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Final

Remedial Investigation Sampling and Analysis Plan Eastern Conservation Area

Former Vieques Naval Training Range Vieques, Puerto Rico

Prepared for

Department of the Navy

NAVFAC ATLANTIC

Contract No.
N62470-08-D-1000
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January 2011

Prepared by

CH2MHILL

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Acronyms and Abbreviations

AHA	activity hazard analysis
ARAR	applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
ATG	air-to-ground
CA	corrective action
CCP	Comprehensive Conservation Plan
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
CLP	contract laboratory program
COC	chain of custody
CSM	Conceptual Site Model
CTO	Contract Task Order
DO	dissolved oxygen
DoD	U.S. Department of Defense
DOI	Department of the Interior
°C	degrees Celsius
DQE	data quality evaluation
DQI	data quality indicator
ECA	Eastern Conservation Area
ED	exposure duration
EF	exposure frequency
EIS	Environmental Information Specialist
EMA	Eastern Maneuver Area
EQB	Environmental Quality Board
ERA	Ecological Risk Assessment
ERP	Environmental Restoration Program
ET	exposure time
FID	Flame Ionization Detector
FTL	Field Team Leader
FWS	Fish and Wildlife Service
GPS	Global Positioning System
GW	Groundwater
H&S	Health & Safety
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
ICAL	Initial Calibration
ICP	inductively coupled plasma
ICS	Interference Check Solutions

IDL	Instrument Detection Limit
IDW	investigation-derived waste
IR	Navy Installation Restoration
IS	Internal Standards
LCS	laboratory control sample
LCL	lower control limit
LCSD	Laboratory Control Sample Duplicate
LIA	Live Impact Area
LIMS	Laboratory Information Management Systems
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MACTEC	MACTEC Inc.
MEC	munitions and explosives of concern
MDL	method detection limit
MIS	multi-incremental sampling
mg/kg	milligrams per kilogram
ml	milliliter(s)
mm	millimeter(s)
MPC	Measurement Performance Criteria
MRAs	Munitions Response Areas
MSA	method of standard additions
MSOPPPs	Master Standard Operating Procedures, Protocols, and Plans
MS/MSD	matrix spike/matrix spike duplicate
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NIRIS	Navy Installation Restoration Information System
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
ORP	oxidation-reduction potential
OU	operable unit
OVM	organic vapor monitor
PAL	project action limit
PDF	portable document format
PDS	post-digestion spike
PID	photoionization detector
PM	Project Manager
POC	Point of Contact
PREQB	Puerto Rico Environmental Quality Board
QA	quality assurance
QAMS	Quality Assurance Management Section
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit

QSM	Quality Systems Manual
RAB	Restoration Advisory Board
RAGs	Risk Assessment Guidance for Superfund
RI	Remedial Investigation
RL	reporting limit
RME	Reasonable Maximum Exposure
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	relative retention times
RSD	relative standard deviation
RSL	Regional Screening Levels
SAP	Sampling and Analysis Plan
SI	Site Inspection
SMI	Incremental sample
SMP	Site Management Plan
SOP	standard operating procedure
SSC	Site Safety Coordinator
SSC-HW	Site Safety Coordinator Hazardous Waste
SVOA	semivolatile organic analytes
SVOC	semivolatile organic compounds
SW	surface water
SWO	Safe Work Observation
TAT	turnaround time
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Removal Action
TOC	Total organic carbon
U.S.	United States
UCL	upper confidence limit
UFP	Uniform Federal Policy
UFP -QAPP	Uniform Federal Policy-Quality Assurance Project Plans
USACE	US Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UTLs	upper tolerance limits
UXO	Unexploded Ordnance
VNTR	Vieques Naval Training Range
VOA	volatile organic analytes
VOC	volatile organic compound
WCHEM	wet chemistry
WP	white phosphorous

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Executive Summary

This Sampling and Analysis Plan (SAP) is prepared to support the Remedial Investigation (RI) field sampling activities at the Eastern Conservation Area (ECA), also known as Unexploded Ordnance (UXO) Site 1, located at the former Vieques Naval Training Range (VNTR) in the eastern portion of Vieques, Puerto Rico (Figure 1). This SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serves as a guideline for the field activities and data assessment. This SAP was developed in general accordance with two guidance documents: 1) U.S. Environmental Protection Agency (USEPA), EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002), and 2) USEPA, Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (Intergovernmental Data Quality Task Force, 2005).

This SAP was prepared under the United States Navy (Navy) Comprehensive Long-Term Environmental Action (CLEAN) Contract N62470-08-D-1000, Contract Task Order 0037, for submittal to the Naval Facilities Engineering Command (NAVFAC) Atlantic Division, USEPA Region 2, the Commonwealth of Puerto Rico Environmental Quality Board (EQB), and the United States Fish and Wildlife Service (USFWS). The Navy, USEPA, EQB, and USFWS work jointly as the Vieques Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Environmental Restoration Program (ERP) Technical Subcommittee.

The ECA is 133 acres in size and is a wilderness area within the designated Vieques National Wildlife Refuge. The ECA was not used as an operational area for munitions; however, the ECA is located adjacent to the Live Impact Area (LIA) (UXO Sites 2, 3, and 4), where naval gunfire and air-to-ground (ATG) training activities occurred from the 1970s through 2003. Munitions and explosives of concern (MEC) have been identified within the ECA, most likely from misfires.

An Interim Time-Critical Removal Action (TCRA) and an Expanded Range Assessment (ERA)/Site Inspection (SI) identified over 1,400 MEC items at the ECA (CH2M HILL, 2009 and 2010). The TCRA was completed in February 2009 and removed munitions from the ground surface over an approximately 125 acre area (the remaining 8 acres is inaccessible steep slope areas and portions of the lagoon that were inundated with water). MEC items identified generally decreased in number from west to east. Subsurface munitions may still remain at the site.

The MEC at the ECA had the potential to release chemical contaminants to the environmental media, from historical detonations and from the deterioration of MEC and related munitions scrap. As a result, an RI is being conducted at the ECA to assess the nature and extent of contamination and potential environmental and human health risks associated with exposure to any contamination identified.

The ECA RI will include the environmental characterization of surface soil, sediment, and surface water. Surface soil sampling will be conducted using the incremental sampling strategy and approach in general accordance with the guidance document prepared by the US Army Corps of Engineers (USACE) titled Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program (USACE, 2009). Due to the large size of the ECA and random distribution of MEC (and associated releases) on the ground surface, incremental sampling of the surface soil will improve the reliability of sampling data by reducing the variability

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NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HA HECHO TODO LO POSIBLE PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

inherent to discrete sampling strategies. Deeper surface soil, sediment, and surface water samples will be collected as discrete samples in accordance with the Master Standard Operating Procedures, Protocols, and Plans (denoted as the Master Plans in this SAP) for the Environmental Restoration Program at Vieques (CH2M HILL, 2010).

In total, 27, 8, 15, and 5 shallow surface soil incremental samples, deeper surface soil discrete samples, discrete sediment, and discrete surface water samples, respectively, will be collected at the ECA and analyzed for constituents of interest (i.e., explosives, perchlorate, inorganics) and supporting general chemistry parameters. In addition, 10 shallow soil background incremental samples will be collected from lithologic areas similar to the ECA, but outside of the ECA, and analyzed for inorganics. The background locations will be in some of the same areas as where discrete grab samples were collected as part of the East Vieques background study (CH2M HILL, 2005). The data collected during the RI will be used to conduct quantitative human health and ecological risk assessments to determine if residual contamination (if present) poses an unacceptable risk to potential receptors. However, prior to the quantitative risk assessments, surface soil data will be compared to the adjusted RSLs and the ERP Technical Subcommittee will reconvene on how the data will be grouped and the appropriate path forward to evaluate potential risks to human health and ecological terrestrial receptors exposed to surface soil. The risk assessment information will then be used to determine whether additional investigation, remedial/removal action, or control mechanisms are warranted.

This SAP will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for the intended uses (i.e., environmental characterization, human health and ecological risk assessments, and path forward). The laboratory information cited in this SAP is for TestAmerica Laboratories, Inc., which will provide analytical services for this investigation.

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Resumen Ejecutivo

Se preparó este Plan de Muestreo y Análisis (SAP, por sus siglas en inglés) para apoyar las actividades de muestreo de campo de la Investigación para la Remediación (RI, por sus siglas en inglés) del Área de Conservación del Este (ECA, por sus siglas en inglés), también conocida como Municiones sin Detonar (UXO, por sus siglas en inglés) Sitio 1, que está localizado en la porción este de Vieques en el Antiguo Campo de Adiestramiento Naval de Vieques (VNTR, por sus siglas en inglés), Puerto Rico (Figura 1). Este SAP incluye 37 hojas de trabajo que detallan los varios aspectos del proceso de investigación ambiental y sirve como guía para las actividades de campo y evaluación de datos. Este SAP se desarrolló siguiendo en general la guía de dos documentos: 1) Agencia de Protección Ambiental de los EEUU (USEPA, por sus siglas en inglés), EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA, 2002), y 2) USEPA, Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) (Intergubernamental e Data Quality Task Force, 2005).

Este SAP se preparó bajo el Contrato Naval de Acción Ambiental Abarcadora a Largo Plazo (CLEAN, por sus siglas en inglés) de la Marina de los Estados Unidos, Contrato Número N62470-08-D-1000, Orden de Trabajo del Contrato 0037, para ser enviado a las Facilidades Navales del Comando de Ingeniería (NAVFAC, por sus siglas en inglés) División del Atlántico, USEPA Región 2, la Junta de Calidad Ambiental del Estado Libre Asociado de Puerto Rico (JCA), y el Servicio Nacional de Pesca y Vida Silvestre de los Estados Unidos (USFWS, por sus siglas en inglés). La Marina, USEPA, JCA, y USFWS trabajan en conjunto como el Subcomité Técnico del Programa de Restauración Ambiental (ERP, por sus siglas en inglés) de la Ley de Respuesta Ambiental, Responsabilidad y Compensación Comprensiva (CERCLA, por sus siglas en inglés).

El ECA consiste de 133 acres y es un área designada como silvestre dentro del Refugio Nacional de Vida Silvestre de Vieques. El ECA no se utilizó como área operacional de municiones; pero; el ECA está localizada adyacente al Área de Impacto Vivo (LIA, por sus siglas en inglés) (Sitios UXO 2, 3, y 4), donde ocurrieron actividades de adiestramiento con armas de fuego naval y aire-a-tierra (ATG, por sus siglas en inglés) desde los años 1970s hasta el 2003. Se identificaron Municiones y Explosivos de Preocupación (MEC, por sus siglas en inglés) dentro del ECA, la mayoría probablemente de tiros errados.

Una Acción de Remoción Interina de Tiempo Crítico (TCRA, por sus siglas en inglés) y una Evaluación de Alcance Expandida (ERA)/Inspección del Sitio (SI) identificó sobre 1,400 artículos MEC en el ECA (CH2M HILL, 2009 y 2010). El TCRA se completó en febrero del 2009 y removió municiones de la superficie de la tierra de un área aproximada de 125 acres (los ocho acres restantes son áreas de cuestas escarpadas y porciones de la laguna inundadas). El número de los artículos MEC identificados generalmente se reducen de oeste a este. Puede que todavía haya municiones en el subsuelo.

Los MEC en el ECA tienen el potencial de liberar contaminantes químicos al medio ambiental, como resultado de detonaciones históricas y de MEC deteriorados y escombros relacionados a municiones. Por esta razón, se está llevando a cabo un RI en el ECA para determinar la naturaleza y extensión de la contaminación y los riesgos para la salud humana y el ambiente asociados con la exposición a cualquier contaminación identificada.

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El investigación (RI) del ECA incluirá la caracterización ambiental de suelos de superficie, sedimentos y agua de superficie. Se llevará a cabo un muestreo de suelos de superficie usando la estrategia de muestreo incremental y de acercamiento, en acuerdo general con el documento guía preparado por el Cuerpo de Ingenieros del Ejército de los EEUU (USACE, por sus siglas en inglés) titulado Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program (USACE, 2009). Debido al gran tamaño del ECA y la distribución al azar de MEC (y escapes asociados) en la superficie del terreno, el muestreo en incrementos del suelo mejorará la credibilidad de los datos de muestreo reduciendo la variabilidad inherente en estrategias de muestreo discretas. Se recogerán muestras discretas de suelo más profundo sedimento y muestras de agua de superficie de acuerdo con los Estándares Maestros de Procedimientos Operacionales, Protocolos, y Planes (denominados como Planes Maestros en este SAP) para el Programa de Restauración Ambiental de Vieques (CH2M HILL, 2010).

En el ECA se recogerán y analizarán para componentes de interés (ej., explosivos, percloratos, metales) y parámetros químicos de apoyo general, un total de 27 muestras en incremento de suelos de superficie poco profundos, 8 muestras discretas de superficie de suelos profundos15 muestras discretas de sedimentos, y 5 muestras de agua de superficie discretas. Ademas, se recogerán 10 muestras en incremento de suelos de trasfondo poco profundos de areas litológicas similares al ECA, pero fuera del ECA, las que serán analizadas para metales. Las localizaciones de muestreo de trasfondo serán en algunas de las mismas áreas donde se recogieron muestras discretas como parte del estudio de Transfondo del Este de Vieques (CH2M HILL, 2005). Los datos recogidos durante el RI se utilizarán para llevar a cabo evaluaciones cuantitativas de riesgo a la salud humana y ecológicos para determinar si la contaminación residual (de haber alguna presente) presenta un riesgo inaceptable para receptores potenciales. Sin embargo, antes de las evaluaciones de riesgo cuantitativos, se compararán los datos de suelo a los RSLs, y el Subcomité Técnico decidirá cómo se agruparán los datos y los pasos subsiguientes adecuados para evaluar riesgos potenciales a la salud humana y a receptores ecológicos terrestres expuestos a la superficie del suelo. La información de la evaluación de riesgo se utilizará para determinar la necesidad de alguna investigación adicional, remediación/acción de remoción o mecanismos de control.

Este SAP ayudará a asegurar que los datos ambientales recogidos o compilados sean científicamente correctos, de calidad conocida y documentada, y adecuados para el uso diseñado (ej., evaluaciones de riesgos humanos y ecológicos luego de la remoción). La información de laboratorio citado en este SAP será enviada a Mitkem Laboratories Inc. of Warwick, Rhode Island, el cual provee servicios analíticos para esta investigación.

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SAP Worksheet #1 — Title and Approval Page

Final
Remedial Investigation Sampling and Analysis Plan
Eastern Conservation Area
Former Vieques Naval Training Range
Vieques, Puerto Rico
January 2011

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USFWS - Remedial Project Manager

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SAP Worksheet #2 — SAP Identifying Information

Site Name/Number: Eastern Conservation Area (ECA) at the former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico
Operable Unit (OU): N/A
Contractor Name: CH2M HILL
Contract Number: N62470-08-D-1000
Contract Title: Navy Comprehensive Long-term Environmental Action—Navy (CLEAN) Program 1000
Work Assignment Number (optional): Contract Task Order (CTO) 037 (Post-Munitions Investigation)

1. This SAP was prepared in general accordance with the requirements of the Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP) (Intergovernmental Data Quality Task Force, 2005) and United States (U.S.) Environmental Protection Agency (USEPA) Guidance for QAPPs, USEPA QA/G-5, Quality Assurance Management Section (QAMS) (USEPA, 2002).
2. Regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
3. This SAP is a project-specific SAP.
4. Dates of scoping sessions:

Scoping Session	Date
Environmental Technical Subcommittee Meeting—San Juan, Puerto Rico	January 26, 2010
Vieques Site Visit and Wrap-up Meeting- Vieques, Puerto Rico	January 27 and 28, 2010
Conference Call Regarding Reasonable Maximum Exposure (RME) Scenarios for Fish and Wildlife Service Workers at the ECA - Vieques	February 11, 2010
Ecological Receptors Conference Call	March 3, 2010
Environmental Technical Subcommittee Meeting—New York, New York	March 10-11, 2010

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

Title	Date
Master Standard Operating Procedures, Protocols, and Plans	April 2010

SAP Worksheet #2 — SAP Identifying Information (continued)

6. Organizational partners (stakeholders) and connection with lead organization:
   - **USEPA Region 2 –** Federal regulatory stakeholder overseeing CERCLA Vieques environmental restoration program (ERP) implemented by lead organization.
   - **Puerto Rico Environmental Quality Board (PREQB) –** Commonwealth regulatory stakeholder overseeing CERCLA Vieques ERP implemented by lead organization.
   - **United States Fish and Wildlife Service (USFWS) –** Land owner of land transferred from lead organization and on which ECA ERP activities are conducted.
   - National Oceanic and Atmospheric Administration (NOAA) – Marine habitat stakeholder and technical advisor to USEPA.
7. Lead organization (see Worksheet #7 for detailed list of data users):
   - U.S. Department of Navy (Navy).
8. The omitted SAP elements excluded and provide an explanation for their exclusion below:
   - Crosswalk table is excluded as all required information is provided in this SAP.

SAP Worksheet #3 — Distribution List

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Kevin Cloe	Vieques Remedial Project Manager (RPM)/ Lead Agency Point of Contact (POC)	Navy	757-322-4736	kevin.cloe@navy.mil	A	CL	A
Chris Penny	Vieques Program Coordinator/No project-specific role	Navy	757-322-4815	christopher.penny@navy.mil	CL	CL	CL
Dan Hood	Vieques RPM/No project-specific role	Navy	757-322-4630	daniel.r.hood@navy.mil	CL	CL	CL
Madeline Rivera	Vieques Environmental Restoration Program Site Manager /On-island coordination	Navy	757-286-6457 (cell)	Madeline.rivera@navy.mil	A		A
John Noles	Biologist/Technical input	Navy	757-322-4891	john.noles@navy.mil	HC		A
Daniel Rodriguez	Vieques RPM/ Regulatory agency POC	USEPA	787-741-5201 787-671-9879 (cell)	rodriguez.daniel@epa.gov	A	CL	A
Carl Soderberg	Caribbean Environmental Protection Division Director	USEPA	787-977-5814	soderberg.carl@epa.gov	CL		CL
Sergio Lopez	QC Specialist/Technical input and draft document review	USEPA	732-321-6778	lopez.sergio@epa.gov	A		A
Michael Sivak	Human Health Risk Assessment (HHRA) Lead/Technical input and draft document review	USEPA	212-637-4310	sivak.michael@epa.gov	A		A
Diana Cutt	Geology/Hydrogeology Lead/Technical input and draft document review	USEPA	212-637-4311	cutt.diana@epa.gov	A		A
Mindy Pensak	Ecological Risk Assessment (ERA) Lead/Technical input and draft document review	USEPA	732-321-6705	pensak.mindy@epa.gov	A		A
John Fellinger	Technical Support Consultant for USEPA/USEPA contractor primary POC	TechLaw	856-878-0988	jfellinger@techlawinc.com	A		A
Pedro J. Nieves, Esq.	President/No project-specific role	PREQB	787-767-8056	pedronieves@jca.gobierno.pr	CL		CL
Wilmarie Rivera	Vieques RPM/ Regulatory agency POC	PREQB	787-767-8181 (x6141) (work) 787-365-8573 (cell)	wilmarierivera@jca.gobierno.pr	A	CL	A
Katarina Rutkowski	Technical Support Consultant for Environmental Quality Board (EQB)/EQB contractor primary POC	TRC	860-298-6202	krutkowski@trcsolutions.com	A		A
Mike Barandiaran	Refuge Manager/No project-specific role	USFWS	787-741-2138	Mike_barandiaran@fws.gov			A
Susan Silander	Caribbean Islands Refuges Supervisor/No project-specific role	USFWS	787-851-7258 (x38)	susan.silander@fws.gov	CL		CL

SAP Worksheet #3 — Distribution List (continued)

Name of SAP Recipients	Title/Project Role	Organization	Telephone Number (Optional)	E-mail Address or Mailing Address	D	DF	F
Richard Henry	Vieques RPM/ Land management agency POC/No project-specific role	USFWS	732-906-6987	richard_henry@fws.gov	A	CL	A
Felix Lopez Arroyo	Environmental Contaminants Specialist/Technical input and draft document review/No project-specific role	USFWS	787-851-7297(x226)	felix_lopez@fws.gov	A		A
William Tucker	Technical Support Consultant for USFWS/USFWS contractor primary POC/No project-specific role	MACTEC	352-332-3318	watucker@mactec.com	A		A
Diane Wehner	Regional Resource Coordinator/Technical input and draft document review/No project-specific role	NOAA	732-872-3030	diane.wehner@noaa.gov	A		A
Brett Doerr	Contractor Environmental Manager/ Navy contractor primary POC	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	A	A	A
John Swenfurth	Project Manager	CH2M HILL	813-281-7762	John.swenfurth@ch2m.com	A	A	A
Stephen Brand	Field Team Leader	CH2M HILL	757-671-6211	Stephen.brand@ch2m.com			A
Monica Marrow	Administrative Record Coordinator	CH2M HILL	757-671-6272	Monica.marrow@ch2m.com			A
Mike Zamboni	Project Chemist	CH2M HILL	709-376-5301	mike.zamboni@ch2m.com			A
Nilo Ligi	Project Manager, POC at primary location.	TestAmerica	(916) 374-4427	Nilo.Ligi@testamericainc.com			HC
Laura Maschoff	Project Manager, POC at primary location	DataQual Environmental Services	(636) 330-1327	dataqual@charter.net			CD
TBD	Project UXO support manager	UXO avoidance TBD					
Roberta W. Britton	Not Applicable (N/A)	Restoration Advisory Board (RAB)	978-463-9660	bdbritt7@gmail.com		CD	
Michael P. Connelly Pagán	N/A	RAB	787-741-4442	mpcbieke@yahoo.com		A	
Michael Diaz	N/A	RAB	787-667-2804	diazmmdo@aol.com		CD	
Wanda Bermudez	N/A	RAB	787-435-2841	wbromero@yahoo.com		CD	
Colleen McNamara	N/A	RAB	787-380-2545	lacolina@hughes.com		A	
Stacie D. Notine	N/A	RAB	N/A	N/A		HC	
Jorge Fernandez Porto	N/A	RAB	787-726-2839	jfporto@onelinkpr.net		CD	
Hector Julian Camacho	N/A	RAB	787-741-8261	vieques357@yahoo.com		HC	
Lionel Sanchez	N/A	RAB	787-241-0063	sanchezcarambot@yahoo.com		HC	
Lirio Marquez D'Acunti	N/A	RAB	787-726-2839	liriomarquez@gmail.com		None	

A = All DF = Draft Final
CL = Cover Letter F = Final
CD = Compact Disc HC = Hard Copy
D = Draft

SAP Worksheet #4 — Project Personnel Sign-Off Sheet

Name	Organization/Title/Project Role	Telephone Number (optional)	Signature/email receipt	SAP Section Reviewed	Date SAP Read
Brett Doerr	CH2M HILL/Vieques Environmental Program Manager/ SAP review	757-671-6219			
Anita Dodson	CH2M HILL/Navy Program Chemist/ SAP review	757-671-6218			
John Swenfurth	CH2M HILL/Contractor PM/Logistics and administration	813-281-7762			
Mark Orman	CH2M HILL/Contractor Health and Safety Lead/Health and Safety officer	414-847-0597 414-712-4138 (cell)			
Vickie Weber	CH2M HILL/Environmental Information Specialist (EIS)/Data tracking and management	757-671-6252			
John Martin	CH2M HILL/ FTL/Ecological Risk Assessment Lead	352-384-7122 352-359-5717 (cell)			
Barrie Selcoe	CH2M HILL/Human Health Risk Assessment Lead	281-721-8527 713-392-8707 (cell)			
Paul Favara	CH2M HILL/ Program QA Officer	352-335-5877			
George DeMetropolis	CH2M HILL/UXO Safety Officer	619-687-0120 Ext. 37239			
Jake Crostic	CH2M HILL/ Vieques field auditor	757-671-6286			
Mike Zamboni	CH2M HILL/Project Chemist	709-376-5301			
Nilo Ligi	TestAmerica/Project Manager	916 374-4427			
Laura Maschoff	DataQual/Data Validator/Project Manager	636-330-1327			
TBD	TBD/UXO avoidance project manager				
Bhavana Reddy	Critigen Project/Data Manager	703-462-3784			
Stephen Brand	CH2M HILL/SSC/Field Team	757-671-6211			

Signed versions of Worksheet #4 will be kept on file at CH2M HILL along with other project documents.

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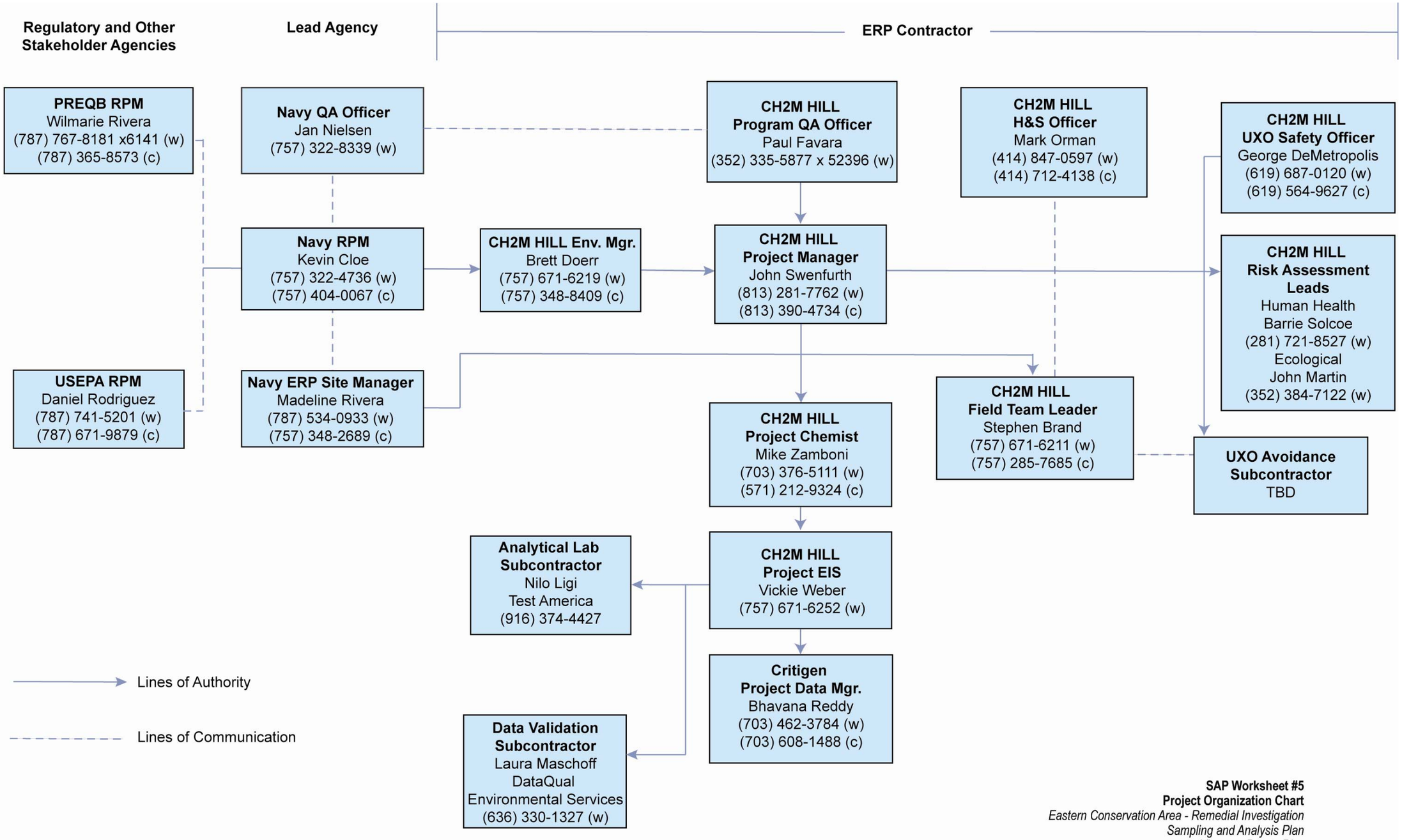
SAP Worksheet #5 — Project Organizational Chart



SAP Worksheet #5
Project Organization Chart
Eastern Conservation Area - Remedial Investigation
Sampling and Analysis Plan
Vieques, Puerto Rico

CH2MHILL

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SAP Worksheet #6 — Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Communication to/from Navy (e.g., submission of SAP for review; receipt of regulatory comments, etc.)	Navy RPM	Kevin Cloe	757-322-4736	Primary POC for Navy (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from USEPA (e.g., receipt of SAP for review; submission of USEPA comments)	USEPA RPM	Daniel Rodriguez	787-741-5201 787-671-9879 (cell)	Primary POC for USEPA (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from PREQB (e.g., receipt of SAP for review; submission of PREQB comments)	PREQB RPM	Wilmarie Rivera	787-767-8181 (x6141)	Primary POC for PREQB (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Communication to/from USFWS (e.g., receipt of SAP for review; submission of USFWS comments)	USFWS RPM	Richard Henry	732-906-6987	Primary POC for USFWS (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other internal or external points of contact.
Navy Quality Assurance (QA)/Quality Control (QC) input	Navy QAO	Janice Nielsen	757-322-8339	Provides review comments to Navy contractor on pre-draft SAP via e-mail through Kevin Cloe. Provides overall Navy guidance via direct communication with Navy contractor QAO, as warranted.
Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations, etc.)	CH2M HILL Environmental Manager	Brett Doerr	757-671-6219	Primary POC for Navy contractor (via e-mail, telephone, hardcopy, or in-person, as warranted); can delegate communication to other contractor staff, as appropriate.
Project administration and logistics	CH2M HILL PM	John Swenfurth	813-281-7762	Direct communication (via e-mail, telephone, hardcopy, or in-person, as warranted) to/from Navy contractor project staff to ensure appropriate project implementation.
Health and safety expectations and procedures	CH2M HILL Health and Safety Officer	Mark Orman	414-847-0597 414-712-4138 (cell)	Review of Health and Safety Plan (HASP). Direct communication (via e-mail, telephone, hardcopy, or in-person, will be notified within 24 hours of incident) to/from Navy contractor project staff to ensure implementation of appropriate health and safety procedures.
Implementation of sampling activities; SAP changes in the field	CH2M HILL FTL	Stephen Brand	757-671-6211 757-285-7685 (cell)	Documentation of deviations from work plan made in field logbooks and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; injection oversight and implementation; deviations made only with approval from contractor PM and/or environmental manager.
Field corrective actions	CH2M HILL FTL	Stephen Brand	757-671-6211 757-285-7685 (cell)	See Worksheet 32 Assessment Findings and Corrective Action (CA) Responses and Worksheet 32-1 CA Form.

SAP Worksheet #6 — Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Daily Field Progress Reports	CH2M HILL Field Team Leader (FTL)	Stephen Brand	757-671-6211	FTL will call to contractor PMs daily
Ensure staff health and safety in the field	CH2M HILL Site Safety Coordinator (SSC)	Stephen Brand	757-671-6211	Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff.
Data tracking from collection through upload to database	CH2M HILL EIS	Vickie Weber	757-671-6252	EIS will track data from sample collection through upload to database, ensuring QAPP requirements are met by laboratory and field staff. Tracking involves receipt of electronic and hardcopy data from laboratory and data validator. EIS communicates with CH2M HILL project chemist, laboratory PM, and data validator PM, as warranted, to ensure adherence to project analysis and validation requirements. EIS also coordinates data upload with contractor database manager.
Uploading project data and maintaining the database to ensure data are stored properly and can be retrieved by the EIS.	Critigen Database Manager	Bhavana Reddy	703-471-1441	Once contractor chemist ensures data are appropriate for upload to database, EIS submits data electronically to contractor database manager, who uploads data to database.
Reporting Lab Data Quality Issues	Laboratory PM (Testamerica Laboratories)	Nilo Ligi	916 374-4427	All QA/QC issues with project field samples will be reported by the lab to the EIS, Project Chemist, and Contractor QAO via e-mail within 2 business days.
Quality Control on Laboratory Data, release of analytical data for upload to database	CH2M HILL Project Chemist	Michael Zamboni	703-376-5301	See Worksheets 24, 25, and 28 for analytical CAs; Upon review of validated data to ensure adherence to project requirements, project chemist communicates via e-mail to EIS that data are ready for release (i.e., upload to database).
Technical Support and Reporting	CH2M HILL Senior Technologist	John Martin and Barrie Selcoe	352-384-7122 281-721-8527	Risk assessment leads, data evaluation, analysis, and reporting
Validated data	Data Validator PM (DataQual Environmental Services)	Laura Maschoff	636-330-1327	Data validator provides data validation reports (electronic and hardcopy) that provide the data qualifiers and associated explanations.
UXO avoidance	UXO avoidance subcontractor PM	TBD	TBD	Field avoidance of UXO, UXO safety while conducting field activities.

SAP Worksheet #7 — Personnel Responsibilities Table

Name	Title	Organizational Affiliation	Responsibilities
Kevin Cloe	Vieques RPM	Navy	Environmental restoration program (ERP) activities implemented under this SAP
Jan Nielson	QAO	Navy	Navy review of SAP and QA input
Madeline Rivera	Vieques ERP Site Manager	Navy	On-island Navy liaison; provides logistical support for implementation of environmental restoration program activities under this SAP
Brett Doerr	Environmental Manager	CH2M HILL	Responsible for ERP at Vieques; primary Navy contractor point of contact (POC); assists in data evaluation and interpretation; reviews report
John Swenfurth	PM	CH2M HILL	Project administration; coordinates staffing; monitors project performance; directs and oversees project staff
Barrie Selcoe and John Martin	Senior Technologists	CH2M HILL	As the technical leads, support human health and ecological risk assessments.
Anita Dodson	Program Chemist	CH2M HILL	Provides program level review and support of the UFP-SAP.
Mike Zamboni	Project Chemist	CH2M HILL	Establishes laboratory scope of work; ensures selected laboratory can meet project-required analytical protocol; primary communications with laboratory and data validator; performs data quality evaluation to determine availability of analytical data
Stephen Brand	FTL	CH2M HILL	Supervises sampling and coordinates field activities; ensures onsite compliance with work plan
Mark Orman	Health and Safety Officer	CH2M HILL	Responsible for overall Navy CLEAN program health and safety performance; reviews project-specific HASP; interacts with SSC to ensure project-specific safety of field personnel
Stephen Brand	SSC	CH2M HILL	Oversees and ensures safety of onsite personnel; responsible for use and completion of all field work related H&S paperwork
Vickie Weber	Environmental Systems Specialist	CH2M HILL	Manages sample tracking; coordinates assimilation of data from field collection through analysis, validation, and upload to environmental database; performs data queries for data evaluation and report writing
Bhavana Reddy	Database Manager	Critigen	Uploads validated data to environmental database
Dr. Doug Weir	Quality Assurance Manager, primary office	Testamerica Laboratories	Responsible for laboratory QA program and review of QC data
Dave Wunderlich	Quality Assurance Manager, Seattle satellite office	Testamerica Laboratories	Assist with laboratory QA program and review of QC data
Nasreen DeRubeis	Quality Assurance Manager, Pittsburgh satellite office	Testamerica Laboratories	Assist with laboratory QA program and review of QC data

SAP Worksheet #7 — Personnel Responsibilities Table (continued)

Name	Title	Organizational Affiliation	Responsibilities
Nilo Ligi	Project Manager, primary Point of Contact	Testamerica Laboratories	Laboratory POC and overall manager for analytical work
Terri Torres	PM, Seattle satellite office	Testamerica Laboratories	Manager Seattle satellite office
Tara Martz	PM, Pittsburgh satellite office	Testamerica Laboratories	Manager Pittsburgh satellite office
Laura Maschoff	Project Manager and Data Validator	DataQual Environmental Services	Responsible for validating analytical data in accordance with project-specific UFP-SAP
TBD	TBD	Investigation-derived Waste (IDW) Subcontractor	Responsible for transport and disposal of IDW deemed necessary for offsite disposal

1 Resumes are maintained by the individuals' organizations and are available upon request; upon execution of the project, staff may be removed (if unnecessary to project execution) and other staff may be added or substituted, as necessary and available.

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
Field activities	Hazwoper 40-hour Training, 8 hour refreshers, as applicable	Various qualified training organizations	Training of CH2M HILL and subcontractors will be verified as current prior to starting field activities by SSC	All field personnel	FTLs, field team members, and SSC (CH2M HILL personnel); IDW subcontractor; and soil removal subcontractor	CH2M HILL Human Resources Department for CH2M HILL personnel; subcontractor organizations for field subcontractors
Field activities	CPR/First Aid Training	Various qualified training organizations	Training will be verified as current prior to starting field activities	CH2M HILL SSC	CH2M HILL SSC	CH2M HILL Human Resources Department
Field activities	SSC-hazardous waste (SSC-HW) training	Various qualified training organizations	Training will be verified as current prior to starting field activities by SSC.	CH2M HILL SSC	CH2M HILL SSC	CH2M HILL Human Resources Department
Field activities	UXO Tech II or better training	U.S. Department of Defense	Training will be verified as current prior to starting field activities by SSC.	Subcontracted UXO Tech II or better	Subcontracted UXO Tech TBD	Subcontractors records and CH2M HILL field safety files

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SAP Worksheet #9a — Project Scoping Session Participants Sheet

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR					
Projected Date(s) of Sampling: January 2011				**Site Name:** Eastern Conservation Area	
PM: John Swenfurth				**Site Location:** Vieques, Puerto Rico	
Dates of Session: January 26 through 28, 2010 **Scoping Session Purpose:** Sampling purpose, CSM, samples and analysis to be completed, and data use.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Kevin Cloe	Vieques RPM	Navy	757-322-4736	kevin.cloe@navy.mil	Primary Navy POC
Chris Penny	NAVFAC Atlantic	Navy	757-322-4815	christopher.penny@navy.mil	Navy Vieques Coordinator
Daniel Hood	Vieques RPM	Navy	757-322-4630	daniel.r.hood@navy.mil	Navy POC for munitions related items
Pedro Ruiz	Vieques Site Manager	Navy	787-630-9881	pedroruizwork@gmail.com	Navy site coordinator
Stacin Martin	Senior Technical Advisor	Navy	787-322-4780	Stacin.martin@navy.mil	Navy additional POC for munitions related items
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Diana Cutt	Geology/Hydrogeology Lead	USEPA	212-637-4311	Cutt.diana@epa.gov	Technical input and review of geology/hydrogeology
Mindy Pensak	Ecological Risk Assessment Lead	USEPA	732-321-6705	Pensak.mindy@epa.gov	Review of ecological risk assessments
Tom Hall	MEC Support Contractor to EPA	TECHLAW			Technical input and review of munitions related items on behalf of EPA
Wilmarie Rivera	Vieques RPM	PREQB	787-767-8181 x 6141	wilmarierivera@jca.gobierno.pr	Primary PREQB POC.
Jim Pastoric	Technical Support Contractor to PREQB,	UXO PRO MEC			Technical input and review of munitions related items on behalf of EQB
Katarina Rutkowski	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC

SAP Worksheet #9a — Project Scoping Session Participants Sheet (continued)

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: January 2011	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: January 26 through 28, 2010 **Scoping Session Purpose:** Sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Phil Rury	Technical Support Contractor to PREQB, Ecological Risk Assessment Lead	TRC	978-656-3590	PRury@trcsolutions.com	Technical input and review of ecological risk aspects on behalf of EQB
Diane Wehner	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review/No project-specific role.
Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Tim Garretson	Munitions Response Lead	CH2M HILL	757-287-5222	timothy.garretson@ch2m.com	Address munitions related items
John Tomik	Activity Manager	CH2M HILL	757-671-6259	john.tomik@ch2m.com	Vieques Activity Manager
Brett Doerr	Environmental Manager	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	Navy contractor primary POC
John Swenfurth	Project Manager	CH2M HILL	813-281-7762	John.swenfurth@ch2m.com	Navy contractor project manager
John Martin	Ecological Risk Assessor	CH2M HILL	352-384-7122	john.martin@ch2m.com	Navy contractor lead ecological risk assessor
Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	281-721-8527	barrie.selcoe@ch2m.com	Navy contractor lead human health risk assessor
Felicia Arroyo	Vieques Site Manager	CH2M HILL	757-671-6205	felicia.arroyo@ch2m.com	If on the island may help with logistics at site
Tim Flood	Facilitator	TME	727-867-2610	tflood@me.com	Facilitator at meetings

Comments/Decisions: See meeting minutes from January 26, 2010 Environmental Restoration Program Technical Subcommittee Meeting below.
Action Items: See below
Consensus Decisions: See below

SAP Worksheet #9a — Project Scoping Session Sheet (continued)

Excerpt from the January 26 through 28, 2010 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (Final)

Brett outlines the objectives of the scoping session to the team: All stakeholders are on board with Why (why sampling), the CSM, the samples and analysis to be completed, and how the data will be used.

ECA RI SAP Scoping Session

The Navy and CH2M HILL completed an internal scoping session and reviewed applicable guidance (with internal experts) to pull together a "seed file" that will be useful in starting the team conversations for the ECA RI SAP.

Brett Displays the ECA RI Scoping Key Elements seed file pulled together by the internal scoping session for review and team discussion. Brett emphasizes that the document is merely to use as a discussion guide for the team.

CSM

Brett explains the CSM while the team follows along with the figure in the support materials.

The ECA is not considered a "bombing range", but some munitions were found in the ECA from overshooting the LIA. Danny Rodriguez comments that in the early 1970s, the ECA was briefly used as part of the LIA. Dan Hood comments that the ECA was briefly used as part of the LIA, but, was cleaned up in the early 1970s.

Source

The source is MEC and the release mechanism is either detonation or surface MEC that has deteriorated over time and released contents to the surface. Transport of contaminants is via surface runoff and leaching to GW and migration to the ocean. The ECA has a temporal lagoon and, therefore, does not likely receive groundwater discharge (at least not continually). Dan Hood comments that the LiDar survey did not find evidence of burial or targets in the ECA.

Discussion: Phil Rury asks if the receptors are strictly terrestrial. Brett Doerr answers "yes, other than the lagoon," and Dan Hood mentions that the open ocean water is a different unit of investigation.

[Brett] The ECA contains limestone and the bedrock is on the surface or within a few inches of the surface over much of the area. The lagoon is a unique environment (e.g., significant evaporites present), which may make it difficult to find a suitable environment for comparison (i.e., background sampling). The lagoon receives runoff and is dry part of the time.

Discussion: Katarina Rutkowski inquires about the lagoon. When it dries up, is the lagoon completely dry, does any moisture remain? Dan Hood comments that it becomes completely dry (i.e., can walk across it). John Martin adds that there are mangroves surrounding the edges of the lagoon in some areas. John Martin explains that land crabs are a possible receptor and can burrow to about 2 feet, which is why 2 feet in the vicinity of the lagoon is proposed for investigation. John Martin indicates that "yes, the area is important to birds when flooded. Phil Rury inquires if the evaporated dried up lagoon has a salt flat effect. Brett Doerr comments that yes, it is a salt flat type of effect.

SAP Worksheet #9a — Project Scoping Session Sheet (continued)

The team concurs that the sampling of the lagoon will be done when it is inundated so that surface water and sediment can be collected.

Discussion: Diane Wehner stated that where it is evident that surface water is running off should possibly consider targeting sampling. The Team clarified that the "offshore waters" will not be sampled as part of the ECA RI and is a different unit, not part of the ECA UXO Site. Dan Hood and John Tomik add that there is no evidence that the ECA was used for anything specific other than for the short period of time during the 1970s as part of the LIA. Kevin Cloe included that there was one point in the ECA that contained batteries from when batteries were changed out in the light tower. Dan Hood clarified that the reef and cliffs do not allow for boat landing.

Discussion: Katarina Rutkowski – is there a potential for the presence of white phosphorous (WP)? Tim Garretson explains that only one item containing WP (M 23) was encountered in the LIA, which is used to ignite napalm. There were no projectiles with WP found in the ECA. John Tomik indicates that all documentation shows that all the targets were in the LIA during the 60s and 70s and that the ECA was not used as a target area.

Brett continues with the relevant physical characteristics from the ECA RI Scoping Key Elements

Dan Hood/Brett adds that the ECA is predominantly limestone with solution cavities in the rock.

Human Receptors (CSM)

[Brett] Trespassers are not likely in the ECA because of the difficulty of trespassers to get to the ECA. A boat cannot readily land due to the reef, scarps, and cliffs, so a trespasser would likely have to come through the LIA to get to ECA.

