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RESOURCE CONSERVATION AND RECOVERY ACT INTERIM CORRECTIVE MEASURE WORK PLAN UNEXPLODED ORDNANCE 1 (UXO 1) SOLID WASTE MANAGEMENT UNIT 77 (SWMU 77) SOIL REMOVAL ATTACHMENT 1 NAVAL ACTIVITY PUERTO RICO
05/01/2015
CH2MHILL

Final

RCRA Interim Corrective Measure Work Plan
UXO 1 (SWMU 77) Soil Removal

NAVAL ACTIVITY PUERTO RICO (NAPR), CEIBA, PR

Attachment 1: Sampling and Analysis Plan

May 2015

Department of the Navy
BRAC Program Management Office Southeast
4130 Faber Place Drive, Suite 202
North Charleston, South Carolina 29405

Contract Number N62470-12-D-7016, CTO JM01

SAP Worksheet #1—Title and Approval Page

Final

Uniform Federal Policy Sampling and Analysis Plan Site UXO 1 (SWMU 77) – Small Arms Range Confirmatory Soil Sampling in Support of RCRA Corrective Action Interim Measures

Naval Activity Puerto Rico
Ceiba, Puerto Rico

Contract Task Order JM04

April 2015

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 8012 Program
Contract N62470-11-D-8012

Prepared by

CH2MHILL®

Atlanta, Georgia

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SAP Worksheet #1—Title and Approval Page (continued)

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Brett Doerr/CH2M HILL – Activity Manager/Date

Approval Signatures:

NAVFAC Atlantic Quality Assurance Officer/Date

Other Approval Signatures:

Stacin Martin
NAVFAC Atlantic Navy Technical Representative

Douglas Pocze
USEPA Region II Remedial Project Manager

Wilmarie Rivera
PREQB Federal Facilities Coordinator

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Executive Summary

This document presents the Sampling and Analysis Plan (SAP) developed using the framework of the Department of the Navy's (Navy's) Uniform Federal Policy (UFP) for Confirmatory Soil Sampling at Site UXO 1 (Solid Waste Management Unit [SWMU] 77) – Small Arms Range (referred to as Site UXO 1 [SWMU 77]) of Naval Activity Puerto Rico (NAPR), located in Ceiba, Puerto Rico. CH2M HILL prepared this document under the Naval Facilities Engineering Command (NAVFAC), Atlantic Division, Comprehensive Long-term Environmental Action – Navy (CLEAN) 8012 Contract N62470-11-D-8012, Contract Task Order JM04, for submittal to NAVFAC Atlantic, the U.S. Environmental Protection Agency (USEPA) Region II, and the Puerto Rico Environmental Quality Board (PREQB).

The objective of this SAP is to present the soil sampling approach and analytical methods to support the Resource Conservation and Recovery Act corrective action interim measure (soil removal) at Site UXO 1 (SWMU 77). Sample collection and analysis is necessary to determine post-removal concentrations of four metals (antimony, copper, lead, and zinc) at the identified removal areas (Pistol Range, Former Pistol Range, and Rifle Range) where the risk evaluation indicates potential unacceptable risk to human health and the environment (Attachment 1). Soil sample collection will be conducted using a tiered approach, consisting of initial field screening with an field portable x-ray fluorescence instrument (FP-XRF), followed by confirmatory analysis by an off-site laboratory. Confirmatory soil samples will be obtained using incremental sampling methods that provide a statistically valid sample of the prescribed area that is tested (see Attachment 2 for details). Samples analyzed at the offsite lab will be collected after the FP-XRF results indicate soil concentrations may meet the Preliminary Remediation Goals (PRGs). The purpose of the lab analyses is to provide post-removal confirmation both laterally and vertically of residual concentrations of the metals with the PRGs as a guide to ensuring the removal action is relatively complete.

This SAP details the procedures necessary to achieve the project quality objectives in accordance with the Navy's UFP-SAP policy guidance. The procedures herein are necessary to ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is specific to Katahdin Analytical Services, Inc. If additional laboratory services are requested that require modification to the existing SAP, revised SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

This SAP consists of the 37 worksheets of a standard UFP-SAP. All tables are embedded within the worksheets. All figures are presented at the end of the document. The risk evaluation and PRG development are provided in Attachment 1, field standard operating procedures are provided in Attachment 2, and the laboratory letters regarding the Department of Defense Environmental Laboratory Accreditation Program are provided in Attachment 3.

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Document Certification (placeholder for final submittal)

(Required per Section XIII of the Resource Conservation and Recovery Act § 7003 Administrative Order on Consent):

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained herein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature: _____

Name: _____

Title: _____

Date: _____

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9 Screening and Confirmatory Sampling Process

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1 Risk Evaluation and PRG Development
2 Field SOPs
3 Katahdin Analytical Services, Inc. ELAP Certification

Acronyms and Abbreviations

AM	Activity Manager
AMSL	above mean sea level
AQM	Activity Quality Manager
Baker	Michael Baker, Jr., Inc.
bgs	below ground surface
BKG	background soil concentration
BRAC	Base Realignment and Closure
BRAC PMO SE	Base Realignment and Closure Program Management Office Southeast
CA	corrective action
CCV	continuing calibration verification
CLEAN	Comprehensive Long-term Environmental Action Navy
CoC	chemical of concern
CoC	Chain of Custody
COPC	chemicals of potential concern
CSM	conceptual site model
DL	detection limit
DoD	Department of Defense
DQI	data quality indicator
ELAP	Environmental Laboratory Accreditation Program
ELCR	excess lifetime carcinogenic risk
EPC	exposure point concentration
ERA	ecological risk assessment
ERP	Environmental Restoration Program
ESV	ecological screening value
FD	field duplicate
FP-XRF	field portable x-ray fluorescence instrument
ft	feet
FTL	Field Team Leader
GPS	global positioning system
H&S	health and safety
HHRA	human health risk assessment
HI	hazard index
HHSL	human health screening level
HQ	hazard quotient
ICAL	initial calibration
ICM	interim corrective measures
ICS	interference check solutions
IR	installation restoration
Katahdin	Katahdin Analytical Services, Inc.
LCS	laboratory control sample
LED	liquid electronic display
LOD	limit of detection

LOQ	limit of quantitation
MC	munitions constituents
MEC	Munitions and Explosives of Concern
mg/kg	milligram(s) per kilogram
MPC	measurement performance criteria
MPPEH	material potentially presenting an explosive hazard
MS	matrix spike
MSD	matrix spike duplicate
MS/MSD	matrix spike/matrix spike duplicate
MSA	method of standard additions
N/A	not applicable
NAPR	Naval Activity Puerto Rico
NAVFAC	Naval Facilities Engineering Command
Navy	United States Department of the Navy
NIRIS	Naval Installation Restoration Information Solution
NIST	National Institute of Standards and Technology
NG	nitroglycerin
NSRR	Naval Station Roosevelt Roads
NTR	Navy Technical Representative
OB/OD	open burn/open detonation
PAL	project action limit
PC	project chemist
.pdf	portable document format
PDM	Project Data Manager
PID	photoionization
PM	Project Manager
POC	point of contact
ppm	parts per million
PQL	project quantitation limit
PQO	project quality objectives
PREQB	Puerto Rico Environmental Quality Board
PRG	preliminary remediation goal
QA	quality assurance
QA/QC	quality assessment/quality control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
Rfd	reference dose
RFI	RCRA facilities investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RR	rifle range
RSL	regional screening level
SAP	sampling and analysis plan

SOP	standard operating procedure
SSCS	site specific calibration standards
STC	Senior Technical Consultant
SWMU	solid waste management unit
TBD	to be determined
UCL	upper confidence limit
UFP	Uniform Federal Policy
USAE	USA Environmental, Inc.
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
XRF	x-ray fluorescence instrument

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Site UXO 1 (Solid Waste Management Unit [SWMU] 77) - Small Arms Range

Contractor Name: CH2M HILL

Contract Number: N62470-11-D-8012

Contract Title: Comprehensive Long-term Environmental Action – Navy (CLEAN) Program 8012

Work Assignment Number: Contract Task Order JM04

1. **Sampling and Analysis Plan (SAP) requirements:** This SAP was prepared in general accordance with the requirements of the U.S. Environmental Protection Agency's (USEPA) *Uniform Federal Policy* (UFP) *for Quality Assurance Project Plans* (QAPPs) (USEPA, 2005a) and *Guidance for QAPPs*, EPA QA/G-5, QAMS (USEPA, 2002).

2. **Regulatory programs:** Resource Conservation and Recovery Act (RCRA) 7003 Administrative Order on Consent (USEPA Docket No. RCRA-02-2007-7301).

3. **Type of SAP:** This is a project-specific SAP for the collection and analysis of confirmatory soil samples associated with an interim corrective measure (soil removal) at Site UXO 1 (SWMU 77).

4. **Dates of scoping session:**

Scoping Session	Date
U.S. Department of the Navy (Navy), USEPA, Puerto Rico Environmental Quality Board (PREQB), and CH2M HILL	September 9, 2013

5. **Dates and titles of SAP documents written for previous site work that are relevant to the current investigation:**

Title	Date
Soil Removal Work Plan (Formal title unknown at this time)	In progress (This UFP-SAP will be an attachment to the Work Plan)

6. **Organizational partners (stakeholders) and connection with lead organization:**
USEPA and PREQB—Federal Facilities Agreement Signatory Parties and Support Agencies

7. **Lead organization:** Navy

8. **Applicable SAP elements:** All the required SAP elements are included in this document; therefore, a crosswalk table is not necessary.

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Stacin Martin	Navy Technical Representative (NTR)	Naval Facilities Engineering Command (NAVFAC) Atlantic	(757) 322-4780	Stacin.Martin@navy.mil
Douglas Pocze	Remedial Project Manager (RPM)	USEPA	(212) 637-4432	Pocze.Doug@epamail.epa.gov
Wilmarie Rivera	Federal Facilities Coordinator	PREQB	(787) 767-8181, ext. 6141	WilmarieRivera@jca.gobierno.pr
Gloria Toro Agrait	Environmental Permits Officer	PREQB	(787) 767-8181, ext. 3586	GloriaToro@jca.gobierno.pr
David Criswell	Base Realignment and Closure (BRAC) Environmental Coordinator	Navy - BRAC Program Management Office (PMO) Southeast (SE)	(843) 743-2130	David.criswell@navy.mil
Debbie Sanders	Contracts Specialist	Navy - BRAC PMO SE	(843) 820-5974	Debbie.sanders@navil.mil
Pedro Ruiz	Naval Activity Puerto Rico (NAPR) Environmental Restoration Program (ERP) Site Manager	Navy - NAVFAC Atlantic	(787) 630-9881	pedro.ruiz1@navy.mil
Jose Font	Puerto Rico Manager	USEPA	(787) 977-5814	Font.jose@epa.gov
Felix Lopez	Environmental Contaminants Specialist	US Fish and Wildlife Service	(787) 851-7297	Felix_lopez@fws.gov
Connie Crossley	Technical Support Consultant for USEPA	Booz Allen Hamilton	(919) 462-9004	Crossley Constance@bah.com
Brett Doerr	Activity Manager (AM)	CH2M HILL	(757) 671-6219	Brett.Doerr@ch2m.com
Jamie Butler	Activity Quality Manager (AQM)	CH2M HILL	(757) 671-6212	Jamie.Butler@ch2m.com
Thomas Roth	Project Manager (PM)	CH2M HILL	(404) 474-7640	Tom.Roth@ch2m.com
James Frank	Field Coordinator	CH2M HILL	(919) 760-1755	James.Frank@ch2m.com
To be determined (TBD)	Field Team Leader (FTL)	CH2M HILL	TBD	TBD
Jennifer Obrin	Laboratory PM	Katahdin Analytical Services, Inc. (Katahdin)	(207) 874-2400	JObrin@katahdinlab.com
TBD	Data Validator	CH2M HILL	TBD	TBD

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/ E-mail Receipt	SAP Section Reviewed	Date SAP Read
Anita Dodson	CH2M HILL/Navy CLEAN Program Chemist	(757) 671-6218			
Michael Zamboni	CH2M HILL/Project Chemist	(703) 376-5301			
Craig Sprinkle, P.G.	Senior Technical Consultant (STC)	(678) 530-4333			
Carl Woods	CH2M HILL/Health & Safety (H&S) Officer	(513) 889-5771			
TBD	CH2M HILL/FTL	TBD			
TBD	CH2M HILL/Field Team Member	TBD			
Barrie Selcoe	CH2M HILL/Human Health Risk Assessor	(281) 246-4322			
William Kappleman	CH2M HILL/Ecological Risk Assessor	(703) 376-5152			
Jennifer Obrin	Katahdin/Laboratory PM	(207) 874-2400			
TBD	Subcontractor TBD/Data Validator	TBD			

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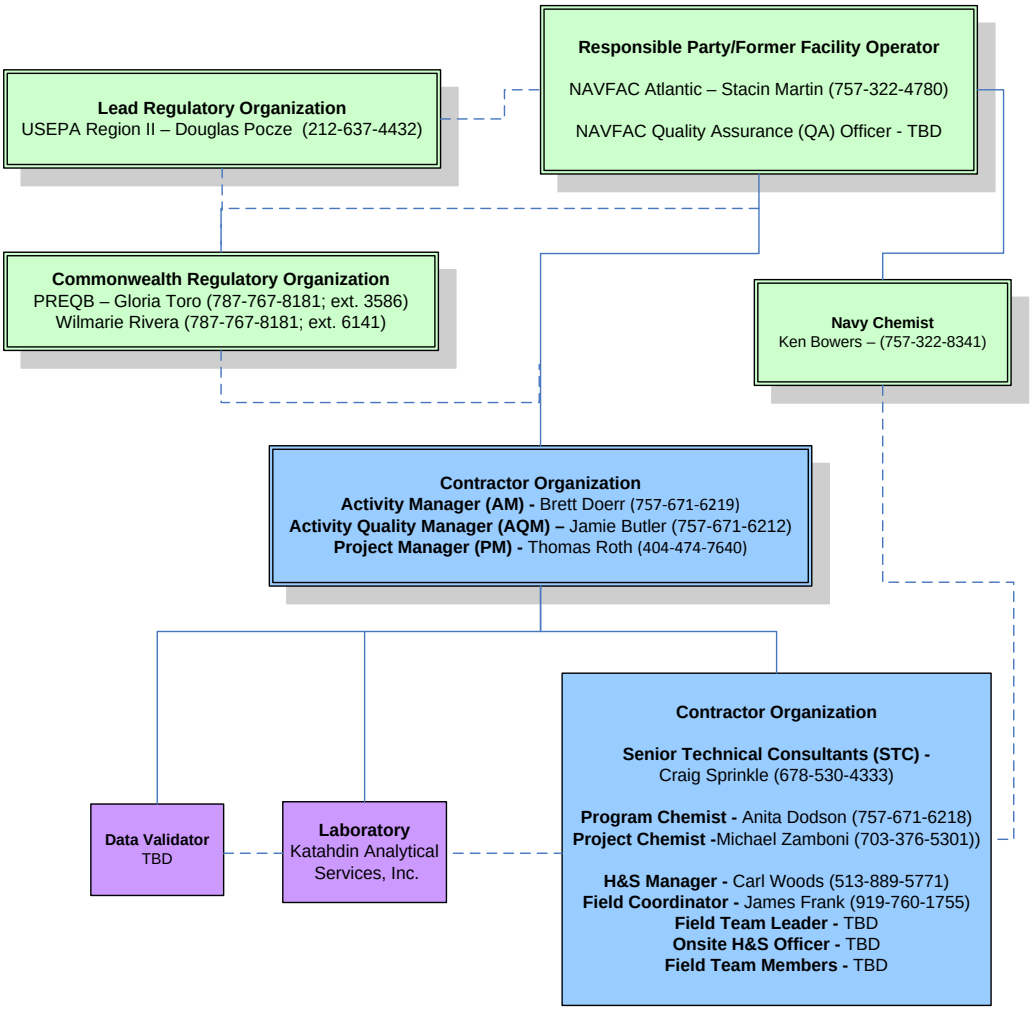
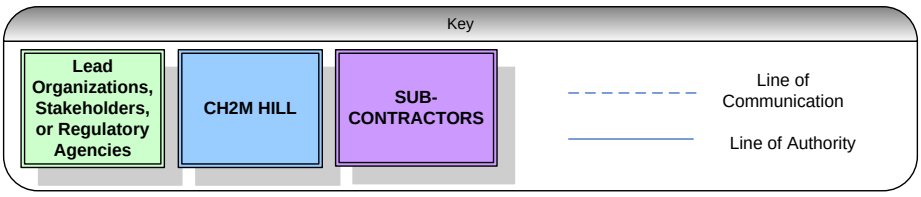
SAP Worksheet #5—Project Organizational Chart





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SAP Worksheet #6—Communication Pathways

Communication Pathways	Responsible Affiliation	Name	Phone Number/E-mail	Procedure
Communication with Navy (lead agency)	NTR	Stacin Martin	Stacin.Martin@navy.mil (757) 322-4780	• Primary point of contact (POC) for Navy; can delegate communication to other internal or external points of contact • Primary contact for stakeholder agency managers
Communication with Navy	BRAC Environmental Coordinator / Navy	David Criswell	David.criswell@navy.mil (843) 743-2130	Primary POC for BRAC Program; can delegate communication to other internal or external points of contact. Any issue that may affect the BRAC program should be reported to the BRAC Environmental Coordinator immediately.
Coordination of field activities	Facility Environmental Manager	Pedro Ruiz	pedro.ruiz1@navy.mil (787) 630-9881	Primary POC for NAPR; can delegate communication to other internal or external points of contact. Any issue that may affect project work should be reported to the facility environmental manager as well as the Navy RPM immediately.
Communication with USEPA	USEPA RPM	Douglas Pocze	Pocze.Doug@epamail.epa.gov (212) 637-4432	• Primary POC for USEPA; can delegate communication to other internal or external points of contact • Navy RPM will notify USEPA via e-mail within 24 hours for field changes affecting the scope or implementation of the SAP.
Communication with PREQB	PREQB Federal Facilities Coordinator	Wilmarie Rivera	WilmarieRivera@jca.gobierno.pr (787) 967-8181; ext. 6141	• Primary POC for PREQB; can delegate communication to other internal or external points of contact • Navy RPM will notify PREQB via e-mail within 24 hours for field changes affecting the scope or implementation of the SAP.
Communication with PREQB	PREQB Environmental Permits Coordinator	Gloria Toro Agrait	GloriaToro@jca.gobierno.pr (787) 767-8181, ext. 3586	• Navy RPM will notify PREQB via e-mail within 24 hours for field changes affecting the scope or implementation of the SAP.
Communication with CH2M HILL regarding Navy chemistry standards as applied to this UFP-SAP	Navy Chemist	Ken Bowers	Kenneth.a.bowers@navy.mil	• Primary POC for Navy to CH2M HILL program chemist
Technical communications for project implementation, and data interpretation	CH2M HILL PM	Thomas Roth	Tom.Roth@ch2m.com (404) 474-7640	• Primary POC for CH2M HILL to Navy, USEPA, and PREQB; can delegate communication to other points of contact within CH2M HILL • Forwards information and materials about the project to Navy NTR, USEPA, and PREQB as needed • Oversees the overall project status • Will be informed of project status by CH2M HILL project personnel • If field changes occur, works with Navy RPM to communicate changes to USEPA and PREQB within 24 hours • Communicates field results to team during Partnering Team meetings

SAP Worksheet #6—Communication Pathways (continued)

Communication Pathways	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
SAP implementation in the field	CH2M HILL FTL	TBD	TBD	• Implements project H&S requirements • Reports H&S near misses and incidents to the PM immediately by phone • Provides daily progress reports/updates to the CH2M HILL PM by phone or e-mail
SAP field changes/field progress reports	CH2M HILL FTL	TBD	TBD	• Documents field activities and work plan deviations (made with the approval of AM, PM, and/or AQM) in field logbooks • Communicates deviations to PM on a daily basis and prior to conducting any actions that may be affected by such communications. Any field issues or SAP deviations that could negatively affect project schedule or render project data quality objectives unattainable will be communicated to the Navy NTR by the AM or PM.
Stop Work Order	CH2M HILL, and NAVFAC Atlantic	TBD	TBD	• Any field member can immediately stop work if an unsafe condition, which is immediately threatening to human health, is observed. Ultimately, the FTL, PM, and AM can stop work for a period of time. NAVFAC Mid-Atlantic can stop work at any time.
Field staff discussion and inquiry regarding human health risk assessment (HHRA)	CH2M HILL Human Health Risk Assessor	Barrie Selcoe	Barrie.Selcoe@ch2m.com (281) 246-4322	• Primary point of contact for field team before, during and after investigation for human health risk concerns • Communicates back to PM, AQM, Data Manager, and Project Data Manager (PDM) as needed
Field staff discussion and inquiry regarding ecological risk assessment (ERA)	CH2M HILL Ecological Risk Assessor	William Kappleman	William.Kappleman@ch2m.com (703) 376-5152	• Primary point of contact for field team before, during and after investigation for ecological risk concerns • Communicates back to PM, AQM, Data Manager, and PDM as needed

SAP Worksheet #6—Communication Pathways (continued)

Communication Pathways	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Field corrective actions (CAs)	CH2M HILL FTL	FTL	TBD	• Field and analytical issues requiring CA will be identified by the FTL and brought to the attention of the PM, who in turn will notify the AQM before any decisions on action are made • Communications and decisions should be made on a daily basis and prior to conducting any actions that may be affected by such communications/decisions • Communications with AQM will be by in-person or phone, followed up with e-mail to document decisions and actions
Management of analytical lab and data validation sub contractors. Analytical CAs/release of analytical data. Data tracking from field collection to database upload.	CH2M HILL Project Chemist	Michael Zamboni	Michael.Zamboni@ch2m.com (703) 376-5301	• Analytical laboratory CAs will be identified by, or brought to the attention of, the project chemist (PC) on a daily basis. • Facilitates resolution on a same-day basis after consulting with the PM and AQM, CH2M HILL program chemist and the Navy chemist (if changes in the SAP are warranted) to ensure SAP requirements are met by the laboratory. • Communicates with subs by phone, followed up with e-mail to document decisions and actions • Should analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data such that the project completeness goal cannot be obtained, the PC will notify the project team including the Navy RPM and Navy Quality Assurance Officer (QAO). • Tracks data from sample collection through database upload • Primary contact for laboratories' PMs • Reports lab issues to the PM and PC by phone or e-mail within 4 business hours
Reporting lab data quality issues	Laboratory PMs and TBD	Jennifer Obrin TBD	JObrin@katahdinlab.com (207) 874-2400 TBD	• Report analytical laboratory CAs to the CH2M HILL PC and/or PDM on a same-day basis • CH2M HILL PC facilitates resolution after consulting with the PM and AQM and the Navy chemist (if changes in the SAP are warranted) to ensure SAP requirements are met by the laboratory. • Communications will be by phone, followed up with e-mail to document decisions and actions.

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SAP Worksheet #7—Personnel Responsibilities Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Stacin Martin	NTR	NAVFAC Atlantic	Manages all ABL Installation Restoration (IR) Program activities.
Ken Bowers	Navy Chemist	NAVFAC Atlantic	Performs lead agency review of UFP-SAP.
Pedro Ruiz	ERP Site Manager	NAVFAC Atlantic	Coordinates ERP site activities.
Douglas Pocze	RPM	USEPA	Reviews SAP and provides input for USEPA.
Wilmarie Rivera	Federal Facilities Coordinator	PREQB	Reviews SAP and provides input for the PREQB
Gloria Toro Agrait	Environmental Permits Officer	PREQB	Reviews SAP and provides input for the PREQB
Brett Doerr	AM	CH2M HILL	Oversees overall project status for NAPR.
Janna Staszak	Navy CLEAN Program UFP-SAP Reviewer	CH2M HILL	Provides program-level review of UFP-SAP
Jamie Butler	Deputy AM	CH2M HILL	Provides support for project implementation.
Jamie Butler	AQM		Provides SAP delivery support and quality assurance (QA) oversight. Responsible for audits, CA, checks of QA performance.
Thomas Roth	PM	CH2M HILL	Manages production of UFP-SAP. Manages project, oversees all project activities, and is responsible for all aspects of the work performed under this SAP.
Craig Sprinkle	STC	CH2M HILL	Provides overall technical quality control (QC) of the field investigation design, implementation, and reporting.
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	Program-level review of UFP-SAP.
Shruti Shah	UFP-SAP Coordinator	CH2M HILL	Coordinates work products of authors; prepares attachments; coordinates with graphics specialists, senior consultants, and publications; assists PM in planning and coordinating.
Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	Provides HHRA oversight.
William Kappleman	Ecological Risk Assessor	CH2M HILL	Provides ERA oversight.
Michael Zamboni	Project Chemist	CH2M HILL	Coordinates laboratory and data validation subcontracts and oversees performance of laboratory and data validation. Writes/coordinates chemistry-specific UFP-SAP worksheets. Provides sample tracking, data management, and communication with laboratory.
Carl Woods	H&S Officer	CH2M HILL	Develops and approves project Health and Safety Plans.
James Frank	Field Coordinator	CH2M HILL	Coordinates all field activities; ensures FTL understands field requirements and has sufficient staff and other resources; reviews field activities to ensure compliance with UFP-SAP.

SAP Worksheet #7—Personnel Responsibilities Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
TBD	FTL	CH2M HILL	Supervises field implementation of the UFP-SAP.
Jennifer Obrin	Laboratory PM	Katahdin	Manages sample tracking and maintains good communication with PC and PDM.
TBD	Data Validator	TBD	Responsible for validation of environmental data.

SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel/Groups Receiving Training	Personnel Titles/Organizational Affiliation	Location of Training Records/Certificates
Site UXO 1 (SWMU 77) Confirmatory Soil Data Collection	Unexploded ordnance (UXO) Safety - Recognize, Retreat, and Report Training	CH2M HILL online, UXO Safety – U.S. Air Force	Agency and subcontractor specific	FTL, field team members	All field team members	Contractor, Navy, regulatory agency or subcontractor human resources department

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SAP Worksheet #9—Project Scoping Session Participants Sheet

Project Name: Site UXO 1 (SWMU 77) RCRA Corrective Action Interim Measures Confirmatory Soil Sampling **Projected Date(s) of Sampling:** Spring 2014 **PM:** Thomas Roth	**Site Name:** UXO 1 (SWMU 77) – Small Arms Range **Site Location:** NAPR, Ceiba, Puerto Rico
Date of Session: Scheduled for September 9, 2013 **Scoping Session Purpose:**	

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Comments: A handout presenting the decision logic as discussed within this SAP was provided prior to the meeting. Due to time constraints, this topic was not fully discussed. Stacin provided a general background and status update of the SWMU 77 RCRA facilities investigation (RFI) and basis for the interim corrective measures. A conference call will be scheduled in the future once the Site UXO 1 (SWMU 77) UFP-SAP is distributed for review. There were no additional comments other than a question as to whether ecological receptor protectiveness should be considered up to 3 feet below ground surface for land crabs. The ecological risk assessor indicated this receptor was considered in the evaluation and the risk evaluation will be presented as an attachment to the UFP-SAP.

Action Items: A conference call will be scheduled following submittal of the UFP-SAP to facilitate review.

Consensus Decisions: None

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SAP Worksheet #10—Conceptual Site Model

This worksheet provides the conceptual site model (CSM) for Site UXO 1 (SWMU 77), including facility and site location descriptions, a brief history of the site, previous investigations conducted, nature and extent of contamination, and information to support the CSM as it pertains to the interim corrective measures.

Facility Location and Description

NAPR is located on the eastern end of Puerto Rico in the municipality of Ceiba. The installation lies immediately east of Puerto Rico Route 3 and is bounded on the east by the Vieques Passage of the Atlantic Ocean (Figure 1). NAPR is approximately 35 miles east of San Juan's Luis Muñoz Marín International Airport, and 5 miles south of Fajardo.

NAPR was previously identified as Naval Station Roosevelt Roads (NSRR), which began in 1941 with the establishment of Fort Bundy in the southwestern portion of the facility as the United States Army headquarters for coastal artillery emplacements. In 1943, the northeastern portion of NSRR was commissioned as a Naval Operating Base to provide training for Atlantic Fleet Operations in the Caribbean. Fort Bundy opened and closed several times between World War II and 1957. In 1957, NSRR was reactivated as the Atlantic Fleet Guided Missile Training Operations Center. It provided missile support to other facilities and training to the Atlantic Fleet's submarine units. The Atlantic Fleet Weapons Training Facility was commissioned in 1963 to support communications and weapons technology, maintenance and operations of weapons testing and exercises, and military training maneuvers.

NSRR closed in March of 2004 and NAPR was established to protect the remaining physical assets, comply with environmental regulations, and sustain the value of the property and assets until their final disposition. The USEPA issued a RCRA § 7003 Administrative Order on Consent (USEPA Docket No. RCRA-02-2007-7301), which identified a number of SWMUs (including Site UXO 1 [SWMU 77]) as having documented releases of solid and/or hazardous waste and/or hazardous constituents, and required follow-on actions. Under the Consent Order, the Navy has responsibility and authority to implement required actions at the SWMUs to protect human health and the environment. Following a public comment period, the Consent Order became effective on January 29, 2007 (USEPA, 2007a).

Although a majority of the property has been transferred to the commonwealth or other federal entities, the Navy remains responsible for environmental clean up. The Navy retained the property at a number of SWMUs, including SWMU 77, until investigation activities are complete and the land can be transferred for its intended use.

Site Location and Description

Site UXO 1 (SWMU 77) – Small Arms Range, comprises approximately 66 acres and is located on the peninsula of Punta Medio Mundo at the northeastern boundary of the facility (Figure 1). Site UXO 1 (SWMU 77) was used as a small arms range, and potentially for munitions disposal or detonation, based on the analysis of historical aerial photographs (Tetra Tech, 2010). Site UXO 1 (SWMU 77) has been divided into six subareas with different potentials for munitions constituents (MC) and/or munitions and explosives of concern (MEC) contamination. Specifically, Site UXO 1 (SWMU 77) subareas comprise of: the Pistol Range, Former Pistol Range, Detonation Area Near Concrete Pad (apparently used for a one-time detonation event), Rifle Range (including a short-yardage range formerly used as a pistol range), Potential Open Burn/Open Detonation (OB/OD), and Potential Munitions Trench (Figure 2).

Most of Site 1 (SWMU 77) is densely vegetated with coastal scrub forest communities dominated in most areas by species such as leadtree (*Leucaena* spp.), box briar (*Randia aculeata*), and sweet acacia (*Acacia farnesiana*). The southwestern end of the site contains mangrove habitat associated with the Los Machos Forest, an approximately 1,000-acre mangrove complex that historically has been adversely affected by hurricanes and construction

activities. The most dominant mangrove species is black mangrove (*Avicennia germinans*) in the immediate vicinity of the Pistol Range Subarea; however, red (*Rhizophora mangle*) and white (*Laguncularia racemosa*) mangroves occur elsewhere in this lagoon system. Federally listed species potentially occurring at or in the vicinity of Site 1 (SWMU 77) are the endangered yellow-shouldered blackbird (*Agelaius xanthomus*), endangered Puerto Rican boa (*Epicrates inornatus*), endangered Virgin Islands tree boa (*Epicrates monensis granti*), and threatened cóbana negra tree (*Stahlia monosperma*).

Although a risk evaluation was completed using data for the entire UXO/SWMU (Attachment 1), only three areas, (Pistol Range, Former Pistol Range, and Rifle Range) warrant an interim corrective measure (Figure 2). Therefore the remainder of this UFP-SAP focuses on these areas. The following descriptions of the Pistol Range, Former Pistol Range, and Rifle Range are adapted from the Phase I RFI Report (Tetra Tech, 2011).

Pistol Range

The Pistol Range Subarea is a level area north of the entrance road to Site UXO 1 (SWMU 77) (Figure 2). The Pistol Range was active until January 1, 2010, although only the southern half of the range was used past 2004. Only small arms ammunition was reportedly used at this subarea. The range consisted of six firing lines across two 50-foot wide side-by-side ranges. Temporary targets were placed as needed before an earthen berm. The berm was cut into the hillside to the west and north and served as the bullet backstop just beyond the target area. Bullets and fragments are visible on ground surface in the berm area.

Former Pistol Range

The Former Pistol Range Subarea is located northeast of the current pistol range and southwest of the Detonation Area Near Concrete Pad Subarea (Figure 2). It is likely that this range was used in a manner similar to the Pistol Range. This range is now overgrown with trees, and no visible evidence remains of a former pistol range. Historical aerial photographs show the area cleared in 1964 and overgrown by 1976. Due to limited historical information and lack of physical evidence, the exact location of the range berms and firing direction is unknown. However, the bullet backstop and firing direction was likely to the west based on presence of a natural hillside.

Rifle Range

The Rifle Range Subarea is a 500-yard-long, narrow feature centrally located in Site UXO 1 (SWMU 77). The firing lines were orientated such that shots were fired toward the outer point of the peninsula (Figure 2). Construction of the range occurred sometime between 1940 and 1958 and the range was closed on January 1, 2010. The range has 100-yard, 200-yard, 300-yard, and 500-yard elevated firing lines and a short-yardage range formerly used as a pistol range. The short-yardage range is located just in front of a fixed target berm. Temporary targets were placed as needed before the bullet backstops. The bullet backstops consisted of a constructed earthen berm that served the short-yardage range, a concrete wall at the rear of the earthen berm equipped with a target carrier mechanism to raise (and lower) targets, and a natural steep-sided and wooded hillside that served as the backstop for elevated targets.

Site Geology and Hydrogeology

The topography within NAPR ranges from 0 to 131 feet (ft) above mean sea level (amsl). The access road entrance area is low lying, but otherwise Site UXO 1 (SWMU 77) is hilly and vegetated except where areas have been cleared and leveled for operational purposes. No floodplains or significant surface water bodies (lakes, ponds, streams, or creeks) are present within Site UXO 1 (SWMU 77). However, the site is on a peninsula bordered by the ocean to the north, south and east. The southwestern end of the site contains mangrove habitat associated with the Los Machos Forest. Although the mangrove habitat is considered in Attachment 1 as part of the site-wide risk evaluation, the interim corrective measures will not impact this area.

Except for tidal swamp soils associated with the access road entrance area, Site UXO 1 (SWMU 77) consists of Descalabrado and Guyana soils, which are shallow, well-drained, and moderately permeable. These soils formed as moderately fine-textured residuum derived from volcanic rock and occupy steep slopes ranging from 5 to 60 percent. These soils have no value as cropland and are suited only for low-intensity grazing or wildlife habitat. The underlying geology of NAPR is predominantly volcanic, composed of lava and tuff, as well as sedimentary rocks derived from discontinuous beds of limestone (NAVFAC, 2005).

Although no groundwater information is available, the nearby marine waters suggest the groundwater beneath the peninsula is brackish to salty. It is possible there is a thin lense of relatively fresh water with distance from the shoreline, which tapers to a feather edge near the tidal zone. There are no drinking water wells at the facility. This interim corrective measures does not consider the soil to groundwater pathway; future evaluations to this pathway will be considered in support of the final corrective action determination.

Previous Investigations

Table 1 summarizes the previous investigations conducted at Site UXO 1 (SWMU 77).

TABLE 1
Site UXO 1 (SWMU 77) Previous Investigations/Actions

Investigation/Report	Results/Summary
Phase I RFI (Tetra Tech, 2011)	A Phase I RFI was conducted in 2011 (Tetra Tech, 2011) to investigate the presence of MEC, material potentially presenting an explosive hazard (MPPEH), non-munitions related debris, and MC-impacted soil. Surface and subsurface geophysical equipment was used to locate suspect MEC/MPPEH and non-munitions related debris. The results of the geophysical surveying indicated that a full RFI should be conducted to investigate the extent of MEC/MPPEH for the Rifle Range Subarea subsurface, Potential OB/OD Subarea surface and subsurface, and Potential Munitions Trench Subarea surface and subsurface. The results of the geophysical surveying guided the positioning of MC soil sampling locations. The MC soil sampling results identified nitroglycerin (NG), metals (specifically antimony, arsenic, copper, lead, and zinc), bullets and/or MC fragments at all subareas except for the Potential Munitions Trench, which had a dataset limited to surface soil. A full RFI was recommended to investigate the nature and extent of MC for all subareas.
Full RFI (draft in progress)	Tetra Tech initiated an RFI in 2012. The objective of the RFI was to assess the nature and extent of MC in surface and subsurface soil within each subarea. Surface and/or subsurface soil samples were analyzed for select metals (antimony, arsenic, copper, lead, and zinc) and/or explosives at each of the six subareas. The Navy determined an interim corrective measure (soil removal) is warranted based on concentrations of metals in soil (primarily lead). The RFI Report (draft in progress) includes the recommendation to conduct interim corrective measures (ICM) soil removal to address soil likely posing unacceptable risks.

Nature and Extent of Contamination

Historical activities at Site UXO 1 (SWMU 77) have resulted in MC in soil at levels that pose potentially unacceptable risk to human health and/of the environment. While the nature and extent of contamination at the subareas may not be fully completed, results to date indicate an interim corrective measure is warranted based on the presence of metals (primarily lead) in soils at the Pistol Range, Former Pistol Range, and Rifle Range. A site-wide human health and ecological risk evaluation (Attachment 1) was completed to develop preliminary remediation goals (PRGs) and to establish areas for consideration for the ICM soil removal. Although antimony, arsenic, copper, lead, and zinc were identified as potential risk drivers, the evaluations presented in Attachment 1 reveal only antimony, copper, lead and zinc warrant action as part of the ICM. In general, the areas identified for removal are based on the ratio of exceedances of PRGs. The ratio of constituent exceedances and sample locations where concentrations exceed the PRGs but are not considered in the ICM are further detailed in Attachment 1. In addition, other MC constituents were considered but the results of the risk evaluations (Attachment 1) do not indicate removal is warranted; for those constituents future investigations and/or evaluations will determine the need for additional corrective action.

An evaluation of the nature and extent of contamination was completed in Attachment 1 where the analytical results for metals in surface soil (less than 2 ft below ground surface [bgs]) and subsurface soil (greater than 2 ft bgs) were compared against the following regulatory criteria/screening and background values:

- USEPA Adjusted Residential Soil Regional Screening Levels (RSL) (USEPA, 2013); the values were adjusted based on the target excess lifetime cancer risk of (ELCR) of 10^{-6} and hazard quotient (HQ) of 0.1.
- Soil Ecological Screening Values (ESVs) (Ecological Soil Screening Levels for plants and soil invertebrates [USEPA, 2007a; 2007b; 2005b; 2005c; 2005d] plus site-specific food web modeling)
- Sediment ESVs (ER-L values from Long and Morgan [1990] and Long et al. [1995])
- Background soil concentrations (BKG) (mean concentration plus two standard deviations; Baker, 2010)

PRGs to support the ICM were developed based on risk evaluations completed with these criteria. The following subsections summarize the extent of contamination for each subarea with respect to the screening criteria and PRGs.

Pistol Range

Surface Soil

During the Phase I RFI and the additional soil sampling conducted in 2013 during the RFI, surface soil samples (generally collected from 0-0.5 and 0.5-2 ft bgs) were analyzed for arsenic, antimony, copper, lead, and/or zinc. All five metals exceeded PRGs and lead was found to exceed the comparison criteria most frequently. The highest concentrations reported for all five metals were reported in sample 77PR-SB010, located just behind the targets within the earthen berm. Table 2 presents a data summary for Pistol Range surface soil. Figure 3 demonstrates a distribution of contaminants with respect to the PRGs (as a ratio).

Subsurface Soil

During the Phase I RFI and the additional soil sampling conducted in 2013 during the RFI, subsurface soil samples (collected deeper than 2 ft bgs) were analyzed for arsenic, antimony, copper, lead, and/or zinc. A summary of these results is presented in Table 3. Antimony, copper, and lead exceeded comparison criteria in only two samples each. The highest concentration reported for lead was in sample 77PR-SB009, located just behind the targets within the earthen berm. Figure 4 represents a distribution of contaminants with respect to the PRGs. Soil impacts at the Pistol Range appear to be confined primarily to the surface (less than 2 ft bgs).

TABLE 2
Summary of Metal Exceedances in Surface Soil at the Pistol Range

Metal	Frequency of Detection	Minimum Concentration milligrams per kilogram (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Comparison Criteria[1] (mg/kg)		Number of Exceedances
Antimony	19/102	1.48 J	326.0	77PR-SB010	BKG	3.17	14
					RSL	3.1	14
					ESV	3.56	14
					PRG	3.56	14
Arsenic	56/102	0.561 J	42.8	77PR-SB010	BKG	2.65	19
					RSL	0.61	55
					ESV	18.0	1
					PRG	11.3	2
Copper	102/102	57	7,990	77PR-SB010	BKG	168	22
					RSL	310	6
					ESV	70	101
					PRG	168	22
Lead	119/124	0.929 J	58,400	77PR-SB010	BKG	22	96
					RSL	400	42
					ESV	120	60
					PRG	120	60
Zinc	102/102	41.8 J	856	77PR-SB010	BKG	115	15
					RSL	2300	0
					ESV	120	14
					PRG	120	14

[1]Shaded value is either the lower of the RSL and ESV, or the BKG if it is higher than the lower of the RSL and ESV.
PRG – See Attachment 1
BKG – Mean plus two standard deviations of the surface soil background concentration (Baker, 2010)
RSL - USEPA RSLs for Residential Soil based on a HQ of 0.1 and ELCR of 10^{-6}.
ESV – Soil Ecological Screening Value

TABLE 3
Summary of Metal Exceedances in Subsurface Soil at the Pistol Range

Chemical Name	Frequency of Detection	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Comparison Criteria[1] (mg/kg)		Number of Exceedances
Antimony	2/33	10.1 J	24.0 J	77PR-SB013	**BKG**	**7.44**	**2**
					RSL	3.1	2
					PRG	31	0
Arsenic	8/33	0.99 J	3.72	77PR-SB013	**BKG**	**6.66**	**0**
					RSL	0.61	8
					PRG	11.3	0
Copper	33/33	36.4	995.0	77PR-SB094	BKG	120	8
					RSL	**310**	**2**
					PRG	3,100	0
Lead	21/33	0.221 J	10,900 J	77PR-SB009	BKG	6.20	13
					RSL	**400**	**2**
					PRG	400	2
Zinc	33/33	43.6 J	591 J	77PR-SB011	BKG	92	9
					RSL	**2300**	**0**
					PRG	7,700	0

[1]Shaded value is the higher of the RSL and BKG.
PRG – See Attachment 1
BKG – Mean plus two standard deviations of the subsurface soil background concentration (Baker, 2010)
RSL - USEPA Regional Screening Levels (RSLs) for Residential Soil based on a HQ of 0.1 and ELCR of 10^{-6}.

Former Pistol Range

Surface Soil

During the Phase I RFI and the additional soil sampling conducted in 2013, surface soil samples (generally collected from 0-0.5 and 0.5-2 ft bgs) were analyzed for arsenic, antimony, copper, lead, and/or zinc. A summary of the results is presented in Table 4. Antimony, copper, lead, and zinc exceeded comparison criteria; lead exceeded comparison criteria most frequently. The highest concentrations reported for copper and zinc were reported in sample 77FP-SB009, located within the northern berm of the subarea. The highest concentration reported for lead was reported in sample 77FP-SB049, located to the west of the subarea. The widespread distribution of metals exceedances to the west of the subarea suggests the firing direction and bullet backstop was to the west. Figure 5 demonstrates a distribution of contaminants in surface soil with respect to the PRGs in the Former Pistol Range.

Subsurface Soil

No subsurface soils (>2 ft bgs) have been collected at the Former Pistol Range.

TABLE 4
Summary of Metal Exceedances in Surface Soil at the Former Pistol Range

Metal	Frequency of Detection	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Comparison Criteria[1] (mg/kg)		Number of Exceedances
Antimony	8/60	0.57 J	6.19	77FP-SB010	**BKG**	**3.17**	**4**
					RSL	3.1	4
					ESV	3.56	3
					PRG	3.56	3
Arsenic	45/60	0.872 J	2.62 J	77FP-SB049	**BKG**	**2.65**	**0**
					RSL	0.61	45
					ESV	18.0	0
					PRG	11.3	0
Copper	60/60	2.97	4,400	77FP-SB009	**BKG**	**168**	**5**
					RSL	310	2
					ESV	70	51
					PRG	168	5
Lead	69/82	0.919 J	4,570	77FP-SB049	BKG	22	50
					RSL	400	10
					ESV	**120**	**30**
					PRG	120	30
Zinc	60/60	30.6	437	77FP-SB009	BKG	115	5
					RSL	2300	0
					ESV	**120**	**4**
					PRG	120	4

[1]Shaded value is either the lower of the RSL and ESV, or the BKG if it is higher than the lower of the RSL and ESV.
PRG – See Attachment 1
BKG – Mean plus two standard deviations of the surface soil background concentration (Baker, 2010)
RSL - USEPA RSLs for Residential Soil based on a HQ of 0.1 and ELCR of 10^{-6}
ESV – Soil Ecological Screening Value

Rifle Range

Surface Soil

During the Phase I RFI and the additional soil sampling conducted in 2013, surface soil samples (generally collected from 0-0.5 and 0.5-2 ft bgs) were analyzed for arsenic, antimony, copper, lead, and/or zinc. A summary of the results is presented in Table 5. All five metals exceeded comparison criteria; lead was exceeded the comparison criteria most frequently. The highest concentrations reported for all five metals were reported in either sample 77RR-SB055 or 77RR-SB133. These sample locations are within the steeply wooded hillside that served as a bullet stop for elevated targets. A comparison of analytical results against the PRGs is shown on Figure 6.

Subsurface Soil

During the Phase I RFI and the additional soil sampling conducted in 2013, subsurface soil samples (collected >2 ft bgs) were analyzed for arsenic, antimony, copper, lead, and/or zinc. A summary of the results is presented in Table 6. Antimony, copper, and lead exceeded comparison criteria; lead exceeded the comparison criteria most frequently. The highest concentration reported for lead was in sample 77RR-SB077, located within the steeply wooded hillside that served as a bullet stop for elevated targets. A comparison of analytical results against the PRGs is shown on Figure 7.

TABLE 5
Summary of Metal Exceedances in Surface Soil at the Rifle Range

Chemical Name	Frequency of Detection	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Comparison Criteria[1] (mg/kg)		Number of Exceedances
Antimony	72/199	0.792 J	6,510 J	77RR-SB055	**BKG**	**3.17**	**59**
					RSL	3.1	59
					ESV	3.56	59
					PRG	3.56	59
Arsenic	151/199	0.533 J	60.5	77RR-SB055	**BKG**	**2.65**	**50**
					RSL	0.61	149
					ESV	18.0	7
					PRG	11.3	11
Copper	197/199	0.563 J	137,000	77RR-SB133	**BKG**	**168**	**55**
					RSL	310	37
					ESV	70	169
					PRG	168	56
Lead	226/228	0.514	118,000	77RR-SB055	BKG	22	199
					RSL	400	120
					ESV	**120**	**162**
					PRG	120	162
Zinc	197/199	23.2	14,100 J	77RR-SB133	BKG	115	59
					RSL	2300	5
					ESV	**120**	**54**
					PRG	120	54

[1]Shaded value is either the lower of the RSL and ESV, or the BKG if it is higher than the lower of the RSL and ESV.
PRG – See Attachment 1
BKG – Mean plus two standard deviations of the surface soil background concentration (Baker, 2010)
RSL - USEPA RSLs for Residential Soil based on a HQ of 0.1 and ELCR of 10^{-6}
ESV – Soil Ecological Screening Value

TABLE 6
Summary of Metal Exceedances in Subsurface Soil at the Rifle Range

Chemical Name	Frequency of Detection	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Location of Maximum Concentration	Comparison Criteria[1] (mg/kg)		Number of Exceedances
Antimony	8/50	0.539 J	62.3 J	77RR-SB075	**BKG**	**7.44**	**5**
					RSL	3.1	5
					PRG	31	2
Arsenic	40/50	0.59 J	6.34	77RR-SB077	**BKG**	**6.66**	**0**
					RSL	0.61	39
					PRG	11.3	0
Copper	50/50	0.642 J	1,760	77RR-SB072	BKG	120	8
					RSL	**310**	**4**
					PRG	3,100	0
Lead	48/50	0.419	17,400 J	77RR-SB077	BKG	6.20	29
					RSL	**400**	**9**
					PRG	400	9
Zinc	50/50	28.9	413 J	77RR-SB122	BKG	92	10
					RSL	**2300**	**0**
					PRG	7,700	0

[1]Bold value is higher of the RSL and BKG.
PRG – See Attachment 1
BKG – Mean plus two standard deviations of the subsurface soil background concentration (Baker, 2010)
RSL - USEPA RSLs for Residential Soil based on a HQ of 0.1 and ELCR of 10^{-6}

Potential Source Areas, Transport Pathways, Exposures, and Receptors

Potential Source Areas

Sources of contamination at the pistol range, former pistol range, and rifle range subareas at Site UXO 1 (SWMU 77) are primarily a result of past use of the site as small arms firing ranges and related activities. The potential source areas, referred to as Subareas, are primarily associated with spent ammunition and casings.

Exposures and Receptors

Potentially complete exposure pathways are present that could result in unacceptable risks to human health and the environment. Based on current (vacant land) and foreseeable future site uses (commercial, retail, and recreation), potential human receptors were identified as current trespassers; future recreational users, and commercial, construction and retail workers. These potential receptors may be exposed to contaminants in soil through incidental ingestion, dermal contact, and inhalation of fugitive dust emissions. Potential exposures to terrestrial ecological receptors include: (1) direct contact and/or ingestion of surface soil for lower trophic level receptors (terrestrial plants, soil invertebrates, and reptiles), and (2) food web exposures and incidental ingestion of surface soil for upper trophic level receptors (birds and mammals). Calculations presented in Attachment 1 show only four metals (antimony, copper, lead, and zinc) in soil presenting a risk to potential receptors that should be addressed by the ICM soil removal.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Project Description

In support of the RCRA corrective action interim measures (soil removal) for Site UXO 1 (SWMU 77), soil sampling and analysis is necessary to determine post-removal concentrations of four metals (antimony, copper, lead, and zinc) at the identified removal areas. Sample analyses will consist of field screening with a field portable x-ray fluorescence instrument (FP-XRF) unit, followed by sample collection for off-site laboratory analysis. Laboratory results will be used to confirm post-removal soil concentrations, and will be used as part of the RFI dataset for Site UXO 1 (SWMU 77), which will include quantitative human health and ecological risk assessments.

The environmental questions/problems to be addressed by this project are:

What are the post-removal soil concentrations at each removal area and do they indicate additional soil removal is warranted during the interim corrective measure?

A tiered post-removal soil sampling approach will be implemented at the three Subareas (Pistol Range, Former Pistol Range, and Rifle Range) where the risk evaluation (Attachment 1) identified potentially unacceptable risks. At a minimum, soil will be removed within the area defined based on an evaluation of existing site data compared against the PRGs (Figure 8). The minimum soil removal will be conducted to a depth of 1 foot bgs with two exceptions; the wooded berm area where the minimum removal will be to 3 ft bgs, and the Rifle Range where the constructed earthen berm will be removed to grade. Following the minimum excavation, screening soil samples will be collected following the FP-XRF SOP provided in Attachment 2. Soil samples will be obtained within grid cells across the floor and along the sidewall of the initial excavation at 100-foot spacings for FP-XRF screening of the four metals. Confirmatory soil samples for offsite analysis will be collected when FP-XRF data suggest residual concentrations are at or below the PRGs. Both the screening and offsite laboratory results will be compared to PRGs as a guide for determining if residual concentrations warrant additional excavation. The decision rationale for whether additional soil removal is warranted is discussed in the project quality objectives (PQOs) section of this worksheet and displayed on Figure 9.

Who will use the data?

The data will be used by the Navy, USEPA, PREQB and CH2M HILL. The data will be used to support further nature and extent delineation, associated risk assessments (excluding the XRF data), and final corrective measures determinations. Chemists will use the data to evaluate overall data quality and usability by preparing a data quality evaluation (see Worksheet #37).

What are the Project Action Limits?

The Project Action Limits (PALs) for the four metal chemical of concerns (COC) are the PRGs. However, the laboratory quantitation limit goals were established to allow the data to be used in the future for nature and extent and risk assessment purposes. PALs are provided in Worksheet #15.

The PAL for copper in incremental surface soil has been set at the background level. Background levels were established based on results from discrete (not incremental) soil samples. The planned post-excavation confirmation soil samples are incremental and, therefore, must undergo laboratory processing (i.e. grinding). There is the potential for elevated metals results due to such laboratory processing. This issue may need to be revisited if it is determined that this phenomenon may be occurring and causing exceedances of the PAL.

What will the data be used for?

The screening data will be used to make in-field decisions on when to collect samples for offsite laboratory analysis. The laboratory data will answer the environmental questions previously defined in this worksheet. The laboratory results also will be used to support further nature and extent delineation, associated risk assessments, and final corrective measures determinations.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

Soil data are needed to help determine the extent of soil removal during the interim measure implementation. Worksheet #17 contains detailed information on the types of data needed for this project, including proposed sample locations and sampling rationale. Planned analysis is based on the risk evaluation and PRG discussion (Attachment 1) which identified four metals (antimony, copper, lead, and zinc) as the primary risk drivers. Sampling techniques are described in Worksheet #14. Worksheet #15 details the laboratory analytical protocol.

Prior to sampling, the floor of each removal area will be staked out in an approximate 50 x 50 foot (2,500 square foot) grid pattern, with grid nodes marked with labeled pin flags and their locations recorded with a global positioning system (GPS) unit. Likewise the sidewalls of the excavation will be marked at approximate 100-foot intervals.

How "good" do the data need to be in order to support the environmental decision?

The standard operating procedure (SOP) for using FP-XRF is provided in Attachment 2. The XRF manufacturer indicates an accuracy of ±5% for the instrument, but screening results for Site UXO 1 (SWMU 77) are expected to have an accuracy in the range of 15-25% because the soil samples are not being processed prior to screening. The detection limits of the FP-XRF for the COC metals are expected to be below the PRGs, even with the accuracy range factored in. The FP-XRF data are for screening purposes only and the offsite laboratory analyses will be used to make final determinations of the effectiveness of the ICMs.

The laboratory data needs to be of the quality necessary to answer the environmental questions with sufficient confidence that risk management and remedial decisions can be made. Details of how the quality of the data will be ensured and assessed are included in Worksheet #37. The quality assessment/quality control (QA/QC) will be performed on all laboratory results. Detailed QA/QC data requirements are found in Worksheet #20. Data validation procedure requirements are detailed in Worksheet #36.

The laboratory will follow the measurement performance criteria (MPC) in Worksheet #28 for field and laboratory QC samples. These MPC are consistent with the U.S. Department of Defense (USDoD) *Quality Systems Manual* (QSM) (USDoD, 2010) as applicable and laboratory in-house limits where the quality systems manual (QSM) does not apply.

How much data should be collected (number of samples for each analytical group, matrix, and concentration)?

Detailed information on how much data will be collected is provided in Worksheets #17 and #18. Numbers of QA/QC samples for each chemical analysis are discussed in Worksheet #20.

Where, when, and how should the data be collected/generated?

- Detailed information on when the data will be collected is provided in Worksheet #16
- Detailed information on where and how the data will be collected is provided in Worksheets #14 and #17
- The sample locations associated with Site UXO 1 (SWMU 77) are provided in Attachment 1 (Figures 1-1 through 1-6)
- The data will be collected following the standard operating procedures (SOPs) presented in Worksheet #21

Who will collect and generate the data?

- The field team will collect the samples and field observations during the project.
- The samples will be shipped by overnight courier to Katahdin for analysis.

Analytical data generated will be submitted to the subcontractor. Once received, data will be reviewed and validated by a subcontracted data validator. The CH2M HILL data management team will receive the validated data and upload it into the Naval Installation Restoration Information Solution (NIRIS), a centralized electronic database used for Navy projects.

How will the data be reported?

A Confirmatory Sampling Report consisting of the field data, validated laboratory results, and maps showing the extent of the subarea excavations.

How will the data be archived?

Data will be archived according to procedures dictated by the Navy CLEAN program/contract. Analytical data will be uploaded into a centralized database developed and maintained for Navy projects by CH2M HILL and provided for upload to NIRIS.

PQOs listed in the form of if/then qualitative and quantitative statements.

The evaluation of the completeness of soil removal will be based on a two-step process of soil analyses. Field screening of decision units (DU) will assess whether remaining soil may meet PRGs, and if so, then confirmatory soil samples from the same area (now termed sampling unit or SU) will be analyzed by offsite laboratory. Field screening using FP-XRF will be done on a 10-point soil composite from each 50ft X 50ft (2,500 sq ft) or 100-ft long DU. If FP-XRF results indicate the soil may contain metals below PRGs then confirmation samples will be analyzed by offsite laboratory. The confirmation samples will be 30-point composite samples obtained from the same area (now termed SU) using incremental sampling (IS) methods (ITRC, 2012). Standard operating procedures for sampling the DU and SU are provided in Attachment 2. The geometry of the DU (and equivalent SU) is based on the assumption that projectiles were somewhat broadly dispersed over each range because individual targets were not fixed in a single location for the entire period of range use. Further the selected DU (SU) area is small enough to be reasonably excavated using equipment available to the Navy. Prior to sampling, the boundaries of each DU (and equivalent SU) will be marked, with grid corners established using labeled pin flags/stakes. Coordinates of the boundary corners will be obtained and recorded with a global positioning system (GPS) unit.

The initial excavation area was determined based on the evaluation of existing site data. The decision rationale for confirmatory sampling is provided on Figure 9. The following are the steps of the iterative process that will be followed based on the XRF results for the confirmatory samples:

1. If there are no exceedances of the PRGs (factoring in a potential 20% error, as discussed previously) at any initial soil sample location analyzed using XRF, a confirmatory sample will be collected for off-site laboratory analysis of four metals (antimony, copper, lead, and zinc). Each excavation floor confirmatory sample for off-site analysis will be collected using incremental sampling (IS) methods (see attachment 2) to obtain a composite soil sample from a depth of 0-12 inches bgs at a frequency of 1 per approximately 2,500 ft^2 (1 per 50 x 50 ft grid cell). Sidewall samples from the initial excavation boundary (IS composites at a depth of 0-12 inches) at a frequency of 1 per 100 linear ft of sidewall will also be collected and submitted to an off-site laboratory for analysis.
2. If there are no exceedances of the PRGs in the off-site confirmatory sample analyses, no further excavation will be conducted at the location of the confirmatory soil sample(s).
3. If there are exceedances of the PRGs in the initial confirmatory samples either through field screening (factoring in % error, as discussed below) or off-site analysis, an additional 1 ft vertical excavation (if the exceedance was in a floor sample) or an additional lateral excavation extending 10 ft into the sidewall (if the exceedance was in a sidewall sample from the initial excavation boundary) will be performed.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

4. A second confirmatory soil sample(s) will be collected following additional excavation (using the same protocol as the initial confirmatory soil samples) and steps 1 and 2 above will be followed verbatim. However, if the process using the second confirmatory soil sample data reaches step 3 and PRG exceedances are identified, the Navy, in consultation with USEPA and PREQB, will evaluate the overall dataset and determine if additional excavation as part of the ICM is warranted. This evaluation will include a multiple-line-of-evidence consideration, such as average site-wide/subarea constituent concentrations, encroachment on sensitive habitats, and available funding.

SAP Worksheet #12—Field Quality Control Samples

(UFP-QAPP Manual Section 2.6.2)

As requested by USEPA for another site in Puerto Rico, all field QC sample information is provided within Worksheet #28 and Worksheet #12 is not applicable (N/A).

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SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
Full RCRA Facilities Investigation Report – Soils Data	*Draft Full Resource Conservation and Recovery Act Facility Investigation Report for Site UXO 1 (SWMU 77) – Small Arms Range, Naval Activity Puerto Rico, (Former Naval Station Roosevelt Roads), Ceiba Puerto Rico* (Tetra Tech, August, 2013)	Originating Organization: Tetra Tech Data Type: Soil Data Generation/Collection Dates: Based on data collected from September 2012 and March 2013 as well as data from previous investigations.	The data have been used to develop estimates of the horizontal extent of the Subareas and extent of impact for both surface and subsurface soils.	There are data gaps associated with analytes and vertical depths of samples.

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SAP Worksheet #14—Summary of Project Tasks

Project Tasks

Project tasks include the field work, quality control, analytical tasks, documentation and reporting, data tracking, storage, etc, and assessment/audit tasks as described below. Applicable SOPs for project tasks outlined in this section are listed on Worksheet #21 and provided in Attachment 2.

Field Work

Anomaly Avoidance

Anomaly avoidance will be performed during the confirmatory soil sampling using the SOP *Surface MEC & Subsurface Anomaly Avoidance* in Attachment 2. UXO technicians, provided by USA Environmental, Inc. (USAE), will be present during sampling and will provide anomaly avoidance for the field team to safely obtain samples with optimal locations within the RCRA corrective action interim measures (soil removal) areas.

Soil Sampling

Field screening via FP-XRF and confirmatory soil sampling via analytical laboratory will be performed using traditional methods in accordance with the applicable SOPs referenced in Worksheet #21. Appropriate laboratory QA/QC samples will be collected as specified on Worksheet #20. The confirmatory soil sampling or screening will be completed using a simple approach to delineate the extent of each of the Subareas with respect to the primary risk drivers, as outlined in Worksheets #10 and #11. Worksheet #17 presents the detailed sampling strategy and rationale for each Subarea.

Surveying

Prior to sampling, grid locations across the excavation floor and along excavation sidewalls will be laid out using a hand-held GPS unit with sub-meter accuracy. Higher accuracy is not required as this is an RCRA corrective action interim measures. All grid locations will be marked and labeled with pin flags, but individual sample locations do not need to recorded with a GPS unit.

Field Documentation

The field team will document detailed field observations in a field notebook in accordance with applicable SOPs referenced on Worksheet #21.

Decontamination

All non-disposable sampling equipment will be decontaminated before sampling activities at each location in accordance with the *Decontamination of Personnel and Equipment* SOPs located in Attachment 2.

Quality Control

In order to maintain quality control, field activities will be implemented following the SOPs provided in Attachment 2. In addition, QC samples will be collected as outlined on Worksheet #20.

Analytical Tasks

The laboratory will calibrate, maintain, test, and inspect analytical instruments (Worksheets #24 and #25). The laboratory will process and prepare samples for analysis. Lastly, the analytical laboratory will process and prepare samples for analyses and analyze all samples for specified analytes in accordance with Worksheet #18.

SAP Worksheet #14—Summary of Project Tasks (continued)

Documentation and Reporting

At the completion of the field investigation and upon receipt of the analytical data package, CH2M HILL will prepare a Confirmatory Sampling Report.

Data Tracking, Storage, Archiving, Retrieval, and Security

CH2M HILL will maintain and archive records as discussed in Worksheet #29. Additionally, the project records will be tracked, stored, and archived (performed by the PC; see organization chart on Worksheet #5).

Assessment/Audit Tasks

Project assessment and audits will be completed as detailed in Worksheets #31 and #32.

SAP Worksheet #15—Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: SMI (surface or subsurface)

Analytical Group: METAL

Analyte	CAS No.	RSLs - Residential Soil Adjusted (May, 2013)	ESVs	SMI (surface) Background (Mean + 2SD)	SMI (subsurface) Background (Mean + 2SD)	SMI (surface) PRGs (PALs)	SMI (surface) PRG Basis	SMI (subsurface) PRGs (PALs)	SMI (subsurface) PRG Basis	Project QL Goal[1] (mg/kg)	Laboratory Specific Limits[2]		
											Limit of Quantitation (LOQs)	Limit of Detection (LODs)	Detection Limits (DLs)
Antimony	7440-36-0	3.1	3.56	3.17	7.44	3.56	Ecological - Food Web	31	Human Health	1.78	0.80	0.50	0.070
Copper	7440-50-8	310	70	168	120	168	Background (Mean +2 SD)	3100	Human Health	84	2.5	1.0	0.16
Lead	7439-92-1	400	120	22	6.2	120	Ecological - Plant	400	Human Health	60	0.50	0.40	0.090
Zinc	7440-66-6	2300	120	115	92	120	Ecological - Invertebrate	7700	Human Health	60	2.5	1.0	0.17

Notes:

1. The project quantitation limit (PQL) Goal is 1/2 the lesser of applicable PRGs. All units are the same as for the PQL Goal column.

2. The laboratory-specific reporting limits (RL) are sufficiently low-concentration for demonstrating absence of the constituents at less than the PRGs (and quantitating detections at less than the PRGs). The laboratory-specific limits are also sufficiently low-concentration for the future data use of calculating residual risk based on these constituents. Therefore, the RSLs, ESVs, and background levels are also presented.

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SAP Worksheet #16—Project Schedule/Timeline Table

Refer to the project schedule in the RCRA Corrective Action Interim Measures Work Plan (USAE, 2013). Confirmatory sampling will coincide with the schedule for soil excavation and confirmatory sampling results will be provided as part of the Confirmatory Sampling Report.

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SAP Worksheet #17—Sampling Design and Rationale

This worksheet presents the sampling design and rationale for Site UXO 1 (SWMU 77) soil sampling. The soil sampling effort will focus on the three Subareas (Pistol Range, Former Pistol Range, and Rifle Range) where the risk evaluation and PRG discussion (Attachment 1) indicated that potentially unacceptable risks exist. The initial soil removal within the defined removal areas will be conducted to a depth of 1 foot bgs with the exception of initial removal will be to 3 ft bgs in portions of the Rifle Range and the constructed berm will be removed to grade. The initial excavation area was determined based on the evaluation of existing site data. The density of the data set will be sufficient to be used as post-removal confirmatory data, as well as combined with other site data for nature and extent, risk assessment, and final corrective measures determinations. The FP-XRF screening and confirmatory soil sampling will be conducted in accordance with the decision rationale detailed in the PQOs in Worksheet #11 and on Figure 9. Rationale for key elements of the confirmatory sampling approach are:

- Soil samples for FP-XRF field screening of four metals (antimony, copper, lead, and zinc) will be collected as a composite of subsamples from 10 points within a DU (as defined in Worksheet #11). XRF samples will be processed and screened as described in the SOP in Attachment 2. Sample spacing is specified to achieve sufficient spatial density for ICM-related decision-making (i.e., when to take offsite confirmatory soil samples, when to perform additional excavation) within logistical constraints (the amount of time needed to process samples given the removal contractor's excavation schedule).
- Confirmatory soil samples will be collected as a 30-point composite from a depth of 0 -12 inches bgs at a frequency of 1 soil sample per 2,500 sq ft SU. Confirmatory sidewall samples will be composed of 30-point composites from depths of 0-4 inches at a frequency of 1 soil sample per 100 linear ft SU. Note that the SU sample area is the same GPS-surveyed area used for the DU screening. Each confirmatory sample will be collected using IS methods as described in the SOP in Attachment 2. The IS methods provide analytical results that are representative of the contaminant levels within each SU (ITRC 2012). The 2,500 sq ft (floor) and 100 linear foot (sidewall) SUs are specified based on planned excavations during the ICM. A sample depth of 0-12 inches was selected for floor samples because the ICM excavations will be conducted in one-foot increments. Also, this depth represents the highest potential exposures for ecological receptors (absent the presence of land crabs, which have not been observed in the proposed removal areas). The depth and location of the sidewall samples provides a similarly representative sample of the unexcavated perimeter.
- A decision tree based on the tiered sampling approach is provided on Figure 9.

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SAP Worksheet #18-1—Location-Specific Sampling Methods/SOP Requirements Table

UFP-QAPP Manual Section 3.1.1

Sampling Unit[1]	ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference
NAPR – Site UXO 1 (SWMU 77) Post-Excavation Confirmatory						
Rifle Range (RR)						
77RR-SO169 (floor)	NAPR-W77RR-SMI169-FL-TTBB	SMI (surface)	TBD	METAL	3 (field triplicate[FT])	See Worksheet #21
	NAPR-W77RR-SMI169T-FL-TTBB					
	NAPR-W77RR-SMI169TT-FL-TTBB					
77RR-SO170 (floor)	NAPR-W77RR-SMI170-FL-TTBB	SMI (subsurface)	TBD	METAL	3 (matrix spike /matrix spike duplicate [MS/MSD])	
	NAPR-W77RR-SMI170-FL-TTBB-MS					
	NAPR-W77RR-SMI170-FL-TTBB-SD					
77RR-SO171 (sidewall)	NAPR-W77RR-SMI171-SW-TTBB	SMI (subsurface)	TBD	METAL	1	
NAPR-W77-QC	NAPR-W77RR-EBXX-MMDDYY	AQ	N/A	METAL	1	

Notes:

[1] Because excavation has not yet been performed, this Worksheet provides example post-excavation Sample IDs which may be collected. Station #169 is the next in the series for Rifle Range. Floor and/or sidewall samples may be required. Incremental (surface and/or subsurface) samples may be required. Depths are to be determined. All samples require analysis for METAL. One FT, one MS/MSD, and one equipment rinsate blank are shown (refer to Worksheet #28 for the required frequency).

SAP Worksheet #18-2—Location-Specific Sampling Methods/SOP Requirements Table

UFP-QAPP Manual Section 3.1.1

Sampling Unit[1]	ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference
NAPR – Site UXO 1 (SWMU 77) Post-Excavation Confirmatory						
Pistol Range (PR)						
77PR-SO105 (floor)	NAPR-W77PR-SMI105-FL-TTBB	SMI (surface)	TBD	METAL	3 (FT)	See Worksheet #21
	NAPR-W77PR-SMI105T-FL-TTBB					
	NAPR-W77PR-SMI105TT-FL-TTBB					
77PR-SO106 (floor)	NAPR-W77PR-SMI106-FL-TTBB	SMI (subsurface)	TBD	METAL	3 (MS/MSD)	
	NAPR-W77PR-SMI106-FL-TTBB-MS					
	NAPR-W77PR-SMI106-FL-TTBB-SD					
77PR-SO107 (sidewall)	NAPR-W77PR-SMI107-SW-TTBB	SMI (subsurface)	TBD	METAL	1	
NAPR-W77-QC	NAPR-W77PR-EBXX-MMDDYY	AQ	N/A	METAL	1	

Notes:

[1] Because excavation has not yet been performed, this Worksheet provides example post-excavation Sample IDs which may be collected. Station #105 is the next in the series for Pistol Range. Floor and/or sidewall samples may be required. Incremental (surface and/or subsurface) samples may be required. Depths are to be determined. All samples require analysis for METAL. One FT, one MS/MSD, and one equipment rinsate blank are shown (refer to Worksheet #28 for the required frequency).

SAP Worksheet #18-3—Location-Specific Sampling Methods/SOP Requirements Table

UFP-QAPP Manual Section 3.1.1

Sampling Unit[1]	ID Number	Matrix	Depth	Analytical Group	Number of Samples	Sampling SOP Reference
NAPR – Site UXO 1 (SWMU 77) Post-Excavation Confirmatory						
Former Pistol Range (FP)						
77FP-SO53 (floor)	NAPR-W77FP-SMI53-FL-TTBB	SMI (surface)	TBD	METAL	3 (FT)	See Worksheet #21
	NAPR-W77FP-SMI53P-FL-TTBB					
	NAPR-W77FP-SMI53P-FL-TTBB					
77FP-SO54 (floor)	NAPR-W77FP-SMI54-FL-TTBB	SMI (subsurface)	TBD	METAL	3 (MS/MSD)	
	NAPR-W77FP-SMI54-FL-TTBB-MS					
	NAPR-W77FP-SMI54-FL-TTBB-SD					
77FP-SB55 (sidewall)	NAPR-W77FP-SMI55-SW-TTBB	SMI (subsurface)	TBD	METAL	1	
NAPR-W77-QC	NAPR-W77FP-EBXX-MMDDYY	AQ	N/A	METAL	1	

Notes:

[1] Because excavation has not yet been performed, this Worksheet provides example post-excavation Sample IDs which may be collected. Station #53 is the next in the series for Former Pistol Range. Floor and/or sidewall samples may be required. Incremental (surface and/or subsurface) samples may be required. Depths are to be determined. All samples require analysis for METAL. One FT, one MS/MSD, and one equipment rinsate blank are shown (refer to Worksheet #28 for the required frequency).

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SAP Worksheet #19—Field Sampling Requirements Table

UFP-QAPP Manual Section 3.1.1

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers[4]	Sample Volume	Preservation Requirements	Maximum Holding Time
SMI (surface or subsurface)	METAL	CA-548, CA-605, CA-608 / SW-846 3050B, 6010C	One or more of 32oz CWM (as needed). Double-bagging with Zip-loc style bags may also be acceptable.	~10g[3]	none[2]	6 months

Notes:

[1] Later versions of the indicated analytical and preparation methods may be used during the ICM.

[2] Soil samples and associated aqueous blanks (chemically-preserved) do not require refrigeration. It is OK to ice samples.

[3] Katahdin will digest approximately 10g of SMI for metals rather than the typical 1g. This is intended to provide a more-representative digestion.

[4] Do not provide triple volume for SMI samples designated for MS/MSD.

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SAP Worksheet #20—Field Quality Control Sample Summary Table

UFP-QAPP Manual Section 3.1.1

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Triplicates	No. of MS/MSD Pairs	No. of Equipment Blanks[1]	Total No. of Samples to Lab
SMI (surface or subsurface)	METAL	100	10	5	10	140

Notes:

[1] The number of blanks is based on a fundamental assumption of the number of days during which sampling occurs. It was assumed that ten incremental samples could be collected per day (incremental soil collection device is decontaminated). Refer to Worksheet #28 for the required frequencies.

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date, and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work?
Attachment 2	Chain-of-Custody; August 2013.	CH2M HILL	None	No
Attachment 2	Decontamination of Personnel and Equipment; August 2013.	CH2M HILL	DPT rods	No
Attachment 2	Disposal of Waste Fluids and Solids; August 2013.	CH2M HILL	55-gallon steel drums, labeling equipment	No
Attachment 2	GPS; August 2013.	CH2M HILL	Trimble Pro XRS GPS Unit	No
Attachment 2	FP-XRF; 2007	Innov-X Systems Inc.	Field Portable XRF	No
Attachment 2	Soil Sampling During Excavation; August 2013.	CH2M HILL	None	No
Attachment 2	Equipment Blank and Field Blank Preparation; August 2013.	CH2M HILL	DPT Acetate Liners	No
Attachment 2	Packing and Shipping Procedures; August 2013.	CH2M HILL	Lab-Supplied Coolers	No
Attachment 2	Multi RAE Photoionization (PID); August 2013.	CH2M HILL	PID	No
Attachment 2	Preparing Field Log Books; August 2013.	CH2M HILL	None	No
Attachment 2	Soil Sample Preeparatoin Prior to FP-XRF Scanning; April 2015.	CH2M HILL	Rubber mallet, stainless steel spoons and hand strainers	No
Attachment 2	Incremental Soil Sampling for Offsite Laboratory Analysis – SWMU 77; April 2015.	CH2M HILL	Steel sampling probes, spoons, and mixing bowls	No

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SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference
Multi RAE PID	Calibrate using ambient air and isobutylene 100 parts per million (ppm) calibration gas	Recharge daily. Inspect instrument casing for damage or soiling. Record all maintenance activities in instrument logbook or field book instrument section.	Visual Inspection	Daily at the beginning and ending of each work shift and as recommended by manufacturer.	Ambient air reads 0.0 ppm +/- 3% Isobutylene gas reads 100 ppm +/- 3%	Follow instructions in manual to clean sensor. Do not use this instrument if unable to calibrate properly.	FTL	Attachment 2
Field Portable XRF	Start of day perform instrument manufacturer's recommended pre-programmed detector energy calibration routine. Acceptance criteria for energy value as described in manufacturer operating manual. Record energy value in instrument log book or field book instrument section. Analyze vendor supplied method blank using silicon dioxide (SiO2) blank branchet. Record results in instrument log book or field book instrument section. If detects are present reanalyze blank sample. Perform manufacturer's recommended instrument cleaning routine if necessary. Analyze blank at beginning and end of each work shift or as needed if contamination is suspected during the course of field work.	Perform daily - recharge all instrument batteries and energy calibration check on detector. Check instrument outer casing for soiling and damage. Follow manufacturer's recommendations for instrument cleaning and de-contamination protocol. Visually inspect instrument aperture for damage. Follow manufacturer procedure for any replacement activity.	Visually inspect instrument casing for damage. Inspect instrument keypad and Liquid Electronic Display (LED) screen for functionality. Inspect battery units of corrosion or Inability to properly charge. Check aperture for soiling or damage. Check film guard (if supplied by manufacturer) for soiling or damage.	Daily, at the beginning and ending of each work shift and as recommended by manufacturer.	Field Portable XRF results must be within ±20% of any SSCS (if in use) or NIST published values as per the vendor/manufacturer supplied reference material certificate of analysis.	Follow manufacturer/vendor instructions in manual to aperture and or instrument casing. Record all activities in instrument log book or field book instrument section. Do not use this instrument for any analytical purposes if unable to meet NIST published values for the supplied reference material. Contact manufacture for additional instructions or replace instrument with an operational unit. Record all analytical results and actions taken in the instrument logbook or field book instrument section.	FTL	Attachment 2

SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table (continued)

Field Equipment	Calibration Activity	Maintenance Activity	Testing/ Inspection Activity	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference
	Perform calibration verification of XRF detector using vendor supplied appropriate National Institute of Standards and Technology (NIST) calibration standards or site specific calibration standards (SSCS) (if available). Perform calibration verification routine at beginning and ending of work shift or as recommended by manufacturer. Record results in instrument logbook or field book instrument section.	Record all maintenance activities in instrument logbook or field book instrument section.						

SAP Worksheet #23—Analytical SOP References Table

UFP-QAPP Manual Section 3.2.1

Lab SOP Number[1]	Title, Revision Date, and/or Number	Date Last Revisited if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis[2]	Variance to QSM	Modified for Project Work?
CA-605	Acid Digestion of Solid Samples by USEPA Method 3050 for Metals Analysis by ICP-AES and GFAA; Rev. 5; Sept., 2010	1/22/2013	Definitive	SMI (surface or subsurface) / METAL	N/A (digestion)	Katahdin	None	Y[4]
CA-608	Trace Metals Analysis by ICP-AES using USEPA Method 6010; Rev. 14; May, 2013		Definitive	SMI (surface or subsurface) / METAL	ICP-AES	Katahdin	none	N
SD-902	Sample Receipt and Internal Control; Rev. 9; Sept., 2010	6/17/2013	N/A	N/A	N/A (receipt)	Katahdin	none	N
SD-903	Sample Disposal; Rev. 5; June, 2013		N/A	N/A	N/A (disposal)	Katahdin	none	N
CA-548	Preparation of Aquoeus and Solid Samples for Explosive Analysis by Method 8330; Rev. 1; December, 2013		Definitive	SMI (surface or subsurface) / METAL	N/A (SMI preparation)	Katahdin	None	N[3]

Notes:

[1] Later versions of the indicated analytical and preparation methods may be used during the ICM.

[2] Katahdin is DoD-Environmental Laboratory Accreditation Program (ELAP) accredited to return the applicable analytes in the matrices via the required analytical methods. Accreditation through L-A-B is granted through February 1, 2016.

[3] Katahdin will use incremental laboratory processing procedures appropriate for metals analysis (i.e. hand grinding, non-metallic equipment, etc.) .

[4] Katahdin will digest approximately 10g of SMI for metals rather than the typical 1g.

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SAP Worksheet #24—Analytical Instrument Calibration Table

UFP-QAPP Manual Section 3.2.2

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference[1]
ICP-AES (METALs)	Initial Calibration (ICAL) for all analytes (minimum one high standard and a calibration blank)	Daily ICAL prior to sample analysis	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed.	Analyst	CA-608
	Second Source Calibration Verification	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes within ±10% of true value.	Verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until calibration has been verified.		
	Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All analytes within ±10% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification. Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate. No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the RL.		
	Linear dynamic range or high-level check standard	Every 6 months.	Within ±10% of true value.	N/A		
	Calibration Blank	Before beginning a sample run, after every 10 samples, and at the end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed. Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.		

Notes:

[1] Later versions of the indicated analytical and preparation methods may be used during the ICM.

DoD QSM v. 4.2 is the basis for specifications on this table.

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SAP Worksheet #25—Analytical Instrument Calibration Table

UFP-QAPP Manual Section 3.2.3

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
ICP-AES (METALs)	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer. Check argon. Replace peristaltic pump tubing as needed. Other maintenance specified in lab Equipment Maintenance SOP.	QC standards	Torch, nebulizer chamber, pump, pump tubing.	Prior to initial calibration and as necessary.	Acceptable calibration or CCV.	Correct the problem and repeat calibration or CCV.	Analyst	CA-608

Notes:

[1] Later versions of the indicated analytical and preparation methods may be used during the ICM.

Laboratory SOPs are the basis for specifications on this table.

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SAP Worksheet #26—Sample Handling System

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	FTL (TBD)/CH2M HILL
Sample Packaging (Personnel/Organization):	Sample Processor or Field Team Member (TBD)/CH2M HILL
Coordination of Shipment (Personnel/Organization):	Sample Processor or Field Team Member (TBD)/CH2M HILL
Type of Shipment/Carrier:	Overnight/FedEx
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Receipt Personnel/Katahdin.
Sample Custody and Storage (Personnel/Organization):	Sample Receipt Personnel/Katahdin.
Sample Preparation (Personnel/Organization):	Digestion Personnel/Katahdin.
Sample Determinative Analysis (Personnel/Organization):	Analyst/Katahdin.
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	90 Days
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	Digestates may be disposed of 90 days after extraction.
Biological Sample Storage (No. of days from sample collection):	N/A
SAMPLE DISPOSAL	
Personnel/Organization:	Environmental Health and Safety Officer/Katahdin.
Number of Days from Analysis:	Samples may be disposed of 90 days after report mail date.

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SAP Worksheet #27—Sample Custody Requirements Table

(UFP-QAPP Manual Section 3.3.3)

Sample Labeling:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservative, and sampler's initials. Labels will be taped to the jar to ensure that they do not separate.

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled, as outlined above. Samples will be cushioned with packaging material and placed into shipping containers. Per Worksheet #19, icing is acceptable but unnecessary. The chain of custody (COC) will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the airbill number indicated on the COC (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Please refer to SD-902 (Sample Receipt and Internal Control) and SD-903 (Sample Disposal).

Sample Identification Procedures:

Upon opening the cooler, the receiving clerk signs the COC and then takes the temperature using the temperature blank (if absent, then a sample container or infrared thermometer is used). The sample containers in the cooler are unpacked and checked against the client's COC and any discrepancies or breakage is noted on the COC. Next, if any water samples require preservative, the clerk will check the pH values to see if they are in the acceptable pH range. The clerk will deliver the COC (and any other paperwork; e.g. temperature or pH QA notice) to the project manager for LIMS entry and client contact (if needed).

The field logbook will identify the sample ID with the location, depth, date/time collected, and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the chain of custody. The laboratory will send sample log-in forms to the project data manager to check sample IDs and parameters are correct.

Chain-of-Custody Procedures:

Please refer to Worksheet #27-1 for an example COC. COCs will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID, date/time collected, number and type of containers, preservative information, analysis method, and comments. The COC will also have the relinquisher's signature. The COC will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the LIMS database for each sample.

SAP Worksheet #27-1—Chain of Custody

Katahdin ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400
Fax: (207) 775-4029

Chain of Custody

Client:	Contact:	Phone #: ( )	Fax #: ( )
Address:	City:	State:	Zip Code:
Purchase Order #:	Proj. Name/No.:		Katahdin Quote #:
Bill (if different than above):		Address:	
Sampler (Print/Sign):			Copies To:

LAB USE ONLY	Work Order #:		
	Katahdin Project Number:		
Remarks:			
Shipping Info:	FEDEX	UPS	CLIENT
Airbill No:			
Temp C	Temp Blank	Intact	Not Intact

*	Sample Description	Date/Time Collected	Matrix	No. of Containers	Analysis and Container Type Preservatives									
					Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N	Filt. Y / N

COMMENTS:

Relinquished By:	Date/Time	Received By:	Relinquished By:	Date/Time	Received By:
Relinquished By:	Date/Time	Received By:	Relinquished By:	Date/Time	Received By:

The terms and conditions on the following page hereof shall govern services, except when a signed contractual agreement exists.

SAP Worksheet #28-1—Field and Laboratory QC Samples Table

UFP-QAPP Manual Section 3.4

Matrix: SMI (surface or subsurface)

Analytical Group: METAL

Analytical Method / SOP Reference: CA-608 / SW-846 6010C

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data quality indicator (DQI)	Measurement Performance Criteria
Field Triplicates	One per 10 normal field samples	%RSD < 30% (advisory only)	None.	PM/FTL, Data Validator	Precision	%RSD < 30% (advisory only)
Equipment Rinseate Blank	One per day when equipment is decontaminated	Same as for method blank	Assess equipment decontamination procedures and ambient field conditions. Qualify as per Worksheet #36.	PM/FTL, Data Validator	Contamination	Same as for method blank
Temperature Blank	One per cooler if samples are iced (refer to Worksheet #19)	≤ 6°C but not frozen	Advisory. Notify PC. Assess sample packaging and shipment procedures.	Laboratory PM, PM/FTL	Representativeness	≤ 6°C but not frozen
Multi Incremental Sample Preparation (for SMI samples)						
Soil drying procedure	Each sample and batch LCS	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.
Soil sieving procedure	Each sample and batch LCS	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.
Sol grinding procedure	Initial demonstration	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 um by passing representative portions of ground sample through a 200 mesh sieve.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 um by passing representative portions of ground sample through a 200 mesh sieve.
Soil grinding blank	Between each sample	A grinding blank using clean solid matrix (such as Ottawa sand) must be prepared (e.g., ground and subsampled) and analyzed in the same manner as a field sample. Grinding blanks can be analyzed individually or composited (composites are preferred). No target analytes detected greater than 1/2 Reporting Limit (RL).	All blank results must be reported and the affected samples must be flagged accordingly if blank criteria is not met. If the composite grinding blank exceeds the acceptance criteria, apply B-flag to all samples associated with the grinding composite. If any individual grinding blank is found to exceed the acceptance criteria, apply B-flag to the sample following that blank.	Analyst	Contamination, Representativeness	A grinding blank using clean solid matrix (such as Ottawa sand) must be prepared (e.g., ground and subsampled) and analyzed in the same manner as a field sample. Grinding blanks can be analyzed individually or composited (composites are preferred). No target analytes detected greater than 1/2 Reporting Limit (RL).

SAP Worksheet #28-1—Field and Laboratory QC Samples Table (continued)

UFP-QAPP Manual Section 3.4

Matrix: SMI (surface or subsurface)

Analytical Group: METAL

Analytical Method / SOP Reference: CA-608 / SW-846 6010C

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data quality indicator (DQI)	Measurement Performance Criteria
Soil subsampling process	Each sample and batch LCS	Entire ground sample is mixed, spread out on a large flat surface (e.g., baking tray), and 30 or more randomly located increments are removed from the entire depth to sum a subsample.	N/A. Flagging criteria are not appropriate.	Analyst	Precision, Representativeness	Entire ground sample is mixed, spread out on a large flat surface (e.g., baking tray), and 30 or more randomly located increments are removed from the entire depth to sum a subsample.
Ground LCS (or cerfified reference material)	One per preparatory batch	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. Accuracy limits are specified below (for unground LCS). However, if a certified referenece material is used, then manufacturer's limits shall apply.	Reevaluate grinding procedure for future samples. At this point, the affected samples have already been ground. Qualify as per Worksheet #36.	Analyst, Data Validator	Accuracy, Representativeness	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. Accuracy limits are specified below (for unground LCS). However, if a certified referenece material is used, then manufacturer's limits shall apply.
Laboratory triplicate	At the subsampling step, one sample per batch. Cannot be performed on any type of blank sample	Three subsamples are taken from a sample expected to contain the highest levels of analytes within the Quantitation Range of the method. The RSD for results above the RL must not exceed 20%.	Corrective action must be taken if this criterion is not met (e.g., the grinding process should be investigated to ensure that the samples are being reduced to a sufficiently small particle size). Apply J-flag if corrective action does not solve problem and no sample available.	Analyst	Precision, Representativeness	Three subsamples are taken from a sample expected to contain the highest levels of analytes within the Quantitation Range of the method. The RSD for results above the RL must not exceed 20%.
Analytical Laboratory QA/QC Samples						
Method Blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.2 . If required, reprep and reanalyze method blank and all samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Contamination	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
Interference Check Solutions (ICS-A and ICS-AB)	At the beginning of an analytical run and every 12 hours.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.	Terminate analysis, locate and correct problem, reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	Analyst	Accuracy	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ±20% of true value.

SAP Worksheet #28-1—Field and Laboratory QC Samples Table (continued)

UFP-QAPP Manual Section 3.4

Matrix: SMI (surface or subsurface)

Analytical Group: METAL

Analytical Method / SOP Reference: CA-608 / SW-846 6010C

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data quality indicator (DQI)	Measurement Performance Criteria
Unground Laboratory Control Sample (LCS)	One per preparatory batch if deemed necessary by the laboratory (i.e. to demonstrate the analytical system is in control).	80-120% recovery for Sb, Cu, Pb, Zn. Limits are as per DoD QSM v. 4.1 Table G-19.	Correct problem then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch. Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.	Analyst	Accuracy	80-120% recovery for Sb, Cu, Pb, Zn. Limits are as per DoD QSM v. 4.1 Table G-19.
Matrix Spike (MS)	One per preparatory batch per matrix	Same as for LCS	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests (dilution test and post-digestion spike addition) are required to evaluate matrix effects. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	Same as for LCS
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix	Same as for LCS and 20% RPD.	Same as for MS.	Analyst	Accuracy / Precision	Same as for LCS and 20% RPD.
Dilution Test	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement.	Perform post-digestion spike addition. Flagging criteria are not appropriate. Only applicable for samples within concentration > 50X LOQ.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement.
Post digestion spike addition	When dilution test fails or analyte concentration for all samples < 50X LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. Spike addition should produce a concentration of 10-100X LOQ.	Analyst	Accuracy	Recovery within 75-125%.
Method of standard additions (MSA)	When matrix interference is confirmed.	N/A	Document use of MSA in the case narrative.	Analyst	Accuracy	N/A
Results reported between DL and LOQ	N/A	Apply J-flag to all results between DL and LOQ.	N/A	Analyst	Accuracy	N/A

Notes:

DoD QSM v. 4.2 is the basis for specifications on this table.

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic portable document format (.pdf) copies in the project file. Hardcopy (bound notebook) in the project file. Archived at project closeout.
Chain-of-custody Records	Electronic .pdf copies in the project file. Hardcopy in the data validation report. Archived at project closeout.
Airbills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
CA Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Various field measurements	Recorded in Field Notebook.
All field equipment calibration information	Recorded in Field Notebook.
Pertinent telephone conversations	Recorded in Field Notebook.
Field equipment maintenance records	Inspected by FTL. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package.
Standard Traceability Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Calibration Logs	Hardcopy in the full data package. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package. Archived at project closeout.
Run Logs	Hardcopy in the full data package. Archived at project closeout.
Equipment Maintenance, Testing, and Inspection Logs	Hardcopy in the full data package. Archived at project closeout.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the data package. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package. Archived at project closeout.
Data Package Completeness Checklists	Hardcopy in the data validation report. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.

SAP Worksheet #29—Project Documents and Records Table (continued)

Document	Where Maintained
Extraction/Cleanup Records	Maintained by the laboratory.
Raw Data	Hardcopy in the full data package. Archived at project closeout.
Field Sampling Audit Checklists	Hardcopy in the project file. Archived at project closeout.
Fixed Laboratory Audit Checklists	If completed, hardcopy in the project file. Archived at project closeout.
Data Validation Reports	Electronic .pdf copies in the project file. Hardcopy stored with the data package. Archived at project closeout.

Following project completion, hardcopy deliverables such as logbooks, chain of custodies, raw data, data validation reports, and so forth will be archived at Iron Mountain until requested by the Navy:

Iron Mountain headquarters:
745 Atlantic Avenue
Boston, MA 02111

SAP Worksheet #30—Analytical Services Table

UFP-QAPP Manual Section 3.5.2.3

Matrix	Analytical Group	Sample Locations / ID Numbers	Analytical SOP[1]	Data Package Turnaround Time[2]	Laboratory / Organization	Backup Laboratory / Organization
SMI (surface and subsurface)	METAL	100	CA-608	~50 at 7-day TAT ~25 at 72-hr TAT ~15 at 48-hr TAT ~10 at 24-hour TAT	Katahdin Analytical Services, Inc. Attn: Sample Receiving 600 Technology Way Scarborough, ME 04074 (207) 874-2400 POC: Jennifer Obrin	TBD

Notes:

[1]Later versions of the indicated analytical and preparation methods may be used during the ICM.

[2] Data package turnaround time is based on the estimated number of samples for each subarea and assuming that the remediation would proceed in the following order: rifle range, pistol range, and former pistol range.

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Field Performance Audit	1 during sampling activities	Internal	CH2M HILL	Field Auditor (TBD) CH2M HILL	FTL (TBD)/CH2M HILL	FTL (TBD)/CH2M HILL	AQM— Jamie Butler/CH2M HILL
Third-Party Laboratory Technical Systems Audit	Laboratory must have current DoD ELAP evaluation letter that will identify the period of performance. The laboratory must be re-evaluated prior to expiration of period of performance.	External	Third-party accrediting bodies on behalf of DoD ELAP	TBD, third-party accrediting bodies on behalf of DoD ELAP	QAO/TBD	QAO/TBD	Program Chemist— Anita Dodson/CH2M HILL

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SAP Worksheet #32—Assessment Findings and CA Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (Name, Title, Organization)	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	Thomas Roth/CH2M HILL, PM	Within 1 week of audit	Memorandum	TBD FTL CH2M HILL Jamie Butler AQM CH2M HILL	Within 1 week of receipt of CA Form
Third-Party Laboratory Technical Systems Audit	Written audit report from third-party accrediting body	QAO/TBD	Within 2 months of audit	Memorandum	Third-party Auditor, TBD	Within 2 months of receipt of initial notification

SAP Worksheet #32-1—Laboratory CA Form

Person initiating CA _____ **Date** _____

Description of problem and when identified: _____

_____

_____

Cause of problem, if known or suspected: _____

_____

_____

Sequence of CA: (including date implemented, action planned, and personnel/data affected) _____

_____

_____

_____

_____

_____

_____

_____

CA implemented by: _____ **Date:** _____

CA initially approved by: _____ **Date:** _____

Follow-up date: _____

Final CA approved by: _____ **Date:** _____

Information copies to:

Anita Dodson/CH2M HILL Navy CLEAN Program Chemist

_____

_____

SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members: _____

Yes __ No __ 1) Is the approved work plan being followed?
Comments _____

_____

Yes __ No __ 2) Was a briefing held for project participants?
Comments _____

_____

Yes __ No __ 3) Were additional instructions given to project participants?
Comments _____

_____

Sample Collection

Yes __ No __ 1) Is there a written list of sampling locations and descriptions?
Comments _____

_____

Yes __ No __ 2) Are samples collected as stated in the Master SOPs?
Comments _____

_____

Yes __ No __ 3) Are samples collected in the type of containers specified in the work plan?
Comments _____

_____

Yes __ No __ 4) Are samples preserved as specified in the work plan?
Comments _____

_____

Yes __ No __ 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments _____

_____

Yes __ No __ 6) Are QA checks performed as specified in the work plan?
Comments _____

_____

SAP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes __ No __ 7) Are photographs taken and documented?
Comments _____

_____

Document Control

Yes __ No __ 1) Have any accountable documents been lost?
Comments _____

_____

Yes __ No __ 2) Have any accountable documents been voided?
Comments _____

_____

Yes __ No __ 3) Have any accountable documents been disposed of?
Comments _____

Yes __ No __ 4) Are the samples identified with sample tags?
Comments _____

_____

Yes __ No __ 5) Are blank and duplicate samples properly identified?
Comments _____

_____

Yes __ No __ 6) Are samples listed on a chain-of-custody record?
Comments _____

Yes __ No __ 7) Is chain-of-custody documented and maintained?
Comments _____

_____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, and so forth)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Field Audit Report	One during sampling activities (if selected for audit on program level)	Submitted with final reports	Lisa Carter Program Field Auditor/CH2M HILL	If applicable, included in Confirmatory Sampling Report.
Data Usability Assessment Report	One after all data are generated and validated	Submitted with final reports	Michael Zamboni Project Chemist/CH2M HILL	Included in Confirmatory Sampling Report.

