082 or 8081B/8082A (Revision 22, 07/07/10)	Definitive	Soil, sediment, groundwater, surface water, and aqueous QC samples/PCBs	GC/ECD	Empirical	N	N
Empirical SOP-219	Gas Chromatography/Flame Ionization Detector (GC/FID) Nonhalogentaed Volatile Organics and Total Petroleum Hydrocarbons (TPH) by Method 8015B/8015C/TN EPH (Revision 14, 12/01/10)	Definitive	Soil and sediment/ TPH-GRO/DRO/ERO	GC/FID	Empirical	NA	Y (IDEM-Specific Ranges)
Empirical SOP-221	Total Organic Carbon (TOC) SM5310C, SW846 Method 9060/9060A and Lloyd Kahn Method (Revision 9, 07/12/10)	Definitive	Sediment/TOC	TOC Analyzer	Empirical	NA	N

LAB SOP NUMBER	TITLE, REVISION DATE, AND/OR NUMBER	DEFINITIVE OR SCREENING DATA	MATRIX AND ANALYTICAL GROUP	INSTRUMENT	ORGANIZATION PERFORMING ANALYSIS	VARIANCE TO QSM? (Y/N)	MODIFIED FOR PROJECT WORK? (Y/N)
Empirical SOP-225	GC/MS Volatile Non-Aqueous Matrix Extraction using SW-846 Method 5035 for 8260B Analysis (Revision 9, 09/07/10)	Definitive	Soil and sediment/VOCs Extraction	GC/MS	Empirical	N	N
Empirical SOP-300	GC/MS Semivolatile BNA-Aqueous Matrix Extraction using SW-846 Method 3510C for 8270/625 Analysis (Revision 18, 04/26/10)	Definitive	Groundwater, surface water, and aqueous QC samples/VOCs/PAHs Extraction	NA/ Extraction	Empirical	NA	N
Empirical SOP-302	Pesticide/PCBs, Aqueous Matrix Extraction for USEPA 608/608.2 and SW846 Method 8081A/8082 Using SW846 Method 3510C (Revision 17, 04/26/10)	Definitive	Groundwater, surface water, and aqueous QC samples/PCBs Extraction	NA/ Extraction	Empirical	N	N
Empirical SOP-320	Total Petroleum Hydrocarbons (TPH) Non-Aqueous Matrix (Low Level) by USEPA SW846 Method 8015B, Large Sonication Horn (Revision 10, 09/09/10)	Definitive	Soil and sediment/TPH-DRO/ERO Extraction	NA/ Extraction	Empirical	NA	N
Empirical SOP-343	BNA, Pesticides/PCBs, and TPH non-Aqueous Matrix (Microwave Extraction) using SW-846 3546 (Revision 01, 09/09/10)	Definitive	Soil and sediment/PAHs and PCBs Extraction	NA/ Extraction	Empirical	NA	N

Copies of laboratory SOPs listed are included in Appendix C.

SAP Worksheet No. 24 -- Analytical Instrument Calibration Table
 (UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS VOCs	Bromofluoro-benzene (BFB) Tune	Prior to each Initial Calibration (ICAL) and at the beginning of each 12-hour period.	Must meet the ion abundance criteria required by the method (SW-846 8260B; Section 7.3.1; Table 4).	Retune and/or clean or replace source. No samples may be accepted without a valid tune.	Analyst/ Supervisor	Empirical SOP-202
	ICAL – a minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, for major instrument changes, or when continuing calibration verification (CCV) does not meet criteria.	The average response factor (RF) for System Performance Check Compound (SPCCs) must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent relative standard deviation (%RSD) for RFs for calibration check compounds (CCCs) must be $\leq 30\%$; and %RSD for each target analyte must be $\leq 15\%$, or the linear regression correlation coefficient (r) must be ≥ 0.995 ; or the coefficient of determination (r^2) must be ≥ 0.99 (6 points are required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	
	Retention Time (RT) Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	Analyst/ Supervisor	
	Evaluation of Relative Retention Times (RRTs)	With each sample.	RRT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst/ Supervisor	
	Initial Calibration Verification (ICV) – Second Source	Once after each ICAL, prior to beginning a sample run.	The percent recovery (%R) for all target analytes must be within 80-120% of true values.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	CCV	Perform one per 12-hour analysis period after tune and before sample analysis.	The minimum RF for SPCCs must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent difference or percent drift (%D) for all target analytes and surrogates must be $\leq 20\%$.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS PAHs	Tune Verification – decafluoro-triphenyl-phosphine (DFTPP)	Prior to each ICAL and at the beginning of each 12-hour analytical sequence.	Must meet the ion abundance criteria required by the method (SW-846 8270C Low Level Full Scan; Section 7.3.1; Table 3).	Retune and/or clean or replace source. No samples may be accepted without a valid tune.	Analyst/ Supervisor	Empirical SOP-201
	ICAL – A minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, instrument change (new column, source cleaning, etc.), when CCV is out of criteria.	The average RF for SPCCs must be ≥ 0.050 . The %RSD for RFs for CCCs must be $\leq 30\%$; and %RSD for each target analyte must be $\leq 15\%$, or r must be ≥ 0.995 ; or r^2 must be ≥ 0.99 (minimum of 6 points required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	
	ICV – Second Source	Perform after each ICAL, prior to beginning a sample run.	The %R of all target analytes must be within 80-120% of the true value. SPCC RFs must be ≥ 0.050 ; CCCs must be $\leq 20\%D$.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	RT Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	Analyst / Supervisor	
	Evaluation of RTs	With each sample.	RT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst / Supervisor	
	CCV	Analyze a standard at the beginning of each 12-hour shift after tune and before sample analysis.	SPCC RFs must be ≥ 0.050 ; all target analytes and surrogates must be $\leq 20\%D$.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/ECD PCBs	ICAL - A minimum of a 5-point calibration of Aroclor 1660 (1016/1260 mixture) is prepared	Upon instrument receipt, major instrument change, when CCV does not meet criteria.	Option 1: %RSD must be $\leq 20\%$ for Aroclor 1016/1260. If not met, Option 2: r must be ≥ 0.995 ; or Option 3: r^2 must be ≥ 0.99 for 6-point calibration. Mid-point calibration of other Aroclors – if an Aroclor is detected in a sample, a minimum of 5-point ICAL must be performed and meet the above criteria.	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-211
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R of all target analytes must be within 80-120% of true value.	Evaluate, repeat, if still failing, recalibrate.	Analyst/ Supervisor	
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %D of all target analytes must be $\leq 20\%$.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	
ICP-AES Metals (total and Dissolved Metals)	ICAL - a 1-point calibration per manufacturer's guidelines is prepared for all target analytes	At the beginning of each day, or if the QC is out of criteria, prior to sample analysis.	None; only one high standard and a calibration blank must be analyzed. If more than one calibration standard is used, r must be ≥ 0.995 .	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP-105
	ICV – Second Source	Following ICAL, prior to the analysis of samples.	The %R of all target analytes must be within 90-110% of true value.	Investigate reasons for failure, reanalyze once. If still unacceptable, correct problem and repeat ICAL.	Analyst/ Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R must be within 90-110% of true value.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze all affected samples.	Analyst/ Supervisor	
	Initial Calibration Blank (ICB)	Before beginning a sample sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze.	Analyst / Supervisor	
	Continuing Calibration Blank (CCB)	After the initial CCV, after every 10 samples, and at the end of the sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze calibration blank and all affected samples.	Analyst / Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Low-Level Check Standard (if using 1-point ICAL)	Daily after 1-point ICAL and before samples.	The %R must be within 80-120% of true value.	Investigate and perform necessary equipment maintenance. Recalibrate and reanalyze all affected samples.	Analyst / Supervisor	
	Interference Check Standards (ICS – ICS A and ICS B)	At the beginning of an analytical run.	ICS A recoveries must be within the absolute value of the LOD; and ICS B recoveries must be within 80-120 %R of true value.	Terminate analysis; locate and correct problem; reanalyze ICS.	Analyst / Supervisor	
Mercury Analyzer	ICAL – a 6-point calibration curve is analyzed.	Daily prior to sample analysis, and if continuing QC fails	The RSD for RFs must be $\leq 20\%$, or r must be ≥ 0.995 .	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst/ Supervisor	Empirical 103/104
	ICB and CCB	Before beginning a sample sequence.	No analytes detected > LOD.	Correct problem, reprepare, and reanalyze.	Analyst/ Supervisor	
	ICV - Second Source	Once after each ICAL and prior to sample analysis	%R must be within 90-110%.	Correct problem and repeat calibration.	Analyst/ Supervisor	
	CCV	CCV-at beginning and end of each run sequence and every 10 samples.	%R must be within 80-120%.	Check problem, recalibrate and reanalyze any samples not bracketed by passing CCVs.	Analyst/ Supervisor	
GC/FID TPH – GRO/DRO/E RO	ICAL – A minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, major instrument change, when CCV does not meet criteria.	The %RSD for each target analyte must be $\leq 20\%$, or r must be ≥ 0.995 ; or r^2 must be ≥ 0.99 (minimum of 6 points required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	Empirical SOP-219
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R of all target analytes must be within 80-120% of true value.	Evaluate, repeat, if still failing, recalibrate.	Analyst/ Supervisor	
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %D of all target analytes must be $\leq 20\%$.	If %D is high and sample result is ND, qualify/narrate with project approval. If %D is low or project approval not received, reanalyze all samples since the last successful CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %R must be within 90-110%.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst / Supervisor	
pH Meter	Calibration	Calibrate before use with two buffers in the area to be measured. Check with a third buffer.	0.05 pH units.	Recalibrate and/or perform necessary equipment maintenance.	Analyst/Supervisor	Empirical SOP-187
IC Sulfate	ICAL – A minimum of a 3-point calibration is prepared and a linear range is established for all target analyses.	Perform after major instrument maintenance and upon failure of second consecutive CCV.	The %RSD must be < 15% over linear range, or $r \geq 0.995$.	Correct the problem, then repeat ICAL.	Analyst / Supervisor	Empirical SOP-145
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R must be within 90-110% of true value and RTs must be within appropriate windows.	Correct problem and verify ICV. If that fails, repeat ICAL.	Analyst / Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R must be within 90-110% of true value and all project analytes must be within established RT windows.	Correct problem and verify CCV. If that fails, repeat ICAL and reanalyze all samples since the last successful CCV.	Analyst / Supervisor	
TOC	ICAL – a minimum of a 5-point calibration is prepared	Upon instrument receipt, major instrument change, or when the CCV does not meet criteria.	The RSD for RFs for the target analyte must be $\leq 20\%$, or r must be ≥ 0.995 .	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst / Supervisor	Empirical SOP-221
	ICV – Second Source	Once after each ICAL prior to sample analysis.	The %R must be within 90-110%.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst / Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	CCV	Analyze standard at the beginning and end of sequence and after every 10 samples.	The %R must be within 90-110%.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst / Supervisor	

SAP Worksheet No. 25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
 ([UFP-QAPP Manual Section 3.2.3](#))

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
GC/MS	Check pressure and gas supply daily. Bake out trap and column, change septa as needed, cut column as needed, change trap as needed. Other maintenance specified in Equipment Maintenance SOP.	VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-202
GC/MS	Check pressure and gas supply daily. Change septa as needed, change liner as needed, cut column as needed. Other maintenance specified in Equipment Maintenance SOP.	PAHs	Ion source, injector liner, column, column flow.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-201
GC/ECD	Check pressure and gas supply daily. Bake out column, change septa and/or liner as needed, replace or cut column as needed. Other maintenance specified in Equipment Maintenance SOP.	PCBs	Injector liner, septa, column, column flow.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-211
ICP-AES	Clean the torch assembly and the spray chamber when they become discolored or when degradation in data quality is observed. Clean the nebulizer, and check the argon supply. Replace the peristaltic pump tubing as needed.	Metals	Inspect the torch, nebulizer chamber, pump, and tubing	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-105

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
Mercury Analyzer	Replace peristaltic pump tubing, replace mercury lamp, replace drying tube, clean optical cell and/or clean liquid/gas separator as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Mercury	Tubing, sample probe, optical cell, waste container.	Prior to ICAL and as necessary.	Acceptable ICAL or CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOPs 103
GC/FID	Check pressure and gas supply daily. Change septa and/or liner as needed, replace or cut column as needed. Other maintenance specified in lab Equipment Maintenance SOP.	TPH/GRO/ DRO/ERO	Injector liner, septa, column, column flow.	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-219
IC	NA	Anions	NA	NA	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-145
TOC Analyzer	Replace sample tubing, clean sample boat, replace syringe.	TOC	Tubing, sample boat, syringe	As needed.	Must meet ICAL and continuing calibration criteria.	Repeat maintenance activity of remove from service.	Analyst/ Supervisor	Empirical SOP-221
pH meter	Clean, drain, refill reference electrode as needed.	pH	Reference electrode for white crystals, Inspect electrode for damage.	Before use	± 0.09 units	Recalibrate and/or perform necessary equipment maintenance. Check buffers. Reanalyze affected data.	Analyst/ Supervisor	Empirical SOP-187

SAP Worksheet No. 26 -- Sample Handling System
[\(UFP-QAPP Manual Appendix A\)](#)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FOL/Tetra Tech
Sample Packaging (Personnel/Organization): FOL/Tetra Tech
Coordination of Shipment (Personnel/Organization): FOL/Tetra Tech
Type of Shipment/Carrier: Overnight courier service (FedEx)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodians/Empirical
Sample Custody and Storage (Personnel/Organization): Sample Custodians/Empirical
Sample Preparation (Personnel/Organization): Extraction Laboratory, Metals Preparation Laboratory, Empirical
Sample Determinative Analysis (Personnel/Organization): GC Laboratory, GC/MS Laboratory, Metals Laboratory/Empirical
SAMPLE ARCHIVING
Field Sample Storage (Number of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (number of days from extraction/digestion): 3 months from sample digestion/extraction
Biological Sample Storage (Number of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodians/ Empirical

SAP Worksheet No. 27 – Sample Custody Requirements Table [\(UFP-QAPP Manual Section 3.3.3\)](#)

Field Sample Custody Procedures

Following sample collection into the appropriate bottleware, all samples will be immediately placed on ice in a cooler. Glass sample containers will be enclosed in bubble wrap to protect the bottleware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to Empirical for analysis. Samples will be preserved as appropriate, based on the analytical method. The selected laboratory will provide pre-preserved sample containers for sample collection. Samples will be maintained at above freezing to 6°C until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for off-site laboratory analysis will be preserved, packaged, and shipped in accordance with [SOP-04 \(Appendix B\)](#).

Chain-of-Custody Procedures

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms will document the date and time of sample collection, sampler's name, and names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. [SOP-03 \(Appendix B\)](#) provides further details on the chain-of-custody procedure.

Laboratory Sample Custody Procedures

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to Empirical SOPs ([Appendix C](#)). Coolers are received and checked for proper temperature. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample containers for accuracy. Samples will be logged into the Laboratory Information Management System (LIMS) and given a unique log number which can be tracked through processing. The Laboratory PM will notify the Tetra Tech FOL verbally or via e-mail of any problems on the same day that an issue is identified.

Sample Designation System

Each sample collected for analysis will be assigned a unique sample tracking number that will consist of a multi-segment alphanumeric code that identifies the site, sample type (sample medium or QC sample designation), sample location, and sample depth. [SOP-02 \(Appendix B\)](#) addresses sample nomenclature. The alphanumeric coding system to be used is as follows:

Site Identifier:

23 = SWMU 23

Sample Medium:

SS = Surface Soil

SB = Subsurface Soil

GW = Groundwater

SD = Sediment

SW = Surface Water

QA/QC Sample Designation:

RB = Rinsate Blank

FD = Field Duplicate

TB = Trip Blank

Sample Location:

The names of all planned sample locations are identified in [Worksheet #18](#).

Surface and subsurface soil samples will be assigned a three digit consecutive location number in the order of collection. This will then be followed by the soil sample depth; indicated by a four-digit number. The first two digits will represent the upper limit of the sample depth interval (rounded to the nearest foot), and the last two digits will represent the lower limit of the sample depth interval.

Groundwater samples will be assigned a three-digit consecutive location number based on the monitoring well ID, as designated on [Figures 17-3](#).

Surface water and sediment samples will be assigned a three-digit consecutive location number in the order of collection, as designated on [Figure 17-2](#). For sediment samples, the three-digit location number will be followed by the sample depth; indicated by a four-digit number. The first two digits will represent

the upper limit of the sample depth, and the last two digits will represent the lower limit of the sample depth interval (depths will be rounded to the nearest inch).

QC Sample Number:

All QC samples will be assigned a sequential sample number. For example, the first equipment rinsate blank collected April 20, 2012, will be assigned the tracking number 23RB04201201. Field duplicate, MS, and MSD samples will be collected from the same location. The field duplicate will be given the same type of sample designation as the samples so that it will be "blind" to the laboratory. The sampling time recorded on the chain-of-custody form, labels and tags for the duplicate samples will be 0000. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

All pertinent information regarding sample identification will be recorded in the field logbooks and on sample log sheets, where appropriate.

SAP Worksheet No. 28 -- Laboratory QC Samples Table
 (UFP-QAPP Manual Section 3.4)

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples.	All target analytes must be $\leq \frac{1}{2}$ LOQ, except common lab contaminants, which must be $< LOQ$.	Investigate source of contamination and rerun method blank prior to analysis of samples, if possible. Evaluate the samples and associated QC: if blank results are above LOQ, then report sample results that are $< LOQ$ or $> 10X$ the blank concentration. Re-prepare and reanalyze blank and those samples that were $> LOQ$ and $< 10X$ the blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
Laboratory Control Sample (LCS)/ Laboratory Control Sample Duplicate (LCSD) (not required)	One per preparatory batch of 20 or fewer samples.	%Rs must meet the DoD Quality Systems Manual (QSM) Version 4.2 limits as per Appendix G of the DoD QSM. RPD must be $\leq 30\%$ (for LCS/LCSD, if LCSD is performed).	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time	Analyst, Supervisor	Accuracy/ Bias Precision also, if LCSD is analyzed	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	VOCs					
Analytical Method/SOP Reference	SW-846 8260B Empirical SOP-202					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be \leq 30%.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/ analysis difficulties, then re-prepare and reanalyze MS/MSD.	Analyst, Supervisor	Accuracy/ Bias/ Precision	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	VOCs					
Analytical Method/SOP Reference	SW-846 8260B Empirical SOP-202					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Internal Standards (IS)	Every field sample, standard, and QC sample - three per sample- Fluorobenzene Chlorobenzene-d ₅ 1,4-dichlorobezene-d ₄ .	RTs must be within ± 30 seconds and the response areas must be within -50% to +100% of the ICAL midpoint standard for each IS.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits
Surrogates	All field and QC samples - four per sample- Dibromofluoromethane 1,2-dichloroethane-d ₄ Toluene-d ₈ BFB.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	If sample volume is available, then re-prepare and reanalyze sample for confirmation of matrix interference when appropriate.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	PAHs					
Analytical Method/SOP Reference	SW-846 8270D-Low Empirical SOP-201					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be $\leq \frac{1}{2}$ LOQ.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are above LOQ, report sample results that are $< LOQ$ or $> 10X$ the blank concentration. Reanalyze blank and samples $> LOQ$ and $< 10X$ the blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be $\leq 30\%$.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met, unless RPDs indicate obvious extraction/ analysis difficulties, then re-prepare and reanalyze MS/MSD.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	PAHs					
Analytical Method/SOP Reference	SW-846 8270D-Low Empirical SOP-201					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
IS	Every field sample, standard, and QC sample - six per sample 1,4-Dichlorobenzene-d ₄ Naphthalene-d ₈ Acenaphthene-d ₁₀ Phenanthrene-d ₁₀ Chrysene-d ₁₂ Perylene-d ₁₂ .	RTs must be within ± 30 seconds and the response areas must be within -50% to +100% of the ICAL midpoint standard for each IS.	Re-analyze affected samples.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits
Surrogates	All field and QC samples - six per sample 2-Fluorophenol Phenol-d ₆ Nitrobenzene-d ₅ 2-Fluorobiphenyl 2,4,6-Tribromophenol Terphenyl-d ₁₄ .	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	(1) Check chromatogram for interference; if found, then flag data. (2) If not found, then check instrument performance; if problem is found, then correct and reanalyze sample. (3) If still out, then re-extract and reanalyze sample. (4) If reanalysis is out, then flag data.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be $\leq \frac{1}{2}$ LOQ.	Investigate source of contamination. Evaluate the samples and associated QC: i.e., if the blank results are above the LOQ, then report sample results that are $<LOQ$ or $> 10X$ the blank concentration. Otherwise, re-prepare a blank and samples $>LOQ$ and $<10X$ LOQ.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix. Spike with Aroclor 1016/1260 mix.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix. (spike same as LCS).	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be $\leq 30\%$.	Evaluate the samples and associated QC and if the LCS results are acceptable, then narrate. If both the LCS and MS/MSD are unacceptable, then re-prepare the samples and QC.	Analyst, Supervisor	Accuracy/ Bias/ Precision	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	PCBs					
Analytical Method /SOP Reference	SW-846 8082A Empirical SOP-211					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogates	All field and QC samples - two per sample Tetrachloro-m-xylene Decachlorobiphenyl.	%Rs must meet the DoD QSM Version 4.2 limits as per Appendix G of the DoD QSM.	No corrective will be taken when one surrogate is within criteria. If surrogates recoveries are high and sample is <LOQ, then no CA is taken. If surrogates recoveries are low, then the affected samples are re-extracted and reanalyzed.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Second Column Confirmation	All positive results must be confirmed.	Results between primary and second column must be $RPD \leq 40\%$. For Method 8082, report the higher of the two concentrations, unless there is interference.	None. Apply "J" flag if $RPD > 40\%$ and discuss in the case narrative.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be $\leq \frac{1}{2}$ LOQ.	If the blank value > LOQ, then report sample results. If the blank value < LOQ or > 10x the blank value, then redigest. If blank value is less than negative LOQ, then report sample results. If > 10x the absolute value of the blank result, then redigest and reanalyze.	Analyst, Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix.	%R must be within 80-120% of true value.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reanalyzed within hold time	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS	One per preparatory batch of 20 or fewer samples of similar matrix.	%R should be within 80-120% of true value (if sample is < 4x spike added).	Flag results for affected analytes for all associated samples with "N".	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Sample Duplicate	One per preparatory batch of 20 or fewer samples of similar matrix.	The RPD should be $\leq 20\%$ for duplicate samples for both water and soils.	Narrate any results that are outside control limits.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits
Serial Dilution	One per preparatory batch with sample concentration(s) >50x LOD.	The 5-fold dilution result must agree within $\pm 10\%D$ of the original sample result if result is >50x LOD.	Perform post spike addition.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits

Matrix	Soil, Sediment, Groundwater, Surface Water, and Aqueous QC Samples					
Analytical Group	Metals, Including Mercury (and Dissolved Metals)					
Analytical Method/SOP Reference	SW-846 6010C, 7470A, 7471B Empirical SOP-103, 105					
QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Post Spike (does not apply to mercury)	One is performed when serial dilution fails or target analyte concentration(s) in all samples are < 50x LOD.	The %R must be within 75-125% of expected value to verify the absence of an interference. Spike addition should produce a concentration of 10-100x LOQ.	Flag results for affected analytes for all associated samples with "J".	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Soil, Sediment, and Aqueous QC Samples					
Analytical Group	TPH-GRO/DRO/ERO					
Analytical Method/SOP Reference	SW-846 Method 8015B Empirical SOP-219					
QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method Blank	One per preparatory batch of 20 or fewer samples.	All target analytes must be $\leq \frac{1}{2}$ LOQ.	If the method blank acceptance criteria are not met, identify and correct the source of contamination, and re-prepare and reanalyze the associated samples.	Analyst, Supervisor	Bias/Contamination	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix.	%R must be within 50-150% of true value.	If LCS acceptance limits are not met, the LCS should be reanalyzed once to confirm that the original analysis is reliable. If the results are still outside control limits, the associated sample must be re-extracted and reanalyzed.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs should be within 50-15% of true value (if sample is < 4x spike added). The RPD between MS and MSD should be $\leq 30\%$.	CA will not be taken for samples when %Rs are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/ analysis difficulties, then re-prepare and reanalyze MS/MSD.	Analyst, Supervisor	Accuracy/ Bias/ Precision	Same as QC Acceptance Limits
Surrogate	All field and QC samples - one per sample o-Terphenyl.	The %R of the surrogate must fall within 50-150%.	If surrogate %R is outside the established limits, verify calculations, dilutions, and standard solutions. Also verify that the instrument performance is acceptable. If the surrogate %R is outside the established limits due to well-documented matrix effects, the results must be flagged and an explanation included in the report narrative.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits
Results between DL and LOQ	NA.	Apply "J" qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Accuracy	Same as QC Acceptance Limits

Matrix	Sediment					
Analytical Group	TOC					
Analytical Method/ SOP Reference	Lloyd Kahn Empirical SOP-221					
QC Sample	Frequency/ Number	Method/SOP Acceptance Limits	QC CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One preparatory per batch of 20 or fewer samples.	The target analyte must be $\leq \frac{1}{2}$ LOQ.	Correct problem, re-prepare and reanalyze along with associated samples.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits.
LCS	One preparatory per batch of 20 or fewer samples.	%R must be within 80-120% of true value.	Correct problem, re-prepare, and reanalyze along with associated samples.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One preparatory per batch of 20 or fewer samples per matrix.	%R should be within 75-125% of true value. RPD should be \leq 50% for sediment.	Contact client for guidance.	Analyst, Supervisor	Accuracy/ Precision Bias/	Same as QC Acceptance Limits

Matrix	Soil					
Analytical Group	pH					
Analytical Method/ SOP Reference	SW-846 9045D Empirical SOP-187					
QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Laboratory Duplicate	One per preparation batch of 10 or fewer samples.	± 0.09 units	Recalibrate and reanalyze samples.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits
LCS	Once per 20 samples.	± 0.25 units	Re-analyze associated samples.	Analyst, Supervisor	Accuracy/bias	Same as QC Acceptance Limits

Matrix	Soil					
Analytical Group	Sulfate					
Analytical Method/SOP Reference	SW-846 9056 Empirical SOP-145					
QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per batch of up to 20 samples.	Analyte concentration must be $< \frac{1}{2}$ LOQ.	Correct problem, re-prepare, and reanalyze along with all associated samples.	Analyst, Supervisor	Bias/Contamination	Same as QC Acceptance Limits.
LCS	One per batch of up to 20 samples.	%R must be within 80-120% of true value.	Correct problem, re-prepare, and reanalyze the LCS along with all associated samples.	Analyst, Supervisor	Accuracy/Bias	Same as QC Acceptance Limits.
Sample Duplicate (Replicate)	One per every 10 samples.	RPD must be $\leq 10\%$.	Correct problem and reanalyze sample and duplicate.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits.
MS/MSD	One per batch of up to 20 samples.	%R should be within 80-120% of true value. RPD should be $\leq 10\%$.	Contact client for guidance.	Analyst, Supervisor	Accuracy/Bias Precision	Same as QC Acceptance Limits.

