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FINAL TIER II SAMPLING AND ANALYSIS PLAN FOR SOIL CHARACTERIZATION  
INVESTIGATION FOR BUILDING 181 AREA NSA CRANE IN  
6/1/2012  
TETRA TECH

**FINAL  
TIER II SAMPLING AND ANALYSIS PLAN  
SOIL CHARACTERIZATION INVESTIGATION FOR  
BUILDING 181 AREA**

**NAVAL SUPPORT ACTIVITY CRANE  
CRANE, INDIANA**



**Naval Facilities Engineering Command  
Midwest**

**Contract Number N62470-08-D-1001**

**Contract Task Order F276**

**June 2012**

**Title and Approval Page**

(UFP-QAPP Manual Section 2.1)

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

**SOIL CHARACTERIZATION INVESTIGATION FOR**  
**BUILDING 181 AREA**  
**NAVAL SUPPORT ACTIVITY CRANE**  
**CRANE, INDIANA**

**Prepared for:**  
Naval Facilities Engineering Command Midwest  
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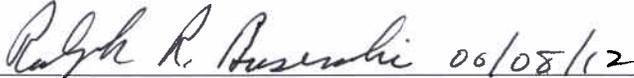
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**Prepared under:**  
Comprehensive Long-Term Environmental Action Navy  
Contract No. N62470-08-D-1001  
Contract Task Order F276

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\_\_\_\_\_  
Government Chemist/Date  
Navy QA Review

## Title and Approval Page

(UFP-QAPP Manual Section 2.1)

**DRAFT/FINAL**  
**TIER II SAMPLING AND ANALYSIS PLAN**  
**(Field Sampling Plan and Quality Assurance Project Plan)**  
**March-June 2012**

**SOIL CHARACTERIZATION INVESTIGATION FOR**  
**BUILDING 181 AREA**  
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**CRANE, INDIANA**

**Prepared for:**  
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Government Chemist/Date  
Navy QA Review

## 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 an investigation to provide data necessary to determine the environmental media quality in the Building 181 (B181) Area. The site is located at Naval Support Activity (NSA) Crane, Crane, Indiana. This SAP was prepared under Contract Task Order (CTO) F276, Contract N62470-08-D-1001, Comprehensive Long-Term Environmental Action Navy (CLEAN).

This SAP complies with applicable United States (U.S.) Department of the Navy (Navy), U. S. Environmental Protection Agency (USEPA) Region 5, and Indiana Department of Environmental Management (IDEM) requirements, regulations, guidance, and technical standards. These include the Department of Defense (DoD), Department of Energy (DOE), and USEPA Intergovernmental Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities (IDQTF, 2005).

The organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the planned investigation at the Building 181 Area are documented in this SAP. Protocols for sample collection, handling and storage, chain-of-custody, laboratory and field analyses, data validation, and reporting are also documented.

The sampling strategy for the B181 Area is to collect and analyze surface and subsurface soil samples, because potential contaminant releases could have occurred on the surface, and in the subsurface as a result of the presence of subsurface structures [i.e., settling basin, cistern, and underground storage tank (UST)]. In addition, surface water and collocated sediment samples will be collected from the drainageway located in the southern portion of the area. All samples will be analyzed for potentially site-related constituents, such as explosives and select metals.

The investigation to be conducted is preliminary, and data collected will be used to update the conceptual site model (CSM) for the site. The data will be fully validated in accordance with USEPA protocols to ensure the data will be suitable to support potential future human health and ecological risk assessments. It is expected that by collecting these data, the CSM for this site can be further developed and that the collected data would support future investigations, if deemed necessary by the Navy.

Investigation procedures will comply with site-specific field Standard Operating Procedures (SOPs), included in Appendix A, and laboratory analytical procedures will comply with the Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM) (USDoD, 2009).

Project-Specific SAP  
Site Name/Project Name: **Building 181 Area**  
Site Location: **Crane, Indiana**

Title: **Building 181 Area SAP**  
Revision Number: **0**  
Revision Date: **June 2012**

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.

**SAP Worksheets**

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- B - Laboratory DoD ELAP Accreditation

## ACRONYMS AND ABBREVIATIONS

°C	Degree Celsius
°F	Degree Fahrenheit
%D	Percent Difference or Percent Drift
%R	Percent Recovery
bgs	Below Ground Surface
BTAG	Biological Technical Assistance Group
CA	Corrective Action
CAAA	Crane Ammunition Army Activity
CAS	Chemical Abstracts Service
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CSM	Conceptual Site Model
CTO	Contract Task Order
DAF	Dilution Attenuation Factor
DL	Detection Limit
DoD	Department of Defense
DOE	Department of Energy
DPT	Direct-Push Technology
DRO	Diesel Range Organics
DQI	Data Quality Indicator
DQO	Data Quality Objective
DVM	Data Validation Manager
Eco	Ecological
Eco SSL	Ecological Soil Screening Level
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Approval Program
Empirical	Empirical Laboratories, LLC
ERO	Extended Range Organics
ERSM	Environmental Restoration Site Manager
FD	Field Duplicate
FOL	Field Operations Leader
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
g	Gram
GDCL	Groundwater Default Closure Level

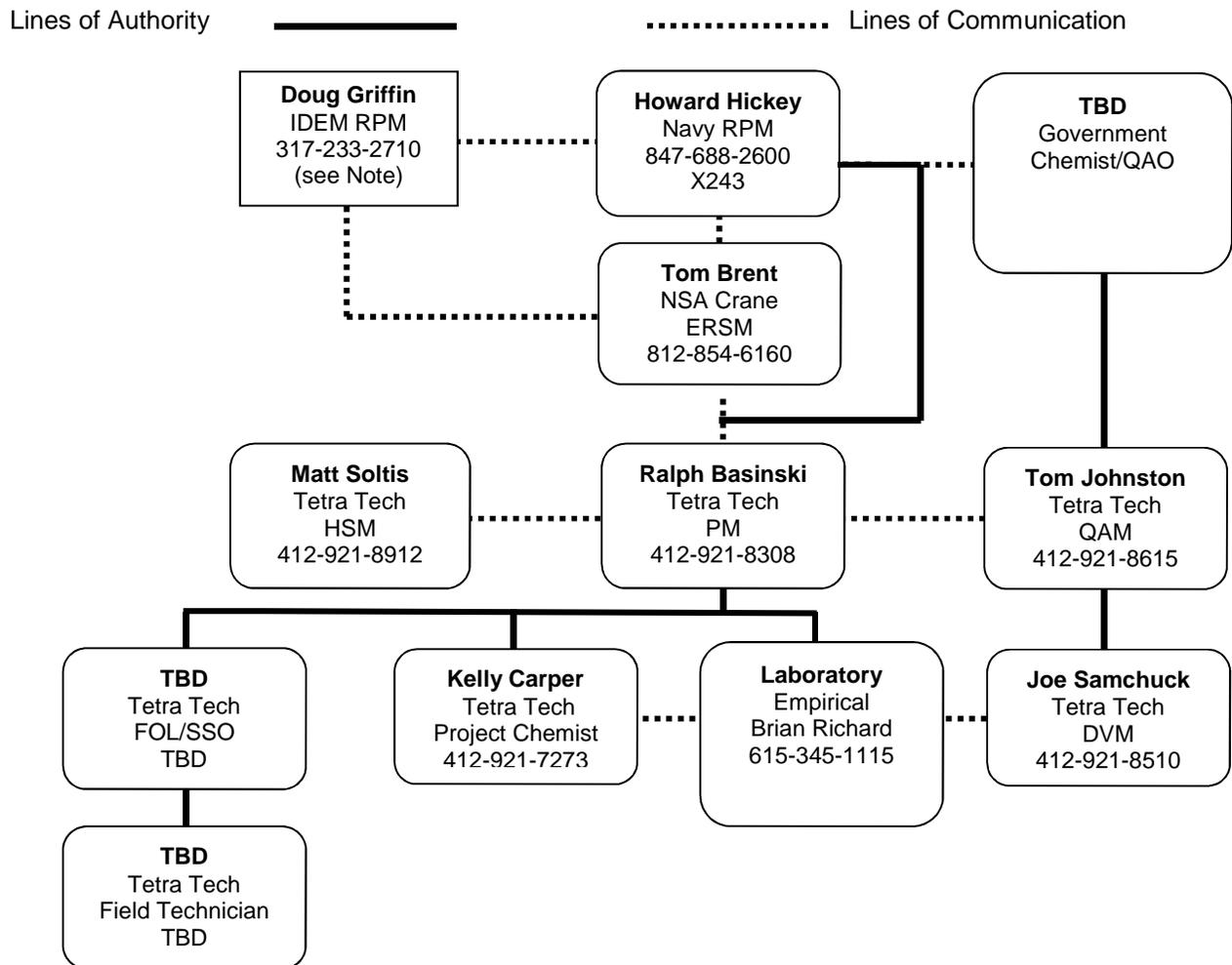
GRO	Gasoline Range Organics
GPS	Global Positioning System
HASP	Health and Safety Plan
HH	Human Health
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine/ His / Her Majesty's Explosive
HNO <sub>3</sub>	Nitric Acid
HPLC	High Performance Liquid Chromatography
HSM	Health and Safety Manager
ICP-AES	Inductively Coupled Plasma Atomic Emission Spectroscopy
IDEM	Indiana Department of Environmental Management
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation-Derived Waste
ILCR	Incremental Lifetime Cancer Risk
IUPPS	Indiana Underground Plant Protection Services
LANL	Los Alamos National Laboratory
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LLC	Limited Liability Corporation
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
mg/kg	Milligram per Kilogram
mL	Milliliter
MPC	Measurement Performance Criterion
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NAD	North American Datum
NAVFAC	Naval Facilities Engineering Command
Navy	U. S. Department of the Navy
NEDD	NIRIS Electronic Data Deliverable
NFA	No Further Action
NIRIS	Naval Installation Restoration Information Solution
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NSA	Naval Support Activity
OSHA	Occupational Safety and Health Administration

oz	Ounce
PID	Photoionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PQLG	Project Quantitation Limit Goal
PSL	Project Screening Level
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RDCL	Residential Default Closure Level
RDX	Octahydro-1,3,5,7-tetranitro-1,3,5-triazine / Royal Demolition Explosive
Reg 3 SD	Region 3 Freshwater Sediment Screening Level
Reg 3 SW	Region 3 Freshwater Surface Water Screening Level
Reg 5 SD	Region 5 Sediment Ecological Screening Level
Reg 5 SO	Region 5 Soil Ecological Screening Level
Reg 5 SW	Region 5 Surface Water Ecological Screening Level
RFI	RCRA Facility Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative Standard Deviation
R-RSL	Risk-Based Residential Direct Contact Soil Screening Level
RB-SSL	Risk-Based Migration-to-Groundwater Soil Screening Level
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SPCS	State Plane Coordinate System
SQL	Structured Query Language
SSL	Soil Screening Level
SSO	Site Safety Officer
SVOC	Semivolatile Organic Compound
TBD	To Be Determined
Tetryl	Trinitrophenylmethyl nitramine
TNT	2,4,6-Trinitrotoluene
TPH	Total Petroleum Hydrocarbons

UFP-SAP	Uniform Federal Policy for Sampling Analysis Plan
µg/L	Microgram per Liter
U.S.	United States
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound
WWII	World War II

## 1.0 -- Project Organizational Chart

[\(UFP-QAPP Manual Section 2.4.1 – Worksheet #5\)](#)



**Note:** Doug Griffen of IDEM serves in an advisory role.

DVM - Data Validation Manager  
 Empirical - Empirical Laboratories, LLC  
 ERSM - Environmental Restoration Site Manager  
 FOL - Field Operation Leader  
 HSM - Health and Safety Manager  
 IDEM - Indiana Department of Environmental Management  
 LLC - Limited Liability Corporation  
 Navy - U.S. Department of the Navy  
 NSA - Naval Support Activity

PM - Project Manager  
 QAM - Quality Assurance Manager  
 QAO - Quality Assurance Officer  
 RPM - Remedial Project Manager  
 SSO - Site Safety Officer  
 TBD - To Be Determined

## 2.0 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2 – Worksheet #6) The communication pathways for the SAP are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	IDEM PM Navy RPM	Doug Griffin Howard Hickey	317-233-2710 847-688-2600 x243	The Navy RPM will contact the regulatory agency via phone and/or e-mail within 24 hours of recognizing an issue whenever issues arise.
Field Progress Reports	Tetra Tech FOL Tetra Tech PM	TBD Ralph Basinski	TBD 412-921-8308	The Tetra Tech FOL will contact the Tetra Tech PM on a daily basis via phone, and every 1-2 days summarizing progress via e-mail.
Gaining Site Access	Tetra Tech FOL NSA Crane ERSM	TBD Tom Brent	TBD 812-854-6160	The Tetra Tech FOL shall contact the NSA Crane ERSM verbally or via e-mail at least 3 days prior to commencement of field work to arrange for access to the site for all field personnel.
Obtaining Utility Clearances	Tetra Tech FOL	TBD	TBD	The Tetra Tech FOL shall contact the Indiana Underground Plant Protection Services (IUPPS) verbally or via e-mail at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.
Stop Work Due to Safety Issues	Tetra Tech FOL/SSO Tetra Tech PM Tetra Tech HSM Navy RPM NSA Crane ERSM	TBD Ralph Basinski Matt Soltis Howard Hickey Tom Brent	TBD 412-921-8308 412-921-8912 847-688-2600 x243 812-854-6160	If Tetra Tech is the responsible party for a stop work command, the Tetra Tech FOL will inform onsite personnel, subcontractor(s), the NSA Crane ERSM, and the identified Project Team members within 1 hour (verbally or by e-mail). 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.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Sampling and Analysis Plan (SAP) Changes Prior to Field/ Laboratory Work	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM NSA Crane ERSM	TBD Ralph Basinski Howard Hickey Tom Brent	TBD 412-921-8308 847-688-2600 x243 812-854-6160	<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 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 to the Navy RPM and 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>
SAP Changes in the Field	Tetra Tech FOL/SSO Tetra Tech PM Navy RPM NSA Crane ERSM	TBD Ralph Basinski Howard Hickey Tom Brent	TBD 412-921-8308 847-688-2600 x243 812-854-6160	<p>The Tetra Tech FOL will verbally inform the Tetra Tech PM on the day that the issue is discovered. The Tetra Tech PM will inform the Navy RPM and the NSA Crane ERSM (verbally or via e-mail) within 1 business day of discovery.</p> <p>The Navy RPM 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>

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Field Corrective Actions	Tetra Tech PM Tetra Tech QAM Navy RPM	Ralph Basinski Tom Johnston Howard Hickey	412-921-8308 412-921-8615 847-688-2600 x243	The Tetra Tech QAM will notify the Tetra Tech PM verbally or by e-mail within 1 business day that the corrective action has been completed. The Tetra Tech PM will then notify the Navy RPM (verbally or by e-mail) within 1 business day.
Analytical Corrective Actions	Empirical Laboratory PM Tetra Tech Project Chemist Tetra Tech DVM Tetra Tech PM Navy RPM	Brian Richard Kelly Carper  Joseph Samchuck Ralph Basinski Howard Hickey	615-345-1115 412-921-7273  412-921-8510 412-921-8308 847-688-2600 x243	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. The Tetra Tech Project Chemist will notify (verbally or via e-mail) the DVM and the Tetra Tech PM within 1 business day. Tetra Tech DVM or Project Chemist notifies Tetra Tech PM verbally or via e-mail within 48 hours 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 within 24 hours of notification from the Tetra Tech Project Chemist or DVM. The Navy RPM takes corrective action appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed tune or initial calibration verification. Corrective actions may include a consult with the Navy Chemist.