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SAP Worksheet #34-36—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)

Data Review Input	Description	Responsible for Verification/Validation	Step I / IIa / IIb[1]	Internal / External[2]
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	FTL/CH2M HILL (TBD)	Step I	Internal
Chains of Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment.	FTL/CH2M HILL (TBD) Michael Zamboni/CH2M HILL, PC	Step I	Internal / External
Sample Condition Upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PDM in the form of laboratory logins.	Michael Zamboni/CH2M HILL, PC	Step I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	Michael Zamboni/CH2M HILL, PC	Step I	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	Michael Zamboni/CH2M HILL, PC	Step I	External
Case Narrative	Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages.	TBD/Subcontractor	Step I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Leslie Dimond/Katahdin (Laboratory QAO)	Step I	Internal
Laboratory Data	The data will be verified for completeness by a PDM.	Michael Zamboni/CH2M HILL, PC	Step I	External
Laboratory Data	All laboratory data packages require signoff by a Puerto Rico Certified chemist.	TBD (Katahdin's subcontractor)	Step I	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	Thomas Roth/CH2M HILL, PM Michael Zamboni/CH2M HILL, PC	Step I	Internal

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification/Validation	Step I / IIa / IIb[1]	Internal / External[2]
Corrective Action Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	Thomas Roth/CH2M HILL, PM Michael Zamboni/CH2M HILL, PC	Step I	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	Michael Zamboni/CH2M HILL, PC	Step IIa	External
Target Compounds List / Target Analyte List	Ensure the laboratory reported all analytes from each analysis group as per Worksheet 15.	Michael Zamboni/CH2M HILL, PC	Step IIa	External
Reporting Limits	Ensure the laboratory met the project-designated quantitation limits as per Worksheet 15. If quantitation limits were not met, the reason will be determined and documented.	Michael Zamboni/CH2M HILL, PC	Step IIb	External
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Ward Dickens/CH2M HILL, DV	Step IIa	External
Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the DV during the data validation process.	Ward Dickens/CH2M HILL, DV	Step IIa / IIb	External
Raw Data[3]	10 percent review of raw data to confirm laboratory calculations.	Ward Dickens/CH2M HILL, DV	Step IIa	External
Onsite Screening	All non-analytical field data will be reviewed against QAPP requirements for completeness and accuracy based on the field calibration records.	FTL/CH2M HILL (TBD)	Step IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Ward Dickens/CH2M HILL, DV	Step IIa	External
Documentation of Field QC Sample Results	Establish that all required QAPP QC samples were run and met limits.	Michael Zamboni/CH2M HILL, PC TBD/Subcontracted Data Validator	Step IIb	External

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table (continued)

Data Review Input	Description	Responsible for Verification/Validation	Step I / IIa / IIb[1]	Internal / External[2]
Analytical Data Validation (METAL)[3]	Analytical methods and laboratory SOPs, as presented in this UFP-SAP, will be used to evaluate compliance against QA/QC criteria. QA/QC criteria for field QC samples are presented in Worksheet 28, QA/QC criteria for calibrations are presented in Worksheet 24, and QA/QC criteria for laboratory QC samples are presented in Worksheet 28. Reference limits and laboratory-specific limits are presented in Worksheet 15. Data may be qualified if QA/QC exceedances have occurred. Data qualifiers will be those presented in *SOP No. HW-2a Revision 15 ICP-AES Data Validation* (USEPA, January 2012). Note that HW-2a is written to accompany EPA CLP ISM01.X and because there are no USEPA Region II SOPs for data validation of 6010 data, the data validator may prepare in-house worksheets similar to those familiar to Region II. Additional guidance from "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (EPA 540-R-10-011, January 2010) may also be applicable.	TBD/Subcontracted Data Validator	Step IIa and IIb	External

Notes:

[1] IIa = compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
IIb = comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

[2] Internal/External is with respect to the data generator.

[3] 100% of Definitive data will be Level IV validated. Of the 100% validated, the DV will recalculate 10% of results from the raw data.

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SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Nondetected site contaminants will be evaluated to ensure that PQLs listed in Worksheet #15 were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable. If PQLs were not achieved, then the reason will be investigated and documented, and the impact on data usability will be discussed.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases are not considered usable for project decisions.
  - J—Analyte present. Reported value is estimated and may or may not be accurate or precise
  - UJ—Analyte not detected. Quantitation limit may be inaccurate or imprecise
  - K—Analyte present. Reported value is estimated and may be biased high. Actual value is expected to be lower.
  - L—Analyte present. Reported value is estimated and may be biased low. Actual value is expected to be higher.
  - UL—Analyte not detected. Quantitation limit is probably higher.
  - R—Rejected result. Result is not usable.
- Additional qualifiers that may be given by the validator include B, N, NJ, and U:
  - B—Not detected significantly greater than that in an associated blank.
  - I—Interferences present that may cause the result to be biased high.
  - N—Tentative ID. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling.
  - NJ—Qualitative ID questionable due to poor resolution. Presumptively present at approximate quantity.
  - U—Not detected.
- For statistical comparison, nondetect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the greater of values will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be assessed as RPD between the two results.
- Deviations from the UFP-SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

SAP Worksheet #37—Usability Assessment (continued)

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

The following will be prepared by CH2M HILL and presented to and submitted to the Tier I Partnering Team (PREQB, USEPA, and the Navy) for review and decisions on the path forward for the site.

Data tables will be produced to reflect detected and nondetected site COCs. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.

Graphical representations will be produced to reflect increasing and/or decreasing concentrations of COCs.

A data quality evaluation will be provided as part of presentations to the Partnering Team, followed by the Confirmatory Sampling Report prepared to assess the interim remedy effectiveness. The Confirmatory Sampling Report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

- The CH2M HILL team, including the PM and PC, will compile project data and make recommendations pertaining to the usability of the data. The data will be provided to the Partnering Team for discussion and review, and the team as a whole will evaluate the usability of the data.

References

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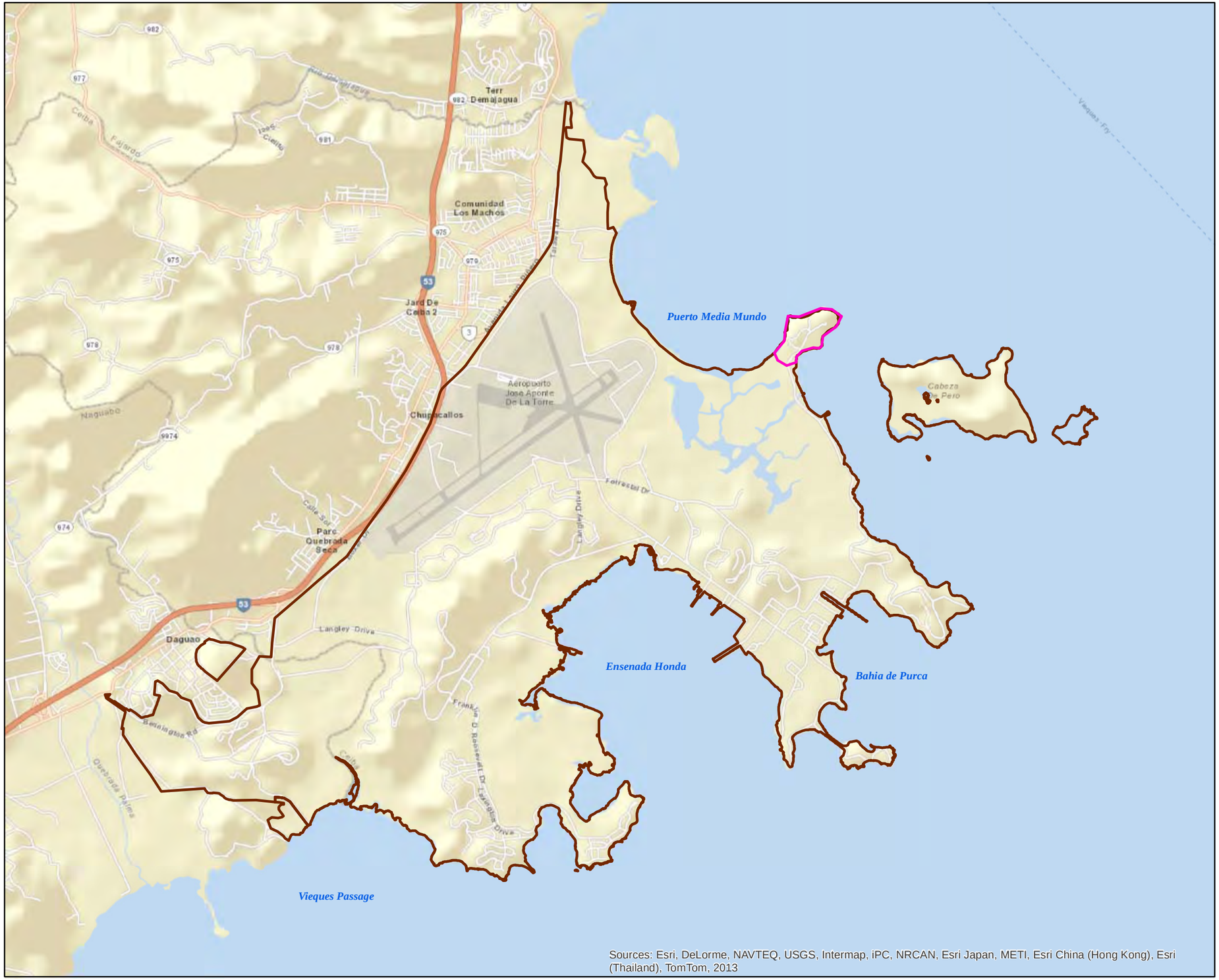
Figures



VICINITY MAP

LEGEND

- Site UXO 1 (SWMU 77) Boundary
- Former Facility Boundary

Notes:
1. Background - ArcMap Streaming Map Service

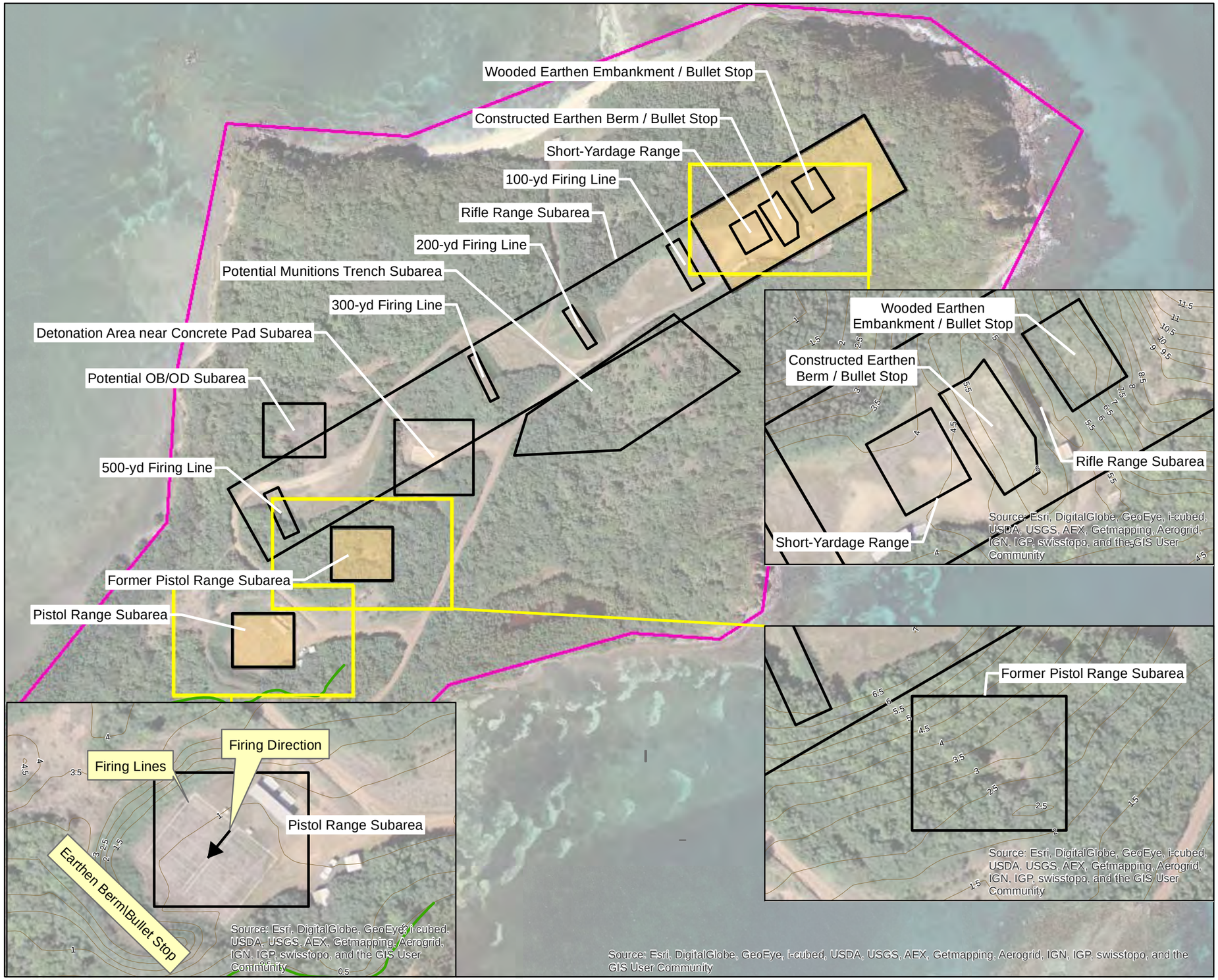
N

0 2,500 5,000 10,000
Feet

FIGURE 1
Facility and Site Location
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL.

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\UFP-SAP\FIGURE01_SWMU77_REGIONALMAP.MXD BMAILHES 9/25/2013 1:05:39 PM



VICINITY MAP

LEGEND

- Approximate mangrove lagoon boundary
- Subarea Boundary
- Subarea Subject to Interim Corrective Measures
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 125 250 500
Feet

FIGURE 2
Site Map
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL.

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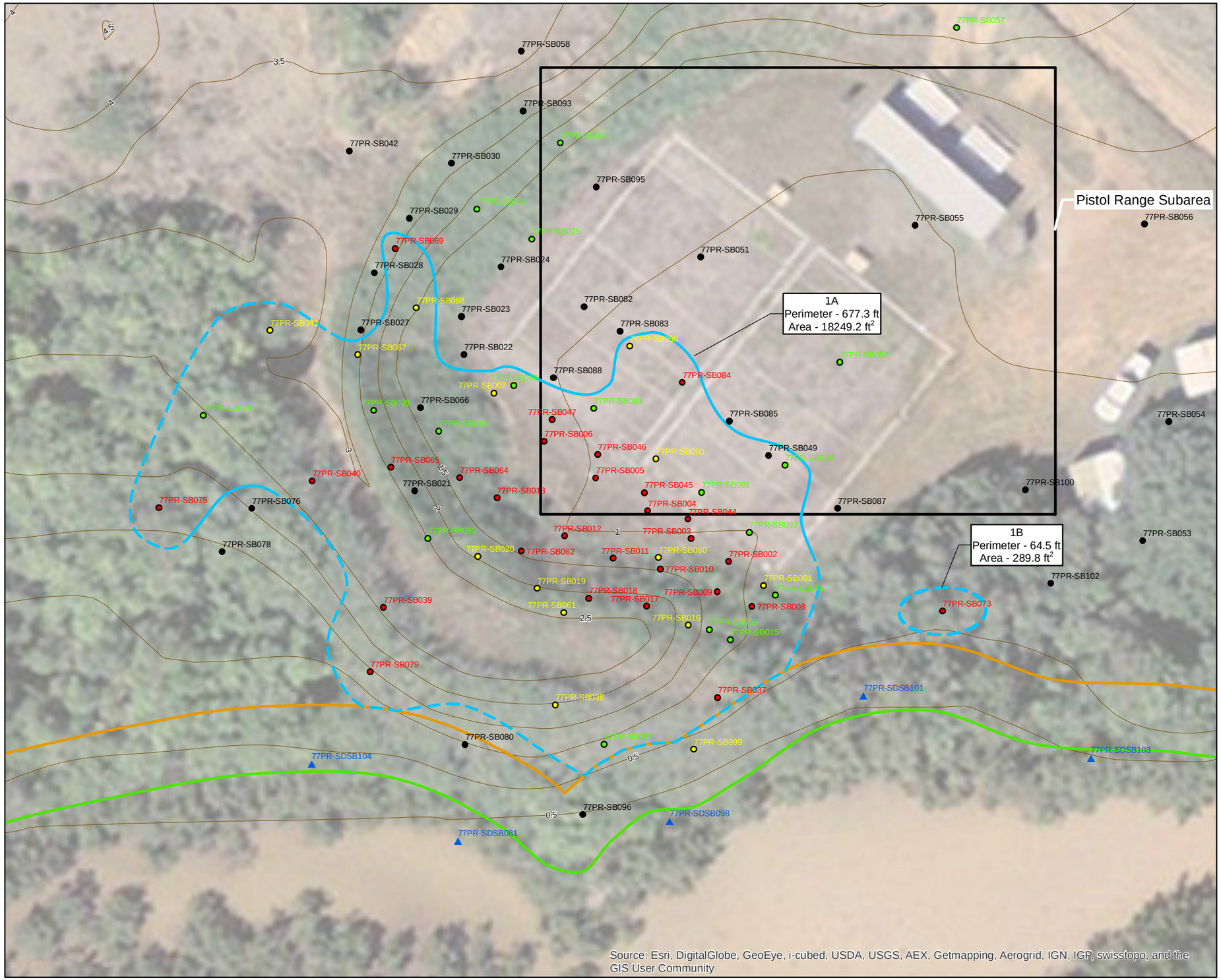

VICINITY MAP

LEGEND

- Sediment Samples from Mangrove Wetland

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Approximate Mangrove Lagoon Boundary
- Disturbance Limit with Engineering Controls
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 3
Surface Soil PRG Comparison
Pistol Range Subarea Surface Soil
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

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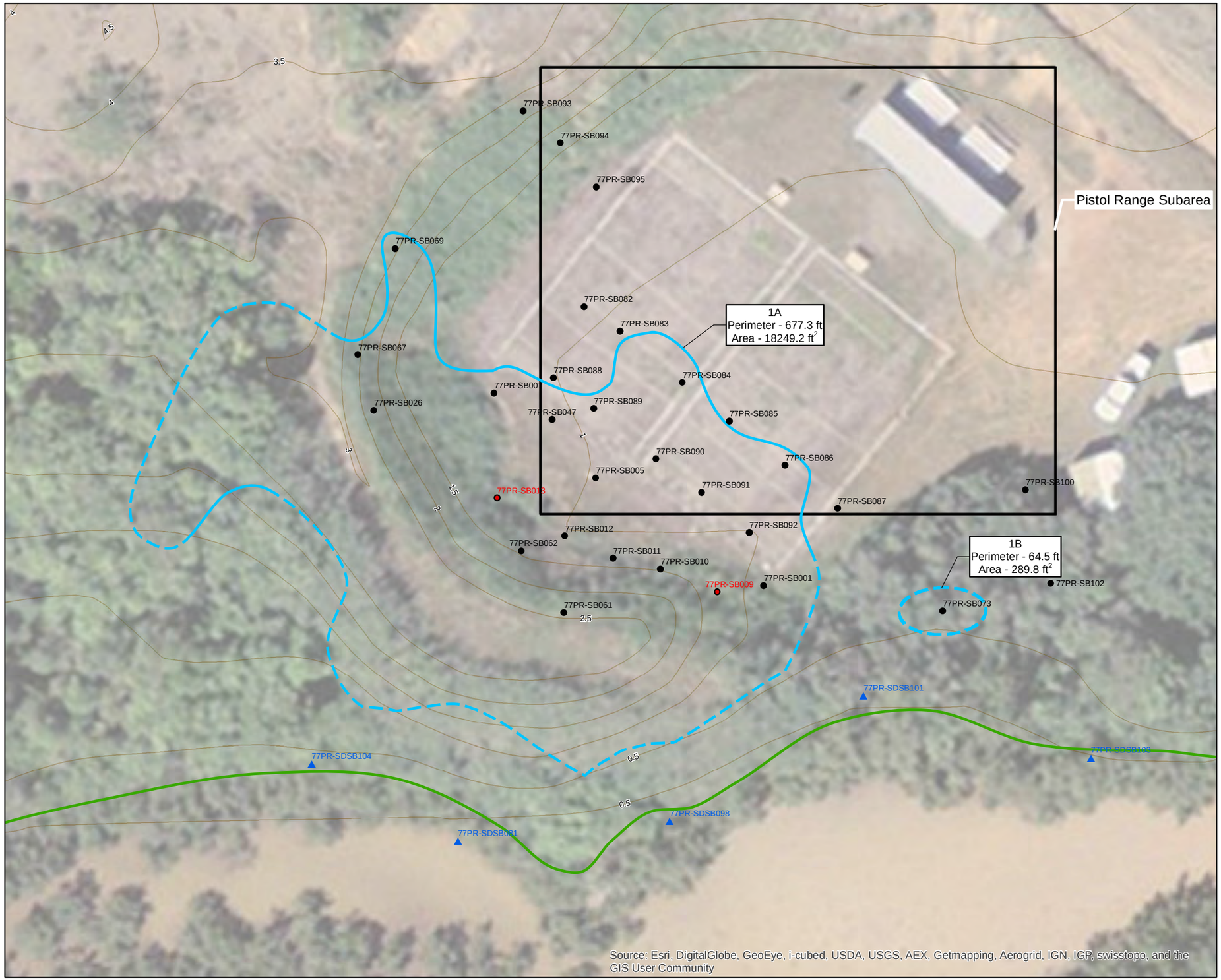

VICINITY MAP

LEGEND

- Sediment Samples from Mangrove Wetland

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Approximate mangrove lagoon boundary
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. Soil removal assumed to be 1 foot with the possibility of extending to 2 feet.

N

0 15 30 60
Feet

FIGURE 4
Subsurface Soil PRG Comparison
Pistol Range Subarea Subsurface Soil
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

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VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 5
Surface Soil PRG Comparison
Former Pistol Range Subarea Surface Soil
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

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VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. All sample locations have a prefix of "77RR-" which is not shown to improve readability of the figure.

N

0 25 50 100
Feet

FIGURE 6
Surface Soil PRG Comparison
Rifle Range Subarea Surface Soil
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\UFP-SAP\FIGURE06_SWMU77_SURFACESOIL_SUBAREA_RIFLERANGE.MXD JCARR 9/19/2013 2:40:42 PM

VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. All sample locations have a prefix of "77RR-" which is not shown to improve readability of the figure.

N

0 25 50 100
Feet

FIGURE 7
Subsurface Soil PRG Comparison
Rifle Range Subarea Subsurface Soil
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\UFP-SAP\FIGURE07_SWMU77_SUBSURFACESOIL_SUBAREA_RIFLERANGE.MXD JCARR 9/19/2013 2:58:58 PM

VICINITY MAP

LEGEND

- Approximate Mangrove Lagoon Boundary
- Topographic Contour (elevation in meters)

Removal Area Boundary

- Actual
- Inferred
- Soil Removal to 1'
- Soil Removal to 3'
- Soil Removal to Grade (approx. 10ft.)
- Subareas
- Site UXO-01 Boundary (SWMU 77)

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 100 200 400
Feet

FIGURE 8
Soil Removal Areas
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

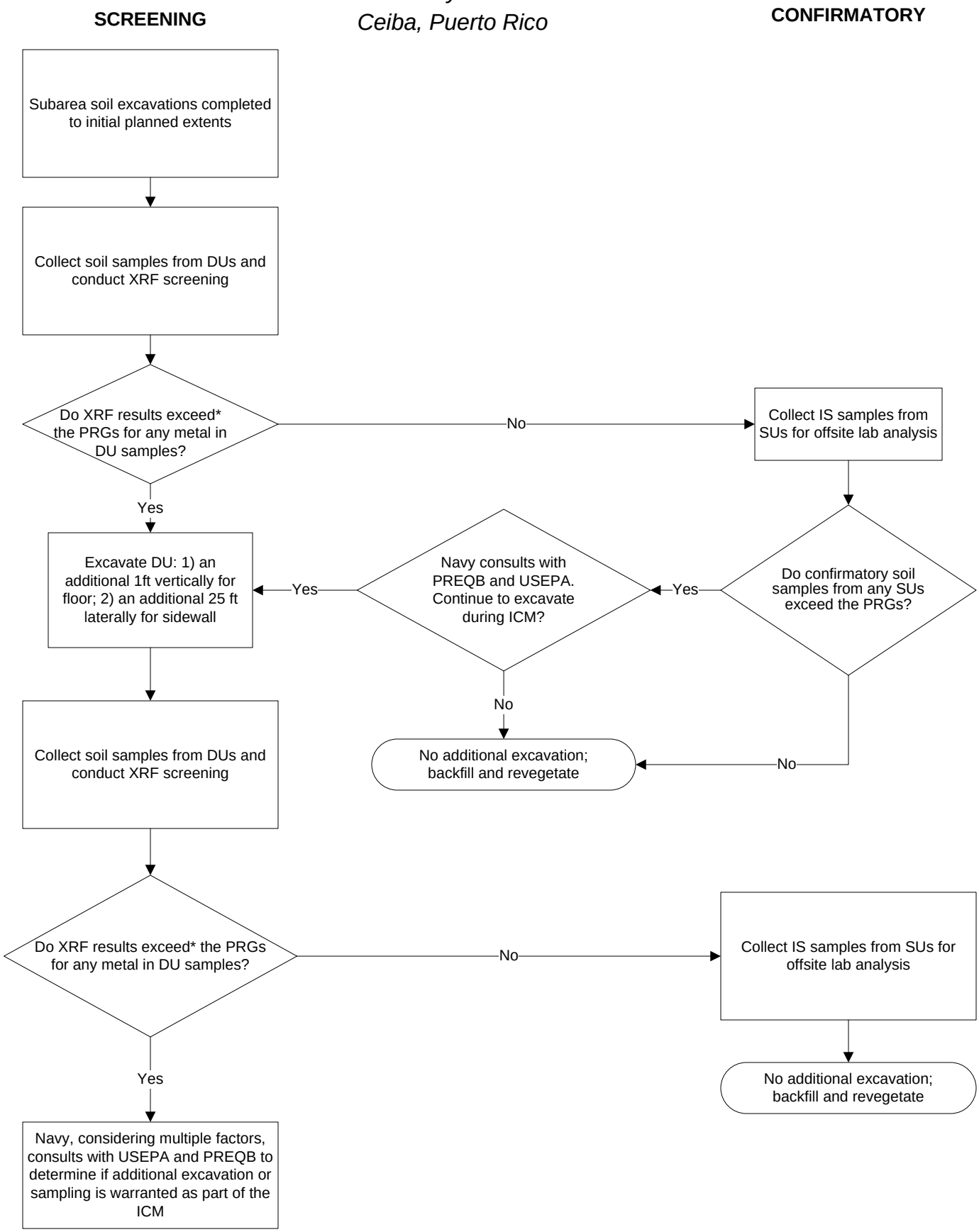
CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\SWMU_77_SUBAREASOILREMOVAL.MXD JCARR 9/23/2013 9:28:18 AM

Figure 9
Screening and Confirmatory Sampling Process
Site UXO 1 (SWMU 77)

Naval Activity Puerto Rico

Ceiba, Puerto Rico



* The exccedance criteria considers a potential 20% error in concentration of metals using XRF.

Attachment 1
Risk Evaluation and PRG Discussion

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ATTACHMENT 1

Risk Evaluation and PRG Development

This attachment includes a human health and ecological risk evaluation for each of the six Subareas at Site UXO 1 (SWMU 77). For Subareas where potentially unacceptable risks exist, preliminary remediation goals (PRGs) were developed for each chemical of concern (COC) in soil. These PRGs, along with available analytical soil data, were then used to identify specific locations within each applicable Subarea where a RCRA corrective action interim measure (soil removal) was appropriate.

All available surface soil (0-0.5 ft), subsurface soil (0.5-2 and 2-3 ft), and surface sediment data from all 6 Subareas (Tables 1-1 through 1-3; Figures 1-1 through 1-6) were considered. In addition to risk-based screening values, facility-specific soil background concentrations (Table 1-4; CH2M HILL, 2013) were used in the evaluation.

1.1 Human Health Risk Evaluation

Human health screening (HHS) was performed on each of the six Subareas at Site UXO 1 (SWMU 77). The HHS used a streamlined but conservative evaluation approach, following the general USEPA Superfund HHRA guidance. The soil samples collected from soil depths between 0 to 3 ft at Site UXO 1 (SWMU 77) in 2010, 2012, and 2013 were grouped into corresponding Subareas. The maximum detected concentrations of analytes detected at each Subarea were then compared to human health screening levels (HHSLs) to identify chemicals of potential concern (COPCs). The EPA's *RSLs for Chemical Contaminants at Superfund Sites* (USEPA, 2013a) for residential and industrial soils, based on a target excess lifetime cancer risk (ELCR) of $1x10^{-6}$ and a non-carcinogenic hazard quotient (HQ) of 0.1, were used as HHSLs. When an analyte had both carcinogenic and non-carcinogenic RSLs, the lower of the two RSLs was used as the final HHSL.

USEPA considers lead to be a special case because of the difficulty in identifying the classic "threshold" needed to develop a reference dose (RfD). Therefore, lead was evaluated separately from the rest of the analytes. The residential soil RSL for lead (400 milligrams per kilogram [mg/kg]) and the industrial soil RSL for lead (800 mg/kg) based on bio-kinetic models were used as HHSLs. Following USEPA guidance (USEPA, 1994), average detected concentrations were used in the lead evaluations.

After identifying COPCs by comparing the maximum detected concentrations to HHSLs based on a ELCR of $1x10^{-6}$ and a HQ of 0.1 at each Subarea, potential carcinogenic risk and non-carcinogenic hazard associated with exposures to COPCs in soil were estimated using the ratio of HHSLs and exposure point concentrations (EPCs). Initially, the potential risk and hazard were conservatively estimated using the maximum detected concentrations as EPCs. USEPA Superfund guidance considers an acceptable site ELCR range to be within 1 to 100 in a million ($1x10^{-6}$ to $1x10^{-4}$). Generally, remedial actions are not warranted for site media with an ELCR of $1x10^{-4}$ or below, or a Hazard Index (HI) of 1 or less. Therefore, an ELCR of $1x10^{-4}$ and HI of 1 were used as the cumulative risk threshold levels for each Subarea. Although maximum detected concentrations were initially used as the EPCs, iterative calculations were performed using the upper confidence limit (UCL) on the mean as the EPCs for those Subareas exhibiting risks above $1x10^{-4}$ or HI above 1 to provide more realistic (rather than worst-case) risk estimates. When the estimated cumulative risk or hazard exceeded the threshold levels for a Subarea, EPCs based on the UCL on the average concentrations were calculated using USEPA ProUCL software version 5.0.00 (USEPA, 2013b) for the chemical posing an ELCR greater than $1x10^{-6}$ or HQ greater than 1, and the potential risk and hazard were recalculated based on the resulting EPCs. Further, when the non-cancer HI summing all HQs exceeded the threshold value of 1, an HI was calculated for each applicable target organ to assess whether the non-cancer hazard was acceptable on a target-organ basis. The chemicals exceeding the risk threshold levels or lead exceeding its HHSLs were identified as COCs and were considered as candidates for remedial action. The data summary, as well as comparison to HHSLs and identification of COPCs/COCs, is presented in Tables 1-5, 1-6, and 1-7.

The results of the human health risk screening, by Subarea, are presented in the following subsections.

1.1.1 Detonation Area Near Concrete Pad Subarea

The estimated cumulative ELCR and HI (on a target-organ basis) are within the risk threshold levels under both residential and industrial exposure scenarios. The average detected concentration of lead was below residential and industrial HHSLs. Therefore, potential human health risk associated with soil in the Detonation Area was considered acceptable and no COCs were identified.

1.1.2 Former Pistol Range Subarea

The estimated cumulative ELCR and HI are within the risk threshold levels under both residential and industrial exposure scenarios. Although lead concentration in one sample (77FP-SS049G-00.5) exceeded 10 times its residential soil HHSL, the average detected concentration of lead was below residential and industrial HHSLs. Because the Former Pistol Range Subarea is relatively small in size (less than 0.5 acres) and the elevated concentrations of lead were observed only in parts of the Subarea, the use of the average detected concentration as the EPC is deemed appropriate. Therefore, potential human health risk associated with soil in the Former Pistol Range Subarea was considered acceptable and no COCs were identified.

1.1.3 Potential Munitions Trench Subarea

The estimated cumulative ELCR and HI are within the risk threshold levels under both residential and industrial exposure scenarios. The average detected concentration of lead was below residential and industrial HHSLs. Therefore, potential human health risk associated with soil in the Munitions Trench Subarea was considered acceptable and no COCs were identified.

1.1.4 Potential OB/OD Subarea

The estimated cumulative ELCR and HI are within the risk threshold levels under both residential and industrial exposure scenarios. The average detected concentration of lead was below residential and industrial HHSLs. Therefore, potential human health risk associated with soil in the Open Burn/Open Detonation Subarea was considered acceptable and no COCs were identified.

1.1.5 Pistol Range Subarea

The estimated cumulative ELCR and HI (on a target-organ basis) are within the risk threshold levels under both residential and industrial exposure scenarios. However, the average detected concentration of lead exceeds both residential and industrial HHSLs. Therefore, lead was identified as a COC at the Pistol Range Subarea.

1.1.6 Rifle Range Subarea

The estimated cumulative HIs for two target organs (whole body and GI system) exceed the non-cancer hazard threshold of 1 due to antimony and copper, respectively, under a residential exposure scenario. The estimated cumulative ELCR under both residential and industrial exposure scenarios, and the estimated HI under the industrial exposure scenario, are below the risk threshold levels. The average detected concentration of lead exceeded both residential and industrial HHSLs. Therefore, antimony, copper, and lead were identified as COCs at the Rifle Range Subarea.

1.1.7 Summary

Unacceptable risks were identified at the Pistol Range and Rifle Range Subareas. COCs for the Pistol Range included lead, and, for the Rifle Range Subarea, included antimony, copper, and lead.

In addition to metal analytes, the data evaluated in this human health risk screening included explosives. With the exception of nitroglycerin, all explosives were detected at concentrations considerably lower than their respective HHSLs and at relatively low frequencies. Nitroglycerin was identified as a COPC in five subareas (Detonation Area, Former Pistol Range, Munitions Trench, Pistol Range, and Rifle Range). Although no unacceptable human health risks were identified for nitroglycerin based on comparisons to risk threshold levels, because of the presence of elevated concentrations at isolated sample locations and limited vertical delineation (i.e., mostly analyzed in samples collected in shallow depth intervals), it was decided not to consider nitroglycerin in delineating areas for

the interim removal action (see Section 1.5). Rather, additional investigation of nitroglycerin will be conducted as part of a supplemental RFI.

1.2 Ecological Risk Evaluation

1.2.1 Conceptual Site Model

Site UXO 1 (SWMU 77) is approximately 66 acres in size and is located on the peninsula of Punta Medio Mundo at the northeastern boundary of the facility. Site UXO 1 (SWMU 77) was used primarily as a small arms range, and potentially for munitions disposal or detonation, based on the analysis of historical aerial photographs. Site UXO 1 (SWMU 77) has been divided into six subareas with different potentials for munitions constituents (MC) and/or munitions and explosives of concern (MEC) contamination: (1) Pistol Range, (2) Former Pistol Range, (3) Detonation Area Near Concrete Pad (apparently used for a one-time detonation event), (4) Rifle Range (including a short-yardage range formerly used as a pistol range), (5) Potential Open Burn/Open Detonation (OB/OD), and (6) Potential Munitions Trench.

Most of Site UXO 1 (SWMU 77) is densely vegetated with coastal scrub forest communities dominated in most areas by species such as leadtree (*Leucaena* spp.), box briar (*Randia aculeata*), and sweet acacia (*Acacia farnesiana*). The southwestern end of the site (Pistol Range) contains mangrove habitat associated with the Los Machos Forest, an approximately 1,000-acre mangrove complex. The most dominant mangrove species is black mangrove (*Avicennia germinans*) in the immediate vicinity of the Pistol Range Subarea; however, red (*Rhizophora mangle*) and white (*Laguncularia racemosa*) mangroves occur elsewhere in this lagoon system. Federally listed species potentially occurring at or in the vicinity of Site UXO 1 (SWMU 77) are the endangered yellow-shouldered blackbird (*Agelaius xanthomus*), endangered Puerto Rican boa (*Epicrates inornatus*), endangered Virgin Islands tree boa (*Epicrates monensis granti*), and threatened cóbana negra tree (*Stahlia monosperma*).

Sources of contamination at the Pistol Range, Former Pistol Range, and Rifle Range Subareas at Site UXO 1 (SWMU 77) are primarily a result of past use of the site as small arms firing ranges and related activities. The potential source areas are primarily associated with spent ammunition and casings.

Potential exposures to terrestrial ecological receptors include: (1) direct contact and/or ingestion of surface soil for lower trophic level receptors (terrestrial plants, soil invertebrates, and reptiles), and (2) food web exposures and incidental ingestion of surface soil for upper trophic level receptors (birds and mammals). There is the potential for surface transport from the Pistol Range to the mangrove wetland and subsequent exposure to lower trophic level aquatic receptors (aquatic plants, aquatic and benthic invertebrates, fish, amphibians, and reptiles).

1.2.2 Methodology

The ecological risk evaluation was conducted using a two step process. In the first step, maximum detected concentrations were compared with ecological screening values (ESVs) and facility-specific background values. This step is comparable to a screening ecological risk assessment (ERA). Soil screenings were conducted for both surface samples (0-0.5 ft) and subsurface samples (0.5-2 ft) since ecological exposures are typically confined to the top two feet of the soil column (even though land crabs, or their burrows, were not observed at the Subareas); deeper soil data were not screened.

Soil ESVs used in the evaluation are summarized in Table 1-8 and marine sediment ESVs (used to evaluate the mangrove area at the Pistol Range) are summarized in Table 1-9. Soil ESVs were the lower of the ESV for lower trophic level receptors (terrestrial plants and soil invertebrates) and the ESV (from site-specific food web models) for upper trophic level receptors (birds and mammals). Based on the terrestrial habitats present at Site UXO 1 (SWMU 77), the following upper trophic level receptors were considered when developing the upper trophic level ESVs: (1) Norway rat; (2) Indian mongoose; (3) pearly-eyed thrasher; (4) common ground dove; and (5) red-tailed hawk. Inputs to the food web models for these receptors are listed in Tables 1-10 through 1-16. The resulting ESV was based on back-calculating the soil concentration from a Maximum Acceptable Toxicant Concentration (MATC; the geometric mean of the No Observed Adverse Effect Level and the Lowest Observed Adverse Effect Level) HQ

of 1. Because the ESVs were used to develop interim PRGs, the use of the MATC-based TRVs from food web exposures in the derivation of ESVs, which is reflective of a baseline ERA, was considered most appropriate. Area Use Factors were set to 1 for all calculations. The lowest resulting value for each chemical among the five receptors was the ESV (Tables 1-17 through 1-21).

If the maximum detected concentration equaled or exceeded both ESVs and background values, the constituent was retained as an initial COPC for that medium. This corresponds to a screening ERA (which is Step 2 of the ERA process outlined in USEPA [1997] and NAVFAC [2003]).

In the second step of the ecological risk evaluation process, an evaluation of the data using more realistic assumptions was then done for the constituents (initial COPCs) with ESV and background exceedances. This step of the process corresponds to the first step of a baseline ERA (which is Step 3A of the ERA process outlined in NAVFAC [2003]). The more realistic evaluations considered the following types of information to select refined COPCs:

- The size of the site
- The type and quality of the habitat present on the site and in surrounding areas, and the potential receptors likely to be present
- The frequency and magnitude of ESV and background exceedances
- Average exposure concentrations (mean and 95% UCL)
- The spatial pattern of exceedances
- Additional ESVs from the literature, where applicable
- Other site-specific factors that might be relevant to assessing potential exposures (e.g., soil type, bioavailability, fate, transport properties)

1.2.3 Initial Screening

Initially, maximum concentrations in surface and shallow subsurface soil from all six Subareas combined were compared with ESVs (Tables 1-22 and 1-23). Based on these comparisons, none of the explosives exceeded ESVs in either surface or shallow subsurface soils. Thus, explosives were not considered in the Subarea-specific screenings. In surface soil, all five metals (antimony, arsenic, copper, lead, and zinc) analyzed for exceeded ESVs and were included in the Subarea-specific screenings. In shallow subsurface soil, antimony, copper, lead, and zinc exceeded ESVs and were included in the Subarea-specific screenings.

1.2.4 Detonation Area Near Concrete Pad Subarea

In surface soil, maximum concentrations of copper, lead, and zinc exceeded both ESVs and background, and these three constituents were identified as initial COPCs (Tables 1-24 and 1-25). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean HQ for lead was less than one. Thus, this constituent was not identified as a refined COPC.
- The mean and 95% UCL HQs for copper and zinc exceeded one. This was due to single exceedances in the field duplicate of sample 77DA-SS009G-00_5. However, the parent sample from this location did not exceed ESVs for any constituent (Table 1-25). Thus, copper and zinc were identified as refined COPCs but the uncertainty related to this conclusion is high.

In shallow subsurface soil, maximum concentrations of lead and zinc exceeded both ESVs and background, and these two constituents were identified as initial COPCs (Tables 1-26 and 1-27). Because only one sample was available, a refined analysis was not possible. Thus, copper and zinc were identified as refined COPCs but the uncertainty related to this conclusion is high given the low sample size.

1.2.5 Former Pistol Range Subarea

In surface soil, maximum concentrations of antimony, copper, lead, and zinc exceeded both ESVs and background, and these four constituents were identified as initial COPCs (Tables 1-28 and 1-29). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and/or 95% UCL HQs for antimony and zinc were less than one. Thus, these two constituents were not identified as refined COPCs.
- The mean and 95% UCL HQs for copper and lead exceeded one. Thus, copper and lead were identified as refined COPCs.

In shallow subsurface soil, maximum concentrations of antimony, copper, lead, and zinc exceeded both ESVs and background, and these four constituents were identified as initial COPCs (Tables 1-30 and 1-31). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and/or 95% UCL HQs for antimony and zinc were less than one. Thus, these constituents were not identified as refined COPCs.
- The mean and 95% UCL HQs for copper exceeded one, and the 95% UCL (but not the mean) HQ for lead exceeded one. Although the magnitude of the exceedances were low, copper and lead were identified as refined COPCs because these constituents were also identified as refined COPCs in surface soil.

1.2.6 Potential Munitions Trench Subarea

In surface soil, no constituent exceeded both ESVs and background (Tables 1-32 and 1-33). Thus, no COPCs were identified and there are no unacceptable ecological risks associated with this medium.

In shallow subsurface soil, no constituent exceeded both ESVs and background (Tables 1-34 and 1-35). Thus, no COPCs were identified and there are no unacceptable ecological risks associated with this medium.

1.2.7 Potential OB/OD Subarea

In surface soil, none of the maximum concentrations exceeded both ESVs and background (Tables 1-36 and 1-37). Thus, no initial COPCs were identified and there are no unacceptable ecological risks associated with this medium.

In shallow subsurface soil, maximum concentrations of copper and zinc exceeded both ESVs and background. However, the background exceedance for copper was at a very low magnitude (1.02) so copper was not identified as an initial COPC. Zinc was identified as an initial COPC (Tables 1-38 and 1-39). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and 95% UCL HQs for zinc did not exceed one. Thus, this constituent was not identified as a refined COPC.
- No refined COPCs were identified. Thus, there are no unacceptable ecological risks associated with this medium.

1.2.8 Pistol Range Subarea

In surface soil, maximum concentrations of antimony, arsenic, copper, lead, and zinc exceeded both ESVs and background, and these five constituents were identified as initial COPCs (Tables 1-40 and 1-41). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and 95% UCL HQs for arsenic were less than one, and the frequency of exceedance was only 1 in 58 samples. Thus, this constituent was not identified as a refined COPC.
- The mean and 95% UCL HQs for antimony, copper, and lead exceeded one. Thus, antimony, copper, and lead were identified as refined COPCs.

- The 95% UCL HQ, but not the mean HQ, for zinc exceeded one. However, the mean HQ for zinc was just under one (0.98) and the frequency of exceedance exceeded 20 percent. Thus, zinc was also identified as a refined COPC.

In shallow subsurface soil, maximum concentrations of antimony, copper, and lead exceeded both ESVs and background, and these three constituents were identified as initial COPCs (Tables 1-42 and 1-43). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and 95% UCL HQs for antimony were less than one. Thus, this constituent was not identified as a refined COPC.
- The mean and 95% UCL HQs for copper and lead exceeded one. Thus, copper and lead were identified as refined COPCs.

In sediment samples collected from the edge of the mangrove swamp, maximum concentrations of antimony, copper, lead, and zinc exceeded both ESVs and background, and these four constituents were identified as initial COPCs (Tables 1-44 and 1-45). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean HQs for antimony, copper, lead, and zinc exceeded one. Thus, antimony, copper, lead, and zinc were identified as refined COPCs.

1.2.9 Rifle Range Subarea

In surface soil, maximum concentrations of antimony, arsenic, copper, lead, and zinc exceeded both ESVs and background, and these five constituents were identified as initial COPCs (Tables 1-46 and 1-47). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and 95% UCL HQs for arsenic were less than one. Thus, this constituent was not identified as a refined COPC.
- The mean and 95% UCL HQs for antimony, copper, lead, and zinc exceeded one. Thus, antimony, copper, lead, and zinc were identified as refined COPCs.

In shallow subsurface soil, maximum concentrations of antimony, copper, lead, and zinc exceeded both ESVs and background, and these four constituents were identified as initial COPCs (Tables 1-48 and 1-49). The initial COPCs were then evaluated using more realistic assumptions to select refined COPCs, as follows:

- The mean and 95% UCL HQs for antimony, copper, lead, and zinc exceeded one. Thus, antimony, copper, lead, and zinc were identified as refined COPCs.

1.2.10 Summary

Potential unacceptable risks were identified at the Former Pistol Range, Pistol Range, and Rifle Range Subareas. Refined COPCs for the Former Pistol Range included copper and lead; for the Pistol Range included antimony, copper, lead, and zinc; and for the Rifle Range Subarea included antimony, copper, lead, and zinc. For the Detonation Area, there is high uncertainty in the risk estimates based on inconsistencies in the analytical data and low sample sizes in subsurface samples.

1.3 Risk Evaluation Conclusions and Recommendations

In conclusion, there were no unacceptable ecological or human health risks in the Potential Munitions Trench and Potential OB/OD Subareas. No RCRA corrective action interim measures are recommended for these two Subareas at this time. For the Detonation Area Near Concrete Pad Subarea, there were no unacceptable human health risks and high uncertainty in the ecological risk estimates. For this Subarea, it is recommended that any RCRA corrective action interim measures be deferred at this time until additional characterization as part of a supplemental RFI can be conducted.

For the Former Pistol Range Subarea, there were no unacceptable human health risks but there were potential ecological risks for soil based on copper and lead. It is recommended that a RCRA corrective action interim measure (soil removal) proceed for this Subarea (see Section 1.5).

At the Pistol Range Subarea, there were potential unacceptable ecological and human health risks for soil based on antimony (ecological), copper (ecological), lead (ecological and human health), and zinc (ecological). There were also potential unacceptable ecological and human health risks for sediment in the adjacent mangrove area based on antimony (ecological), copper (ecological), lead (ecological and human health), and zinc (ecological). It is recommended that a RCRA corrective action interim measure (soil removal) proceed for this Subarea (see Section 1.5) but that any action in the mangrove area be deferred at this time.

For the Rifle Range Subarea, there are potential unacceptable ecological and human health risks for soil based on antimony (ecological and human health), copper (ecological and human health), lead (ecological and human health), and zinc (ecological). It is recommended that a RCRA corrective action interim measure (soil removal) proceed for this Subarea (see Section 1.5).

1.4 Development of Preliminary Remediation Goals for Soil

Human health and ecological PRGs were developed for all of the soil constituents with potential unacceptable risks (antimony, arsenic, copper, lead, and zinc). Facility-specific background soil concentrations were also considered during this process. Ecological PRGs were only applied to soil from 0 to 2 ft based on conservative exposure depths for ecological receptors. Human health PRGs were considered for all depth strata.

For soil from 0-2 ft, the selected PRG (Table 1-50) was the lower of the human health and ecological values; the surface soil background value was used if this background value exceeded the lower of the risk-based values. For soil >2 ft, the PRG was the higher of the human health value and the subsurface background value.

1.5 Application of PRGs

To delineate potential removal areas (Figures 1-7, 1-8, and 1-9; Table 1-51), PRGs were used as “not-to-exceed” values but exceedances were categorized by magnitude: (1) ratio of the soil concentration to the PRG <1 (removal not necessary; black dots); (2) ratio 1 – 2 (green dots); (3) ratio >2 – 5 (yellow dots); and (4) ratio >5 (red dots). A not-to-exceed approach was used because it is the most conservative approach and is the simplest to implement for an interim measure.

Preliminary removal areas were plotted for each of the three Subareas based on all metal exceedances, regardless of magnitude, for the 0 – 2 foot soil data, which are representative of conservative ecological exposure depths when backfilled. Preliminary removal areas were then modified to join nearby non-contiguous areas containing high magnitude exceedances (red or yellow sample locations), “square” contours to ease removal logistics, and eliminate non-contiguous areas with low magnitude exceedances (green sample locations only).

For the Pistol Range (Figure 1-7), this resulted in proposed soil removal from two non-contiguous areas totaling approximately 18,540 ft^2 (0.43 acres). Three non-contiguous areas with low magnitude exceedances remain outside of these two areas: (1) 77PR-SB057; (2) 77PR-SB025, 77PR-SB070, and PR77-SB094; and (3) PR77-SB052. The southern boundary of the main removal area (1A) was also adjusted to remain 20 ft from the approximate boundary of the mangrove area (the limit of disturbance with engineering controls). This resulted in one yellow-colored sample location (PR77-SB099) falling outside of the removal area (Figure 1-7).

For the Rifle Range (Figure 1-8), this resulted in proposed soil removal from a single contiguous area totaling about 77,620 ft^2 (1.78 acres). One non-contiguous area (SB055) with low magnitude exceedances remains outside of this area. For the Former Pistol Range (Figure 1-9), this resulted in proposed soil removal from two non-contiguous areas totaling approximately 14,450 ft^2 (0.33 acres).

Within each proposed removal area, an initial one foot removal depth is recommended, with the following exceptions:

- Rifle Range – initial removal depth to three ft at the earthern embankment bullet stop based on 2 – 3 foot PRG exceedances (Figure 1-10)
- Rifle Range – complete removal of the constructed berm bullet stop because all surface samples exceed PRGs and no samples deeper than two ft are currently available

For the Pistol Range, there were only two PRG exceedances in 2 – 3 foot samples (Figure 1-11) so the initial removal will occur at the one foot depth interval. At the Former Pistol Range, no 2 – 3 foot samples have been collected so there are no data on which to adjust the initial removal depth of one foot.

Worksheets #11 and #17 of the UFP-SAP presents the project quality objects and sampling design and rationale, respectively for this project. A 50 x 50 ft grid (discussed in Worksheet #11) is specified based on previous experience with similar removals at Vieques; this spatial resolution is considered appropriate to the receptors and habitats potentially present on the site. A sample depth of 0-12 inches (also discussed in Worksheet #11) was selected because the removal will be conducted in one-foot increments and this depth represents the highest potential exposures for ecological receptors (absent the presence of land crabs, which have not been observed in the proposed removal areas). Up to 60 laboratory confirmation samples from the bottom of the excavation areas (floor samples) will be collected (Table 1-52), plus field duplicates and QC samples (blanks). In addition, up to 40 sidewall laboratory confirmation samples (plus field duplicates and QC samples [blanks]) will be collected, for a total of approximately 100 laboratory confirmation samples.

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Tables

TABLE 1-1

Site UXO 1 (SWMU 77) Surface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
Detonation Area Near Concrete Pad Subarea			
77DA-SB001	77DA-SS001G-00_5	0 - 0.5	5/22/2010
77DA-SB002	77DA-SS002G-00_5	0 - 0.5	5/22/2010
77DA-SB003	77DA-SS003G-00_5	0 - 0.5	9/20/2012
77DA-SB004	77DA-SS004G-00_5	0 - 0.5	9/20/2012
77DA-SB005	77DA-SS005G-00_5	0 - 0.5	9/20/2012
77DA-SB006	77DA-SS006G-00_5	0 - 0.5	9/20/2012
77DA-SB007	77DA-SS007G-00_5	0 - 0.5	9/20/2012
77DA-SB008	77DA-SS008G-00_5	0 - 0.5	9/20/2012
77DA-SB009	77DA-SS009G-00_5	0 - 0.5	9/20/2012
77DA-SB009	77DA-SS009G-00_5-D	0 - 0.5	9/20/2012
77DA-SB010	77DA-SS010G-00_5	0 - 0.5	9/20/2012
77DA-SB011	77DA-SS011G-00_5	0 - 0.5	9/20/2012
77DA-SB012	No surface sample	--	--
77DA-SB013	No surface sample	--	--
77DA-SB014	77DA-SS014G-00_5	0 - 0.5	3/23/2013
77DA-SB014	77DA-SS014G-00_5-D	0 - 0.5	3/23/2013
77DA-SB015	77DA-SS015G-00_5	0 - 0.5	3/23/2013
77DA-SB016	77DA-SS016G-00_5	0 - 0.5	3/23/2013
77DA-SB017	77DA-SS017G-00_5	0 - 0.5	3/23/2013
77DA-SB018	77DA-SS018G-00_5	0 - 0.5	3/23/2013
Former Pistol Range Subarea			
77FP-SB001	77FP-SS001-0006	0 - 0.5	5/21/2010
77FP-SB002	77FP-SS002-0006	0 - 0.5	5/21/2010
77FP-SB003	77FP-SS003-0006	0 - 0.5	5/21/2010
77FP-SB004	77FP-SS004-G00_5	0 - 0.5	5/21/2010
77FP-SB005	77FP-SS005-0006	0 - 0.5	5/21/2010
77FP-SB006	77FP-SS006-0006	0 - 0.5	5/21/2010
77FP-SB007	77FP-SS007-0006	0 - 0.5	5/21/2010
77FP-SB008	77FP-SS008-0006	0 - 0.5	5/21/2010
77FP-SB009	77FP-SS009-G00_5	0 - 0.5	5/21/2010
77FP-SB010	77FP-SS010-G00_5	0 - 0.5	5/21/2010
77FP-SB011	77FP-SS011-0006	0 - 0.5	5/21/2010
77FP-SB012	77FP-SS012-G00_5	0 - 0.5	5/21/2010
77FP-SB013	77FP-SS013-G00_5	0 - 0.5	5/21/2010
77FP-SB014	77FP-SS014-0006	0 - 0.5	5/21/2010
77FP-SB015	77FP-SS015-0006	0 - 0.5	5/21/2010
77FP-SB016	77FP-SS016-0006	0 - 0.5	5/21/2010
77FP-SB017	77FP-SS017-0006	0 - 0.5	5/21/2010
77FP-SB018	77FP-SS018-G00_5	0 - 0.5	5/21/2010
77FP-SB019	77FP-SS019-0006	0 - 0.5	5/21/2010
77FP-SB020	77FP-SS020-G00_5	0 - 0.5	5/21/2010
77FP-SB021	77FP-SS021-0006	0 - 0.5	5/26/2010
77FP-SB022	77FP-SS022-G00_5	0 - 0.5	5/26/2010
77FP-SB023	77FP-SS023-0006	0 - 0.5	5/26/2010
77FP-SB024	77FP-SS024-0006	0 - 0.5	5/26/2010
77FP-SB025	77FP-SS025-G00_5	0 - 0.5	5/26/2010
77FP-SB025	77FP-SS025-G00_5-D	0 - 0.5	5/26/2010
77FP-SB026	77FP-SS026-G00_5	0 - 0.5	5/26/2010
77FP-SB026	77FP-SS026-G00_5-D	0 - 0.5	5/26/2010
77FP-SB027	77FP-SS027-0006	0 - 0.5	5/26/2010

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77FP-SB028	77FP-SS028-0006	0 - 0.5	5/26/2010
77FP-SB029	77FP-SS029-0006	0 - 0.5	5/26/2010
77FP-SB030	77FP-SS030-0006	0 - 0.5	5/26/2010
77FP-SB031	77FP-SS031-C00_5	0 - 0.5	5/20/2010
77FP-SB032	77FP-SS032-C00_5	0 - 0.5	5/20/2010
77FP-SB033	77FP-SS033G-00_5	0 - 0.5	9/20/2012
77FP-SB034	77FP-SS034G-00_5	0 - 0.5	9/20/2012
77FP-SB035	77FP-SS035G-00_5	0 - 0.5	9/20/2012
77FP-SB036	77FP-SS036G-00_5	0 - 0.5	9/20/2012
77FP-SB037	77FP-SS037G-00_5	0 - 0.5	9/20/2012
77FP-SB038	77FP-SS038G-00_5	0 - 0.5	9/20/2012
77FP-SB038	77FP-SS038G-00_5-D	0 - 0.5	9/20/2012
77FP-SB039	77FP-SS039G-00_5	0 - 0.5	9/20/2012
77FP-SB040	77FP-SS040G-00_5	0 - 0.5	9/20/2012
77FP-SB041	77FP-SS041G-00_5	0 - 0.5	3/24/2013
77FP-SB042	77FP-SS042G-00_5	0 - 0.5	3/24/2013
77FP-SB043	77FP-SS043G-00_5	0 - 0.5	3/23/2013
77FP-SB044	77FP-SS044G-00_5	0 - 0.5	3/23/2013
77FP-SB045	77FP-SB045G-00_3	0 - 0.3	9/20/2012
77FP-SB046	77FP-SS046G-00_5	0 - 0.5	3/23/2013
77FP-SB047	77FP-SS047G-00_5	0 - 0.5	3/23/2013
77FP-SB048	77FP-SS048G-00_5	0 - 0.5	3/23/2013
77FP-SB049	77FP-SS049G-00_5	0 - 0.5	3/24/2013
77FP-SB050	77FP-SS050G-00_5	0 - 0.5	3/24/2013
77FP-SB051	77FP-SS051G-00_5	0 - 0.5	3/22/2013
77FP-SB052	77FP-SS052G-00_5	0 - 0.5	3/22/2013
77FP-SB052	77FP-SS052G-00_5-D	0 - 0.5	3/22/2013
Potential Munitions Trench Subarea			
77MT-SB001	77MT-SS001G-00_5	0 - 0.5	5/22/2010
77MT-SB002	77MT-SS002G-00_5	0 - 0.5	5/22/2010
77MT-SB003	77MT-SS003G-00_5	0 - 0.5	5/22/2010
77MT-SB004	77MT-SS004G-00_5	0 - 0.5	9/22/2012
77MT-SB005	77MT-SS005G-00_5	0 - 0.5	9/22/2012
77MT-SB006	77MT-SS006G-00_5	0 - 0.5	9/22/2012
77MT-SB007	77MT-SS007G-00_5	0 - 0.5	9/22/2012
77MT-SB008	77MT-SS008G-00_5	0 - 0.5	9/22/2012
77MT-SB009	77MT-SS009G-00_5	0 - 0.5	9/22/2012
77MT-SB009	77MT-SS009G-00_5-D	0 - 0.5	9/22/2012
77MT-SB010	77MT-SS010G-00_5	0 - 0.5	9/22/2012
77MT-SB011	No surface sample	--	--
77MT-SB012	No surface sample	--	--
77MT-SB013	No surface sample	--	--
77MT-SB014	No surface sample	--	--
77MT-SB015	No surface sample	--	--
77MT-SB016	No surface sample	--	--
77MT-SB017	No surface sample	--	--
77MT-SB018	No surface sample	--	--
77MT-SB019	No surface sample	--	--
77MT-SB020	No surface sample	--	--
77MT-SB021	77MT-SS021G-00_5	0 - 0.5	9/25/2012
77MT-SB022	77MT-SS022G-00_5	0 - 0.5	9/25/2012

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
Potential OB/OD Subarea			
77OB-SB001	77OB-SS001-G00_5	0 - 0.5	5/22/2010
77OB-SB001	77OB-SS001-G00_5-D	0 - 0.5	5/22/2010
77OB-SB002	77OB-SS002-G00_5	0 - 0.5	5/22/2010
77OB-SB003	77OB-SS003-G00_5	0 - 0.5	5/22/2010
77OB-SB004	77OB-SS004-G00_5	0 - 0.5	5/22/2010
77OB-SB005	77OB-SS005-G00_5	0 - 0.5	5/22/2010
77OB-SB006	77OB-SS006-G00_5	0 - 0.5	5/22/2010
77OB-SB007	77OB-SS007G-00_5	0 - 0.5	9/24/2012
77OB-SB008	77OB-SS008G-00_5	0 - 0.5	9/19/2012
77OB-SB009	77OB-SS009G-00_5	0 - 0.5	9/19/2012
77OB-SB009	77OB-SS009G-00_5-D	0 - 0.5	9/19/2012
77OB-SB010	77OB-SS010G-00_5	0 - 0.5	9/19/2012
77OB-SB011	No surface sample	--	--
77OB-SB012	No surface sample	--	--
77OB-SB013	No surface sample	--	--
77OB-SB014	No surface sample	--	--
77OB-SB015	No surface sample	--	--
77OB-SB016	No surface sample	--	--
77OB-SB017	No surface sample	--	--
77OB-SB018	No surface sample	--	--
77OB-SB019	No surface sample	--	--
Pistol Range Subarea			
77PR-SB001	77PR-SS001-G00_5	0 - 0.5	5/24/2010
77PR-SB002	77PR-SS002-0006	0 - 0.5	5/24/2010
77PR-SB003	77PR-SS003-0006	0 - 0.5	5/24/2010
77PR-SB004	77PR-SS004-0006	0 - 0.5	5/24/2010
77PR-SB005	77PR-SS005-0006	0 - 0.5	5/24/2010
77PR-SB006	77PR-SS006-G00_5	0 - 0.5	5/24/2010
77PR-SB007	77PR-SS007-0006	0 - 0.5	5/24/2010
77PR-SB008	77PR-SS008-G00_5	0 - 0.5	5/24/2010
77PR-SB009	77PR-SS009-0006	0 - 0.5	5/24/2010
77PR-SB010	77PR-SS010-G00_5	0 - 0.5	5/24/2010
77PR-SB011	77PR-SS011-G00_5	0 - 0.5	5/24/2010
77PR-SB012	77PR-SS012-G00_5	0 - 0.5	5/24/2010
77PR-SB013	77PR-SS013-G00_5	0 - 0.5	5/24/2010
77PR-SB014	77PR-SS014-0006	0 - 0.5	5/24/2010
77PR-SB015	77PR-SS015-0006	0 - 0.5	5/24/2010
77PR-SB016	77PR-SS016-0006	0 - 0.5	5/24/2010
77PR-SB017	77PR-SS017-0006	0 - 0.5	5/24/2010
77PR-SB017	77PR-SS017-0006-D	0 - 0.5	5/24/2010
77PR-SB018	77PR-SS018-0006	0 - 0.5	5/24/2010
77PR-SB019	77PR-SS019-G00_5	0 - 0.5	5/24/2010
77PR-SB020	77PR-SS020-0006	0 - 0.5	5/24/2010
77PR-SB021	77PR-SS021-G00_5	0 - 0.5	5/24/2010
77PR-SB022	77PR-SS022-0006	0 - 0.5	5/24/2010
77PR-SB023	77PR-SS023-0006	0 - 0.5	5/24/2010
77PR-SB023	77PR-SS023-0006-D	0 - 0.5	5/24/2010
77PR-SB024	77PR-SS024-0006	0 - 0.5	5/24/2010
77PR-SB025	77PR-SS025-0006	0 - 0.5	5/24/2010
77PR-SB026	77PR-SS026-0006	0 - 0.5	5/24/2010

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77PR-SB027	77PR-SS027-0006	0 - 0.5	5/24/2010
77PR-SB028	77PR-SS028-0006	0 - 0.5	5/24/2010
77PR-SB029	77PR-SS029-0006	0 - 0.5	5/24/2010
77PR-SB030	77PR-SS030-G00_5	0 - 0.5	5/24/2010
77PR-SB031	77PR-SS031-C00_5	0 - 0.5	5/21/2010
77PR-SB032	77PR-SS032-C00_5	0 - 0.5	5/21/2010
77PR-SB033	77PR-SS033-C00_5	0 - 0.5	5/21/2010
77PR-SB034	77PR-SS034-C00_5	0 - 0.5	5/21/2010
77PR-SB035	77PR-SS035-C00_5	0 - 0.5	5/21/2010
77PR-SB036	77PR-SS036-C00_5	0 - 0.5	5/21/2010
77PR-SB037	77PR-SS037G-00_5	0 - 0.5	9/17/2012
77PR-SB038	77PR-SS038G-00_5	0 - 0.5	9/17/2012
77PR-SB039	77PR-SS039G-00_5	0 - 0.5	9/17/2012
77PR-SB040	77PR-SS040G-00_5	0 - 0.5	9/17/2012
77PR-SB041	77PR-SS041G-00_5	0 - 0.5	9/17/2012
77PR-SB042	77PR-SS042G-00_5	0 - 0.5	9/17/2012
77PR-SB043	77PR-SS043G-00_5	0 - 0.5	9/18/2012
77PR-SB044	77PR-SS044G-00_5	0 - 0.5	9/18/2012
77PR-SB045	77PR-SS045G-00_5	0 - 0.5	9/18/2012
77PR-SB046	77PR-SS046G-00_5	0 - 0.5	9/18/2012
77PR-SB047	77PR-SS047G-00_5	0 - 0.5	9/18/2012
77PR-SB048	77PR-SS048G-00_5	0 - 0.5	9/18/2012
77PR-SB049	77PR-SS049G-00_5	0 - 0.5	9/17/2012
77PR-SB050	77PR-SS050G-00_5	0 - 0.5	9/17/2012
77PR-SB051	77PR-SS051G-00_5	0 - 0.5	9/17/2012
77PR-SB052	77PR-SS052G-00_5	0 - 0.5	9/17/2012
77PR-SB052	77PR-SS052G-00_5-D	0 - 0.5	9/17/2012
77PR-SB053	77PR-SS053G-00_5	0 - 0.5	9/17/2012
77PR-SB054	77PR-SS054G-00_5	0 - 0.5	9/17/2012
77PR-SB055	77PR-SS055G-00_5	0 - 0.5	9/17/2012
77PR-SB056	77PR-SS056G-00_5	0 - 0.5	9/17/2012
77PR-SB057	77PR-SS057G-00_5	0 - 0.5	9/17/2012
77PR-SB058	77PR-SS058G-00_5	0 - 0.5	9/17/2012
77PR-SB059	No surface sample	--	--
77PR-SB060	No surface sample	--	--
77PR-SB061	No surface sample	--	--
77PR-SB062	No surface sample	--	--
77PR-SB063	No surface sample	--	--
77PR-SB064	No surface sample	--	--
77PR-SB065	No surface sample	--	--
77PR-SB066	No surface sample	--	--
77PR-SB067	No surface sample	--	--
77PR-SB068	No surface sample	--	--
77PR-SB069	No surface sample	--	--
77PR-SB070	No surface sample	--	--
77PR-SB071	No surface sample	--	--
77PR-SB072	No surface sample	--	--
77PR-SB073	77PR-SS073G-00_5	0 - 0.5	9/19/2012
77PR-SB074	77PR-SS074G-00_5	0 - 0.5	3/23/2013
77PR-SB075	77PR-SS075G-00_5	0 - 0.5	3/23/2013
77PR-SB076	77PR-SS076G-00_5	0 - 0.5	3/23/2013

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77PR-SB077	77PR-SS077G-00_5	0 - 0.5	9/19/2012
77PR-SB078	77PR-SS078G-00_5	0 - 0.5	3/23/2013
77PR-SB079	77PR-SS079G-00_5	0 - 0.5	3/23/2013
77PR-SB080	77PR-SS080G-00_5	0 - 0.5	3/23/2013
77PR-SB081	Reclassified as sediment	--	--
77PR-SB082	77PR-SS082G-00_5	0 - 0.5	3/21/2013
77PR-SB083	77PR-SS083G-00_5	0 - 0.5	3/21/2013
77PR-SB084	77PR-SS084G-00_5	0 - 0.5	3/21/2013
77PR-SB085	77PR-SS085G-00_5	0 - 0.5	3/21/2013
77PR-SB086	77PR-SS086G-00_5	0 - 0.5	3/21/2013
77PR-SB087	77PR-SS087G-00_5	0 - 0.5	3/21/2013
77PR-SB088	77PR-SS088G-00_5	0 - 0.5	3/21/2013
77PR-SB089	77PR-SS089G-00_5	0 - 0.5	3/21/2013
77PR-SB090	77PR-SS090G-00_5	0 - 0.5	3/21/2013
77PR-SB091	77PR-SS091G-00_5	0 - 0.5	3/21/2013
77PR-SB092	77PR-SS092G-00_5	0 - 0.5	3/21/2013
77PR-SB092	77PR-SS092G-00_5-D	0 - 0.5	3/21/2013
77PR-SB093	77PR-SS093G-00_5	0 - 0.5	3/25/2013
77PR-SB094	77PR-SS094G-00_5	0 - 0.5	3/23/2013
77PR-SB095	77PR-SS095G-00_5	0 - 0.5	3/21/2013
77PR-SB096	77PR-SS096G-00_5	0 - 0.5	3/23/2013
77PR-SB097	77PR-SS097G-00_5	0 - 0.5	3/23/2013
77PR-SB098	Reclassified as sediment	--	--
77PR-SB099	77PR-SS099G-00_5	0 - 0.5	3/23/2013
77PR-SB100	77PR-SS100G-00_5	0 - 0.5	3/22/2013
77PR-SB101	Reclassified as sediment	--	--
77PR-SB102	77PR-SS102G-00_5	0 - 0.5	3/23/2013
77PR-SB103	Reclassified as sediment	--	--
77PR-SB104	Reclassified as sediment	--	--
Rifle Range Subarea			
77RR-SB001	77RR-SS001-G00_5	0 - 0.5	5/22/2010
77RR-SB002	77RR-SS002-G00_5	0 - 0.5	5/22/2010
77RR-SB003	77RR-SS003-G00_5	0 - 0.5	5/22/2010
77RR-SB004	77RR-SS004-0006	0 - 0.5	5/22/2010
77RR-SB005	77RR-SS005-0006	0 - 0.5	5/22/2010
77RR-SB006	77RR-SS006-0006	0 - 0.5	5/22/2010
77RR-SB007	77RR-SS007-G00_5	0 - 0.5	5/22/2010
77RR-SB007	77RR-SS007-G00_5-D	0 - 0.5	5/22/2010
77RR-SB008	77RR-SS008-G00_5	0 - 0.5	5/22/2010
77RR-SB009	77RR-SS009-0006	0 - 0.5	5/22/2010
77RR-SB010	77RR-SS010-0006	0 - 0.5	5/22/2010
77RR-SB011	77RR-SS011-0006	0 - 0.5	5/23/2010
77RR-SB012	77RR-SS012-0006	0 - 0.5	5/23/2010
77RR-SB012	77RR-SS012-0006-D	0 - 0.5	5/23/2010
77RR-SB013	77RR-SS013-0006	0 - 0.5	5/23/2010
77RR-SB014	77RR-SS014-0006	0 - 0.5	5/23/2010
77RR-SB015	77RR-SS015-G00_5	0 - 0.5	5/23/2010
77RR-SB016	77RR-SS016-G00_5	0 - 0.5	5/23/2010
77RR-SB017	77RR-SS017-0006	0 - 0.5	5/23/2010
77RR-SB018	77RR-SS018-G00_5	0 - 0.5	5/23/2010
77RR-SB019	77RR-SS019-0006	0 - 0.5	5/23/2010

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB020	77RR-SS020-0006	0 - 0.5	5/23/2010
77RR-SB021	77RR-SS021-0006	0 - 0.5	5/23/2010
77RR-SB022	77RR-SS022-0006	0 - 0.5	5/23/2010
77RR-SB023	77RR-SS023-0006	0 - 0.5	5/23/2010
77RR-SB023	77RR-SS023-0006-D	0 - 0.5	5/23/2010
77RR-SB024	77RR-SS024-0006	0 - 0.5	5/23/2010
77RR-SB025	77RR-SS025-0006	0 - 0.5	5/23/2010
77RR-SB026	77RR-SS026-G00_5	0 - 0.5	5/23/2010
77RR-SB027	77RR-SS027-0006	0 - 0.5	5/23/2010
77RR-SB028	77RR-SS028-0006	0 - 0.5	5/23/2010
77RR-SB029	77RR-SS029-G00_5	0 - 0.5	5/23/2010
77RR-SB030	77RR-SS030-0006	0 - 0.5	5/23/2010
77RR-SB031	77RR-SS031-C00_5	0 - 0.5	5/22/2010
77RR-SB032	77RR-SS032-C00_5	0 - 0.5	5/23/2010
77RR-SB033	77RR-SS033-C00_5	0 - 0.5	5/23/2010
77RR-SB034	77RR-SS034-C00_5	0 - 0.5	5/23/2010
77RR-SB035	77RR-SS035-C00_5	0 - 0.5	5/23/2010
77RR-SB036	77RR-SS036-C00_5	0 - 0.5	5/24/2010
77RR-SB037	77RR-SS037-C00_5	0 - 0.5	5/24/2010
77RR-SB038	77RR-SS038-C00_5	0 - 0.5	5/24/2010
77RR-SB039	77RR-SS039-C00_5	0 - 0.5	5/24/2010
77RR-SB039	77RR-SS039-C00_5-D	0 - 0.5	5/24/2010
77RR-SB040	77RR-SS040-C00_5	0 - 0.5	5/25/2010
77RR-SB041	77RR-SS041-C00_5	0 - 0.5	5/25/2010
77RR-SB042	77RR-SS042-C00_5	0 - 0.5	5/25/2010
77RR-SB043	77RR-SS043-0006	0 - 0.5	5/25/2010
77RR-SB044	77RR-SS044-0006	0 - 0.5	5/25/2010
77RR-SB044	77RR-SS044-0006-D	0 - 0.5	5/25/2010
77RR-SB045	77RR-SS045-G00_5	0 - 0.5	5/25/2010
77RR-SB046	77RR-SS046-G00_5	0 - 0.5	5/25/2010
77RR-SB047	77RR-SS047-G00_5	0 - 0.5	5/25/2010
77RR-SB048	77RR-SS048-G00_5	0 - 0.5	5/25/2010
77RR-SB049	77RR-SS049-0006	0 - 0.5	5/25/2010
77RR-SB050	77RR-SS050-G00_5	0 - 0.5	5/25/2010
77RR-SB051	77RR-SS051-0006	0 - 0.5	5/25/2010
77RR-SB052	77RR-SS052-G00_5	0 - 0.5	5/25/2010
77RR-SB053	77RR-SS053-0006	0 - 0.5	5/25/2010
77RR-SB054	77RR-SS054-G00_5	0 - 0.5	5/25/2010
77RR-SB054	77RR-SS054-G00_5-D	0 - 0.5	5/25/2010
77RR-SB055	77RR-SS055-G00_5	0 - 0.5	5/25/2010
77RR-SB056	77RR-SS056-G00_5	0 - 0.5	5/25/2010
77RR-SB057	77RR-SS057-0006	0 - 0.5	5/25/2010
77RR-SB058	No surface sample	--	--
77RR-SB059	No surface sample	--	--
77RR-SB060	No surface sample	--	--
77RR-SB061	No surface sample	--	--
77RR-SB062	No surface sample	--	--
77RR-SB063	No surface sample	--	--
77RR-SB064	No surface sample	--	--
77RR-SB065	No surface sample	--	--
77RR-SB066	No surface sample	--	--

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB067	No surface sample	--	--
77RR-SB068	No surface sample	--	--
77RR-SB069	No surface sample	--	--
77RR-SB070	No surface sample	--	--
77RR-SB071	No surface sample	--	--
77RR-SB072	No surface sample	--	--
77RR-SB073	No surface sample	--	--
77RR-SB074	No surface sample	--	--
77RR-SB075	No surface sample	--	--
77RR-SB076	No surface sample	--	--
77RR-SB077	No surface sample	--	--
77RR-SB078	77RR-SS078G-00_5	0 - 0.5	9/22/2012
77RR-SB079	77RR-SS079G-00_5	0 - 0.5	9/22/2012
77RR-SB080	77RR-SS080G-00_5	0 - 0.5	9/22/2012
77RR-SB081	77RR-SS081G-00_5	0 - 0.5	9/22/2012
77RR-SB082	77RR-SS082G-00_5	0 - 0.5	9/22/2012
77RR-SB083	77RR-SS083G-00_5	0 - 0.5	9/21/2012
77RR-SB084	77RR-SS084G-00_5	0 - 0.5	9/21/2012
77RR-SB085	77RR-SS085G-00_5	0 - 0.5	9/21/2012
77RR-SB086	77RR-SS086G-00_5	0 - 0.5	9/21/2012
77RR-SB087	77RR-SS087G-00_5	0 - 0.5	9/21/2012
77RR-SB087	77RR-SS087G-00_5-D	0 - 0.5	9/21/2012
77RR-SB088	77RR-SS088G-00_5	0 - 0.5	9/25/2012
77RR-SB089	77RR-SS089G-00_5	0 - 0.5	9/25/2012
77RR-SB090	77RR-SS090G-00_5	0 - 0.5	9/25/2012
77RR-SB091	77RR-SS091G-00_5	0 - 0.5	9/25/2012
77RR-SB092	77RR-SS092G-00_5	0 - 0.5	9/25/2012
77RR-SB093	77RR-SS093G-00_5	0 - 0.5	9/25/2012
77RR-SB094	77RR-SS094G-00_5	0 - 0.5	9/25/2012
77RR-SB095	77RR-SS095-00_5	0 - 0.5	9/21/2012
77RR-SB096	77RR-SS096-00_5	0 - 0.5	9/21/2012
77RR-SB097	77RR-SS097-00_5	0 - 0.5	9/21/2012
77RR-SB098	77RR-SS098-00_5	0 - 0.5	9/21/2012
77RR-SB099	77RR-SS099-00_5	0 - 0.5	9/21/2012
77RR-SB100	77RR-SS100-00_5	0 - 0.5	9/21/2012
77RR-SB101	77RR-SS101-00_5	0 - 0.5	9/21/2012
77RR-SB102	77RR-SS102G-00_5	0 - 0.5	9/21/2012
77RR-SB103	77RR-SS103G-00_5	0 - 0.5	9/21/2012
77RR-SB104	77RR-SS104G-00_5	0 - 0.5	9/21/2012
77RR-SB105	77RR-SS105G-00_5	0 - 0.5	9/21/2012
77RR-SB106	77RR-SS106G-00_5	0 - 0.5	9/21/2012
77RR-SB106	77RR-SS106G-00_5-D	0 - 0.5	9/21/2012
77RR-SB107	No surface sample	--	--
77RR-SB108	No surface sample	--	--
77RR-SB109	No surface sample	--	--
77RR-SB110	No surface sample	--	--
77RR-SB111	No surface sample	--	--
77RR-SB112	No surface sample	--	--
77RR-SB113	77RR-SS113G-00_5	0 - 0.5	9/24/2012
77RR-SB114	77RR-SS114G-00_5	0 - 0.5	9/24/2012
77RR-SB115	77RR-SS115G-00_5	0 - 0.5	9/24/2012

TABLE 1-1
Site UXO 1 (SWMU 77) Surface Soil Samples
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB116	77RR-SS116G-00_5	0 - 0.5	9/24/2012
77RR-SB117	77RR-SS117G-00_5	0 - 0.5	9/26/2012
77RR-SB118	77RR-SS118G-00_5	0 - 0.5	9/26/2012
77RR-SB119	77RR-SS119G-00_5	0 - 0.5	3/19/2013
77RR-SB120	77RR-SS120G-00_5	0 - 0.5	3/19/2013
77RR-SB120	77RR-SS120G-00_5-D	0 - 0.5	3/19/2013
77RR-SB121	77RR-SS121G-00_5	0 - 0.5	3/19/2013
77RR-SB122	77RR-SS122G-00_5	0 - 0.5	3/19/2013
77RR-SB123	77RR-SS123G-00_5	0 - 0.5	3/19/2013
77RR-SB124	77RR-SS124G-00_5	0 - 0.5	3/22/2013
77RR-SB124	77RR-SS124G-00_5-D	0 - 0.5	3/22/2013
77RR-SB125	77RR-SS125G-00_5	0 - 0.5	3/22/2013
77RR-SB126	77RR-SS126G-00_5	0 - 0.5	3/22/2013
77RR-SB127	77RR-SS127G-00_5	0 - 0.5	3/21/2013
77RR-SB128	77RR-SS128G-00_5	0 - 0.5	3/21/2013
77RR-SB129	77RR-SS129G-00_5	0 - 0.5	3/21/2013
77RR-SB130	77RR-SS130G-00_5	0 - 0.5	3/21/2013
77RR-SB131	77RR-SS131G-00_5	0 - 0.5	3/21/2013
77RR-SB132	77RR-SS132G-00_5	0 - 0.5	3/21/2013
77RR-SB133	77RR-SS133G-00_5	0 - 0.5	3/21/2013
77RR-SB134	77RR-SS134G-00_5	0 - 0.5	3/22/2013
77RR-SB135	77RR-SS135G-00_5	0 - 0.5	3/21/2013
77RR-SB136	77RR-SS136G-00_5	0 - 0.5	3/21/2013
77RR-SB136	77RR-SS136G-00_5-D	0 - 0.5	3/21/2013
77RR-SB137	77RR-SS137G-00_5	0 - 0.5	3/22/2013
77RR-SB138	77RR-SS138G-00_5	0 - 0.5	3/22/2013
77RR-SB139	77RR-SS139G-00_5	0 - 0.5	3/22/2013
77RR-SB140	77RR-SS140G-00_5	0 - 0.5	3/22/2013
77RR-SB141	77RR-SS141G-00_5	0 - 0.5	3/22/2013
77RR-SB142	77RR-SS142G-00_5	0 - 0.5	3/22/2013
77RR-SB143	77RR-SS143G-00_5	0 - 0.5	3/22/2013
77RR-SB144	77RR-SS144G-00_5	0 - 0.5	3/22/2013
77RR-SB145	77RR-SS145G-00_5	0 - 0.5	3/22/2013
77RR-SB146	77RR-SS146G-00_5	0 - 0.5	3/20/2013
77RR-SB147	77RR-SS147G-00_5	0 - 0.5	3/20/2013
77RR-SB148	77RR-SS148G-00_5	0 - 0.5	3/20/2013
77RR-SB149	77RR-SS149G-00_5	0 - 0.5	3/20/2013
77RR-SB150	77RR-SS150G-00_5	0 - 0.5	3/19/2013
77RR-SB151	77RR-SS151G-00_5	0 - 0.5	3/19/2013
77RR-SB152	77RR-SS152G-00_5	0 - 0.5	3/19/2013
77RR-SB153	77RR-SS153G-00_5	0 - 0.5	3/19/2013
77RR-SB154	77RR-SS154G-00_5	0 - 0.5	3/19/2013
77RR-SB155	77RR-SS155G-00_5	0 - 0.5	3/25/2013
77RR-SB156	77RR-SS156G-00_5	0 - 0.5	3/25/2013
77RR-SB157	77RR-SS157G-00_5	0 - 0.5	3/25/2013
77RR-SB158	77RR-SS158G-00_5	0 - 0.5	3/25/2013
77RR-SB159	77RR-SS159G-00_5	0 - 0.5	3/25/2013
77RR-SB160	77RR-SS160G-00_5	0 - 0.5	3/19/2013
77RR-SB161	77RR-SS161G-00_5	0 - 0.5	3/19/2013
77RR-SB162	77RR-SS162G-00_5	0 - 0.5	3/20/2013
77RR-SB163	77RR-SS163G-00_5	0 - 0.5	3/19/2013

TABLE 1-1

Site UXO 1 (SWMU 77) Surface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB164	77RR-SS164G-00_5	0 - 0.5	3/20/2013
77RR-SB165	77RR-SS165G-00_5	0 - 0.5	3/23/2013
77RR-SB166	77RR-SS166G-00_5	0 - 0.5	3/20/2013
77RR-SB167	77RR-SS167G-00_5	0 - 0.5	3/23/2013
77RR-SB168	77RR-SS168G-00_5	0 - 0.5	3/23/2013

Gray shaded cells denote field duplicates

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
Detonation Area Near Concrete Pad Subarea			
77DA-SB003	77DA-SB003G-0_502	0.5 - 2	3/23/2013
77DA-SB012	77DA-SB012G-0_502	0.5 - 2	9/20/2012
77DA-SB013	77DA-SB013G-0_502	0.5 - 2	9/20/2012
Former Pistol Range Subarea			
77FP-SB009	77FP-SB009G-0_502	0.5 - 1.5	3/24/2013
77FP-SB010	77FP-SB010G-0_502	0.5 - 1.5	3/24/2013
77FP-SB011	77FP-SB011G-0_502	0.5 - 2	3/24/2013
77FP-SB012	77FP-SB012G-0_502	0.5 - 2	3/24/2013
77FP-SB013	77FP-SB013G-0_502	0.5 - 2	3/24/2013
77FP-SB026	77FP-SB026G-0_502	0.5 - 1	3/24/2013
77FP-SB027	77FP-SB027G-0_502	0.5 - 2	3/24/2013
77FP-SB028	77FP-SB028G-0_502	0.5 - 2	3/24/2013
77FP-SB029	77FP-SB029G-0_502	0.5 - 2	3/24/2013
77FP-SB033	77FP-SB033G-0_502	0.5 - 2	9/20/2012
77FP-SB034	77FP-SB034G-0_502	0.5 - 2	9/20/2012
77FP-SB035	77FP-SB035G-0_502	0.5 - 2	9/20/2012
77FP-SB036	77FP-SB036G-0_502	0.5 - 2	9/20/2012
77FP-SB037	77FP-SB037G-0_502	0.5 - 2	9/20/2012
77FP-SB038	77FP-SB038G-0_502	0.5 - 2	9/20/2012
77FP-SB039	77FP-SB039G-0_502	0.5 - 2	9/20/2012
77FP-SB040	77FP-SB040G-0_502	0.5 - 2	9/20/2012
77FP-SB041	77FP-SB041G-0_502	0.5 - 2	3/24/2013
77FP-SB042	77FP-SB042G-0_502	0.5 - 2	3/24/2013
77FP-SB043	77FP-SB043G-0_502	0.5 - 2	3/23/2013
77FP-SB044	77FP-SB044G-0_502	0.5 - 2	3/23/2013
77FP-SB046	77FP-SB046G-0_502	0.5 - 1	3/23/2013
77FP-SB047	77FP-SB047G-0_502	0.5 - 2	3/23/2013
77FP-SB048	77FP-SB048G-0_502	0.5 - 1	3/23/2013
77FP-SB049	77FP-SB049G-0_502	0.5 - 2	3/24/2013
77FP-SB050	77FP-SB050G-0_502	0.5 - 1	3/24/2013
77FP-SB051	77FP-SB051G-0_502	0.5 - 2	3/22/2013
77FP-SB052	77FP-SB052G-0_502	0.5 - 2	3/22/2013
77FP-SB052	77FP-SB052G-0_502-D	0.5 - 2	3/22/2013
Potential Munitions Trench Subarea			
77MT-SB011	77MT-SB011G-0_502	0.5 - 2	9/22/2012
77MT-SB012	77MT-SB012G-0_502	0.5 - 2	9/24/2012
77MT-SB013	77MT-SB013G-0_502	0.5 - 2	9/24/2012
77MT-SB014	77MT-SB014G-0_502	0.5 - 2	9/24/2012
77MT-SB015	77MT-SB015G-0_502	0.5 - 2	9/24/2012
77MT-SB016	77MT-SB016G-0_502	0.5 - 2	9/24/2012
77MT-SB017	77MT-SB017G-0_502	0.5 - 2	9/24/2012
77MT-SB018	77MT-SB018G-0_502	0.5 - 2	9/24/2012
77MT-SB019	77MT-SB019G-0_502	0.5 - 2	9/24/2012
77MT-SB020	77MT-SB020G-0_502	0.5 - 2	9/24/2012
Potential OB/OD Subarea			
77OB-SB001	77OB-SB001-G0102	1 - 2	5/22/2010
77OB-SB011	77OB-SB011G-0_502	0.5 - 2	9/24/2012
77OB-SB012	77OB-SB012G-0_502	0.5 - 2	9/24/2012
77OB-SB013	77OB-SB013G-0_502	0.5 - 2	9/24/2012
77OB-SB014	77OB-SB014G-0_502	0.5 - 2	9/24/2012

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77OB-SB015	77OB-SB015G-0_502	0.5 - 2	9/24/2012
77OB-SB016	77OB-SB016G-0_502	0.5 - 2	9/24/2012
77OB-SB017	77OB-SB017G-0_502	0.5 - 2	9/24/2012
77OB-SB018	77OB-SB018G-0_502	0.5 - 2	9/24/2012
77OB-SB019	77OB-SB019G-0_502	0.5 - 2	9/24/2012
Pistol Range Subarea			
77PR-SB037	77PR-SB037G-0_502	0.5 - 2	3/21/2013
77PR-SB037	77PR-SB037G-0_502-D	0.5 - 2	3/21/2013
77PR-SB038	77PR-SB038G-0_502	0.5 - 2	3/21/2013
77PR-SB039	77PR-SB039G-0_502	0.5 - 2	3/21/2013
77PR-SB040	77PR-SB040G-0_502	0.5 - 2	3/21/2013
77PR-SB041	77PR-SB041G-0_502	0.5 - 2	3/21/2013
77PR-SB043	77PR-SB043G-0_502	0.5 - 2	9/18/2012
77PR-SB044	77PR-SB044G-0_502	0.5 - 2	9/18/2012
77PR-SB045	77PR-SB045G-0_502	0.5 - 2	9/18/2012
77PR-SB046	77PR-SB046G-0_502	0.5 - 2	9/18/2012
77PR-SB047	77PR-SB047G-0_502	0.5 - 2	9/18/2012
77PR-SB048	77PR-SB048G-0_502	0.5 - 2	9/18/2012
77PR-SB059	77PR-SB059G-0_502	0.5 - 2	9/18/2012
77PR-SB060	77PR-SB060G-0_502	0.5 - 2	9/18/2012
77PR-SB061	77PR-SB061G-0_502	0.5 - 2	9/18/2012
77PR-SB062	77PR-SB062G-0_502	0.5 - 2	9/18/2012
77PR-SB063	77PR-SB063G-0_502	0.5 - 2	9/18/2012
77PR-SB064	77PR-SB064G-0_502	0.5 - 2	9/18/2012
77PR-SB065	77PR-SB065G-0_502	0.5 - 2	9/18/2012
77PR-SB066	77PR-SB066G-0_502	0.5 - 2	9/18/2012
77PR-SB067	77PR-SB067G-0_502	0.5 - 2	9/18/2012
77PR-SB068	77PR-SB068G-0_502	0.5 - 2	9/18/2012
77PR-SB069	77PR-SB069G-0_502	0.5 - 2	9/18/2012
77PR-SB070	77PR-SB070G-0_502	0.5 - 2	9/18/2012
77PR-SB071	77PR-SB071G-0_502	0.5 - 2	9/17/2012
77PR-SB071	77PR-SB071G-0_502-D	0.5 - 2	9/17/2012
77PR-SB072	77PR-SB072G-0_502	0.5 - 2	9/17/2012
77PR-SB073	77PR-SB073G-0_502	0.5 - 2	9/19/2012
77PR-SB082	77PR-SB082G-0_502	0.5 - 2	3/21/2013
77PR-SB083	77PR-SB083G-0_502	0.5 - 2	3/21/2013
77PR-SB084	77PR-SB084G-0_502	0.5 - 2	3/21/2013
77PR-SB085	77PR-SB085G-0_502	0.5 - 2	3/21/2013
77PR-SB086	77PR-SB086G-0_502	0.5 - 2	3/21/2013
77PR-SB087	77PR-SB087G-0_502	0.5 - 2	3/21/2013
77PR-SB088	77PR-SB088G-0_502	0.5 - 2	3/21/2013
77PR-SB089	77PR-SB089G-0_502	0.5 - 2	3/21/2013
77PR-SB090	77PR-SB090G-0_502	0.5 - 2	3/21/2013
77PR-SB091	77PR-SB091G-0_502	0.5 - 2	3/21/2013
77PR-SB092	77PR-SB092G-0_502	0.5 - 2	3/21/2013
77PR-SB092	77PR-SB092G-0_502-D	0.5 - 2	3/21/2013
77PR-SB093	77PR-SB093G-0_502	0.5 - 2	3/25/2013
77PR-SB094	77PR-SB094G-0_502	0.5 - 2	3/23/2013
77PR-SB095	77PR-SB095G-0_502	0.5 - 2	3/21/2013
77PR-SB100	77PR-SB100G-0_502	0.5 - 2	3/22/2013
77PR-SB102	77PR-SB102G-0_502	0.5 - 2	3/23/2013

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77PR-SB001	77PR-SB001G-0203	2 - 3	3/22/2013
77PR-SB001	77PR-SB001G-0203-D	2 - 3	3/22/2013
77PR-SB005	77PR-SB005G-0203	2 - 3	3/22/2013
77PR-SB007	77PR-SB007G-0203	2 - 3	3/22/2013
77PR-SB009	77PR-SB009G-0203	2 - 3	3/22/2013
77PR-SB010	77PR-SB010G-0203	2 - 3	3/22/2013
77PR-SB011	77PR-SB011G-0203	2 - 3	3/22/2013
77PR-SB012	77PR-SB012G-0203	2 - 3	3/22/2013
77PR-SB013	77PR-SB013G-0203	2 - 3	3/22/2013
77PR-SB026	77PR-SB026G-0203	2 - 3	3/21/2013
77PR-SB047	77PR-SB047G-0203	2 - 3	3/22/2013
77PR-SB061	77PR-SB061G-0203	2 - 3	3/21/2013
77PR-SB062	77PR-SB062G-0203	2 - 3	3/25/2013
77PR-SB067	77PR-SB067G-0203	2 - 3	3/21/2013
77PR-SB069	77PR-SB069G-0203	2 - 3	3/21/2013
77PR-SB073	77PR-SB073G-0203	2 - 3	3/25/2013
77PR-SB082	77PR-SB082G-0203	2 - 3	3/21/2013
77PR-SB083	77PR-SB083G-0203	2 - 3	3/21/2013
77PR-SB084	77PR-SB084G-0203	2 - 3	3/21/2013
77PR-SB085	77PR-SB085G-0203	2 - 3	3/21/2013
77PR-SB086	77PR-SB086G-0203	2 - 3	3/21/2013
77PR-SB087	77PR-SB087G-0203	2 - 3	3/21/2013
77PR-SB088	77PR-SB088G-0203	2 - 3	3/21/2013
77PR-SB089	77PR-SB089G-0203	2 - 2.5	3/21/2013
77PR-SB090	77PR-SB090G-0203	2 - 3	3/21/2013
77PR-SB091	77PR-SB091G-0203	2 - 3	3/21/2013
77PR-SB092	77PR-SB092G-0203	2 - 3	3/21/2013
77PR-SB092	77PR-SB092G-0203-D	2 - 3	3/21/2013
77PR-SB093	77PR-SB093G-0203	2 - 3	3/25/2013
77PR-SB094	77PR-SB094G-0203	2 - 2.5	3/23/2013
77PR-SB095	77PR-SB095G-0203	2 - 3	3/21/2013
77PR-SB100	77PR-SB100G-0203	2 - 3	3/22/2013
77PR-SB102	77PR-SB102G-0203	2 - 2.5	3/23/2013
Rifle Range Subarea			
77RR-SB058	77RR-SB058G-0_502	0.5 - 2	9/25/2012
77RR-SB059	77RR-SB059G-0_502	0.5 - 2	9/25/2012
77RR-SB060	77RR-SB060G-0_502	0.5 - 2	9/25/2012
77RR-SB061	77RR-SB061G-0_502	0.5 - 2	9/25/2012
77RR-SB062	77RR-SB062G-0_502	0.5 - 2	9/25/2012
77RR-SB063	77RR-SB063G-0_502	0.5 - 2	9/25/2012
77RR-SB064	77RR-SB064G-0_502	0.5 - 2	9/25/2012
77RR-SB065	77RR-SB065G-0_502	0.5 - 2	9/25/2012
77RR-SB065	77RR-SB065G-0_502-D	0.5 - 2	9/25/2012
77RR-SB066	77RR-SB066G-0_502	0.5 - 2	9/25/2012
77RR-SB067	77RR-SB067G-0_502	0.5 - 2	9/25/2012
77RR-SB068	77RR-SB068G-0_502	0.5 - 2	9/22/2012
77RR-SB069	77RR-SB069G-0_502	0.5 - 2	9/22/2012
77RR-SB070	77RR-SB070G-0_502	0.5 - 2	9/22/2012
77RR-SB071	77RR-SB071G-0_502	0.5 - 2	9/25/2012
77RR-SB072	77RR-SB072G-0_502	0.5 - 2	9/22/2012
77RR-SB073	77RR-SB073G-0_502	0.5 - 2	9/25/2012