SAP Worksheet No. 29 -- Project Documents and Records Table
 ([UFP-QAPP Manual Section 3.5.1](#))

Document	Location Maintained
<p>Sample Collection Documents and Records:</p> <ul style="list-style-type: none"> • Field logbook (and sampling notes) • Field sample forms (e.g., boring logs, sample log sheets, drilling logs, etc.) • Chain-of-custody records • Sample shipment airbills • Equipment calibration logs • Photographs • Field Task Modification Request forms • SAP • Field Sampling SOPs 	<p>Tetra Tech project file; results will be discussed in subject document.</p>
<p>Laboratory Documents and Records in the form of analytical data package:</p> <ul style="list-style-type: none"> • Sample receipt/login form • Sample storage records • Sample preparation logs • Equipment calibration logs • Sample analysis run logs • Reported results for standards, QC checks, and QC samples • Data completeness checklists • Telephone logs • Extraction/clean-up records • Raw data <p>Electronic Data Deliverables (EDDs)</p>	<p>Tetra Tech project file; long-term data package storage at third-party commercial document storage firm.</p>
<p>Other Documents:</p> <ul style="list-style-type: none"> • HASP • All letter and e-mail correspondence with regulatory agencies, including approvals and comments • Telephone logs • Field investigation data packages • All versions of project reports 	<p>Tetra Tech project file; final reports will be uploaded to NIRIS.</p>

SAP Worksheet No. 30 -- Analytical Services Table
 ([UFP-QAPP Manual Section 3.5.2.3](#))

MATRIX	ANALYTICAL GROUP	SAMPLE LOCATIONS/ IDENTIFICATION NUMBERS	ANALYTICAL METHOD	DATA PACKAGE TURNAROUND TIME	LABORATORY/ ORGANIZATION (name and address, contact person and telephone number)	BACKUP LABORATORY/ ORGANIZATION (name and address, contact person, and telephone number)
Groundwater, surface water, soil, and sediment	VOCs	See Worksheet #18	SW-846 8260B	21 calendar days	Brian Richard brichard@empirlabs.com Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, TN 37228 (615) 345-1115	NA
	PAHs		SW-846 8270D-Low			
	PCBs		SW-846 8082A			
	Metals		SW-846 6010C, 7470A, 7471B			
	pH (soil only)		SW-846 9045D			
Soil and sediment	TPH (GRO/ DRO/ERO)		SW-846 Method 8015B			
Soil	Sulfate		SW-846 9056			
Sediment	TOC		Lloyd Kahn			

SAP Worksheet No. 31 -- Planned Project Assessments Table
 ([UFP-QAPP Manual Section 4.1.1](#))

ASSESSMENT TYPE	FREQUENCY	INTERNAL OR EXTERNAL	ORGANIZATION PERFORMING ASSESSMENT	PERSON(S) RESPONSIBLE FOR PERFORMING ASSESSMENT (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR RESPONDING TO ASSESSMENT FINDINGS (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR IDENTIFYING AND IMPLEMENTING CA (title and organizational affiliation)	PERSON(S) RESPONSIBLE FOR MONITORING EFFECTIVENESS OF CA (title and organizational affiliation)
Laboratory Systems Audit ¹	Every two years	External	DoD ELAP Accrediting Body	DoD ELAP Accrediting Body Auditor	Laboratory QAM or Laboratory Manager, Empirical	Laboratory QAM or Laboratory Manager, Empirical	Laboratory QAM or Laboratory Manager, Empirical

1 Empirical is DoD ELAP accredited by a recognized Accrediting Body for all analytical groups and target analytes required for this project. The DoD ELAP accreditation letter is included in Appendix C.

SAP Worksheet No. 32 -- Assessment Findings and Corrective Action Responses
[\(UFP-QAPP Manual Section 4.1.2\)](#)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (name, title, organization)	Timeframe for Response
Laboratory Systems Audit	Written audit report	Marcia McGinnity, Laboratory QAM, Empirical	Specified by DoD ELAP Accrediting Body	Letter	DoD ELAP Accrediting Body	Specified by DoD ELAP Accrediting Body

SAP Worksheet No. 33 -- QA Management Reports Table
[\(UFP QAPP Manual Section 4.2\)](#)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Data Validation Report	Per sample delivery group (SDG)	Within 3 weeks after receiving the data from the laboratory	Project Chemist or Data Validator, Tetra Tech	PM, Tetra Tech; project file
Project Monthly Progress Report	Monthly for duration of the project	Monthly	PM, Tetra Tech	PM, Tetra Tech; QAM, Tetra Tech; Program Manager, Tetra Tech; Navy RPM; project file
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (on the same day)	Laboratory PM, Empirical	PM and project file, Tetra Tech

SAP Worksheet No. 34 -- Verification (Step I) Process Table
 ([UFP-QAPP Manual Section 5.2.1](#))

VERIFICATION INPUT	DESCRIPTION	INTERNAL/ EXTERNAL	RESPONSIBLE FOR VERIFICATION (name, organization)
Chain-of-Custody Forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that the samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, the Tetra Tech PM, and the Tetra Tech Data Validators.	Internal	Sampler and FOL, Tetra Tech
Chain-of-Custody Forms	The Empirical Sample Custodian will review the sample shipment for completeness, integrity, and sign accepting the shipment. The Tetra Tech Data Validators will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses.	External	1 - Laboratory Sample Custodian, Empirical 2 - Data Validators, Tetra Tech
SAP Sample Tables/Chain-of-Custody Forms	Verify that all proposed samples listed in the SAP tables have been collected.	Internal	FOL or designee, Tetra Tech
Sample Log Sheets	Verify that information recorded in the log sheets is accurate and complete.	Internal	FOL or designee, Tetra Tech
SAP/ Field Logs/Analytical Data Packages	Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved. Particular attention should be given to verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain-of-custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented.	Internal	PM or designee, Tetra Tech
SAP/Analytical SOPs/Analytical Data Packages	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.	Internal	Laboratory QAM, Empirical
SAP/Laboratory SOPs/Raw Data/Applicable Control Limits Tables	Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM verbally or via e-mail for guidance prior to report preparation.	Internal	Laboratory QAM, Empirical
SAP/Chain-of-Custody Forms	Check that field QC samples listed in Worksheet #20 were collected as required.	Internal	FOL or designee, Tetra Tech

VERIFICATION INPUT	DESCRIPTION	INTERNAL/ EXTERNAL	RESPONSIBLE FOR VERIFICATION (name, organization)
EDDs/Analytical Data Packages	Each EDD will be verified against the chain-of-custody and hard copy data package for accuracy and completeness. Laboratory analytical results will be verified and compared to the electronic analytical results for accuracy. Sample results will be evaluated for laboratory contamination and will be qualified for false positives using the laboratory method/preparation blank summaries. Positive results reported between the DL and the LOQ will be qualified as estimated. Extraneous laboratory qualifiers will be removed from the validation qualifier.	External	Data Validators, Tetra Tech
Analytical Data Packages	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory QAM will sign the case narrative for each data package.	Internal	Laboratory QAM, Empirical
	Each data package will be verified for completeness by the Tetra Tech Data Validator. Missing information will be requested by the Tetra Tech Data Validator from the Empirical Laboratory PM.	External	Data Validators, Tetra Tech

Notes: Verification includes field data verification and laboratory data verification. Verification inputs as per [Worksheet #34](#) will be checked.

SAP Worksheet No. 35 -- Validation (Steps IIa and IIb) Process Table
 (UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SAP/Sample Log Sheets	Ensure that sample locations are correct and in accordance with the SAP proposed locations. Document any discrepancies in the final report.	PM, FOL, or designee, Tetra Tech
IIa	Chain-of-Custody Forms	Ensure that the custody and integrity of the samples was maintained from collection to analysis, the custody records are complete, and any deviations are recorded. Review that the samples were shipped and store at the required temperature and sample pH for chemically preserved samples meet the requirements listed in Worksheet #19 . Ensure that the analyses were performed within the holding times listed in Worksheet #19 .	Project Chemist or Data Validators, Tetra Tech
IIa/IIb	SAP/Laboratory Data Packages/ EDDs	Ensure that the laboratory QC samples listed in Worksheet #28 were analyzed and that the MPCs listed in Worksheet #12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Project Chemist or Data Validators, Tetra Tech
		Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCSD, if available. Ensure compliance with the methods and project MPCs accuracy goals listed in Worksheet #12 .	
		Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis.	
		Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet #36 .	

Step IIa/IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIb	SAP/Laboratory Data Packages/ EDDs	<p>Ensure that the LOQs listed in Worksheet #15 were achieved.</p> <p>Discuss the impact of matrix interferences or sample dilutions performed because of the high concentration of one or more other contaminants, on the other target compounds reported as non-detected.</p> <p>Summarize deviations from methods, procedures, or contracts in the Data Validation Report. If possible determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications.</p> <p>Ensure that the laboratory QC samples listed in Worksheet #28 were analyzed and that the MPCs listed in Worksheet #12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.</p>	Project Chemist or Data Validators, Tetra Tech

SAP Worksheet No. 36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table
[\(UFP-QAPP Manual Section 5.2.2.1\)](#)

STEP IIa / IIb	MATRIX	ANALYTICAL GROUP	VALIDATION CRITERIA	DATA VALIDATOR (title and organizational affiliation)
IIa and IIb	Groundwater, surface water, soil, and sediment	VOCs, PAHs, and PCBs	Data validation will be performed using criteria for SW-846 Methods 8260B, 8270D-Low, and 8082A listed in Worksheets Nos.12, 15, 24, and 28 and the current DoD QSM. If not included in the aforementioned, then the logic outlined in the "USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review" USEPA-540/R-99-008, (USEPA, October 1999) will be used to apply qualifiers to data.	Data Validation Specialist, Tetra Tech
IIa and IIb	Groundwater, surface water, soil, and sediment	Metals, Dissolved Metals	Data validation will be performed using criteria for SW-846 Method 6010C, 7470A, and 7471B listed in Worksheets Nos.12, 15, 24, and 28 and the current DoD QSM. If not included in and the aforementioned, then the logic outlined in the "USEPA CLP National Functional Guidelines for Inorganic Data Review", USEPA 540-R-04-004, (USEPA, October 2004) will be used to apply qualifiers to data.	Data Validation Specialist, Tetra Tech
IIa and IIb	Soil and sediment	TPH (GRO/DRO/ERO)	Data validation will be performed using criteria for SW-846 Method 8015B listed in Worksheets Nos.12, 15, 24, and 28 and the current DoD QSM 4.1. If not included in the aforementioned, then the logic outlined in the "USEPA CLP National Functional Guidelines for Organic Data Review" USEPA-540/R-99-008, (USEPA, October 1999) will be used to apply qualifiers to data.	Data Validation Specialist, Tetra Tech
IIa and IIb	Soil and sediment	pH and TOC	Data validation will be not performed on pH and TOC data.	None

SAP Worksheet No. 37 -- Usability Assessment (UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment

The usability of the data generated during the RFI directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum, and the results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the evaluator will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics:

- **Completeness**

For each matrix scheduled to be sampled, the Tetra Tech FOL, acting on behalf of the Project Team, will prepare a table listing to compare planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

- **Precision**

The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in [Worksheets #12 and #28](#). This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met, or if data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report.

Accuracy

The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in [Worksheet #28](#). This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, MSs, and LCSs. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will also be described in the project report.

- **Representativeness**

A Tetra Tech Project Scientist, identified by the Tetra Tech PM and acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations (as applicable), and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Project Scientist indicates that a quantitative analysis is required.

- **Comparability**

The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech Project Chemist indicates that such quantitative analysis is required. Dissolved and total metals results will also be compared to ensure that dissolved metals results are not greater than total metals concentrations after allowance for typical measurement uncertainty.

- **Sensitivity**

The Tetra Tech Project Chemist, acting on behalf of the Project Team, will determine whether project sensitivity goals listed in [Worksheet #15](#) were achieved. The overall sensitivity and LOQs from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described in the project report. The Tetra Tech Project Chemist may enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

- **Project Assumptions and Data Outliers**

The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include those related to data distributions (e.g., normal or log-normal) and estimates of data variability. Potential data outliers will be removed if a review of the associated data indicates that the results have an assignable cause that renders them inconsistent with the remainder of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

After the completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these DQI characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples with non-detected results, number of samples with detected results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Tetra Tech PM, will assess whether the data collectively support the attainment of project objectives. The Project Team will consider whether any missing or rejected data have compromised the ability to make decisions or to make decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated for by other data. Although rejected data will generally not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to one-half of the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the NSA Crane ERSM, Navy RPM, and IDEM RPM. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or teleconference, depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest resampling or other corrective actions, if necessary.

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TABLE 10-1
 INTERIM MEASURES SOIL DATA SUMMARY
 SWMU 23 - BATTERY SHOP BUILDING 36
 NSA CRANE, INDIANA

LOCATION SAMPLE ID SAMPLE DATE SAMPLE CODE MATRIX SAMPLE TYPE SUBMATRIX	CHOICE2	BACKGROUND	CRITERIA SOURCE	23/00-001 23/00-001 19950718 NORMAL SO Waste Characterization SS	23/00-002 23/00-002 19950718 NORMAL SO Waste Characterization SS	23/00-003 23/00-003 19951116 NORMAL SO Soil Characterization SS	23/00-004 23/00-004 19951116 NORMAL SO Soil Characterization SS	23/00-005 23/00-005 19960222 NORMAL SO Soil Characterization SS	23/00-006 23/00-006 19960222 NORMAL SO Soil Characterization SS	23/00-007 23/00-007 19960222 NORMAL SO Soil Characterization SS	23/00-008 23/00-008 19960222 NORMAL SO Soil Characterization SS	23/00-009 23/00-009 19960222 NORMAL SO Soil Characterization SS	23/00-010 23/00-010 19960222 NORMAL SO Soil Characterization SS	23/00-011 23/00-011 19960222 NORMAL SO Soil Characterization SS	23/00-013 23/00-013 19960222 NORMAL SO Soil Characterization SS
DIOXINS/FURANS (UG/KG)															
1,2,3,4,6,7,8,9-OCDD	0.000199	NC	R5DQLSO	5.6	0.93	NA									
TOTAL TCDD	NC	NC	ECOSLAV	0.0501 U	0.74	NA									
HERBICIDES (UG/KG)															
2,4,5-T	596	NC	R5DQLSO	39 U	44 U	NA	NA	1.8 JBP	32 U	28 U	6.3 JBP	29 U	31 U	31 U	1.8 JBP
2,4-D	27.2	NC	R5DQLSO	39 U	44 U	NA	NA	120 U	130 U	11 JP	22 JBP	120 U	120 U	130 U	100 U
METALS (UG/KG)															
ANTIMONY	270	6872.53299	ECOSSLMAM	2600 U	3000 U	NA	NA	1500 BN	4200 BN	990 BN	1.4 BN	1800 BN	440 BN	540 BN	440 BN
ARSENIC	18000	11831.981	ECOSSLPL	10700	6800	NA	NA	5400	4500	6000	5900	6300	6900	5900	5100
BARIUM	330000	210703.7373	ECOSSLINV	74700	120000	NA	NA	30800	66200	40600	48900	43600	70700	25600	25400
BERYLLIUM	21000	0	ECOSSLMAM	670	1900	NA	NA	170 B	220 B	280 B	290 B	320 B	370 B	590	2200
CADMIUM	360	6052.175561	ECOSSLMAM	520 U	3000	NA	NA	30 B	250 U	190 B	23 U	23 U	25 U	38 U	21 U
CHROMIUM	26000	28723.08617	ECOSLAV	22800	23000	NA	NA	30500	11300	11900	11900	14400	12500	11200	10400
COBALT	13000	32360.80804	ECOSSLPL	5200	39100	NA	NA	2800	2700	2600	3500	4500	6300	7700	9300
COPPER	28000	17611.6783	ECOSLAV	14700	139000	NA	NA	11200	16900	16700	11600	17700	12100	8200	8700
LEAD	11000	27019.14416	ECOSLAV	30800	40100	NA	NA	227000 N	776000 N	109000 N	119000 N	161000	16800 N	10500 N	15300 N
LITHIUM	2000	0	PLSS	NA	NA	NA	NA	1700 B	3900 B	3500 B	4600 B	5900 B	6900 B	2300 B	4100 B
NICKEL	38000	22097.11483	ECOSSLPL	13500	80200	NA	NA	6400	10100	5500	6900	13300	9600	86600	81100
SELENIUM	520	812.415	ECOSSLPL	650 U	740 U	NA	NA	370 U	400 U	350 BN	350 U	350 U	900	810	320 B
SILVER	4200	0	ECOSLAV	1000 U	4900	NA	NA	94 U	110 U	160 B	93 U	94 U	110 U	110 U	73 U
TIN	7620	0	R5DQLSO	32700 U	36000 U	NA	NA	1200 BN	1800 B	1600 BN	1800 BN	3500 B	1200 BN	1400 BN	950 B
VANADIUM	7800	51205.22483	ECOSLAV	25500	20600	NA	NA	7300	10500	12400	14500	15100	21100	10100	11900
ZINC	46000	65572.446	ECOSLAV	45900	152000	NA	NA	41900	45100	42200	45400	92400	28600	91600	80700
MISCELLANEOUS PARAMETERS (F)															
FLASHPOINT	NC	NC	NC	NA	NA	203 U	203	NA							
MISCELLANEOUS PARAMETERS (S.U.)															
PH	NC	NC	NC	NA	NA	8.9	8.9	NA							
MISCELLANEOUS PARAMETERS (UG/KG)															
SULFIDE	3.58	NC	NC	52000 U	59000 U	NA	NA	56000	37000	33000 U	33000 U	36000	36000	47000	70000
ORGANOPHOSPHOROUS PESTICIDES (UG/KG)															
DIMETHOATE	218	NC	NC	42 U	48 U	NA	NA	28 P	14	8.4 JP	7.2 JP	12 U	18 P	16	10 U
DISULFOTON	19.9	NC	NC	21 U	24 U	NA	NA	12 U	13 U	11 U	12 U	17	12 U	13 U	10 U
FAMPHUR	49.7	NC	NC	21 U	24 U	NA	NA	2.7 JP	13 P	11 U	12 U	12 U	30 P	9 JP	10 U
PESTICIDES/PCBS (UG/KG)															
1,1-DICHLOROETHENE	8280	NC	NC	NA	NA	NA	NA	0.91 JP	0.14 JP	0.18 JP	3.4 JP	0.18 JP	0.09 JP	1.2 JP	0.25 J
4,4-DDD	21	NC	NC	4.2 U	4.9 U	NA	NA	0.5 J	0.17 JP	0.25 JP	0.24 JP	1.5 JP	0.16 JP	4.4 U	3.6 U
4,4-DDDE	21	NC	NC	8	4.9 U	NA									
4,4-DDT	21	NC	NC	6.2	4.9 U	NA	NA	0.61 JB	0.41 JB	0.75 JBP	0.37 JBP	7.9 BP	0.12 JBP	0.11 JBP	0.098 JBP
ALDRIN	3.32	NC	NC	2.1 U	2.4 U	NA	NA	1.2 U	1.3 U	0.12 J	0.2 J	0.1 J	0.053 JP	0.093 JBP	0.034 JP
ALPHA-BHC	99.4	NC	NC	2.1 U	2.4 U	NA	NA	0.067 JP	1.3 U	1.1 U	1.2 U	0.048 JP	1.2 U	1.3 U	1 U
BETA-BHC	3.98	NC	NC	2.1 U	2.4 U	NA	NA	0.49 JP	1.1 JBP	0.19 J	0.2 JP	1.5	0.27 JP	1.3 U	1 U
DELTA-BHC	9940	NC	NC	2.1 U	2.4 U	NA	NA	0.11 JP	1.3 U	1.1 U	1.2 U	0.053 J	0.059 JP	0.12 JP	1 U
DIELDRIN	4.9	NC	NC	4.2 U	4.9 U	NA	NA	0.51 JP	0.37 JP	0.18 JP	0.48 JP	3.2 P	1.8 U	1.9 U	1.5 U
ENDOSULFAN I	119	NC	NC	3.1 U	2.4 U	NA	NA	0.4 JP	0.13 JBP	1.7 U	0.5 JP	0.89 JP	0.21 J	1.9 U	1.5 U
ENDOSULFAN II	119	NC	NC	4.2 U	4.9 U	NA	NA	0.48 JBP	0.1 JBP	0.48 JBP	0.25 JBP	0.84 JBP	4.2 U	0.123 JP	3.6 U
ENDOSULFAN SULFATE	35.8	NC	NC	4.2 U	4.9 U	NA	NA	0.12 JP	0.14 JP	0.16 JP	0.075 JP	1.4 JP	0.1 JP	0.17 JP	0.19 JP
ENDRIN	10.1	NC	NC	4.2 U	4.9 U	NA	NA	0.47 JP	0.6 J	0.23 JP	0.075 JP	1.3 JP	0.55 JP	3.1 U	2.6 U
ENDRIN ALDEHYDE	10.5	NC	NC	4.2 U	4.9 U	NA	NA	1.7 P	4.1 P	0.6 JP	0.61 JP	2.5 P	0.35 JP	0.17 JP	1 U
GAMMA-BHC (LINDANE)	5	NC	NC	4.2 U	4.9 U	NA	NA	0.047 J	1.3 U	1.1 U	0.098 JP	0.37 J	0.015 JP	1.3 U	1 U
HEPTACHLOR	5.98	NC	NC	2.1 U	2.4 U	NA	NA	0.043 JBP	1.3 U	1.1 U	0.059 JBP	0.16 JBP	0.048 JBP	0.063 JBP	0.038 JBP
HEPTACHLOR EPOXIDE	152	NC	NC	2.1 U	2.4 U	NA	NA	0.083 JP	1.3 U	1.1 JBP	0.16 JP	2.3	0.057 J	1.3 U	1 U
METHOXYCHLOR	19.9	NC	NC	21 U	24 U	NA	NA	5.8 BP	1 JBP	1.1 JBP	0.46 JBP	3.8 JBP	0.49 JBP	0.52 JBP	0.2 JBP
SEMIVOLATILES (UG/KG)															
ACENAPHTHENE	29000	NC	NC	330 U	340 U	NA	NA	780 U	64 J	760 U	770 U	810 U	810 U	840 U	690 U
ANTHRACENE	29000	NC	NC	330 U	340 U	NA	NA	870 U	77 J	850 U	860 U	860 U	910 U	940 U	770 U
BENZO(A)ANTHRACENE	1100	NC	NC	330 U	340 U	NA	NA	40 J	240 J	760 U	770 U	34 J	810 U	840 U	690 U
BENZO(B)FLUORANTHENE	1100	NC	NC	330 U	340 U	NA	NA	110 XJ	420 XJ	880 U	900 U	87 J	950 U	970 U	800 U
BENZO(G,H,I)PERYLENE	1100	NC	NC	330 U	340 U	NA	NA	43 J	110 J	710 U	720 U	720 U	770 U	780 U	650 U
BENZO(K)FLUORANTHENE	1100	NC	NC	330 U	340 U	NA	NA	110 XJ	440 XJ	710 U	720 U	92 J	770 U	780 U	650 U
BIS(2-ETHYLHEXYL)PHTHALATE	925	NC	NC	330 U	340 U	NA	NA	70 J	66 J	67 J	200 J	96 J	46 J	69 J	44 J
CHRYSENE	1100	NC	NC	330 U	340 U	NA	NA	54 J	280 J	620 U	630 U	46 J	670 U	680 U	560 U
FLUORANTHENE	29000	NC	NC	330 U	340 U	NA	NA	83 J	520 J	1100 U	1100 U	45 J	1100 U	1200 U	960 U
FLUORENE	29000	NC	NC	330 U	340 U	NA	NA	810 U	58 J	790 U	800 U	810 U	850 U	870 U	720 U
INDENO(1,2,3-CD)PYRENE	1100	NC	NC	330 U	340 U	NA	NA	540 U	110 J	530 U	530 U	540 U	570 U	580 U	480 U
PHENANTHRENE	29000	NC	NC	330 U	340 U	NA	NA	46 J	470 J	710 U	720 U	720 U	770 U	780 U	650 U
PYRENE	1100	NC	NC	330 U	340 U	NA	NA	100 J	540 J	840 U	850 U	53 J	900 U	920 U	760 U
SAFROLE	404	NC	NC	330 U	340 U	NA	NA	110	730 U	670 U	870 U	680 U	720 U	730 U	600 U
TCIP METALS (UG/L)															
BARIUM	NC	NC	NC	NA	NA	1270	766	NA							
TCIP MISCELLANEOUS (UG/L)															
REACTIVE SULFIDE	NC	NC	NC	NA	NA	40000 U	48000	NA							
VOLATILES (UG/KG)															
2,4,5-TRICHLOROPHENOL	NC	NC	NC	NA	NA	NA	NA	5.9 JBP	3.7 JBP	1.4 JBP	1.9 JBP	29 U	2.3 JBP	9.5 JBP	2.5 JBP
ACETONE	NC	NC	NC	130 U	150 U	NA	NA	20 BN	13 U	12 U	11 U	12 U	12 U	13 U	13 U
METHYLENE CHLORIDE	NC	NC	NC	22	41	NA	NA	11 JB	18 B	27 B	13	11 JB	12 B	11 JB	12 B
TRICHLOROETHENE	NC	NC	NC	6.5 U	7.4 U	NA	NA	12 U	13 U	11 U	12 U	12 U	13 U	13 U	22