Danny Rodriguez explains that there is an opening to the ECA from the West side and poachers can get in. Dan Hood indicates that due to the reef and currents, the chances of landing a boat are slim Stacin Martin indicated that no land crab traps have been found in the ECA, but have been found in the LIA. . Brett Doerr explains that the primary human receptors are FWS personnel and the Coast Guard when inspecting and repairing the light tower. Rich Henry adds that the beaches will be monitored by FWS for turtles and that internal areas of the ECA will be visited infrequently (possibly for herpetology studies). Rich Henry indicates that the human receptors for the ECA should strictly be law enforcement and natural resource activities (USFWS), not visitors.

The Team consensus on the trespassers is "Yes" that they will be considered an exposure receptor, at least qualitatively.

Rich Henry indicates that USFWS is monitoring the beaches for sea turtle activity in order to relocate if needed.

Dan Hood explains the light house does not house any facilities, is simply a light beacon on a pole.

Brett summarizes the conceptual human receptors to the team. The team agrees that no decisions on human receptors on the CSM will be made until after the site visit.

[Brett] Conceptually, ecological receptors would be land crabs around the lagoon and sea turtles on the beaches. Based on that, it is proposed that 0 – 2 "will be sampled for "upland" terrestrial receptors, but that the areas along the lagoon and beaches will be investigated to 2 feet (lagoon area) and 3 feet (beach area), where possible.

SAP Worksheet #9a — Project Scoping Session Sheet (continued)

Rich Henry indicates that nesting birds are probably not a receptor, but, birds that use the lagoon and probe in the mud may need to be considered. Dan Hood explains that the physical characteristics of the site will depend on how deep a sample can be collected. Rich Henry explains that most of the area is exposed bedrock with a thin organic overlay. Diane Cutt and Mindy Pensak inquire why sampling is from 0 – 2" when "standard' sampling for surface soil is deeper. Brett responds that MIS sampling procedures are to sample to 2."

Team Suggestions on the CSM

Michael Sivak – suggests adding ingestion of land crabs and sea turtle eggs to CSM

Diane Wehner – do not rule out aquatic receptors (fish could be a potential receptor)

Diana Cutt- consider groundwater seepage along the cliffs (nesting birds along the cliffs) if present?

Proposed Sampling Protocol

[Brett] MIS for surface soil because is widely recognized as appropriate for characterizing ranges. Data from discrete sampling locations are not as reproducible.

Discussion: Diane Wehner suggests that the team get the EPA training module on MIS. Diane poses the question: If HHRA normally uses discrete sampling, does MIS provide a data set that risk assessors can use? Brett explains that when considering the various types of sampling approaches, the best option may still be MIS and not discrete sampling because of the release mechanisms (not sure exactly the location where a release might have occurred). MIS is likely to find the contamination and average concentrations are then used in the risk assessments. The key is to define the decision appropriately. The combination of appropriate decision units and sampling units (if smaller than the decision units) should provide the level of comfort that the results can be used for characterization and for risk assessments. Diane asked that if the explosives will be characterized with MIS, will the metals be as well. Brett indicates that the conceptual model shows that the release mechanisms are the same, so, sampling can be the same for metals. John Tomik adds that it is impossible to go back and identify discrete locations of where munitions were detonated because only fragments remain. Although discrete locations of some of the larger MEC items that were removed from the ECA were recorded, smaller items were consolidated so specific locations are not available. Dan Hood adds that the GPS coordinates of the items are not accurate enough (could be accurate to about 6 feet) to find the exact locations for discrete sampling. Dan Hood indicates that Hawaii and Alaska have done MIS sampling and it has progressed over the past 3 – 4 years and the Navy has internal guidance on the MIS technique. Michael Sivak indicates that MIS has not been approved on any other site he is familiar with, and does not have a lot of experience with the technique and agrees there is possibly value with the technique, but, would need more information to accept it. Barrie Selcoe explains that triplicates are collected at a rate of 10% and the standard deviation is calculated. Each decision unit has 30 – 50 samples that are composited to make up one sample. Michael Sivak asks Barrie if multiple composite samples are being collected for each exposure area. Barrie answers possibly, if each exposure area (decision unit) contains multiple sampling units.

SAP Worksheet #9a — Project Scoping Session Sheet (continued)

Katarina indicated that a study out of Arizona showed low recovery of explosives using the MIS technique. Arizona DEQ was not certain of the cause, but suspected grinding of the sample.

It was concurred that the various agencies will upload available information regarding the use of MIS to the Vieques website to help reach consensus on sampling approach.

Background Sampling Approach

Discussion: Brett explains that if the MIS approach is used, the existing background dataset is not sufficient because those samples are discrete samples. Additionally, the ECA is a unique geology and may not be present elsewhere on the island. For this reason, it is proposed that the background dataset be collected in the ECA, in areas where there were no items found. Outlier tests can be used to help minimize the likelihood of using any samples affected by past releases. Danny Rodriguez suggests that Puerto Ferro may be similar to the ECA. Chris Penny adds that we want to develop an approach that can be consistently applied to the other east Vieques areas that will be investigated. Brett adds that site specific background would be an ideal situation. The LIA and ECA are similar lithologically, so it is possible to use the same dataset for both of those areas. Diana adds that there is always an unknown, and, if another similar area can be found, that would be best. Brett agrees that the team should look to find other locations with similar geologic settings like the ECA, noting that if it cannot be found, the team will have to determine how metals can be considered. Katarina asks if we can look at relative ratios of certain metals from the existing background dataset and then do the same on the dataset collected during the ECA RI (if collected within the ECA) to support its use as background

Danny Rodriguez- reservations about using background within the ECA; it may be tough for people to be convinced that it has not been impacted. Puerto Ferro has similar areas that should be considered for background.

Mindy- marine sedimentary rock, how unique is that to the island? Bill Hannah explains that a fault line runs across the area and limestone is predominant in the ECA and LIA, but not common elsewhere.

Team suggests taking a closer look at the geology across Vieques to see if there are areas similar to the ECA. Brett poses the question to the team: For the lagoon, how will we distinguish metals concentrations attributable to releases from those attributable to background when the lagoon is such a unique environment (temporal, evaporite), so we may not be able to find suitable background sampling locations? Dan Hood adds that there are no other comparable lagoon environments that can represent background. Danny Rodriguez suggests looking into salt flats at Puerto Ferro. Brett asks the team: What is the alternative if we cannot find a suitable background location? The question remained outstanding until we can do additional evaluation of potential background areas.

Brett – We should keep in mind that while trying to convince the public that acceptable background data were found in the ECA may be tough, it is better to have to do that than to use an inappropriate background dataset.

John Martin asks if there are beach background data. Brett answers no; background MIS will need to be performed on the beaches as well to get background.

SAP Worksheet #9a — Project Scoping Session Sheet (continued)

Proposed Decision and Sampling Units

Brett reviews the decision and sampling units concept. Decision units defined based on exposure scenarios, focusing on areas of suspected contamination (i.e., both high density of anomalies and covering the range of munitions items that were found). The size of the decision units will vary by human receptor and ecological receptor and will be some multiple of the 100 x 100 ft grids used for the MEC removal. The sampling units may be the same as the decision units or smaller, if more samples per decision unit are necessary.

Proposed Analytical Protocol

Based on contaminant sources, it is proposed that samples be analyzed for explosives by Method 8330B and 8332 (PETN and nitroglycerin) and metals.

There is a concern that the grinding process inherent to the MIS method can introduce metals into the sample. It can also bias high the results due to changing the grain size.

Dan Hood notes that in EPA's Method 8330B, the grinding is done to yield the most homogenous sample and make the results statistically reproducible.

Action Items

CH2M HILL – add the battery pile location to the CSM for the ECA

CH2M HILL – provide MIS guidance to team (Alaska, Hawaii, others) by uploading to Vieques website.

TEAM – after site visit, reconvene on conference call with other ideas for MIS approach and background locations.

CH2M HILL – look back into the geology of the previous background samples to see if any of these areas may be suitable for the ECA background. Also look into the geology of the LIA, SIA, and EMA for future work.

CH2M HILL – look into the most prevalent metals contained within the munitions items found in the ECA

TEAM – Conference call or meeting to get concurrence of sampling procedures (after site visit and individual research)

Katarina – provide more information on MIS sampling conducted in Arizona by contacting ADEQ.

CH2M HILL – provide US Army Corps MIS Guidance (2009) to team for review

USFWS – Determine if beaches are still viable turtle nesting habitats.

CH2M HILL - look along the cliffs to see if there are seeps present and provide observational and technical information in SAP to justify how handled.

CH2M HILL – Create subdirectory on Vieques website to allow various agencies to upload MIS-related guidance or studies

TEAM - Set up second scoping session.

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SAP Worksheet #9b — Project Scoping Session Participants Sheet

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: January 2011	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: February 11, 2010 **Scoping Session Purpose:** Reasonable Maximum Exposure (RME) Scenarios for Fish and Wildlife Service Workers.	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Barrie Selcoe	Human Health Risk Assessor	CH2M HILL	281-721-8527	barrie.selcoe@ch2m.com	Navy contractor lead human health risk assessor
Michael Sivak	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Katarina Rutkowski	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC

Comments/Decisions: See below
Action Items: See below
Consensus Decisions: See below

SAP Worksheet #9b — Project Scoping Session Participants Sheet (continued)

On February 11, 2010, a teleconference was held to discuss the draft memo sent by Richard Henry on February 2, 2010 entitled *"Draft Human Health Risk Assessment Scenarios and Exposure Model Parameters for Fish and Wildlife Service Workers in the Eastern Conservation Area"* (Appendix C). Prior to the conference call, Richard indicated in the February 2, 2010 email to USEPA that the memo summarized statements made by FWS during the site reconnaissance on January 27, 2010, and was a starting point for HHRA discussions regarding the tasks and exposure parameters for the HHRA. The memo presents what the FWS is required to do based on their mission in terms of natural resource management and restoration, and activities and tasks may be added or changed as additional data are gathered and funding is obtained.

The issues discussed and conclusions reached by all attendees are summarized below:

There are 5 general exposure areas for FWS workers:

Beaches (from the shoreline to 20 meters inland from the vegetation edge)
Highland (where evergreen scrub is present)
Lowland (where forest scrub is present, near the lagoon)
Lagoon (lagoon plus 10 meters inland)
Site-wide ECA (general exposure areas 1 through 4)

The specific activities performed within each exposure area can be grouped to address the RME scenario for FWS workers in that exposure area.

Beaches – Current/future FWS workers perform sea turtle monitoring; appropriate RME exposure factors for soil are:

exposure time (ET) = 6 hours/day
exposure frequency (EF) = 3 days/week
exposure duration (ED) = 10 months/year for 25 years

Highland – Future FWS workers will perform dry forest restoration (surveying/monitoring/planting); appropriate RME exposure factors for soil are:

ET = 10 hours/day (surveying/monitoring) plus 10 hours/day (planting)
EF = 5 days/week (surveying/monitoring) plus 5 days/week (planting)
ED = 2 weeks/year for 25 years (surveying/monitoring) plus 6 weeks/year for 5 years (planting)

Lowland – Future FWS workers will perform forest restoration (surveying/monitoring/planting); appropriate RME exposure factors for soil are:

ET = 8 hours/day (surveying/monitoring) plus 8 hours/day (planting)
EF = 3 days/week (surveying/monitoring) plus 3 days/week (planting)

ED = 1 week/year for 25 years (surveying/monitoring) plus 3 weeks/year for 5 years (planting)

Lagoon – Current/future FWS workers perform migratory waterfowl surveying & monitoring; appropriate RME exposure factors for soil, sediments, and surface water are:

ET = 4 hours/day
EF = 3 days/week
ED = 4 months/year for 25 years

SAP Worksheet #9b — Project Scoping Session Participants Sheet (continued)

Site-Wide ECA – Current/future FWS workers perform wildlife surveying & monitoring; appropriate RME exposure factors for soil (site-wide) and sediment and surface water (in the lagoon) are:

ET = 10 hours/day
EF = 2 days/week
ED = 4 months/year for 25 years

Current/future FWS workers also perform law enforcement activities; however, the exposure factors (ET, EF, ED) for law enforcement activities are minimal compared to the exposure factors used for the FWS scenarios that will be quantified in the HHRA and therefore do not warrant separate quantification.

A cumulative exposure scenario (summing general exposure areas 1 through 5) will be presented in the HHRA to represent hypothetical FWS workers who may be involved in all activities. Prior to adding the risk estimates for this hypothetical FWS worker group, the exposure time, frequency, and duration for all activities combined should be checked to ensure that a typical work schedule (e.g., approximately 250 days per year) is not exceeded.

Richard stated that FWS workers in all areas (general areas 1 through 5) are required to wear a Health & Safety Level D work uniform; only the lower arms, hands, and face will be exposed; these body parts should be addressed for dermal exposures in the HHRA.

FWS workers will use hip waders and/or kayaks to enter the lagoon; contact with surface water and sediment can occur from touching the kayak bottom, oars, and wader boots.

An Executive Order designated the ECA as a Wilderness Area and as such, public access is barred (and consequently, a recreational use scenario does not need to be evaluated); Richard will provide a copy of the Executive Order.

The area near the Coast Guard light pole where the used batteries were disposed should be addressed as a separate exposure area in the HHRA if data from that area indicate different concentrations/constituents from the remaining areas of the ECA.

Based on the conversations today, CH2M HILL will prepare draft RAGS D Tables 1 and 4 for presentation at the technical subcommittee meeting on March 10 and 11, 2010.

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SAP Worksheet #9c — Project Scoping Session Participants Sheet

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: January 2011	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 3, 2010 **Scoping Session Purpose:** Ecological Receptors Conference Call	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Richard Henry	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC, technical input and draft document review
Phil Rury	Technical Support Contractor to PREQB, Ecological Risk Assessment Lead	TRC	978-656-3590	PRury@trcsolutions.com	Technical input and review of ecological risk aspects on behalf of EQB
Diane Wehner	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review
John Martin	Ecological Risk Assessor	CH2M HILL	352-384-7122	john.martin@ch2m.com	Navy contractor lead ecological risk assessor
Bill Kappleman	Ecological Risk Assessor	CH2M HILL	703-376-5152	William.kappleman@ch2m.com	Navy contractor ecological risk assessor
Mindy Pensak	Ecological Risk Assessor	USEPA			EPA ecological risk assessor
Stan Powell	Ecological Risk Assessor				Technical support to USEPA on the ecological risk assessment
Felix Lopez	Site Manager	USFWS			Site manager for USFWS
Daniel Rodriguez	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC

The scoping session included discussions of the potential ecological receptors and the “strawman” risk assessment information included in **Appendix D**. The draft “strawman” was provided ahead of the meeting. Following the meeting the discussed changes were incorporated into the “strawman” and reviewed for approval at the March 10, 11 2010 meeting. See March 10, 11 2010 meeting minutes for details.

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SAP Worksheet #9d — Project Scoping Session Participants Sheet

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: January 2011	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 10, 11, 2010 **Scoping Session Purpose:** Concurrence on sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Dates	Title	Affiliation	Phone #	E-mail Address	Project Role
Kevin Cloe	3-10&11	Vieques RPM	Navy	757-322-4736	Kevin.cloe@navy.mil	Primary Navy POC
Daniel Hood	3-10&11	Vieques RPM	Navy	757-322-4630	daniel.r.hood@navy.mil	Navy POC for munitions related items
Stacin Martin	3-10&11	Senior Technical Advisor	Navy	787-322-4780	Stacin.martin@navy.mil	Navy additional POC for munitions related items
Daniel Rodriguez	3-10&11	Vieques RPM	USEPA	787-741-5201 787-671-9879 (cell)	Rodriguez.daniel@epamail.gov	Primary USEPA POC
Michael Sivak	3-10&11	Human Health Risk Assessment Lead	USEPA	212-637-4310	Sivak.michael@epa.gov	Technical input and review of human health risk evaluation
Wilmarie Rivera	3-10&11	Vieques RPM	PREQB	787-767-8181 x 6141	wilmarierivera@jca.gobierno.pr	Primary PREQB POC.
Katarina Rutkowski	3-10	Technical Support Contractor to PREQB, Human Health Risk Assessment Lead	TRC	860-298-6202	krutkowski@trcsolutions.com	Technical input and review of human health risk aspects on behalf of EQB; Primary TRC POC
Phil Rury	3-11	Technical Support Contractor to PREQB, Ecological Risk Assessment Lead	TRC	978-656-3590	PRury@trcsolutions.com	Technical input and review of ecological risk aspects on behalf of EQB
Diane Wehner	3-10&11	Ecological Risk Assessor	NOAA	732-872-3030	Diane.wehner@noaa.gov	Technical input and draft document review/No project-specific role.

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

Project Name: Remedial Investigation Sampling, Eastern Conservation Area, Former VNTR	
Projected Date(s) of Sampling: November 2010	**Site Name:** Eastern Conservation Area
PM: John Swenfurth	**Site Location:** Vieques, Puerto Rico
Dates of Session: March 10, 11, 2010 **Scoping Session Purpose:** Concurrence on sampling purpose, CSM, samples and analysis to be completed, and data use.	

Name	Date	Title	Affiliation	Phone #	E-mail Address	Project Role
Richard Henry	3-10&11	Vieques RPM	USFWS	732-906-6987	Richard_henry@fws.gov	Primary USFWS POC/No project-specific role
Brett Doerr	3-10&11	Environmental Manager	CH2M HILL	757-671-6219	brett.doerr@ch2m.com	Scope development and technical review. Primary CH2M HILL POC.
Bill Hannah	3-10&11	Project Manager	CH2M HILL	757-671-6277	bill.hannah@ch2m.com	Project Management
John Martin	3-10&11	Ecological Risk Assessor	CH2M HILL	352-384-7122	john.martin@ch2m.com	Technical input and review.
Barrie Selcoe	3-10&11	Human Health Risk Assessor	CH2M HILL	281-721-8527	barrie.selcoe@ch2m.com	Technical input and review.
Stan Powell	3-10&11	Ecological Risk Assessor				Technical input and support to USEPA on the ecological risk assessment
Sergio Lopez	3-10&11	EPA Quality Assurance	USEPA			USEPA QA review
Mindy Pensak	3-10&11	EPA Ecological Risk Assessor	USEPA			USEPA ecological risk assessment

Comments/Decisions:.
Action Items: See below.
Consensus Decisions: See below.

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

Excerpt from the March 10-11, 2010 Environmental Restoration Program/ Munitions Response Program Technical Subcommittee Meeting Minutes (DRAFT)

ECA RI Sampling Approach – Scoping Session

Brett Doerr reviews the agenda, discusses the objectives of the scoping session, and walks the team through the updated seed file.

Conceptual Site Model Elements

The team briefly revisited the CSM elements. Brett added the list of explosive constituents analyzed using EPA Method 8330B. A list of potential munitions constituents associated with the items found at the site was passed around.

Sample Media

The team had discussions on characterizing groundwater at the site. Michael Sivak had a discussion with Diana regarding groundwater at the site and the potential for seepage through the cliffs, and whether it was necessary to characterize groundwater in the lowland area. Brett responded that LUCs will be in place for the site because of the potential presence of munitions, which means this site cannot get a no further action with unrestricted use designation. Further, no industrial or residential use of the ECA will be allowed because of legislation (the Congressional Order designating the ECA as a Wilderness Area), and groundwater can only discharge to the ocean or potentially the lagoon. Therefore, no additional institutional control is needed to restrict its use. Michael added the site will require a Five Year Review because it will not get a no further action with unrestricted use designation. He also questioned whether there is an ARAR for groundwater that requires it to be characterized. He noted that it is not the typical case to require institutional controls without having characterized the affected media. Katarina Rutkowski asked if a phased approach could be used, and evaluate groundwater if we find contamination in soil. Brett responded that this scenario was brainstormed (including surface water/sediment), but would like the team to continue to consider the unique circumstances that exist and will continue to exist at the ECA. Michael said that he needs to discuss with the EPA attorney (Jim Doyle) for Vieques regarding the groundwater designation at the ECA. Michael indicated that it is EPA's preference to sample all media in most cases, and the SAP should provide rationale for why groundwater is not being sampled in this round. Brett indicated that we will look at soil data, weathering, and degradation issues for the detected constituents, and a decision tree will be included in the SAP indicating the path to characterizing or not characterizing groundwater. Brett also stated that the cliffs are limestone, and there is Karst terrain; during the ECA site visit, the cliff faces were observed in several areas and no evidence of seeps was observed. Wilmarie Rivera said that she will need site data to receive buy-off from her superiors to not characterize groundwater.

Consensus – Proceed with preparation of the SAP and do not include groundwater as a medium to be characterized (at least in the initial phase of study). The rationale for when/why groundwater will or will not be characterized will be included.

Sampling Method

Brett asked the regulators if they had looked into multi-incremental sampling (MIS) and come to consensus on its applicability. Michael responded that he, Doug Maddox (EPA Federal Facilities Restoration and Reuse Office [FFRO]), Mary Cook (FFRO), and Dina Crumbling (EPA Office of Solid Waste and Emergency Response) had a conference call and discussed MIS in detail, and they

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

learned that MIS is typically used for analysis of explosives only, and not for other constituents. Michael added that they know of another sampling approach that could help discrete samples for the other parameters (i.e., metals) may be considered in addition to the MIS for explosives. Michael stated that he couldn't find any other sampling options besides discrete and MIS. Michael indicated that a phased approach to sampling could be conducted: first sampling using MIS for explosives, and then discrete sampling targeting areas for metals if explosives MIS data indicate the need. Rich Henry stated that from his understanding of the guidance documents, MIS could be used for the analysis of metals, and the samples do not need to be ground. He added that the samples could be split for explosives (grinding) and metals (no grinding). If the samples for metals are ground, since the soil sample is ground to a fine-grain, the metals results will provide a more conservative concentration. Katarina followed up with Alaska and Arizona project managers that had implemented MIS. She said that for the project where grinding contaminated the sample with metals (discussed in the January 26, 2010 meeting in San Juan), the lab (TestAmerica) had left the stainless steel grinder operational over the weekend (i.e., longer than appropriate) and chromium had been introduced into the sample. Two other options were discussed: (1) Grinding all samples and excluding those metals from the analysis that could be introduced by the grinder and (2) Grinding all samples, but using a non-metallic grinder, if available. Michael will have follow-up discussions within EPA and provide feedback to the team.

Decision Units

Brett presented a plot size conceptual sampling approach map for the ECA. Five decision units were selected based on receptor type and land cover: upland, lowland, lagoon, lagoon fringe, and beach. Within each decision unit, sampling units were selected based on receptor exposure area, and type and number of MEC items encountered. The team had further discussions on the rationale for selection of the decision units and sampling units, and on how the sampling unit data would be used in the risk assessment evaluation.

Rich stated that the approach presented is a really good starting point on the development of the sampling approach at the site. Danny Rodriguez asked whether the items found were low order, high order, cracked, etc., and if these details were recorded in the database. Stacin answered that only some of this information was included. He also added that the munitions items found were older munitions (pre-1970s), since the site was avoided when it was established as a conservation area. Dan Hood indicated that the lagoon may have historically been used for bomb consolidation. Danny asked about what we would do for the areas that were not covered as part of the ECA removal action. Stacin added that there is only one small area (<1 acre) to the southeast of the turtle nesting area and access to this area is difficult because of the steep cliff in the area. Danny added that it was most likely covered by the aerial magnetometer survey. Dan Hood responded that the aerial magnetometer survey fly-over only evaluates target areas and high density areas, and cannot identify individual items smaller than a drum.

Rich asked for an inventory of items found in each sampling unit to justify why the sampling unit was picked. Rich stated that solely scrap metal locations should not be selected as sampling units. After the team reviewed the sampling approach map, they noted that the map included munitions, munitions-related scrap, and non-munitions-related scrap and that the sampling units were based on the number and location of all three. It was concurred that the map should be reproduced to exclude the non-munitions-related scrap and the sampling units redrawn based solely on munitions items and munitions-related scrap. It was further noted that the sampling units will not

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

include the roads, and that a discrete sample will be collected at the "lighthouse" battery disposal area instead of MIS due to its small size (less than 5 square feet). The draft sampling units will be re-evaluated to consider spatial distribution, high density munitions items, the range of munitions items, and munitions-related scrap. It was further determined that the sampling units do not need to be made up of four contiguous grid cells.

The team then discussed the number of soil sample increments that would need to be collected per sampling unit. Michael added that 100 increments are currently being collected at an industrial site in Region 4 (Florida site). Barrie Selcoe asked what size the decision unit for that site was, and Michael said he did not know. Rich added that a range of 30 to 100 increments are mentioned in the Army Corps of Engineers (ACOE) guidance, and that a higher number is selected for highly variable decision units. If there is no knowledge of the variability, 30 to 100 is a good range for energetics. Rich stated that he expects a high degree of variability. Michael added that he would be comfortable if we collected the number of increments near the higher end of that range, such as 70-75 increments, but agreed that we should calculate the target number of increments using the equation in the ACOE guidance (which is dependent on the size of the core sampler and mass needed by the lab). Rich added that since we do not know the chemical variability at the site, he would be comfortable near the higher end of the range as well.

Stacin added that collecting a smaller plug sample (1 cm in diameter) would facilitate collecting more increments. The group discussed that a certain sample mass is needed to pass through a 2 mm size (#10 sieve); Brett stated that the sieving and drying would be performed by the lab. Dan indicated that sticks/rocks/grass from each increment would be included in the sample. Katarina asked if we could identify areas where the sample core method would and would not work. Brett indicated that the field staff will perform a test-run of the proposed sampling methods while the SAP is being prepared so that a feasible sampling approach(es) can be included in the SAP. Rich answered that the key for this sampling approach is to be consistent on the sampling method, but either a trowel or a sample corer can be used. Rich added that the sample mass has to be sufficient to meet the analytical requirements (e.g., 500 grams is 170 increments).

Consensus – The team agreed to attempt to follow the prescriptive approach provided in the ACOE guidance to calculate the appropriate number of increments required.

Action Item - CH2M HILL will attempt to collect core samples during the SAP development to confirm that the core sampling method will work at the site.

The team then went into detailed discussions on the number of QA/QC samples required. Barrie mentioned that the guidance documents say that at least one sampling unit needs to have a triplicate. Sergio Lopez responded that 5 to 10% QA/QC would be required for each decision unit. The team then had detailed discussions on how to analyze replicate results and what to do with the calculation of the standard deviation. Brett added that the target data validation 30% standard deviation may not be applicable in areas with really low concentrations, and as a group we should accept that 30% is not a pass/fail criterion due to the analytical/natural variability, especially at low concentrations. For example, 1 ppm vs 2 ppm can be a 100% difference, but the concentrations are for all intents and purposes the same.

Consensus – Triplicate samples will be collected at a 10% frequency per decision unit. Replicate samples will only be used to evaluate the analytical variability within one sampling unit for QC purposes (not to calculate an upper confidence limit [UCL] on the mean concentration). The maximum concentration of the three samples will be used to represent the analytical results from

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

that sampling unit. ProUCL software will be used to calculate the 95% UCL on the mean for MIS results in each decision unit, even when there are only 2 sampling units in the decision unit.

The team then had discussions on background samples. Background soil samples will be collected using MIS in the same lithologic unit as that in the ECA that was sampled during the East Vieques background study. If ECA samples are ground for metals analysis, background samples will need to be ground too.

Brett proposed that since we do not have a background comparison for the lagoon, the team should consider not analyzing for metals at the lagoon. An alternative could be conducting biological community sampling to determine if a natural community exists in this lagoon, considering its unique characteristics of frequent drying and high salt content. We could also consider just looking for explosives initially and then base any future sample analysis on the explosive results. Michael suggested we consider the feasibility of analyzing samples for metals and looking at a ratio comparison. The team then had further discussions on how the metals data could be evaluated. NOAA/EPA/EQB would prefer to analyze the lagoon for metals. Brett continued to point out that if we cannot as a team come up with a certain ability to distinguish metals concentrations present as a result of contamination from metals concentrations present from natural conditions, we should not be analyzing the samples for metals.

Human Health Receptors and Exposure Pathways

Barrie led the discussion and presented the RAGs Tables 1 and 4. Michael indicated that our discussion of the 0-2 inch surface soil being representative of 0-1 foot is a site-specific application since subsurface soil is not present everywhere and activities at depth occur at a low frequency for Fish and Wildlife Service (FWS) workers, and would need to be re-evaluated for other sites such as the LIA. The team then walked through the receptor scenarios/exposure frequency for each decision unit. Table 1 presented the exposure pathways and Table 4 presented the exposure frequency, etc. for each receptor as discussed during the human health risk assessment conference calls.

Consensus – All soil profiles for the highland area will be characterized by the 0-2 inch surface soil MIS samples. Clarification will also be added to describe that this is a site-specific decision.

The team then discussed subsurface soil samples at the lagoon fringe and beach area. Katarina asked if we are collecting deeper surface soil samples within the lagoon fringe for the land crab, then why are we not collecting deeper surface soil samples in the lowland area for human receptors. Dan responded that the surface soil sample results would be the worst-case scenario. The team then had further discussions on the lowland area.

Consensus – The team decided that only surface soil MIS samples would be collected in the lowland area. The MIS results from each sampling unit will be compared to adjusted Regional Screening Levels (RSLs). The team will regroup to discuss results of the individual sampling unit comparisons, how data should be grouped, and the appropriate path forward.

Consensus –RAGS Table 1 will be modified to indicate that a qualitative analysis will be included for the trespasser scenario instead of indicating "none" and to add references to the specific worker types identified in Rich's exposure memorandum (dated February 4, 2010). Barrie will schedule a conference call with Michael and Katarina approximately 2 weeks after they have reviewed the revised RAGS D Tables 1 and 4.

For the battery disposal area, the team discussed comparing the data to adjusted RSLs and based on the results, possibly removing the soil rather than completing a full risk assessment.

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

Kevin Cloe asked the team if we have evaluated too many FWS worker exposure scenarios for the site. Katarina and Michael responded that if detailed exposure information is available, then you use this information in a HHRA; therefore, there are not too many.

ECA RI Sampling Approach – Scoping Session

Ecological Receptors and Exposure Pathways

John Martin led the discussion and presented the target wildlife receptors to be evaluated in the ERA, as previously discussed with the eco risk team during two conference calls. Two endangered species were identified as potentially occurring at the site (brown pelican and roseate tern). John discussed the general terrestrial habitat conditions, and summarized the terrestrial wildlife target receptors as follows:

Fruit bat - terrestrial mammalian herbivore

Velvet free-tailed bat - terrestrial mammalian invertivore

Norway rat -- terrestrial mammalian omnivore

Indian mongoose -- terrestrial mammalian omnivore

Common ground dove – terrestrial avian herbivore

Pearly-eyed thrasher - terrestrial avian omnivore

Cave swallow – terrestrial avian insectivore

Red-tailed hawk - terrestrial avian carnivore.

Mindy Pensak added that the fruit bat was not identified at the site from the previous assessments, but will be evaluated as a conservative measure. The team had further discussions on evaluation of ecological risk nuisance and invasive species (i.e., mongoose and Norway rat).

Consensus – The Norway rat and Indian mongoose will be evaluated in the ecological risk assessment (ERA) not for intrinsic risk, but for the risk to higher order predators that may feed on these two species since they are a part of the food chain and can be eaten by other animals (i.e., red-tailed hawk). The team will make a risk management decision for these species should potential risk be identified in the ERA.

The team had discussions that the lagoon historically has not been connected to the ocean since at least 1937 (based on aerial photos). John added that the vegetation line within the lagoon has been retreating at the site, even before the Navy was involved at the site. He believes that this is related to the increasingly hypersaline condition of the lagoon. Dan stated that the lagoon dries up each year, that no fish were seen in the craters of the lagoon this year (the craters are the last areas of the lagoon to dry), and that you can see an encrusting layer of salt across the lagoon when it dries. This is why the lagoon is such a unique environment and finding suitable background may not be possible.

The team discussed the potential aquatic receptors at the site. John identified the aquatic target receptors as follows:

- Fishing bat - terrestrial mammalian piscivore
- Velvet free-tailed bat - terrestrial mammalian invertivore

SAP Worksheet #9d — Project Scoping Session Participants Sheet (continued)

- Cave swallow – terrestrial avian insectivore
- Green heron - aquatic avian invertivore/piscivore
- Spotted sandpiper – aquatic avian invertivore
- White-cheeked pintail – protected aquatic avian herbivore

Michael stated that a qualitative evaluation of land crab ingestion at the site should be added to RAGS D Table 1, and the percent of a person's diet due to the inaccessibility of the site should be indicated.

The ERA will evaluate the upland and lowland sampling units combined together for the terrestrial receptors. At the beach, two MIS sampling units and two discrete samples from 18 to 24 inches will be collected. The discrete samples will be placed at historical turtle nest sites (not active nests), using existing location records. The team discussed how the data would be evaluated.

Consensus – The MIS and discrete samples collected at the beach generally will be evaluated as separate exposure media for turtles in the ERA. The MIS and discrete samples will be merged and evaluated together for land crabs only. Every other ecological receptor will be evaluated using MIS data. The two MIS and two discrete samples collected from the beach will be merged together for the HHRA and an EPC will be calculated using ProUCL.

The southern shoreline of the site will not be evaluated as a turtle nesting area, unless otherwise verified by a site visit by USFWS. Rich stated that the high energy environment there is not very conducive for turtle nesting and that even if turtles nest in the southern beach area, FWS workers would not go there due to accessibility issues (i.e., inaccessible from land or sea).

SAP Worksheet #10 — Problem Definition

Introduction

This worksheet provides a summary of site background and key elements of the conceptual site model (CSM), followed by a narrative description of the problems to be addressed during the proposed RI sampling activities.

Site Background

The former VNTR consists of approximately 14,600 acres and is divided operationally into four Munitions Response Areas (MRAs) that from west to east comprise: the 11,000-acre Eastern Maneuver Area (EMA); the 2,500-acre Surface Impact Area (SIA); the 900-acre Live Impact Area (LIA); and the 133-acre ECA (**Figure 2**). The former VNTR was transferred from the Navy to the Department of Interior (DOI) in 2003 to be managed by USFWS as part of the National Wildlife Refuge System. The ECA is managed as a wilderness area and public access is restricted. While all military activities have ceased at the former VNTR, the Navy retains responsibility for any MEC and/or environmental contaminant concerns attributable to past Navy activities that may exist.

The ECA was established as a conservation area and not used as an operational area for munitions. However, the site is located immediately adjacent to the LIA, where naval gunfire and air to ground (ATG)bombing took place. Due to the close proximity to the LIA, potential misfires likely resulted in the MEC that was identified at the ECA.

Investigation History

In 2005, the VNTR was placed on the National Priorities List (NPL) and response activities are conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The NPL requires all subsequent environmental restoration activities for Navy Installation Restoration (IR) sites on Vieques to be conducted under CERCLA unless and until removed from CERCLA authority.

An Interim TCRA and ERA/SI conducted at the ECA identified over 1,400 MEC items within the ECA, as show in **Figure 3** (CH2M HILL, 2009 and 2010). The Interim TCRA was conducted from June 2005 to February 2009 and included the removal of surface MEC from 125 acres of the ECA. Areas inundated with water (some portions of the lagoon) and steep slope areas were not cleared. Subsurface munitions may still remain at the site. Details on the MEC removal procedures are included in the Interim TCRA (CH2M HILL, 2010).

The removal of subsurface MEC at the beaches and roads is currently planned as part of a non-TCRA. Results of the Interim TCRA and ERA/SI will be included in the RI Report to characterize the nature and extent of MEC and to assess the explosives safety hazard associated with the munitions.

No environmental investigations have been conducted at the ECA.

Release History

MEC items identified within the ECA are likely a result of misfires of the targets in the LIA. Munitions items found at the site from highest to lowest quantity include:

SAP Worksheet #10 — Problem Definition (continued)

- 1,087 projectiles/mortars
- 130 rockets/guided missiles
- 45 MEC components
- 23 bombs
- 17 flares-pyrotechnics
- 6 submunitions

Potential chemical constituents associated with these items are summarized in **Table 1**. The density of munitions items recovered was greater in the western half of the site (approximately 16 items per acre) and decreased to the east (approximately 4.5 items per acre) (**Figure 3**). Craters were identified along the western boundary and within the lagoon (CH2M HILL, 2009) (**Figure 3**).

Intact and detonated MEC items and munitions debris and the historical detonations had the potential to release chemical contaminants to the environmental media. In addition, disposed batteries from the operation of a "light post" located on the eastern end of the site may be a small, isolated source of contamination (approximately 10–foot-diameter disposal area).

Potential contaminants of interest from the munitions items identified comprise explosives and inorganic constituents. White phosphorous is not considered a constituent of interest at the ECA. Only 1 item out of over 1,400 items within the ECA contained white phosphorous (an MK 23 igniter).

Conceptual Site Model

Figure 4 presents the generalized conceptual site model of the ECA.

Physical Characteristics

The ECA is characterized as a forested area along the west and northwest portions to rough terrain of limestone and dolomite exposed at the ground surface with low-growing, dense vegetation in the eastern portion. The topography ranges from 0 ft msl at Bahia Playa Blanca to above 60 ft msl on the eastern and southwestern portions of the site. Large cliff faces separate the ocean from the land, except at Playa Blanca (**Figure 5**).

A 9-acre lagoon partially surrounded by a narrow fringe of mangroves is also present in the northwestern portion of the ECA. The lagoon is not tidally influenced and the temporal presence of surface water is believed to be the result of precipitation. During dry periods, the lagoon has been observed to dewater, with salts appearing on the lagoon flat. The lagoon has been isolated from the adjacent Bahia Playa Blanca by a stretch of forested upland since 1937, based on historic aerial photographs.

The soil overburden is expected to be thin (non-existent where the bedrock outcrops), fine-grained, and to have a high clay content from the weathering of the bedrock. In the topographically elevated areas, limestone and dolomite bedrock are exposed at the ground surface. In the western portion, shallow weathering and beach deposits overly the limestone and dolomite bedrock.

Percolating rainwater infiltrates downwards within the Karst terrain and fractures of the limestone and dolomite. Limestone typically does not have impermeable surfaces to cause perched

SAP Worksheet #10 — Problem Definition (continued)

groundwater conditions, especially under Karst conditions. Groundwater within the ECA likely occurs within the limestone and dolomite bedrock and the water table is likely encountered near sea level and tidally influenced. Groundwater seeps were not observed along the cliff faces, which is consistent with what would be expected in a Karst terrain. Groundwater discharge is to the ocean and is not believed to perennially discharge to the lagoon since the lagoon is periodically dry. The general groundwater geochemistry is likely brackish to saline and hard.

Potential Contaminant Sources and Transport Pathways

Contaminated surface soils may be transported by surface runoff (overland flow) in the direction of the sloping ground surface. In the western portion of the site, the ground surface generally slopes from the LIA to the ECA and towards the lagoon and Playa Blanca. In the eastern portion of the ECA, the ground surface primarily slopes to the west.

Contaminants at the ground surface may migrate downward through the unsaturated zone by leaching from infiltration. Contaminants could then migrate within groundwater and discharge to the ocean.

Other potential migration pathways at the ECA include wind dispersion, storm surges, tides, and waves. Contaminated surface soils may be transported by wind erosion; however, the vegetation onsite limits transport. Storm surges, tides, and waves could potentially erode and transport impacted soils along the beach.

Future Land Use

The former VNTR was transferred to the DOI in 2003 to be managed by USFWS as part of the National Wildlife Refuge System, pursuant to Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). A provision of this law states that the ECA must be managed as a wilderness area and public access is restricted (Public Laws 106-398 and 107-107). Therefore, no lawful public access is allowed on the ECA and groundwater cannot be developed for use.

A Comprehensive Conservation Plan (CCP) for the Vieques National Wildlife Refuge was completed by USFWS, which outlines the land use plan for managing the former VNTR as a wildlife refuge (DOI, 2007). Roads within the ECA will be maintained to provide USFWS access to natural resource areas, such as the turtle nesting area along the Bahia Playa Blanca beach, and to access the navigational "light post" at the eastern end of the ECA for maintenance.

Receptors

Potential receptors at the site include both human and ecological.

Human Health

If contamination attributable to past Navy activities is identified, a baseline human health risk assessment (HHRA) will be conducted on the data collected to evaluate potential harm to human health. The HHRA will evaluate potential current and future health risks from exposure to environmental media under actual or probable land use scenarios.

Potential human health exposure pathways and frequencies are summarized in more detail in the USEPA Risk Assessment Guidance for Superfund (RAGS) D Tables 1 and 4, included in **Appendix C**. Potential exposure pathways will be quantified for current and future USFWS workers (RAGS D Table 1). There are five general exposure pathways for USFWS workers that comprise:

SAP Worksheet #10 — Problem Definition (continued)

- Beach – Ingestion, dermal contact, and inhalation of soil during sea turtle monitoring and conservation activities. The beach includes the potential turtle nesting areas from the beach vegetation line to 60 feet inland.
- Upland – Ingestion, dermal contact, and inhalation of soil while conducting restoration, surveillance, and monitoring of the upland evergreen scrub.
- Lowland – Ingestion, dermal contact, and inhalation of soil while conducting restoration, surveillance, and monitoring of the lowland forest scrub.
- Lagoon – Ingestion, dermal contact, and inhalation of soil, ingestion and dermal contact of sediment, and dermal contact of surface water, while conducting surveillance and monitoring of migratory water fowl. The area includes the lagoon and 30 feet inland from the lagoon.
- Site-wide – Ingestion, dermal contact, and inhalation of soil, ingestion and dermal contact of lagoon sediment, and dermal contact of lagoon surface water, while conducting wildlife surveillance and monitoring.

A cumulative exposure scenario will also be presented in the HHRA to represent hypothetical USFWS workers who may be involved in all activities.

Qualitative evaluations will be conducted for the USFWS workers conducting law enforcement activities, US Coast Guard workers maintaining the "light post," and for hypothetical public trespassers. The USFWS law enforcement workers and US Coast Guard workers have minimal exposures due to the short term duration of the activities. Public trespassers are unlikely to access the ECA due to the inaccessible nature of the site; access by sea is unlikely due to the presence of coral barriers and steep cliffs, and access by land is unlikely because the trespassers would have to cross through the LIA.

It is important to note that if, prior to or during conduct of the HHRA, data gaps are identified that warrant additional sampling, the additional sampling may be proposed/conducted prior to completing the HHRA and preparing the RI Report. The additional sampling would be conducted in accordance with this SAP or an addendum to this SAP should alternate sampling methodologies/protocols be proposed.

Ecological

If contamination attributable to past Navy activities is identified, a screening ecological risk assessment (SERA), including Steps 1 and 2 of the ecological risk assessment (ERA) process, and the first step (Step 3A) of a baseline ecological risk assessment (BERA) will be conducted for the ECA. The ERA will evaluate the potential adverse effects to the environment do to any contamination identified at the ECA. Detailed discussions of the potential ecological exposure pathways and terrestrial/aquatic receptors at the ECA are summarized in the strawman ecological risk assessment information included in **Appendix D**.

Exposure media for ecological receptors within the ECA include the following:

- Surface soil – 0 to 2 inches across the evergreen scrub (upland area) and forest scrub (lowland area) habitats

SAP Worksheet #10 — Problem Definition (continued)

- Deeper surface soil – 2.5-inches to 2 feet within the lagoon fringe (lagoon boundary to 30 feet inland), where habitat is suitable for land crabs around the perimeter of the lagoon; 18 to 24 inches in turtle nesting beaches (vegetation line to 60 feet inland)
- Surface water – in the lagoon
- Surface sediment – 0 to 6 inches in the lagoon

Potentially complete exposure pathways exist for terrestrial receptors exposed to surface soil and deeper surface soil, and aquatic receptors exposed to surface water and sediment in the lagoon. The receptors include:

- Terrestrial – plants, soil invertebrates, birds, mammals, and reptiles exposed to surface soil; land crabs within the lagoon fringe exposed to deeper surface soil (0 to 2 feet); sea turtles eggs within the beach exposed to deeper surface soil (18 to 24 inches)
- Aquatic – fish, benthic invertebrates (including crabs), aquatic plants, birds, and mammals exposed to surface water and sediment in the lagoon

It is important to note that if, prior to or during conduct of the ERA, data gaps are identified that warrant additional sampling, the additional sampling may be proposed/conducted prior to completing the ERA and preparing the RI Report. The additional sampling would be conducted in accordance with this SAP or an addendum to this SAP should alternate sampling methodologies/protocols be proposed.