### 3.0 -- Project Planning Session Participants Sheet

(UFP-QAPP Manual Section 2.5.1 – Worksheet #9)

<b>Project Name:</b> Soil Characterization Investigation		<b>Site Name:</b> <u>Building 181 Area</u>			
<b>Projected Date(s) of Sampling:</b> <u>Spring 2012</u>		<b>Site Location:</b> <u>Crane, Indiana</u>			
<b>Project Manager:</b> <u>Ralph Basinski</u>					
<b>Date of Session:</b> May 17, 2011					
<b>Scoping Session Purpose:</b> Data Quality Objective (DQO) Scoping Meeting					
Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Ralph Basinski	Crane Activity Coordinator/ PM	Tetra Tech	412-921-8308	ralph.basinski@tetrattech.com	Management /Oversight
Ed Sedlmyer	Project Scientist	Tetra Tech	412-921-8704	ed.sedlmyer@tetrattech.com	Technical Support
Bob Jupin	Senior Scientist	Tetra Tech	412-921-8195	bob.jupin@tetrattech.com	Human health risk assessor
Preston Smith	Scientist	Tetra Tech	412-921-8167	preston.smith@tetrattech.com	Ecological risk assessor
Tom Johnston	DQO Facilitator	Tetra Tech	412-921-8615	tom.johnston@tetrattech.com	DQO Facilitator
John Ducar	Senior Geologist	Tetra Tech	412-921-8089	john.ducar@tetrattech.com	Technical Support

**Note:** NSA Crane ERSM (Tom Brent) was involved via phone on several occasions to discuss site history and investigative strategy. Outcomes of those conversations were incorporated directly into this SAP.

**Comments/Decisions:**

The Navy has identified the need to obtain the following data to make preliminary determinations of human health and ecological risks for the following locations:

- Building 181 (B181) Area: The former B181 (which was demolished in 2005), the surrounding area of approximately 2.3 acres, and the associated structures constitute the B181 Area site. This site is located slightly more than 1 mile from the southern boundary of NSA Crane. Surface and subsurface soil, sediment, and surface water samples are to be collected for analysis for nitroaromatic and nitramine explosives, Appendix IX volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH) [gasoline range organics (GRO)/ diesel range organics (DRO)/extended range organics (ERO)], and Appendix IX metals plus lithium. Use of SW-846 Method 8330B (without the multi-incremental sampling or grinding) will ensure that the desired explosive target analytes are analyzed.

- Data must be validated. Additional detail needs to be collected before completing the CSM. Screening against risk-based criteria will be the basis for data evaluation. A letter report will be prepared to summarize the findings.

**Action Items:**

- Tetra Tech will prepare a draft and final SAP [Tier II Uniform Federal Policy (UFP)-SAP].
- Tetra Tech will prepare a draft and final HASP.

**Consensus Decisions:**

None.

<b>Project Name:</b> Soil Characterization Investigation			<b>Site Name:</b> <u>Building 181 Area</u>		
<b>Projected Date(s) of Sampling:</b> <u>Spring 2012</u>			<b>Site Location:</b> <u>Crane, Indiana</u>		
<b>Project Manager:</b> <u>Ralph Basinski</u>					
<b>Date of Session:</b> December 7, 2011					
<b>Scoping Session Purpose:</b> <b>Data Quality Objective (DQO)</b> Scoping Meeting					
<b>Name</b>	<b>Title</b>	<b>Affiliation</b>	<b>Phone #</b>	<b>E-Mail Address</b>	<b>Project Role</b>
Ralph Basinski	Crane Activity Coordinator/ PM	Tetra Tech	412-921-8308	ralph.basinski@tetrattech.com	Management /Oversight
Tom Johnston	DQO Facilitator	Tetra Tech	412-921-8615	tom.johnston@tetrattech.com	DQO Facilitator
Tom Brent	ERSM	Navy	812-854-6160	thomas.brent@navy.mil	Environmental Department Manager/NSA Crane

**Note:** Ralph Basinski and Tom Johnston met with NSA Crane ERSM Tom Brent to conduct a site walk, and to discuss site history and investigative strategy.

**Comments/Decisions:**

Based on the site history, although incomplete, and based on the site configuration observed during a site visit, it did not appear that VOCs or TPH (GRO/DRO/ERO) would be plausible site contaminants. The underground storage tank (UST) contains, and has only contained, water according to available site history. There was no evidence (e.g., staining odors, oily sheens) of oil usage. Therefore, the target analyte list was limited to site-related metals and nitramine/nitroaromatic explosives. The metals that are plausibly related to site operations are metals commonly associated with batteries, especially lithium, because this is a lithium battery test site. These metals are listed in Section 9.0.

Use of the on-site earthen barricade could not be deduced from its placement or orientation relative to other site features. Use of thionyl chloride as an electrolyte in lithium batteries was discussed, but thionyl chloride is such a reactive compound that residual contamination from it is highly unlikely. Degradation products of thionyl chloride are hydrochloric acid and inorganic sulfur compounds. An anecdote was discussed regarding migration of a large cloud (presumably containing uncombusted thionyl chloride) from a battery explosion at B181. This cloud is reported to have traveled off-site toward the south and killed some melons in a melon patch. The site is in a hollow so a decision was made to add sampling locations throughout the site in an effort to detect contaminants that might have been released through such explosions. Locations distributed throughout the site and on the hillside south of the site were identified as useful for this purpose.

**Action Items:**

Mr. Johnston will provide observations and changes to analyte lists and sampling locations to SAP preparers at Tetra Tech.

**Consensus Decisions:**

None.

## **4.0 -- Conceptual Site Model**

[\(UFP-QAPP Manual Section 2.5.2 – Worksheet #10\)](#)

This SAP governs the environmental investigation at the B181 Area within NSA Crane (see Figures 4-1 and 4-2). The aspects of the operational history, climate, geology, hydrology, and current land use that are pertinent to this investigation are discussed below. Following these descriptions is a site-specific CSM that describes characteristics unique to the site.

### **4.1 GENERAL SITE CHARACTERISTICS**

NSA Crane (see Figure 4-1) was commissioned in 1941 as Ammunition Depot Burns City. This naval base has undergone several subsequent name changes from Naval Ammunition Depot Crane in 1943 to Naval Surface Warfare Center in 1975, to Naval Surface Warfare Center Crane in 1992, and Naval Support Activity Crane in 2003. Consequently, environmental plans and reports for this base incorporate these various names, depending on when the documents were prepared.

All portions of NSA Crane, including the B181 Area, lie in a temperate climate. Temperature ranges from an average maximum July temperature of 89 degrees Fahrenheit (°F) to an average minimum January temperature of 26 °F. Precipitation is fairly evenly distributed throughout the calendar year; the maximum precipitation occurs during spring and early summer. Average annual precipitation at the facility is 44 inches.

NSA Crane is situated in a rugged, highly vegetated, dissected plateau bounded by the Mitchell Plain, which is a low, dissected limestone plateau characterized by sinkholes and karst topographic features, especially in the eastern portion of the base. The boundary between the Crawford Upland and the Mitchell Plain is marked by the highly irregular, eastern-facing Chester Escarpment. The terrain is predominantly rolling with moderately incised stream valleys throughout and occasional flat areas in the central and northern portions of NSA Crane. Topographic relief in the Crawford Upland generally ranges from 100 to 350 feet. Greater relief exists in the eastern part of NSA Crane (Murphy and Wade, 1995).

Unconsolidated overburden deposits at NSA Crane generally range from 0 to 65 feet thick (Nohrstedt, et. al., 1998). These deposits generally consist of alluvial and colluvial deposits near the floodplains of streams and unconsolidated residual soil and loess on sides and tops of ridges. Residual soils on or near the tops of ridges, which is where the Building 181 Area is located, is generally classified as well drained to moderately drained. They have a brown organic silt loam at the surface (typically about 8 inches thick), which is underlain by 42 to 48 inches of mottled tan, gray, and yellow clay with varying percentages of

sand and silt. Occasionally, a clay hardpan occurs between 25 and 32 inches below ground surface (bgs). Soil thickness on ridge tops is often thin and rock outcrops are common.

Groundwater occurs in bedrock at depths of approximately 15 to 25 feet bgs within the NSA Crane facility boundary; therefore, groundwater will not be encountered during the soil investigation at the B181 Area.

The surface drainages at NSA Crane have formed a dense, dendritic pattern throughout the installation (see Figure 4-1). Most of the major streams flow in a general southward or southwestward direction. Seven primary creeks in five drainage basins carry surface water off the installation, where they eventually drain into the eastern fork of the White River and then to the Wabash River to the southwest (not shown on figures). A typical surface water drainage pathway is located in the southern portion of the B181 Area.

Current land use at the B181 Area is industrial/military. There is no state or local planning within the vicinity of NSA Crane. Because most of the region is covered by vegetation, the area is classified as rural (Tetra Tech, 2001). The only zoning and land use regulations are in the municipalities in the region. None of the municipalities are close enough to impact NSA Crane, and the site being investigated under this SAP are slightly more than 1 mile from the NSA Crane property boundary. None of the areas adjacent to NSA Crane are zoned, and zoning is not anticipated in the near future. No known land use or community actions are being considered or proposed at this time (Tetra Tech, 2001).

#### **4.2 BUILDING 181 AREA CONCEPTUAL SITE MODEL**

The location of former B181 (which was demolished in 2005), the surrounding area of approximately 2.3 acres, and the associated structures constitute the B181 Area site (see Figure 4-2). This site is located slightly more than 1 mile from the southern boundary of NSA Crane (Figure 4-1). Very little is known about this site in terms of operational history.

The following information was provided in the September 4, 2008 Ordnance Briefing Program for Explosives Safety Personnel Session Memo (NSA Crane, 2008).

B181 was designed and constructed during World War II (WWII) as a chemical decontamination building. During WWII NSA Crane was designated a storage facility for Navy chemical weapons. At that time, the chemical weapons in use were aerial bombs containing mustard gas. The B181 structure had many small rooms for work with weapon items and also had support rooms for showers, etc. It remained dormant after the end of WWII when the mustard gas bombs were removed from Crane storage.

During the Vietnam conflict, a saw was installed in B181 with a remote control room located in Magazine 1441 down the road. This was in response to two train derailments in which bombs exploded. The sawing was used to open completed bombs to determine the extent of cavitation within the explosive. It was theorized by experts, that 2,4,6-trinitrotoluene (TNT) crystals within such cavities were super-sensitive to the shock of transportation, thus generating a hazard that resulted in the explosions. Many bombs were sawed open in B181, but none indicated that a special hazard existed in the bomb cavities.

After the bomb sawing effort, the B181 facility again remained dormant and deteriorated until the early 1980's, when the Navy acquired the facility from the Crane Ammunition Army Activity (CAAA), which had received it as a part of the license for the transfer of buildings from Crane Ordnance. The Navy completely rebuilt the facility and redesigned it for abusive testing of lithium batteries. After a Lithium Battery Test Facility was later built in the Industrial Area of the base, and the use of lithium batteries became a well-understood technology, the B181 Area was no longer needed. It was demolished as a part of the military footprint reduction effort in 2005. Some of the external test facilities (i.e., gun tubs) still remain on the site.

The text below describes information obtained by Tetra Tech about site features in May 2011 from the NSA Crane Environmental Manager, and available photographs and diagrams.

It is believed that wash water used to wash explosives from the insides of bombs in the former B181 was directed through a drain to an external location. There is no indication that organic solvents or surfactants were used in this process, and the position of the external drain location is unknown. A UST currently located near the former B181 may have been the receiver of the wash water containing explosives, and possibly other contaminants such as metals (see Figure 4-2). This UST is open to the air via a 6-inch metal stand pipe (Figure 4-2).

On the northern edge of this site is a drop tower. The tower consists of four wooden poles approximately 40 feet high. Three sides of the structure are covered with steel plates roughly 7 feet high. This drop tower was used for abusive testing of lithium batteries and drop testing of explosives. Abusive battery testing required dropping the batteries from various heights to determine the degree of damage associated with that kind of physical abuse. West of the drop tower is a concrete pad where iron surface warfare ship gun tubs were placed and used for testing lithium batteries. In addition, a gun tub is located south of the concrete pad. The exact type of testing conducted is unknown.



A settling basin is located in the northern portion of the Site (see Figure 4-2). The concrete structure is approximately 5-feet by 4-feet and 2-feet deep. Approximately 4-inches of water and 1-inch of sediment were observed in the basin during a Site walk conducted by Tetra Tech on November 21, 2011.

A square concrete cistern-like structure with dimensions of approximately 2-feet by 2-feet and 9.4 feet deep is located in the western portion of the Site (see Figure 4-2). Several inches of water and an unknown amount of sediment were observed in the cistern during a Site walk conducted by Tetra Tech on November 21, 2011. The purpose of this structure is unknown.

**View of Lithium Battery Drop Tower Facing Northeast**

A collapsed earthen and wooden barricade is located southeast of the former B181 footprint, but its use is unknown. It does not appear to be a source of chemical contaminants, except perhaps creosote-related chemicals that could have leached from the wooden railroad ties used to construct the barricade.

Potentially site-related contaminants are contaminants commonly associated with bomb demilitarization and lithium battery drop testing such as metals, including lithium, and explosives. No environmental sampling has been conducted at the B181 Area site.



**View of Setting Basin Facing North**



**View of Cistern**

40 feet south of the southern tree line of the site (see Figure 4-2). If any surface runoff has occurred, this would be the most likely place to find contamination. Because the creek bed is usually dry, however, contaminant transport in surface water is likely to be limited.