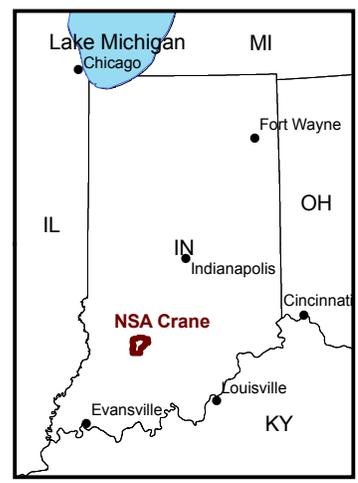
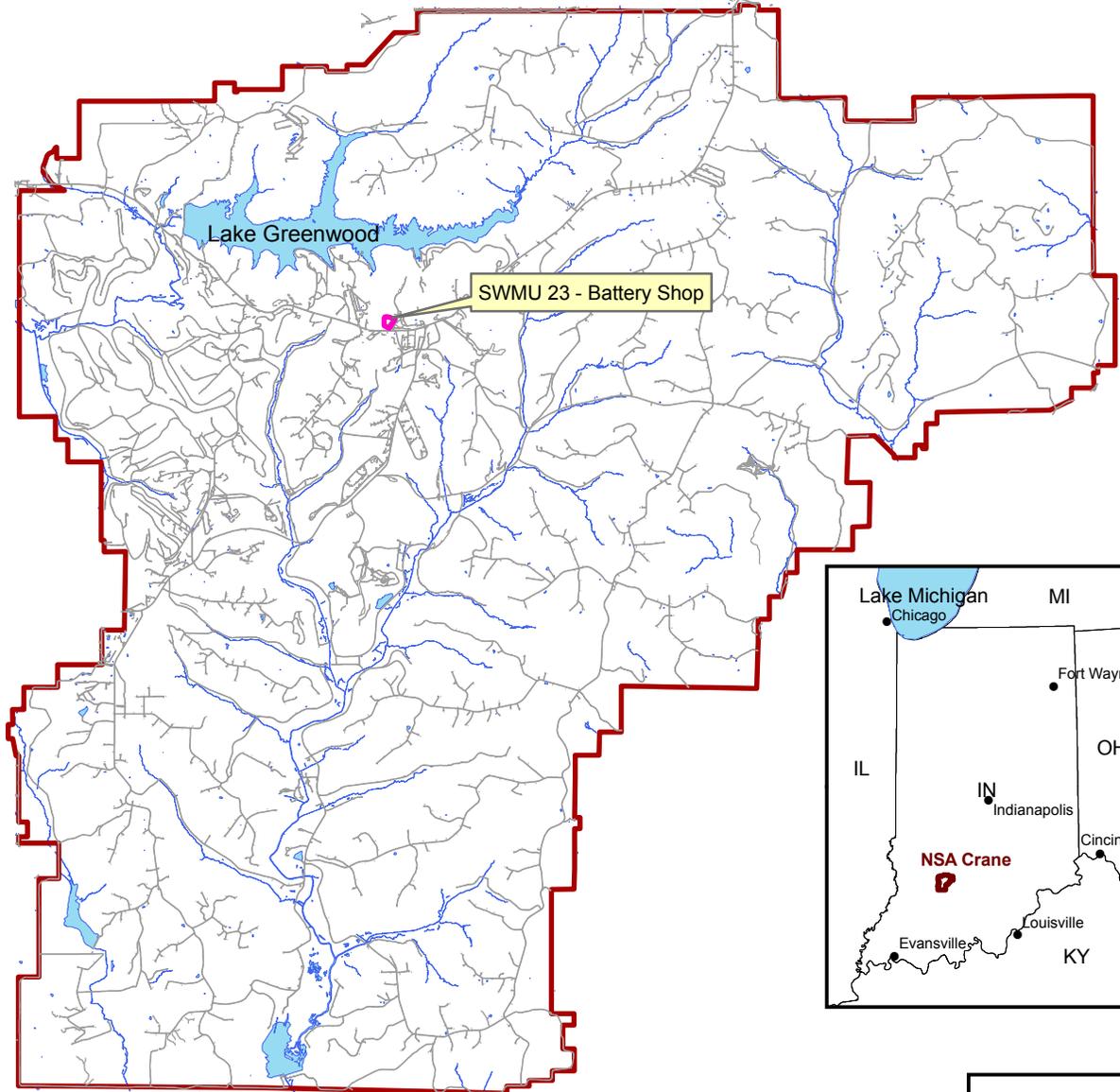
TABLE 10-2

**INTERIM MEASURES SURFACE WATER SUMMARY
SWMU 23 - BATTERY SHOP BUILDING 36
NSA CRANE, INDIANA**

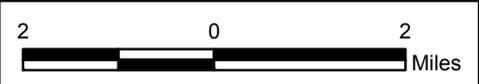
LOCATION SAMPLE ID	FINAL SCREENING	CRITERIA SOURCE	23/00-012 23/00-012	23/00-014 23/00-014
SAMPLE DATE SAMPLE CODE	CRITERIA		19960222 NORMAL	19960222 NORMAL
MATRIX SAMPLE TYPE SUBMATRIX			SW NORMAL NA	SW NORMAL NA
METALS (UG/L)				
BARIUM	210	IDEMC	45.3 B	87.1 B
BERYLLIUM	0.41	IDEMC	0.32 B	4.3 B
CADMIUM	0.66	IDEMS	0.2 U	0.36 B
CHROMIUM	11	EPACHRON	1.9 B	6.3 B
COBALT	19	IDEMC	0.64 U	3.4
COPPER	6.5	IDEMS	3.1 B	13.9 B
LEAD	1.3	IDEMS	2.4 B	10.1
NICKEL	88	IDEMS	37.5 B	316
VANADIUM	12	IDEMC	0.9 B	5.9
ZINC	59	IDEMS	27.7	272
ORGANOPHOSPHOROUS PESTICIDES (UG/L)				
DIMETHOATE	6.2	R3FRSW	0.5 U	0.77
FAMPHUR	NC	IDEMS	0.5 U	1 PB
PESTICIDES/PCBS (UG/L)				
4,4'-DDD	0.011	R3FRSW	0.1 U	0.0008 BJP
DELTA-BHC	667	R5SW	0.03 U	0.0014 J
DIELDRIN	0.0019	IDEMS	0.03 U	0.0018 JP
ENDOSULFAN I	0.056	EPACHRON	0.0003 JP	0.0011 JP
ENDOSULFAN SULFATE	2.22	R5SW	0.0062 JP	0.05 U
HEPTACHLOR	0.0038	IDEMS	0.0012 JP	0.03 U
HEPTACHLOR EPOXIDE	0.0038	EPACHRON	0.0017 JP	0.0019 JP
METHOXYCHLOR	0.03	EPACHRON	0.3 U	0.0097 JP
SEMIVOLATILES (UG/L)				
BIS(2-ETHYLHEXYL)PHTHALATE	0.3	R5SW	1 J	25 U
VOLATILES (UG/L)				
1,1,1-TRICHLOROETHANE	410	IDEMC	10 U	8 J
1,1-DICHLOROETHENE	210	IDEMC	10 U	5 J
METHYLENE CHLORIDE	1500	IDEMC	1 J	8 J
TETRACHLOROETHENE	60	IDEMC	10 U	4 J
TRICHLOROETHENE	260	IDEMC	65	460

IDEMS = IDEM WATER QUALITY STANDARDS (CAC)
 IDEMC = IDEM WATER QUALITY CRITERIA (CAC)
 EPACHRON = EPA FRESHWATER CHRONIC CRITERIA
 R5SW = REGION 5 SURFACE WATER CRITERIA
 R3FRSW = REGION 3 FRESHWATER SW CRITERIA

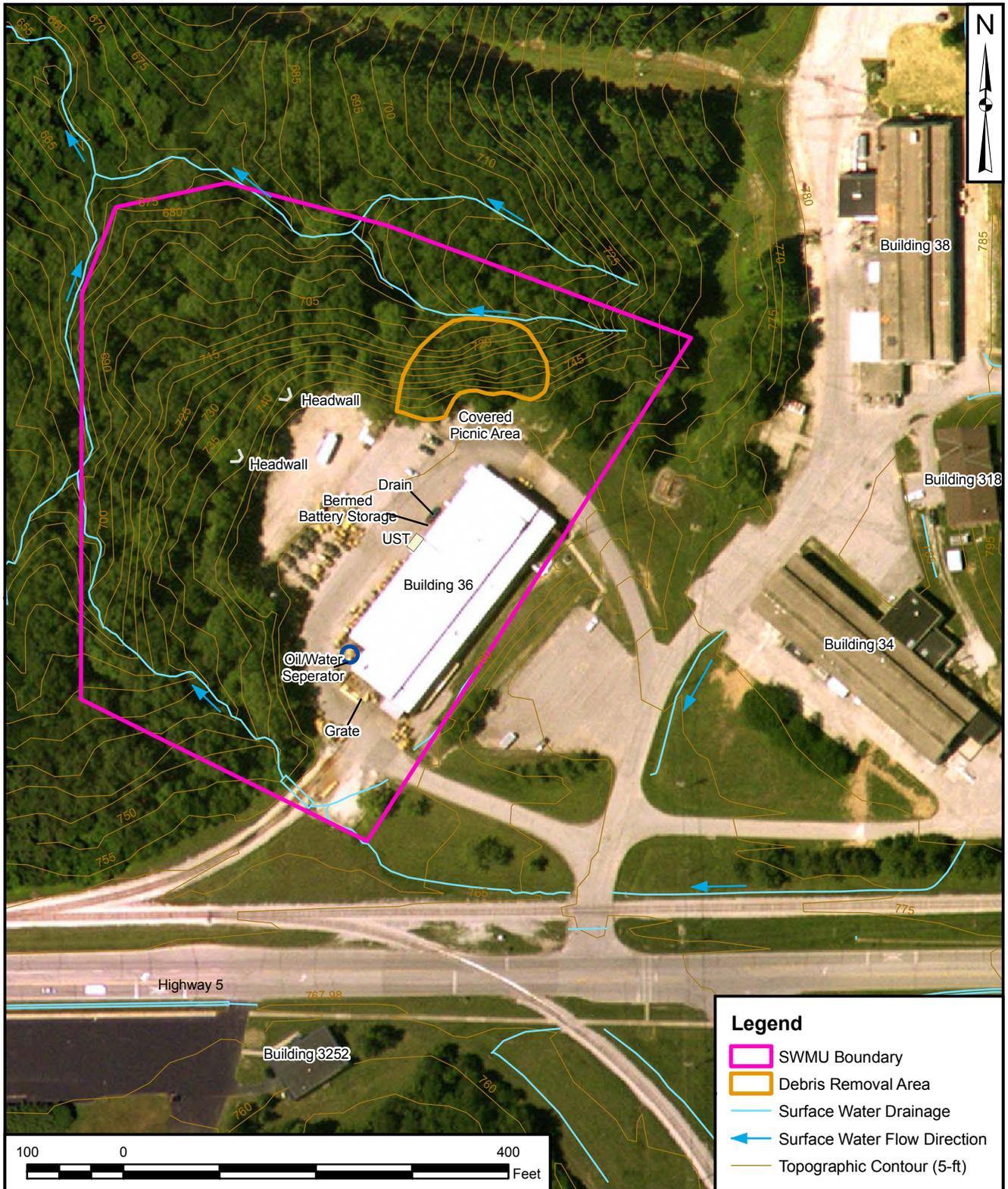
U - Compound or analyte was analyzed for but not detected.
 J - Value is estimated.
 B - Compound or analyte was found in the associated method blank.
 P - Greater than 25% difference between two GC columns. The lower value is reported.



Legend	
	SWMU 23
	Road
	Base Boundary
	Water

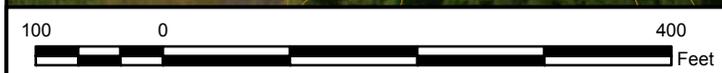


DRAWN BY K. MOORE	DATE 8/5/11	 TETRA TECH	CTO NUMBER F27Q	
CHECKED BY J. DUCAR	DATE 10/11/11		APPROVED BY _____ DATE _____	
REVISED BY MK BOND	DATE 10/11/11	BASE AND SITE LOCATION MAP SWMU 23 - BATTERY SHOP BUILDING 36 NSA CRANE CRANE, INDIANA	APPROVED BY _____ DATE _____	
SCALE AS NOTED			FIGURE NO. _____	REV 0
			FIGURE 10-1	



Legend

- SWMU Boundary
- Debris Removal Area
- Surface Water Drainage
- ← Surface Water Flow Direction
- Topographic Contour (5-ft)



DRAWN BY	DATE
K. MOORE	8/5/11
CHECKED BY	DATE
J. DUCAR	10/25/11
REVISED BY	DATE
MK BOND	10/25/11
SCALE	
AS NOTED	



TETRA TECH

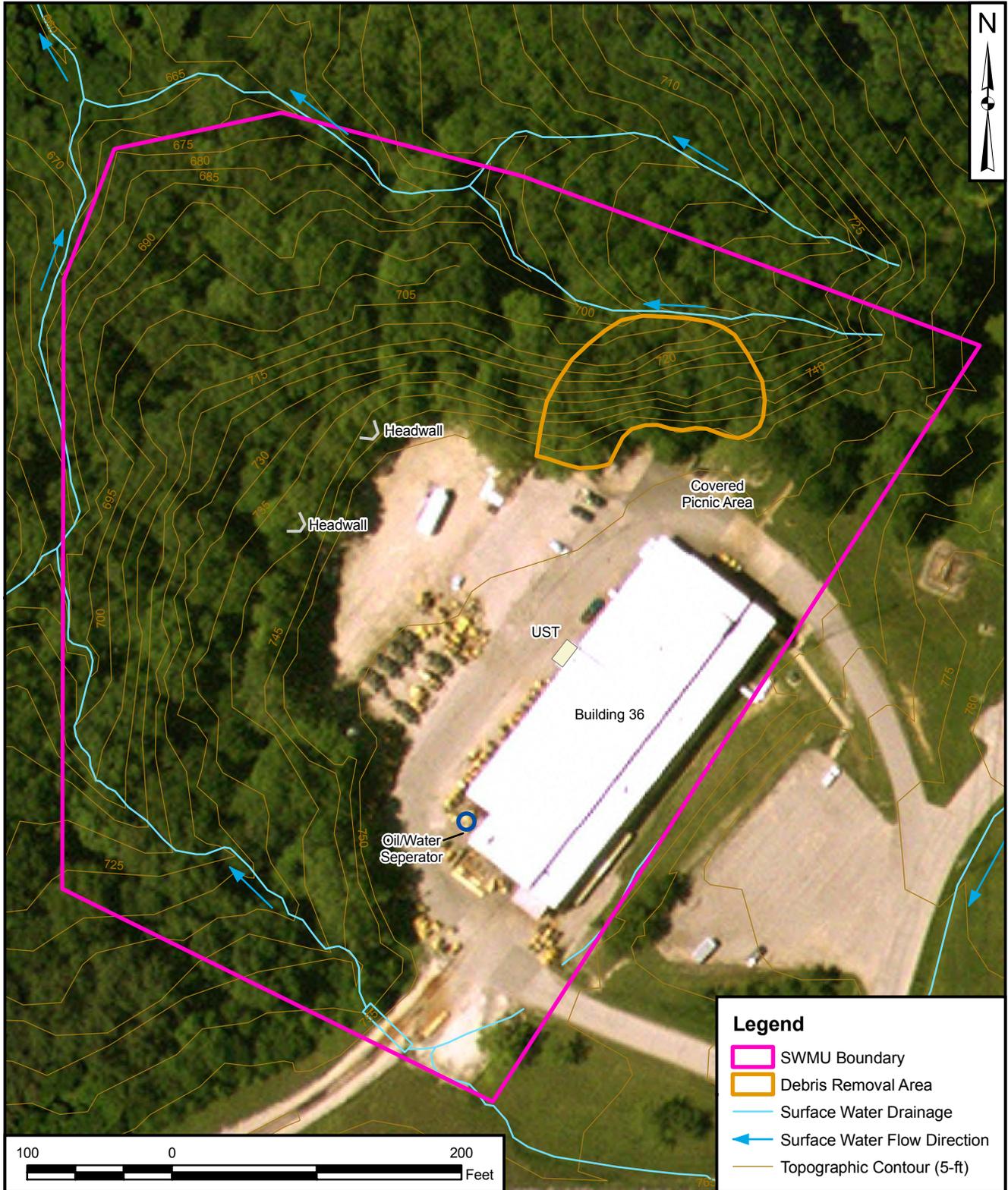
SITE MAP

SWMU 23 - BATTERY SHOP BUILDING 36

NSA CRANE

CRANE, INDIANA

CTO NUMBER		F27Q	
APPROVED BY	DATE	APPROVED BY	DATE
APPROVED BY	DATE	APPROVED BY	DATE
FIGURE NO.	FIGURE 10-2	REV	0



Legend

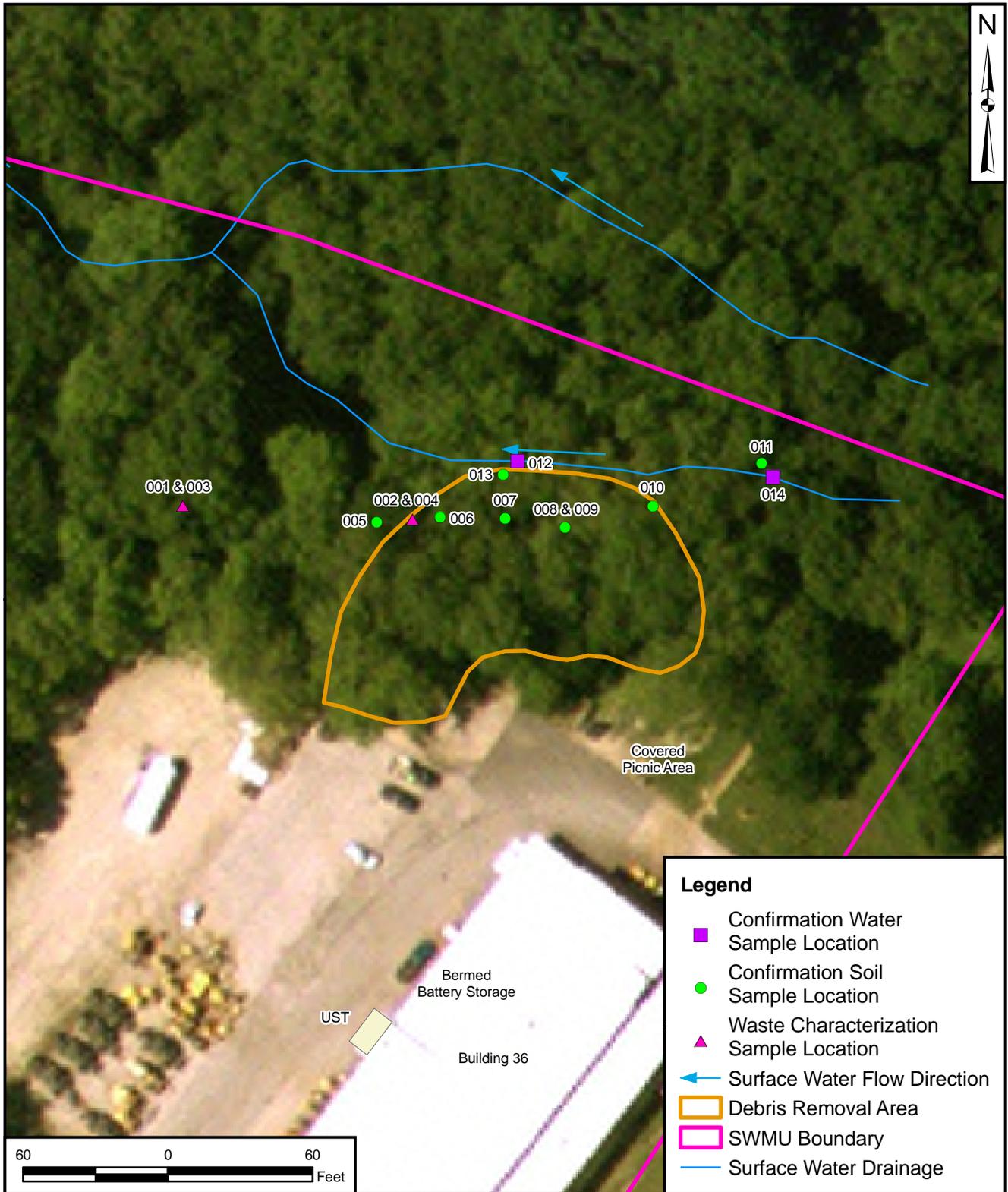
- SWMU Boundary
- Debris Removal Area
- Surface Water Drainage
- ← Surface Water Flow Direction
- Topographic Contour (5-ft)

DRAWN BY	DATE
K. MOORE	8/5/11
CHECKED BY	DATE
J. DUCAR	10/10/11
REVISED BY	DATE
MK BOND	10/10/11
SCALE AS NOTED	



INTERIM MEASURES DEBRIS REMOVAL AREA
SWMU 23 - BATTERY SHOP BUILDING 36
NSA CRANE
CRANE, INDIANA

CTO NUMBER F27Q	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 10-3	0

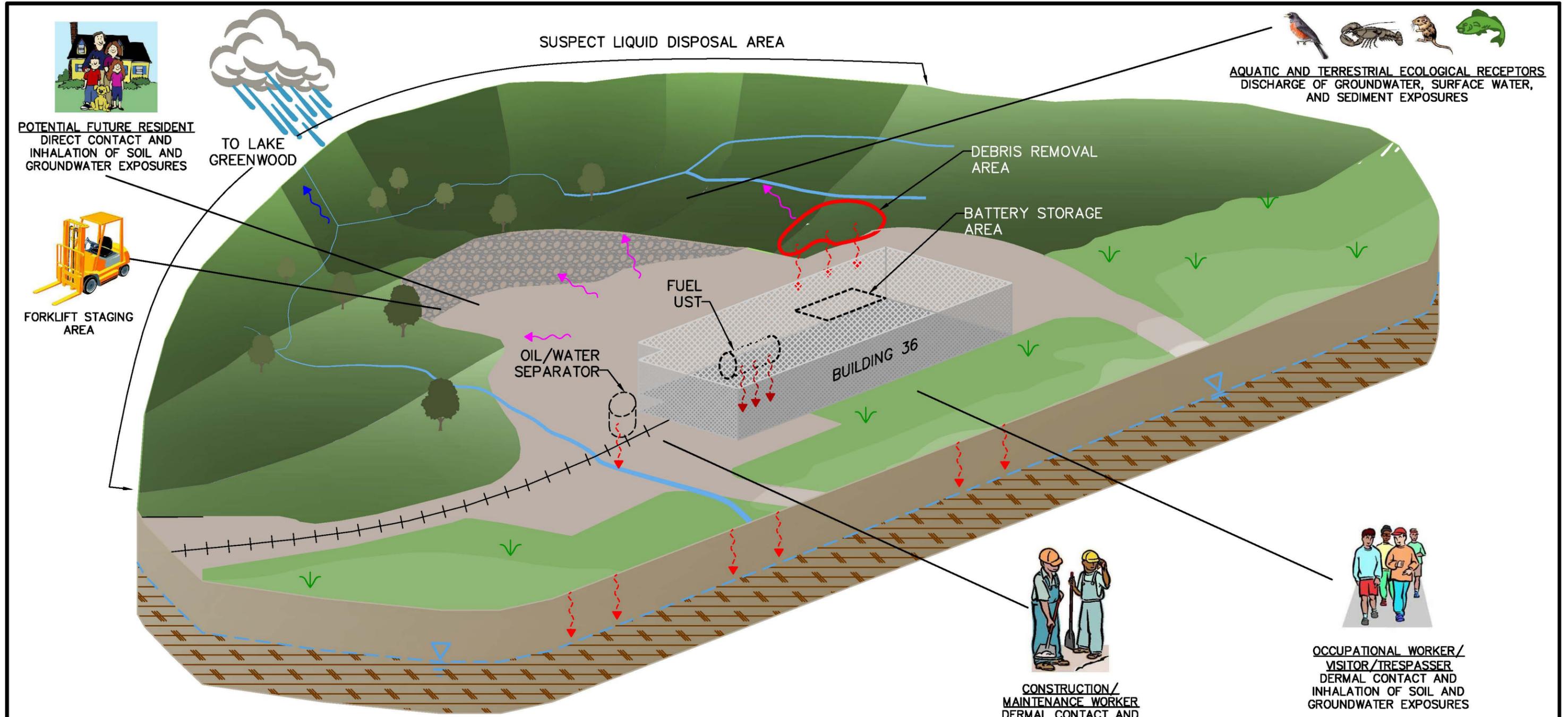


Legend

- Confirmation Water Sample Location
- Confirmation Soil Sample Location
- ▲ Waste Characterization Sample Location
- ← Surface Water Flow Direction
- Debris Removal Area
- SWMU Boundary
- Surface Water Drainage