General Problems to Address

Details on the sampling approach, design, and rationale on incremental sampling and discrete sampling at the ECA are detailed in Worksheet #17.

The ERP Technical Subcommittee met in January and March 2010 to scope and agree upon the rationale, sampling approach, and analysis for the ECA RI. The objectives of the RI are to sufficiently characterize the nature and extent of potential contamination in the ECA environmental media and, if present, to assess the potential risks posed by this contamination to human health and the environment. This information will be used to determine whether additional investigation, remedial/removal action, or control mechanisms are warranted.

Characterizing potential contamination within soil at the ECA is challenging due to the large size of the site (approximately 200 acres), the random distribution of MEC and related scrap, and the large number of discrete analyses that would be required (if that approach was taken). However, various studies have shown that concentrations of energetic residues at military ranges measured using an incremental sampling approach were statistically more representative relative to traditional sampling and analytical protocols (USACE, 2009). Levels of statistical confidence and decision uncertainty can be obtained using fewer incremental samples than multiple discrete analyses. Incremental sampling reduces the impacts of soil heterogeneity on laboratory analytical results by providing an average concentration over an exposure area rather than at a discrete point (i.e., reduces field sampling and laboratory processing errors), and has a higher likelihood of detecting contamination than discrete sampling if the location of contamination is unknown. Quality Assurance/Quality Control (QA/QC) field triplicate samples are also planned for this investigation to confirm the representativeness of the analytical results. The greater of field triplicate samples will be used to represent the sampling unit.

SAP Worksheet #10 — Problem Definition (continued)

Incremental sampling provides a single result (per chemical) for a decision unit or from one or more sampling units within that decision unit. A decision unit and associated sampling units are generally selected based on the exposure domain for human or ecological exposure, by an area influenced by a specific activity, and/or by an area influenced by a single event. Decision unit and sampling unit size and shape are controlled by the environmental concerns posed by the contaminants present and the intended use of the site.

A background data set for soil on Eastern Vieques was documented in the report titled *East Vieques Background Soil, Inorganics Investigation Report* (CH2M HILL, 2007). However, the background data set for soil was collected using discrete sampling techniques. As part of the ECA RI, ten surface soil samples will be collected in background areas within the same lithologic unit as the ECA using incremental sampling techniques for inorganic constituent comparison to the surface soil samples collected using incremental sampling techniques at the ECA. Deeper surface soil samples collected using discrete sampling techniques at the ECA will be compared to the historic East Vieques background data set.

The primary goal of the RI at the ECA is to determine the nature and extent of contamination associated with CERCLA-related release(s) attributable to past Navy activities. The ability to distinguish constituents and constituent concentrations attributable to past Navy activities from those attributable to other sources, such as background, is essential to achieving this objective, especially when constituent concentrations pose potentially unacceptable risk. For constituents with significant non-CERCLA-related sources, such as inorganic constituents, establishing a representative background dataset is the surest means of making this important distinction.

The ECA lagoon is unique among lagoons on Vieques in that it is evaporative in nature, is a depositional environment for surrounding eroded sediments, and is influenced by sea spray. During dry conditions, evaporate-rich sediments (salt flats) are observed at the surface of the lagoon. Therefore, even in the absence of inorganics contamination, naturally occurring inorganics will accumulate in the lagoon as they are concentrated in the surface salts during successive evaporative periods. There is no other known lagoon of this nature on Vieques, other than possibly one within the LIA, which would not provide a suitable background dataset due the potential for it to have been impacted by past Navy activities.

In the absence of a representative background dataset, other lines of evidence may be used to help determine if inorganics concentrations observed in the lagoon are attributable to past Navy activities. For example, if surface water or sediment samples collected from the ECA lagoon are found to have inorganics concentrations above screening levels, a "weight of evidence" evaluation may be conducted that could include, but not necessarily be limited to, the following:

- Inorganics concentrations in ECA lagoon sediment relative to inorganics concentrations in the east Vieques background soil dataset for the same lithology encountered in the ECA
- Inorganics concentrations in ECA lagoon sediment relative to inorganics concentrations in soil samples collected from the perimeter of the lagoon
- Inorganics concentrations in ECA lagoon sediment relative to inorganics concentrations in ECA lagoon surface water
- Distribution (uniformity) of inorganics concentrations detected across the ECA lagoon

SAP Worksheet #10 — Problem Definition (continued)

- Ratio/fingerprint of inorganics concentrations in the ECA lagoon relative to the ratio/fingerprint of inorganics concentrations expected in munitions identified in the ECA
- Ratio of inorganics concentrations in ECA lagoon sediment relative to the ratio of inorganics concentrations in ECA soil samples

It is important to note that while the lines of evidence listed above may help distinguish inorganics concentrations attributable to past Navy activities from those attributable to background, it is not a certainty. For example, if the inorganics concentrations observed in ECA lagoon sediment are within the range of inorganics concentrations observed in the east Vieques background soil dataset, then it can be assumed that the lagoon inorganics concentrations are attributable to background. However, exceedance of the east Vieques background soil concentrations would not necessarily indicate the inorganics concentrations are a result of contamination. The levels may be elevated simply as a result of being concentrated due to successive evaporation, as noted previously. Therefore, if the weight of evidence evaluation is inconclusive, it will not be concluded that the inorganics concentrations are present as a result of past Navy activities. In this case, further evaluation or an alternative approach for considering the lagoon may be proposed.

Results of this investigation will be presented in a RI Report. The report will include evaluations of the physical characteristics, nature and extent of contamination, fate and transport of contaminants, human health and ecological risk assessments (if contamination is identified), and path forward for the ECA.

Environmental Questions to be Answered by the RI

To achieve the objectives stated above, the following environmental questions will be answered via implementation of this SAP:

1. <u>What is the nature and extent of contamination at the ECA?</u>
   Details of the sampling design and rationale is presented in Worksheet #17. Delineation of the extent of contamination will be answered by collecting environmental media (soil, surface water, and sediment) samples concurred upon by the Vieques ERP Technical Subcommittee during the scoping sessions. Sampling locations were selected to provide sufficient spatial coverage across the site, to characterize potential contamination in areas with the highest frequency of munitions items, and to account for the different munitions types identified at the site. Due to the type of potential contaminant sources and release mechanisms at the site, potential contamination is likely to occur primarily within the surface soil, sediment, and/or surface water. The surface soil interval is identified in the conceptual model as 0-2.5 inches throughout the site except under the following circumstances:

   - The beach Decision Unit, where the highly mobile sands that form the beach and turtle nesting habits warrant the beach to be characterized by two separate zones: a 0-2.5-inch zone to be sampled by incremental sampling methods, and an 18-24-inch zone to be discretely sampled.

SAP Worksheet #10 — Problem Definition (continued)

- The Lagoon Fringe Decision Unit, where the potential for land crab habitat warrant the lagoon fringe to be characterized by two separate zones: a 0-2.5-inch zone to be sampled by incremental sampling methods, and a 2.5-24-inch zone to be discretely sampled.
- The battery disposal area, where Vieques soil sampling protocol requires sampling surface soil under a former potential surface source at a depth of 0-12-inches below ground surface.

However, to provide another line of evidence to determine if site contamination is potentially impacting groundwater in the ECA, up to 15 subsurface soil samples will be collected, 3 from within each sampling unit within the lowland decision unit. Subsurface soil sample collection will be attempted in the 2-foot interval above groundwater or bedrock surface, whichever is shallower. If insufficient soil exists to collect a 2 foot sample below the surface soil sample depth, the sample will be shortened accordingly. Subsurface soil samples will only be collected if there is greater than 6-inches of soil below the surface soil sampling depth and above the water table or bedrock, whichever is shallower. Up to three attempts will be made to collect each subsurface soil sample at each sampling unit in the lowland decision unit, for a total of up to 15 samples, not including QC. Details on why groundwater is not evaluated are discussed in Worksheet #17.

2. <u>What are the ecological communities present at the ECA?</u>

Terrestrial species (flora and fauna), threatened and endangered species, and critical habitat surveys at the ECA were previously evaluated, as documented in the report titled *Live Impact Area Biological Assessment – Amendment 1* by Geo-Marine Inc. (Geo-Marine, 2007). No protected plant or animal species were identified. A qualitative survey of the aquatic communities (fish, invertebrates, plants) within the isolated lagoon will be conducted as part of this sampling event to support the characterization of aquatic receptors and potential exposure routes..

3. <u>What are the potential human health and ecological risks posed by contamination attributable to the ECA?</u>

Results from the RI will be evaluated in the human health and ecological risk assessments.

4. <u>Based on the data collected during the RI (including supplemental sampling if additional data needs are identified), what is the appropriate path forward for the ECA?</u>

The results of the HHRA and ERA will be used, in conjunction with risk management considerations (e.g., land uses, control mechanisms, remedy feasibility), to determine: (1) if additional data are warranted to make site-specific determinations, or (2) if remedy/removal actions are warranted, or (3) if no further action (beyond the source removal that has already taken place) other than land use controls is warranted.

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

1. Who will use the data and what will the data be used for?

The Navy, USEPA, EQB, and USFWS will use the data collected during the RI at the ECA to assess the nature and extent of contamination, evaluate if there are potential risks to human health and the environment, and determine if further action is warranted for the site.

2. What are the Project Action Limits (PALs)?

The PALs are defined in the Master Standard Operating Procedures, Protocols, and Plans (CH2M HILL, 2009) and are listed, by constituent group and medium, in Worksheet #15. In general, the PALs are:

- Vieques human health screening values for soil, sediment, and surface water are the current (as of the time the HHRA is being conducted) Regional Screening Levels (RSLs) (adjusted for a hazard quotient [HQ] of 0.1 for non-carcinogens) provided by USEPA.
- Vieques ecological screening values for soil, sediment, and surface water are derived from multiple sources, which are listed in the Vieques Master Ecological Risk Assessment Protocol (CH2M HILL, 2010).
- Vieques soil-to-groundwater leaching screening values provided by USEPA.
- Vieques discrete surface soil inorganics screening values are the East Vieques background soil inorganics upper tolerance limits (UTLs) (CH2M HILL, 2007). Surface soil inorganics collected using incremental sampling at the site will be compared to background incremental samples collected as part of the RI.
- Where a specific PAL deviates from the above, it is footnoted in the applicable Worksheet #15 table.
- Results for screening data (i.e., general chemistry parameters such as total organic carbon [TOC], pH, etc.) collected to support the interpretation of ecological risk results will not be compared to strictly-defined PALs, but will be evaluated qualitatively. These parameters are identified in Worksheet #15. If there are any indicator limits, these are identified in Worksheet 15 as Project Indicator Limits (PILs).

In addition to listing the particular analytes, PALs, and quantitation limits (QLs), Worksheets #15 identify where QLs are higher than PALs. Even though QLs may be higher than certain PALs, method detection limits (MDLs) may be closer to or lower than PALs. Theoretically, the laboratory instrument could detect a constituent down to its MDL at concentrations that would then be reported as estimated. The majority of the constituents have MDLs below the PALS. The explosive constituents tetryl and nitrobenzene for the surface soil, subsurface soil, and sediment samples, and 2-NT, 3-NT, and nitroglycerin for the surface water samples have PALs below QLs, but MDLs below the PALs. Therefore, these constituents could be detected at the PALs and reported as estimated and therefore will not adversely impact the risk assessments. Additionally, the human health PAL is the adjusted RSL for tap water, which is a conservative (and unrealistic) screening criterion for the saline conditions of the surface water at the lagoon.

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

3. What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?

- Soil, sediment, and surface water samples will be submitted to an offsite laboratory for analysis (TestAmerica Laboratories of Sacramento, California)
- Chemicals of interest consist of explosives constituents (USEPA Method 8330B list and perchlorate) and inorganic constituents, as shown in Worksheet #15
- Surface soil incremental background samples will be collected for inorganic constituents
- A qualitative survey of terrestrial and aquatic communities occurring at the ECA
- Worksheets #10, #15, and #18 define the matrices, analytical groups, and, where applicable, specific target analytes for the ECA

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

- The data will be of the quantity and quality necessary to provide technically sound and defensible assessments of the site conditions and potential risks at the ECA. Laboratory methods will meet CERCLA, USEPA Region 2, and Navy guidance and the data will be validated by a third-party validator using national functional guidance, methodology, and laboratory Standard Operating Procedures (SOPs) as described in Worksheet #36
- The laboratory will follow the Measurement Performance Criteria (MPC) in Worksheet #12 for field QC samples and Worksheet #28 for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM) as applicable and laboratory in-house limits where the QSM does not apply.

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

- Worksheet #18 contains the number of samples per matrix per analytical group for the ECA. Worksheets #15 contain the particular analytes, PALs, and quantitation limits (QLs). Worksheet #17 provides the rationale for the particular sampling at each area.
- 27 surface soil incremental samples, 8 deeper surface soil discrete samples, 5 surface water, and 15 sediment samples will be collected at the site (**Figure 6**) and analyzed for explosives, perchlorate, inorganic constituents, and general chemistry parameters. Fifteen subsurface soil discrete samples will be collected and analyzed for explosives, perchlorate, and inorganic constituents.
- 10 surface soil incremental samples will be collected as background samples within limestone and dolomite soils (**Figure 7**) and analyzed for inorganic constituents
- Field measurements of the surface water salinity, conductivity, dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), temperature, and turbidity will be made.

- <u>Where, when, and how should the data be collected/generated?</u>
  - Samples will be collected during one field mobilization planned to occur in winter 2010/2011.
  - Data will be collected and generated in accordance with the procedures outlined in the UFP-SAP. Specifically, see the SOPs in Appendix A for more details.

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

- Who will collect and generate the data? How will the data be reported?
  - CH2M HILL field staff will collect the samples.
  - Laboratory analysis will be performed by TestAmerica Laboratories of Sacramento, California.
- How will the data be archived?

The data will be archived in accordance to procedures dictated in the Navy CLEAN program/contract. At the end of the project, archived data will be returned to the Navy.

- List the PQOs in the form of if/then qualitative and quantitative statements

  The general objectives of the decision analysis process are:
  - To assess the nature and extent of contamination and potential environmental and human health risks associated with exposure to environmental media.
  - To determine the appropriate path forward for the site and determine if additional actions are warranted to mitigate unacceptable risks.

The associated PQO/decision statements were developed in lieu of a decision tree and include the following:

- The shallow surface soil data collected will be compared to the adjusted RSLs and the ERP Technical Subcommittee will reconvene to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health and ecological terrestrial receptors exposed to surface soil.
- If the human health and ecological risk assessments determine that no potentially unacceptable risks occur at the ECA, no further investigation or action related to the environmental media will be necessary. If the risk assessments determine that potential risks remain, the ERP Technical Subcommittee will reconvene to discuss an appropriate path forward for the site.
- The soil sample collected from the battery disposal area will be compared to the adjusted RSLs and the East Vieques background data. If the soil concentrations associated with the former batteries exceed the RSLs and background, the soil in that area will be removed rather than evaluating in a quantitative risk assessment. If the soil concentrations are below the RSLs and background, no further action is required for the battery disposal area.
- Sediment and surface water data will be evaluated in accordance with the Vieques Master Human Health and Ecological Risk Assessment Protocols, unless deviations are warranted, in which case they will be presented in the respective pre-interim and/or interim deliverables.

If the environmental conditions do not allow for the incremental sampling device to collect samples (i.e., bedrock depth shallower than 2.5-inches), a stainless steel spoon may be used.

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SAP Worksheet #12-1 — Measurement Performance Criteria Table

Matrix: Incremental Sample for Surface Soil

Analytical Group: METAL

Concentration Level: Medium (SW-846 6010B) and Low (SW-846-6020 and 7196A)

Measurement Performance Criteria Table – Field QC Samples

QC Sample[2]	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Metals (SW-846 6010B); Arsenic, Selenium, and Thallium (SW-846 6020); and Hexavalent Chromium (SW-846 7196A)					
Field Triplicates	METAL	One per 10 field samples	Precision	%RSD ≤30% (advisory)	S & A
Equipment Rinseate Blank	METAL	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-1.	S
Temperature Blank	METAL	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

SAP Worksheet #12-1a — Measurement Performance Criteria Table

Matrix: Discrete Sample for Surface Soil, Subsurface Soil, or Sediment

Analytical Group: METAL

Concentration Level: Medium (SW-846 6010B) and Low (SW-846-6020 and 7196A)

Measurement Performance Criteria Table – Field QC Samples

QC Sample2	Analytical Group1	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Metals (SW-846 6010B); Arsenic, Selenium, and Thallium (SW-846 6020); and Hexavalent Chromium (SW-846 7196A)					
Field Duplicate	METAL	One per 10 field samples	Precision	%RPD ≤30%	S & A
Equipment Rinseate Blank	METAL	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-1.	S
Temperature Blank	METAL	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

SAP Worksheet #12-2 — Measurement Performance Criteria Table

Matrix: Incremental Sample for Surface Soil

Analytical Group: EXPLO

Concentration Level: Low (SW-846 8330B, 6850)

Measurement Performance Criteria Table – Field QC Samples

QC Sample[2]	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Explosives (SW-846 8330B) and Perchlorate (SW-846 6850)					
Field Triplicates	EXPLO	One per 10 field samples	Precision	%RSD ≤30% (advisory)	S & A
Equipment Rinseate Blank	EXPLO	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-2.	S
Temperature Blank	EXPLO	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

SAP Worksheet #12-2a — Measurement Performance Criteria Table

Matrix: Discrete Surface Soil, Subsurface Soil, or Sediment

Analytical Group: EXPLO

Concentration Level: Low (SW-846 8330B, 6850)

Measurement Performance Criteria Table – Field QC Samples

QC Sample[2]	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Explosives (SW-846 8330B) and Perchlorate (SW-846 6850)					
Field Duplicate	EXPLO	One per 10 field samples	Precision	%RPD ≤30%	S & A
Equipment Rinseate Blank	EXPLO	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-2.	S
Temperature Blank	EXPLO	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

SAP Worksheet #12-3 — Measurement Performance Criteria Table

Matrix: Incremental Sample for Surface Soil					
Analytical Group: WCHEM					
Concentration Level: N/A (SW-846 9045C)					
Measurement Performance Criteria Table – Field QC Samples					
QC Sample	**Analytical Group[1]**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
pH (SW-846 9045C)					
Temperature Blank	WCHEM	One per cooler	Accuracy / Representativeness	2-6°C	S

[1] If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-3a — Measurement Performance Criteria Table

Matrix: Discrete Surface Soil or Sediment[2]					
Analytical Group: WCHEM					
Concentration Level: N/A (SW-846 9045C) and Low (Lloyd Kahn)					
Measurement Performance Criteria Table – Field QC Samples					
QC Sample	**Analytical Group[1]**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
pH (SW-846 9045C) and Total Organic Carbon (TOC) (Lloyd Kahn)					
Temperature Blank	WCHEM	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 TOC will not be analyzed in the discrete surface soil sample collected at the former battery storage area..

SAP Worksheet #12-4 — Measurement Performance Criteria Table

Matrix: Sediment

Analytical Group: GRAINSIZE

Concentration Level: N/A (ASTM D422)

Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
N/A: Field QC samples are not planned for grain size (sieve) analysis.					

[1] If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-5 — Measurement Performance Criteria Table

Matrix: Aqueous (blanks associated with soil samples only)					
Analytical Group: METAL					
Concentration Level: Medium (SW-846 6010B) and Low (SW-846-6020 and 7196A)					
Measurement Performance Criteria Table – Field QC Samples					
QC Sample	**Analytical Group[1]**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Metals (SW-846 6010B); Arsenic, Selenium, and Thallium (SW-846 6020); and Hexavalent Chromium (SW-846 7196A)					
Temperature Blank	METAL	One per cooler	Accuracy / Representativeness	2-6°C	S

[1] If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-5a — Measurement Performance Criteria Table

Matrix: Surface Water and Aqueous (blanks associated with surface water samples only)

Analytical Group: METAL and FMETAL

Concentration Level: Medium (SW-846 6010B) and Low (SW-846-6020 and 7196A)

Measurement Performance Criteria Table – Field QC Samples

QC Sample[2]	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Metals (SW-846 6010B and 6020) and Hexavalent Chromium (SW-846 7196A)					
Field Duplicate	METAL, FMETAL	One per 10 field samples	Precision	%RPD ≤20%	S & A
Equipment Rinseate Blank	METAL, FMETAL	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-5.	S
Temperature Blank	METAL, FMETAL	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

SAP Worksheet #12-6 — Measurement Performance Criteria Table

Matrix: Aqueous (blanks only)					
Analytical Group: EXPLO					
Concentration Level: Low (SW-846 8330B, 6850)					
Measurement Performance Criteria Table – Field QC Samples					
QC Sample	**Analytical Group[1]**	**Frequency**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
Explosives (SW-846 8330B) and Perchlorate (SW-846 6850)					
Temperature Blank	EXPLO	One per cooler	Accuracy / Representativeness	2-6°C	S

[1] If information varies within an analytical group, separate by individual analyte.

SAP Worksheet #12-6a — Measurement Performance Criteria Table

Matrix: Surface Water

Analytical Group: EXPLO

Concentration Level: Low (SW-846 8330B, 6850)

Measurement Performance Criteria Table – Field QC Samples

QC Sample[2]	Analytical Group[1]	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Explosives (SW-846 8330B) and Perchlorate (SW-846 6850)					
Field Duplicate	EXPLO	One per 10 field samples	Precision	%RPD ≤20%	S & A
Equipment Rinseate Blank	EXPLO	One per day	Bias / Contamination	Same as method blank. Refer to Worksheet 28-6.	S
Temperature Blank	EXPLO	One per cooler	Accuracy / Representativeness	2-6°C	S

1 If information varies within an analytical group, separate by individual analyte.

2 MS/MSD is described on Worksheet 28.

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SAP Worksheet #13 — Secondary Data Criteria and Limitations Table

The table below provides general information on how secondary data will be used in meeting the current project objectives and the limitations on their use in developing the SAP. Secondary data criteria and limitations tables are presented for each site where historical analytical data exist (applicable to the scope of work covered by this SAP), specifically to address the use and limitations of the historical analytical data.

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Data Types, Data Generation/ Collection Dates)	How Data Will Be Used	Limitations on Data Use
ECA				
MEC, MD item locations	Time Critical Removal Action Interim Action-After Action Report, Surface Munitions and Explosives of Concern at Munitions Response Area- Live Impact Area, and Eastern Conservation Area, Former Vieques Naval Training Range (VNTR) Vieques, Puerto Rico	MEC and MD items located and disposed of during surface clearance of ECA.	Locations, varieties, and concentrations of MEC/MD items have been used to locate systematic incremental sampling.	Locations of items limited to the accuracy of the PDA used to collect the data. In some cases MD scrap was relocated to a central position on each site prior to marking the location.

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SAP Worksheet #14 — Summary of Project Tasks for ECA

The *Master Standard Operating Procedures, Protocols, and Plans (MSOPPPs)* (CH2M HILL, 2010) in conjunction with the Random Incremental Sampling SOP A-7 (Appendix A) address the protocols and standard operating procedures (SOPs) to be used for the RI. The proposed field activities for the ECA are discussed below. The technical approach and sample design for the proposed field activities are discussed in Worksheet #17. SOP A-7 has been incorporated into the MSOPPPs.

Mobilization

Prior to mobilization, NAVFAC Atlantic, USEPA, PREQB, and USFWS will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, CH2M HILL will procure the following subcontractors to support investigation activities:

- Analytical laboratory
- Data validation
- Investigation-derived waste (IDW) disposal contractor
- UXO avoidance support

Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M HILL field team mobilizes for field activities.

UXO Avoidance

A UXO avoidance subcontractor will be present at all times during field activities. Any anomaly detected will be avoided with an exclusion zone of a distance specified by the UXO safety officer, but not less than 2 feet in diameter. Very detailed UXO avoidance will be conducted in the areas where submunitions were identified and removed (i.e., beach). UXO avoidance will be followed in accordance with the Vieques Master Environmental Health & Safety Plan (CH2MHILL, 2010c).

Sample Location Mark-out

The sampling unit boundaries will be established with survey tape and pin flags or stakes at each corner using Global Positioning System (GPS) coordinates. Each sampling unit area and discrete sampling point will be walked by UXO avoidance subcontractors prior to staking and sampling for UXO avoidance.

Soil Sampling

Incremental Sample Collection

Each sampling unit will be sampled for the specified analytes in accordance with the sampling decision in Worksheet #17 and following the incremental sampling SOP (**Appendix A**). The sampling device used to collect the subsample soil plugs will be the MIST™ 02 or equivalent (**Appendix A**), using the 0.5-inch diameter 2.5-inch (nominal 2-inch) core bit. Samples will be collected to approximately 2.5-inches or to refusal if bedrock/sample tool refusal is shallower than 2.5-inches. If the environmental conditions do not allow for the incremental sampling device to collect samples (i.e., bedrock depth shallower than 2.5-inches), a stainless steel spoon may be used. Due to the quantity of soil needed for analysis (1,000 grams) and sampling device size, each

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

sampling unit will have a target of 100 subsample soil plugs collected in approximately even distribution over the entire sampling unit area. Some vegetation clearing may be required to approximately evenly distribute subsample locations. More subsamples may be required if the soil layer is particularly thin, or poor recovery is obtained from the subsample coring device, so that the target 1,000-gram sample mass is achieved..

Background incremental samples will be collected in the general area of the former discrete samples taken during the East Vieques Background Soil Inorganics Investigation in the Ti geologic terrane (**Figure 7**). Samples will be collected following the incremental sampling SOP. Within the ECA and background areas, locations will be inspected by the UXO subcontractor prior to sampling for incidental metal scrap, and sampling units will be relocated away from any metal found.

Discrete Soil Sample Collection

Discrete samples from the beach (18 to 24 inches), lagoon fringe (2.5 to 24 inches) upland area (0 to 12 inches at the battery disposal area), and lowland subsurface soil samples (up to a 2 foot interval, excluding the surface soil sampling interval, either the 2 foot interval above the water table or bedrock, whichever is shallower), will be collected with a hand auger, direct push probe or similar sampling devices in accordance with the Master Protocols (detailed in Worksheet #17).

Surface Water and Sediment Sampling

Surface water sampling will follow Vieques Master Protocols SOP G-1 (Surface Water Sampling) to the extent practicable (based on quantity and depth of water present). Surface water samples will be collected prior to sediment samples. Sediment will be sampled following Vieques Master Protocols SOP G-2 (Sediment Sampling). Depending on the depth of the water, sediments will either be sampled from a canoe or from waders. For UXO safety purposes, the preferred method of sampling is from a canoe. Waders will only be used if the sampler sinks into the sediment less than the safe resolution depth of UXO avoidance Schonstadts. Detailed UXO avoidance will be conducted prior to sampling.

Field surface water quality parameters to be measured and logged in the field comprise temperature, pH, DO, ORP, conductivity, salinity, and turbidity.

Sample Analysis

Incremental samples will not be homogenized or ground in the field, but will be sent to the laboratory in appropriate sample containers for explosives, inorganic constituents, and pH. The laboratory will sieve the samples to remove debris and in the process homogenize the sample. A subsample will be collected in the laboratory from the main sample to analyze for inorganics and ground with a non-metallic device (i.e., ceramic) by hand. Another subsample will be collected from the main sample for pH (general chemistry parameter). Following removal of the inorganics and general chemistry sample fractions, the main sample will be ground and further homogenized for analysis for explosives. Details of the laboratory analysis are included in Worksheet #28 and **Appendix B**.

The laboratory will maintain, test, inspect, and calibrate analytical instruments (Worksheets #24 and #25). The laboratory will analyze soil, sediment and surface water samples for various groups of parameters as shown on Worksheets # 15 and #18.

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

Equipment Decontamination

Equipment decontamination will follow the Master Protocols SOP E-1.

Investigation-Derived Waste Management

IDW will be managed and disposed of in accordance with the Master Protocols. Liquid and solid IDW will be sampled for TCLP and RCI to determine the disposal options. The disposal subcontractor will determine the necessary parameters.

Shipments

All offsite analytical samples will be delivered to the laboratory by FedEx. All samples will be shipped in accordance with the Master SOP H-9 "Packaging and Shipping Procedures for Low-Concentration Samples."

Quality Control

All quality control samples are listed on Worksheet #20. In reference to the field tasks, field work will be overseen by a field team leader, or his delegate, who is responsible for the quality control of the sampling and make sure the proper SOPs are followed for each task.

Data Management

The Project EIS, Vickie Weber, is responsible for data tracking and storage. In addition a third party data validator will receive all analytical data from the laboratory and the data will be validated prior to its use by the Navy. All validated analytical data will be loaded into the NIRIS database.

Procedures for Recording and Correcting Data

Field data will be recorded in field logbooks.

Project Assessment/Audit: Worksheets #31 and #32

Data Validation: Worksheets #35 and #36

Data Usability Assessment: Worksheet #37.

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SAP Worksheet #15-1 — Reference Limits and Evaluation Table

Matrix: SMI, SS, SB, and SD
Analytical Group: METAL

Analyte	CAS Number	Analysis Method	RSLs Industrial Soil Adjusted (mg/kg)	Ecological Soil ESVs (mg/kg)	Marine Sediment ESVs (mg/kg)	Project Quantitation Limit Goal[1,2] (mg/kg)	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[3]		
							QLs (mg/kg)	MDLs (mg/kg)	LCL	UCL	RPD
Aluminum	7429-90-5	6010B	99000	NC	18000	9000	20	5.6	80	120	20
Antimony	7440-36-0	6010B	41	78	2	2	3	0.94	80	120	20
Arsenic	7440-38-2	6020	1.6	18	8.2	0.8	0.5	0.15	80	120	20
Barium	7440-39-3	6010B	19000	330	48	24	2	0.4	80	120	20
Beryllium	7440-41-7	6010B	200	40	NC	20	0.3	0.03	80	120	20
Cadmium	7440-43-9	6010B	80	32	1.2	0.6	0.3	0.03	80	120	20
Calcium	7440-70-2	6010B	NC	NC	NC	50	50	4.5	80	120	20
Chromium	7440-47-3	6010B	5.6	64	81	2.8	1	0.14	80	120	20
Chromium (hexavalent)	18540-29-9	7196A	5.6	NC	NC	2.8	0.05	0.01	85	115	30
Cobalt	7440-48-4	6010B	30	13	10	5	1	0.25	80	120	20
Copper	7440-50-8	6010B	4100	70	34	17	1.5	0.22	80	120	20
Iron	7439-89-6	6010B	72000	NC	220000	36000	10	1.1	80	120	20
Lead	7439-92-1	6010B	800	120	46.7	23.35	1	0.26	80	120	20
Magnesium	7439-95-4	6010B	NC	NC	NC	50	50	4.5	80	120	20
Manganese	7439-96-5	6010B	2300	220	260	110	1	0.25	80	120	20
Nickel	7440-02-0	6010B	2000	38	20.9	10.45	1	0.24	80	120	20
Potassium	7440-09-7	6010B	NC	NC	NC	100	100	10	80	120	20
Selenium	7782-49-2	6020	510	0.52	1	0.52	0.3	0.1	80	120	20
Silver	7440-22-4	6010B	510	560	1	0.5	0.5	0.09	75	120	20
Sodium	7440-23-5	6010B	NC	NC	NC	100	100	11	80	120	20
Thallium	7440-28-0	6020	NC	1	NC	0.5	0.15	0.05	80	120	20
Vanadium	7440-62-2	6010B	520	130	57	28.5	2	0.19	80	120	20
Zinc	7440-66-6	6010B	31000	120	150	60	2	0.19	80	120	20

Shading represents cases where the PAL is less than the laboratory QL. Refer to Worksheet #11 "What are the project action limits" for discussion on how the data will be used and how non-detections at the laboratory QL will be addressed.

NC: No screening level for this compound. Ca, Mg, K, and Na are nutrients. N/A: Not applicable.

[1]The Project Action Limit for SMI and SS is "RSLs Industrial Soil Adjusted" (November, 2010) and "Ecological Soil ESVs" (August, 2010). The project action limit for SB is "RSLs Industrial Soil Adjusted" (November, 2010). The project action limit for SD is "RSLs Industrial Soil Adjusted" (November, 2010) and "Marine Sediment ESVs" (August, 2010).

[2]The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific QL, as applicable.

[3]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.

DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-2 — Reference Limits and Evaluation Table

Matrix: SMI, SS, SB, and SD
Analytical Group: EXPLO (SW-846 8330B, 6850)

Analyte	CAS Number	RSLs Industrial Soil Adjusted (µg/kg)	Ecological Soil ESVs (µg/kg)	Marine Sediment ESVs (µg/kg)	Project Quantitation Limit Goal[1,2] (µg/kg)	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[3]		
						QLs (µg/kg)	MDLs (µg/kg)	LCL	UCL	RPD
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	4900000	10000	115000	5000	250	12.1	75	125	20
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	24000	10000	891000	5000	250	12	70	135	20
1,3,5-Trinitrobenzene (1,3,5-TNB)	99-35-4	2700000	NC	7000	3500	250	10	75	125	20
1,3-Dinitrobenzene (1,3-DNB)	99-65-0	6200	NC	NC	3100	250	4.2	80	125	20
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8	250000	10000	72	72	250	10	10	150	20
Nitrobenzene (NB)	98-95-3	24000	2260	21	21	250	17.6	75	125	20
2,4,6-Trinitrotoluene (2,4,6-TNT)	118-96-7	42000	10000	20000	5000	250	19.4	55	140	20
4-Amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-0	190000	NC	NC	95000	250	10	80	125	20
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-2	200000	80000	NC	40000	250	12.5	80	125	20
2,4-Dinitrotoluene (2,4-DNT)	121-14-2	5500	11000	NC	2750	250	5.3	80	125	20
2,6-Dinitrotoluene (2,6-DNT)	606-20-2	62000	8500	549	274.5	250	7.3	80	120	20
2-Nitrotoluene (2-NT)	88-72-2	13000	NC	NC	6500	250	13	80	125	20
3-Nitrotoluene (3-NT)	99-08-1	6200	NC	NC	3100	250	15.5	75	120	20
4-Nitrotoluene (4-NT)	99-99-0	110000	NC	NC	55000	250	80	75	125	20
Nitroglycerin (NG)	55-63-0	6200	NC	NC	3100	500	15	74	112	20
Pentaerythritol tetranitrate (PETN)	78-11-5	NC	NC	NC	500	500	25	75	117	20
3,5-Dinitroaniline (3,5-DNA)	618-87-1	NC	NC	NC	500	500	25	70	130	20
Perchlorate	14797-73-0	72000	1000	NC	500	0.5	0.26	80	120	15

Shading represents cases where the PAL is less than the laboratory QL. Refer to Worksheet #11 "What are the project action limits" for discussion on how the data will be used and how non-detections at the laboratory QL will be addressed.

NC: No screening level for this compound. N/A: Not applicable.

[1]The Project Action Limit for SMI and SS is "RSLs Industrial Soil Adjusted" (November, 2010) and "Ecological Soil ESVs" (August, 2010). The Project Action Limit for SB is "RSLs Industrial Soil Adjusted" (November, 2010). The Project Action Limit for SD is "RSLs Industrial Soil Adjusted" (November, 2010) and "Marine Sediment ESVs" (August, 2010).

[2]The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific QL, as applicable.

[3]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.

DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-3 — Reference Limits and Evaluation Table

Matrix: SMI, SS, and/or SD
Analytical Group: WCHEM

Analyte	CAS Number	Project Quantitation Limit Goal[1]	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[2]		
			QLs	MDLs	LCL	UCL	RPD
pH	PH	N/A	N/A	N/A	N/A	N/A	N/A
Total organic carbon (TOC)	TOC	250 mg/kg	250 mg/kg	67 mg/kg	75	125	20

NC: No screening level for this compound. N/A: Not applicable.
[1]There are no project action limits for these wet chemistry analyses (they are screening data).
[2]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.
DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-4 — Reference Limits and Evaluation Table

Matrix: SD
Analytical Group: GRAINSIZE

Analyte	CAS Number[2]	Project Quantitation Limit Goal[1] (%)	Laboratory-specific[1]	
			QLs (%)	MDLs (%)
GS03 Sieve 3" (75 mm)	SIEVE75.0	N/A	N/A	N/A
GS05 Sieve 2" (50 mm)	SIEVE50.0	N/A	N/A	N/A
GS06 Sieve 1.5" (37.5 mm)	SIEVE37.5	N/A	N/A	N/A
GS07 Sieve 1" (25.0 mm)	SIEVE25.0	N/A	N/A	N/A
GS08 Sieve 0.75" (19.0 mm)	SIEVE19.0	N/A	N/A	N/A
GS10 Sieve 0.375" (9.5 mm)	SIEVE9.5	N/A	N/A	N/A
Sieve No. 004 (4.75 mm)	SIEVE4.75	N/A	N/A	N/A
Sieve No. 010 (2.00 mm)	SIEVE2.0	N/A	N/A	N/A
Sieve No. 020 (850 um)	SIEVE850	N/A	N/A	N/A
Sieve No. 040 (425 um)	SIEVE425	N/A	N/A	N/A
Sieve No. 060 (250 um)	SIEVE250	N/A	N/A	N/A
Sieve No. 140 (106 um)	SIEVE106	N/A	N/A	N/A
Sieve No. 200 (75um)	SIEVE75	N/A	N/A	N/A
Gravel (%)	GRAVEL	N/A	N/A	N/A
Sand (%)	14808-60-7	N/A	N/A	N/A
Coarse Sand (%)	COARSESAND	N/A	N/A	N/A
Medium Sand (%)	MEDIUMSAND	N/A	N/A	N/A
Fine Sand (%)	FINESAND	N/A	N/A	N/A
Fines (%)	FINES	N/A	N/A	N/A

NC: No screening level for this compound. N/A: Not applicable.
[1]There are no project action limits for GRAINSIZE (they are screening data). QLs and MDLs are not applicable to GRAINSIZE. The project quantitation limit goal is not applicable to GRAINSIZE.
[2]These CAS numbers are contractor-specific.

SAP Worksheet #15-5 — Reference Limits and Evaluation Table

Matrix: AQ (blanks associated with soil samples only)
Analytical Group: METAL

Analyte	CAS Number	Analysis Method	Project Quantitation Limit Goal[1] (µg/L)	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[2]		
				QLs (µg/L)	MDLs (µg/L)	LCL	UCL	RPD
Aluminum	7429-90-5	6010B	200	200	48	80	120	20
Antimony	7440-36-0	6010B	30	30	9.8	80	120	20
Arsenic	7440-38-2	6020	3	3	1	80	120	20
Barium	7440-39-3	6010B	20	20	0.25	80	120	20
Beryllium	7440-41-7	6010B	3	3	0.31	80	120	20
Cadmium	7440-43-9	6010B	3	3	0.5	80	120	20
Calcium	7440-70-2	6010B	500	500	50	80	120	20
Chromium	7440-47-3	6010B	10	10	1.2	80	120	20
Chromium (hexavalent)	18540-29-9	7196A	10	10	2.1	85	115	20
Cobalt	7440-48-4	6010B	10	10	3	80	120	20
Copper	7440-50-8	6010B	15	15	2.1	80	120	20
Iron	7439-89-6	6010B	100	100	20	80	120	20
Lead	7439-92-1	6010B	10	10	2.5	80	120	20
Magnesium	7439-95-4	6010B	500	500	40	80	120	20
Manganese	7439-96-5	6010B	10	10	0.43	80	120	20
Nickel	7440-02-0	6010B	10	10	2.4	80	120	20
Potassium	7440-09-7	6010B	1000	1000	93	80	120	20
Selenium	7782-49-2	6020	3	3	1	80	120	20
Silver	7440-22-4	6010B	5	5	0.84	80	120	20
Sodium	7440-23-5	6010B	1000	1000	250	80	120	20
Thallium	7440-28-0	6020	30	30	9	80	120	20
Vanadium	7440-62-2	6010B	20	20	1.9	80	120	20
Zinc	7440-66-6	6010B	20	20	3	80	120	20

NC: No screening level for this compound. Ca, Mg, K, and Na are nutrients. N/A: Not applicable.
[1]There are no project action limits for AQ because these samples are blanks (associated with soil samples) only.
[2]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.
DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-5A — Reference Limits and Evaluation Table

Matrix: SW and AQ (blanks associated with surface water samples only)
Analytical Group: METAL and FMETAL

Analyte	CAS Number	Analysis Method	RSLs Tapwater Adjusted (µg/L)	Marine Surface Water ESVs (µg/L)	Project Quantitation Limit Goal[1,2] (µg/L)	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[3]		
						QLs (µg/L)	MDLs (µg/L)	LCL	UCL	RPD
Aluminum	7429-90-5	6010B	3700	NC	1850	200	48	80	120	20
Antimony	7440-36-0	6020	1.5	500	1.5	6	2	80	120	20
Arsenic	7440-38-2	6020	0.045	36	0.045	3	1	80	120	20
Barium	7440-39-3	6010B	730	200	100	20	0.25	80	120	20
Beryllium	7440-41-7	6010B	7.3	100	3.65	3	0.31	80	120	20
Cadmium	7440-43-9	6020	1.8	8.8	1.8	1.5	0.5	80	120	20
Calcium	7440-70-2	6010B	NC	NC	500	500	50	80	120	20
Chromium	7440-47-3	6020	0.043	50	0.0215	5	1.5	80	120	20
Chromium (hexavalent)	18540-29-9	7196A	0.043	50	0.043	10	2.1	85	115	20
Cobalt	7440-48-4	6020	1.1	NC	1.1	3	1	80	120	20
Copper	7440-50-8	6020	150	3.1	3.1	3	1	80	120	20
Iron	7439-89-6	6020	2600	50	50	100	25	80	120	20
Lead	7439-92-1	6020	15	8.1	4.05	2.5	0.6	80	120	20
Magnesium	7439-95-4	6010B	NC	NC	500	500	40	80	120	20
Manganese	7439-96-5	6010B	88	100	44	10	0.43	80	120	20
Nickel	7440-02-0	6020	73	8.2	4.1	3	1	80	120	20
Potassium	7440-09-7	6010B	NC	NC	1000	1000	93	80	120	20
Selenium	7782-49-2	6020	18	71	9	3	1	80	120	20
Silver	7440-22-4	6020	18	2.24	1.12	1	0.3	80	120	20
Sodium	7440-23-5	6010B	NC	NC	1000	1000	250	80	120	20
Thallium	7440-28-0	6020	NC	21.3	10.65	1.5	0.5	80	120	20
Vanadium	7440-62-2	6020	18	50	9	12	4	80	120	20
Zinc	7440-66-6	6010B	1100	81	40.5	20	3	80	120	20

Shading represents cases where the PAL is less than the laboratory QL. Refer to Worksheet #11 "What are the project action limits" for discussion on how the data will be used and how non-detections at the laboratory QL will be addressed.

NC: No screening level for this compound. Ca, Mg, K, and Na are nutrients. N/A: Not applicable.

[1]The Project Action Limit for SW is "RSLs Tapwater Adjusted" (November, 2010) and Marine Surface Water ESVs (August, 2010). There are no PALs for AQ samples because they are blanks only.

[2]The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific QL, as applicable.

[3]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.

DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

SAP Worksheet #15-6 — Reference Limits and Evaluation Table

Matrix: SW and AQ (blanks only)
Analytical Group: EXPLO (SW-846 8330B, 6850)

Analyte	CAS Number	RSLs Tapwater Adjusted (µg/L)	Marine Surface Water ESVs (µg/L)	Project Quantitation Limit Goal[1,2] (µg/L)	Laboratory-specific		LCS, MS, and MSD %R and %RPD Limits[3]		
					QLs (µg/L)	MDLs (µg/L)	LCL	UCL	RPD
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	180	NC	90	0.10	0.036	80	115	20
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	0.61	5000	0.305	0.10	0.036	50	160	20
1,3,5-Trinitrobenzene (1,3,5-TNB)	99-35-4	110	15	7.5	0.10	0.030	65	140	20
1,3-Dinitrobenzene (1,3-DNB)	99-65-0	0.37	180	0.185	0.10	0.050	45	160	20
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	479-45-8	15	8	4	0.10	0.050	20	175	20
Nitrobenzene (NB)	98-95-3	0.12	66.8	0.12	0.10	0.050	50	140	20
2,4,6-Trinitrotoluene (2,4,6-TNT)	118-96-7	1.8	100	0.9	0.10	0.050	50	145	20
4-Amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-0	7.3	NC	3.65	0.10	0.050	55	155	20
2-Amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-2	7.3	NC	3.65	0.20	0.1	50	155	20
2,4-Dinitrotoluene (2,4-DNT)	121-14-2	0.22	480	0.11	0.10	0.050	60	135	20
2,6-Dinitrotoluene (2,6-DNT)	606-20-2	3.7	1000	1.85	0.10	0.050	60	135	20
2-Nitrotoluene (2-NT)	88-72-2	0.31	NC	0.31	0.50	0.088	45	135	20
3-Nitrotoluene (3-NT)	99-08-1	0.37	NC	0.37	0.50	0.057	50	130	20
4-Nitrotoluene (4-NT)	99-99-0	4.2	NC	2.1	0.65	0.088	50	130	20
Nitroglycerin (NG)	55-63-0	0.37	NC	0.37	1	0.015	84	118	20
Pentaerythritol tetranitrate (PETN)	78-11-5	NC	NC	1	1	0.23	75	118	20
3,5-Dinitroaniline (3,5-DNA)	618-87-1	NC	NC	0.5	0.5	0.025	40	140	20
Perchlorate	14797-73-0	2.6	NC	1.3	0.5	0.082	80	120	15

Shading represents cases where the PAL is less than the laboratory QL. Refer to Worksheet #11 "What are the project action limits" for discussion on how the data will be used and how non-detections at the laboratory QL will be addressed.