Human exposure to soil contamination could occur via dermal contact, incidental ingestion, and inhalation of resuspended dust. Plausible current receptors representing the various degrees of potential exposure are the occupational worker who works 8 hours per day at the B181 Area and is exposed to surface soil, the maintenance worker who maintains B181 and the surrounding grounds and also is exposed to surface soil, a construction worker who may dig into soils and be exposed to



**View of Wooden Barricade Facing Northeast**

surface and subsurface soil and groundwater, and a trespasser who wanders onto the site and is exposed to surface soil. Future plausible receptors include these receptors as well as a site resident who may be exposed to surface and subsurface soil. The hypothetical future resident may also be exposed to groundwater used as potable water. Humans could be exposed to contaminants (if present in surface water or sediment) in the drainageway located in the woods in the southern portion of the B181 Area site.



**View of Dry Drainageway Facing East**

Exposure to water in the UST near former B181 is not likely, but is a possibility. At both the drainageway and the UST, dermal contact and incidental ingestion are the plausible exposure pathways.

In addition, there is an unsubstantiated report of a large cloud (presumably containing uncombusted thionyl chloride) which was released during a battery explosion at B181 at an unknown date. This cloud is

reported to have traveled off site toward the south and damaged a melon patch.

The representative human receptors and their potential pathways for exposure to environmental media are depicted on Figure 4-3.

Ecological receptors potentially at risk of being exposed to contaminated surface soil and their plausible exposure pathways are:

- Plants exposed to surface soil via uptake of contaminants from the soil as well as direct contact with the soil;
- Soil invertebrates exposed as a result of ingestion of surface soil and direct contact with the soil; and
- Herbivorous and insectivorous mammals exposed via direct contact with surface soil, ingestion of soil, and contaminant assimilation via the food chain.

## **5.0 -- Project Quality Objectives/Systematic Planning Process Statements**

[\(UFP-QAPP Manual Section 2.6.1 – Worksheet #11\)](#)

### **5.1 PROBLEM STATEMENT**

The potential exists for site-related contaminants to be present in environmental media within, and possibly downgradient of, the B181 Area at concentrations that could pose an unacceptable level of human health or environmental risk. Therefore, the site must be investigated to determine if unacceptable levels of site-related contaminants exist, and if a corrective action or additional investigation is necessary. To efficiently and cost effectively use resources, it is most efficient to investigate the site in phases. The first phase is described in this document. Subsequent phases, if needed, will use the results of this Phase I investigation as a basis for additional investigation.

All data collected under this project must be of sufficient quality to support human health and ecological risk assessments, which may be conducted as part of future activities.

### **5.2 DATA NEEDS**

The following data are needed to support the desired data collection described in Section 5.1:

- Concentrations of explosives and select metals likely associated with the bomb cutting and battery testing operations (including nickel, cadmium, lead, copper, zinc, manganese, mercury, silver, tin, and lithium) in surface soil, subsurface soil, surface water and sediment are needed to determine the nature and extent of site-related contaminants and to support risk assessments, if necessary.
- Project Screening Level (PSL) criteria to which the data may be compared and could be useful for selecting analytical methods that provide data suitable for future human health and ecological risk assessments. Refer to Section 9.0 for a list of the target analytes, their respective PSL criteria in each environmental medium, and the sources of the applicable PSL criteria. To conduct comparisons of site data to PSLs, the selected laboratory must be able to achieve Limits of Quantitation (LOQs) that are low enough to measure constituent concentrations less than the PSLs. Analytical data reported by the laboratory use the following reporting conventions: All concentrations less than the Detection Limit (DL) will be considered non-detects and will be reported as the limit of detection (LOD) value with a "U" qualifier; and concentrations between the DL and LOQ will be reported as estimated values with a "J" qualifier. In the event that a target analyte has a PSL between the LOD and LOQ, the "J" flagged data will be accepted to achieve project goals. The inability to quantify select analytes to PSLs with confidence will be addressed in the final report.

- Global positioning system (GPS) coordinates (sub-meter accuracy) of data collection points. Data collection point coordinates must be documented in the State Plane Coordinate System (SPCS) North American Datum (NAD) 1983 Indiana West (feet), in accordance with Standard Operating Procedure (SOP)-13.
- Depths of soil intervals to be investigated must be obtained as described in Section 5.3.
- Quality Control Sample Data. Quality control data must be collected as described in Section 6.0.
- Observations of physical characteristics. Notations of physical site features such as potential additional contaminant release points, type and composition of debris, environmental media visibly or potentially affected by contaminant releases, potential contaminant migration pathways, presence and location of standing or flowing water, surface runoff flow patterns, degree of vegetation and slope, evidence of soil erosion, and other characteristics that are suitable for further developing the CSM.

### **5.3 STUDY AREA BOUNDARIES**

The population of interest for the preliminary investigation of the B181 Area is surface soil (0 to 2 feet bgs) and subsurface soil (greater than 2 feet bgs to the top of the water table or top of bedrock, whichever is shallower) at locations where contaminant releases are most likely to have occurred within the site limits, and off-site, as shown on Figure 4-2. In addition, surface water and sediment are media of concern in the southern area of B181 Area where a surface water drainage pathway is located (Figure 4-2).

#### **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 with the B181 Area. These include:
  - Area (especially downgradient) of the settling basin.
  - Area (especially downgradient) of the UST.
  - Area (especially downgradient) of the cistern.
  - Areas in the immediate vicinity of the footprint of the former B181.
  - Areas off the concrete pad outside the opening of the gun tubs.
  - Area in the immediate vicinity of the Lithium Battery Drop Tower.
  - Area in the immediate vicinity of the Earthen and Wooden Barricade.

- Area in the immediate vicinity of the Railroad Tie "Loading Dock" and Gravel Mound.
  - Potential historic spill areas; in particular any areas which exhibit stressed vegetation (possibly related to environmental conditions) or staining, if present.
  - Off-site (downwind) surface soil locations.
- Surface water and collocated sediment from the drainage pathway located in the southern portion of the B181 Area. The top 6 inches of sediment in the drainage channel is the sediment depth of interest because this interval is the most likely to be contaminated. If sediment is not readily available, depositional areas will be investigated.
  - Standing water from within the UST, settling basin, and cistern. This will be sampled for waste or potential contaminant characterization purposes.
  - Sediment from the base of the UST (if present), settling basin, and cistern (entire sediment column).

For the purpose of this SAP, soil is defined as material in areas outside of watercourses or drainages, and sediment is defined as material in watercourses or drainages, whether saturated or dry.

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 soil study is 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, cistern, or the settling basin, or near subsurface ancillary piping at depth. Therefore, the interval of interest for representing subsurface soil contamination is a 2-foot interval selected based on visual observations.

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 15 to 25 feet bgs based on other site investigations at NSA Crane.

Surface water (if present) and collocated sediment upstream, downstream, and downgradient of the potential contaminant source areas must be investigated to distinguish impacts from the site and impacts from other potential sources (see Section 7.0). If surface water is not present at the time of sampling, the Project Team will convene to determine if it is necessary to return to the site at a later date during a wet period when surface water is present. This decision will be based on the results of the surface soil and sediment laboratory analyses. If no contaminants are detected in the surface soil and sediment samples at concentrations above PSLs or NSA Crane Basewide background values (metals only), it will be determined that surface water data is not necessary for the site. If the analytical data shows the surface soil or sediment samples to contain concentrations of site-related compounds above PSLs, which indicate the potential for surface water contamination, the surface water will be required to be sampled.

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 stream levels caused by rain events, sampling events are not dependent on weather or other temporal factors. Subsequent field sampling activities, if deemed necessary based on the initial sampling event results, will be conducted in a timely manner.

#### **5.4 ANALYTIC APPROACH**

The data collected during this effort will be used primarily to further develop the CSM for the site. Recommendations on future actions will be made following evaluation of the data and CSM. Decisions will be made by the Project Team once the data has been evaluated to determine whether additional sampling is required to fully delineate contamination, if present. If contamination is present, the Project Team will determine if certain source areas, media, and/or compounds can be omitted from future sampling activities in order to focus on hot spots (source areas) to lessen the investigation area footprint. If a source area does not exhibit concentrations above PSLs and background, that source area will not be investigated further.

In addition, the concentrations of metals detected in the offsite surface soil samples will be compared against the Basewide Background data.

If all sample concentrations are less than PSL values and background levels (metals only), no further action (NFA) will be recommended; otherwise it will be recommended that a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) be conducted.

## **5.5 PERFORMANCE CRITERIA**

This is a focused preliminary investigation that requires collection of the planned samples to be successful. If all planned samples are collected, and no significant data quality deficiencies are identified, the Project Team will conclude that the data are sufficient to support planning for future environmental investigations. If the planned data are not collected, or significant data quality deficiencies are identified, the Project Team will meet to assess the effect of the deficiencies on attaining project objectives. The tendency will be to collect data to fill data gaps if any missing or rejected data are identified, unless the Project Team can demonstrate qualitatively or quantitatively that the deficiencies do not prevent attainment of project objectives. Data quality will be established in accordance with processes described in Section 8.1.

If any data gaps are identified, including missing or rejected data, the Project Team will assess whether project objectives can be achieved despite the existence of data gaps. This assessment will depend on the number and type of identified data gaps. All Project Team stakeholders will be involved in rendering the final conclusion regarding adequacy of the data. U-flagged values, even if the concentrations are greater than DLs, will not be used to classify a sampling point as contaminated.

## **5.6 SAMPLING DESIGN AND RATIONALE**

The sampling design and rationale are presented in Section 7.0.

## 6.0 – Field Quality Control Samples

[\(UFP-QAPP Manual Section 2.6.2 – Worksheet #12\)](#)

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

1. Equipment rinsate blanks will be collected if non-dedicated sampling equipment is used. For disposable equipment, one sample per batch of disposable equipment will be collected.
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.

## **7.0 -- Sampling Design and Rationale**

[\(UFP-QAPP Manual Section 3.1.1 – Worksheet #17\)](#)

Samples will be collected from areas of potential contamination for the B181 Area site. The sampling design is a biased design targeting locations within the Site boundary most likely to have been contaminated under the assumption that a contaminant release occurred. Targeted locations were selected based on local physical conditions indicating a potential contaminant release. Figure 7-1 shows the locations of the planned onsite samples, and Figure 7-2 shows the locations of the planned off-Site samples.

The onsite sample locations will be biased toward locations wherever evidence of a potential contaminant release is observed (e.g., where there is staining, odors, etc.). The intent is to collect a sample from the location that appears to be the most contaminated. If there is no visual or olfactory evidence of a contaminant release, a sample will be collected as near the potential source as possible, on the downgradient side.

The off-site surface soil samples will be collected from random, predetermined locations based on the areas potentially affected by the cloud (presumably containing uncombusted thionyl chloride) generated by a battery explosion at B181. This cloud is reported to have traveled off site toward the south and damaged a melon patch.

A table of samples is provided in Section 8.3. Sampling and other field task methodologies are described in Section 8.1.

Groundwater typically occurs in bedrock at depths of approximately 15 to 25 feet bgs within the NSA Crane facility boundary; therefore, groundwater may not be encountered during the soil investigation.

In addition to samples being collected and submitted for chemical analysis, that site features which provide evidence of contaminant releases, migration patterns, etc. will be documented in the field notes.

### **B181 AREA SAMPLING**

Samples will be collected from areas of potential contamination within the B181 Area. Figure 7-1 shows the locations of the planned on-site samples, and Figure 7-2 shows the locations of the planned off-site samples. The on-site sample locations will be biased toward locations wherever evidence of a potential contaminant release is observed (e.g., where there is staining, odors, etc.). The intent is to collect a sample from the location that appears to be the most contaminated. If there is no visual or olfactory

evidence of a contaminant release, a sample will be collected as near the potential source as possible, on the downgradient side.

The off-site surface soil samples will be collected from random, predetermined locations based on the areas potentially affected by the cloud (presumably containing uncombusted thionyl chloride) from a battery explosion at B181. This cloud is reported to have traveled off-site toward the south and damaged a melon patch.

Eighteen surface soil (0 to 2 feet bgs) and ten subsurface (greater than 2 feet bgs) soil samples will be collected within the site boundary. The vertical boundary of the initial soil study is soil from the ground surface to the top of the water table or top of bedrock, whichever is shallower. All soil borings will be sampled for surface soil. In addition, the five locations (B181SB023 – B181SB027) associated with subsurface structures will also be sampled for subsurface soils. The greatest likelihood of encountering contamination in subsurface soil is considered to be at the depth interval below the base of the subsurface structures (i.e., UST, cistern, and settling basin) and the top of the water table or bedrock. Therefore, the interval of interest for representing subsurface soil contamination is the 2-foot interval below the base of subsurface structures being investigated, and the 2-foot interval above the top of the water table or bedrock. 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.

Each sample will be labeled according to the sample identifiers (Sample IDs) shown in Section 8.3. In addition, three surface water and three sediment samples will be collected from the drainageway located in the southern portion of the area.

Also, water samples will be collected from the UST, settling basin, and cistern. If a sufficient amount of sediment is present at the time of sampling, sediment samples will also be collected at the base of the UST, settling basin, and the cistern.

All samples will be analyzed for explosives (SW-846 Method 8330B target analytes) and select metals likely associated with the battery testing operations (i.e., nickel, cadmium, lead, copper, zinc, manganese, mercury, silver, tin, and lithium). The water samples (surface water and structure) will be analyzed for both total and dissolved select metals.

The total metals analyses for the surface water samples collected from the drainageway will be used to compare to PSLs. The dissolved metals data will be used in the future for fate and transport analyses if concentrations of metals above PSLs are detected in the total metal samples.

Both the total and dissolved metals data for the structure water samples will be used to aid the Navy in determining appropriate waste disposal technologies for the structure water.

## **8.0 – Field Project Implementation (Field Project Instructions)**

[\(UFP-QAPP Manual Section 5.2.3\)](#)

### **8.1 Field Project Tasks**

[\(UFP-QAPP Manual Section 2.8.1 – Worksheet #14\)](#)

Site-specific SOPs have been developed for field activities at NSA Crane and are located in Appendix A. Field tasks are summarized below with a short description for each task.

- Mobilization/Demobilization
- Utility Clearance
- Site-Specific Health and Safety Training
- Monitoring Equipment Calibration
- Sample Collection Tasks
- Field Documentation Procedures
- Sample Handling
- Surface and Subsurface Soil Sampling
- Surface Water Sampling
- Sediment Sampling
- Global Positioning System Locating
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Quality Control Tasks

#### **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.

### **Utility Clearance**

One week 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. The Tetra Tech FOL will be responsible for coordinating these activities.

### **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 Occupational Safety and Health Administration (OSHA) 40-hour course (and 8-hour refresher, if applicable) in health and safety training. Safety requirements are addressed in greater detail in the site-specific HASP.