DRAWN BY K. MOORE	DATE 8/5/11	TETRA TECH	CTO NUMBER F27Q
CHECKED BY J. DUCAR	DATE 10/25/11	INTERIM MEASURES POST DEBRIS REMOVAL CONFIRMATION AND WASTE CHARACTERIZATION SAMPLE LOCATIONS - FEBRUARY 1996 SWMU 23 - BATTERY SHOP BUILDING 36 NSA CRANE CRANE, INDIANA	APPROVED BY _____ DATE _____
REVISED BY MK BOND	DATE 10/25/11		APPROVED BY _____ DATE _____
SCALE AS NOTED			FIGURE NO. FIGURE 10-4 REV 0



- LEGEND**
- SURFACE WATER DRAINAGE PATHWAY
 - SURFACE WATER RUNOFF
 - POTENTIAL RELEASE (SURFACE)
 - POTENTIAL RELEASE (SUBSURFACE)
 - RAILROAD TRACKS
 - BEDROCK
 - CLAY AND SAND
 - GRAVEL
 - PAVED ASPHALT
 - NATIVE TREES
 - NATIVE GRASS
 - WATER TABLE

TETRA TECH

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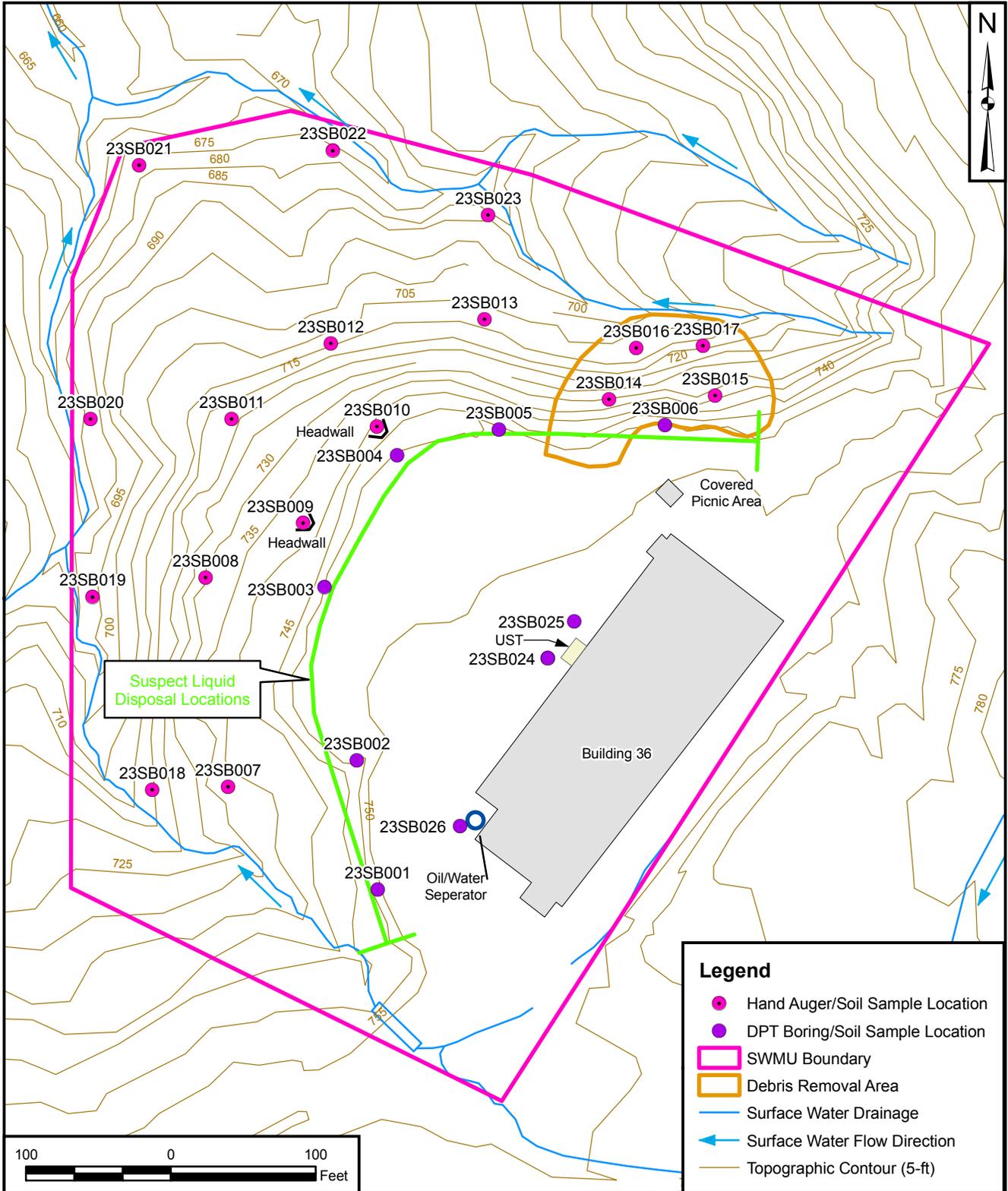
661 ANDERSEN DRIVE – FOSTER PLAZA 7
PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

NSA CRANE
CRANE, INDIANA

CONCEPTUAL SITE MODEL
SWMU 23 – BATTERY SHOP
BUILDING 36

SCALE: NOT TO SCALE

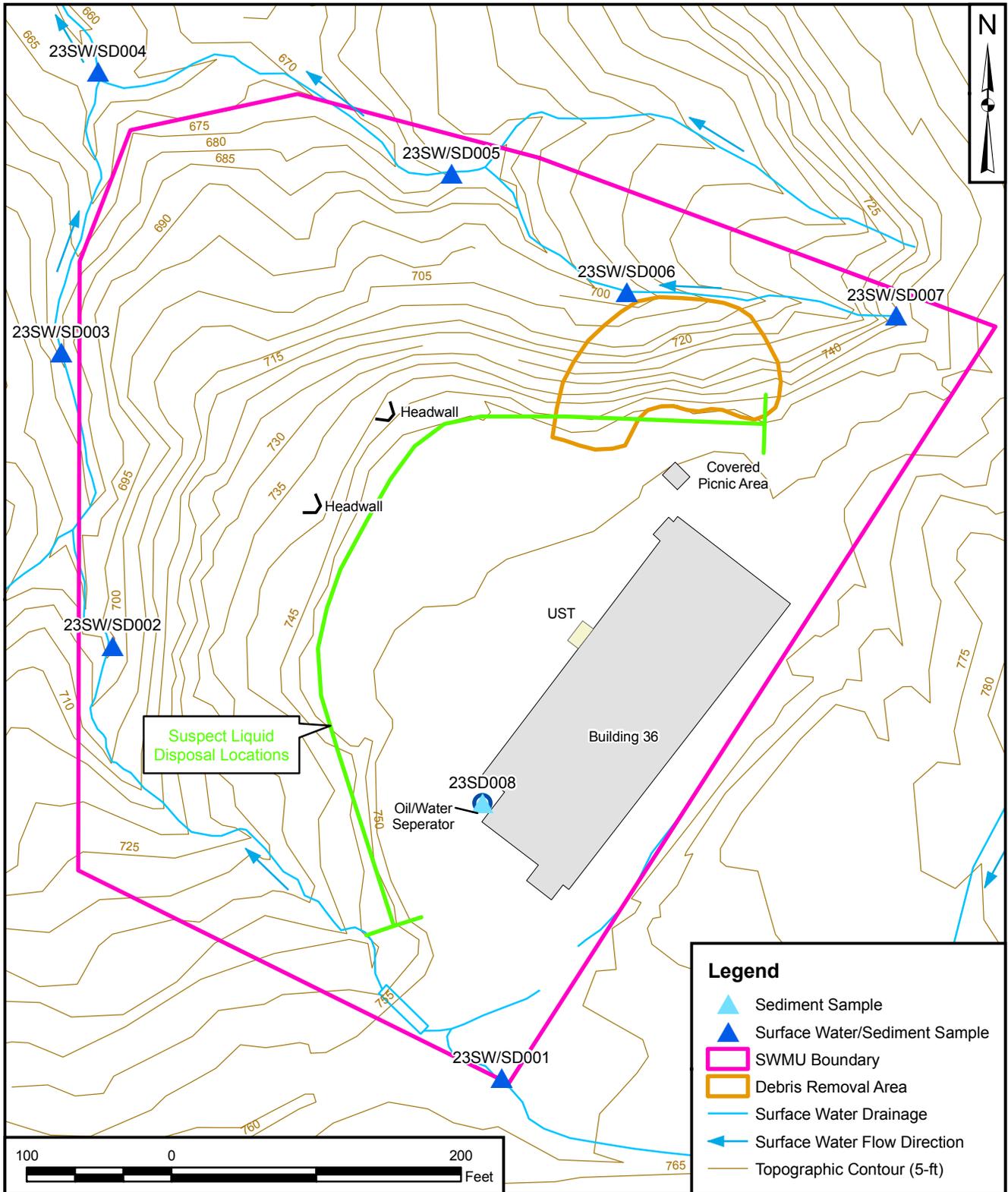
DATE:	8/19/11
PROJECT NO.:	112G03539
DESIGNED BY:	
DRAWN BY:	CK
CHECKED BY:	
SHEET:	1 OF 1
COPYRIGHT TETRA TECH INC.	
FIGURE 10-5	



DRAWN BY K. MOORE	DATE 8/5/11
CHECKED BY J. DUCAR	DATE 10/26/11
REVISED BY MK BOND	DATE 10/26/11
SCALE AS NOTED	


SOIL SAMPLE LOCATIONS
SWMU 23 - BATTERY SHOP BUILDING 36
NSA CRANE
CRANE, INDIANA

CTO NUMBER F27Q	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 17-1	REV 0



Legend

- ▲ Sediment Sample
- ▲ Surface Water/Sediment Sample
- SWMU Boundary
- Debris Removal Area
- Surface Water Drainage
- ← Surface Water Flow Direction
- Topographic Contour (5-ft)

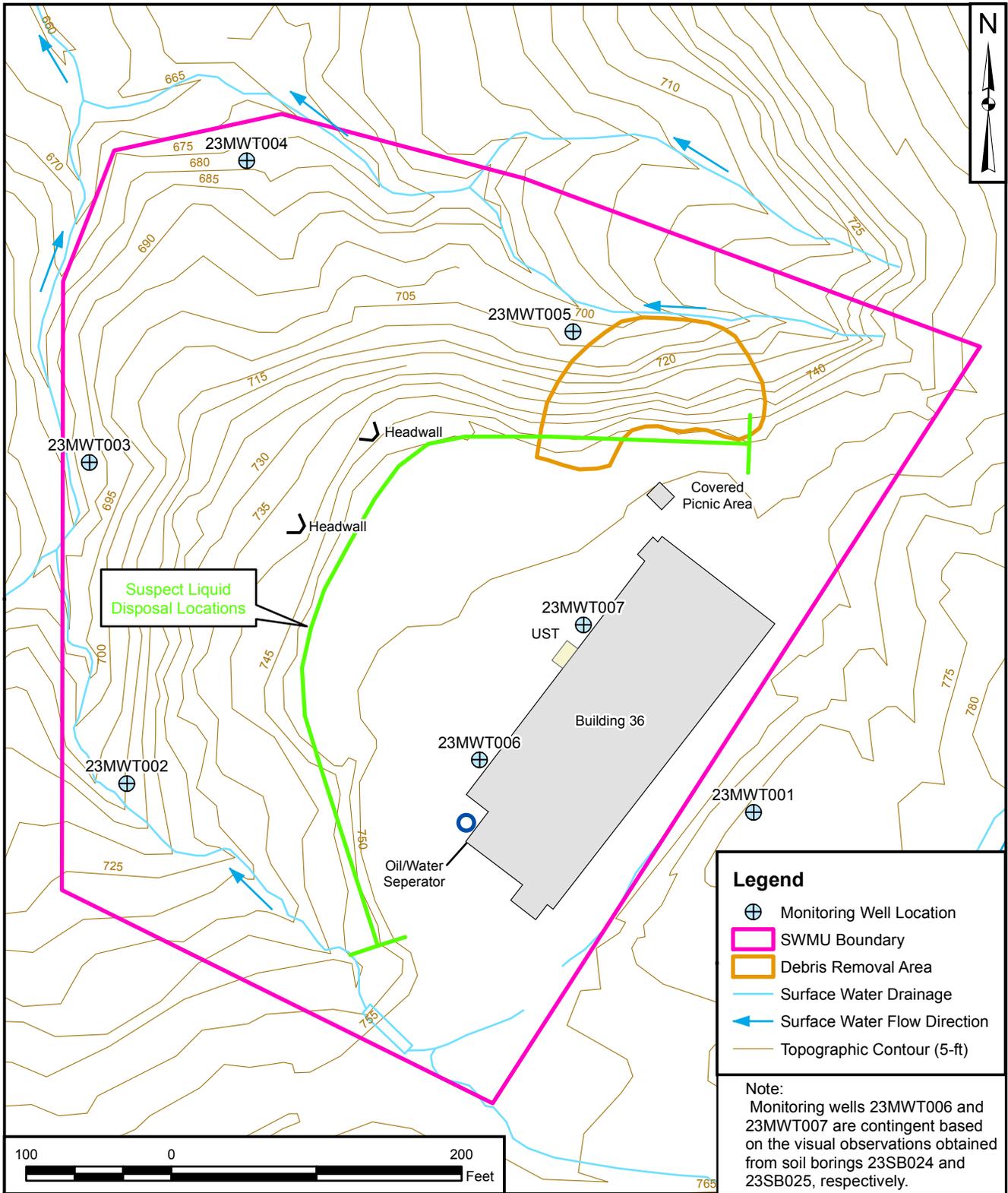


DRAWN BY K. MOORE	DATE 8/5/11
CHECKED BY J. DUCAR	DATE 10/26/11
REVISED BY MK BOND	DATE 10/26/11
SCALE AS NOTED	



SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
SWMU 23 - BATTERY SHOP BUILDING 36
NSA CRANE
CRANE, INDIANA

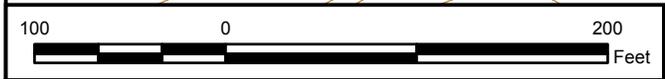
CTO NUMBER F27Q	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 17-2	0



Legend

- ⊕ Monitoring Well Location
- ◻ SWMU Boundary
- ◻ Debris Removal Area
- Surface Water Drainage
- ← Surface Water Flow Direction
- Topographic Contour (5-ft)

Note:
Monitoring wells 23MWT006 and 23MWT007 are contingent based on the visual observations obtained from soil borings 23SB024 and 23SB025, respectively.



DRAWN BY	DATE
K. MOORE	8/5/11
CHECKED BY	DATE
J. GOERDT	05/30/12
REVISED BY	DATE
J. NOVAK	05/30/12
SCALE AS NOTED	


GROUNDWATER SAMPLE LOCATIONS
SWMU 23 - BATTERY SHOP BUILDING 36
NSA CRANE
CRANE, INDIANA

CTO NUMBER F27Q	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 17-3	0

APPENDIX
TABLE OF CONTENTS

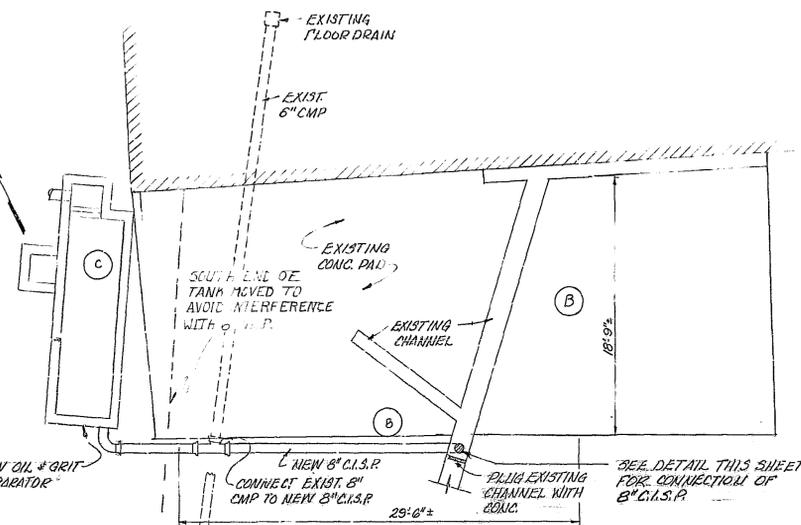
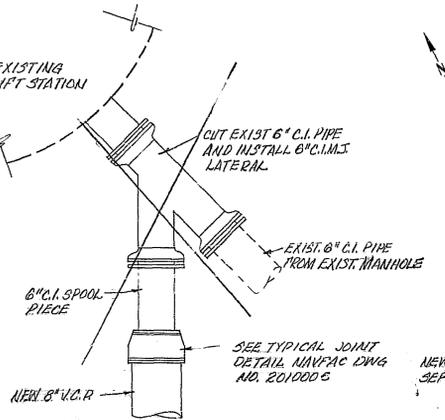
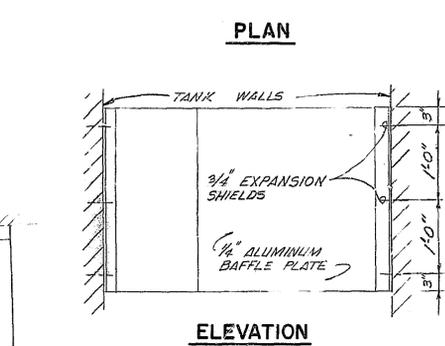
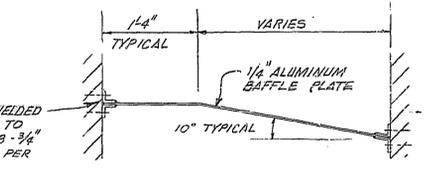
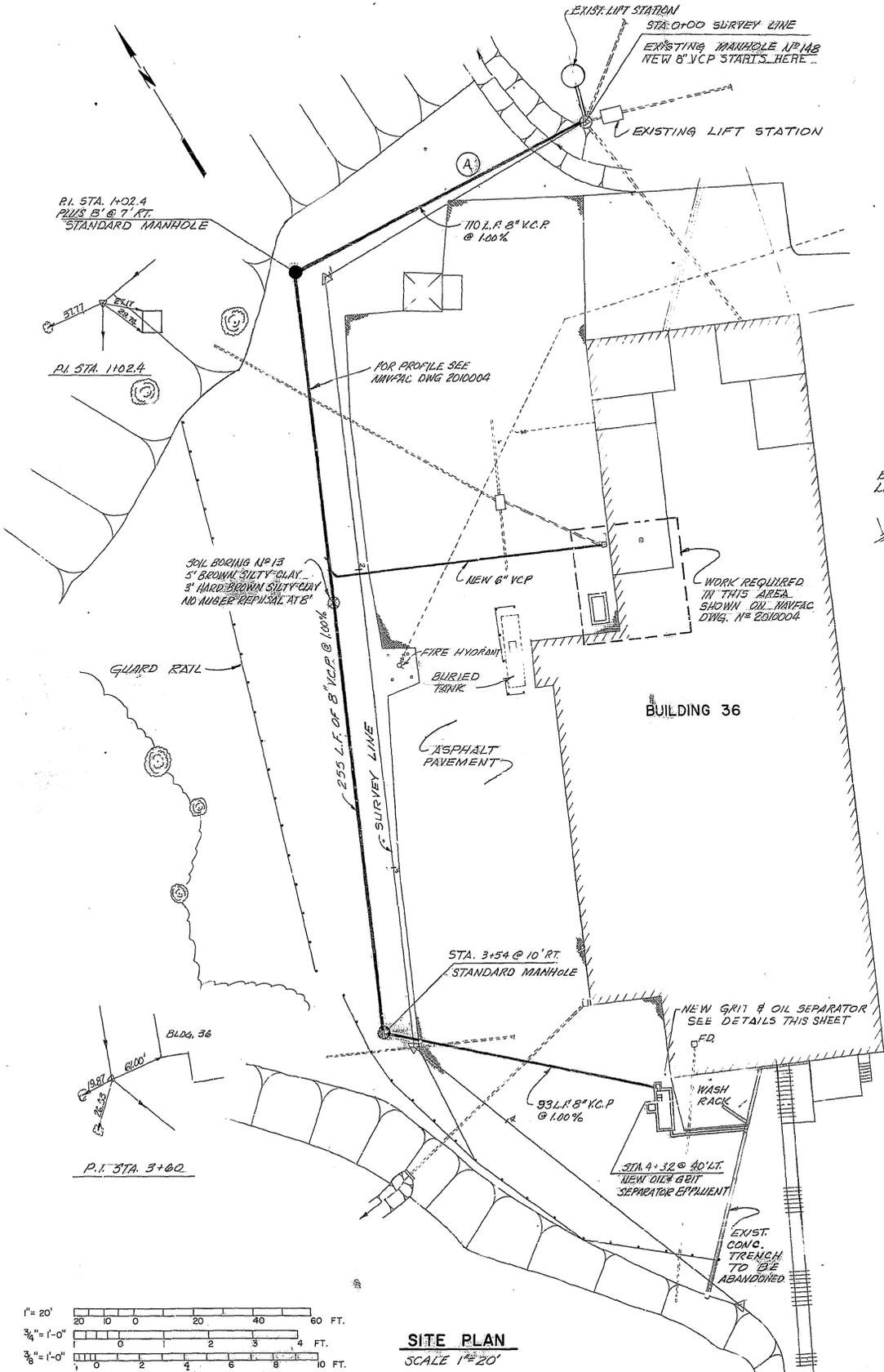
Appendix A	Historical Drawings
Appendix B	Field Standard Operating Procedures
Appendix C	Laboratory DOD ELAP Certification

APPENDIX A

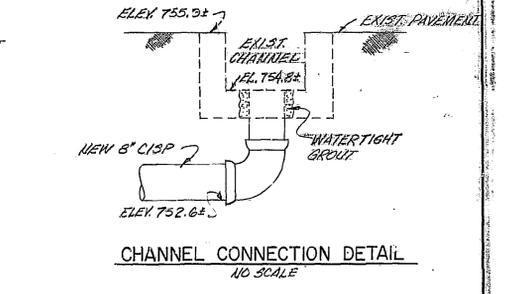
HISTORICAL SITE INFORMATION

STATION	DESCRIPTION	REVISIONS
755	110 L.R. 8" V.C.P. @ 1.00%	
750	EXISTING GRADE	
745	EXISTING GRADE	
740	EXISTING GRADE	

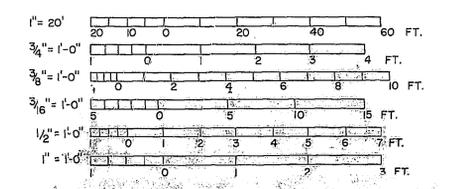
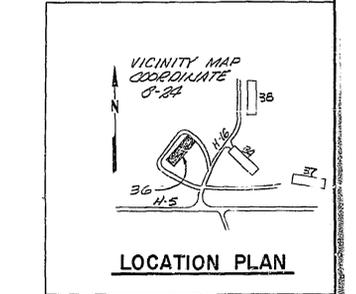
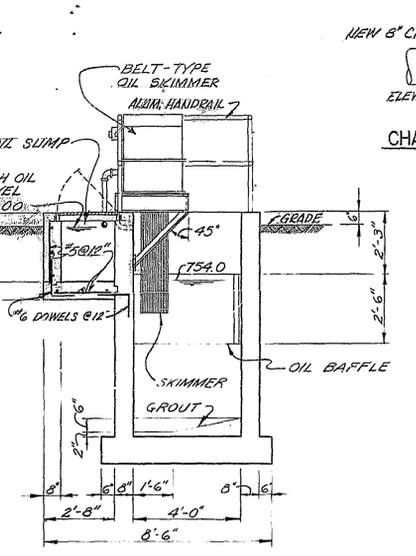
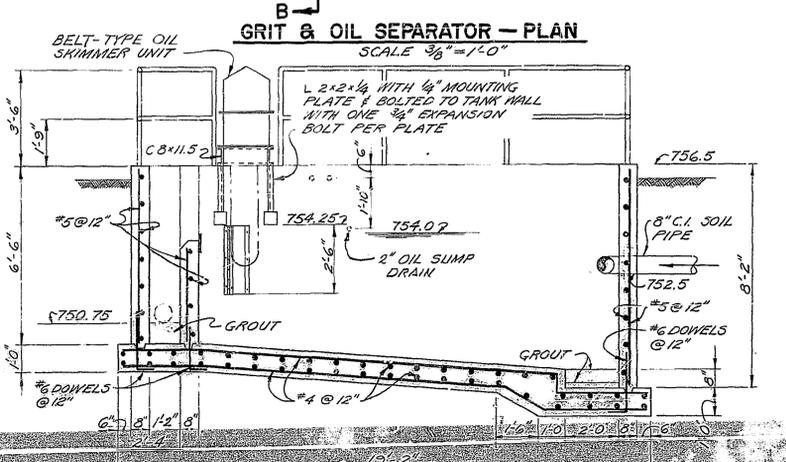
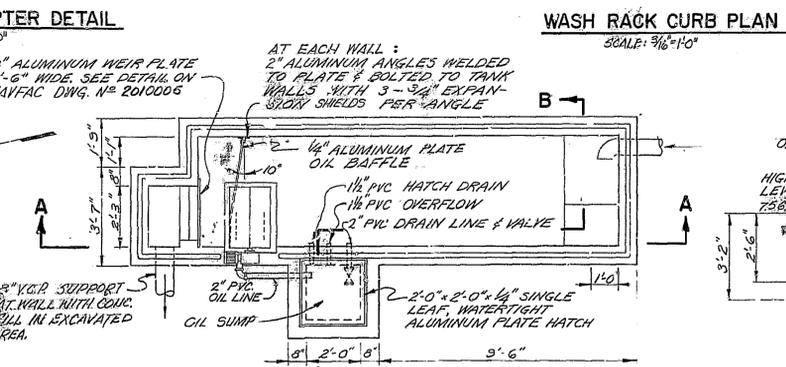
REVISIONS	DESCRIPTION	PREP'D BY	DATE	APPROVED
1	REVISED AS BUILT, REVISED LOCATION OF 8" V.C.P. FROM STA. 1102.4 TO STA. 1102.4	W. B. STEEG	11/14	REJ
2	ELIMINATED CONC. CURB FROM WASH RACK	W. B. STEEG	11/14	REJ
3	DELEGATED NEW DRAINAGE DEPARTMENT	W. B. STEEG	11/14	REJ