NC: No screening level for this compound. N/A: Not applicable.

[1]The Project Action Limit for SW is "RSLs Tapwater Adjusted" (November, 2010) and Marine Surface Water ESVs (August, 2010). There are no PALs for AQ samples because they are blanks only.

[2]The Project Quantitation Limit Goal is 1/2 the PAL, the PAL, or the Laboratory Specific QL, as applicable.

[3]DoD QSM v. 4.1 is the basis for LCS and MS/MSD limits.

DoD QSM v. 4.1 does not provide limits for this compound. In-house limits used.

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SAP Worksheet #16 — Project Schedule / Timeline

The field investigation activities are anticipated to occur in winter 2010/2011. The official schedule is the Site Management Plan (SMP) schedule that is distributed and updated separately.

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SAP Worksheet #17 — Sampling Design and Rationale

The proposed sampling design is shown in **Figure 6** for the ECA and **Figure 7** for the background samples.

Environmental Media

The ECA RI will include the environmental characterization of surface soil, subsurface soil, sediment, and surface water. Groundwater will not be characterized (at least initially) as part of this investigation, since: 1) groundwater likely only discharges to the ocean and not to the lagoon or through the limestone cliff faces; 2) groundwater will not flow to other areas of Vieques where it could impact existing or future groundwater users; 3) groundwater use cannot occur at the ECA due to development restriction at the site by a Congressional Order; and 4) the general groundwater geochemistry would be hard (due to the limestone bedrock) and brackish to saline as it is likely tidally influenced and subject to saltwater mixing. However, the final determination of whether groundwater evaluation is warranted will be deferred until after the other media have been sampled and their data evaluated. Evaluation of the data to help make this determination will include reviewing soil data to determine the potential for contaminants to leach to groundwater (i.e., fate and transport mechanisms) and reviewing sediment and surface water data to determine potential impacts to the lagoon (although groundwater discharge to the lagoon is not expected).

Surface soil will be analyzed for explosives and inorganic constituents (background samples will be analyzed for inorganics). Subsurface soil samples and lagoon sediment and surface water will be analyzed for explosives and inorganic constituents.

Sampling Method and Approach

Discrete deeper surface soil, sediment, and surface water will be collected in accordance with the applicable Vieques SOPs (CH2M HILL, 2010). Surface soil sampling will be conducted using the incremental sampling strategy and approach, in general accordance with the guidance document prepared by the US Army Corps of Engineers (USACE) titled *Interim Guidance 09-02, Implementation of Incremental Sampling (IS) of Soil for the Military Munitions Response Program* (USACE, 2009). Due to the large size of the ECA and random distribution of MEC, incremental sampling will improve the reliability of sampling data by reducing the variability inherent to discrete sampling strategies.

Decision units were established at the ECA to be a specific area about which a decision is to be made. Since the human health and ecological exposure pathways and exposure areas at the ECA are different, each decision unit was selected to be representative of the different receptors, receptor exposure areas and durations, and type and number of MEC items encountered at the site. The ECA was separated into five decision units (**Figure 6**):

- Upland – approximately 90 acres in size; human health (upland area and site-wide scenarios) and ecological terrestrial receptors exposed to surface soil
- Lowland – approximately 20 acres in size; human health (lowland area and site-wide scenarios) and ecological terrestrial receptors exposed to surface soil

SAP Worksheet #17 — Sampling Design and Rationale (continued)

- Beach – approximately 10 acres in size; human health (beach and site-wide scenarios) and ecological terrestrial receptors exposed to surface and deeper surface soil
- Lagoon Fringe – approximately 2 acres in size; human health (lagoon and site-wide scenarios) exposed to surface soil and ecological terrestrial receptors exposed to surface and deeper surface soil
- Lagoon – approximately 9 acres in size; human health (lagoon and site-wide scenarios) and ecological aquatic receptors exposed to surface water and sediment

Within each decision unit, sampling units were selected to be the smallest area for which concentrations will be obtained, and to be representative of the concentrations within that exposure area. Sampling units were generally approximately 1 acre in size or less to account for the receptors with smaller exposure areas (except at the beach). Each sampling unit is the same size within its decision unit. Sampling units were designed to target areas with high density munitions items and to account for each type of munitions item and munitions related scrap identified during the Interim TCRA and ERA/SI (**Figure 6**). Sampling units in areas other than the beach and lagoon fringe decision units were based on compiling multiple quarter-acre grid areas established for MEC surface clearance. Where one or more of these quarter-acre grids shares a common boundary with another decision unit, the sampling unit is configured to end at (and not cross over) the boundary.

Within each sampling unit, 100 subsamples (increments) will be collected using a 0.5-inch (1.3-centimeter) diameter coring device (to a depth of approximately 2.5-inches) to achieve an adequate total sample mass of 1,000 grams (in accordance with the approach in the USACE guidance and SOPs in **Appendix A**). Each increment will include approximately 11 grams of soil (see coring specifications for the incremental sampling tool in **Appendix A**). Subsamples will be collected in a systematic random sampling approach, where the subsamples are collected in a general uniform grid across the sampling unit.

Quality assurance/quality control (QA/QC) samples will be collected at a 10% frequency, as shown in Worksheet #28. Triplicate incremental samples will be collected within the sampling unit by "walking" in a different grid direction (i.e., if the "normal" sample was collected north to south, triplicates will be collected west to east and northwest to southeast [or northeast to southwest]).

The sampling design and rationale for each decision unit and the background data set, and how the data will be evaluated, is discussed below.

Upland

Fifteen incremental surface soil samples (0 to approximately 2.5 inches) will be collected within the upland decision unit. **Table 2** summarizes the MEC items historically found and removed within the 15 sampling units. Due to the shallow depth of soils within the upland area (bedrock exposed at the ground surface in areas) and limited subsurface activities for the receptors, the soil profile will be characterized by the surface soil incremental samples (a site-specific decision by the ERP Technical Subcommittee). The surface soil data will be compared to the adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health (upland area and site-wide scenarios) and ecological terrestrial receptors (in combination with the lowland data) exposed to surface soil.

SAP Worksheet #17 — Sampling Design and Rationale (continued)

One discrete shallow soil sample will be collected from the battery disposal area and evaluated separately from the incremental samples. The soil sample will be compared to the adjusted RSLs and background, and if the soil concentrations associated from the battery disposal area exceed the RSLs and background, the soil in that area will be removed rather than evaluating in a quantitative risk assessment.

Lowland

Five incremental surface soil samples (0 to approximately 2.5 inches) and up to 15 discrete subsurface soil samples (2 feet above bedrock or the water table, whichever is shallower, not to include the surface sample interval) will be collected within the lowland decision unit. **Table 2** summarizes the MEC items historically found and removed within the five sampling units. Surface and subsurface soil data will be compared to adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health (Lowland area and site-wide scenarios) and ecological terrestrial receptors (in combination with the upland data) exposed to surface soil.

Beach

Two incremental surface soil samples (0 to approximately 2.5 inches) and two discrete deeper surface soil samples (18 to 24 inches) will be collected within the beach decision unit. **Table 2** summarizes the MEC items historically found and removed within the two sampling units. Since the beach decision unit is a dynamic environment and there was less frequency of munitions items found, two incremental surface soil samples are planned. Two discrete deeper surface soil samples will be collected from 18 to 24 inches to best represent the depth of turtle egg nests. The discrete sample locations will be located where historical turtle nests have occurred, and as close to possible where higher frequencies of MEC have been identified. The surface soil data will be compared to the adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health (beach area and site-wide scenarios) and ecological terrestrial receptors exposed to surface and deeper surface soil. The incremental and discrete soil samples will be evaluated as separate exposure media in the ERA; surface soil to terrestrial receptors, and deeper surface soil to turtle eggs only.

Lagoon Fringe

Five incremental surface soil samples (0 to approximately 2.5 inches) and five discrete deeper surface soil samples (approximately 2.5 to 24 inches) will be collected within the lagoon fringe decision unit. **Table 2** summarizes the MEC items historically found and removed within the five sampling units. The lagoon fringe boundary begins at the high water mark of the lagoon to 30 feet inland where USFWS workers traverse while monitoring migratory water fowl. Five discrete deeper surface soil samples will be collected from approximately 2.5 to 24 inches where higher frequencies of MEC were found and removed to represent land crab exposure depth. The surface soil data will be compared to the adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health (lagoon Fringe area and site-wide scenarios) from surficial soil exposure and ecological terrestrial receptors exposed to surface and deeper surface soil. The incremental and discrete soil samples will be

SAP Worksheet #17 — Sampling Design and Rationale (continued)

merged and evaluated together for land crabs only. All other ecological receptors will be evaluated using only incremental soil samples.

Lagoon

Fifteen discrete sediment samples (0 to 6 inches) and five surface water samples (at mid-depth) will be collected within the lagoon decision unit. Samples will be collected following a minimum two to four week period of inundation to allow aquatic communities to become established. Samples were located for spatial distribution characterization and in areas with the highest frequencies of MEC identified. The sediment and surface water data will be compared to the adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results, how the data should be grouped, and the appropriate path forward to evaluate potential risks to human health (lagoon and site-wide scenarios) and ecological aquatic receptors exposed to surface water and sediment

Background

Ten incremental surface soil samples (0 to approximately 2.5 inches) will be collected offsite within East Vieques background study locations of similar lithology to the ECA. Each sampling unit will be 1-acre in size. The background locations were chosen to match as closely as possible the limestone of the ECA and using the same sampling technique and sampling unit size.

Laboratory Analysis

Details regarding laboratory analyses for explosives, inorganic constituents, pH, and TOC are discussed in detail in Worksheet #28.

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
Beach Decision Unit (1)						
VEECA-1DU01	VEECA-1SMI01-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	3 (triplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-1DU02	VEECA-1SMI02-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-1SB01	VEECA1SB01-TTBB-MMYY (planned to be 1H-2, i.e. 18-24-inches)	Deeper surface Soil	1.5-2 (ft bgs) (high enough in the beach that 18-24-inches is above the water table, i.e. turtle nesting zone)	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-1SB02	VEECA1SB02-TTBB-MMYY (planned to be 1H-2, i.e. 18-24-inches)	Deeper surface Soil	1.5-2 (ft bgs) (high enough in the beach that 18-24-inches is above the water table, i.e. turtle nesting zone)	EXPLO, METAL, and WCHEM (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
Lowland Decision Unit (2)						
VEECA-2DU01	VEECA-2SMI01-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2DU02	VEECA-2SMI02-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	3 (triplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2DU03	VEECA-2SMI03-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2DU04	VEECA-2SMI04-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-2DU05	VEECA-2SMI05-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB01	VEECA-2SB01-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB02	VEECA-2SB02-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB03	VEECA-2SB03-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB04	VEECA-2SB04-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB05	VEECA-2SB05-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB06	VEECA-2SB06-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB07	VEECA-2SB07-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB08	VEECA-2SB08-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB09	VEECA-2SB09-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	2 (including 1 duplicate)1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-2SB10	VEECA-2SB10-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB11	VEECA-2SB11-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB12	VEECA-2SB12-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB13	VEECA-2SB13-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB14	VEECA-2SB14-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-2SB15	VEECA-2SB15-TTBB-MMYY	Subsurface soil	2 foot interval above bedrock or water table, whichever is shallower	EXPLO, METAL, (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-1, A-2, E-1, H-1, H-4, H-5, and H-6)
Lagoon Fringe Decision Unit (3)						
VEECA-3DU01	VEECA-3SMI01-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3DU02	VEECA-3SMI02-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	3 (triplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3DU03	VEECA-3SMI03-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3DU04	VEECA-3SMI04-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-3DU05	VEECA-3SMI05-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3SB01	VEECA3SB01-TTBB-MMYY	Deeper surface Soil	2-inches to 2-ft bgs (land crab sample depth)	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3SB02	VEECA3SB02-TTBB-MMYY	Deeper surface Soil	2-inches to 2-ft bgs (land crab sample depth)	EXPLO, METAL, and WCHEM (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3SB03	VEECA3SB03-TTBB-MMYY	Deeper surface Soil	2-inches to 2-ft bgs (land crab sample depth)	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3SB04	VEECA3SB04-TTBB-MMYY	Deeper surface Soil	2-inches to 2-ft bgs (land crab sample depth)	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-3SB05	VEECA3SB05-TTBB-MMYY	Deeper surface Soil	2-inches to 2-ft bgs (land crab sample depth)	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
Upland Decision Unit (4)						
VEECA-4DU01	VEECA-4SMI01-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU02	VEECA-4SMI02-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	3 (triplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU03	VEECA-4SMI03-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU04	VEECA-4SMI04-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU05	VEECA-4SMI05-MMYY	Soil random incremental sample	0-2.5-inchse bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-4DU06	VEECA-4SMI06-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU07	VEECA-4SMI07-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU08	VEECA-4SMI08-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU09	VEECA-4SMI09-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU10	VEECA-4SMI10-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU11	VEECA-4SMI11-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU12	VEECA-4SMI12-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU13	VEECA-4SMI13-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU14	VEECA-4SMI14-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4DU15	VEECA-4SMI15-MMYY	Soil random incremental sample	0-2.5-inches bgs	EXPLO, METAL, and WCHEM (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-4SS01	VEECA4SS01-TTBB-MMYY	Surface Soil (battery disposal area)	0-1 ft bgs Standard surface sample	METAL and pH (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
Lagoon Decision Area (5)						

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-5SD01	VEECA-5SD01-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD02	VEECA-5SD02-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD03	VEECA-5SD03-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD04	VEECA-5SD04-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD05	VEECA-5SD05-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD06	VEECA-5SD06-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD07	VEECA-5SD07-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD08	VEECA-5SD08-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD09	VEECA-5SD09-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD10	VEECA-5SD10-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD11	VEECA-5SD11-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD12	VEECA-5SD12-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD13	VEECA-5SD13-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-5SD14	VEECA-5SD14-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SD15	VEECA-5SD15-TTBB-MMYY	Sediment	0-6-inches bgs (00-0H)	EXPLO, METAL, WCHEM, and GRAINSIZE (see Worksheet 15)	1	See Worksheet 21 (SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6)
VEECA-5SW01	VEECA-5SW01-MMYY	Surface water	Mid-column	EXPLO, METAL, and FMETAL (see Worksheet 15)	1	See Worksheet 21 (SOPs G-1, H-1, H-4, H-5, and H-6)
VEECA-5SW02	VEECA-5SW02-MMYY	Surface water	Mid-column	EXPLO, METAL, and FMETAL (see Worksheet 15)	2 (including 1 duplicate)	See Worksheet 21 (SOPs G-1, H-1, H-4, H-5, and H-6)
VEECA-5SW03	VEECA-5SW03-MMYY	Surface water	Mid-column	EXPLO, METAL, and FMETAL (see Worksheet 15)	1	See Worksheet 21 (SOPs G-1, H-1, H-4, H-5, and H-6)
VEECA-5SW04	VEECA-5SW04-MMYY	Surface water	Mid-column	EXPLO, METAL, and FMETAL (see Worksheet 15)	1	See Worksheet 21 (SOPs G-1, H-1, H-4, H-5, and H-6)
VEECA-5SW05	VEECA-5SW05-MMYY	Surface water	Mid-column	EXPLO, METAL, and FMETAL (see Worksheet 15)	1	See Worksheet 21 (SOPs G-1, H-1, H-4, H-5, and H-6)
Background Decision Area (6)						
VEECA-6DU01	VEECA-6SMI01-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU02	VEECA-6SMI02-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	3 (triplicate)	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU03	VEECA-6SMI03-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU04	VEECA-6SMI04-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU05	VEECA-6SMI05-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)

SAP Worksheet #18 — ECA Sampling Locations and Methods/SOP Requirements Table (continued)

Station ID	Sample ID	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates) [2]	Sampling SOP Reference [1]
VEECA-6DU06	VEECA-6SMI06-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU07	VEECA-6SMI07-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU08	VEECA-6SMI08-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU09	VEECA-6SMI09-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)
VEECA-6DU10	VEECA-6SMI10-MMYY	Soil random incremental sample	0-2.5-inches bgs	METAL (see Worksheet 15)	1	See Worksheet 21 (SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6)

[1] SOP or worksheet that describes the sample collection procedures.
[2] Other than duplicates, QA/QC samples are not included in this worksheet. Please refer to Worksheet 28 for the required QA/QC samples.
TTBB = depth below ground surface of the top of the sample interval (TT) and the bottom of the sample interval (BB).

SAP Worksheet #19 — Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers	Sample Volume[2]	Preservation Requirements[5]	Maximum Holding Time[3, 5] (preparation / analysis)
SMI	EXPLO	SW-846 8330B / WS-QA-0028, WS-LC-0009	2 of 16oz glass jar (need 1kg)	30g	Cool to 4°C, headspace in jar	14 days / 40 days
		SW-846 6850 / WS-QA-0028, WS-LC-0012		1g		28 days
	METAL	SW-846 6010B, 6020 / WS-QA-0028, WS-IP-0002, WS-MT-003, WS-MT-0001		10g, 10g		6 months
		SW-846 7196A / WS-QA-0028, WS-WC-0020		10g		30 days / 24 hours
	WCHEM	SW-846 9045C / WS-QA-0028, WS-WC-0044		25g		ASAP[6]
SS, SB, and/or SD	EXPLO	SW-846 8330B / WS-LC-0009	8 oz glass jar[4]	30g	Cool to 4°C, headspace in jar	14 days / 40 days
		SW-846 6850 / WS-LC-0012		1g		28 days
	METAL	SW-846 6010B, 6020 / WS-IP-0002, WS-MT-003, WS-MT-0001		2g. 2g		6 months
		SW-846 7196A / WS-WC-0020		10g		30 days / 24 hours
	WCHEM	SW-846 9045C, Lloyd Kahn / WS-WC-0044, PT-WC-30		25g, 10g		ASAP for pH[6], 14 days for TOC
	GRAINSIZE	ASTM D422 / TA-WC-0183	1 of 16 oz glass jar	16 oz	None	N/A

SAP Worksheet #19 — Analytical SOP Requirements Table (continued)

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference[1]	Containers	Sample Volume[2]	Preservation Requirements[5]	Maximum Holding Time[3, 5] (preparation / analysis)
SW or AQ	EXPLO	SW-846 8330B / WS-LC-0009	2 of 1L Amber	1L	Cool to 4°C	7 days / 40 days
		SW-846 6850 / WS-LC-0012	1 of 125mL HDPE	10mL	Field-filtering with 0.2 µm PTFE membrane filter; Cool to 4°C, headspace in jar, protect from light	28 days
	METAL	SW-846 6010B, 6020 / WS-IP-0002, WS-MT-003, WS-MT-0001	1 of 500mL HDPE	100mL, 100mL	HNO_3 to pH < 2; Cool to 4°C	6 months
		SW-846 7196A / WS-WC-0020	1 of 250mL HDPE	20mL	Cool to 4°C	24 hours
	FMETAL	SW-846 6010B, 6020 / WS-IP-0002, WS-MT-003, WS-MT-0001	1 of 500mL HDPE	100mL, 100mL	HNO_3 to pH < 2; Cool to 4°C	6 months
		SW-846 7196A / WS-WC-0020	1 of 250mL HDPE	20mL	Cool to 4°C	24 hours

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).
[2]Provide the minimum sample volume or mass requirement if it differs from the container volume.
[3]Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.
[4]Surface soil samples analyzed only for METAL and WCHEM will need a 4oz jar. Subsurface soil samples are analyzed only for METAL and EXPLO.
[5]All samples will be stored on ice from time of collection. Due to shipping difficulties, samples (with the exception of aqueous hexavalent chromium fractions) may be held overnight (stored on ice and shipped the next day). Because holding times are greater than or equal to 7 days (with the exception of aqueous hexavalent chromium fractions), this does not cause a holding time concern.
[6]There is a 28-day holding time for pH analysis on soil samples. The samples should be leached as soon as possible. Leachates, however, must be analyzed within 24 hours of the beginning of the leaching process.

SAP Worksheet #20 — Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Field Triplicates	No. of MS/MSDs[1]	No. of Field Blanks[4]	No. of Equip. Blanks[4]	No. of VOA Trip Blanks[4]	No. of PT Samples[3]	Total No. of Samples to Lab
Beach Sampling										
SMI	METAL	2		1	1		1			7
	EXPLO	2		1	1		1			7
	WCHEM (pH)	2								2
SS	METAL	2	1		1		1			6
	EXPLO	2	1		1		1			6
	WCHEM (pH)	2								2
Lowland Sampling										
SMI	METAL	5		1	1		2			11
	EXPLO	5		1	1		2			11
	WCHEM (pH)	5								5
SB	METAL	15	2		1		1			20
	EXPLO	15	2		1		1			20
Lagoon Fringe Sampling										
SMI	METAL	5		1	1		2			11
	EXPLO	5		1	1		2			11
	WCHEM (pH)	5								5
SS	METAL	5	1		1		2			10
	EXPLO	5	1		1		2			10
	WCHEM (pH)	5								5
Upland Sampling										
SMI	METAL	15		2	1		6			27
	EXPLO	15		2	1		6			27
	WCHEM (pH)	15								15

SAP Worksheet #20 — Field Quality Control Sample Summary Table (continued)

Matrix	Analytical Group	No. of Sampling Locations[2]	No. of Field Duplicates	No. of Field Triplicates	No. of MS/MSDs[1]	No. of Field Blanks[4]	No. of Equip. Blanks[4]	No. of VOA Trip Blanks[4]	No. of PT Samples[3]	Total No. of Samples to Lab
Upland (Battery Disposal Area) Sampling										
SS	METAL	1	1		1		1			5
	WCHEM (pH)	1								1
Lagoon Sampling										
SD	WCHEM (pH and TOC)	15								15
	METAL	15	2		1		2			21
	EXPLO	15	2		1		2			21
	GRAINSIZE	15								15
SW	EXPLO	5	1		1		1			9
	METAL	5	1		1		1			9
	FMETAL	5	1		1		1			9
Background Sampling										
SMI	METAL	10		1	1		4			18

[1]Although the MS/MSD is not typically considered a field QC, it is included here because location determination is often established in the field.
[2]If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.
[3]The number of Batch or Project-specific proficiency testing (PT) samples are optional but highly recommended.
[4]The number of equipment blanks, field blanks, and trip blanks is based on a fundamental assumption of the number of sampling days each site will require. One equipment blank is collected per day per piece of equipment when equipment is decontaminated. One equipment blank is collected per event when equipment is disposable. Ambient field blanks will not be collected. One trip blank will be placed into each cooler containing volatiles samples (typically one per day; this project does not include volatiles).

SAP Worksheet #21 — Project Sampling SOP References Table

Reference numbers refer to the SOP number in the Master Protocols.

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP A-2	Soil Sampling	CH2M HILL	Stainless steel hand auger or stainless steel spoons	N	
SOP A-7	Systematic Random Increment Sampling	CH2M HILL	Clean hardened plastic or metal scoops, spoons, or coring tools (such as a MIST sampling tool)	N	
SOP C-1	Calibration and measurement with Field Instruments	CH2M HILL	Multi-parameter surface water monitoring instrument	N	
SOP E-1	Decontamination of Personnel and Equipment	CH2M HILL	Decon equipment	N	
SOP G-1	Surface Water Sampling	CH2M HILL	Kemmerer or pump	N	
SOP G-2	Sediment Sampling	CH2M HILL	Grab sampler	N	
SOP H-1	Preparing Field Log Books	CH2M HILL	Log book	N	
SOP H-4	Chain-of-Custody	CH2M HILL	SOP, tape, custody seals, electronic chain of custody forms	N	
SOP H-5	Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods	CH2M HILL	SOP	N	
SOP H-6	Equipment Blank Preparation	CH2M HILL	Sample containers	N	

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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	Corrective Action (CA)	Resp. Person	SOP Reference
YSI pH probe	Calibrate probe using YSI Auto-Calibration Standard Solution			Daily, before use	Std X-0.2<Reading<Std X+0.2	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
YSI Specific conductance Probe	Calibrate probe using YSI Calibration Standard Solution			Daily, before use	±3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
Hach Turbidity Meter	Calibrate probe using Hach-Calibration Standard			Daily, before use	0.1 to 10 NTU standard - ±10%; 11 to 40 NTU standard - ±8%; 41 to 100 NTU standard - ±6.5%; >100 NTU standard - ±5%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
YSI Dissolved oxygen and Temperature Probes	Calibrate probe using YSI-Calibration Standard Solution		During calibration of other probes, check these readings against the day's atmospheric pressure and ambient temperature Check sensor for bubbles and membrane for wrinkles or tear	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±3 mg/L DO of what the tabulated DO is for the measured temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly. Follow manufacturer's instructions to remove bubble or replace torn membrane	FTL	SOP C-1

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

Field Equipment	Calibration Activity	Maintenance Activity	Testing/Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Resp. Person	SOP Reference
YSI multi-meter	Calibrate probe using multiple Calibration Standard Solutions	Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check.	Visual Inspection	Daily before use, at the end of the day (if practicable), and when unstable readings occur.	Stable readings after 3 minutes pH reads 4.0 +/- 3% conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly.	FTL	SOP C-1
ORP	Calibrate using ORP standard solution	Check batteries and have a replacement set on hand	Visual inspection	Daily, before use, at the end of the day (if practicable), and when unstable readings occur	±10 mV of the theoretical redox standard value at that temperature	Clean probe with deionized water and calibrate again. Do not use this instrument if unable to calibrate properly	FTL	SOP C-1

SAP Worksheet #23 — Analytical SOP References Table

Lab SOP Number	Title	Revision Date	Revision Number	Date Last Revisited if not Revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?[1] (y/n)
PT-WC-30	Total Organic Carbon Analysis for Solid and Sediment Matrices; Method(s): Lloyd Kahn)	10/16/09	3		Screening	SD / WCHEM	TOC Analyzer	TA-Pittsburgh	N
TA-WC-0183	Particle Size Analysis of Soils; Methods ASTM D421-85, D422-63, D2217	04/16/10	1		Screening	SD / GRAINSIZE	Sieve	TA-Seattle	N
WS-EHS-0001	Waste Disposal[2]	02/13/09	4		N/A	N/A	N/A	TA-West Sacramento	N
WS-IP-0001	Acid Digestion of Aqueous Samples by SW-846 and MCAWW 200-Series Methods; Methods 3005A, 3010A, 200.7, and 200.8	10/02/09	5.1		Definitive	SW, AQ / METAL, FMETAL	N/A	TA-West Sacramento	N
WS-IP-0002	Acid Digestion of Soils, SW-846 Method 3050B; Method EPA 3050B	10/19/09	5.1		Definitive	SMI, SS, SB, SD / METAL	N/A	TA-West Sacramento	N
WS-LC-0009	Determination of Nitraomatics, Nitramines, and Specialty Explosives Based on Method 8330, SW-846; Method 8330, 8330A, and 8330B	03/23/10	4.1		Definitive	SMI, SS, SB, SD, SW, AQ / EXPLO	HPLC	TA-West Sacramento	N
WS-LC-0012	Determination of Perchlorate by Liquid Chromatography Coupled with Tandem Mass Spectrometry (LC/MS/MS) by Method 6850 or 8321 Modified; Method 6850 and Modified 8321	09/04/09	5.2		Definitive	SMI, SS, SB, SD, SW, AQ / EXPLO	LC/MS/MS	TA-West Sacramento	N
WS-MT-0001	Analysis of Metals by Inductively Coupled Plasma / Mass Spectrometry; Methods 6020, 6020A	01/15/10	3.2		Definitive	SMI, SS, SB, SD, SW, AQ / METAL, FMETAL	ICP-MS	TA-West Sacramento	N
WS-MT-0003	Inductively Coupled Plasma - Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analyses, SW-846 Method 6010B/6010C and EPA Method 200.7; Methods 6010B/6010C and 200.7	09/04/09	5.1		Definitive	SMI, SS, SB, SD, SW, AQ / METAL, FMETAL	ICP-AES	TA-West Sacramento	N
WS-QA-0003	Sample Receipt and Procedures; Quality Assurance Procedure	10/19/09	11.2		N/A	N/A	N/A	TA-West Sacramento	N
WS-QA-0028	Multi-Incremental Subsampling of Soils and Sediments	03/27/10	3	3/27/10	Definitive	SMI / EXPLO, METAL	Grinder, etc.	TA-West Sacramento	N
WS-WC-0044	EPA Method 9045D pH Soils; Method 9045D	02/19/10	6.1		Screening	SMI, SS, SD / WCHEM	pH Probe	TA-West Sacramento	N
WS-WC-0020	Determination of Hexavalent Chromium By Manual Colorimetric Method; Method SW-846/7196A	09/04/09	7.2	12/23/09	Definitive	SMI, SS, SB, SD, SW, AQ / METAL, FMETAL	Colorimeter	TA-West Sacramento	N

SOP is currently in-review at time of preparation of this Worksheet (April 27, 2010).

1 If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the Navy QAO.

2 WS-EHS-0001 is on a 2-year review schedule as it is not a technical SOP. Each method SOP also has its own waste disposal requirements.

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SAP Worksheet #24 — Analytical Instrument Calibration Table

Instrument[3]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
HPLC	Initial Calibration (ICAL; minimum five-point for all analytes)	ICAL prior to sample analysis. Once calibration curve or line is generated, the lowest calibration standard must be reanalyzed.	The apparent signal-to-noise ratio at the RL must be at least 5:1. If linear regression is used, r ≥ 0.995. If using Internal Standardization, RSD ≤ 15%.	Correct problem then repeat ICAL. Flagging criteria are not appropriate.	Analyst	WS-LC-0009
	Second Source Calibration Verification (ICV)	Once after each ICAL.	All project analytes and surrogates within ± 20% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	Continuing Calibration Verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All target analytes and surrogates within ± 20% of the expected value from the ICAL.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. 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 last acceptable CCV.		
LC/MS/MS	Initial Calibration (ICAL)	Minimum of five calibration standards to establish linearity at method set-up and after major maintenance	r ≥ 0.995 or RSD ≤ 20%. The concentration corresponding to the absolute value of the calibration curve's Y-intercept must be ≤ LOD.	Correct problem then repeat ICAL. Flagging criteria are not appropriate. Problem must be corrected. No samples may be run until ICAL has passed. The calibration is linear and shall not be forced through the origin.	Analyst	WS-LC-0012
	Second Source Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard at the midpoint of the calibration.	Within ±15% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.		
	Continuing Calibration Verification (CCV)	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard demonstrating that the system was capable of accurately detecting and quantifying perchlorate.	Within ±15% of true value.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV. 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 last acceptable CCV.		
	Tuning	Prior to ICAL and after any mass calibration or maintenance is performed	Tuning standards must contain the analytes of interest and meet acceptance criteria outlined in SOP WS-LC-0012 section 10.2 and 10.3.	Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Flagging criteria are not appropriate. Problem must be corrected. Sample analysis shall not proceed without acceptable tuning.		
	Limit of Detection Verification (LODV) (per batch)	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within ±30% of true value. Perchlorate spike concentration is approximately 2 times the limit of detection.	Correct problem and rerun LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported. 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 LODV. Problem must be corrected. Results may not be reported without a valid LODV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.		
	Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved). Problem must be corrected. No samples may be analyzed under a failing mass calibration.	Mass calibration range must bracket the ion masses of interest without greatly exceeding the range. The most recent mass calibration must be used for an analytical run, and the same mass calibration must be used for all data files in an analytical run. Mass calibration must be verified by acquiring a full scan continuum mass spectrum of a perchlorate stock standard. Perchlorate ions should be within ± 0.3 m/z of mass 99, 101, and 107 or their respective daughter ion masses (83, 85, and 89), depending on which ions are quantitated.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance. Flagging criteria are not appropriate.		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

Instrument[3]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
ICP-AES	Linear dynamic range or high-level check standard	Every 6 months	Within ±10% of true value.	N/A	Analyst	WS-MT-0003
	Initial Calibration (ICAL; Minimum one high standard and a calibration blank for all analytes)	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.		
	Second Source Calibration Verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analytes(s) within ±10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL. Flagging criteria are not appropriate.		
	Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	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.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate.		
	Calibration Blank	Refer to Worksheet 28-1 and 28-5	Refer to Worksheet 28-1 and 28-5	Refer to Worksheet 28-1 and 28-5		
ICP-MS	Instrument Detection Limit (IDL) Study	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be ≤ LOD	N/A	Analyst	WS-MT-0001
	Tuning	Prior to ICAL	Mass calibration < 0.1 amu from the true value; Resolution ≤ 0.9 amu full width at 10% peak height; For stability, RSD ≤ 5% for at least four replicate analyses.	Retune instrument and reanalyze tuning solutions. Flagging criteria are not appropriate. No analysis shall be performed without a valid MS tune.		
	Linear dynamic range or high-level check standard	Every 6 months	Within ±10% of true value.	N/A		
	Initial Calibration (ICAL; 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.		
	Second Source Calibration Verification (ICV)	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.		
	Low-level calibration check standard	Daily, after one-point ICAL.	Within ±20% of true value.	Correct problem, then reanalyze. Flagging criteria are not appropriate.		
	Calibration Blank	Refer to Worksheet 28-1 and 28-5	Refer to Worksheet 28-1 and 28-5	Refer to Worksheet 28-1 and 28-5		

SAP Worksheet #24 — Analytical Instrument Calibration Table (continued)

Instrument[3]	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA[2]	SOP Reference[1]
pH Meter	Initial Calibration (minimum of three buffers)	Daily	±0.05 pH units	Perform maintenance/repair. Use new buffers, recalibrate	Analyst	WS-WC-0044
	Initial Calibration Verification	Immediately following initial calibration	±0.1 pH units	Stop the analysis and correct the problem before resuming.		
	Continuing Calibration Verification	After every 10 or fewer samples and at the end of the run.	±0.1 pH units	All associated samples must be reanalyzed.		
Colorimeter	Initial Calibration (ICAL; Minimum three standards and a calibration blank)	Daily ICAL prior to sample analysis.	r ≥ 0.995	Correct problem, then repeat ICAL. Flagging criteria are not appropriate.	Analyst	WS-WC-0020
	Second Source Calibration Verification (ICV; also known as independently prepared check standard)	Before beginning a sample run.	Value of second source within ±10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat calibration. Flagging criteria are not appropriate.		
	Continuing Calibration Verification (CCV)	After every 15 field samples and at the end of the analysis sequence.	Value of CCV within ±10% of true value.	Correct problem then repeat CCV and reanalyze all samples since 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.		
TOC Analyzer	Initial Calibration	Every analytical run	correlation coefficient ≥0.995	Check instrument performance, perform corrective maintenance, recalibrate	Analyst	PT-WC-30
	Continuing Calibration	Every 20 drops and at the end of the analytical sequence.	Total Organic Carbon within ±15%	Check instrument performance, perform corrective maintenance, recalibrate and reanalyze all samples analyzed since the last successful calibration verification.		

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).
2 Name or title of responsible person may be used.
3 DoD QSM v. 4.1 is the basis for specifications on this table. Specifications are based on the SW-846 method that will be performed. Laboratory SOPs and analytical methods are the basis for pH, and TOC methods.

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SAP Worksheet #25 — Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person[2]	SOP Reference[1]
LC/MS/MS	Replace columns as needed, check effluent reservoirs, check for leaks.	Mass Tuning Verification, Continuing Calibration Verification	Monitor instrument performance via ion ratios and Continuing Calibration Verification.	Refer to Worksheet 24	Refer to Worksheet 24.	As needed, replace/refresh effluents, HPLC column, guard column and/or in-line frit. Repeat mass tuning check, initial calibration or CCV and reanalyze affected samples. See SOP for more details.	Analyst	WS-LC-0012
HPLC	Replace columns as needed, check effluent reservoirs, check for leaks.	Continuing Calibration Verification	Monitor instrument performance via Continuing Calibration Verification.	Refer to Worksheet 24	Refer to Worksheet 24.	As needed, replace/refresh effluents, HPLC column, guard column and/or in-line frit. Repeat initial calibration or CCV and reanalyze affected samples. See SOP for more details.	Analyst	WS-LC-0009
ICP-AES ICP-MS	Perform leak test, check pump tubing, clean torch and window, clean filters.	Initial Calibration Verification and Initial Calibration Blank	Monitor instrument performance via Initial Calibration Verification and Initial Calibration Blank	Refer to Worksheet 24	Refer to Worksheet 24.	Check/replace pump tubing, clean torch and window, clean all filters. Repeat calibration or calibration verification and any affected samples. See SOP for more details.	Analyst	WS-MT-0003 WS-MT-0001
pH Meter	Perform routine calibration check	Calibrate meter with pH 4, and 10 solutions	Monitor instrument performance via pH 7 check	Daily	±0.1 pH unit	Clean electrode, re-fill with solution, replace as necessary. Recalibrate.	Analyst	WS-WC-0044
Colorimeter	Clear cuvettes, cuvette holder, and lense as necessary. Perform outside calibration annually.	Continuing Calibration Verification	Monitor instrument performance via Continuing Calibration Verification.	Refer to Worksheet 24	Refer to Worksheet 24	Correct problem and repeat calibration.	Analyst	WS-WC-0020
TOC Analyzer	Check for leaks, fill humidifier vessel, Replace DI water.	Standard Check sample	Monitor instrument performance via Standard Check sample	Daily, after every 10 samples	Total Organic Carbon within ±10%	Replace catalysts, clean tubing or replace tubing.	Analyst	PT-WC-30

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

[2] Name or title of responsible person may be used.

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SAP Worksheet #26 — Sample Handling System

Sample Handling System
SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Field Team Leader (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/Test America West Sacramento; Note that all analytical fractions will be shipped directly to Test America West Sacramento. Test America West Sacramento will ship applicable fractions to Test America Seattle and Test America Pittsburgh.
Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/ Test America West Sacramento
Sample Preparation (Personnel/Organization): Extractions Personnel/ Test America West Sacramento
Sample Determinative Analysis (Personnel/Organization): Analyst/ Test America West Sacramento, Analyst/ Test America Seattle, Analyst/ Test America Pittsburgh
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days
Sample Extract/Digestate Storage (No. of days from extraction/digestion): Extracts 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/ Test America West Sacramento, Environmental Health and Safety Officer/ Test America Seattle, Environmental Health and Safety Officer/ Test America Pittsburgh
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

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 field team leader. 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 coolers containing enough ice to keep the samples below 4°C until they are received by the laboratory. The chain of custody (COC) will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the air bill 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 SOPs WS-QA-0003 and WS-EHS-0001.

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 EIS to check sample IDs and parameters are correct.

Chain-of-Custody Procedures

Chains of custody 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 chain of custody will also have the sampler's name and signature. The chain of custody 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.

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SAP Worksheet #28-1 — Laboratory QC Samples Table

Matrix: SMI, SS, SB, or SD
Analytical Group: METAL
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-QA-0028, WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
METALs by SW-846 6010B						
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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1).	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1).
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.	Analyst	Accuracy/Bias, Contamination	No analytes detected > LOD.
Interference Check Solutions (ICS)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike 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 al samples associated with the ICS.	Analyst	Accuracy/Bias	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes). ICS-AB: Within ±20% of true value.
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1. 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests 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/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-1.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-1.
Serial Dilution	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform post-digestion spike (PDS) addition.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.
Post-digestion Spike (PDS)	When dilution test fails or analyte concentration in all samples < 50X LOD.	75-125%R	Run all associated samples in the preparatory batch by method of standard additions (MSA). Or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	75-125%R
METALs by SW-846 6020						
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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .

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

Matrix: SMI, SS, SB, or SD
Analytical Group: METAL
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-QA-0028, WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
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.	Analyst	Accuracy/Bias, Contamination	No analytes detected > LOD.
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 spike 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 al samples associated with the ICS.	Analyst	Accuracy/Bias	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes). ICS-AB: Within ±20% of true value.
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests 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/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-1.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-1.
Serial Dilution	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform post-digestion spike (PDS) addition.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.
Internal Standards (IS)	Every sample	IS intensity within 30-120% of intensity of the IS in the ICAL	Reanalyze sample at 5-fold dilution with addition of appropriate amounts of internal standards. Flagging criteria are not appropriate.	Analyst	Accuracy	IS intensity within 30-120% of intensity of the IS in the ICAL
Post-digestion Spike (PDS)	When dilution test fails or analyte concentration in all samples < 50X LOD.	75-125%R	Run all associated samples in the preparatory batch by method of standard additions (MSA). Or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	75-125%R
Hexavalent Chromium by SW-846 7196A						
Reference Blank (reagent water)	Before beginning standards or sample analysis.	N/A	N/A	Analyst	N/A	N/A
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 (see Box D-1 of DoD QSM v 4.1)..	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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 (see Box D-1 of DoD QSM v 4.1)..

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

Matrix: SMI, SS, SB, or SD						
Analytical Group: METAL						
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-QA-0028, WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020						
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated batch for the failed analyte in all samples in the associated preparatory batch, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-1. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Sample Matrix Verification (also known as matrix spike)	Once for every sample matrix analyzed.	Same as LCS.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions. Flagging criteria are not appropriate.	Analyst	Accuracy/Bias	Same as LCS.
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-1.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. Flagging criteria are not appropriate.	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-1.
Post-digestion matrix spike	One per preparatory batch.	Same as LCS.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst	Accuracy/Bias	Same as LCS.

Preparation for SMI (does not apply to SS, SB, or SD samples)						
Soil drying procedure	Refer to Worksheet 28-2					
Soil sieving procedure	Refer to Worksheet 28-2					
Soil grinding procedure (for METAL, grinding is done by hand with ceramic equipment and only the subsamples are ground).	Refer to Worksheet 28-2					
Soil grinding blank	Refer to Worksheet 28-2					
Soil subsampling process (for METAL, aliquots are 10g for 6010B, 10g for 6020, and 10g for 7196A)	Each sample, duplicate, 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 ~10 g subsample.	No corrective action needed.	Analyst	Accura cy	No measurement performance criteria needed.
Soil sample triplicate analysis	Refer to Worksheet 28-2					

[1] DoD QSM v. 4.1 is the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

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SAP Worksheet #28-2 — Laboratory QC Samples Table

Matrix: SMI, SS, SB, or SD

Analytical Group: EXPLO

Analytical Method / SOP Reference: SW-846 8330B, 6850 / WS-QA-0028, WS-LC-0009, WS-LC-0012

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
EXPLO by SW-846 8330B						
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. 4.1 . If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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.
Laboratory Control Sample	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. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	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. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.
Environmental Resource Associates (ERA) Performance Evaluation (PE) Sample	One per preparatory batch.	100-200g Certified Reference Material (CRM) [part number COE 8330B Explosives in Soils Standard from ERA]. QC acceptance limits are same as LCS.	Same as LCS	Analyst	Accuracy/Bias	Same as LCS.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-2.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-2.
Confirmation analysis	All field and QC samples.	All samples with positive results	Peaks within the retention time window for the compound on both columns.	Analyst	Accuracy / Precision	Peaks within the retention time window for the compound on both columns.
Perchlorate by SW-846 6850						
Method Blank	One per preparatory batch.	No perchlorate detected > ½ RL and greater than 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. quantitation limit	If associated detects are < QL, the results will be reported and the contamination will be narrated. If associated detects > QL, the batch will be re-extracted and reanalyzed.	Analyst	Accuracy/Bias, Contamination	No perchlorate detected > ½ RL and greater than 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.
Laboratory Control Sample	One per preparatory batch. LCS must be spiked at the RL.	Refer to Worksheet 15-2. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-2. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix. The MS must be spiked at the RL	Refer to Worksheet 15-2. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Refer to Worksheet 15-2. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike Duplicate	One per preparatory batch per matrix. The MS must be spiked at the RL	Same as MS and refer to Worksheet 15-2.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-2.