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB074	77RR-SB074G-0_502	0.5 - 2	9/22/2012
77RR-SB075	77RR-SB075G-0_502	0.5 - 2	9/25/2012
77RR-SB076	77RR-SB076G-0_502	0.5 - 2	9/22/2012
77RR-SB077	77RR-SB077G-0_502	0.5 - 2	9/25/2012
77RR-SB078	77RR-SB078G-0_502	0.5 - 2	9/22/2012
77RR-SB079	77RR-SB079G-0_502	0.5 - 2	9/22/2012
77RR-SB080	77RR-SB080G-0_502	0.5 - 2	9/22/2012
77RR-SB081	77RR-SB081G-0_502	0.5 - 2	9/22/2012
77RR-SB082	77RR-SB082G-0_502	0.5 - 2	9/22/2012
77RR-SB083	77RR-SB083G-0_502	0.5 - 2	9/21/2012
77RR-SB084	77RR-SB084G-0_502	0.5 - 2	9/21/2012
77RR-SB085	77RR-SB085G-0_502	0.5 - 2	9/21/2012
77RR-SB086	77RR-SB086G-0_502	0.5 - 2	9/21/2012
77RR-SB087	77RR-SB087G-0_502	0.5 - 2	9/21/2012
77RR-SB088	77RR-SB088G-0_502	0.5 - 2	3/19/2013
77RR-SB089	77RR-SB089G-0_502	0.5 - 2	3/23/2013
77RR-SB090	77RR-SB090G-0_502	0.5 - 2	3/23/2013
77RR-SB093	77RR-SB093G-0_502	0.5 - 2	3/20/2013
77RR-SB094	77RR-SB094G-0_502	0.5 - 1.5	3/23/2013
77RR-SB096	77RR-SB096G-0_502	0.5 - 2	3/20/2013
77RR-SB097	77RR-SB097G-0_502	0.5 - 2	3/23/2013
77RR-SB099	77RR-SB099G-0_502	0.5 - 2	3/22/2013
77RR-SB100	77RR-SB100G-0_502	0.5 - 1.5	3/22/2013
77RR-SB101	77RR-SB101G-0_502	0.5 - 1.5	3/22/2013
77RR-SB102	77RR-SB102G-0_502	0.5 - 2	9/21/2012
77RR-SB104	77RR-SB104G-0_502	0.5 - 2	9/21/2012
77RR-SB105	77RR-SB105G-0_502	0.5 - 2	9/21/2012
77RR-SB106	77RR-SB106G-0_502	0.5 - 2	9/21/2012
77RR-SB107	77RR-SB107G-0_502	0.5 - 2	9/21/2012
77RR-SB108	77RR-SB108G-0_502	0.5 - 2	9/20/2012
77RR-SB109	77RR-SB109G-0_502	0.5 - 2	9/21/2012
77RR-SB110	77RR-SB110G-0_502	0.5 - 2	9/21/2012
77RR-SB111	77RR-SB111G-0_502	0.5 - 2	9/21/2012
77RR-SB112	77RR-SB112G-0_502	0.5 - 2	9/21/2012
77RR-SB119	77RR-SB119G-0_502	0.5 - 2	3/19/2013
77RR-SB119	77RR-SB119G-0_502-D	0.5 - 2	3/19/2013
77RR-SB120	77RR-SB120G-0_502	0.5 - 2	3/19/2013
77RR-SB121	77RR-SB121G-0_502	0.5 - 2	3/19/2013
77RR-SB122	77RR-SB122G-0_502	0.5 - 2	3/19/2013
77RR-SB123	77RR-SB123G-0_502	0.5 - 2	3/19/2013
77RR-SB124	77RR-SB124G-0_502	0.5 - 1	3/22/2013
77RR-SB124	77RR-SB124G-0_502-D	0.5 - 1	3/22/2013
77RR-SB127	77RR-SB127G-0_502	0.5 - 2	3/21/2013
77RR-SB128	77RR-SB128G-0_502	0.5 - 2	3/21/2013
77RR-SB129	77RR-SB129G-0_502	0.5 - 2	3/21/2013
77RR-SB130	77RR-SB130G-0_502	0.5 - 1	3/21/2013
77RR-SB131	77RR-SB131G-0_502	0.5 - 2	3/21/2013
77RR-SB132	77RR-SB132G-0_502	0.5 - 2	3/21/2013
77RR-SB133	77RR-SB133G-0_502	0.5 - 1.5	3/21/2013
77RR-SB134	77RR-SB134G-0_502	0.5 - 1	3/21/2013
77RR-SB135	77RR-SB135G-0_502	0.5 - 2	3/21/2013

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB136	77RR-SB136G-0_502	0.5 - 2	3/21/2013
77RR-SB136	77RR-SB136G-0_502-D	0.5 - 2	3/21/2013
77RR-SB137	77RR-SB137G-0_502	0.5 - 1	3/22/2013
77RR-SB138	77RR-SB138G-0_502	0.5 - 1.5	3/22/2013
77RR-SB139	77RR-SB139G-0_502	0.5 - 1.5	3/22/2013
77RR-SB141	77RR-SB141G-0_502	0.5 - 1.5	3/22/2013
77RR-SB142	77RR-SB142G-0_502	0.5 - 2	3/22/2013
77RR-SB143	77RR-SB143G-0_502	0.5 - 2	3/22/2013
77RR-SB144	77RR-SB144G-0_502	0.5 - 2	3/22/2013
77RR-SB145	77RR-SB145G-0_502	0.5 - 1.5	3/22/2013
77RR-SB146	77RR-SB146G-0_502	0.5 - 2	3/20/2013
77RR-SB147	77RR-SB147G-0_502	0.5 - 2	3/20/2013
77RR-SB148	77RR-SB148G-0_502	0.5 - 2	3/20/2013
77RR-SB149	77RR-SB149G-0_502	0.5 - 2	3/20/2013
77RR-SB150	77RR-SB150G-0_502	0.5 - 2	3/19/2013
77RR-SB151	77RR-SB151G-0_502	0.5 - 2	3/19/2013
77RR-SB152	77RR-SB152G-0_502	0.5 - 2	3/19/2013
77RR-SB153	77RR-SB153G-0_502	0.5 - 2	3/19/2013
77RR-SB154	77RR-SB154G-0_502	0.5 - 2	3/19/2013
77RR-SB155	77RR-SB155G-0_502	0.5 - 2	3/25/2013
77RR-SB156	77RR-SB156G-0_502	0.5 - 2	3/25/2013
77RR-SB157	77RR-SB157G-0_502	0.5 - 2	3/25/2013
77RR-SB158	77RR-SB158G-0_502	0.5 - 2	3/25/2013
77RR-SB159	77RR-SB159G-0_502	0.5 - 2	3/25/2013
77RR-SB160	77RR-SB160G-0_502	0.5 - 2	3/19/2013
77RR-SB161	77RR-SB161G-0_502	0.5 - 2	3/19/2013
77RR-SB162	77RR-SB162G-0_502	0.5 - 2	3/20/2013
77RR-SB163	77RR-SB163G-0_502	0.5 - 2	3/19/2013
77RR-SB164	77RR-SB164G-0_502	0.5 - 2	3/20/2013
77RR-SB165	77RR-SB165G-0_502	0.5 - 2	3/23/2013
77RR-SB166	77RR-SB166G-0_502	0.5 - 2	3/20/2013
77RR-SB168	77RR-SB168G-0_502	0.5 - 1	3/23/2013
77RR-SB069	77RR-SB069G-0203	2 - 3	3/20/2013
77RR-SB069	77RR-SB069G-0203-D	2 - 3	3/20/2013
77RR-SB070	77RR-SB070G-0203	2 - 3	3/21/2013
77RR-SB072	77RR-SB072G-0203	2 - 3	3/21/2013
77RR-SB073	77RR-SB073G-0203	2 - 3	3/21/2013
77RR-SB074	77RR-SB074G-0203	2 - 3	3/21/2013
77RR-SB075	77RR-SB075G-0203	2 - 3	3/21/2013
77RR-SB077	77RR-SB077G-0203	2 - 3	3/21/2013
77RR-SB083	77RR-SB083G-0203	2 - 3	3/19/2013
77RR-SB085	77RR-SB085G-0203	2 - 3	3/19/2013
77RR-SB087	77RR-SB087G-0203	2 - 3	3/19/2013
77RR-SB088	77RR-SB088G-0203	2 - 3	3/19/2013
77RR-SB089	77RR-SB089G-0203	2 - 2.5	3/23/2013
77RR-SB090	77RR-SB090G-0203	2 - 3	3/23/2013
77RR-SB093	77RR-SB093G-0203	2 - 2.5	3/20/2013
77RR-SB096	77RR-SB096G-0203	2 - 3	3/20/2013
77RR-SB097	77RR-SB097G-0203	2 - 2.5	3/23/2013
77RR-SB099	77RR-SB099G-0203	2 - 3	3/22/2013
77RR-SB119	77RR-SB119G-0203	2 - 3	3/19/2013

TABLE 1-2

Site UXO 1 (SWMU 77) Subsurface Soil Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
77RR-SB119	77RR-SB119G-0203-D	2 - 3	3/19/2013
77RR-SB120	77RR-SB120G-0203	2 - 3	3/19/2013
77RR-SB121	77RR-SB121G-0203	2 - 3	3/19/2013
77RR-SB122	77RR-SB122G-0203	2 - 3	3/19/2013
77RR-SB123	77RR-SB123G-0203	2 - 2.5	3/19/2013
77RR-SB127	77RR-SB127G-0203	2 - 3	3/21/2013
77RR-SB128	77RR-SB128G-0203	2 - 2.5	3/21/2013
77RR-SB129	77RR-SB129G-0203	2 - 3	3/21/2013
77RR-SB131	77RR-SB131G-0203	2 - 2.5	3/21/2013
77RR-SB135	77RR-SB135G-0203	2 - 3	3/21/2013
77RR-SB136	77RR-SB136G-0203	2 - 3	3/21/2013
77RR-SB136	77RR-SB136G-0203-D	2 - 3	3/21/2013
77RR-SB143	77RR-SB143G-0203	2 - 3	3/22/2013
77RR-SB146	77RR-SB146G-0203	2 - 3	3/20/2013
77RR-SB147	77RR-SB147G-0203	2 - 3	3/20/2013
77RR-SB148	77RR-SB148G-0203	2 - 3	3/20/2013
77RR-SB149	77RR-SB149G-0203	2 - 3	3/20/2013
77RR-SB150	77RR-SB150G-0203	2 - 3	3/19/2013
77RR-SB151	77RR-SB151G-0203	2 - 3	3/19/2013
77RR-SB152	77RR-SB152G-0203	2 - 3	3/19/2013
77RR-SB153	77RR-SB153G-0203	2 - 3	3/19/2013
77RR-SB154	77RR-SB154G-0203	2 - 3	3/19/2013
77RR-SB156	77RR-SB156G-0203	2 - 3	3/25/2013
77RR-SB157	77RR-SB157G-0203	2 - 3	3/25/2013
77RR-SB158	77RR-SB158G-0203	2 - 3	3/25/2013
77RR-SB159	77RR-SB159G-0203	2 - 3	3/25/2013
77RR-SB160	77RR-SB160G-0203	2 - 3	3/19/2013
77RR-SB161	77RR-SB161G-0203	2 - 3	3/19/2013
77RR-SB162	77RR-SB162G-0203	2 - 3	3/20/2013
77RR-SB163	77RR-SB163G-0203	2 - 3	3/19/2013
77RR-SB164	77RR-SB164G-0203	2 - 3	3/20/2013

Gray shaded cells denote field duplicates

TABLE 1-3

Site UXO 1 (SWMU 77) Surface Sediment Samples

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Location	Sample ID	Sample Depth (ft)	Sample Date
Pistol Range Subarea			
77PR-SDSB081	77PR-SDSS081G-00_5	0 - 0.5	3/23/2013
77PR-SDSB081	77PR-SDSS081G-00_5-D	0 - 0.5	3/23/2013
77PR-SDSB098	77PR-SDSS098G-00_5	0 - 0.5	3/23/2013
77PR-SDSB101	77PR-SDSS101G-00_5	0 - 0.5	3/23/2013
77PR-SDSB103	77PR-SDSS103G-00_5	0 - 0.5	3/23/2013
77PR-SDSB104	77PR-SDSS104G-00_5	0 - 0.5	3/23/2013

Gray shaded cells denote field duplicates

TABLE 1-4

Site UXO 1 (SWMU 77) Background Concentrations Used in the Risk Evaluation

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil		Subsurface Soil[1]		Sediment[2]	
	Maximum	95% UTL	Maximum	95% UTL	Maximum	95% UTL
Explosives (UG/KG)						
1,3,5-Trinitrobenzene	--	--	--	--	--	--
1,3-Dinitrobenzene	--	--	--	--	--	--
2,4,6-Trinitrotoluene	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--
2-Amino-4,6-dinitrotoluene	--	--	--	--	--	--
2-Nitrotoluene	--	--	--	--	--	--
3-Nitrotoluene	--	--	--	--	--	--
4-Amino-2,6-dinitrotoluene	--	--	--	--	--	--
4-Nitrotoluene	--	--	--	--	--	--
HMX	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--
Nitroglycerin	--	--	--	--	--	--
RDX	--	--	--	--	--	--
Tetryl	--	--	--	--	--	--
Metals (MG/KG)						
Antimony	2.80	2.70	4.60	5.58	2.70	2.06
Arsenic	2.50	2.75	3.40	3.59	7.40	7.82
Copper	180	192	131	141	130	136
Lead	21.0	34.2	7.80	13.2	38.0	36.5
Zinc	120	132	98.5	131	92.8	131

1 - Sand/silt

2 - Estuarine wetland

TABLE 1-5

Data Summary and Preliminary Risk Estimates (Residential Scenario)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

														Risk Estimates (based on MaxDet)							Risk Estimates (based on EPC)						
Subarea	Chem Group	CAS	Chemical Name	Minimum Detected Concentration	Maximum Detected Concentration	Unit	No. of Detection	No. of Samples	HHSL (adjusted) [1]	HHSL Basis	COPC? [2]	HHSL [3] carcinogenic	HHSL [3] non-carcinogenic	MaxDet [4]	ELCR [5]	HQ [5]	Target Organ	Cumulative ELCR [8]	Cumulative HI [7]	Target Organ driving unacceptable NC hazards	EPC [6]	EPC Basis	ELCR [5]	HQ [5]	Cumulative ELCR [8]	Cumulative HI [7]	Target Organ driving unacceptable NC hazards
Detonation Area	METAL	7440-38-2	Arsenic	0.876	4.63	mg/kg	16	19	0.61	ca	Yes	0.61	34	4.63	8E-06	0.1	Skin and Blood	8E-06	3	GI system	4.63	MaxDet	8E-06	0.1	8E-06	2	(none)
Detonation Area	METAL	7440-50-8	Copper	47.2	7960	mg/kg	19	19	310	nc	Yes		3100	7960		3	GI system				2574	95% Chebyshev (Mean, Sd) UCL		0.8		0.9 (blood)†	
Detonation Area	METAL	7440-66-6	Zinc	61.2	2480	mg/kg	19	19	2300	nc	Yes		23000	2480		0.1	Blood				2480	MaxDet		0.1			
Detonation Area	EXPLO	55-63-0	Nitroglycerin	53.2	3960	ug/kg	7	14	610	nc	Yes	29000	6100	3960	1E-07	0.6	Blood				3960	MaxDet	1E-07	0.6			
Former Pistol Range	METAL	7440-36-0	Antimony	0.57	6.26	mg/kg	8	60	3.1	nc	Yes		31	6.26		0.2	Whole body	4E-06	2	GI system	6.26	MaxDet		0.2	4E-06	0.9	(none)
Former Pistol Range	METAL	7440-38-2	Arsenic	0.872	2.62	mg/kg	45	60	0.61	ca	Yes	0.61	34	2.62	4E-06	0.08	Skin and Blood				2.62	MaxDet	4E-06	0.08			
Former Pistol Range	METAL	7440-50-8	Copper	2.97	4400	mg/kg	60	60	310	nc	Yes		3100	4400		1.4	GI system				569.4	95% Chebyshev (Mean, Sd) UCL		0.2			
Former Pistol Range	METAL	7440-66-6	Zinc	30.6	437	mg/kg	60	60	2300	nc	No	--	--	--							--						
Former Pistol Range	EXPLO	55-63-0	Nitroglycerin	1180	2650	ug/kg	3	5	610	nc	Yes	29000	6100	2650	9E-08	0.4	Blood				2650	MaxDet	9E-08	0.4			
Munitions Trench	METAL	7440-36-0	Antimony	0.541	0.633	mg/kg	2	28	3.1	nc	No	--	--	--				5E-06	4	Blood	--				4E-06	0.9	(none)
Munitions Trench	METAL	7440-38-2	Arsenic	0.675	2.57	mg/kg	14	28	0.61	ca	Yes	0.61	34	2.57	4E-06	0.08	Skin and Blood				2.57	MaxDet	4E-06	0.08			
Munitions Trench	METAL	7440-50-8	Copper	1.89	134	mg/kg	28	28	310	nc	No	--	--	--							--						
Munitions Trench	METAL	7440-66-6	Zinc	20.5	131	mg/kg	28	28	2300	nc	No	--	--	--							--						
Munitions Trench	EXPLO	121-82-4	RDX	169	232	ug/kg	3	23	5600	ca	No	--	--	--							--						
Munitions Trench	EXPLO	479-45-8	Tetryl	26	42.2	ug/kg	2	23	12000	nc	No	--	--	--							--						
Munitions Trench	EXPLO	55-63-0	Nitroglycerin	419	21800	ug/kg	15	38	610	nc	Yes	29000	6100	21800	8E-07	4	Blood				4971	95% KM (t) UCL	2E-07	0.8			
Munitions Trench	EXPLO	88-72-2	2-Nitrotoluene	25.5	25.5	ug/kg	1	23	2900	ca	No	--	--	--							--						
Munitions Trench	EXPLO	99-65-0	1,3-Dinitrobenzene	71.8	71.8	ug/kg	1	23	610	nc	No	--	--	--							--						
Open Burn/Open Detonation	METAL	7440-38-2	Arsenic	0.825	3.41	mg/kg	13	22	0.61	ca	Yes	0.61	34	3.41	6E-06	0.1	Skin and Blood	6E-06	0.1	(none)							(none)
Open Burn/Open Detonation	METAL	7440-50-8	Copper	74.9	144	mg/kg	20	20	310	nc	No	--	--	--													
Open Burn/Open Detonation	METAL	7440-66-6	Zinc	65	205	mg/kg	20	20	2300	nc	No	--	--	--													
Open Burn/Open Detonation	EXPLO	121-14-2	2,4-Dinitrotoluene	74.6	74.6	ug/kg	1	22	1600	ca	No	--	--	--													
Open Burn/Open Detonation	EXPLO	121-82-4	RDX	112	210	ug/kg	6	22	5600	ca	No	--	--	--													
Open Burn/Open Detonation	EXPLO	2691-41-0	HMX	1780	1780	ug/kg	1	22	380000	nc	No	--	--	--													
Open Burn/Open Detonation	EXPLO	479-45-8	Tetryl	28.1	72.8	ug/kg	9	22	12000	nc	No	--	--	--													
Pistol Range	METAL	7440-36-0	Antimony	1.48	326	mg/kg	22	141	3.1	nc	Yes		31	326		11	Whole body	7E-05	16	GI system	11.15	95% KM (BCA) UCL		0.4	5E-06	1.5	(none)
Pistol Range	METAL	7440-38-2	Arsenic	0.561	42.8	mg/kg	69	141	0.61	ca	Yes	0.61	34	42.8	7E-05	1.3	Skin and Blood			Whole body	2.922	95% KM (t) UCL	5E-06	0.1		1.0 (blood)†	
Pistol Range	METAL	7440-50-8	Copper	36.4	7990	mg/kg	141	141	310	nc	Yes		3100	7990		3	GI system			Skin	505.7	95% Chebyshev (Mean, Sd) UCL		0.2			
Pistol Range	METAL	7440-66-6	Zinc	41.8	856	mg/kg	141	141	2300	nc	No	--	--	--						Blood	--						
Pistol Range	EXPLO	55-63-0	Nitroglycerin	674	7850	ug/kg	9	9	610	nc	Yes	29000	6100	7850	3E-07	1.3	Blood				5696	95% Student's-t UCL	2E-07	0.9			
Rifle Range	METAL	7440-36-0	Antimony	0.539	6510	mg/kg	80	243	3.1	nc	Yes		31	6510		210	Whole body	1E-04	263	GI system	174.2	95% KM (Chebyshev) UCL		6	7E-06	8	Whole body
Rifle Range	METAL	7440-38-2	Arsenic	0.533	60.5	mg/kg	186	243	0.61	ca	Yes	0.61	34	60.5	1E-04	1.8	Skin and Blood			Whole body	4.034	95% KM (BCA) UCL	7E-06	0.1		6 (whole body)†	GI system
Rifle Range	METAL	7440-50-8	Copper	0.563	137000	mg/kg	241	241	310	nc	Yes		3100	137000		44	GI system			Skin	5481	95% Chebyshev (Mean, Sd) UCL		2			
Rifle Range	METAL	7440-66-6	Zinc	23.2	14100	mg/kg	241	241	2300	nc	Yes		23000	14100		0.6	Blood			Blood	625.1	95% Chebyshev (Mean, Sd) UCL		0.03			
Rifle Range	EXPLO	121-14-2	2,4-Dinitrotoluene	37	37	ug/kg	1	29	1600	ca	No	--	--	--							--						
Rifle Range	EXPLO	121-82-4	RDX	136	161	ug/kg	3	27	5600	ca	No	--	--	--							--						
Rifle Range	EXPLO	479-45-8	Tetryl	22.9	63.5	ug/kg	5	26	12000	nc	No	--	--	--							--						
Rifle Range	EXPLO	55-63-0	Nitroglycerin	69	39400	ug/kg	24	35	610	nc	Yes	29000	6100	39400	1E-06	6	Blood				4584	95% KM (BCA) UCL	2E-07	0.8			

Notes:

Chemicals detected in at least one sample within the subarea are presented in this table.

1) Human Health Screening Levels, HHSL (adjusted) are US EPA Regional Screening Levels (RSLs) for residential soil based on an excess lifetime cancer risk (ELCR) of 10^{-6} and non-cancer hazard quotient (HQ) of 0.1

2) Chemicals whose maximum detected concentration exceeds SL (adjusted) were identified as Chemical of Potential Concern (COPC).

3) Carcinogenic and non-carcinogenic HHSLs are based on an ELCR of 10^{-6} and HQ of 1 and were used to estimate potential carcinogenic risk and non-carcinogenic hazard.

4) Maximum Detected Concentration (MaxDet) was used as EPCs.

5) ELCR and HQ were calculated using the ratio of MaxDet or exposure point concentration (EPC) and HHSL, as follows.

ELCR = MaxDet * 10^{-6} / HHSL or ELCR = EPC * 10^{-6} / HHSL

HQ = MaxDet * 1 /HHSL HQ = EPC * 1 /HHSL

6) EPC (upper confidence limit [UCL] on the mean) was calculated using EPA ProUCL software for chemicals posing an unacceptable HQ of greater than 1.

7) For those subareas with the non-cancer HI exceeds 1, an HI was calculated for each applicable target organ to assess whether the non-cancer hazard is acceptable on a target-organ basis.

8) The cumulative ELCR for each subarea was calculated by summing the chemical-specific ELCRs for the chemicals within the subarea.

† the highest target-organ-specific HI.

HHSL Basis: nc - non-cancer; ca - cancer.

TABLE 1-6

Data Summary and Preliminary Risk Estimates (Industrial Scenario)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

															Risk Estimates (based on MaxDet)							Risk Estimates (based on EPC)						
Subarea	Chem Group	CAS	Chemical Name	Minimum Detected Concentration	Maximum Detected Concentration	Unit	No. of Detection	No. of Samples	HHSL (adjusted) [1]	HHSL Basis	COPC? [2]	HHSL [3] carcinogenic	HHSL [3] non-carcinogenic	MaxDet [4]	ELCR [5]	HQ [5]	Target Organ	Cumulative ELCR [8]	Cumulative HI [7]	Target Organ driving unacceptable NC hazards	EPC [6]	EPC Basis	ELCR [5]	HQ [5]	Cumulative ELCR [8]	Cumulative HI [7]	Target Organ driving unacceptable NC hazards
Detonation Area	METAL	7440-38-2	Arsenic	0.876	4.63	mg/kg	16	19	2.4	ca	Yes	2.4	380	4.63	2E-06	0.01	Skin and Blood	2E-06	0.2	(none)							(none)
Detonation Area	METAL	7440-50-8	Copper	47.2	7960	mg/kg	19	19	4100	nc	Yes		41000	7960		0.2	GI system										
Detonation Area	METAL	7440-66-6	Zinc	61.2	2480	mg/kg	19	19	31000	nc	No	--	--	--													
Detonation Area	EXPLO	55-63-0	Nitroglycerin	53.2	3960	ug/kg	7	14	6200	nc	No	--	--	--													
Former Pistol Range	METAL	7440-36-0	Antimony	0.57	6.26	mg/kg	8	60	41	nc	No	--	--	--				1E-06	0.1	(none)							(none)
Former Pistol Range	METAL	7440-38-2	Arsenic	0.872	2.62	mg/kg	45	60	2.4	ca	Yes	2.4	380	2.62	1E-06	0.007	Skin and Blood										
Former Pistol Range	METAL	7440-50-8	Copper	2.97	4400	mg/kg	60	60	4100	nc	Yes		41000	4400		0.1	GI system										
Former Pistol Range	METAL	7440-66-6	Zinc	30.6	437	mg/kg	60	60	31000	nc	No	--	--	--													
Former Pistol Range	EXPLO	55-63-0	Nitroglycerin	1180	2650	ug/kg	3	5	6200	nc	No	--	--	--													
Munitions Trench	METAL	7440-36-0	Antimony	0.541	0.633	mg/kg	2	28	41	nc	No	--	--	--				1E-06	0.4	(none)							(none)
Munitions Trench	METAL	7440-38-2	Arsenic	0.675	2.57	mg/kg	14	28	2.4	ca	Yes	2.4	380	2.57	1E-06	0.007	Skin and Blood										
Munitions Trench	METAL	7440-50-8	Copper	1.89	134	mg/kg	28	28	4100	nc	No	--	--	--													
Munitions Trench	METAL	7440-66-6	Zinc	20.5	131	mg/kg	28	28	31000	nc	No	--	--	--													
Munitions Trench	EXPLO	121-82-4	RDX	169	232	ug/kg	3	23	24000	ca	No	--	--	--													
Munitions Trench	EXPLO	479-45-8	Tetryl	26	42.2	ug/kg	2	23	120000	nc	No	--	--	--													
Munitions Trench	EXPLO	55-63-0	Nitroglycerin	419	21800	ug/kg	15	38	6200	nc	Yes	100000	62000	21800	2E-07	0.4	Blood										
Munitions Trench	EXPLO	88-72-2	2-Nitrotoluene	25.5	25.5	ug/kg	1	23	13000	ca	No	--	--	--													
Munitions Trench	EXPLO	99-65-0	1,3-Dinitrobenzene	71.8	71.8	ug/kg	1	23	6200	nc	No	--	--	--													
Open Burn/Open Detonation	METAL	7440-38-2	Arsenic	0.825	3.41	mg/kg	13	22	2.4	ca	Yes	2.4	380	3.41	1E-06	0.009	Skin and Blood	1E-06	0.009	(none)							(none)
Open Burn/Open Detonation	METAL	7440-50-8	Copper	74.9	144	mg/kg	20	20	4100	nc	No	--	--	--													
Open Burn/Open Detonation	METAL	7440-66-6	Zinc	65	205	mg/kg	20	20	31000	nc	No	--	--	--													
Open Burn/Open Detonation	EXPLO	121-14-2	2,4-Dinitrotoluene	74.6	74.6	ug/kg	1	22	5500	ca	No	--	--	--													
Open Burn/Open Detonation	EXPLO	121-82-4	RDX	112	210	ug/kg	6	22	24000	ca	No	--	--	--													
Open Burn/Open Detonation	EXPLO	2691-41-0	HMX	1780	1780	ug/kg	1	22	4900000	nc	No	--	--	--													
Open Burn/Open Detonation	EXPLO	479-45-8	Tetryl	28.1	72.8	ug/kg	9	22	120000	nc	No	--	--	--													
Pistol Range	METAL	7440-36-0	Antimony	1.48	326	mg/kg	22	141	41	nc	Yes		410	326		0.8	Whole body	2E-05	1.2	(none)							(none)
Pistol Range	METAL	7440-38-2	Arsenic	0.561	42.8	mg/kg	69	141	2.4	ca	Yes	2.4	380	42.8	2E-05	0.1	Skin and Blood		0.8†								
Pistol Range	METAL	7440-50-8	Copper	36.4	7990	mg/kg	141	141	4100	nc	Yes		41000	7990		0.2	GI system										
Pistol Range	METAL	7440-66-6	Zinc	41.8	856	mg/kg	141	141	31000	nc	No	--	--	--													
Pistol Range	EXPLO	55-63-0	Nitroglycerin	674	7850	ug/kg	9	9	6200	nc	Yes	100000	62000	7850	8E-08	0.1	Blood										
Rifle Range	METAL	7440-36-0	Antimony	0.539	6510	mg/kg	80	243	41	nc	Yes		410	6510		16	Whole body	3E-05	20	Whole body	174.2	95% KM (Chebyshev) UCL		0.4	3E-05	1.4	(none)
Rifle Range	METAL	7440-38-2	Arsenic	0.533	60.5	mg/kg	186	243	2.4	ca	Yes	2.4	380	60.5	3E-05	0.2	Skin and Blood			GI system	60.5	MaxDet	3E-05	0.2		0.8 (blood)†	
Rifle Range	METAL	7440-50-8	Copper	0.563	137000	mg/kg	241	241	4100	nc	Yes		41000	137000		3	GI system				5481	95% Chebyshev (Mean, Sd) UCL		0.1			
Rifle Range	METAL	7440-66-6	Zinc	23.2	14100	mg/kg	241	241	31000	nc	No	--	--	--							--						
Rifle Range	EXPLO	121-14-2	2,4-Dinitrotoluene	37	37	ug/kg	1	29	5500	ca	No	--	--	--							--						
Rifle Range	EXPLO	121-82-4	RDX	136	161	ug/kg	3	27	24000	ca	No	--	--	--							--						
Rifle Range	EXPLO	479-45-8	Tetryl	22.9	63.5	ug/kg	5	26	120000	nc	No	--	--	--							--						
Rifle Range	EXPLO	55-63-0	Nitroglycerin	69	39400	ug/kg	24	35	6200	nc	Yes	100000	62000	39400	4E-07	0.6	Blood				39400	MaxDet	4E-07	0.6			

Notes:

Chemicals detected in at least one sample within the subarea are presented in this table.

1) Human Health Screening Levels, HHSL (adjusted) are US EPA Regional Screening Levels (RSLs) for industrial soil based on an excess lifetime cancer risk (ELCR) of $1C^{-6}$ and non-cancer hazard quotient (HQ) of 0.1

2) Chemicals whose maximum detected concentration exceeds SL (adjusted) were identified as Chemical of Potential Concern (COPC).

3) Carcinogenic and non-carcinogenic HHSLs are based on an ELCR of 10^{-6} and HQ of 1 and were used to estimate potential carcinogenic risk and non-carcinogenic hazard

4) Maximum Detected Concentration (MaxDet) was used as EPCs.

5) ELCR and HQ were calculated using the ratio of MaxDet or exposure point concentration (EPC) and HHSL, as follows.

ELCR = MaxDet * 10^{-6} / HHSL or ELCR = EPC * 10^{-6} / HHSL

HQ = MaxDet * 1 /HHSL HQ = EPC * 1 /HHSL

6) EPC (upper confidence limit [UCL] on the mean) was calculated using EPA ProUCL software for chemicals posing an unacceptable HQ of greater than 1.

7) For those subareas with the non-cancer HI exceeds 1, an HI was calculated for each applicable target organ to assess whether the non-cancer hazard is acceptable on a target-organ basis.

8) The cumulative ELCR for each subarea was calculated by summing the chemical-specific ELCRs for the chemicals within the subarea.

† the highest target-organ-specific HI.

HHSL Basis: nc - non-cancer; ca - cancer.

TABLE 1-7

Data Summary of Lead Results

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Subarea	CAS	Chemical Name	Minimum Detected Concentration	Maximum Detected Concentration	Average Detected Concentration	No. of Detection	No. of Samples	Residential Scenario			Industrial Scenario		
								HHSL [1] (residential)	HHSL Basis	COPC? [2]	HHSL [1] (industrial)	HHSL Basis	COPC? [2]
Detonation Area	7439-92-1	Lead	0.624	427	60.9	19	19	400	nc	No	800	nc	No
Former Pistol Range	7439-92-1	Lead	0.919	4570	289.5	69	82	400	nc	No	800	nc	No
Munitions Trench	7439-92-1	Lead	0.544	249	20.7	22	28	400	nc	No	800	nc	No
Open Burn/Open Detonation	7439-92-1	Lead	0.872	104	21.9	21	22	400	nc	No	800	nc	No
Pistol Range	7439-92-1	Lead	0.221	58400	1478	146	163	400	nc	Yes	800	nc	Yes
Rifle Range	7439-92-1	Lead	0.419	118000	4888	268	272	400	nc	Yes	800	nc	Yes

Notes:

Units are presented in mg/kg.

1) Human Health Screening Levels (HHSLs) are US EPA Regional Screening Levels (RSLs) for residential (400 mg/kg) and industrial soil (800 mg/kg).

2) When the average detected concentration exceeds HHSL, lead was identified as Chemical of Potential Concern (COPC).

HHSL Basis: nc - non-cancer.

TABLE 1-8

Soil Ecological Screening Values (ESVs)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value					
	Plant		Invertebrate		Food Web	Receptor
Explosives (UG/KG)						
1,3,5-Trinitrobenzene	--	--	--	--	60,000	Norway rat
1,3-Dinitrobenzene	--	--	--	--	4,400	Common ground dove
2,4,6-Trinitrotoluene	10,000	Talmage et al. 1999	100,000	Talmage et al. 1999	4,300	Common ground dove
2,4-Dinitrotoluene	11,000	NRCC 2006	11,000	NRCC 2006	1,050	Common ground dove
2,6-Dinitrotoluene	8,500	NRCC 2006	8,500	NRCC 2006	1,050	Common ground dove
2-Amino-4,6-dinitrotoluene	80,000	Talmage et al. 1999	--	--	203,000	Norway rat
2-Nitrotoluene	--	--	--	--	40,300	Norway rat
3-Nitrotoluene	--	--	--	--	48,650	Norway rat
4-Amino-2,6-dinitrotoluene	80,000	Talmage et al. 1999			203,000	Norway rat
4-Nitrotoluene	--	--	--	--	88,750	Norway rat
HMX	--	--	10,000	Talmage et al. 1999	200,000	Common ground dove
Nitrobenzene	--	--	2,260	Efroymson et al. 1997b[1]	157,000	Norway rat
Nitroglycerin	--	--	--	--	98,700	Norway rat
RDX	50,000	Talmage et al. 1999	10,000	Talmage et al. 1999	16,300	Pearly-eyed thrasher
Tetryl	10,000	Talmage et al. 1999	--	--	286,000	Norway rat
Metals (MG/KG)						
Antimony	5.00	Efroymson et al. 1997a	78.0	USEPA 2005c	3.56	Norway rat
Arsenic	18.0	USEPA 2005a	60.0	Efroymson et al. 1997b	94.1	Norway rat
Copper	70.0	USEPA 2007a	80.0	USEPA 2007a	302	Common ground dove
Lead	120	USEPA 2005b	1,700	USEPA 2005b	136	Common ground dove
Zinc	160	USEPA 2007b	120	USEPA 2007b	3,906	Pearly-eyed thrasher

1 - LC50 of 226,000; UF of 100

Shaded values indicate the ESV used in the site-specific screening tables

TABLE 1-9

Marine Sediment Ecological Screening Values (ESVs)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	ESV	Units	Type	Reference
Antimony	2.00	mg/kg	ER-L	Long and Morgan 1990
Arsenic	8.20	mg/kg	ER-L	Long et al. 1995
Copper	34.0	mg/kg	ER-L	Long et al. 1995
Lead	46.7	mg/kg	ER-L	Long et al. 1995
Zinc	150	mg/kg	ER-L	Long et al. 1995

TABLE 1-10

Soil Bioconcentration Factors For Plants (Dry Weight)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Baseline		
	Value	**Basis**	**Reference**
Metals			
Antimony	see Table 1-11	--	--
Arsenic	see Table 1-11	--	--
Copper	see Table 1-11	--	--
Lead	see Table 1-11	--	--
Zinc	see Table 1-11	--	--
Explosives			
1,3,5-Trinitrobenzene	1.00	Assumed	--
1,3-Dinitrobenzene	1.00	Assumed	--
2,4,6-Trinitrotoluene	4.23	Median	USEPA 2007c
2,4-Dinitrotoluene	1.00	Assumed	--
2,6-Dinitrotoluene	1.00	Assumed	--
2-Amino-4,6-dinitrotoluene	1.00	Assumed	--
2-Nitrotoluene	1.00	Assumed	--
3-Nitrotoluene	1.00	Assumed	--
4-Amino-2,6-dinitrotoluene	1.00	Assumed	--
4-Nitrotoluene	1.00	Assumed	--
HMX	0.56	Mean	Johnson et al. 2009
Nitrobenzene	1.00	Assumed	--
Nitroglycerine	1.00	Assumed	--
RDX	0.43	Median	USEPA 2007c
Tetryl	1.00	Assumed	--

TABLE 1-11

Bioconcentration/Bioaccumulation Factor Models (Dry Weight)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Plants[1]	Reference	Soil Invertebrates[2]	Reference	Small Mammal Omnivores[3]	Reference
Metals						
Antimony	$C_p = e^{(-3.233 + 0.938(\ln Cs))}$	USEPA 2007c	--	--	--	--
Arsenic	$C_p = e^{(-1.992 + 0.564(\ln Cs))}$	Bechtel Jacobs 1998	$C_w = e^{(-1.421 + 0.706(\ln Cs))}$	Sample et al. 1998a; USEPA 2007c	$C_m = e^{(-4.5796 + 0.7354(\ln Cs))}$	Sample et al. 1998b
Copper	$C_p = e^{(0.669 + 0.394(\ln Cs))}$	Bechtel Jacobs 1998; USEPA 2007c	$C_w = e^{(1.675 + 0.264(\ln Cs))}$	Sample et al. 1998a	$C_m = e^{(1.4592 + 0.2681(\ln Cs))}$	Sample et al. 1998b
Lead	$C_p = e^{(-1.328 + 0.561(\ln Cs))}$	Bechtel Jacobs 1998; USEPA 2007c	$C_w = e^{(-0.218 + 0.807(\ln Cs))}$	Sample et al. 1998a; USEPA 2007c	$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$	Sample et al. 1998b; USEPA 2007c
Zinc	$C_p = e^{(1.575 + 0.555(\ln Cs))}$	Bechtel Jacobs 1998; USEPA 2007c	$C_w = e^{(4.449 + 0.328(\ln Cs))}$	Sample et al. 1998a; USEPA 2007c	$C_m = e^{(4.4713 + 0.0738(\ln Cs))}$	Sample et al. 1998b

[1] Where C_p = Concentration in aboveground portion of plant (mg/kg dry wt) and C_s = Concentration in soil (mg/kg dry

[2] Where C_w = Concentration in earthworm (mg/kg dry wt) and C_s = Concentration in soil (mg/kg dry wt)

[3] Where C_m = Concentration in whole-body small mammal (mg/kg dry wt) and C_s = Concentration in soil (mg/kg dry wt)

TABLE 1-12

Soil Bioaccumulation Factors For Soil Invertebrates (Dry Weight)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Baseline		
	Value	**Basis**	**Reference**
Metals			
Antimony	1.00	Assumed	--
Arsenic	see Table 1-11	--	--
Copper	see Table 1-11	--	--
Lead	see Table 1-11	--	--
Zinc	see Table 1-11	--	--
Explosives			
1,3,5-Trinitrobenzene	1.00	Assumed	--
1,3-Dinitrobenzene	1.00	Assumed	--
2,4,6-Trinitrotoluene	1.00	Assumed	--
2,4-Dinitrotoluene	1.00	Assumed	--
2,6-Dinitrotoluene	1.00	Assumed	--
2-Amino-4,6-dinitrotoluene	1.00	Assumed	--
2-Nitrotoluene	1.00	Assumed	--
3-Nitrotoluene	1.00	Assumed	--
4-Amino-2,6-dinitrotoluene	1.00	Assumed	--
4-Nitrotoluene	1.00	Assumed	--
HMX	0.54	Mean	Johnson et al. 2009
Nitrobenzene	1.00	Assumed	--
Nitroglycerine	1.00	Assumed	--
RDX	6.40	Mean	Johnson et al. 2009
Tetryl	1.00	Assumed	--

TABLE 1-13

Soil Bioaccumulation Factors For Small Mammals (Dry Weight) - Omnivores

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Baseline		
	Value	**Basis**	**Reference**
Metals			
Antimony	NA	--	--
Arsenic	see Table 1-11	--	--
Copper	see Table 1-11	--	--
Lead	see Table 1-11	--	--
Zinc	see Table 1-11	--	--
Explosives			
1,3,5-Trinitrobenzene	0	Assumed	per USEPA 2007c for TNT/RDX
1,3-Dinitrobenzene	0	Assumed	per USEPA 2007c for TNT/RDX
2,4,6-Trinitrotoluene	0	Assumed	USEPA 2007c
2,4-Dinitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
2,6-Dinitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
2-Amino-4,6-dinitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
2-Nitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
3-Nitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
4-Amino-2,6-dinitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
4-Nitrotoluene	0	Assumed	per USEPA 2007c for TNT/RDX
HMX	0	Assumed	per USEPA 2007c for TNT/RDX
Nitrobenzene	0	Assumed	per USEPA 2007c for TNT/RDX
Nitroglycerine	0	Assumed	per USEPA 2007c for TNT/RDX
RDX	0	Assumed	USEPA 2007c
Tetryl	0	Assumed	per USEPA 2007c for TNT/RDX

NA - Not Available

TABLE 1-14

Exposure Parameters for Upper Trophic Level Ecological Receptors - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (percent)				Soil Ingestion (percent)	
	Value	Reference	Value	Reference	Value	Reference	Terrestrial Plants	Soil Invertebrates	Small Mammals	Reference	Value	Reference
Birds												
Pearly-eyed thrasher	0.104	Dunning 2008 (mean for male/female - Puerto Rico)	0.0129	allometric equation (USEPA 1993)[1]	0.0123	allometric equation (Nagy 2001)[3]	20.0	75.4	0	Oberle 2000 (estimated based on description of diet)	4.6	Sample and Suter 1994 (value is for American robin)
Red-tailed hawk	1.134	USEPA 1993 (mean of 6 adult values [3 male/3 female])	0.0642	allometric equation (USEPA 1993)[1]	0.0363	Sample and Suter 1994	0	0	100	USEPA 1993; Sample and Suter 1994	0	Sample and Suter 1994
Common ground dove	0.0320	Dunning 2008 (mean - Puerto Rico [gender not reported])	0.0059	allometric equation (USEPA 1993)[1]	0.0069	allometric equation (Nagy 2001)[4]	95.0	0	0	Martin et al. 1951	5.0	Assumed based upon diet
Mammals												
Norway rat	0.209	Silva and Downing 1995 (mean for male/female - Arkansas)	0.0242	allometric equation (USEPA 1993)[2]	0.0207	allometric equation (Nagy 2001)[5]	49.0	49.0	0	Linzey 1998 (estimated based on description of diet)	2.0	Beyer et al. 1994 (value is for deer mouse)
Indian mongoose	0.528	Silva and Downing 1995 (mean for male/female - Puerto Rico)	0.0557	allometric equation (USEPA 1993)[2]	0.0285	allometric equation (Nagy 2001)[6]	11.1	56.4	29.7	Nellis 1989	2.8	Beyer et al. 1994 (value is for red fox)

1 - All birds equation: $0.059\ (BW)^{0.67}$

2 - All mammals equation: $0.099\ (BW)^{0.90}$

3 - Omnivorous birds equation: $(0.67*((BW*1000)^{0.627}))/1000$

4 - All birds equation: $(0.638*((BW*1000)^{0.685)})/1000$

5 - Rodent equation used: $(0.332*((BW*1000)^{0.774}))/1000$

6 - Carnivore equation used: $(0.153*((BW*1000)^{0.834)})/1000$

TABLE 1-15

Ingestion-Based Toxicity Reference Values (TRVs) for Mammals

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Chemical Form	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	Reference	NOAEL (mg/kg/d)	Reference	MATC (mg/kg/d)
Metals											
Antimony	--	rat	--	31 days	oral in water	survival, growth, reproduction	0.590	USEPA 2005c	0.059	USEPA 2005c	0.187
Arsenic	Arsenite (As+3)	mouse	0.03	3 generations	oral in water/food	reproduction	1.26	Sample et al. 1996	0.25 a	--	0.56
Arsenic	--	dog	--	8 weeks	oral in diet	survival, growth, reproduction	1.66	USEPA 2005a	1.04	USEPA 2005a	1.31
Copper	--	pig	--	4 weeks	oral in diet	survival, growth, reproduction	9.34	USEPA 2007a	5.60	USEPA 2007a	7.23
Copper	Copper sulfate	mink	1.00	357 days	oral in diet	reproduction	15.1	Sample et al. 1996	11.7	Sample et al. 1996	13.3
Lead	--	rat	--	7 weeks	oral in water	survival, growth, reproduction	8.90	USEPA 2005b	4.70	USEPA 2005b	6.47
Zinc	--	multiple	--	--	oral	survival, growth, reproduction	377 b	--	75.4	USEPA 2007b	169
Explosives											
1,3,5-Trinitrobenzene	--	rat	0.35	2 years	oral in diet	reproduction	13.4	Talmage et al. 1999	2.64	Talmage et al. 1999	5.96
1,3-Dinitrobenzene	--	rat	0.35	90 days	oral in diet	reproduction	1.73	Talmage et al. 1999	0.35	Talmage et al. 1999	0.78
2,4,6-Trinitrotoluene	--	rat	0.289	13 weeks	oral in diet	reproduction	160	Talmage et al. 1999	34.7	Talmage et al. 1999	74.5
2,4-Dinitrotoluene	--	dog	--	2 years	oral (capsule)	neurological	1.50	USACHPPM 2006	0.20	USACHPPM 2006	0.55
2,6-Dinitrotoluene	--	rat	--	52 weeks	oral in diet	growth (body weight)	7.00	USACHPPM 2006	1.40 a	USACHPPM 2006	3.13
2-Amino-4,6-dinitrotoluene	--	rat	--	--	oral	survival	45.0 b	--	9.00 c	USACHPPM 2005	20.1
2-Nitrotoluene	--	rat	--	chronic	oral	--	8.95 b	--	1.79	LANL 2008	4.00
3-Nitrotoluene	--	rat	--	chronic	oral	--	10.8 b	--	2.16	LANL 2008	4.83
4-Amino-2,6-dinitrotoluene	--	rat	--	--	oral	survival	45.0 b	--	9.00 c	USACHPPM 2005	20.1
4-Nitrotoluene	--	rat	--	chronic	oral	--	19.7 b	--	3.94	LANL 2008	8.81
HMX	--	mouse	0.024	13 weeks	oral in diet	survival	75.0	Talmage et al. 1999	30.0	Talmage et al. 1999	47.4
Nitrobenzene	--	mouse	--	chronic	oral	--	34.8 b	--	6.95	LANL 2008	15.5
Nitroglycerine	--	rat	--	chronic	oral	--	32.0	USACHPPM 2007	3.00	USACHPPM 2007	9.80
RDX	--	mouse	0.04	2 years	oral in diet	reproduction	35.0	Talmage et al. 1999	7.00	Talmage et al. 1999	15.7
Tetryl	--	rat	0.258	90 days	oral in diet	survival; reproduction	62.0	Talmage et al. 1999	13.0	Talmage et al. 1999	28.4

[a] Uncertainty factor of 5 applied to LOAEL

[b] Uncertainty factor of 5 applied to NOAEL

[c] Uncertainty factor of 100 applied to LD50

TABLE 1-16

Ingestion-Based Toxicity Reference Values (TRVs) for Birds

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Chemical Form	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	Reference	NOAEL (mg/kg/d)	Reference	MATC (mg/kg/d)
Metals											
Antimony	--	--	--	--	--	--	NA	--	NA	--	NA
Arsenic	--	chicken	--	19 days	oral in diet	survival, growth,reproduction	11.2 a	--	2.24	USEPA 2005a	5.01
Copper	--	chicken	--	84 days	oral in diet	survival, growth,reproduction	12.1	USEPA 2007a	4.05	USEPA 2007a	7.00
Lead	--	chicken	--	4 weeks	oral in diet	survival, growth,reproduction	3.26	USEPA 2005b	1.63	USEPA 2005b	2.31
Lead	Metallic	American kestrel	0.13	7 months	oral in diet	reproduction	19.3 a	--	3.85	Sample et al. 1996	8.61
Zinc	--	multiple	--	--	oral in diet	survival, growth,reproduction	331 a	--	66.1	USEPA 2007b	148
Explosives											
1,3,5-Trinitrobenzene	--	--	--	--	--	--	NA	--	NA	--	NA
1,3-Dinitrobenzene	--	red-winged blackbird	--	--	oral	survival	2.11 a	--	0.42 c	LANL 2008	0.94
2,4,6-Trinitrotoluene	--	rock dove	--	60 days	oral (gavage)	systemic	7.00 b	Johnson and Salice 2009	2.00 b	Johnson and Salice 2009	3.74
2,4-Dinitrotoluene	--	northern bobwhite	--	60 days	oral (gavage)	survival; growth	0.50 b	Johnson and Salice 2009	0.10 b	Johnson and Salice 2009	0.22
2,6-Dinitrotoluene	--	northern bobwhite	--	60 days	oral (gavage)	survival; growth	0.50 b	2,4-Dinitrotoluene value	0.10 b	2,4-Dinitrotoluene value	0.22
2-Amino-4,6-dinitrotoluene	--	--	--	--	--	--	NA	--	NA	--	NA
2-Nitrotoluene	--	--	--	--	--	--	NA	--	NA	--	NA
3-Nitrotoluene	--	--	--	--	--	--	NA	--	NA	--	NA
4-Amino-2,6-dinitrotoluene	--	--	--	--	--	--	NA	--	NA	--	NA
4-Nitrotoluene	--	--	--	--	--	--	NA	--	NA	--	NA
HMX	--	northern bobwhite	0.19	28 days	oral in diet	reproduction	79.0	Johnson and Salice 2009	7.90	Johnson and Salice 2009	25.0
Nitrobenzene	--	--	--	--	--	--	NA	--	NA	--	NA
Nitroglycerine	--	--	--	--	--	--	NA	--	NA	--	NA
RDX	--	northern bobwhite	0.19	14 - 90 days	oral in diet	reproduction	10.6	Johnson and Salice 2009	8.70	Johnson and Salice 2009	9.60
Tetryl	--	--	--	--	--	--	NA	--	NA	--	NA

NA - Not Available

[a] Uncertainty factor of 5 applied to NOAEL

[b] Subchronic to chronic uncertainty factor of 10 applied

[c] Uncertainty factor of 100 applied to LD50

TABLE 1-17

Summary of Norway Rat Exposure Doses - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil Concentration (mg/kg)[1]	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	MATC HQ
Metals											
Antimony	3.56	1.000	3.56E+00	Regresson	1.30E-01	0	1.87E-01	0.059	0.19	0.59	1.00E+00
Arsenic	94.1	Regression	5.97E+00	Regresson	1.77E+00	0	5.63E-01	0.25	0.56	1.26	1.00E+00
Copper	302	Regression	2.41E+01	Regresson	1.85E+01	0	2.67E+00	5.60	7.23	9.34	3.69E-01
Lead	136	Regression	4.24E+01	Regresson	4.17E+00	0	2.53E+00	4.70	6.47	8.90	3.92E-01
Zinc	3,906	Regression	1.29E+03	Regresson	4.76E+02	0	9.36E+01	75.4	169	377	5.55E-01
Explosives											
1,3,5-Trinitrobenzene	60.0	1.000	6.00E+01	1.000	6.00E+01	0	5.96E+00	2.64	5.96	13.4	1.00E+00
1,3-Dinitrobenzene	4.41	1.000	4.41E+00	1.000	4.41E+00	0	4.37E-01	0.35	0.78	1.73	5.62E-01
2,4,6-Trinitrotoluene	4.29	1.000	4.29E+00	4.230	1.82E+01	0	1.10E+00	34.7	74.5	160	1.48E-02
2,4-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	1.04E-01	0.20	0.55	1.50	1.89E-01
2,6-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	1.04E-01	1.40	3.13	7.00	3.31E-02
2-Amino-4,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	2.01E+01	9.00	20.1	45.0	1.00E+00
2-Nitrotoluene	40.3	1.000	4.03E+01	1.000	4.03E+01	0	4.00E+00	1.79	4.00	8.95	1.00E+00
3-Nitrotoluene	48.7	1.000	4.87E+01	1.000	4.87E+01	0	4.83E+00	2.16	4.83	10.8	1.00E+00
4-Amino-2,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	2.01E+01	9.00	20.1	45.0	1.00E+00
4-Nitrotoluene	88.8	1.000	8.88E+01	1.000	8.88E+01	0	8.81E+00	3.94	8.81	19.7	1.00E+00
HMX	200	0.540	1.08E+02	0.560	1.12E+02	0	1.11E+01	30.0	47.4	75.0	2.34E-01
Nitrobenzene	157	1.000	1.57E+02	1.000	1.57E+02	0	1.55E+01	6.95	15.5	34.8	1.00E+00
Nitroglycerin	98.7	1.000	9.87E+01	1.000	9.87E+01	0	9.80E+00	3.00	9.80	32.0	1.00E+00
RDX	16.3	6.400	1.05E+02	0.430	7.03E+00	0	5.46E+00	7.00	15.7	35.0	3.49E-01
Tetryl	286	1.000	2.86E+02	1.000	2.86E+02	0	2.84E+01	13.0	28.4	62.0	1.00E+00

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0207 = Food ingestion rate (kg/day dry weight)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.490 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.490 = Proportion of diet composed of food item (terrestrial plants)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.020 = Proportion of diet composed of soil
WIR = 0.0242 = Water ingestion rate (L/day)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.209 = Body weight (kg)

1 - Yellow shaded cells indicate the soil concentration that resulted in a MATC-based HQ of 1 and represents the lowest concentration for all 5 receptors evaluated

TABLE 1-18

Summary of Pearly-eyed Thrasher Exposure Doses - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil Concentration (mg/kg)[1]	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	MATC HQ
Metals											
Antimony	3.56	1.000	3.56E+00	Regresson	1.30E-01	0	3.41E-01	NA	NA	NA	NA
Arsenic	94.1	Regression	5.97E+00	Regresson	1.77E+00	0	1.09E+00	2.24	5.01	11.2	2.17E-01
Copper	302	Regression	2.41E+01	Regresson	1.85E+01	0	4.24E+00	4.05	7.00	12.1	6.05E-01
Lead	136	Regression	4.24E+01	Regresson	4.17E+00	0	4.63E+00	3.85	8.61	19.3	5.37E-01
Zinc	3,906	Regression	1.29E+03	Regresson	4.76E+02	0	1.48E+02	66.1	148	331	1.00E+00
Explosives											
1,3,5-Trinitrobenzene	60.0	1.000	6.00E+01	1.000	6.00E+01	0	7.11E+00	NA	NA	NA	NA
1,3-Dinitrobenzene	4.41	1.000	4.41E+00	1.000	4.41E+00	0	5.22E-01	0.42	0.94	2.11	5.53E-01
2,4,6-Trinitrotoluene	4.29	1.000	4.29E+00	4.230	1.82E+01	0	8.38E-01	2.00	3.74	7.00	2.24E-01
2,4-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	1.24E-01	0.10	0.22	0.50	5.53E-01
2,6-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	1.24E-01	0.10	0.22	0.50	5.53E-01
2-Amino-4,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	2.40E+01	NA	NA	NA	NA
2-Nitrotoluene	40.3	1.000	4.03E+01	1.000	4.03E+01	0	4.78E+00	NA	NA	NA	NA
3-Nitrotoluene	48.7	1.000	4.87E+01	1.000	4.87E+01	0	5.77E+00	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	2.40E+01	NA	NA	NA	NA
4-Nitrotoluene	88.8	1.000	8.88E+01	1.000	8.88E+01	0	1.05E+01	NA	NA	NA	NA
HMX	200	0.540	1.08E+02	0.560	1.12E+02	0	1.34E+01	7.90	25.0	79.0	5.37E-01
Nitrobenzene	157	1.000	1.57E+02	1.000	1.57E+02	0	1.85E+01	NA	NA	NA	NA
Nitroglycerin	98.7	1.000	9.87E+01	1.000	9.87E+01	0	1.17E+01	NA	NA	NA	NA
RDX	16.3	6.400	1.05E+02	0.430	7.03E+00	0	9.60E+00	8.70	9.60	10.6	1.00E+00
Tetryl	286	1.000	2.86E+02	1.000	2.86E+02	0	3.39E+01	NA	NA	NA	NA

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0123	= Food ingestion rate (kg/day dry weight)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.754	= Proportion of diet composed of food item (soil invertebrates)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.200	= Proportion of diet composed of food item (terrestrial plants)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.046	= Proportion of diet composed of soil
WIR =	0.0129	= Water ingestion rate (L/day)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.104	= Body weight (kg)

1 - Yellow shaded cells indicate the soil concentration that resulted in a MATC-based HQ of 1 and represents the lowest concentration for all 5 receptors evaluated

TABLE 1-19

Summary of Common Ground Dove Exposure Doses - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil Concentration (mg/kg)[1]	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	MATC HQ
Metals											
Antimony	3.56	1.000	3.56E+00	Regresson	1.30E-01	0	6.45E-02	NA	NA	NA	NA
Arsenic	94.1	Regression	5.97E+00	Regresson	1.77E+00	0	1.37E+00	2.24	5.01	11.2	2.73E-01
Copper	302	Regression	2.41E+01	Regresson	1.85E+01	0	7.00E+00	4.05	7.00	12.1	1.00E+00
Lead	136	Regression	4.24E+01	Regresson	4.17E+00	0	2.30E+00	1.63	2.31	3.26	1.00E+00
Zinc	3,906	Regression	1.29E+03	Regresson	4.76E+02	0	1.39E+02	66.1	148	331	9.38E-01
Explosives											
1,3,5-Trinitrobenzene	60.0	1.000	6.00E+01	1.000	6.00E+01	0	1.28E+01	NA	NA	NA	NA
1,3-Dinitrobenzene	4.41	1.000	4.41E+00	1.000	4.41E+00	0	9.44E-01	0.42	0.94	2.11	1.00E+00
2,4,6-Trinitrotoluene	4.29	1.000	4.29E+00	4.230	1.82E+01	0	3.74E+00	2.00	3.74	7.00	1.00E+00
2,4-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	2.24E-01	0.10	0.22	0.50	1.00E+00
2,6-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0	2.24E-01	0.10	0.22	0.50	1.00E+00
2-Amino-4,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	4.34E+01	NA	NA	NA	NA
2-Nitrotoluene	40.3	1.000	4.03E+01	1.000	4.03E+01	0	8.63E+00	NA	NA	NA	NA
3-Nitrotoluene	48.7	1.000	4.87E+01	1.000	4.87E+01	0	1.04E+01	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0	4.34E+01	NA	NA	NA	NA
4-Nitrotoluene	88.8	1.000	8.88E+01	1.000	8.88E+01	0	1.90E+01	NA	NA	NA	NA
HMX	200	0.540	1.08E+02	0.560	1.12E+02	0	2.50E+01	7.90	25.0	79.0	1.00E+00
Nitrobenzene	157	1.000	1.57E+02	1.000	1.57E+02	0	3.35E+01	NA	NA	NA	NA
Nitroglycerin	98.7	1.000	9.87E+01	1.000	9.87E+01	0	2.11E+01	NA	NA	NA	NA
RDX	16.3	6.400	1.05E+02	0.430	7.03E+00	0	1.60E+00	8.70	9.60	10.6	1.67E-01
Tetryl	286	1.000	2.86E+02	1.000	2.86E+02	0	6.12E+01	NA	NA	NA	NA

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0069 = Food ingestion rate (kg/day dry weight)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.050 = Proportion of diet composed of soil
WIR = 0.0059 = Water ingestion rate (L/day)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.0320 = Body weight (kg)

1 - Yellow shaded cells indicate the soil concentration that resulted in a MATC-based HQ of 1 and represents the lowest concentration for all 5 receptors evaluated

TABLE 1-20

Summary of Indian Mongoose Exposure Doses - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil Concentration (mg/kg)[1]	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF	Small Mammal Concentration (mg/kg dw)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	MATC HQ
Metals													
Antimony	3.56	1.000	3.56E+00	Regresson	1.30E-01	See footnote	1.88E+00	0	1.45E-01	0.059	0.19	0.59	7.76E-01
Arsenic	94.1	Regression	5.97E+00	Regresson	1.77E+00	Regresson	2.90E-01	0	3.40E-01	1.04	1.31	1.66	2.59E-01
Copper	302	Regression	2.41E+01	Regresson	1.85E+01	Regresson	1.99E+01	0	1.62E+00	11.7	13.3	15.1	1.22E-01
Lead	136	Regression	4.24E+01	Regresson	4.17E+00	Regresson	9.47E+00	0	1.67E+00	4.70	6.47	8.90	2.59E-01
Zinc	3,906	Regression	1.29E+03	Regresson	4.76E+02	Regresson	1.61E+02	0	5.06E+01	75.4	169	377	3.00E-01
Explosives													
1,3,5-Trinitrobenzene	60.0	1.000	6.00E+01	1.000	6.00E+01	0.000	0.00E+00	0	2.28E+00	2.64	5.96	13.4	3.83E-01
1,3-Dinitrobenzene	4.41	1.000	4.41E+00	1.000	4.41E+00	0.000	0.00E+00	0	1.67E-01	0.35	0.78	1.73	2.15E-01
2,4,6-Trinitrotoluene	4.29	1.000	4.29E+00	4.230	1.82E+01	0.000	0.00E+00	0	2.46E-01	34.7	74.5	160	3.31E-03
2,4-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0.000	0.00E+00	0	3.97E-02	0.20	0.55	1.50	7.24E-02
2,6-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0.000	0.00E+00	0	3.97E-02	1.40	3.13	7.00	1.27E-02
2-Amino-4,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0.000	0.00E+00	0	7.70E+00	9.00	20.1	45.0	3.83E-01
2-Nitrotoluene	40.3	1.000	4.03E+01	1.000	4.03E+01	0.000	0.00E+00	0	1.53E+00	1.79	4.00	8.95	3.83E-01
3-Nitrotoluene	48.7	1.000	4.87E+01	1.000	4.87E+01	0.000	0.00E+00	0	1.85E+00	2.16	4.83	10.8	3.83E-01
4-Amino-2,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0.000	0.00E+00	0	7.70E+00	9.00	20.1	45.0	3.83E-01
4-Nitrotoluene	88.8	1.000	8.88E+01	1.000	8.88E+01	0.000	0.00E+00	0	3.37E+00	3.94	8.81	19.7	3.83E-01
HMX	200	0.540	1.08E+02	0.560	1.12E+02	0.000	0.00E+00	0	4.27E+00	30.0	47.4	75.0	9.01E-02
Nitrobenzene	157	1.000	1.57E+02	1.000	1.57E+02	0.000	0.00E+00	0	5.95E+00	6.95	15.5	34.8	3.83E-01
Nitroglycerin	98.7	1.000	9.87E+01	1.000	9.87E+01	0.000	0.00E+00	0	3.75E+00	3.00	9.80	32.0	3.83E-01
RDX	16.3	6.400	1.05E+02	0.430	7.03E+00	0.000	0.00E+00	0	3.25E+00	7.00	15.7	35.0	2.08E-01
Tetryl	286	1.000	2.86E+02	1.000	2.86E+02	0.000	0.00E+00	0	1.09E+01	13.0	28.4	62.0	3.83E-01

It was assumed that the concentration of each chemical in the small mammal's tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0285	= Food ingestion rate (kg/day dry weight)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.564	= Proportion of diet composed of food item (soil invertebrates)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.111	= Proportion of diet composed of food item (terrestrial plants)
FCxi =	Chemical-specific	= Concentration of chemical in food item (small mammals, dry weight basis)
PDFi =	0.297	= Proportion of diet composed of food item (small mammals)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.028	= Proportion of diet composed of soil
WIR =	0.0557	= Water ingestion rate (L/day)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.528	= Body weight (kg)

1 - Yellow shaded cells indicate the soil concentration that resulted in a MATC-based HQ of 1 and represents the lowest concentration for all 5 receptors evaluated

TABLE 1-21

Summary of Red-tailed Hawk Exposure Doses - Baseline

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Surface Soil Concentration (mg/kg)[1]	Soil-Worm BAF	Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF	Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF	Small Mammal Concentration (mg/kg dw)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)	MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	MATC HQ
Metals													
Antimony	3.56	1.000	3.56E+00	Regresson	1.30E-01	See footnote	1.88E+00	0	6.01E-02	NA	NA	NA	NA
Arsenic	94.1	Regression	5.97E+00	Regresson	1.77E+00	Regresson	2.90E-01	0	9.28E-03	2.24	5.01	11.2	1.85E-03
Copper	302	Regression	2.41E+01	Regresson	1.85E+01	Regresson	1.99E+01	0	6.36E-01	4.05	7.00	12.1	9.09E-02
Lead	136	Regression	4.24E+01	Regresson	4.17E+00	Regresson	9.47E+00	0	3.03E-01	3.85	8.61	19.3	3.52E-02
Zinc	3,906	Regression	1.29E+03	Regresson	4.76E+02	Regresson	1.61E+02	0	5.15E+00	66.1	148	331	3.49E-02
Explosives													
1,3,5-Trinitrobenzene	60.0	1.000	6.00E+01	1.000	6.00E+01	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
1,3-Dinitrobenzene	4.41	1.000	4.41E+00	1.000	4.41E+00	0.000	0.00E+00	0	0.00E+00	0.42	0.94	2.11	0.00E+00
2,4,6-Trinitrotoluene	4.29	1.000	4.29E+00	4.230	1.82E+01	0.000	0.00E+00	0	0.00E+00	2.00	3.74	7.00	0.00E+00
2,4-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0.000	0.00E+00	0	0.00E+00	0.10	0.22	0.50	0.00E+00
2,6-Dinitrotoluene	1.04	1.000	1.04E+00	1.000	1.04E+00	0.000	0.00E+00	0	0.00E+00	0.10	0.22	0.50	0.00E+00
2-Amino-4,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
2-Nitrotoluene	40.3	1.000	4.03E+01	1.000	4.03E+01	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
3-Nitrotoluene	48.7	1.000	4.87E+01	1.000	4.87E+01	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	203	1.000	2.03E+02	1.000	2.03E+02	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
4-Nitrotoluene	88.8	1.000	8.88E+01	1.000	8.88E+01	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
HMX	200	0.540	1.08E+02	0.560	1.12E+02	0.000	0.00E+00	0	0.00E+00	7.90	25.0	79.0	0.00E+00
Nitrobenzene	157	1.000	1.57E+02	1.000	1.57E+02	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
Nitroglycerin	98.7	1.000	9.87E+01	1.000	9.87E+01	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA
RDX	16.3	6.400	1.05E+02	0.430	7.03E+00	0.000	0.00E+00	0	0.00E+00	8.70	9.60	10.6	0.00E+00
Tetryl	286	1.000	2.86E+02	1.000	2.86E+02	0.000	0.00E+00	0	0.00E+00	NA	NA	NA	NA

It was assumed that the concentration of each chemical in the small mammal's tissues was equal to the chemical concentration in its diet, that is, a diet to whole-body BAF of 1.0 was assumed

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0363	= Food ingestion rate (kg/day dry weight)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.000	= Proportion of diet composed of food item (soil invertebrates)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.000	= Proportion of diet composed of food item (terrestrial plants)
FCxi =	Chemical-specific	= Concentration of chemical in food item (small mammals, dry weight basis)
PDFi =	1.000	= Proportion of diet composed of food item (small mammals)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.000	= Proportion of diet composed of soil
WIR =	0.0642	= Water ingestion rate (L/day)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	1.134	= Body weight (kg)

1 - Yellow shaded cells indicate the soil concentration that resulted in a MATC-based HQ of 1 and represents the lowest concentration for all 5 receptors evaluated

TABLE 1-22

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil (0-0.5 feet) - All Subareas

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Initial COPC?
Explosives (UG/KG)											
1,3,5-Trinitrobenzene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	60,000	-- / --	0.01	NO
1,3-Dinitrobenzene	38.1 - 396	1 / 41	71.8	71.8	77MT-SS021G-00_5	37.0	30.4	4,400	0 / 41	0.02	NO
2,4,6-Trinitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	4,300	-- / --	0.09	NO
2,4-Dinitrotoluene	38.1 - 396	1 / 42	74.6	74.6	77OB-SS007G-00_5	36.7	30.2	1,050	0 / 42	0.07	NO
2,6-Dinitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	1,050	-- / --	0.38	NO
2-Amino-4,6-dinitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	80,000	-- / --	0.005	NO
2-Nitrotoluene	38.1 - 396	0 / 41	--	--	--	35.8	30.0	40,300	-- / --	0.01	NO
3-Nitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	48,650	-- / --	0.01	NO
4-Amino-2,6-dinitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	80,000	-- / --	0.005	NO
4-Nitrotoluene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	88,750	-- / --	0.004	NO
HMX	38.1 - 396	1 / 42	1,780	1,780	77OB-SS005-G00_5	76.6	271	10,000	0 / 42	0.18	NO
Nitrobenzene	38.1 - 396	0 / 42	--	--	--	35.4	29.7	2,260	-- / --	0.18	NO
Nitroglycerin	95.2 - 250	35 / 71	53.2	21,800	77RR-SS103G-00_5	2,125	4,308	98,700	0 / 71	0.22	NO
RDX	38.1 - 396	10 / 41	127	232	77MT-SS001G-00_5	64.5	68.0	10,000	0 / 41	0.02	NO
Tetryl	38.1 - 396	5 / 41	22.9	63.5	77RR-SS079G-00_5	37.7	29.9	10,000	0 / 41	0.01	NO
Metals (MG/KG)											
Antimony	0.30 - 42.8	63 / 227	0.54	6,510	77RR-SS055-G00_5	46.2	443	3.56	47 / 227	1,829	**YES**
Arsenic	0.82 - 32.1	168 / 227	0.53	60.5	77RR-SS055-G00_5	3.34	7.18	18.0	7 / 227	3.36	**YES**
Copper	-- - --	225 / 225	0.86	36,700	77RR-SS052-G00_5	828	3,795	70.0	195 / 225	524	**YES**
Lead	0.93 - 30.0	279 / 293	0.62	118,000	77RR-SS055-G00_5	3,579	11,960	120	161 / 293	983	**YES**
Zinc	-- - --	225 / 225	30.3	3,470	77RR-SS052-G00_5	169	406	120	50 / 225	28.9	**YES**
Other Parameters											
pH	-- - --	10 / 10	5.44	8.15	77PR-SS032-C00_5	6.94	1.04	--	-- / --	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-23

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - All Subareas

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Initial COPC?
Explosives (UG/KG)											
1,3,5-Trinitrobenzene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	60,000	-- / --	0.002	NO
1,3-Dinitrobenzene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	4,400	-- / --	0.02	NO
2,4,6-Trinitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	4,300	-- / --	0.02	NO
2,4-Dinitrotoluene	37.4 - 100	1 / 30	37.0	37.0	77RR-SB084G-0_502	20.9	6.37	1,050	0 / 30	0.04	NO
2,6-Dinitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	1,050	-- / --	0.10	NO
2-Amino-4,6-dinitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	80,000	-- / --	0.001	NO
2-Nitrotoluene	37.4 - 100	1 / 30	25.5	25.5	77MT-SB020G-0_502	20.6	5.68	40,300	0 / 30	0.001	NO
3-Nitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	48,650	-- / --	0.002	NO
4-Amino-2,6-dinitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	80,000	-- / --	0.001	NO
4-Nitrotoluene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	88,750	-- / --	0.001	NO
HMX	37.4 - 100	0 / 30	--	--	--	20.4	5.61	10,000	-- / --	0.01	NO
Nitrobenzene	37.4 - 100	0 / 30	--	--	--	20.4	5.61	2,260	-- / --	0.04	NO
Nitroglycerin	93.5 - 250	19 / 44	87.4	39,400	77RR-SB112G-0_502	2,108	6,248	98,700	0 / 44	0.40	NO
RDX	37.4 - 40.0	1 / 29	205	205	77OB-SB001-G0102	25.7	34.5	10,000	0 / 29	0.02	NO
Tetryl	37.4 - 100	11 / 28	28.1	72.8	77OB-SB018G-0_502	31.1	16.1	10,000	0 / 28	0.01	NO
Metals (MG/KG)											
Antimony	0.52 - 3.98	34 / 175	1.04	212	77RR-SB097G-0_502	5.90	19.8	3.56	27 / 175	59.6	**YES**
Arsenic	1.04 - 13.9	110 / 175	0.58	14.9	77RR-SB097G-0_502	2.03	2.15	18.0	0 / 175	0.83	NO
Copper	-- - --	175 / 175	0.56	137,000	77RR-SB133G-0_502	1,796	13,176	70.0	144 / 175	1,957	**YES**
Lead	0.82 - 2.06	163 / 175	0.51	96,200	77RR-SB097G-0_502	1,884	8,191	120	80 / 175	802	**YES**
Zinc	-- - --	175 / 175	20.5	14,100	77RR-SB133G-0_502	248	1,322	120	25 / 175	118	**YES**

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-24

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Detonation Area

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Backgroun d Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.59 - 3.35	0 / 16	--	--	--	1.17	0.33	--	3.56	-- / --	0.94	--	-- / --	--	NO	--	--	NO
Arsenic	1.63 - 1.66	14 / 16	0.88	4.63	77DA-SS018G-00_5	1.80	1.00	--	18.0	0 / 16	0.26	--	-- / --	--	NO	--	--	NO
Copper	-- - --	16 / 16	47.2	7,960	77DA-SS009G-00_5	585	1,967	2,729	70.0	11 / 16	114	192	2 / 16	41.5	**YES**	39.0	8.36	**YES**
Lead	-- - --	16 / 16	0.62	427	77DA-SS003G-00_5	46.8	105	161	120	1 / 16	3.56	--	-- / --	--	**YES**	1.34	0.39	NO
Zinc	-- - --	16 / 16	61.2	2,480	77DA-SS009G-00_5	232	600	885	120	2 / 16	20.7	132	1 / 16	18.8	**YES**	7.38	1.93	**YES**
Other Parameters																		
pH	-- - --	1 / 1	8.00	8.00	77DA-SS002G-00_5	8.00	--	--	--	-- / --	--	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-25

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Detonation Area

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77DA-SB001	77DA-SB002	77DA-SB003	77DA-SB004	77DA-SB005	77DA-SB006	77DA-SB007	77DA-SB008	77DA-SB009	
			77DA-SS001G-00_5	77DA-SS002G-00_5	77DA-SS003G-00_5	77DA-SS004G-00_5	77DA-SS005G-00_5	77DA-SS006G-00_5	77DA-SS007G-00_5	77DA-SS008G-00_5	77DA-SS009G-00_5	77DA-SS009G-00_5-D
			05/22/10	05/22/10	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12
Metals (MG/KG)												
Arsenic	18.0	2.75	**1.87 J**	**2.44**	**2.34 J**	**1.74 J**	**1.55 J**	**1.45 J**	**1.01 J**	1.66 U	**1.25 J**	**1.37 J**
Copper	70.0	192	**129**	**51.4**	**120 J**	**73.9 J**	**47.2 J**	**65.2 J**	**85.1 J**	**88.5 J**	**63.9 J**	**7,960 J**
Lead	120	34.2	**34.1**	**40.7**	**427**	**22.1**	**4.38 J**	**16.9 J**	**6.54 J**	**106 J**	**6.12 J**	**15.5 J**
Zinc	120	132	**112**	**62.1**	**120**	**71.5**	**69.5 J**	**77.6 J**	**82 J**	**79.2 J**	**92.8 J**	**2,480 J**
Other Parameters												
pH	--	--	NA	**8.00**	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-25

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77DA-SB010	77DA-SB011	77DA-SB014		77DA-SB015	77DA-SB016	77DA-SB017	77DA-SB018
			77DA-SS010G-00_5	77DA-SS011G-00_5	77DA-SS014G-00_5	77DA-SS014G-00_5-D	77DA-SS015G-00_5	77DA-SS016G-00_5	77DA-SS017G-00_5	77DA-SS018G-00_5
			09/20/12	09/20/12	03/23/13	03/23/13	03/23/13	03/23/13	03/23/13	03/23/13
Metals (MG/KG)										
Arsenic	18.0	2.75	1.63 U	**0.876 J**	3.35 U	**0.92 J**	**3.02**	**1.72 J**	**2.17 J**	**4.63**
Copper	70.0	192	**101 J**	**92.2 J**	**72.1**	**87.8**	**271**	**60.2 J**	**71.5**	**59.1**
Lead	120	34.2	**0.624 J**	**5.95 J**	**8.18 J**	**2.53 J**	**35.5 J**	**3.28 J**	**4.92 J**	**16.9 J**
Zinc	120	132	**101 J**	**82.6 J**	**62.6**	**75.0**	**104**	**61.7**	**67.3**	**61.2**
Other Parameters										
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-26

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Detonation Area

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	2.84 - 2.84	0 / 1	--	--	--	1.42	--	--	3.56	-- / --	0.80	--	-- / --	--	NO	--	--	NO
Copper	-- - --	1 / 1	102	102	77DA-SB003G-0_502	102	--	--	70.0	1 / 1	1.46	141	0 / 1	0.72	NO	--	--	NO
Lead	-- - --	1 / 1	399	399	77DA-SB003G-0_502	399	--	--	120	1 / 1	3.33	--	-- / --	--	**YES**	--	3.33	**YES**
Zinc	-- - --	1 / 1	161	161	77DA-SB003G-0_502	161	--	--	120	1 / 1	1.34	131	1 / 1	1.23	**YES**	--	1.34	**YES**

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-27

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Detonation Area

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77DA-SB003 77DA-SB003G-0_502 03/23/13	77DA-SB012 77DA-SB012G-0_502 09/20/12	77DA-SB013 77DA-SB013G-0_502 09/20/12
Metals (MG/KG)					
Copper	70.0	141	**102**	NA	NA
Lead	120	13.2	**399 J**	NA	NA
Zinc	120	131	**161**	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-28

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Former Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.61 - 3.60	7 / 29	0.57	6.26	77FP-SS010-G00_5	1.58	1.18	1.91	3.56	2 / 29	1.76	--	-- / --	--	**YES**	0.54	0.44	NO
Arsenic	0.94 - 2.72	23 / 29	0.87	2.62	77FP-SS049G-00_5	1.29	0.51	--	18.0	0 / 29	0.15	--	-- / --	--	NO	--	--	NO
Copper	-- - --	29 / 29	3.95	4,400	77FP-SS009-G00_5	318	870	1,023	70.0	25 / 29	62.9	192	4 / 29	22.9	**YES**	14.6	4.55	**YES**
Lead	2.67 - 30.0	42 / 49	3.79	4,570	77FP-SS049G-00_5	329	824	843	120	20 / 49	38.1	--	-- / --	--	**YES**	7.02	2.74	**YES**
Zinc	-- - --	29 / 29	30.6	437	77FP-SS009-G00_5	87.0	79.7	152	120	3 / 29	3.64	132	3 / 29	3.31	**YES**	1.26	0.73	NO
Other Parameters																		
pH	-- - --	2 / 2	5.67	6.26	77FP-SB045G-00_3	5.97	0.42	--	--	-- / --	--	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Former Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB001 77FP-SS001-0006 05/21/10	77FP-SB002 77FP-SS002-0006 05/21/10	77FP-SB003 77FP-SS003-0006 05/21/10	77FP-SB004 77FP-SS004-G00_5 05/21/10	77FP-SB005 77FP-SS005-0006 05/21/10	77FP-SB006 77FP-SS006-0006 05/21/10	77FP-SB007 77FP-SS007-0006 05/21/10	77FP-SB008 77FP-SS008-0006 05/21/10	77FP-SB009 77FP-SS009-G00_5 05/21/10
Metals (MG/KG)											
Antimony	3.56	2.70	NA	NA	NA	**0.57 J**	NA	NA	NA	NA	**1.62 J**
Arsenic	18.0	2.75	NA	NA	NA	**1.08**	NA	NA	NA	NA	**1.51 J**
Copper	70.0	192	NA	NA	NA	**28.8**	NA	NA	NA	NA	**4,400**
Lead	120	34.2	5.33 U	**21**	2.67 U	**375**	**21.7**	3.33 U	**13.3**	**133**	**660**
Zinc	120	132	NA	NA	NA	**30.6**	NA	NA	NA	NA	**437**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	**5.67**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB010 77FP-SS010-G00_5 05/21/10	77FP-SB011 77FP-SS011-0006 05/21/10	77FP-SB012 77FP-SS012-G00_5 05/21/10	77FP-SB013 77FP-SS013-G00_5 05/21/10	77FP-SB014 77FP-SS014-0006 05/21/10	77FP-SB015 77FP-SS015-0006 05/21/10	77FP-SB016 77FP-SS016-0006 05/21/10	77FP-SB017 77FP-SS017-0006 05/21/10	77FP-SB018 77FP-SS018-G00_5 05/21/10
Metals (MG/KG)											
Antimony	3.56	2.70	**6.26 J**	NA	**3.80 J**	**1.19 J**	NA	NA	NA	NA	0.606 U
Arsenic	18.0	2.75	**1.3 J**	NA	**1.82 J**	**1.82**	NA	NA	NA	NA	**1.02**
Copper	70.0	192	**204**	NA	**99**	**61.7**	NA	NA	NA	NA	**56.7**
Lead	120	34.2	**3,215**	**27.7**	**2,004**	**484**	**17**	**37**	5.5 U	**20.3**	**59.6**
Zinc	120	132	**69.2**	NA	**53.1**	**38.6**	NA	NA	NA	NA	**45.1**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB019	77FP-SB020	77FP-SB021	77FP-SB022	77FP-SB023	77FP-SB024	77FP-SB025	
			77FP-SS019-0006	77FP-SS020-G00_5	77FP-SS021-0006	77FP-SS022-G00_5	77FP-SS023-0006	77FP-SS024-0006	77FP-SS025-G00_5	77FP-SS025-G00_5-D
			05/21/10	05/21/10	05/26/10	05/26/10	05/26/10	05/26/10	05/26/10	05/26/10
Metals (MG/KG)										
Antimony	3.56	2.70	NA	1.57 U	NA	1.56 U	NA	NA	1.53 U	NA
Arsenic	18.0	2.75	NA	0.944 U	NA	**1.13 J**	NA	NA	**1.16 J**	NA
Copper	70.0	192	NA	**147**	NA	**93.4**	NA	NA	**122**	NA
Lead	120	34.2	3.33 U	30 U	3.5 U	**486**	**155**	**202**	**287**	**293**
Zinc	120	132	NA	**69.3**	NA	**49.1**	NA	NA	**64.5**	NA
Other Parameters										
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB026		77FP-SB027	77FP-SB028	77FP-SB029	77FP-SB030	77FP-SB031	77FP-SB032	77FP-SB033
			77FP-SS026-G00_5	77FP-SS026-G00_5-D	77FP-SS027-0006	77FP-SS028-0006	77FP-SS029-0006	77FP-SS030-0006	77FP-SS031-C00_5	77FP-SS032-C00_5	77FP-SS033G-00_5
			05/26/10	05/26/10	05/26/10	05/26/10	05/26/10	05/26/10	05/20/10	05/20/10	09/20/12
Metals (MG/KG)											
Antimony	3.56	2.70	1.57 U	NA	NA	NA	NA	NA	NA	NA	2.4 UJ
Arsenic	18.0	2.75	0.943 U	NA	NA	NA	NA	NA	NA	NA	**1.57 J**
Copper	70.0	192	**2,110**	NA	NA	NA	NA	NA	NA	NA	**106 J**
Lead	120	34.2	**422**	**281**	**234**	**169**	**235**	**73**	NA	NA	**216 J**
Zinc	120	132	**269**	NA	NA	NA	NA	NA	NA	NA	**69.3 J**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB034	77FP-SB035	77FP-SB036	77FP-SB037	77FP-SB038		77FP-SB039	77FP-SB040	77FP-SB041
			77FP-SS034G-00_5	77FP-SS035G-00_5	77FP-SS036G-00_5	77FP-SS037G-00_5	77FP-SS038G-00_5	77FP-SS038G-00_5-D	77FP-SS039G-00_5	77FP-SS040G-00_5	77FP-SS041G-00_5
			09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	09/20/12	03/24/13
Metals (MG/KG)											
Antimony	3.56	2.70	2.37 UJ	2.42 UJ	2.36 UJ	2.28 UJ	2.36 UJ	2.34 UJ	2.23 UJ	2.44 UJ	**3.06 J**
Arsenic	18.0	2.75	**1.51 J**	**0.983 J**	**1.08 J**	1.71 UJ	**1.06 J**	**1.07 J**	1.67 U	1.83 UJ	**2.09 J**
Copper	70.0	192	**104**	**111**	**115**	**98.6**	**120**	**123**	**99.6**	**94**	**243**
Lead	120	34.2	**134**	**143**	**99.5**	**64.7**	**100**	**100**	**55.4**	**20.9**	**938**
Zinc	120	132	**61.4**	**69.1**	**63.6**	**58.6**	**78.6 J**	**83.1 J**	**76.2 J**	**63.4**	**81.9**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB042 77FP-SS042G-00_5 03/24/13	77FP-SB043 77FP-SS043G-00_5 03/23/13	77FP-SB044 77FP-SS044G-00_5 03/23/13	77FP-SB045 77FP-SB045G-00_3 09/20/12	77FP-SB046 77FP-SS046G-00_5 03/23/13	77FP-SB047 77FP-SS047G-00_5 03/23/13	77FP-SB048 77FP-SS048G-00_5 03/23/13	77FP-SB049 77FP-SS049G-00_5 03/24/13	77FP-SB050 77FP-SS050G-00_5 03/24/13
Metals (MG/KG)											
Antimony	3.56	2.70	3.28 UJ	2.8 UJ	2.72 UJ	NA	2.72 UJ	2.76 UJ	2.96 UJ	**3.26 J**	3.6 UJ
Arsenic	18.0	2.75	**1.86 J**	**0.872 J**	2.72 U	NA	**1.04 J**	**0.888 J**	**1.48 J**	**2.62 J**	**2.28 J**
Copper	70.0	192	**3.95**	**71.8**	**83.4**	NA	**82.3**	**86.1**	**88.3**	**138**	**97**
Lead	120	34.2	**4.92**	**6.78**	**6.02**	NA	**11.7**	**3.79**	**11.1**	**4,570 J**	**275**
Zinc	120	132	**62.9**	**52.3**	**69.6**	NA	**81.5**	**69.4**	**66.8**	**151**	**90.1**
Other Parameters											
pH	--	--	NA	NA	NA	**6.26**	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-29

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface So

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB051	77FP-SB052	
			77FP-SS051G-00_5	77FP-SS052G-00_5	77FP-SS052G-00_5-D
			03/22/13	03/22/13	03/22/13
Metals (MG/KG)					
Antimony	3.56	2.70	2.9 UJ	2.91 UJ	2.91 UJ
Arsenic	18.0	2.75	**1.24 J**	**1.07 J**	**1.1 J**
Copper	70.0	192	**90.5**	**72.7**	**72.5**
Lead	120	34.2	**47.7 J**	**24.3 J**	**22.4 J**
Zinc	120	132	**68.3 J**	**59.6 J**	**60.4 J**
Other Parameters					
pH	--	--	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-30

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Former Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	2.33 - 3.98	1 / 28	6.19	6.19	77FP-SB010G-0_502	1.65	0.92	--	3.56	1 / 28	1.74	5.58	1 / 28	1.11	**YES**	--	0.46	NO
Copper	-- - --	28 / 28	2.97	182	77FP-SB010G-0_502	93.5	36.1	105	70.0	23 / 28	2.60	141	2 / 28	1.29	**YES**	1.50	1.34	**YES**
Lead	0.86 - 1.71	23 / 28	0.92	997	77FP-SB010G-0_502	114	231	254	120	8 / 28	8.31	--	-- / --	--	**YES**	2.11	0.95	**YES**
Zinc	-- - --	28 / 28	44.3	163	77FP-SB049G-0_502	67.2	24.2	75.0	120	1 / 28	1.36	131	1 / 28	1.24	**YES**	0.62	0.56	NO

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-31

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Former Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB009 77FP-SB009G-0_502 03/24/13	77FP-SB010 77FP-SB010G-0_502 03/24/13	77FP-SB011 77FP-SB011G-0_502 03/24/13	77FP-SB012 77FP-SB012G-0_502 03/24/13	77FP-SB013 77FP-SB013G-0_502 03/24/13	77FP-SB026 77FP-SB026G-0_502 03/24/13	77FP-SB027 77FP-SB027G-0_502 03/24/13	77FP-SB028 77FP-SB028G-0_502 03/24/13
Metals (MG/KG)										
Antimony	3.56	5.58	2.8 UJ	**6.19 J**	3.52 UJ	3.43 UJ	3.43 UJ	2.96 UJ	2.85 UJ	3.98 UJ
Copper	70.0	141	**116**	**182**	**150**	**80.6**	**55.8**	**129**	**119**	**61.1**
Lead	120	13.2	**181**	**997**	**8.67**	**151**	**46.9**	**151**	1.71 U	**126**
Zinc	120	131	**62.4**	**64.9**	**88**	**62.5**	**46.3**	**64.7**	**78.5**	**47.2**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-31

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface S

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB029 77FP-SB029G-0_502 03/24/13	77FP-SB033 77FP-SB033G-0_502 09/20/12	77FP-SB034 77FP-SB034G-0_502 09/20/12	77FP-SB035 77FP-SB035G-0_502 09/20/12	77FP-SB036 77FP-SB036G-0_502 09/20/12	77FP-SB037 77FP-SB037G-0_502 09/20/12	77FP-SB038 77FP-SB038G-0_502 09/20/12	77FP-SB039 77FP-SB039G-0_502 09/20/12
Metals (MG/KG)										
Antimony	3.56	5.58	3.79 UJ	2.58 UJ	2.36 UJ	2.39 UJ	2.4 UJ	2.42 UJ	2.45 UJ	2.41 UJ
Copper	70.0	141	**70.7**	**108 J**	**101 J**	**108**	**103**	**106**	**109**	**109**
Lead	120	13.2	**26.8**	**190 J**	**153 J**	**38.1**	**65.3**	**37.4**	**10**	**29.5**
Zinc	120	131	**54.5**	**65.8 J**	**61.3 J**	**61**	**55.9**	**55.6**	**61.9 J**	**71.5 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-31

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface S

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB040 77FP-SB040G-0_502 09/20/12	77FP-SB041 77FP-SB041G-0_502 03/24/13	77FP-SB042 77FP-SB042G-0_502 03/24/13	77FP-SB043 77FP-SB043G-0_502 03/23/13	77FP-SB044 77FP-SB044G-0_502 03/23/13	77FP-SB046 77FP-SB046G-0_502 03/23/13	77FP-SB047 77FP-SB047G-0_502 03/23/13	77FP-SB048 77FP-SB048G-0_502 03/23/13
Metals (MG/KG)										
Antimony	3.56	5.58	2.33 UJ	3.07 UJ	3.3 UJ	2.87 UJ	2.91 UJ	2.76 UJ	2.79 UJ	2.86 UJ
Copper	70.0	141	**92.9**	**9.85**	**2.97 J**	**87.2**	**83.9**	**88.9**	**95.2**	**79.3**
Lead	120	13.2	**8.51**	**25.2**	0.991 U	0.862 U	**14.6**	**7.27**	**0.919**	**18.9**
Zinc	120	131	**56.5**	**44.3**	**119**	**45.8**	**68.1**	**72.8**	**77**	**61.7**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-31

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface S

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77FP-SB049	77FP-SB050	77FP-SB051	77FP-SB052	
			77FP-SB049G-0_502	77FP-SB050G-0_502	77FP-SB051G-0_502	77FP-SB052G-0_502	77FP-SB052G-0_502-D
			03/24/13	03/24/13	03/22/13	03/22/13	03/22/13
Metals (MG/KG)							
Antimony	3.56	5.58	3.44 UJ	3.31 UJ	3.09 UJ	3.24 UJ	3.23 UJ
Copper	70.0	141	**117**	**98.8**	**57.2 J**	**97.2**	**95.3**
Lead	120	13.2	**793**	**118**	0.933 U	0.972 UJ	0.968 UJ
Zinc	120	131	**163**	**72.1**	**44.7**	**53.7 J**	**51.9 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-32

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Potential Munitions Trench

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.30 - 2.43	2 / 12	0.54	0.63	77MT-SS002G-00_5	0.94	0.32	--	3.56	0 / 12	0.18	--	-- / --	--	NO	--	--	NO
Arsenic	1.60 - 1.66	6 / 12	0.68	1.53	77MT-SS002G-00_5	0.97	0.26	--	18.0	0 / 12	0.09	--	-- / --	--	NO	--	--	NO
Copper	-- - --	12 / 12	1.89	92.3	77MT-SS002G-00_5	22.9	28.1	--	70.0	1 / 12	1.32	192	0 / 12	0.48	NO	--	--	NO
Lead	2.62 - 5.05	6 / 12	2.47	12.0	77MT-SS022G-00_5	4.52	3.84	--	120	0 / 12	0.10	--	-- / --	--	NO	--	--	NO
Zinc	-- - --	12 / 12	30.3	126	77MT-SS022G-00_5	56.2	28.4	--	120	1 / 12	1.05	132	0 / 12	0.95	NO	--	--	NO
Other Parameters																		
pH	-- - --	1 / 1	5.44	5.44	77MT-SS002G-00_5	5.44	--	--	--	-- / --	--	--	-- / --	--	--		--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-33

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Potential Munitions Trench

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77MT-SB001 77MT-SS001G-00_5 05/22/10	77MT-SB002 77MT-SS002G-00_5 05/22/10	77MT-SB003 77MT-SS003G-00_5 05/22/10	77MT-SB004 77MT-SS004G-00_5 09/22/12	77MT-SB005 77MT-SS005G-00_5 09/22/12	77MT-SB006 77MT-SS006G-00_5 09/22/12	77MT-SB007 77MT-SS007G-00_5 09/22/12	77MT-SB008 77MT-SS008G-00_5 09/22/12
Metals (MG/KG)										
Antimony	3.56	2.70	0.3 U	**0.633 J**	**0.541 J**	2.13 U	2.14 U	2.2 U	2.21 U	2.13 U
Arsenic	18.0	2.75	**0.675**	**1.53**	**1.27**	1.6 U	1.6 U	1.65 U	1.66 U	1.6 U
Copper	70.0	192	**1.89**	**92.3**	**13.4**	**5.34**	**9.95**	**5.44**	**10.1**	**10.6**
Lead	120	34.2	**2.47**	**3.89**	3.13 U	3.21 U	3.12 U	**6.98**	2.62 U	4.05 U
Zinc	120	132	**35.3**	**48.8**	**57.1**	**42.4**	**32.1**	**33.1**	**54.7**	**30.3**
Other Parameters										
pH	--	--	NA	**5.44**	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-33

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil -

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77MT-SB009		77MT-SB010	77MT-SB021	77MT-SB022
			77MT-SS009G-00_5	77MT-SS009G-00_5-D	77MT-SS010G-00_5	77MT-SS021G-00_5	77MT-SS022G-00_5
			09/22/12	09/22/12	09/22/12	09/25/12	09/25/12
Metals (MG/KG)							
Antimony	3.56	2.70	2.19 UJ	NA	2.26 UJ	2.43 UJ	2.24 UJ
Arsenic	18.0	2.75	1.65 U	NA	**1.23 J**	**1.07 J**	**0.942 J**
Copper	70.0	192	**17.2 J**	NA	**67 J**	**9.84**	**31.4**
Lead	120	34.2	5.05 U	NA	**10.9**	**7.43**	**12**
Zinc	120	132	**48.7**	NA	**76.4**	**89.3 J**	**126 J**
Other Parameters							
pH	--	--	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-34

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Potential Munitions Trench

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	2.05 - 2.84	0 / 10	--	--	--	1.18	0.10	--	3.56	-- / --	0.80	--	-- / --	--	NO	--	--	NO
Copper	-- - --	10 / 10	2.69	122	77MT-SB016G-0_502	26.3	35.6	--	70.0	1 / 10	1.74	141	0 / 10	0.87	NO	--	--	NO
Lead	-- - --	10 / 10	0.54	20.7	77MT-SB019G-0_502	3.11	6.21	--	120	0 / 10	0.17	--	-- / --	--	NO	--	--	NO
Zinc	-- - --	10 / 10	20.5	87.4	77MT-SB015G-0_502	61.7	22.3	--	120	0 / 10	0.73	--	-- / --	--	NO		--	NO

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-35

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Potential Munitions Trench

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77MT-SB011 77MT-SB011G-0_502 09/22/12	77MT-SB012 77MT-SB012G-0_502 09/24/12	77MT-SB013 77MT-SB013G-0_502 09/24/12	77MT-SB014 77MT-SB014G-0_502 09/24/12	77MT-SB015 77MT-SB015G-0_502 09/24/12	77MT-SB016 77MT-SB016G-0_502 09/24/12	77MT-SB017 77MT-SB017G-0_502 09/24/12	77MT-SB018 77MT-SB018G-0_502 09/24/12	77MT-SB019 77MT-SB019G-0_502 09/24/12	77MT-SB020 77MT-SB020G-0_502 09/24/12
Metals (MG/KG)												
Copper	70.0	141	**2.69 J**	**7 J**	**14.2 J**	**42.2 J**	**7.19 J**	**122 J**	**26.9 J**	**20.3 J**	**9.1 J**	**11.3 J**
Lead	120	13.2	**1.99**	**1.25**	**1.24**	**0.885**	**1.08**	**0.698 J**	**0.544 J**	**2.15**	**20.7**	**0.554 J**
Zinc	120	131	**82.5 J**	**53.5 J**	**48.5 J**	**87 J**	**87.4 J**	**58.6 J**	**69.1 J**	**36.8 J**	**20.5 J**	**73.2 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-36

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Potential OB/OD

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.57 - 2.19	0 / 10	--	--	--	0.78	0.30	--	3.56	-- / --	0.62	--	-- / --	--	NO	--	--	NO
Arsenic	0.82 - 1.64	7 / 10	1.09	3.41	77OB-SS001-G00_5	1.41	0.83	--	18.0	0 / 10	0.19	--	-- / --	--	NO	--	--	NO
Copper	-- - --	9 / 9	74.9	133	77OB-SS005-G00_5	102	18.3	--	70.0	9 / 9	1.90	192	0 / 9	0.69	NO	--	--	NO
Lead	-- - --	10 / 10	9.66	104	77OB-SS010G-00_5	36.4	30.6	--	120	0 / 10	0.87	--	-- / --	--	NO	--	--	NO
Zinc	-- - --	9 / 9	65.0	100	77OB-SS007G-00_5	80.1	11.1	--	120	0 / 9	0.83	--	-- / --	--	NO	--	--	NO
Other Parameters																		
pH	-- - --	1 / 1	5.79	5.79	77OB-SS002-G00_5	5.79	--	--	--	-- / --	--	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-37