TYPICAL BAFFLE DETAIL
SCALE: 1"=1'-0"



CHANNEL CONNECTION DETAIL
NO SCALE



SITE PLAN
SCALE: 1"=20'

SECTION "A-A"
SCALE: 3/8"=1'-0"

SECTION "B-B"
SCALE: 3/8"=1'-0"

R.W. 3820



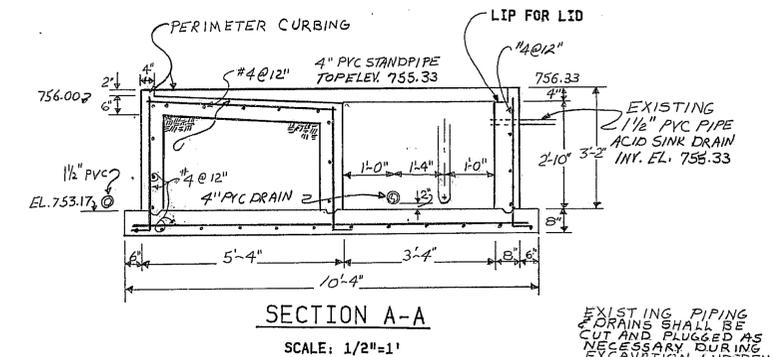
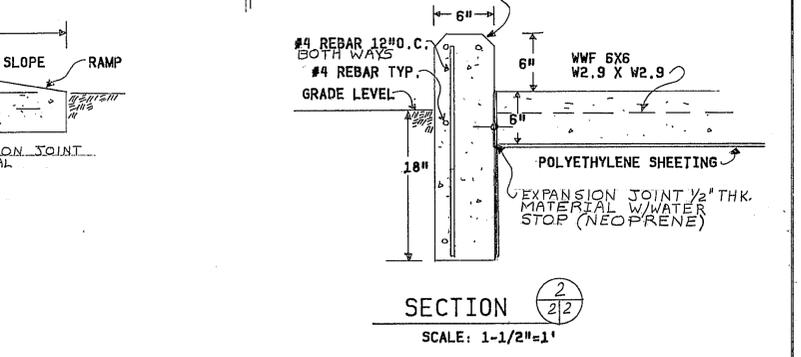
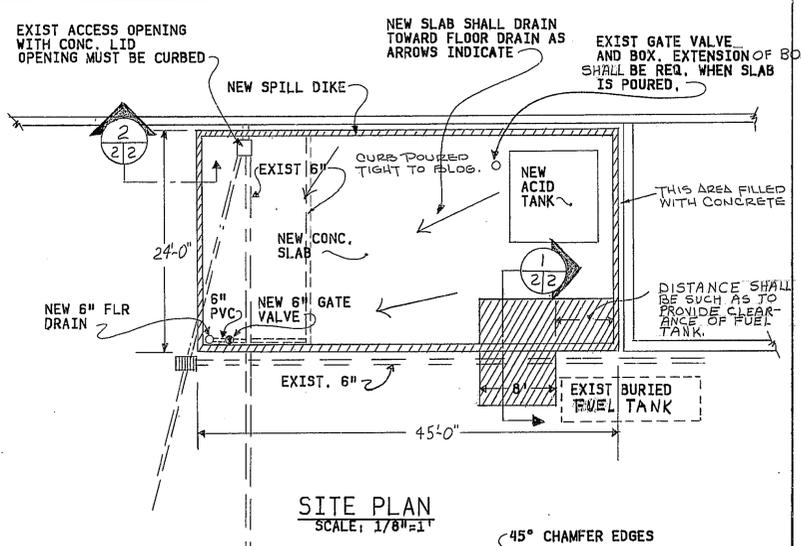
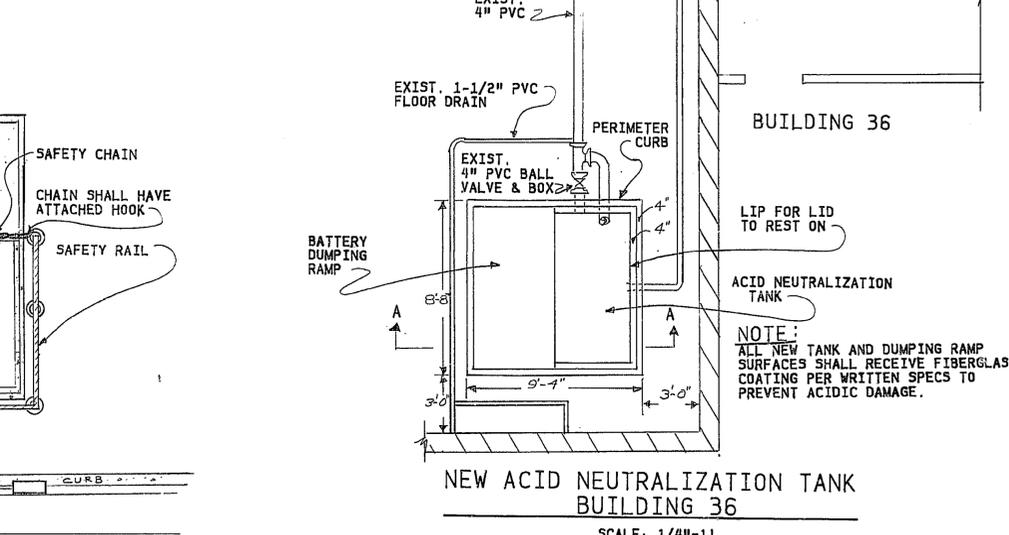
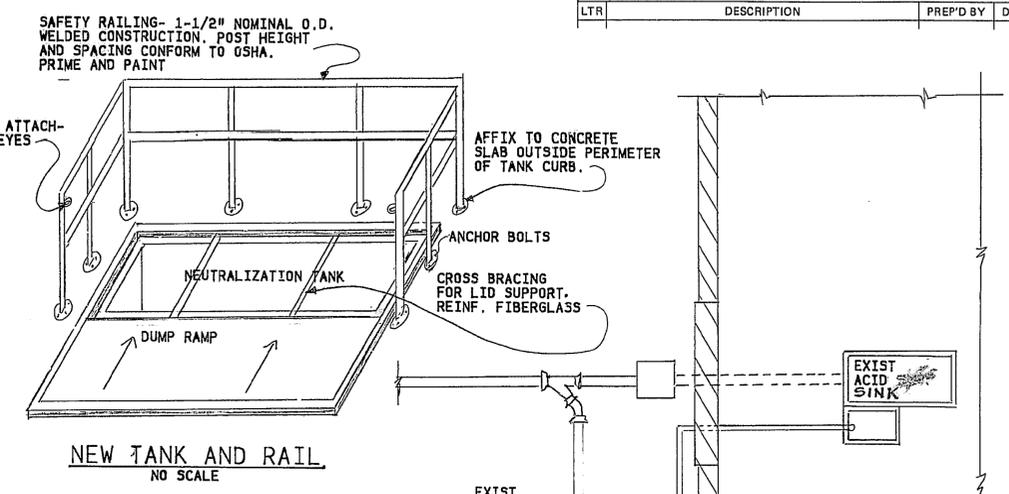
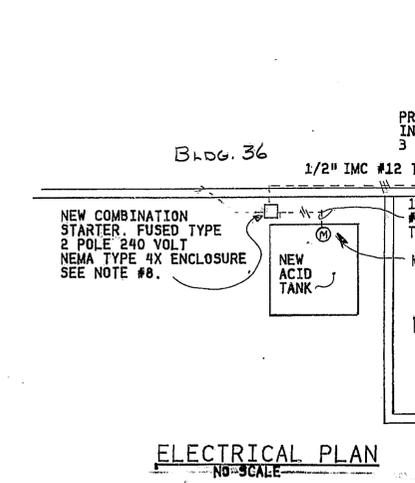
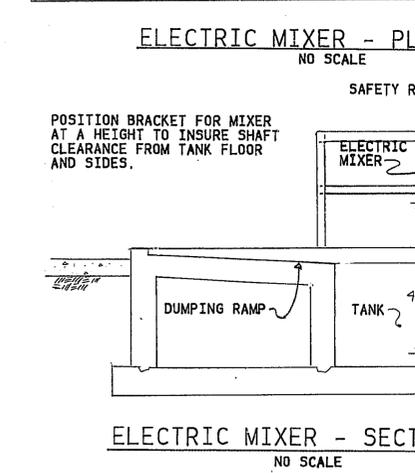
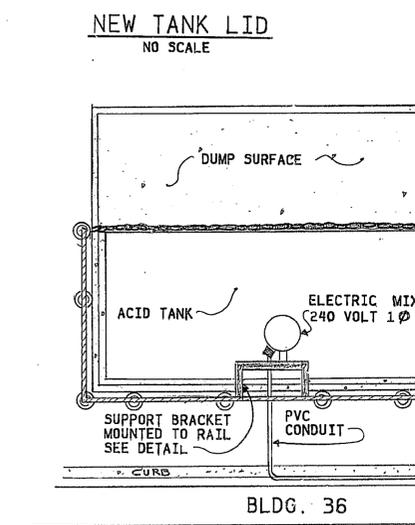
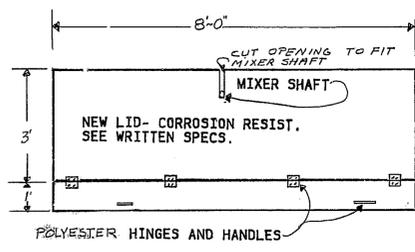
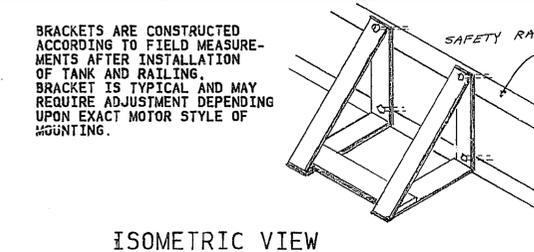
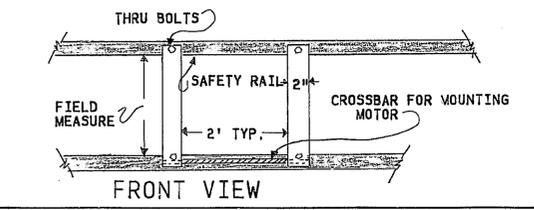
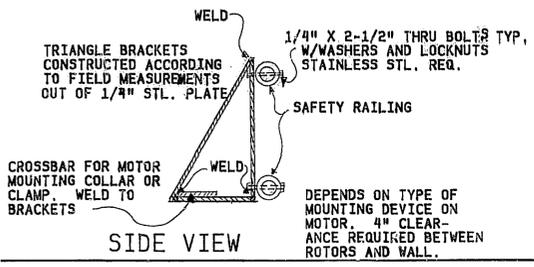
HENRY B. STEEG & ASSOCIATES, INC.
 INDIANAPOLIS, INDIANA
 DEPARTMENT OF THE NAVY - NAVAL FACILITIES ENGINEERING COMMAND
 NORTHERN DIVISION
 PHILADELPHIA, PA.
 NAVAL AMMUNITION DEPOT CRANE, INDIANA
 INDUSTRIAL WASTE TREATMENT FACILITIES
 BUILDING 36 GRIT & OIL SEPARATOR
 NEUTRALIZATION EQUIP. & SEWER CONNECTIONS
 APPROVED: [Signature] DATE: 11/14
 CHECKED: [Signature] DATE: 11/14
 DRAWN: [Signature] DATE: 11/14
 SIZE: 11x17
 SHEET: 15 OF 29

NOTES

- DEMOLITION OF EXISTING TANK IS NECESSARY. NEW TANK IS TO BE CONSTRUCTED IN SAME LOCATION.
- NEW DRAINS AND PIPING SHALL BE INSTALLED AS NECESSARY TO PROVIDE NEW TANK COMPLETE AND READY FOR USE.
- PIPING IN NEW TANK SHALL BE THE SAME AS THAT IN THE ORIGINAL TANK BEFORE DEMOLITION.
- ANY PIPING OR DRAINS DAMAGED DURING TOTAL PROJECT SHALL BE REPLACED BY CONTRACTOR.
- DEMOLISHED MATERIALS SHALL BE REMOVED AND DISPOSED OF ACCORDING TO CODE 0924 (ENVIRONMENTAL DEPT.) INSTRUCTIONS.
- FIBERGLASS COATING SHALL BE APPLIED TO ALL TANK AND DUMP RAMP SURFACES TO PREVENT ACIDIC DAMAGE. REFER TO WRITTEN SPECIFICATIONS FOR FIBERGLASS REQUIREMENTS.
- LID IS TO BE CONSTRUCTED FROM REINFORCED FIBERGLASS OR EQUALLY ACID RESISTANT MATERIAL.
- COMBINATION STARTER SHALL HAVE PUSH BUTTON START, STOP, AND PILOT LIGHT.
- EXISTING SURFACE AROUND EXISTING TANK IS ASPHALT.
- EXISTING ASPHALT SHALL BE REMOVED PRIOR TO CONSTRUCTION OF DIKE, RAMP, AND SLAB. THE SLAB SITE SHALL BE PREPARED AS NECESSARY TO PROVIDE SOLID STABLE BASE FOR NEW CONCRETE.
- SURROUNDING GROUND AREA DISTURBED DURING DEMOLITION OR CONSTRUCTION SHALL BE RESTORED TO EXISTING CONDITION.
- CONTRACT IS TO INCLUDE ALL MATERIALS AND LABOR NECESSARY TO REMOVE AND REPLACE TANK AND DUMPING RAMP READY FOR USE, TO INSTALL NEW MIXER (CONTRACTOR PROVIDED), AND CONSTRUCTION SLAB, DIKE, AND VEHICLE RAMP (WITH DRAIN AND VALVE.)
- ONE METER OF SOIL IN ALL DIRECTIONS SHALL BE EXCAVATED FROM THE SITE OF THE EXISTING TANK. MATERIAL SHALL BE DISPOSED OF PER CONTRACTING OFFICER.

MIXER NOTE

MIXER SHALL BE A DIRECT DRIVE, DUAL PROPELLER FOR LIGHT AND MEDIUM SOLUTIONS, WITH UNIVERSAL MOUNTING CLAMP. PROPELLERS AND SHAFT SHALL BE A MINIMUM OF 316 STAINLESS STEEL. SHAFT SHALL BE TYP. 48" LONG 3/4" DIAMETER WITH A 4" PROPELLER. MOTOR SHALL HAVE ALUMINUM HOUSING WITH VIBRATION PAD AND SHALL BE TOTALLY ENCLOSED FAN COOLED. MOTOR SHALL BE 240 VOLT 1 PHASE 1725 RPM 1/2 HP NEMA 56C FLANGE FRAME. OVERALL LENGTH SHALL APPROXIMATELY 68". MIXER SHALL BE DESIGNED FOR INTENDED USE.



NEW SPILL CURB, RAMP, AND SLAB B-36

REVISIONS				
LTR	DESCRIPTION	PREP'D BY	DATE	APPROVED

SATISFACTORY TO 096 James J. Conley DATE 11 July 1984	PWO DWG REF PWO DRAWING NO. 4612	DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND CRANE, INDIANA
SATISFACTORY TO 0924 Cathy Andrews DATE 11 July 1984	DESIGN DRAWN CHECKED SUPV.	NEW ACID NEUTRALIZATION TANK BLDG. 36
SATISFACTORY TO 04 DATE 18 July 1984	APPROVED DATE	NAVFAC DRAWING NO. 2075973
CONSTR. CONTR. NO. N62472-84-C-7077		SCALE NOTED SPEC. NO. 04-84-7077 SHEET 2 OF 2

APPENDIX B

SITE-SPECIFIC FIELD STANDARD OPERATING PROCEDURES

APPENDIX B
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SOP-08	Borehole Advancement and Soil Coring Direct-Push Technology and Hand Auger Techniques
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STANDARD OPERATING PROCEDURE

SOP-01

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample identification number (ID), date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)

Disposable medical-grade gloves (e.g. latex, nitrile)

Sample log sheets

Required sample containers: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified-clean by the laboratory.

Sample labels

Chain-of-custody records

Sealable polyethylene bags

Heavy-duty cooler

Ice

3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to mobilizing for field activities. Additional "generic" labels will also be printed prior to mobilization to be used for field QC and backups.

- Project Number
- Sample Location ID
- Contract Task Order Number (CTO F27Q)
- Sample ID

- Sample Matrix
- Preservative
- Analysis to be Performed
- Laboratory Name

3.2 Select the container(s) that are appropriate for a given sample. Select the sample-specific ID label(s), complete date, time, and sampler name, and affix to the sample container(s).

3.3 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.

3.4 Place the sample container in a sealable polyethylene bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

4.0 ATTACHMENTS

1. Sample Label

ATTACHMENT 1 SAMPLE LABEL

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090		Project:
		Location:
		CTO:
Sample No:		Matrix:
Date:	Time:	Preserve:
Analysis:		
Sampled by:		Laboratory

STANDARD OPERATING PROCEDURE

SOP-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 Support Activity (NSA) Crane. 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 sample identification

The NSA Crane Environmental Protection Department must approve any deviations from this procedure.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)

Sample tags

Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Environmental Samples

All environmental samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

3.1.1 Environmental Sample Numbering Scheme

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) number, SWMU subarea letter (if

applicable), sample type, location, and for soil or sediment samples, where applicable, sample depth, and for aqueous samples, where applicable, whether a sample is filtered. For soil samples, the final four tracking numbers will identify the depth in units of feet below ground surface (bgs) at which the sample was collected (rounded to the nearest foot). For sediment samples, the final four tracking numbers will identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

NN	A	AA	NNN (-F)	NNNN (Soils and Sediment only)	NN (Surface Water, Sediment, and Groundwater only)
SWMU Number	Subarea (if applicable)	Matrix	Sample Location Number	Sequential depth interval from freshly exposed surface	Sequential sample round

Character Type:

A = Alpha
 N = Numeric

SWMU Number (NN):

18 = SWMU 23

Matrix Code (AA):

SS = Surface Soil Sample
 SB = Subsurface Soil Sample
 SD = Sediment Sample
 SW = Surface Water Sample
 GW = Groundwater Sample (Permanent Well)

Location Number (NNN):

The sample location number is the well location number, soil sample location, sediment sample location, composite sample location, or the surface water sample location. Sequential number beginning with "001" for each matrix per subarea (where applicable). The location number for each sample is listed on

the figures and tables in the site-specific work plan. Existing monitoring well numbers will be used when unique. New wells numbers will be designated by the SWMU number, followed by "MW" for permanent monitoring wells, a "T" for Tetra Tech, and number sequentially beginning with "001".

Note: To keep the sample identification nomenclature to a minimum number of characters and to avoid redundancy, "MWT" (monitoring well) is used for text, figures, and tables and replaced with "GWT" (groundwater) in the sample identification. For example, a groundwater sampled collected from 23MWT001 would be labeled 23GWT001.

Filtered:

Water samples that are field-filtered (dissolved analysis) will be identified with a "-F" at the end of the sample location number. No entry in this segment signifies an unfiltered (total) sample.

Depth Interval (NNNN):

This code section will be used for soil and sediment samples only. The depth code is used to note the depth 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 numbers specify the bottom interval of the sample depth. 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 soil, 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

For sediment samples, the final four tracking numbers will identify the depth in units of inches below the sediment/water interface, or from the ground surface if surface water is not present. Sediment samples will be collected from 0 to 6 inches bgs.

Sample Round Identifier (NN):

This code section will be used for surface water, sediment, and groundwater samples only. The sample round identifier is used to note the number of samples collected from a particular surface water or sediment location or groundwater monitoring well.

3.1.2 Examples of Sample Nomenclature

A surface soil sample collected from soil boring location 003 at SWMU 23, at a depth of 0- to 2-feet bgs, would be labeled as “23SS0030002”.

An unfiltered groundwater sample collected from monitoring well MWT001 during a second round of sampling would be designated as 23GWT001-02.

A filtered groundwater sample collected from monitoring well MWT001 during the first round of sampling would be designated as 23GWT001-01-F.

A sediment sample collected from sediment sampling location 001 at a depth of 0- to 6- inches bgs would be labeled as “23SD0010006”.

A surface water sample collected from sampling location 003 during a third round of sampling would be labeled as “23SW003-03”. The filtered fraction for this sample would be labeled as “23SW003-03-F”.

3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in the UFP-SAP. They will be designated using a different coding system than the one used for regular field samples.

3.2.1 QC Sample Numbering

The QC code will consist of a four-segment alpha-numeric code that identifies the SWMU number, sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

NN	AA	NNNNNN	NN
SWMU Number	QC Type	Date	Sequence Number (per day)

The QC types are identified as:

TB = Trip Blank

RB = Rinsate Blank

FD = Field Duplicate

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 at SWMU 23 for a groundwater sample collected on April 20, 2012 would be designated as "23FD04201201".

The second duplicate of the day taken at SWMU 23 of a surface soil sample collected on April 23, 2012 would be designated as "23FD04231202".

The first trip blank associated with samples collected on May 6, 2012 would be designated as "23TB05061201".

The only rinsate blank associated with samples collected on May 22, 2012 would be designated as "23RB05221201".

STANDARD OPERATING PROCEDURE

SOP-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, labels, and equipment are required.

Writing utensil (preferably black pen with indelible ink)

Site logbook

Field logbook

Sample label

Chain-of-Custody Form

Custody seals

Equipment calibration log

Soil Boring Log

Soil and Sediment Sample Log Sheet

Surface Water Sample 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 Tetra Tech 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. At a minimum, the following activities and events will be recorded (daily) in the field logbooks:

- Field personnel for activities in the field logbook
- 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

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 field logbook:

- Project name
- Project number
- Book number
- Start date
- End date

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. Sample labeling and nomenclature are described in SOP-01 and SOP-02, respectively.

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. This

form must accompany any samples collected for laboratory chemical analysis. Each COC will be uniquely numbered. A copy of a blank COC form is attached at the end of this SOP.

The Tetra Tech FOL must include the name of the laboratory in the upper right hand corner section to ensure that the samples are forwarded to the correct location. If more than one COC is necessary for any cooler, the Tetra Tech FOL will indicate "Page ___ of ___" on each COC. The original (top) signed copy of the COC will be placed inside a sealable polyethylene 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 Tetra Tech Project Manager (PM). 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 and is part of the chain-of-custody process. Custody seals are used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transit to the laboratory. Custody seals will be signed and dated by the samplers and affixed across the opening edges of each cooler (two seals per cooler on opposite sides) containing environmental samples. The laboratory sample custodian will examine the custody seal for evidence of tampering and will notify the Tetra Tech PM if evidence of tampering is observed.

3.6 Equipment Calibration Log

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 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 Sample Log Sheets

The Soil and Sediment Sample Log Sheets and Surface Water Sample Log Sheets are used to document the sampling of soil, sediment, and surface water. Copies of the sample log sheets are

attached at the end of the SOP. A sample log sheet will be prepared for each sample collected and submitted for laboratory analysis.

4.0 ATTACHMENTS

1. Chain-of-Custody Record
2. Equipment Calibration Log
3. Soil and Sediment Sample Log
4. Surface Water Sample Log

STANDARD OPERATING PROCEDURE

SOP-04

SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures for sample preservation, packaging, and shipping to be used in handling soil, sediment, and aqueous samples.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Shipping labels

Custody seals

Chain-of-custody (COC) form(s)

Sample containers with preservatives: All sample containers for analysis by fixed-base laboratories will be supplied, with preservatives added (if required) and deemed certified clean by the laboratory.