SAP Worksheet #28-2 — Laboratory QC Samples Table (continued)

Matrix: SMI, SS, SB, or SD

Analytical Group: EXPLO

Analytical Method / SOP Reference: SW-846 8330B, 6850 / WS-QA-0028, WS-LC-0009, WS-LC-0012

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Interference Check Sample	Once ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ±30% of true value.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate. Analysis of a standard containing perchlorate at the RL and interfering anions at the concentration determined by the interference threshold study. Monitor recovery of perchlorate and retention time. No samples may be reported that are associated with a failing ICS.	Analyst	Accuracy	Once ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.
Isotope ratio $^{35}Cl/^{37}Cl$	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8 .	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.
Internal Standard	Addition of ^{18}O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured ^{18}O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0±2% (0.98-1.02).	Rerun the sample at increasing dilutions until the ±50% acceptance criteria are met. If criteria cannot be met with dilution, the interference is suspected and the sample must be reprepared using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing internal standard should be thoroughly documented in the case narrative.	Analyst	Accuracy/Bias	Measured ^{18}O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0±2% (0.98- 1.02).
Preparation for SMI (does not apply to SS, SB, or SD 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.	No corrective action needed.	Analyst	Accuracy	No measurement performance criteria needed.
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.	No corrective action needed.	Analyst	Accuracy	No measurement performance criteria needed.

SAP Worksheet #28-2 — Laboratory QC Samples Table (continued)

Matrix: SMI, SS, SB, or SD

Analytical Group: EXPLO

Analytical Method / SOP Reference: SW-846 8330B, 6850 / WS-QA-0028, WS-LC-0009, WS-LC-0012

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Soil grinding procedure (for EXPLO, the entire sample is mechanically ground).	Initial demonstration.	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 µm by passing representative portions of ground sample through a 200 mesh sieve (ASTM E11).	No corrective action needed.	Analyst	Accuracy	No measurement performance criteria needed.
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. 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 are 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	Accuracy/Bias, Contamination	All blank results must be reported and the affected samples must be flagged accordingly if blank criteria are 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.
Soil subsampling process (for EXPLO, aliquots are 10g for 8330B and 1g for 6850)	Each sample, duplicate, 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 ~10 g or ~1 g subsample.	No corrective action needed.	Analyst	Accuracy	No measurement performance criteria needed.
Soil sample laboratory triplicate	At the subsampling step, one sample per batch. Cannot be performed on any type of blank sample.	Three 10 g subsamples are taken from a sample expected to contain the highest levels of explosives 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	Accuracy	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.

[1] DoD QSM v. 4.1 is the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

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SAP Worksheet #28-3 — Laboratory QC Samples Table

Matrix: SMI, SS, and SD
Analytical Group: WCHEM
Analytical Method / SOP Reference: SW-846 9045C, Lloyd Kahn / WS-QA-0028, WS-WC-0044, PT-WC-30

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
pH (SW-846 9045C)						
Laboratory Control Sample (LCS)	One per batch	±0.1 pH units	All samples associated with a failed LCS must be reanalyzed	Analyst, Laboratory Supervisor	Accuracy, Bias	±0.1 pH units
Laboratory Replicate	One per batch	RPD < 0.5 pH units	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias	RPD < 0.5 pH units
Total Organic Carbon (Lloyd Kahn)						
Method Blank	One per batch	no analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample	Investigate source of contamination. Rerun method blank.	Analyst, Laboratory Supervisor	Bias/Contamination	no analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample
Laboratory Control Sample (LCS)	One per batch of 20 or fewer samples	75-125%R	Reanalyze. Investigate standards and recalibrate if necessary.	Analyst, Laboratory Supervisor	Accuracy, Precision	75-125%R
Laboratory Control Sample Duplicate (LCSD)	If no MSD in batch	Same as LCS. %RPD < 20%	Same as LCS	Analyst, Laboratory Supervisor	Accuracy, Precision	Same as LCS. %RPD < 20%
Laboratory Quadruplicate	One per batch	%RSD ≤20%	Advisory. Reanalysis may be done unless obvious matrix issues.	Analyst, Laboratory Supervisor	Accuracy, Bias	%RSD ≤20%
Preparation for SMI (does not apply to SS or SD samples)						
Soil drying procedure	Refer to Worksheet 28-2					
Soil sieving procedure	Refer to Worksheet 28-2					
Soil subsampling process (for pH, the aliquot is 25g)	Each sample, duplicate, 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 ~25 g subsample.	No corrective action needed.	Analyst	Accuracy	No measurement performance criteria needed.

[1] DoD QSM v. 4.1 is the basis for specifications on this table. Laboratory SOPs are the basis for QA/QC procedures for pH and TOC.
Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

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SAP Worksheet #28-4 — Laboratory QC Samples Table

Matrix: SD						
Analytical Group: GRAINSIZE						
Analytical Method / SOP Reference: ASTM D422 / D422						
QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator (DQI)**	**Measurement Performance Criteria**
N/A: Laboratory QC samples are not planned for grain size (sieve) analysis.						

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

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SAP Worksheet #28-5 — Laboratory QC Samples Table

Matrix: SW and AQ (blanks only)
Analytical Group: METAL or FMETAL
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
METALs or FMETALs by SW-846 6010B						
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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .
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.	Analyst	Accuracy/Bias, Contamination	No analytes detected > LOD.
Interference Check Solutions (ICS)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike 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 al samples associated with the ICS.	Analyst	Accuracy/Bias	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes) ICS-AB: Within ±20% of true value.
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests 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/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-5 or 15-5A.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-5 or 15-5A.
Serial Dilution	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform post-digestion spike (PDS) addition.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.
Post-digestion Spike (PDS)	When dilution test fails or analyte concentration in all samples < 50X LOD.	75-125%R	Run all associated samples in the preparatory batch by method of standard additions (MSA). Or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	75-125%R
METALs or FMETALs by SW-846 6020						
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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1 . If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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. For common laboratory contaminants, no analytes detected > RL (see Box D-1 of DoD QSM v 4.1) .

SAP Worksheet #28-5 — Laboratory QC Samples Table (continued)

Matrix: SW or AQ (blanks only)
Analytical Group: METAL or FMETAL
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
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.	Analyst	Accuracy/Bias, Contamination	No analytes detected > LOD.
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 spike 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 al samples associated with the ICS.	Analyst	Accuracy/Bias	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spike analytes) ICS-AB: Within ±20% of true value.
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests 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/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-5 or 15-5A.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-5 or 15-5A.
Serial Dilution	One per preparatory batch.	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.	Perform post-digestion spike (PDS) addition.	Analyst	Accuracy	Five-fold dilution must agree within ±10% of the original measurement. Only applicable for samples with concentrations > 50X LOQ.
Internal Standards (IS)	Every sample	IS intensity within 30-120% of intensity of the IS in the ICAL	Reanalyze sample at 5-fold dilution with addition of appropriate amounts of internal standards. Flagging criteria are not appropriate.	Analyst	Accuracy	IS intensity within 30-120% of intensity of the IS in the ICAL
Post-digestion Spike (PDS)	When dilution test fails or analyte concentration in all samples < 50X LOD.	75-125%R	Run all associated samples in the preparatory batch by method of standard additions (MSA). Or, for the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy	75-125%R
Hexavalent Chromium or Filtered Hexavalent Chromium by SW-846 7196A						
Reference Blank (reagent water)	Before beginning standards or sample analysis.	N/A	N/A	Analyst	N/A	N/A
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 (see Box D-1 of DoD QSM v 4.1)..	Correct problem, then see criteria in Box D-1 of DoD QSM v. 4.1. If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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 (see Box D-1 of DoD QSM v 4.1)..

SAP Worksheet #28-5 — Laboratory QC Samples Table (continued)

Matrix: SW or AQ (blanks only)						
Analytical Group: METAL or FMETAL						
Analytical Method / SOP Reference: SW-846 6010B, 6020, 7196A / WS-IP-0002, WS-MT-0003, WS-MT-0001, WS-WC-0020						
Laboratory Control Sample	One per preparatory batch.	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated batch for the failed analyte in all samples in the associated preparatory batch, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-5 or 15-5A. Limits are as per DoD QSM v. 4.1. In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Sample Matrix Verification (also known as matrix spike)	Once for every sample matrix analyzed.	Same as LCS.	If check indicates interference, dilute and reanalyze sample; persistent interference indicates the need to use alternative method or analytical conditions, or to use method of standard additions. Flagging criteria are not appropriate.	Analyst	Accuracy/Bias	Same as LCS.
Matrix Spike Duplicate (MSD) or Laboratory Replicate	One per every 10 project sample per matrix.	Same as MS and refer to Worksheet 15-5 or 15-5A.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. Flagging criteria are not appropriate.	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-5 or 15-5A.
Post-digestion matrix spike	One per preparatory batch.	Same as LCS.	Correct problem and rehomogenize, redigest, and reanalyze samples. Persistent interference indicates the need to use an alternative method or analytical conditions, or to use method of standard additions.	Analyst	Accuracy/Bias	Same as LCS.

[1] DoD QSM v. 4.1 is the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

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SAP Worksheet #28-6 — Laboratory QC Samples Table

Matrix: SW and AQ
Analytical Group: EXPLO
Analytical Method / SOP Reference: SW-846 8330B, 6850 / WS-LC-0009, WS-LC-0012

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
EXPLO by SW-846 8330B						
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. 4.1 . If required, reprepare 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 analytes(s) in all samples in the associated preparatory batch.	Analyst	Accuracy/Bias, 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.
Laboratory Control Sample	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. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	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. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.
Matrix Spike	One per preparatory batch per matrix.	Same as LCS.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Same as LCS.
Matrix Spike Duplicate	One per preparatory batch per matrix.	Same as MS and refer to Worksheet 15-6.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-6.
Confirmation analysis	All field and QC samples.	All samples with positive results	Peaks within the retention time window for the compound on both columns.	Analyst	Accuracy / Precision	Peaks within the retention time window for the compound on both columns.
Perchlorate by SW-846 6850						
Method Blank	One per preparatory batch.	No perchlorate detected > ½ RL and greater than 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. quantitation limit	If associated detects are < QL, the results will be reported and the contamination will be narrated. If associated detects > QL, the batch will be re-extracted and reanalyzed.	Analyst	Accuracy/Bias, Contamination	No perchlorate detected > ½ RL and greater than 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.
Laboratory Control Sample	One per preparatory batch. LCS must be spiked at the RL.	Refer to Worksheet 15-6. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Refer to Appendix G of DoD QSM v. 4.1 . 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.	Analyst	Accuracy/Bias	Refer to Worksheet 15-6. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike	One per preparatory batch per matrix. The MS must be spiked at the RL	Refer to Worksheet 15-6. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst	Accuracy/Bias	Refer to Worksheet 15-6. Limits are as per DoD QSM v. 4.1 . In-house statistical laboratory limits are provided when DoD QSM v. 4.1 does not specify.
Matrix Spike Duplicate	One per preparatory batch per matrix. The MS must be spiked at the RL	Same as MS and refer to Worksheet 15-6.	Same as MS	Analyst	Accuracy/Bias, Precision	Same as MS and refer to Worksheet 15-6.

SAP Worksheet #28-6 — Laboratory QC Samples Table (continued)

Matrix: SW and AQ
Analytical Group: EXPLO
Analytical Method / SOP Reference: SW-846 8330B, 6850 / WS-LC-0009, WS-LC-0012

QC Sample[1]	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Interference Check Sample	Once ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ±30% of true value.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed. Flagging criteria are not appropriate. Analysis of a standard containing perchlorate at the RL and interfering anions at the concentration determined by the interference threshold study. Monitor recovery of perchlorate and retention time. No samples may be reported that are associated with a failing ICS.	Analyst	Accuracy	Once ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.
Isotope ratio $^{35}Cl/^{37}Cl$	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8 .	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.). Apply J-flag if acceptance criteria are not met. Decision to report data failing ratio check should be thoroughly documented in case narrative.	Analyst	Accuracy	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~3.06. Must fall within 2.3 to 3.8.
Internal Standard	Addition of ^{18}O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank.	Measured ^{18}O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0±2% (0.98-1.02).	Rerun the sample at increasing dilutions until the ±50% acceptance criteria are met. If criteria cannot be met with dilution, the interference is suspected and the sample must be reprepared using additional pretreatment steps. Apply Q-flag and discuss in the case narrative. If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing internal standard should be thoroughly documented in the case narrative.	Analyst	Accuracy/Bias	Measured ^{18}O IS area within ±50% of the value from the average of the IS area counts of the ICAL. RRT of the perchlorate ion must be 1.0±2% (0.98- 1.02).

[1] DoD QSM v. 4.1 is the basis for specifications on this table.

Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36.

SAP Worksheet #29 — Project Documents and Records Table

Document	Where Maintained
Field Notebooks	Electronic .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 project file. Archived at project closeout.
Air Bills	Hardcopy in the project file. Archived at project closeout.
Telephone Logs	Hardcopy in the project file. Archived at project closeout.
Corrective Action Forms	Electronic .pdf copies in the project file. Hardcopy in the project file. Archived at project closeout.
Water quality field parameters collected during surface water sampling	Recorded in Field Notebook. Stored in VDMS.
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 Field Team Leader. Not maintained.
Sample Receipt, Custody, and Tracking Records	Electronic .pdf copies in the project file. Hardcopy in the full data package.
Equipment Calibration Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Sample Prep Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Run Logs	Hardcopy in the full data package[1]. Archived at project closeout.
Reported Field Sample Results	Electronic .pdf copies in the project file. Hardcopy in the full data package[1]. Archived at project closeout.
Reported Results for Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout.
Instrument Printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples	Hardcopy in the full data package[1]. Archived at project closeout.
Sample Disposal Records	Maintained by the laboratory.
Extraction/Clean-up Records	Hardcopy in the full data package[1].
Raw Data	Hardcopy in the full data package[1]. 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.
Remedial Investigation Report	Electronic .pdf copies in the project file. Hardcopy (bound notebook) in the project file and administrative record. Archived at project closeout.

* Data archiving will be done in accordance with Navy requirements. CH2M HILL will provide the Navy (currently Bonnie Capito) all data and reports for archiving.
1 The format of the full hardcopy data package is described in TestAmerica SOP 10.0021. CH2M HILL requires a “Level 4” package.

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SAP Worksheet #30 — Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time[2]	Laboratory / Organization[1] (name and address, contact person, and telephone number)	Backup Laboratory / Organization (name and address, contact person, and telephone number)
SMI	EXPLO	37	EXPLOs by SW-846 8330B Perchlorate by SW-846 6850	Standard 28 Calendar-day TAT	Test America-West Sacramento 880 Riverside Parkway West Sacramento, CA 95605 POC: Nilo Ligi (916) 374-4427	TBD
	WCHEM		pH by SW-846 9045C			
	METAL	47 (includes 10 background samples)	METALs (ICP-AES) by SW-846 6010B METALs (ICP-MS) by SW-846 6020 Hexavalent chromium by SW-846 7196A			
SD	EXPLO	15	EXPLOs by SW-846 8330B Perchlorate by SW-846 6850	Standard 28 Calendar-day TAT	Test America-West Sacramento	TBD
	METAL		METALs (ICP-AES) by SW-846 6010B METALs (ICP-MS) by SW-846 6020 Hexavalent chromium by SW-846 7196A			
	WCHEM		pH by SW-846 9045C			
			Total Organic Carbon (TOC) by Lloyd Kahn		Test America-Pittsburgh 301 Alpha Drive Pittsburgh, PA 15238 POC: Tara Martz (412) 963-7058	
	GRAINSIZE		Grain Size (Sieve Only, No Hydrometer) by ASTM D422		Test America-Seattle 5755 8th Street East Tacoma, WA 98424 POC: Terri Torres (425) 420-9200	
SS	EXPLO	7	EXPLOs by SW-846 8330B Perchlorate by SW-846 6850	Standard 28 Calendar-day TAT	Test America-West Sacramento	TBD
	METAL	8 (includes 1 Battery Disposal Area sample)	METALs (ICP-AES) by SW-846 6010B METALs (ICP-MS) by SW-846 6020 Hexavalent chromium by SW-846 7196A			
	WCHEM		pH by SW-846 9045C			
SB	EXPLO	5	EXPLOs by SW-846 8330B Perchlorate by SW-846 6850	Standard 28 Calendar-day TAT	Test America-West Sacramento	TBD
	METAL		METALs (ICP-AES) by SW-846 6010B METALs (ICP-MS) by SW-846 6020 Hexavalent chromium by SW-846 7196A			

SAP Worksheet #30 — Analytical Services Table (continued)

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time[2]	Laboratory / Organization[1] (name and address, contact person, and telephone number)	Backup Laboratory / Organization (name and address, contact person, and telephone number)
SW	EXPLO	5	EXPLOs by SW-846 8330B Perchlorate by SW-846 6850	Standard 28 Calendar-day TAT	Test America-West Sacramento	TBD
	METAL		METALs (ICP-AES) by SW-846 6010B METALs (ICP-MS) by SW-846 6020 Hexavalent chromium by SW-846 7196A			
	FMETAL		FMETALs (ICP-AES) by SW-846 6010B FMETALs (ICP-MS) by SW-846 6020 Filtered Hexavalent chromium by SW-846 7196A			

[1]If the laboratory is not known at time of SAP submission, put "TBD" in the column as a placeholder.

[2]Standard 28 calendar-day TAT is for analytical laboratory data. Data validation is conducted using a standard 14 calendar-day TAT.

SAP Worksheet #31 — Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Field Performance Audit	One during sampling activities	Internal	CH2M HILL	Jake Crostic Field auditor CH2M HILL	Project Field Team CH2M HILL	John Swenfurth PM CH2M HILL	Brett Doerr Environmental Manager CH2M HILL
Safe Work Observation	One per week during field activities	Internal	CH2M HILL	Stephen Brand Field Team Leader CH2M HILL	Project Field Team CH2M HILL	Mark Orman H & S Officer CH2M HILL	Mark Orman H&S Officer CH2M HILL

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SAP Worksheet #32 — Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of Corrective Action (CA) Response Documentation	Individual(s) Receiving CA Response (name, title, organization)	Timeframe for Response
Field Performance Audit	Field Performance Audit Checklist	Field Team PM Environmental Manager	Within one day of audit	Verbal and CA Form	FTL CH2M HILL	Within one day of receipt of CA Form
Safe Work Observation (SWO)	Safe Work Observation Form	FTL Field Team PM	Immediately (person involved or observed person). Following day (field team). Within 1 week if worthy of elevation (H&S officer)	On SWO Form	FTL and individual being observed, and the PM and if elevated to the H&S officer.	Corrected in the field immediately, and within 1 week if elevated.

SAP Worksheet #32-1 — Corrective Action 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: .....

CA initially approved by: .....

.....

Date: .....

.....

Follow-up date: .....

.....

Final CA approved by: .....

.....

Date: .....

.....

Information copies to:

.....

.....

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 the work plan?
Comments _____

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

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

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 #32-3 — Safe Work Observation Form

Project:		**Observer:**	**Date:**
Position/Title of worker observed:		**Background Information/comments:**	
Task/Observation Observed:			

Identify and reinforce safe work practices/behaviors

Identify and improve on at-risk practices/acts

Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards

Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)

Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's CAs/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's CAs/Comments:**
Other…			

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SAP Worksheet #33 — QA Management Reports Table

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliations)
Field Audit Report	One during sampling activities	Submitted with report in which data are analyzed and presented	Project Manager: John Swenfurth/CH2M HILL	Regional Health, Safety, Environment, and Quality Manager: Mark Orman/CH2M HILL Included in project files.
Data Validation Reports	Once, after analysis by laboratory, for all laboratory analytical data except WCHEM and GRAINSIZE analyses.	Submitted by the data validator within 14 calendar-days of notification to begin)	Project Manager: TBD	Project Chemist: Michael Zamboni/CH2M HILL Project EIS: Vickie Weber/CH2M HILL Project Manager: John Swenfurth/CH2M HILL
Data Usability Assessments (Data Quality Evaluation)	Once, as an appendix to the report in which data are analyzed and presented.	Along with the project report.	Project Chemist: Michael Zamboni/CH2M HILL	Vieques RPM: Daniel Rodriquez/USEPA and Vieques RPM Wilmarie Rivera/PREQB

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SAP Worksheet #34 — Verification (Step I) Process Table

Verification Input	Description	Internal / External[1]	Responsible for Verification (name, organization)
Field Notebooks	Field notebooks will be reviewed internally and placed into the project file for archival at project closeout.	Internal	Field Team Leader (TBD)/CH2M HILL
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.	Internal / External	Field Team Leader (TBD)/CH2M HILL Project EIS: Vickie Weber/CH2M HILL
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the project EIS in the form of laboratory logins.	External	Project EIS: Vickie Weber/CH2M HILL
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the project chemist. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package.	Internal	Project Chemist: Michael Zamboni/CH2M HILL
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10% check).	Internal	Project EIS: Vickie Weber/CH2M HILL
Case Narrative	Case narratives will be reviewed by the data validator during the data validation process. This is verification that they were generated and applicable to the data packages.	External	Data Validation Subcontractor: Laura Maschoff/DataQual
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Internal	Laboratory QAO (Test America-West Sacramento) Laboratory QAO (Test America-Pittsburgh) Laboratory QAO (Test America-Seattle)
Laboratory Data	The data will be verified for completeness by an Environmental Information System (EIS) specialist.	External	Project EIS: Vickie Weber/CH2M HILL
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If corrective actions are required, a copy of the documented corrective action 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 corrective action forms will be reviewed internally to ensure that all appropriate corrective actions have been taken and that corrective action reports are attached. If corrective actions have not been taken, the site manager will be notified to ensure action is taken.	Internal	Project Manager: John Swenfurth/CH2M HILL Project Chemist: Michael Zamboni/CH2M HILL
Corrective Action Reports	Corrective action reports will be reviewed by the project chemist or project manager and placed into the project file for archival at project closeout.	External	Project Manager: John Tomik/CH2M HILL Project Chemist: Michael Zamboni/CH2M HILL

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

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SAP Worksheet #35 — Validation (Steps IIa and IIb) Process Table

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	Project Chemist: Michael Zamboni/CH2M HILL
IIa	Target Compound List and Target Analyte List	Ensure the laboratory reported all analytes from each analysis group as per Worksheet 15.	Project Chemist: Michael Zamboni/CH2M HILL
IIb	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.	Project Chemist: Michael Zamboni/CH2M HILL
IIa	Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIa / IIb	Sample Chronology	Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIa	Raw Data	10 percent review of raw data to confirm laboratory calculations.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIb	Onsite Screening	All non-analytical field data will be reviewed against QAPP requirements for completeness and accuracy based on the field calibration records.	Field Team Leader (TBD)
IIa	Documentation of Method QC Results	Establish that all required QC samples were run and met limits.	Data Validation Subcontractor: Laura Maschoff/DataQual
IIb	Documentation of field QC Sample Results	Establish that all required QAPP QC samples were run and met limits.	Project Chemist: Michael Zamboni/CH2M HILL Data Validation Subcontractor: Laura Maschoff/DataQual

[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]

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SAP Worksheet #36 — Analytical Data Validation (Steps IIa and IIb) Summary Table

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	SMI or SW or SD or SS or SB	EXPLO[1]	For SW-846 8330B: "Nitroaromatics and Nitroamines by HPLC"; SOP HW-16 Revision 2; September, 2006. Note that this document is specific to SW-846 8330 and the data validator will use the QC limits specified in this UFP-SAP such that the data validation guidance is applicable to SW-846 8330B. For SW-846 6850: 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 12, QLs and PALs are presented in Worksheet 15, QA/QC criteria for calibrations are presented in Worksheet 24, and QA/QC criteria for laboratory QC samples are presented in Worksheet 28. Data may be qualified if QA/QC exceedances have occurred. Data qualifiers will be those presented in "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, October, 2004).	Data Validation Subcontractor: Laura Maschoff/DataQual
		METAL or FMETAL[1]	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 12, QLs and PALs are presented in Worksheet 15, QA/QC criteria for calibrations are presented in Worksheet 24, and QA/QC criteria for laboratory QC samples are presented in Worksheet 28. Data may be qualified if QA/QC exceedances have occurred. Data qualifiers will be those presented in "Evaluation of Metals Data for the CLP Program"; SOP HW-2 Rev.13, ILM05.3; September, 2006. Guidance and qualifiers from USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, October, 2004) may also be applicable.	
IIa and IIb	SMI or SS or SD	WCHEM	WCHEM and GRAINSIZE data will not undergo third-party data validation. However, they are still subject to the verification and validation procedures specified in Worksheets 34 and 35. The case narratives will be read, any issues will be investigated, and the impact (if any) on data quality or data usability will be discussed with the project team.	Project Chemist: Michael Zamboni/CH2M HILL
		GRAINSIZE		

[1] 100% of EXPLO, METAL, and FMETAL data will be third-party validated. Of the 100% validated, the third-party data validator will also recalculate 10% of results from the raw data.

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SAP Worksheet #37 — Usability Assessment

Data usability evaluation comprises critical assessment of the data with respect to the project objective. Given that the primary objective of the pilot studies is to evaluate the nature and extent of contamination, the comprehensive dataset will be reviewed to determine if it is adequate for making the project-specific determinations.

Some specific examples of data availability and usability protocol are:

- The third-party data validator is the only party that may apply qualifiers to the data. Minor QC exceedances will result in "estimated" data, represented by J, NJ, and UJ qualifiers. Major QC exceedances will result in "rejected" data, represented by R-qualifiers. The effect on availability and usability of rejected results will be evaluated.
- The use of "estimated" data will be discussed in the report. "Estimated" data are generally considered usable for all purposes. The project team may choose to use "rejected" data in a qualitative manner under some circumstances, if the direction of bias and proximity to a project action limit are known. For example, if there were a hypothetical location where a benzene detection was rejected because of an extremely low bias, yet the result was still greater than the project action limit, this rejected result would still be usable for demonstrating that an exceedance has occurred.
- While all non-rejected data are available for use to the project team, non-detect (and attributable to blank contamination) results may not be useful if the QL is greater than the associated project action limit. In these cases, the project team will determine whether or not the laboratory would likely have detected the contaminant if present at or above the PAL (i.e., evaluation of the PAL versus the MDL).
- Ten percent of hardcopy analytical data will be checked against the electronic data to identify discrepancies. This check will be performed manually. The check will verify results and data validation qualifiers. This process is intended to identify discrepancies between the hardcopy and electronic data. If any discrepancies are identified during the ten percent verification, the laboratory will be contacted, the discrepancies will be communicated, and the laboratory will resolve the discrepancies.
- If significant deviation is evident between parent samples and their field or laboratory duplicate, the cause will be investigated. The possibility of a switched sample will be examined. Field duplicates are expected to exhibit greater deviation than laboratory duplicates. Field duplicate and laboratory duplicate reproducibility is outlined in Worksheets 12 and 28.
- The greater of results between field duplicates (discreet sampling) or field triplicates (for multi-incremental sampling) are used for each constituent when making comparisons to screening levels and in risk assessment calculations.

SAP Worksheet #37 — Usability Assessment (continued)

- Significant biases may be evident based on LCS, MS/MSD, and spiked surrogate exceedances. The third-party data validator will consider QC exceedances and biases when applying qualifiers to data. The project team will consider the direction of bias when determining the usability of qualified data compared to PALs. Low biases are expected to occur more frequently than high biases. In the case of rejected non-detect data, low biases represent the inability of the laboratory to detect contaminants that may or may not be present at the site. The project team will act conservatively and understand that it is not known whether or not these compounds are present below, at, or above the PAL. High biases indicate that a result may be lower than it is reported. When high-biased data are greater than a PAL, the project team will examine the proximity of the result to the PAL to determine whether additional data are needed or if the result should simply be considered a PAL exceedance.
- After completion of the data validation, the distribution of applied data validation qualifiers will be examined to determine if there are patterns that negatively affect the usability of data. This information will be compiled into a DQE, which will be presented as an appendix to the project report.
- Data usability is not decided upon by any one individual or entity. The project team, as a whole, will decide upon the usability of the data.
- Deviations from the SAP sampling and analytical protocols will be reviewed to ascertain whether or not they are significant enough to negatively affect the usability of data.

Notes:

1. Completeness is defined as the percentage of measurements that are judged to be available compared to the total number of measurements made. The objective of the overall completeness goal for this project is set at 95% available data. This goal is inclusive of both field and laboratory analytical data.
2. Discussions of precision, accuracy, representativeness, completeness, and comparability will be included in the data quality review to describe the impact of data quality on project data quality objectives and data usability.

References

CH2M HILL, 2007. Final East Vieques Background Soil Inorganics Investigation Report, Former Vieques Naval Training Range, Vieques, Puerto Rico. October 2007.

CH2M HILL, 2009. Draft Expanded Range Assessment/Site Inspection Report, Former Vieques Naval Training Range, Vieques, Puerto Rico. October 2009.

CH2M HILL, 2010a. Final Master Standard Operating Procedures, Protocols, and Plans, Environmental Restoration Program Vieques, Puerto Rico. April 2010.

CH2M HILL, 2010b. Draft Time Critical Removal Action Interim Action-After Action Report, Surface Munitions and Explosives of Concern at Munitions Response Area-Live Impact Area, and Eastern Conservation Area, Former Vieques Naval Training Range (VNTR), Vieques, Puerto Rico. April 2010.

CH2M HILL, 2010c. Vieques Environmental Master Health and Safety Plan. February, 2010.

Geo-Marine, 2007. Live Impact Area Biological Assessment – Amendment 1, Eastern Conservation Area. August 2007.

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Figures

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FIGURE 1
Regional Location Map
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

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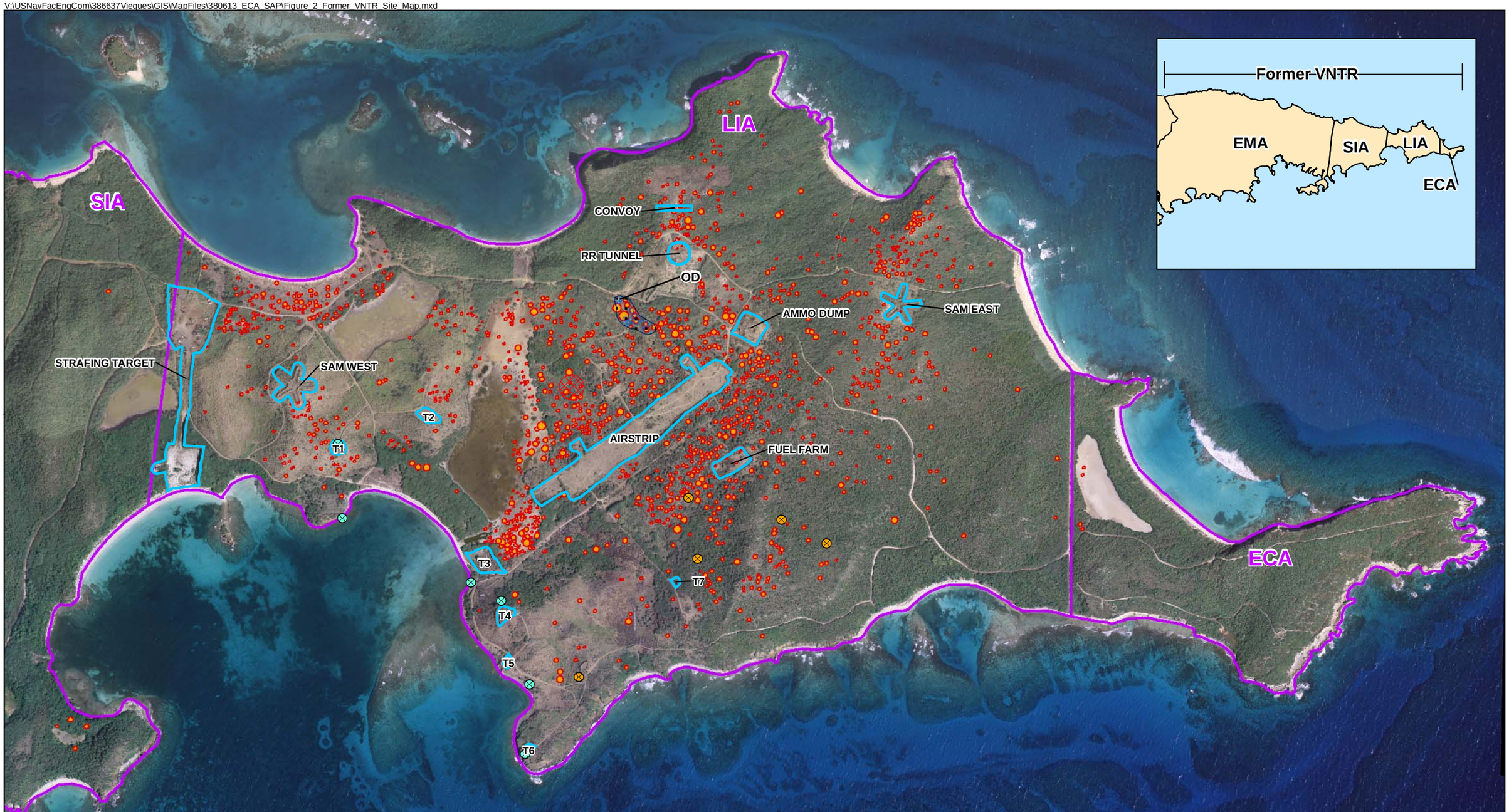
V:\USNavFacEngCom\386637Vieques\GIS\MapFiles\380613_ECA_SAP\Figure_2_Former_VNTR_Site_Map.mxd



Legend

- Air to Ground Target
- Naval Gunfire Support Target
- OB - Open Burn
- Target Features
- Open Detonation Area
- Open Detonation Pits
- Craters
- Vieques Boundary Section

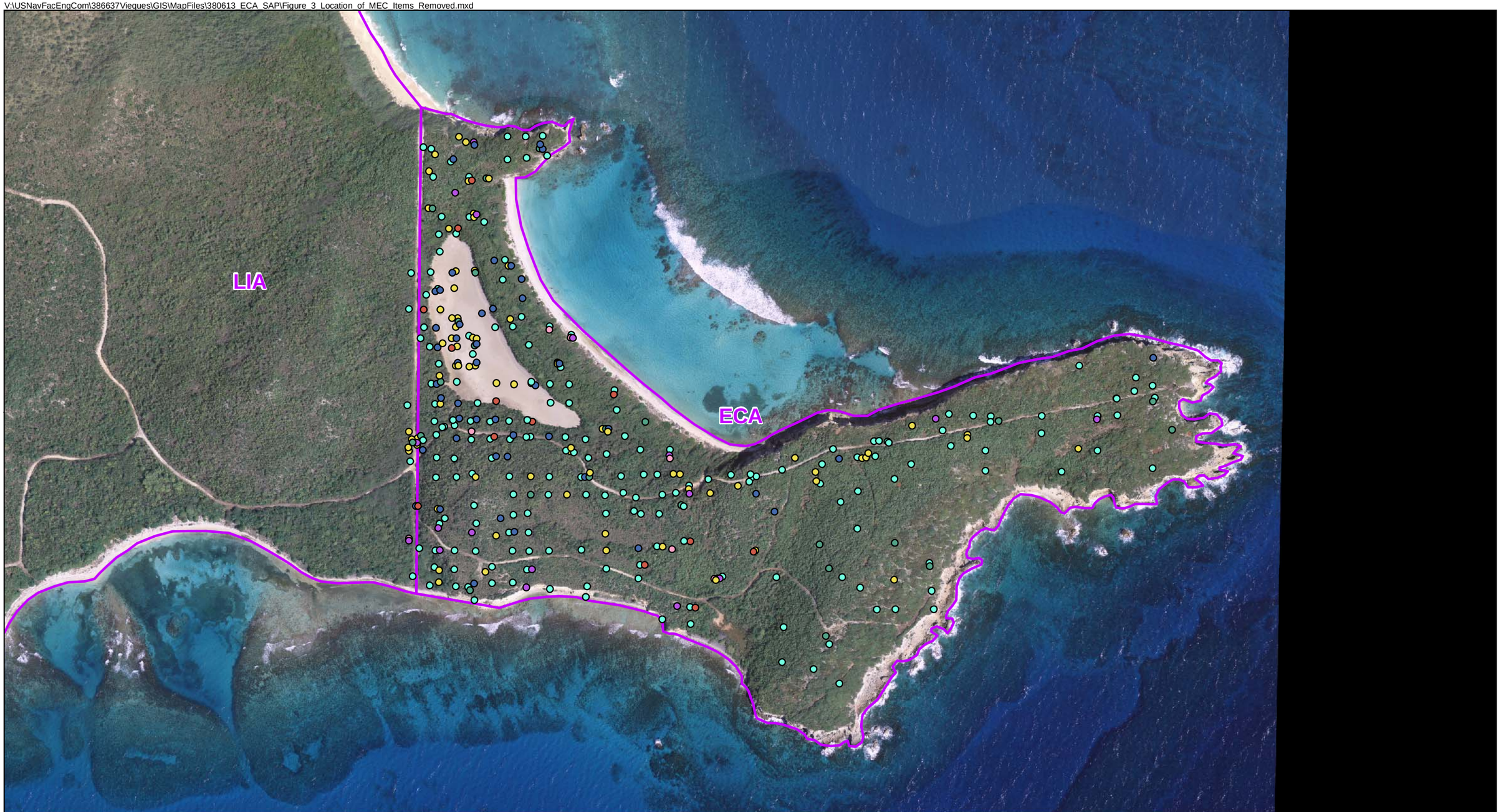
N
W E
S

0 500 1,000 2,000 Feet

Figure 2
Former VNTR Site Map
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

CH2MHILL

V:\USNavFacEngCom\386637Vieques\GIS\MapFiles\380613_ECA_SAP\Figure_3_Location_of_MEC_Items_Removed.mxd



Legend

- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Submunitions
- Munitions Scrap
- Vieques Boundary Section

N
W E
S

0 250 500 1,000 Feet

Figure 3
Location of Surface Items Removed
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

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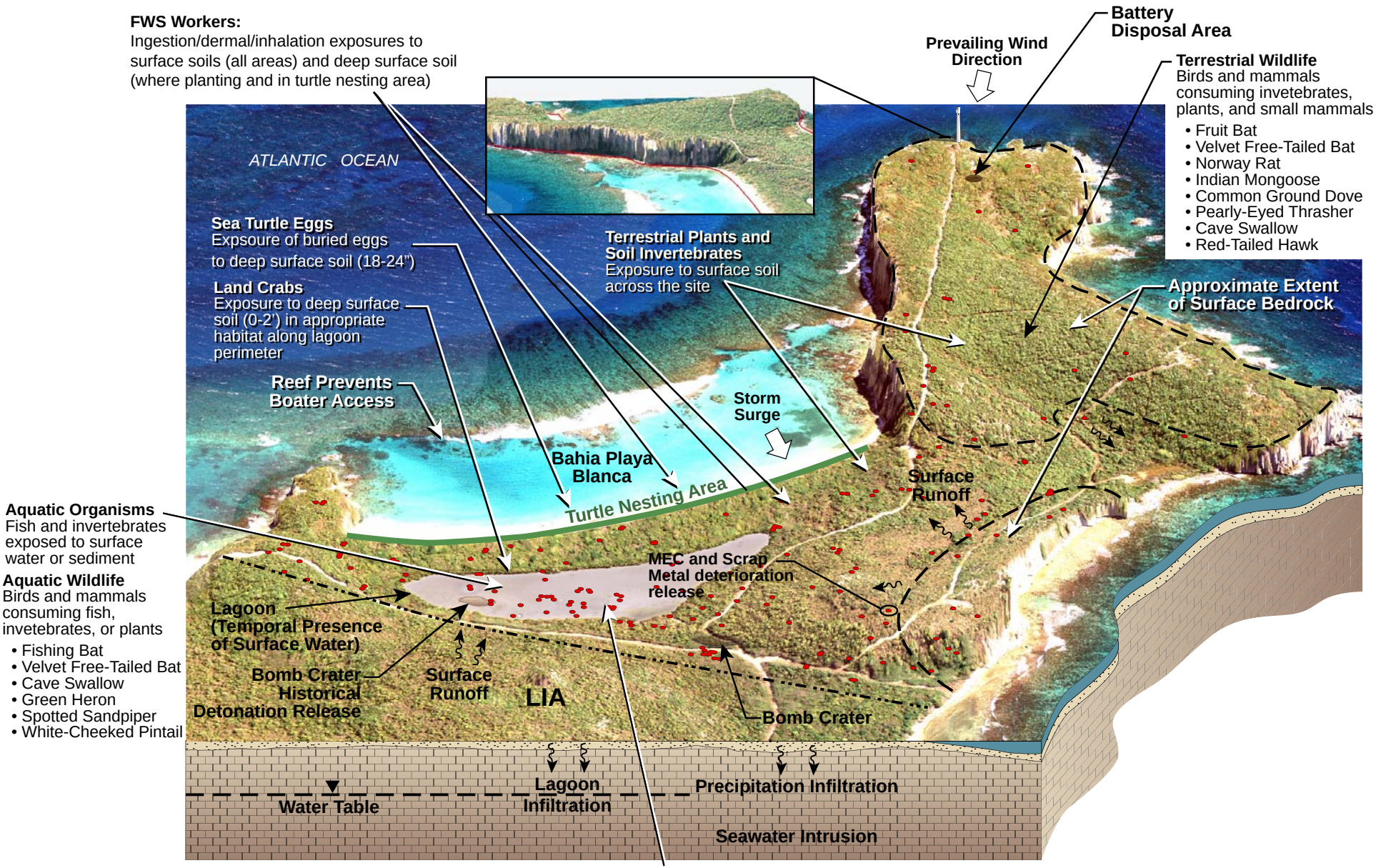

FIGURE 4
Conceptual Site Model
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques Puerto Rico

CH2MHILL

ES042710231858TPA F4-ECA Conceptual Site Model-rev9.ai mstuart

V:\USNavFacEngCom\386637Vieques\GIS\MapFiles\380613_ECA_SAP\Figure_5_Eastern_Conservation_Area_Topography_and_Geology.mxd

Legend

Topographic Contour (10 foot interval)

ECA Boundary

Geology

TI - Marine Sedimentary Rocks, Undivided

Notes:
Topographic Contours derived from LIDAR.
Topographic Contour elevations are feet above sea level at time of LIDAR survey.