### **Monitoring Equipment Calibration**

Monitoring equipment calibration procedures are described in SOP-11.

### **Sample Collection Tasks**

The sampling and analysis program is outlined in Section 7.0 and Section 8.3. Sample collection will be in accordance with the site-specific SOPs listed in Section 8.2 and provided in Appendix A. The sampling requirements for each type of analysis (i.e., bottleware, preservation, holding time) are listed in Section 8.4. Field and laboratory QC samples will also be collected as outlined in Section 8.5.

### **Field Documentation Procedures**

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

### **Sample Handling**

Methods and requirements 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. Sample labeling will be in accordance with SOP-01 (Sample Labeling), and the sample numbering scheme will be in accordance with Section 8.3 and SOP-02 (Sample Identification Nomenclature). The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with Section 8.4 and SOP-04 (Sample Preservation, Packaging, and Shipping).

### **Surface and Subsurface Soil Sampling**

Surface and subsurface soil samples will be collected in accordance with SOP-05 [Borehole Advancement and Soil Coring Using Direct Push Technology (DPT) and Hand Auger Techniques]. Surface soil only samples will be collected with a hand auger or stainless steel trowel. The soil samples will be described by the field personnel in accordance with SOP-06 (Soil Sample Logging). Any qualitative visual signs of potential contamination (such as soil staining) will be noted on the soil boring log. The soil samples will be collected in accordance with SOP-07 (Surface and Subsurface Soil Sampling).

### **Surface Water Sampling**

The surface water sampling procedures discussed in SOP-08 (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-09 (Measurement of Water Quality Parameters). The Tetra Tech PM or FOL will coordinate with the NSA Crane ERSM regarding the timing of and locations where surface water samples will be collected so as not to conflict with regulatory National Pollutant Discharge Elimination System (NPDES) permit sampling activities (if applicable).

### **Sediment Sampling**

During sediment sampling the procedures discussed in SOP-10 (Sediment Sampling) will be followed. Sediment samples from the drainage pathway will be collected from the same locations as surface water samples. Sediment samples will be collected from 0 to 6 inches beneath the sediment surface, which is the interval most likely to be contaminated.

### **Global Positioning System Locating**

A GPS unit will be used to survey the locations of all soil sampling points in accordance with SOP-13 (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. Data collection point coordinates must be documented in the SPCS NAD 1983 Indiana West (feet).

### **Investigation-Derived Waste (IDW) Management**

Solid or semi-solid IDW in the form of soil will be generated during field activities. Soil will be replaced into the boring from which it was removed.

IDW generated, including personal protective equipment (PPE) and decontamination fluids, will be handled in accordance with SOP-14 (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) 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-12 (Decontamination of Field Sampling Equipment).

### **Quality Control Tasks**

Quality assurance/quality control (QA/QC) samples will be collected at frequencies listed in Section 6.0.

## **ADDITIONAL PROJECT-RELATED TASKS**

Additional project-related tasks include:

- Analytical Tasks
- Data Management
- Data Review
- Project Reports

### **Analytical Tasks**

Chemical analyses will be performed by Empirical, which is a DoD Environmental Laboratory Approval Program (ELAP)-accredited laboratory. A copy of the laboratory accreditation for Empirical is included in Appendix B. Analyses will be performed in accordance with the analytical methods identified in Section 8.4. Empirical will perform the chemical analyses following laboratory-specific SOPs (see Section 8.4 and Section 10.0) developed based on the methods listed in Section 8.4. Laboratory SOPs are not included in this SAP, but have been reviewed by the Tetra Tech Project Chemist to ensure that they are suitable for use on this project.

All soil sample results will be reported by the laboratory on an adjusted dry-weight basis. 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 Solution (NIRIS) database. Percent moisture information will also be captured in the site investigation report.

The analytical data packages provided by Empirical will be in a Contract Laboratory Program (CLP)-like format 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, percent recoveries (%Rs), RPDs, relative standard deviations (RSDs), and/or percent differences or percent drifts (%Ds), etc.].

### **Data Management**

The principal data generated for this project will be from field data and laboratory analytical data. 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 laboratory technical specifications. Electronic data results will be automatically downloaded into the Tetra Tech database in accordance with 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 will be 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 monitor the data validation effort, which will include verifying that the data packages are complete and that results for all samples have been delivered by Empirical.
- **Data Storage, Archiving, and Retrieval.** The data packages received from Empirical will be tracked in the data validation logbook. After the data are validated, the data packages will be entered into the Tetra Tech 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. Project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Tetra Tech.

- **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.
- **Data Review.** This review comprises data verification, validation, and a usability assessment. The data verification and validation processes and requirements are described in Section 12.0. The data usability assessment will, at a minimum, constitute evaluation of the following characteristics to ensure that the amount, type, and quality of data are sufficient to achieve project objectives. The means of conducting these evaluations will vary depending on the nature of the data. Examples include:
  - Comparing actual to intended sampling locations and verifying that the correct datum was used to delineate contamination.
  - Evaluating trends across sample delivery groups or sampling events.
  - Identifying potential errant or outlier data points.
  - Assessing planning assumption validity.
  - Evaluating the potential for contamination of samples by samplers.

Data quality indicators to be evaluated during this assessment include:

1. **Precision.** A semiquantitative estimate of the uncertainty in contaminant concentrations.
2. **Accuracy.** Accuracy data will be evaluated to ensure sampling and measurement accuracy is within or exceeds analytical method specifications and may depend in part on the data validation findings.
3. **Representativeness.** This evaluation will assess whether the data are adequately representative of intended populations based on the sample collection and data generation requirements specified in this SAP.

4. **Completeness.** Failure to obtain critical data from planned locations will be documented. Minor variations in actual versus intended sampling locations (or depths) that do not adversely affect the attainment of project objectives will not be documented.
5. **Comparability.** This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction for each sampled area.
6. **Sensitivity.** The Tetra Tech Project Chemist will determine whether project sensitivity goals were achieved by comparing non-detect values to Project Screening Limits (PSLs).

If significant data quality deficiencies are detected that prevent the attainment of project objectives, the limitations on the affected data will be described in the project report. The Tetra Tech PM will bring these deficiencies to the attention of the Project Team for their evaluation, and the team will determine an appropriate corrective action depending on the circumstances.

### **Project Reports**

At the completion of this preliminary investigation, a letter report will be compiled by Tetra Tech and submitted to the Navy RPM. The report will identify the locations sampled, the concentrations of target analytes in each sample, and whether or not the concentrations exceed the applicable PSLs. The report will include no recommendations. However, site conditions, including physical features and characteristics, will be described in sufficient detail to support further development of the CSM for the B181 Area site.

## 8.2 Field SOPs Reference Table

(UFP-QAPP Manual Section 3.1.2 – Worksheet #21)

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, 03/12, Revision 0.	Tetra Tech	Not Applicable (NA)	N	Contained in <a href="#">Appendix A</a>
SOP-02	Sample Identification Nomenclature, 03/12, Revision 0.	Tetra Tech	NA	Y	Contained in <a href="#">Appendix A</a>
SOP-03	Sample Custody and Documentation of Field Activities, 03/12, Revision 0.	Tetra Tech	Field logbook, sample log sheets, boring logs	N	Contained in <a href="#">Appendix A</a>
SOP-04	Sample Preservation, Packaging, and Shipping, 03/12, Revision 0.	Tetra Tech	NA	N	Contained in <a href="#">Appendix A</a>
SOP-05	Borehole Advancement and Soil Coring Using Direct-Push Technology (DPT) and Hand Auger Techniques, 03/12, Revision 0.	Tetra Tech	DPT rig, stainless steel augers, extension rods, and T-handle	N	Contained in <a href="#">Appendix A</a>
SOP-06	Soil Sample Logging, 03/12, Revision 0.	Tetra Tech	NA	N	Contained in <a href="#">Appendix A</a>
SOP-07	Surface and Subsurface Soil Sampling, 03/12, Revision 0.	Tetra Tech	Stainless steel auger bucket, extension rods, and T-handle, photoionization detector (PID)	N	Contained in <a href="#">Appendix A</a>
SOP-08	Surface Water Sampling, 03/12, Revision 0.	Tetra Tech	NA	N	Contained in <a href="#">Appendix A</a>
SOP-09	Measurement of Water Quality Parameters, 03/12, Revision 0.	Tetra Tech	Multi-parameter water quality meter, such as a Horiba U-22	N	Contained in <a href="#">Appendix A</a>
SOP-10	Sediment Sampling, 03/12, Revision 0.	Tetra Tech	Stainless steel or disposable trowel, long-handled sampling device	N	Contained in <a href="#">Appendix A</a>
SOP-11	Calibration and Care of Water Quality Meters; 03/12, Revision 0.	Tetra Tech	Multi-parameter water quality meter, such as a Horiba U-22, turbidity meter	Y (project-specific SOP)	Contained in <a href="#">Appendix A</a>
SOP-12	Decontamination of Field Sampling Equipment, 03/12, Revision 0.	Tetra Tech	Decontamination equipment, scrub brushes, 5-gallon buckets, spray bottles, phosphate free detergent, de-ionized water	N	Contained in <a href="#">Appendix A</a>
SOP-13	Global Positioning System, 03/12, Revision 0.	Tetra Tech	GPS unit	N	Contained in <a href="#">Appendix A</a>
SOP-14	Management of Investigation-Derived Waste, 03/12, Revision 0.	Tetra Tech	NA	N	Contained in <a href="#">Appendix A</a>

### 8.3 Sample Details Table

(UFP-QAPP Manual Section 3.1.1 and 3.5.2.3 – Worksheet #18)

Sample Location	Sample ID <sup>(1)</sup>	Analyses		
		Explosives	Total Metals	Dissolved Metals
<b>SURFACE SOIL</b>				
B181SB001	B181SS0010002	1	1	-- <sup>(3)</sup>
B181SB002	B181SS0020002	1	1	--
B181SB003	B181SS0030002	1	1	--
B181SB004	B181SS0040002	1	1	--
B181SB005	B181SS0050002	1	1	--
B181SB006	B181SS0060002	1	1	--
B181SB007	B181SS0070002	1	1	--
B181SB008	B181SS0080002	1	1	--
B181SB009	B181SS0090002	1	1	--
B181SB010	B181SS0100002	1	1	--
B181SB011	B181SS0110002	1	1	--
B181SB012	B181SS0120002	1	1	--
B181SB013	B181SS0130002	1	1	--
B181SB014	B181SS0140002	1	1	--
B181SB015	B181SS0150002	1	1	--
B181SB016	B181SS0160002	1	1	--
B181SB017	B181SS0170002	1	1	--
B181SB018	B181SS0180002	1	1	--
B181SB019	B181SS0190002	1	1	--
B181SB020	B181SS0200002	1	1	--
B181SB021	B181SS0210002	1	1	--
B181SB022	B181SS0220002	1	1	--
B181SB023	B181SS0230002	1	1	--
B181SB024	B181SS0240002	1	1	--
B181SB025	B181SS0250002	1	1	--
B181SB026	B181SS0260002	1	1	--
B181SB027	B181SS0270002	1	1	--

Sample Location	Sample ID <sup>(1)</sup>	Analyses		
		Explosives	Total Metals	Dissolved Metals
<b>SUBSURFACE SOIL</b>				
B181SB023	B181SB023XXXX <sup>(2)</sup>	1	1	--
B181SB023	B181SB023XXXX	1	1	--
B181SB024	B181SB024XXXX	1	1	--
B181SB024	B181SB024XXXX	1	1	--
B181SB025	B181SB025XXXX	1	1	--
B181SB025	B181SB025XXXX	1	1	--
B181SB026	B181SB026XXXX	1	1	--
B181SB026	B181SB026XXXX	1	1	--
B181SB027	B181SB027XXXX	1	1	--
B181SB027	B181SB027XXXX	1	1	--
<b>STREAM SURFACE WATER</b>				
B181SW001	B181SW001	1	1	1
B181SW002	B181SW002	1	1	1
B181SW003	B181SW003	1	1	1
<b>STREAM SEDIMENT</b>				
B181SD001	B181SD001	1	1	--
B181SD002	B181SD002	1	1	--
B181SD003	B181SD003	1	1	--
<b>STRUCTURE WATER</b>				
B181SU001	B181SU001	1	1	1
B181SU002	B181SU002	1	1	1
B181SU003	B181SU003	1	1	1
<b>STRUCTURE SEDIMENT</b>				
B181SL001	B181SL001	1	1	--
B181SL002	B181SL002	1	1	--
B181SL003	B181SL003	1	1	--

1. The interval of the sample from below ground surface. For example, if the sample is collected from 0 to 2 feet bgs, the depth will be recorded as 0002.
2. XXXX and X – X' represents the interval of the sample from below 2 feet bgs and above top of the water table or bedrock. Depth will be determined in the field based on the 2-foot interval below the base of the subsurface structure being investigated, and the 2-foot interval above the top of the water table or bedrock. For example, if sample is collected from 8 to 10 feet bgs, the depth will be recorded as 0810.
3. -- Not analyzed

## 8.4 Analytical SOP Requirements and Analytical Services Table

[\(UFP-QAPP Manual Section 3.1.1 – Worksheets #19 and 30\)](#)

**Laboratory point of contact, e-mail address, and phone number:** Brian Richard, [brichard@empirlabs.com](mailto:brichard@empirlabs.com), (615) 345-1115

**Laboratory Name and Address:**

Empirical Laboratories, LLC  
 621 Mainstream Drive, Suite 270  
 Nashville, TN 37228

**Data Package Turnaround time:** 21 days

**Tentative Sampling Dates:** To be determined (TBD)

MATRIX	ANALYTICAL GROUP	ANALYTICAL AND PREPARATION METHOD/ SOP REFERENCE	CONTAINERS (number, size, and type)	SAMPLE VOLUME (units)	PRESERVATION REQUIREMENTS (chemical, temperature, light protected)	MAXIMUM HOLDING TIME (preparation/ analysis)
Surface water, structure water, and aqueous QC samples	Explosives	SW-846 8330B Empirical SOP-327	Two 1-liter amber glass	1000 milliliters (mL)	Cool to above freezing and $\leq 6^{\circ}\text{C}$	7 days to extraction; 40 days to analysis
Soil and Sediment	Explosives	SW-846 8330B Empirical SOP-327	One 4-ounce (oz) glass jar with a Teflon <sup>®</sup> -lined lid	30 grams (g)	Cool to above freezing and $\leq 6^{\circ}\text{C}$	14 days to extraction; 40 days to analysis
Surface water, structure water, and aqueous QC samples	Metals (and Dissolved Metals)	SW-846 3010A/6010C, 7470A Empirical SOP-100/103/105	One 500-mL plastic bottle	50 mL	Nitric acid ( $\text{HNO}_3$ ) to pH <2; Cool to above freezing and $\leq 6^{\circ}\text{C}$	180 days to analysis except mercury, 28 days for mercury
Soil and sediment	Metals	SW-846 3050B/6010C, 7471B Empirical SOP-100/104/105	One 4-oz glass jar with a Teflon <sup>®</sup> -lined lid	1 to 2 g	Cool to above freezing and $\leq 6^{\circ}\text{C}$	180 days to analysis except mercury, 28 days for mercury