Sample shipping containers (coolers): All sample shipping containers are supplied by the laboratory.

Packaging material: Bubble wrap, sealable polyethylene bags, strapping tape, etc.

3.0 PROCEDURES FOR SAMPLE PRESERVATION, PACKAGING, AND SHIPPING

3.1 The laboratory provides sample containers with preservative already included (as required) for the analytical parameter for which the sample is to be analyzed. All samples will be held, stored, and shipped above freezing, at ≤ 6 degrees Celsius ($^{\circ}\text{C}$). This will be accomplished through refrigeration (used to hold samples prior to shipment) and/or ice.

3.2 The sampler shall maintain custody of the samples until the samples are relinquished to another custodian or to the common carrier.

3.3 Check that each sample container is properly labeled, the container lid is securely fastened, and the container is sealed in a polyethylene bag.

3.4 If the container is glass, place the sample container into a bubble-out shipping bag and seal the bag using the self-sealing, pressure sensitive tape supplied with the bag.

- 3.5 Inspect the insulated shipping cooler. Check for any cracks, holes, broken handles, etc. If the cooler has a drain plug, make certain it is sealed shut, both inside and outside of the cooler. If the cooler is questionable for shipping, the cooler must be discarded.
- 3.6 Line the cooler with large plastic bag, and line the bottom of the cooler with a layer of bubble wrap. Place the sample containers into the shipping cooler in an upright position (containers will be upright, with the exception of any 40-milliliter vials). Continue filling the cooler with ice until the cooler is nearly full and the movement of the sample containers is limited.
- 3.7 Wrap the large plastic bag closed and secure with tape.
- 3.8 Place the original (top) signed copy of the COC form inside a sealable polyethylene bag. Tape the bag to the inside of the lid of the shipping cooler.
- 3.9 Close the cooler and seal the cooler with approximately four wraps of strapping tape at each end of the cooler. Prior to wrapping the last wrap of strapping tape, apply a signed and dated custody seal to each side of the cooler (one per side). Cover the custody seal with the last wrap of tape. This will provide a tamper evident custody seal system for the sample shipment.
- 3.10 Affix shipping labels to each of the coolers, ensuring all of the shipping information is filled in properly. Overnight (e.g., FedEx Priority Overnight) courier services will be used for all sample shipments.
- 3.11 All samples will be shipped to the laboratory no more than 72 hours after collection. Under no circumstances should sample hold times be exceeded.

STANDARD OPERATING PROCEDURE

SOP-05

SURFACE WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting surface water samples at the Naval Support Activity (NSA) 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 (preferably black pen with indelible ink)

Multi-parameter water-quality meter: The water-quality meter is used for the measurement of dissolved oxygen, pH, specific conductance, temperature, and oxidation-reduction potential (see SOP-06).

LaMotte Turbidity Meter: Used to measure turbidity in the field (see SOP-06).

Disposable sample containers: Disposable sample containers are used to fill sample containers and transport sample(s) to a pump for filtering.

Sample containers: Certified-clean sample containers will be provided by the laboratory that performs the analyses.

Sample labels: One label 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 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 (only if Volatile Organic Compounds [VOCs] samples are being collected)

Temperature blank

3.0 SURFACE WATER SAMPLING PROCEDURES

3.1 Surface water sampling will start at the downstream end of a stream and proceed to upstream.

- 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 Obtain measurements of dissolved oxygen, pH, specific conductance, temperature, turbidity, and oxidation-reduction potential immediately downstream of the sample collection point using the multi-parameter water-quality meter and LaMotte Turbidity Meter (see SOP-06). Record the readings in the appropriate fields on the Surface Water Sample Log Sheet.
- 3.4 Place the sample container(s) into the water at the sampling location at a 45-degree angle. With the mouth of the container facing upstream, fill the container with water, being careful not to disturb the sediment.
- 3.5 For collecting dissolved metals sample fractions from sample locations, while standing downstream or from the bank, fill two 1-liter unpreserved polyethylene bottles; use these bottles as transfer bottles via field filtering to preserved samples bottles. Once out of the stream, 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 milliliters of sample water prior to filling the sample containers. Using the discharge from the filter cartridge, fill the sample bottle for dissolved metals.
- 3.6 All samples will be collected in 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 VOCs must be completely filled so no headspace exists in the container. Other sample containers should not be filled completely; a small amount of air should be left at the top. Sample containers will be collected in the following sequence:
 - VOCs
 - Other Organics (including SVOCs, energetics and perchlorate)
 - Total metals
 - Water chemistry parameters
 - Dissolved metals
- 3.7 Record the date and time that the sample containers are filled on the Surface Water Sample Log Sheet, the sample labels, and the Chain-of-Custody Form.

- 3.8 After the sample label is 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.
- 3.09 Repeat steps 3.3 through 3.8 until all the sample bottles have been filled.
- 3.10 Estimate the flow rate of the stream or spring. 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.
- 3.11 Decontaminate equipment as necessary, and load the equipment and the sample cooler in the sample vehicle for transport.

4.0 ATTACHMENTS

1. Surface Water Sample Log Sheet

STANDARD OPERATING PROCEDURE

SOP-06

MEASUREMENT OF WATER QUALITY PARAMETERS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for measurement of water quality parameters during the collection of aqueous samples to support field investigations.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for measuring water quality parameters during aqueous sampling:

Disposable medical-grade gloves (e.g., latex, nitrile)

Writing utensil (preferably black pen with indelible ink)

Plastic storage bags

Multi-Parameter Water Quality Meter

Turbidity Meter

Shipping containers (containing ice)

Sample containers: Sample containers are certified clean by the laboratory supplying the containers.

Surface Water Sample Log Forms.

Field logbook

Chain-of-Custody Form.

3.0 GLOSSARY

Specific Conductance – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and relative concentrations, and on temperature of measurement. Conductivity is highly dependent on temperature and should be reported as specific conductance which is conductivity corrected to a temperature of 25°C.

Dissolved Oxygen (DO) – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

Turbidity – Turbidity in water is caused by suspended matter, such as clay, silt, fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

4.0 ON-SITE WATER QUALITY TESTING

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- DO
- ORP
- Turbidity

This section also provides general information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters used to measure field parameters require calibration on a daily basis. Refer to SOP-18 regarding equipment calibration.

4.1 Measurement of pH

4.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other

chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

The method for pH measurement is the pH sensor on a water quality meter. The response of a pH sensor can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described.

4.1.2 Principles of Equipment Operation

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

4.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Stand-alone portable pH meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).
- Buffer solutions, as specified by the manufacturer.
- Manufacturer's operation manual.

4.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure is used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

- Inspect the instrument and batteries prior to initiation of the field effort.
- Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
- If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- Calibrate on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on an equipment calibration log sheet (See SOP-18).
- Immerse the electrode(s) in the sample or body of water. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.
- Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH unit. Also record the sample temperature.
- Rinse the electrode(s) with deionized water.
- Store the electrode(s) in an appropriate manner when not in use.

Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

4.2 Measurement of Specific Conductance

4.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the

temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

Most conductivity meters in use today display specific conductance (SC); units of milliSiemens per centimeter, which is the conductivity normalized to temperature at 25°C. This format (SC) is the required units recorded on the sample log field form.

4.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

4.2.3 Equipment

The following equipment is needed for taking SC measurements:

- Stand alone portable conductivity meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available which may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirement of the sampling program.

4.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet. Potassium chloride solutions with a SC closest to the values expected in the field shall be used for calibration.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the water and measure the conductivity.
- Read and record the results in a field logbook or sample log sheet.
- Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for details.

4.3 Measurement of Temperature

4.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contamination. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

4.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22). In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

4.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample:

- Immerse the thermometer in the water until temperature equilibrium is obtained (1-3 minutes).
- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is used, the instrument shall be calibrated according to manufacturer's recommendations.

4.4 **Measurement of Dissolved Oxygen**

4.4.1 General

DO levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible and is not susceptible to interference caused by color, turbidity, colloidal material or suspended matter.

4.4.2 Principles of Equipment Operation

DO probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH⁻) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low

readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, while leaving the surface of the solution undisturbed.

DO probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide, which are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

4.4.3 Equipment

The following equipment is needed to measure DO concentration:

- Stand alone portable dissolved oxygen meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

4.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading.

The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked before going to the field.
- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument shall be calibrated in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature.
- Record all pertinent information on an equipment calibration sheet.

- Rinse the probe with deionized water.
- Immerse the probe in the water.
- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.
- Rinse the probe with deionized water.
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

4.5 Measurement of Oxidation-Reduction Potential

4.5.1 General

The ORP provides a measure of the tendency of organic or inorganic compounds to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

4.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

4.5.3 Equipment

The following equipment is needed for measuring the ORP of a solution:

- Combination meters with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

4.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring ORP:

- The equipment shall be checked using the manufacturer's recommended reference solution and have its batteries checked before going to the field.
- Thoroughly rinse the electrode with deionized water.
- If the probe does not respond properly to the recommended reference solution, then verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised) thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.
- Record all pertinent information on an equipment calibration log sheet.

4.6 **Measurement of Turbidity**

4.6.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and microscopic organisms, including plankton.

It is important to obtain a turbidity reading immediately after taking a sample, since irreversible changes in turbidity may occur if the sample is stored too long.

4.6.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTU) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

4.6.3 Equipment

The following equipment is needed for turbidity measurement:

- Light meter (e.g., LaMotte 2020) which calibrates easily using test cells with standards of 0.0 NTUs, and 10 NTUs, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

4.6.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the electrode with one or more portions of the sample to be tested or with deionized water (applies to "e").
- Fill the light meters glass test cell with approximately 5 milliliters of sample, screw on cap, wipe off glass, place test cell in light meter and close the lid (applies to "l").
- Immerse the electrode in the sample and measure the turbidity (applies to "e").
- The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.
- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.
- Rinse the electrode or test cell with deionized water.

STANDARD OPERATING PROCEDURE

SOP-07

SEDIMENT SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for sediment sampling in streams, other waterways, and subsurface structures (e.g., settling basins).

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.

Writing utensil (preferably black pen with indelible ink)

Indelible marker

Bound field logbook

Disposable plastic trowels

Survey stakes and flagging: Used to mark sampling locations after completion of sampling.

Labeled sample containers: See SOP-02 for sample identification procedures. Sample containers are certified clean by the laboratory supplying the containers.

Sealable polyethylene bags

Shipping containers (containing ice)

Disposable medical-grade gloves (e.g., latex, nitrile)

Chain-of-Custody Form

3.0 SEDIMENT SAMPLE LOCATION SELECTION

Sampling locations for sediment in waterways will be chosen along stream channels and drainage pathways 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.

Sampling of sediment from subsurface structures will be collected from beneath the water surface at the basin'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.

4.0 SEDIMENT SAMPLING PROCEDURES

4.1 The sampler will wear clean, disposable medical-grade gloves. Clear vegetative matter or debris, if present, from the sample location using a disposable sampling trowel or spoon (waterways) or long-handled sampling device (e.g., settling basin). Use the trowel or long-handled sampling device to collect sediment from 0 to 6 inches depth.

- Use the same sampling device to scoop the sediment into the requisite labeled sample container(s).

4.2 Record the sample time (using military time) on the Sediment Sample Log Form and sample container labels. Record all other information required on the labels as specified by SOP-01.

4.3 Place the labeled sample container into a sealable polyethylene bag and then place the bag holding the sample container into a cooler containing ice.

4.4 Record date, sampling site, site conditions, location map, and other information (e.g., presence and flow rate of water in waterway channel, depth of water and thickness of sediments in basins, etc.) on the Sediment Collection Log Sheet. Enter the sample information onto the Chain-of-Custody Form in accordance with SOP-03.

4.5 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

STANDARD OPERATING PROCEDURE

SOP-08

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 Naval Support Activity (NSA) Crane facility.

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-09.

DPT Equipment:

DPT Probe Rig

Geoprobe® Macrocore Sampler or equivalent

Geoprobe® Sampling Kit or equivalent

Clear acetate liners: one new liner for each soil core

Hand Auger Equipment:

Stainless Steel Auger Buckets

Stainless Steel Extension Rods

Cross Handle

Required decontamination materials (see SOP-20)

Bentonite pellets

3.0 BOREHOLE ADVANCEMENT AND SOIL SAMPLING USING A DPT

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 sampling core barrel, and attach the coring device to the DPT rig.
- 3.3 Drive the sampler (lined with an acetate sleeve) into the ground to the desired depth using hydraulic pressure.
- 3.4 Retract the sampler from the borehole, and remove the acetate liner and the soil core from the sampler barrel.
- 3.5 Attach the metal trough from the sampling kit firmly to a 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 Sample Collection: Once the acetate liner is opened, collect the soil samples as described in SOP-10.
- 3.9 Log the soil core on the Boring Log Sheet (see SOP-09).
- 3.10 Repeat steps 3.2 through 3.9 for the next depth intervals.
- 3.11 Upon completion of the boring, backfill the borehole with the soil from the location. 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. If soil materials from the boring are suspected of being contaminated, the soil boring will be backfilled with bentonite pellets up to the ground surface.

The contaminated material will be securely staged until arrangements are made for proper off-site disposal.

- 3.12 Decontaminate all soil sampling equipment in accordance with SOP-20 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 when the area is inaccessible by the drill rig. 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 of 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, litter, etc.)
- 4.3 Begin augering to the desired sample depth (periodically removing accumulated soils from the bucket bit into a properly decontaminated stainless steel mixing bowl), and add additional rod extensions as necessary. Discard the top of the core (approximately 1"), which represents any loose material collected by the bucket bit before penetrating the sample material.
- 4.4 Log the soil core each time soil is placed into the mixing bowl on the Boring Log Sheet (see SOP-09). Also, note (in a field notebook or on standardized data sheets) the changes in the color, texture or odor of the soil.
- 4.5 After reaching the desired sample depth, slowly and carefully withdraw the apparatus from the borehole.

- 4.6 Utilizing a properly decontaminated stainless steel trowel or disposable trowel, remove the last of the sample material from the bucket bit and place into the properly decontaminated stainless steel mixing bowl and thoroughly homogenize the sample material prior to filling the sample containers, as described in SOP-10.

- 4.12 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 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-19).

- 4.14 If soil materials from the boring are suspected of being contaminated, 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-20 before collecting the next sample.

STANDARD OPERATING PROCEDURE

SOP-09

SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil samples.

2.0 FIELD FORMS AND EQUIPMENT

Knife

Ruler (marked in tenths and hundredths of feet)

Boring Log: An example of this form is attached.

Writing utensil (preferably black pen with indelible ink)

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all activities and assuring that each soil sample is properly and completely logged.

4.0 PROCEDURES FOR 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" (S) and "gravel" (G) 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-inch or 1/2-inch diameter)" 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 non-cohesive (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

5.0 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
Silts and Clays LL = > 50			OL	Organic silts and organic silty clays of low plasticity		
			MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts		
Highly Organic Soils		CH	Inorganic silts of high plasticity, fat clays			
		OH	Organic clays of high plasticity, organic silty clays, organic silts			
			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
	3" to 3/4"	76.2 to 4.76
Sand	3/4" to No. 4	19.1 to 4.76
	No. 4 to No. 200	4.76 to 0.074
Sand	No. 4 to No. 10	4.76 to 2.00
	No. 10 to No. 40	2.00 to 0.420
Silt and Clay	No. 40 to No. 200	0.420 to 0.074
	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

STANDARD OPERATING PROCEDURE

SOP-10

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) or hand augers during field activities at Naval Support Activity (NSA) Crane SWMU 23. This procedure also describes the collection of samples for analysis of volatile organic compounds (VOCs), in accordance with SW-846 Method 5035A, and the use of field screening [i.e., photoionization detector (PID) or flame ionization detector (FID)] to select the subsurface soil intervals for VOC sample selection.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen 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

Terra Core® samplers

Disposable trowels

Photoionization Detector (PID) or similar

Required sample containers: All sample containers including shipping coolers for analysis by fixed-base laboratories will be supplied and certified clean by the laboratory.

Required decontamination materials

Chain-of-custody records

Required personnel protective equipment (PPE)

Wooden stakes or pin flags

Survey tape

Marking Paint

Sealable polyethylene bags

Heavy-duty cooler

Ice

Razor knife

DPT Probe Rig and sampling equipment

Sample labels

3.0 COLLECTION OF SOIL SAMPLES FOR VOLATILE ORGANIC COMPOUNDS (VOCs) AND GASOLINE-RANGE ORGANICS (GRO)

When soil cores are collected using DPT, such as Geoprobe®, 4- to 5-foot soil intervals will be collected in clear acetate tubes, which can be extracted from the Geoprobe® Macro-Core® upon retrieval at the surface (see SOP-08). Note: A surface soil sample is collected from the 0- to 2-foot depth. Additional subsurface soil samples each consist of 2-foot core segments. All samples collected for VOC analyses, including total petroleum hydrocarbons (TPH) - Gasoline Range Organics (GRO), will be collected with the use of a DPT to the extent possible. The samples must be collected as soon as possible after the soil has been brought to the surface. Sample collection should be completed as soon as possible, preferably within 3 to 5 minutes after the soil has been exposed to the atmosphere to minimize volatilization. The following presents the sample collection tasks.

- 3.1 Establish a suitable work area near the point of sample collection. Prior to sample collection, ensure all necessary equipment (e.g., PID) is calibrated (if necessary) and operating properly.
- 3.2 Slit the liner lengthwise with an appropriate cutting tool (e.g., Geoprobe® liner cutter), remove the cut section of the liner, and expose the length of the soil interval (see SOP-08). Note: the rate of Macro-Core® collection should not proceed faster than the field samplers can process the samples in order to prevent the soil from being exposed to the atmosphere for a long period of time and potential volatilization of the contaminants from the Macro-Core®.
- 3.3 Scan the soil core interval with an organic vapor monitor (PID or FID), slowly moving the air 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/FID 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/FID, collect the soil for VOC and GRO analyses from the interval where the highest PID reading is measured. If no above-background PID readings are measured, then collect the sample from a specific interval where visual signs of contamination (staining, etc.) are

observed. If no above-background PID/FID reading is measured, and no discoloration or odor in the soil core indicates potential contamination, then collect the VOC and GRO samples from near the center of the core at the bottom of the interval. The VOC and GRO samples will be collected using Terra Core® samplers for each sample.

- 3.4 The 0- to 2-foot core interval will be collected as a surface soil sample. Collection of soil for analysis from surface soil cores will be the same as described in Step 3.3 above. Soil samples collected for VOCs and GROs will be obtained directly from soil cores using Terra Core® samplers for each sample.

The Terra Core® sampling method is as follows:

Step 1

Have ready a 40-milliliter (mL) glass volatile organic analyte (VOA) vial containing the appropriate preservative (i.e., methanol, sodium bisulfate, or deionized water). With the plunger seated in the handle, push the Terra Core® into freshly exposed soil until the sample chamber is filled. A filled chamber will deliver approximately 5 grams (g) of soil. Note: The ratio of soil to methanol must be 1:1; consequently, if the vials contain 5 mL of methanol, the soil aliquot must be 5 g.

Step 2

Wipe all soil or debris from the outside of the Terra Core® sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.

Step 3

Rotate the plunger that was seated in the handle top 90 degrees until it is aligned with the slots in the body. Place the mouth of the sampler into the 40-mL VOA vial containing the appropriate preservative and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40-mL VOA vial. Note: When capping the 40-mL VOA vial, be sure to remove any soil or debris from the top and/or threads of the vial.

In addition, each VOC and GRO soil sample will include a separate aliquot to be used for percent moisture analysis. The percent moisture sample will be collected by filling one 2-ounce (oz) container with sample representing the same location where the 40-mL VOA vial sample was collected. Every effort will be made to obtain the percent moisture soil aliquot as close as possible to the location where the VOC and GRO sample aliquots were collected.

Step 4

Place the three sample vials for each sample in the holder that comes with the sample kit and fill in appropriate information, including sample identification, date, time, and other information on the label. Place the sample vial holders and moisture sample in a plastic bag and place the tag on the bag, identifying the sample identification and other necessary information (see SOP-01 and SOP-02). No additional labels will be added to the pre-weighed sample vials received from the laboratory. Be sure that laboratory-provided information (i.e., vial tare weight and/or identification bar codes) are exposed and legible on the vials.

Once the samples are properly labeled and bagged, place the samples into the cooler containing ice and a trip blank. The cooler should be kept above freezing and $\leq 6^{\circ}\text{C}$ and shipped to the analytical laboratory for preservation or extraction within 48 hours. 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.

4.0 COLLECTION OF NON-VOC SOIL SAMPLE ALIQUOTS USING DPT

4.1 After the VOC and GRO samples have been collected for the soil interval of interest (see Section 3.0 above), the remainder of the soil interval will be homogenized and used to fill 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 into a one-gallon Ziploc® bag and mix the soil thoroughly within the bag and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

- Other organic analyses (i.e., polycyclic aromatic hydrocarbons [PAHs], polychlorinated biphenyls [PCBs], and TPH [Diesel Range Organics (DRO) and Extended Range Organics (ERO)]),
- Metals,
- Sulfate,
- Moisture.

4.3 Complete all required information on the sample labels and secure the label to the sample container (see SOP-01).

4.4 Place the sample container in a Ziploc® plastic bag and seal closed. Place the bag in a cooler containing ice and cool to above freezing and $\leq 6^{\circ}\text{C}$.

4.5 Record the required information on the Soil Sample Log Sheet and the COC Record form.

5.0 COLLECTION OF SOIL SAMPLES USING A HAND AUGER

5.1 Utilizing a properly decontaminated stainless steel or disposable trowel, advance the auger to the designated depth and then carefully retract the auger bucket from the hole.

5.2 Remove the sample material from the hand auger bucket bit, and remove gravel, large pebbles, and other coarse materials. Scan the soil core interval with an organic vapor monitor (PID or FID). Note on the boring log the range of PID/FID readings that are detected and the specific location(s) along the sample interval where above-background readings are encountered.

5.2 If collecting VOC and GRO samples, collect the sample aliquot directly from an open-sided hand auger bucket prior to disturbing the material, following the applicable VOC and GRO sampling procedures stated in Sections 3.0 through 3.4 above.

5.3 Collect sample aliquots for non-VOC parameters by sliding the remaining core material out of the hand auger bucket and into a one-gallon Ziploc® bag and mix the soil thoroughly within the bag and remove gravel, large pebbles, and other coarse materials.

5.4 Fill the required sample containers in the following order:

- Other organic analyses (i.e., PAHs, PCBs, and TPH [DRO and ERO]),
- Metals,
- Sulfate,
- Moisture.

5.5 Complete all required information on the sample labels and secure the label to the sample container (see SOP-01).

5.6 Place the sample container in a Ziploc® plastic bag and seal closed. Place the bag in a cooler containing ice and cool to above freezing and $\leq 6^{\circ}\text{C}$.

5.7 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-04.

7.0 ATTACHMENTS

1. Soil and Sediment Sample Log Sheet

ATTACHMENT 1
SOIL AND SEDIMENT SAMPLE LOG SHEET



Tetra Tech

SOIL & SEDIMENT SAMPLE LOG SHEET

Page ___ of ___

Project Site Name: _____ Project No.: _____ <input type="checkbox"/> Surface Soil <input type="checkbox"/> Subsurface Soil <input type="checkbox"/> Sediment <input type="checkbox"/> Other: _____ <input type="checkbox"/> QA Sample Type: _____	Sample ID No.: _____ Sample Location: _____ Sampled By: _____ C.O.C. No.: _____ Type of Sample: <input type="checkbox"/> Low Concentration <input type="checkbox"/> 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:		Signature(s):
<input type="checkbox"/> MS/MSD	<input type="checkbox"/> Duplicate ID No.:	

STANDARD OPERATING PROCEDURE

SOP-11

GEOPHYSICAL SURVEY FOR UNDERGROUND STORAGE TANKS

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the geophysical survey procedures planned for implementation on an underground storage tank investigation near Building 36 at Naval Support Activity (NSA) Crane SWMU 23.

2.0 REQUIRED EQUIPMENT

Writing utensil (preferably black pen with indelible ink)

Field Notebook

Measuring Tape

Marking Paint / Chalk

Geophysical instruments

3.0 GPR SURVEY

Ground Penetrating Radar (GPR) is an electromagnetic (EM) method, where EM pulses are propagated into the ground, and the reflections of this signal from materials with sufficiently contrasting electrical properties are subsequently measured. The system can be used to detect both metallic and non-metallic items, though non-metallic items typically generate weaker or no reflections based on their electrical properties, thereby making them more difficult or sometimes not possible to detect. The GPR system will be used to trigger readings by a survey wheel or by a time cycle to provide data stations every 1 to 2 inches along the survey lines. Data will be recorded digitally, and later downloaded to a computer for data interpretation and archiving. A 250- to 400- megahertz frequency GPR antenna is typically utilized for underground storage tank surveys. The following survey procedures will be followed to perform the GPR survey for the buried tank search;

- 1) Pre-arrange with site tenants to have the survey area clear of any physical obstructions, and ensure this has taken place upon arrival to the site.
- 2) Establish a survey grid using taped measurements to provide field markings to conduct the planned survey lines.