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Potential OB/OD

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77OB-SB001		77OB-SB002	77OB-SB003	77OB-SB004	77OB-SB005	77OB-SB006	77OB-SB007	77OB-SB008	77OB-SB009		77OB-SB010
			77OB-SS001-G00_5	77OB-SS001-G00_5-D	77OB-SS002-G00_5	77OB-SS003-G00_5	77OB-SS004-G00_5	77OB-SS005-G00_5	77OB-SS006-G00_5	77OB-SS007G-00_5	77OB-SS008G-00_5	77OB-SS009G-00_5	77OB-SS009G-00_5-D	77OB-SS010G-00_5
			05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	09/24/12	09/19/12	09/19/12	09/19/12	09/19/12
Metals (MG/KG)														
Arsenic	18.0	2.75	**3.41**	**3.16**	**1.37 J**	0.82 U	**1.49 J**	**2**	**1.45**	1.63 U	1.64 U	1.6 U	**1.09 J**	**1.21 J**
Copper	70.0	192	128 R	12,500 R	**83.0**	**95.2**	**99.3**	**133**	**74.9**	**97.6**	**124**	**110**	**96.8**	**101**
Lead	120	34.2	**22.8**	**25.3**	**13.3**	**15.4**	**26.1**	**74**	**9.66**	**47.8**	**16.7**	**20.8**	**31.6**	**104**
Zinc	120	132	212 R	927 R	**72.5**	**77.4**	**71.9**	**81.5**	**65**	**100**	**79.1 J**	**78.7 J**	**76.9 J**	**95.1 J**
Other Parameters														
pH	--	--	NA	NA	**5.79**	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-38

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Potential OB/OD

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.52 - 2.24	0 / 10	--	--	--	0.98	0.25	--	3.56	-- / --	0.63	--	-- / --	--	NO	--	--	NO
Copper	-- - --	10 / 10	90.3	144	77OB-SB014G-0_502	112	18.3	--	70.0	10 / 10	2.06	141	1 / 10	1.02	NO	--	--	NO
Lead	2.06 - 2.06	9 / 10	0.87	16.8	77OB-SB012G-0_502	5.29	5.36	--	120	0 / 10	0.14	--	-- / --	--	NO	--	--	NO
Zinc	-- - --	10 / 10	71.7	205	77OB-SB012G-0_502	96.9	39.9	120	120	1 / 10	1.71	131	1 / 10	1.56	**YES**	1.00	0.81	NO

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-39

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Potential OB/OD

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77OB-SB001 77OB-SB001-G0102 05/22/10	77OB-SB011 77OB-SB011G-0_502 09/24/12	77OB-SB012 77OB-SB012G-0_502 09/24/12	77OB-SB013 77OB-SB013G-0_502 09/24/12	77OB-SB014 77OB-SB014G-0_502 09/24/12	77OB-SB015 77OB-SB015G-0_502 09/24/12	77OB-SB016 77OB-SB016G-0_502 09/24/12	77OB-SB017 77OB-SB017G-0_502 09/24/12	77OB-SB018 77OB-SB018G-0_502 09/24/12	77OB-SB019 77OB-SB019G-0_502 09/24/12
Metals (MG/KG)												
Copper	70.0	141	**114**	**93.8**	**123**	**110**	**144**	**97.6**	**99.6**	**108**	**138**	**90.3**
Lead	120	13.2	**2.18**	2.06 U	**16.8**	**11.6**	**2.69**	**0.872**	**6.14**	**7.77**	**0.889**	**2.89**
Zinc	120	131	**75.1**	**87.9**	**205**	**115**	**71.7**	**79.9**	**92.5**	**84.9**	**78.2**	**79.1**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-40

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.60 - 3.60	12 / 58	1.72	326	77PR-SS010-G00_5	9.17	43.4	18.7	3.56	10 / 58	91.6	--	-- / --	--	**YES**	5.26	2.58	**YES**
Arsenic	0.82 - 3.60	37 / 58	0.56	42.8	77PR-SS010-G00_5	3.16	5.85	4.66	18.0	1 / 58	2.38	--	-- / --	--	**YES**	0.26	0.18	NO
Copper	-- - --	58 / 58	57.4	7,990	77PR-SS010-G00_5	298	1,039	892	70.0	57 / 58	114	192	12 / 58	41.6	**YES**	12.7	4.25	**YES**
Lead	0.93 - 0.93	77 / 78	1.26	58,400	77PR-SS010-G00_5	2,112	7,817	5,970	120	44 / 78	487	--	-- / --	--	**YES**	49.8	17.6	**YES**
Zinc	-- - --	58 / 58	41.8	856	77PR-SS010-G00_5	118	112	142	120	12 / 58	7.13	132	10 / 58	6.48	**YES**	1.19	0.98	**YES**
Other Parameters																		
pH	-- - --	2 / 2	7.70	8.15	77PR-SS032-C00_5	7.93	0.32	--	--	-- / --	--	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB001 77PR-SS001-G00_5 05/24/10	77PR-SB002 77PR-SS002-0006 05/24/10	77PR-SB003 77PR-SS003-0006 05/24/10	77PR-SB004 77PR-SS004-0006 05/24/10	77PR-SB005 77PR-SS005-0006 05/24/10	77PR-SB006 77PR-SS006-G00_5 05/24/10	77PR-SB007 77PR-SS007-0006 05/24/10	77PR-SB008 77PR-SS008-G00_5 05/24/10	77PR-SB009 77PR-SS009-0006 05/24/10	77PR-SB010 77PR-SS010-G00_5 05/24/10
Metals (MG/KG)												
Antimony	3.56	2.70	1.44 U	NA	NA	NA	NA	**1.72 J**	NA	**5.05**	NA	**326**
Arsenic	18.0	2.75	**1.22 J**	NA	NA	NA	NA	**4.14**	NA	**2.06**	NA	**42.8**
Copper	70.0	192	**290**	NA	NA	NA	NA	**174**	NA	**176**	NA	**7,990**
Lead	120	34.2	**556**	**1,203**	**1,884**	**1,921**	**1,046**	**754**	**384**	**5,370**	**750**	**58,400**
Zinc	120	132	**156**	NA	NA	NA	NA	**110**	NA	**90**	NA	**856**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB011	77PR-SB012	77PR-SB013	77PR-SB014	77PR-SB015	77PR-SB016	77PR-SB017		77PR-SB018	77PR-SB019
			77PR-SS011-G00_5	77PR-SS012-G00_5	77PR-SS013-G00_5	77PR-SS014-0006	77PR-SS015-0006	77PR-SS016-0006	77PR-SS017-0006	77PR-SS017-0006-D	77PR-SS018-0006	77PR-SS019-G00_5
			05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10
Metals (MG/KG)												
Antimony	3.56	2.70	**65.8**	**7.42**	**2.24**	NA	NA	NA	NA	NA	NA	0.602 U
Arsenic	18.0	2.75	**8.69**	**4.11**	**2.1**	NA	NA	NA	NA	NA	NA	**0.641 J**
Copper	70.0	192	**1,060**	**401**	**251**	NA	NA	NA	NA	NA	NA	**132**
Lead	120	34.2	**31,800**	**22,000**	**3,720**	**148**	**171**	**325**	**1,548**	**1,788**	**2,494**	**423**
Zinc	120	132	**295**	**110**	**94.5**	NA	NA	NA	NA	NA	NA	**72.9**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB020	77PR-SB021	77PR-SB022	77PR-SB023		77PR-SB024	77PR-SB025	77PR-SB026	77PR-SB027	77PR-SB028
			77PR-SS020-0006	77PR-SS021-G00_5	77PR-SS022-0006	77PR-SS023-0006	77PR-SS023-0006-D	77PR-SS024-0006	77PR-SS025-0006	77PR-SS026-0006	77PR-SS027-0006	77PR-SS028-0006
			05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/24/10
Metals (MG/KG)												
Antimony	3.56	2.70	NA	1.37 U	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	18.0	2.75	NA	0.821 U	NA	NA	NA	NA	NA	NA	NA	NA
Copper	70.0	192	NA	**106**	NA	NA	NA	NA	NA	NA	NA	NA
Lead	120	34.2	**517**	**61.7**	**104**	**116**	**108**	**56.7**	**132**	**196**	**30**	**8.5**
Zinc	120	132	NA	**75.6**	NA	NA	NA	NA	NA	NA	NA	NA
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB029 77PR-SS029-0006 05/24/10	77PR-SB030 77PR-SS030-G00_5 05/24/10	77PR-SB031 77PR-SS031-C00_5 05/21/10	77PR-SB032 77PR-SS032-C00_5 05/21/10	77PR-SB033 77PR-SS033-C00_5 05/21/10	77PR-SB034 77PR-SS034-C00_5 05/21/10	77PR-SB035 77PR-SS035-C00_5 05/21/10	77PR-SB036 77PR-SS036-C00_5 05/21/10	77PR-SB037 77PR-SS037G-00_5 09/17/12	77PR-SB038 77PR-SS038G-00_5 09/17/12
Metals (MG/KG)												
Antimony	3.56	2.70	NA	1.42 U	NA	NA	NA	NA	NA	NA	2.25 UJ	2.25 UJ
Arsenic	18.0	2.75	NA	0.849 U	NA	NA	NA	NA	NA	NA	1.69 UJ	1.69 UJ
Copper	70.0	192	NA	**105**	NA	NA	NA	NA	NA	NA	**112**	**193**
Lead	120	34.2	**24**	**47**	NA	NA	NA	NA	NA	NA	**1,030**	**410**
Zinc	120	132	NA	**77**	NA	NA	NA	NA	NA	NA	**70.6 J**	**87.7 J**
Other Parameters												
pH	--	--	NA	NA	NA	**8.15**	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB039 77PR-SS039G-00_5 09/17/12	77PR-SB040 77PR-SS040G-00_5 09/17/12	77PR-SB041 77PR-SS041G-00_5 09/17/12	77PR-SB042 77PR-SS042G-00_5 09/17/12	77PR-SB043 77PR-SS043G-00_5 09/18/12	77PR-SB044 77PR-SS044G-00_5 09/18/12	77PR-SB045 77PR-SS045G-00_5 09/18/12	77PR-SB046 77PR-SS046G-00_5 09/18/12	77PR-SB047 77PR-SS047G-00_5 09/18/12	77PR-SB048 77PR-SS048G-00_5 09/18/12
Metals (MG/KG)												
Antimony	3.56	2.70	2.17 UJ	**19.6 J**	2.28 UJ	2.08 UJ	2.23 UJ	**3.83 J**	**3.57 J**	**11.4 J**	2.13 UJ	2.23 UJ
Arsenic	18.0	2.75	1.63 UJ	**2.51 J**	1.71 UJ	1.56 UJ	**1.3 J**	**4.97 J**	**10.3 J**	**6.17 J**	**3.36 J**	**0.875 J**
Copper	70.0	192	**114**	**112**	**115**	**93.2**	**103**	**210**	**216**	**398**	**121**	**141**
Lead	120	34.2	**702**	**2,640 J**	**244 J**	**4.07 J**	**126**	**1,670**	**2,300**	**6,250**	**669 J**	**160 J**
Zinc	120	132	**70.6 J**	**68.8 J**	**72.5 J**	**70.2 J**	**239 J**	**105 J**	**88.2**	**121**	**64 J**	**77.3 J**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB049	77PR-SB050	77PR-SB051	77PR-SB052		77PR-SB053	77PR-SB054	77PR-SB055	77PR-SB056	77PR-SB057
			77PR-SS049G-00_5	77PR-SS050G-00_5	77PR-SS051G-00_5	77PR-SS052G-00_5	77PR-SS052G-00_5-D	77PR-SS053G-00_5	77PR-SS054G-00_5	77PR-SS055G-00_5	77PR-SS056G-00_5	77PR-SS057G-00_5
			09/17/12	09/17/12	09/17/12	09/17/12	09/17/12	09/17/12	09/17/12	09/17/12	09/17/12	09/17/12
Metals (MG/KG)												
Antimony	3.56	2.70	2.2 UJ	2.17 UJ	2.38 UJ	2.12 UJ	2.16 UJ	2.3 UJ	2.14 UJ	2.14 UJ	2.46 UJ	2.15 UJ
Arsenic	18.0	2.75	**1.82 J**	**12.8**	**1.89 J**	**1.5 J**	**2.27 J**	**1.59 J**	**8.5 J**	**2.37 J**	**1.06 J**	1.61 UJ
Copper	70.0	192	**118**	**139**	**128**	**92.9**	**109**	**129**	**57.4**	**99.5**	**103**	**240**
Lead	120	34.2	**36.8 J**	**456 J**	**93 J**	**17.1 J**	**24.3 J**	**67.5 J**	**27 J**	**72.5 J**	**1.74 J**	**1.26 J**
Zinc	120	132	**82.4 J**	**257 J**	**116 J**	**76.3 J**	**179 J**	**95.3 J**	**76.4 J**	**110 J**	**41.8 J**	**87.1 J**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB058 77PR-SS058G-00_5 09/17/12	77PR-SB073 77PR-SS073G-00_5 09/19/12	77PR-SB074 77PR-SS074G-00_5 03/23/13	77PR-SB075 77PR-SS075G-00_5 03/23/13	77PR-SB076 77PR-SS076G-00_5 03/23/13	77PR-SB077 77PR-SS077G-00_5 09/19/12	77PR-SB078 77PR-SS078G-00_5 03/23/13	77PR-SB079 77PR-SS079G-00_5 03/23/13	77PR-SB080 77PR-SS080G-00_5 03/23/13	77PR-SB082 77PR-SS082G-00_5 03/21/13
Metals (MG/KG)												
Antimony	3.56	2.70	2.22 UJ	2.29 UJ	2.84 UJ	2.81 UJ	2.78 UJ	NA	2.8 UJ	**4.57 J**	2.78 UJ	2.97 UJ
Arsenic	18.0	2.75	1.66 UJ	**1.86 J**	2.84 U	2.81 U	2.78 U	NA	2.8 UJ	**1.34 J**	2.78 U	**0.93 J**
Copper	70.0	192	**117**	**93.5**	**123**	**628**	**122**	NA	**107**	**106**	**99.1**	**114**
Lead	120	34.2	**6.73 J**	**626**	**238**	**3,170**	**80.5**	NA	**86.4**	**1,310**	**118**	**101 J**
Zinc	120	132	**77 J**	**101 J**	**75.1**	**159**	**78.7**	NA	**81.4**	**75.1**	**74.9**	**89.6**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	**7.70**	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB083 77PR-SS083G-00_5 03/21/13	77PR-SB084 77PR-SS084G-00_5 03/21/13	77PR-SB085 77PR-SS085G-00_5 03/21/13	77PR-SB086 77PR-SS086G-00_5 03/21/13	77PR-SB087 77PR-SS087G-00_5 03/21/13	77PR-SB088 77PR-SS088G-00_5 03/21/13	77PR-SB089 77PR-SS089G-00_5 03/21/13	77PR-SB090 77PR-SS090G-00_5 03/21/13	77PR-SB091 77PR-SS091G-00_5 03/21/13
Metals (MG/KG)											
Antimony	3.56	2.70	1.25 UJ	**27.3 J**	1.11 UJ	1.12 UJ	1.21 UJ	2.86 UJ	2.95 UJ	2.88 UJ	2.97 UJ
Arsenic	18.0	2.75	**0.561 J**	**3.07 J**	**1.28 J**	**2.72 J**	**1.91 J**	**1.38 J**	**2.22 J**	2.88 UJ	2.97 U
Copper	70.0	192	**103**	**105**	**97.6**	**100**	**109**	**99.7 J**	**84.3 J**	**110 J**	**137 J**
Lead	120	34.2	**5.52 J**	**3,720 J**	**34.4 J**	**111 J**	**51.6 J**	**101 J**	**132 J**	**414 J**	**17.3 J**
Zinc	120	132	**71.2**	**288**	**82.3**	**143**	**111**	**81.8**	**154**	**103**	**130**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-41

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB092		77PR-SB093	77PR-SB094	77PR-SB095	77PR-SB096	77PR-SB097	77PR-SB099	77PR-SB100	77PR-SB102
			77PR-SS092G-00_5	77PR-SS092G-00_5-D	77PR-SS093G-00_5	77PR-SS094G-00_5	77PR-SS095G-00_5	77PR-SS096G-00_5	77PR-SS097G-00_5	77PR-SS099G-00_5	77PR-SS100G-00_5	77PR-SS102G-00_5
			03/21/13	03/21/13	03/25/13	03/23/13	03/21/13	03/23/13	03/23/13	03/23/13	03/22/13	03/23/13
Metals (MG/KG)												
Antimony	3.56	2.70	2.79 UJ	2.86 UJ	3.6 UJ	3.08 UJ	2.99 UJ	2.83 UJ	2.79 UJ	2.77 UJ	2.99 UJ	2.84 UJ
Arsenic	18.0	2.75	**4.97**	2.86 UJ	3.6 UJ	3.08 U	**1 J**	2.83 U	2.79 U	2.77 U	**5.39**	**3.11**
Copper	70.0	192	**261 J**	**126 J**	**124**	**106**	**102 J**	**98.3**	**101**	**111**	**96.4**	**81.3**
Lead	120	34.2	**204 J**	**106 J**	**17 J**	0.925 U	**28.1 J**	**63.6**	**121**	**468**	**36.8 J**	**18.7**
Zinc	120	132	**114**	**86**	**94.8**	**67**	**73.3**	**72.5**	**71.4**	**82.4**	**84.3 J**	**75.5**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-42

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	2.19 - 3.69	7 / 40	1.48	7.57	77PR-SB065G-0_502	1.84	1.35	2.66	3.56	4 / 40	2.13	5.58	1 / 40	1.36	**YES**	0.75	0.52	NO
Copper	-- - --	40 / 40	76.2	323	77PR-SB062G-0_502	136	56.5	151	70.0	40 / 40	4.61	141	12 / 40	2.29	**YES**	2.15	1.94	**YES**
Lead	0.89 - 1.01	36 / 40	0.93	5,770	77PR-SB065G-0_502	519	1,142	1,046	120	15 / 40	48.1	--	-- / --	--	**YES**	8.72	4.33	**YES**
Zinc	-- - --	40 / 40	53.9	121	77PR-SB048G-0_502	87.0	13.9	--	120	2 / 40	1.01	131	0 / 40	0.92	NO	--	--	NO

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB037		77PR-SB038	77PR-SB039	77PR-SB040	77PR-SB041	77PR-SB043	77PR-SB044
			77PR-SB037G-0_502	77PR-SB037G-0_502-D	77PR-SB038G-0_502	77PR-SB039G-0_502	77PR-SB040G-0_502	77PR-SB041G-0_502	77PR-SB043G-0_502	77PR-SB044G-0_502
			03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	09/18/12	09/18/12
Metals (MG/KG)										
Antimony	3.56	5.58	2.84 UJ	2.75 UJ	2.91 UJ	2.83 UJ	2.79 UJ	2.84 UJ	2.27 UJ	**2.68 J**
Copper	70.0	141	**97.9**	**94.5**	**102**	**108**	**102**	**96.1**	**95.8**	**186**
Lead	120	13.2	**43.1 J**	**45.4 J**	**28.5 J**	**30.7 J**	**3.1 J**	**14.7 J**	**76.9**	**1,600**
Zinc	120	131	**70.5**	**69.4**	**75.4**	**80.4**	**74.7**	**71.1**	**81.9 J**	**90.6 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB045	77PR-SB046	77PR-SB047	77PR-SB048	77PR-SB059	77PR-SB060	77PR-SB061	77PR-SB062
			77PR-SB045G-0_502	77PR-SB046G-0_502	77PR-SB047G-0_502	77PR-SB048G-0_502	77PR-SB059G-0_502	77PR-SB060G-0_502	77PR-SB061G-0_502	77PR-SB062G-0_502
			09/18/12	09/18/12	09/18/12	09/18/12	09/18/12	09/18/12	09/18/12	09/18/12
Metals (MG/KG)										
Antimony	3.56	5.58	**1.48 J**	**5.47 J**	2.23 UJ	2.24 UJ	2.19 UJ	2.22 UJ	2.21 UJ	**4.22 J**
Copper	70.0	141	**154**	**233**	**76.2**	**152**	**135**	**171**	**112**	**323**
Lead	120	13.2	**957**	**1,850**	**52.6 J**	**162 J**	**167**	**528**	**496**	**3,470**
Zinc	120	131	**78.2**	**86.8**	**53.9 J**	**121 J**	**91.9 J**	**92.9 J**	**93.9 J**	**121**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB063 77PR-SB063G-0_502 09/18/12	77PR-SB064 77PR-SB064G-0_502 09/18/12	77PR-SB065 77PR-SB065G-0_502 09/18/12	77PR-SB066 77PR-SB066G-0_502 09/18/12	77PR-SB067 77PR-SB067G-0_502 09/18/12	77PR-SB068 77PR-SB068G-0_502 09/18/12	77PR-SB069 77PR-SB069G-0_502 09/18/12	77PR-SB070 77PR-SB070G-0_502 09/18/12
Metals (MG/KG)										
Antimony	3.56	5.58	2.25 UJ	**1.87 J**	**7.57 J**	2.26 UJ	2.23 UJ	2.22 UJ	**4.99 J**	2.34 UJ
Copper	70.0	141	**295**	**191**	**172**	**139**	**114**	**149**	**262**	**118**
Lead	120	13.2	**78.4**	**1,370**	**5,770**	**97.4 J**	**342 J**	**242 J**	**2,530 J**	**146 J**
Zinc	120	131	**94.1**	**89.1**	**85.5**	**73.9 J**	**72.9 J**	**84.4 J**	**105 J**	**87.4 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB071		77PR-SB072	77PR-SB073	77PR-SB082	77PR-SB083	77PR-SB084	77PR-SB085
			77PR-SB071G-0_502	77PR-SB071G-0_502-D	77PR-SB072G-0_502	77PR-SB073G-0_502	77PR-SB082G-0_502	77PR-SB083G-0_502	77PR-SB084G-0_502	77PR-SB085G-0_502
			09/17/12	09/17/12	09/17/12	09/19/12	03/21/13	03/21/13	03/21/13	03/21/13
Metals (MG/KG)										
Antimony	3.56	5.58	NA	NA	NA	2.2 UJ	2.97 UJ	3.06 UJ	3.16 UJ	3.01 UJ
Copper	70.0	141	NA	NA	NA	**99**	**104**	**98.4**	**109**	**96.2**
Lead	120	13.2	NA	NA	NA	**567**	0.89 U	0.918 UJ	**1.56 J**	**0.929 J**
Zinc	120	131	NA	NA	NA	**107 J**	**83.4**	**79.7**	**98.4**	**92.8**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB086	77PR-SB087	77PR-SB088	77PR-SB089	77PR-SB090	77PR-SB091	77PR-SB092	
			77PR-SB086G-0_502	77PR-SB087G-0_502	77PR-SB088G-0_502	77PR-SB089G-0_502	77PR-SB090G-0_502	77PR-SB091G-0_502	77PR-SB092G-0_502	77PR-SB092G-0_502-D
			03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13
Metals (MG/KG)										
Antimony	3.56	5.58	3.06 UJ	3.38 UJ	2.86 UJ	2.9 UJ	3.22 UJ	3.14 UJ	3.2 UJ	3.25 UJ
Copper	70.0	141	**90.3**	**108**	**110**	**105**	**110**	**108**	**106**	**84**
Lead	120	13.2	**9.3 J**	1.01 UJ	**4.03**	**0.967**	0.967 U	**2.28**	**55.1 J**	**3.04 J**
Zinc	120	131	**105**	**93.4**	**78.4**	**78.5**	**84.4**	**91.4**	**107**	**76.3**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-43

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SB093 77PR-SB093G-0_502 03/25/13	77PR-SB094 77PR-SB094G-0_502 03/23/13	77PR-SB095 77PR-SB095G-0_502 03/21/13	77PR-SB100 77PR-SB100G-0_502 03/22/13	77PR-SB102 77PR-SB102G-0_502 03/23/13
Metals (MG/KG)							
Antimony	3.56	5.58	3.69 UJ	2.76 UJ	2.99 UJ	2.9 UJ	3.04 UJ
Copper	70.0	141	**108**	**168**	**111**	**91.2**	**122**
Lead	120	13.2	**5.74 J**	**48.4**	**1.94**	**4.16 J**	**2.89**
Zinc	120	131	**78.6**	**101**	**79.1**	**70.5 J**	**76.1**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-44

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Sediment - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	3.32 - 4.89	1 / 5	8.45	8.45	77PR-SDSS081G-00_5	3.22	2.94	--	2.00	1 / 5	4.23	2.06	1 / 5	4.10	**YES**	--	1.61	**YES**
Arsenic	3.32 - 3.32	4 / 5	1.36	3.23	77PR-SDSS101G-00_5	2.36	0.81	--	8.20	0 / 5	0.39	--	-- / --	--	NO	--	--	NO
Copper	-- - --	5 / 5	96.9	2,170	77PR-SDSS104G-00_5	830	1,003	--	34.0	5 / 5	63.8	136	2 / 5	16.0	**YES**	--	24.4	**YES**
Lead	-- - --	5 / 5	83.9	4,260	77PR-SDSS081G-00_5	1,299	1,816	--	46.7	5 / 5	91.2	--	-- / --	--	**YES**	--	27.8	**YES**
Zinc	-- - --	5 / 5	73.6	341	77PR-SDSS104G-00_5	169	109	--	150	2 / 5	2.27	--	-- / --	--	**YES**	--	1.13	**YES**

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-45

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Sediment - Pistol Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77PR-SDSB081		77PR-SDSB098	77PR-SDSB101	77PR-SDSB103	77PR-SDSB104
			77PR-SDSS081G-00_5	77PR-SDSS081G-00_5-D	77PR-SDSS098G-00_5	77PR-SDSS101G-00_5	77PR-SDSS103G-00_5	77PR-SDSS104G-00_5
			03/23/13	03/23/13	03/23/13	03/23/13	03/23/13	03/23/13
Metals (MG/KG)								
Antimony	2.00	2.06	**8.45 J**	4.47 UJ	3.32 UJ	3.37 UJ	4.89 UJ	3.67 UJ
Arsenic	8.20	7.82	**2.68 J**	**1.85 J**	3.32 U	**3.23 J**	**2.89 J**	**1.36 J**
Copper	34.0	136	**1,650 J**	**499 J**	**119 J**	**112 J**	**96.9 J**	**2,170 J**
Lead	46.7	36.5	**4,260 J**	**1,640 J**	**179 J**	**83.9 J**	**122 J**	**1,850 J**
Zinc	150	131	**209 J**	**119 J**	**73.6 J**	**132 J**	**91.5 J**	**341 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-46

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Surface Soil - Rifle Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	1.06 - 42.8	42 / 102	1.42	6,510	77RR-SS055-G00_5	96.8	658	383	3.56	35 / 102	1,829	--	-- / --	--	**YES**	107	27.2	**YES**
Arsenic	1.67 - 32.1	81 / 102	0.53	60.5	77RR-SS055-G00_5	4.73	9.55	6.43	18.0	6 / 102	3.36	--	-- / --	--	**YES**	0.36	0.26	NO
Copper	-- - --	101 / 101	0.86	36,700	77RR-SS052-G00_5	1,478	5,482	3,856	70.0	92 / 101	524	192	30 / 101	191	**YES**	55.1	21.1	**YES**
Lead	-- - --	128 / 128	1.52	118,000	77RR-SS055-G00_5	6,770	16,498	13,126	120	96 / 128	983	--	-- / --	--	**YES**	109	56.4	**YES**
Zinc	-- - --	101 / 101	56.1	3,470	77RR-SS052-G00_5	233	543	469	120	32 / 101	28.9	132	25 / 101	26.3	**YES**	3.91	1.94	**YES**
Other Parameters																		
pH	-- - --	3 / 3	7.20	7.80	77RR-SS118G-00_5	7.46	0.31	--	--	-- / --	--	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil - Rifle Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB001	77RR-SB002	77RR-SB003	77RR-SB004	77RR-SB005	77RR-SB006	77RR-SB007		77RR-SB008
			77RR-SS001-G00_5	77RR-SS002-G00_5	77RR-SS003-G00_5	77RR-SS004-0006	77RR-SS005-0006	77RR-SS006-0006	77RR-SS007-G00_5	77RR-SS007-G00_5-D	77RR-SS008-G00_5
			05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10	05/22/10
Metals (MG/KG)											
Antimony	3.56	2.70	**11.2**	**13.5**	**22.6**	NA	NA	NA	0.601 U	1.46 UJ	1.46 U
Arsenic	18.0	2.75	**8.99**	**7.27**	**8.85**	NA	NA	NA	**1.24**	**1.23 J**	**1.32 J**
Copper	70.0	192	**557**	**7,130**	**13,300**	NA	NA	NA	**138**	**226**	**110**
Lead	120	34.2	**12,500**	**14,800**	**22,900**	**9,556**	**8,350**	**8,678**	**347**	**403**	**881**
Zinc	120	132	**149**	**864**	**1,620**	NA	NA	NA	**62.9**	**83.2**	**65.2**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB009	77RR-SB010	77RR-SB011	77RR-SB012		77RR-SB013	77RR-SB014	77RR-SB015	77RR-SB016
			77RR-SS009-0006	77RR-SS010-0006	77RR-SS011-0006	77RR-SS012-0006	77RR-SS012-0006-D	77RR-SS013-0006	77RR-SS014-0006	77RR-SS015-G00_5	77RR-SS016-G00_5
			05/22/10	05/22/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10
Metals (MG/KG)											
Antimony	3.56	2.70	NA	NA	NA	NA	NA	NA	NA	**425 J**	**8.39**
Arsenic	18.0	2.75	NA	NA	NA	NA	NA	NA	NA	**38.3**	**2.54**
Copper	70.0	192	NA	NA	NA	NA	NA	NA	NA	**3,860**	**12,200**
Lead	120	34.2	**3,716**	**2,779**	**4,580**	**7,434**	**8,173**	**8,697**	**6,485**	**89,000**	**8,820**
Zinc	120	132	NA	NA	NA	NA	NA	NA	NA	**507**	**1,570**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB017	77RR-SB018	77RR-SB019	77RR-SB020	77RR-SB021	77RR-SB022	77RR-SB023		77RR-SB024	77RR-SB025
			77RR-SS017-0006	77RR-SS018-G00_5	77RR-SS019-0006	77RR-SS020-0006	77RR-SS021-0006	77RR-SS022-0006	77RR-SS023-0006	77RR-SS023-0006-D	77RR-SS024-0006	77RR-SS025-0006
			05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10	05/23/10
Metals (MG/KG)												
Antimony	3.56	2.70	NA	**43.3**	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	18.0	2.75	NA	**12.7**	NA	NA	NA	NA	NA	NA	NA	NA
Copper	70.0	192	NA	**5,960**	NA	NA	NA	NA	NA	NA	NA	NA
Lead	120	34.2	**2,921**	**34,600**	**6,401**	**7,834**	**6,814**	**7,473**	**2,590**	**2,915**	**6,181**	**3,595**
Zinc	120	132	NA	**626**	NA	NA	NA	NA	NA	NA	NA	NA
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB026 77RR-SS026-G00_5 05/23/10	77RR-SB027 77RR-SS027-0006 05/23/10	77RR-SB028 77RR-SS028-0006 05/23/10	77RR-SB029 77RR-SS029-G00_5 05/23/10	77RR-SB030 77RR-SS030-0006 05/23/10	77RR-SB031 77RR-SS031-C00_5 05/22/10	77RR-SB032 77RR-SS032-C00_5 05/23/10	77RR-SB033 77RR-SS033-C00_5 05/23/10	77RR-SB034 77RR-SS034-C00_5 05/23/10	77RR-SB035 77RR-SS035-C00_5 05/23/10
Metals (MG/KG)												
Antimony	3.56	2.70	**4.69**	NA	NA	**16.7**	NA	NA	NA	NA	NA	NA
Arsenic	18.0	2.75	**1.32 J**	NA	NA	**2.67**	NA	NA	NA	NA	NA	NA
Copper	70.0	192	**370**	NA	NA	**161**	NA	NA	NA	NA	NA	NA
Lead	120	34.2	**5,710**	**9,576**	**8,613**	**5,250**	**3,480**	NA	NA	NA	NA	NA
Zinc	120	132	**110**	NA	NA	**71.8**	NA	NA	NA	NA	NA	NA
Other Parameters												
pH	--	--	**7.38**	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB036	77RR-SB037	77RR-SB038	77RR-SB039		77RR-SB040	77RR-SB041	77RR-SB042	77RR-SB043
			77RR-SS036-C00_5	77RR-SS037-C00_5	77RR-SS038-C00_5	77RR-SS039-C00_5	77RR-SS039-C00_5-D	77RR-SS040-C00_5	77RR-SS041-C00_5	77RR-SS042-C00_5	77RR-SS043-0006
			05/24/10	05/24/10	05/24/10	05/24/10	05/24/10	05/25/10	05/25/10	05/25/10	05/25/10
Metals (MG/KG)											
Antimony	3.56	2.70	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	18.0	2.75	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	70.0	192	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	120	34.2	NA	NA	NA	NA	NA	NA	NA	NA	**2,789**
Zinc	120	132	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB044		77RR-SB045	77RR-SB046	77RR-SB047	77RR-SB048	77RR-SB049	77RR-SB050	77RR-SB051
			77RR-SS044-0006	77RR-SS044-0006-D	77RR-SS045-G00_5	77RR-SS046-G00_5	77RR-SS047-G00_5	77RR-SS048-G00_5	77RR-SS049-0006	77RR-SS050-G00_5	77RR-SS051-0006
			05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10
Metals (MG/KG)											
Antimony	3.56	2.70	NA	NA	**12.1**	**123**	**15.3**	**1.94 J**	NA	**27.8**	NA
Arsenic	18.0	2.75	NA	NA	**4.95**	**7.99**	**4.36**	**1.78**	NA	**7.2**	NA
Copper	70.0	192	NA	NA	**477**	**713**	**1,230**	**154**	NA	**339**	NA
Lead	120	34.2	**7,321**	**7,537**	**8,774**	**50,500**	**8,910**	**2,712**	**13,688**	**19,700**	**8,062**
Zinc	120	132	NA	NA	**141**	**129**	**170**	**66.3**	NA	**92.6**	NA
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB052	77RR-SB053	77RR-SB054		77RR-SB055	77RR-SB056	77RR-SB057	77RR-SB078	77RR-SB079
			77RR-SS052-G00_5	77RR-SS053-0006	77RR-SS054-G00_5	77RR-SS054-G00_5-D	77RR-SS055-G00_5	77RR-SS056-G00_5	77RR-SS057-0006	77RR-SS078G-00_5	77RR-SS079G-00_5
			05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	05/25/10	09/22/12	09/22/12
Metals (MG/KG)											
Antimony	3.56	2.70	**1,040**	NA	**348 J**	**295 J**	**6,510 J**	**918 J**	NA	**7.35 J**	**5.33 J**
Arsenic	18.0	2.75	**34.3**	NA	**24.6**	**26.7**	**60.5**	**49.6**	NA	**2.78**	**3.06**
Copper	70.0	192	**36,700**	NA	1,800 R	17,600 R	**959**	**1,810**	NA	**153**	**218**
Lead	120	34.2	**73,600**	**4,444**	**55,300**	**52,200**	**118,000**	**52,100**	**14,565**	**1,460**	**1,100**
Zinc	120	132	**3,470**	NA	295 R	1,710 R	**164**	**283**	NA	**87.5**	**122**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB080	77RR-SB081	77RR-SB082	77RR-SB083	77RR-SB084	77RR-SB085	77RR-SB086	77RR-SB087	
			77RR-SS080G-00_5	77RR-SS081G-00_5	77RR-SS082G-00_5	77RR-SS083G-00_5	77RR-SS084G-00_5	77RR-SS085G-00_5	77RR-SS086G-00_5	77RR-SS087G-00_5	77RR-SS087G-00_5-D
			09/22/12	09/22/12	09/22/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12
Metals (MG/KG)											
Antimony	3.56	2.70	**12.6 J**	**6.15 J**	**1.52 J**	**8.86 J**	**9.74 J**	**11.2 J**	**9.78 J**	**14.2 J**	**10.7 J**
Arsenic	18.0	2.75	**28**	**1.26 J**	**2.7 J**	**3.78**	**4.58**	**6.88**	**6.33**	**7.01**	**3.25**
Copper	70.0	192	**157**	**150**	**138**	**251**	**393**	**358**	**530**	**445**	**324**
Lead	120	34.2	**4,480**	**1,000**	**546**	**6,660**	**6,970**	**8,400**	**8,630**	**8,110**	**6,440**
Zinc	120	132	**257**	**94.8**	**134**	**112**	**132**	**151**	**156**	**217**	**206**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB088 77RR-SS088G-00_5 09/25/12	77RR-SB089 77RR-SS089G-00_5 09/25/12	77RR-SB090 77RR-SS090G-00_5 09/25/12	77RR-SB091 77RR-SS091G-00_5 09/25/12	77RR-SB092 77RR-SS092G-00_5 09/25/12	77RR-SB093 77RR-SS093G-00_5 09/25/12	77RR-SB094 77RR-SS094G-00_5 09/25/12	77RR-SB095 77RR-SS095-00_5 09/21/12	77RR-SB096 77RR-SS096-00_5 09/21/12	77RR-SB097 77RR-SS097-00_5 09/21/12
Metals (MG/KG)												
Antimony	3.56	2.70	2.47 UJ	2.25 UJ	2.55 UJ	2.46 UJ	2.26 U	2.31 UJ	2.23 UJ	2.32 UJ	**2.11 J**	2.18 UJ
Arsenic	18.0	2.75	1.85 UJ	**0.921 J**	**1.61 J**	**1.07 J**	**1.13 J**	**3.06 J**	**1.34 J**	1.74 U	**1.74 J**	**1.48 J**
Copper	70.0	192	**79.1**	**86.1**	**83.5**	**95.7**	**62.3**	**203**	**151**	**99.2**	**130**	**82.3**
Lead	120	34.2	**118**	**368**	**328**	**117**	**119**	**653**	**1,610**	**110**	**917**	**306**
Zinc	120	132	**76.5 J**	**74.7 J**	**122 J**	**69.7 J**	**60.4**	**126 J**	**115 J**	**81.4**	**91.1**	**68**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB098	77RR-SB099	77RR-SB100	77RR-SB101	77RR-SB102	77RR-SB103	77RR-SB104	77RR-SB105	77RR-SB106	
			77RR-SS098-00_5	77RR-SS099-00_5	77RR-SS100-00_5	77RR-SS101-00_5	77RR-SS102G-00_5	77RR-SS103G-00_5	77RR-SS104G-00_5	77RR-SS105G-00_5	77RR-SS106G-00_5	77RR-SS106G-00_5-D
			09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12	09/21/12
Metals (MG/KG)												
Antimony	3.56	2.70	2.15 UJ	42.8 UJ	**31.8 J**	**27.9 J**	2.18 UJ	2.11 UJ	2.22 UJ	2.19 UJ	2.58 UJ	2.13 UJ
Arsenic	18.0	2.75	**1.41 J**	32.1 U	**1.66 J**	**1.53 J**	**1.06 J**	**1.08 J**	1.67 U	**1.29 J**	**2.52 J**	**2.57 J**
Copper	70.0	192	**78.4**	**33,900**	**1,240**	**167**	**102**	**88.8**	**134 J**	**108 J**	**66.2 J**	**111 J**
Lead	120	34.2	**150**	**807**	**8,880**	**2,240**	**7.69**	**249**	**33.1**	**26.6**	**36**	**28.6**
Zinc	120	132	**134**	**3,440**	**176**	**93.4**	**85.8**	**103**	**131**	**115**	**80.2**	**60.8**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB113	77RR-SB114	77RR-SB115	77RR-SB116	77RR-SB117	77RR-SB118	77RR-SB119	77RR-SB120	
			77RR-SS113G-00_5	77RR-SS114G-00_5	77RR-SS115G-00_5	77RR-SS116G-00_5	77RR-SS117G-00_5	77RR-SS118G-00_5	77RR-SS119G-00_5	77RR-SS120G-00_5	77RR-SS120G-00_5-D
			09/24/12	09/24/12	09/24/12	09/24/12	09/26/12	09/26/12	03/19/13	03/19/13	03/19/13
Metals (MG/KG)											
Antimony	3.56	2.70	**1.74 J**	**6.65**	2.21 U	**33.5**	NA	NA	**4.87**	**2.34 J**	**4.64**
Arsenic	18.0	2.75	**3.71**	**1.21 J**	**2.69 J**	**3.13**	NA	NA	**2.96**	**2.55**	**3.3**
Copper	70.0	192	**339**	**227**	**143**	**147**	NA	NA	**229**	**104**	**127**
Lead	120	34.2	**624**	**883**	**370**	**10,300**	NA	NA	**950**	**644**	**927**
Zinc	120	132	**165**	**89.8**	**86.5**	**84.8**	NA	NA	**239**	**154 J**	**147**
Other Parameters											
pH	--	--	NA	NA	NA	NA	**7.2**	**7.8**	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB121	77RR-SB122	77RR-SB123	77RR-SB124		77RR-SB125	77RR-SB126	77RR-SB127	77RR-SB128
			77RR-SS121G-00_5	77RR-SS122G-00_5	77RR-SS123G-00_5	77RR-SS124G-00_5	77RR-SS124G-00_5-D	77RR-SS125G-00_5	77RR-SS126G-00_5	77RR-SS127G-00_5	77RR-SS128G-00_5
			03/19/13	03/19/13	03/19/13	03/22/13	03/22/13	03/22/13	03/22/13	03/21/13	03/21/13
Metals (MG/KG)											
Antimony	3.56	2.70	1.12 UJ	1.18 UJ	**9.35 J**	2.9 UJ	2.96 UJ	2.82 UJ	2.72 UJ	2.63 UJ	3.02 UJ
Arsenic	18.0	2.75	**1.78**	**1.08 J**	**3.69**	2.9 U	2.96 U	2.82 U	2.72 U	2.63 U	3.02 U
Copper	70.0	192	**81**	**95.1**	**273**	**173**	**133**	**99.5**	**52.8**	**136**	**103**
Lead	120	34.2	**50.8**	**15.8**	**3,960**	**633 J**	**327 J**	**54.6 J**	**36 J**	**1,010 J**	**51.2**
Zinc	120	132	**61.9 J**	**64.1 J**	**200 J**	**90.1**	**78.9**	**63.2**	**61.2**	**82.2**	**62.4**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB129	77RR-SB130	77RR-SB131	77RR-SB132	77RR-SB133	77RR-SB134	77RR-SB135	77RR-SB136	
			77RR-SS129G-00_5	77RR-SS130G-00_5	77RR-SS131G-00_5	77RR-SS132G-00_5	77RR-SS133G-00_5	77RR-SS134G-00_5	77RR-SS135G-00_5	77RR-SS136G-00_5	77RR-SS136G-00_5-D
			03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/22/13	03/21/13	03/21/13	03/21/13
Metals (MG/KG)											
Antimony	3.56	2.70	3.16 UJ	**10.4 J**	3.1 UJ	2.94 UJ	**6.42 J**	2.98 UJ	2.88 UJ	2.84 UJ	2.8 UJ
Arsenic	18.0	2.75	3.16 U	**1.66 J**	3.1 U	2.94 U	**2.21 J**	2.98 U	2.88 U	2.84 U	**1.01 J**
Copper	70.0	192	**115**	**17,100**	**123**	**116**	**347**	**124**	**96.3**	**108**	**118**
Lead	120	34.2	**32.7 J**	**4,990 J**	**76.7 J**	**260 J**	**4,220 J**	**485 J**	**82.4 J**	**80.2 J**	**692 J**
Zinc	120	132	**70.3 J**	**1,860 J**	**63.1 J**	**56.6 J**	**127 J**	**72.7 J**	**73.9 J**	**67.4 J**	**72.9 J**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB137 77RR-SS137G-00_5 03/22/13	77RR-SB138 77RR-SS138G-00_5 03/22/13	77RR-SB139 77RR-SS139G-00_5 03/22/13	77RR-SB140 77RR-SS140G-00_5 03/22/13	77RR-SB141 77RR-SS141G-00_5 03/22/13	77RR-SB142 77RR-SS142G-00_5 03/22/13	77RR-SB143 77RR-SS143G-00_5 03/22/13	77RR-SB144 77RR-SS144G-00_5 03/22/13	77RR-SB145 77RR-SS145G-00_5 03/22/13	77RR-SB146 77RR-SS146G-00_5 03/20/13
Metals (MG/KG)												
Antimony	3.56	2.70	3.57 UJ	3.78 UJ	2.87 UJ	2.81 UJ	2.85 UJ	2.87 UJ	2.93 UJ	2.89 UJ	2.82 UJ	3.01 UJ
Arsenic	18.0	2.75	3.57 U	**1.83 J**	**1.59 J**	2.81 U	2.85 U	**1.11 J**	2.93 U	**1.64 J**	**1.32 J**	**1.53 J**
Copper	70.0	192	**106**	**126**	**108**	**79.4**	**95.5**	**109**	**88.2**	**81.6**	**24.5**	**126**
Lead	120	34.2	**1,770**	**349**	**169 J**	**137**	**289 J**	**456 J**	**19.6 J**	**344 J**	**64.3 J**	**292**
Zinc	120	132	**87.1**	**83.2**	**87.7**	**84.2**	**77.2**	**105**	**80.5**	**85.9**	**79**	**88.1**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB147 77RR-SS147G-00_5 03/20/13	77RR-SB148 77RR-SS148G-00_5 03/20/13	77RR-SB149 77RR-SS149G-00_5 03/20/13	77RR-SB150 77RR-SS150G-00_5 03/19/13	77RR-SB151 77RR-SS151G-00_5 03/19/13	77RR-SB152 77RR-SS152G-00_5 03/19/13	77RR-SB153 77RR-SS153G-00_5 03/19/13	77RR-SB154 77RR-SS154G-00_5 03/19/13	77RR-SB155 77RR-SS155G-00_5 03/25/13
Metals (MG/KG)											
Antimony	3.56	2.70	**1.96 J**	**5.27 J**	**1.42 J**	**2.26 J**	1.1 UJ	1.06 UJ	1.14 UJ	2.81 UJ	2.78 UJ
Arsenic	18.0	2.75	**1.81**	**3.25**	**2.01**	**1.96**	**1.14**	**1.82**	**1.15**	**1.28 J**	**2.37 J**
Copper	70.0	192	**157**	**160**	**54.2**	**41.8**	**4**	**0.855 J**	**8.01**	**87.1**	**102**
Lead	120	34.2	**822**	**2,170**	**331**	**338**	**11.6**	**1.52**	**9.63**	**6.91**	**80.2 J**
Zinc	120	132	**95.4**	**90.2**	**90.6**	**95.8 J**	**56.1 J**	**113 J**	**84.2**	**93.6 J**	**129**
Other Parameters											
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB156 77RR-SS156G-00_5 03/25/13	77RR-SB157 77RR-SS157G-00_5 03/25/13	77RR-SB158 77RR-SS158G-00_5 03/25/13	77RR-SB159 77RR-SS159G-00_5 03/25/13	77RR-SB160 77RR-SS160G-00_5 03/19/13	77RR-SB161 77RR-SS161G-00_5 03/19/13	77RR-SB162 77RR-SS162G-00_5 03/20/13	77RR-SB163 77RR-SS163G-00_5 03/19/13	77RR-SB164 77RR-SS164G-00_5 03/20/13	77RR-SB165 77RR-SS165G-00_5 03/23/13
Metals (MG/KG)												
Antimony	3.56	2.70	2.73 UJ	2.84 UJ	2.85 UJ	2.77 UJ	1.13 UJ	1.17 UJ	1.15 UJ	2.99 UJ	2.95 UJ	3.49 UJ
Arsenic	18.0	2.75	2.73 UJ	**1.54 J**	2.85 UJ	2.77 UJ	**1.32**	**0.951 J**	**0.876 J**	**1.59 J**	**1.46 J**	**1.25 J**
Copper	70.0	192	**86.7**	**106**	**108**	**95.7**	**36**	**98**	**92.7**	**121**	**92.6**	**109**
Lead	120	34.2	**4.82 J**	**40.4 J**	**141 J**	**62.3 J**	**169**	**51.3**	**12.8 J**	**1.67**	**106 J**	**318**
Zinc	120	132	**101**	**76**	**87**	**58.4**	**81.8 J**	**78**	**66.4**	**79.6**	**102**	**92.7**
Other Parameters												
pH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-47

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Surface Soil

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB166 77RR-SS166G-00_5 03/20/13	77RR-SB167 77RR-SS167G-00_5 03/23/13	77RR-SB168 77RR-SS168G-00_5 03/23/13
Metals (MG/KG)					
Antimony	3.56	2.70	1.07 UJ	3.34 UJ	3.87 UJ
Arsenic	18.0	2.75	**0.533 J**	**1.52 J**	**1.26 J**
Copper	70.0	192	**79.5**	**168**	**97.3**
Lead	120	34.2	**67.3**	**338**	**65.7**
Zinc	120	132	**69.4**	**106**	**72.2**
Other Parameters					
pH	--	--	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-48

Ecological Screening Statistics - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Rifle Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean[3]	Standard Deviation of Mean[3]	95% UCL	Ecological Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Background UTL	Frequency of Background Exceedance	Maximum Background Ratio	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Metals (MG/KG)																		
Antimony	0.61 - 3.95	26 / 86	1.04	212	77RR-SB097G-0_502	10.3	27.6	17.7	3.56	22 / 86	59.6	5.58	21 / 86	38.0	**YES**	4.98	2.90	**YES**
Copper	-- - --	86 / 86	0.56	137,000	77RR-SB133G-0_502	3,544	18,690	12,329	70.0	69 / 86	1,957	141	27 / 86	972	**YES**	176	50.6	**YES**
Lead	0.82 - 0.87	84 / 86	0.51	96,200	77RR-SB097G-0_502	3,549	11,453	8,933	120	56 / 86	802	--	-- / --	--	**YES**	74.4	29.6	**YES**
Zinc	-- - --	86 / 86	23.2	14,100	77RR-SB133G-0_502	423	1,875	1,304	120	20 / 86	118	131	18 / 86	108	**YES**	10.9	3.52	**YES**

1 - Count of detected samples exceeding or equaling ESV

2 - Shaded cells indicate hazard quotient based on reporting limits

3 - One-half of the sample reporting limit was used for non-detected constituents when calculating these statistics

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurface Soil (0.5-2.0 feet) - Rifle Range

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB058 77RR-SB058G-0_502 09/25/12	77RR-SB059 77RR-SB059G-0_502 09/25/12	77RR-SB060 77RR-SB060G-0_502 09/25/12	77RR-SB061 77RR-SB061G-0_502 09/25/12	77RR-SB062 77RR-SB062G-0_502 09/25/12	77RR-SB063 77RR-SB063G-0_502 09/25/12	77RR-SB064 77RR-SB064G-0_502 09/25/12
Metals (MG/KG)									
Antimony	3.56	5.58	2.26 U	2.39 U	2.32 U	2.47 U	2.29 U	**73.3**	**96.7 J**
Copper	70.0	141	**238**	**106**	**91.3**	**71.4**	**35.5**	**1,080**	**699 J**
Lead	120	13.2	**1,410**	**743**	**944**	**209**	**196**	**20,400**	**26,800**
Zinc	120	131	**119**	**84.2**	**62.6**	**55**	**23.2**	**385**	**179 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB065		77RR-SB066	77RR-SB067	77RR-SB068	77RR-SB069	77RR-SB070	77RR-SB071	77RR-SB072
			77RR-SB065G-0_502	77RR-SB065G-0_502-D	77RR-SB066G-0_502	77RR-SB067G-0_502	77RR-SB068G-0_502	77RR-SB069G-0_502	77RR-SB070G-0_502	77RR-SB071G-0_502	77RR-SB072G-0_502
			09/25/12	09/25/12	09/25/12	09/25/12	09/22/12	09/22/12	09/22/12	09/25/12	09/22/12
Metals (MG/KG)											
Antimony	3.56	5.58	2.31 UJ	2.52 UJ	**6.99 J**	2.37 U	**41 J**	**52.4 J**	**11.3 J**	**46.3**	**20.3 J**
Copper	70.0	141	**115 J**	**123 J**	**211 J**	**99.4**	**45,100**	**873**	**215 J**	**775**	**275 J**
Lead	120	13.2	**487**	**722**	**3,450**	**1,320**	**13,800**	**12,600**	**2,670**	**3,470**	**4,840**
Zinc	120	131	**90.7 J**	**87.5 J**	**121 J**	**81.4**	**2,590**	**181**	**89.7**	**175**	**107**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB073 77RR-SB073G-0_502 09/25/12	77RR-SB074 77RR-SB074G-0_502 09/22/12	77RR-SB075 77RR-SB075G-0_502 09/25/12	77RR-SB076 77RR-SB076G-0_502 09/22/12	77RR-SB077 77RR-SB077G-0_502 09/25/12	77RR-SB078 77RR-SB078G-0_502 09/22/12	77RR-SB079 77RR-SB079G-0_502 09/22/12
Metals (MG/KG)									
Antimony	3.56	5.58	**42.6**	**32.1 J**	**28.4**	**32.3 J**	**40.8**	2.21 UJ	2.28 UJ
Copper	70.0	141	**992**	**99,500 J**	**719**	**551 J**	**1,220**	**111**	**165**
Lead	120	13.2	**25,800**	**10,800**	**3,060**	**8,630**	**16,100**	**76.5**	**251**
Zinc	120	131	**232**	**10,300**	**179**	**140**	**227**	**102**	**88.9**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB080 77RR-SB080G-0_502 09/22/12	77RR-SB081 77RR-SB081G-0_502 09/22/12	77RR-SB082 77RR-SB082G-0_502 09/22/12	77RR-SB083 77RR-SB083G-0_502 09/21/12	77RR-SB084 77RR-SB084G-0_502 09/21/12	77RR-SB085 77RR-SB085G-0_502 09/21/12	77RR-SB086 77RR-SB086G-0_502 09/21/12	77RR-SB087 77RR-SB087G-0_502 09/21/12	77RR-SB088 77RR-SB088G-0_502 03/19/13
Metals (MG/KG)											
Antimony	3.56	5.58	1.98 UJ	**1.77 J**	2.27 UJ	**7.16 J**	**10.1 J**	**8.25 J**	**18.6 J**	**8.99 J**	**2.42 J**
Copper	70.0	141	**120**	**123**	**299**	**279**	**238**	**245**	**379**	**275**	**98.3**
Lead	120	13.2	**265**	**382**	**545**	**4,430**	**4,670**	**4,450**	**13,500**	**5,870**	**768**
Zinc	120	131	**253**	**84.9**	**141**	**114**	**185**	**92.9**	**137**	**124**	**79.1 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB089 77RR-SB089G-0_502 03/23/13	77RR-SB090 77RR-SB090G-0_502 03/23/13	77RR-SB093 77RR-SB093G-0_502 03/20/13	77RR-SB094 77RR-SB094G-0_502 03/23/13	77RR-SB096 77RR-SB096G-0_502 03/20/13	77RR-SB097 77RR-SB097G-0_502 03/23/13	77RR-SB099 77RR-SB099G-0_502 03/22/13
Metals (MG/KG)									
Antimony	3.56	5.58	3.46 UJ	3.36 UJ	1.13 UJ	3.36 UJ	**1.04 J**	**212 J**	3.09 UJ
Copper	70.0	141	**139**	**94.8**	**93**	**151**	**119**	**7,850**	**104**
Lead	120	13.2	**485**	**35.7**	**145**	**383**	**499**	**96,200**	**395**
Zinc	120	131	**98.4**	**69.2**	**118**	**85.4**	**80.9**	**1,250**	**81.2**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB100 77RR-SB100G-0_502 03/22/13	77RR-SB101 77RR-SB101G-0_502 03/22/13	77RR-SB102 77RR-SB102G-0_502 09/21/12	77RR-SB104 77RR-SB104G-0_502 09/21/12	77RR-SB105 77RR-SB105G-0_502 09/21/12	77RR-SB106 77RR-SB106G-0_502 09/21/12	77RR-SB107 77RR-SB107G-0_502 09/21/12	77RR-SB108 77RR-SB108G-0_502 09/20/12	77RR-SB109 77RR-SB109G-0_502 09/21/12
Metals (MG/KG)											
Antimony	3.56	5.58	3.09 UJ	3.03 UJ	NA	NA	NA	NA	NA	NA	NA
Copper	70.0	141	**71.9**	**140**	NA	NA	NA	NA	NA	NA	NA
Lead	120	13.2	**416**	**912**	NA	NA	NA	NA	NA	NA	NA
Zinc	120	131	**66.1**	**81.9**	NA	NA	NA	NA	NA	NA	NA

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB110	77RR-SB111	77RR-SB112	77RR-SB119		77RR-SB120	77RR-SB121	77RR-SB122	77RR-SB123
			77RR-SB110G-0_502	77RR-SB111G-0_502	77RR-SB112G-0_502	77RR-SB119G-0_502	77RR-SB119G-0_502-D	77RR-SB120G-0_502	77RR-SB121G-0_502	77RR-SB122G-0_502	77RR-SB123G-0_502
			09/21/12	09/21/12	09/21/12	03/19/13	03/19/13	03/19/13	03/19/13	03/19/13	03/19/13
Metals (MG/KG)											
Antimony	3.56	5.58	NA	NA	NA	**1.71**	**0.792 J**	0.614 UJ	1.15 UJ	1.27 UJ	1.15 UJ
Copper	70.0	141	NA	NA	NA	**58.6**	**46.8**	**77.8 J**	**92.1**	**36.5**	**13**
Lead	120	13.2	NA	NA	NA	**229 J**	**116 J**	**1.43 J**	**18.8**	**2.01**	**55.3**
Zinc	120	131	NA	NA	NA	**147**	**118**	**57.6 J**	**69.1 J**	**78.2 J**	**113 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB124		77RR-SB127	77RR-SB128	77RR-SB129	77RR-SB130	77RR-SB131	77RR-SB132	77RR-SB133
			77RR-SB124G-0_502	77RR-SB124G-0_502-D	77RR-SB127G-0_502	77RR-SB128G-0_502	77RR-SB129G-0_502	77RR-SB130G-0_502	77RR-SB131G-0_502	77RR-SB132G-0_502	77RR-SB133G-0_502
			03/22/13	03/22/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13	03/21/13
Metals (MG/KG)											
Antimony	3.56	5.58	2.94 UJ	2.94 UJ	2.81 UJ	2.89 UJ	3.18 UJ	**4.18 J**	2.91 UJ	3.13 UJ	**7.87 J**
Copper	70.0	141	**100**	**116**	**123**	**82.9**	**101**	**282**	**147**	**144**	**137,000**
Lead	120	13.2	**71.1 J**	**135 J**	**764 J**	0.868 U	**3.44 J**	**2,090 J**	**226 J**	**264 J**	**4,520**
Zinc	120	131	**60**	**71.6**	**64.4**	**58.6**	**62.8 J**	**110 J**	**75.6 J**	**76.6 J**	**14,100 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB134	77RR-SB135	77RR-SB136		77RR-SB137	77RR-SB138	77RR-SB139	77RR-SB141	77RR-SB142
			77RR-SB134G-0_502	77RR-SB135G-0_502	77RR-SB136G-0_502	77RR-SB136G-0_502-D	77RR-SB137G-0_502	77RR-SB138G-0_502	77RR-SB139G-0_502	77RR-SB141G-0_502	77RR-SB142G-0_502
			03/21/13	03/21/13	03/21/13	03/21/13	03/22/13	03/22/13	03/22/13	03/22/13	03/22/13
Metals (MG/KG)											
Antimony	3.56	5.58	**9.71 J**	2.77 UJ	2.73 UJ	2.85 UJ	3.32 UJ	3.95 UJ	2.98 UJ	2.78 UJ	2.85 UJ
Copper	70.0	141	**65**	**110**	**112**	**114**	**95.2**	**123**	**125**	**101**	**102**
Lead	120	13.2	**1,010 J**	**50.9 J**	**470 J**	**393 J**	**209**	**228**	**348 J**	**614 J**	**196 J**
Zinc	120	131	**41.7 J**	**76.1 J**	**70.2 J**	**71.2**	**75.3**	**76.8**	**84.9**	**77.2**	**78.9**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB143 77RR-SB143G-0_502 03/22/13	77RR-SB144 77RR-SB144G-0_502 03/22/13	77RR-SB145 77RR-SB145G-0_502 03/22/13	77RR-SB146 77RR-SB146G-0_502 03/20/13	77RR-SB147 77RR-SB147G-0_502 03/20/13	77RR-SB148 77RR-SB148G-0_502 03/20/13	77RR-SB149 77RR-SB149G-0_502 03/20/13	77RR-SB150 77RR-SB150G-0_502 03/19/13	77RR-SB151 77RR-SB151G-0_502 03/19/13
Metals (MG/KG)											
Antimony	3.56	5.58	2.97 UJ	2.83 UJ	2.8 UJ	2.75 UJ	1.33 UJ	1.07 UJ	1.06 UJ	2.81 U	1.08 UJ
Copper	70.0	141	**80.2**	**48.5**	**19**	**104**	**106**	**86.2**	**17.8**	**105**	**2.22**
Lead	120	13.2	**38.3 J**	**199 J**	**46.9 J**	**109**	**55.5**	**180**	**78.7**	**130**	**3.47**
Zinc	120	131	**75.5**	**66.1**	**68.9**	**78.1**	**67.9**	**63.8**	**66.6**	**94**	**64.8 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB152 77RR-SB152G-0_502 03/19/13	77RR-SB153 77RR-SB153G-0_502 03/19/13	77RR-SB154 77RR-SB154G-0_502 03/19/13	77RR-SB155 77RR-SB155G-0_502 03/25/13	77RR-SB156 77RR-SB156G-0_502 03/25/13	77RR-SB157 77RR-SB157G-0_502 03/25/13	77RR-SB158 77RR-SB158G-0_502 03/25/13	77RR-SB159 77RR-SB159G-0_502 03/25/13	77RR-SB160 77RR-SB160G-0_502 03/19/13
Metals (MG/KG)											
Antimony	3.56	5.58	1.07 UJ	1.09 UJ	1.05 UJ	3.37 UJ	2.73 UJ	2.79 UJ	2.79 UJ	2.81 UJ	1.11 UJ
Copper	70.0	141	**0.563 J**	**3.19**	**20.8**	**133**	**23.7**	**104**	**36.8**	**121**	**11.6**
Lead	120	13.2	**0.718**	**0.705**	**1.67**	**60 J**	0.819 U	**6.83 J**	**5.44 J**	**3.99 J**	**2.11**
Zinc	120	131	**102 J**	**78.7**	**30.3 J**	**156**	**90.8**	**104**	**46.6**	**74.3**	**87 J**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-49

Exceedances of ESVs and Background - Site UXO 1 (SWMU 77) Subsurfac

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Ecological Screening Value	Background UTL	77RR-SB161 77RR-SB161G-0_502 03/19/13	77RR-SB162 77RR-SB162G-0_502 03/20/13	77RR-SB163 77RR-SB163G-0_502 03/19/13	77RR-SB164 77RR-SB164G-0_502 03/20/13	77RR-SB165 77RR-SB165G-0_502 03/23/13	77RR-SB166 77RR-SB166G-0_502 03/20/13	77RR-SB168 77RR-SB168G-0_502 03/23/13
Metals (MG/KG)									
Antimony	3.56	5.58	1.06 UJ	2.97 UJ	1.19 UJ	1.18 UJ	3.73 UJ	1.04 UJ	3.81 UJ
Copper	70.0	141	**37.6**	**97.6**	**86.7**	**93.2**	**127**	**51.1**	**95.7**
Lead	120	13.2	**1.41**	**2.44 J**	**0.854**	**12 J**	**179**	**0.514**	**27.3**
Zinc	120	131	**79.8**	**72.8**	**62.5**	**87.9**	**90**	**57.9**	**70.1**

Grey highlighting indicates value greater than or equal to screening value

Red highlighting indicates value greater than both screening value and background

Bold indicates detections

NA - Not analyzed

TABLE 1-50
Site UXO 1 (SWMU 77) Soil PRGs
Naval Activity Puerto Rico, Ceiba, Puerto Rico

Chemical	Units	Background UTL	Ecological PRG	Basis	Human Health PRG	Basis	Selected PRG	Basis
Surface Soil (0-2 feet bgs)								
Antimony	mg/kg	2.70	3.56	Food web (rat)	31.0	Non-carcinogenic risk (HI = 1)	3.56	Ecological - Food Web
Arsenic	mg/kg	2.75	18.0	Plant SSL	11.3	Non-carcinogenic risk (HI = 0.33)	11.3	Human Health
Copper	mg/kg	192	70.0	Plant SSL	3,100	Non-carcinogenic risk (HI = 1)	192	Background UTL
Lead	mg/kg	34.2	120	Plant SSL	400	Non-carcinogenic risk (RSL)	120	Ecological - Plant
Zinc	mg/kg	132	120	Invertebrate SSL	7,700	Non-carcinogenic risk (HI = 0.33)	132	Background UTL
Subsurface Soil (>2 feet bgs)								
Antimony	mg/kg	5.58	--	--	31.0	Non-carcinogenic risk (HI = 1)	31.0	Human Health
Arsenic	mg/kg	3.59	--	--	11.3	Non-carcinogenic risk (HI = 0.33)	11.3	Human Health
Copper	mg/kg	141	--	--	3,100	Non-carcinogenic risk (HI = 1)	3,100	Human Health
Lead	mg/kg	13.2	--	--	400	Non-carcinogenic risk (RSL)	400	Human Health
Zinc	mg/kg	131	--	--	7,700	Non-carcinogenic risk (HI = 0.33)	7,700	Human Health

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
Former Pistol Range Subarea																		
77FP-SB001	X			NA	NA	NA	5.33 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB002	X			NA	NA	NA	21.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB003	X			NA	NA	NA	2.67 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB004	X			0.57 J	1.08	28.8	375	30.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB005	X			NA	NA	NA	21.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB006	X			NA	NA	NA	3.33 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB007	X			NA	NA	NA	13.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB008	X			NA	NA	NA	133	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB009	X	X		1.62 J	1.51 J	4,400	660	437	2.80 UJ	1.08 J	116	181	62.4	NA	NA	NA	NA	NA
77FP-SB010	X	X		6.26 J	1.30 J	204	3,215	69.2	6.19 J	1.12 J	182	997	64.9	NA	NA	NA	NA	NA
77FP-SB011	X	X		NA	NA	NA	27.7	NA	3.52 UJ	1.59 J	150	8.67	88.0	NA	NA	NA	NA	NA
77FP-SB012	X	X		3.80 J	1.82 J	99.0	2,004	53.1	3.43 UJ	1.94 J	80.6	151	62.5	NA	NA	NA	NA	NA
77FP-SB013	X	X		1.19 J	1.82	61.7	484	38.6	3.43 UJ	1.67 J	55.8	46.9	46.3	NA	NA	NA	NA	NA
77FP-SB014	X			NA	NA	NA	17.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB015	X			NA	NA	NA	37.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB016	X			NA	NA	NA	5.50 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB017	X			NA	NA	NA	20.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB018	X			0.606 U	1.02	56.7	59.6	45.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB019	X			NA	NA	NA	3.33 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB020	X			1.57 U	0.944 U	147	30.0 U	69.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB021	X			NA	NA	NA	3.50 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB022	X			1.56 U	1.13 J	93.4	486	49.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB023	X			NA	NA	NA	155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB024	X			NA	NA	NA	202	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB025	X			1.53 U	1.16 J	122	287	64.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB025	X			NA	NA	NA	293	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB026	X	X		1.57 U	0.943 U	2,110	422	269	2.96 UJ	1.41 J	129	151	64.7	NA	NA	NA	NA	NA
77FP-SB026	X			NA	NA	NA	281	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB027	X	X		NA	NA	NA	234	NA	2.85 UJ	2.85 U	119	1.71 U	78.5	NA	NA	NA	NA	NA
77FP-SB028	X	X		NA	NA	NA	169	NA	3.98 UJ	2.16 J	61.1	126	47.2	NA	NA	NA	NA	NA
77FP-SB029	X	X		NA	NA	NA	235	NA	3.79 UJ	1.27 J	70.7	26.8	54.5	NA	NA	NA	NA	NA
77FP-SB030	X			NA	NA	NA	73.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB031	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB032	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB033	X	X		2.40 UJ	1.57 J	106 J	216 J	69.3 J	2.58 UJ	1.45 J	108 J	190 J	65.8 J	NA	NA	NA	NA	NA
77FP-SB034	X	X		2.37 UJ	1.51 J	104	134	61.4	2.36 UJ	1.54 J	101 J	153 J	61.3 J	NA	NA	NA	NA	NA
77FP-SB035	X	X		2.42 UJ	0.983 J	111	143	69.1	2.39 UJ	0.969 J	108	38.1	61.0	NA	NA	NA	NA	NA
77FP-SB036	X	X		2.36 UJ	1.08 J	115	99.5	63.6	2.40 UJ	1.80 UJ	103	65.3	55.9	NA	NA	NA	NA	NA
77FP-SB037	X	X		2.28 UJ	1.71 UJ	98.6	64.7	58.6	2.42 UJ	0.977 J	106	37.4	55.6	NA	NA	NA	NA	NA
77FP-SB038	X	X		2.36 UJ	1.06 J	120	100	78.6 J	2.45 UJ	0.965 J	109	10.0	61.9 J	NA	NA	NA	NA	NA
77FP-SB038	X			2.34 UJ	1.07 J	123	100	83.1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB039	X	X		2.23 UJ	1.67 U	99.6	55.4	76.2 J	2.41 UJ	1.80 U	109	29.5	71.5 J	NA	NA	NA	NA	NA
77FP-SB040	X	X		2.44 UJ	1.83 UJ	94.0	20.9	63.4	2.33 UJ	0.90 J	92.9	8.51	56.5	NA	NA	NA	NA	NA
77FP-SB041	X	X		3.06 J	2.09 J	243	938	81.9	3.07 UJ	3.07 U	9.85	25.2	44.3	NA	NA	NA	NA	NA
77FP-SB042	X	X		3.28 UJ	1.86 J	3.95	4.92	62.9	3.30 UJ	3.30 U	2.97 J	0.991 U	119	NA	NA	NA	NA	NA
77FP-SB043	X	X		2.80 UJ	0.872 J	71.8	6.78	52.3	2.87 UJ	1.27 J	87.2	0.862 U	45.8	NA	NA	NA	NA	NA

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77FP-SB044	X	X		2.72 UJ	2.72 U	83.4	6.02	69.6	2.91 UJ	2.91 U	83.9	14.6	68.1	NA	NA	NA	NA	NA
77FP-SB045	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77FP-SB046	X	X		2.72 UJ	1.04 J	82.3	11.7	81.5	2.76 UJ	2.76 U	88.9	7.27	72.8	NA	NA	NA	NA	NA
77FP-SB047	X	X		2.76 UJ	0.888 J	86.1	3.79	69.4	2.79 UJ	1.22 J	95.2	0.919	77.0	NA	NA	NA	NA	NA
77FP-SB048	X	X		2.96 UJ	1.48 J	88.3	11.1	66.8	2.86 UJ	1.07 J	79.3	18.9	61.7	NA	NA	NA	NA	NA
77FP-SB049	X	X		3.26 J	2.62 J	138	4,570 J	151	3.44 UJ	1.84 J	117	793	163	NA	NA	NA	NA	NA
77FP-SB050	X	X		3.60 UJ	2.28 J	97.0	275	90.1	3.31 UJ	1.96 J	98.8	118	72.1	NA	NA	NA	NA	NA
77FP-SB051	X	X		2.90 UJ	1.24 J	90.5	47.7 J	68.3 J	3.09 UJ	1.37 J	57.2 J	0.933 U	44.7	NA	NA	NA	NA	NA
77FP-SB052	X	X		2.91 UJ	1.07 J	72.7	24.3 J	59.6 J	3.24 UJ	3.24 U	97.2	0.972 UJ	53.7 J	NA	NA	NA	NA	NA
77FP-SB052	X	X		2.91 UJ	1.10 J	72.5	22.4 J	60.4 J	3.23 UJ	3.23 U	95.3	0.968 UJ	51.9 J	NA	NA	NA	NA	NA
Pistol Range Subarea																		
77PR-SB001	X		X	1.44 U	1.22 J	290	556	156	NA	NA	NA	NA	NA	3.31 UJ	1.32 J	75.5	45.3 J	84.0 J
77PR-SB001			X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.95 UJ	2.23 J	116	342 J	208 J
77PR-SB002	X			NA	NA	NA	1,203	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB003	X			NA	NA	NA	1,884	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB004	X			NA	NA	NA	1,921	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB005	X		X	NA	NA	NA	1,046	NA	NA	NA	NA	NA	NA	2.78 UJ	2.78 U	107	0.834 UJ	73.7 J
77PR-SB006	X			1.72 J	4.14	174	754	110	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB007	X		X	NA	NA	NA	384	NA	NA	NA	NA	NA	NA	2.72 UJ	2.72 U	55.9	0.816 UJ	79.7 J
77PR-SB008	X			5.05	2.06	176	5,370	90.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB009	X		X	NA	NA	NA	750	NA	NA	NA	NA	NA	NA	10.1 J	2.78 U	138	10,900 J	91.2 J
77PR-SB010	X		X	326	42.8	7,990	58,400	856	NA	NA	NA	NA	NA	2.89 UJ	2.89 U	103	12.9 J	72.3 J
77PR-SB011	X		X	65.8	8.69	1,060	31,800	295	NA	NA	NA	NA	NA	2.72 UJ	1.31 J	192	282 J	591 J
77PR-SB012	X		X	7.42	4.11	401	22,000	110	NA	NA	NA	NA	NA	2.81 UJ	1.29 J	388	137 J	130 J
77PR-SB013	X		X	2.24	2.10	251	3,720	94.5	NA	NA	NA	NA	NA	24.0 J	3.72	197	7,940 J	78.5 J
77PR-SB014	X			NA	NA	NA	148	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB015	X			NA	NA	NA	171	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB016	X			NA	NA	NA	325	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB017	X			NA	NA	NA	1,548	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB017	X			NA	NA	NA	1,788	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB018	X			NA	NA	NA	2,494	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB019	X			0.602 U	0.641 J	132	423	72.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB020	X			NA	NA	NA	517	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB021	X			1.37 U	0.821 U	106	61.7	75.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB022	X			NA	NA	NA	104	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB023	X			NA	NA	NA	116	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB023	X			NA	NA	NA	108	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB024	X			NA	NA	NA	56.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB025	X			NA	NA	NA	132	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB026	X		X	NA	NA	NA	196	NA	NA	NA	NA	NA	NA	2.99 UJ	2.99 UJ	100	3.47 J	66.4
77PR-SB027	X			NA	NA	NA	30.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB028	X			NA	NA	NA	8.50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB029	X			NA	NA	NA	24.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB030	X			1.42 U	0.849 U	105	47.0	77.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB031	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB032	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB033	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)																
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77PR-SB034	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB035	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB036	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB037	X	X		2.25 UJ	1.69 UJ	112	1,030	70.6 J	2.84 UJ	2.84 UJ	97.9	43.1 J	70.5	NA	NA	NA	NA	NA
77PR-SB037		X		NA	NA	NA	NA	NA	2.75 UJ	2.75 UJ	94.5	45.4 J	69.4	NA	NA	NA	NA	NA
77PR-SB038	X	X		2.25 UJ	1.69 UJ	193	410	87.7 J	2.91 UJ	2.91 UJ	102	28.5 J	75.4	NA	NA	NA	NA	NA
77PR-SB039	X	X		2.17 UJ	1.63 UJ	114	702	70.6 J	2.83 UJ	2.83 UJ	108	30.7 J	80.4	NA	NA	NA	NA	NA
77PR-SB040	X	X		19.6 J	2.51 J	112	2,640 J	68.8 J	2.79 UJ	2.79 UJ	102	3.10 J	74.7	NA	NA	NA	NA	NA
77PR-SB041	X	X		2.28 UJ	1.71 UJ	115	244 J	72.5 J	2.84 UJ	2.84 UJ	96.1	14.7 J	71.1	NA	NA	NA	NA	NA
77PR-SB042	X			2.08 UJ	1.56 UJ	93.2	4.07 J	70.2 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB043	X	X		2.23 UJ	1.30 J	103	126	239 J	2.27 UJ	1.41 J	95.8	76.9	81.9 J	NA	NA	NA	NA	NA
77PR-SB044	X	X		3.83 J	4.97 J	210	1,670	105 J	2.68 J	3.96 J	186	1,600	90.6 J	NA	NA	NA	NA	NA
77PR-SB045	X	X		3.57 J	10.3 J	216	2,300	88.2	1.48 J	6.97 J	154	957	78.2	NA	NA	NA	NA	NA
77PR-SB046	X	X		11.4 J	6.17 J	398	6,250	121	5.47 J	5.28 J	233	1,850	86.8	NA	NA	NA	NA	NA
77PR-SB047	X	X	X	2.13 UJ	3.36 J	121	669 J	64.0 J	2.23 UJ	1.98 J	76.2	52.6 J	53.9 J	2.70 UJ	2.70 U	97.0	0.586 J	73.5 J
77PR-SB048	X	X		2.23 UJ	0.875 J	141	160 J	77.3 J	2.24 UJ	1.17 J	152	162 J	121 J	NA	NA	NA	NA	NA
77PR-SB049	X			2.20 UJ	1.82 J	118	36.8 J	82.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB050	X			2.17 UJ	12.8	139	456 J	257 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB051	X			2.38 UJ	1.89 J	128	93.0 J	116 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB052	X			2.12 UJ	1.50 J	92.9	17.1 J	76.3 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB052	X			2.16 UJ	2.27 J	109	24.3 J	179 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB053	X			2.30 UJ	1.59 J	129	67.5 J	95.3 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB054	X			2.14 UJ	8.50 J	57.4	27.0 J	76.4 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB055	X			2.14 UJ	2.37 J	99.5	72.5 J	110 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB056	X			2.46 UJ	1.06 J	103	1.74 J	41.8 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB057	X			2.15 UJ	1.61 UJ	240	1.26 J	87.1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB058	X			2.22 UJ	1.66 UJ	117	6.73 J	77.0 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB059		X		NA	NA	NA	NA	NA	2.19 UJ	1.64 U	135	167	91.9 J	NA	NA	NA	NA	NA
77PR-SB060		X		NA	NA	NA	NA	NA	2.22 UJ	1.57 J	171	528	92.9 J	NA	NA	NA	NA	NA
77PR-SB061		X	X	NA	NA	NA	NA	NA	2.21 UJ	0.994 J	112	496	93.9 J	1.08 UJ	1.79 J	36.4	1.37 J	82.7
77PR-SB062		X	X	NA	NA	NA	NA	NA	4.22 J	3.26	323	3,470	121	2.65 UJ	2.65 U	110	129 J	70.5 J
77PR-SB063		X		NA	NA	NA	NA	NA	2.25 UJ	1.69 U	295	78.4	94.1	NA	NA	NA	NA	NA
77PR-SB064		X		NA	NA	NA	NA	NA	1.87 J	1.78 J	191	1,370	89.1	NA	NA	NA	NA	NA
77PR-SB065		X		NA	NA	NA	NA	NA	7.57 J	0.911 J	172	5,770	85.5	NA	NA	NA	NA	NA
77PR-SB066		X		NA	NA	NA	NA	NA	2.26 UJ	1.69 UJ	139	97.4 J	73.9 J	NA	NA	NA	NA	NA
77PR-SB067		X	X	NA	NA	NA	NA	NA	2.23 UJ	1.67 UJ	114	342 J	72.9 J	2.82 UJ	2.82 UJ	90.2	10.7 J	71.5
77PR-SB068		X		NA	NA	NA	NA	NA	2.22 UJ	1.59 J	149	242 J	84.4 J	NA	NA	NA	NA	NA
77PR-SB069		X	X	NA	NA	NA	NA	NA	4.99 J	2.37 J	262	2,530 J	105 J	2.84 UJ	2.84 UJ	143	0.852 UJ	95.9
77PR-SB070		X		NA	NA	NA	NA	NA	2.34 UJ	1.15 J	118	146 J	87.4 J	NA	NA	NA	NA	NA
77PR-SB071		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB071		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB072		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB073	X	X	X	2.29 UJ	1.86 J	93.5	626	101 J	2.20 UJ	1.99 J	99.0	567	107 J	3.19 UJ	1.46 J	78.8	74.6 J	94.8
77PR-SB074	X			2.84 UJ	2.84 U	123	238	75.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB075	X			2.81 UJ	2.81 U	628	3,170	159	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB076	X			2.78 UJ	2.78 U	122	80.5	78.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB077	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)														
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77PR-SB078	X			2.80 UJ	2.80 UJ	107	86.4	81.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB079	X			4.57 J	1.34 J	106	1,310	75.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB080	X			2.78 UJ	2.78 U	99.1	118	74.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
No 81 - Sediment																		
77PR-SB082	X	X	X	2.97 UJ	0.93 J	114	101 J	89.6	2.97 UJ	2.97 UJ	104	0.89 U	83.4	3.08 UJ	3.08 UJ	84.5	0.925 U	84.4
77PR-SB083	X	X	X	1.25 UJ	0.561 J	103	5.52 J	71.2	3.06 UJ	3.06 UJ	98.4	0.918 UJ	79.7	3.23 UJ	3.23 UJ	105	1.94 UJ	71.8
77PR-SB084	X	X	X	27.3 J	3.07 J	105	3,720 J	288	3.16 UJ	3.16 UJ	109	1.56 J	98.4	1.28 UJ	1.28 UJ	115	0.221 J	72.8
77PR-SB085	X	X	X	1.11 UJ	1.28 J	97.6	34.4 J	82.3	3.01 UJ	3.01 UJ	96.2	0.929 J	92.8	2.80 UJ	2.80 UJ	80.1	0.841 UJ	100
77PR-SB086	X	X	X	1.12 UJ	2.72 J	100	111 J	143	3.06 UJ	3.06 UJ	90.3	9.30 J	105	3.16 UJ	3.16 UJ	97.5	0.949 UJ	94.1
77PR-SB087	X	X	X	1.21 UJ	1.91 J	109	51.6 J	111	3.38 UJ	3.38 UJ	108	1.01 UJ	93.4	1.28 UJ	1.28 UJ	89.1	0.764 J	61.4
77PR-SB088	X	X	X	2.86 UJ	1.38 J	99.7 J	101 J	81.8	2.86 UJ	2.86 UJ	110	4.03	78.4	2.98 UJ	2.98 UJ	99.0	0.894 U	77.4
77PR-SB089	X	X	X	2.95 UJ	2.22 J	84.3 J	132 J	154	2.90 UJ	2.90 UJ	105	0.967	78.5	3.03 UJ	3.03 UJ	112	1.18	78.1
77PR-SB090	X	X	X	2.88 UJ	2.88 UJ	110 J	414 J	103	3.22 UJ	3.22 UJ	110	0.967 U	84.4	3.12 UJ	3.12 UJ	84.8	0.937 U	83.3
77PR-SB091	X	X	X	2.97 UJ	2.97 U	137 J	17.3 J	130	3.14 UJ	3.14 UJ	108	2.28	91.4	2.98 UJ	2.98 U	87.3	0.895 UJ	82.6 J
77PR-SB092	X	X	X	2.79 UJ	4.97	261 J	204 J	114	3.20 UJ	3.20 U	106	55.1 J	107	3.22 UJ	3.22 U	91.8	0.655 J	85.3
77PR-SB092	X	X	X	2.86 UJ	2.86 UJ	126 J	106 J	86	3.25 UJ	3.25 UJ	84.0	3.04 J	76.3	3.19 UJ	3.19 UJ	101	1.92 U	82.1
77PR-SB093	X	X	X	3.60 UJ	3.60 UJ	124	17 J	94.8	3.69 UJ	3.69 UJ	108	5.74 J	78.6	3.42 UJ	3.42 UJ	172	7.12 J	92.0
77PR-SB094	X	X	X	3.08 UJ	3.08 U	106	0.925 U	67.0	2.76 UJ	1.09 J	168	48.4	101	2.83 UJ	2.83 U	995	368	246
77PR-SB095	X	X	X	2.99 UJ	1.00 J	102 J	28.1 J	73.3	2.99 UJ	2.99 UJ	111	1.94	79.1	2.62 UJ	2.62 UJ	84.6	1.57 U	60.6
77PR-SB096	X			2.83 UJ	2.83 U	98.3	63.6	72.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB097	X			2.79 UJ	2.79 U	101	121	71.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
No 98 - Sediment																		
77PR-SB099	X			2.77 UJ	2.77 U	111	468	82.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77PR-SB100	X	X	X	2.99 UJ	5.39	96.4	36.8 J	84.3 J	2.90 UJ	1.20 J	91.2	4.16 J	70.5 J	3.28 UJ	3.28 U	89.0	1.39 J	43.6 J
No 101 - Sediment																		
77PR-SB102	X	X	X	2.84 UJ	3.11	81.3	18.7	75.5	3.04 UJ	1.22 J	122	2.89	76.1	2.88 UJ	0.99 J	173	40.5	138
Rifle Range Subarea																		
77RR-SB001	X			11.2	8.99	557	12,500	149	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB002	X			13.5	7.27	7,130	14,800	864	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB003	X			22.6	8.85	13,300	22,900	1,620	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB004	X			NA	NA	NA	9,556	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB005	X			NA	NA	NA	8,350	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB006	X			NA	NA	NA	8,678	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB007	X			0.601 U	1.24	138	347	62.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB007	X			1.46 UJ	1.23 J	226	403	83.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB008	X			1.46 U	1.32 J	110	881	65.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB009	X			NA	NA	NA	3,716	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB010	X			NA	NA	NA	2,779	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB011	X			NA	NA	NA	4,580	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB012	X			NA	NA	NA	7,434	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB012	X			NA	NA	NA	8,173	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB013	X			NA	NA	NA	8,697	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB014	X			NA	NA	NA	6,485	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB015	X			425 J	38.3	3,860	89,000	507	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB016	X			8.39	2.54	12,200	8,820	1,570	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB017	X			NA	NA	NA	2,921	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB018	X			43.3	12.7	5,960	34,600	626	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB019	X			NA	NA	NA	6,401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB020	X			NA	NA	NA	7,834	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB021	X			NA	NA	NA	6,814	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB022	X			NA	NA	NA	7,473	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB023	X			NA	NA	NA	2,590	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB023	X			NA	NA	NA	2,915	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB024	X			NA	NA	NA	6,181	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB025	X			NA	NA	NA	3,595	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB026	X			4.69	1.32 J	370	5,710	110	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB027	X			NA	NA	NA	9,576	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB028	X			NA	NA	NA	8,613	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB029	X			16.7	2.67	161	5,250	71.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB030	X			NA	NA	NA	3,480	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB031	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB032	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB033	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB034	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB035	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB036	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB037	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB038	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB039	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB039	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB040	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB041	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB042	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB043	X			NA	NA	NA	2,789	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB044	X			NA	NA	NA	7,321	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB044	X			NA	NA	NA	7,537	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB045	X			12.1	4.95	477	8,774	141	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB046	X			123	7.99	713	50,500	129	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB047	X			15.3	4.36	1,230	8,910	170	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB048	X			1.94 J	1.78	154	2,712	66.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB049	X			NA	NA	NA	13,688	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB050	X			27.8	7.20	339	19,700	92.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB051	X			NA	NA	NA	8,062	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB052	X			1,040	34.3	36,700	73,600	3,470	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB053	X			NA	NA	NA	4,444	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB054	X			348 J	24.6	1,800 R	55,300	295 R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB054	X			295 J	26.7	17,600 R	52,200	1,710 R	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB055	X			6,510 J	60.5	959	118,000	164	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB056	X			918 J	49.6	1,810	52,100	283	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB057	X			NA	NA	NA	14,565	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB058		X		NA	NA	NA	NA	NA	2.26 U	1.80 J	238	1,410	119	NA	NA	NA	NA	NA
77RR-SB059		X		NA	NA	NA	NA	NA	2.39 U	0.941 J	106	743	84.2	NA	NA	NA	NA	NA
77RR-SB060		X		NA	NA	NA	NA	NA	2.32 U	1.93 J	91.3	944	62.6	NA	NA	NA	NA	NA
77RR-SB061		X		NA	NA	NA	NA	NA	2.47 U	1.89 J	71.4	209	55.0	NA	NA	NA	NA	NA

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)																
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB062		X		NA	NA	NA	NA	NA	2.29 U	2.46 J	35.5	196	23.2	NA	NA	NA	NA	NA
77RR-SB063		X		NA	NA	NA	NA	NA	73.3	13.6	1,080	20,400	385	NA	NA	NA	NA	NA
77RR-SB064		X		NA	NA	NA	NA	NA	96.7 J	11.5	699 J	26,800	179 J	NA	NA	NA	NA	NA
77RR-SB065		X		NA	NA	NA	NA	NA	2.31 UJ	1.74 U	115 J	487	90.7 J	NA	NA	NA	NA	NA
77RR-SB065		X		NA	NA	NA	NA	NA	2.52 UJ	1.43 J	123 J	722	87.5 J	NA	NA	NA	NA	NA
77RR-SB066		X		NA	NA	NA	NA	NA	6.99 J	2.14 J	211 J	3,450	121 J	NA	NA	NA	NA	NA
77RR-SB067		X		NA	NA	NA	NA	NA	2.37 U	0.971 J	99.4	1,320	81.4	NA	NA	NA	NA	NA
77RR-SB068		X		NA	NA	NA	NA	NA	41.0 J	4.34	45,100	13,800	2,590	NA	NA	NA	NA	NA
77RR-SB069		X	X	NA	NA	NA	NA	NA	52.4 J	4.98	873	12,600	181	0.539 J	0.837 J	76.8	168 J	63.6
77RR-SB069			X	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.06 UJ	0.591 J	86.0	160 J	68.0
77RR-SB070		X	X	NA	NA	NA	NA	NA	11.3 J	2.51 J	215 J	2,670	89.7	29.4 J	4.30	411	9,030 J	119
77RR-SB071		X		NA	NA	NA	NA	NA	46.3	4.48	775	3,470	175	NA	NA	NA	NA	NA
77RR-SB072		X	X	NA	NA	NA	NA	NA	20.3 J	2.71 J	275 J	4,840	107	23.4 J	4.75	1,760	10,400 J	241
77RR-SB073		X	X	NA	NA	NA	NA	NA	42.6	10.1	992	25,800	232	2.95 UJ	2.95 U	105	177 J	64.0
77RR-SB074		X	X	NA	NA	NA	NA	NA	32.1 J	12.1 U	99,500 J	10,800	10,300	9.82 J	1.78 J	210	3,310 J	79.8
77RR-SB075		X	X	NA	NA	NA	NA	NA	28.4	5.24	719	3,060	179	62.3 J	3.79	634	15,200 J	133
77RR-SB076		X		NA	NA	NA	NA	NA	32.3 J	5.84	551 J	8,630	140	NA	NA	NA	NA	NA
77RR-SB077		X	X	NA	NA	NA	NA	NA	40.8	4.36	1,220	16,100	227	40.2 J	6.34	1,060	17,400 J	215
77RR-SB078	X	X		7.35 J	2.78	153	1,460	87.5	2.21 UJ	1.66 U	111	76.5	102	NA	NA	NA	NA	NA
77RR-SB079	X	X		5.33 J	3.06	218	1,100	122	2.28 UJ	1.03 J	165	251	88.9	NA	NA	NA	NA	NA
77RR-SB080	X	X		12.6 J	28	157	4,480	257	1.98 UJ	2.49	120	265	253	NA	NA	NA	NA	NA
77RR-SB081	X	X		6.15 J	1.26 J	150	1,000	94.8	1.77 J	1.08 J	123	382	84.9	NA	NA	NA	NA	NA
77RR-SB082	X	X		1.52 J	2.70 J	138	546	134	2.27 UJ	3.26	299	545	141	NA	NA	NA	NA	NA
77RR-SB083	X	X	X	8.86 J	3.78	251	6,660	112	7.16 J	9.02	279	4,430	114	3.35 UJ	2.45 J	99.5	0.625 J	76.7 J
77RR-SB084	X	X		9.74 J	4.58	393	6,970	132	10.1 J	4.90	238	4,670	185	NA	NA	NA	NA	NA
77RR-SB085	X	X	X	11.2 J	6.88	358	8,400	151	8.25 J	5.69	245	4,450	92.9	3.13 UJ	1.64 J	111	28.2	71.7 J
77RR-SB086	X	X		9.78 J	6.33	530	8,630	156	18.6 J	8.97	379	13,500	137	NA	NA	NA	NA	NA
77RR-SB087	X	X	X	14.2 J	7.01	445	8,110	217	8.99 J	3.00	275	5,870	124	2.85 UJ	1.25 J	87.4	102	66.2 J
77RR-SB087	X			10.7 J	3.25	324	6,440	206	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB088	X	X	X	2.47 UJ	1.85 UJ	79.1	118	76.5 J	2.42 J	1.47	98.3	768	79.1 J	0.558 UJ	1.11	3.61	1.85	67.3 J
77RR-SB089	X	X	X	2.25 UJ	0.921 J	86.1	368	74.7 J	3.46 UJ	1.61 J	139	485	98.4	3.40 UJ	1.52 J	125	468	93.8
77RR-SB090	X	X	X	2.55 UJ	1.61 J	83.5	328	122 J	3.36 UJ	1.35 J	94.8	35.7	69.2	3.48 UJ	3.48 U	106	0.529 J	62.6
77RR-SB091	X			2.46 UJ	1.07 J	95.7	117	69.7 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB092	X			2.26 U	1.13 J	62.3	119	60.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB093	X	X	X	2.31 UJ	3.06 J	203	653	126 J	1.13 UJ	1.02 J	93.0	145	118	1.04 UJ	1.04 U	55.9	1.92	58.0
77RR-SB094	X	X		2.23 UJ	1.34 J	151	1,610	115 J	3.36 UJ	3.36 U	151	383	85.4	NA	NA	NA	NA	NA
77RR-SB095	X			2.32 UJ	1.74 U	99.2	110	81.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB096	X	X	X	2.11 J	1.74 J	130	917	91.1	1.04 J	1.75	119	499	80.9	1.13 UJ	1.18	78.6	226	73.6
77RR-SB097	X	X	X	2.18 UJ	1.48 J	82.3	306	68.0	212 J	14.9	7,850	96,200	1,250	3.34 UJ	1.03 J	110	348	99.1
77RR-SB098	X			2.15 UJ	1.41 J	78.4	150	134	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB099	X	X	X	42.8 UJ	32.1 U	33,900	807	3,440	3.09 UJ	0.94 J	104	395	81.2	2.84 UJ	1.24 J	117	36.2	80.4
77RR-SB100	X	X		31.8 J	1.66 J	1,240	8,880	176	3.09 UJ	3.09 U	71.9	416	66.1	NA	NA	NA	NA	NA
77RR-SB101	X	X		27.9 J	1.53 J	167	2,240	93.4	3.03 UJ	0.992 J	140	912	81.9	NA	NA	NA	NA	NA
77RR-SB102	X	X		2.18 UJ	1.06 J	102	7.69	85.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB103	X			2.11 UJ	1.08 J	88.8	249	103	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB104	X	X		2.22 UJ	1.67 U	134 J	33.1	131	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB105	X	X		2.19 UJ	1.29 J	108 J	26.6	115	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB106	X	X		2.58 UJ	2.52 J	66.2 J	36.0	80.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB106	X			2.13 UJ	2.57 J	111 J	28.6	60.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB107		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB108		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB109		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB110		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB111		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB112		X		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB113	X			1.74 J	3.71	339	624	165	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB114	X			6.65	1.21 J	227	883	89.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB115	X			2.21 U	2.69 J	143	370	86.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB116	X			33.5	3.13	147	10,300	84.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB117	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB118	X			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB119	X	X	X	4.87	2.96	229	950	239	1.71	2.21	58.6	229 J	147	1.12 U	1.40	12.0	31.2 J	51.8
77RR-SB119		X	X	NA	NA	NA	NA	NA	0.792 J	1.65	46.8	116 J	118	1.17 U	1.48	15.5	4.93 J	47.2
77RR-SB120	X	X	X	2.34 J	2.55	104	644	154 J	0.614 UJ	1.24 J	77.8 J	1.43 J	57.6 J	0.556 UJ	0.962	6.64 J	0.783	43.4 J
77RR-SB120	X			4.64	3.30	127	927	147	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB121	X	X	X	1.12 UJ	1.78	81.0	50.8	61.9 J	1.15 UJ	0.905 J	92.1	18.8	69.1 J	1.13 UJ	1.01 J	80.7	28.1	63.9 J
77RR-SB122	X	X	X	1.18 UJ	1.08 J	95.1	15.8	64.1 J	1.27 UJ	1.76	36.5	2.01	78.2 J	1.18 UJ	0.965 J	117	20.1	413 J
77RR-SB123	X	X	X	9.35 J	3.69	273	3,960	200 J	1.15 UJ	1.81	13.0	55.3	113 J	1.14 UJ	1.56	6.21	1.45	124 J
77RR-SB124	X	X		2.90 UJ	2.90 U	173	633 J	90.1	2.94 UJ	2.94 U	100	71.1 J	60.0	NA	NA	NA	NA	NA
77RR-SB124	X	X		2.96 UJ	2.96 U	133	327 J	78.9	2.94 UJ	2.94 U	116	135 J	71.6	NA	NA	NA	NA	NA
77RR-SB125	X			2.82 UJ	2.82 U	99.5	54.6 J	63.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB126	X			2.72 UJ	2.72 U	52.8	36.0 J	61.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB127	X	X	X	2.63 UJ	2.63 U	136	1,010 J	82.2	2.81 UJ	2.81 U	123	764 J	64.4	3.04 UJ	3.04 U	113	735 J	93.7
77RR-SB128	X	X	X	3.02 UJ	3.02 U	103	51.2	62.4	2.89 UJ	2.89 U	82.9	0.868 U	58.6	3.00 UJ	3.00 U	96.0	23.1	77.3
77RR-SB129	X	X	X	3.16 UJ	3.16 U	115	32.7 J	70.3 J	3.18 UJ	3.18 U	101	3.44 J	62.8 J	3.00 UJ	3.00 U	102	8.42 J	47.1 J
77RR-SB130	X	X		10.4 J	1.66 J	17,100	4,990 J	1,860 J	4.18 J	2.87 U	282	2,090 J	110 J	NA	NA	NA	NA	NA
77RR-SB131	X	X	X	3.10 UJ	3.10 U	123	76.7 J	63.1 J	2.91 UJ	2.91 U	147	226 J	75.6 J	2.86 UJ	2.86 U	246	899 J	88.2 J
77RR-SB132	X	X		2.94 UJ	2.94 U	116	260 J	56.6 J	3.13 UJ	3.13 U	144	264 J	76.6 J	NA	NA	NA	NA	NA
77RR-SB133	X	X		6.42 J	2.21 J	347	4,220 J	127 J	7.87 J	13.9 U	137,000	4,520	14,100 J	NA	NA	NA	NA	NA
77RR-SB134	X	X		2.98 UJ	2.98 U	124	485 J	72.7 J	9.71 J	3.18 U	65	1,010 J	41.7 J	NA	NA	NA	NA	NA
77RR-SB135	X	X	X	2.88 UJ	2.88 U	96.3	82.4 J	73.9 J	2.77 UJ	2.77 U	110	50.9 J	76.1 J	2.69 UJ	2.69 U	100	16.1 J	52.6 J
77RR-SB136	X	X	X	2.84 UJ	2.84 U	108	80.2 J	67.4 J	2.73 UJ	0.973 J	112	470 J	70.2 J	2.90 UJ	1.06 J	130	476 J	75.5 J
77RR-SB136	X	X	X	2.80 UJ	1.01 J	118	692 J	72.9 J	2.85 UJ	0.952 J	114	393 J	71.2	2.92 UJ	1.08 J	88.6	204 J	57.4
77RR-SB137	X	X		3.57 UJ	3.57 U	106	1,770	87.1	3.32 UJ	3.32 U	95.2	209	75.3	NA	NA	NA	NA	NA
77RR-SB138	X	X		3.78 UJ	1.83 J	126	349	83.2	3.95 UJ	1.33 J	123	228	76.8	NA	NA	NA	NA	NA
77RR-SB139	X	X		2.87 UJ	1.59 J	108	169 J	87.7	2.98 UJ	1.39 J	125	348 J	84.9	NA	NA	NA	NA	NA
77RR-SB140	X			2.81 UJ	2.81 U	79.4	137	84.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
77RR-SB141	X	X		2.85 UJ	2.85 U	95.5	289 J	77.2	2.78 UJ	0.886 J	101	614 J	77.2	NA	NA	NA	NA	NA
77RR-SB142	X	X		2.87 UJ	1.11 J	109	456 J	105	2.85 UJ	2.85 U	102	196 J	78.9	NA	NA	NA	NA	NA
77RR-SB143	X	X	X	2.93 UJ	2.93 U	88.2	19.6 J	80.5	2.97 UJ	2.97 U	80.2	38.3 J	75.5	3.09 UJ	1.04 J	79.0	2.13 J	67.6
77RR-SB144	X	X		2.89 UJ	1.64 J	81.6	344 J	85.9	2.83 UJ	1.48 J	48.5	199 J	66.1	NA	NA	NA	NA	NA
77RR-SB145	X	X		2.82 UJ	1.32 J	24.5	64.3 J	79.0	2.80 UJ	1.17 J	19.0	46.9 J	68.9	NA	NA	NA	NA	NA
77RR-SB146	X	X	X	3.01 UJ	1.53 J	126	292	88.1	2.75 UJ	1.23 J	104	109	78.1	0.891 J	1.48	96.9	265	79.3
77RR-SB147	X	X	X	1.96 J	1.81	157	822	95.4	1.33 UJ	1.13 J	106	55.5	67.9	3.08 UJ	1.43 J	115	145	81.5