## 8.5 Field Quality Control Sample Summary Table

[\(UFP-QAPP Manual Section 3.1.1 – Worksheet #20\)](#)

Matrix	Analytical Group	No. of Samples	Duplicate Samples	No. of MS/MSDs <sup>(1)</sup>	No. of Field Blanks	No. of Equip. Blanks	No. of VOC Trip Blanks	Total No. of Samples to Lab
Surface Soil	Explosives	27	2	2	0	1	0	30
	Total Metals <sup>(2)</sup>	27	2	2	0	1	0	30
Subsurface Soil	Explosives	10	1	1	0	0	0	11
	Total Metals	10	1	1	0	0	0	11
Stream Surface Water	Explosives	3	1	1	0	0	0	4
	Total Metals	3	1	1	0	0	0	4
	Dissolved Metals	3	1	1	0	0	0	4
Stream Sediment	Explosives	3	1	1	0	1	0	5
	Total Metals	3	1	1	0	1	0	5
Structure Water	Explosives	3	1 <sup>(3)</sup>	0	0	0	0	4
	Total Metals	3	1 <sup>(3)</sup>	0	0	0	0	4
	Dissolved Metals	3	1 <sup>(3)</sup>	0	0	0	0	4
Structure Sediment	Explosives	3	1 <sup>(3)</sup>	0	0	0	0	4
	Total Metals	3	1 <sup>(3)</sup>	0	0	0	0	4

1. Although Matrix Spike/Matrix Spike Duplicates (MS/MSDs) are not typically considered field QC samples, they are included here because location determination will be established in the field. The MS/MSDs are not included in the total number of samples sent to the laboratory.
2. Metals to be analyzed for are listed in Section 9.0.
3. The duplicate samples for the water and sediment samples will be attempted to be collected from one of the subsurface structures, pending sufficient volume recovery. If not enough sample volume is available from the structures, the duplicate samples will be collected from a stream surface water and/or sediment sample location.

## 9.0 – Reference Limits and Evaluation Tables

(UFP-QAPP Manual Section 2.8.1 – Worksheet #15)

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

Analyte	CAS Number	HH PSL (mg/kg)	HH PSL Reference <sup>1</sup>	Eco PSL (mg/kg)	Eco PSL Reference <sup>2</sup>	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
<b>Metals</b>									
Cadmium	7440-43-9	7.0	R-RSL	0.36	Eco SSL	0.12	0.25	0.1	0.05
Copper	7440-50-8	310	R-RSL	28	Eco SSL	9.3	0.5	0.4	0.2
Lead	7439-92-1	400	R-RSL	11	Eco SSL	3.7	0.25	0.15	0.075
Lithium <sup>3</sup>	7439-93-2	16	R-RSL	2	NOAA	0.67	TBD	TBD	TBD
<b>Manganese</b>	<b>7439-96-5</b>	<b>180</b>	<b>R-RSL</b>	220	Eco SSL	<b>0.7</b>	<b>3</b>	<b>1.2</b>	<b>0.6</b>
Mercury	7439-97-6	0.66	RB-SSL	0.1	Reg 5 SO	0.033	0.033	0.033	0.013
Nickel	7440-02-0	150	R-RSL	38	Eco SSL	12.7	0.5	0.3	0.15
Silver	7440-22-4	12	RB-SSL	4.2	Eco SSL	1.4	0.5	0.1	0.05
<b>Tin</b>	<b>7440-31-5</b>	4,700	R-RSL	<b>7.62</b>	<b>Reg 5 SO</b>	<b>2.5</b>	<b>20</b>	<b>10</b>	<b>0.5</b>
Zinc	7440-66-6	2,300	R-RSL	46	Eco SSL	15.3	1	0.5	0.25
<b>Explosives</b>									
1,3,5-Trinitrobenzene	99-35-4	34	RB-SSL	0.376	Reg 5 SO	0.13	0.080	0.040	0.020
<b>1,3-Dinitrobenzene</b>	<b>99-65-0</b>	<b>0.028</b>	<b>RB-SSL</b>	0.655	Reg 5 SO	<b>0.0093</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>2,4-Dinitrotoluene</b>	<b>121-14-2</b>	<b>0.0056</b>	<b>RB-SSL</b>	1.28	Reg 5 SO	<b>0.0019</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>2,6-Dinitrotoluene</b>	<b>606-20-2</b>	0.40	RB-SSL	<b>0.0328</b>	<b>Reg 5 SO</b>	<b>0.011</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>Nitrobenzene</b>	<b>98-95-3</b>	<b>0.00158</b>	<b>RB-SSL-</b>	1.31	Reg 5 SO	<b>0.00053</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
2,4,6-Trinitrotoluene	118-96-7	0.26	RB-SSL	6	Sunahara	0.087	0.080	0.040	0.020
2-Amino-4,6-Dinitrotoluene	35572-78-2	0.46	RB-SSL	2.1	LANL	0.15	0.080	0.040	0.020
<b>2-Nitrotoluene</b>	<b>88-72-2</b>	<b>0.0050</b>	<b>RB-SSL</b>	2	LANL	<b>0.0017</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>3-Nitrotoluene</b>	<b>99-08-1</b>	<b>0.024</b>	<b>RB-SSL</b>	2.4	LANL	<b>0.008</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
4-Amino-2,6-Dinitrotoluene	19406-51-0	0.46	RB-SSL	0.73	LANL	0.15	0.080	0.040	0.020
<b>4-Nitrotoluene</b>	<b>99-99-0</b>	<b>0.068</b>	<b>RB-SSL</b>	4.4	LANL	<b>0.23</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
HMX	2691-41-0	19.8	RB-SSL	27	LANL	6.6	0.080	0.040	0.020
Tetryl	479-45-8	11.8	RB-SSL	0.99	LANL	0.33	0.080	0.040	0.020
<b>RDX</b>	<b>121-82-4</b>	<b>0.0046</b>	<b>RB-SSL</b>	7.5	LANL	<b>0.0015</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>

CAS – Chemical Abstracts Service

HH – Human Health

Eco – Ecological

PQLG - Project Quantitation Limit Goal

mg/kg – Milligram per Kilogram

HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine/ His / Her Majesty's Explosive

RDX Octahydro-1,3,5,7-tetranitro-1,3,5-triazine / Royal Demolition Explosive

Tetryl Trinitrophenylmethylnitramine

- 1 - HH PSL References: The R-RSL and RB-SSL were taken from the November 2011 USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (USEPA, 2011a), available online at [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). 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 EPA 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. RB-SSLs are based on a Dilution Attenuation Factor (DAF) of 20.
- 2 - Eco PSL References: 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: Eco SSL - USEPA Ecological Soil Screening Levels, lower of the plant, soil invertebrate, bird, or mammal screening level values (Eco SSL documents are available on-line at <http://www.epa.gov/ecotox/ecossl/>) (USEPA, 2005a-b, 2006a, 2007a-c); Reg 5 SO - USEPA Region 5 Soil Ecological Screening Levels (USEPA, 2005c); LANL – Los Alamos National Laboratory ECORISK Database (Release 2.4) (LANL, December 2009); Sunahara - Ecotoxicology of Explosives (Sunahara, et. al., 2009); and NOAA - NOAA Screening Quick Reference Tables (Buchman, 2008).
- 3 - The laboratory will perform a DL study for Lithium. The DL number in the table will be filled in upon completion of the DL study.

**Bolded** rows identify the PSLs in that row that are between the laboratory LOQ and LOD. The Project Team has agreed to accept this data for decision making if results below the LOQ are "J" qualified and the results will be discussed in the uncertainties section of the report.

**Bolded and Shaded** rows indicate the PSLs in that row that are less than the LOD; the Project Team has agreed to report non-detected results for these chemicals at the LOD and any limitations on data use that result from having detection limits (i.e., data qualified U) that are greater than PSLs will be described in the report. However, if the only exceedances of the PSLs are U-flagged values, that analytical group will be considered to be below screening values.

**Matrix : Sediment**

Analyte	CAS Number	HH PSL (mg/kg)	HH PSL Reference <sup>1</sup>	Eco PSL (mg/kg)	Eco PSL Reference <sup>2</sup>	PQLG (mg/kg)	Empirical		
							LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
<b>Metals</b>									
Cadmium	7440-43-9	7.0	R-RSL	0.99	Reg 5 SD	0.33	0.25	0.1	0.05
Copper	7440-50-8	310	R-RSL	31.6	Reg 5 SD	10.5	0.5	0.4	0.2
Lead	7439-92-1	400	R-RSL	35.8	Reg 5 SD	11.9	0.25	0.15	0.075
Lithium <sup>3</sup>	7439-93-2	16	R-RSL	NA	NA	5.3	TBD	TBD	TBD
Manganese	7439-96-5	180	R-RSL	460	Reg 3 SD	60	3	1.2	0.6
Mercury	7439-97-6	1.0	R-RSL	0.174	Reg 5 SD	0.058	0.033	0.033	0.013
Nickel	7440-02-0	150	R-RSL	22.7	Reg 5 SD	7.6	0.5	0.3	0.15
Silver	7440-22-4	39	R-RSL	0.5	Reg 5 SD	0.17	0.5	0.1	0.05
Tin	7440-31-5	4,700	R-RSL	NA	NA	1,560	10	20	0.5
Zinc	7440-66-6	2,300	R-RSL	121	Reg 5 SD	40	1	0.5	0.25
<b>Explosives</b>									
1,3,5-Trinitrobenzene	99-35-4	220	R-RSL	1	Sunahara	0.33	0.080	0.040	0.020
<b>1,3-Dinitrobenzene</b>	<b>99-65-0</b>	<b>0.61</b>	<b>R-RSL</b>	<b>0.00861</b>	<b>Reg 5 SD</b>	<b>0.0029</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>2,4-Dinitrotoluene</b>	<b>121-14-2</b>	1.6	R-RSL	<b>0.0144</b>	<b>Reg 5 SD</b>	<b>0.0048</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
<b>2,6-Dinitrotoluene</b>	<b>606-20-2</b>	6.1	R-RSL	<b>0.0398</b>	<b>Reg 5 SD</b>	<b>0.013</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>
Nitrobenzene	98-95-3	4.8	R-RSL	0.145	Reg 5 SD	0.0093	0.080	0.040	0.020
2,4,6-Trinitrotoluene	118-96-7	3.6	R-RSL	0.092	Reg 3 SD	0.031	0.080	0.040	0.020
2-Amino-4,6-Dinitrotoluene	35572-78-2	15	R-RSL	NA	NA	5	0.080	0.040	0.020
2-Nitrotoluene	88-72-2	2.9	R-RSL	NA	NA	0.97	0.080	0.040	0.020
3-Nitrotoluene	99-08-1	0.61	R-RSL	NA	NA	0.2	0.080	0.040	0.020
4-Amino-2,6-Dinitrotoluene	19406-51-0	15	R-RSL	NA	NA	5	0.080	0.040	0.020
4-Nitrotoluene	99-99-0	24	R-RSL	4.06	Reg 3 SD	1.3	0.080	0.040	0.020
HMX	2691-41-0	380	R-RSL	126	Sunahara	42	0.080	0.040	0.020
Tetryl	479-45-8	24	R-RSL	0.1	Sunahara	0.033	0.080	0.040	0.020
<b>RDX</b>	<b>121-82-4</b>	5.6	R-RSL	<b>0.013</b>	<b>Reg 3 SD</b>	<b>0.0043</b>	<b>0.080</b>	<b>0.040</b>	<b>0.020</b>

1 - HH PSL References: The residential direct contact screening value (R-RSL) was taken from the November 2011 USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites, (USEPA, 2011a) available online at [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). The risk-based screening levels are based on a target hazard quotient of 1 for noncarcinogens (denoted in the EPA tables with an "N" flag) divided by 10 or an ILCR of 1E-6 for carcinogens (denoted in the EPA 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.

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: Reg 5 SD - USEPA Region 5 Sediment Ecological Screening Levels (USEPA, 2005c); Reg 3 SD – USEPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Levels (USEPA, 2006b); and Sunahara - Ecotoxicology of Explosives (Sunahara, et. al., 2009).

3 - The laboratory will perform a DL study for Lithium. The DL number in the table will be filled in upon completion of the DL study.

**Bolded** rows identify the PSLs in that row that are between the laboratory LOQ and LOD. The Project Team has agreed to accept these data for decision making if results below the LOQ are "J" qualified and the results will be discussed in the uncertainties section of the report.

**Bolded and Shaded** rows identify the PSLs in that row that are less than the LOD; the Project Team has agreed to report non-detected results for these chemicals at the LOD and any limitations on data use that result from having detection limits (i.e. data qualified U) that are greater than PSLs will be described in the report.