- 3) Calibrate the survey equipment according to manufacturer's specifications / recommendations - including survey wheel (if utilized), or measurements per second if no survey wheel is utilized.
- 4) Establish field documentation concerning site and survey conditions, and document survey line locations to allow for potential reacquisition of items of interest from the survey results.
- 5) Ensure GPR data are stored and downloaded for analysis and archival.
- 6) If in-field data processing can be performed, mark possible buried tank location (if interpreted) in the field, and note its location.

4.0 MAGNETIC LOCATOR SURVEY

Magnetic locators refer to fluxgate magnetometers that sense magnetic bodies near the sensors. Rather than producing an actual measurement of a magnetic field, these simplified units specialize in detecting magnetic objects instead. Detection is communicated through a change in audio tone, and sometimes through a relative graphical display deflection. The following survey procedures will be followed to perform the magnetic locator survey for the buried tank search;

- 1) Pre-arrange with site tenants to have the survey area clear of any physical obstructions, and ensure this has taken place upon arrival to the site.
- 2) Establish a survey grid using taped measurements to provide field markings to conduct the planned survey lines.
- 3) Check the battery condition, and the sensitivity of the unit. Test proper operation and sensitivity against nearby aboveground ferrous metallic objects.
- 4) Establish field documentation on site and survey conditions, and ensure planned survey coverage is achieved.
- 5) Mark potential tank anomalies in the field, and note their locations for documentation.

5.0 EM61 SURVEY

The EM61 is a time domain electromagnetic (TDEM) system that was designed to detect buried metal and minimize interference from aboveground metallic objects. This instrument generates EM pulses, which in turn induce secondary magnetic fields that can be measured. In theory, between each pulse, the transmitter unit is switched off long enough for the response from the earth to dissipate before measuring the prolonged response from buried metal. This response is recorded in millivolts (mV). The EM61 normally consists of ½ meter by 1 meter transmitting and receiving coils. The unit can trigger data collection by a survey wheel to record readings approximately every 8 inches, or trigger readings on a time cycle that should be set to also trigger readings less than a foot apart. Data can be stored, downloaded, and processed into contour maps or survey line data profiles for interpretation and inclusion

in a report. If an EM61 survey is determined to be needed for this investigation, the same survey procedures outlined for the GPR survey above will be followed for the EM61 buried tank search.

6.0 PIPE AND CABLE LOCATOR SURVEY

If metallic suspect tank piping is accessible aboveground, a pipe and cable locator, consisting of a separate transmitter and receiver, may be used for the geophysical survey, if necessary. The transmitter portion will be used to attempt to send electrical current along accessible suspect piping, and the receiver will be used to search for the alignment of the suspect piping by survey personnel walking along the ground surface operating the receiver. Detection is normally communicated through a change in audio tone, and also through a relative graphical display deflection. If performed, the following survey procedures will be followed to perform the pipe and cable locator survey for the buried tank search;

- 1) Search the buried tank area for aboveground suspect tank piping, and make note of findings.
- 2) Arrange to have any aboveground suspect metallic tank piping accessible to the pipe and cable locator transmitter.
- 3) Check the battery condition of the transmitter and receiver.
- 4) Establish transmittal of current to suspect metallic tank piping, and search the area around the transmitter connection point for a resultant pipe trace using the receiver unit.
- 5) Mark potential tank piping in the field. Note location of pipe trace within the survey area, and if the pipe trace terminates within survey area, note that location as well.

STANDARD OPERATING PROCEDURE

SOP-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 for the collection of groundwater samples in the upper water-bearing zone. The methods described herein are specific for monitoring well construction at the Naval Support Activity (NSA) 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) should be consulted.

2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. 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). The driller is also responsible for obtaining, in advance, any required permits for drilling and monitoring well installation and construction.

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. The Field Geologist must be familiar with and experienced with the various formations of NSA Crane.

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 (SSO).

Well drilling and installation equipment with associated materials (typically supplied by the driller).

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

Overburden well borings will be drilled using minimum 4-inch inside diameter hollow-stem augers to the desired depth of each well boring. Rotary drilling with a roller bit and water wash or air rotary drilling can be used to extend the shallow well borings to allow well installation in the upper water-bearing zone. In no cases will the Mississippian Elwren Shale Formation be completely penetrated unless a steel casing is installed and grouted in place at the top of the Elwren Formation.

Bedrock monitoring well borings will be drilled using hollow-stem auger or rotary drilling techniques until the bedrock is reached. For shallow bedrock wells (i.e., those monitoring the upper water-bearing zone in bedrock) where no overburden soil contamination is present, a temporary 6-inch, steel casing will be installed to isolate the overburden while the upper bedrock is drilled. For wells to be installed in the upper water-bearing zone where soil contamination is known to be present, a 6-inch-diameter steel casing will be installed 3- to 5-into to the top of competent bedrock and will be grouted with cement-bentonite slurry in a manner to ensure that the entire annulus between the casing and borehole is sealed. Diamond coring (NX) or air rotary drilling will be initiated after the grout is allowed to cure for a minimum of 24 hours.

For wells using diamond coring, the coring will proceed from the bottom of the casing to the full depth of the boring. Once the coring has been completed and the core has been logged (see SOP-13), then the hole will be reamed out with a minimum 5-inch-diameter air rotary bit.

For wells using air rotary drilling in those cases where coring is not anticipated, the drilling will be performed through the casing after the grout has sufficiently set. These borings will be logged using the rock chips and dust blown up the boring by the return air of the drill bit (see SOP-13). The borehole will then be cleaned out using compressed air from the drill bit. The air rotary equipment must have a filter on the compressed air line going to the borehole to prevent oil and other organics from being introduced.

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 0.010-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 or packer testing, if performed. 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 2.0 feet above the top of the well screen. Clean silica sand of U.S. Standard Sieve Size No. 10 to 20 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. 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.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward to prevent bridging and to provide a better seal. However, in shallow boreholes that do not collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

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. A vent hole will be provided in the cap to

allow venting of gases and maintain atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the riser pipe and is set into the wet cement grout over the well upon completion or can be placed between the steel casing and the riser pipe in the case of deep monitoring well borings. 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. In traffic areas or high visibility areas, a flush-to-grade protective may be installed over the top of the riser pipe.

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 soil borehole logging are contained in SOP-09; details of rock borehole logging are contained in SOP-13.

6.0 ATTACHMENTS

1. Bedrock Monitoring Well Sheet
2. Overburden Monitoring Well Sheet

ATTACHMENT 1 BEDROCK MONITORING WELL SHEET



Tetra Tech

WELL No.: _____

MONITORING WELL SHEET

PROJECT: _____	DRILLING Co.: _____	BORING No.: _____
PROJECT No.: _____	DRILLER: _____	DATE COMPLETED: _____
SITE: _____	DRILLING METHOD: _____	NORTHING: _____
GEOLOGIST: _____	DEV. METHOD: _____	EASTING: _____

	Elevation / Depth of Top of Riser: _____ / _____
	Elevation / Height of Top of Surface Casing: _____ / _____
	I.D. of Surface Casing: _____
	Type of Surface Casing: _____
	Type of Surface Seal: _____
	I.D. of Riser: _____
	Type of Riser: _____
	Borehole Diameter: _____
	Elevation / Depth Top of Rock: _____ / _____
	Type of Backfill: _____
	Elevation / Depth of Seal: _____ / _____
	Type of Seal: _____
	Elevation / Depth of Top of Filter Pack: _____ / _____
	Elevation / Depth of Top of Screen: _____ / _____
	Type of Screen: _____
Slot Size x Length: _____	
I.D. of Screen: _____	
Type of Filter Pack: _____	
Elevation / Depth of Bottom of Screen: _____ / _____	
Elevation / Depth of Bottom of Filter Pack: _____ / _____	
Type of Backfill Below Well: _____	
Elevation / Total Depth of Borehole: _____ / _____	

Not to Scale

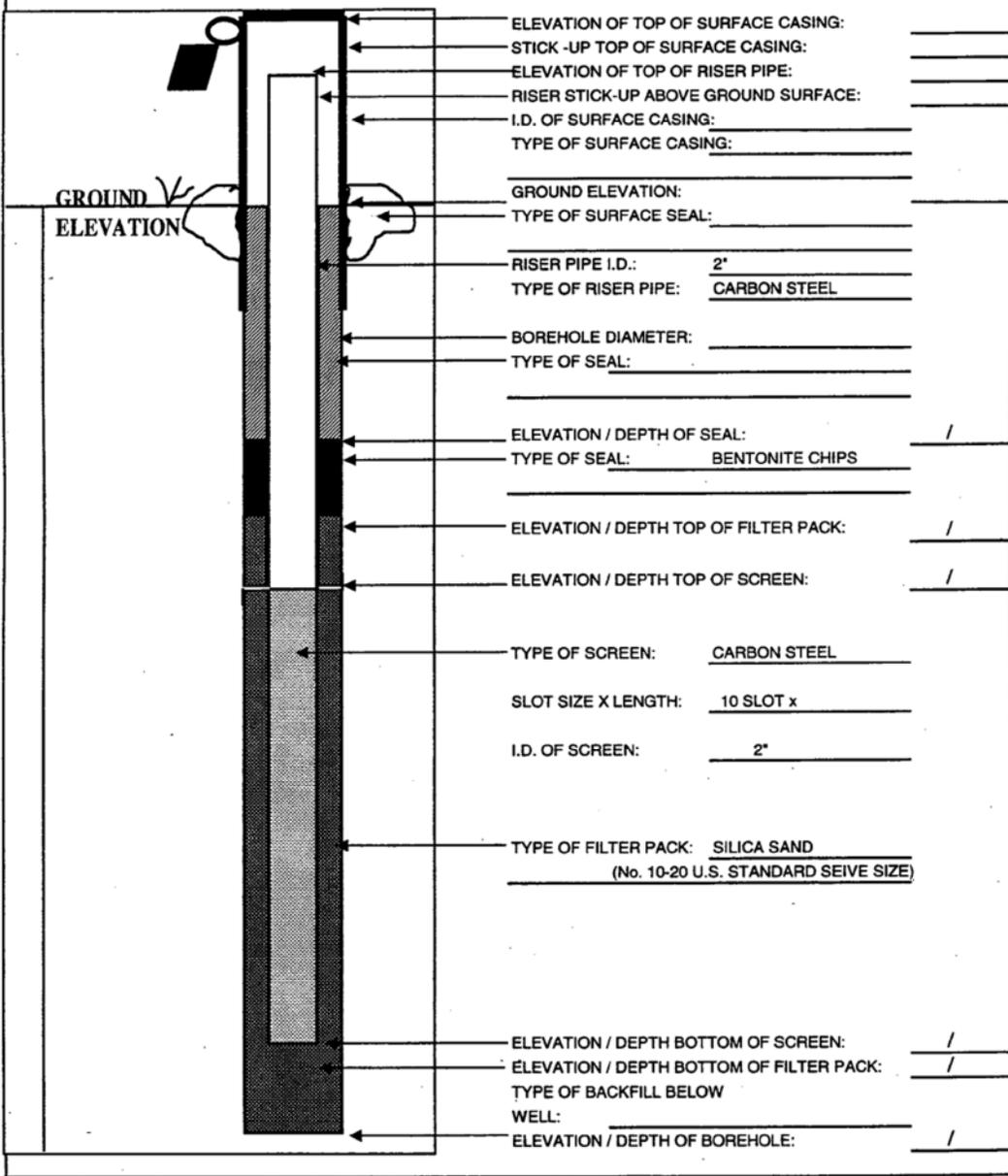
ATTACHMENT 2 OVERBURDEN MONITORING WELL SHEET



BORING NO.: _____

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:



STANDARD OPERATING PROCEDURE

SOP-13

DRILLING AND GEOLOGIC LOGGING OF BOREHOLES IN BEDROCK

1.0 PURPOSE

This procedure describes the methods and equipment necessary to drill bedrock 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 four types of drilling activities and equipment will be used to drill holes and install monitoring wells at the Naval Support Activity (NSA) Crane facility:

- Auger drilling with continuous split-spoon sampling will be used to drill through the overburden material.
- Diamond coring equipment will 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. Diamond coring is relatively slow and more expensive compared to the air rotary method of drilling, so one hole per subarea is proposed to be cored.
- Air-rotary or roto-sonic drilling will be used to advance the boreholes not cored. The holes need to be a minimum of 5 inches in diameter in order to install a 2-inch-diameter monitoring well. Air rotary may also be used to deepen well borings in the event bedrock is encountered before the desired well boring depth is reached.
- Rotary drilling with a roller bit and water wash may be used to complete well borings in the event that bedrock is encountered before the desired well boring depth is reached.

2.0 RESPONSIBILITIES

Field Operations Leader (FOL) - The Tetra Tech FOL is responsible for coordinating all on-site personnel and for providing technical assistance, when required. The Tetra Tech FOL, or designee, will coordinate and lead all activities and will ensure the availability, maintenance, and proper field decontamination of all materials and equipment. The Tetra Tech FOL is responsible for the completion of all field activities and

field and chain-of-custody documentation. The Tetra Tech FOL will assume custody of all samples and will ensure the proper handling and shipping of samples. The Tetra Tech FOL is a highly experienced environmental professional who will report directly to the Tetra Tech Project Manager (PM). Specific Tetra Tech 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 Tetra Tech PM.
- 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 Tetra Tech PM.
- 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 NSA Crane Environmental Restoration Site Manager (ERSM), 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.

Determination of the exact location for borings is the responsibility of the Field Geologist. The final location for drilling must be properly documented on the boring log. The general area in which the borings are to be located will be shown on a site map included in the Sampling and Analysis Plan (SAP).

Drilling Subcontractor - The subcontractor operates under the supervision of the Tetra Tech FOL. He or she is responsible for obtaining all drilling permits and clearances and supplying all services (including labor), equipment, and material required to perform the drilling, testing, and well installation program, as well as maintenance and quality control of such required equipment except as stated in signed and approved subcontracts.

The driller must report any major technical problems encountered in the field to the Tetra Tech FOL within 24 hours of determination and must provide advance written notification of any changes in field procedures, describing and justifying such changes. No such changes will be made unless requested and authorized in writing by the Tetra Tech FOL (with the concurrence of the Tetra Tech PM). Depending on the subcontract, the project manager may need to obtain written authorization from appropriate administrative personnel before approving any changes.

The drilling subcontractor is responsible for following decontamination procedures specified for drilling and coring equipment specified in the project plan documents. The Tetra Tech FOL will oversee the in-field equipment decontamination procedures to confirm compliance with the appropriate SOP and specific requirements of the NSA Crane Environmental Department. Upon completion of the work, the driller is responsible for demobilizing all equipment, cleaning up any materials deposited on site during drilling operations, and properly backfilling any open borings.

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-20. 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

Drilling is done by rotating and applying downward pressure to the drill rods and drill bit. The drill bit is a circular, hollow, diamond-studded bit attached to the outer core barrel in a double-tube core barrel. The use of single-tube core barrels is not recommended because the rotation of the barrel erodes the sample and limits its use for detailed geological evaluation. Water or air is circulated down through the drill rods and annular space between the core barrel tubes to cool the bit and remove the cuttings. The bit cuts a

core out of the rock that rises into an inner barrel mounted inside the outer barrel. The inner core barrel and rock core are removed by lowering a wire line with a coupling into the drill rods, latching onto the inner barrel, and withdrawing the inner barrel. A less efficient variation of this method utilizes a core barrel that cannot be removed without pulling all the drill rods. This variation is practical only if fewer than 50 feet of core is required. When coring rock, the speed of the drill and the drilling pressure, amount and pressure of water, and length of run can be varied to give the maximum recovery from the rock being drilled.

Advantages of core drilling include:

- Undisturbed rock cores can be recovered for examination and/or testing.
- In formations in which the cored hole will remain open without casing, water from the rock fractures may be recovered from the well without the installation of a well screen and gravel pack.
- Formation logging is extremely accurate.
- Drill rigs are relatively small and mobile.

Disadvantages include:

- Water or air is needed for drilling.
- Coring is slower than rotary drilling (and more expensive).
- Depth to water cannot accurately be determined if water is used for drilling.
- The size of the borehole is limited.

This drilling method is useful if accurate determinations of rock lithology are desired or if open wells are to be installed into bedrock. To install monitoring wells in coreholes, the hole will be reamed out to the proper size after boring, using air rotary drilling methods. Rock coring enables a detailed assessment of borehole conditions to be made, showing precisely all lithologic changes and characteristics. Because coring is an expensive drilling method, it is commonly used for shallow studies of 500 feet or less or for specific intervals in the drill hole that require detailed logging and/or analyzing. Rock coring can, however, proceed for thousands of feet continuously, depending on the size of the drill rig, and can yield better quality data than air-rotary drilling, although at a substantially reduced drilling rate.

Borehole diameter can be drilled to various sizes, depending on the information needed. NX, or a similar size (2- to 3-inch-diameter core recovery), may be used.

Begin the core drilling using a double-tube swivel-core barrel of the desired size. After drilling no more than 10-feet (3-meters), remove the core barrel from the hole and take out the core. If the core blocks the flow of the drilling fluid during drilling, remove the core barrel immediately.

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. If such broken zones or cavities prevent further advance of the boring, one of the following three steps shall be taken: cement the hole, ream and case, or case and advance with the next smaller size core barrel, as conditions warrant.

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 (Sections 4.0 and 5.0 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. The core boxes will be constructed to accommodate at least 20 linear feet of core in rows of approximately 5 feet each. Wood 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 wooden partitions with indelible ink. These blocks 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)
- Contact person's name and telephone number

For easy retrieval when core boxes are stacked, the sides and ends of the box will also be labeled and will include project 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 Air Rotary Drilling

Air-rotary drilling is a method of drilling where the drill rig simultaneously turns and exerts a downward pressure on the drilling rods and bit while circulating compressed air down the inside of the drill rods, around the bit, and out the annulus of the borehole. Air circulation serves to both cool the bit and remove the cuttings from the borehole.

Advantages of this method include:

- The drilling rate is high (even in rock).
- The cost per foot of drilling is relatively low.
- Air-rotary rigs are common in most areas.
- No drilling fluid is required (except when water is injected to keep down dust).
- The borehole diameter is large to allow room for proper well installation procedures.

Disadvantages to using this method include:

- Formations must be logged from the cuttings that are blown to the surface and thus the depths of materials logged are approximate.
- Air blown into the formation during drilling may "bind" the formation and impede well development and natural groundwater flow.

- In-situ samples cannot be taken, unless the hole is cased.
- Air-rotary drill rigs are large and heavy.
- Large amounts of investigation-derived waste (IDW) may be generated that may require containerization, sampling, and off-site disposal.

3.5 Rotosonic Drilling

The rotosonic drilling method employs a high frequency vibrational and low speed rotational motion coupled with down pressure to advance the cutting edge of a drill string. This produces a uniform borehole while providing a continuous, undisturbed core sample of both unconsolidated and most bedrock formations. Rotosonic drilling advances a 4-inch diameter to 12-inch diameter core barrel for sampling and can advance up to a 12-inch diameter outer casing for the construction of standard and telescoped monitoring wells. During drilling, the core barrel is advanced ahead of the outer barrel in increments as determined by the site geologist and depending upon type of material, degree of subsurface contamination and sampling objectives. The outer casing can be advanced at the same time as the inner drill string and core barrel, or advanced down over the inner drill rods and core barrel, or after the core barrel has moved ahead to collect the undisturbed sample and has been pulled out of the borehole. The outer casing can be advanced dry in most cases, or can be advanced with water or air depending upon the formations being drilled, the depth and diameter of the hole, or requirements of the project.

Advantages of this method include:

- Sampling and well installation are faster as compared to other drilling methods.
- Continuous sampling, with larger sample volume as compared to split-spoon sampling.
- The ability to drill through difficult formations such as cobbles or boulders, hard till and bedrock.
- Reduction of IDW by an average of 70 to 80 percent.
- Well installations are quick and controlled by elimination of potential bridging of annular materials during well installation, due to the ability to vibrate the outer casing during removal.

Disadvantages include:

- The cost for rotosonic drilling as compared to other methods are generally higher. However, the net result can be a significant savings considering reduced IDW and shortened project duration.
- Rotosonic drill rigs are large and need ample room to drill, however, rotosonic units can be placed on the ground or placed on an A TV.

- There are a limited number of roto sonic drilling contractors at the present time.

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

4.2 Classification of Rocks

In classifying 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 NSA 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.

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.

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 United States Geological Services (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 air-cored samples will be scraped clean of cuttings prior to color classifications. 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." 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.

$$\text{RQD \%} = r/l \times 100$$

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 American Society for Testing and Materials (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 hydrochloric acid (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 Rock Classification

Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate core run number, RQD percent, and core recovery under the appropriate columns.

Indicate lithology change by drawing a line at the appropriate depth, as explained above.

Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.

Enter color as determined while the core sample is wet; if the sample is cored by air, the core is to be scraped clean before the color is described.

Enter rock type. For sedimentary rocks, use terms as described in Section 4.2. Again, be consistent in classification. Use modifiers and additional terms as needed.

Enter brokenness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M, as explained in Section 4.2.6 and as noted on the back of the boring log.

The following information will be entered under the remarks column. Items will include but are not limited to the following:

- Indicate depths of joints, fractures, and breaks and also approximate to horizontal angle (such as high, low) (i.e., 70° angle from horizontal, high angle).
- Indicate calcareous zones, description of any cavities or vugs.
- Indicate any loss or gain of drill water.

- Indicate drop of drill tools or change in color of drill water.

Remarks at the bottom of boring log will include

- Type and size of core obtained
- Depth casing was set
- Type of rig used

As a final check, the boring log will include the following:

- Vertical lines will be drawn as explained for soil classification to indicate consistency of bedrock material.
- If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying rock samples when cores are obtained. However, some drilling methods (air/mud rotary) 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, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or ziplock bag for future reference, and label the jar or bag (i.e., hole number, depth, date, etc.). 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 split-barrel and 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 using air and mud rotary methods.

5.4 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.

7.0 ATTACHMENTS

1. Boring Log

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

SOP-14

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 Naval Support Activity (NSA) 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, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. 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.

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 15-20 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 Tetra Tech Project Manager (PM) 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.

5.0 ATTACHMENTS

1. Monitoring Well Development Record

STANDARD OPERATING PROCEDURE

SOP-15

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.

Groundwater Level Measurement Form: A copy of the Groundwater Level Measurement Form is attached.

Bound field logbook

Photoionization detector (PID)

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-20 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 Groundwater 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 the owner's manual. 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 Groundwater Level Measurement Form. If the reading is less than concentrations specified in the site-specific Health and Safety Plan (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-20.
- 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 Groundwater 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-20.

- 3.13 Containerize any decontamination fluids and personal protective equipment (PPE) in accordance with the procedures described in SOP-19.

4.0 ATTACHMENTS

1. Groundwater Level Measurement Sheet

STANDARD OPERATING PROCEDURE

SOP-16

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.

Groundwater Sample Log Sheet: A copy of this form and instructions for its completion are included in SOP-17.

Bound field logbook

Writing utensil

Photoionization detector (PID): The procedures for the operation of the PID are found in the Health and Safety Plan (HASP).

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-15).

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 (DO), oxidation-reduction potential (ORP), temperature, and specific conductance (see SOP-06).

Flow-through cell adapter for water-quality meter

LaMotte Turbidity Meter: Used to measure turbidity (see SOP-06).

Purge water containers

Graduated cylinder and stopwatch: Used to calculate flow rate.

Decontamination supplies: SOP-20 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-15 to obtain a static water-level measurement of the well to be purged. Record the information on the Groundwater 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 nephelometric turbidity units (NTUs) after all other field parameters have stabilized. If groundwater 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 quality assurance (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 \pm 0.1 standard units
 - Specific conduct \pm 5%
 - Temperature \pm 5%
 - Turbidity less than 10 NTUs
 - Dissolved oxygen \pm 10%

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 Form onto the Groundwater 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

STANDARD OPERATING PROCEDURE

SOP-17

GROUNDWATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting groundwater samples from permanent and temporary monitoring wells. Low-flow sampling techniques will be used for groundwater sampling at the Naval Support Activity (NSA) Crane facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

Writing utensil (preferably black ink)

Stainless steel Geoprobe Screen Point Groundwater Sampler (or equivalent)

Groundwater Sample Log Form: A copy of this form is attached at the end of this SOP.

Low Flow Purge Data Sheet: A copy of this form is attached at the end of this SOP.

Bound field log book

Chain-of-Custody Form

Bladder pump

Photoionization Detector (PID)

Peristaltic pump

Silicon tubing

Teflon tubing

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.

Surgical gloves

Water-level indicator

0.45-micron filter cartridge

Bucket: to collect development/purge water

Calculator, wristwatch, and timer

Stainless steel clamps

Plastic storage bags

Shipping containers with ice

3.0 SAMPLING PROCEDURES FOR PERMANENT MONITORING WELLS

- 3.1 Groundwater sampling may be initiated when the monitoring well has been purged and stabilized in accordance with SOP-16.
- 3.2 Record the sample start time (using military time) on the Groundwater Sample Log Sheet. Record the field measurements for pH, oxidation-reduction potential (ORP), specific conductance, temperature, dissolved oxygen (DO), 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 Groundwater Sample Log Form, the sample label, and the sample label.
- 3.7 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.
- 3.8 Enter the proper information on the Chain-of-Custody Form for each sample container (see SOP-03).