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	SS	SB1	SB2	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc	Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB148	X	X	X	5.27 J	3.25	160	2,170	90.2	1.07 UJ	1.15	86.2	180	63.8	1.13 UJ	1.15	92.1	58.5	68.4
77RR-SB149	X	X	X	1.42 J	2.01	54.2	331	90.6	1.06 UJ	1.21	17.8	78.7	66.6	1.08 UJ	1.19	3.85	13.6	68.8
77RR-SB150	X	X	X	2.26 J	1.96	41.8	338	95.8 J	2.81 U	1.42 J	105	130	94.0	0.734 J	2.59	90.9	219	88.6
77RR-SB151	X	X	X	1.10 UJ	1.14	4.00	11.6	56.1 J	1.08 UJ	1.12	2.22	3.47	64.8 J	1.12 UJ	1.09 J	0.642 J	0.723	82.4 J
77RR-SB152	X	X	X	1.06 UJ	1.82	0.855 J	1.52	113 J	1.07 UJ	1.27	0.563 J	0.718	102 J	1.12 UJ	0.858 J	2.23	0.419	80.6 J
77RR-SB153	X	X	X	1.14 UJ	1.15	8.01	9.63	84.2	1.09 UJ	1.07 J	3.19	0.705	78.7	1.13 UJ	0.862 J	2.55	1.05	28.9
77RR-SB154	X	X	X	2.81 UJ	1.28 J	87.1	6.91	93.6 J	1.05 UJ	1.62	20.8	1.67	30.3 J	1.14 UJ	1.13 J	2.72	0.725	42.6 J
77RR-SB155	X	X		2.78 UJ	2.37 J	102	80.2 J	129	3.37 UJ	3.37 UJ	133	60.0 J	156	NA	NA	NA	NA	NA
77RR-SB156	X	X	X	2.73 UJ	2.73 UJ	86.7	4.82 J	101	2.73 UJ	2.73 UJ	23.7	0.819 U	90.8	2.72 UJ	2.72 UJ	8.65	0.82 U	70.1
77RR-SB157	X	X	X	2.84 UJ	1.54 J	106	40.4 J	76.0	2.79 UJ	2.79 UJ	104	6.83 J	104	2.93 UJ	0.988 J	21.4	5.29 J	39.3
77RR-SB158	X	X	X	2.85 UJ	2.85 UJ	108	141 J	87.0	2.79 UJ	0.956 J	36.8	5.44 J	46.6	2.80 UJ	0.859 J	40.1	5.35 J	99.2
77RR-SB159	X	X	X	2.77 UJ	2.77 UJ	95.7	62.3 J	58.4	2.81 UJ	2.81 UJ	121	3.99 J	74.3	2.79 UJ	2.79 UJ	74.4	1.68 U	68.6
77RR-SB160	X	X	X	1.13 UJ	1.32	36.0	169	81.8 J	1.11 UJ	1.08 J	11.6	2.11	87.0 J	1.06 UJ	0.874 J	12.0	0.504	65.1 J
77RR-SB161	X	X	X	1.17 UJ	0.951 J	98.0	51.3	78.0	1.06 UJ	0.582 J	37.6	1.41	79.8	1.12 UJ	1.11 J	19.7	0.745	88.1
77RR-SB162	X	X	X	1.15 UJ	0.876 J	92.7	12.8 J	66.4	2.97 UJ	1.80 J	97.6	2.44 J	72.8	3.08 UJ	1.16 J	110	0.697 J	68.8
77RR-SB163	X	X	X	2.99 UJ	1.59 J	121	1.67	79.6	1.19 UJ	0.902 J	86.7	0.854	62.5	2.85 UJ	1.60 J	110	0.619 J	65.6
77RR-SB164	X	X	X	2.95 UJ	1.46 J	92.6	106 J	102	1.18 UJ	1.18	93.2	12.0 J	87.9	2.64 UJ	1.16	84.9	1.78 J	78.5
77RR-SB165	X	X		3.49 UJ	1.25 J	109	318	92.7	3.73 UJ	1.22 J	127	179	90.0	NA	NA	NA	NA	NA
77RR-SB166	X	X		1.07 UJ	0.533 J	79.5	67.3	69.4	1.04 UJ	1.04 U	51.1	0.514	57.9	NA	NA	NA	NA	NA
77RR-SB167	X			3.34 UJ	1.52 J	168	338	106	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Soil Data (mg/kg)															
				Surface (0-0.5 ft)					Subsurface (0.5-2 ft)					Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**	**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**	**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**	**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77RR-SB168	X	X		3.87 UJ	1.26 J	97.3	65.7	72.2	3.81 UJ	3.81 U	95.7	27.3	70.1	NA	NA	NA	NA	NA

Gray shaded location IDs indicate field duplicates

Gray shaded concentrations indicate detections

NA - Not Analyzed

Ratio to PRG 1 - 2

Ratio to PRG >2 - 5

Ratio to PRG >5

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
Former Pistol Range Subarea																					
77FP-SB001	X																				
77FP-SB002	X							0.18													
77FP-SB003	X																				
77FP-SB004	X				0.16	0.10	0.15	3.13	0.23												
77FP-SB005	X							0.18													
77FP-SB006	X																				
77FP-SB007	X							0.11													
77FP-SB008	X							1.11													
77FP-SB009	X	X			0.46	0.13	22.92	5.50	3.31			0.10	0.60	1.51	0.47						
77FP-SB010	X	X			1.76	0.12	1.06	26.79	0.52		1.74	0.10	0.95	8.31	0.49						
77FP-SB011	X	X						0.23				0.14	0.78	0.07	0.67						
77FP-SB012	X	X			1.07	0.16	0.52	16.70	0.40			0.17	0.42	1.26	0.47						
77FP-SB013	X	X			0.33	0.16	0.32	4.03	0.29			0.15	0.29	0.39	0.35						
77FP-SB014	X							0.14													
77FP-SB015	X							0.31													
77FP-SB016	X																				
77FP-SB017	X							0.17													
77FP-SB018	X					0.09	0.30	0.50	0.34												
77FP-SB019	X																				
77FP-SB020	X						0.77		0.53												
77FP-SB021	X																				
77FP-SB022	X					0.10	0.49	4.05	0.37												
77FP-SB023	X							1.29													
77FP-SB024	X							1.69													
77FP-SB025	X					0.10	0.64	2.39	0.49												
77FP-SB025	X							2.44													
77FP-SB026	X	X					10.99	3.52	2.04			0.12	0.67	1.26	0.49						
77FP-SB026	X							2.34													
77FP-SB027	X	X						1.95					0.62		0.59						
77FP-SB028	X	X						1.41				0.19	0.32	1.05	0.36						
77FP-SB029	X	X						1.96				0.11	0.37	0.22	0.41						
77FP-SB030	X							0.61													
77FP-SB031	X																				
77FP-SB032	X																				
77FP-SB033	X	X				0.14	0.55	1.80	0.53			0.13	0.56	1.58	0.50						
77FP-SB034	X	X				0.13	0.54	1.12	0.47			0.14	0.53	1.28	0.46						
77FP-SB035	X	X				0.09	0.58	1.19	0.52			0.09	0.56	0.32	0.46						
77FP-SB036	X	X				0.10	0.60	0.83	0.48				0.54	0.54	0.42						
77FP-SB037	X	X					0.51	0.54	0.44			0.09	0.55	0.31	0.42						
77FP-SB038	X	X				0.09	0.63	0.83	0.60			0.09	0.57	0.08	0.47						
77FP-SB038	X					0.09	0.64	0.83	0.63												
77FP-SB039	X	X					0.52	0.46	0.58				0.57	0.25	0.54						
77FP-SB040	X	X					0.49	0.17	0.48			0.08	0.48	0.07	0.43						
77FP-SB041	X	X			0.86	0.18	1.27	7.82	0.62				0.05	0.21	0.34						
77FP-SB042	X	X				0.16	0.02	0.04	0.48				0.02		0.90						
77FP-SB043	X	X				0.08	0.37	0.06	0.40			0.11	0.45		0.35						

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG															
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77FP-SB044	X	X					0.43	0.05	0.53				0.44	0.12	0.52						
77FP-SB045	X																				
77FP-SB046	X	X				0.09	0.43	0.10	0.62				0.46	0.06	0.55						
77FP-SB047	X	X				0.08	0.45	0.03	0.53			0.11	0.50	0.01	0.58						
77FP-SB048	X	X				0.13	0.46	0.09	0.51			0.09	0.41	0.16	0.47						
77FP-SB049	X	X			0.92	0.23	0.72	38.08	1.14			0.16	0.61	6.61	1.23						
77FP-SB050	X	X				0.20	0.51	2.29	0.68			0.17	0.51	0.98	0.55						
77FP-SB051	X	X				0.11	0.47	0.40	0.52			0.12	0.30		0.34						
77FP-SB052	X	X				0.09	0.38	0.20	0.45				0.51		0.41						
77FP-SB052	X	X				0.10	0.38	0.19	0.46				0.50		0.39						
Pistol Range Subarea																					
77PR-SB001	X		X			0.11	1.51	4.63	1.18									0.12	0.02	0.11	0.01
77PR-SB001			X															0.20	0.04	0.86	0.03
77PR-SB002	X							10.02													
77PR-SB003	X							15.70													
77PR-SB004	X							16.01													
77PR-SB005	X		X					8.72											0.03		0.01
77PR-SB006	X				0.48	0.37	0.91	6.28	0.83												
77PR-SB007	X		X					3.20											0.02		0.01
77PR-SB008	X				1.42	0.18	0.92	44.75	0.68												
77PR-SB009	X		X					6.25									0.33		0.04	27.25	0.01
77PR-SB010	X		X		91.57	3.79	41.61	486.67	6.48										0.03	0.03	0.01
77PR-SB011	X		X		18.48	0.77	5.52	265.00	2.23									0.12	0.06	0.71	0.08
77PR-SB012	X		X		2.08	0.36	2.09	183.33	0.83									0.11	0.13	0.34	0.02
77PR-SB013	X		X		0.63	0.19	1.31	31.00	0.72								0.77	0.33	0.06	19.85	0.01
77PR-SB014	X							1.23													
77PR-SB015	X							1.43													
77PR-SB016	X							2.71													
77PR-SB017	X							12.90													
77PR-SB017	X							14.90													
77PR-SB018	X							20.78													
77PR-SB019	X					0.06	0.69	3.53	0.55												
77PR-SB020	X							4.31													
77PR-SB021	X						0.55	0.51	0.57												
77PR-SB022	X							0.86													
77PR-SB023	X							0.97													
77PR-SB023	X							0.90													
77PR-SB024	X							0.47													
77PR-SB025	X							1.10													
77PR-SB026	X		X					1.64											0.03	0.01	0.01
77PR-SB027	X							0.25													
77PR-SB028	X							0.07													
77PR-SB029	X							0.20													
77PR-SB030	X						0.55	0.39	0.58												
77PR-SB031	X																				
77PR-SB032	X																				
77PR-SB033	X																				

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77PR-SB034	X																				
77PR-SB035	X																				
77PR-SB036	X																				
77PR-SB037	X	X					0.58	8.58	0.53				0.51	0.36	0.53						
77PR-SB037		X											0.49	0.38	0.53						
77PR-SB038	X	X					1.01	3.42	0.66				0.53	0.24	0.57						
77PR-SB039	X	X					0.59	5.85	0.53				0.56	0.26	0.61						
77PR-SB040	X	X			5.51	0.22	0.58	22.00	0.52				0.53	0.03	0.57						
77PR-SB041	X	X					0.60	2.03	0.55				0.50	0.12	0.54						
77PR-SB042	X						0.49	0.03	0.53												
77PR-SB043	X	X				0.12	0.54	1.05	1.81			0.12	0.50	0.64	0.62						
77PR-SB044	X	X			1.08	0.44	1.09	13.92	0.80		0.75	0.35	0.97	13.33	0.69						
77PR-SB045	X	X			1.00	0.91	1.13	19.17	0.67		0.42	0.62	0.80	7.98	0.59						
77PR-SB046	X	X			3.20	0.55	2.07	52.08	0.92		1.54	0.47	1.21	15.42	0.66						
77PR-SB047	X	X	X			0.30	0.63	5.58	0.48			0.18	0.40	0.44	0.41				0.03	0.00	0.01
77PR-SB048	X	X				0.08	0.73	1.33	0.59			0.10	0.79	1.35	0.92						
77PR-SB049	X					0.16	0.61	0.31	0.62												
77PR-SB050	X					1.13	0.72	3.80	1.95												
77PR-SB051	X					0.17	0.67	0.78	0.88												
77PR-SB052	X					0.13	0.48	0.14	0.58												
77PR-SB052	X					0.20	0.57	0.20	1.36												
77PR-SB053	X					0.14	0.67	0.56	0.72												
77PR-SB054	X					0.75	0.30	0.23	0.58												
77PR-SB055	X					0.21	0.52	0.60	0.83												
77PR-SB056	X					0.09	0.54	0.01	0.32												
77PR-SB057	X						1.25	0.01	0.66												
77PR-SB058	X						0.61	0.06	0.58												
77PR-SB059		X											0.70	1.39	0.70						
77PR-SB060		X										0.14	0.89	4.40	0.70						
77PR-SB061		X	X									0.09	0.58	4.13	0.71			0.16	0.01	0.00	0.01
77PR-SB062		X	X								1.19	0.29	1.68	28.92	0.92				0.04	0.32	0.01
77PR-SB063		X											1.54	0.65	0.71						
77PR-SB064		X									0.53	0.16	0.99	11.42	0.68						
77PR-SB065		X									2.13	0.08	0.90	48.08	0.65						
77PR-SB066		X											0.72	0.81	0.56						
77PR-SB067		X	X										0.59	2.85	0.55				0.03	0.03	0.01
77PR-SB068		X										0.14	0.78	2.02	0.64						
77PR-SB069		X	X								1.40	0.21	1.36	21.08	0.80				0.05		0.01
77PR-SB070		X										0.10	0.61	1.22	0.66						
77PR-SB071		X																			
77PR-SB071		X																			
77PR-SB072		X																			
77PR-SB073	X	X	X			0.16	0.49	5.22	0.77			0.18	0.52	4.73	0.81			0.13	0.03	0.19	0.01
77PR-SB074	X						0.64	1.98	0.57												
77PR-SB075	X						3.27	26.42	1.20												
77PR-SB076	X						0.64	0.67	0.60												
77PR-SB077	X																				

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG															
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77PR-SB078	X						0.56	0.72	0.62												
77PR-SB079	X				1.28	0.12	0.55	10.92	0.57												
77PR-SB080	X						0.52	0.98	0.57												
No 81 - Sediment																					
77PR-SB082	X	X	X			0.08	0.59	0.84	0.68				0.54		0.63				0.03		0.01
77PR-SB083	X	X	X			0.05	0.54	0.05	0.54				0.51		0.60				0.03		0.01
77PR-SB084	X	X	X		7.67	0.27	0.55	31.00	2.18				0.57	0.01	0.75				0.04	0.00	0.01
77PR-SB085	X	X	X			0.11	0.51	0.29	0.62				0.50	0.01	0.70				0.03		0.01
77PR-SB086	X	X	X			0.24	0.52	0.93	1.08				0.47	0.08	0.80				0.03		0.01
77PR-SB087	X	X	X			0.17	0.57	0.43	0.84				0.56		0.71				0.03	0.00	0.01
77PR-SB088	X	X	X			0.12	0.52	0.84	0.62				0.57	0.03	0.59				0.03		0.01
77PR-SB089	X	X	X			0.20	0.44	1.10	1.17				0.55	0.01	0.59				0.04	0.00	0.01
77PR-SB090	X	X	X				0.57	3.45	0.78				0.57		0.64				0.03		0.01
77PR-SB091	X	X	X				0.71	0.14	0.98				0.56	0.02	0.69				0.03		0.01
77PR-SB092	X	X	X			0.44	1.36	1.70	0.86				0.55	0.46	0.81				0.03	0.00	0.01
77PR-SB092	X	X	X				0.66	0.88	0.65				0.44	0.03	0.58				0.03		0.01
77PR-SB093	X	X	X				0.65	0.14	0.72				0.56	0.05	0.60				0.06	0.02	0.01
77PR-SB094	X	X	X				0.55		0.51			0.10	0.88	0.40	0.77				0.32	0.92	0.03
77PR-SB095	X	X	X			0.09	0.53	0.23	0.56				0.58	0.02	0.60				0.03		0.01
77PR-SB096	X						0.51	0.53	0.55												
77PR-SB097	X						0.53	1.01	0.54												
No 98 - Sediment																					
77PR-SB099	X						0.58	3.90	0.62												
77PR-SB100	X	X	X			0.48	0.50	0.31	0.64			0.11	0.48	0.03	0.53				0.03	0.00	0.01
No 101 - Sediment																					
77PR-SB102	X	X	X			0.28	0.42	0.16	0.57			0.11	0.64	0.02	0.58			0.09	0.06	0.10	0.02
Rifle Range Subarea																					
77RR-SB001	X				3.15	0.80	2.90	104.17	1.13												
77RR-SB002	X				3.79	0.64	37.14	123.33	6.55												
77RR-SB003	X				6.35	0.78	69.27	190.83	12.27												
77RR-SB004	X							79.63													
77RR-SB005	X							69.59													
77RR-SB006	X							72.31													
77RR-SB007	X					0.11	0.72	2.89	0.48												
77RR-SB007	X					0.11	1.18	3.36	0.63												
77RR-SB008	X					0.12	0.57	7.34	0.49												
77RR-SB009	X							30.97													
77RR-SB010	X							23.16													
77RR-SB011	X							38.16													
77RR-SB012	X							61.95													
77RR-SB012	X							68.11													
77RR-SB013	X							72.48													
77RR-SB014	X							54.04													
77RR-SB015	X				119.38	3.39	20.10	741.67	3.84												
77RR-SB016	X				2.36	0.22	63.54	73.50	11.89												
77RR-SB017	X							24.34													
77RR-SB018	X				12.16	1.12	31.04	288.33	4.74												

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	SS	SB1	SB2		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB019	X							53.34													
77RR-SB020	X							65.28													
77RR-SB021	X							56.78													
77RR-SB022	X							62.27													
77RR-SB023	X							21.58													
77RR-SB023	X							24.29													
77RR-SB024	X							51.51													
77RR-SB025	X							29.96													
77RR-SB026	X				1.32	0.12	1.93	47.58	0.83												
77RR-SB027	X							79.80													
77RR-SB028	X							71.77													
77RR-SB029	X				4.69	0.24	0.84	43.75	0.54												
77RR-SB030	X							29.00													
77RR-SB031	X																				
77RR-SB032	X																				
77RR-SB033	X																				
77RR-SB034	X																				
77RR-SB035	X																				
77RR-SB036	X																				
77RR-SB037	X																				
77RR-SB038	X																				
77RR-SB039	X																				
77RR-SB039	X																				
77RR-SB040	X																				
77RR-SB041	X																				
77RR-SB042	X																				
77RR-SB043	X							23.24													
77RR-SB044	X							61.01													
77RR-SB044	X							62.81													
77RR-SB045	X				3.40	0.44	2.48	73.12	1.07												
77RR-SB046	X				34.55	0.71	3.71	420.83	0.98												
77RR-SB047	X				4.30	0.39	6.41	74.25	1.29												
77RR-SB048	X				0.54	0.16	0.80	22.60	0.50												
77RR-SB049	X							114.07													
77RR-SB050	X				7.81	0.64	1.77	164.17	0.70												
77RR-SB051	X							67.18													
77RR-SB052	X				292.13	3.04	191.15	613.33	26.29												
77RR-SB053	X							37.04													
77RR-SB054	X				97.75	2.18		460.83													
77RR-SB054	X				82.87	2.36		435.00													
77RR-SB055	X				1828.65	5.35	4.99	983.33	1.24												
77RR-SB056	X				257.87	4.39	9.43	434.17	2.14												
77RR-SB057	X							121.38													
77RR-SB058		X										0.16	1.24	11.75	0.90						
77RR-SB059		X										0.08	0.55	6.19	0.64						
77RR-SB060		X										0.17	0.48	7.87	0.47						
77RR-SB061		X										0.17	0.37	1.74	0.42						

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	SS	SB1	SB2		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB062		X										0.22	0.18	1.63	0.18						
77RR-SB063		X									20.59	1.20	5.63	170.00	2.92						
77RR-SB064		X									27.16	1.02	3.64	223.33	1.36						
77RR-SB065		X											0.60	4.06	0.69						
77RR-SB065		X										0.13	0.64	6.02	0.66						
77RR-SB066		X									1.96	0.19	1.10	28.75	0.92						
77RR-SB067		X										0.09	0.52	11.00	0.62						
77RR-SB068		X									11.52	0.38	234.90	115.00	19.62						
77RR-SB069		X	X								14.72	0.44	4.55	105.00	1.37		0.02	0.07	0.02	0.42	0.01
77RR-SB069			X															0.05	0.03	0.40	0.01
77RR-SB070		X	X								3.17	0.22	1.12	22.25	0.68		0.95	0.38	0.13	22.58	0.02
77RR-SB071		X									13.01	0.40	4.04	28.92	1.33						
77RR-SB072		X	X								5.70	0.24	1.43	40.33	0.81		0.75	0.42	0.57	26.00	0.03
77RR-SB073		X	X								11.97	0.89	5.17	215.00	1.76				0.03	0.44	0.01
77RR-SB074		X	X								9.02		518.23	90.00	78.03		0.32	0.16	0.07	8.28	0.01
77RR-SB075		X	X								7.98	0.46	3.74	25.50	1.36		2.01	0.34	0.20	38.00	0.02
77RR-SB076		X									9.07	0.52	2.87	71.92	1.06						
77RR-SB077		X	X								11.46	0.39	6.35	134.17	1.72		1.30	0.56	0.34	43.50	0.03
77RR-SB078	X	X			2.06	0.25	0.80	12.17	0.66				0.58	0.64	0.77						
77RR-SB079	X	X			1.50	0.27	1.14	9.17	0.92			0.09	0.86	2.09	0.67						
77RR-SB080	X	X			3.54	2.48	0.82	37.33	1.95			0.22	0.63	2.21	1.92						
77RR-SB081	X	X			1.73	0.11	0.78	8.33	0.72		0.50	0.10	0.64	3.18	0.64						
77RR-SB082	X	X			0.43	0.24	0.72	4.55	1.02			0.29	1.56	4.54	1.07						
77RR-SB083	X	X	X		2.49	0.33	1.31	55.50	0.85		2.01	0.80	1.45	36.92	0.86			0.22	0.03	0.00	0.01
77RR-SB084	X	X			2.74	0.41	2.05	58.08	1.00		2.84	0.43	1.24	38.92	1.40						
77RR-SB085	X	X	X		3.15	0.61	1.86	70.00	1.14		2.32	0.50	1.28	37.08	0.70			0.15	0.04	0.07	0.01
77RR-SB086	X	X			2.75	0.56	2.76	71.92	1.18		5.22	0.79	1.97	112.50	1.04						
77RR-SB087	X	X	X		3.99	0.62	2.32	67.58	1.64		2.53	0.27	1.43	48.92	0.94			0.11	0.03	0.26	0.01
77RR-SB087	X				3.01	0.29	1.69	53.67	1.56												
77RR-SB088	X	X	X				0.41	0.98	0.58		0.68	0.13	0.51	6.40	0.60			0.10	0.00	0.00	0.01
77RR-SB089	X	X	X			0.08	0.45	3.07	0.57			0.14	0.72	4.04	0.75			0.13	0.04	1.17	0.01
77RR-SB090	X	X	X			0.14	0.43	2.73	0.92			0.12	0.49	0.30	0.52				0.03	0.00	0.01
77RR-SB091	X					0.09	0.50	0.98	0.53												
77RR-SB092	X					0.10	0.32	0.99	0.46												
77RR-SB093	X	X	X			0.27	1.06	5.44	0.95			0.09	0.48	1.21	0.89				0.02	0.00	0.01
77RR-SB094	X	X				0.12	0.79	13.42	0.87				0.79	3.19	0.65						
77RR-SB095	X						0.52	0.92	0.62												
77RR-SB096	X	X	X		0.59	0.15	0.68	7.64	0.69		0.29	0.15	0.62	4.16	0.61			0.10	0.03	0.57	0.01
77RR-SB097	X	X	X			0.13	0.43	2.55	0.52		59.55	1.32	40.89	801.67	9.47			0.09	0.04	0.87	0.01
77RR-SB098	X					0.12	0.41	1.25	1.02												
77RR-SB099	X	X	X				176.56	6.73	26.06			0.08	0.54	3.29	0.62			0.11	0.04	0.09	0.01
77RR-SB100	X	X			8.93	0.15	6.46	74.00	1.33				0.37	3.47	0.50						
77RR-SB101	X	X			7.84	0.14	0.87	18.67	0.71			0.09	0.73	7.60	0.62						
77RR-SB102	X	X				0.09	0.53	0.06	0.65												
77RR-SB103	X					0.10	0.46	2.08	0.78												
77RR-SB104	X	X					0.70	0.28	0.99												
77RR-SB105	X	X				0.11	0.56	0.22	0.87												

TABLE 1-51
Site UXO 1 (SWMU 77) Soil PRG Exceedances
Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	SS	SB1	SB2		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc		Antimony	Arsenic	Copper	Lead	Zinc
77RR-SB106	X	X				0.22	0.34	0.30	0.61												
77RR-SB106	X					0.23	0.58	0.24	0.46												
77RR-SB107		X																			
77RR-SB108		X																			
77RR-SB109		X																			
77RR-SB110		X																			
77RR-SB111		X																			
77RR-SB112		X																			
77RR-SB113	X				0.49	0.33	1.77	5.20	1.25												
77RR-SB114	X				1.87	0.11	1.18	7.36	0.68												
77RR-SB115	X					0.24	0.74	3.08	0.66												
77RR-SB116	X				9.41	0.28	0.77	85.83	0.64												
77RR-SB117	X																				
77RR-SB118	X																				
77RR-SB119	X	X	X		1.37	0.26	1.19	7.92	1.81		0.48	0.20	0.31	1.91	1.11			0.12	0.00	0.08	0.01
77RR-SB119		X	X								0.22	0.15	0.24	0.97	0.89			0.13	0.01	0.01	0.01
77RR-SB120	X	X	X		0.66	0.23	0.54	5.37	1.17			0.11	0.41	0.01	0.44			0.09	0.00	0.00	0.01
77RR-SB120	X				1.30	0.29	0.66	7.73	1.11												
77RR-SB121	X	X	X			0.16	0.42	0.42	0.47			0.08	0.48	0.16	0.52			0.09	0.03	0.07	0.01
77RR-SB122	X	X	X			0.10	0.50	0.13	0.49			0.16	0.19	0.02	0.59			0.09	0.04	0.05	0.05
77RR-SB123	X	X	X		2.63	0.33	1.42	33.00	1.52			0.16	0.07	0.46	0.86			0.14	0.00	0.00	0.02
77RR-SB124	X	X					0.90	5.28	0.68				0.52	0.59	0.45						
77RR-SB124	X	X					0.69	2.73	0.60				0.60	1.13	0.54						
77RR-SB125	X						0.52	0.46	0.48												
77RR-SB126	X						0.28	0.30	0.46												
77RR-SB127	X	X	X				0.71	8.42	0.62				0.64	6.37	0.49				0.04	1.84	0.01
77RR-SB128	X	X	X				0.54	0.43	0.47				0.43		0.44				0.03	0.06	0.01
77RR-SB129	X	X	X				0.60	0.27	0.53				0.53	0.03	0.48				0.03	0.02	0.01
77RR-SB130	X	X			2.92	0.15	89.06	41.58	14.09		1.17		1.47	17.42	0.83						
77RR-SB131	X	X	X				0.64	0.64	0.48				0.77	1.88	0.57				0.08	2.25	0.01
77RR-SB132	X	X					0.60	2.17	0.43				0.75	2.20	0.58						
77RR-SB133	X	X			1.80	0.20	1.81	35.17	0.96		2.21		713.54	37.67	106.82						
77RR-SB134	X	X					0.65	4.04	0.55		2.73		0.34	8.42	0.32						
77RR-SB135	X	X	X				0.50	0.69	0.56				0.57	0.42	0.58				0.03	0.04	0.01
77RR-SB136	X	X	X				0.56	0.67	0.51			0.09	0.58	3.92	0.53			0.09	0.04	1.19	0.01
77RR-SB136	X	X	X			0.09	0.61	5.77	0.55			0.08	0.59	3.28	0.54			0.10	0.03	0.51	0.01
77RR-SB137	X	X					0.55	14.75	0.66				0.50	1.74	0.57						
77RR-SB138	X	X				0.16	0.66	2.91	0.63			0.12	0.64	1.90	0.58						
77RR-SB139	X	X				0.14	0.56	1.41	0.66			0.12	0.65	2.90	0.64						
77RR-SB140	X						0.41	1.14	0.64												
77RR-SB141	X	X					0.50	2.41	0.58			0.08	0.53	5.12	0.58						
77RR-SB142	X	X				0.10	0.57	3.80	0.80				0.53	1.63	0.60						
77RR-SB143	X	X	X				0.46	0.16	0.61				0.42	0.32	0.57			0.09	0.03	0.01	0.01
77RR-SB144	X	X				0.15	0.43	2.87	0.65			0.13	0.25	1.66	0.50						
77RR-SB145	X	X				0.12	0.13	0.54	0.60			0.10	0.10	0.39	0.52						
77RR-SB146	X	X	X			0.14	0.66	2.43	0.67			0.11	0.54	0.91	0.59		0.03	0.13	0.03	0.66	0.01
77RR-SB147	X	X	X		0.55	0.16	0.82	6.85	0.72			0.10	0.55	0.46	0.51			0.13	0.04	0.36	0.01

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	3.56	11.3	192	120	132	*PRG:*	3.56	11.3	192	120	132	*PRG:*	31.0	11.3	3,100	400	7,700
					Surface (0-0.5 ft)						Subsurface (0.5-2 ft)						Subsurface (2-3 ft)				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77RR-SB148	X	X	X		1.48	0.29	0.83	18.08	0.68			0.10	0.45	1.50	0.48			0.10	0.03	0.15	0.01
77RR-SB149	X	X	X		0.40	0.18	0.28	2.76	0.69			0.11	0.09	0.66	0.50			0.11	0.00	0.03	0.01
77RR-SB150	X	X	X		0.63	0.17	0.22	2.82	0.73			0.13	0.55	1.08	0.71		0.02	0.23	0.03	0.55	0.01
77RR-SB151	X	X	X			0.10	0.02	0.10	0.43			0.10	0.01	0.03	0.49			0.10	0.00	0.00	0.01
77RR-SB152	X	X	X			0.16	0.00	0.01	0.86			0.11	0.00	0.01	0.77			0.08	0.00	0.00	0.01
77RR-SB153	X	X	X			0.10	0.04	0.08	0.64			0.09	0.02	0.01	0.60			0.08	0.00	0.00	0.00
77RR-SB154	X	X	X			0.11	0.45	0.06	0.71			0.14	0.11	0.01	0.23			0.10	0.00	0.00	0.01
77RR-SB155	X	X				0.21	0.53	0.67	0.98				0.69	0.50	1.18						
77RR-SB156	X	X	X				0.45	0.04	0.77				0.12		0.69				0.00		0.01
77RR-SB157	X	X	X			0.14	0.55	0.34	0.58				0.54	0.06	0.79			0.09	0.01	0.01	0.01
77RR-SB158	X	X	X				0.56	1.18	0.66			0.08	0.19	0.05	0.35			0.08	0.01	0.01	0.01
77RR-SB159	X	X	X				0.50	0.52	0.44				0.63	0.03	0.56				0.02		0.01
77RR-SB160	X	X	X			0.12	0.19	1.41	0.62			0.10	0.06	0.02	0.66			0.08	0.00	0.00	0.01
77RR-SB161	X	X	X			0.08	0.51	0.43	0.59			0.05	0.20	0.01	0.60			0.10	0.01	0.00	0.01
77RR-SB162	X	X	X			0.08	0.48	0.11	0.50			0.16	0.51	0.02	0.55			0.10	0.04	0.00	0.01
77RR-SB163	X	X	X			0.14	0.63	0.01	0.60			0.08	0.45	0.01	0.47			0.14	0.04	0.00	0.01
77RR-SB164	X	X	X			0.13	0.48	0.88	0.77			0.10	0.49	0.10	0.67			0.10	0.03	0.00	0.01
77RR-SB165	X	X				0.11	0.57	2.65	0.70			0.11	0.66	1.49	0.68						
77RR-SB166	X	X				0.05	0.41	0.56	0.53				0.27	0.00	0.44						
77RR-SB167	X					0.13	0.88	2.82	0.80												

TABLE 1-51

Site UXO 1 (SWMU 77) Soil PRG Exceedances

Naval Activity Puerto Rico, Ceiba, Puerto Rico

				Ratio of Soil Concentration to PRG																
				PRG:	**3.56**	**11.3**	**192**	**120**	**132**	***PRG:***	**3.56**	**11.3**	**192**	**120**	**132**	***PRG:***	**31.0**	**11.3**	**3,100**	**400**	**7,700**
					Surface (0-0.5 ft)						**Subsurface (0.5-2 ft)**						**Subsurface (2-3 ft)**				
Location	**SS**	**SB1**	**SB2**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**		**Antimony**	**Arsenic**	**Copper**	**Lead**	**Zinc**
77RR-SB168	X	X				0.11	0.51	0.55	0.55				0.50	0.23	0.53						

Gray shaded location IDs indicate field duplicates

Gray shaded concentrations indicate detections

NA - Not Analyzed

Ratio to PRG 1 - 2

Ratio to PRG >2 - 5

Ratio to PRG >5

TABLE 1-52

Site UXO 1 (SWMU 77) Laboratory Confirmation Samples (Floor)

Naval Activity Puerto Rico, Ceiba, Puerto Rico

Area	Subarea	Perimeter, ft	Area, sq ft	Potential Samples	Proposed Samples
1A	Pistol Range	677	18,249	7	7
1B	Pistol Range	64.5	290	0	1
	Total:	742	18,539	7	8
2A	Rifle Range	1,253	77,617	31	31
3A	Former Pistol Range	501	14,031	6	6
3B	Former Pistol Range	73.8	418	0	1
	Total:	575	14,449	6	7
	Subtotal:				46
			Plus 30% contingency		**60**

Figures

VICINITY MAP

LEGEND

- Soil Sample Location
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 1-1
Soil Sampling Locations
Detonation Area near Concrete Pad Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-1_SWMU77_RISKEVALUATION_SUBAREA_DETONATION.MXD JCARR 9/4/2013 3:54:09 PM

CH2MHILL.

VICINITY MAP

LEGEND

- Soil Sample Location
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

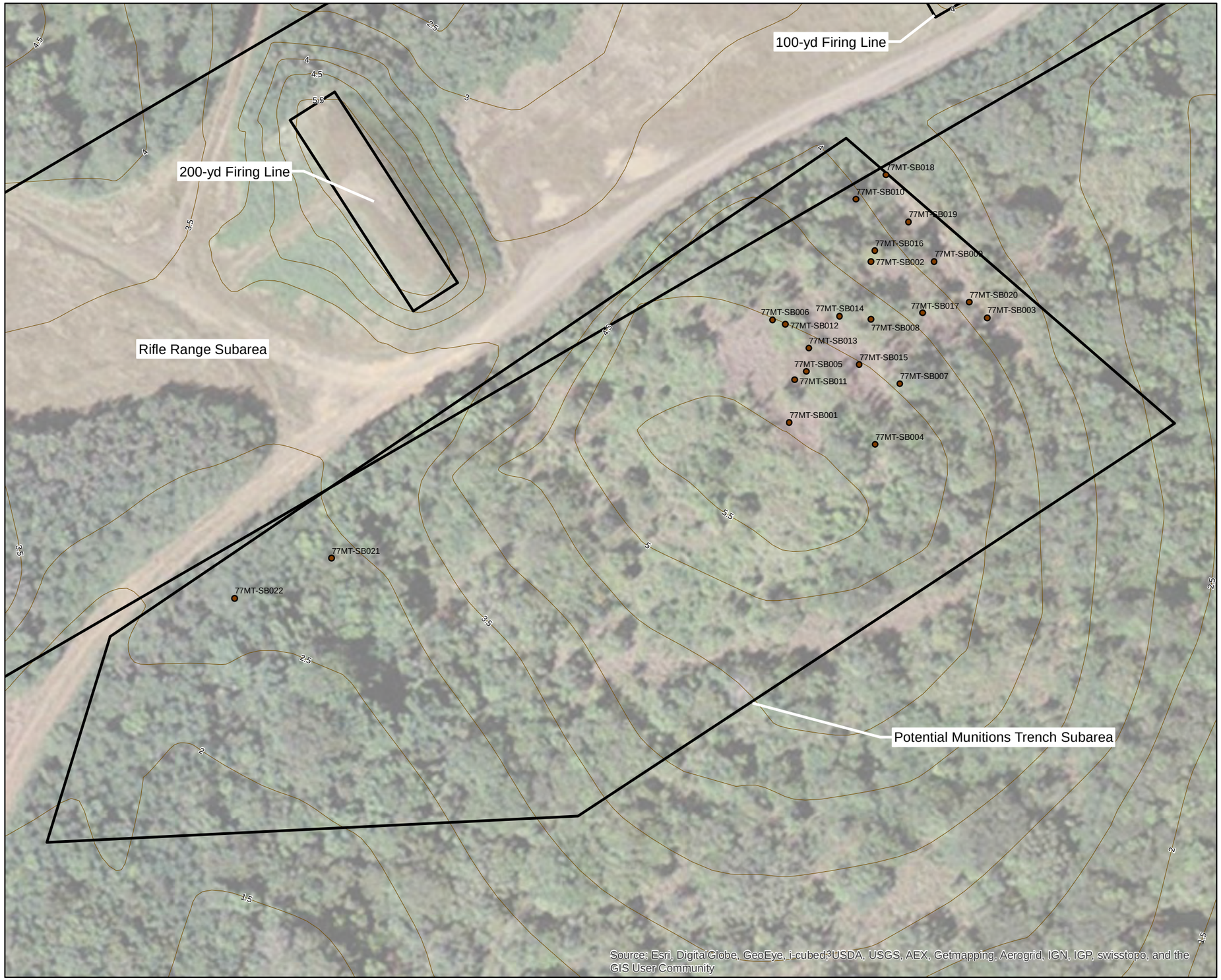
N

0 15 30 60
Feet

FIGURE 1-2
Soil Sampling Locations
Former Pistol Range Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-2_SWMU77_RISKEVALUATION_SUBAREA_FORMERPISTOLRANGE.MXD JCARR 9/4/2013 3:55:43 PM



VICINITY MAP

LEGEND

- Soil Sample Location
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 30 60 120
Feet

FIGURE 1-3
Soil Sampling Locations
Potential Munitions Trench Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-3_SWMU77_RISKEVALUATION_SUBAREA_MUNITIONSTRENCH.MXD JCARR 9/4/2013 3:58:35 PM

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

VICINITY MAP

LEGEND

- Soil Sample Location
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

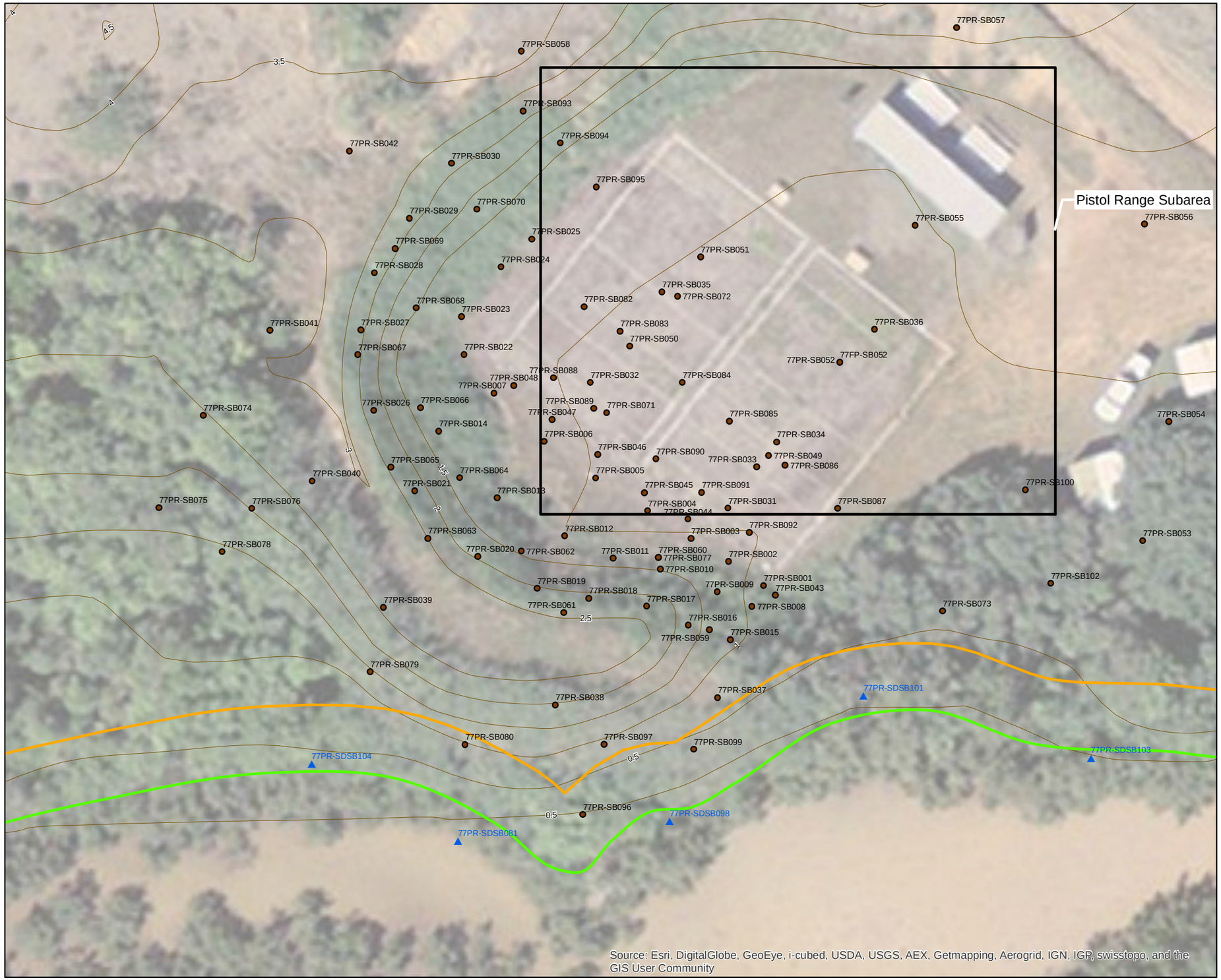
N

0 15 30 60
Feet

FIGURE 1-4
Soil Sampling Location
Potential OB/OD Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-4_SWMU77_RISKEVALUATION_SUBAREA_OBOD.MXD JCARR 9/4/2013 3:59:36 PM



VICINITY MAP

LEGEND

- Soil Sample Location
- Sediment Sample from Mangrove Wetland
- Approximate Mangrove Lagoon Boundary
- Disturbance Limit with Engineering Controls
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 1-5
Soil and Sediment Sampling Locations
Pistol Range Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-5_SWMU77_RISKEVALUATION_SUBAREA_PISTOLRANGE.MXD JCARR 9/4/2013 4:02:04 PM

VICINITY MAP

LEGEND

- Soil Sample Location
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. All sample locations have a prefix of "77RR-" which is not shown to improve readability of the figure.

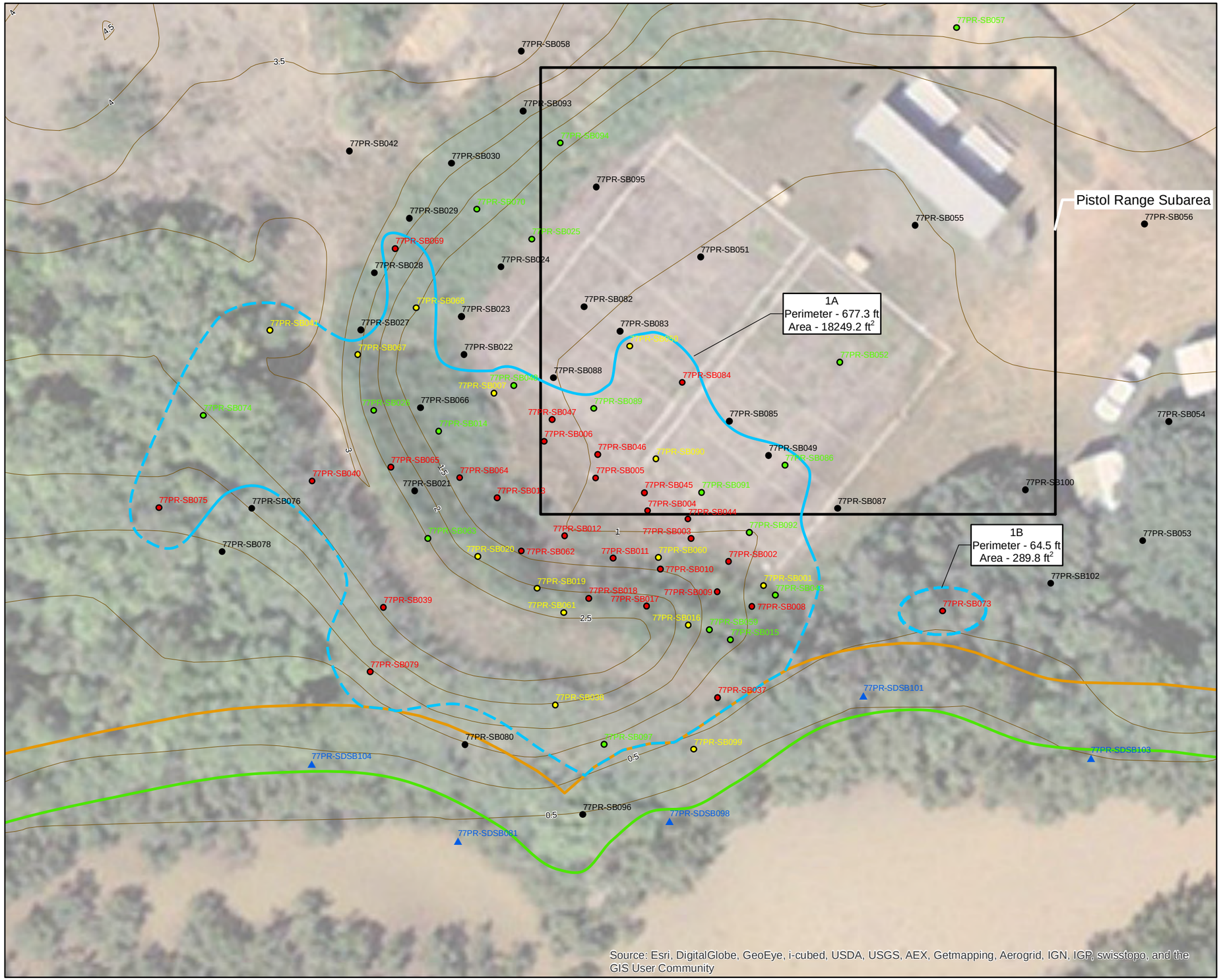
N

0 25 50 100
Feet

FIGURE 1-6
Soil Sampling Locations
Rifle Range Subarea
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-6_SWMU77_RISKEVALUATION_SUBAREA_RIFLERANGE.MXD JCARR 9/4/2013 4:04:46 PM



Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

VICINITY MAP

LEGEND

- Sediment Samples from Mangrove Wetland

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Approximate Mangrove Lagoon Boundary
- Disturbance Limit with Engineering Controls
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 1-7
Pistol Range Subarea
Risk Evaluation 0-2 ft depth
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-7_SWMU77_RISKEVALUATION_SUBAREA_PISTOLRANGE_METALSONLY.MXD JCARR 9/19/2013 3:10:12 PM

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VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. All sample locations have a prefix of "77RR-" which is not shown to improve readability of the figure.

N

0 25 50 100
Feet

FIGURE 1-8
Rifle Range Subarea
Risk Evaluation 0-2 ft depth
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-8_SWMU77_RISKEVALUATION_SUBAREA_RIFLERANGE_METALSONLY.MXD JCARR 9/19/2013 3:11:22 PM

VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 1-9
Former Pistol Range Subarea
Risk Evaluation 0-2 ft depth
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-9_SWMU77_RISKEVALUATION_SUBAREA_FORMERPISTOLRANGE_METALSONLY.MXD JCARR 9/19/2013 3:12:24 PM

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VICINITY MAP

LEGEND

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service
2. All sample locations have a prefix of "77RR-" which is not shown to improve readability of the figure.

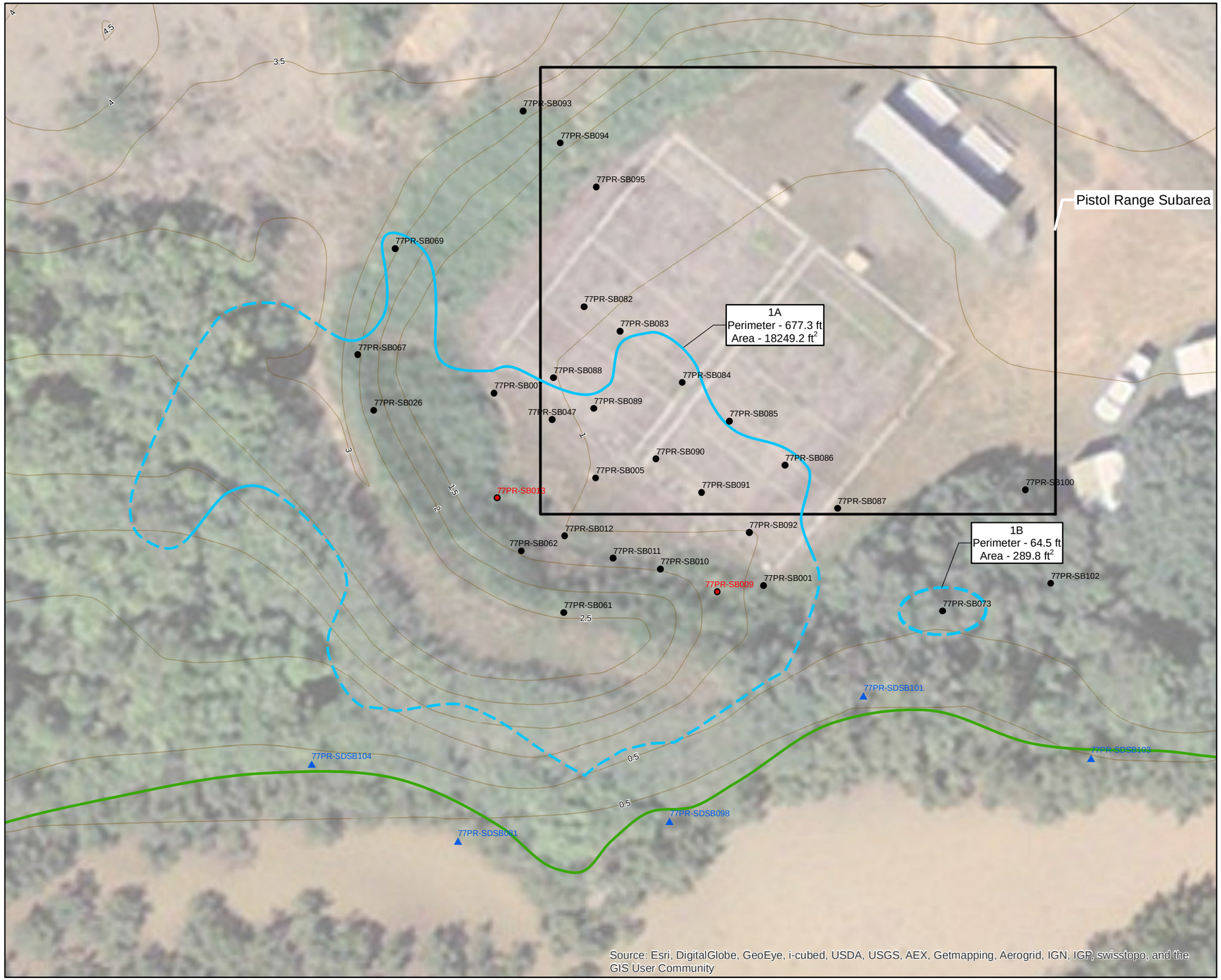
N

0 25 50 100
Feet

FIGURE 1-10
Rifle Range Subarea
Risk Evaluation GT 2 ft depth
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-10_SWMU77_RISKEVALUATION_SUBAREA_RIFLERANGE_METALSONLY.MXD JCARR 9/19/2013 3:13:50 PM

CH2MHILL



VICINITY MAP

LEGEND

- Sediment Samples from Mangrove Wetland

Data comparison of constituents of concern against the PRGs

- Ratio <1
- Ratio 1-2
- Ratio 2-5
- Ratio >5

Removal Area Boundary

- Actual
- Inferred
- Approximate mangrove lagoon boundary
- Topographic Contour (elevation in meters)
- Subarea Boundary
- Site UXO 1 (SWMU 77) Boundary

Notes:
1. Imagery 2010 - ArcMap Streaming Map Service

N

0 15 30 60
Feet

FIGURE 1-11
Pistol Range Subarea
Risk Evaluation GT 2 ft depth
Site UXO 1 (SWMU 77)
Naval Activity Puerto Rico
Ceiba, Puerto Rico

CH2MHILL

R:\USNAVYPUERTORICO20000317\MAPFILES\SWMU_77\RISKASSESSMENT\FIGURE1-11_SWMU77_RISKEVALUATION_SUBAREA_PISTOLRANGE_METALSONLY.MXD JCARR 9/19/2013 3:23:50 PM

Attachment 2
Field SOPs

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

The purpose of this SOP is to provide information on chain-of-custody procedures to be used under the CLEAN Program.

II Scope

This procedure describes the steps necessary for transferring samples through the use of Chain-of-Custody Records. A Chain-of-Custody Record is required, without exception, for the tracking and recording of samples collected for on-site or off-site analysis (chemical or geotechnical) during program activities (except wellhead samples taken for measurement of field parameters). Use of the Chain-of-Custody Record Form creates an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis. This procedure identifies the necessary custody records and describes their completion. This procedure does not take precedence over region specific or site-specific requirements for chain-of-custody.

III Definitions

Chain-of-Custody Record Form - A Chain-of-Custody Record Form is a printed two-part form that accompanies a sample or group of samples as custody of the sample(s) is transferred from one custodian to another custodian. One copy of the form must be retained in the project file.

Custodian - The person responsible for the custody of samples at a particular time, until custody is transferred to another person (and so documented), who then becomes custodian. A sample is under one's custody if:

- It is in one's actual possession.
- It is in one's view, after being in one's physical possession.
- It was in one's physical possession and then he/she locked it up to prevent tampering.
- It is in a designated and identified secure area.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the point and time that it was collected.

IV. Procedures

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is valid. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom, as well as providing security for the evidence as it is moved and/or passed from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain-of-possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

Sample Identification

The method of identification of a sample depends on the type of measurement or analysis performed. When *in situ* measurements are made, the data are recorded directly in bound logbooks or other field data records with identifying information.

Information which shall be recorded in the field logbook, when in-situ measurements or samples for laboratory analysis are collected, includes:

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

Sample Label

Samples, other than for *in situ* measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling and Analysis Plan. Each sample container is identified by a sample label (see Attachment A). Sample labels are provided, along with sample containers, by the analytical laboratory. The information recorded on the sample label includes:

- Project - CTO Number.

- Station Location - The unique sample number identifying this sample.

- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 08/21/12).

- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

Using only the work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing the analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site). The field team should always follow the sample ID system prepared by the project EIS and reviewed by the Project Manager.

Chain-of-Custody Procedures

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed.

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.

- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include ***only*** the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify sample

locations in photographs, an easily read sign with the appropriate sample location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. **A Chain-of-Custody Record Form must be completed for each cooler and should include only the samples contained within that cooler**. A Chain-of-Custody Record Form example is shown in Attachment B. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as given below:

- Enter header information (CTO number, samplers, and project name).
- Enter sample specific information (sample number, media, sample analysis required and analytical method grab or composite, number and type of sample containers, and date/time sample was collected).
- Sign, date, and enter the time under "Relinquished by" entry.
- Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (i.e., Federal Express).
- If a carrier is used, enter the airbill number under "Remarks," in the bottom right corner;
- Place the original (top, signed copy) of the Chain-of-Custody Record Form in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date the custody seal, a 1-inch by 3-inch white paper label with black lettering and an adhesive backing. Attachment C is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals shall be provided by the analytical laboratory.
- Place the seal across the shipping container opening (front and back) so that it would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

The custody record is completed using waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as custody forms are sealed inside the shipping container and the custody seals are intact, commercial carriers are not required to sign the custody form.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

V Quality Assurance Records

Once samples have been packaged and shipped, the Chain-of-Custody copy and airbill receipt become part of the quality assurance record.

VI Attachments

A. Sample Label
B. Chain of Custody Form
C. Custody Seal

VII References

USEPA. *User's Guide to the Contract Laboratory Program*. Office of Emergency and Remedial Response, Washington, D.C. (EPA/540/P-91/002), January 1991.

Attachment A
Example Sample Label

COC.doc

Quality Analytical Laboratories, Inc.
2567 Fairlane Drive
Montgomery, Alabama 36116
PH. (334)271-2440

Client _____
Sample No. _____
Location _____
_____
Analysis _____
_____
Preservative HCL
Date _____ By _____

CEIMIC
CORPORATION
10 Dean Knauss Drive, Narragansett, R.I. 02882 • (401) 782-8900

SITE NAME	DATE
ANALYSIS	TIME
	PRESERVATIVE

SAMPLE TYPE

☐ Grab ☐ Composite ☐ Other _____

COLLECTED BY:

Attachment B
Example Chain-of-Custody Record

COC.doc

CH2M HILL
APPLIED SCIENCES LABORATORY

CHAIN OF CUSTODY RECORD AND AGREEMENT TO PERFORM SERVICES

CH2M Hill Project #

Purchase Order #

Project Name

Company Name CH2M HILL Office

Project Manager & Phone #
Mr. [ ]
Ms. [ ]
Dr. [ ]

Report Copy to:

Requested Completion Date:

Sampling Requirements: SDWA ☐ NPDES ☐ RCRA ☐ OTHER ____

Sample Disposal: Dispose ☐ Return ☐

Sampling Date	Sampling Time	Type COMP	Type GRAB	Matrix WATER	Matrix SOIL	Matrix AIR	CLIENT SAMPLE ID (9 CHARACTERS)	# OF CONTAINERS	LAB TEST CODES	ANALYSES REQUESTED	REMARKS	LAB 1 ID	LAB 2 ID

SHADED AREA– FOR LAB USE ONLY

Lab 1 #	Lab 2 #
Quote #	Kit Request #
Project #	
No. of Samples	Page of
Login	LIMS Ver

Sampled By & Title (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Relinquished By (Please sign and print name) Date/Time
Received By (Please sign and print name)	Date/Time	Shipped Via UPS BUS Fed-Ex Hand Other ____ Shipping #
Work Authorized By (Please sign and print name)	Remarks	

QC Level: 1 2 3 Other: ____

COC Rec	ICE
Ana Req	TEMP
Cust Seal	Ph

Instructions and Agreement Provisions on Reverse Side

DISTRIBUTION: Original - LAB, Yellow - LAB, Pink - Client

REV 3/94 FORM 340

Attachment C
Example Custody Seal

CRM HILL

CUSTODY SEAL

Date _____ _____

Signature _____ _____

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® (or Alconox®) and water solution
- Concentrated (V/V) pesticide grade isopropanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.

2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.

3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.

4. Remove respirator (if worn).

5. Remove inner gloves and discard.

6. At the end of the work day, shower entire body, including hair, either at the work site or at home.

7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.

2. Spread plastic on the ground to keep equipment from touching the ground

3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.

4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.

5. Rinse with 1 gallon of 10% isopropanol solution pumped through the pump. (DO NOT USE ACETONE). (Optional)

6. Rinse with 1 gallon of tap water.

7. Rinse with 1 gallon of deionized water.

8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.

9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.

10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in either DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and isopropanol solution (DO NOT USE ACETONE). (Optional)
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums or with solid waste in garbage bags, dependent on Facility/project requirements.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, methanol (optional), and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

This SOP describes the procedures used to dispose of hazardous fluid and solid materials generated as a result of the site operations. This SOP does not provide guidance on the details of Department of Transportation regulations pertaining to the transport of hazardous wastes; the appropriate Code of Federal Regulations (49 CFR 171 through 177) should be referenced. Also, the site investigation-derived waste management plan should be consulted for additional information and should take precedence over this SOP.

II. Equipment and Materials

A. Fluids

- DOT-approved 55-gallon steel drums or Baker® Tanks
- Tools for securing drum lids
- Funnel for transferring liquid into drum
- Labels
- Paint Pens
- Marking pen for appropriate labels
- Seals for 55-gallon steel drums

B. Solids

- DOT-approved 55-gallon steel drums or rolloffs
- Tools for securing drum lids
- Paint Pens
- Plastic sheets
- Labels
- Marking pen for appropriate labels

III. Procedures and Guidelines

A. Methodology

Clean, empty drums or rolloffs or Baker® Tanks will be brought to the site by the drilling subcontractor for soil and groundwater collection and storage. The empty drums will be located at the field staging area and moved to drilling locations as required. The drums will be filled with the drilling and well installation wastes, capped, sealed, and moved to the onsite drum storage area by the drilling subcontractor. The full drums will separate types of wastes by media. The drums will

be labeled as they are filled in the field and labels indicating that the contents are pending analysis affixed.

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. The drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. The analysis will be used to determine if drilling wastes are covered by land disposal restrictions.

If rolloffs are used, compositing and sampling of soil will comply with applicable state and federal regulations.

B. Labels

Drums and other containers used for storing wastes from drilling operations will be labeled when accumulation in the container begins. Labels will include the following minimum information:

- Container number
- Container contents
- Origin (source area including individuals wells, piezometers, and soil borings)
- Date that accumulation began
- Date that accumulation ended
- Generator Contact Information
- When laboratory results are received, drum labels will be completed or revised to indicate the hazardous waste constituents in compliance with Title 40 of the Code of Federal Regulations, Part 262, Subpart C if the results indicate hazardous waste or labeled as non-hazardous if applicable.

C. Fluids

Drilling fluids generated during soil boring and groundwater discharged during development and purging of the monitoring wells will be collected in 55-gallon, closed-top drums. When a drum is filled, the bung will be secured tightly. Fluids may also be transferred to Baker® Tanks after being temporarily contained in drums to minimize the amount of drums used.

When development and purging is completed, the water will be tested for appropriate hazardous waste constituents. Compositing and sampling of fluids will comply with applicable state and federal regulations.

D. Solids

The soil cuttings from well and boring drilling will constitute a large portion of the solids to be disposed of.

The solid waste stream also will include plastic sheeting used for decontamination pads, Tyveks, disposable sampling materials, and any other disposable material used during the field operations that appears to be contaminated. These materials will be placed in designated drums.

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on pallets on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills.

Waste solid materials that contain hazardous constituents will be disposed of at an offsite location in a manner consistent with applicable solid waste, hazardous waste, and water quality regulations. Transport and disposal will be performed by a commercial firm under subcontract.

The liquid wastes meeting acceptable levels of discharge contamination may be disposed of through the sanitary sewer system at the site. However, prior to disposal to the sanitary sewer system, approval and contract arrangements will be made with the appropriate authorities. Wastes exceeding acceptable levels for disposal through the sanitary sewer system will be disposed of through contract with a commercial transport and disposal firm.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

STANDARD OPERATING PROCEDURE

Global Positioning System

I. Purpose

The procedure describes the calibration, operation, and functions associated with a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. GPS signal information is differentially corrected to sub-meter accuracy on a continual basis using a second satellite signal broadcast from OmniSTAR satellite subscription service. The procedure applies to all field data collection activities.

II. Scope

This procedure provides information regarding the field operation and general maintenance of a Trimble® Pro XRS GPS Unit with a TSC-1 Asset Surveyor for datalogging. The information contained herein presents the operation procedures for this equipment. Review of the equipment's instruction manual is a necessity for more detailed descriptions pertaining to the operation and maintenance of the equipment.

III. Definitions

GPS: Global Positioning System - A system of 24 satellites developed and operated by the US DOD. Continuous 3D coordinate information is broadcast free of charge on a worldwide basis enabling precise positional location. Three standard categories of positional accuracy are generally used:

1. Uncorrected Signal - accuracy +/-10 meters - a single satellite transmission is used
2. Differentially Corrected Signal - accuracy +/- <1 meter - additional positional transmissions are recorded simultaneously and used to triangulate coordinate position.
3. Carrier Phase Signal- accuracy +/- <1 centimeter - requires a second receiver and additional software. Both receivers need to be equipped to receive Carrier Phase signals.

IV. Procedures and Guidelines

The procedure for calibration, operation, and maintenance of the GPS unit is outlined below. Daily calibration and battery recharging is typical operating procedure; frequencies other than daily shall be noted in the logbook and reason for increased frequency recorded. If using a different instrument, the operation manual supplied by the manufacturer should be consulted for instructions.

The procedures described below include additional features pre-programmed into the GPS datalogger to aid the data collection process.

A. Calibration

1. Check to ensure that the datalogger and antenna cables are properly connected to the receiver and that the batteries are securely connected.
2. Turn the datalogger unit on by pressing the green **On** key in the bottom left corner. The datalogger will perform a self-calibration. Wait to ensure that the antenna is receiving a sufficient number of satellite signals (usually a minimum of 3).
3. Once the datalogger receives a satellite signal then it is ready for operation.

B. Operations for surveying coordinates of a location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Field data may be immediately recorded in the datalogger.
3. The first screen view is the 'Main Menu'. Use the round keypad to select 'Data Collection' and press the **Enter** key.
4. Use the round keypad to select either 'Create new file' or 'Open existing file' and press the **Enter** key. It is not necessary to create a new file at each new location; however, it may be useful to create a new file at the beginning of each day.
5. If a new file is created then the GPS unit will automatically assign it a file name. The file name may be changed if desired. Press the enter key after the file name is assigned. If opening an existing file then use the round keypad to scroll through existing file names.
6. The next screen is 'Antenna options'. Press the **Enter** key to move to the next screen.
7. Select the type of activity to be performed. At the beginning of each day 'Sample Site Detail' should be completed. This allows the operator to enter each field team member, weather, objectives, health and safety meetings, etc. Once the 'Sample Site Detail' is completed then data entry activities may begin including well purging, water level elevations, and sample collection
8. The datalogger prompts the operator when a data field is required and by using the round key pad, numeric, alphanumeric, enter, and escape keys, the operator can perform electronic data capture on the GPS datalogger.
9. Once all information pertaining to an individual site has been recorded, press enter to complete data entry. If GPS signal is obstructed (tree canopy, building height, etc) user may choose to remain in same location until satellite transmission clears the obstruction. This usually takes only a few moments. Data may still be captured and recorded electronically even if GPS signal is insufficient for positioning.
10. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.
11. All data from the datalogger should be downloaded into Trimble Pathfinder Office software on a PC a minimum of once daily. It is recommended that data is downloaded twice daily. Data may be viewed and mapped using Pathfinder Office or exported to

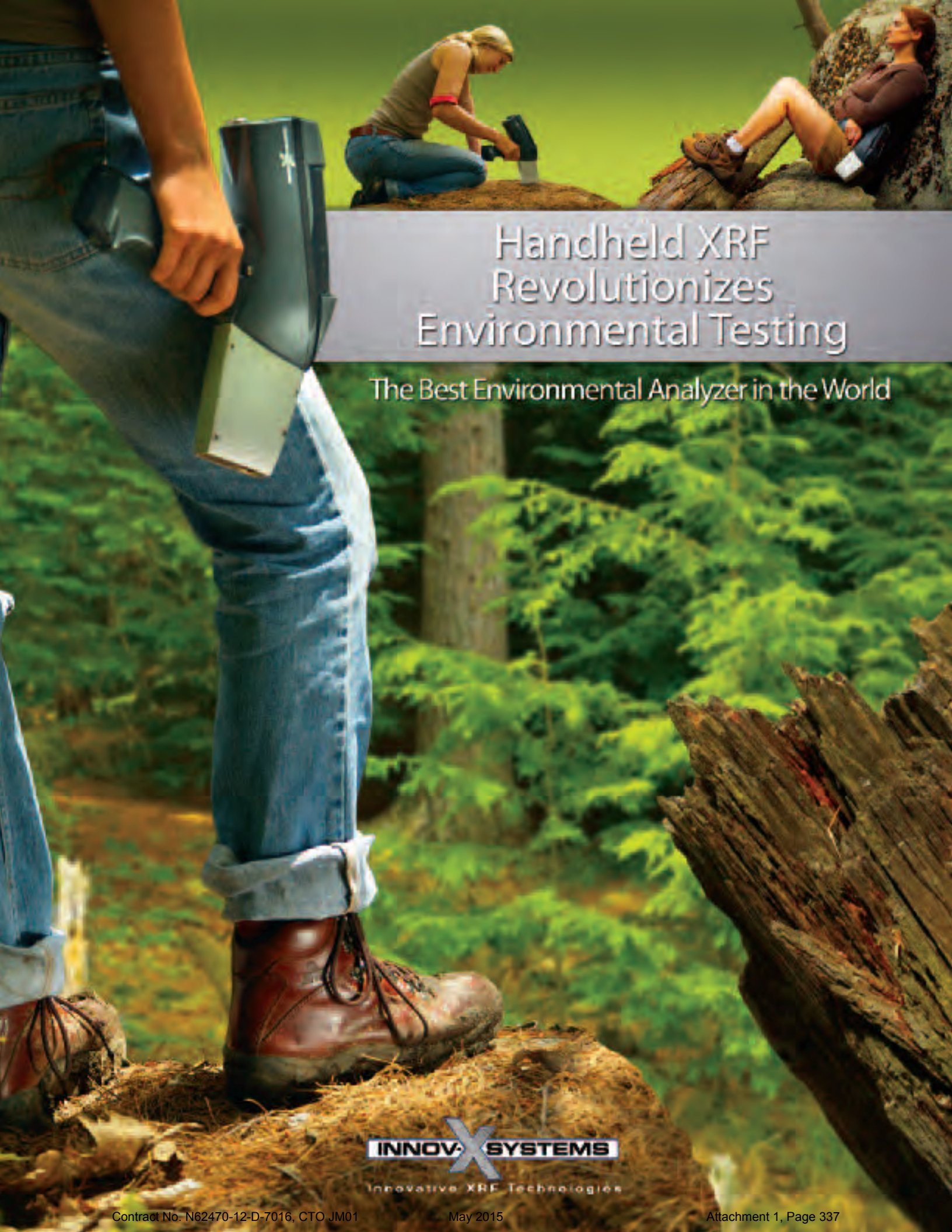
other software. Export file formats support standard ASCII text, generic database .dbf and most GIS and CAD software.

C. Operations for locating a point using coordinates/reacquiring a previously surveyed location

1. The datalogger and GPS receiver are ready for use after the initial self-calibration.
2. Use the Trimble Pathfinder software to load the data file containing the coordinates for each desired location ("programmed location").
3. The first screen view is the 'Main Menu'. Use the keypad to select 'Navigation' and press the **Enter** key.
4. Use the round keypad to select 'Open existing file' to open the file loaded in Step 2 above.
5. Select the location to be reacquired from the screen and press the enter key.
6. A circle with an arrow will appear. As you begin walking, the arrow will point in the direction of the programmed location. Walk in the direction indicated by the arrow.
7. Once you are within 10-feet of the location being reacquired, the GPS unit will display a circle (representing the programmed location) and an "X" (representing the GPS unit). Continue to walk in the direction of the circle until the "X" is centered in the circle. Once the "X" is centered, you are standing at the programmed location.
8. To shut down, press the **Escape** key to return to the 'Main Menu'. The unit can be turned off by pressing the green key in the left hand corner. The datalogger should only be turned off when the 'Main Menu' screen is displayed.

D. Preventive Maintenance

The antenna and datalogger are weatherproof. It is recommended that the receiver remain in the provided backpack carrier. Care should be taken not to crease, pinch or bend the antenna cable. Data should be downloaded from the datalogger a minimum of once daily, twice daily is preferred. At the end of each day the receiver batteries should be recharged. For technical assistance call the rental company through which you acquired the Trimble® unit. Guidance is also provided in the manual and at http://www.trimble.com.


Handheld XRF
Revolutionizes
Environmental Testing
The Best Environmental Analyzer in the World
INNOV-X SYSTEMS
Innovative XRF Technologies

Environmental Testing Explore the World and Beyond

The advent of Innov-X Portable XRF analyzers has completely revolutionized environmental testing. Site sampling need no longer be a limiting factor in a comprehensive site investigation. In the past, studies relied exclusively on expensive and time consuming laboratory analysis based on samples they hoped fully characterized the site.

Portable XRF liberates and empowers environmental studies. While you're at the site, you can check the composition of soils, debris, run off streams, dust wipes, coatings, corings, paints, plastic and wood. This means you won't lose precious time collecting non-representative samples and running up unnecessary lab costs.

Environmental studies can now save time and money with real-time, on-the-spot elemental analysis - from Magnesium to Uranium, from PPM to 100% - in solids, liquids, powders, cores, fragments, filters & films, slurries and more.

Portable XRF provides cost-effective, timely analysis. One simple test can analyze up to 25 separate elements in seconds, including priority pollutants. Portable XRF analyzers help you determine zonal and contamination patterns; track pollutant migration caused by extreme weather; perform real-time surveys to delineate and define metals present; essentially, help you evaluate data at the site for a rapid, comprehensive site investigation while you're there.

Classic PDA-based XRF

Innov-X Handheld XRF with removable PDA
World's first and still most portable tube-based handheld XRF

The Ultimate in Customer Choice

Innov-X customers choose the ideal environmental analyzer for their needs: The classic PDA-based model in a field-proven, rugged package. It offers the convenience of a removable PDA, instant data syncing to your computer, and all the features of an off-the-shelf device. Or do you need the ultra-rugged, sealed model with totally internal electronics? No PDA, just a tough, easy-to-use environmental analyzer with good ergonomic touch.

You can inexpensively convert PDA to Ultra-Rugged and vice versa anytime after purchase if you change your mind.
Innov-X offers the most upgrade-able, flexible handheld XRF package available.

Ergonomic superiority

- The lightest weight, smallest, and best-balanced handheld XRF
- Bright, color display that is easy to read in any lighting conditions - even direct sunlight
- Touch trigger. No uncomfortable triggers to squeeze and hold. Comfortable "deadman" trigger also
- Dual display: Angled front display plus rear display for easy viewing of test results

Feature	Removable PDA-Driven Controller	Integrated, Sealed Controller
Sealed to Moisture and Dust		✓
Use PDA display and user interface?	✓	
Removable PDA	✓	
Operator can use Multiple PDAs	✓	
Color Touchscreen	✓	✓

Introducing the Latest in Environmental Field Analysis Technology

NEW

Ultra Rugged Weatherproof

Innov-X Handheld XRF with fully integrated, sealed controller

Heavy-duty, ultra-ruggedized handheld XRF with industrial-grade touchscreen

Take it to the field … where it really counts

Since its inception, Innov-X Systems pioneered a new approach to handheld environmental analysis. We delivered the world's first handheld x-ray fluorescence (XRF) analyzer using miniature x-ray tube technology – a system totally free of radioactive isotopes. And it was engineered around PDA technology to provide a worldwide standard operating system and microelectronics. It used a revolutionary 6-position filter wheel yielding optimal performance across the broadest range of elements.

The Innov-X design provided unprecedented upgrade-ability as new analytical needs emerged. For the first time ever, analyzers could be updated for new applications, elements or calibrations added. Obsolescence defied! There are now thousands of Innov-X Handheld XRF systems used worldwide for alloy, environmental, mining and other materials analysis applications.

Innov-X now offers two handheld configurations. One handheld XRF is a fully sealed, weatherproof XRF featuring a heavy-duty, ultra-rugged design that is impervious to moisture and dust. The second is our classic, popular handheld engineered around a removable PDA.

Either Innov-X Handheld XRF system is configured with a standard package of up to 25 elements including priority pollutants. They provide the element ID, its calculated concentration and the error of the measurement in seconds. You can specify additional or replacement elements at any time, provided they can be measured by handheld XRF.

Innov-X Handhelds: Comprehensive, High-Performance XRF in the Field

Innov-X portable XRF meets **EPA Method 6200** for metals in soil, **NIOSH Method 7702** for lead in air filters, and **OSHA Method ID-204** for lead in air filters and dust wipes. The **8 RCRA Metals and Priority Pollutant Metals** are easily monitored on-site with the Innov-X portable XRF.

In-Situ Soil Analysis for Rapid Comprehensive Site Investigations:

What does the EPA say?

In a recent Performance Evaluation, Innov-X generally outperformed all other "portable" XRFs and outperformed or matched laboratory (benchtop) XRFs.

Key Innov-X handheld performance points:

- Superior cadmium (Cd) LOD performance: 20ppm or less
- Best accuracy for Cd Analysis: RPD<10%
- Excellent limits of Detection in General: As, Cu, Pb, Hg, Se, and Zn
- Superior precision on RoHS Elements: Pb, Cd, Hg all in the RSD<5% range; As in the RSD<5% for China RoHS Regs

Superior performance of tube-based portable XRF

From a Government Study presented at the American Industrial Hygiene Conference and Exposition, May, 2003:

"It is clear that portable tube-based XRF technology is the most suitable multielemental analysis tool available for field work due to its simplicity, speed, precision, accuracy, reliability, and overall cost effectiveness. Innov-X Systems pioneered this technology to overcome the significant limitations of early portable source-based systems…The newest and most exciting development in the field of portable XRF technology is the use of battery operated, miniature X-ray tubes pioneered by Innov-X Systems, Inc…The significant advancements by Innov-X Systems have taken portable XRF technology to the next level."

Disclaimer: This is published data, but it is not an endorsement or recommendation by NIOSH or the EPA

Lead (Pb) Paint Analysis:
Now available for residential lead-based paint testing

- FIRST tube-based system to receive a HUD PCS
- Fast test results – as little as 3 seconds!
- Starts fast, STAYS fast – no isotope fade

Analyze paints, coatings and solid debris:

- Analyze Cd, Cr and other RCRA, Priority Pollutant Metals in paints, plastics
- CCA-treated wood products: Quantify Cr, As and Cu in seconds
- Screen debris for hazardous or non-hazardous disposal in lieu of TCLP testing

Measure filter media for air or liquid samples:

- Measure airborne metal concentration during renovation and welding
- Analyze TSP, particulate filter media on-the-spot, non-destructively
- Analyze metals in water, waste oils
- Achieve ultra-low detection limits after filtration

On-site analysis for dust wipes:

- Avoid Lead clearance failures
  – immediate assurance clearance standards met
- Superior risk assessment and EBL investigations
  – analyze more samples, on-site
- Perform metal screening at construction or disposal sites
  – Pb, U, others

In-situ soil analysis for rapid, comprehensive site investigations:

- Delineate metals present and contamination patterns
- Measure high volume of field tests to minimize off-site analytical costs
- Establish contamination boundaries and depth profiles for remediation and disposal
- Collecting soil cores? Test directly through plastic corings
- Works directly on bagged soil samples

Collect samples to produce rock-solid analytical data at the site

- XRF is non-destructive – submit same sample for laboratory confirmation
- Avoid clearance failures! Assure requirements are met on-site
- Prepared soil sample testing assures the maximum possible accuracy – ask for our Guideline to Using Portable XRF according to EPA Method 6200 for more details!

Common Elements	Handheld XRF LODs (ppm)
Cr	30 - 50
Cd	15 - 20
Ag	15 - 20
Sn	30 - 50
Sb	30 - 50
Ba	150 - 200
Pb	10 - 15
As	7 - 10
Hg	10 - 15
Tl	10 - 15
Se	7 - 10
Cu	15 - 20
Ni	20 - 25
Zn	15 - 20

Limits of Detection shown are interference-free, for 1-2 minute tests, in sample matrices ranging from SiO2 to 5% Fe content. Actual limits of detection depend upon specific sample types, and presence of interfering elements.

Innov-X manufactures the leading handheld XRF for analysis of alloys, RoHS compliance, environmental applications and many general materials analysis. It is the most portable, rugged handheld XRF available with nearly 5,000 installed worldwide. It is available with a removable PDA, or for ultra rugged applications, totally sealed internal electronics. The system may be optionally equipped with internal vacuum (Model LZX to include Al, Si, Mg analysis) or an internal camera + collimator for photo-documentation of samples and smaller spot analysis, predominately for RoHS compliance applications. Both systems run on Windows operating system.

Handheld XRF Options and Accessories

Innov-X Handheld XRF analyzers have a variety of options and accessories including bar code reading, wireless data transfer and GPS capability. There is real-time access to results, audit trails, QC data and more for you and your clients. This obviously enhances the Chain of Custody of your site samples. Of course, the multi-language option is a real benefit in the international world of regulatory affairs. And there are a variety of other accessories that make your job easier – holsters, wrist bands, soil foot, bench-top stand, battery back up packs and more.

World Power Kit

Field Side-Holster

Soil Foot

Blue-Tooth GPS

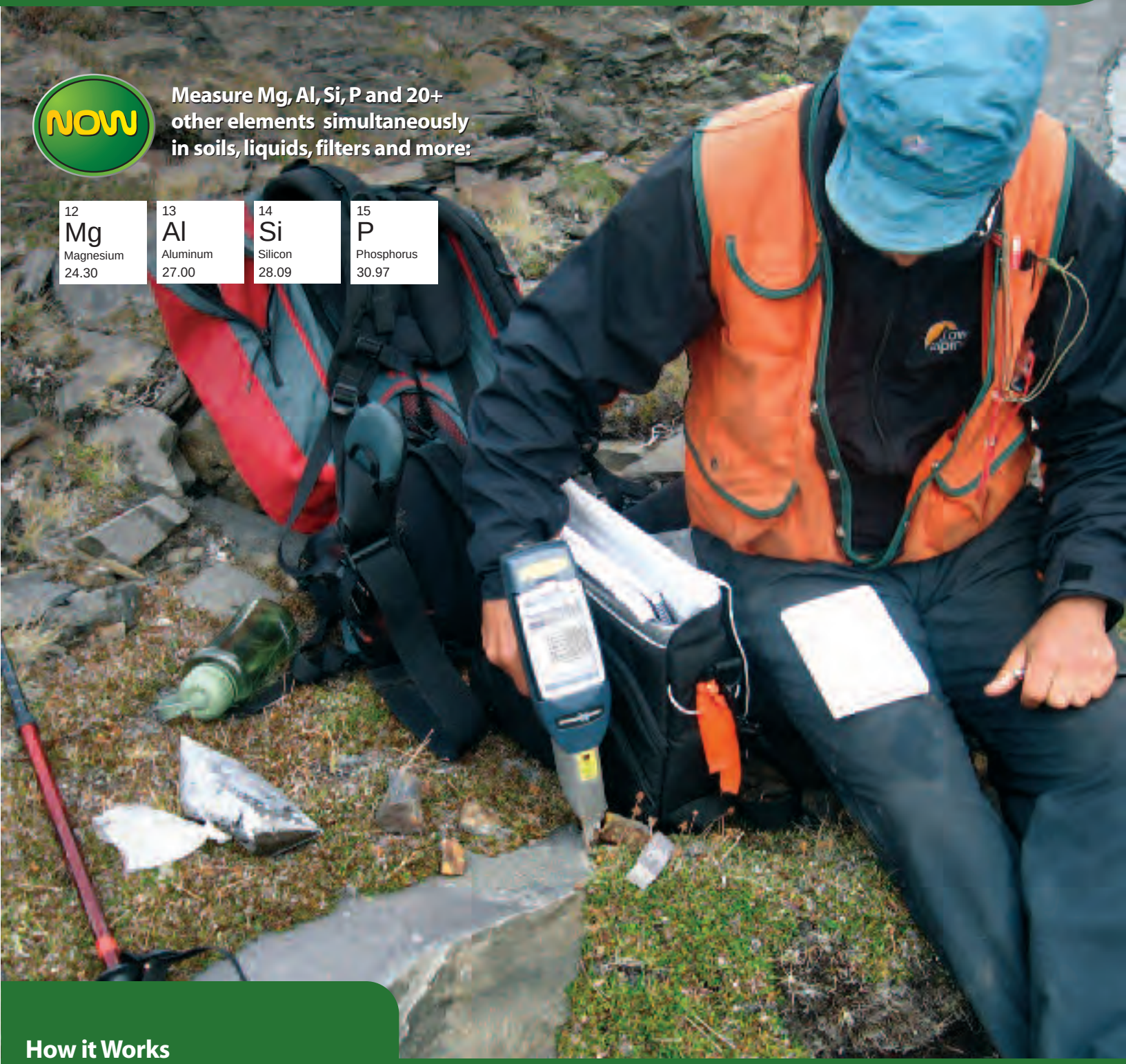
High-Capacity Battery

Bar Code Reader

Bench-Top Stand

Revolutionary Internal Vacuum Technology for Light Element Analysis

Introducing the Innov-X LZX (patent pending)



How it Works

An atmosphere-free zone is created between the sample and detector, uniquely designed for fast, repeatable measurements of the low-energy x-rays from these elements. **The operation is simple:**

- Just connect the miniature, battery-operated pump for 20 seconds, disconnect and begin testing
- Internal vacuum is maintained for hours, no need to carry a pump!
- On-screen monitor alerts you when pump is needed

The LZX offers numerous advantages. There are no tanks of compressed He gas to lug around. Attached vacuum pumps are a thing of the past. Our internal vacuum chamber is engineered to handle daily environmental analysis and maintain vacuum for up to 6 hours. A small pump is standard to recharge the vacuum as needed.

Upgrade-ability and back-compatibility

Do you really need the vacuum option? As with all Innov-X XRF products, existing customers may add the LZX option at any time. Not sure? Start with the standard system, and add LZX at a later date, usually for just the price difference. LZX option is available with either the Sealed or Classic PDA model.

Innov-X Software Makes It Easy

Environmental Compliance Requirements can be demanding – **CCA, China RoHS, ELV, EPA, HUD, ISO, Lead-Free, NIOSH, OSHA, Priority Pollutants, RCRA, RoHS, WEEE** and more. Innov-X Systems Portable XRF Analyzer combines advanced portable tube-based XRF technology with comprehensive, universal data modeling to put superior and flexible environmental analysis in your hands. And, if your work is multi-national, Innov-X Systems Handheld XRF Analyzers are available in multiple languages.

Collecting data

You have choices for handheld XRF data collection: start/stop manually, preset test times, preset statistical certainty or relative standard deviation (RSD) of measurements, and you can even preset action levels for individual elements with statistical certainty.

Viewing data

You have choices for handheld XRF data display: individual concentrations with statistical error, pass/fail results, identification through matching libraries, and spectral plots with element identification and zoom-in viewing. You can even reevaluate stored data sets with added elements, new parameters, models or calibration curves.

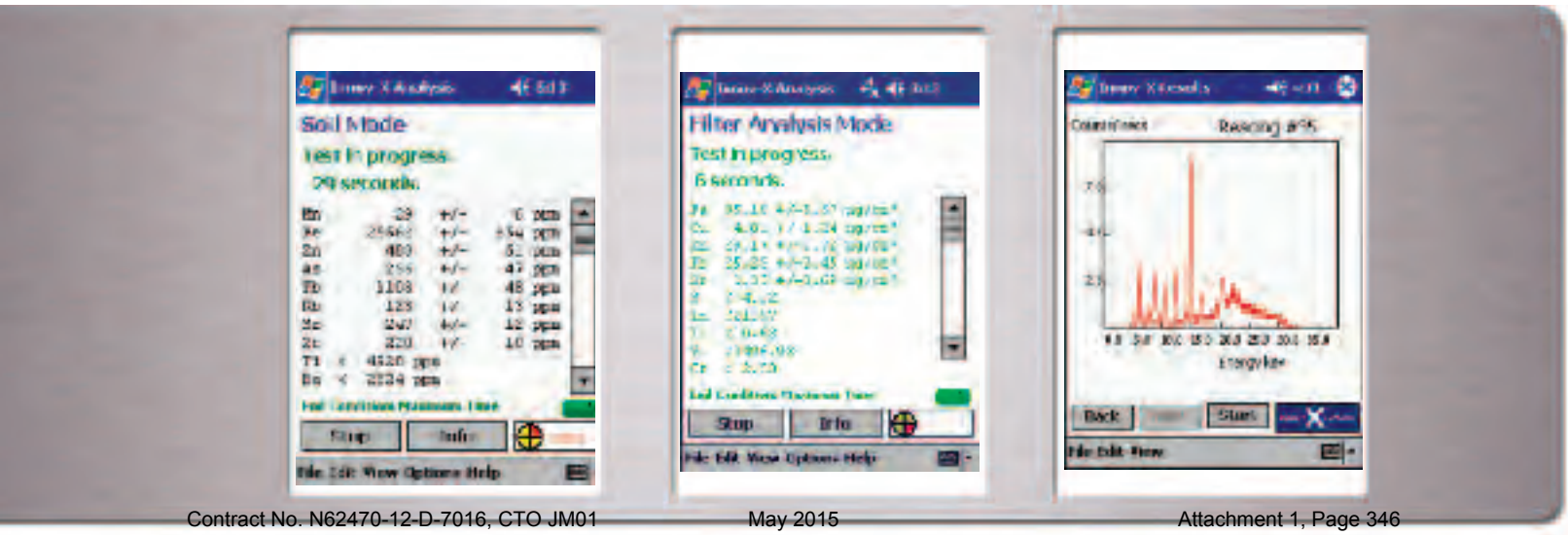
Analyzing data

Innov-X Handheld XRF Data Analysis Software is as comprehensive as Lab XRF software. Our advanced, universal XRF data analysis models give you superior environmental analysis where and when you need it.

- Compton Normalization: "Internal Standard" for quantitative analysis without site specific calibrations
- Fundamental Parameters: "Standardless" for samples with high and low concentrations of several elements
- Empirical Calibrations: "Calibration Curves" for user-generated calibration curves

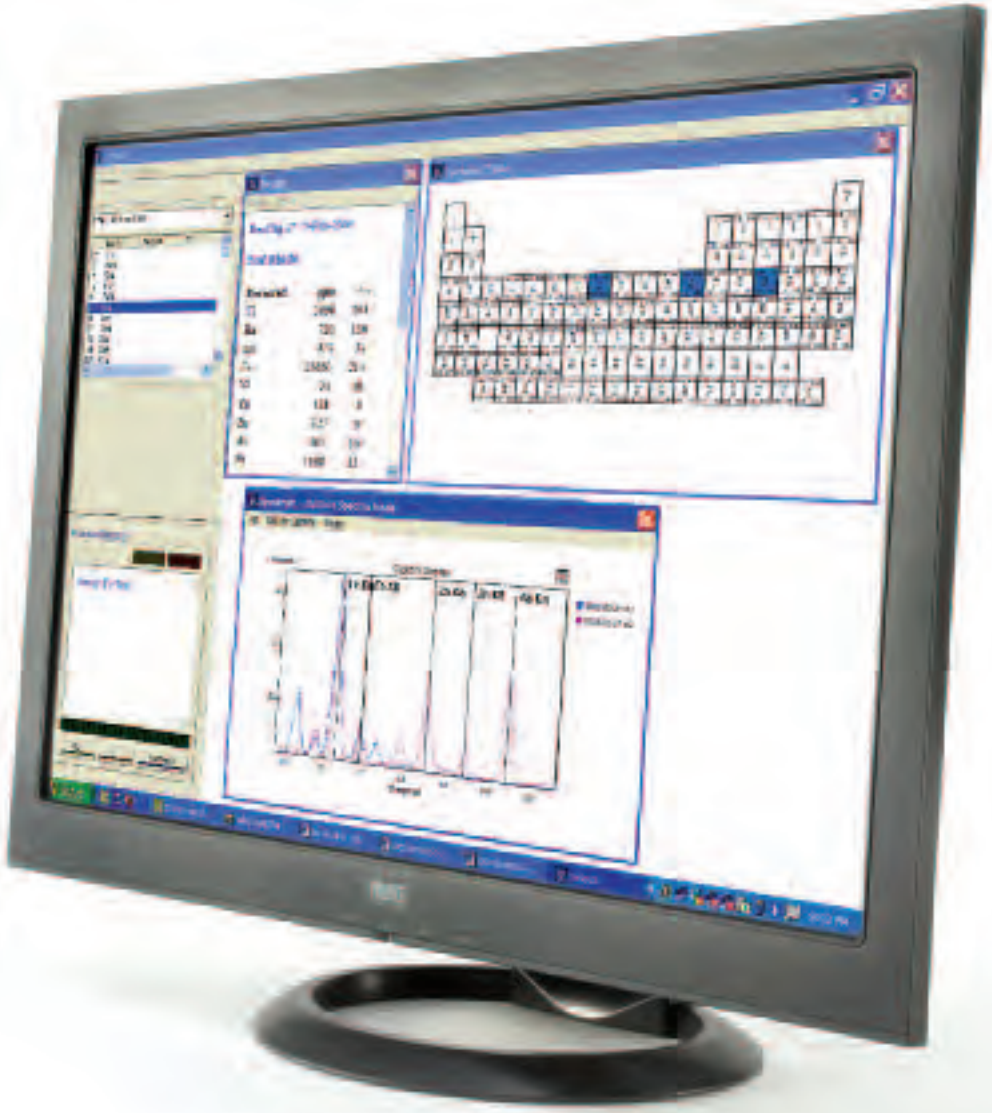
Typical Innov-X Software Soil Mode Results screen

The standard Soil Mode Results screen displays the concentration (in ppm) and error in measurement for detected elements. You can also easily add new elements and calibrations, rerun stored tests with new parameters or models; and your data is stored in binary format – virtually impossible to alter. As with all Innov-X analytical modes, it is possible to view both test and spectra information.