**Matrix Surface Water**

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

**Metals**

<b>Cadmium</b>	<b>7440-43-9</b>	<b>0.69</b>	<b>Tapwater RSL</b>	<b>0.25</b>	<b>AWQC</b>	<b>0.083</b>	<b>1.25</b>	<b>0.5</b>	<b>0.25</b>
Copper	7440-50-8	62	Tapwater RSL	9	AWQC	3	2.5	2	1
Lead	7439-92-1	15	MCL/IDEM GW-DCL	2.5	AWQC	0.83	0.75	0.75	0.375
<b>Lithium<sup>3</sup></b>	<b>7439-93-2</b>	<b>3.1</b>	<b>Tapwater RSL</b>	<b>14</b>	<b>Reg 3 SW</b>	<b>1</b>	<b>5</b>	<b>2.5</b>	<b>1.25</b>
Manganese	7439-96-5	32	Tapwater RSL	120	Reg 3 SW	10	15	6	3
Mercury	7439-97-6	0.063	Tapwater RSL	0.77	AWQC	0.021	0.20	0.20	0.0800
Nickel	7440-02-0	30	Tapwater RSL	52	AWQC	10	2.5	1.5	0.75
Silver	7440-22-4	7.1	Tapwater RSL	0.12	Reg 5 SW	0.04	2.5	0.5	0.25
Tin	7440-31-5	930	Tapwater RSL	180	Reg 5 SW	60	7.5	5	2.5
Zinc	7440-66-6	470	Tapwater RSL	120	AWQC	40	5.0	2.5	1.25

**Explosives**

1,3,5-Trinitrobenzene	99-35-4	46	Tapwater RSL	11.1	Sunahara	3.7	0.080	0.040	0.020
1,3-Dinitrobenzene	99-65-0	0.15	Tapwater RSL	22	Reg 5 SW	0.05	0.080	0.040	0.020
2,4-Dinitrotoluene	121-14-2	0.2	Tapwater RSL	44	Reg 5 SW	0.067	0.080	0.040	0.020
2,6-Dinitrotoluene	606-20-2	1.5	Tapwater RSL	81	Reg 5 SW	0.5	0.080	0.040	0.020
Nitrobenzene	98-95-3	0.12	Tapwater RSL	220	Reg 5 SW	0.04	0.080	0.040	0.020
2,4,6-Trinitrotoluene	118-96-7	0.76	Tapwater RSL	100	Reg 3 SW	0.73	0.080	0.040	0.020
2-Amino-4,6-Dinitrotoluene	35572-78-2	3.0	Tapwater RSL	1480	Reg 3 SW	1	0.080	0.040	0.020
2-Nitrotoluene	88-72-2	0.27	Tapwater RSL	750	Reg 3 SW	0.09	0.080	0.040	0.020
3-Nitrotoluene	99-08-1	0.13	Tapwater RSL	750	Reg 3 SW	0.043	0.080	0.040	0.020
4-Amino-2,6-Dinitrotoluene	19406-51-0	3.0	Tapwater RSL	1,480	Reg 3 SW	1	0.080	0.040	0.020
4-Nitrotoluene	99-99-0	3.7	Tapwater RSL	1,900	Reg 3 SW	1.2	0.080	0.040	0.020
HMX	2691-41-0	78	Tapwater RSL	150	Reg 3 SW	26	0.080	0.040	0.020
Tetryl	479-45-8	6.3	Tapwater RSL	NA	NA	2.1	0.080	0.040	0.020
RDX	121-82-4	0.61	Tapwater RSL	360	Reg 3 SW	0.2	0.080	0.040	0.020

(1) HH PSL References: The tapwater screening levels (Tapwater RSLs) were taken from the November 2011 USEPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (USEPA, 2011a) available online at [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration\\_table/index.htm](http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm). 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 Tapwater RSLs for noncarcinogens were adjusted by dividing by 10, equivalent to a target hazard quotient of 0.1. USEPA Maximum Contaminant Levels (MCLs) were taken from the 2011 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2011b).

IDEM GW-DCL - IDEM Groundwater Default Closure Levels were taken from the IDEM RISC Technical Guide, January 31, 2006, Appendix 1, revised May 1, 2009 (IDEM, 2009), available online at [http://www.in.gov/idem/files/riscotech\\_appendix1\\_2006\\_r1.pdf](http://www.in.gov/idem/files/riscotech_appendix1_2006_r1.pdf).

2 -Eco PSL References: 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: Ambient Water Quality Criteria (AWQC) - National Recommended Water Quality Criteria, Freshwater Chronic Effects (USEPA, 2009), followed by Reg 5 SW - USEPA Region 5 Surface Water Ecological Screening Levels (USEPA, 2005c), and Reg 3 SW – USEPA Region 3 BTAG Freshwater Surface Water Screening Levels (USEPA, 2006c).

3- Estimated LOQ, LOD, and DL.

**Bolded** rows identify the PSLs in that row that are between the laboratory LOQ and LOD. The Project Team has agreed to accept this data for decision making if results below the LOQ are “J” qualified and the results will be discussed in the uncertainties section of the report.

**Bolded and Shaded** rows identify the PSLs in that row that are less than the LOD; the Project Team has agreed to report non-detected results for these chemicals at the LOD and any limitations on data use that result from having detection limits (i.e. data qualified U) that are greater than PSLs will be described in the report.

### 10.0 – Analytical SOP Reference Table

[\(UFP-QAPP Manual Section 3.2.1 – Worksheet #23\)](#)

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 (REV22, 11/17/10)	Definitive	Soil, sediment, 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 USEPA SW846 7470A and 245.1, CLP-M 4.1 (REV20, 05/16/11)	Definitive	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 (REV20, 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 <sup>th</sup> Edition 2340B, USEPA CLP ILMO 4.1 (REV17, 05/16/11)	Definitive	Soil, sediment, surface water and aqueous QC samples/ Metals	ICP-AES	Empirical	N	N
Empirical SOP-327	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC) Method 8330, 8330A, 8330B and 8332 (REV21, 10/31/11)	Definitive	Soil, sediment, surface water and aqueous QC samples/ Explosives	HPLC/ Ultraviolet (UV)	Empirical	N	N

## 11.0 – Laboratory QC Samples Tables

(UFP-QAPP Manual Section 3.4 – Worksheet #28)

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action (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.	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
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs for aqueous and soil must be between 60-120%	Evaluate and reanalyze if possible. If an MS/MSD was performed in the same 12 hour clock and is acceptable, narrate. If the LCS recoveries are high but the sample results are <QL then narrate, otherwise re-prepare and reanalyze.	Analyst, Supervisor	Accuracy/ Bias	Same as QC Acceptance Limits
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix.	%Rs for aqueous and soil should be between 50-140% RPD should be $\leq 50\%$ .	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	1,2-dinitrobenzene: %R must be within 60%-140% for aqueous %R must be within 50-150% for soil	If surrogate %Rs are 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

<b>Matrix</b>	<b>Soil, sediment, surface water, and aqueous QC samples</b>					
<b>Analytical Group</b>	<b>Explosives</b>					
<b>Analytical Method / SOP Reference</b>	<b>SW-846 8330B Empirical SOP-327</b>					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>Corrective Action (CA)</b>	<b>Person(s) Responsible for CA</b>	<b>DQI</b>	<b>MPC</b>
Results between DL and LOQ	NA.	Apply "J" qualifier to results detected between DL and LOQ.	NA.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits
Second Column Confirmation	All positive results must be confirmed.	Results between primary and second column must be RPD ≤ 40%.	None. Apply "J" flag if RPD >40% and discuss in the case narrative.	Analyst, Supervisor	Accuracy/Precision	Same as QC Acceptance Limits

<b>Matrix</b>	<b>Soil, sediment, surface water, and aqueous QC samples</b>					
<b>Analytical Group</b>	<b>Metals (Including Mercury)</b>					
<b>Analytical Method / SOP Reference</b>	<b>SW-946 6010C, 7470A, 7471B/ Empirical SOP-103, 104, 105</b>					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>CA</b>	<b>Person(s) Responsible for CA</b>	<b>DQI</b>	<b>MPC</b>
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix.	All target analytes must be ≤ ½ LOQ.	Re-analysis to confirm the positive value. Re-prepare and reanalyze samples associated with the blank.	Analyst, Supervisor	Bias/ Contamination	Same as QC Acceptance Limits

Matrix	Soil, sediment, surface water, and aqueous QC samples					
Analytical Group	Metals (Including Mercury)					
Analytical Method / SOP Reference	SW-946 6010C, 7470A, 7471B/ Empirical SOP-103, 104, 105					
QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
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 ≤ 20% for duplicate samples for both water and soils%, if both results are >5x LOQ.	Narrate any results that are outside control limits.	Analyst, Supervisor	Precision	Same as QC Acceptance Limits
Serial Dilution (ICP Only)	One per preparatory batch with sample concentration(s) >50x LOD.	The 5-fold dilution result must agree within ±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

<b>Matrix</b>	<b>Soil, sediment, surface water, and aqueous QC samples</b>					
<b>Analytical Group</b>	<b>Metals (Including Mercury)</b>					
<b>Analytical Method / SOP Reference</b>	<b>SW-946 6010C, 7470A, 7471B/ Empirical SOP-103, 104, 105</b>					
<b>QC Sample</b>	<b>Frequency / Number</b>	<b>Method / SOP QC Acceptance Limits</b>	<b>CA</b>	<b>Person(s) Responsible for CA</b>	<b>DQI</b>	<b>MPC</b>
Post Digestion Spike (ICP Only)	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

## 12.0 – Data Verification and Validation (Steps I and IIa/IIb) Process Table

[\(UFP-QAPP Manual Section 5.2.1, UFP-QAPP Manual Section 5.2.2., Figure 37 UFP-QAPP Manual, Table 9 UFP-QAPP Manual – Worksheets #34, 35, 36\)](#)

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
Chain of Custody Forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that all 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. The Tetra Tech FOL or designee will review the chain-of-custody form to verify that all samples listed in the SAP have been collected. All deviations should be documented in the report.	Sampler and FOL, Tetra Tech	Internal
Chain of Custody Forms	1 - The Laboratory Sample Custodian will review the sample shipment for completeness and integrity, and sign accepting the shipment. 2- 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.	1 - Laboratory Sample Custodian, Empirical  2 - Data Validators, Tetra Tech	External
Chain of Custody Forms and SAP	Ensure that the custody and integrity of the samples was maintained from collection to analysis and the custody records are complete and any deviations are recorded. Review that the samples were shipped and stored at the required temperature and preservation conditions for chemically-preserved samples meet the requirements listed in the SAP. Ensure that the analyses were performed within the holding times listed in the SAP.	Data Validators, Tetra Tech	External
Sample Log Sheets, Chain of Custody Forms, SAP, and Laboratory Sample Login Documentation	Verify that information recorded in the log sheets is accurate and complete. 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. Document any discrepancies in the final report.	PM, FOL, or designee, Tetra Tech	Internal
SAP, Analytical SOPs, and Analytical Data Packages	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. 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.	Laboratory QAM, Empirical	Internal

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
SAP/ Chain-of-Custody Forms	Check that all field QC samples determined necessary were collected as required.	FOL or designee, Tetra Tech	Internal
Analytical Data Package	Verify all analytical data packages for completeness. The Laboratory QAM will sign the case narrative for each data package.	Laboratory QAM, Empirical	Internal
Electronic Data Deliverables (EDDs)/ Analytical Data Packages	Check each EDD against the chain-of-custody and hard copy data package for accuracy and completeness. Compare laboratory analytical results to the electronic analytical results to verify accuracy. Evaluate sample results for laboratory contamination and qualify false detections using the laboratory method/preparation blank summaries. Qualify analyte concentrations between the DL and the LOQ as estimated. Remove extraneous laboratory qualifiers from the validation qualifier.	Data Validators, Tetra Tech	External
Analytical Data Package	Verify each data package for completeness. Request missing information from the Laboratory PM.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Ensure that the laboratory QC samples were analyzed and that the MPCs listed in 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.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Check the field sampling precision by calculating RPDs for field duplicate samples. Check laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/Laboratory Control Sample Duplicate (LCSD), if available. Ensure compliance with the methods and project MPCs accuracy goals listed in the SAP.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Check that the laboratory recorded the temperature at sample receipt and the pH of samples preserved with acid or base to ensure sample integrity from sample collection to analysis.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	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. Check that all data have been transferred correctly and completely to the Tetra Tech Structured Query Language (SQL) database.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Ensure that the project LOQs listed in SAP were achieved.	Data Validators, Tetra Tech	External

Data Review Input	Description	Responsible for Verification (name, organization)	Internal/ External
SAP/ Laboratory Data Packages/ EDDs	Discuss the impact on DLs that are elevated because of matrix interferences. Be especially cognizant of and evaluate the impact of sample dilutions on low-concentration analytes when the dilution was performed because of the high concentration of one or more other contaminants. Document this usability issue and inform the Tetra Tech PM. Review and add PSLs to the laboratory EDDs. Flag samples and notify the Tetra Tech PM of samples that exceed PSLs listed in SAP.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Ensure that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the Laboratory QAM shall have contacted the Tetra Tech PM.	Data Validators, Tetra Tech	External
SAP/ Laboratory Data Packages/ EDDs	Summarize deviations from methods, procedures, or contracts in the Data Validation Report. 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. Print a copy of qualified data stored the project database to depict data qualifiers and data qualifier codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.	Data Validators, Tetra Tech	External

**12.1 VALIDATION SUMMARY**

<b>MATRIX</b>	<b>ANALYTICAL GROUP</b>	<b>VALIDATION CRITERIA</b>	<b>DATA VALIDATOR</b> (title and organizational affiliation)
Surface water, soil, and sediment	Explosives	Data validation will be performed using criteria for SW-846 Method 8330B listed in SAP Sections 6.0, 9.0, and 11.0 and the current DoD QSM. 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
Surface water, soil, and sediment	Metals	Data validation will be performed using criteria for SW-846 Method 6010C, 7470A, and 7471B listed in SAP Sections 6.0, 9.0, and 11.0 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

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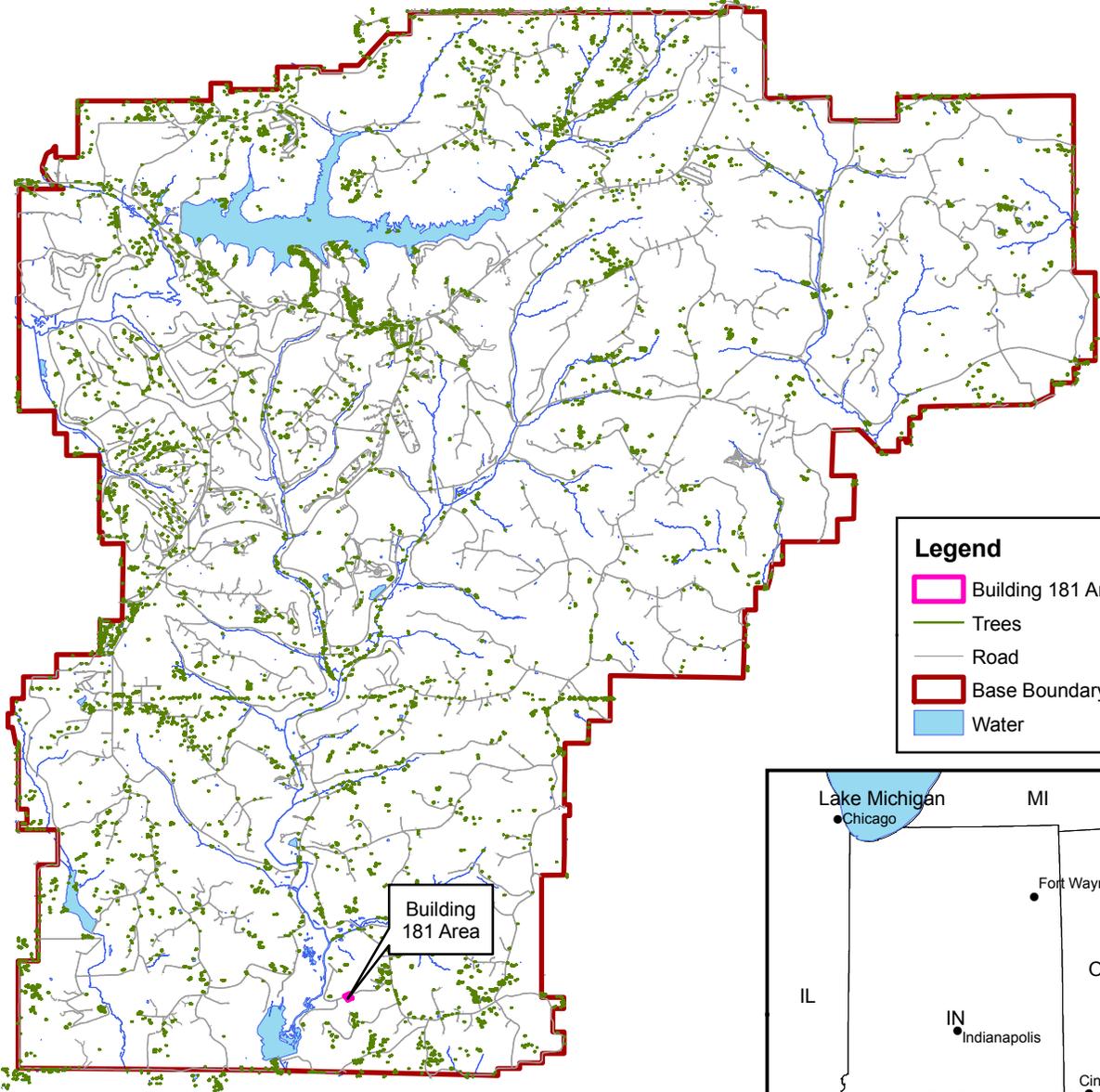
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**Legend**