N
W E
S

0 250 500 1,000 Feet

Figure 5
Eastern Conservation Area Topography and Geology
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

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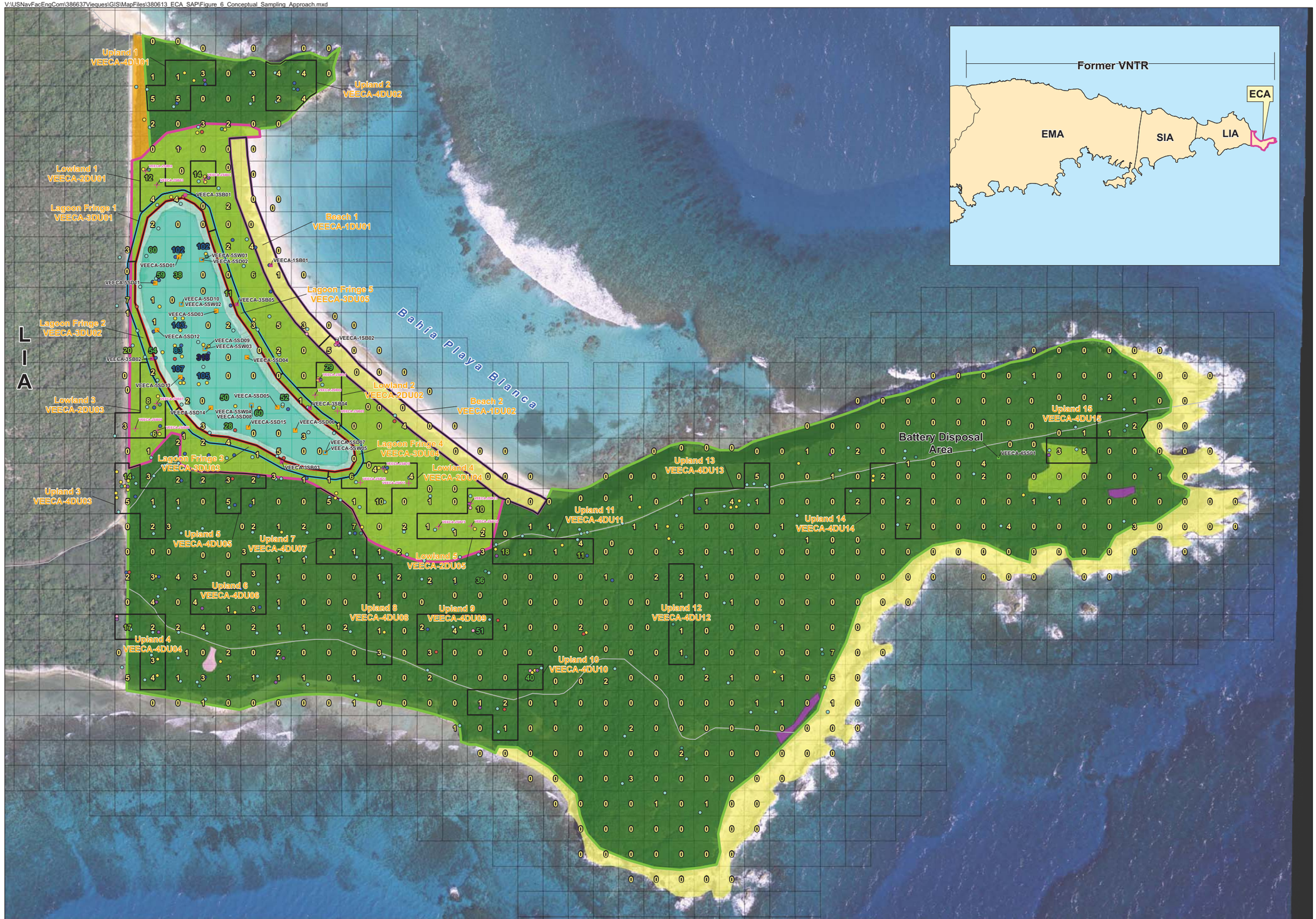

Legend

- Subsurface Soil Sample
- Surface Water Sample
- Sediment Sample
- Surface Soil Sample
- Deep Surface Soil Sample
- Sampling Units

Decision Unit Boundary

- Beach
- Upland
- Lowland
- Lagoon
- Lagoon Fringe

- Bombs
- Flares-Pyrotechnics
- MEC Component
- Projectiles / Mortars
- Rockets / Guided Missiles
- Submunitions
- Munitions Scrap

Land Cover

- Bare Ground
- Beach
- Evergreen Scrub
- Forest Scrub
- Mangrove
- Open Water
- Salt/Sand Flat
- Sparse Thorn Scrub

Quantity of Item Findings (MEC and Munitions Scrap)

- 0 - 5
- 5 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 200
- 200 - 300
- > 300

Notes:
Subsamples will not be collected on roads.
Approximately 100 subsamples per sampling unit is proposed.
ECA = Eastern Conservation Area
LIA = Live Impact Area
SIA = Surface Impact Area
EMA = Eastern Maneuver Area

N
W E
S

0 60 120 240
Feet

Figure 6
Conceptual Sampling Approach
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

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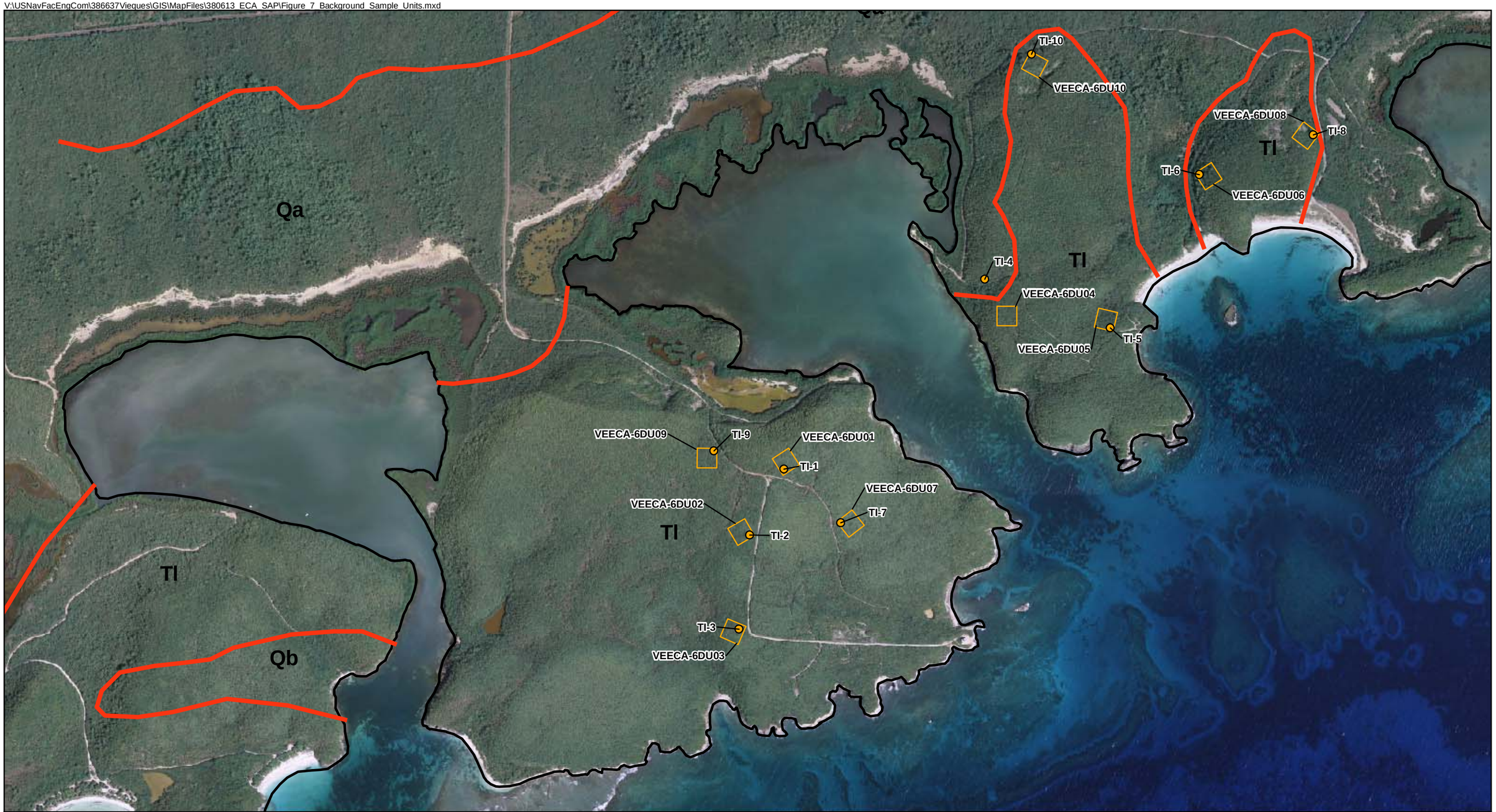

Legend

- October 2007 Background Study Soil Sample Location
- Geology Boundary Sections
- Proposed Background Incremental Sampling Unit

N
W E
S

0 500 1,000 2,000
Feet

Figure 7
Background Sampling Units
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

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Tables

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TABLE 1
MEC/MD Items Encountered in the ECA and Their Constituents
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

Item	Primary Metal	Secondary Metal	Possible Additional Metal Constituent	Likely Filler
20MM HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	TETRYL MAIN CHARGE
25MM HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	RDX
30MM HE PROJECTILES	STEEL (IRON)	COPPER ROTATING BAND		RDX
155MM HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	TNT OR COMPOSITION B
5 INCH HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	EXPLOSIVE D OR COMPOSITION A3
5 INCH PUFF PROJECTIES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	TETRYL AND TITANIUM TETRACHLORIDE
75MM HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	TNT OR COMPOSITION B
37MM HE PROJECTILES	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	TNT
105 MM ILUMINATION PROJECTILE	STEEL PROJ. BODY (IRON)	COPPER ROTATING BAND	POSSIBLE GUILDING METAL ROTATING BAND (90%COPPER 10 % ZINC)	ILLUMINATING COMPOUND
MK 82 500 LB BOMB	STEEL			TRITONAL OR H6
BDU 33 PRACTICE BOMBS	CAST IRON			RED PHOSPHORUS
2.75 INCH HE ROCKET WARHEAD	STEEL			COMPOSITION B
2.75 INCH ROCKET MOTOR	ALUMINUM			DOUBLE BASE BALLISITE (NITROCELLULOSE AND NITROGLYCERINE) PROPELLANT
	STEEL (IRON)			BLACK POWDER (potassium nitrate, charcoal, sulfur)
				MAGNESIUM
MK 23 IGNITER	STEEL			TETRYL
				WHITE PHOSPHORUS
MK 118 SUB MUNITIONS	STEEL			COMPOSITION B
MK24/45 AIRCRAFT FLARE	ALLUMINUM			ILLUMINATING COMPOUND
MK 25 MARINE MARKER	ALUMINUM			Pyrotechnic Composition

TABLE 2
MEC/MD Removed During Surface Clearance
Eastern Conservation Area Sampling and Analysis Plan
Former VNTR, Vieques, Puerto Rico

Sample Unit	Bombs Quantity	Flares-Pyrotechnics Quantity	MEC Component Quantity	Projectiles / Mortars Quantity	Rockets / Guided Missiles Quantity	Submunitions Quantity	Munitions Scrap Quantity
Beach 1	0	0	0	0	2	1	2
Beach 2	0	1	0	0	0	1	3
Lagoon Fringe 1	0	0	1	1	0	0	4
Lagoon Fringe 2	0	0	0	0	0	0	3
Lagoon Fringe 3	0	0	0	0	0	0	0
Lagoon Fringe 4	0	0	0	0	0	0	2
Lagoon Fringe 5	0	0	0	0	10	0	0
Lowland 1	1	1	0	4	0	0	20
Lowland 2	0	0	0	2	2	0	27
Lowland 3	1	0	0	2	4	0	10
Lowland 4	1	0	0	2	1	0	20
Lowland 5	0	1	0	2	0	1	10
Upland 1	0	1	0	3	2	0	8
Upland 2	2	0	0	0	2	0	10
Upland 3	2	1	0	7	1	0	4
Upland 4	0	2	0	2	0	1	21
Upland 5	0	0	1	0	3	0	7
Upland 6	0	1	0	1	3	0	6
Upland 7	1	0	0	2	3	0	6
Upland 8	0	0	0	2	0	0	4
Upland 9	0	0	1	1	2	1	55
Upland 10	0	3	1	2	0	1	37
Upland 11	0	1	0	3	1	0	26
Upland 12	2	0	0	0	0	0	3
Upland 13	0	0	0	3	1	0	7
Upland 14	0	0	0	2	0	0	11
Upland 15	1	1	0	0	0	0	9

Attachment A
Field SOPs

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STANDARD OPERATING PROCEDURE A-2

Soil Sampling

I. Purpose and Scope

The purpose of this procedure is to provide standardized procedures for obtaining samples of surface and subsurface soils. Any project required deviations from Standard Operating Procedures (SOPs), will be provided in site specific Sampling and Analysis Plans (SAPs).

II. Equipment and Materials

- Personal Protection Equipment
- Stainless-steel hand auger, split spoon, or appropriate hand tool
- Thin-walled sampling tubes (such as a shelby tube)
- Direct-push rig, drilling rig, soil-coring rig, or hand auger equipment
- Stainless-steel pan or bowl
- Stainless-steel spoons or dedicated wooden spoons
- Sample bottles and equipment
- photo-ionization detector (PID) or flame-ionization detector (FID)

III. Procedures and Guidelines

All personnel shall be wearing personal protective equipment (PPE) per health and safety plan (HASP). Decontaminate all equipment per SOP "*Decontamination of Drilling Rigs and Equipment*" and "*Decontamination of Personnel and Equipment.*" Locate and record the sample point in the logbook. If appropriate, record sample location using global positioning system (GPS) or land survey.

A. Surface and Shallow Subsurface Sampling with Hand Auger

Remove soil to a point just above the interval to be sampled. Collect soil at the desired sampling depth. Immediately take soil for volatile organic compound (VOC) analysis directly from the end of the hand auger with an Encore sampler. Place soil for analyses other than VOCs into a stainless-steel bowl, take a PID or FID reading of the soil collected, and log the readings accordingly into the boring (or other) log. Mix the soil in the bowl according to "*Homogenization of Soil and Sediment Samples*" SOP. If this interval is to be collected for analysis, use a stainless-steel spoon or dedicated wooden spoon to transfer the sample from the bowl to the sample container(s). Try not to touch soil to be collected with bare or gloved hands. Soil samples in sample containers should be free of pebbles, roots, and other non-soil debris. Preferably, soil jars should be filled full, but if difficulties are

encountered in getting sample volume, see SAP for minimum sample volume required by lab, or have the Environmental Information Specialist (EIS) call lab for minimum volume lab will need for that/those analyses. For VOC samples in jars, fill completely to avoid headspace. For VOC samples in Encore® samplers see SOP *"Soil Sampling for VOCs using the Encore ® Sampler"*. For VOC samples in Terra core® samplers see SOP *"Soil Sampling for VOCs using the Terra core ® Sampler"*.

B. Split-Spoon or Direct Push Sampling

Advance a boring to just above the sample depth using a drilling rig, slide hammer, or direct push technology (DPT) rig. Lower the sampler into the hole and advance it to a depth equal to the total length of the desired interval. If using a drilling rig, or slide hammer, advance the split spoon sampler using a weighted or pneumatic hammer. Record the weight, type, blow count (number of blows required to advance 6 inches), and penetrated length into the boring log. Record only the penetrated length if using DPT.

The driller will then open the sampler or extrude the lexan (or similar) sample tube and cut open the tube, leaving the cut piece of tube on the sample to minimize the possibility of soil and vapors to escape. Record the total length of sample retrieved. Using a PID or FID, take readings along several points of the sampler and record them. Also, record any visual observations of suspected contamination. If this interval is to be collected, samples for VOC analysis are to be collected immediately from the core or split spoon at the target location (based on visual observations and PID/FID readings). Samples for analyses other than VOCs should be homogenized according to *"Homogenization of Soil and Sediment Samples"* SOP. Additional sample volume may be obtained by collecting a second sample below the first sample and compositing the sample for non-volatile parameters only (if still within the desired sample depth interval). A co-located hole within approximately 2 feet from the first hole may also be used to collect additional sample volume.

C. Thin-Walled Tube Sampling

Undisturbed samples may be collected for analysis for physical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24 to 36 inches long and 3 to 4 inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax (or comparable) and then sealed with end caps and tape. The sample designation, date and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing.

D. Sampling Descriptions

Following sample retrieval, the soils should be visually described in the boring log using ASTM D 2488, (attached) including approximated depths, PID readings, and any other relevant observations. Use the standard CH2M HILL soil description format found on soil boring log headers:: soil name, USCS group symbol, Munsell number and color, moisture content, relative density or consistency, soil structure, mineralogy (note approximate percentages of sand, silt and clay). Use a measuring tape or folding ruler calibrated in feet

and 10ths for logging soils. Note the depths that drilling penetration is easier/faster. Note at what depth drillers switched from augering to air hammer, as applicable. Make sure to note at what depth soil becomes saturated (and if it appears to return to an unsaturated state, indicating pearched water).

IV. Key Checks and Preventative Maintenance

- Decontamination of all non-disposable equipment between sampling locations.
- PID/FID calibration and checks.

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Designation: D 1587 – 08

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope*

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively intact soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452, D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232 for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 The tubing tolerances presented in Table 1 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 1452 Practice for Soil Investigation and Sampling by Auger Borings

D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils

D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D 4220 Practices for Preserving and Transporting Soil Samples

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Oct. 1, 2008. Published October 2008. Originally approved in 1958. Last previous edition approved in 2007 as D 1587 – 00 (2007)$^{\varepsilon 1}$.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

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TABLE 1 Dimensional Tolerances for Thin-Walled Tubes

	Nominal Tube Diameters from Table 2[A] Tolerances					
Size Outside Diameter	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007 -0.000	+0.179 -0.000	+0.010 -0.000	+0.254 -0.000	+0.015 -0.000	0.381 -0.000
Inside diameter, D_i	+0.000 -0.007	+0.000 -0.179	+0.000 -0.010	+0.000 -0.254	+0.000 -0.015	+0.000 -0.381
Wall thickness	±0.007	±0.179	±0.010	±0.254	±0.015	±0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i, or D_o and Wall thickness, or D_i and Wall thickness.

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %, n*—the ratio of the difference in the inside diameter of the tube, D_i, minus the inside diameter of the cutting edge, D_e, to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality, n*—the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively intact sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

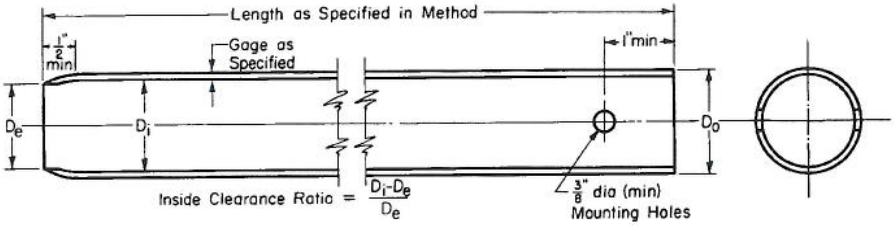
5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively intact specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gauge wall thickness to comply with area ratio criteria accepted for "intact samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gauge tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
3/8	9.53
1/2	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

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TABLE 2 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter (D_o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

[A] The three diameters recommended in Table 2 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 2 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 1.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (0.03 m).

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. (76 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 2.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water or suction pressures (or both) and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (6 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm)

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of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (Practice D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top."

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to Guide D 5434. This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; intact; sampling; soil exploration; soil investigations; subsurface investigations

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1587 – 00 (2007)$^{\varepsilon 1}$) that may impact the use of this standard. (Approved October 1, 2008.)

(*1*) Replaced "undisturbed" with "intact" in Sections 1.1, 4.1, 5.1, 10, and Note 4 of Fig. 1.

(*2*) Editorial changes made in Sections 1.4, 7.3, 7.4.1, 7.6, 8.1, and 8.1.2.

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Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-µm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Feb. 10, 2000. Published May 2000. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 93ϵ1.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

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limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

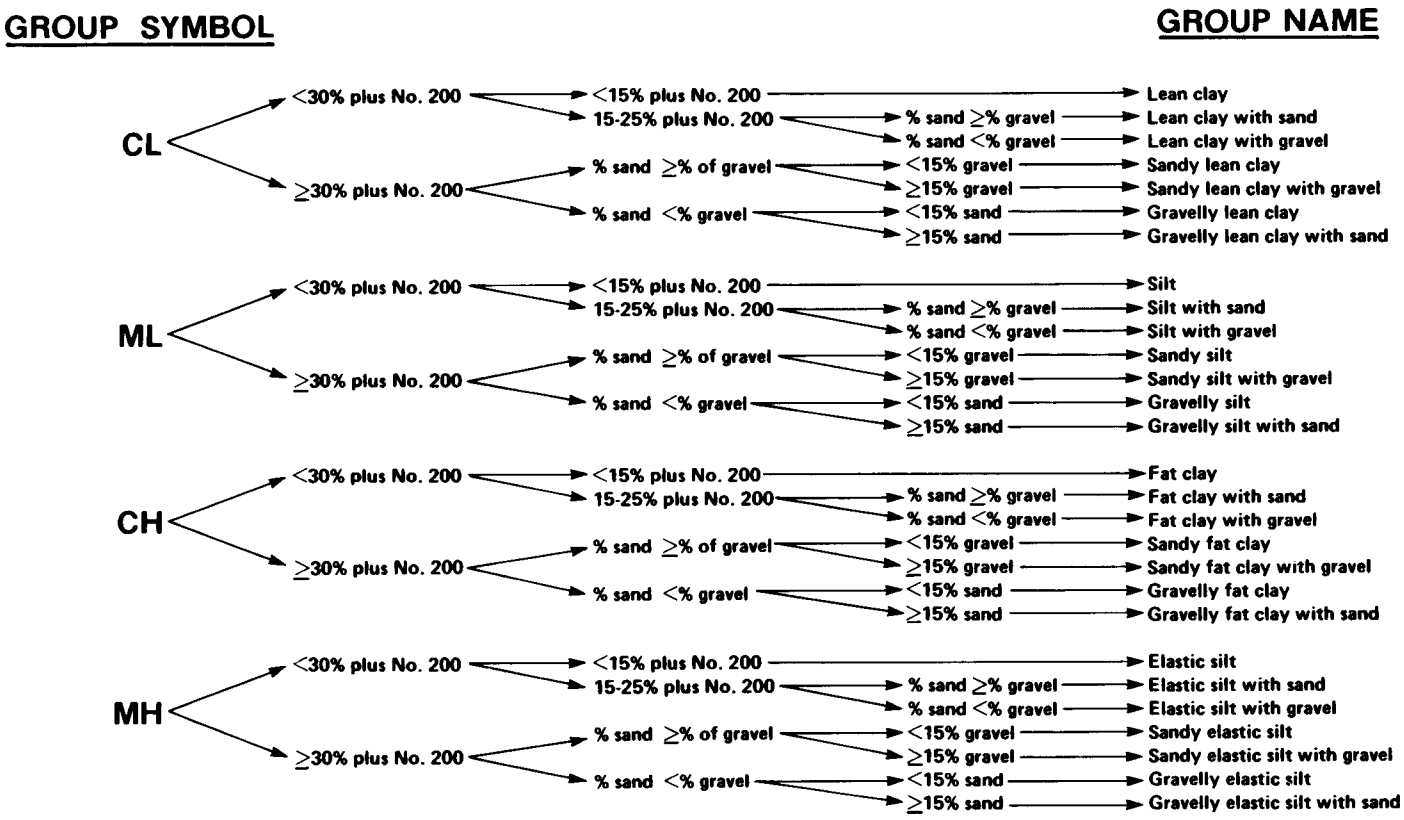
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

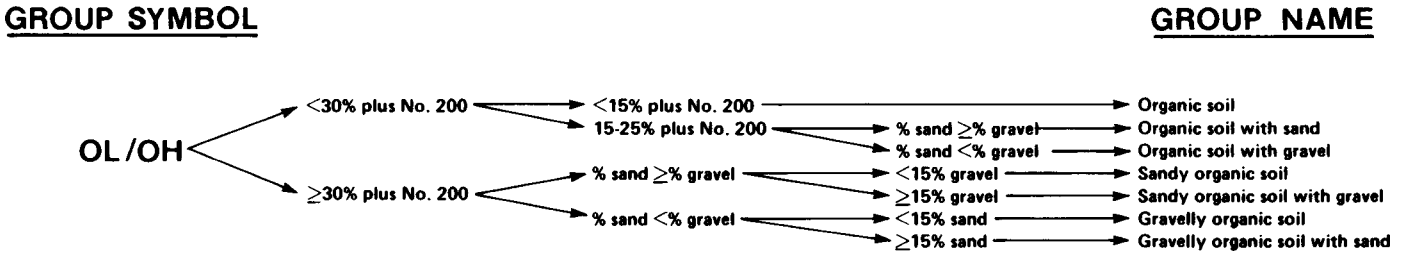
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

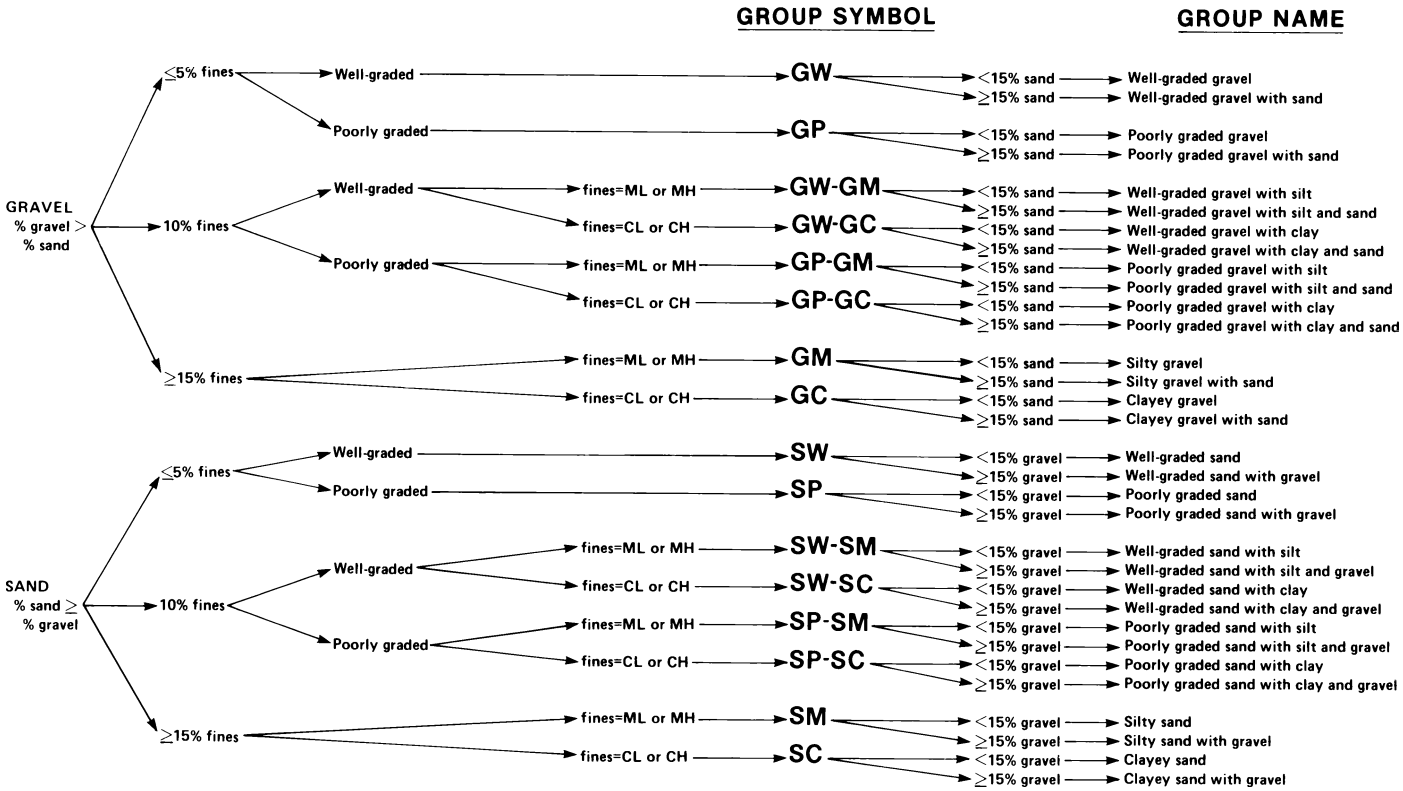
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (⅜ in.)	200 g (0.5 lb)
19.0 mm (¾ in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

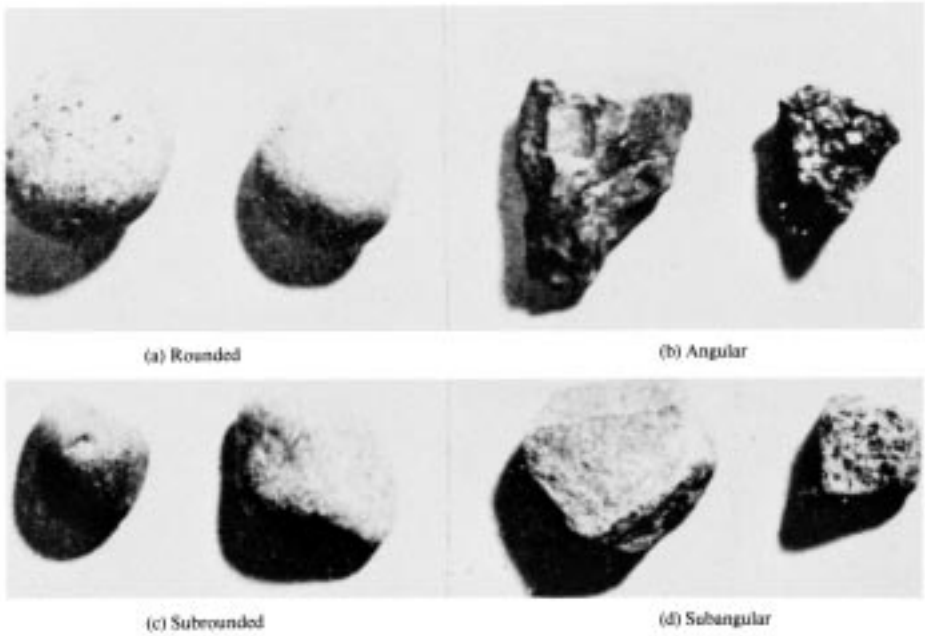


FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.	
Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

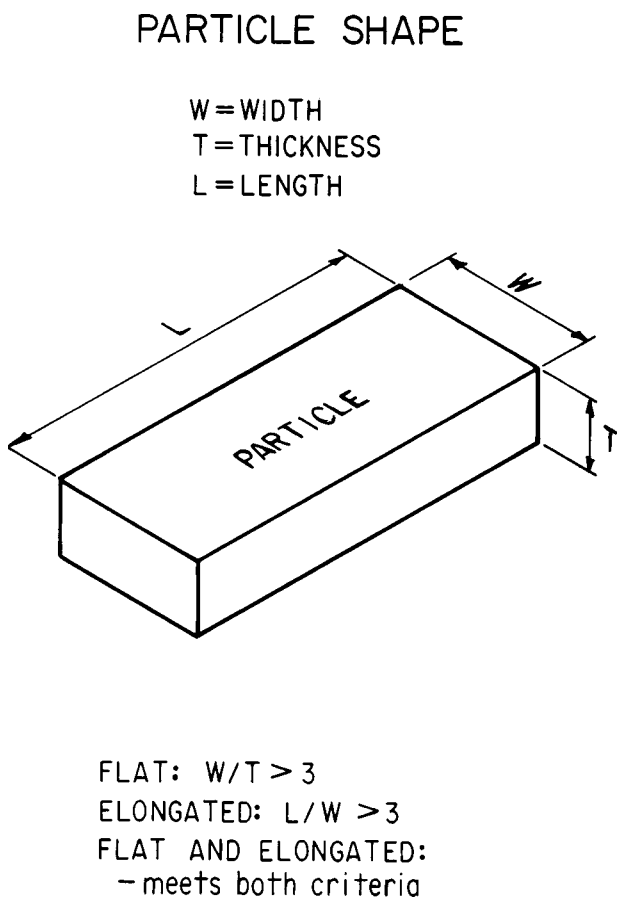


FIG. 4 Criteria for Particle Shape

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Dilatancy

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Toughness

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Dilatancy

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low,

medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

TABLE 8 Criteria for Describing Toughness

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as “Sandy Lean Clay (CL)”; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; “Poorly Graded Gravel with Sand (GP).”

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; “Poorly Graded Gravel (GP)”; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard,

angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:

s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1993$^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

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STANDARD OPERATING PROCEDURE- A.7

Systematic Random Increment Sampling

I. Purpose

The Systematic random increment sampling of surface soil samples is performed to minimize any bias of sample representativeness introduced by compositional and distribution heterogeneity of constituents within the sample. This procedure should only be used when sampling surface soils for explosive residuals and metals.

II. Scope

Standard techniques for surface soil random incremental sampling for the analysis of explosives residuals and metals, and required equipment are provided in this SOP. These procedures do not apply to aliquots collected for VOCs, SVOCs, pesticides/ herbicides, PCBs, or field GC screening (samples for these analyses should NOT be collected using RI sampling).

III. Equipment and Materials

Random incremental sampling will be performed with clean hardened plastic or metal scoops, spoons, or coring tools (such as a MIST sampling tool) depending on the cohesiveness of the soil. Sample containers are lab and analyte specific, but generally 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. Soil will be homogenized in the laboratory rather than the field.

IV. Procedures and Guidelines

Surface soil composite samples will be collected from Decision or Sampling Units for analysis for explosives residues and/or total metals. Each Decision Unit will be defined based on past range activities and ecological and human health risks associated with that area. Where applicable, larger Decision Units may be sampled multiple times in one acre area Sampling Units. Each Decision/Sampling Unit location sampled and a summary of sampling activities will be recorded in a field book.

Increment composite surface soil samples will be collected within the Decision or Sampling Unit using a systematic sampling pattern with a random starting point. Number of increments should be between 30 and 100 depending on the size of the Decision or Sampling Unit (increments should be discussed with stakeholders prior to sampling) . Samples will be collected by walking from one corner of the grid systematically back and forth across the entire grid area, collecting an increment of soil every so many paces, depending on the grid size and number of increments to be collected. The sample increments will be approximately equal in the amount of

soil, which will be collected from depths of approximately 0-2 inches (up to about 2.5-inches) below ground surface. While walking the sampling unit grid, subsamples will be stored in a gallon ziplock or equivalent plastic bag, labeled with the sampling unit number. After the Decision/Sampling Unit has been sampled, the individual increment samples will be transferred to the appropriate laboratory-supplied sample containers. Triplicate (two replicate) samples should be collected from each Decision Unit on a one per 10 basis. Each replicate sample will be collected using the same method as the original sample. The replicate samples should be started from a different corner of the decision unit to avoid sampling the same location as the original sample.

Samples will be stored on ice in clean plastic bags or clean large mouth glass bottles and submitted for laboratory analysis by one or more of the following analytical methods: EPA SW-846 Method 8330, Method 8330B, and the appropriate project specific analytical methods for metals. Method 8330B uses an air drying and mechanical grinding process. Mechanical grinding will not be conducted for samples submitted for metals analysis. A minimum of 1 kg of soil will be collected per RI sample.

The sampling tools will not need to be cleaned between increments since each individual increment will be apart of the same sample, but tools will be cleaned between each RI sample. The decontamination process follows SOP E1, Decontamination of Personnel and Equipment.

Follow manufacturer's instructions for use of the sampling tool. For pogo-stick type MIS samplers, insert the appropriate core tip, place the tip on the surface to be sampled, and drive the sampler tip into the ground with the pogo-stick foot pedals. If using both foot pedals at the same time, be careful about balance, and if this method cannot be done safely, discontinue use of both foot pedals simultaneously. To extrude the sample, press on the sample extruder, holding the sample tip over the plastic bag in which the sample is to be collected. Decontaminate sampling equipment that has come in contact with the ground before switching to sample a separate sampling unit.

V. Attachments

None

VI. Key Checks and Items

- Triplicate samples collected from each Decision Unit at 1 per 10 samples.
- Replicate samples should be started from a different corner of the decision unit to avoid sampling the same location as the original sample.
- Sampling method is only applicable to explosives residues and metals.
- Number of increments should be between 30 and 100 depending on the size of the Decision Unit.
- Check that decontamination of equipment is thorough.

STANDARD OPERATING PROCEDURE C-1

Calibration and Measurement with Field Instruments

I. Purpose and Scope

The purpose of this document is to provide standardized procedures for using field instruments to collect measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of liquid sample media (groundwater or surface water). The operator's manual should be consulted for detailed calibration and operating procedures for each specific instrument. This guideline will cover field equipment used on a routine basis for field conditions likely encountered on a Vieques site. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

II. Equipment and Materials

- Instruments to be calibrated (and spares)
- Manufacturer's calibration manual
- Distilled water in squirt bottle
- Calibration Standard Solution(s) applicable to site conditions and manual

III. Procedures and Guidelines

A. Documentation of Field Calibration and Measurements

Document successful calibration and verification for each instrument in the project logbook. This calibration will be linked with the associated sample measurements.

- Designate the identity of specific instrumentation in the documentation with a unique description or code for each instrument used.
- Record manufacturer name, model number and identifying number such as a serial number for each instrument.
- Record the time and date of all initial calibrations and all calibration verifications.
- Record the instrument reading (value in appropriate measurement units) of all calibration verifications.
- Record the name of the analyst(s) performing the calibration or verification.

- Document the specific standards used to calibrate or verify the instrument or field test with the following information:
  - Type of standard or standard name (e.g., pH, buffer, isobutylene) and value of standard, including correct units (e.g., pH = 7.0 SU)
  - Document lot number on calibration gas bottle
- Document whether successful initial calibration occurred or failed.
- Document any corrective actions taken to modify instrument performance and date and time of any corrective actions.
- Note any incidence of discontinuation of use of the instrument due to calibration failure.

B. Instrument Calibration

Prior to each day's use, clean and calibrate the instrument using the procedures described by the manufacturer of the instrument..The following describes typical calibration checks for specific field parameters:

1. pH

   Use at least two standards for initial calibration. One of the standards must be pH 7.0, the other at a value such that it will bracket the anticipated pH of the samples. Always the pH 7 first and rinse the probe between solutions. Follow the manufacturer's calibration instructions specific to your meter.

   Most instruments allow for a two-point calibration and a few models can perform a three-point calibration. Use the appropriate number of standard buffer solutions for calibration. Groundwater is usually between pH 4 and 7 and surface water between pH 7 and 10 (including salt water). Acceptance criteria for initial or continuing calibrations will be Std X – 0.2 < Reading < Std X + 0.2

2. Conductivity

   Check the meter in the field with at least one KCl std with a value close to the conductivity expected in the field. For fresh water groundwater and surface water applications, a standard of 1000 µS (or µmhos) is used while standards of 10,000, 30,000, and 50,000 µS are available for estuarine and marine surface water conditions. Acceptance criterion for this check is that the meter reads in the interval within Std X ± 3% of Std X.

3. Dissolved Oxygen

   Calibrate the meter at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument.

   Allow an appropriate warm up period before initial field calibration. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this

ensures 100% humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate.

Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (See FT 1500-1) what the DO should measure. A stable and accurate temperature is required for a valid calibration. The acceptance criterion for DO calibration verification is +/- 0.3 mg DO/L.

The dissolved oxygen probe requires careful attention to the following items:

- Check sensor for bubbles and membrane for wrinkles or tear (before mobilization)
- Always store probe in saturated atmosphere
- Salinity affects DO readings (make correction, if needed)
- Common interferences: reactive gases, chlorine gas and sulfide will cause bias in results

4. Turbidity

This SOP describes the use of true nephelometric measurement which measures the scattering effect that suspended solids have on the propagation of light through a body of water (surface or ground waters). The higher the effect (i.e., intensity of scattered light), the higher the turbidity value. The use of in-situ probes with turbidity sensors (infra-red light source) may be used for screening purposes (e.g., groundwater purge stabilization measurements) only. Do not report their results for regulatory purposes.

Perform an initial calibration verification by reading at least one primary standard as a sample. The acceptance criterion for the initial calibration verification depends on the range of turbidity of the standard value:

- Standard Value = 0.1-10 NTU: the response must be within 10% of the standard;
- Standard Value = 11-40 NTU: the response must be within 8% of the standard;
- Standard Value = 41-100 NTU: the response must be within 6.5% of the standard; and
- Standard Value > 100 NTU: the response must be within 5% of the standard.

Take readings with a turbidimeter using the following procedure:

- Gently agitate the sample and wait until air bubbles disappear.
- Double-rinse the sample cell or cuvette with a small amount of the sample. Discard, and pour an aliquot into the sample cell or cuvette.
- Gently dry out its external surface with lint-free paper.
- Insert the cell in the instrument and read the turbidity directly from the meter display.
- Pour out the sample, double-rinse the cuvette with de-ionized water in preparation for the next sample.

5. Oxidation Reduction Potential (ORP)

   Oxidation Reduction Potential (ORP) is a measurement of the potential for a reaction to occur where a positive value indicates that the water is in an oxidized state or oxygen is present and a negative value is indicative of an anaerobic type environment or reducing condition. Equilibrate the standard solution to the temperature of the sample. Calibrate as follows:

   - Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt mode.
   - Let the electrode equilibrate for several minutes and record the reading to the nearest millivolt. The reading must be within ±10 mV from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.
   - Record the mV reading and temperature in the field notebook.
   - Rinse the electrode with distilled water and proceed with the sample measurement.

C. Sample Measurement

Obtain readings and record them in the field notebook or sampling log. Watch for potential fouling of probes, high concentrations of odors, drifting of calibrated zero, or other factors that may skew readings. Record all field-testing measurement data, to include the following:

- Project name
- Date and time of measurement or test
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units for the measurement
- Initials or name of analyst performing the measurement

IV. Key Checks and Preventive Maintenance

- Refer to operations manuals for recommended maintenance and calibrations and follow them to the extent practical. Note deviations in logbook.
- Clean all instruments when done.

V. Optional but Suggested Practices

- Have a spare unit readily available in case of an equipment malfunction. Check batteries, and have a replacement set on hand.
- Confirm there is sufficient calibration standard on hand. Compressed gas calibration standards cannot be air shipped to Vieques; they must be shipped to mainland Puerto Rico and either brought over by a subcontractor, or an employee must take the ferry to Puerto Rico and courier them back on the ferry. Confirm there is sufficient supply on hand and write "Empty" on empty cylinders, vent the dregs and throw them away immediately (regular landfill disposal of empty cylinders is acceptable). Segregate "in-use" cylinders.
- Check age date on calibration gas cylinders and vent and dispose of out of date cylinders, reconfirming sufficient supplies on hand.

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STANDARD OPERATING PROCEDURE E-1

Decontamination of Personnel and Equipment

I. Purpose and Scope

This standard operating procedure (SOP) provides standardized procedures for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments. Any project required deviations from SOPs, will be provided in site specific sampling and analysis plans (SAPs).

II. Equipment and Materials

1. Potable water from a municipal water supplier.
2. ASTM Type II reagent water with analysis certification.
3. Soap solution, such as 2.5% (W/W) Liquinox, or Alconox.
4. 10% solvent such as methanol, isopropyl, hexane or other approved solvent (DO NOT USE ACETONE). Pesticide-grade solvents will only be used if directed by project-specific SAPs.
5. Large plastic pails or tubs, scrub brushes, squirt bottles for soap and solvent solutions, plastic bags and sheets.
6. Department of transportation approved 55-gallon drum for disposal of waste (if required)Personal protective equipment (PPE).

III. Procedures and Guidelines

A. Personnel Decontamination

This is a guide, and may be modified if the contamination is less or more than what is required here.

- Only if there is gross contamination present that cannot be removed using the procedures below should the PPE be disposed of with investigation derived waste (IDW).
- Wash boots in soap solution and rinse with water. If disposable latex booties are worn over boots in the work area, rinse with soap solution, remove, and discard with normal trash.
- Wash outer gloves in soap solution, rinse, remove, and discard with normal trash.
- Remove disposable coveralls ("Tyveks"), wash any obvious dirt or contamination off with soap solution, rinse, and discard with normal trash.

- Remove respirator (if worn).
- Remove inner gloves and discard with normal trash.
- Sanitize respirator if worn in accordance with manufacturer's instructions.
- At the end of the work day, shower entire body, including hair, either at the work site or at home.

B. Sampling Pump Decontamination

- Don disposable gloves.
- Spread plastic on the ground to keep hoses from touching the ground.
- Turn off pump after sampling. Remove pump from well and place pump in decontamination container.
- Pre-rinse the pump in potable water to remove bulk soil or contamination.
- Disassemble pump, as practical, and scrub pump with soap solution. If disassembly of pump not practical, run solution through pump for 1 minute.
- Scrub in tap water, then reassemble and run pump in tap water for one minute.
- Disassemble and spray pump with 70-100% solvent solution. (DO NOT USE ACETONE). If disassembly of pump not practical, run 10 percent solution through pump for 1 minute.
- Allow to air dry.
- Spray with ASTM type II reagent water with analysis certification.
- Reassemble and wrap pump in aluminum foil or clean plastic sheeting and place into decontamination tube.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can be decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

C. Other Sampling Equipment Decontamination

- Don latex-free gloves.
- Pre-rinse and scrub equipment with potable water.
- Wash all equipment surfaces that contacted the potentially contaminated soil/water with soap solution.
- Rinse with potable water.
- Rinse with distilled water and 10% solvent solution.

- Air dry.
- Rinse with ASTM type II reagent water with analysis certification.
- Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling.
- Collect all rinsate and dispose of according to the Master Waste Management Plan.
- Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment can decontaminated (using the above procedure) and disposed of with normal trash or can be disposed of according to the Master Waste Management Plan.