Optional Innov-X Systems PC software

Innov-X Systems also offers PC Software which allows operation of our handheld XRF analyzers from a desktop PC via a serial connection. Additionally, the remote display option allows data to be sent via Bluetooth from a handheld to a PC for display and further data manipulation. The PC software includes all functionalities available on the handheld platform: data collection, data display and data analysis choices. The PC Software includes additional functionalities – beyond what is available on the handheld platform. Added features include the ability to overlay multiple spectra, to print spectral overlays, and label peaks for all elements. You can click on a peak to bring up a peak identifier, or select an element from the periodic table to show the corresponding lines. The PC Software option is particularly beneficial to those who present their work in report format internally or through publication.



Optimize Enviro-chemical Surveys: Real-time GPS Mapping Systems & XRF Field Analysis

Map courtesy of Google

Don't wait! Get the facts on metal content and location where you are – get real-time answers to take real-time action. Whichever corner of the earth you work from, you can depend on Innov-X Portable XRF with GPS Mapping for quick and easy surveys.

Handheld XRF Applications

Each Innov-X Handheld XRF is equipped with a software and factory calibration package optimized specifically for its intended use – RoHS, Environmental, Mining, Alloy, Oil Analysis and more. Additional packages may be added anytime.

Need custom or unique calibrations? Innov-X Handheld XRF's also feature a full empirical package. Operators may develop their own calibration models for 25 or more elements, fit curves, customize background corrections, and more.

RoHS

The handheld delivers fast & simple RoHS compliance results for Cd, Pb, Hg, total Cr and Br. Features and advantages include:

- Easy point-and-shoot screening for a variety of samples: cables, connectors, PCB's, metal components, solders
- RoHS-Engine (patent pending) method to automatically optimize x-ray source and filtering for optimal detection limits – no operator input required!
- Superior cadmium LOD's of 20ppm or less in polymers and the best accuracy with RPD<10%
- Sn-based Solders: Confirm metal content for classification of Sn-whiskering challenges
- The optional internal camera + collimator configuration for photo-documentation of samples and smaller spot analysis, predominately for RoHS compliance applications

Mining

Put the Innov-X Handheld XRF in your tool belt! Handheld XRF is ideal for ores, tailings, concentrates, borings, cores, fragments, slurries, filters & films. This has completely revolutionized geochemical exploration for surface and underground mining. Site sampling need no longer be a limiting factor in a comprehensive mining investigation. Portable XRF liberates and empowers geochemical studies.

- Fast, ergonomically-friendly analysis of cores, bagged or prepped samples
- Check leaching baths, holding ponds and steel tank solutions
- Exploration, precious metals: 10-100ppm LOD for Au and Pt; 50-150ppm LOD for Ag and Pd
- Wear metals in oils for early detection of potential equipment component failures

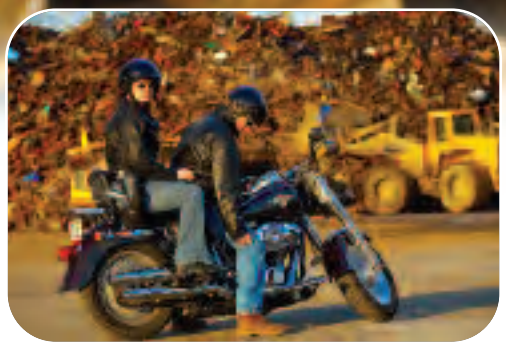
Environmental

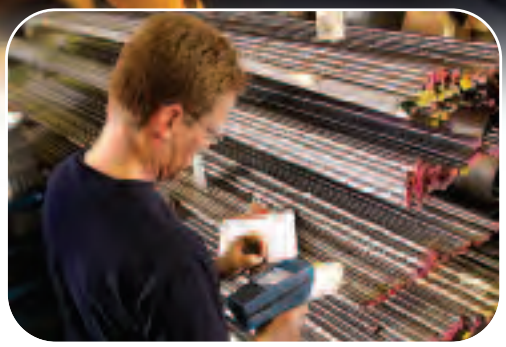
Whether screening according to EPA Method 6200 or performing quantitative analysis on prepared samples, simultaneously analyze 25 elements, including 8 RCRA Metals & Priority Pollutants, in seconds! Innov-X Handhelds put the power of XRF in your hands.

Take it to the field … where it really counts.

- Analyze bagged or prepared soil samples in the field or in the lab. Complies with EPA Method 6200
- Wet sediments no problem! Software can apply calibration correction for water content to convert to dry-basis concentrations
- Detection limits (depending on matrix) <20ppm Cd, 10-100 ppm Cr, 1-20ppm As, Pb. Excellent LOD's and precision throughout the periodic table
- Air filters, or wipe tests – superior limits of detection. Complies with NIOSH 7702, OSHA Method ID-204
- Sulfur in fuels and oils for regulatory compliance

92	17	50	51	35
U	Cl	Sn	Sb	Br
Uranium	Chlorine	Tin	Antimony	Bromium
238.03	35.45	118.71	121.76	79.90





Scrap Sorting & Processing

Innov-X pioneered the first x-ray tube-based handheld for scrap metal sorting. Many scrap processors prefer the Innov-X because of the wide variety of alloys they can test, responsive customer service, and ease of isotope-free travel.

- Fast, fast sorting of high-temps, stainless, red metals, some common Al grades
- Use on tough separations: Ni/Co superalloys, 97-3 & Ta, exotic alloys
- Add precious metal analysis for catalysts, electronics scrap at any time
- Low alloy steels? Excellent sensitivity to low levels of Cr, Ni, Mo, V
- Excellent performance on turnings
- Use for non-metals too

Alloy Analysis

Innov-X XRF has become the preferred analyzer for petrochemical, production/power and fabrication industries. It is widely accepted for alloy verification in nearly every major refinery, the nuclear power industry, and by leading alloy producers and fabricators.

- Removable handle to test through insulation ports, other hard-to-reach areas
- Flow-accelerated Corrosion (FAC): the best handheld for low Cr measurements (down to 0.02% in carbon steels)
- Engineered for in service PMI, proven on surface temperatures up to 900°F
- Performs well on tough separations: Ni/Co superalloys, 97-3 & Ta, exotic alloys
- Sort common Al-grades 6061, 2024, 7050, 7075, 3003 and others. Ideal for sorting mixed Al-alloy into MLC loads
- Excellent sensitivity to low concentrations of Cr, Ni, Mo, V for many low-alloy applications
- Measure low Fe concentration in cobalt alloys for biomedical application

Other Applications:
Forensics • Catalysts • Powders
General Materials Analysis

The power of Innov-X Portable XRF is in the variety of calibrations, ease of adding new elements for analysis, spectral viewing, and ease of use. Many applications require analysis where few if any known concentration standards exist for instrument calibration. Or in many cases, standards are proprietary to the customer. In these cases, the handheld offers a variety of user-calibration methods, peak fitting and background subtraction:

- User chooses from simple spectral acquisition, peak ID, to displayed intensities, and calibration curve fitting
- Add elements any time
- Inter-element effects: Fundamental Parameters, Compton Normalization, Empirical
- Calibration methods named, saved, and easily recalled later

Why should your next Handheld XRF Purchase be an Innov-X?

You're buying more than an environmental analyzer. You're buying a company that routinely delivers the next innovation in environmental analysis – a company with a proven record of delivering state-of-the-art XRF solutions, and customer-friendly upgrades and trade-in options.

Relentless innovation

Innov-X drives the advancement of portability and performance in XRF instrumentation, proven by our history of solutions:

- Handheld XRF with removable PDA: World's first and still most portable tube-based handheld XRF

- Ultra-rugged model with fully integrated, sealed electronics

- Vacuum Option– delivering Al, Si, Mg & P analysis in a handheld XRF without compressed helium gas

Ergonomic superiority

- The lightest weight, smallest, and best-balanced handheld XRF
- Bright, color display that is easy to read in any lighting conditions - even direct sunlight
- Touch trigger. No uncomfortable triggers to squeeze and hold. Comfortable "deadman" trigger also available
- Dual display: Angled front display plus rear display for easy viewing of test results

Customer appreciation

We don't take your business for granted after you've purchased an analyzer. You talk to a person when you call. You'll receive rapid response and regular updates to your requests. We offer extensive full service sites worldwide. In virtually every location on the planet you can be assured of well-trained service and application support.

Totally free of radioactive materials

Why deal with radioactive materials? Regulations are increasing, the liability is a headache, and travel restrictions are becoming ever more onerous. Our pioneering tube technology eliminates the risk and headaches of controlling radioactive materials:

- Reduce regulatory baggage – no wipe tests, minimal travel restrictions, easy to transport
- Eliminates the liability of isotope control, improper use, theft and disposal

The Innov-X XRF Family

Innov-X Continues the Portable XRF Revolution

What it comes down to is that the real world is waiting with the real answers. Take your Innov-X Portable XRF to the field where it really counts. Innov-X Portable XRF Analyzers go where you go – no matter the environment – flexibility and capability for the right answers where and when you need them!

X-50 Mobile XRF Analyzers

Innov-X takes Portable XRF up a Notch

If you are looking for even higher power in portable XRF analysis, the Innov-X Mobile X-50 is your choice. Configured like a ruggedized tool case, with up to 25x the power of the handhelds, the X-50 is ideal for ores, tailings, concentrates, borings, cores, fragments, slurries, filters and films. The X-50's higher power delivers greatly improved performance – compared to handheld XRF – for many transition metals including Cd, Ag, Sn, Sb, precious metals and rare earths. It yields the power of bench top performance built for on-the-spot analysis.

QXR High Volume Material Sorting Systems

Applications include:

- Alloys – upgrading stainless, zorba, copper and other heavies
- Also high Cu or Zn aluminum
- Glass
- PVC, BFR in polymer streams
- "Meatball" extraction (diverting copper-bearing materials from ferrous streams)

For high throughput automated sorting, Innov-X offers the conveyor based QXR sorting systems. These systems operate at 20-100 tons/hour depending on the material, and are designed for continuous, high feed rate material identification and sorting.

SEA-Mate™ Oil Analyzer

In partnership with the world's largest shipping company A. P. Moller-Maersk, Innov-X has designed and manufactured the SEA-Mate™ line of XRF analyzers for analysis of oils, fuels and lubricants. These analyzers are designed for the marine and other heavy transportation industries and have been rigorously tested on board numerous Maersk vessels.

FOX-IQ Factory Online XRF Analyzers

A complete line of XRF-based process analyzers. Applications include continuous or discrete analysis of alloy tubing, liquid and slurry streams via our patent-pending flow cell technology.

16 S Sulfur 32.07	26 Fe Iron 55.85	29 Cu Copper 63.55	23 V Vanadium 50.94	28 Ni Nickel 58.69

Come take an INNOQUEST for yourself
www.innovxsys.com/innoquest

BASIC SPECIFICATIONS

Weight:	3 lbs. 4 oz. (1.6 kg)
Excitation Source:	X-ray tube, Ag, W, Ta or Mo anode, 5-40 kV, 10–100 µA, up to 6 filter positions
SmartBeam:	Delivers industry-leading detection limits on critical elements Cr, V, Ti
Detector:	High resolution Si PIN diode detector
Temperature Range:	-10C to +50C
Operation:	Trigger or Start/Stop Icon. One-touch trigger or "deadman" trigger option. Optional control from external PC.
Power:	Li-ion batteries, rechargeable (charger included). Powers analyzer, PDA (iPDA model), charges batteries simultaneously. AC Adapter optional.
Battery life:	8 hours (typical duty cycle), 3 hrs continuous (tube on) operation.
No. of Elements:	Standard package includes 20-25 elements depending upon application. Customer may specify additional elements, or use multiple suites of 25 elements each. Extra charge may be added depending upon elements and total additions. LZX Option includes Al, Si, Mg, P. Others possible.
Display Screen:	Color, high resolution touchscreen. Variable brightness provides easy viewing in all ambient lighting conditions.
Data Display:	Concentrations in ppm, spectra and/or peak intensities (count rate) or user-specified units, depending on software mode selected.
Data storage:	Minimum 20,000 test results with spectra, upgradeable to >100,000 test results with upgrade to 1 Gb flash card. 128 Mb standard memory.
Processor:	Intel 400 MHz StrongArm processor or equivalent for sealed unit.
Operating System:	Microsoft Windows CE (portable system) or Windows (PC-based).
Software Modes:	Alloy Analytical, Fast Verification, Pass/Fail. Optional RoHS, Process, Soil, Lead paint, others available.
Vacuum Life:	4-6 hours typical. Pump down requires 20 sec.

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INNOV-X SYSTEMS™
Innovative XRF Technologies

■*Application Brief*

Alpha Series™

portable XRF technology for analysis of arsenic and lead in soil.

Improper waste disposal often leads to soil contamination.

Alpha Series™ XRF analyser enables fast site survey for on-site analysis of As and Pb.

Overview.

For decades, field portable X-ray fluorescence (XRF) has provided rapid, on-site measurements of metals contamination in soil. The purpose of such assessments was the identification and remediation of contaminated soil.

In 1998, EPA incorporated Method 6200 for portable XRF into SWA846 as a standard method. However, because field portable XRF systems used radioactive isotopes as their source of X-rays, they were expensive to own and operate. They also created regulatory burdens for their owners and made site-to-site travel difficult due to the requirements for transporting a radioactive source.

With its Alpha Series™ Innov-X Systems has pioneered a handheld XRF analyzer that utilizes an X-ray tube instead of radioactive isotopes. This battery powered point-and-shoot XRF system eliminates burdensome radioactive sources and provides on-the-spot quality data about elements critical to the analysis of metals in soil.

The single X-ray tube replaces multiple isotopes used in source-based systems to offer simultaneous analysis of 20-25 metals including all eight RCRA metals and the EPA priority pollutant metals. It generally provides superior detection limits (DL) compared to isotope systems. Moreover, the testing time never increases with an X-ray tube because there is no source decaying. The testing speed after 4-5 years is the same as when the analyzer was purchased.

Innov-X Systems developed this technology to overcome the significant regulatory headaches of isotope-based XRF systems. Isotope-based units require the use of radioactive materials to irradiate the sample. The sources decay and lose testing speed over time. In addition to the loss in analytical capabilities, the sources have to be replaced. The use and subsequent disposal of radioactive isotopes also require licensing (state-to-state in the US) and a radioactive materials control program.

Interstate travel is particularly difficult because multiple state licensing and reciprocity arrangements must be made prior to travel – making rapid response impractical. Isotopes can be difficult to ship and transport, as they require hazardous materials declarations and/or permits.

All of these factors add significant additional cost and paperwork for source-based systems – more so for the environmental consulting community where regular travel to multiple job sites is common.

Arsenic and Lead Analysis.

Two of the most common metals requiring field analysis are lead (Pb) and arsenic (As). Interestingly, while both of these elements are ideal candidates for XRF analysis, analyzing As in the presence of high Pb concentration presents some challenges, whereas high As content has no effect on the analysis of Pb. Interference-free detection limits (DLs) are shown in Table 1.

Table 1 ***Interference-free detection limits (DLs)***

Element	Detection Limit, ppm (Interference-Free, 2-minute Test Time)
Pb	13
As	9

*As values represent latest (Aug. 2003) values.

Results on laboratory-analyzed samples are shown in Fig. 1a and 1b for arsenic and lead respectively. Correlations are good in a variety of soil samples, exhibiting R2 values of 0.99 in each case. The XRF calibration method – Compton Normalization method as described in EPA Method 6200 – provides good results without the need for site-specific calibration corrections.

fig. 1a As Results: Portable XRF Analysis of Soil Samples

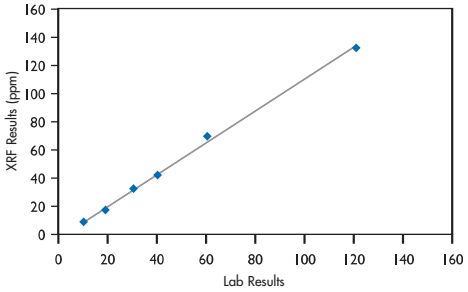
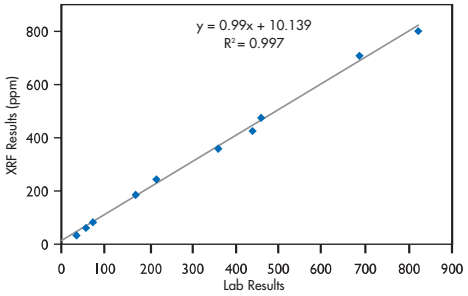


fig. 1b Pb Results: Portable XRF Analysis of Soil Samples



INNOV-X SYSTEMS™

Innovative XRF Technologies

Alpha Series™

portable XRF technology for analysis of arsenic and lead in soil.

Using in-situ XRF data, site contamination patterns are quickly determined to facilitate remediation.

XRF Analysis for Arsenic in the Presence of Lead.

While analyzing lead and arsenic with portable XRF is relatively straightforward, analyzing arsenic when lead is present, particularly in high concentrations, poses an additional challenge. Lead produces two strong spectral peaks L_α at energy 10.5 keV and L_β at 12.6 keV. Generally the lead L_β peak is used for lead analysis. The best arsenic spectral line for measurement is the K_α peak – also at 10.5 keV. Thus lead produces an interference, whereby the lead L_α completely overlaps the desired arsenic K_α spectral peak. The lead interference becomes detrimental to arsenic measurement in two ways:

- Elevates the arsenic detection level.
- Moderately reduces arsenic precision for the same testing time compared to an identical sample with no lead.

The Innov-X software algorithm automatically corrects the arsenic result when lead is present. The algorithm predicts the contribution in the 10.5 keV spectral reason from the lead L_α based on the interference-free measurement of the lead L_β. The lead L_α contribution is subtracted, yielding the peak intensity due solely to the arsenic K_α.

However, the precision of the arsenic result (and the detection limit in the case of low arsenic concentrations) are affected because the statistical uncertainty of the lead L_α background subtraction yields a less precise result for the arsenic concentration. This effect does not occur if there is negligible lead present in the spectrum.

The impact on both As detection limit and precision can be determined. The arsenic detection limit as a function of lead concentration is presented in Fig. 2. Based on X-ray measurement statistics, the As detection limit increases as the square root of the increase in lead concentration, following the functional form in the equation below:

$$As\big|_{Pb} = As\big|_{noPb} + \sqrt{Pb(ppm)}$$

fig.2 Effect of Lead Concentration on Arsenic Detection Limit

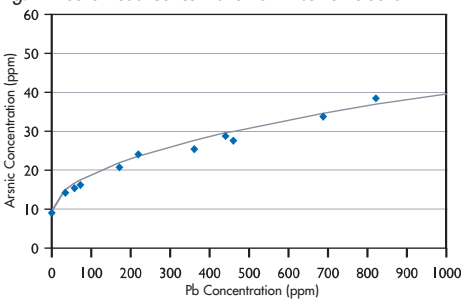


Figure 2 shows both the calculated (solid line) and measured arsenic detection limit as a function of lead concentration. For example, for no detectable lead in the sample (< 13 ppm) the As detection limit is approximately 9 ppm. The As DL increases smoothly to a value of about 19 for 100 ppm lead, and about 45 for 1,000 ppm lead. Thus for a 10-fold increase in lead concentration (100 ppm to 1,000 ppm), the detection limit worsens by a factor of about 2.5. The effect on precision of the arsenic measurement will follow a similar trend.

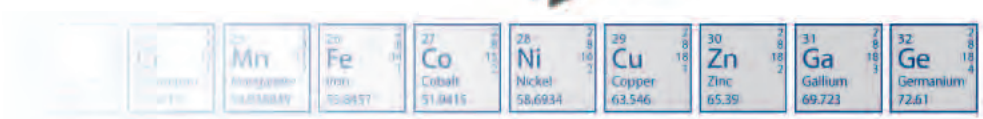
Summary.

Innov-X Alpha Series™ X-ray tube technology offers faster, higher-precision measurements of important environmental metals in soil and relieves the regulatory burden of using radioactive isotopes. Two of the most common elements analyzed are lead and arsenic. By themselves, both elements are excellent candidates for portable XRF analysis due to the high accuracy achievable, and the low detection limits.

Measurement of low concentrations of arsenic in the presence of high lead concentrations presents some unique challenges due to the large interference of the lead with the arsenic measurement. By quantifying the effect of lead concentrations on arsenic measurements, Alpha Series™ provides operators with a way to determine data quality objectives at sites with both Pb and As present, rather than relying solely on interference-free detection limits.

INNOV-X SYSTEMS™

Innovative XRF Technologies



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AB-301 6-05

Chapter 1 Introduction

1.0 INSPECTING YOUR INNOV-X ANALYZER

Upon receipt:

1. Locate and remove the shipping papers and documentation from under the lid's foam padding.
2. Remove the Innov-X Analyzer and all of the components from the protective carrying case and identify each on the enclosed shipping list.
3. Connect the battery charger to an 110V-240V AC power source. Place one Li-ion battery on the charger and charge it for at least 2 hours. Charge the second battery.
4. Charge the HP iPAQ using the attached AC adaptor for at least ½ hour.
5. Read and review the "Quick Start" section of the User's Manual. Innov-X recommends that you read the entire manual.
6. Install the fully charged battery into the analyzer.
7. Press the ON/OFF button on the back of the analyzer and the power button on the iPAQ.
8. Select Innov-X from the start menu located in the upper left hand corner of iPAQ screen.
9. Select the desired analysis mode (i.e., Analytical, FastID, Pass/Fail or Soil). The instrument will undergo a one minute hardware initialization period.
10. Standardize the instrument with the 316 Stainless Steel mask. Standardize the instrument every 4 hours or as directed by the display.
11. Release the software trigger lock and analyze a sample of known composition, in order to verify the correct operation of the analyzer.
12. Analyze samples of unknown composition.

1.1 COMPONENTS INCLUDED WITH THE ANALYZER

Shown here are the various items which are included with the Innov-X portable XRF analyzer. Unless otherwise noted, all items are standard accessories.

Analyzer, with iPAQ attached.

Two, Li-ion batteries (one shown).

Battery charger and an AC adaptor. Battery shown mounted in charging system.

Standardization cap and weld mask (optional)

The standard standardization cap has no weld slit.

iPAQ cradle and AC adaptor. The cradle is used to connect the iPAQ to a PC for downloading data and reports.

Testing stand. This is the benchtop docking station for the analyzer. It is an optional accessory

1.2 QUICK START INSTRUCTIONS

The following section provides a quick overview to using the Innov-X portable XRF analyzer. This is intended to provide the basic startup and operational instruction needed to perform simple analyses. It is highly recommended that the user read the sections on Radiation Safety (Chapter 3) and the detailed description on operation (Chapter 4). The following Quick Start information is also provided as a separate, bound, laminated publication for quick reference.

1. Place a battery in the analyzer.
2. Power on the Analyzer (On/Off switch located on back of analyzer)
3. Power on the iPAQ (Button located in upper right hand corner of iPAQ)
4. Select Innov-X from the start menu located in the upper left hand corner of iPAQ screen.
5. Read the radiation safety notice and acknowledge that you are a certified user by pressing Start.
6. Select Desired Mode.
7. The analyzer will undergo a 60 second hardware initialization.
8. Place a standardization clip on the nose of the analyzer. Tap the button on the screen to standardize. ***(Manual section 4.4 Standardization)***
9. When standardization is complete, remove the standardization clip.

10. Release the software trigger lock by tapping the locked icon on the iPAQ screen and tapping yes in response to the software prompt.
11. Test standard to verify instrument performance.
12. Results will display on screen. Subsequent tests may be started from either the Results or Analysis screens.

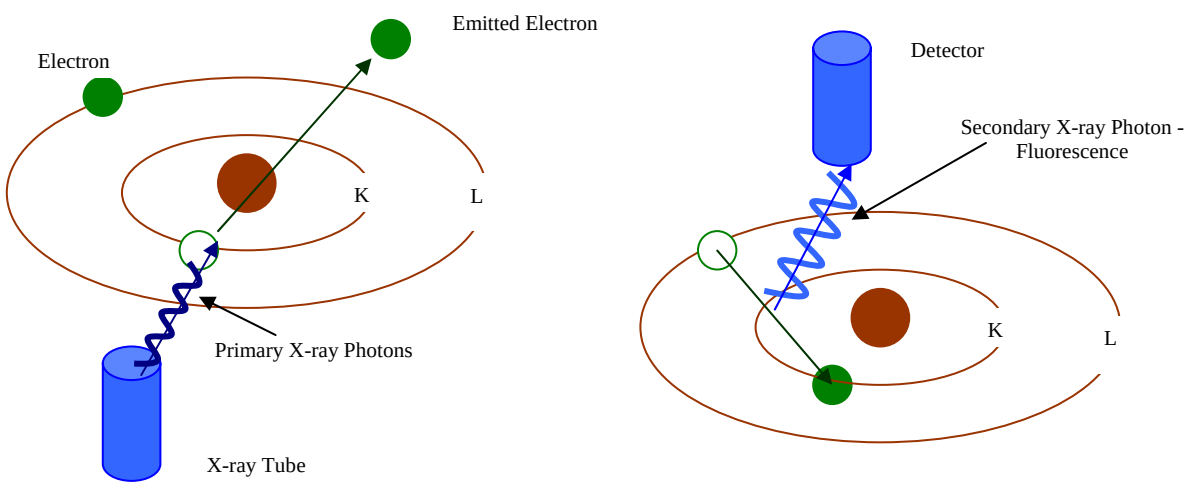
1.3 INTRODUCTION TO XRF: X-RAY FLUORESCENCE SPECTROMETRY OVERVIEW

Basic Theory

Although most commonly known for diagnostic use in the medical field, the use of x-rays forms the basis of many powerful analytical measurement techniques, including X-ray Fluorescence (XRF) Spectrometry.

XRF Spectrometry is used to identify elements in a substance and quantify the amount of those elements present. An element is identified by its characteristic X-ray emission wavelength (λ) or energy (E). The amount of an element present is quantified by measuring the intensity of its characteristic line. XRF Spectrometry ultimately determines the elemental composition of a material.

All atoms have a fixed number of electrons (negatively charged particles) arranged in orbitals around the nucleus. The number of electrons in a given atom is equal to the number of protons (positively charged particles) in the nucleus; and, the number of protons is indicated by the Atomic Number in the Periodic Table of Elements. Each Atomic Number is assigned an elemental name, such as Iron (Fe), with Atomic Number 26. Energy Dispersive (ED) XRF and Wavelength Dispersive (WD) XRF Spectrometry typically utilize activity in the first three electron orbitals, the K, L, and M lines, where K is closest to the nucleus. Each electron orbital corresponds to a specific and different energy level for a given element.



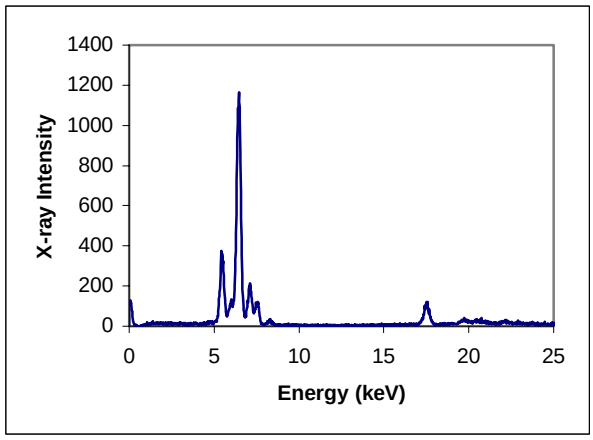
In XRF Spectrometry, high-energy primary X-ray photons are emitted from a source (X-ray tube) and strike the sample. The primary photons from the X-ray tube have enough energy to knock electrons out of the innermost, K or L, orbitals. When this occurs, the atoms become ions, which are unstable. Electrons seek stability; therefore, an electron from an outer orbital, L or M, will move into the newly vacant space at the inner orbital. As the electron from the outer orbital moves into the inner orbital space, it emits an energy known as a secondary X-ray photon. This phenomenon is called fluorescence. The secondary X-ray produced is characteristic of a specific element. The energy (E) of the emitted fluorescent X-ray photon is determined by the difference in energies between the initial and final orbitals of the individual transitions.

This is described by the formula

$$E=hc/\lambda$$

where h is Planck's constant; c is the velocity of light; and λ is the characteristic wavelength of the photon.

Wavelengths are inversely proportional to the energies; they are characteristic for each element. For example the Kα energy for Iron (Fe) is about 6.4keV. The number of element-specific characteristic X-rays produced in a sample over a given period of time, or the intensity, can be measured to determine the quantity of a given element in a sample. Typical spectra for EDXRF Spectrometry appear as a plot of Energy (E) versus the Intensity (I).



History

Wilhelm Roentgen discovered X-rays in 1895. Methods for identifying and quantifying elements using XRF were first published by Henry Moseley in 1913. Much research and development of XRF continued after Moseley's pioneering work, especially during WWII when rapid developments in the aircraft, automotive, steel and other metals industries heightened the need to identify alloys quickly and reliably. However, the first commercial XRF Spectrometers weren't available until the early 1950's. Those systems were based on WDXRF technology and measured the characteristic wavelength of an element, one element at a time. Although the use of these systems was critical for elemental analyses, they were large, expensive, and required highly skilled operators to use and maintain them.

In the late 1960's, EDXRF technology, which measures the characteristic energy of an element, began to rival the use of WDXRF due to the development of Si (Li) solid state detectors, which offered better energy resolution of the signal. EDXRF systems offered the potential of collecting and displaying information on all of the elements in a sample at the same time, as opposed to one at a time with typical WDXRF systems. Many of the early EDXRF systems used radioisotopes for excitation instead of X-ray tubes, which could require changing sources to determine all the elements of interest. Some of those early EDXRF systems did not easily resolve multiple elements in a single analytical run.

As can be imagined, the equipment and applications of XRF Spectrometers have developed tremendously since the 1960's. Advancements in technology, electronics, computers, software and the use and modification of them for XRF Spectrometers by instrument manufacturers, research scientists & engineers, and industrial users alike have led to the current state of the art in XRF Spectrometers. Now a mature technology, XRF Spectrometry is routinely used for R&D, QC and analytical services in support of production.

Elemental Analysis

XRF Spectrometry is the choice of many analysts for elemental analysis when compared to the other techniques available. Wet chemistry instrument techniques for elemental analysis require destructive and time-consuming specimen preparation, often using concentrated acids or other hazardous materials. Not only is the sample destroyed, waste streams are generated during the analytical process that need to be disposed of, many of which are hazardous. These wet chemistry elemental analysis techniques often take twenty minutes to several hours for specimen preparation and analysis time. All of these factors lead to a relatively high cost per sample. However, if PPB and lower elemental concentrations are the primary measurement need, wet chemistry instrument elemental analysis techniques are necessary.

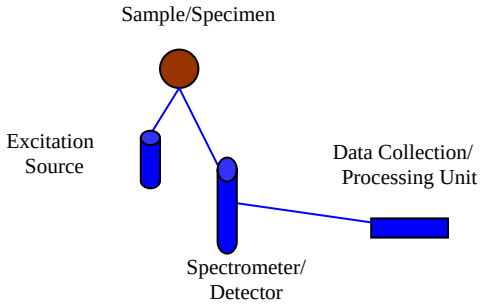
XRF Spectrometry easily and quickly identifies and quantifies elements over a wide dynamic concentration range, from PPM levels up to virtually 100% by weight. XRF Spectrometry does not destroy the sample and requires little, if any, specimen preparation. It has a very fast overall sample turnaround time. These factors lead to a significant reduction in the per sample analytical cost when compared to other elemental analysis techniques.

All elemental analysis techniques experience interferences, both chemical and physical in nature, and must be corrected or compensated for in order to achieve adequate analytical results. Most wet chemistry instrument techniques for elemental analysis suffer from interferences that are corrected for by both extensive and complex specimen preparation techniques, instrumentation advancements, and by mathematical corrections in the system's software. In XRF Spectrometry, the primary interference is from other specific elements in a substance that can influence (matrix effects) the analysis of the element(s) of interest. However, these interferences are well known and documented; and, instrumentation advancements and mathematical corrections in the system's software easily and quickly correct for them. In certain cases, the geometry of the sample can effect XRF analysis, but this is easily compensated for by grinding or polishing the sample, or by pressing a pellet or making glass beads.

Quantitative analysis for XRF Spectrometry is typically performed using Empirical Methods (calibration curves using standards similar in property to the unknown) or Fundamental Parameters (FP). FP is frequently preferred because it allows elemental analysis to be performed with no standards or calibration curves. This enables the analyst to use the system immediately, without having to spend additional time setting up individual calibration curves for the various elements and materials of interest. The capabilities of modern computers allow the use of this no-standard mathematical analysis, FP, accompanied by stored libraries of known materials, to determine not only the elemental composition of an unknown material quickly and easily, but even to identify the unknown material itself.

EDXRF Spectrometers

EDXRF Spectrometer systems are mechanically very simple; essentially there are no moving parts. An EDXRF system typically has three major components: an excitation source, a spectrometer/detector, and a data collection/processing unit. The ease of use, rapid analysis time, lower initial purchase price and substantially lower long-term maintenance costs of EDXRF Spectrometers have led to having more systems in use today worldwide than WDXRF Spectrometer systems.



EDXRF has been found most useful for scrap alloy sorting, forensic science, environmental analysis, archaeometry and a myriad of other elemental field-oriented analyses.

Handheld EDXRF Spectrometers for Field Analyses

It is clear that a future trend for elemental analysis is in rapid site investigation using techniques that are fast, inexpensive, reliable, and long-term cost effective. There is a need for immediate decisions to be made during the delivery of materials, industrial processing, and in the field for positive materials identification or environmental site assessment and remediation. It is also clear that EDXRF Spectrometry is the most suitable elemental analysis technique available for field analysis due to its simplicity, speed, precision, accuracy, reliability, and overall cost effectiveness.

Recent technological developments in cell phones, pocket PC's and other portable consumer electronics have led to the advancement of many high-performance, miniature components. X-ray equipment manufacturers began to take advantage of these developments in the late 1990's and developed Handheld EDXRF systems. An obvious advantage of Handheld EDXRF systems is that the analyzer is taken to the sample as opposed to bringing the sample to the analyzer and configuring it to fit in an analysis chamber. In addition to the per sample analytical cost savings, a key factor in using non-destructive EDXRF analysis, especially in the field, is the overall project cost savings due to improved and more timely decision making. The use of EDXRF for immediate positive materials identification or to guide an environmental site characterization will generally reduce the overall time required in the field due to the quick turnaround for the sample analysis; this invariably reduces the overall costs of analytical field work.

Of course, Handheld EDXRF technology has continued to evolve in concert with portable consumer electronic developments. Just like the early Benchtop EDXRF systems, early Handheld EDXRF systems used radioisotopes for excitation. There are several practical problems with the use of radioactive isotopes for handheld systems. The source decays and loses its testing speed over time. In addition to the loss in analytical capabilities, the sources have to be replaced incurring a cost. The use of radioactive isotopes also requires licensing (state-to-state in the US) and a radioactive materials control program; they are difficult to ship and transport, as they require hazardous materials declarations and/or permits. Consequently, the newest and most exciting development in Handheld EDXRF technology is the use of battery operated, miniature X-ray tubes, which was pioneered by the staff at Innov-X Systems.

Innov-X Systems Handheld EDXRF Spectrometers

Innov-X Systems specializes in Handheld EDXRF technology with the most advanced miniature components available for X-ray Tube sources, detectors, and PC 's. Innov-X Systems Handheld EDXRF Spectrometers are ideally suited for field analysis of alloys, lead-based paint, environmental soils, filters, dust wipes, forensics, archaeometry, and a variety of other elemental analyses in the field or around the plant. Innov-X Systems EDXRF Spectrometers are affordable, easy to use, reliable, and overall cost effective. The Innov-X Systems Handheld EDXRF units incorporate state-of the art components including a battery operated miniature X-ray tube, a high-resolution silicon pin detector, high speed data acquisition circuitry, and a Compaq IPAQ Pocket PC® handheld computer for calculations, results and operator interface.

Innov-X Systems EDXRF Spectrometers offer the following invaluable features:

- Portable
- Battery operated, rechargeable
- X-ray Tube-based (Ag or W anode, 10-40kV, 10-100uA)
- Si PiN diode detector.
- Integrated pocket PC
- Pistol-shaped design for difficult testing locations and welds
- Auto-compensation for irregular or small samples
- Fundamental Parameters for no-standard analyses
- Stored Grade Libraries for rapid Grade ID's
- Stored Fingerprint Libraries for rapid material ID's

- Docking station available for use as standard benchtop unit
- Results shown after a few seconds of testing time.

For more information on how to utilize your Innov-X Systems Handheld EDXRF Spectrometer optimally, please review this Instruction Manual or contact us directly.

Chapter 2. Usage and Assembly of Accessories

2.0 ACCESSORIES

This chapter describes the various accessories that are provided with an Innov-X XRF analysis system. Included are:

- Batteries
- Battery Charger
- iPAQ cradle and charger
- Testing Stand Assembly (not standard with all units)
- Standardization Clip or Standardization Clip/Welding mask.

2.1 ANALYZER BATTERY

The Innov-X Systems XRF Analyzer is powered by a replaceable, rechargeable Lithium ion battery. In addition, the iPAQ has its own internal battery.

Innov-X Systems Main Battery

The Innov-X Analyzer uses a rechargeable Lithium Ion Smart Battery. A picture of the battery is shown in Fig. 2.1. Two batteries are included with each analyzer. The batteries are charged an external battery charger. Batteries typically function for 4 to 8 hours, depending on usage patterns. Heavier duty cycles deplete the battery more quickly. Therefore, users who do longer and more frequent tests will need to replace their batteries more often than users who take shorter or fewer tests.

Figure 2.1. Li-ion Battery for analyzer

Replacement batteries can be purchased directly by calling Innov-X Systems at 781-938-5005. (P/N A003)

Battery power indicators:

There are two ways of determining the charge remaining on a battery: the LED indicator on the battery and the battery status icon on the analyzer screen. The battery icon, when tapped, will indicate the percent charge remaining on a battery inside the analyzer. Additionally, the battery icon will change from green to yellow when the battery gets low, indicating it has about 15 minutes left of charge.

To use the battery LED, push the button below the indicator. The lighting will indicate the % of charge. If possible, try to use batteries with at least 50% of their full charge, according to the indicator.

2.2 CHANGING A BATTERY

To change a battery, perform the following steps:

1. Hold the instrument by the handle, upside down, so the bottom of the instrument base is pointing upward. Please refer to Fig. 2.2.
2. Hold the instrument so that the nose is pointing away from the operator.
3. Open the battery door on the bottom of the handle. The batteries have a small tab attached for ease of removal.

4. Pull out the existing battery, and replace with a new battery.
5. Insert the charged battery into the analyzer such that the connectors on the top of the battery are facing to the right. Note that the battery slot is keyed so that the battery can only be inserted one way.

Figure 2.2a. Instrument handle. Pull the rubber latch and lift door. Reach into opening and remove battery.

Figure 2.2b Insert new battery into opening.

2.3 BATTERY CHARGER

The battery charger is shown in Fig. 2.3. It takes about 2 hours to completely charge a battery. The status of the charger is shown by two lights on the power adaptor. Table 2.1 lists the information conveyed by the lights.

Figure 2.3. Battery charger.

Left Light	Right light	Status
On	Off	Battery is charging
On	On	Battery is 80% charged
Off	On	Battery is completely charged
Blink	Blink	Error. Remove battery and replace on charger. If error persists, call Innov-X Systems Technical support.
Off	Off	No battery is on charger

Table 2.1 Battery charger status lights

2.4 HP IPAQ POCKET PC BATTERY

The iPAQ has an internal rechargeable battery, which can be recharged by using the power adaptor that is included with the unit. This adaptor can be connected either to the iPAQ itself, or to the cradle. If it is connected to the cradle, and plugged in, the iPAQ will recharge whenever it is placed in the cradle. In addition, the iPAQ Battery will recharge whenever the iPAQ is mounted in an Innov-X analyzer which is powered, but not actively taking a test. The amber light on the top of the iPAQ will blink whenever the battery is charging. It will remain solid when the battery is completely charged.

Since the iPAQ will be recharged whenever the Innov-X Systems Analyzer is in use, it may never be necessary to use the iPAQ power adaptor. However, care should be taken when the analyzer is not used for a period of several days, as the iPAQ uses some power even when it is powered off. It is therefore possible to completely discharge the battery simply by not using the iPAQ for several days, or by using it for several hours without recharging it.

If you do not use your Innov-X Analyzer on a daily basis, or if you will have a down period of more than several days, it is recommended that you remove the iPAQ from the Analyzer when it is not in use and plug in the iPAQ to a power outlet to recharge it. This will ensure that your iPAQ is always charged and ready for use. You should also always plug in the power cord whenever the iPAQ is removed from the analyzer for data transfer.

If you do allow the iPAQ battery to discharge significantly, either by allowing it to sit too long unused, or by using it for a period of time without it being connected to a power source, it may not be possible to operate your analyzer. If this happens, the Innov-X software will provide an error message indicating that the iPAQ battery is too low. Recharge the iPAQ for at least a half an hour before attempting another measurement.

If the iPAQ battery is completely discharged, it will not be possible to turn on the iPAQ until it is recharged. A complete power failure will erase anything that is stored in the Main Memory of the iPAQ. All Innov-X program and data files are stored on the storage card, rather than in Main Memory, so you will not lose any data or have to reinstall the Innov-X software.

1. If the battery on the iPAQ is completely discharged, charge it for at least one half hour.
2. You will be required to follow the prompts on the iPAQ screen before you can use the iPAQ. This procedure involves realigning the screen by tapping in several spots, and going through a quick tutorial.
3. The iPAQ will reinitialize the Innov-X Systems software. A message will appear indicating that this is going to happen. You must tap ok to initialize.
4. The software will open automatically; a message will appear indicating that several registries have been restored. Tap ok to dismiss this message.
5. Set the clock to the current time. **Note, this is very important,** as your data is indexed by date. If the date in the iPAQ is incorrect, you may not be able to locate your results. The instrument will not allow you to take a reading until the date has been changed.
    a. From the Start Menu, tap Settings.
    b. Select the System tab, and tap clock.
    c. Set the proper date. Further details about this procedure can be found in the HP iPAQ user's manual.

2.5 REMOVING THE IPAQ FROM THE ANALYZER

It is very important to properly remove the iPAQ Pocket PC from the analyzer to avoid damaging the connector on the back of the iPAQ.

In order to remove the iPAQ, push the iPAQ retainer shown in Fig. 2.4 towards the front of the analyzer. Holding the retainer forward, grab the iPAQ from the sides, slide the iPAQ forward until it is clear of its

connector, then tilt the front end up enough so it clears the front holder allowing the iPAQ to be lifted out of the instrument.

Note: Never grab the iPAQ and twist it side-to-side to remove it from the analyzer. Always move the iPAQ retainer forward as instructed above, slide the iPAQ forward and remove from the analyzer.

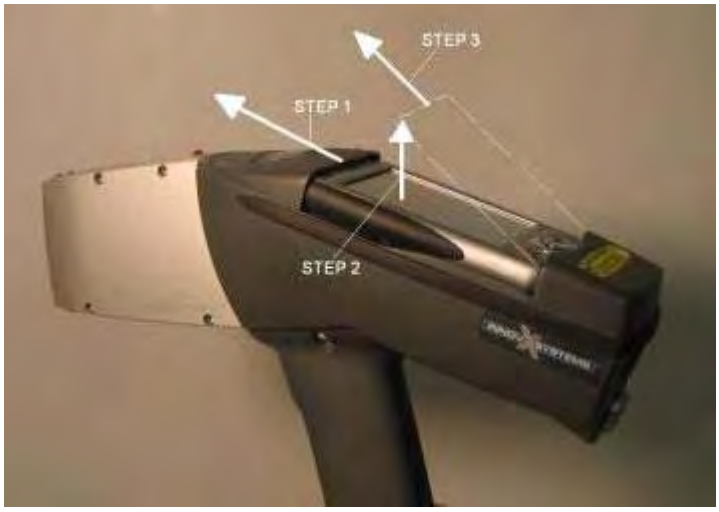


Figure 2.4. Removing the iPAQ from the analyzer.

2.6 STANDARDIZATION CAP and/or WELD TESTING MASK

All analyzers are supplied with either a standardization cap or a combination standardization cap welding mask. The standardization mask is the standard accessory. Welding masks can be purchased as an additional accessory, or in lieu of the standardization mask.

Standardization Cap

The cap clips on the front end of the analyzer and is used to standardize the system as described in Chapter 4. To attach the cap, snap it onto the nose of the analyzer over the Kapton window.

Combination Standardization Cap/Welding Mask

The standardization/welding mask is shown in Fig. 2.5. The cap clips onto the front end of the analyzer and is used to standardize the system as described in Chapter 4. To attach the cap, snap it onto the nose of the analyzer over the Kapton window. Be sure that when attaching the cap, that the solid end (as opposed to the end with the ¼" wide slit) is covering the window. To remove the mask, slide it off to either side.

The opposite end of the standardization cap serves as a welding mask. This mask is used to shield the base metal from analysis, when analyzing a weld. It is important to use this mask since failure to do so will produce an alloy chemistry that is a mixture of the base metal and the actual weld. For best results:

a. Use the welding mask only for welds that are larger than the opening in the mask;
b. Make solid contact between the surface of the mask and the material to test;
c. Use the mask only in the Analytical Mode – not with the standard Fast ID library;
d. Consider using longer test periods to compensate for the smaller testing area – especially with more difficult separations.

If it is desirable to use the welding mask in FastID mode, a user can create a special "Welding Mask Library." Teach all relevant alloys with the welding mask is in position. Make sure these fingerprints are

saved in library that contains ONLY fingerprints taught with a welding mask. When measuring a weld, make sure the "Weld" library is the only one selected. By creating a special finger print library using the welding mask, a user can get good results in the Fast ID Mode as well.

Figure 2.5 Standardization cap and welding mask. (Optional accessory)
The standard standardization cap does not have the welding slit.

2.7 TESTING STAND (optional accessory)

The testing stand is designed as a docking station for the handheld analyzer. It can be used as a bench-top system, or to test small samples. A list of components and an assembled stand is shown in Figure 2.6:

Figure 2.6. Assembled Testing Stand

Components of the testing stand:

1 Three (3) short legs
2. Three (3) long legs
3. Lower Stand
4. Upper Stand
5. Four (4) knobs for top plate
6. Test stand cradle
7. Clip for cradle.
8. Adaptor cable (connects serial connector on iPAQ cradle to auxiliary port on analyzer)

Assembly of Testing Stand

1. Insert the three Short Legs through the holes in the Lower Stand by inserting the threaded screw through the holes. This will balance the Lower Stand on the table top. (Fig. 2.7).

Figure 2.7. Mounting Lower Stand onto Short Legs.

2. Mount the three Long Legs onto the Lower Stand by inserting the threaded screws from the Short Legs into the holes on the Long Legs and turning until snug. Remove iPAQ from analyzer by following the instructions in Figure 2.4. Place the analyzer into the gap in the Lower Stand as shown. (Fig. 2.8).

Figure 2.8. Mounting Long Legs onto Lower Stand and inserting analyzer.

3. Mount the Upper Stand onto the Long Legs. The Upper Stand has holes for the screws at the end of each of the Long Legs. The Upper Stand will also fit snugly over the front end of the analyzer. Be sure that the Upper Stand is mounted so that all three screws are inserted through the holes, and the front end of the analyzer is flush with the top surface of the upper stand. (Fig. 2.9).

Figure 2.9. Mounting Upper Stand onto Testing Stand.

5. Put three knobs to secure testing stand onto analyzer. The iPAQ clip can be secured with any of the knobs. This clip grabs the base of the iPAQ cradle to hold the iPAQ securely in place.

6. Place the iPAQ in the cradle and connect it to the Auxiliary Port on the analyzer using the serial cable adaptor.

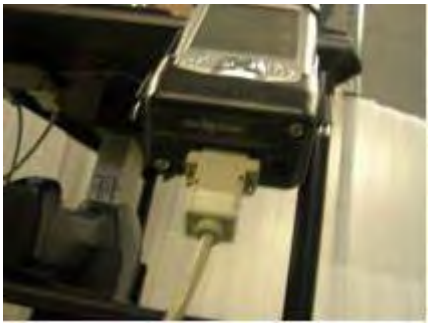


Figure 2.10. Connecting iPAQ to Auxiliary Port on analyzer.

Chapter 3 Safety Information

3.0 IMPORTANT SAFETY INFORMATION

THE XRF SHOULD NOT BE POINTED AT ANYONE OR ANY BODY PART, ENERGIZED OR DE-ENERGIZED! The safe and proper operation of the Innov-X XRF instruments is the highest priority. These instruments produce ionizing radiation and should **ONLY** be operated by individuals, who have been trained by Innov-X Systems, Inc. and received a manufacturer's training certificate. Innov-X recommends that operators and companies implement a written Radiation Safety Program, with safety components specific to the site and application of use of the instrument. The Radiation Safety Program should be reviewed annually and revised appropriately by a competent individual.

Innov-X analyzers must be used by trained operators, according to the instructions presented in this manual. Improper usage may circumvent safety protections and could potentially cause harm to the user. Pay attention to all warning labels and messages.

Important Notice for all Canadian Users:

Canadian Federal Regulations (Radiation Emitting Devices Act) require that all Canadian users must be certified according to NRC Standard CAN/CGSB-48.97/2-2000 in order to use this device.

For this certification contact: Natural Resources Canada, Manager Nondestructive Testing Certification, CANMET, 568 Booth St., Ottawa, ON, K1A 0G1; Tele: (613) 943-0583; Fax(613) 943-8297.

Users are advised to contact their appropriate federal/provincial./territorial radiation protection agency for applicable rules of operation.

The Innov-X analyzer is a very safe instrument when used according to manufacturer's recommended safety procedures as detailed in this chapter.

Radiation levels during testing are < 0.1 mR/hr on all surfaces of the analyzer except at or near the exit port for the radiation. This means that if an operator follows standard operating procedures, they will not obtain any detectable radiation dose above naturally occurring background radiation, on their hand while holding the analyzer, or on any area of their body.

This chapter details specifics of the radiation levels. It covers both standard (safe) and un-safe methods of operation, it provides radiation emission information, and also provides dose estimates for unsafe operations.

3.1 GENERAL SAFETY PRECAUTIONS AND INFORMATION:

Retain and follow all product safety and operating instructions. Observe all warnings on the product and in the operating instructions. To reduce the risk of bodily injury, electric shock, fire and damage to the equipment, observe the following precautions:

Heed service markings. Except as explained in this documentation, do not service any Innov-X product yourself. Opening or removing covers may expose you to electric shock. Service needed on components inside these compartments should be done only by Innov-X Systems, INC.

Damage requiring service:

- The power cord, plug or battery contacts for the battery charger are damaged.

- Liquid has been spilled or an object has fallen onto the instrument.
- The instrument has been exposed to rain or water.
- The instrument has been dropped or damaged.
- There are noticeable signs of overheating.
- The instrument does not operate normally when you follow operating instructions.

Safety Precautions:

Use the correct external power source: Ensure that the voltage is appropriate (100V-240 V/ 50-60 Hz) for charging the battery packs. Do not overload an electrical outlet, power strip, or convenience receptacle. The overall load should not exceed 80% of the branch circuit rating.

Use cables and power cords properly:
Plug the battery charger into a grounded electrical outlet that is easily accessible at all times. Do not pull on cords and cables. When unplugging the cord form the electrical outlet, grasp and pull the cord by the plug.

Handle battery packs properly; do not: disassemble, crush, puncture, short external contacts, dispose of in fire or water, or expose a battery pack to temperatures higher than 60 ^{o}C (140 ^{o}F).Do not attempt to open or service a battery pack.

WARNING: Danger of explosion if battery is incorrectly substituted. Replace only with Innov-X specified batteries. Used batteries may be returned to Innov-X Systems for disposal.

3.2 INNOV-X SYSTEMS – RECOMMENDED RADIATION SAFETY TRAINING COMPONENTS

Individual Companies and States have specific regulations and guidelines for the use of X-ray tube generated ionizing radiation. The purpose of the recommendations below is to provide generic guidance for an ALARA - best practice - approach to radiation safety. These recommendations do not replace the requirement to understand and comply with the specific policies of any state or organization.

1. **Proper Usage.** Never point the instrument at another person. Never point the instrument into the air and perform a test. Never hold a sample in your hand and test that part of the sample.
2. **Establish Controlled Areas.** The location of storage and use should be of restricted access to limit potential exposure to ionizing radiation. In use, the target should not be hand held and the area at least three paces beyond the target should be unoccupied.
3. **Specific Controls.** The instrument should be stored, in a locked case, or locked cabinets when not in use. When in use, it must remain in the direct control of a factory trained, certified operator.
4. **Time - Distance - Shielding Policies**. Operators should minimize the time around the energized instrument, maximize the distance from the instrument window, and shoot into high density materials whenever possible. Under no circumstances should the operator point the instrument at themselves or others.
5. **Prevent Exposure to Ionizing Radiation**. - All reasonable measures, including labeling, operator training and certification, and the concepts of time, distance, & shielding, should be implemented to limit radiation exposure to ***as low as reasonably achievable*** (ALARA).
6. **Personal Monitoring.** Radiation control regulations may require implementation of a radiation monitoring program, where each instrument operator wears a film badge or TLD detector for an initial period of 1 year to establish a baseline exposure record. Continuing radiation monitoring after this

period is recommended, but may be discontinued if accepted by radiation control regulators. Please refer to Sect. 3.10 for a list of providers of film badges.

3.3 INNOV-X SAFETY FEATURES

The Innov-X analyzer is very safe when used correctly, however the analyzer does emit radiation through the analyzer window, and all precautions must be taken to reduce exposure to this radiation. In order to minimize the possibility of accidental exposure, the following safety features are standard in all Innov-X analyzers.

1. "Deadman" trigger. The trigger must be held for the duration of the test. This requires that the user consciously depress the trigger whenever x-rays are emitted, and ensures that the analyzer is attended at all times while x-rays are emitted.

   Upon completion of safety training, an INNOV-X certified trainer may deactivate this feature upon request. The deactivation of the trigger is recommended only if long tests are required (such as for soil mode) and if the unit is used primarily by only 1 or 2 users who utilize it frequently, in a very controlled environment. In situations where multiple users are sharing the unit, it is recommended that the deadman trigger remain active.

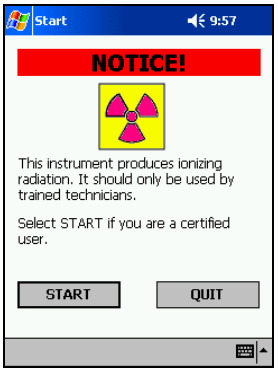
   Note: Canadian Regulations <u>require</u> that the deadman trigger be used at all times. This feature will not be disabled for usage in Canada.

2. Software Trigger lock. Before using the trigger, the user must tap on a lock icon located in the lower right hand corner of the iPAQ screen. The user must then confirm that they wish to unlock the trigger. If the instrument is used continuously, the software trigger lock will remain off. If five minutes elapse between tests, the trigger will lock automatically.

3. Software Proximity sensor. The software requires that a sample be present in front of the analyzing window. This prevents the accidental exposure of bystanders to an open beam. If the analyzer detects that a sample is not present, it will abort the test and shut off x-rays two seconds after the test is started.

3.4 PERFORMING A TEST FOLLOWING APPROPRIATE RADIATION SAFETY PROCEDURES

Starting the Analyzer:



When an operator opens the Innov-X software on the iPAQ, he or she will be presented with one of the displays shown to the right. Provided an operator has received training from an authorized Innov-X trainer, he/she should tap the START button to begin using the analyzer.

In Canada, INNOV-X ANALYZERS MUST BE OPERATED BY CERTIFIED USERS ONLY!

From this point the operator is presented with the main menu of the analyzer to choose an operating mode and begin testing (described in Chapter 4). The remainder of this section is dedicated to operational and safety aspects that pertain to safe use and storage of the analyzer.

Starting a test using the trigger.

When the trigger is depressed, the analyzer supplies power to the x-ray tube and opens the shutter to emit x-rays.

If deadman trigger is enabled, the trigger must be depressed for the duration of the test. Releasing the trigger will close the shutter and immediately end the test. If deadman trigger is disabled, pulling the trigger once will start a test, pulling it again will stop it.

Figure 3.1 Handle of analyzer. Trigger is located at top of handle.

Starting a Test Using the "Start" Icon on the iPAQ Screen

This feature is disabled in all units shipped. It will become active only if the "deadman" trigger is disabled.

An operator may also begin a test by pressing the **Start** button on the touch screen, as shown at the right. The **Start** button, rather than the trigger, is generally used when the analyzer is docked into the testing stand.

This Feature is not available in Canada. All tests must be started via the trigger.

3.5 CORRECT AND INCORRECT INSTRUMENT USAGE:

The Innov-X XRF analyzer can be used in several different testing configurations. Safety guidelines are described for each configuration.

Configuration 1: Usage as a Handheld Alloy Analyzer:

In this configuration the analyzer is held in the hand, placed on various types of samples and a test is performed. Samples include pipes, valves, large pieces of scrap metal, basically any sample large enough to be tested in place, rather than held in the operator's hand. Point the instrument at a metal sample such that no part of your body including hands and/or fingers is near the aperture of the analyzer where x-rays are emitted.

Using the analyzer in this manner assures that the operator will not obtain a radiation dose to any body part or extremity in excess of naturally occurring background radiation. The radiation at any surface of the analyzer is < 0.1 mR/hr except at the exit port and the immediate area around the exit port.

The user should take care that personnel are not located within 3' (1 m) of the front end of the analyzer during testing, in the direction of the x-ray beam. Provided the analysis window is completely covered, there is virtually no radiation being emitted around the area of the sample. However, if a small component or curved surface is being analyzed, some radiation will be detectable.

Configuration 2: Usage in the Testing Stand

Innov-X strongly recommends that testing small pieces or small samples (rod, fasteners, turnings, XRF sample cups, bagged samples, etc.) be analyzed using the Innov-X Testing Stand. This allows the sample to be placed onto the analysis window of the analyzer without requiring the sample to be held by the operator. See figure below titled "Testing Stand Operation."

Note for Canadian Usage: The testing stand is not available for use in Canada at this time because it has not received regulatory approval yet. When an interlocked version of the testing stand has received regulatory approval, it will be available for sale into Canada. Please contact Innov-X Systems for an update on this process at 781-938-5005.

Figure 3.2 Testing Stand Operation. Please refer to **Section 2.7: Testing Stand** for assembly instructions.

Warning: Innov-X strongly recommends that operators do NOT hold samples in their hand for testing. Never hold a small sample in your hand, and test that sample, such that your hand is exposed to the x-ray beam being emitted from the analyzer. This type of testing produces a small but non-negligible radiation dose to the operator's hand. Please see **Section 3.7: Radiation Doses for Several Scenarios** for dose levels. Also, see **Figure 3.4** for an example of incorrect usage.

Figure 3.2.

Testing of Small Components:

Operators often are required to test small components, particularly in the field of alloy analysis. Examples of small samples include turnings, weld rod, wires, fasteners, nuts and/or bolts.

There are specific procedures to test small components. These procedures should be followed at all times. **Never hold a small part with your fingers or in the palm of your hand and perform a test. Doing so may deliver a significant dose of radiation to your fingers or hand.** Please refer to the Examples of Mis-use below.

Method 1: Testing a sample lying on a flat surface.

Figures 3.2.: Performing a testing for a sample lying on the surface of a table. This is a good way to test small samples, rather than holding them in your hand.

To analyzer small sample:

- Place the sample onto a flat surface.
- Place the window of the analyzer onto the sample and begin the test.

Safety Precautions:

Do not test samples in this manner at a desk or table where the operator is sitting. If the desk is made of wood or another non-metallic material, some radiation will penetrate the desk and may provide exposure to legs or feet if the operator is sitting at the desk or table.

Analytical Precautions:

If the sample does not completely cover the window, be sure the surface used does not contain metals or even trace levels of metals, as this may affect the accuracy of the XRF result. The XRF may report the presence of additional metals in the surface material. For this type of testing, it is good to place the sample onto a piece of 1100series aluminum alloy and perform the analysis. The operator should disable the aluminum analysis capability (See Section 8.3.3 in the manual for instructions).

Method 2: Use the testing stand as described above (see also Fig. 3.2).

Examples of Incorrect and Possible Unsafe Operation:

Improper Operation, DO NOT TEST SAMPLES LIKE THIS:

Exposure to the operator's hand/fingers will likely be minimal for this type of a testing, because the operator's hands and fingers are not in the primary beam. However, Innov-X believes that this type of the analyzer sets a poor safety precedent in that any operation where the operator places their fingers or hands near the window should not be permitted.

Figure 3.3. Incorrect Usage. While the dose to the operator's fingers/hand is negligible, testing this way sets a poor safety example for other operators, possibly encouraging other unsafe usage. Innov-X strongly recommends against this type of testing.

DO NOT TEST SAMPLES LIKE THIS:
Never hold a sample in your hand such that any part of your body or appendages are exposed to the x-ray beam. Testing samples in this way may generate significant radiation exposure (up to 27 R/hr) to the operator's fingers.

Figure 4.4 Extreme example of incorrect usage. An operator should NEVER hold small samples by hand

3.6 RADIATION WARNING LIGHTS AND LABELING:

3.6.1 Main Power switch and Indicator Light:

The main power switch is found on the rear of the unit and is shown in the figure to the left. Pressing the switch for several seconds will turn on the main power. A green LED indicates the main power is on. The main power must be turned on in order to operate the unit however, this switch DOES NOT turn on the x-ray tube. No power will be supplied to the x-ray tube unit the Innov-X software is started.

3.6.2 Probe Light and Probe Label:

The Innov-X analyzer is equipped with warning lights that alert the operator when the tube is receiving power, and when x-rays are being emitted from the analyzer. Please see Fig. 3.5.

When the red light on the front nose of the analyzer is ON continuously (not blinking), this indicates the x-ray tube is receiving a low level of electrical power and the shutter is closed. The system is producing a low level of x-rays internally in this condition, but the shutter is providing adequate shielding to keep x-ray levels below levels of detection. The instrument is safe to be carried around or set down in this configuration.

When the red light is blinking, this indicates the tube is powered, the shutter is open and the analyzer is emitting x-ray radiation out of the analysis window. The analyzer should only be pointed at a sample, or be in the testing stand with a sample resting on the window, in this configuration.

3.6.3 Display on Back of Analyzer:

The display on the back of the analyzer, shown in Fig. 3.6, provides a "testing" message to indicate that the x-ray tube is energized and the shutter is open. This display is for testing conditions (i.e. overhead) where the operator cannot see the Probe Light or the iPAQ display.

3.6.4 Label Behind iPAQ:

The analyzer also has a label just below the iPAQ indicating, as shown in Figure 3.7:

CAUTION: Radiation. This Equipment Produces Radiation When Energized.

This label is required by most regulatory agencies. The term "When Energized" refers to the condition where the tube is fully energized and the shutter is open. This condition is also indicated by the red blinking light on the probe.

Figure 3.5. Probe light and labeling. When the light is on continuously, the x-ray tube is receiving minimal power and it is producing a minimum level of x-rays. The shutter is also closed so there is no radiation exposure to the operator or bystanders.

Figure 3.6. Back light on analyzer.

Figure 3.7. Label behind iPAQ. Top version is used in Canada

3.7 RADIATION LEVELS FROM ANALYZER

Two pictures of the analyzer are shown below. In the first picture, all the relevant components referenced in this radiation safety section are displayed and labeled. The second picture shows a close-up of the front end of the window. The four sides A, B, C and D are indicated on this picture because they are referenced in terms of radiation levels output by the analyzer. The measured radiation levels for standard operating conditions are shown in the figures and tables below. Standard operating conditions are tube voltage operating at 35 kV, tube current of 5 uA, and 2 mm aluminum filtration.

Figure 3.8 Innov-X Analyzer, Side View

Figure 3.9 Innov-X Analyzer, Front View

Radiation Levels (mrem/hr) for Alloy Analysis, Standard Beam Conditions: 35kV, 5 uA, 2mm aluminum filtering:

Sample at Window	Trigger	Location A (Top)	Location B (Right Side)	Location C (Bottom)	Location D (Left Side)
Blank (Air)	<0.1	<0.1	<0.1	<0.1	<0.1
Metal	<0.1	<0.1	<0.1	<0.1	<0.1

Table 3.1. Dose rates (units of mrem/hr) at various locations with a metal sample covering the window and with no sample present. For "no sample" the analyzer is shooting the x-ray beam into air.

As shown in the Table 3-1, the dose to the operator's hand is negligible. The radiation levels at the side surfaces of the instrument snout (aluminum housing) are all <0.1 mrem/hour. Despite these low levels of radiation, there is no reason for any body part to be in the locations denoted A, B, C and D!

Table 3-2 shows the radiation levels directly in the x-ray beam that is emitted from the analyzer. Radiation levels at the exit aperture (or "port") are substantial. There is no reason for the operator or any personnel to be exposed by the direct beam. Operators should never hold samples in their fingers or cupped in their hands, as this may generate a significant radiation exposure.

Operations should never point the analyzer at another person and start a test, as this may also provide significant exposure to the person if they are within a few inches of the port of the instrument.

Radiation Levels in the Primary Beam Versus Distance from Port:
For Alloy Analysis, Standard Beam Conditions: 35kV, 5 uA, 2mm aluminum filtering:

Tube Conditions	At Trigger, or any part of operator's body.	At Window	4 inches	12 inches	36 inches	48 inches
35 kV, 5 uA, 2 mm Al filtering	<0.05	28,160	2,080	186	24	14
15 kV, 25 uA, thinner filter material	< 0.05	27,780	1,620	145	19	11

Table 3.2. Dose rates (units of mrem/hr) in the direct x-ray beam being emitted from the analyzer

3.8 RADIATION DOSES FOR SEVERAL SCENARIOS

In this section we provide data, concrete examples of use and misuse of the analyzer and common questions and answers we encounter when training personnel on the safe use of the Innov-X analyzer. The goal is to explain scenarios of safe versus improper usage of the analyzer.

The table below presents radiation doses for normal operating conditions and also for examples of misuse of the analyzer and even extreme misuse. Innov-X provides installation training that includes detailed radiation safety training and documentation designed to prevent misuse of the analyzer

Example of Instrument Usage	Radiation Exposure and Comments
Normal Operation - Dose to Hand: User analyzes samples according to standard operating procedures described in this manual. Assumption: Operator using system with x-ray tube ON for 8 hours/day, 5 days/week, 50 weeks/year. (Practically constant usage).	Maximum exposure is to operator's hand, at the trigger. Exposure is < 0.1 mrem/hr. Annual exposure to hand is then < 200 mrem (2mSv). US: Maximum exposure under OSHA regulations is 50,000 mrem annually. Thus continuous operation provides a dose that is at least 250 times lower than maximum allowed by OSHA. Canada: Maximum exposure under ICRP regulations is 500 mSv for radiation workers and 50 mSv for the general public. Thus continuous operation provides a dosage 250 times lower for a radiation worker and and 25 times lower for the general public.
Normal Operation – Dose to Torso: Analyzer is used under the same operating conditions described above.	Exposure to Torso is so low it cannot be measured. To be conservative we use the same figure as the trigger, <0.1 mrem hr. Annual exposure using operating conditions above is < 40 mrem. (0.4 mSv) Maximum allowed is 5,000 mrem under OSHA and 20 mSv under ICRP for radiation workers (1 mSv for general public).

For the x-ray energy emitted by portable XRF analyzers (10-60 keV region), the bone in the fingers will absorb radiation about 3-5 times more than soft tissue, so the bone would be at an elevated radiation risk compared to soft tissue. For this reason no person shall hold a test specimen in front of the window with the fingers in the direct beam, or direct the beam at any part of the human body. Reference: Health Physics 66(4):463-471;1994.

Misuse Example 1: Operator holds samples in front of window with fingers, such that fingers are directly in the primary beam. Do not do this!.	For fingers at the port, in the primary beam, the maximum dose to the fingers is 28,160 mrem/hr. Assume an operator performs a 10 sec test (typical). The dose to the operator's fingers or hand is 28,160 x (10/3600) = 78 mrem. If the operator did this 641 times/year they would exceed the allowable annual dose of 50,000 mrem to an extremity. In Canada, the maximum allowed dose is 500 mSv/year (Canada ICRP radiation worker) or 50 mSv/year (Canada ICRP general public). If the test time was 30 seconds instead of 10 seconds, the operator would receive a dose of 234 mrem for each exposure, and thus would exceed the annual safe limit of 50,000 mrem after 213 tests. Even though it is unlikely to make this mistake so many times in a year, do not even do it once. Take the extra time to test a sample on a surface or use a testing stand. **Note: If the operator takes an average of only two shortcuts per week and places his/her fingers within the primary x-ray beam at the window, they will exceed the annual dose rate.**

Misuse Example 2:
Operator places analyzer against body and pulls the trigger to start a test. Analyzer tests to preset testing time (usually 10 seconds) unless operator pulls trigger again to stop test. This applies to analyzer being in contact with operator or with bystander.

Dose at exit of sampling window is 28,160 mrem/hr.

Dose for a 10 second exposure with analyzer in contact with Torso: 78 mrem (.78 mSv).
US: If an operator did this act 64 times in a year, the operator would exceed the annual safe dosage to the torso of 5,000 mrem/year. The maximum dose of 5,000 mrem/year is a whole body limit, which does not truly apply in this case because the x-ray beam size is small (about 2 cm^2 area – 1.5 cm x 1 .3 cm – at the port). Applying correction factors for the beam size is complex and beyond the scope of this manual. The important point is that for proper operation there is no reason to ever exposure any part of the human body directly to the x-ray source. This example serves to provide estimated exposure in the event this occurs.

If the testing time was 30 seconds instead of 10 seconds, thus the operator placed the port against his body or that of a bystander and performed a 30 second test, the dose would be 234 mrem. This is about the same as a mammogram. Repeating this gross mis-use 22 times would exceed the annual allowable limits.

Canada: Radiation worker would have to repeat this example (234 mrem exposure) of gross misuse 8 times to achieve the ICRP level of 20 mSv. (general public 1.3 times to achieve limit of 1mSv)

Misuse Example 3:
Operator manages to initiate a test for 10 seconds and exposes a bystander that is standing 12" away from analyzer port. What is exposure to bystander?

Note: The proximity sensor would automatically shut down the x-ray tube after 2 seconds, so this is an extremely improbable occurrence.

Note 2: Equations to scale these to other scenarios involving longer or shorter tests, and bystander being at distances other than 12" are provided at right.

Dose to bystander at 1 foot is 350 mrem/hr. For a 10 second exposure dose is 1 mrem. This is 5,000 times lower than the allowable dose to a worker in a year. This would have to happen 5,000 times to for that worker or bystander to obtain the maximum allowable dose.

Formula for calculating other scenarios:

$$Dose = 1mrem\left(\frac{13.25}{D+1.25}\right)^2 x\left(\frac{t}{10}\right)$$

D = distance from port in inches
T = testing time

Example: Bystander is 3' away from port for a 30 second test. In this case the dose is calculated as:

$$Dose = 1mr\left(\frac{13.25}{36+1.25}\right)^2 x\left(\frac{30}{10}\right) = 0.38mrem$$

US OSHA: Maximum allowable level is 5,000 mrem assuming bystander's torso is exposed. Thus, this misuse would have to occur 12,500 times in a year to the same bystander before that bystander achieved his maximum allowed dose.
ICRP: 5000 times for rad worker, 250 for general public

Comparative: Radiation Doses from Typical Exposures to Ionizing Radiation

Common medical and/or dental x-rays:	20-30 mrem each.
Mammogram:	100-200 mrem
Flying in a commercial jet coast to coast (6 hrs.):	1-2 mrem.
Daily exposure from background radiation: * depends on geographic location	0.3 to 0.5 mrem/day

Table 3.3 Radiation Doses from Typical Exposures to Ionizing Radiation

From the above table, a single case of analyzer misuse, thus producing a one-time exposure of 70-250 mrem, is comparable with single-event common medical x-ray procedures such as an annual chest x-ray or mammogram, or 25-50 airline flights in a year, and thus is not considered harmful. Regular misuse, such as taking safety shortcuts twice weekly, produces radiation exposure that greatly exceeds these typical levels and should be avoided entirely.

3.9 COMMON QUESTIONS AND ANSWERS REGARDING RADIATION SAFETY

Question: When I'm shooting a piece of pipe or valve on a rack or on a table top, is there any exposure to people standing in other locations, or standing several feet away from the analyzer?

> Answer: Even a thin amount of metal sample (1-2 mm thickness) is enough to completely attenuate the x-ray beam emitted from the Innov-X analyzer. Shooting a piece of material that covers the sampling window on the analyzer will completely shield any bystanders from radiation exposure. However, good practice recommends that the area for at least 4-5 feet in front of the analyzer is clear of people.

Question: If I forgot to switch the safety on the trigger to "ON", I pick up the analyzer and accidentally pull the trigger, is that dangerous to nearby personnel?

> Answer: No, this example of misuse is not dangerous, but it may produce a non-negligible radiation exposure to nearby personnel. For an exposure to occur, the following things must happen. First, you must be holding the analyzer so that a bystander is actually standing in the x-ray beam being emitted. Just being near the analyzer is totally safe otherwise. Second, the bystander must be within 1-3 feet from the nose of the analyzer in addition to being in the beam path, to receive any appreciable dose. If all of these conditions are true, the dose received by a bystander is still extremely low. It ranges between 0.1 to 0.5 mrem depending on the exact location of the bystander. This dose is 10,000 to 50,000 times less than the allowed dose. Please see Misuse Example 4 in the table above.

Question: Do I need to create restricted areas where I am using the analyzer?

> Answer: No, provided you are following normal operating procedures there is no reason to restrict access to an area where the analyzer is in use. The operator should take precautions to keep any personnel more than 3 feet away from the sampling window of the analyzer in the event of accidental misuse as detailed above. Should the operator also elect to test small components like weld rod as shown in Figure 3.3, the operator should also be sure that no personnel are standing within about 4-5 feet of the sampling window.

Question: How does the x-ray tube in the Innov-X system compare to a radiography system used for taking images of metal parts.

Answer: The x-ray tube used in the Innov-X system produces between 1,000 and 10,000 times lower power than most radiography systems (0.5-1 watt for Innov-X versus kW for radiography systems). This is because a portable XRF is designed to perform surface analysis of alloys and other samples, whereas radiography systems are designed to shoot x-rays entirely through metal components in order to obtain an image on the other side of the object being bombarded with x-rays. For example, many tube-based radiography systems use a 300-400 kV tube and currents in the tens or hundreds of milliamps (mA). The Innov-X analyzer uses a tube operating at 35 kV and 5-30 micro-amps. The radiation levels produced are therefore thousands or tens of thousands times lower with the Innov-X system.

Question: Should we use dosimeter badges with the Innov-X analyzer.

Answer: Dosimeter badges are required by some states, and optional by other states. Innov-X recommends that operators wear badges, at least for the first year of operation, as a general precaution to flag any misuse of the analyzer. Dosimeter badges are available for the torso (generally worn on the belt loop or shirt pocket) and are available as "ring" badges. The best single badge to obtain is a ring badge that is worn on a finger, on the opposite hand used to hold the analyzer. This will record accidental exposure for the most likely case – an operator grabbing a small sample and holding it in one hand while analyzing it. Note: these badges generally have a threshold of 10 mrem, and are renewed monthly. So it will take several cases of misuse even to obtain a reading on a typical badge. When purchasing a badge, obtain the type used for x-ray and low energy gamma ray radiation.

3.10 SAFE GUARDS AND EMERGENCY RESPONSE

The main safeguards to use as an owner of an Innov-X portable XRF are really intended to restrict access to properly trained operators:. **Note: Canadian regulations require certified personnel to use the device, refer to section 3.0 in this chapter.**

1. Keep the system in a controlled location, where only authorized users are likely to have access to the analyzer at any given time.
2. Make a simple sign that is kept with the analyzer indicating that an operator must have completed a training class provided by your company or must have attended an Innov-X training course in order to use the analyzer. Note that when the Innov-X system is turned on, the screen displays a message indicating that the system should only be used by authorized personnel.

Emergency Response:

Because the Innov-X system is a battery operated, x-ray tube based analyzer, the emergency response plan is very simple. If the operator believes the analyzer is locked up in an "OPEN" position, they should do two things:

1. Press the On/Off switch on the base to power the analyzer off. The green LED indicator will turn off, indicating system power is off. At this point it is not possible for the analyzer to be producing x-rays.
2. As an additional precaution, the operator may remove the battery trap door at the bottom of the analyzer (have the nose pointing away from personnel), and pull out the battery. Even if the operator has failed to properly power the system off in Step #1, removing the battery guarantees that no x-rays can be produced. There is no electrical power being provided to the x-ray tube.

Note: It would be highly unusual for an operator to somehow lock up the analyzer with the x-ray tube powered on. This would require the operator to crash the iPAQ during an analysis. If this happens the analyzer will shut off the x-ray tube 10 seconds after the last communication with the iPAQ. However, if at any time the operator believes the x-ray tube is on and no test is in progress, powering off the analyzer and

restarting will automatically shut down the x-ray tube and close the shutter. It will no longer be possible to produce x-rays at this point.

3.11 DOSIMETER BADGES

Dosimeter badges are provided as a monthly service by several companies, listed in this section (see below). The badges are generally provided monthly, and the operator returns the previous month badges to the company for analysis. The operator receives a monthly report showing any personnel with readings higher than typical background radiation.

Dosimeter badges are required by some states, and optional by other states. Innov-X recommends that operators wear badges, at least for the first year of operation, as a general precaution to flag any misuse of the analyzer. Dosimeter badges are available for the torso (generally worn on the belt loop or shirt pocket) and are available as "ring" badges. The best single badge to obtain is a ring badge that is worn on a finger, on the opposite hand used to hold the analyzer. This will record accidental exposure for the most likely case – an operator grabbing a small sample and holding it in one hand while analyzing it. Note: these badges generally have a threshold of 10 mrem, and are renewed monthly. So it will take several cases of misuse even to obtain a reading on a typical badge. When purchasing a badge, obtain the type used for x-ray and low energy gamma ray radiation.

Dosimeter Companies:

Here are two companies that provide badges as a regular service. There are certainly many more.

Landauer Inc. Glenwood, IL 708-755-7000	AEIL Houston, TX 713-790-9719

3.12 TYPICAL REGISTRATION REQUIREMENTS

Innov-X maintains a database of the registration requirements for every state, including sample registration forms. Most states require some form of registration, and generally they require the registration to be received within 30 days of receipt of the instrument. Some states require no registration, while a few require notification in advance. Please contact Innov-X for specific questions regarding the state where the instrument will be used, or for copies of registration forms.

In general a company will have to provide the following information regarding the device:

1. Purpose of device. Generally this is "Analytical" or "Industrial." Be sure to inform the state registration office that the device will NOT be used for radiography or for medical uses.
2. Radiation Safety Officer – Monitors training, safe use, and controls access to the instrument.
3. Authorized Users – Trained by Innov-X Factory Authorized Representatives in the safe and proper use of the XRF.
4. Operating parameters of the analyzer – 35 kV, 5-30 micro-amps.
5. Type of system, either fixed, mobile or portable. Generally the correct choice is "Portable."
6. User Training Specified – Indicate that only individuals receiving manufacturer training, documented by a manufacturer's training certificate will operate the instrument.
7. Personal Monitoring. This may be required by radiation control authorities. Many registration forms will ask that you indicate whether or not you intend to perform dosimeter monitoring.
8. Copy of Registration & Manual at the Job Site

If you have any questions regarding the type of registration form or filling out the form, please contact Innov-X Systems. Many states may confuse a portable XRF system that uses a tube with medical or

industrial radiography systems. This is because of the relative newness of portable tube-based systems. In all likelihood, Innov-X personnel have experience providing the necessary documentation to the state in question, and can readily assist the customer in this process.

Chapter 4 Operation

4.0 OPERATION - GENERAL

Power to the instrument is controlled by the ON/OFF button located at the rear of the analyzer. The green LED next to this button will illuminate when the analyzer power is on. The iPAQ operates on the Microsoft Windows CE ® operating system and is activated separately by the power button on the right top face, just over the display. The trigger is locked via the software.

4.1 WORKING WITH THE HP iPAQ Pocket PC®

The Microsoft Windows CE ® operating system and Innov-X software provided on the iPAQ handheld computer are operated by user input through the touch screen. For comprehensive details on the iPAQ's operation, please refer to the iPAQ reference materials included with your unit.

General tips

- The Start Menu is found in the upper left corner of the iPAQ screen. This is used to launch all applications, including the Innov-X Systems Analyzer software.
- The instrument is designed as a "point and shoot" system that requires little, if any, entry of information for most operations. In the event the user modifies the grade library, enters testing information data, or performs other functions, it will be necessary to enter data via the virtual keyboard, which can be accessed by tapping the keyboard icon in the lower right corner. The iPAQ also includes character recognition software. This can be selected from the drop-down menu to the right of the keyboard icon.
- The File toolbar which will be used to Change Functions, Screens and Options is located at the bottom of the screen.
- It is possible to cut, copy, rename and delete files from within Windows File Explorer by selecting the file to be modified and holding the stylus on the screen for 2 seconds.
- Pressing buttons on the bottom of the iPAQ will perform various functions that are described in the iPAQ documentation. The button on the right hand size of the analyzer is the iPAQ task manager. Pressing this button will show all programs that are currently open. Open files can be closed from this menu. Simply hold the stylus on the file for a few seconds. The option to close the file will appear.

4.2 OPERATION - MAIN SOFTWARE SCREENS

The Innov-X Software consists of three main screens:

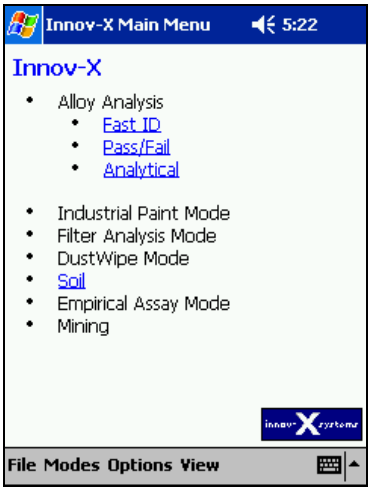
- **Main Menu screen:** Used to select the analysis mode, open the results screen, and change the administrator password.
- **Analysis Screen:** Used to change settings, edit libraries, and perform tests.
- **Results Screen:** Displays results from current reading, allows scrolling back to previous test results. Allows recorded data to be exported to a comma delimited file which is directly compatible with Microsoft Excel.

4.2.1 Innov-X Main Menu

The main menu below appears upon startup. The Main Menu allows you to choose an analysis mode, as well as perform certain administrative functions such as changing your login password. The modes which

are available on the analyzer are shown in blue. For information on adding additional analysis modes to an analyzer, please contact the Innov-X Sales Department at 781-938-5005.

- **Use the Main Menu to select the desired analysis mode.** The analysis mode can be selected by either tapping on the name of the method (shown in blue) or by selecting the appropriate mode from the Modes menu.
- The administrative password can be changed by selecting ***Options → Change Password.***
- It is possible to go directly to the Results Screen by selecting ***View→Results***. If the results screen is opened in this manner, it is possible to view results when the iPAQ is not connected to the analyzer.



4.2.2 The Analysis Screen

Selecting a mode opens the analysis window for that mode. All data acquisition and analyzer control are done from this window. This window allows the user to start or stop an analysis, change testing parameters, and modify the fingerprint and grade libraries (Alloy Analysis only).

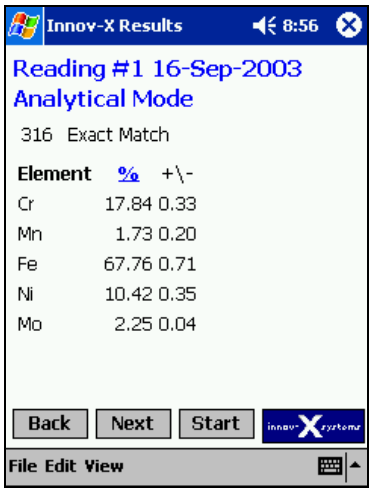
The analysis screen runs continually while during normal instrument operation. From the results menu, it is always possible to go back to the Analysis screen by selecting ***File→Exit*** or by tapping the X in the upper right hand corner of the screen.

The analysis screen for Analytical mode is shown to the right. Screens from other modes are similar and will be described in later in this manual. The analysis screen shows the name of the mode that is currently active, a start/stop button (which is inactive in most cases), an info button that is used to enter descriptive information for any given test, a trigger lock and a battery indicator. In addition, a message appears directly below the name of the mode which will indicate the current state of the analyzer. Typically it reads "Ready to Test," but also provides other information in certain circumstances. Any mode specific information will be displayed at the bottom of the screen above the menu choices.

4.2.3 The Results Screen

The Results screen displays the current reading and old data. All data handling functions such as exporting and deleting readings are carried out from this screen. Once the Results Screen is open, the user may start new tests without going back to the analysis screen by pulling and holding the trigger. Tapping the X in the upper right hand corner will return the user to the analysis screen without starting a test. If no analysis mode is running, an Exit button will appear which will close the Results screen.

The Results screen is automatically shown at the completion of any analysis. It can also be accessed from the analysis screen for any mode or the **Main Menu**, by selecting ***View→Results***. Once the Results screen has been opened, the information which is displayed can be changed by selecting options from the View menu. The various viewing options will be described in detail in later chapters.



4.3 PASSWORDS - ABOUT PASSWORD PROTECTION

Certain functions such as adding and deleting fingerprints from the libraries, and Pass/Fail setup have been specified as Administrative Level Functions. These functions are described in detail in later sections of the manual. In order to use these functions, a password must be entered. The default password is set as the lowercase letter "z". This password can be entered whenever the system prompts for a password.

Changing the Administrator Password.

The Administrator password may be changed at any time from the **Innov-X Main Menu** by choosing ***Options→Change Password***. When the change password option is selected, this screen will appear.

If you are changing the password for the first time, enter the letter "z"; otherwise enter the current system password. Then, choose a password and enter it twice, once in the "New Password" box and again in the "Confirm Password" box. Passwords may be any combination of letters or numbers.

4.4 STANDARDIZATION

4.4.1 Standardization Procedure

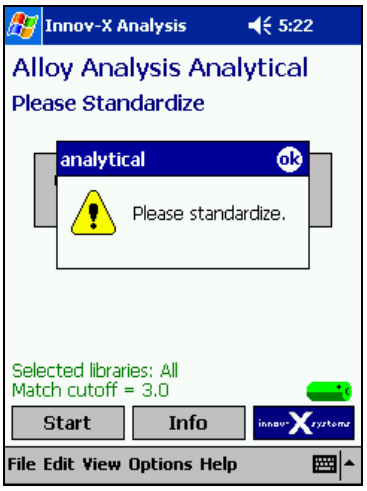
Before performing tests, it is necessary to standardize the instrument. This automated procedure involves collecting a spectrum on a known standard (Alloy 316) and comparing a variety of parameters to values stored when the instrument was calibrated at the factory. If there are any problems with the instrument, they will be indicated by an error message.

The standardization procedure takes about 1 minute. Standardization must be done any time the analyzer hardware is initiated or restarted and must be repeated if the instrument is operating for more than 4 hours.

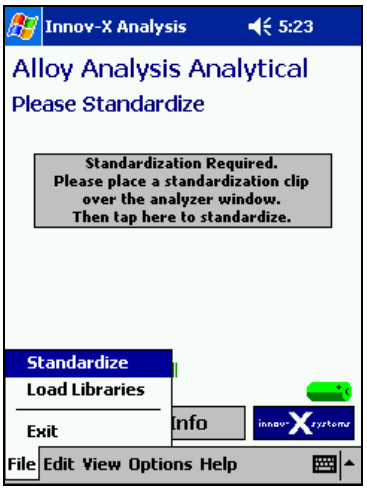
It is possible to re-standardize the instrument at any point while the software is running. Standardization is always initiated from the Analysis Screen of any Mode.

If the analyzer is restarted, you will be required to standardize the instrument before performing any measurements. This is indicated by the message "**Standardization Required. Please place a standardization clip over the analyzer window. Then tap here to standardize.**" on the analysis screen

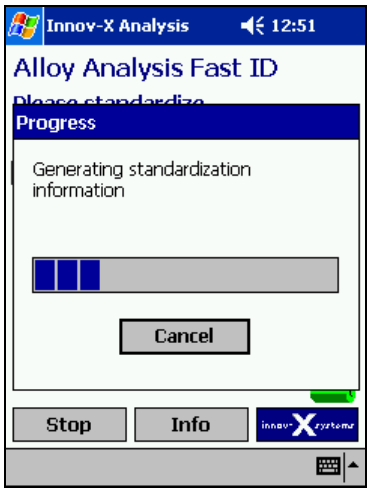
It is not possible to start a test before standardization. If the trigger is pulled before the standardization procedure is completed, a message box will appear. Press **ok** to acknowledge and clear the message.



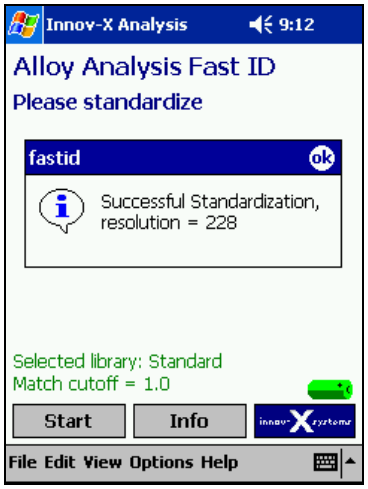
To initiate the standardization procedure, snap the standardization piece on the front of the instrument. Verify that it completely covers the analyzer window. When using a standardization mask with a weld collimator, be sure that the solid portion of the mask covers the analyzer window. Tap the grey box in the center of the screen or select ***File→Standardize*** to begin.



When standardization is in progress, the red light on the top of the instrument will blink, indicating that the X-ray tube is energized and the shutter is open. In addition, a status bar will appear, tracking the progress of the measurement.

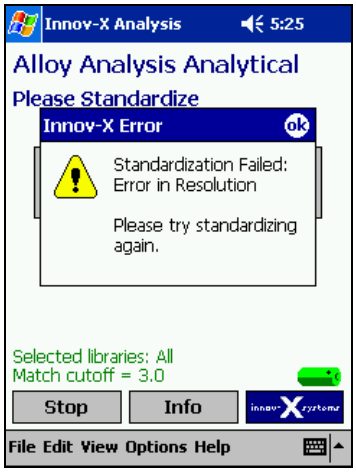


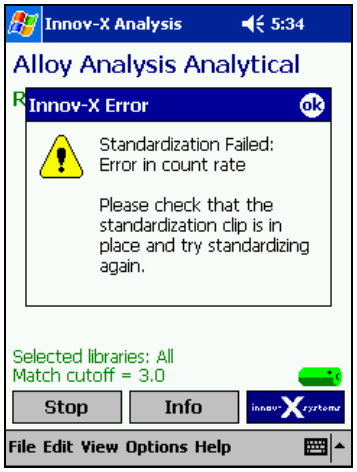
When standardization is complete, the message "Successful Standardization" will appear, along with the resolution of the instrument. Tap **ok** to acknowledge and clear the message. The instrument is ready for testing.



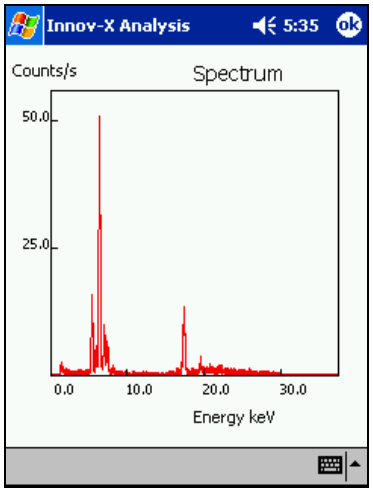
4.4.2 Standardization Errors

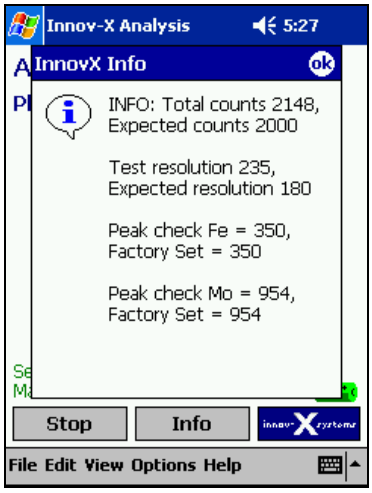
The analyzer performs several diagnostic checks during the standardization process. If the standardization fails, the instrument will prompt the user regarding the next step. Several errors could occur while standardizing: "Wrong Standardization Material," "Error in Resolution" or "Error in Count Rate"





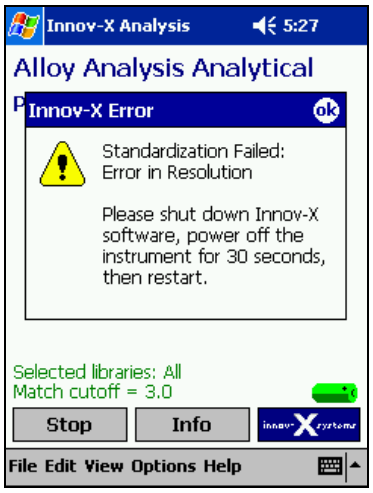
After closing the Standardization Failed message, two additional screens will appear. The first is a picture of the spectrum generated during the standardization. The second is a summary comparing factory set values for resolution, count rate, and peak positions to values calculated during the standardization.

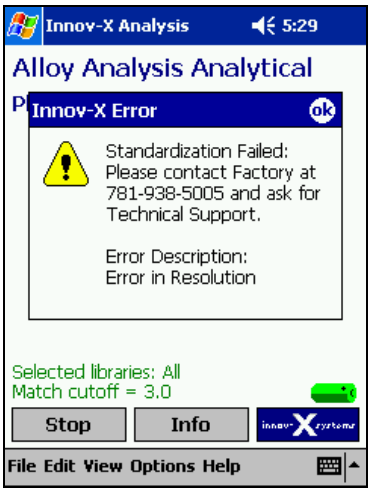




When standardization fails, verify that the standardization mask is in place, and attempt standardization again. To restandardize after a failure, tap the grey box in the center of the display, or choose ***File→Standardize***. If you are using a weld collimator, make sure that the solid part of the mask is covering the window.

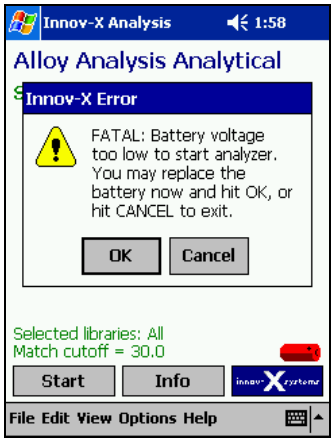
If standardization fails again, exit the analysis screen and power off the instrument. Restart and restandardize. If the standardization fails a 3rd time, you will be prompted to perform a soft reset of the iPAQ. Selecting Yes on this screen will automatically soft reset the IPAQ. You should also power cycle the instrument. Restart and restandardize. If the standardization fails again, replace the battery in the instrument and attempt another standardization. If this fails, please contact the Innov-X Systems service center at **781-938-5005.**





4.4.3 Battery Replacement and Initialization/Standardization

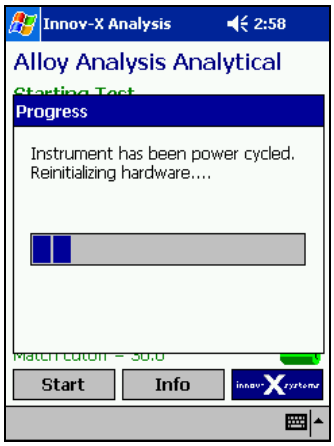
When the battery is too low to take a measurement, an error message will appear:



In order to continue testing, replace the battery immediately, and then tap "OK." The analysis screen will remain open, and the instrument will reinitialize. This process will take 1 minute. It is not necessary to re-standardize, provided that less than 4 hours has elapsed since the last standardization and the battery swap is completed within 10 minutes.

After re-initialization is completed, testing can continue.

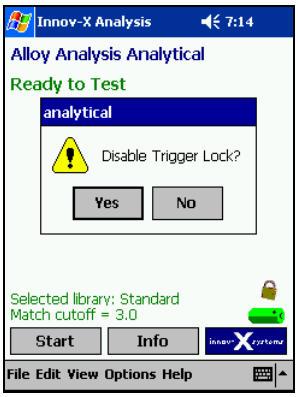
If the battery is not replaced, and cancel is selected, the Analysis screen will close. When the software is restarted, the instrument will go through a complete 1 minute initialization and will require standardization.



4.5 THE SOFTWARE TRIGGER LOCK

Innov-X analyzers are equipped with a software trigger lock which prevents the trigger from being actuated unintentionally. The lock is released by tapping an icon on the iPAQ screen. Once the lock is released, it will remain unlocked for subsequent tests, until more than five minutes has elapsed between tests. At that point, the trigger lock will be activated and will need to be disabled before additional testing can commence.