- Building 181 Area
- Trees
- Road
- Base Boundary
- Water



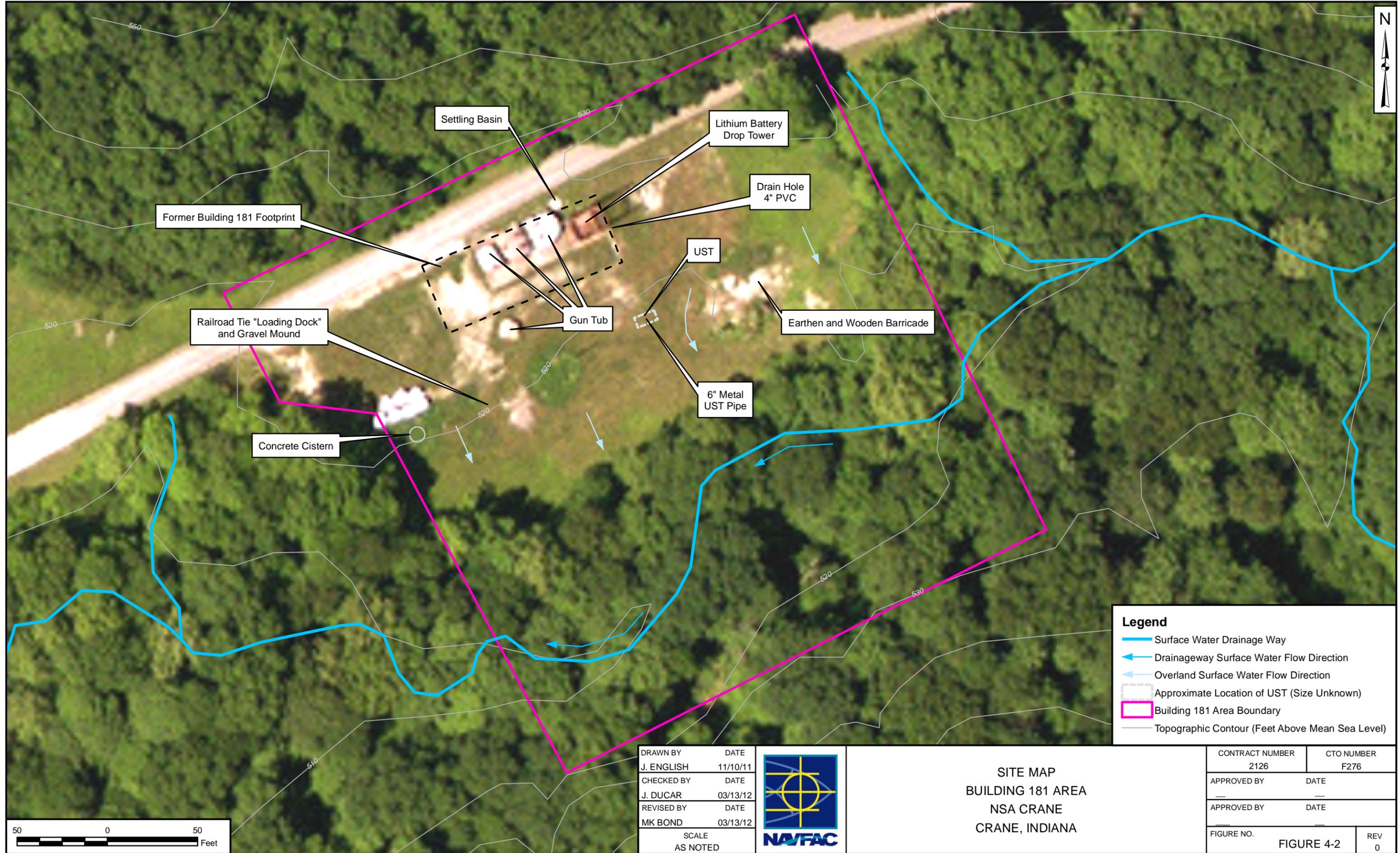
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CHECKED BY	DATE
J. DUCAR	11/10/11
REVISED BY	DATE



**BASE AND SITE LOCATION MAP  
BUILDING 181 AREA  
NSA CRANE  
CRANE, INDIANA**

CONTRACT NUMBER	CTO NUMBER
2126	F276
APPROVED BY	DATE
_____	_____
APPROVED BY	DATE
_____	_____
FIGURE NO.	REV
FIGURE 4-1	0

SCALE  
AS NOTED



Legend	
	Surface Water Drainage Way
	Drainageway Surface Water Flow Direction
	Overland Surface Water Flow Direction
	Approximate Location of UST (Size Unknown)
	Building 181 Area Boundary
	Topographic Contour (Feet Above Mean Sea Level)

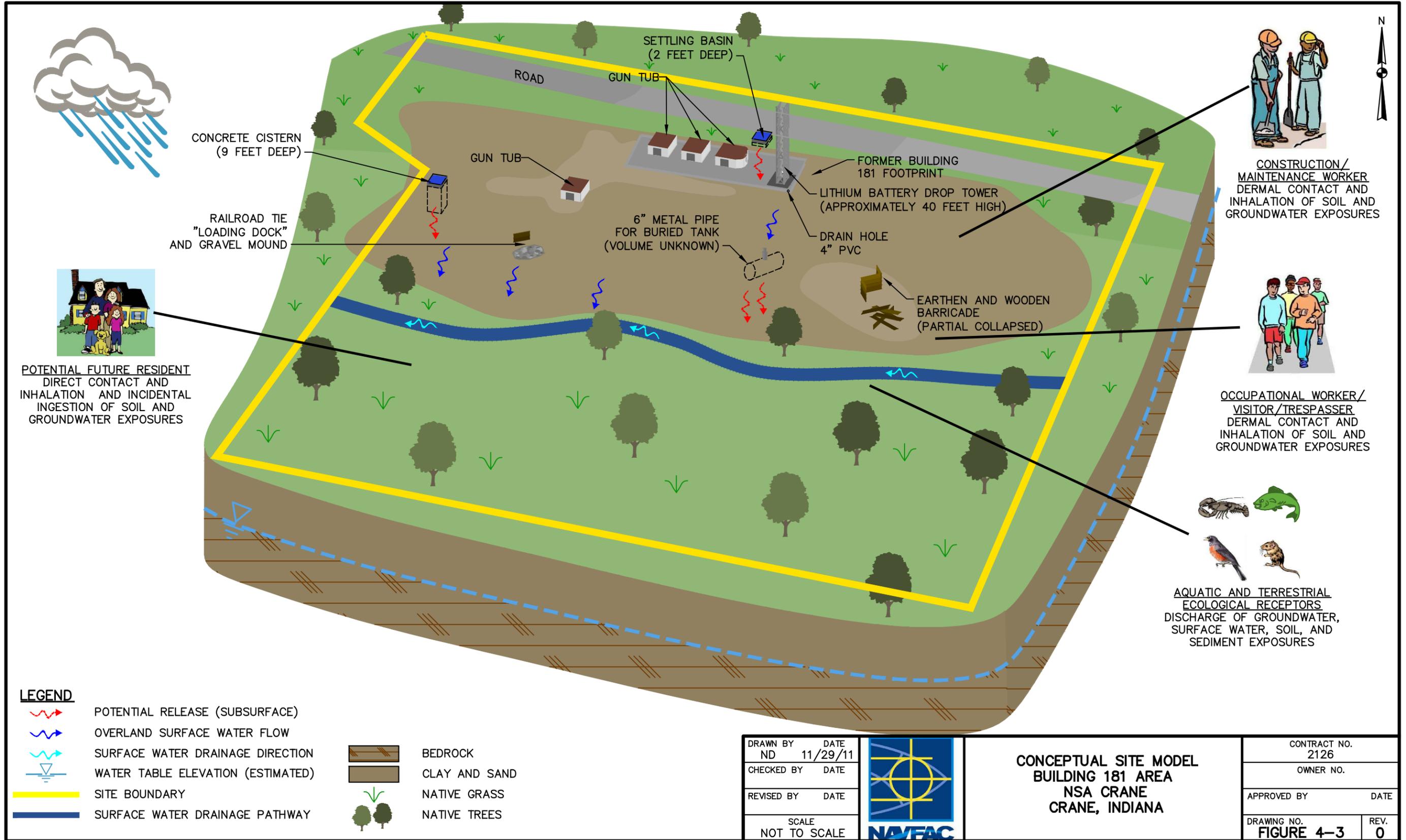


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J. ENGLISH	11/10/11
CHECKED BY	DATE
J. DUCAR	03/13/12
REVISED BY	DATE
MK BOND	03/13/12
SCALE AS NOTED	



**SITE MAP**  
**BUILDING 181 AREA**  
**NSA CRANE**  
**CRANE, INDIANA**

CONTRACT NUMBER	CTO NUMBER
2126	F276
APPROVED BY	DATE
---	---
APPROVED BY	DATE
---	---
FIGURE NO.	REV
FIGURE 4-2	0



**LEGEND**

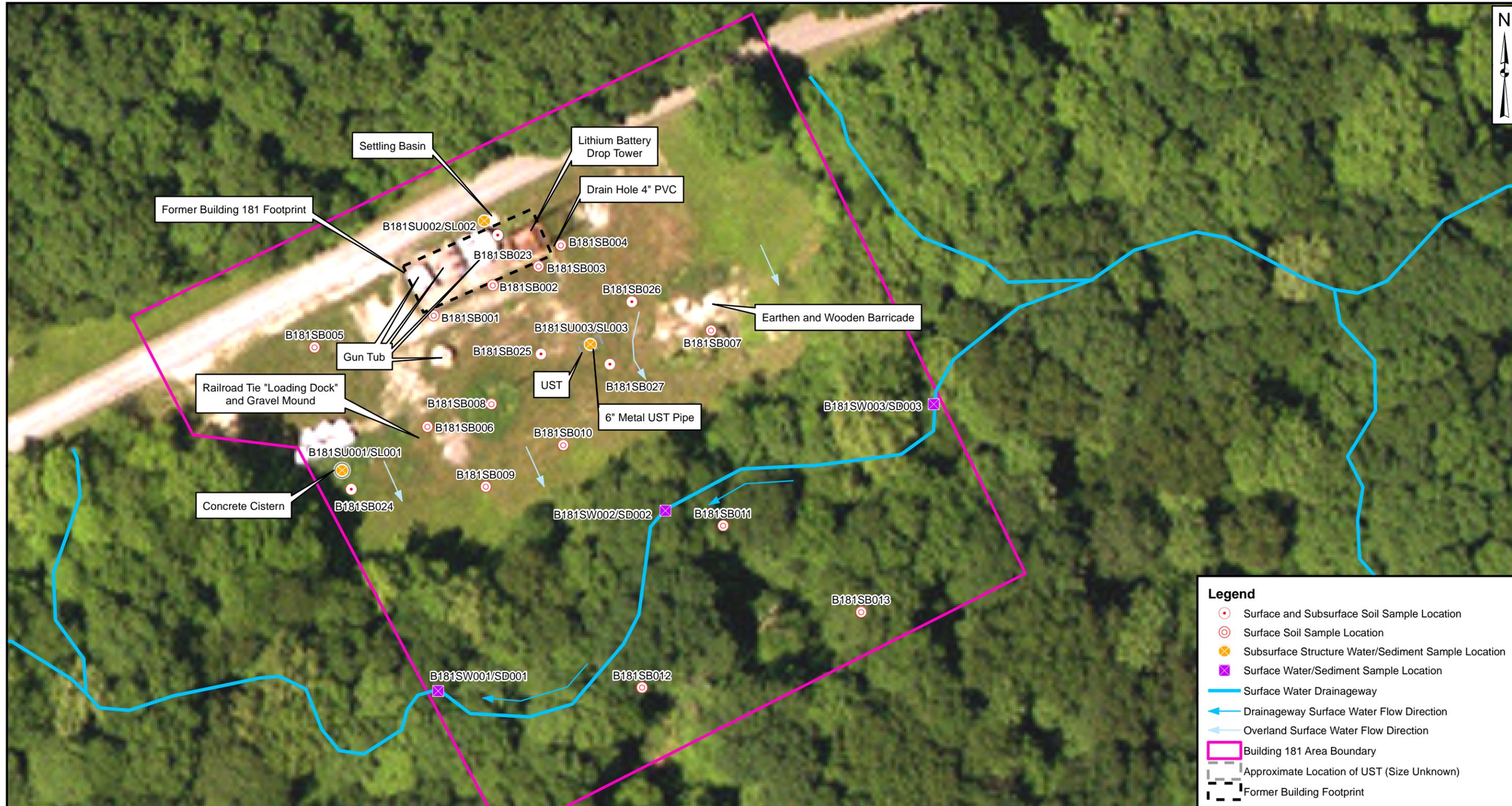
- POTENTIAL RELEASE (SUBSURFACE)
- OVERLAND SURFACE WATER FLOW
- SURFACE WATER DRAINAGE DIRECTION
- WATER TABLE ELEVATION (ESTIMATED)
- SITE BOUNDARY
- SURFACE WATER DRAINAGE PATHWAY
- BEDROCK
- CLAY AND SAND
- NATIVE GRASS
- NATIVE TREES