- 3.9 Repeat steps 3.3 through 3.8 for each sample container collected.
- 3.10 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 Groundwater Sample Log Form.
- 3.11 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):
- VOCs
 - Other organics
 - Metals
 - Other Inorganics
 - Filtered Metals (only if turbidity reading > 10 nephelometric turbidity units [NTU], see section 3.12 below)
- 3.12 If the last turbidity measurement prior to the commencement of sampling showed turbidity to be greater than 10 NTUs, then filtered aliquots of groundwater 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.
- 3.13 After completion of sample collection, remove the bladder pump (if bladder pump is used for sampling) from the well and decontaminate the pump following the procedures in SOP-20. Leave dedicated tubing inside the well for possible future sampling events.
- 3.14 Replace the outer protective well cap and lock the well.
- 3.15 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 (IDW) (SOP-19).

4.0 SAMPLING PROCEDURES FOR TEMPORARY WELL POINTS

- 4.1 Groundwater samples may be collected from temporary well screens inserted into auger holes or direct-push technology (DPT) soil borings. The temporary well screens can be constructed of polyvinyl chloride (PVC) or stainless steel.
- 4.2 Once the water table has been encountered, and the Geoprobe hole or auger hole has been completed, insert a 0.75- to 1.0-inch diameter slotted PVC well screen and riser to the bottom of the hole.
- 4.3 Field screening of volatile organic vapors in the borehole shall be performed using a PID in accordance with SOP-15.
- 4.4 The temporary well screen will be allowed to equilibrate for at least 15 minutes. Measure water level in well every 5 minutes and record on the Low Flow Purge Data Sheet.
- 4.5 Development of the screen point will be accomplished using a peristaltic pump and Teflon tubing.
- 4.6 Insert the intake end of a length of Teflon[®] tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the Teflon[®] tubing. The silicon tubing will be threaded around the rotor of the pump and out of the pump.
- 4.7 The Teflon tubing will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development. However, the yield of the formation will dictate the pumping rate. Measure water level in well every 5 minutes and record on the Low Flow Purge Data Sheet.
- 4.8 Measurement of pH, specific conductance, turbidity, DO, ORP, and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell.
- 4.9 The screen point will be pumped until discharge water is visibly clear, the turbidity readings do not improve over time, or the well screen goes dry.

4.10 Once the water has cleared or will clear no further, the pumping rate will be lowered to 50 to 100 milliliters (mL) per minute. Stabilization is achieved after two consecutive readings taken at 5 to 10 minutes intervals of the following field parameters has occurred:

- pH +/- 0.1 standard units
- Turbidity +/- 10% for values greater than 1 NTU
- Specific conductance +/- 3%
- Temperature +/- 3%
- ORP +/- 10 millivolts
- DO +/- 10%

If the above condition(s) have not been met after three well point volumes have been removed, this will be recorded on the field sample form and the groundwater sample collection can commence.

4.11 Samples will be collected using the peristaltic pump set at a flow rate of 100 mL per minute or less, depending on the yield of the formation. Samples will be collected directly from the pump discharge tubing. The pump shall operate continuously between development, purging, and sampling.

4.12 Record the sample date and time (using military time) on a Tetra Tech Groundwater Sample Log Sheet and on a chain of custody form.

4.13 Record the sample date and time (using military time) on an adhesive-backed sample label and affix the sample label securely to the sample container.

4.14 With the pump continuing to run, allow the pump discharge to flow gently down the inside of the sample container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled.

4.15 Cap each container immediately after filling.

4.16 Place the sample container into a ziplock bag and then into a cooler containing ice.

4.17 Repeat steps 4.14 through 4.16 for each sample container collected.

- 4.18 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 Tetra Tech Groundwater Sample Log Sheet.
- 4.19 All samples will be collected into pre-preserved bottles (if required) supplied by an approved laboratory. Worksheet No. 19 of the Sampling and Analysis Plan (SAP) includes information on preservation requirements and types of sample containers. The hierarchy of filling sample containers is as follows:
- VOCs
 - Other Organics
 - Total metals
 - Other Inorganics
 - Filtered metals (only if turbidity reading > 10 NTU, see section 4.20 below)

This hierarchy takes into consideration the volatilization sensitivity of groundwater samples.

- 4.20 If the turbidity of a groundwater sample is greater than 10 NTU and a total metals sample aliquot is collected, then a dissolved metals aliquot will also be collected. A single-use, disposable, in-line 0.45-micron filter cartridge shall be used to collect dissolved metals samples. Attach the filter cartridge to the discharge end of the pump tubing. Prior to filling containers with filtered sample, rinse the filter cartridge with approximately 100 mL of water from the boring to be sampled. Direct the discharge from the filter cartridge into the sample bottle and collect the filtered sample. Types of sample containers, sample volume, preservation requirements, and holding times are summarized in Worksheet No. 19 of the SAP. The laboratory will supply all sample containers, and the laboratory will pre-preserve sample containers where appropriate.
- 4.21 Once all of the sample containers have been filled, the pump shall be shut off. Record the sample date and time (in military time) on an adhesive-backed sample label and affix the sample label securely to the sample container. Record the end time for sampling on a Tetra Tech Groundwater Sample Log Sheet.
- 4.22 Once collection of samples is complete, remove tubing from temporary well screen and discard as IDW (see SOP-19). The screen point shall be removed from the boring and decontaminated in accordance with the procedures outlined in SOP-20.

4.23 Proceed to abandon the borehole with bentonite chips and excess soil core material.

5.0 ATTACHMENTS

1. Groundwater Sample Log Sheet
2. Low Flow Purge Data Sheet

STANDARD OPERATING PROCEDURE

SOP-18

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 or the Horiba U20-Series multi-parameter water quality monitoring system will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), and dissolved oxygen (DO) in water. A LaMotte turbidity meter will be used in conjunction with the water quality meter to measure turbidity. The multi-parameter water quality meter will have 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 groundwater 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. All comparable equipment used in place of the equipment items identified in Section 2.0 below must be comparable in terms of sensitivity, accuracy, and precision.

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 Series and Sonde or Horiba U20 Series, or comparable

LaMotte Turbidity Meter, or comparable

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 Horiba U20 series multi-parameter water quality meters and the LaMotte turbidity meter. Each meter is supplied with an instruction manual and will be on-site and 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 and Horiba U20 Series

The YSI Model 600 series and Sonde and the Horiba U20 series are multi-parameter water quality meters 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 meters have the ability to measure water-quality parameters in groundwater via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the groundwater comes in contact with the atmosphere. The parameters measured by the YSI or Horiba meters for this field effort may include 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

The parameters listed in Section 3.1 (except temperature which is factory calibrated) must be calibrated prior to the start of each field effort. After this initial calibration, the meter 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 5-1 (YSI) or page 93 (Horiba). 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 the 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.
- For all other parameters, make certain that the applicable sensor is completely submersed in solution, and the parameter 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 the rental company will also be recorded on the equipment calibration form.

3.2.3 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 in the meter according the manual recommendations.

4.0 MAINTENANCE

The YSI and/or Horiba 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 and Horiba Meters

For this field effort, the meter storage will be short term, [i.e. overnight or between work shifts (4-day break)]. During these breaks, the meter will be charged. One-half inch of tap water will be placed in the meter calibration cup, and the cup will be 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 for the YSI and Horiba Meters

- 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 (YSI) or Section 7.1 on page 86 (Horiba) of the equipment manual.

Note: Reagents that are used to calibrate and check the water quality meter may be hazardous. Review the Health and Safety Plan (HASP) and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

4.3 Meter Storage for the LaMotte Turbidity Meter

For this field effort, the meter storage will be short term, [i.e. overnight or between work shifts (4-day break)]. Proper storage of the meter between usages 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. Equipment Calibration Log

STANDARD OPERATING PROCEDURE

SOP-19

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 Naval Support Activity (NSA) Crane. The following types of IDW may be generated during this investigation:

- Decontamination solutions
- Personal protective equipment (PPE) and clothing
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)

Bucket (with collected development/purge water)

Decontamination equipment

Field logbook

Writing utensil (preferably black pen with indelible ink)

Plastic sheeting and/or tarps

55-gallon drums with sealable lids

IDW labels for drums

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 if necessary.

3.1 Liquid Wastes

Liquid wastes that may be generated during the site activities include decontamination solutions from sampling equipment. These wastes will be collected and containerized in a central location at NSA Crane for proper disposal.

3.2 Solid Wastes

No solid wastes are expected to be generated during this investigation. Excess soil core/sampling 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 and hydrated with potable water. The disposition of this materials will be carried out in a manner such as not to contribute further environmental degradation or pose a threat to public health or safety.

3.3 PPE and Incidental Trash

All PPE wastes and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper, etc.) will be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

STANDARD OPERATING PROCEDURE

SOP-20

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating all down-hole drilling equipment and non-dedicated field sampling equipment during the field investigations.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)

Non-latex rubber or plastic gloves

Cotton gloves

Field logbook

Potable water

Deionized water

Isoproponal (optional)

Liqui-Nox® or Alconox® detergent

Brushes, spray bottles, paper towels, etc.

Container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

Prior to its use at NSA Crane, all down-hole drilling equipment must be decontaminated with a high-pressure steam cleaner. All other non-dedicated sampling equipment must be thoroughly cleaned prior to use at the site.

All down-hole drilling equipment and hand augers must undergo the following field decontamination procedures between sample locations:

3.1 Don non-latex and/or cotton gloves.

- 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 Liqui-Nox® or Aloconox® detergent. Prepare the detergent wash solution in accordance with the instructions on the detergent container. Collect the 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 an isopropanol wash and repeat the detergent 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 and 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-19.

STANDARD OPERATING PROCEDURE

SOP-21

GLOBAL POSITIONING SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide the field personnel with basic instructions for operating a handheld Global Positioning System (GPS) unit allowing them to set GPS parameters in the receiver, record GPS positions on the field device, and update existing Geographic Information System (GIS) data. This SOP is specific to GIS quality data collection for Trimble®-specific hardware and software.

If possible, the Trimble® GeoXM™ or GeoXH™ operators manual should be downloaded onto the operator's personal computer for reference before or while in the field. The manual can be downloaded at <http://trl.trimble.com/docushare/dsweb/Get/Document-311749/TerraSyncReferenceManual.pdf>

Unless the operator is proficient in the setup and operation of the GPS unit, the Tetra Tech Project Manager (PM) (or designee) should have the GPS unit shipped to the project-specific contact listed below in the Pittsburgh, Pennsylvania, office at least five working days prior to field mobilization so project-specific shape files, data points, background images, and correct coordinate systems can be uploaded into the unit.

Tetra Tech
Attn: Kevin Moore
661 Anderson Drive, Bldg #7
Pittsburgh, PA 15220

2.0 REQUIRED EQUIPMENT

The following hardware and software should be utilized for locating and establishing GPS points in the field:

2.1 Required GPS Hardware

- Hand-held GPS unit capable of sub-meter accuracy (i.e. Trimble® GeoXM™ or Trimble® GeoXH™). This includes the docking cradle, alternating current (A/C) adapter, stylus, and Universal Serial Bus (USB) cable for data transfer.

Optional Accessories:

- External antenna
- Range pole
- Hardware clamp (for mounting GPS unit to range pole)
- GeoBeacon
- Writing utensil (preferably black pen with indelible ink)
- Non-metallic pin flags for temporary marking of positions

2.2 Required GPS Software

The following software is required to transfer data from the handheld GPS unit to a personal computer:

- Trimble® TerraSync version 2.6 or later (pre-loaded onto GPS unit from vendor)
- Microsoft® ActiveSync® version 4.5 or later. Download to personal computer from:
<http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.mspx>
- Trimble® Data Transfer Utility (freeware version 2.1 or later). Download to personal computer from:
<http://www.trimble.com/datatransfer.shtml>

3.0 START-UP PROCEDURES

Prior to utilizing the GPS in the field, ensure the unit is fully charged. The unit may come charged from the vendor, but an overnight charge is recommended prior to fieldwork.

The Geo-series GPS units require a docking cradle for both charging and data transfer. The Geo-series GPS unit is docked in the cradle by first inserting the domed end in the top of the cradle, then gently seating the contact end into the latch. The power charger is then connected to the cradle at the back end using the twist-lock connector. Attach a USB cable as needed between the cradle (B end) and the laptop/PC (A end).

It is recommended that the user also be familiar and check various Windows Mobile settings. One critical setting is the Power Options. The backlight should be set as needed to conserve power when not in use.

Start Up:

- 1) Power on the GPS unit by pushing the small green button located on the lower right front of the unit.
- 2) Utilizing the stylus that came with the GPS unit, launch **TerraSync** from the Windows Operating System by tapping on the start icon located in the upper left hand corner of the screen and then tap on **TerraSync** from the drop-down list.
- 3) If the unit does not default to the Setup screen, tap the Main Menu (uppermost left tab, just below the Windows icon) and select Setup.
- 4) If the unit was previously shipped to the Pittsburgh office for setup, you can skip directly to Section 4.0. However, to confirm or change settings, continue on to Section 3.1.

3.1 Confirm Setup Settings

Use the Setup section to confirm the TerraSync software settings. To open the Setup section, tap the Main Menu and select Setup.

- 1) Coordinate System
 - a. Tap on the Coordinate System.
 - b. Verify the project specs are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
Note: It is always best to utilize the Cancel tab rather than the OK tab if no changes are made since configurations are easily changed by mistake.
 - c. Tap on the Units.
 - d. Verify the user preferences are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
 - e. Tap Real-time Settings.

- f. Verify the Real-time Settings are correct for your specific project by scrolling through the various settings. Edit as needed and then tap OK; otherwise, tap Cancel to return to Setup Menu.
- g. The GPS unit is now configured correctly for your specific project.

4.0 ANTENNA CONNECTION

- 1) If a connection has been properly made with the internal antenna, a satellite icon along with the number of usable satellites will appear at the top of the screen next to the battery icon. If no connection is made (e.g.: no satellite icon), tap on the GPS tab to connect antenna.
- 2) At this point the GPS unit is ready to begin collecting data.

5.0 COLLECTING NEW DATA IN THE FIELD

- 1) From the Main Menu select Data.
- 2) From the Sub Menu (located below the Data tab) select New which will bring up the New Data File menu.
- 3) An auto-generated filename appears and should be edited for your specific project. If the integral keyboard does not appear, tap the small keyboard icon at the bottom of the screen.
- 4) After entering the file name, tap Create to create the new file.
- 5) Confirm antenna height if screen appears. Antenna height is the height that the GPS unit will be held from the ground surface (Typically 3 to 4 feet).
- 6) The Choose Feature screen appears.

5.1 Collecting Features

- 1) If not already open, the Collect Feature screen can be opened by tapping the Main Menu and selecting Data. The Sub Menu should default to Collect.
- 2) **Do not begin the data logging process until you are at the specific location for which you intend to log the data.**
- 3) A known reference or two should be shot at the beginning and at the end of each day in which the GPS unit is being used. This allows for greater accuracy during post-processing of the data.
- 4) Upon arriving at the specific location, tap on Point_generic as the Feature Name.
- 5) Tap Create to begin data logging.
- 6) In the Comment Box enter sample ID or location-specific information.

- 7) Data logging can be confirmed by viewing the writing pencil icon in the upper part of the screen. Also, the logging counter will begin. As a Rule of Thumb, accumulate a minimum of 20 readings on the counter, per point, as indicated by the logging counter before saving the GPS data.
- 8) Once the counter has reached a minimum number of counts (i.e. 20), tap on OK to save the data point to the GPS unit. Confirm the feature. All data points are automatically saved within the GPS unit.
- 9) Repeat steps 2 through 8, giving each data point a unique name or number.

Note: If the small satellite icon or the pencil icon is blinking, this is an indication the GPS unit is not collecting data. A possible problem may be too few satellites. While still in data collection mode, tap on Main Menu in upper left hand corner of the screen and select Status. Skyplot will display as the default showing the number of available satellites. To increase productivity (number of usable satellites) use the stylus to move the pointer on the productivity and precision line to the left. This will decrease precision, but increase productivity. The precision and productivity of the GPS unit can be adjusted as the number of usable satellites changes throughout the day. To determine if GPS is correctly recording data, see Section 5.2.

5.2 Viewing Data or Entering Additional Data Points to the Current File

- 1) To view the stored data points in the current file, tap on the Main Menu and select Map. Stored data points for that particular file will appear. Use the +/- and <-/> icons in lower left hand corner of screen to zoom in/out and to manipulate current view.
- 2) To return to data collection, tap on the Main Menu and select Data. You are now ready to continue to collect additional data points.

5.3 Viewing Data or Entering Data Points from an Existing File

- 1) To view data points from a previous file, tap on Main Menu and select Data, then select File Manager from the Sub Menu.
- 4) Highlight the file you want to view and select Map from the Main Menu.
- 5) To add data points to this file, tap on Main Menu and select Data. Continue to collect additional data points.

6.0 NAVIGATION

This section provides instructions on navigating to saved data points in an existing file within the GPS unit.

- 1) From the Main Menu select Map.
- 2) Using the Select tool, pick the point on the map to where you want to navigate.
- 3) The location you select will have a box placed around the point.
- 4) From the Options menu, choose the Set Nav Target (aka set navigation target).
- 5) The location will now have double blue flags indicating this point is you navigation target.
- 6) From the Main Menu select Navigation.
- 7) The dial and data on this page will indicate what distance and direction you need to travel to reach the desired target.
- 8) Follow the navigation guide until you reach the point you select.
- 9) Repeat as needed for any map point by going back to Step 1.

7.0 PULLING IN A BACKGROUND FILE

This section provides instructions on pulling in a pre-loaded background file. These files are helpful in visualizing your current location.

- 1) From the Main Menu select Map, then tap on Layers, select the background file from drop down list.
- 2) Select the project-specific background file from the list of available files.
- 3) Once the selected background file appears, the operator can manipulate the screen utilizing the +/- and <-/> functions at the bottom of the screen.
- 4) In operating mode, the operator's location will show up on the background file as a floating "x".

8.0 DATA TRANSFER

This section provides instructions on how to transfer stored data on the handheld GPS unit to a personal computer. Prior to transferring data from the GPS unit to a computer, Microsoft ActiveSync and Trimble Data Transfer Utility software must be downloaded to the computer from the links provided in Section 2.2 (Required GPS Software). If a leased computer is utilized in which the operator cannot download files, see the Note at the end of Section 8.0.

- 1) See Attachment A at the end of this SOP for instructions on how to transfer data from the GPS to a personal computer.

Note: If you are unable to properly transfer data from the GPS unit to a personal computer, the unit should be shipped to the project-specific contact listed in Section 1.0 where the data will be transferred and the GPS unit then shipped back to the vendor.

9.0 SHUTTING DOWN

This section provides instruction for properly shutting down the GPS unit.

- 1) When shutting down the GPS unit for the day, first click on the "X" in the upper right hand corner.
- 2) You will be prompted to ensure you want to exit TerraSync. Select Yes.
- 3) Power off the GPS unit by pushing the small green button located on the bottom face of the unit.
- 4) Place the GPS unit in its cradle to recharge the battery overnight. Ensure the green charge light is visible on the charging cradle.

ATTACHMENT A

How to Transfer Trimble GPS Data between Data Collector and PC

original 11/21/06 (5/1/08 update) – Kevin Moore

Remember – Coordinate System, Datum, and Units are critical!!!

Trimble Data Collection Devices:

Standard rental systems include the Trimble® ProXR/XRS backpack and the newer handheld GeoXT™ or GeoXH™ units. Some of the older backpack system may come with either a RECON “PDA-style” or a TSCe or TSC1 alpha-numeric style data collector.

The software on all of the above units should be Trimble® TerraSync (v 2.53 or higher – current version is 3.20) and to the user should basically look and function similar. The newer units and software versions (which should always be requested when renting) include enhancements for data processing, real-time display functions, and other features.

Data Transfer:

Trimble provides a free transfer utility program to aid in the transfer of GIS and field data. The Data Transfer Utility is a standalone program that will run on a standard office PC or laptop.

To connect a field data collector such as a RECON, GeoXM, GeoXT, GeoXH, or ProXH, you must first have Microsoft® ActiveSync® installed to allow the PC and the data collector to talk to one another. A standard USB cable is also needed to connect the two devices.

A CD or USB drive is provided with the data collector for use in data transfer. If needed, these programs are also available without charge via the web at:

- **Trimble Data Transfer Utility** (v 1.38) program to download the RECON or GeoXH field data to your PC: <http://www.trimble.com/datatransfer.shtml>
- **ActiveSync** from Microsoft to connect the data collector to the PC. The latest version (v4.5) can be found at: <http://www.microsoft.com/windowsmobile/en-us/downloads/microsoft/activesync-download.msp>
(see page 2 for data transfer instructions)

To Transfer Data Collected in the Field:

- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Make sure the data file desired is CLOSED in TerraSync prior to transfer
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "**GIS Datalogger on Windows CE**" or similar selection
- Hit the green connect icon to the right - the far right area should say "**Connected to**" if successful
- Select the "**Receive**" data tab (under device)
- Select "**Data**" from file types on the right
- Find the file(s) needed for data transfer. You can sort the data files by clicking on the date/time header
- Select or browse to a C-drive folder you can put this file for emailing
- When the file appears on the list, hit the "**Transfer All**"
- Go to your Outlook or other email, send a message to: Kevin.Moore@tetrattech.com (or GIS department)
- Attach the file(s) you downloaded from your C-drive. For each TerraSync data file created you should have a packet of multiple data files. All need to be sent as a group – make sure you attach all files (the number of files may vary – examples include: ssf, obx, obs, gix, giw, gis, gip, gic, dd, and car)

To Transfer GIS Data from PC to the Field Device (must be converted in Pathfinder Office):

- Obtain GIS file(s) desired from GIS Department and have converted to Trimble extension
- Contact Kevin Moore (Kevin.Moore@tetrattech.com) if needed for file conversion and upload support
- The GIS file(s) can be quickly converted if requested and sent back to the field user in the needed "Trimble xxx.imp" extension via email – then quickly downloaded from Outlook to your PC for transfer
- Install the Data Transfer and ActiveSync software installed on your PC
- Connect the RECON or GeoXH to your PC via an A/B USB cable (blade end and square end type "HP printer" style)
- ActiveSync should auto-detect the connection and recognize the data collector
- Connect via ActiveSync as a guest (not a partnership)
- Run the Trimble Data Transfer Utility program on your PC
- Select "**GIS Datalogger on Windows CE**" or similar selection
- Hit the green connect icon to the right - the far right area should say "**Connected to**" if successful
- Select the "**Send**" data tab (under device)
- Select "**Data**" from file types on the right (you can also send background files)
- Browse to the location of the data on your PC (obtain the file from Pathfinder Office or from the person who converted the data for field use)
- Select the options as appropriate for the name and location of the data file to go on the data collector (usually you can choose main memory or a data storage card)
- When the file(s) appears on the list, hit the "**Transfer All**"
- Run TerraSync on the field device and open the existing data files. Your transferred file should appear (make sure you have selected Main Memory, Default, or Storage Card as appropriate)

APPENDIX C

LABORATORY DOD ELAP CERTIFICATION



**LABORATORY
ACCREDITATION
BUREAU**

Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2226

Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: November 30, 2012

**R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 30th of November 2009**

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	1-Chlorohexane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonirile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Allyl chloride
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Di-isopropyl ether
GC/MS	EPA 8260B	ETBE
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	t-Butyl alcohol
GC/MS	EPA 8260B	tert-Amyl methyl ether
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzdine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)

Non-Potable Water		
Technology	Method	Analyte
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)

Non-Potable Water		
Technology	Method	Analyte
HPLC/UV	EPA 8330A/B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A/B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A/B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A/B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium

Non-Potable Water		
Technology	Method	Analyte
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7470A	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Sulfate
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate

Non-Potable Water		
Technology	Method	Analyte
Titration	SM 2320B 20 th /21 st edition	Alkalinity
Colorimetric	SM 4500 B, G, 20 th /21 st edition	Ammonia
Colorimetric	EPA 410.4	COD
UV/Vis	EPA 7196A	Hexavalent Chromium
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 353.2	Nitrate/Nitrite
Gravimetric	EPA 1664A	O&G
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20 th /21 st edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20 th /21 st edition	Total Phosphorus (as P)
UV/Vis	SM 4500 PE, 20 th /21 st edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20 th /21 st edition	Total Organic Carbon
Gravimetric	SM 2540C, 20 th /21 st edition	TDS
Gravimetric	SM 2540D, 20 th /21 st edition	TSS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
Preparation	Method	Type
Preparation	EPA 1311	TCLP
Preparation	EPA 3005A	Metals digestion
Preparation	EPA 3010A	Metals digestion
Preparation	EPA 3510C	Organics Liquid Extraction
Preparation	EPA 5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonitrile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Allyl chloride

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242

Solid and Chemical Materials		
Technology	Method	Analyte
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A	Nitroguanidine

Solid and Chemical Materials		
Technology	Method	Analyte
HPLC/UV	EPA 8330A	PETN
HPLC/UV	EPA 8330B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroguanidine
HPLC/UV	EPA 8330B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total

Solid and Chemical Materials		
Technology	Method	Analyte
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7471A/B	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
UV/Vis	EPA 7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	EPA 9034	Sulfide
Probe	EPA 9045C/D	pH
Preparation	Method	Type
Preparation	EPA 1311	TCLP
Preparation	EPA 1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	EPA 3050B	Metals Digestion
Preparation	EPA 3546	Organics Microwave Extraction



Solid and Chemical Materials		
Technology	Method	Analyte
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20 th /21 st edition	Percent Solids (Percent Moisture)
Preparation	EPA 5035 /A	Purge and Trap Solid

Notes:

- 1) This laboratory offers commercial testing service.



Approved By: _____

R. Douglas Leonard
Chief Technical Officer

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