Tap the lock icon located directly above the battery indicator.



Select yes to disable the trigger lock

The open lock icon indicates when the trigger is disabled.

4.6 TEST INFORMATION - LABEL INPUT

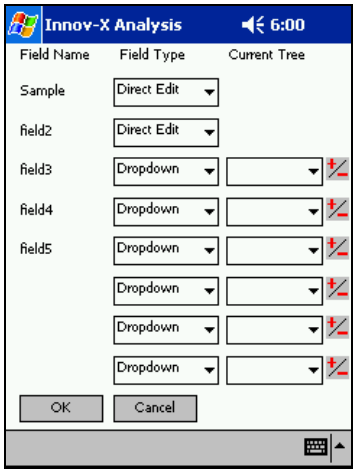
Information such as sample name, and identifying characteristics can be stored with each measurement. This is done from the test information (Test Info) screen which can be accessed from the **Analysis Screen** of any mode by tapping the **Info** button, or selecting ***Edit→Edit Test Information***.

The **Test Info** screen consists of eight fields. The name and format of each field can be changed by using the **Modify Test Info Template** feature described in section ***4.6.1* Modifying the Test Info Template**. The process of entering test information prior to each analysis is described in section **4.6.2 Entering Test Information**. Finally, the process of entering or changing test information after the analysis has been completed is described in section **4.6.3 Editing Test Info from the Results Screen**.

4.6.1 Modifying the Test Info Template

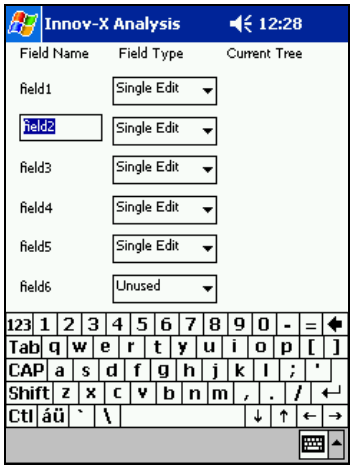
Test Info fields are modified via the Modify Test Info Template option found in the edit menu on the analysis screen in every software mode. Each field can be designated to be Direct Entry, Drop-down, or Tree. Direct entry fields allow users to enter characters directly from the virtual keyboard, or a bar code reader. Drop down menus provide a list of options to choose from. Trees are more complicated drop-downs; which allow users to subdivide large numbers of choices for ease in quickly locating the correct label. For example, a user may set up a tree with several parts for a main assembly. Subassemblies for the parts can be linked to their parent parts.

To make any changes to the Test Info format, select ***Edit →Modify Test Info Template*** from the analysis screen of any Mode. Modifications of Test Info screens are specific to each mode, and will need to be made to each mode if more than one is used.



4.6.1a Changing Field Names

Field names can be edited by tapping on the current name. This will open an editable text box. A new name can be entered with the virtual keyboard. Selecting another cell or tapping **ok** will save this info.

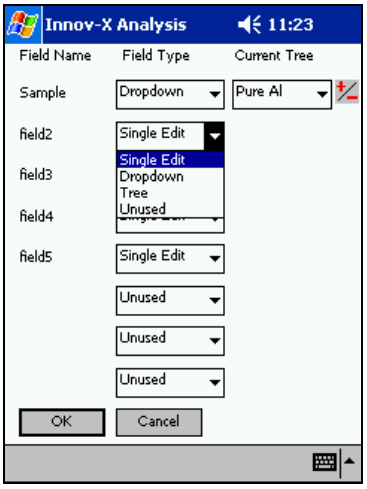


4.6.1b Selecting Field Type

From the Modify Test Info screen, the type of field can be selected from a drop-down menu. Simply tap the arrow in the Field Type box for the field being modified.

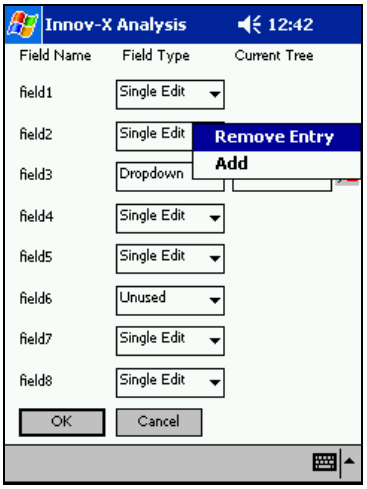
- Select **Direct Edit** for a text field which will accept data from the virtual keyboard, or a bar code scanner.
- Select **Drop-down** for a drop-down list
- Select **Tree** for a Drop-down menu with many choices, some of which may be grouped into categories and subcategories.

Select **Unused** to eliminate the field from the Test Info screen.

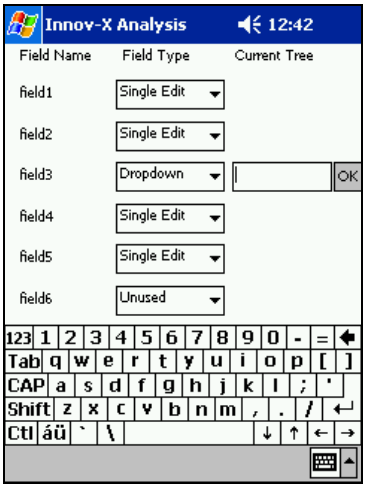


4.6.1c Changing Drop-down Menu Entries

Once a field has been designated a drop-down menu, entries can be added or deleted by clicking the +/- symbol to the right of the field. Two choices will appear; **Remove Entry** and **Add**.
To delete a drop-down entry, first select the label to be deleted, then press +/- and tap **Remove Entry**.

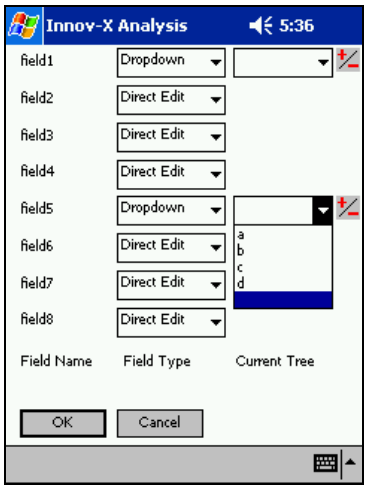


To add an entry from a drop-down list, tap the +/- symbol next to appropriate field, and select **Add**. Type the new info into the blank text box that appears. Select **OK** and the entry will be added to the drop-down menu.



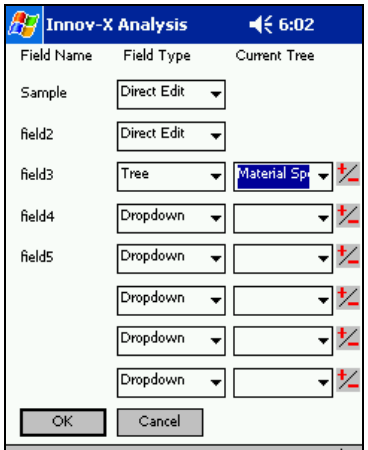
Repeat the process above to complete the complete drop-down list.

If it is anticipated that a drop-down field will not be used for all samples, enter an empty field as a choice so you can choose to leave the field blank.



4.6.1d Changing Tree lists.

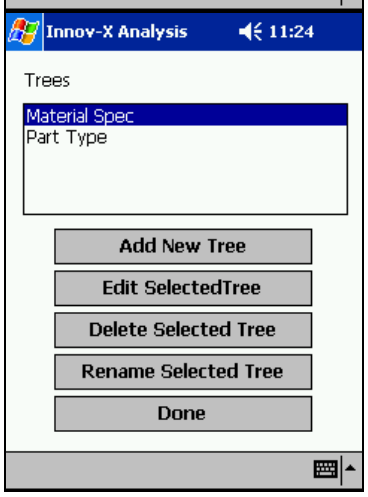
Once a field has been designated a tree, modifications to the contents of the tree can be made by tapping the +/- symbol to the right of the tree.



All modifications to trees are made from the menu shown on the right.

It is possible to add, edit, delete or rename trees. Select the appropriate choice from the menu to perform any of these functions.

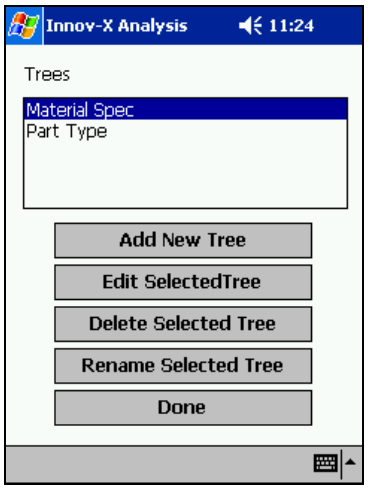
When you have finished creating/editing your tree, highlight it and select **Done.**



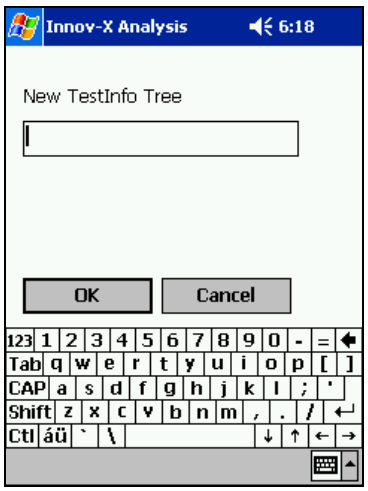
The following is an example of how a user might create a tree: A manufacturer of tubes and valves tests all parts to ensure that they're made of the proper material. The company's QC procedure involves labeling each test with the part number of the item. Rather than forcing operators to look through a long list of part numbers, a tree is created in order to subdivide the parts number into groups based on part type.

The procedure for creating the tree is as follows:

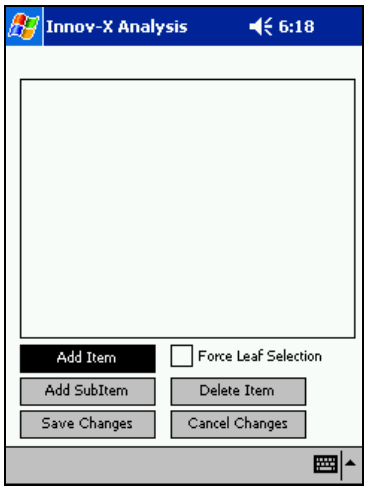
Select: Add New Tree:



Enter the Name of the Tree in the text box and select OK.



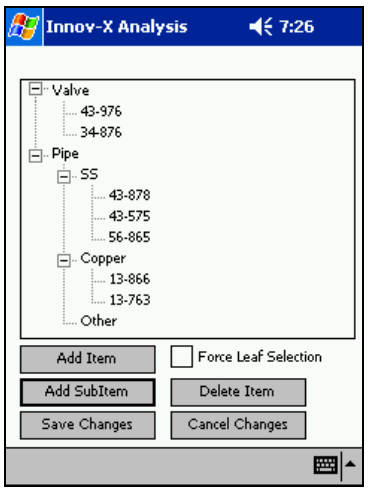
Tap Add to add the first item



Enter the name of the item

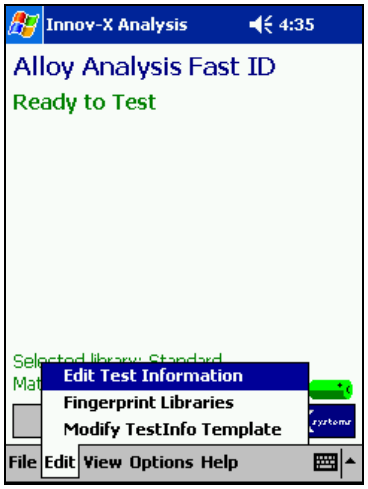
Once the tree is started, continue to Tap Add Item to add a top level menu item, or select an item and tap Add SubItem to link a subcategory to the item. Continue until all items have been added.

In this example, the part numbers for pipes and valves are separated into categories. The pipes are further subdivided by material type.

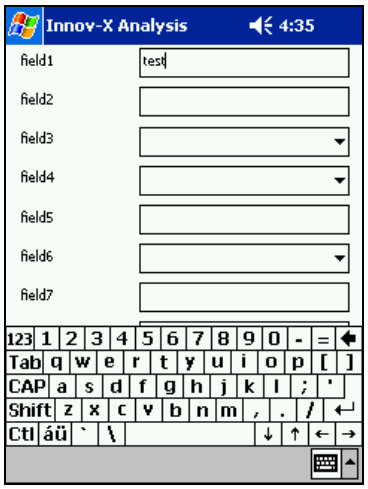


4.6.2 Entering Test Information

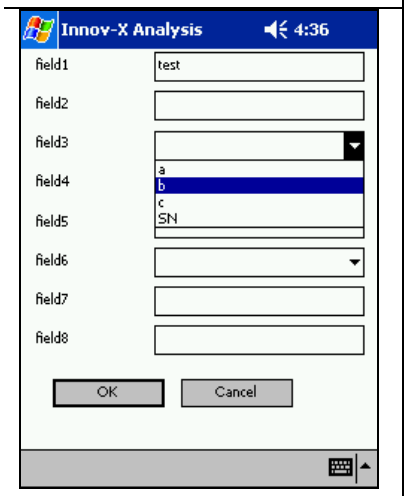
1. To enter the Test Info screen, you must be in the Analysis Screen. If the Results Screen is open, tap the ⊗ in the upper right hand corner to return to the Analysis Screen. From the Analysis Screen, select ***Edit→Edit Test Information,*** or tap the **Info** icon.



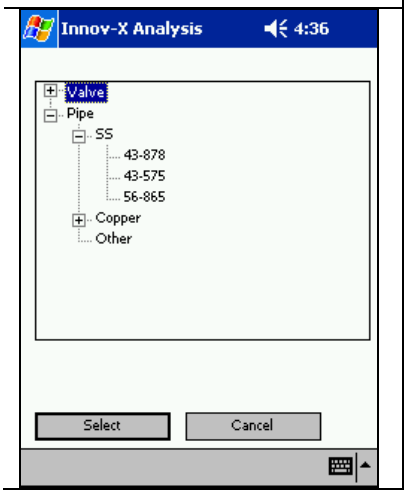
2. To enter a unique sample name or number, select a direct entry field by tapping anywhere within the field. Use the virtual keyboard to enter the information.



3. To select information from one of the drop-down menus, tap the arrow to the right of the box. Select the desired entry.



4. Some drop-down fields are formatted as trees. To select information from these fields, tap the arrow to the right of the box. A screen will appear showing options. The plus (+) symbol will appear before some choices indicating the presence of sub-items. Tap on the + symbol to expand the menu. Tap on any item or sub-item to select it, then press **Select**.

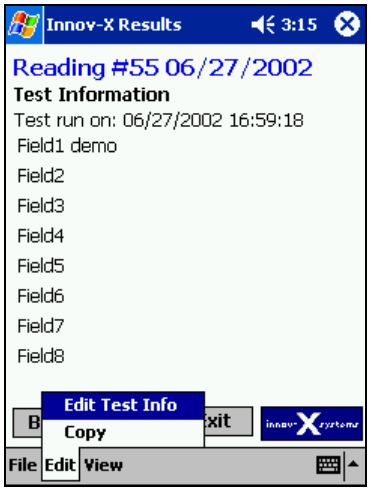


5. When all the necessary data have been entered. select OK
6. The information entered in the test info screen will be saved with each reading until the test info screen is modified again.

4.6.3 Editing Test Info from the results screen

Test information can be edited, or added to a test after its completion.

- From the results screen, scroll to the reading to be modified.
- Select ***View →Test Info*** to see in the information which is already stored.
- Select ***Edit → Edit Test Info*** to bring up the editing menu.



You will then be presented with the same test information screen described in **Section 4.5.2: Entering Test Information.**

4.7 EXPORTING AND ERASING DATA

Because the memory of the iPAQ is limited, you should periodically backup the data on your analyzer, and erase the memory. Depending on test volume, it is recommended that all data is erased on a weekly or monthly basis.

4.7.1 Installing ActiveSync

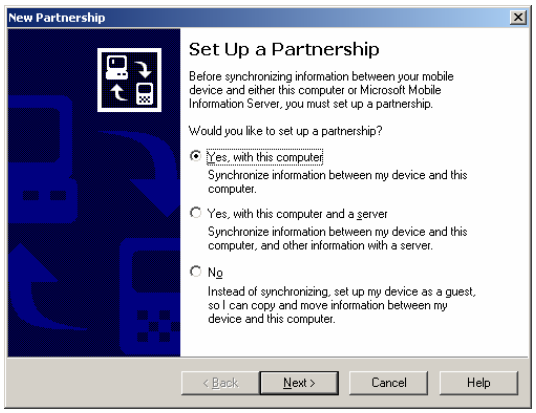
In order to copy files between the iPAQ and a desktop PC, Microsoft Active Sync Software must be installed on the desktop PC. Innov-X strongly recommends that you download the latest version of ActiveSync from the internet. ActiveSync v3.7 may be downloaded from http://www.microsoft.com/windowsmobile/resources/downloads/pocketpc/activesync37.mspx

If it is not possible to download the latest version, an ActiveSync CD (v3.5) was shipped with your analyzer. Check behind the foam in the instrument case.

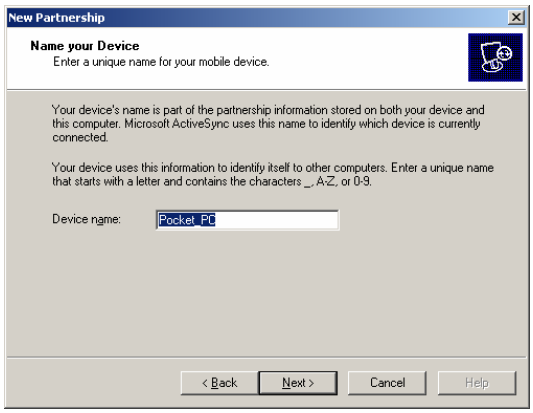
The iPAQ cradle should be hooked up to the USB port on the desktop computer before installing software.

The Procedure for installing and setting up ActiveSync is as follows:

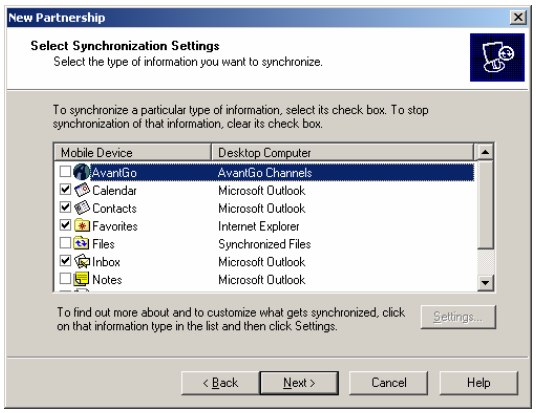
1. Insert the ActiveSync CD in your CD Drive. It will start automatically. The CD contains information about Getting Started with Your Pocket PC. This changes periodically, so it's difficult to describe exactly what the screens will look like. Step through the screens until you see the option "Install ActiveSync." Select this to start the installation process.
2. Follow the prompts on the screen. When given the choice, select "Run this program from its current location" and click OK.
3. Complete the install process. You will be required to restart your computer in order to complete the installation.
4. After restarting your computer, dock the iPAQ in the cradle. The iPAQ should automatically communicate with your computer. If it doesn't, check the connections and try removing the iPAQ and reseating it. If that doesn't work, try doing a soft reset on the iPAQ
5. When the computer communicates, you will be prompted to "Set Up a Partnership." Select "Yes, with this computer"



6. Enter a name for your iPAQ and click next.



7. You will be prompted to "Select Synchronization Settings." **Select "Files" only**. ***It is important to make sure that* Files *is the only item checked. Otherwise, the files such as address books and emails will be copied from the desktop computer to the iPAQ.***



8. Step through the rest of the process.

9. A folder will automatically be created on the PC's desktop with the name of the device entered in step 8 above. Results files saved on the iPAQ will automatically be synched and will be stored in this folder. Opening this folder and clicking on the name of the file will open the file in Excel.

10. After ActiveSync is set up correctly, copying results to a desktop computer will consist of

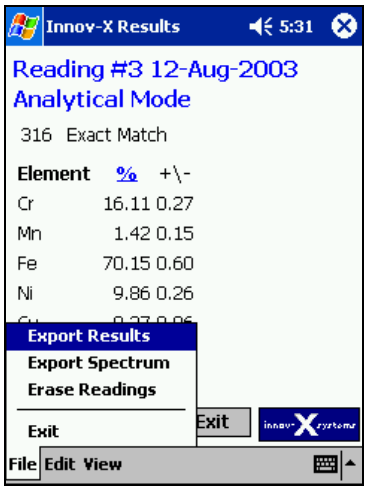
a. Exporting results on the iPAQ. (described in section 4.6.2)
b. Synching the iPAQ to the computer
c. Opening the results in Excel for viewing, or printing.

4.7.2 Exporting Results

All data from your Innov-X Systems analyzer can be exported as a comma delimited text file (csv). This format allows the data to be easily exported to spreadsheet programs. It is possible to export all data from a single day, or to export all data saved in the iPAQ. Results and spectra are exported separately.

To export or erase data, you must be in the Results Screen. This is automatically opened when a reading is taken, or can be accessed by choosing ***View→Results*** from any analysis screen.

From the results screen, select ***File→Export Results***

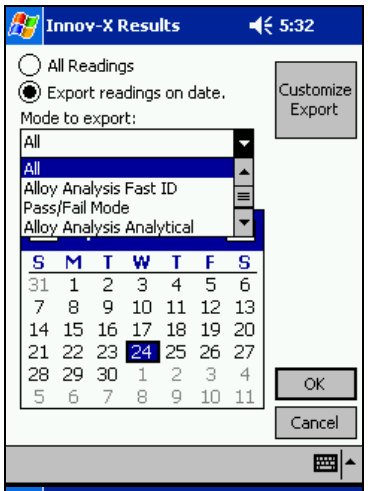


You can choose to export All Readings or just Readings on a specific date. Choosing **All Readings**: will export all readings saved in memory and is a good choice if you want to backup all data stored on the instrument before deleting. If a large number of readings stored, this option will take several minutes.

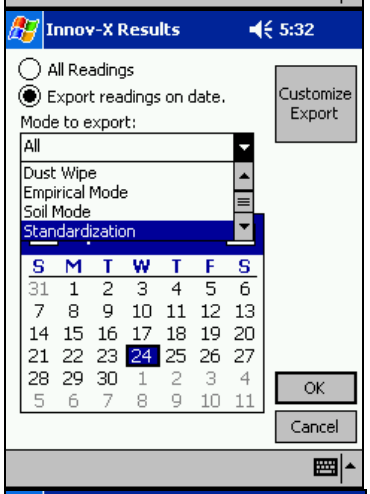
Choosing **Export Readings on date** requires that you pick a date from the calendar below. It is strongly recommended that you use this option and export data on a daily basis.

The customize export option allows users with administrative password privileges to customize the format in which data is exported. This is described in **Section 4.7.3: Customizing Results Export**.

After choosing which readings to export, you may choose to export all data, or just data from a specific mode. Selecting the arrow to the right of the mode to export will open a drop-down menu. Select the mode for which you want to export data.

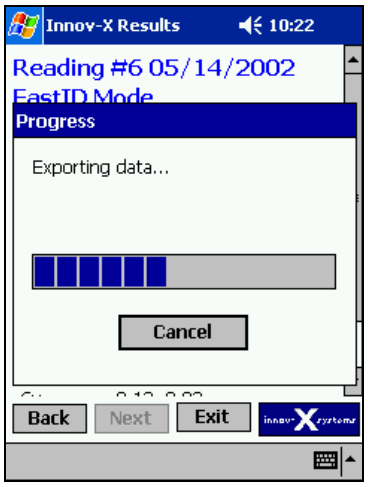


All standardization data are stored as results files. These data are automatically included in exported results files when the selected "Mode to export" is **All.** Additionally, it is possible to export only the standardization data by selecting **Standardization** as the "Mode to export."

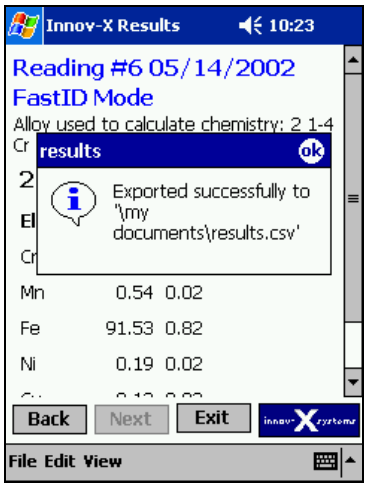


When the proper selections have been made, select **OK**. A **Save A**s box will appear. Select the folder in which you want to save the data, and name the file. The file Type will always be **Comma Separated Values**. The recommended Location is Main memory and Folder is **None.** This will export files into the "My Documents" folder in the main Memory of the iPAQ.
If you select a File Name which already exists, you will be asked if you want to replace the existing file. If you do, select **Yes**. Otherwise select **No** and choose another file name.

A status bar will indicate the progress of the export. It may take several minutes to export many readings. Daily downloading and weekly erasing of data simplifies and shortens this procedure.



When all readings are exported, a message will appear confirming the export. Tap **ok** to acknowledge and clear the reading.



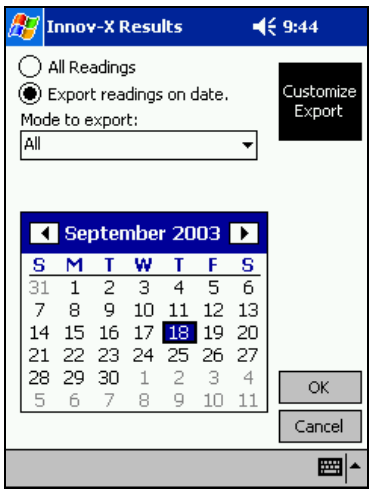
4.7.3 Customizing Results Export

All units come with a standard results export format which reports a variety of information relevant to a test. Users can select which fields are exported as well as modify the order.

To modify exported results files, select **File ⟶Export Readings** from the Results screen.

Tap the **Customize Export** box.

Enter the administrative level password when prompted.



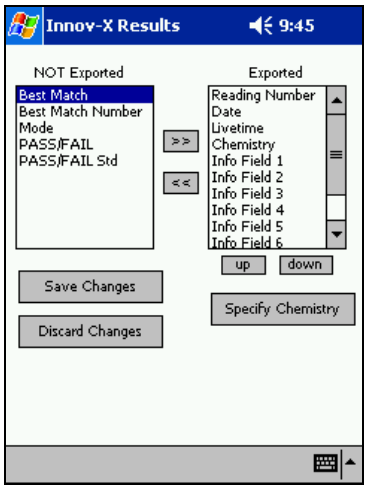
Two columns appear on the screen; the column on the left lists fields which will NOT be exported, and the right-hand column lists fields which will be exported.

Fields can be moved from one column to another via the >> and << buttons located in the center of the screen

Exported field order can be changed by using the **Up/Down** buttons. Select a field and move it up or down as desired

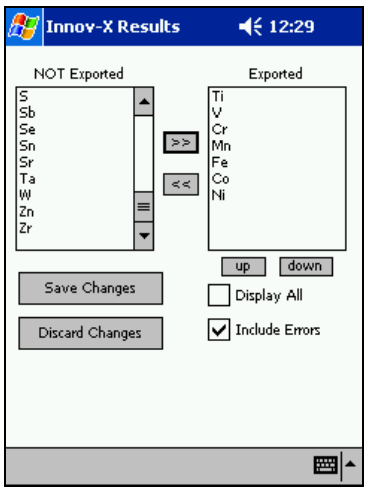
Once all changes have been made, choose **Specify Chemistry** if changes need to be made to the list of exported elements.

In chemistry is not edited, select **Save Changes** to keep the modified settings, or **Discard Changes** to ignore any changes.



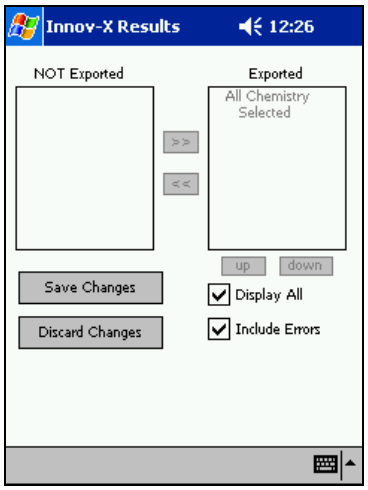
The Specify Chemistry screen resembles the previous screen. Move elements to the appropriate column, depending on whether or not an element should appear in exported files.

Select **Include Errors** to export the error associated with each measurement.



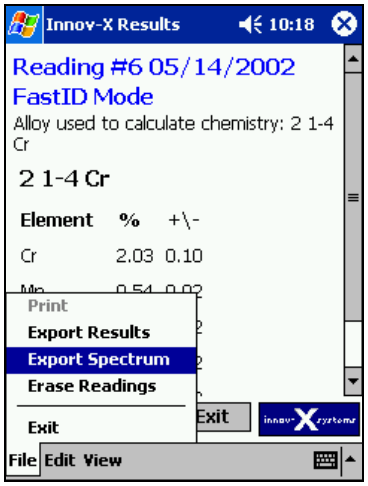
Select **Display All** to include all measured elements. *This setting is recommended, as it will ensure that all data measured with the instrument is exported.*

When all changes have been made, tap **Save Changes** or **Discard changes,** depending on whether the changes should be saved.



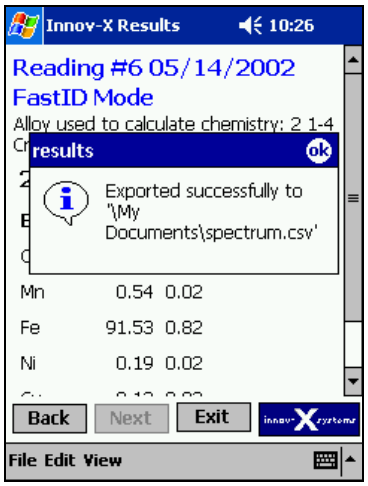
4.7.4 Exporting spectra

Only one spectrum may be exported at a time. In the results screen, scroll to the reading for which you wish to export the spectrum, and ***Select File→Export Spectrum***.



Choose the File name, and make sure that **Comma Separated Values** and **Main Memory** are selected. This will save the spectrum to the My Documents folder in the Main Memory of the iPAQ.

A message will appear indicating a successful export. Tap **ok** to acknowledge and clear the window.



4.7.5 Erasing readings

It is possible to erase a single reading, a range of readings, all readings from a specific data, or all readings before a specific date.

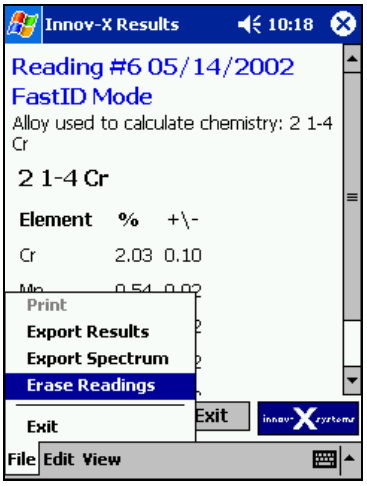
In order to erase a single reading, the reading to be erased must displayed on the screen before selecting delete. If necessary scroll to the reading you wish to delete.

In order to select a range of readings, you must have a reading open from the date you wish to delete the readings. If a reading from the desired date is not open, you may select ***View→Go to date***, and select the appropriate date.

The reading displayed in the results screen is not relevant if you want to delete all readings from a specific date, or all readings before a specific date .

From the results screen, select ***File→Erase Readings.***

A message box will appear prompting you to enter your password. Enter your administrative level password and select **OK**.

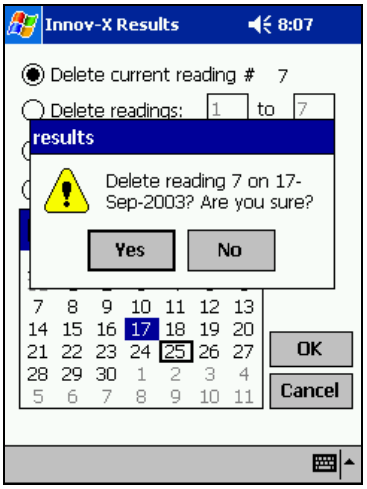


A dialogue box will appear allowing a choice of which results to delete. Select the appropriate choice:

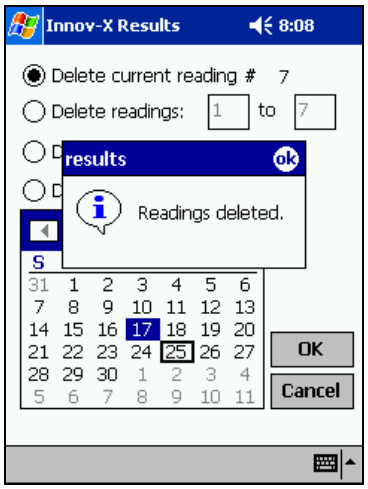
- Selecting **Delete current reading** will delete the reading that is currently open.
- Choosing **Delete readings XX to XX** will delete a range of readings from the date of the reading that is currently open.
- **Delete all readings on date** deletes all readings from a specific day.
- **Delete readings before date** deletes all readings taken prior to a specific day.

If you select **Delete all readings on date** or **Delete readings before date**, you must specify a date from the calendar. The default date is the current date.

When you've selected the readings to delete, Click **OK**. You will be asked if you're sure you want to proceed. If you want to proceed with the data erase, select **Yes**. Otherwise, click **No.**



A message will indicate the readings were successfully deleted. Tap **ok** to acknowledge and clear the message window.



Chapter 5 Soil Analysis

The Innov-X analyzer can be used to analyze in situ (directly on the ground), bagged or prepared soil samples. A guide to Soil analysis using field portable X-ray fluorescence is found in the appendix. This document summarizes EPA Method 6200 which is the standard protocol for field screening. It also provides information on prepared sample testing.

5.0 CHECK STANDARDS

It is recommended that a check standard is measured after each standardization, and periodically throughout the day. Innov-X provides several NIST certified standards for verification. The certified values for these samples are provided in the appendix. At least one standard should be measured for a minimum of 1 minute. Elemental concentrations for elements of interest plus or minus the error on the reading should be within 20% of the standard value. The Field screening guide in the appendix describes in more detail recommended quality assurance considerations.

The standards provided with the XRF analyzer are contained in XRF sample cups with a Mylar window (through which the soil can be viewed) on one side, and a solid cap on the other side. Samples should be measured in the sample cup, through the Mylar window. The best way to measure a prepared sample is using the test stand. If this is not available, the sample may be placed on the ground, and the analyzer may be pointed downwards in full contact with the soil cup. Do not hold the soil cup in your hand while measuring.

5.1 SAMPLE PRESENTATION

In situ testing:

In situ testing is performed by pointing the analyzer at the ground. Any grass or large rocks should be cleared away and the analyzer should be held such that the front of the probe head is held flush to the ground.

Since dirt can accumulate on the analyzer window, it is recommended that the window is wiped clean after each analysis. The window should also be checked to ensure it is not ripped or punctured. Instructions for replacing the window are found in the appendix.

Bagged or prepared sample testing:

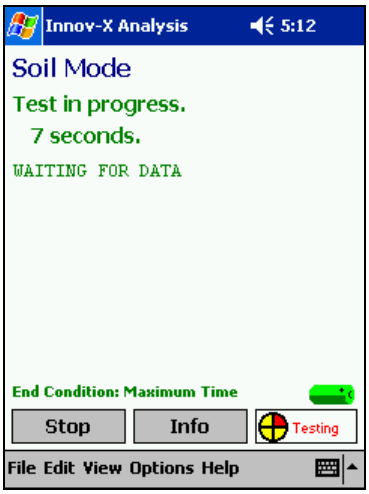
It is strongly recommended that all prepared samples be analyzed in the testing stand. Samples should be placed on top of the testing stand, completely covering the window. **Never hold prepared or bagged samples while testing,** as this could expose the operator to the x-ray beam.

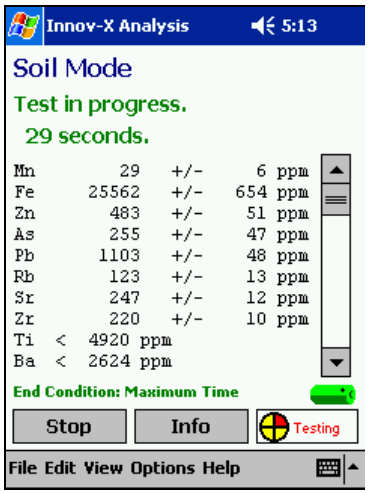
Avoid measuring very thin samples, as this can affect results. Prepare samples cups to contain at least 0.5 inches of packed samples. When analyzing bagged samples, make sure that sufficient sample exists in the bag to completely cover the window with a sample thickness of a minimum of 0.5 inches.

5.2 TESTING IN SOIL MODE

After the instrument has been standardized, testing can begin. Simply pull the trigger or press **Start** on the iPAQ screen to begin the test. The red warning light on the top of the instrument will blink, indicating X-rays are being emitted. The screen will display the words “Test in progress” and the time elapsed. The word “Testing” will blink on and off in the low right hand corner of the screen.

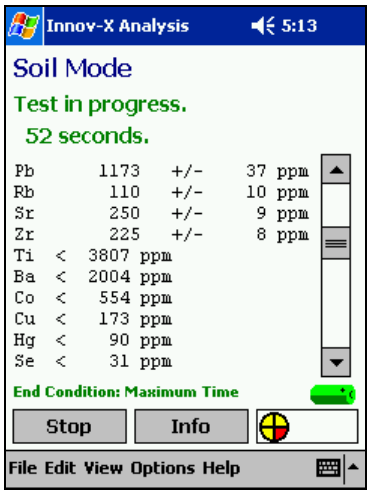
After a minimum time has elapsed, intermediate results will be displayed on the screen. Until this minimum time has elapsed, the words "WAITING FOR DATA" will appear instead. This minimum time can be set by the user by selecting ***Options→Set Testing Times***, which is described in **Section 5.4: Soil Mode Options.** Each line of the results display shows the name of an element, its calculated concentration and the error on the measurement. This error is the 1 sigma error on the counting statistics of the measurement. The error will decrease with increased testing time.





Too many elements are measured in soil mode to display them at one time. However, is possible to use the scroll bar located to the right of the chemistry display to view other elements. The complete display shows detected elements first, listed in order of emission line energy, from lowest to highest. Following the detected elements are the elements which are below the detection limit of the instrument. These elements are shown as less than a calculated LOD. This LOD is defined as three times the error on the counting statistics of the measurement.

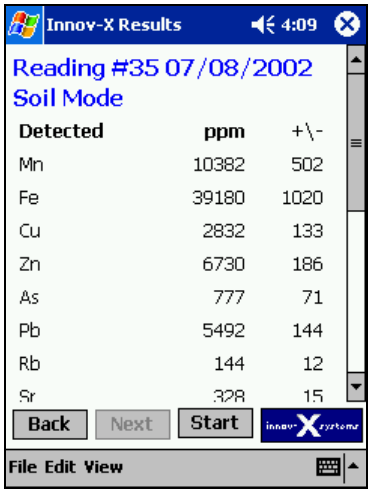
When the measurement is complete the results screen will open, displaying the final results of the measurement.

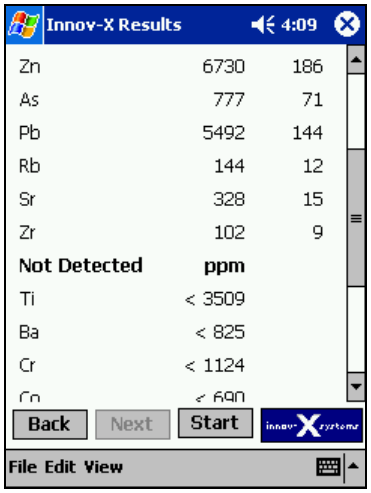


5.3 SOIL RESULTS SCREEN

5.3.1 Results View Menu

The standard Soil Mode results screen displays the concentration (in ppm) and error in measurement for detected elements, followed by the list of non-detected elements with the calculated limit of detection for each element for that test. If the display does not show soil chemistry results, change the display by selecting ***View→Results***.



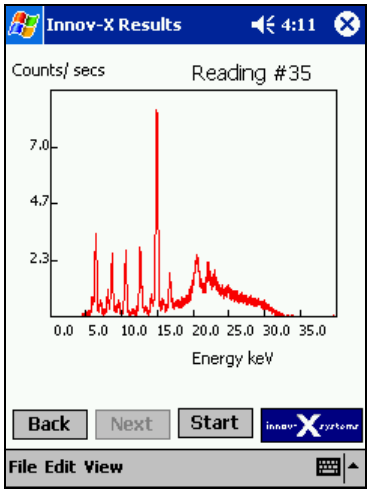


The standard soil chemistry display can be modified by using the View Menu. As with all Innov-X analytical modes, it is possible to view spectra and Test Information.

5.3.2 Spectrum Screen

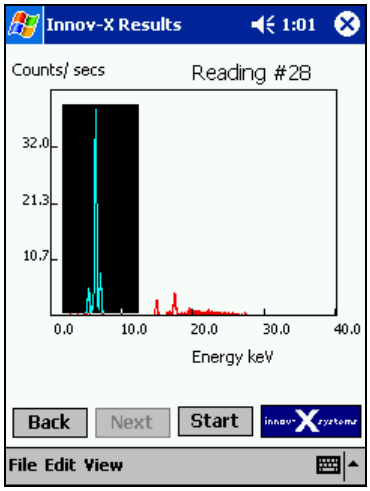
This screen displays a plot of the x-ray fluorescence spectrum for an individual test, plotting the intensity on the y-axis versus the energy of the fluorescence x-rays on the x-axis.

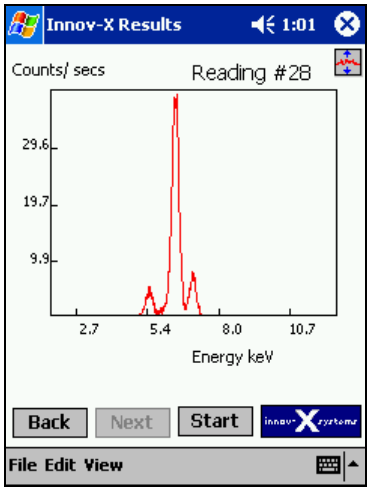
Tapping on the spectra will show the energy scale and counts rate at the selected point



It is possible to zoom in on certain areas of the graph by selecting one corner and drawing out the region

Tapping the symbol in the upper right hand corner beneath the X will restore the graph to full scale.





5.3.3 Test Info Screen

The test information screen shows any test information that was entered prior to the start of the test. Changes to that test information can be made by selecting **Edit→Test Information.**

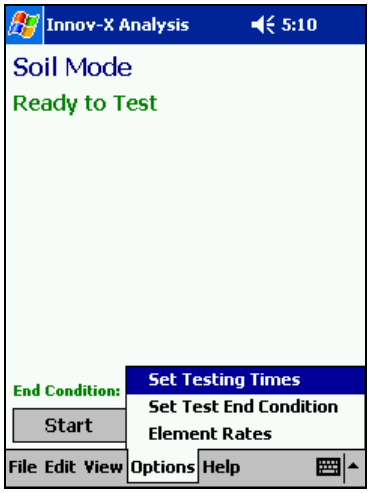
5.4 SOIL MODE OPTIONS

The length of tests in Soil Mode is user settable. Users may select a minimum testing time, and as well as choose from a variety of test end conditions.

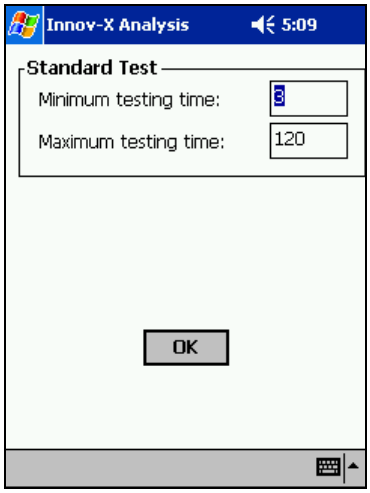
The options related to test time are contained in two menus: ***Options→Set Testing Times***, and ***Options→Set Test End Condition. Set Testing Times*** contains minimum and maximum testing time information, while ***Set Test End Condition*** allows the user to select test end conditions.

5.4.1 Set Testing Times

To set the minimum and maximum test lengths, select **Options→Set Testing Times**



A screen appears prompting you to enter a Minimum and Maximum Testing times. Instruments equipped with the optional LEAP package will be able to set Light Element Testing times in this screen, as well.



The minimum testing time is the required time that must elapse before results can be calculated. Live Update results will not be displayed on the screen until the minimum has elapsed, likewise a test must complete the minimum time before any test end condition can be used. If a test is stopped before the minimum testing time has elapsed, the test will be aborted, and no results will be calculated.

Maximum testing time is relevant only if "Maximum Testing Time" is selected from **Set Test End Condition**. This will automatically end the test at a preset testing time. Typically, the maximum testing time will be in excess of 30 seconds, and may be 1 or 2 minutes, depending on detection limits and desired precision.

It should be noted, that all testing times in this section refer to "Real Time," the time the measurement takes when timed on a normal clock. The time stored with each analytical result (accessible by selecting **View→Test Information** from the Results screen), refers to the test's "Live Time". This is the amount of time that the analyzer hardware was collecting spectra. Since there is some detector dead time associated with a measurement, the live time of a test will be slightly shorter than the preset "Real time".

5.4.2 Soil Mode Test End Condition

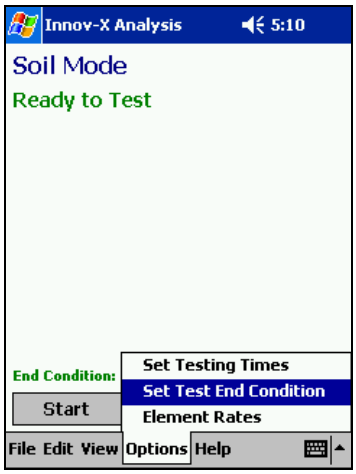
Four options exist for the test end criteria in soil mode. Depending on your application, you may choose to end the test manually, at a preset testing time, or when the uncertainty in the measurement is within a

specified relative standard deviation of the reading. Additionally, you can set up an action level for a single element. As soon as the measuring statistics are good enough to ensure that that the reading is above, below or at the action level, the test will end automatically. This allows for very rapid tests for elements that are well above or below an action level.

In all modes, pressing Stop, or pulling the trigger will end the test. If the minimum testing time has elapsed, results will be calculated. Otherwise the test will be aborted without calculating results.

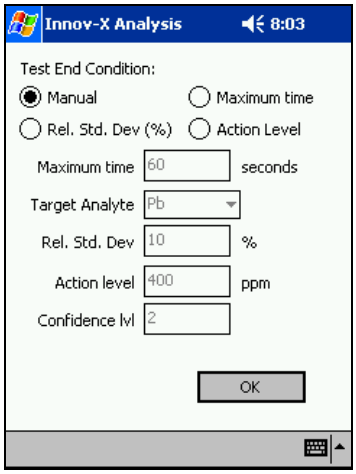
Changes to the test end condition are made by selecting ***Options→Set Test End Condition***

The currently selected end condition will be displayed at the bottom of the screen above the Start button on the Ready To Test screen.



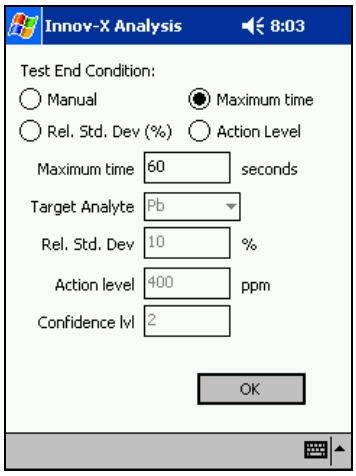
Manual: This option allows you to look at the results which are being continually updated on the screen and determine when the results look satisfactory. The test will continue until the trigger is pulled, or **Stop** is tapped on the iPAQ screen. Results will be calculated if the testing time has exceeded the Minimum Test time which is set up in ***Options→Set Testing Times***. In order to preserve battery life, the software will stop if the testing time exceeds 300 seconds, since there is little to no advantage to continuing a test beyond 300 seconds.

To use Manual Test End Condition, simply choose ***Options→Set Test End Condition*** and select **Manual**. Press **OK** to return to the analysis screen.



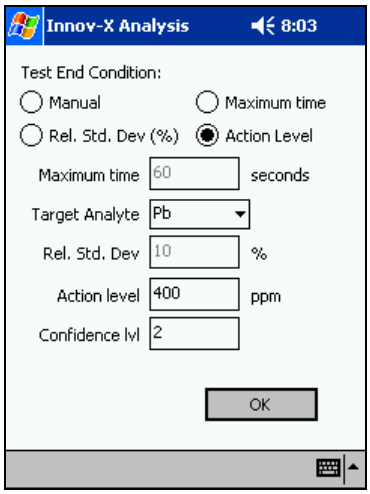
Maximum Time: If Maximum Time is selected, the test will continue until the preset time is reached. This is useful if you wish to do a set of measurements with the same testing time.

To choose to end test based on a maximum time, select ***Options→Set Test End Condition*** and select **Maximum Time**. Enter the desired testing time in the appropriate box. Tap OK to save your selections.



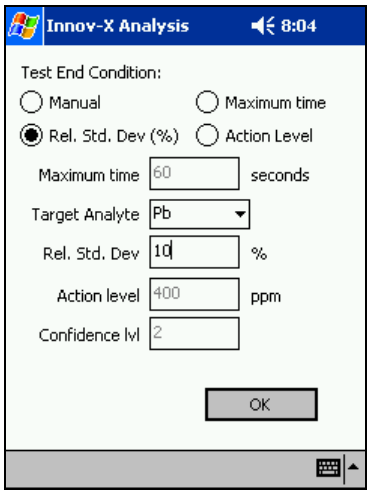
Action Level: System ends test when result for target analyte including chosen precision level is above or below pre-set action level.

To choose to end a test based on an Action Level, select ***Options→Set Test End Condition*** and select **Action Level**. Select a target analyte, specify an action level in ppm, and a confidence level. This confidence level refers to the number of sigma required for the precision. This should typically be set to 2. Tap **OK** to save your selections.



Relative Standard Deviation (RSD): When RSD is selected as a test end criteria, the system will end a test when the relative standard deviation on a target analyte reaches a pre-set level. This standard deviation is specified as a percentage of the reading. For example, if the measured value for an analyte was 1000 ppm, and the RSD was set to 10, the reading would stop when the error reached 100 ppm, or 10% of 1000.

To choose to end a test based on a Relative Standard Deviation, select ***Options→Set Test End Condition*** and select **Rel. Std. Dev (%).** Select a target analyte and the desired Relative Standard Deviation. Tap **OK** to save your selections.



5.5 LEAP Mode (Light Element Analysis Program):

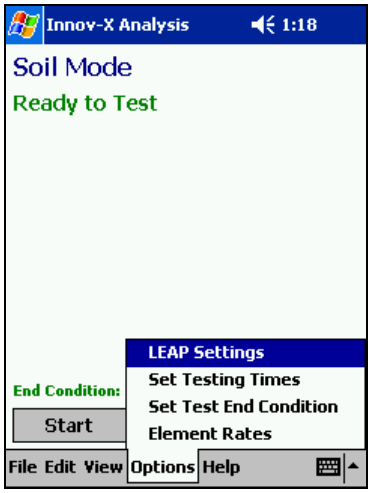
This is a factory installed optional module. Instruments can be upgraded to LEAP capabilities. Please contact the Innov-X Systems Sales department for information and pricing.

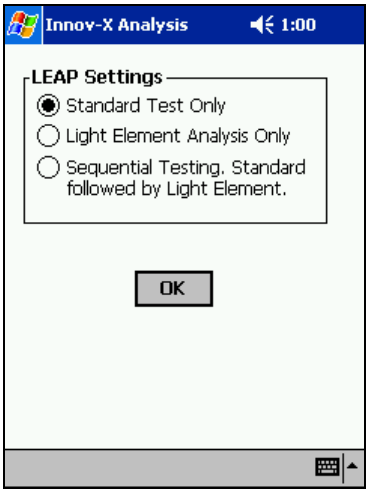
The LEAP module provides the lowest possible detection limits for elements lighter than iron. The standard LEAP package includes the elements Ti, Ba and Cr. Elements as low as Phosphorus can be detected with the Advanced LEAP package which includes a thin window detector.

The standard x-ray beam conditions used by Innov-X environmental analyzers are designed to provide good excitation for a wide range of detected elements. However it is not possible to select one beam condition which provides the absolute best excitation conditions for all elements of interest. Elements such as Chromium produce lower energy x-rays then other elements analyzed. These lower energy x-rays are not as effectively excited by the standard conditions. LEAP works by changing the X-ray tube beam conditions to settings which are optimized for the detection of elements lighter than iron. Instruments are factory calibrated with the LEAP beam conditions for all applicable elements.

5.5.1 LEAP Settings

To activate LEAP, select ***Options→LEAP Settings*** from the Soil analysis screen. This brings up the menu shown below on the right.



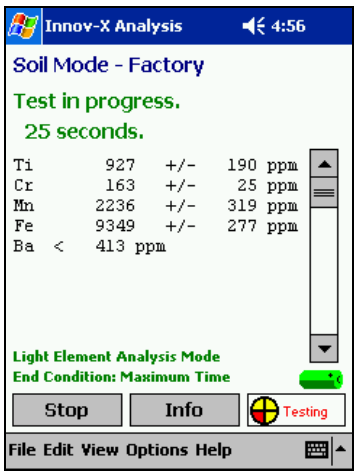


Standard Test Only: The analyzer will provide analysis for the standard suite of elements.

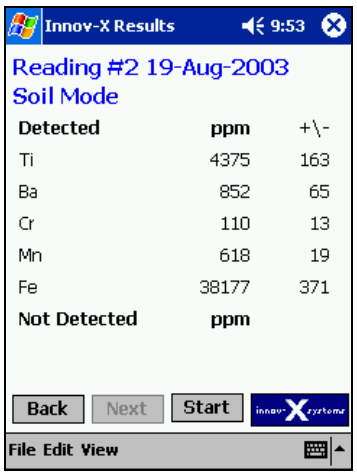
Light Element Analysis Only: The analyzer will provide analysis for elements in the LEAP suite (Typically Ti, Ba and Cr)

Sequential Testing: When sequential testing is selected, all tests will start with an analysis of elements in the standard suite. If that test ends due to reaching the selected end condition of Maximum Test Time, Action Level, or RSD, then the analyzer will immediately begin a second test analyzing the LEAP suite of elements. At the conclusion of this test, the Results screen will open with two new entries. The first summarizes the standard test results, while the second summarizes the LEAP results. For safety reasons, the second test will not begin if the test ends due to user intervention (pulling the trigger or hitting Stop). In this case, the Results screen will open with only one reading.

If Light Element Analysis Only is activated, the words "Light Element Analysis Mode" will appear above the currently selected End Condition. Instrument operation in this mode is identical to Standard (Non-LEAP) analysis. Tests can be started or stopped either by pulling the trigger, or by tapping the Start/Stop button on the iPAQ screen. The results screen for a test will show results for all elements analyzed with the LEAP mode.

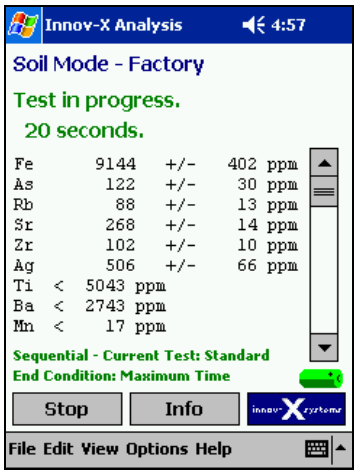


Test in progress screen, LEAP Only, Live Updates on

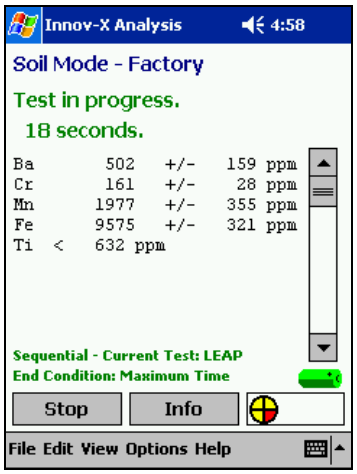


Results Screen Showing LEAP results

If Sequential testing is selected, the words “Sequential – Current Test: Standard” will appear above the currently selected End Condition. When a test is started, the instrument will appear to operate in the same manner as a Standard test. However, if the test ends according to the specified end condition (excluding Manual), the results screen will not open. Instead, the timer will reset to 0, and the description of the current test will change from “Standard” to “LEAP”. The live update screen will begin to show analysis for all LEAP elements.



Test in progress screen, Sequential.
First Test – Standard Analysis.

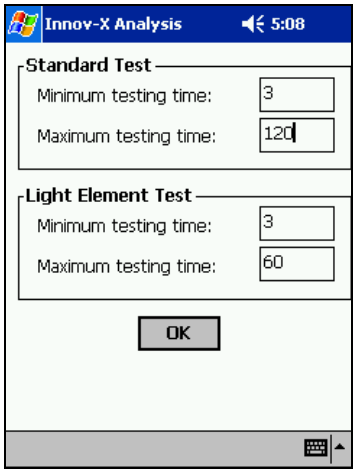


Test in progress screen, Sequential.
Second Test – LEAP Analysis

5.5.2 Testing Times

To set the minimum and maximum test lengths for LEAP analysis, select **Options→Set Testing Times.**

The testing time screen includes an extra section labeled “Light Element Test” that is not found on non-LEAP systems. These are the minimum and maximum test lengths for any LEAP tests.



As with standard tests, the minimum testing time is the required time that must elapse before results can be calculated. Live Update results will not be displayed on the screen until the minimum has elapsed, likewise a test must complete the minimum time before any test end condition can be used. If a test is stopped before the minimum testing time has elapsed, the test will be aborted, and no results will be calculated.

ELEMENTS DETECTABLE

BY INNOV-X SYSTEMS HANDHELD XRF ANALYZERS

INNOV-X SYSTEMS

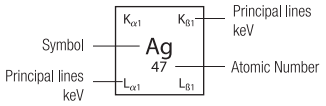
	IIA	IIIB	IVB	VB	VIB	VIIB	Group VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	
H 1																	He 2
0.05 Li 3	0.11 Be 4											0.18 B 5	0.28 C 6	0.39 N 7	0.52 O 8	0.68 F 9	0.85 Ne 10
1.04 1.07 Na 11	1.25 1.3 Mg 12											1.49 1.56 Al 13	1.74 1.84 Si 14	2.01 2.14 P 15	2.31 2.46 S 16	2.62 2.82 Cl 17	2.96 3.19 Ar 18
3.31 3.59 K 19	3.69 4.01 Ca 20 0.34 0.34	4.09 4.46 Sc 21 0.4 0.4	4.51 4.93 Ti 22 0.45 0.46	4.95 5.43 V 23 0.51 0.52	5.41 5.95 Cr 24 0.57 0.58	5.9 6.49 Mn 25 0.64 0.65	6.4 7.06 Fe 26 0.71 0.72	6.93 7.65 Co 27 0.78 0.79	7.48 8.26 Ni 28 0.85 0.87	8.05 8.91 Cu 29 0.93 0.95	8.64 9.57 Zn 30 1.01 1.03	9.25 10.26 Ga 31 1.1 1.12	9.89 10.98 Ge 32 1.19 1.22	10.54 11.73 As 33 1.28 1.32	11.22 12.5 Se 34 1.38 1.42	11.92 13.29 Br 35 1.48 1.53	12.65 14.11 Kr 36 1.59 1.64
13.4 14.96 Rb 37 1.69 1.75	14.17 15.84 Sr 38 1.81 1.87	14.96 16.74 Y 39 1.92 2	15.78 17.67 Zr 40 2.04 2.12	16.62 18.62 Nb 41 2.17 2.26	17.48 19.61 Mo 42 2.29 2.39	18.37 20.62 Tc 43 2.42 2.54	19.28 21.66 Ru 44 2.56 2.68	20.22 22.72 Rh 45 2.83	21.18 23.82 Pd 46 2.84 2.99	22.16 24.94 Ag 47 2.98 3.15	23.17 26.1 Cd 48 3.13 3.32	24.21 27.28 In 49 3.29 3.49	25.27 28.49 Sn 50 3.44 3.66	26.36 29.73 Sb 51 3.6 3.84	27.47 31 Te 52 3.77 4.03	28.61 32.29 I 53 3.94 4.22	29.78 33.62 Xe 54 4.11 4.42
30.97 34.99 Cs 55 4.29 4.62	32.19 36.38 Ba 56 4.47 4.83		55.79 63.23 Hf 72 7.9 9.02	57.53 65.22 Ta 73 8.15 9.34	59.32 67.24 W 74 8.4 9.67	61.14 69.31 Re 75 8.65 10.01	63 71.41 Os 76 8.91 10.36	64.9 73.56 Ir 77 9.18 10.71	66.83 75.75 Pt 78 9.44 11.07	68.8 77.98 Au 79 9.71 11.44	70.82 80.25 Hg 80 9.99 11.82	72.87 82.58 Tl 81 10.27 12.21	74.97 84.94 Pb 82 10.55 12.61	77.11 87.34 Bi 83 10.84 13.02	79.29 89.8 Po 84 11.13 13.45	81.52 92.3 At 85 11.43 13.88	83.78 94.87 Rn 86 11.73 14.32
86.1 97.47 Fr 87 12.03 14.77	88.47 100.13 Ra 88 12.34 15.24																

Lanthanides 57-71	33.44 37.8 La 57 4.65 5.04	34.72 39.26 Ce 58 4.84 5.26	36.03 40.75 Pr 59 5.03 5.49	37.36 42.27 Nd 60 5.23 5.72	38.72 43.83 Pm 61 5.43 5.96	40.12 45.41 Sm 62 5.64 6.21	41.54 47.04 Eu 63 5.85 6.46	43 48.7 Gd 64 6.06 6.71	44.48 50.38 Tb 65 6.27 6.98	46 52.12 Dy 66 6.5 7.25	47.55 53.88 Ho 67 6.72 7.53	49.13 55.68 Er 68 6.95 7.81	50.74 57.52 Tm 69 7.18 8.1	52.39 59.37 Yb 70 7.42 8.4	54.07 61.28 Lu 71 7.66 8.71
Actinides 89-103	90.88 102.85 Ac 89 12.65 15.71	93.35 105.61 Th 90 12.97 16.2	95.87 108.43 Pa 91 13.29 16.7	98.44 111.3 U 92 13.61 17.22	101.00 114.18 Np 93 13.95 17.74	103.65 117.15 Pu 94 14.28 18.28	106.35 120.16 Am 95 14.62 18.83	109.10 123.24 Cm 96 14.96 19.39	111.90 126.36 Bk 97 15.31 19.97	114.75 129.54 Cf 98 15.66 20.56	117.65 132.78 Es 99 16.02 21.17	120.60 136.08 Fm 100 16.38 21.79	Md 101	No 102	Lr 103

Alloy Elements and Detection Limit Guidelines:

Elements Detected Magnesium (Mg, Z=12) through Silicon (Si, Z=14) and Titanium (Ti, Z=22) through Plutonium (Pu, Z=94) typically 0.1% - some elements as low as 0.01%

Low-Density Sample Types (Soils, powders, liquids)



- Requires vacuum, LOD 0.2 – 3%
- LOD 1% - 5%
- 250 - 2,500 ppm
- 10 - 100 ppm
- 50 - 150 ppm
- Not Measured

Detection limits are a function of testing time, sample matrix and presence of interfering elements.
Detection limits are estimates based on 1-2 minutes test times and detection confidence of 3σ (99.7% confidence).
Interference-free detection limits are intended as guidelines: please contact Innov-X Systems to discuss your specific application.

PHOTON ENERGIES, IN ELECTRON VOLTS, OF PRINCIPAL K- AND L-SHELL EMISSION LINES

Element	Symbol	Atomic #	$K_{\alpha 1}$	$K_{\beta 1}$	$L_{\alpha 1}$	$L_{\beta 1}$
Actinium	Ac	89	90.88	102.85	12.65	15.71
Aluminum	Al	13	1.49	1.56	0	0
Antimony	Sb	51	26.36	29.73	3.6	3.84
Argon	Ar	18	2.96	3.19	0	0
Arsenic	As	33	10.54	11.73	1.28	1.32
Astatine	At	85	81.52	92.3	11.43	13.88
Barium	Ba	56	32.19	36.38	4.47	4.83
Beryllium	Be	4	0.11	0	0	0
Bismuth	Bi	83	77.11	87.34	10.84	13.02
Boron	B	5	0.18	0	0	0
Bromine	Br	35	11.92	13.29	1.48	1.53
Cadmium	Cd	48	23.17	26.1	3.13	3.32
Calcium	Ca	20	3.69	4.01	0.34	0.34
Carbon	C	6	0.28	0	0	0
Cerium	Ce	58	34.72	39.26	4.84	5.26
Cesium	Cs	55	30.97	34.99	4.29	4.62
Chlorine	Cl	17	2.62	2.82	0	0
Chromium	Cr	24	5.41	5.95	0.57	0.58
Cobalt	Co	27	6.93	7.65	0.78	0.79
Copper	Cu	29	8.05	8.91	0.93	0.95
Dysprosium	Dy	66	46	52.12	6.5	7.25
Erbium	Er	68	49.13	55.68	6.95	7.81
Europium	Eu	63	41.54	47.04	5.85	6.46
Fluorine	F	9	0.68	0	0	0
Francium	Fr	87	86.1	97.47	12.03	14.77
Gadolinium	Gd	64	43	48.7	6.06	6.71
Gallium	Ga	31	9.25	10.26	1.1	1.12
Germanium	Ge	32	9.89	10.98	1.19	1.22
Gold	Au	79	68.8	77.98	9.71	11.44
Hafnium	Hf	72	55.79	63.23	7.9	9.02
Holmium	Ho	67	47.55	53.88	6.72	7.53
Indium	In	49	24.21	27.28	3.29	3.49
Iodine	I	53	28.61	32.29	3.94	4.22
Iridium	Ir	77	64.9	73.56	9.18	10.71
Iron	Fe	26	6.4	7.06	0.71	0.72
Krypton	Kr	36	12.65	14.11	1.59	1.64
Lanthanum	La	57	33.44	37.8	4.65	5.04
Lead	Pb	82	74.97	84.94	10.55	12.61
Lithium	Li	3	0.05	0	0	0
Lutetium	Lu	71	54.07	61.28	7.66	8.71
Magnesium	Mg	12	1.25	1.3	0	0
Manganese	Mn	25	5.9	6.49	0.64	0.65
Mercury	Hg	80	70.82	80.25	9.99	11.82
Molybdenum	Mo	42	17.48	19.61	2.29	2.39
Neodymium	Nd	60	37.36	42.27	5.23	5.72

Element	Symbol	Atomic #	$K_{\alpha 1}$	$K_{\beta 1}$	$L_{\alpha 1}$	$L_{\beta 1}$
Neon	Ne	10	0.85	0	0	0
Nickel	Ni	28	7.48	8.26	0.85	0.87
Niobium	Nb	41	16.62	18.62	2.17	2.26
Nitrogen	N	7	0.39	0	0	0
Osmium	Os	76	63	71.41	8.91	10.36
Oxygen	O	8	0.52	0	0	0
Palladium	Pd	46	21.18	23.82	2.84	2.99
Phosphorus	P	15	2.01	2.14	0	0
Platinum	Pt	78	66.83	75.75	9.44	11.07
Polonium	Po	84	79.29	89.8	11.13	13.45
Potassium	K	19	3.31	3.59	0	0
Praseodymium	Pr	59	36.03	40.75	5.03	5.49
Promethium	Pm	61	38.72	43.83	5.43	5.96
Protactinium	Pa	91	95.87	108.43	13.29	16.7
Radium	Ra	88	88.47	100.13	12.34	15.24
Radon	Rn	86	83.78	94.87	11.73	14.32
Rhenium	Re	75	61.14	69.31	8.65	10.01
Rhodium	Rh	45	20.22	22.72	2.7	2.83
Rubidium	Rb	37	13.4	14.96	1.69	1.75
Ruthenium	Ru	44	19.28	21.66	2.56	2.68
Samarium	Sm	62	40.12	45.41	5.64	6.21
Scandium	Sc	21	4.09	4.46	0.4	0.4
Selenium	Se	34	11.22	12.5	1.38	1.42
Silicon	Si	14	1.74	1.84	0	0
Silver	Ag	47	22.16	24.94	2.98	3.15
Sodium	Na	11	1.04	1.07	0	0
Strontium	Sr	38	14.17	15.84	1.81	1.87
Sulfur	S	16	2.31	2.46	0	0
Tantalum	Ta	73	57.53	65.22	8.15	9.34
Technetium	Tc	43	18.37	20.62	2.42	2.54
Tellurium	Te	52	27.47	31	3.77	4.03
Terbium	Tb	65	44.48	50.38	6.27	6.98
Thallium	Tl	81	72.87	82.58	10.27	12.21
Thorium	Th	90	93.35	105.61	12.97	16.2
Thulium	Tm	69	50.74	57.52	7.18	8.1
Tin	Sn	50	25.27	28.49	3.44	3.66
Titanium	Ti	22	4.51	4.93	0.45	0.46
Tungsten	W	74	59.32	67.24	8.4	9.67
Uranium	U	92	98.44	111.3	13.61	17.22
Vanadium	V	23	4.95	5.43	0.51	0.52
Xenon	Xe	54	29.78	33.62	4.11	4.42
Ytterbium	Yb	70	52.39	59.37	7.42	8.4
Yttrium	Y	39	14.96	16.74	1.92	2
Zinc	Zn	30	8.64	9.57	1.01	1.03
Zirconium	Zr	40	15.78	17.67	2.04	2.12

STANDARD OPERATING PROCEDURE

Soil Sampling During Excavations

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of subsurface soils during excavations, soil stockpiles, and import fill sources using hand tools or heavy equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, disposable plastic scoop, coring device, hand auger, or other appropriate hand tool
- Excavator with bucket
- Stainless-steel pan or bowl or disposable sealable bags
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling by Hand Methods

Either a shovel, post-hole digger, or trowel, will be used to remove soil immediately above the interval to be sampled. Once the desired sample interval is exposed, a decontaminated sampling tool (shovel, post-hole digger, trowel, disposable plastic scoop, etc) will be used to collect the sample. Soil that will be analyzed for semi-volatile organic compounds (SVOC) and inorganic analyses will be placed in a stainless steel sample bowl or disposable plastic scoop and will be homogenized using a stainless steel spoon or plastic disposable scoop. Procedures detailing the homogenization process are provided in SOP *Homogenization of Soil and Sediment Samples*. Note that during homogenization, pieces of gravel, asphalt, and metal should be removed as they do not make up the soil fraction of the sample and may produce erroneous results following chemical analysis. The homogenized sample will then be placed in the sample containers for chemical analysis. Soil samples that will be analyzed for volatile organic compounds (VOC) will not be composited, but will be placed directly into the sample containers for chemical analysis.

During sample collection, sampling personnel will also record the following information in a bound field notebook:

- Lithology of the material encountered (including soil type, color, grain-size, moisture content, and a record of any foreign material encountered (concrete, asphalt, metal, plastic, etc.)
- Sampling interval,
- Date and time the sample was collected
- Results of screening measurements (i.e., photo ionization detector, etc.)
- Presence of odors or staining

Logbook entry procedures are described in detail in SOP *Preparing Field Log Books*.

B. Sampling Using Excavator Bucket

The following procedures will be used when collecting soil samples from the bucket of an excavator:

- Using an excavator bucket, scoop a volume of soil from the sampling location which is large enough to collect sample soil that did not come into direct contact with the surfaces of the bucket.
- Once the soil is removed, use a decontaminated trowel or shovel to remove the upper few inches of soil in the center of the bucket to expose a "fresh" sample. Once exposed use a decontaminated trowel, spoon, disposable plastic scoop, or shovel to collect a soil sample for chemical analysis. Samples collected for volatiles analysis should be placed directly into the sample containers. Material for samples for all other parameters should be removed to a decontaminated stainless steel bowl, tray, or disposable sealable bag. Samples that will be analyzed for SVOCs and inorganic will be homogenized as previously described in Section A above, and follow the procedures provided in SOP *Homogenization of Soil and Sediment Samples*.

Additionally, the logbook entry procedures summarized in Section A above and detailed in SOP *Preparing Field Log Books* will be followed during sample collection.

C. Stockpile and Import Fill Sampling

Procedure for Collecting Volatile Fractions

Using an auger, split spoon, or other device, retrieve a core from the stockpile or borrow source area to be sampled. Remove the core from the auger, split spoon, or other device and place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core®** sampler or **Terra Core®** Sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. After filling the required VOA vials, fill a 4-ounce jar with the remaining core

sample. (This will be used by the laboratory to determine percent moisture.) Label the vials and place on ice for shipment to the laboratory.

Procedure for Collecting Non-Volatile Samples

From five randomly selected sample locations, use a stainless steel spoon to collect equal amounts of soil for the required samples and place the soils into a stainless steel bowl or tray. The volume of soil collected should be sufficient to completely fill all sample containers requested by the laboratory. Homogenize the five samples by following the procedures provided in SOP *Homogenization of Soil and Sediment Samples*. Fill each required sample container with the required volume of homogenized soils. Complete the sample labels and place the sample containers on ice for shipment to the laboratory.

IV. Attachments

None

V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite or absorbent pads.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

STANDARD OPERATING PROCEDURE

Multi RAE Photoionization Detector (PID)

I. Purpose

The purpose of this SOP is to provide general reference information for using the Multi RAE PID in the field. Calibration and operation, along with field maintenance, will be included in this SOP.

II. Scope

This procedure provides information on the field operation and general maintenance of the Multi RAE PID. Review of the information contained herein will ensure that this type of field monitoring equipment will be properly utilized. Review of the owner's instruction manuals is a necessity for more detailed descriptions.

III. Definitions

Carbon Monoxide Sensor (CO) - Expresses the Carbon Monoxide concentration in ppm.

Volatile Organic Compound (VOC) – Expresses the VOC concentration in ppm

Lower Explosive Limit (LEL) - Combustible gas is expressed as a percent of the lower explosive limit.

Hydrogen Sulfide Sensor (H_2S) - Expresses the Hydrogen Sulfide concentration in ppm.

Oxygen Sensor (OXY) - Expresses the Oxygen concentration as a percentage.

ppm - parts per million: parts of vapor or gas per million parts of air by volume.

IV. Procedures

The Multi RAE utilizes the principle of detecting sensors. The PID operates on the principle that most organic compounds and some inorganic compounds are ionized when they are bombarded by high-energy ultraviolet light. These compounds absorb the energy of the light, which excites the molecules and results in a loss of electron and the formation of a positively charged ion. The number of ions formed and the ion current produced is directly proportional to mass and concentration. The amount of energy required to displace an electron is called photo ionization potential (PIP). The air sample is drawn into a UV lamp using a pump or a fan. The energy of the lamp determines whether a particular chemical will be ionized. Each chemical compound has a unique ionizing potential. When the UV light energy is greater than

the ionization potential of the chemical, ionization will occur. When the sample is ionized, the electrical signal is displayed on an analog or digital output. Although the output does not distinguish between chemicals, it does detect an increase in the ion current. If only one chemical is present in the air, it is possible to use PIDs quantitatively. Chemical structure and lamp intensity affects the sensitivity of the instrument to a given contaminant. All PID readings are relative to the calibration gas, usually isobutylene. It is important to calibrate the PID in the same temperature and elevation that the equipment will be used, and to determine the background concentrations in the field before taking measurements. For environments where background readings are high, factory zero calibration gas should be used.

Note: for volatile and semi-volatile compounds, knowing the PIP is critical in determining the appropriate instrument to use when organic vapor screening. Consult the QAPP and manufacturer's manual to determine that the proper instrument has been selected for the contaminate vapors of interest. If an expected compound at a site has a PIP less than 11.7 eV, it is possible to use a PID. If the ionization potential is greater than 11.7eV, an FID is required.

The following subsections will discuss Multi RAE calibration, operation, and maintenance. These sections, however, do not take the place of the instruction manual.

A. Calibration

For Multi RAE configured with O_2, LEL, H_2S, CO, sensors and a 10.6eV PID Lamp.

Start up Instrument

- Press **Mode** button
- Observe displays:

On!……..

Multi RAE Version X.XX

Model Number SN XXXX

Date Time Temp

Checking Sensor Ids….

VOC Installed

CO Installed

H_2S Installed

OXY Installed

LEL Installed

H_2S VOC CO LEL OXY

Alarm Limits=

XX XX.X XX XX High XX.X

XX XX.X XX XX Low XX.X

XX XX.X XX STEL

XX XX.X XX TWA

Battery = X.XV Shut off at 4.2V

User Mode=

Alarm Mode=

Datalog Time Left

Datalog Mode

Datalog Period

Unit ready in….. 10 Seconds

- The pump will start, the seconds will count down to zero, and the instrument will be ready for use

Calibration Check and Adjustment

Allow instrument to warm up for 15 minutes.

- Depress the **[N/-]** key first, then while depressing the **[N/-]**, depress the **[Mode]** key also and depress both keys for 5 seconds.
- Display will read:

```
Calibrate
Monitor?
```

- Press the **[Y/+]** key
- Display will read:

```
Fresh Air
Calibration?
```

- If "Zero Air" is necessary, attach the calibration adapter over the inlet port of the Multi RAE Monitor and connect the other end of the tube to the gas regulator (HAZCO loaner regulator LREG.5, RAE Systems P/N 008-3011 or suitable .5 LPM regulator) on the Zero Air bottle (HAZCO P/N SGZA, RAE P/N 600-0024). If no Zero Air is available, perform the Fresh Air Calibration in an area free of any detectable vapor.
- Press the **[Y/+]** key
- Display will read:

```
Zero….
In progress…
```

```
CO Zeroed!
Reading = X
```

```
VOC Zeroed!
Reading = X
```

```
LEL Zeroed!
Reading = X
```

```
OXY Zeroed!
Reading = X
```

```
Zero Cal done!
```

H_2S Zeroed!

Reading = X

In each of the above screens, "X" is equal to the reading of the sensor before it was zeroed.

- Display will then read:

```
Multiple Sensor
Calibration?
```

- Press the **[Y/+]** key
- The display shows all of the pre-selected sensors and the "OK?" question:

```
CO H2S
LEL OK? OXY
```

- Apply calibration gas – use either HAZCO Services Part Number R-SGRAE4 or Rae Systems Part Number 008-3002 – using a .5 LPM regulator and direct tubing.
- Press the **[Y/+]** key. Display will read:

```
Apply Mixed gas
```

```
Calibration
In progress …
```

- The display will count down showing the number of remaining seconds:

```
CO cal'ed
Reading=50
```

```
H2S cal'ed
Reading=25
```

```
LEL cal'ed
Reading=50
```

```
OXY cal'ed
Reading=20.9
```

```
Calibration done
Turn off gas!
```

- Display will read:

```
Single Sensor
Calibration?
```

- Press the **[Y/+]**.
- Display will read:

```
CO VOC H2S
LEL pick? OXY
```

- Attach 100 ppm Isobutylene (HAZCO P/N r-SGISO or Rae P/N 600-0002) using a 1.0 LPM regulator (HAZCO P/N LR10HS or Rae P/N 008-3021). Open regulator.
- Press the **[Mode]** key once, the V of VOC will be highlighted.

- Press the **[Y/+]**. The display will read:

Apply VOC Gas

Calibration In progress…

- The display will count down showing the number of remaining seconds:, then display:

VOC cal'd Reading=100

Calibration done Turn off gas!

Single Sensor Calibration?

- Press **[Mode]** key twice to return to main screen.
- **CALIBRATION IS COMPLETE!**

B. Operation

Due to the Multi RAE having many functions in terms of operation, it is recommended that you follow the operational procedures as outlined in the instruction manual from pages 9 to 14.

C. Site Maintenance

After each use, the meter should be recharged and the outside of the instruments should be wiped clean with a soft cloth.

D. Scheduled Maintenance

Function	Frequency
Check alarm and settings	Monthly/before each use
Clean screens and gaskets around sensors	Monthly
Replace sensors	Biannually or when calibration is unsuccessful

V. Quality Assurance Records

Quality assurance records will be maintained for each air monitoring event. The following information shall be recorded in the field logbook.

- Identification - Site name, date, location, CTO number, activity monitored, (surface water sampling, soil sampling, etc), serial number, time, resulting concentration, comments and identity of air monitoring personnel.
- Field observations - Appearance of sampled media (if definable).
- Additional remarks (e.g, Multi RAE had wide range fluctuations during air monitoring activities.)

VI. References

Multi RAE Plus Multiple Gas Monitor User Manual, RAE Systems, Revision B1, November 2003.

MultiRAE Plus

PGM-50/4, PGM-50/4P, PGM-50/5P
Multiple-Gas Monitor

ISO 9001
CERTIFIED

RAE SYSTEMS

USER MANUAL

008-4022-000, Revision B1, November 2003

Equipment List

Number	Part	Part Number
	Monitor Only	
(not shown)*	Shipping case	008-3040-000
2	Monitor with wrist strap	*as specified*
2	Sensors	*as specified*
2	Rubber boot with belt clip	008-3042-000
2	Rechargeable Li-Ion battery	500-0037-100
3	Alkaline battery adapter	500-0029-000
4	120-230 V AC/DC wall adapter	*as specified*
5	Calibration adapter	008-3016-000
5	External filters	008-3022-003
5	Inlet probe	008-3012-001
5	Charcoal filters	008-3006-005
6	Training CD	008-4013-000
7	User manual	008-4022-000
	Monitor with Accessories Kit	
1	Hard transport case	002-3009-000
8	Remote sampling probe with coiled Teflon tubing	008-3015-200
9	Tool kit	081-0005-000
	Optional Calibration Kit	***008-3001-000***
10	Calibration gas	*as specified*
11	Regulators with tubing (male)	007-3021-000
11	Regulators with tubing (female)	002-3011-000
	Datalogging Upgrade Option	***008-001-000***
6	ProRAE Suite software package, for Microsoft® Windows™ 95, 98, 2000, NT, ME & XP	000-5001-000
12	Computer interface cable	008-3003-000

*Different shipping cases are used for monitor-only and single calibration gas kits.

This is a complete kit, which includes the accessories and calibration kits with a MultiRAE Plus monitor that is datalog-enabled.

i

Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

⚠ **Caution!**

To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor modules for service. Never operate this monitor while the cover is removed. Remove monitor cover and sensor modules only in an area known to be non-hazardous.

⚠ **Special Note**

When the MultiRAE Plus monitor is taken out of the transport case and is turned on for the first time, there may be some residual vapors trapped inside the monitor and the initial toxic gas sensors may indicate a few ppm. After running the monitor for several minutes in clean air, the residual vapors should clear and readings should return to near zero.

⚠ **Attention! For European Applications**

A. CE 0575 Ex II 2G
DEMKO 03 ATEX 0308256X, EEx ia d IIC T3/T4

B. Recharge batteries in non-hazardous locations.

C. Do not connect external cable to serial interface jack in hazardous locations.

D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non hazardous area.

Protected by U.S. Patents 5,393,979 , 5,561,344 , 5,773,833 , 6,225,633 , 6,313,638 , 6,333,632 , 6,320,388

⚠ Warnings ⚠

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand the instruction manual completely before operating or servicing.

⚠ Battery Pack

Use only RAE Systems battery packs, part number 500-0029 or 500-0037. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous atmospheres.

⚠ Computer Interface

Do not transfer data by means of the computer interface cable in hazardous atmospheres.

⚠ Static Hazard

Clean only with a damp cloth.

⚠ Calibration

The calibration of any newly purchased RAE Systems Instrument should be tested by exposing it to known concentration calibration gases before the instrument is put into service for the first time. For safety, check the accuracy of the monitor by exposing the sensors to known concentration calibration gas(es) before each day's use.

⚠ Readings

Any rapid up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond upper scale limit, which may be hazardous.

⚠ Avertissements ⚠

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

⚠ Ensemble de Batterie

Utiliser seulement l'ensemble de batterie RAE Systems avec numéro de série 500-0029 ou 500-0037. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans l'emplacement désigné non dangereux.

⚠ Câble de Computer

Connecter pas le câble externe que dans environnements non dangereux.

⚠ Danger Risque D'origine Electrostatique

Nettoyer uniquement avec un chiffon humide.

⚠ La Calibration

La calibration de toute instruments de RAE Systems doit être testé en exposant l'instrument à une concentration de gaz connue par une procédure die talonnage avant de mettre en service l'instrument pour la première fois. Pour une sécurité maximale, la sensibilité du MultiRAE Plus doit être vérifié en exposant l'instrument à une concentration de gaz connue par une procédure die talonnage avant chaque utilisation journalière.

⚠ Les Lectures

Toute lecture rapide et positive, suivie d'une baisse subite au erratique de la valeur, peut indiquer une concentration de gaz hors gamme de détection qui peut être dangereuse.

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General Information

The MultiRAE Plus is a programmable multiple-gas monitor designed to provide continuous exposure monitoring of toxic organic and inorganic gases, oxygen and combustible gases for workers in hazardous environments.

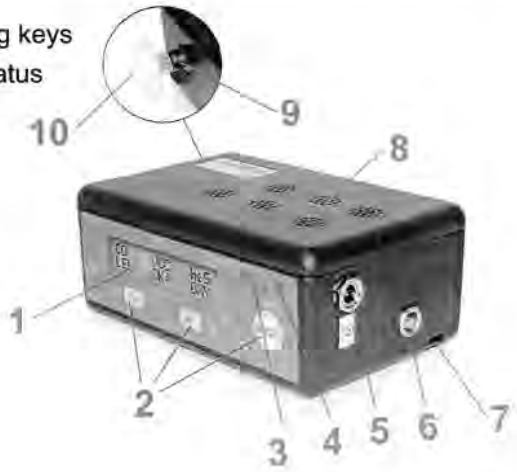
The MultiRAE Plus is an extremely flexible one-to-five sensor instrument for use in confined space, emergency response, industrial hygiene, and many other monitoring applications. The MultiRAE Plus is the only instrument available on the market today that can offer protection using both standard gas detection sensors for the detection of oxygen, combutible gas, and specific toxic gases, as well as an integrated Photo-Ionization Detector (PID) for the ultimate broad-range toxic gas detection. The MultiRAE Plus is easily reconfigured and upgraded to meet your changing needs. Its versatility replaces a wide range of monitors, saving training, and maintenance costs. The MultiRAE Plus transitions quickly and easily from a sophisticated technician instrument to a simple text or display only monitor. The same monitor can be used as a personal monitor, a hand-held sniffer, or as a continuous operational area monitor.

Dataloging-Enabled Monitors

Datalog monitors are capable of storing datalog data in the instrument's non-volatile memory. When the version number appears during the power-on sequence, the "D" indicates a Datalog monitor. Call the factory to learn how to upgrade the instrument to a Datalog monitor.

Physical Description

1. Display
2. Operation/programming keys
3. Visual alarm/charge status
4. Light sensor
5. Power jack
6. RS-232 port
7. Wrist strap holder
8. Buzzer and gas outlet
9. Gas inlet
10. External filter



Operating the MultiRAE Plus

⚠ **The external filter must always be used with the monitor.**

Turning the Monitor On and Off

To turn on, press (MODE) . The monitor will beep once and go through a 90-second warm-up sequence as follows:

On! – English, PGM-50

Multi-Gas Monitor, Software Version

RAE Systems, Inc. (customizable using ProRAE Suite software)

Monitor Type, Serial Number

Date, Time, Temperature

Checking Sensor ID's (As the MultiRAE Plus checks each sensor, it displays the date it was last calibrated and its warranty expiration date. If a new sensor is installed, it will ask for it to be calibrated.)

Alarm Limits (for High, Low, STEL, TWA)

Instrument Calibration (The last calibration date must be within the last 30 days for safe operation.)

Battery Shut Off Voltage

User Mode

Alarm Mode

Datalog Memory

Datalog Time Left

Datalog Mode

Datalog Period

To turn off after the warm-up is complete, press and hold (MODE) for 5 seconds. The monitor beeps each second during the count-down sequence. Release when "Off! ....." flashes on the LCD. Plug the 110 VAC/12 VDC transformer into the monitor when not in use; the "Charging....." message appears on the screen.

User Modes

The MultiRAE Plus has three user modes: **Text**, **Display**, and **Advanced**. Each mode provides a different level of access to the monitor's features. Text mode is the simplest mode, Advanced mode is the most complex.

The table shows the features in the order in which they appear. Regardless of which user mode the monitor is in, press MODE to advance to the next available feature.

Features	Text Mode	Display Mode	Advanced Mode
Sensor Names & Instantaneous Readings - instantaneous readings are the actual gas concentrations for the following sensors: **TOX1** (toxic gas) – parts-per-million (ppm) **TOX2** (toxic gas) – ppm **VOC** (volatile organic compound) – ppm **LEL** (lower explosive limit) – percentage **OXY** (oxygen) - percentage	yes (with "OK" on LCD)	yes	yes
PEAK - the highest reading for each gas concentration since the monitor was turned on; updated every second.	no	yes	yes
MIN - the lowest reading for each gas concentration since the monitor was turned on; updated every second.	no	yes	yes
STEL - the Short Term Exposure Limit for VOC and toxic gases only; the average reading of the gas concentration for the last 15 minutes, which is updated every minute. **NOTE:** "*****" will appear for the first fifteen minutes.	no	yes	yes
TWA - the Time Weighted Average for VOC and toxic gases only; the accumulated reading of the gas concentration, divided by 8 hours, since the monitor was turned on. Updated every minute.	no	yes	yes

Battery Voltage - the current battery voltage, measured in volts. **Shut off** - A fully charged battery will be 4.8 V or greater. When the battery voltage falls below 4.4 V, the "Bat" warning message appears and only 20-30 minutes of run time remain before the instrument will automatically shut down (at 4.2 V).	yes	yes	yes
Date & Time, Run-Time and Temp - the runtime is how long the instrument has been on in hours and minutes.	no	no	yes
Start/Stop Datalog - turns manual datalogging on/off.	no	no	yes
LEL Gas - monitor measures LEL in units of specified target gas. **NOTE:** Correction factor may only be changed in Program Mode.	no	no	yes
VOC Gas - monitor measures VOC in units of specified target gas. **NOTE:** Correction factor may only be changed in Program Mode.	no	no	yes
Print Reading - capable of printing out the gas concentration readings if a serial printer is connected to the instrument. **NOTE:** This feature can be turn on using ProRAE Suite.	no	yes	yes
PC Communication - capable of uploading data from the monitor to a computer or downloading configuration information from a computer to the monitor via a serial port.	yes	yes	yes

Calibrating the Monitor

⚠ **While all instruments are calibrated prior to leaving the factory, temperature extremes and/or shocks during shipment can cause sensor drift. Therefore, the accuracy of any newly purchased RAE Systems monitor should be tested by exposing the sensor(s) to known concentration calibration gas before the monitor is used or put into service. For maximum safety, the accuracy of the monitor should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.**

When should you calibrate the monitor?

The monitor should be calibrated no less than every 30 days, or if it does not pass a fresh air reading, or if it does not pass a field verification.

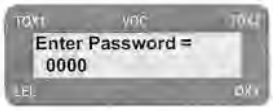
Calibration

The sensors are calibrated in a two-step process using fresh air and span gas (a span gas contains a known concentration of a given gas). Some sensors may show sensitivity to other gases - this is called "cross sensitivity". Therefore, it is important to choose the gas mixture carefully. We recommend the standard RAE Systems MultiRAE Plus 4-gas calibration mix (50% LEL methane, 20.9% oxygen, 25 ppm H_2S, 50 ppm CO in a single gas cylinder) to calibrate the LEL, H_2S and CO sensors, and isobutylene (100 ppm) for the PID. You will also need a calibration adapter in order to connect the monitor (with external filter!) to the outlet of the gas cylinder. For the calibration of other toxic sensors, you will need the specific gas for that sensor.

Getting Started

To calibrate the monitor, the instrument must be in Program Mode. To enter Program Mode, press and hold MODE and N/- for 5 seconds.

If the monitor is in Text or Display Mode, you will be prompted for a password. Use Y/+ to change the number. Use MODE to move on to the next digit. The default password is "0000". Press and hold MODE to submit the password.



Fresh Air Calibration

The first step of calibration is a Fresh Air Calibration:

Calibrate Monitor?

Press (Y/+) .

Fresh Air Calibration?

Press (Y/+) .

The monitor will cycle through each sensor. When the process is complete, the display will read, "Zero Cal Complete!".

Zero Organic Filters for Zeroing PID

Use an optional external zero organic filter (P/N 008-3024-000, 3-pack) when the ambient air may be contaminated with hydrocarbons.

Attach the filter to the MultiRAE Plus during fresh air calibration. The filter can be used up to 20 times before disposing. This filter removes most heavier organic and inorganic compounds, but may not completely remove lighter compounds such as methane, propane, and CO.

Span Gas Calibration

To complete step two of calibration, a Span Gas Calibration must be performed for each sensor.

The instructions below are for a standard confined space entry instrument utilizing CO, H_2S, LEL, Oxygen sensors.

For this calibration you will need the standard RAE Systems MultiRAE Plus 4-gas calibration mix (50% LEL methane, 20.9% oxygen, 25 ppm H_2S, 50 ppm CO in a single gas cylinder). For the calibration of other toxic sensors, or to calibrate a single sensor, please go to the Program Mode section of this manual.

Multiple Sensor Calibration

Press [Y/+] .

The monitor will assume you want to calibrate the CO, H_2S, LEL and Oxygen sensors.

Press [Y/+] .

Apply the RAE Systems 4-gas span gas mixture and start the gas flow.

The 60-second countdown timer appears.

"Span Cal Done! Turn Off Gas" message appears. The readings should be very close to the span gas values shown on the gas cylinder.

Turn off the gas flow and disconnect the calibration adapter from the monitor. If calibration fails, an error message appears instead. *Refer to Troubleshooting: "Calibration Error Message" on page 38.*

NOTE: If calibration is accidentally started and gas has run out or has been disconnected, press [MODE] repeatedly. Calibration will stop and revert back to the previous calibration values.

Calibrating the PID Sensor

The single sensor method used to calibrate the PID can also be used to calibrate single toxic sensors. For the PID, use isobutylene (100ppm) span gas. For other toxic sensors, use the appropriate gas, e.g., ammonia sensor - use ammonia gas, etc.

Single Sensor Calibration

Press (Y/+) .

When the installed sensors appear on the display use (MODE) to move from sensor to sensor.

Press (Y/+) to select the highlighted sensor and start calibration.

Apply span gas mixture and start gas flow.

The 60-second countdown timer appears.

NOTE: Some sensors (Cl_2, PH_3, NH_3, HCN) require a special "presoak" period prior to starting calibration. Turn the gas on to the MultiRAE Plus for this time period. ***Refer to Range, Resolution and Response Time chart on page 41 BEFORE starting the calibration procedure.*** When calibration has started and if the MultiRAE Plus displays "No gas flow..." apply gas or hit any key to start. Press (Y/+) to start calibration.

Calibration is complete when the sensor name and its span value appear, confirmed by a "Span Cal Done! Turn Off Gas" message. If no gas has reached a sensor after sixty seconds, calibration will abort. The readings should be relatively close to the span gas values.

Turn off the gas flow and disconnect the calibration adapter from the monitor. If calibration fails, an error message appears instead. *Refer to Troubleshooting: "Calibration Error Message" on page 38.*

Calibration Time Stamp

A time stamp is created and stored each time a sensor calibration is performed, which is included in the datalog report.

Press (MODE) twice to exit calibration mode and return to the main display.

NOTE: Residual gas may linger on the sensors for up to 60 seconds.

If the sensors do not return to zero, repeat fresh air calibration.

MultiRAE Plus Usage Overview

Storage

Always keep the MultiRAE Plus on charge in a dry indoor area when not in use.

⚠ **If the MultiRAE Plus is to be stored more than 2 weeks off the charger, it is recommended to remove the Li-ion battery. Upon reinstalling the battery, it will need a complete charge and some sensors (like NO and NH_3) may require time to warm up, anywhere from 20 minutes to 24 hours.** *Refer to Technical Note-114 Sensor Specifications and Cross Sensitivities.* **The clock will also need to be reset.**

Confined Space Pre-Entry Test

Test the atmosphere in the confined space by sampling air at 3 levels (Top, Middle and Bottom) in the Confined Space. Give the instrument time to sample the gas at each level - the correct sampling time is 60 seconds plus 1 second per every foot of hose.

Alarms

If there are any gas **ALARMS** at any level in the confined space it is not safe. **DO NOT ENTER!**

Identify the alarm condition and then start your preventive actions according to your company's Confined Space Entry procedures.

No Alarms

If there are no alarms, the Confined Space may be safe for entry. Disconnect the hose before carrying the MultiRAE Plus into the Confined Space. If monitoring is to be done by a Confined Space attendant, they should continue to monitor while you enter the area.

If the unit alarms and "BAT" is displayed, the battery needs to be charged. There is 15 minutes or less of run time remaining. ***Leave the Confined Space immediately!*** *See the Applications and Technical Notes Guide for more information regarding Confined Space Entry and other applications.*

After Usage

Turn the MultiRAE Plus off by pressing and holding (MODE). The buzzer will beep and count down 5-4-3-2-1 and read "OFF". Return the MultiRAE Plus to the dry, indoor storage area and connect the charger to the MultiRAE Plus.