D. Sample Container Exterior 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.
- Wipe container with a paper towel dampened with soap solution. Repeat the above steps using potable water.
- Dispose of all used paper towels according to the Master Waste Management Plan.

E. Water Level Meter

Water level meters will be decontaminated before being used in the first well, and after measuring each well as follows:

1. Wipe tape, first with a towel dampened with 10 percent solvent solution, then with a towel dampened with DI water.
2. Spray off probe, first with 10 percent solvent solution, then with ASTM type II reagent water with analysis certification.

IV. Key Checks and Items

- Clean with solutions of soap, solvent, and ASTM type II reagent water with analysis certification.
- Do not use acetone for decontamination.
- Minimize generation of IDW to the maximum extent possible by decontaminating to the extent practical and disposing with normal trash.

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STANDARD OPERATING PROCEDURE G-1

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting representative surface water related data, including samples for analytical chemistry, and stream flow measurements.

For typical collection of surface water samples, this SOP describes acceptable equipment selection and construction materials, as well as standard grab, depth-specific, and depth-composited surface water sampling techniques.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the SAP should be consulted for project-specific details. Typical equipment required includes some or all of the following:

Surface Water Analytical Sample Collection

- Dip sampler for direct grabs
- Clean unpreserved containers
- Peristaltic pump and appropriate tubing
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Sample containers
- Polypropylene rope and weight
- Extendable pole
- Meters for specific conductance, temperature, pH, and dissolved oxygen

A. Streamflow Measurement

- Current meter such as the Marsh-McBirney with a steel wading rod and electronic meter to measure the relative velocity of the flow at different locations within the stream channel
- Measuring tape or cable marked in even increments for determining the width of the stream and controlling the location where measurements are taken
- Waders (if necessary)

III. Procedures and Guidelines

Before surface water analytical samples are taken, all sample collection equipment are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. For surface water samples collected from tidal water bodies, the tide stage should be considered when selecting sampling time(s).

Methods for surface water sample collection and streamflow are described below.

A. Surface Water Analytical Sample Collection

Manual Sampling

Use manual sampling for collecting grab samples for immediate in-situ field analyses. Measurements of specific conductance, temperature, pH, and dissolved oxygen, are collected after all surface water samples are collected at each station.

1. Surface Grab Samples

Collect surface grab samples within the top 12 inches of the water column unless a specific depth strata has been specified in the Sampling and Analysis Plan (SAP) Avoid skimming the surface of the water during collection unless specifically required by the SAP Very shallow water bodies may require careful techniques of sample collection to avoid disturbing sediments.

Where practical, use the actual sample container (unpreserved) as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

2. Direct Grab Technique

- Use an unpreserved sample container to collect the sample.
- Slowly remove the container cap and slowly submerge the container, opening first, into the water.
- Invert the bottle so the opening is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.
- Return the filled container quickly to the surface.
- Pour out a small volume of sample away from and downstream of the sampling location. This procedure allows for addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives, if required, securely cap container, label and complete field notes.
- If preservatives have been added, invert the container several times to ensure sufficient mixing of sample and preservatives.
- Check preservation of the sample and adjust pH with additional preservative, if necessary.
  - If the sample cannot be collected directly into the sample container to be submitted to the laboratory or if the laboratory provides prepreserved sample containers, use

an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately including any poles or extension arms used to access the sample location.

- If the intermediate vessel is not a precleaned sample container, decontaminate the vessel following the SOP E1 *Decontamination of Personnel and Equipment.* Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample. Discard rinsate away from or downstream of the sampling location. After adequate rinsing, fill the intermediate vessel with sample water. Minimize agitation of the sample.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.
- Add preservatives if required, securely cap container, label and complete field notes. Invert the container several times to ensure sufficient mixing of sample and preservatives.

3. Pumping Technique

Use appropriate pumps, equipment, and tubing (confirming reusable equipment has been appropriately decontaminated) when using a pump to collect surface water samples. Do not collect oil & grease or TRPH with a pump. Follow this procedure:

- Measure the water column to determine the maximum depth and the sampling depth (for surface samples collect at least 12 inches below the surface, where feasible).
- Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do <u>not</u> use a lead or metallic weight if collecting metals samples. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament polypropylene, etc.) so that it is located below the inlet of the tubing.
- Lower tubing to a depth 6-12 inches below water surface, where possible.
- Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.
- Fill individual sample bottles via the discharge tubing, being careful not to remove the inlet tubing from the water.
- Try to avoid touching the discharge tubing to the sample container.
- Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

4. Depth Grab Samples

Examples of equipment that may be used for depth grab sampling include Kemmerer, Niskin, Van Dorn and similar samplers; pumps with tubing (see above section), and double

check-valve bailers. Before using any reusable equipment, confirm equipment is appropriately decontaminated.

Many of these Kemmerer, Niskin and Van Dorn type samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Stainless steel or Teflon-coated devices are acceptable for all analyte groups.

- Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.
- Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.
- Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.
- At the desired depth, send the messenger weight down to trip the closure mechanism.
- Retrieve the sampler slowly.
- Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.

B Streamflow Measurement

Water discharge can be measured in shallow (less than 4 feet deep) rivers and streams using a hand-held probe that measures instantaneous velocity, and is positioned at multiple depths and distances across that stream cross section.

The current meter is used by suspending the sensing probe in the stream and pointing it in the upstream direction. The assumption is that the stream to be measured is sufficiently shallow to wade in. The sensing probe is attached to a special rod which is graduated in such units as centimeters and which allows the probe to be positioned in the stream at a known depth. The probe measures water velocity by creating a magnetic field and measuring the voltage produced when water flows through the field.

A straight stretch of stream with a fairly constant depth is preferred for conducting streamflow measurements. This will maximize the likelihood that the streamlines are parallel to one another. There should be few if any rocks, holes, or structures in the stream. Preferably the depth of the section to be measured is greater than 0.5 feet and the velocity is greater than 0.5 feet per second.

A tape or marked cable is stretched across the stream channel and anchored securely at each end. The total width of the stream is determined. Flow measurements are taken at known increments (even increments are best because it simplifies the subsequent calculations). There should be 10 to 20 measurements across a large stream, fewer across a small one. The data collected are used to calculate the discharge by the midsection method normally employed by the USGS.

Set the rod firmly on the stream bottom and hold it vertically at the desired distance mark on the tape. Point the probe upstream and stand to the side so that the flow around your legs does not affect the meter.

If the stream is less than 2.5 feet deep, a one point method is used. The probe should be placed at a depth of 0.6 of the total stream depth measured downward from the surface.

If the stream is more than 2.5 feet deep, then the two-point method is used. Measurements are taken at depths of 0.2 and 0.8 of the total stream depth. The measurements at 0.2 and 0.8 are averaged.

The velocity of flow for each set of measurements is determined using tables provided with the current meter used.

IV. Attachments

- Surface water quality sampling field data form.

V. Key Checks and Items

- When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.
- When wading, collect samples upstream from the body.
- Avoid disturbing sediments in immediate area of sample collection.
- Collect water samples prior to taking sediment samples when obtaining both from the same area (site).
- Collect water samples for chemical analyses prior to taking field measurements.
- Consider the representativeness of selected sampling locations, for example, when attempting to characterize a water body that may be stratified or heterogeneous.
- Unless dictated by the SAP, sampling at or near structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.
- Collect surface water samples from downstream toward upstream.

Surface Water Quality Sampling Field Data

SITE:

FIELD CREW:

DATE: **CLOUD COVER:**

TIME: **ANTECEDENT RAIN:**

DEPTH OF WATER (FT): **AMBIENT TEMPERATURE:**

FLOW VELOCITY AND DIRECTION:

FIELD MEASUREMENTS

Time	Conductivity (µmhos)	DO (mg/L)	Salinity (ppt)	Temperature (°C)	pH (su)	ORP	Turbidity (NTU)	

SAMPLE PARAMETERS (GRAB OR COMPOSITE) :

OBSERVATIONS

COLOR: CLEAR , AMBER , TAN , BROWN , GREY , MILKY WHITE , OTHER:

ODOR: NONE , LOW , MEDIUM , HIGH , VERY STRONG , H2S , FUEL LIKE , CHEMICAL ?, UNKNOWN

TURBIDITY: NONE , LOW , MEDIUM , HIGH , VERY TURBID. HEAVY SILTS

COMMENTS:

OTHER: PLEASE USE BACK OF SHEET.FOR SKETCHING MAPS , **SEE BACK OF SHT Y / N.**

Q.C. SAMPLE TYPE: DUPLICATE , EQUIPMENT BLANK , OTHER :

SIGNED/SAMPLER: _____

Updated May 2007 PAGE_____OF_____

STANDARD OPERATING PROCEDURE G-2

Sediment Sampling

I. Purpose

These standardized procedures describe the collection and handling of sediment samples during field operations.

II. Scope

Sediments occur in freshwater and marine environments such as streams/rivers, ponds/lakes, canals, ditches, wetlands, lagoons, and estuaries. The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Always collect surface water quality samples prior to collecting sediment samples if sampling locations are located with or near each other.

The sampling team will document the site conditions (e.g., surrounding land use, surface water characteristics, obvious nearby sources of contamination) and sediment characteristics (e.g., color, texture, odor, sediment depth sampled) through a brief description in the logbook, sediment log sheet, and/or representative site photos. It is also important to document that the media being sampled is in fact sediment (and not soil), meaning that overlying water was present at the time of sampling, or that there is obvious evidence of frequent and recent inundation (e.g., sampling exposed sediment at low tide). Any project required deviations from the standard operating procedures (SOPs) will be provided in the site specific sampling and analysis plan (SAP).

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device).
- Rope to lower sediment grab or dredge.
- Measuring tape to measure water depth.
- Sediment log sheets.
- Camera (to document sample characteristics and site conditions).
- Hip waders.
- Materials for classifying soils, particularly the percentage of fines.
- Sample jars, including jars for grain size, total organic carbon, and pH, as appropriate.
- Boat or canoe with U.S. Coast Guard-approved safety equipment.

IV. Procedures and Guidelines

Sediment samples can be collected using one of three different types of equipment: (1) scoops, (2) corers and (3) dredges/grab samplers. Soil sampling equipment is generally not applicable to sediments because of the low cohesion of the medium, but may be used if appropriate. When selecting the appropriate sampling equipment, consider sampling location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity, and analytes of interest.

Direct collection with the appropriate sample container may be appropriate in very low water or where sediment is exposed. Use dredges for hard or rocky substrates (can also be used for fine sediment). They are heavy enough to use in high velocity streams. Use coring devices in quiescent waters, unless water depth precludes effective sample collection. Always note the depth of sediment actually collected; environmental and mechanical factors may prevent collection to targeted depth (e.g., 0-6 inches).

A. Scoops or Similar Equipment

- Scooping is generally most useful in shallow waters, and where water flow is minimal so as not to disturbed the scooped sample as it is brought up through the water column. Collect samples by facing the direction of minimal flow and approach the location from the downstream direction. Take precautions not to disturb the bottom prior to scooping. Scoop and transfer the sample to the appropriate sample container(s) or to a decontaminated bowl if homogenization is required.

B. Corers

Coring devices can be easily fabricated from many materials. Some corers are simple "push tubes," whereas other more sophisticated models may be finned, gravity driven devices. A core may be useful for preserving the historical layering of sediments.

The corer is an acceptable choice for sampling fine sediments. Corer diameter, grain size, and sample consistency will determine if the sample will remain in the corer upon withdrawal. Sample washout can be a problem, and ways to reduce or prevent it are as follows:

- Fit the leading edge of the corer with a nosepiece or core catcher that physically keeps the sample from slipping back out of the corer. The core catcher material must also be compatible with the analytes of interest.
- A second option is fit the top or back end with a check valve which creates negative pressure as it is being pulled from the substrate, and prevents surface water from washing out the top portion of the sample.
- Rotate the corer, if needed, as it is pushed into the sediment but do not rock the coring device back and forth. Rotation improves penetration and prevents compaction of the sample.
- Upon withdrawal from the water surface, place a cap on the bottom to prevent the sample from sliding out.

- Corers can also be fitted with liners if a complete core is desired.
- As the core is extruded, carefully remove the sample with a decontaminated, non-reactive utensil and transfer into the appropriate sample container(s) or a bowl if homogenization is required or if a specific depth fraction is required to be sampled.

C. Dredges or Grab Samplers

The three main types of devices used in freshwater are the Peterson, Ponar, and Ekman. The Peterson and Ponar dredges are suitable for hard or rocky substrates, deep water bodies, and streams with fast currents. The Peterson and Ponar are virtually the same, except that the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. Use the following method to collect a sediment sample:

- Open the jaws and place the cross bar into the proper notch.
- Lower the dredge to the bottom, making sure it settles flat.
- When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a decontaminated, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

The Ekman is designed for sampling soft substrates (e.g., sand, silt, or mud) in areas with little current and is used as follows:

- Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.
- Lower the dredge to the bottom, making sure it settles flat.
- Holding the line taut, send down the messenger to close the jaws of the dredge.
- Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.
- Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s) or bowl for homogenization.

D. General Sampling Procedures

1. Field personnel will start downstream and work upstream to prevent disturbance of or influence on unsampled areas. In surface water bodies that are tidally influenced, sampling should be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants; however, sampling at other tide stages may be warranted to provide data representative of other, actual conditions. Sediment sampling activities should not occur immediately after periods of heavy rainfall.

2. As needed, make a sketch of the sample area that shows important nearby river features and permanent structures that can be used to locate the sample points on a map. Use a GPS to gather station coordinates, if needed. Also characterize depth and width of waterway, rate of flow, type, consistency, and odor of sediment, and point and depth of sample removal (along shore, mid-channel, etc.).
3. Transfer sample into appropriate sample jars with a stainless steel utensil. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. Minimize the amount of overlying water that is collected with the sample matrix. Decant the excess water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since skin or gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
4. Samples for volatile organics (and, if applicable, acid volatile sulfides/simultaneously extracted metals [AVS/SEM]) should immediately be placed in jars prior to homogenization of sediment. Rocks and other debris should be removed with utensils before placement in jars. If sediment is stiff enough to sample with EnCore® or Terra Core® samplers for VOC analysis, follow the instructions contained in the EnCore® or Terra Core® SOPs, as applicable.
5. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, broken bottles, sharps, snakes, drop-offs, loose silt and muck) which can make wading dangerous.
6. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
7. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

Sediment Log Form.

VI. Key Checks and Items

- When working in flowing streams, start downstream and work upstream.
- As necessary and practical, log exact locations using permanent features, and gather GPS coordinates.
- Beware of hidden hazards in the water column.
- When sediment sampling at a location for the first time, bring several types of sampling equipment in case one does not work.

CH2MHILL

PROJECT NUMBER	SAMPLE NUMBER SHEET 1 OF 1

SEDIMENT LOG

PROJECT : LOCATION : DATE:

WEATHER:

METHOD AND EQUIPMENT USED :

LOGGER :

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SEDIMENT DESCRIPTION COLOR, ODOR, MOISTURE CONTENT PARTICLE SIZE CHARACTERIZATION	COMMENTS UNUSUAL CHARACTERISTICS
0.5						
1.0						
1.5						
2.0						
2.5						

Sampler Signature: _____ Date: _____

G-2_Sediment SAMPLING FORMS2_jrm_jl.xls Updated May 2007

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STANDARD OPERATING PROCEDURE H-1

Preparing Field Log Books

I. Purpose and Scope

This SOP will provide standardized procedures and basic requirements for entering field data into log books during field activities. Log books are legal documents. They must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy.

II. Equipment and Materials

- Log book
- Indelible pen

III. Procedures and Guidelines

Properly completed field log books are a requirement of the work performed under the Navy CLEAN contract.

A. Procedures for Completing Field Log Books

1. Field notes are to be kept in bound, hard-covered logbooks, as well as task-specific logs. The pages are to be water-resistant and notes will be taken only with a water-proof, non-erasable permanent ink pen.
2. The inside cover of the log book generally should include:
    - Company name and address.
    - Log-holders name if log book was assigned specifically to that person.
    - Activity or location.
    - Project name.
    - Project manager's (PM's) name.
    - Phone numbers of the company, supervisors, emergency response, etc.
3. Daily entries will be made chronologically. Each page of the log book will have the date of the work and the note takers initials.
4. Information will be recorded directly into the field log during the work activity. Entries into the log should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on memory. Entries must be legible and complete.

5. Every line should be used to prevent later additions of text, or be marked through with a line, initialed and dated. Unused pages will be marked through with a line, the author's initials, date, and the note "Intentionally Left Blank."
6. 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 person performing the correction. If possible, all corrections should be made by the individual keeping the log.
7. Only information relevant to the subject project will be added to the log book.
8. The final page of each day's notes will include the note-takers signature and date.
9. Copies of the field notes generally should be sent to the PM or designee in a timely manner (generally by the end of each week of work being performed).

B. Information generally to be Included in Field Logs

1. Use the left side border to record times and the remainder of the page to record information.
2. General project information will be recorded at the beginning of each field project; the project title, project number, staff, scope of the day's work and weather conditions (note changes).
3. Subcontractor Information: Record name of company, names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List start and stop times, and quantities of billable line items accomplished.
4. Technical and Project Information: Describe the details of the work being performed. The project SAP will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the PM prior to beginning the field work.
5. Any conditions that might adversely affect the work or data obtained.
6. Time: Keep a running time log explaining field activities as they occur throughout the day.
7. Tail Gate Safety Talks: Record topics discussed.
8. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE). Also record other required health and safety procedures as specified in the project specific health and safety plan.
9. Instrument Calibration: Record calibration information for each piece of health and safety/field equipment if not recorded elsewhere.
10. Personnel: Record when personnel and visitors enter and leave the site.
11. Communications: Record all communications that impact performance of the project.
12. Deviations from the SAP: Record deviations from the SAP; document the reasons and communications authorizing deviations.

13. Heath and Safety Incidents: Record all health and safety incidents in detail, immediately reporting them to the field team leader (FTL) and PM.
14. Problems and Corrective Actions: Clearly describe problems encountered during the field work and the corrective actions taken.
15. 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 – If location not already identified on a map or figure, 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 identifier, date and time.
    - 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.
    - If the PM specifies, some of the above can be entered in GBC or spiral bound field sampling books printed specifically for the sampling task instead of in the hard cover log book.

C. Suggested Format for Recording Field Data

1. Use tables to record sampling information and field data from multiple samples. Keep data organized for easier review.
2. Sketch sampling locations, construction sites, and other pertinent information.
3. Sketch well construction diagrams or use well-completion logs.

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STANDARD OPERATING PROCEDURE H-4

Chain-of-Custody

I. Purpose

This SOP provides standardized procedures for completing chain of custody (COC) forms. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs).

II. Scope

This procedure describes the steps necessary for transferring samples through the use of a COC. A COC is required for the tracking and recording of samples collected during program activities. Use of the COC 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 regional- or site-specific requirements.

III. Definitions

Chain-of-Custody Record - A COC is a printed form that accompanies a sample or group of samples as custody 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 the 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 is secured to prevent tampering.

Sample - A sample is physical evidence 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.

A. 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 may 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.

1. Sample Label

Samples removed and transported from the sample location to a laboratory or other location for analysis will be collected into laboratory provided containers and labeled. Sample labels will include:

- Project - CTO Number.
- Sample Identification - The SAP/SSP I.D. provided for the sample.
- Date - Day, month, and year of sample collection.
- Time - A four-digit number in the 24-hour format at time of collection.
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type of preservation.
- Analysis – Type of analysis to be performed (e.g., VOC).

- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

B. Chain-of-Custody Procedures

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

1. Field Custody Procedures

- Care must be taken to ensure that the sample information on the label matches the COC exactly.
- 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.
- Sample labels shall be completed for each sample, using waterproof ink.

2. Transfer of Custody and Shipment

Samples are accompanied by a COC. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the COC. This documents sample custody transfer from the sampler to the analyst in the laboratory. The COC is shipped as described below:

- Place the original (top, signed copy) of the COC in a plastic zipper-type bag or other appropriate sample-shipping package. Retain the copy with field records.
- Sign and date two custody seals, 1-inch by 3-inch white paper labels with black lettering and an adhesive backing. The custody seals are part of the COC process and are 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 seals across the shipping container opening on diagonally opposite corners, so that one would be broken if the container were to be opened.
- Complete other carrier-required shipping papers.

Any corrections are made by drawing a line through, initialing and dating the change, then entering the correct information. Erasures are not permitted.

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 then signs and dates the COC, completing the sample transfer process. It is then the laboratory's responsibility to maintain custody records throughout sample preparation and analysis.

V. Quality Assurance Records

Once samples have been packaged and shipped, the COC copy and airbill receipt become part of the QA record.

VI. Attachments

Chain of Custody Form.

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.

STANDARD OPERATING PROCEDURE H-5

Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of samples of various media to a laboratory for analysis. This standardized procedure only covers samples of sufficiently low concentration as to not be considered dangerous goods for purposes of shipping.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have sufficiently low concentrations of chemical constituents as to not be considered dangerous goods when being shipped. 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 following procedures for dangerous-goods shipping specified by the intended shipper (e.g., Federal Express).

III. Equipment and Materials

- Coolers
- Clear tape
- Duct tape
- “This Side Up” labels
- “Fragile” labels
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

A. Sample Packing

1. Prepare coolers for shipment:
   - Tape drains shut from the inside of the cooler.
   - Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler, if available.
   - Place mailing label with laboratory address on top of coolers.
   - As necessary (helpful for large bottle ware), fill bottom of coolers with about 3 inches of bubble wrap.
2. Arrange decontaminated sample containers in groups by sample number. Consolidate volatile organic compound (VOC) samples into one cooler to minimize the need for trip blanks.
3. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.
4. Seal each set of sample bottles within a separate water proof zipper-type plastic bag and bubble wrap, if available. Make every attempt to ensure the samples are water proof. Double bag Encore VOC samples and soil samples. Sample label should be visible through the bag.
5. Place two large plastic bag liners, one inside the other, openings up. Arrange sample containers in liners so bags do not touch each other. Temp blank should go on the bottom of the cooler, in an area where it can be completely surrounded by ice.
6. If ice is required to preserve the samples, use at least two full bags and place on and around the containers.
7. Fill remaining spaces with bubble wrap or ice as required and add the laboratory provided trip blank.
8. Close the inside liner first by twisting the opening to the bag liner closed, allowing as much air to escape as possible. Zip-tie the bag closed and tie the end into a knot. Do the same to the second liner being sure to remove as much air as possible.
9. Complete and sign COC (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier. Place into a zip-type bag and tape it to the inside of the lid of the cooler.
10. Close lid and latch.
11. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
12. Tape cooler shut on both ends, making several complete revolutions with tape. Do not cover custody seals.

13. Relinquish to Federal Express or to a courier arranged with the laboratory. Scan airbill receipt and COCs to the sample documentation coordinator (or mail if scanner not available) along with the other documentation.

B. Medium- and High-Concentration Samples

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with several additional restrictions. 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.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label.
- Pack sample bottles carefully, with adequate bubble wrap or other packaging and without allowing bottles to touch.
- Be sure there is adequate ice.
- Include COC.
- Affix custody seals.

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STANDARD OPERATING PROCEDURE H-6

Equipment Blank Preparation

I. Purpose and Scope

This document provides standardized procedures for collecting equipment blanks used to determine whether decontamination procedures are adequate during sampling. Any project required deviations from standard operating procedures (SOPs) will be provided in site specific sampling and analysis plans (SAPs). 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.

II. Equipment and Materials

- ASTM Type II reagent water with analysis certification (blank water).
- Sample bottles with preservatives according to the SAP.
- Gloves.

III. Procedures and Guidelines

A. Decon all sampling equipment according to "Decontamination of Personnel and Equipment" SOP.

B. For volatile organic compound (VOC) analysis from the surfaces of equipment other than pumps, pour blank water over one piece of equipment and into three 40-ml vials as per VOC water sampling procedure.

C. For non-VOC analyses, one aliquot is to be used for equipment. Pour blank water into the sampling bowl and other equipment so surfaces which previously contacted the sample are now in contact with the blank water. Pour blank fluid from pan into the appropriate sample bottles.

D. For pumps, run an extra gallon of blank water through the pump while collecting the pump outflow into appropriate containers. If a pump with disposable tubing is used, put new tubing onto the pump to collect the equipment blank.

E. Document and ship samples in accordance with the procedures for other samples.

IV. Attachments

None.

V. Key Checks and Items

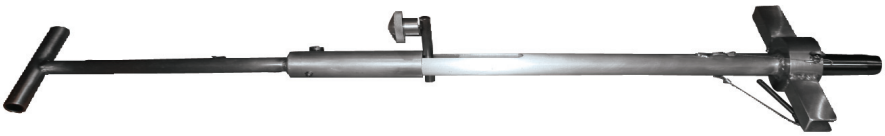
- Wear gloves.
- Do not use any disposable or non-decontaminated equipment to prepare blank.
- Use ASTM-Type II reagent water with analysis certification.

INTRODUCING THE MIST™
MULTI-INCREMENTAL SAMPLING TOOL

Centauri Labs is now offering the patented MIST™ sampling tools, specifically designed for Multi-Incremental Sampling Programs.

MIST™- 01:

MIST™- 02:



The MIST™ family of tools is currently available in two models:

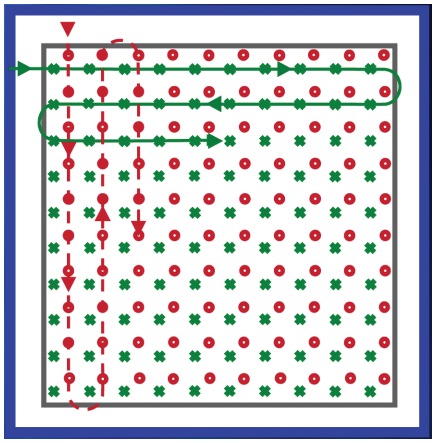
- The MIST™-01 is our entry level tool and based on the classic CRREL design
- The MIST™-02 is a more advanced version of the CRREL design with numerous innovations

The MIST™-01 and MIST™-02 are ideal for use in multi-incremental sampling programs, because they provide:

- Enhanced speed in sample collection
- Consistent sample-plug size and shape
- Ergonomic design to avoid back pain and back injuries
- Improved field sampling efficiency
- Homogenous and statistically valid soil collection from each decision unit

Using Centauri's MIST™ tools results in obtaining sampling accuracy in the field and the analytical accuracy in the laboratory.

MIS IS A TWO-PART PROCESS:



1. Field Sample Collection

- Collect multiple (> 30 to 100) increments of uniform size from the entire area to be represented (i.e. the Decision Unit)
- Composite increments into a single sample (1 to 2 kilogram)

2. Laboratory Processing and Sub-sampling

- Air drying and sieving entire sample
- Particle size reduction (grinding) of entire sample
- Multi-increment sub-sampling (>30 increments) to provide representative ~10 gram aliquot for extraction and analysis

PRODUCT SPECIFICATIONS:

Size –
Length 45 cm, Weight 3 kg

Core Details –
Core #1: 1.0″ wide x 4.0″ deep = 95 grams
Core #2: 1.0″ wide x 2.5″ deep = 28 grams
Core #3: 1.5″ wide x 2.5″ deep = 60 grams
Core #4: 0.5″ wide x 2.5″ deep = 11 grams

Note: The cores were tested on wet grassy soil. Sample weight may vary.

Pricing –
MIST™-01 with 4 coring tips = $ 1,000
MIST™-02 with 4 coring tips = $ 1,300

Note: Call for rental options.

For more information or to schedule a Multi-Incremental Sampling Seminar please contact Centauri Labs at (301) 694-5310 or info@centaurilabs.com.

CENTAURI LABS™

7210 Corporate Court, Frederick, MD 21703 P: (301) 694-5310 F: (301) 620-0731 **www.centaurilabs.com**

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Attachment B
Laboratory SOPs

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Due to their proprietary and confidential nature, analytical laboratory SOPs are removed from this document and not available to the general public.

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Attachment C
Human Health Risk Scenarios

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TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Eastern Conservation Area

Former VNTR, Vieques, Puerto Rico

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Surface Soil (0-2 inches) [a]	Site-Wide Soil	FWS Worker #1	Adult	Ingestion, Dermal, Inhalation	On-Site	Quant	FWS Wildlife Survey and Monitoring Workers may contact surface soil while conducting site-wide wildlife surveillance and monitoring.
		Surface and Deeper Surface Soil (0-2 feet)	Bahia Playa Blanca Beach and Edge of Vegetation [c] (Turtle-Nesting Ground Beach) Soil	FWS Worker #2	Adult	Ingestion, Dermal, Inhalation	On-Site	Quant	FWS Sea Turtle Monitoring Workers may contact surface soil and deeper surface soil while conducting sea turtle monitoring and conservation activities.
		Surface Soil (0-2 inches) [a]	Site-Wide Soil	FWS Law Enforcement Workers	Adult	Ingestion, Dermal, Inhalation	On-Site	Qual	FWS Law Enforcement Workers conducting emergency or infrequent response activities are expected to have insignificant exposure to site-wide soil based on the nature of the activities they are conducting and the short term duration of their activities. Risk estimates for FWS Workers conducting surveillance, restoration and conservation activities can be used as conservative estimates of Law Enforcement Worker risks.
		Surface Soil (0-2 inches) [a]	Light Post (Including Battery Disposal Area) Soil	Coast Guard Workers	Adult	Ingestion, Dermal, Inhalation	On-Site	Qual	Coast Guard Workers are expected to have insignificant exposure to site soil based on the nature and short duration of maintenance activities (annually changing the light bulb and battery) at the "Light Post" area. Risk estimates for FWS Workers conducting surveillance, restoration and conservation activities can be used as conservative estimates of Coast Guard Worker risks.
		Surface Soil (0-2 inches) [a]	Site-Wide Soil	Trespassers	Adult, Youth, Child	Ingestion, Dermal, Inhalation	On-Site	Qual	The ECA is a Congressionally Mandated Wilderness Area that is closed to the public[d]. Trespassers are unlikely to access the site due to the inaccessible nature of the site: the site is remote, it is only accessible through the LIA, the roads that access the site are rough and unpaved, and there are numerous locked gates and fences that must be opened to reach the site. The site cannot be accessed via boat or small craft due to the shallow reef and cliff elevation. FWS Workers are present on the site and would arrest and remove trespassers from the site if discovered there. Land crab from the ECA are a very small (or zero) percentage of a trespasser's diet due to the inaccessibility of the site. Risk estimates for FWS Workers conducting surveillance, restoration and conservation activities can be used as conservative estimates of trespasser risks.
		Land Crab	Land Crab Around the Lagoon [b]	Trespassers	Adult, Youth, Child	Ingestion	On-Site	Qual	
	Sediment	Sediment	Lagoon Sediment	FWS Worker #1	Adult	Ingestion, Dermal	On-Site	Quant	FWS Wildlife Survey and Monitoring Workers may incidentally ingest sediment while conducting surveillance and monitoring of migratory water fowl; FWS workers enter the lagoon approximately 15% of the time they are onsite. Lagoon sediment is too soft to support body weight, but may become available for ingestion by adhering to kayaks, oars and wader boots. Workers will not enter the lagoon without wearing waders.
	Surface Water	Surface Water	Lagoon Surface Water	FWS Worker #1	Adult	Dermal	On-Site	Quant	FWS Wildlife Survey and Monitoring Workers may contact surface water while conducting surveillance and monitoring of migratory water fowl. FWS workers enter the lagoon approximately 15% of the time they are onsite. Surface water may be contacted when workers wade at the edge of the lagoon or during the entry and exiting of kayaks. Workers will not enter the lagoon without waders.

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Soil	Surface Soil (0-2 inches) [(a)]	Highlands Soil	FWS Worker #3	Adult	Ingestion, Dermal, Inhalation	On-Site	Quant	FWS ECA Highland Dry Forest Restoration Workers may contact surface soil while conducting restoration, surveillance and monitoring of the Highlands.
		Surface Soil (0-2 inches) [(a)]	Lowlands Soil	FWS Worker #4	Adult	Ingestion, Dermal, Inhalation	On-Site	Quant	FWS ECA Lowland Forest Restoration Workers may contact surface soil while conducting restoration, surveillance and monitoring of the Lowlands.
		Surface Soil (0-2 inches) [(a)]	Lagoon [(b)]	FWS Worker #5	Adult	Ingestion, Dermal, Inhalation	On-Site	Quant	FWS Migratory Waterfowl Survey Workers may contact surface soil while conducting surveillance and monitoring of migratory water fowl.
	Sediment	Sediment	Lagoon Sediment	FWS Worker #5	Adult	Ingestion, Dermal	On-Site	Quant	FWS Migratory Waterfowl Survey and Monitoring Workers may incidentally ingest sediment while conducting surveillance and monitoring of migratory water fowl. Lagoon sediment is too soft to support body weight, but may become available for ingestion by adhering to kayaks, oars and wader boots. Workers will not enter the lagoon without wearing waders.
	Surface Water	Surface Water	Lagoon Surface Water	FWS Worker #5	Adult	Dermal	On-Site	Quant	FWS Migratory Waterfowl Survey and Monitoring Workers may contact surface water while conducting surveillance and monitoring of migratory water fowl. Surface water may be contacted when workers wade at the edge of the lagoon or during the entry and exiting of kayaks. Workers will not enter the lagoon without waders.

Note:
ECA = Eastern Conservation Area
FWS = Fish and Wildlife Service
LIA = Live Impact Area

(a) A site-specific surface soil depth of 0-2 inches bgs is used since subsurface soil is not present everywhere and subsurface activities occur at a low frequency for FWS workers.

(b) The area designated "Lagoon" extends 10 meters inland from the shoreline.

(c) The area designated Bahia Playa Blanca extends 20 meters inland from the edge of the vegetation to encompass the entire area in which sea turtles are known to travel to nest and lay eggs.

(d) ECA was transferred to the Department of the Interior to be managed by the FWS as a National Wildlife Refuge and Wilderness pursuant to Section 1049 of the National Defense Authorization Act for Fiscal Year 2002 (Public Law 107-107). The area is to be administered as a wilderness area under Wilderness Act (16 U.S.C. 1131 et seq) and access to the public is to be denied.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil (0-2 inches) or Subsurface Soil (0-2 ft)[a]

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	FWS Worker #2	Adult	Bahia Playa Blanca Beach and Edge of Vegetation (Turtle-Nesting Ground Beach) Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	Chronic Daily Intake (CDI) (mg/kg-day) =
			Activity:	IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
			Sea Turtle Monitoring and Conservation	EF	Exposure Frequency	130	days/year	3 days/week, 10 months/year	
				ED	Exposure Duration	25	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 6 hours per work day.
	FWS Worker #3	Adult	Highlands Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
			Dry Forest Restoration	EF	Exposure Frequency	10	days/year	5 days/week, 2 weeks/yr	
			(Surveillance and Monitoring)	ED	Exposure Duration	25	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.
	FWS Worker #3	Adult	Highlands Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
			Dry Forest Restoration	EF	Exposure Frequency	30	days/year	5 days/week, 6 weeks/yr	
			(Planting)	ED	Exposure Duration	5	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	1,825	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.
	FWS Worker #4	Adult	Lowlands Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
			Forest Restoration	EF	Exposure Frequency	3	days/year	3 days/week, 1 week/yr	
			(Surveillance and Monitoring)	ED	Exposure Duration	25	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	Although it is not included in the CDI equation, workers are
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	assumed to be exposed to site soil for 8 hours per work day.
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil (0-2 inches) or Subsurface Soil (0-2 ft)[a]

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion (cont.)	FWS Worker #4	Adult	Lowlands Soil **Activity:** Forest Restoration (Planting)	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	330	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
				EF	Exposure Frequency	9	days/year	3 days/week, 3 weeks/yr	
				ED	Exposure Duration	5	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	Although it is not included in the CDI equation, workers are
				AT-N	Averaging Time (Non-Cancer)	1,825	days	(3)	assumed to be exposed to site soil for 8 hours per work day.
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	
	FWS Worker #5	Adult	Lagoon Fringe **Activity:** Surveillance and Monitoring of Migratory Waterfowl	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
				EF	Exposure Frequency	52	days/year	3 days/week, 4 months/yr	
				ED	Exposure Duration	25	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 4 hours per work day.
	FWS Worker #1	Adult	Site-Wide Soil **Activity:** Wildlife Surveillance and Monitoring	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				IR-S	Ingestion Rate of Soil	100	mg/day	EPA, 2002 (1)	CS x IR-S x EF x ED x CF x 1/BW x 1/AT
				EF	Exposure Frequency	35	days/year	2 days/week, 4 months/yr	
				ED	Exposure Duration	25	years	(2)	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil (0-2 inches) or Subsurface Soil (0-2 ft)[a]

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	FWS Worker #2	Adult	Bahia Playa Blanca Beach and Edge of Vegetation (Turtle-Nesting Ground Beach) Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
			Sea Turtle Monitoring	SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
			and Conservation	DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	130	days/year	3 days/week, 10 months/year	
				ED	Exposure Duration	25	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 6 hours per work day.
	FWS Worker #3	Adult	Highlands Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
			Dry Forest Restoration	SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
			(Surveillance and Monitoring)	DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	10	days/year	5 days/week, 2 weeks/yr	
				ED	Exposure Duration	25	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.
	FWS Worker #3	Adult	Highlands Soil	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
			Activity:	SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
			Dry Forest Restoration	SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
			(Planting)	DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	30	days/year	5 days/week, 6 weeks/yr	
				ED	Exposure Duration	5	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	1,825	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil (0-2 inches) or Subsurface Soil (0-2 ft)[a]

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont.)	FWS Worker #4	Adult	Lowlands Soil **Activity:** Forest Restoration (Surveillance and Monitoring)	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	3	days/year	3 days/week, 1 week/yr	
				ED	Exposure Duration	25	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	Although it is not included in the CDI equation, workers are
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	assumed to be exposed to site soil for 8 hours per work day.
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	
	FWS Worker #4	Adult	Lowlands Soil **Activity:** Forest Restoration (Planting)	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	9	days/year	3 days/week, 3 weeks/yr	
				ED	Exposure Duration	5	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	Although it is not included in the CDI equation, workers are
				AT-N	Averaging Time (Non-Cancer)	1,825	days	(3)	assumed to be exposed to site soil for 8 hours per work day.
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	
	FWS Worker #5	Adult	Lagoon Fringe **Activity:** Surveillance and Monitoring of Migratory Waterfowl	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	52	days/year	3 days/week, 4 months/yr	
				ED	Exposure Duration	25	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 4 hours per work day.

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Eastern Conservation Area
Former VNTR, Vieques, Puerto Rico

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil (0-2 inches) or Subsurface Soil (0-2 ft)[a]

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont.)	FWS Worker #1	Adult	Site-Wide ECA **Activity:** Wildlife Surveillance and Monitoring	CS	Chemical Concentration in Soil	Site-Specific	mg/kg	Site-Specific	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,500	cm^2	EPA, 2004 (5)	CS x SA x SSAF x DABS x CF x EF x
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004 (6)	ED x 1/BW x 1/AT
				DABS	Dermal Absorption Factor Solids	Chemical-Specific	--	EPA, 2004	
				CF	Conversion Factor	0.000001	kg/mg	- -	
				EF	Exposure Frequency	35	days/year	2 days/week, 4 months/yr	
				ED	Exposure Duration	25	years	(2)	
				BW	Body Weight	70	kg	EPA, 2002	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(3)	Although it is not included in the CDI equation, workers are
				AT-C	Averaging Time (Cancer)	25,550	days	(4)	assumed to be exposed to site soil for 10 hours per work day.

Notes:

ECA = Eastern Conservation Area

FWS = Fish and Wildlife Service

RME = Reasonable Maximum Exposure

(a) Subsurface soil from the Bahia Playa Blanca turtle nesting area from 0-2 ft bgs will be included.

(1) The typical Vieques maintenance worker soil ingestion rate was selected to represent FWS Worker activities not involving planting; the typical Vieques construction worker soil ingestion rate was selected to represent FWS Worker planting activities.

(2) Exposure duration selected during the EPA/PREQB/FWS conference call on February 11, 2010 concerning RME scenarios for FWS Workers at the ECA.

(3) Calculated as the product of ED (years) x 365 days/year.

(4) Calculated as the product of 70 years assumed human lifetime x 365 days/year.

(5) SA includes lower arms, hands and face.

(6) The typical Vieques maintenance worker soil-to-skin adherence factor was selected to represent FWS Worker activities not involving planting; the typical Vieques construction worker soil-to-skin adherence factor was selected to represent FWS Worker planting activities.

Sources:

EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24.

EPA, 2004. Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual. Part E Supplemental Guidance for Dermal Risk Assessment).

cm^2 = Square centimeter

kg = Kilogram

kg/mg = Kilogram per milligram

mg/kg = Milligram per kilogram

mg/kg-day = Milligram per kilogram per day

mg/cm^2-day = Milligram per square centimeter per day

mg/day = Milligram per day

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Draft Human Health Risk Assessment
Scenarios and Exposure Model Parameters for
Fish and Wildlife Service Workers in the Eastern Conservation Area

Sea Turtle Monitoring

Activities:

1. Traverse beach on foot looking for sea turtle tracks and nests.
2. Measure dimensions of tracks/nest.
3. Mark location and GPS.
4. If the nest is in an "at risk' location, the nest is relocated by digging up eggs and moving them to a location on that beach or adjacent beach.
5. Return to nest location after approximately 70 days to determine hatching success by digging up the nest, and counting eggs hatched and eggs not hatched.

Duration: Ten months per year

Frequency: Current - 1 day per week
Optimum - 3 days per week
Likely - 2 days per week

Exposure time: Current - 3 to 6 hours per day

Number of staff: Current - 2
Optimum - 4
Likely - 2

ECA Highland Dry Forest Restoration - Survey and Monitoring

Activities:

1. Establish permanent plots and transects.
2. Identify, count, measure size, and map number of species numbers of individuals of each species and GPS location.
3. Collect soil for seed bank evaluation (this task is likely to be performed only once at start of restoration effort).
4. Apply invasive species control as needed.

Duration: Two weeks per year

Frequency: Annually until dry forest recovers (approximately 25 years)
Every 3 years thereafter

Exposure Time: Eight to 10 hour days

Number of Staff: Likely - 4

ECA Highland Dry Forest Restoration - Planting

Activities:
1. Traverse ECA and collect fruit and/or seeds for use in greenhouse
2. Grow plants in greenhouse
3. Plant seedlings in ECA

Duration: Seed/fruit collection - 3 weeks
Planting - 3 weeks

Frequency: Seed/fruit collection - annual activity for first 5 years and on an as needed basis thereafter
Planting – annual activity for first 5 years and on an as needed basis thereafter

Exposure Time: Seed/fruit collection - 8 to 10 hours per day
Planting - 8 to10 hours per day

Number of Staff: Seed/fruit collection - likely - 2
Planting - likely - 4

ECA Lowland Forest Restoration

The same activity scenario used for the dry forest in the exposed bedrock upland area can be applied to the lowland forest area, however since the total area is less and the techniques are better established, the exposure assumptions will be approximately half of those in the dry forest.

Migratory Waterfowl Survey and Monitoring

Activities:
1. Establish permanent survey points and transects.
2. Identify, count, the number of migratory waterfowl species present.
3. Enhance habitat as needed.

Duration: Four months per year total - 2 in spring and 2 in fall migratory season

Frequency: Optimum - 3 days per week
Likely - 1 day per week

Exposure time: Four hours per day

Number of staff: Optimum - 4
Likely - 2

Wildlife Survey and Monitoring

Activities:
1. Establish permanent survey points and transects.
3. Identify, count, the number of wildlife species present.

3. Enhance habitat as needed.

Duration:	Four months per year total timing as appropriate
Frequency:	Optimum - 2 days per week Likely - 1 day per week
Exposure time:	Eight to 10 hours per day
Number of staff:	Optimum - 4 Likely - 2

Law Enforcement Activities

Per the Executive Order 12580, the Eastern Conservation Area will be managed as a wilderness area with no public access. Consequently, Fish and Wildlife law enforcement activities in the ECA are likely to be limited to emergencies or other infrequent response activities. No prescriptive scenario will likely be accurate; however because of the nature of FWS Law Enforcement, the exposure scenarios detailed for other activities, will be protective of law enforcement officers.

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Attachment D
Ecological Risk Scenarios

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Eastern Conservation Area (ECA) – Strawman Ecological Risk Assessment Information

The ecological risk assessment (ERA) for the Eastern Conservation Area (ECA) will be conducted in accordance with the Final Ecological Risk Assessment Protocol for Vieques Environmental Restoration Program (currently under review/revision). However, ECA-specific sampling approaches, such as the use of Multi-Increment Sampling (MIS) and special lagoon and beach sampling, are currently being considered and may ultimately require deviating from the ERA Protocol. Per the ERA protocol process, any such deviations will be documented in the ECA-specific ERA interim deliverable.