DRAWN BY	DATE
ND	11/29/11
CHECKED BY	DATE
REVISED BY	DATE
SCALE	
NOT TO SCALE	



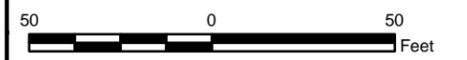
**CONCEPTUAL SITE MODEL  
BUILDING 181 AREA  
NSA CRANE  
CRANE, INDIANA**

CONTRACT NO. 2126	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. <b>FIGURE 4-3</b>	REV. <b>0</b>



**Legend**

- Surface and Subsurface Soil Sample Location
- Surface Soil Sample Location
- ⊗ Subsurface Structure Water/Sediment Sample Location
- ⊠ Surface Water/Sediment Sample Location
- Surface Water Drainageway
- Drainageway Surface Water Flow Direction
- ← Overland Surface Water Flow Direction
- Building 181 Area Boundary
- Approximate Location of UST (Size Unknown)
- - - Former Building Footprint

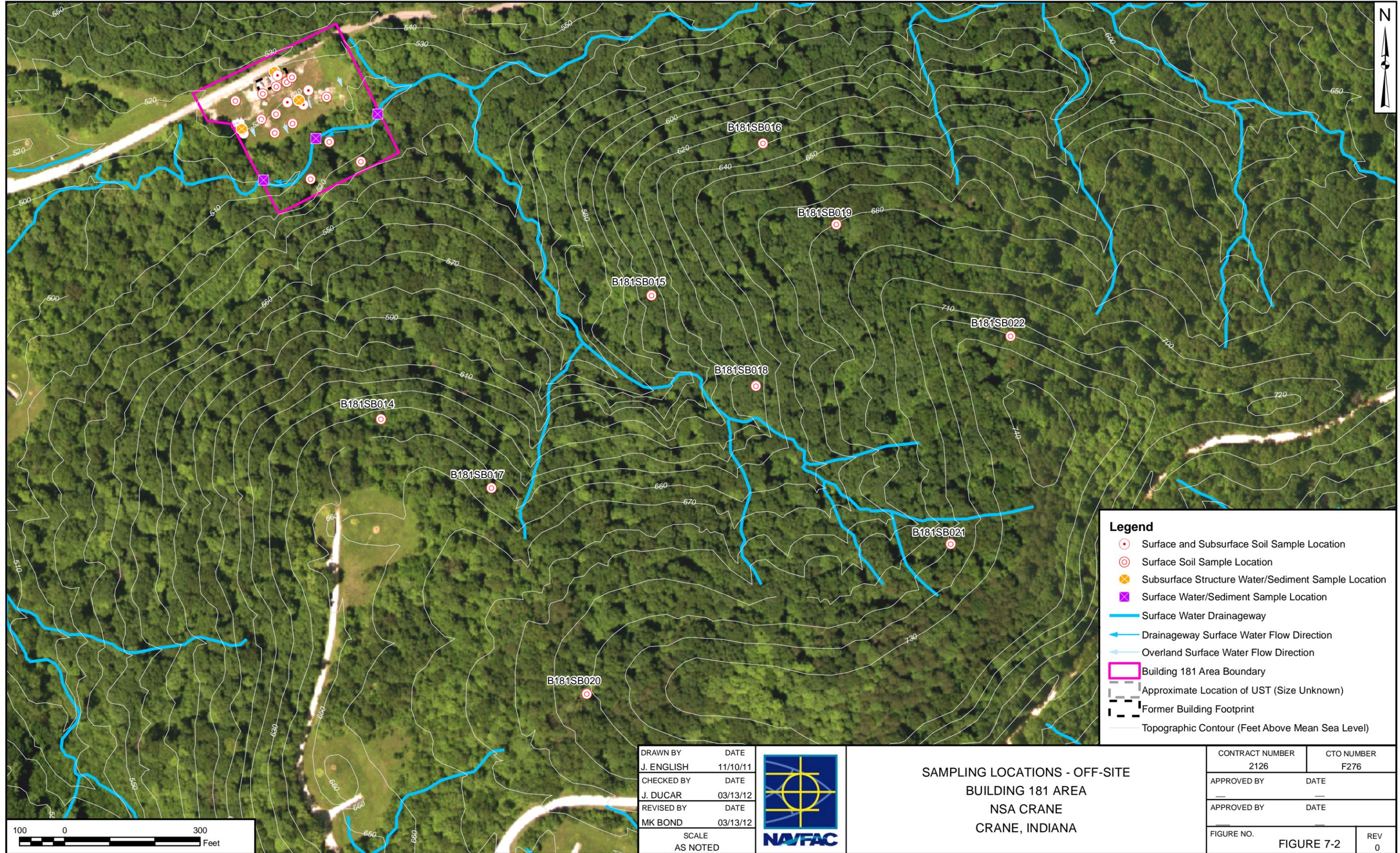


DRAWN BY	DATE
J. ENGLISH	11/10/11
CHECKED BY	DATE
J. DUCAR	03/13/12
REVISED BY	DATE
MK BOND	04/12/12
SCALE AS NOTED	



SAMPLING LOCATIONS - ON-SITE  
BUILDING 181 AREA  
NSA CRANE  
CRANE, INDIANA

CONTRACT NUMBER	CTO NUMBER
2126	F276
APPROVED BY	DATE
---	---
APPROVED BY	DATE
---	---
FIGURE NO.	REV
FIGURE 7-1	0



DRAWN BY	DATE
J. ENGLISH	11/10/11
CHECKED BY	DATE
J. DUCAR	03/13/12
REVISED BY	DATE
MK BOND	03/13/12
SCALE AS NOTED	



**SAMPLING LOCATIONS - OFF-SITE  
BUILDING 181 AREA  
NSA CRANE  
CRANE, INDIANA**

CONTRACT NUMBER	CTO NUMBER
2126	F276
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO.	REV
FIGURE 7-2	0

**Legend**

- Surface and Subsurface Soil Sample Location
- Surface Soil Sample Location
- Subsurface Structure Water/Sediment Sample Location
- Surface Water/Sediment Sample Location
- Surface Water Drainageway
- Drainageway Surface Water Flow Direction
- Overland Surface Water Flow Direction
- Building 181 Area Boundary
- Approximate Location of UST (Size Unknown)
- Former Building Footprint
- Topographic Contour (Feet Above Mean Sea Level)

**APPENDIX A**

**SITE-SPECIFIC FIELD STANDARD OPERATING PROCEDURES**

## 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 F276)
- 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		<b>Project:</b>
		<b>Location:</b>
		<b>CTO:</b>
<b>Sample No:</b>		<b>Matrix:</b>
<b>Date:</b>	<b>Time:</b>	<b>Preserve:</b>
<b>Analysis:</b>		
<b>Sampled by:</b>		<b>Laboratory</b>

## 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:

<b>ANNN</b>	<b>AA</b>	<b>NNN (-F)</b>	<b>NNNN (Soils and Sediment only)</b>
SWMU Number	Matrix	Sample Location Number	Sequential depth interval from freshly exposed surface

#### Character Type:

A = Alpha  
 N = Numeric

#### SWMU Number (NN):

B181 = Building 181 Area

#### Matrix Code (AA):

SS = Surface Soil Sample  
 SB = Subsurface Soil Sample  
 SD = Sediment Sample  
 SW = Surface Water Sample  
 SU = Subsurface Structure Water Sample  
 SL = Subsurface Structure Sediment Sample

### **Location Number (NNN):**

The sample location number is the soil sample location, sediment 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.

### **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 below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth 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

For sediment samples, the final four tracking numbers will identify the depth in units of inches below the sediment/water interface. Sediment samples will be collected from 0 to 6 inches.

### **3.1.2 Examples of Sample Nomenclature**

A surface soil sample collected from soil boring location 003 at B181 Area, at a depth of 0 to 2 feet bgs, would be labeled as "B181SS0030002".

A surface water sample collected from sampling location 003 would be labeled as "B181SW003". The filtered fraction for this sample would be labeled as "B181SW003-F".

A sediment sample collected from sediment sampling location 001 at a depth of 0 to 6 inches bgs would be labeled as "B181SD0010006".

A subsurface structure water sample collected from sampling location 001 would be labeled as "B181SU001".

A subsurface structure sediment sample collected from sampling location 001 would be labeled as "B181SL001".

### **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.

<b>NN</b>	<b>AA</b>	<b>NNNNNN</b>	<b>NN</b>
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 the Building 181 Area for a groundwater sample collected on April 20, 2012 would be designated as "B181FD04201201".

The second duplicate of the day taken at the Building 181 Area of a surface soil sample collected on April 23, 2012 would be designated as "B181FD04231202".

The first trip blank associated with samples collected on May 6, 2012 would be designated as "B181TB05061201".

The only rinsate blank associated with samples collected on May 7, 2012 would be designated as "B181RB05071201".

## **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 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 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



**ATTACHMENT 2**  
**EQUIPMENT CALIBRATION LOG**





**ATTACHMENT 4**  
**SURFACE WATER SAMPLE LOG SHEET**



## 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 at above freezing and  $\leq 6$  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

## 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-06.

**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-12)**

**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 Log the soil core on the Boring Log Sheet (see SOP-06).
- 3.09 Place the soil core in a stainless-steel mixing bowl, thoroughly homogenize, and collect the remainder of the soil sample aliquots, as described in SOP-07.
- 3.10 Repeat steps 3.2 through 3.11 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-11 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-06). 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-07.
  
- 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-14).
  
- 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-12 before collecting the next sample.

## STANDARD OPERATING PROCEDURE

### SOP-06

#### 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**

<b>Consistency</b>	<b>Standard Penetration Resistance (Blows per Foot)</b>	<b>Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)</b>	<b>Field Identification</b>
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:

<b>Terms of Identifying Proportion of the Component</b>	<b>Defining Range of Percentages by Weight</b>
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.
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



## **OPERATING PROCEDURE**

### **SOP-07**

## **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 Building 181 Area.

### **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**

**Disposable trowels**

**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 NON-VOC SOIL SAMPLE ALIQUOTS USING DPT**

3.1 The soil sample 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.

3.2 Slide the remaining core material out of the acetate liner and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, and other coarse materials. Fill the required sample containers in the following order:

- Organic analyses (i.e., explosives),
- Metals,
- Moisture.

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

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

3.5 Record the required information on the Soil Sample Log Sheet and the chain-of-custody (COC) Record form.

### **4.0 COLLECTION OF SOIL SAMPLES USING A HAND AUGER**

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

4.2 Collect sample aliquots for non-volatile organic compound (VOC) parameters by sliding the core material out of the hand auger bucket and into a clean, decontaminated stainless-steel mixing bowl. Mix the soil thoroughly with a stainless-steel spoon and remove gravel, large pebbles, and other coarse materials.

4.3 Fill the required sample containers in the following order:

- Organic analyses (i.e., explosives),
- Metals,
- Moisture.

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

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

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

## **5.0 PACKAGING AND SHIPPING OF SAMPLES**

Samples will be packaged and shipped according to SOP-04.

## **6.0 ATTACHMENTS**

1. Soil and Sediment Sample Log Sheet

**ATTACHMENT 1**  
**SOIL AND SEDIMENT SAMPLE LOG SHEET**



Tetra Tech NUS, Inc.

**SOIL & SEDIMENT SAMPLE LOG SHEET**

Page \_\_\_ of \_\_\_

Project Site Name: _____ Project No.: _____  <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: <input type="checkbox"/> MS/MSD	Duplicate ID No.: _____	Signature(s): _____
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## STANDARD OPERATING PROCEDURE

### SOP-08

## 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-09).

**LaMotte Turbidity Meter:** Used to measure turbidity in the field (see SOP-09).

**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-09). 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; however, no VOCs are planned for this project. 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:
- Organics (i.e, and explosives)
  - 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 (COC) 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-09

## 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
- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (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-11 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-09).
- 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 @ 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 SC.

#### 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 SC 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 SC or dissolved oxygen (DO) 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 DO concentration. Thus, analysis for DO 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 DO 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<sup>-</sup>) 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 DO 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 DO 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 DO 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 oxidation-reduction potential (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 (mL) 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-10

#### 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 basin).

##### 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-11

## 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 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-12**

#### **DECONTAMINATION OF FIELD SAMPLING EQUIPMENT**

##### **1.0 PURPOSE**

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

##### **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**

3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.

3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.

3.3 Wash the equipment with a solution of 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-14.

## STANDARD OPERATING PROCEDURE SOP-13

### 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 Project Manager (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, Inc.  
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, A/C adapter, stylus, and 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](mailto: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](mailto: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)

## **STANDARD OPERATING PROCEDURE**

### **SOP-14**

#### **MANAGEMENT OF INVESTIGATION-DERIVED WASTE**

##### **1.0 PURPOSE**

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, segregated, classified, and managed during the field investigations at 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**

The only solid wastes expected to be generated during this investigation are the used DPT macrocore sleeves. The sleeves will be double bagged, securely tied shut, and placed in a designated waste receptacle at NSA Crane.

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.

**APPENDIX B**

**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

A handwritten signature in black ink, appearing to read 'R.D.L.', positioned above a horizontal line.

**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

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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)

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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)

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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	MCP (Mecoprop)

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Non-Potable Water</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
Titration	SM 2320B 20 <sup>th</sup> /21 <sup>st</sup> edition	Alkalinity
Colorimetric	SM 4500 B, G, 20 <sup>th</sup> /21 <sup>st</sup> 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 <sup>th</sup> /21 <sup>st</sup> edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20 <sup>th</sup> /21 <sup>st</sup> edition	Total Phosphorus (as P)
UV/Vis	SM 4500 PE, 20 <sup>th</sup> /21 <sup>st</sup> edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20 <sup>th</sup> /21 <sup>st</sup> edition	Total Organic Carbon
Gravimetric	SM 2540C, 20 <sup>th</sup> /21 <sup>st</sup> edition	TDS
Gravimetric	SM 2540D, 20 <sup>th</sup> /21 <sup>st</sup> edition	TSS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
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

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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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)

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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)

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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

<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
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
<b>Preparation</b>	<b>Method</b>	<b>Type</b>
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



<b>Solid and Chemical Materials</b>		
<b>Technology</b>	<b>Method</b>	<b>Analyte</b>
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20 <sup>th</sup> /21 <sup>st</sup> 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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