Alarm Signals

When an alarm condition occurs, the monitor will provide audible and visual alarms to alert users of unsafe conditions. *Refer to the Alarm Signals table on page 11 for a complete list of alarm conditions.*

⚠ **The alarm signals are disabled while in the following modes: Communicate with PC, Print Reading, Calibrate Monitor. To reduce the risk of exposure to hazardous atmospheres, use these modes only in an area known to be non-hazardous.**

The alarm system can be set up in one of two ways:

Auto Reset Alarm (default): The alarm signals automatically reset when the alarm condition is no longer present. **NOTE:** Not all alarm conditions have this option.

Latched Alarm: The alarm signal remains on even when the alarm condition is no longer present; press [Y/+] to acknowledge and reset alarm signals.

Testing Alarm Signals

Press [Y/+] . If functional, the buzzer will beep once and the backlight will flash once.

	Alarm Signal				
Alarm Condition	**beep/sec**	**flash/sec**	**vibration***	**Screen Message**	**Reset Alarm**
Gas concentration exceeds High Alarm	3	3	yes	sensor name "HIGH"	move away from gas
Gas concentration exceeds Low Alarm	2	2	yes	sensor name "LOW"	move away from gas
Gas concentration exceeds STEL	1	1	yes	sensor name "STEL"	move away from gas & wait 15 minutes
Gas concentration exceeds TWA	1	1	yes	sensor name "TWA"	move away from gas & turn unit OFF/ON
Gas concentration exceeds sensor range	3	3	yes	sensor name "OVR"	move away from gas
Unit short circuits *or* Reading over max range	3	3	yes	sensor name "MAX"	indicates possible sensor failure. calibrate sensor to verify performance
Excessive sensor negative drift	1	1	yes	sensor name "NEG"	perform zero calibration
Blocked inlet *or* Pump failure	3	3	yes	"PUMP"	unblock inlet; press [Y/+] to restart pump
PID lamp fails to light	3	3	yes	"LAMP"	turn off/on or wait; lamp may turn on by itself
Excessive LEL gas *or* LEL sensor is OFF	3	3	yes	sensor name "OFF"	move away from gas & turn LEL sensor ON (press [Y/+])
Low battery	1/min	1/min	no	"Bat"	charge battery
Datalog memory full	1	1	yes	"Mem"	clear datalog memory or turn on "wrap-around
Datalog memory write error	1	1	yes	"EEm"	turn unit OFF/ON

*The external vibration alarm is an optional feature.

Preset Alarm Limits and Calibration

The monitor is factory calibrated with standard calibration gas and is programmed with default alarm limits as listed:

Gas	Cal Gas/Balance	Unit	TWA	STEL	Low	High
CO	50/Air	ppm	35	100	35	200
H_2S	25/N_2	ppm	10	15	10	20
SO_2	5/N_2	ppm	2	5	2	10
NO	25/N_2	ppm	25	25	25	50
NO_2	5/Air	ppm	1	1	1	10
Cl_2	10/N_2	ppm	0.5	1	0.5	5
O_2	20.9/N_2	%Vol	-	-	19.5	23.5
CH_4	50/Air	%LEL	-	-	10	20
HCN	10/N_2	ppm	5	5	5	50
NH_3	50/N_2	ppm	25	35	25	50
PH_3	5/N_2	ppm	0.3	1	1	2
VOC*	100/Air	ppm	10.0	25.0	50.0	100

*Note: 100 ppm isobutylene gas is used for VOC gas calibration

Back Light

The backlight assists reading the LCD in poor lighting conditions and automatically turns on anytime the MultiRAE Plus is in alarm.

To manually turn on, press [N/-], and it will automatically turn off after 60 seconds. The backlight can also be set to automatically turn on in low lighting conditions, and likewise turn off in adequate lighting conditions. **NOTE:** The backlight can shorten the operating time by 20-30%.

Sampling Pump

The integrated sampling pump automatically turns on when the monitor is turned on and remains on during normal operation. The pump speed is adjustable between the default low setting (~200 cc/min) and the high setting (~300 cc/min). Use the low setting to save battery and filter life. Use the high setting for reactive gases and remote sampling in applications like Wingtank entry and HazMat.

The monitor can detect any obstructions in the external filter that causes a pump stall. The alarm will activate and a "Pump" error message will appear. To acknowledge the pump stall, press [Y/+] to start the pump again.

Refer to Pump Stall on page 29 for details on how to adjust the pump stall threshold for either the high or low settings.

Datalogging

A small "L" at the center of the screen means the monitor is datalogging. Datalogging-enabled monitors can calculate and store hours of gas readings based on the time-interval and type of gas measurement specified. The time-interval can be set to between 1 and 3600 seconds in 1-second increments. The average and peak gas concentrations are the two types of gas measurements that can be stored for each sensor. **NOTE:** STEL and TWA values will only be logged if average is selected. All data is stored in non-volatile memory that can be downloaded to a computer. Users may select one of two types of memory storage: wrap-around or stop. *Refer to Select Memory Full Type on page 23.*

NOTE: Datalogging pauses upon entering Program Mode or PC Communication Standby Mode. Upon exiting Program Mode datalogging will resume. Upon exiting PC Communication Standby Mode, datalogging will resume only if datalogging mode was set to "Automatic".

Maximum Datalog Time for 5 Sensors

Log Interval	1 sec	60 sec	300 sec (5 min)
Tmax	80 minutes	80 hours	400 hours

Datalog Options

Automatic: Datalogging automatically starts/stops when the monitor is turned on/off.

Manual: If the MultiRAE Plus is in Advanced mode, press [Y/+] at the "Start Datalog" screen. Set a timer to specify the maximum datalogging time using ProRAE Suite software.

Periodic: Set a daily start/stop time to datalog using ProRAE Suite.

Scheduled: Set a monthly start/stop time to datalog using ProRAE Suite.

Charging the Battery Pack

To charge the battery pack plug the transformer supplied with the monitor into the power jack on the monitor.

When a Li-Ion battery pack is installed, charging automatically begins. The LED appears red during charging, and once the battery is fully charged, the LED turns green. The display also indicates the charge status. A completely drained battery pack charges to full capacity in less than 10 hours. When the "Bat" message appears on the LCD, the battery pack needs to be recharged.

NOTE: A fully charged battery pack will switch to trickle charge to maintain battery life. Repeatedly turning the power to the transformer on and off will reset the charge and possibly burn out the battery.

To change the battery pack or to use the alkaline battery adapter, *refer to Replacing the Battery Pack or Emergency Alkaline Battery Adapter on page 32.*

⚠ **If the MultiRAE Plus is to be stored more than 2 weeks off the charger, it is recommended to remove the Li-ion battery.**

Accessories

External Filters

The external filter is a PTFE (Teflon®) membrane with a 0.2 micron pore that reduces the amount of liquid and dust that can contaminate the sensor. Using the external filter prolongs sensor and pump life.

Change the external filter whenever it becomes discolored, clogged with particles, or draws in liquid.

NOTE: Do not use the external filter when calibrating reactive gases. Instead, use the High Pump Speed setting and a short Teflon® tube. Although this shortens battery life, it provides a faster response.

Remote Sampling Probe

When searching in hard-to-reach areas, use the standard remote sampling probe (P/N 008-3015-200) with a telescoping handle and 6 feet of Teflon tubing. For longer distances, attach a length of Teflon tubing. The monitor is capable of drawing samples from over 100 feet.

Optional Dilution Fitting

When gas samples have less than 10% oxygen, the dilution fitting (P/N 008-3025/3026) will increase the oxygen concentration. The dilution fitting can also measure combustible, VOC or toxic gases when the concentration exceeds the upper limit of the sensor range. In Program Mode, set the dilution ratio to obtain the correct gas reading when the dilution fitting is used. The dilution fitting attaches directly to the meter and the sample tubing attaches to the dilution fitting. *Refer to Technical Note-167 Proper Use of Dilution Fittings on Pumped Monitors for more information.*

⚠ **The monitor and the dilution air inlet must be located in a clean atmosphere outside the confined space. Use either a remote sampling probe or Tygon tube test gas samples.**

Calibration Adapter

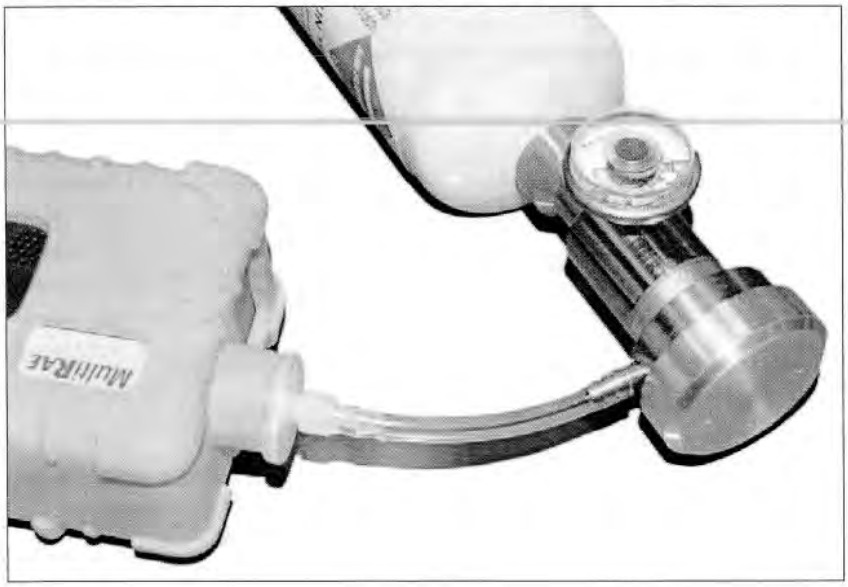
The calibration adapter is a 6-inch Tygon tube with a male Luer connector on the end. During calibration, connect one end of the tube to the external filter (on the monitor) and the other end to the calibration gas.

Alternatively, the calibration gas can be sampled from:

an optional **Tedlar gas bag** (P/N 500-0003-000) filled with calibration gas,

an optional **open cup** (P/N 007-3002-000) with calibration gas flow exceeding the pump demand,

or an optional **demand flow regulator** (P/N 002-3051-000, female or P/N 008-3052-000, male) directly from the gas cylinder.

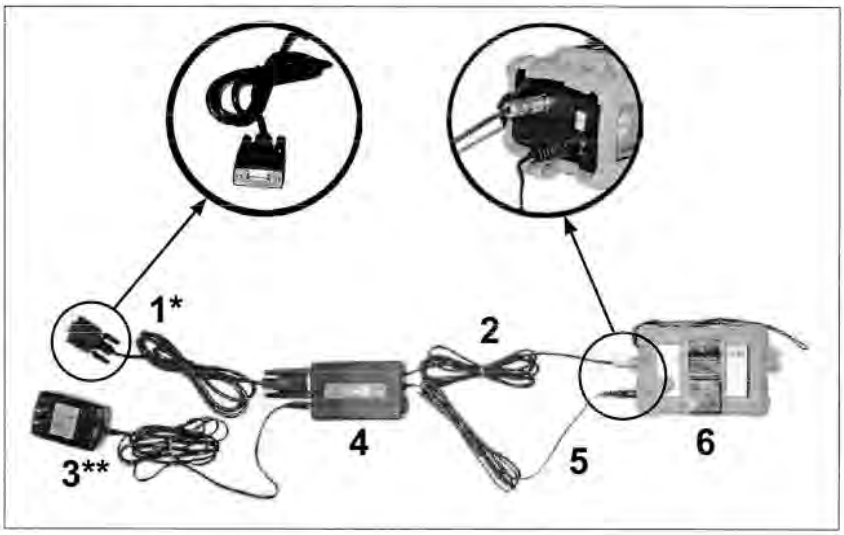


Using the Intrinsically Safe Barrier Box

⚠ **This does NOT ship with UL/cUL-approved monitors. The barrier box is only for ATEX European approved MultiRAE monitors.**

To conform to ATEX European safety standard, the barrier box **must be used** when utilizing an RS-232 cable and/or transformer.

1. RS-232 cable (detachable)*
2. Computer interface cable
3. Transformer (detachable)**
4. Intrinsically safe barrier
5. Power cable
6. MultiRAE Plus monitor



Communicating with a Computer

*** This connection is not necessary during normal charging.**

Connect the RS-232 cable from the barrier box to the monitor.

Connect the computer interface cable to the barrier box.

Plug the computer interface cable into a computer.

Charging the Monitor

**** Connection is optional during computer communication.**

Connect the power cable from the barrier box to the monitor.

Connect the transformer to the barrier box.

Plug the transformer into an appropriate outlet.

Programming Mode

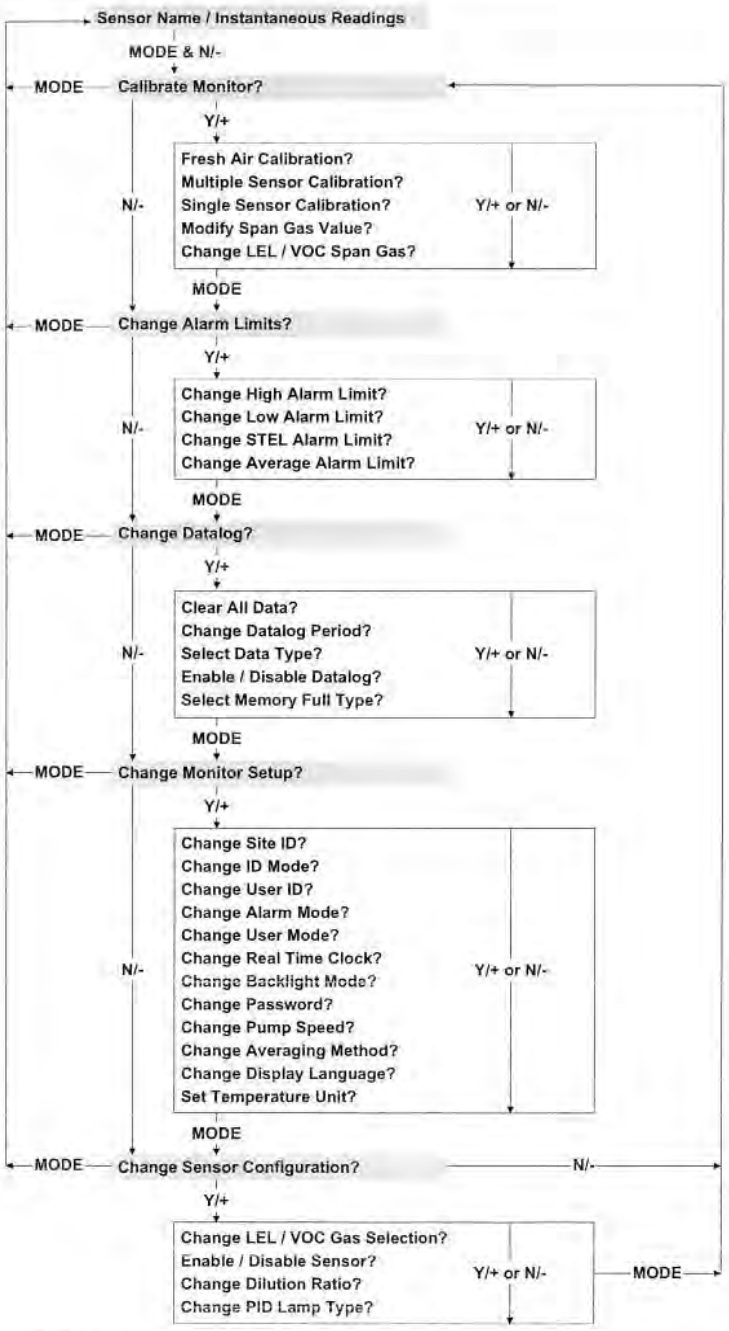
In addition to calibration, authorized users may change the monitor settings to their requirements using the Programming Mode.

NOTE: Monitoring gas concentrations continues during Programming Mode, but pauses during Calibration. Datalogging also pauses during Programming Mode, but resumes when programming is finished.

Press N/-	for desired menu to answer "no" to decrease a digit
Press Y/+	for desired submenu to answer "yes" to increase a digit
Press MODE	to return to the sensor name/ instantaneous reading display to exit a submenu to advance digits

To enter the Program Mode, press MODE and N/- together until the first program menu appears: "Calibrate Monitor?" *Refer to Getting Started on page 5.* The figure on the following page summarizes the programming menus and how to navigate through them.

Programming Menus



Security Levels

Security levels are setup via computer using ProRAE Suite. The default password is: 0000. **NOTE:** For security purposes "0000" always appears instead of actual password.

No changes will be saved unless the user is in the correct mode with the correct security level.

User Mode	Text			Display			Advanced		
Security Level	**0**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**2**
Calibrate Monitor?									
Fresh Air Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Multiple Sensor Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Single Sensor Calibration?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Modify Span Gas Value?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change LEL/VOC Span Gas?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Alarm?									
Change High Alarm Limit?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Low Alarm Limit?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change STEL Alarm Limit?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Average Alarm Limit?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Datalog?									
Clear All Data?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Datalog Period?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Select Data Type?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Enable/Disable Datalog?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Select Memory Full Type?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Monitor Setup?									
Change Site ID?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change ID Mode?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change User ID?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Alarm Mode?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Alarm Mode?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change User Mode?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Real Time Clock?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Backlight Mode?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Password?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Pump Speed?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Averaging Method?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Display Language?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Set Temperature Unit?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change Sensor Configuration?									
Change LEL/VOC Gas Selection?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Enable/Disable Sensor?	✓*	✓*	✓*	✓*	✓*	✓*	✓	✓*	✓
Change Dilution Ratio?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓
Change PID Lamp Type?	✓*#	✓*	✓*	✓*#	✓*	✓*	✓#	✓*	✓

*** Need password**

 # No change allowed

Calibrate Monitor

Fresh Air Calibration? *Refer to Calibrating the Monitor on page 5.*

Multiple Sensor Calibration? *Refer to Calibrating the Monitor.*

Single Sensor Calibration? *Refer to Calibrating the Monitor.*

Oxygen Sensor Calibration: The oxygen sensor calibration is slightly different from other sensors; span calibration at 20.9% O_2 is perormed during fresh air calibration. During single sensor calibration, the oxygen sensor can be calibrated to 0% O_2 with pure nitrogen gas, by pressing [Y/+] when asked "0%? Oxygen?" To calibrate at a different concentration specified in Modify Span Gas Value, press [N/-].

NOTE: After a single sensor oxygen calibration, perform fresh air calibration to ensure the oxygen sensor is calibrated correctly.

Modify Span Gas Value?

The span gas is the second point of reference for calibration. Users may modify the span values of the standard calibration gases to use other calibration gases. However, DO NOT modify the span values when using the RAE Systems calibration gas supplied with the monitor.

Change LEL/VOC Span Gas?

Change the type of calibration gas from methane (LEL) and isobutylene (VOC) to be used as the span gas during LEL or VOC gas calibration. However, DO NOT modify the span gases when using the RAE Systems calibration gas supplied with the monitor.

Change Alarm Limits

Users may change the alarm limits for each sensor. Use [N/-] to cycle through the submenu options. Press [Y/+] to enter a submenu. To modify the limit, use [Y/+] and [N/-] to change the value. Use (MODE) to move from character to charater.

To escape the submenu without saving changes, press (MODE). To save, press (MODE) until "Save?" appears. Press [Y/+] to save changes, otherwise press [N/-] to discard changes.

Change High Alarm Limit?

Change Low Alarm Limit?

Change STEL Alarm Limit? (Short Term Exposure Limit)

Change Average Alarm Limit? (TWA – Time Weighted Average)

Change Datalog Setting

The monitor calculates and stores the gas readings at specified intervals, which can be reviewed by the user. Users may also program additional datalog options for the monitor through the computer.

Clear All Data?

Erase all data stored in the non-volatile memory, but does not delete the PEAK, MIN, STEL, TWA displayed values, which are stored separately.

Change Datalog Period?

Program the datalog period from 1 second to an hour (3,600 seconds).

Select Data Type?

Store either the average (TWA) or peak value for each datalog interval. If peak values are selected, average values like STEL and TWA will not be selected.

Enable/Disable Datalog?

Enable or disable the datalogging function for each sensor. If a * is displayed next to a sensor name, data will be recorded. Use MODE to move from sensor to sensor. An asterisk (*) means the sensor is enabled; no asterisk means the sensor is disabled. Press Y/+ to select or press N/- to deselect. To save changes, press MODE until "Save?" appears. Then press Y/+ to accept. Otherwise, hold MODE to escape and cancel changes.

Select Memory Full Type?

The instrument's memory can store about 3 days' worth of data, as a result of continuous monitoring at 1-minute intervals. Users may select one of two types of memory storage:

Wrap-around: after the memory becomes full, the latest data overwrites the oldest data. e.g. the most recent 3 days' worth of data is stored.

Stop: halts datalogging when the memory is full, and the "MEM" alarm sounds. e.g. the first 3 days' worth of data is stored.

Change Monitor Setup

Change the monitor setup or enter user information for the monitor. Use (MODE) to move the cursor from character to character. Use [Y/+] and [N/-] to toggle up and down the alphabet and numbers. To save, press (MODE) until "Save?" appears. Press [Y/+] to save changes, otherwise, press [N/-] to discard changes. To escape this menu without saving changes, press and hold (MODE).

Change Site ID?

Enter an eight-character alphanumeric site identification, which is included in datalog reports.

Change ID Mode?

Set up an identification code to use during start-up or to access a previously saved customized ID.

Change User ID?

Enter an eight-character alphanumeric user identification, which is included in datalog reports.

Change Alarm Mode?

Choose either latched or automatic reset. The user must manually acknowledge a latched alarm by pressing [Y/+].

Change User Mode?

The three different user modes are: Text, Display and Advanced.

Change Real Time Clock?

Change or update the real time clock and calendar.

Change Back Light Mode?

Automatic – the monitor turns the back light on/off when ambient light falls below/above the threshold or **Manual** – press [N/-] to turn the back light on/off.

Change Password?

Modify the password.

Change Pump Speed?

Low – (default) use when operating conditions are slow to change; prolongs pump motor life, LEL sensor life and battery run time.

High – use for long lengths of tubing or when rapid changes in input conditions are expected, such as HazMat response or when used for measuring heavy, low vapor pressure compounds like jet fuel.

Change Averaging Method?

Choose: **TWA** (default) – an eight-hour Time Weighted Average or **AVG** – the running average

Change Display Language?

Choose English or Spanish.

Set Temperature Unit?

Choose Celsius or Fahrenheit to measure temperature.

Change Sensor Configuration

Change LEL/VOC Gas Selection?

Choose an LEL or VOC gas listed in the monitor to calculate its correction factor relative to the LEL or VOC calibration gas. *Refer to Correction Factors on page 26.* The correction factor allows the unit to display the equivalent concentration of the selected LEL or VOC gas. To create a custom factor for a specific gas or mixture of gases, modify the relative correction factor to increase or decrease the gas reading.

Enable/Disable Sensor?

Enable or disable sensor(s); a disabled sensor will not measure or display the gas concentration. Use if a sensor has failed or is providing erroneous readings. Use MODE to move from sensor to sensor. An asterisk (*) means the sensor is enabled; likewise, no (*) means the sensor is disabled. Press Y/+ to select or press N/- to deselect. To save changes, press MODE until "Save?" appears. Then press Y/+ to accept. Otherwise, hold MODE to escape and cancel changes.

Change Dilution Ratio?

Attach an optional dilution fitting on the gas inlet port to dilute the gas sample. Enter a dilution ratio (from 1 to 10) to compensate the reading for the actual gas concentration.

Change PID Lamp Type?

This only applies to PID monitors. The PID sensor can utilize either a 10.6 eV or an 11.7eV UV. Since each lamp type has a different correction factor table, it is important to select the correct lamp type.

Correction Factors

VOC and LEL sensors respond to a broad range of gases and show a different sensitivity to different gases; correction factors allow measurement of a specific gas (the measurement gas) while using a different gas for calibration (the calibration gas). The correction factor (CF) for a measurement gas is defined as:

CF = Sensitivity to a Calibration Gas ÷ Sensitivity to a Measurement Gas

To convert the monitor reading of the calibration gas to the true concentration of a measurement gas, use the following equation:

True Concentration (ppm) = CF x Monitor Reading (ppm)

The monitor has three sets of correction factors, one for the LEL and two for the VOC (10.6 eV and 11.7 eV) Each set consists of 20 to 40 different gases. Specify the PID lamp type (e.g. 10.6 eV or 11.7 eV) to access the proper VOC correction factor.

To set up a correction factor, first choose a calibration gas in the Calibrate Monitor program menu and then choose a measurement gas in the Change Sensor Configuration menu. If the calibration gas is different from methane for LEL or isobutylene for PID, then the new CF is calculated and the displayed value will be different from the values in Technical Notes 106 or 156.

NOTE: Correction factors provide an estimate of the measurement gas concentration. For greatest accuracy, it is necessary to calibrate the LEL or VOC sensor directly with the measurement gas.

Refer to Technical Note-106 Correction Factors and/or Technical Note-156 LEL Correction Factors.

Diagnostic Mode

The monitor is equipped with a diagnostic mode that can display critical, low lever parameters to help users identify problems. *Refer to Troubleshooting on page 38.*

⚠ **The diagnostic mode allows the user to set several low level parameters which are very critical to the operation of the monitor. Extra care should be taken when setting these low level parameters. If the user is unfamiliar with these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction. The diagnostic mode should only be used by qualified personnel.**

To switch the monitor to diagnostic mode, turn the monitor off.

Press and hold [Y/+] and (MODE) together; release both keys when the unit beeps. The monitor is now in diagnostic mode.

Press (MODE) until the desired diagnostic parameter appears:

Sensor Name and Raw Sensor Readings

If a sensor is programmed and is properly installed, the sensor name should appear. If the sensor name does not appear, then the sensor may be improperly programmed or defective. The raw sensor reading is the uncalibrated output for each sensor. When fresh air is applied, the raw sensor readings should be 200 to 700 for toxic gas and VOC sensors; 100 to 1300 for the LEL sensor; and 1200 to 2300 for the oxygen sensor. When calibration gas is applied, the raw sensor readings should increase or decrease by the amounts listed in Technical Note - 123 Special Diagnostic Modes. If the raw sensor readings are outside the normal range or do not change when gas is applied, the sensor or monitor may be defective.

RF Test (Radio Frequency)

This feature applies when the monitor is used with the RAELink Remote package. The RF test shows the successful rate of communication.

Adjust Lamp Failure Threshold

If the lamp physically appears fine, but the "Lamp" error message appears during normal operation, the lamp failure threshold may be set too high.

To adjust the level:

Turn the monitor on in diagnostic mode and go to the "Lamp = xxx, Fail = yyy +/-" display. ("xxx" is the lamp current reading; "yyy" is the value of the lamp failure threshold.)

Decrease the "yyy" value until it is about 10 counts below the "xxx" value. Press (MODE) to exit.

Then press [Y/+] to save changes, or press [N/-] to discard changes.

Battery Type and Bias

The type of battery (Lithium-Ion battery pack or alkaline battery adapter) used to charge the monitor is displayed. Some toxic gas sensors require a bias voltage of a few hundred millivolts for the sensor to function properly. These include NO and NH_3 sensors.

To manually switch the bias voltage supply on, *refer to Special Bias Voltage for Toxic Sensors on page 35.*

Install a biased sensor in the TOX1 socket. If the bias voltage is switched on, the bias reading should be below 182, otherwise it may be defective.

Show x1 and x10 Range of PID Sensor (PID detectors only)

The PID sensor is connected to two amplifiers with two different gains: unity gain and gain of ten; these are the raw outputs of both amplifiers. When fresh air is applied, both amplifier outputs should be 200 to 500. When a VOC gas is applied, both amplifier outputs should increase; the amount of increase for the unity gain (x1) should be 1/10 of the increase for the gain of ten (x10). If the increase does not agree with the expected value, then the gain switch of the amplifier may be defective.

Display Contrast

Press [Y/+] to increase the contrast and [N/-] to decrease the contrast. The LCD contrast bar indicates the current setting. If the display appears to have dark lines, press [Y/+] a few times to see the display more clearly. **NOTE:** In extreme temperatures, the display may fade or bleed out.

LEL Power

The top line indicates the instantaneous reading of raw counts from the LEL sensor. The bottom line shows if the LEL sensor is on or off. Press [N/-] to turn the power off, and press [Y/+] to turn the power on.

Clock, Time, Battery, and Temperature

This display shows the real time clock, the date, the battery voltage in raw count and temperature sensor reading.

Sensor Expiration Date

The expiration date (month and year) for each installed sensor is based on the manufacturing date and expected life of each sensor. If the current date exceeds the expiration date for any sensor, the performance of the given sensor cannot be guaranteed. It is strongly recommended to replace the sensor immediately to ensure proper operation.

Pump Stall

The "Pump = 20/20" reading is the minimum and maximum pump raw count (RC), and "Stall = 40 +/-" is the pump stall threshold. The pump stalls if the maximum raw count reaches the pump stall threshold, which causes the pump to shut off. To determine the pump stall threshold:

[(max RC when pump is free + max RC when pump is blocked)] ÷ 2

To adjust the pump stall threshold, press [Y/+] to increase or [N/-] to decrease the numerical value.

Back Light Threshold

Adjust the threshold for the LCD backlight to automatically turn on/off; verify the threshold is 100, which is suitable for most situations.

Serial Number and Pump

Displays the monitor's serial number and the pump status. If a pump is installed and a pump speed control circuit is available, toggle the display "Pump=Low/High" by pressing [N/-]. **NOTE**: Changes made are only for testing the pump condition and are not saved to the nonvolatile memory. *Refer to Change Pump Speed on page 25.*

Battery Duration Time

Use to test battery life and displays the last run time before the unit turned itself off due to low battery.

Communicate with PC

Connect monitor to a personal computer to upload a configuration file or download stored data.

Maintenance

⚠ **Power from the battery is flowing to the printed circuit board (PCB) and sensors even when the power is off. Therefore, it is very important to disconnect the battery pack before servicing or replacing sensors or any components insides the monitor. Severe damage to the PCB may occur if the battery pack is not disconnected before servicing the unit.**

Li-Ion Battery Pack

The factory supplied Li-Ion battery pack is designed to last for 10 hours of normal operation (without alarm or backlight conditions).The rechargeable batteries have a 1-year warranty. Age, ambient temperature, and heavy useage may impact battery life. Battery packs will slowly drain even if the monitor is turned off. If the battery packs have not been charged for 10 days, the battery voltage will be low. It is recommended to fully charge the battery packs before going into the field, and recharge the battery pack upon returning from the field.

⚠ **To reduce the risk of ignition of hazardous atmospheres, recharge battery only in areas known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous. Ne charger les batteries que dans emplacements désignés non dangereux.**

Replacing the Battery Pack

⚠ **To reduce the risk of ignition of hazardous atmospheres, recharge battery only in areas known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous. Ne charger les batteries que dans emplacements désignés non dangereux.**

Remove the monitor cover by loosening the two case screws, and then unplug the battery pack from the battery jack.

Place a fully charged spare battery pack into the monitor.

Make sure the battery plug is connected securely.

Reattach the cover and tighten the screws.

Emergency Alkaline Battery Adapter

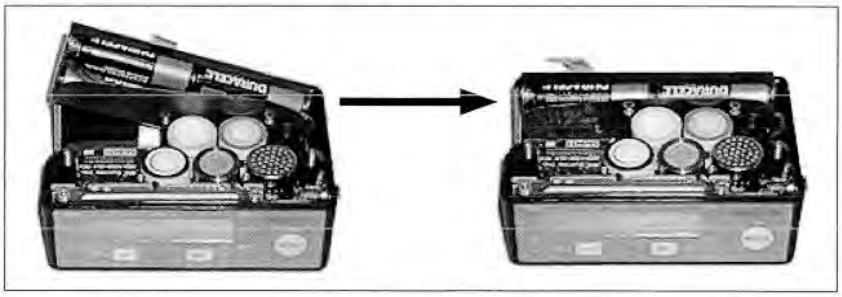
⚠ **The alkaline battery adapter supplied by RAE Systems is intrinsically safe. The adapter is intended to be used in emergency situations when there is no time to recharge the Li-Ion battery pack. The adapter accepts 4-AA alkaline batteries to provide approximately 12-14 hours of operation.**

To install the adapter, remove the monitor cover. Remove the Li-Ion battery pack from the monitor by carefully disconnecting the wires.

Install four AA alkaline batteries into the battery adapter, making sure the battery polarity is correct.

Connect the battery adapter to the monitor. Make sure the wires are placed inside the adapter, running between the batteries. Close the flap over.

Install the battery adapter in the monitor.



The monitor automatically detects the alkaline batteries and will run for 8-10 hours. Use the monitor once the alkaline battery adapter is installed. Replace the alkaline batteries when spent.

Sensor Replacement

Under normal operating conditions, most sensors will lose their original sensitivity after the expected operating life and eventually need to be replaced. Each sensor has a non-volatile memory that has the manufacturing and expiration dates, which appear during the warm-up period or can be looked up in the diagnostic mode.

Warranties: Oxygen (O_2), combustible gas (LEL), hydrogen sulfide (H_2S) and carbon monoxide (CO) sensors all have a 2-year warranty. All other toxic sensors have a 1-year warranty.

NOTE: The Oxygen and the LEL sensors have assigned sockets. These are identified on the PCB. High bias toxic sensors should be installed in socket 1/A. *Refer to Special Bias Voltage for Toxic Sensors on page 35.* Any toxic sensor can be installed in socket 2/B.

Replace the sensor when it fails to calibrate.

To replace sensor(s), turn the monitor off and remove the cover.

Using the sensor puller. remove the sensor to be replaced by carefully pulling straight out.

Plug a new sensor into the empty socket. Make sure the sensor pins are aligned with the socket holes before firmly pushing the sensor all the way down.

Replace the monitor cover.

Turn on the power of the monitor and the newly installed sensors should be recognized. Let the monitor run for 15 minutes before calibration.

Some sensors, like NO and NH3, require up to 24 hours on-bias in the monitor prior to calibration and use. *Refer to Techincal Note 114 Sensor Specifications and Cross Sensitivities.*

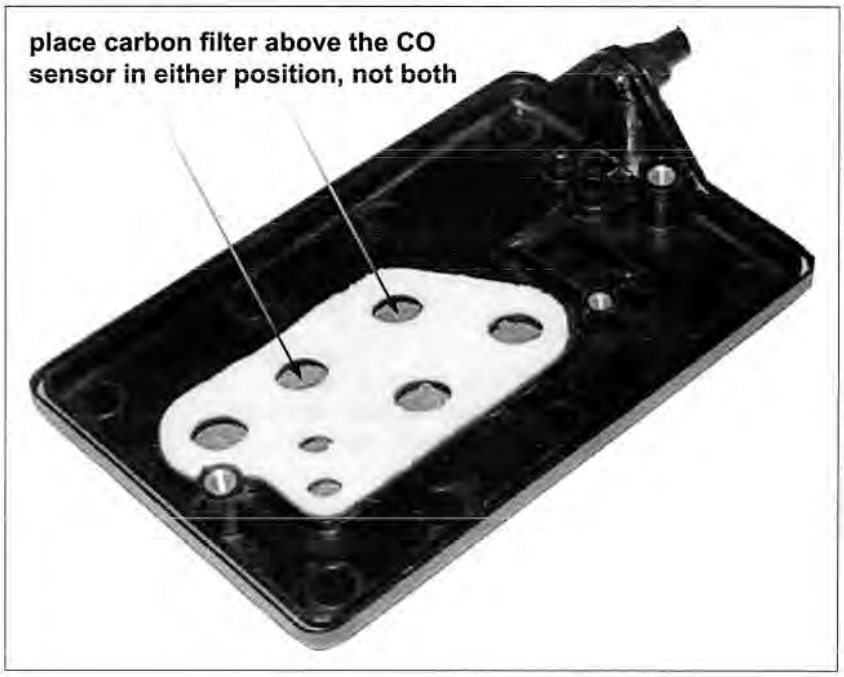
NOTE: Calibrate all sensors prior to use!

CO Sensor Charcoal Filters

CO sensors can be sensitive to hydrocarbons. To reduce or eliminate this cross sensitivity, a charcoal filter is installed in the gas plate above the CO sensor. The charcoal filter removes organic vapor cross-sensitivity and will last 4-6 weeks under normal operation conditions before it needs to be replaced. However, if the monitor is exposed to high concentrations of VOC gases, the carbon filter needs to be replaced more frequently. (P/N 008-3006-005, 5-pack; keep unused filters sealed during storage.)

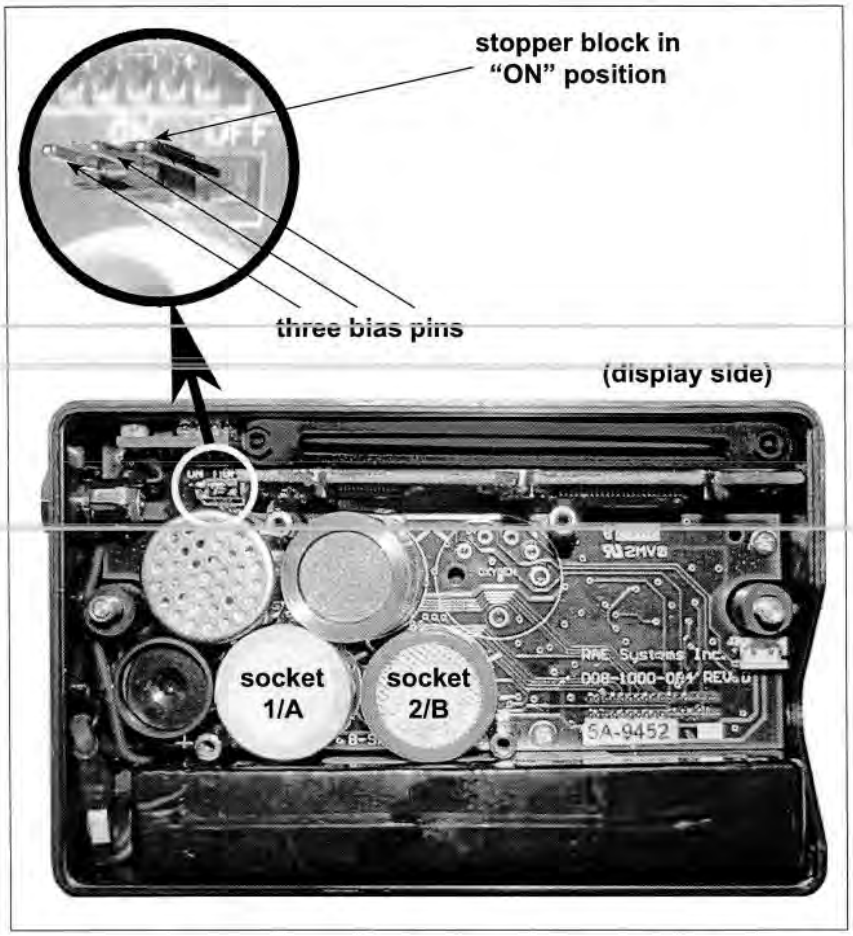
Refer to Technical Note-121 CO Sensor Cross-Sensitivity and Removal with Charcoal Filter for cross-sensitivity data.

⚠ **The carbon filter used for CO sensors may lower the reading if used on other sensors. Remove the filter if another sensor is replacing a CO sensor in the monitor.**



Special Bias Voltage for Toxic Gas Sensors

NO and some NH_3 sensors require a special high bias. The bias pins are located next to the PID sensor socket. Using the sensor puller, move the stopper block from the "OFF" pins to the "ON" pins. The sensor ID and bias voltage will be checked during the power on sequence. An error message appears if the sensors are plugged into the wrong socket, or if the bias voltage is disabled. Biased sensors require 24 hours on bias before calibration.



PID Sensor Cleaning/Replacement

During the course of normal operation, a film of gas vapor may build up inside the PID sensor module and the lamp; the rate of build-up depends on the type and concentration being sampled. As a guide, it is recommended to clean the PID sensor module and lamp only when the PID is malfunctioning.

Periodically cleaning the lamp window also removes film deposits and restores lamp sensitivity. Exercise with care when cleaning the window surface to avoid damage.

Turn the monitor off and remove the cover.

Remove the stainless steel shielding cap for the PID sensor. Using the sensor puller, remove the PID sensor by carefully pulling straight out.

Dip the entire PID sensor into RAE Systems' lamp cleaning solution (supplied in the Lamp Cleaning Kit, P/N 081-0002-000).

⚠ **DO NOT store the methanol from the lamp cleaning kit in the same case as the MultiRae Plus, as long-term exposure to methanol can damage electrochemical sensors.**

It is highly recommended to use an ultrasound bath for at least three minutes. Then thoroughly air-dry the sensor.

⚠ **DO NOT use heat to dry sensors.**

DO NOT disassemble PID sensor.

If the lamp is operational, use a cotton swab or lens tissue to clean the flat window surface with GC grade methanol. If the lamp does not turn on replace with a new lamp. Avoid contact with the flat window surface.

Reinstall the PID sensor. Install the shielding cap. Replace the monitor cover.

shielding cap
P/N 023-2601-000

PID sensor
P/N 008-3007-000

lamp
10.6 P/N 050-0010-000
11.7 P/N 050-0011-001

Taking Care of the Lamp

⚠ **Never touch the window surface with fingers or anything which may leave a film. Water will degrade window surfaces, especially the 11.7 eV lamp window.**

The 10.6 eV PID lamp has a 1-year warranty. The "Lamp" error is an indication of a problem with the lamp current. A dirty or contaminated sensor often causes high readings of the VOC sensor. A weak or inoperative lamp often causes low readings or no response to test gas. If the UV lamp is on while the error message persists, then it is necessary to adjust the lamp threshold. *Refer to Adjust Lamp Failure Threshold on page 27.*

Sampling Pump Replacement

The sampling pump is a positive displacement piston pump, which needs to be replaced as it approaches the end of its life span. The pump's draw capability reduces significantly as it consumes a greater amount of energy to keep running. The sampling pump has a 1-year warranty. **To replace** the pump:

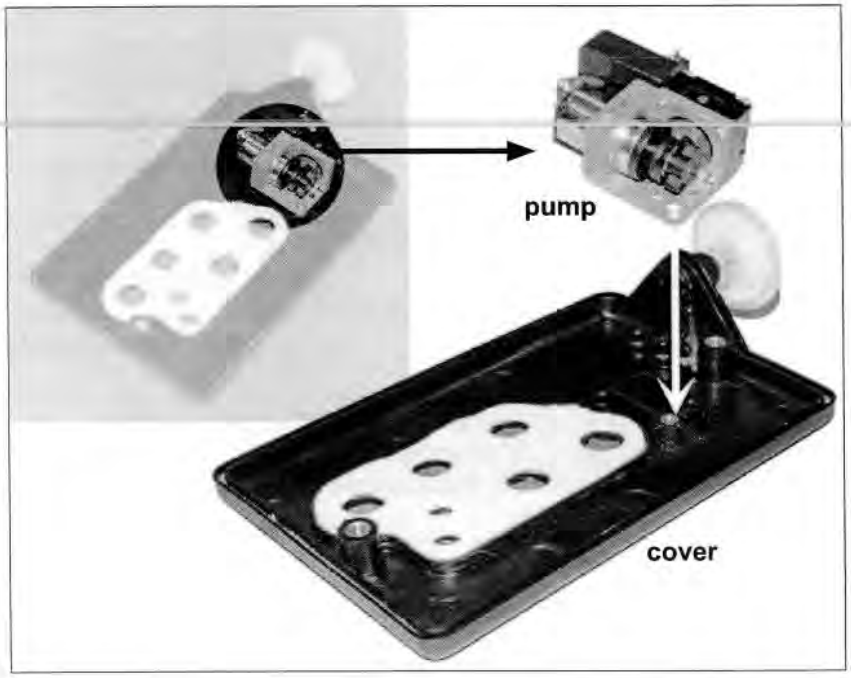
Turn the monitor OFF and remove the cover.

The sampling pump is attached to the cover.

Remove the single screw holding the pump to the cover.

Gently pull the pump assembly off the cover.

Replace with a new pump assembly and reassemble.



Troubleshooting

Technical Service: 1.888.723.4800 or email: Tech@raesystems.com

Problem	Possible Reason(s)	Possible Solution(s)
Cannot turn on after charging battery.	Defective battery. Microprocessor hang-up.	Charge or replace battery. Disconnect then reconnect battery to reset computer. Otherwise, install alkaline battery pack. If that still does not work, then call Service.
"Incorrect Year - Check Clock!" error message.	Battery has died and there is a mismatch between the date code on the sensors and its internal clock.	Press [Y/+] and reset clock.
Cannot turn off. Corrupted characters.	Microprocessor hang-up.	Disconnect and reconnect battery to reset computer. Reload firmware.
No LED or LCD backlight.	Defective LED or LCD backlight.	Check if backlight is in manual mode. Otherwise, call service center.
Lost password.	Forgot.	Use ProRAE Suite to reset password.
Buzzer inoperative.	Bad buzzer. Setting could be in special run silent mode.	Call authorized service center.
Calibration error message.	No calibration gas input. Low sensitivity to calibration gas.	Check standard gas flow path or cylinder pressure. Change calibration gas or sensor.
"Voltage too high" error message, while charging.	Battery fuse blown. Wrong AC adapter. AC adapter not fully plugged in.	Check battery and adapter.
"Bat" error message.	Battery low.	Recharge battery.

High pump noise. No inlet suction.	Leaky inlet path. Defective pump.	Check inlet connection. Clean or replace pump.
Abnormally low reading.	Bad calibration. Low sensitivity to calibration gas. Wrong span value. Bad sensor. Low flow.	Recalibrate. Use stronger span gas. Check span value. Replace sensor. Replace filters. Check flow.
Abnormally high reading.	Bad calibration. Wrong span value. Dirty PID sensor. Dirty filters. Excessive moisture.	Recalibrate. Check span value. Clean PID sensor in methanol in ultrasound bath. Replace filters. Dry PID sensor.
Reading jumping around.	Incorrect calibration gas. Wrong span value.	Calibrate the sensors. Use different calibration gas. Change sensor.
Read a small background value.	Small background gas level present. Sensor zero drift or newly installed.	Run fresh air calibration. Wait for newly installed sensor to stabilize.
"Lamp" error message.	Wrong threshold. Weak lamp. Dirty Sensor.	Adjust threshold. Clean or replace lamp. Clean PID sensor.
VOC reading plateaus at certain level.	Weak PID lamp. Dirty PID sensor.	Replace lamp. Clean lamp & PID sensor. Replace filters.
Full scale measurement in humid environment.	Dirty or wet sensor.	Clean and dry sensor. Replace external filter.

Specifications

Size	4.65"L x 3.0"W x 1.9"H (11.8 x 7.6 x 4.8 cm)
Weight	16 oz with battery (454g)
Sensors	Up to 5 sensors including: • Photo-Ionization detector for VOCs, 10.6 eV lamp standard • Protected catalytic bead for combustible gases • Interchangeable electrochemical sensors for oxygen and toxic gases (2)
Battery	• Interchangeable Li-Ion and alkaline battery packs • Rechargeable units include lithium-ion battery pack with internal smart charging, 120V AC/DC wall adapter, and spare alkaline battery pack
Operating Hours	• 14 hours continuous with Li-Ion (typical) • Unit will run and charge simultaneously
Display	2 line, 16 digit LCD with LED backlighting automatically in dim light or alarm condition
Keypads	1 operation and 2 programming keys
Direct Readout	Instantaneous (up to 5) values: • Oxygen as percentage by volume • Combustible gas as percentage of lower explosive level (LEL) • Toxic gases and VOCs as parts per million by volume (VOC scaleable using correction factors) • High and low values for all gases • STEL and TWA values of toxic gases and VOCs • Battery and shut down voltage • Date, time, elapsed time, temperature
Alarms	90 dB buzzer and flashing red LED to indicate exceeded preset limits: • High: 3 beeps and flashes per second • Low: 2 beeps and flashes per second • STEL and TWA: 1 beep and flash per second • Automatic reset or latching with manual override • Additional diagnostic alarms and display messages for low battery and pump stall
Datalogging	20,000 points (80 hours, 5 channels at one minute intervals) download to PC with serial number of unit, user ID, site number, and calibration date

Calibration	Two-point field calibration for zero and span gas
Sampling Pump	Internal two-speed pump. Flow rates: • Low: ~200 cc/min • High: ~300 cc/min
Low Flow Alarm	Auto shut-off pump at low flow condition
Temperature	-4° to 113°F (-20° to 45°C)
Humidity	0% to 95% relative humidity (non-condensing)
Attachment	Wrist strap and high-visibility rubber boot
Warranty	Lifetime on non-consuming components (per RAE Standard Warranty). 2 years for O_2, LEL, CO, and H_2S sensors. 1 year all other sensors. 1 year pump, 1 year battery, 1 year for 10.6eV PID lamp.
EMI Immunity	No effect when exposed to 0.43 mW/cm RF interference (5 watts at 12 inches)
Intrinsic Safety	U.S.A. and Canada: UL & cUL Class I, Division I, Groups A, B, C, D, hazardous locations, Temperature Code T3C Europe: DEMKO 03 ATEX 0308256X; EEx ia d IIC T4 (w/ Battery P/N 500-0029); EEx ia d IIC T3 (w/ Battery P/N 500-0037)

Range, Resolution & Response Time

(t_{90} for pump-equipped instruments)

Sensor	Range	Resolution	t_{90} (sec)	Presoak Time for 60-sec Cal
LEL	0-100% LEL	1%	15	None
VOC	0-200 ppm	0.1 ppm	10	None
VOC	200-2000 ppm	1 ppm	10	None
O_2	0-30%	0.1%	15	None
CO	0-500 ppm	1.0 ppm	40	None
H_2S	0-100 ppm	1.0 ppm	35	None
SO_2	0-20 ppm	0.1 ppm	35	None
NO	0-250 ppm	1.0 ppm	30	None
NO_2	0-20 ppm	0.1 ppm	25	None
Cl_2	0-50 ppm	0.1 ppm	60	60 sec
PH_3	0-5 ppm	0.1 ppm	60	60 sec
NH_3	0-50 ppm	1.0 ppm	150	90 sec
HCN	0-100 ppm	1.0 ppm	200	170 sec

Service and Repair Record

Date	Service / Repair Type

Notes

RAE Systems World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Fax: 408.952.8480

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Web Site: www.raesystems.com

RAE Systems Technical Support
Monday through Friday, 7:00AM to 5:00PM Pacific Time
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email: tech@raesystems.com

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P/N 008-4022-000
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STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

   - Company name and address
   - Log-holders name if log book was assigned specifically to that person
   - Activity or location

- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

- Description of the general sampling area – site name, buildings and streets in the area, etc.
- Station/Location identifier
- Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
- Sample matrix and type
- Sample date and time
- Sample identifier
- Draw a box around the sample ID so that it stands out in the field notes
- Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
- Number and type of sample containers collected
- Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).

2. Use tables to record sampling information and field data from multiple samples.

3. Sketch sampling locations and other pertinent information.

4. Sketch well construction diagrams.

V. Attachments

Example field notes.

(47) MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M HILL STAFF:
John Smith: FIELD TEAM LEADER
Bob Builder: SITE SAFETY COORD.
WEATHER: OVERCAST + COOL, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • COLLECT GROUNDWATER SAMPLES for LTM work at SITE 14
• SUPERVISE SURVEY CREW AT SITE 17
0725 BB ~~Can~~ ~~JS~~ (JS) Calibrates PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #
0730 BB Calibrates HORIBA METER
Model #, SERIAL #
→ List calibration RESULTS
0738 Survey CREW ARRIVES on SITE
→ List NAMES
0745 BB Holds H+S TALK on Slips, Trips, Falls, Ticks + AIR MONITORING
JS + Survey CREW ATTEND
No H+S ISSUES IDENTIFIED as CONCERNS. All work is in "LEVEL D."
0755 JS Conducts SITE-WIDE AIR Monitoring
All readings = 0.0 ppm in

JS 5-12-03

MAY 12, 2003 EXAMPLE (48)

SITE 14 LTM
BREATHING ZONE (BZ)
0805 Mobilize to well MW-22 to SAMPLE, surveyors SETTING UP AT SITE 17
0815 PM (PAUL PAPER PUSHER) CALLS AND INFORMS JS to collect GW SAMPLE AT well MW-44 today for 24 hour TAT ANALYSIS OF VOCS
0820 Purging MW-22
→ RECORD WATER QUALITY DATA
JS 5-12-03
0843 Collect SAMPLE AT MW-22 for total TAL Metals AND VOC'S. No Dissolved Metals Needed PER PM
0905 JS + BB Mobilize to SITE 17 to show surveyors wells to Survey.
0942 Mobilize to well MW-22 to Collect SAMPLE
0950 CAN not ACCESS WELL MW-22 due to BASE OPERATIONS; CONTACT PAUL PAPERPUSHER AND HE STATED he will check on GAINING ACCESS with BASE contact.
0955 Mobilize to well MW-19

JS 5-12-03

STANDARD OPERATING PROCESURE

Incremental Soil Sampling for Offsite Laboratory Analysis – SWMU 77

1. Purpose

This procedure is based on ITRC (2012) methods for Incremental Sampling (IS). The procedure employs IS for surface soil in excavated areas within SWMU 77. Laboratory analyses of soil samples are needed to provide definitive metals and explosives data to define the extent of soil contamination and to complete the human health and ecological risk assessment of SWMU 77. The purpose of using IS methods is to minimize potential bias to sample representativeness introduced by compositional and distribution heterogeneity of constituents within the sampling unit (SU) soil.

2. Scope

The procedure describes equipment and techniques for obtaining surface soil samples from SUs at SWMU 77, NAPR. The procedure includes field preparation (mixing) the soil samples, and packaging for shipment to an offsite laboratory. Further sample preparation and analysis at the laboratory is described in Worksheet #23 of this UFP-SAP.

3. Equipment and Materials

Incremental sampling will be performed with clean steel sampling probes, spoons, and mixing bowls. Example soil sampling probes (33-inch step probe and hand probe) are shown below. The tools shown are available from Grainger (http://www.grainger.com/product/AMS-Soil-Recovery-Probe-4KMK2?s_pp=false and http://www.grainger.com/product/4KMK5?cm_sp=HIO-_-HIDP-_-BTM_V2V&cm_vc=IDPBVZ12, respectively). Sample containers will consist of two clean 16 ounce wide mouth glass jars for 1 kg samples and two clean 32 ounce wide mouth glass jars for 2 kg samples as required by the applicable analytical method (see Worksheet #19). Soil will be homogenized in a clean stainless steel pan or bowl using clean stainless-steel spoon or spatula. Individual laboratory sample bottles will be provided as required per the methods listed in Worksheet #19. Soil samples will be shipped to the contract laboratory in a mass of not less than 3 kg per SU in sample containers supplied by the laboratory.

Example step-probes (33-inch and 40-inch) for sampling excavation floor.

Example hand probe for sampling sidewalls.

4. General Guidance

Composite soil samples will be collected from each SU at SWMU 77 for analysis for four metals (antimony, copper, lead, and zinc). Each SU will be defined by field dimensions: excavation floor SUs will be approximately 50 ft X 50 ft, or approximately 2500 square feet in area; and sidewall SUs will be approximately 100 linear ft of unexcavated soil at the limits of the excavation. Both floor and sidewall composites will be composed of 30-point increments. Sample increments from a SU will be approximately equal mass. During sampling the operator will discard large particles (rocks, cobbles), trash, debris, and plant roots/pieces before transferring the soil sample to the bulk sample container (zip-lock bag). The mixed bulk sample will be described and classified according to Universal Soil Classification System (USCS) nomenclature. The location, actual (final) geometry, soil description, and a summary of sampling activities for each SU will be recorded in a field book.

Sampling tools will be new or cleaned before initial use at a SU. The sampling tools will not be decontaminated between increments because each increment will be part of the same composite sample. The decontamination process involves first removing all adhering soil using soapy water and nylon brush, then rinsing the sampling probe, spoons, and pans with deionized water, concluding with an acetone rinse.

The two types of SUs will be sampled as follows:

Excavation Floor SU

Incremental sampling from floor SUs will use a systematic random sampling pattern (see below). The sampling probe will be pre-marked to 12-inch depth, and the operator will "step" the probe vertically into the soil to the mark. Floor samples will be obtained from approximately 6 rows of 5 points to obtain 30 points. The operator will walk from one corner of the SU systematically back and forth across the entire gridded area, collecting an increment of soil from a random location within each subarea. Figure 1 shows an example of sampling patterns for a floor SU. After the entire SU has been sampled, the individual increments will be composited into a single bulk sample by mixing in a large stainless steel bowl. Mixing may be accomplished using a stainless steel spoon or spatula. Energetic mixing is not required, because the entire bulk sample will then be transferred to appropriate sample containers for shipment to the laboratory. For excavation areas that contain 10 or fewer SUs, one SU will be sampled three times in order to obtain two replicate samples. For excavation areas containing more than 10 SUs, two SUs should be sampled three times to obtain two replicate samples. Each replicate sample will be collected, composited, prepared and analyzed using the same methods as the original sample. However, the sampling pattern for the replicates will start at a new location, to avoid re-sampling at the same locations in the subareas (see Figure 1).

Sidewall SU

Incremental sampling from the sidewall SUs will use a stratified random sampling pattern (see below). The sidewall samples will be obtained from a row of 30 subareas. The operator will use the hand probe to obtain samples at random locations within each subarea. The hand probe will be pre-marked to 4 –inch depth, and the operator will sample by pushing the probe horizontally into the sidewall to the mark. After the entire SU has been sampled, the individual increments will be composited into a single

bulk sample by mixing in a large clean stainless-steel bowl. Mixing may be accomplished using a clean stainless steel spoon or spatula. Energetic mixing is not required, because the entire bulk sample will then be transferred to appropriate sample containers for shipment to the laboratory. For excavation areas that contain 10 or fewer sidewall SUs, one sidewall SU will be sampled three times in order to obtain two replicate samples. For excavation areas containing more than 10 sidewall SUs, two sidewall SUs should be sampled three times to obtain two replicate samples. Each replicate sample will be collected, composited, prepared and analyzed using the same methods as the original sample. Note the original and replicate samples should be obtained using different stratified random sampling plans (see below).

5. Procedure

The following steps define the procedure for obtaining incremental samples at SWMU 77.

Selecting SUs

The boundaries of the excavation areas within SWMU 77 will be marked on scale drawings (maps). Using the scale drawings, the field team will identify and assign unique names to each of the floor and sidewall SUs. The layout of the SUs should use the following approximate dimensions: floor SUs should be approximately 2500 square feet, and sidewall SUs should be approximately 100 feet long. The maps should contain as many "rectangular" or "square" floor SUs as practical.

Setting up a Sampling Grid

The grid system should divide each SU into 30 approximately equal-sized areas. For example, a "square" floor SU could be divided into five rows and six columns. For sidewall samples, there should be a row of 30 equal-length subareas. Note that for irregularly-shaped SUs, the shape of the subareas may also be irregular, but the subareas should be the same size. Before mobilizing to the field, the project team should generate maps that identify the SUs and show the sampling grids for each excavation area.

In the field, systematic random sampling of the excavation floor begins by selecting a random starting point in one corner or end of the SU. Once the operator has selected his starting location, he samples the first grid subarea then moves to the next, and samples in approximately the same location within the new subarea. Figure 1 shows multiple sampling patterns in the same SU.

A stratified random approach will be used for sampling the sidewall SUs. The approximate sample locations (increments) within the sidewall SUs should be pre-determined in the office using a random number generating program such as RANDOM.ORG - Integer Generator. The example program allows the user to select the quantity of random integers (30), the range of integer values, and the output format (number of columns of integers). For example, the lateral location within each sidewall grid may be represented by a random number ranging from 1 to 3 (representing 1 - left, 2 – middle, and 3 - right thirds of the subarea length), and the vertical location may be represented by a random number ranging from 1 to 4 (representing approximate depths below ground surface [bgs] of 1: 0 to 3 inches, 2: 3

to 6 inches, 3: 6 to 9 inches, and 4: 9 to 12 inches). For replicate samples from a sidewall SU, a new random sampling plan should be developed for each bulk sample.

Field Delineation of Sampling Grids (Subareas)

Prior to mobilizing to the field, the name and corners of each SU, and a few other strategic locations should be entered into a Global Positioning System (GPS) device. The field team should also acquire engineer's tape, and paint, string, rope or flags sufficient to mark temporarily the "grids" within each SU. After the excavation is concluded, using the GPS device and engineer's tape, the field team will mark the ends of each row with flags or paint to help establish the SU grid corners. Note that the grid may be adjusted to conform to the actual excavation area. Flags, string, or rope may be placed along the edges of the SU to help ensure uniform spacing. Placing flags at every increment collection point is <u>not</u> necessary. An engineer's tape may be employed for defining the grids for sidewall SU sampling. Each grid should extend 1/30 of the total sidewall SU length (about 3 ft+4 in for a 100 ft long SU). The field team must locate using GPS sufficient points around (and within) the actual SU to document the SU location and geometry. The GPS coordinates are necessary to create maps for the interim corrective measures report.

Tools for Collecting Incremental Samples

The field team at SWMU 77 will use soil coring probes (similar to those shown above) to collect increments that are cylindrical or core-shaped. The soil at SWMU 77 is expected to be soft enough to penetrate with hand probes. If rocky or hard soils are encountered, the field team may use battery-operated drills with large coring bits, or a coring device with slide hammer. Note the sampling probe will be pre-marked with desired sample depth, and each increment will be obtained by inserting the probe to the mark.

Collecting Samples

Once the SU has been delineated in the field, collection of sample increments may begin. For floor sampling, the operator selects a random starting point in one grid subarea at the corner of the SU, collects a soil sample at this location, and then samples approximately the same location at each subsequent grid subarea. For sidewall sampling, a single-row grid is set up, and one soil increment from each subarea is collected following the stratified random plan developed for the SU.

For either SU, the following procedures should be followed:

- Sampling tools will be new or decontaminated prior to use in each SU. Sampling tools need not be decontaminated between increments of the same SU.
- Pre-mark the step probe and hand probes to assure appropriate sample depths for floor and sidewall SUs, respectively. Incremental samples should be obtained from uniform depths across the SU.
- Large particles (rocks, cobbles), trash, debris, and plant roots should be discarded before transferring the incremental sample to the bulk sample container.
- Individual increments will be placed in a single sample container to produce the bulk sample.
- Floor replicate samples should be obtained using a different pattern and starting

location to avoid re-sampling the same locations.. Original and replicate sidewall samples should be obtained using different stratified random sampling plans.

- The sample collector will record in the field log book a description and classification of the mixed bulk soil sample according to Universal Soil Classification System (USCS) nomenclature. However, the operator, during collection of increments, should also note significant changes in soil type across the SU.
- Store, package, and ship bulk samples as required by this UFP-SAP.

Collecting Field Replicate Samples

To evaluate sampling and processing precision, replicate incremental samples will be collected from SUs in each excavation area. Proper selection of replicate sampling locations is discussed above. Replicate samples will be sent to the laboratory as "blind" samples, meaning the laboratory does not know they represent replicate samples from the same SU. The replicate samples will be prepared and analyzed in the same manner as carried out for the initial sample.

Sample Handling

New or clean equipment will be used to prepare and handle the 30 increments in a bulk sample. Individual soil increments typically weigh between 30 and 50 grams, with the bulk sample typically weighing between 900 and 1,500 grams. The mass of the bulk sample depends on the soil density and the volume of the sample probe. Sufficient bulk sample is needed to perform the total number and type(s) of analyses planned, and the lab digestion/analysis mass required for each test. A minimum of 1 kg of soil will be collected per MI sample. Field preparation (mixing) will be done using stainless steel bowl and spoon or spatula. The entire bulk sample will be transferred to the appropriate laboratory-supplied clean large-mouth glass bottles with labels properly filled out. Samples will be stored on ice and submitted for laboratory analysis by one or more of the methods presented on Worksheet #19. Further sample preparation at the laboratory will be conducted as described in Worksheet #23.

6. Key Items

- The bulk sample from each SU will consist of 30 incremental samples.
- The step probe should be pre-marked to obtain a floor sample 0-12 inches bgs. The hand probe should be pre-marked to obtain a sample 0-4 inches depth into the sidewall face.
- For excavation areas containing 10 or less floor SUs, collect original and 2 replicates from one floor SU. For excavation areas containing more than 10 floor SUs, collect original and 2 replicates from two floor SUs. Use the same replicate strategy for sidewall SUs around each excavation area.
- Floor samples will be collected from approximately the same location within each grid (systematic random sampling). Replicate floor samples should be obtained using a different pattern and starting location to avoid re-sampling the same locations.

- Sidewall samples should be collected from stratified random locations in each grid (laterally – left, middle, right; vertically – top 0-3 inches, upper 3-6 inches, lower 6-9 inches, and bottom 9-12 inches, bgs). Sidewall replicates should use random locations that are different from the original plan.
- Planned SU geometries should be altered to match actual excavation areas. After completing the grid layout, the field team must determine and record actual SU location and geometry using GPS devices.
- Increment samples should be homogenized in the field in a clean, stainless steel pan/bowl using clean stainless steel spoon or spatula. Vigorous mixing is not required because the entire bulk sample will be shipped to the lab.
- Decontamination of equipment is required between SUs, but not within a SU. Check that decontamination of equipment is thorough.

(1st Walk)

LEGEND

Path of Travel

Sample Collection Point

(2nd Walk)

FIGURE 1
Example Systematic- Random Multi-Increment Sampling Pattern

(3rd Walk)

ES052007026WDC Figure 1_2

SOP for Soil Sample Preparation Prior to FP-XRF Scanning
SWMU 77, NAPR

Latest Revision: April 2015

1. Introduction

The effectiveness of the interim corrective measures (ICM) soil removal will be tested using a two-step procedure. During initial testing, levels of four metals (antimony, copper, lead and zinc) in soil within a defined decision unit (DU) will be screened for potential exceedances of the PRGs. Soil samples for FP-XRF screening will be a composite of ten (10) subsamples within each DU. The geometry of the DUs is explained in Worksheet #11 of the UFP-SAP. The following text describes a field expedient procedure for processing soil samples that will be analyzed by the field portable x-ray fluorescence (FP-XRF) meter. The purpose of this procedure is to provide a processed sample that is compatible with FP-XRF analytical methodology and minimizes variability in instrument readings due to grain-size heterogeneity and moisture content of soil samples.

2. Scope

This procedure is designed to produce a representative sample aliquot with reduced moisture content and "uniform" particle size. This procedure employs basic tools and materials readily available in the field.

3. Equipment inventory

This field sample preparation procedure will require the following common items and tools in order to process soil samples.

1. Standard sized rubber mallet
2. One gallon zip lock storage bags
3. Sharpie marking pen
4. Aluminum or Teflon cookie sheets
5. Stainless steel spoons or spatulas
6. Aluminum foil
7. Stainless-steel hand strainer
8. Small oven with low-temperature setting (110° F)
9. Sturdy work table
10. Small (1 sq ft) piece of carpet or hard rubber mat
11. Clean water and supplies to decontaminate FP-XRF sample holder (Blanchet), cookie sheets, strainer, and spoons/spatulas for re-use.

4. Safety

While preparing samples, the individual(s) must wear safety glasses (or face shield), and Nitrile examination gloves. A dust mask may be needed to avoid inhaling any airborne particulates. The work area must have adequate lighting, properly equipped work space, and proper ventilation around the drying oven.

5. Procedure

This procedure begins after a 10-point composite sample has been obtained using procedures described in the sampling SOPs for SWMU 77. Typically, the 10-point composite soil sample has been contained in a one (1) gallon zip-lock bag for delivery to the FP-XRF workbench.

1. Check that the zip-lock is secure then carefully tumble the bag to mix the soil sample. Mix the sample by slowly turning the bag over end to end at least 12 times. Repeat this mixing process by turning the bag over side to side at least 12 times. During mixing, attempt to reduce larger pieces of clumped soil material by kneading the soil pieces through the bag. Do not open the bag and knead soil directly.

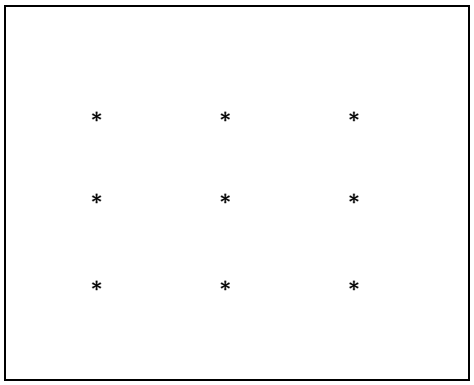
2. Cover a cookie sheet with clean (unused) aluminum foil. Use a Sharpie marker to write down the sample ID (from sample bag) on the corner of the aluminum foil. Open the sample bag and pour entire sample onto the aluminum foil. Using nitrile gloved hands and clean spatula (or other similar hand tool), spread the sample evenly onto the cookie sheet. The spread sample should be no deeper than 0.5 inch.

3. Allow sample to air dry. Fold up a lip in the aluminum foil around the sample, if needed to prevent potential cross contamination when multiple sheets of samples are in close proximity. Also, during this drying step, properly shield the samples from potential wind-borne and moisture contamination.

4. Samples should air dry for approximately about 1 hour, but the objective of air drying is to get the sample sufficiently dry that clay/silt clumps will crumble and separate from larger grains (coarse sand, gravel). Depending upon initial soil conditions, some samples will require more or less drying time. Use of a hair dryer may expedite drying of really wet sample. During air drying and using a nitrile gloved hand, remove gravel, pebbles, sticks, grass clumps, and other large debris (>2 mm, or coarse sand) from the cookie sheet. Change out current nitrile gloves with a new pair before moving to the next sample.

5. Once the sample is sufficiently dry to permit further processing, sub-sample the sheet from nine (9) points (see Diagram 1) using a clean spoon/spatula. Sub-samples should be (visually) the same size (about 5 grams mass); total mass from 9 points should be about 50 grams. Make a small tray of aluminum foil suitable to hold the sample and fit in the oven. Use Sharpie marker to label oven tray with sample ID, and place the sub-samples aliquots in the tray.

Diagram 1



Sub-sampling tray of air-dried soil

6. Place the sample tray in oven that is pre-heated to approximately 110°F (±5°). Typical drying times are approximately one hour, but the sub-sample should be out of the oven in as short of time as possible. Check sub-sample periodically by stirring with clean spatula to assure uniform dryness. Remove sub-sample from oven when completely dry. Place tray on sample table to allow soil to cool to ambient room temperature. Once the sample has cooled, place entire sub-sample in new/clean 1 gallon zip-lock bag. Label bag with sample ID and include "XRF" on bag to designate sample will be scanned with FP-XRF instrument.

7. Assure that zip-lock is secure, then place FP-XRF bag on a piece of carpet or hard rubber mat, and gently pound the sample bag using the rubber mallet. Use either the floor or a substantial table to support the carpet/mat during pounding. Gently pound the sample with the rubber mallet and tumble the bag

several times using both hands to mix the FP-XRF sample thoroughly. Note that pounding is not intended to crush sand or metallic grains (for example, bullet fragments) in the sample.

8. Continue pounding and mixing until larger clay/silt clumps have been reduced, and sample has been reduced to a powdery consistency. Be sure to tumble the bag frequently to create a homogeneous mixture.

9. After pounding ceases, mix sample by tumbling for one minute. Sieve the entire sample using a clean stainless-steel strainer. Capture sieved sample on a clean piece of aluminum foil approx. 10 inches long. Carefully fold aluminum foil and pore sieved sample into a clean FP-XRF Blanchet (plastic cup to hold sample). Fill the cup to rim.

10. Gently tap Blanchet on hard surface to settle the sample. Continue filling and tapping as necessary - Blanchet shall be full to the rim.

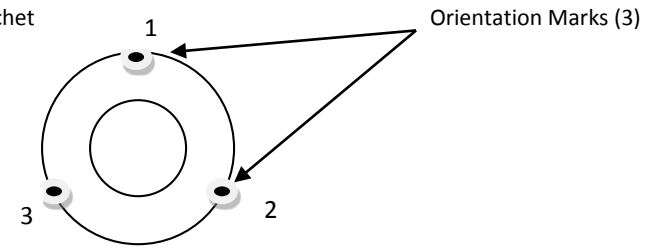
11. Place a single sheet of Mylar® film over the open end of the Blanchet. Gently place the sealing ring over the Mylar film. Press the ring downward in a uniform manner until the ring seats onto the Blanchet. When seated properly, the top of ring and top of the Blanchet should be flush, and the Mylar film shall be smooth and wrinkle free. Sample is now ready for FP-XRF screening.

12. Using the Sharpie pen make a small orientation mark on the side or top edge of the Blanchet container. Rotate the Blanchet approximately 120° and make another orientation mark. Repeat this step one more time so the Blanchet has 3 orientation marks spaced approximately 120° apart (see Diagram 2). These orientation marks will be used to align the Blanchet with the FP-XRF detector.

13. Following manufacturer's instructions load Blanchet into FP-XRF, and take reading at first mark. After analysis, rotate the Blanchet to the next orientation mark. Each sample must be scanned 3 times, one scan for each orientation mark. Taking three readings potentially helps reduce bias that may be caused by compositional heterogeneity in the sample matrix. Record sample ID date, time, and all 3 sets of readings in log book. Report FP-XRF analyses per project instructions.

Diagram 2

Top view of FP-XRF Blanchet



Attachment 3
ELAP Certification

LABORATORY ACCREDITATION BUREAU®

Certificate of Accreditation

ISO/IEC 17025:2005 **Certificate Number L2223**

Katahdin Analytical Services, Inc.

600 Technology Way
Scarborough ME 04074

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 valid through: February 1, 2016

R. Douglas Leonard, Jr., President, COO
Laboratory Accreditation Bureau
Presented the 1st of February 2013

*See the laboratory's Scope of Accreditation for details of accredited parameters
**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
Katahdin Analytical Services, Inc.

600 Technology Way
Scarborough, ME 04074
Leslie Dimond
207-874-2400

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 v4.2) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Katahdin Analytical Services to perform the following tests:

Accreditation granted through: February 1, 2016

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2, 4`-DDD
GC/ECD	EPA 8081B	2, 4`-DDE
GC/ECD	EPA 8081B	2, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDD
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDE
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	Aldrin
GC/ECD	EPA 608; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 608; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608; EPA 8081B	delta-BHC
GC/ECD	EPA 608; EPA 8081B	Dieldrin
GC/ECD	EPA 608; EPA 8081B	Endosulfan I
GC/ECD	EPA 608; EPA 8081B	Endosulfan II

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 608; EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 608; EPA 8081B	Endrin
GC/ECD	EPA 608; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 608; EPA 8081B	Heptachlor
GC/ECD	EPA 608; EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 608; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 608; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4’, 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
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	Dichloroprop

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbon (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	CT ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 1-Trichloroethane
GC/MS	EPA 624; 8260B/C; EPA 524.2	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 2-Trichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1-Dichloropropene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trimethylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromoethane (EDB)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3, 5-Trimethylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3-Dichloropropane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C; EPA 524.2	2, 2-Dichloropropane
GC/MS	EPA 8260B/C; EPA 524.2	2-Butanone
GC/MS	EPA 624; EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C; EPA 524.2	2-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	2-Hexanone
GC/MS	EPA 8260B/C; EPA 524.2	4-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C; EPA 524.2	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 624; EPA 8260B/C	Acrolein
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Acrylonitrile
GC/MS	EPA 8260B/C; EPA 524.2	Allyl chloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C; EPA 524.2	Bromobenzene
GC/MS	EPA 8260B/C; EPA 524.2	Bromochloromethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromodichloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromoform
GC/MS	EPA 8260B/C; EPA 524.2	Carbon disulfide
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Carbon tetrachloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C; EPA 524.2	cis-1, 2-Dichloroethene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	Cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dibromochloromethane
GC/MS	EPA 8260B/C; EPA 524.2	Dibromomethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dichlorodifluoromethane
GC/MS	EPA 8260B/C; EPA 524.2	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C; EPA 524.2	Ethyl methacrylate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C; EPA 524.2	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C; EPA 524.2	Isopropyl benzene
GC/MS	EPA 8260B/C; EPA 524.2	m p-xylenes
GC/MS	EPA 8260B/C	Methyl acetate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C; EPA 524.2	Methacrylonitrile
GC/MS	EPA 624 / 8260B,C	Methyl bromide (Bromomethane)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C; EPA 524.2	Methyl methacrylate
GC/MS	EPA 8260B/C; EPA 524.2	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methylene chloride
GC/MS	EPA 8260B/C; EPA 524.2	Naphthalene
GC/MS	EPA 8260B/C; EPA 524.2	n-Butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	n-Propylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	o-Xylene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C; EPA 524.2	p-Isopropyltoluene
GC/MS	EPA 8260B/C; EPA 524.2	Propionitrile
GC/MS	EPA 8260B/C; EPA 524.2	sec-butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C; EPA 524.2	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Tetrachloroethene (Perchloroethylene)
GC/MS	EPA 8260B/C; EPA 524.2	Tetrahydrofuran
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Toluene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 2-Dichloroethylene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C; EPA 524.2	trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Vinyl chloride
GC/MS	EPA 624 / 8260B,C	Xylene
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	8260B, C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrophenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrotoluene (2, 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 6-Dinitrotoluene (2, 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 625; EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 625; EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 625; EPA 8270C/D	2-Methyl-4 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 625; EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 625; EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	3, 4-Methylphenol
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7, 12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 625; EPA 8270C/D	Acenaphthene
GC/MS	EPA 625; EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 625; EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 625; EPA 8270C/D	Benzidine
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 625; EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 625; 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	1,1-Biphenyl
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane)
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl)adipate
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 625; EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 625; EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 625; EPA 8270C/D	Diethyl phthalate

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 625; EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 625; EPA 8270C/D	Fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Fluorene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 625; EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 625; EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methy methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 625; EPA 8270C/D	Naphthalene
GC/MS	EPA 625; EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodimethylamine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 625; EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 625; EPA 8270C/D	Phenanthrene
GC/MS	EPA 625; EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 625; EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 625; EPA 8270C/D	3, 3’-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Pyrene
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-Trinitrotoluene
HPLC/UV	EPA 8330A/B	2, 4-Dinitrotoluene
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
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	4-Amino-2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene
HPLC/UV	EPA 8330A/B	Ethylene glycol dinitrate (EGDN)
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 MOD	Nitroglycerin
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A/B	Tetryl
CVAA	EPA 245.1; EPA 7470A	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 200.7; EPA 6010B/C	Aluminum
ICP/AES	EPA 200.7; EPA 6010B/C	Antimony
ICP/AES	EPA 200.7; EPA 6010B/C	Arsenic
ICP/AES	EPA 200.7; EPA 6010B/C	Barium
ICP/AES	EPA 200.7; EPA 6010B/C	Beryllium
ICP/AES	EPA 200.7; EPA 6010B/C	Boron
ICP/AES	EPA 200.7; EPA 6010B/C	Cadmium
ICP/AES	EPA 200.7; EPA 6010B/C	Calcium
ICP/AES	EPA 200.7; EPA 6010B/C	Chromium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/AES	EPA 200.7; EPA 6010B/C	Cobalt
ICP/AES	EPA 200.7; EPA 6010B/C	Copper
ICP/AES	EPA 200.7; EPA 6010B/C	Iron
ICP/AES	EPA 200.7; EPA 6010B/C	Lead
ICP/AES	EPA 200.7; EPA 6010B/C	Magnesium
ICP/AES	EPA 200.7; EPA 6010B/C	Manganese
ICP/AES	EPA 200.7; EPA 6010B/C	Molybdenum
ICP/AES	EPA 200.7; EPA 6010B/C	Nickel
ICP/AES	EPA 200.7; EPA 6010B/C	Potassium
ICP/AES	EPA 200.7; EPA 6010B/C	Selenium
ICP/AES	EPA 200.7; EPA 6010B/C	Silicon
ICP/AES	EPA 200.7; EPA 6010B/C	Silver
ICP/AES	EPA 200.7; EPA 6010B/C	Sodium
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 200.7; EPA 6010B/C	Thallium
ICP/AES	EPA 200.7; EPA 6010B/C	Tin
ICP/AES	EPA 200.7; EPA 6010B/C	Titanium
ICP/AES	EPA 200.7; EPA 6010B/C	Vanadium
ICP/AES	EPA 200.7; EPA 6010B/C	Zinc
ICP/MS	EPA 200.8; EPA 6020A	Aluminum
ICP/MS	EPA 200.8; EPA 6020A	Antimony
ICP/MS	EPA 200.8; EPA 6020A	Arsenic
ICP/MS	EPA 200.8; EPA 6020A	Barium
ICP/MS	EPA 200.8; EPA 6020A	Beryllium
ICP/MS	EPA 200.8; EPA 6020A	Boron
ICP/MS	EPA 200.8; EPA 6020A	Cadmium
ICP/MS	EPA 200.8; EPA 6020A	Calcium
ICP/MS	EPA 200.8; EPA 6020A	Chromium
ICP/MS	EPA 200.8; EPA 6020A	Cobalt
ICP/MS	EPA 200.8; EPA 6020A	Copper
ICP/MS	EPA 200.8; EPA 6020A	Iron

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	EPA 200.8; EPA 6020A	Lead
ICP/MS	EPA 200.8; EPA 6020A	Magnesium
ICP/MS	EPA 200.8; EPA 6020A	Manganese
ICP/MS	EPA 200.8; EPA 6020A	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A	Nickel
ICP/MS	EPA 200.8; EPA 6020A	Potassium
ICP/MS	EPA 200.8; EPA 6020A	Selenium
ICP/MS	EPA 200.8; EPA 6020A	Silicon
ICP/MS	EPA 200.8; EPA 6020A	Silver
ICP/MS	EPA 200.8; EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 200.8; EPA 6020A	Thallium
ICP/MS	EPA 200.8; EPA 6020A	Tin
ICP/MS	EPA 200.8; EPA 6020A	Titanium
ICP/MS	EPA 200.8; EPA 6020A	Tungsten
ICP/MS	EPA 200.8	Uranium
ICP/MS	EPA 200.8; EPA 6020A	Vanadium
ICP/MS	EPA 200.8; EPA 6020A	Zinc
IC	EPA 300.0; EPA 9056A	Bromide
IC	EPA 300.0; EPA 9056A	Chloride
IC	EPA 300.0; EPA 9056A	Fluoride
IC	EPA 300.0; EPA 9056A	Nitrate as N
IC	EPA 300.0; EPA 9056A	Nitrite as N
IC	EPA 300.0; EPA 9056A	Nitrate + Nitrite
IC	EPA 300.0; EPA 9056A	Orthophosphate as P
IC	EPA 300.0; EPA 9056A	Sulfate
IC	SOP CA-776	Lactic Acid
IC	SOP CA-776	Acetic Acid
IC	SOP CA-776	Propionic Acid
IC	SOP CA-776	Formic Acid
IC	SOP CA-776	Butyric Acid

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	SOP CA-776	Pyruvic Acid
IC	SOP CA-776	i-Pentanoic Acid
IC	SOP CA-776	Pentanoic Acid
IC	SOP CA-776	i-Hexanoic Acid
IC	SOP CA-776	Hexanoic Acid
Titration	EPA 310.1; SM 2320B	Alkalinity
Caculation	SM 2340B	Hardness
Gravimetric	EPA 1664A; EPA 9070A	Oil and Grease, Oil and Grease with SGT
Gravimetric	SM 2540B/C/D	Solids
ISE	EPA 120.1; SM 2510B	Conductivity
ISE	SM 2520B	Practical Salinity
ISE	SM 4500F- C	Fluoride
ISE	SM 4500H+ B	pH
ISE	SM 5210B	TBOD / CBOD
Physical	EPA 1010A	Ignitability
Physical	EPA 9040C	pH
Titration	SM 2340C	Hardness
Titration	SM 4500SO_3 B	Sulfite
Titration	EPA 9034; SM 4500S^{2-} F	Sulfide
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	EPA 9060A; SM 5310B	Total organic carbon
Turbidimetric	EPA 180.1; SM 2130B	Turbidity
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 335.4; EPA 9012B; SM 4500-CN G	Amenable cyanide
UV/VIS	EPA 350.1; SM 4500NH3 H	Ammonia as N
UV/VIS	SM 3500Fe D	Ferrous Iron
UV/VIS	EPA 351.2	Kjeldahl nitrogen - total
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrate + Nitrite
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrate as N
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrite as N
UV/VIS	EPA 365.2; SM 4500P E	Orthophosphate as P

Non-Potable Water		
Technology	**Method**	**Analyte**
UV/VIS	EPA 365.4	Phosphorus total
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	EPA 410.4	COD
UV/VIS	EPA 420.1; EPA 9065	Total Phenolics
UV/VIS	SM 4500Cl G	Total Residual Chlorine
UV/VIS	SM 5540C	MBAS
UV/VIS	EPA 7196A; SM 3500-Cr D	Chromium VI
UV/VIS	EPA 9012B; EPA 335.4	Total Cyanide
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide

Preparation	Method	Type
Cleanup Methods	EPA 3640A	Gel Permeation Clean-up
Cleanup Methods	EPA 3630C	Silica Gel
Cleanup Methods	EPA 3660B	Sulfur Clean-Up
Cleanup Methods	EPA 3665A	Sulfuric Acid Clean-Up
Organic Preparation	EPA 3510C	Separatory Funnel Extraction
Organic Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030C	Purge and Trap

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2,4`-DDD
GC/ECD	EPA 8081B	2,4`-DDE
GC/ECD	EPA 8081B	2,4`-DDT
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT
GC/ECD	EPA 8081B	Aldrin

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	Cis-Nonachlor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	Trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 5', 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4’, 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
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	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Total Petroleum Hydrocarbons (TPH)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	MA DEP EPH EPA 3546	Extractable Petroleum Hydrocarbons Microwave Extraction Preparation
GC/FID	CT-ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/C	1, 1, 1-Trichloroethane
GC/MS	EPA 8260B/C	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C	1, 1-Dichloroethane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	1, 1-Dichloroethylene
GC/MS	EPA 8260B/C	1, 1-Dichloropropene
GC/MS	EPA 8260B/C	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 2-Dibromoethane
GC/MS	EPA 8260B/C	1, 2-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 2-Dichloroethane
GC/MS	EPA 8260B/C	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 3-Dichloropropane
GC/MS	EPA 8260B/C	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C	2, 2-Dichloropropane
GC/MS	EPA 8260B/C	2-Butanone
GC/MS	EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	4-Chlorotoluene
GC/MS	EPA 8260B/C	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 8260B/C	Acrolein
GC/MS	EPA 8260B/C	Acrylonitrile
GC/MS	EPA 8260B/C	Allyl chloride

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C	Bromobenzene
GC/MS	EPA 8260B/C	Bromochloromethane
GC/MS	EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 8260B/C	Bromoform
GC/MS	EPA 8260B/C	Carbon disulfide
GC/MS	EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 8260B/C	Chlorobenzene
GC/MS	EPA 8260B/C	Chloroethane
GC/MS	EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C	cis-1, 2-Dichloroethene
GC/MS	EPA 8260B/C	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	cis-1,3-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 8260B/C	Dibromomethane
GC/MS	EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C	Isopropyl benzene
GC/MS	EPA 8260B/C	m p-xylenes

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B, C	Methyl acetate
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methylene chloride
GC/MS	EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 8260B/C	n-proplybenzene
GC/MS	EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	pentachloroethane
GC/MS	EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 8260B/C	Propionitrile
GC/MS	EPA 8260B/C	sec-butylbenzene
GC/MS	EPA 8260B/C	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 8260B/C	Toluene
GC/MS	EPA 8260B/C	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260B/C	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C	Trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 8260B/C	Vinyl chloride
GC/MS	EPA 8260B/C	Xylene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
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, 5-Trinitrobenzene
GC/MS	EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 8270C/D	2, 4-Dinitrotoluene (2 4-DNT)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 8270C/D	2, 6-Dinitrotoluene (2 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methyl-4, 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3, 3`-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D	3,4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
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 phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
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
GC/MS	EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 8270C/D	Dibenzofuran
GC/MS	EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Diethyladipate

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methyl methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O, O, O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2-pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A	1 ,3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A	1, 3-Dinitrobenzene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330A	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4, 6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene
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
HPLC/UV	EPA 8330A	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A	Tetryl
HPLC/UV	8330B (W/O Soil Grinding)	1, 3, 5-Trinitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	1, 3-Dinitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	2, 4, 6-Trinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2, 4-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2, 6-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2-Amino-4, 6 –Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	2-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	3-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	3,5-Dinitroaniline
HPLC/UV	8330B (W/O Soil Grinding)	4-Amino-2,3-Dinitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	4-Nitrotoluene
HPLC/UV	8330B (W/O Soil Grinding)	Ethylene glycol dinitrate (EGDN)
HPLC/UV	8330B (W/O Soil Grinding)	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	8330B (W/O Soil Grinding)	Nitrobenzene
HPLC/UV	8330B (W/O Soil Grinding)	Nitroglycerin

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
HPLC/UV	8330B (W/O Soil Grinding)	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	8330B (W/O Soil Grinding)	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	8330B (W/O Soil Grinding)	Tetryl
CVAA	EPA 7471B	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 6010B/C	Aluminum
ICP/AES	EPA 6010B/C	Antimony
ICP/AES	EPA 6010B/C	Arsenic
ICP/AES	EPA 6010B/C	Barium
ICP/AES	EPA 6010B/C	Beryllium
ICP/AES	EPA 6010B/C	Boron
ICP/AES	EPA 6010B/C	Cadmium
ICP/AES	EPA 6010B/C	Calcium
ICP/AES	EPA 6010B/C	Chromium
ICP/AES	EPA 6010B/C	Cobalt
ICP/AES	EPA 6010B/C	Copper
ICP/AES	EPA 6010B/C	Iron
ICP/AES	EPA 6010B/C	Lead
ICP/AES	EPA 6010B/C	Magnesium
ICP/AES	EPA 6010B/C	Manganese
ICP/AES	EPA 6010B/C	Molybdenum
ICP/AES	EPA 6010B/C	Nickel
ICP/AES	EPA 6010B/C	Potassium
ICP/AES	EPA 6010B/C	Selenium
ICP/AES	EPA 6010B/C	Silicon
ICP/AES	EPA 6010B/C	Silver
ICP/AES	EPA 6010B/C	Sodium
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 6010B/C	Thallium
ICP/AES	EPA 6010B/C	Tin
ICP/AES	EPA 6010B/C	Titanium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010B/C	Vanadium
ICP/AES	EPA 6010B/C	Zinc
ICP/MS	EPA 6020A	Aluminum
ICP/MS	EPA 6020A	Antimony
ICP/MS	EPA 6020A	Arsenic
ICP/MS	EPA 6020A	Barium
ICP/MS	EPA 6020A	Beryllium
ICP/MS	EPA 6020A	Boron
ICP/MS	EPA 6020A	Cadmium
ICP/MS	EPA 6020A	Calcium
ICP/MS	EPA 6020A	Chromium
ICP/MS	EPA 6020A	Cobalt
ICP/MS	EPA 6020A	Copper
ICP/MS	EPA 6020A	Iron
ICP/MS	EPA 6020A	Lead
ICP/MS	EPA 6020A	Magnesium
ICP/MS	EPA 6020A	Manganese
ICP/MS	EPA 6020A	Molybdenum
ICP/MS	EPA 6020A	Nickel
ICP/MS	EPA 6020A	Potassium
ICP/MS	EPA 6020A	Selenium
ICP/MS	EPA 6020A	Silver
ICP/MS	EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 6020A	Thallium
ICP/MS	EPA 6020A	Tin
ICP/MS	EPA 6020A	Titanium
ICP/MS	EPA 6020A	Tungsten
ICP/MS	EPA 6020A	Vanadium
ICP/MS	EPA 6020A	Zinc
IC	EPA 9056A	Chloride

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate as N
IC	EPA 9056A	Nitrite as N
IC	EPA 9056A	Orthophosphate
IC	EPA 9056A	Sulfate
Gravimetric	EPA 9071A; EPA 9071B	Oil and Grease, Oil and Grease with SGT
Physical	EPA 1010A	Ignitability
Physical	EPA 9045D	pH
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
Titration	Walkley-Black	Total Organic Carbon
IR	Lloyd Kahn	Total organic carbon
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 350.1; SM 4500NH3 H	Ammonia as N
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	SM 3500Fe D	Ferrous Iron
Cleanup Methods	EPA 3630C	Silica Gel
UV/VIS	EPA 7196	Chromium VI
UV/VIS	EPA 7196A	Chromium VI
UV/VIS	EPA 9012B	Total cyanide
Preparation	**Method**	**Type**
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	EPA 3660B	Sulfur Clean-up
Cleanup Methods	EPA 3620C	Florsil Clean-up
Cleanup Methods	EPA 3630C	Silica Gel Clean-up
Cleanup Methods	EPA 3640A	GPC Clean-up
Organic Preparation	EPA 3540C	Soxhlet Extraction
Organic Preparation	EPA 3545A	Pressurized Fluid Extraction

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
Organic Preparation	EPA 3546	Microwave Extraction Preparation for EPA 8082A, 8081B and 8270C, D
Organic Preparation	EPA 3550C	Sonication
Inorganics Preparation	EPA 3050B	Hotblock
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Volatile Organics Preparation	EPA 5035/5035A	Closed System Purge and Trap

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Propene
GC/MS	EPA TO-15	1, 1, 1-Trichloroethane
GC/MS	EPA TO-15	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA TO-15	1, 1, 2-Trichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethylene
GC/MS	EPA TO-15	1, 2, 4-Trichlorobenzene
GC/MS	EPA TO-15	1, 2, 4-Trimethylbenzene
GC/MS	EPA TO-15	1, 2-Dibromoethane (EDB)
GC/MS	EPA TO-15	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
GC/MS	EPA TO-15	1, 2-Dichlorobenzene
GC/MS	EPA TO-15	1, 2-Dichloroethane
GC/MS	EPA TO-15	1, 2-Dichloroethenes (Total)
GC/MS	EPA TO-15	1, 2-Dichloropropane
GC/MS	EPA TO-15	1, 3, 5-Trimethylbenzene
GC/MS	EPA TO-15	1, 3-Butadiene
GC/MS	EPA TO-15	1, 3-Dichlorobenzene
GC/MS	EPA TO-15	1, 4-Dichlorobenzene
GC/MS	EPA TO-15	1,4-Difluorobenzene
GC/MS	EPA TO-15	1, 4-Dioxane
GC/MS	EPA TO-15	2-Butanone
GC/MS	EPA TO-15	2-Hexanone

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	2-Propanol
GC/MS	EPA TO-15	4-Ethyltoluene
GC/MS	EPA TO-15	4-Methyl-2-pentanone
GC/MS	EPA TO-15	Acetone
GC/MS	EPA TO-15	Acrolein
GC/MS	EPA TO-15	Benzene
GC/MS	EPA TO-15	Benzyl chloride
GC/MS	EPA TO-15	Bromochloromethane
GC/MS	EPA TO-15	Bromodichloromethane
GC/MS	EPA TO-15	Bromoform
GC/MS	EPA TO-15	Carbon disulfide
GC/MS	EPA TO-15	Carbon tetrachloride
GC/MS	EPA TO-15	Chlorobenzene
GC/MS	EPA TO-15	Chloroethane
GC/MS	EPA TO-15	Chloroform
GC/MS	EPA TO-15	Cis-1, 2-Dichloroethene
GC/MS	EPA TO-15	Cis-1, 3-Dichloropropene
GC/MS	EPA TO-15	Cyclohexane
GC/MS	EPA TO-15	Dibromochloromethane
GC/MS	EPA TO-15	Dichlorodifluoromethane (Freon 12)
GC/MS	EPA TO-15	Ethanol
GC/MS	EPA TO-15	Ethyl acetate
GC/MS	EPA TO-15	Ethylbenzene
GC/MS	EPA TO-15	Hexachlorobutadiene
GC/MS	EPA TO-15	Isopropyl alcohol
GC/MS	EPA TO-15	m, p-Xylene
GC/MS	EPA TO-15	Methyl bromide (Bromomethane)
GC/MS	EPA TO-15	Methyl chloride (Chloromethane)
GC/MS	EPA TO-15	Methyl methacrylate
GC/MS	EPA TO-15	Methyl tert-butyl ether
GC/MS	EPA TO-15	Methylene chloride

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Naphthalene
GC/MS	EPA TO-15	n-Heptane
GC/MS	EPA TO-15	n-Hexane
GC/MS	EPA TO-15	o-Xylene
GC/MS	EPA TO-15	Styrene
GC/MS	EPA TO-15	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA TO-15	Tetrahydrofuran
GC/MS	EPA TO-15	Toluene
GC/MS	EPA TO-15	trans-1, 2-Dichloroethylene
GC/MS	EPA TO-15	trans-1, 3-Dichloropropylene
GC/MS	EPA TO-15	Trichloroethene (Trichloroethylene)
GC/MS	EPA TO-15	Trichlorofluoromethane (Freon 11)
GC/MS	EPA TO-15	1,1,2-Trichloro1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA TO-15	Vinyl acetate
GC/MS	EPA TO-15	Vinyl chloride
GC/MS	EPA TO-15	Xylenes (Total)
GC/MS	MA DEP APH	Aliphatic C5-C8 range
GC/MS	MA DEP APH	Aliphatic C9-C12 range
GC/MS	MA DEP APH	Aromatic C9-C10 range
GC/MS	MA DEP APH	1,3-Butadiene
GC/MS	MA DEP APH	Benzene
GC/MS	MA DEP APH	Ethylbenzene
GC/MS	MA DEP APH	m+p-Xylene
GC/MS	MA DEP APH	Methyl tert-butyl ether
GC/MS	MA DEP APH	Naphthalene
GC/MS	MA DEP APH	o-Xylene
GC/MS	MA DEP APH	Toluene

Notes:

1) This laboratory offers commercial testing service.

Approved by: _____ Date: March 13, 2013

R. Douglas Leonard
Chief Technical Officer

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