This strawman document is intended to provide preliminary information on key, site-specific elements of the ERA for consideration by the management team, prior to implementation of RI activities.

1.1 Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. As part of problem formulation, the ecological setting of the ECA will be characterized in terms of the habitats and biota known or likely to be present. A conceptual model will be developed that describes source areas, transport pathways and exposure media, exposure pathways and routes, and receptors.

1.1.1 Ecological Setting

Information described in the following paragraphs will be used to develop the ecological setting for the ECA.

A review of aerial photos showed that the ECA lagoon has been isolated from the adjacent lagoon since 1936. In 1936 the lagoon contained about 100 percent coverage of vegetation, probably mangrove species, but showed a slow decline in coverage until 1985 when nearly all vegetation was absent, replaced with either open water or bare sediment.

A biological assessment (BA) for the ECA was conducted by Geo-Marine Inc (GMI) (Geo-Marine, 2007) which included a thorough survey of listed biological species and critical habitats in the ECA. The results are summarized as follows:

- 155 plant species were identified (Attachment A).
- None of the identified plants were listed as threatened, endangered, or rare.
- Six distinct vegetation communities were identified:
    1. Evergreen scrub (89.9acres)
    2. Forest scrub (18.9 acres)

3. Beach (9.5 acres)
4. Mangrove (1.0 acres)
5. Salt/sand flat (0.2 acres) (occurs in isolated patches in the east and southeast portions of the ECA)
6. Sparse thorn scrub (0.1 acres)

- Although several distinct and productive habitats were seen, no areas of designated critical habitat were observed.
- Brown pelicans (endangered; proposed for de-listing) were observed daily, feeding and/or resting at the west end of Playa Blanca either on the beach, in the water, or on the exposed coral outcrops.
- No roseate terns (threatened) were observed, however GMI noted they can occur from May through October, and are known to occur and/or nest on the ECA beaches.
- Twenty other bird species were observed flying over the area (Attachment A).
- No snakes or amphibians were observed.
- Soils types identified:
    - Rocky land (113.7 acres), consists of areas where rock crops out on 50% to 70% of the surface; loose stones common; very shallow soil material between outcrops and stones. The predominant rock is limestone.
    - Coastal beaches (9.5 acres), consists of narrow strips of light-colored beach sand saturated with seawater.
- The open water lagoon on the northwest side of the ECA was noted, but not specifically described in the BA report.

The BA for the Live Impact Area (LIA) (which encompasses the ECA beaches) also includes the results of sea turtle surveys, including data summary tables, observation location maps, and descriptions of nesting behaviors and occurrence on Vieques (Geo-Marine, 2006). Four species of federally-listed sea turtles are commonly found in the ocean waters off Puerto Rico. Species confirmed nesting on Vieques include the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*). The loggerhead (*Caretta caretta*) sea turtle has been observed in waters near Puerto Rico, but nesting on Vieques would be considered rare.

In 2007, GMI produced updated maps illustrating sea turtle nesting beaches and protective zones for the LIA, ECA, EMA, SIA, and SWMU 4 beaches. These maps were based on turtle nesting data collected between 2000 and 2006. Attachment B provides the map for the LIA which encompasses the ECA beaches. Turtle nesting beaches occur along the north side of the ECA (along Playa Blanca) and on unnamed narrow beaches along the south side.

In 2001, GMI conducted an evaluation of the general health and status of the mangrove communities on Navy property on the eastern end of Vieques Island (Geo-Marine, 2002).

Mangrove species occurring on Vieques include button mangrove (*Conocarpus erectus*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and red mangrove (*Rhizophora mangle*). There are 498.0 acres of mangrove forest located within 28 areas on the Navy Lands on Vieques. All of these mangrove forests are either basin or fringe types. All but two of the basin mangrove communities displayed indicators of good health. The lagoon in the ECA is identified as Bahia Playa Blanca (lagoon #34). It is described as an 8.6 acre closed lagoon (includes open water and/or exposed mudflats, depending on hydrologic conditions) with 1.0 acre of mangrove, and has an assigned USFWS wetland classification code of E2SS3P (estuarine, intertidal, scrub-shrub, broad-leaved evergreen, irregularly flooded).

The Vieques Integrated Natural Resources Management Plan (INRMP), Plan Years 2003 – 2012 (Geo-Marine, 2003), will also be used as a source of information for the environmental setting and ecological resources on Vieques, as applicable to the environment at the ECA. This document includes information on soils, hydrology, climate, topography, geology, flora, fauna, protected and rare species, exotic and invasive plants and animals, and unique natural communities. The list of protected and rare species is included in Attachment A. Based on general habitat requirements and records of occurrence, the brown pelican, roseate tern, white-cheeked pintail, and hawksbill, leatherback, and green sea turtles could occur at the ECA. Similarly, the Vieques National Wildlife Refuge Comprehensive Conservation Plan (CCP) and Environmental Impact Statement (USFWS, 2007) will be used as a source of physical environment and biological resource information for the ECA.

Specific surveys of wildlife using the lagoon in the ECA (Bahia Playa Blanca) have not been identified. However, the CCP provides a list of fish, aquatic invertebrates, birds, and mammals that will be used as a source of potential species that may use the lagoon habitat (Attachment A). Wildlife observed during various site visits will also be included. A draft list will be provided to USFWS for their comment and review.

Specific surveys of soil invertebrates are not known to have occurred in the ECA. The following is an excerpt from the CCP regarding the types of terrestrial invertebrates known to occur on Vieques, however, the presence of any of these organisms at the ECA cannot be confirmed without site-specific surveys:

> "Land invertebrates make up the largest group of terrestrial fauna in the Vieques Refuge. At this time [2007], an inventory and a description of these species has not been fully compiled. Aside from the different species of water and land crabs, which are listed above as aquatic organisms, there are several arthropods, gastropods, one or two Onychophora [velvet worms], and some annelids that can be found throughout various habitats within and around the refuge. Some of these are arachnids, such as the greater Puerto Rican Tarantula (*Cyrtopholis portoricae*), Banana Spiders (*Argiope* spp.), hexagonal shaped spiders (*Gasteracantha* spp.), and a few different species of scorpions probably from the genera *Centruroides* and *Tytius*. The diploda are represented by two known genera of millipedes on the refuge, *Rhinocricus* and *Orthocricus*, while the chilopoda are represented by different species of centipedes perhaps including the genus *Scolopendra*. The Class Insecta is well represented by a large variety of butterflies, moths, bees, wasps, ants, dragonflies, beetles, weevils, grasshoppers, walking sticks, termites, etc. There are at least two species of annelids (earthworms) along with perhaps two species of *Peripatus* (velvet

worms) that have been collected in and around the refuge (Segui, University of Puerto Rico, personal communication 2005), and there are several species of gastropods (snails) in these habitats. This last group includes the *Pseudopineria viequensis*, a land snail that was first discovered and described on the island of Vieques (Ortiz, University of Puerto Rico, personal communication 2005)."

No new surveys of terrestrial habitats in the ECA will be conducted. Terrestrial habitats described by the above references will be relied upon.

1.1.2 Conceptual Model

The conceptual model relates potentially exposed receptor populations with potential source areas based upon physical site characteristics and complete exposure pathways. Important components of the conceptual model are the identification of potential source areas, transport pathways, exposure media, exposure pathways and routes, and receptors. Actual or potential exposures of ecological receptors associated with a site are determined by identifying the most likely, and most important, mechanisms and pathways of contaminant release and transport. A complete exposure pathway has three components: (1) a source of chemicals that results in a release to the environment; (2) a pathway of chemical transport through an environmental medium; and (3) an exposure or contact point for an ecological receptor.

1.1.2.1 Potential Source Areas

Potential source areas in the ECA include:

- Deterioration of MEC and related scrap metal (i.e., point source releases).
- Former battery pile associated with the lighthouse on the eastern end of the ECA.
- Historical detonations (dispersion of explosive contamination [i.e., non-point source releases]). However, data collected to date (e.g., SWMU 4, few soil samples within ECA, and air monitoring stations) indicate this mechanism of release is not likely to be significant.

1.1.2.2 Transport Pathways and Exposure Media

A transport pathway describes the mechanisms whereby site-related chemicals, once released, may be transported from a source to ecologically relevant media where exposures may occur. The following pathways will be considered in the ERA:

- Overland flow (runoff) that distributes surface soil contaminants.
- Leaching from soil to groundwater, and subsequent migration to ocean.
- Groundwater is assumed not to discharge to the lagoon (at least perennially) because the lagoon is periodically dry.
- Groundwater seepage along the cliff faces is considered unlikely based on geologic conditions (karstic) and some visual inspection.
- Wind dispersion is expected to be minimal due to the thin soil horizon and heavy growth of vegetation across the ECA.

- Storm surges, tides, and waves may distribute contaminants associated with soils in low lying areas, primarily the beaches. In this storm surge scenario, contaminant migrations from the lagoon flushing onto the beach is unlikely due to large strip of vegetated land between lagoon and beach.

Exposure media for ecological receptors will include the following:

- Surface soil – 0-2 inches (if MIS is used) across the upland habitats of the ECA
- Deeper surface soil – 0-2 feet within habitat suitable for land crabs around the perimeter of the lagoon.
- Deeper surface soil – 18-24 inches in turtle nesting beaches, within the zone of suitable nesting habitat, and preferably at locations of historical nests if appropriate data is available. This depth interval is the zone where hawksbill and green sea turtles lay their eggs. Leatherback sea turtles, which do not nest in ECA, can lay their eggs to a depth of 4 feet.
- Surface water – in the lagoon, sampled at mid-depth.
- Surface sediment – in the lagoon, 0-6 inches.

1.1.2.3 Exposure Pathways and Routes

An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist.

Potentially complete exposure pathways exist for terrestrial receptors exposed to surface soil. The following receptor groups will be evaluated in the ERA:

- Plants
- Soil invertebrates
- Birds
- Mammals
- Reptiles

Potentially complete exposure pathways exist for terrestrial receptors exposed to deeper surface soil. The following receptor groups will be evaluated in the ERA:

- Land crabs where co-located surface and deeper (0 to 2 feet) surface soil samples are collected around the lagoon.
- Sea turtle eggs where co-located surface and deeper (18 to 24 inches) soil samples are collected along the beaches.

Potentially complete exposure pathways exist for aquatic receptors exposed to surface water and sediment in the lagoon. The following receptor groups will be evaluated in the ERA:

- Fish

- Benthic invertebrates (including crabs)
- Aquatic plants
- Birds
- Mammals

Terrestrial plants may be exposed to chemicals present in surface soils through their root surfaces during water and nutrient uptake. Unrooted, floating aquatic plants, rooted submerged vascular aquatic plants, and algae may be exposed to chemicals directly from the water or (for rooted plants) from sediment. Terrestrial and aquatic invertebrates may be exposed to chemicals in surface soil, surface sediment, and/or surface water through dermal contact and ingestion.

Animals may be exposed to chemicals through the: (1) inhalation of gaseous chemicals or of chemicals adhered to airborne particulate matter; (2) incidental ingestion of contaminated abiotic media (soil and/or sediment) during feeding or preening activities; (3) ingestion of contaminated water; (4) ingestion of contaminated plant and/or animal tissues for chemicals that have entered food webs; and/or (5) dermal contact with contaminated abiotic media. The following pathways, however, will not be evaluated for wildlife in the ERA:

- The contribution to the total dose from the inhalation route is generally insignificant for upper trophic level ecological receptors relative to ingestion pathways. Hence, the air pathway will not be evaluated for ecological receptors.
- Direct ingestion of drinking water is only considered when the salinity is below 15 parts per thousand, the approximate toxic threshold for wildlife receptors. Though salinity data are not available for the lagoon, there is strong evidence that this lagoon is predominantly brackish or marine when inundated (i.e., visible salts when lagoon is dry, salt tolerant wetland plant species [e.g., mangroves, saltwort] and invertebrates [e.g., fiddler crabs] observed during site visit). Therefore, ingestion of lagoon surface water by wildlife will not be evaluated for the ECA if salinity testing during the RI field activities confirms the water is not potable.
- Exposure to chemicals present in surface soil and surface sediment via dermal contact may occur but is unlikely to represent a major exposure pathway for most upper trophic level receptors, therefore this exposure pathway will not be evaluated.
- Terrestrial receptors (and their prey) are not exposed directly to groundwater at this site.

1.1.2.4 Receptors

The following upper trophic level receptors have been selected for exposure modeling in terrestrial, upland habitats:

- Fruit bat (*Artibeus jamaicensis*) - terrestrial mammalian herbivore
- Velvet free-tailed bat (*Molossus molossus*) - terrestrial mammalian invertivore
- Common ground dove (*Columbina passerine*) – terrestrial avian herbivore

- Pearly-eyed thrasher (*Margarops fuscatus*) - terrestrial avian omnivore
- Cave swallow (*Petrochelidon fulva*) – terrestrial avian insectivore
- Red-tailed hawk (*Buteo jamaicensis*) - terrestrial avian carnivore.

The following upper trophic level receptors have been selected for exposure modeling in the aquatic/wetland habitats of the lagoon:

- Fishing bat (*Noctilio leporinus*) - terrestrial mammalian piscivore
- Velvet free-tailed bat (*Molossus molossus*) - terrestrial mammalian invertivore
- Cave swallow (*Petrochelidon fulva*) – terrestrial avian insectivore
- Green heron (*Butorides virescens*) - aquatic avian invertivore/piscivore
- Spotted sandpiper (*Actitis macularia*) – aquatic avian invertivore
- White-cheeked pintail (*Anas discors*) – protected aquatic avian herbivore

The brown pelican (*Pelecanus occidentalis*) is a protected species frequently observed at the ECA, though not specifically at the lagoon. However, this large bird forages by high aerial diving and thus requires deep water. The depth of the lagoon, when inundated, is shallow based on field marks along the shoreline; water depth is not likely to exceed two feet.

A qualitative survey of fish and invertebrates will be conducted in the lagoon to determine what receptors are present, as part of the SAP. This aquatic survey will be conducted during a single sampling event lasting approximately 1 week. Long-term or repeated surveying will not be conducted since the purpose is to identify species typically present during a period of inundation, and not to document trends in metrics such as species density or diversity. Felix Lopez recommended this sampling occur at least 2 to 4 weeks following inundation to allow aquatic communities to become established. Felix is not aware of any site specific aquatic surveys in the ECA lagoon

Bats are the only native mammals on Vieques. As described in the INRMP, all other mammals were introduced by man to the island and include the house mouse (*Mus musculus*), rat (*Rattus* spp.), small Indian mongoose (*Herpestes auropunctatus*), and domestic animals such as cattle (*Bos taurus* and *Bos indicus*), horses (*Equus caballus*), dogs (*Canis familiaris*), and cats (*Felis catus*). The Vieques National Wildlife Refuge has proposed strategies to control or remove the mongoose, horses, and cattle from within refuge lands.

There is a high degree of uncertainty regarding estimating bioaccumulated contaminants in aerial insects, as consumed by insectivorous bats and birds. This is also true for estimating contaminant concentrations in edible parts of plants, such as fruit or nectar for bats.

The rat and mongoose will be evaluated as target receptors, recognizing however that should these receptors be found at risk at a site, risk managers will consider their status as invasive species. The primary issue is that should populations of these mammals be reduced, there could be an adverse effect of reduced diet sources for predator species such as the red-tailed hawk.

Deeper surface soil collected from land crab habitat (2 inches-2 feet) will be evaluated against TRVs for soil invertebrates.

The evaluation of deeper surface soil collected from turtle nesting habitat (2 inches-4 feet) for the protection of turtle eggs is not straightforward since there are limited TRVs that may apply. For example, residue based TRVs for the protection of bird eggs are available but limited, and will need to be carefully considered in modeling from soil to turtle eggs.

Lower trophic level receptor species will be evaluated based upon those taxonomic groupings for which medium-specific TRVs have been developed. As such, specific species of aquatic biota have not been chosen as receptors because of the limited information available for specific species and because aquatic biota (fish and benthic invertebrates) are evaluated on a community level. Similarly, specific species of terrestrial biota (plants and soil invertebrates) have not been chosen as receptors because of the limited information available for specific species and because these receptors are evaluated on a community level via a comparison to soil TRVs developed for these groups.

Reptiles are also an applicable receptor group. However, individual species of reptiles were not selected for evaluation because of the lack of available toxicological information for this taxonomic group for direct effects and effects from exposures via food webs. Potential risks to reptiles from food web exposures will be evaluated using other fauna (birds and mammals) as surrogates. Similarly, potential risks to reptiles from direct exposures to surface soil are evaluated using TRVs developed for other taxonomic groups (described above, with the exception of the evaluation of sea turtle eggs as previously discussed.

Adult sea turtles will not be evaluated for exposure to soil, only their eggs as deposited in nests. Protection of sea turtle eggs will be difficult to evaluate due to limited information.

1.2 References

Geo-Marine. 2007. Biological Assessment of the Former Live Impact Area within the Former Vieques Naval Training Range, Vieques, Puerto Rico, Amendment I: Eastern Conservation Area

Geo-Marine. 2006. Biological Assessment of the Former Live Impact Area within the Former Vieques Naval Training Range, Vieques, Puerto Rico. Final Report.

Geo-Marine. 2003. Integrated Natural Resources Management Plan (INRMP). Navy Lands on Vieques, Vieques Island, Puerto Rico. Plan Years 2003-2012. Final Draft.

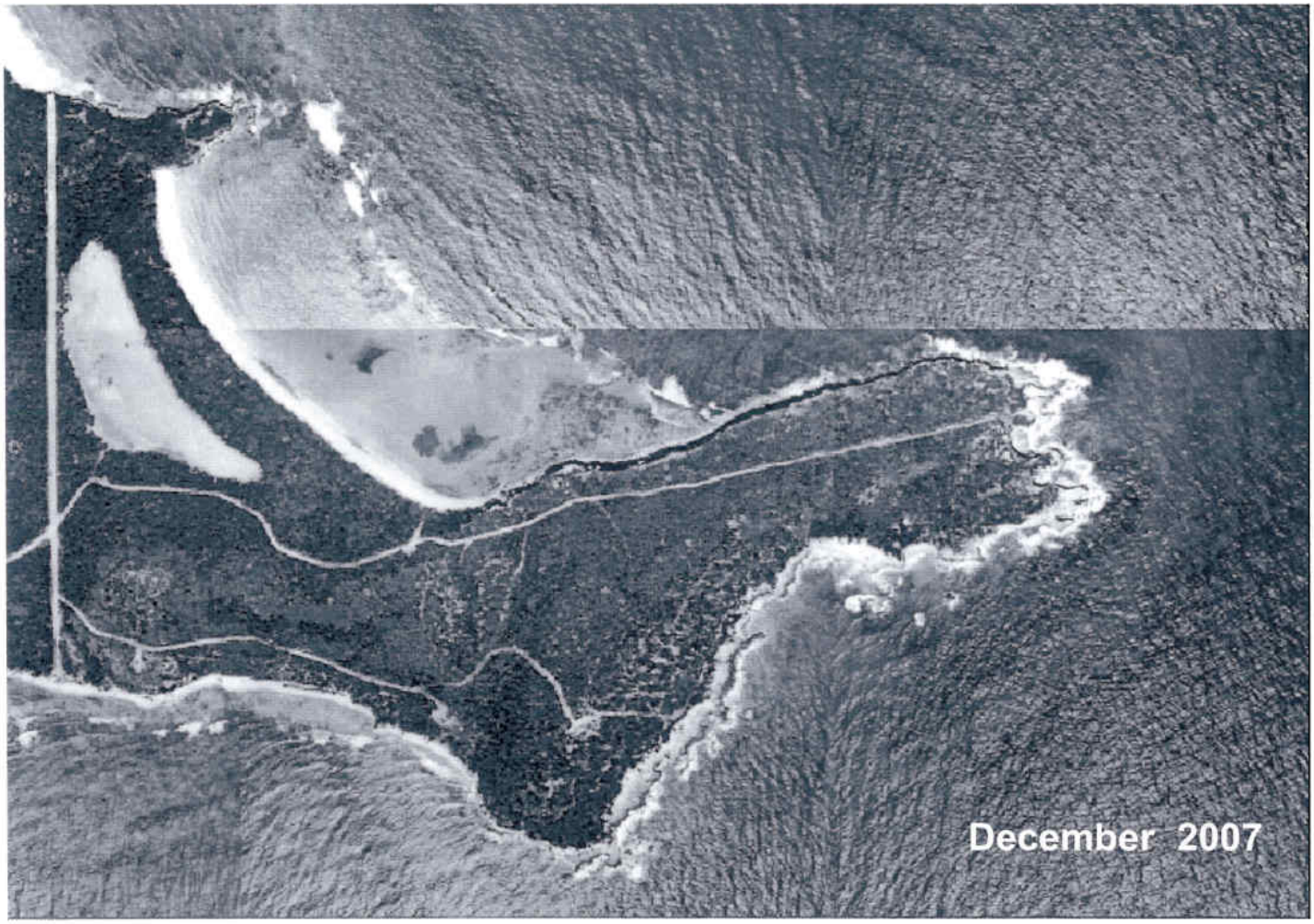
Geo-Marine. 2002. Mangrove Forest Health Status Vieques Island, Naval Station Roosevelt Roads, Puerto Rico, March. Draft.

U.S. Department of the Interior Fish and Wildlife Service (USFWS),Southeast Region. 2007. Final Comprehensive Conservation Plan/ Environmental Impact Statement for Vieques National Wildlife Refute, Vieques, Puerto Rico. August.

Biological Assessment of the Former Live Impact Area within the Former Vieques Naval Training Range, Vieques, Puerto Rico

AMENDMENT I:

EASTERN CONSERVATION AREA



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APPENDIX B
Plant Species List

LIST OF ALL PLANT SPECIES OBSERVED IN THE EASTERN CONSERVATION AREA, VIEQUES, PUERTO RICO
30 Jan 07– 15 Feb 07

***New records for Vieques in bold**

These species are not included in G. R. Proctor's list of 1994 published by the *Department of Natural and Environmental Resources*), and in G. Breckon's *List of Plants from Vieques Island* (unpublished).

Family	Species	Common Name(s)
ACANTHACEAE		
	Oplonia spinosa (Jacq.) Raf.	Espinosa; Prickly bush
AIZOACEAE		
	Sesuvium portulacastrum (L.) L.	Verdolaga rosada; Sea purslane
AMARANTHACEAE		
	Celosia nitida Vahl	none
ANACARDIACEAE		
	Comocladia dodonaea (L.) Urban	Chicharrón; Cock´s spur
APOCYNACEAE		
	Echites agglutinatus Jacq.	Bejuco lechoso
	Pentalinon luteum (L.) Hansen & Wunderlin	Babeiro amarillo
	Plumeria alba L.	Alhelí; Milk tree
	Rauvolfia nitida Jacq.	Cachimbo de leche; Milk bush
ARECACEAE		
	Thrinax morrisii H. Wendl.	Palma de escoba; Pandereta
ASCLEPIADACEAE		
	Metastelma decipiens Schlecht.	none
ASTERACEAE		
	Baccharis dioica Vahl	none
	Borrichia arborescens (L.) DC.	Clavelón de playa; Sea ox-eye
	Chromolaena sinuata (Lam.) R. M. King & H. Rob.	Cariaquillo: Bitter bush
	Melanthera aspera (Jacq.) Small	Salaíllo
	Pectis humifusa Sw.	Yerba de San Juan
	Tridax procumbens L.	Pancha, San Juan del monte; Tridax
	Wedelia calycina L.	Margarita de las rocas
AVICENNIACEAE		
	Avicennia germinans (L.) L.	Mangle negro; Black mangrove
BIGNONIACEAE		
	Distictis lactiflora (Vahl) DC.	Liana fragante
	Tabebuia heterophylla (DC.) Britton	Roble nativo
BORAGINACEAE		
	Argusia gnaphalodes (L.) Heine	Nigua de playa; Bay lavander

Family	Species	Common Name(s)
	Bourreria succulenta Jacq.	Palo de vaca; Pigeon berry
	*Cordia ricksecker*i Millsp.	Palo de lija; Sand-paper tree
	Heliotropium curassavicum L.	Cotorra de playa; Seaside heliotrope
	Tournefortia microphylla Bertero ex Spreng.	Nigüita
BRASSICACEAE		
	Cakile lanceolata (Willd.) O. E. Schulz	Mostacilla; Sea-rocket
BROMELIACEAE		
	Tillandsia recurvata (L.) L.	Nido de gungulén; Bunch moss
BURSERACEAE		
	Bursera simaruba (L.) Sarg.	Almácigo
CACTACEAE		
	Melocactus intortus (Mill.) Urb.	Melón de costa; Turk´s cap
	Opuntia dillenii (Ker-Gawl.) Haw.	Higo de mar; Prickly pear
	Pilosocereus royenii (L.) Byles & Rowley	Dildo; Organ pipe
CANELLACEAE		
	Canella winteriana (L.) Gaertn.	Barbasco; Canelle
CAPPARACEAE		
	Capparis cynophallophora L.	Bejuco inglés; Black wattle
	Capparis flexuosa (L.) L.	Palinguán; Caper tree
	Capparis indica (L) Fawc. & Rendle	Sapo prieto; Linguam
CELASTRACEAE		
	Cassine xylocarpa Vent.	Coscorrón; Marble-tree
	Crossopetalum rhacoma Crantz	Coral; Poison cherry
	Gyminda latifolia (Sw.) Urb.	Araña; False boxwood
	Maytenus laevigata (Vahl) Griseb. ex Eggers	Alfilerillo; Bois flamant
	Schaefferia frutescens Jacq.	Cafeíllo; Florida boxwood
CLUSIACEAE		
	Garcinia portoricensis (Urban) Alain	Guayabacoa, Palo de cruz
COMBRETACEAE		
	Bucida buceras L.	Úcar
	Conocarpus erecta L.	Mangle botón; Botton tree
COMMELINACEAE		
	Commelina diffusa Burm. f.	Cohitre; Blue day flower
CONVOLVULACEAE		
	Cuscuta americana L.	Bejuco de Mona; Dodder
	Evolvulus convolvuloides Stearn	none
	Evolvulus sericeus Sw.	none
	Ipomoea pes–caprae (L.) R. Br.	Bejuco playero; Bay hops
	Ipomoea steudelii Millsp.	Bejuquillo guitarra; Guitar-vine

Family	Species	Common Name(s)
	Ipomoea violacea L.	Bejuco de luna; Coast moon-vine
	Jacquemontia havanensis (Jacq.) Urban	Aguinaldo de costa
	Jacquemontia pentanthos (Jacq.) G. Don	Aguinaldo azul
	Merremia quinquefolia (L) Hall. f.	Batatilla blanca
CYPERACEAE		
	Bulbostylis pauciflora (Liebm.) Clarke	none
	Cyperus sp.	none
	Scleria lithosperma (L.) Sw.	none
EUPHORBIACEAE		
	Adelia ricinella L.	Escambrón
	Argythamnia candicans Sw.	Plateada
	Chamaesyce articulata (Aubl.) Britton	Lechoso; Little red devil, Bush spurge
	Chamaesyce messembryanthemifolia (Jacq.) Dugand	Lecherito de costa
	Chamaesyce turpinii (Boiss.) Millsp.	Lecherita
	Croton astroites Dryand.	Maná
	Croton betulinus Vahl	none
	Croton discolor Willd.	Lechecillo
	Euphorbia petiolaris Sims	Indio desnudo; Manchineel berry
	Gymnanthes lucida Sw.	Yaití; Ramón; Crabwood
	Hippomane mancinella L.	Manzanillo; Manchineel
	Jatropha gossypiifolia L.	Higuereta cimarrona
FABACEAE		
	Aeschynomene americana L.	Yerba Rosario
GOODENIACEAE		
	Scaevola plumieri (L.) Vahl.	Bosborin; Ink berry
LAURACEAE		
	Cassytha filiformis L.	Bejuco dorado; Love vine
LEG. CAESALPINACEAE		
	Caesalpinia bonduc (L.) Roxb.	Haba de San Antonio; Gray nickers
	Caesalpinia ciliata (Berg. ex Wikstr.) Urban	Mato amarillo; Yellow nickers
	***Caesalpinia culebrae* (Britton & Wilson) Alain**	**Mato de Culebra**
	Chamaecrista portoricensis (Urban) Cook & Collins	none
LEG. FABACEAE		
	Canavalia rosea (Sw.) DC.	Canavalia; Bay-bean

Family	Species	Common Name(s)
	Centrosema virginianum (L.) Benth.	Conchita de Virginia
	Dalbergia ecastaphyllum (L.) Taub.	Maraimaray
	Rhynchosia reticulata (Sw.) DC.	Frijolillo de monte
	Stylosanthes hamata (L.) Taubert in Verh.	Zarzabacoa enana; Pencil flower
	Tephrosia cinerea (L.) Pers.	Añil cenizo
	Teramnus labialis (L. f.) Sprengel	Frijolillo
LEG. MIMOSACEAE		
	Acacia tortuosa (L.) Willd.	Casia; Twisted acacia
	Leucaena leucocephala (Lam.) De Wit	Acacia pálida; Wild tamarind
	Mimosa ceratonia L.	Zarza; Black amaret
	Pithecellobium unguis-cati (L.) Mart.	Escambrón colorado; Black bean
	Prosopis juliflora (Sw.) DC.	Mesquite
MALPIGHIACEAE		
	Stigmaphyllon emarginatum (Cav.) A. Juss.	Bejuco de San Pedro
	Byrsonima lucida (Miller) L. C. Rich.	Aceituna; Candle berry
MALVACEAE		
	Gossypium barbadense L.	Algodón; Wild cotton
	Thespesia populnea (L.) Soland ex Correa	Emajagüilla; Cork tree
MORACEAE		
	Ficus citrifolia P. Miller	Jagüeillo; Boislaglu
MYRTACEAE		
	Eugenia axillaris (Sw.) Willd.	Grajo; Krum-berry
	Eugenia biflora (L.) DC.	Hoja menuda; Black rod-wood
	Eugenia foetida Pers.	Anhuila; Spanish stopper
	Eugenia foetida Pers.	Anhuila; Spanish stopper
	Eugenia monticola (Sw.) DC.	Birijí; Black cherry
NYCTAGINACEAE		
	Pisonia subcordata Sw.	Corcho blanco; Water mampoo
OLACACEAE		
	Schoepfia obovata C. Wright in Sauv.	Araña
	Ximenia americana L.	Ciruelo de la Florida; Florida plum
	Forestiera segregata (Jacq.) Krug & Urban	Florida privet, Ink-bush
ORCHIDACEAE		
	Psychilis macconnelliae Sauleda	Cañuela de costa: Mac Connell's orchid
PASSIFLORACEAE		
	Passiflora suberosa L.	Flor de pasión

Family	Species	Common Name(s)
PHYTOLACCACEAE		
	Rivina humilis L.	Carmín; Cat´s blood
POACEAE		
	Bothriochloa pertusa (L.) A. Camus	Huracán; Hurricane grass
	Cenchrus echinatus L.	Abrojo; Bur grass
	Chloris inflata Link	Horquetilla morada; Blue grass
	Chloris petraea Sw.	Yerba de dedo; Finger grass
	Chloris radiata (L.) Sw.	Grama de costa; Plush-grass
	Paspalum laxum Lam.	Matojo de arena
	Spartina patens (Ait.) Muhl.	Yerba de sal; Salt grass
	Sporobolus jacquemontii Kunth	Pelo de burro
	Sporobolus virginicus (L.) Kunth	Matojo de burro; Sea-shore rushgrass
	Uniola virgata (Poir.) Griseb.	Lágrima de San Pedro
POLYGONACEAE		
	Coccoloba krugii Lindau in Engler	Uverita playera
	Coccoloba krugii x *C. uvifera*	none
	Coccoloba microstachya Willd.	Uverillo
	Coccoloba uvifera (L.) L.	Uva de playa; Sea grape
RHAMNACEAE		
	Colubrina arborescens (Mill.) Sarg.	Abeyuelo, Sanguinaria; Greenheart
	***Colubrina elliptica* (Sw.) Briz. & Stern**	**Catire; Naked wood**
	Krugiodendron ferreum (Vahl) Urban	Bariaco; Black iron-wood
	Reynosia uncinata Urban	Cascarroya
	***Ziziphus reticulata* (Vahl) DC.**	**Azufaifo, Cascarilla**
RUBIACEAE		
	Antirhea acutata (DC.) Urban	Boje, Quina
	Catesbaea parviflora Sw.	none
	Erithalis fruticosa L.	Jayajabico; Black torch
	Ernodea littoralis Sw.	none
	Exostema caribaeum (Jacq.) Roem & Schult.	Albarillo; Prince-wood
	Guettarda elliptica Sw.	Cucubano liso; Velvet seed
	Morinda citrifolia L.	Gardenia hedionda; Indian mulberry
	Randia aculeata L.	Tintillo; Ink-berry
	Strumpfia maritima Jacq.	Lirio
RUTACEAE		
	Amyris elemifera L.	Cuabilla
	***Zanthoxylum flavum* Vahl.**	**Aceitillo; Yellow sander**
SAPINDACEAE		
	Melicoccus bijugatus Jacq.	Quenepa; Ginep
SAPOTACEAE		
	Sideroxylon obovatum Lam.	Alquitrán; Break hill

Family	Species	Common Name(s)
SCROPHULARIACEAE		
	Capraria biflora L.	Té del país; Goat weed
SOLANACEAE		
	Solanum persicifolium Dunal	Berenjena de playa; Rubia
STERCULIACEAE		
	Helicteres jamaicensis Jacq.	Cuernecillo; Cowbush
	Melochia nodiflora Sw.	Bretónica prieta
	Melochia pyramidata L.	Bretónica piramidal
	Melochia tomentosa L.	Bretónica afelpada
	Waltheria indica L.	Basora prieta, Malvavisco
THEOPHRASTACEAE		
	Jacquinia arborea Vahl	Azúcares
	Jaquinia berterii Spreng.	Mercocha
TILIACEAE		
	Corchorus hirsutus L.	Malvaté
	Corchorus siliquosus L.	Escoba blanca
TURNERACEAE		
	Turnera diffusa Willd. ex Schult.	Damiana
VERBENACEAE		
	Citharexylum fruticosum L.	Palo de guitarra; Old woman bitter
	Clerodendron aculeatum (L.) Schlecht.	Botón de oro; Crab prickly
	Lantana involucrata L.	Santa María; Button sage
	Stachytarpheta jamaicensis (L.) Vahl	Bretónica
	Stachytarpheta strigosa Vahl	Bretónica de costa
VITACEAE		
	Cissus trifoliata L.	Caro costero
ZYGOPHYLLACEAE		
	Guaiacum officinale L.	Guayacán; Lignum vitae

APPENDIX C
Bird Species List

LIST OF ALL BIRD SPECIES OBSERVED IN THE EASTERN CONSERVATION AREA, VIEQUES, PUERTO RICO
30 Jan 07– 15 Feb 07

Species	Common Name
Charadrius vociferous	killdeer
Coccyzus minor	mangrove cuckoo
Coereba flaveola	bananaquit
Dendroica adelaidae	Adelaide's warbler
Dendroica petechia	yellow warbler
Elaenia martinica	Caribbean elaenia
Falco sparverius	American kestrel
Fregata magnificens	magnificent frigatebird
Haematopus ostralegus	American oystercatcher
Melanerpes portoricensis	Puerto Rican woodpecker
Mimus polyglottos	northern mockingbird
Orthorhyncus cristatus	Antillean crested hummingbird
Pandion haliaetus	osprey
Pelecanus erythrorhynchos	American white pelican
Pelecanus occidentalis	brown pelican
Phaethon lepturus	white-tailed tropicbird
Progne dominicensis	Caribbean martin
Quiscalus niger	greater Antillean grackle
Sula leucogaster	brown booby
Tyrannus dominicensis	gray kingbird

Vieques National Wildlife Refuge

Comprehensive Conservation Plan
and Environmental Impact Statement

U.S. Department of the Interior
Fish and Wildlife Service
Southeast Region

August 2007

Submitted by: //S// *Date:* 8/1/07

Oscar Diaz, Refuge Manager
Vieques NWR

Concur: //S// *Date:* 8/1/07

Susan Silander, Project Leader
Caribbean Refuges Complex

Concur: //S// *Date:* 8/1/07

Pete Jerome, Refuge Supervisor
Southeast Region

Concur: //S// *Date:* 8-1-07

Jon Andrew, Regional Chief
Southeast Region

Approved by: //S// *Date:* 8/1/07

Sam Hamilton, Regional Director
Southeast Region

Vieques Nacional Wildlife Refuge Fauna
Vida Silvestre de Vieques Nacional Wildlife Refuge

Amphibians and Reptiles / Anfibiosy Reptiles

Family	English Name	Spanish Name	Genus & Species
BUFONIDAE	Marine toad (I)	Sapo común	*Bufo marinus*
LEPTODACTYLIDAE	Coqui (U/P)	Coquí (U/P)	*Eleutherodactylus coqui*
	Churri coqui	Churrí	*Eleutherodactylus antillensis*
	Cochran's coqui	Coquí pitito	*Eleutherodactylus cochranae*
	White-lip frog	Sapito de labio blanco	*Leptodactylus albilabris*
BOIDAE	Ball python (I/P)	Piton real (I/P)	*Python reguis*
	Boa constrictor (I/P)	Boa constrictora (I/P)	*Boa constrictor*
	Virgin Island boa (P)	Boa de las Islas Virgenes (P)	*Epicrates monensis granti*
COLUBRIDAE	Puerto Rican racer	Alsophis de Puerto Rico	*Alsophis portoricensis aphantus*
TYPHLOPIDAE	Worm snake	Culebra ciega	*Typhlops hypomethes*
	Worm snake	Culebra ciega	*Typhlops platycephalus*
	Worm snake (P)	Culebra ciega (P)	*Typhlops richardi*
VIPERIDAE	Fer-de-Lance (P)	Fer-de-Lance (P)	*Bothrops asper*
AMPHISBAENIDAE	Legless lizard	Culebra de dos cabezas	*Amphisbaena caeca*
IGUANIDAE	Crested anole	Lagartijo común	*Anolis cristatellus*
	Culebra giant anole (P)	Lagarto gigante de Culebra (P)	*Anolis roosevelti*
	Garden anole	Lagartijo jardinero	*Anolis pulchellus*
	Giant anole	Lagarto verde	*Anolis cuvieri*

Family	English Name	Spanish Name	Genus & Species
	Tree anole	Lagartijo manchado	*Anolis stratulus*
	Green iguana (I)	Iguana verde (I)	*Iguana iguana*
GEKKONIDAE	Common dwarf gecko	Salamanquita común	*Sphaerodactylus macrolepis inigoi*
	Littoral gecko	Salamanquita de Roosevelt	*Sphaerodactylus roosevelti*
	Pigmy gecko	Salamanquita pigmea	*Sphaerodactylus Nicholsi townsendi*
	Common bent-toe gecko	Salamanquesa	*Hemidactylus mabouia*
SCINCIDAE	Slippery back skink	Santa Lucía	*Mabuya mabuya sloanii*
TEIIDAE	Common ground lizard	Siguana común	*Ameiva exsul*
TESTUDINIDAE	Antillean painted turtle	Jicotea	*Trachemys stejnegeri stejnegeri*
	Green sea turtle (M)	Peje blanco (M)	*Chelonia mydas*
	Hawksbill (M)	Carey (M)	*Eretmochelys imbricata*
	Leatherback (M)	Tinglar (M)	*Dermochelys coriacea*
	Loggerhead (M)	Cabezona (M)	*Caretta caretta*

Source: U.S. Navy Draft Environmental Impact for Vieques, 1979; Rivero, 1980; Pough, 1998; Saliva, 1994; Joglar, 2002; Puerto Rico Conservation Trust, 2002; Unpublished personal communications, 2005.

I= Introduced species (Especies introducidas)
M= Marine species (Especies marinas)
P= Probability that species occurs on refuge and/or have unconfirmed reports (Probabilidad que estas especies existan en el refugio y/o hay reportes aun no confirmados)
U= Species occurs in urban areas (Especies se encuentran en areas urbanas)

Birds / Aves

Family	English Name	Spanish Name	Scientific name
ANATIDAE	Blue-winged Teal	Pato Zarcel	*Anas discors*
	Lesser Scaup	Pato Pechiblanco Menor	*Aythya affinis*
	Northern Shoveler (P)	Pato Cuchareta (P)	*Anas clypeata*
	Ruddy Duck	Pato Chorizo	*Oxyura jamaicensis*
	West Indian Whistling Duck	Chiriría Caribena	*Dendrocygna arborea*
	White-cheeked Pintail	Pato Quijada Colorada	*Anas bahamensis*
	Red-breasted Merganser (P)	Mergansa Piquilarga (P)	*Mergus serrator*
PODICIPEDIDAE	Pied-billed Grebe	Zaramago	*Podylymbus podiceps*
SULIDAE	Brown Booby	Boba Parda	*Sula leucogaster*
PELECANIDAE	Brown Pelican	Pelícano Pardo	*Pelecanus occidentales*
FREGATIDAE	Magnificent Frigatebird	Tijereta	*Fregata magnificens*
ARDEIDAE	Black-crowned Night Heron	Yaboa Real	*Nycticorax nycticorax*
	Cattle Egret	Garza Ganadera	*Bubulcus ibis*
	Great Blue Heron	Garzón Cenizo	*Ardea herodias*
	Great Egret	Garza Real	*Casmoredius albus*
	Green-backed Heron	Martinete	*Butorides striatus*
	Least Bittern	Martinetito	*Ixobrychus exilis*
	Little Blue Heron	Garza Azul	*Egretta caerulea*
	Snowy Egret	Garza Blanca	*Egretta thula*
	Tricolored Heron	Garza Pechiblanca	*Egretta tricolor*
	Yellow-crowned Heron	Yaboa Común	*Nycticorax violacea*
ACCIPITRIDAE	Broad-winged Hawk (P)	Guaraguao de bosque (P)	*Buteo platypterus*
	Osprey	Aguila pescadora	*Pandion haliaetus*
	Red tailed Hawk	Guaraguao colirrojo	*Buteo jamaicensis*
PHOENICOPTERIDAE	Greater Flamingo (P)	Flamenco(P)	*Phoenicopterus ruber*
RALLIDAE	Common Gallinule	Garalleta Común	*Gallinula chloropus*
	American Coot	Gallinazo Americano	*Fulica americana*
	Caribbean Coot	Gallinazo Caribeno	*Fulica caribaea*

Family	English Name	Spanish Name	Scientific name
HAEMATOPODIDAE	American Oystercatcher	Ostrero	*Haematopus palliatus*
RECURVIROSTRIDAE	Black-necked Stilt	Viuda	*Himantopus mexicanus*
CHARADRIIDAE	Black-bellied Plover	Playero Cabezón	*Pluvialis squatarola*
	Killdeer	Playero Sabanero	*Charadrius vociferus*
	Semipalmated Plover	Playero Acollarado	*Charadrius semipalmatus*
	Snowy Plover	Playero Blanco	*Charadrius alexandrinus*
	Wilson's Plover	Playero Marítimo	*Charadrius wilsonia*
SCOLOPACIDAE	Wilson's Snipe	Becasina	*Gallinago delicata*
	Greater Yellowlegs	Playero Guineilla Mayor	*Tringa melanoleuca*
	Lesser Yellowlegs	Playero Guineilla Menor	*Tringa flavipes*
	Least Sandpiper	Playero Menudillo	*Calidris minutilla*
	Ruddy Rurnstone	Playero Turco	*Arenaria interpres*
	Semipalmated Sandpiper	Playero Gracioso	*Calidris pusilla*
	Short-billed Dowitcher	Agujeta piquicorta	*Limnodromus griseus*
	Stilt Sandpiper	Playero Patilargo	*Calidris himantopus*
	Spotted Sandpiper	Playero Coleador	*Actitis macularius*
	Willet	Playero Aliblanco	*Catoptrophorus semipalmatus*
LARIDAE	Laughing Gull	Gaviota Gallega	*Larus atricilla*
	Least Tern	Charrancito	*Sterna antillarum*
	Roseate tern	Palometa	*Sterna dougallii*
	Royal Tern	Charran Real	*Thalasseus maximus*
COLUMBIDAE	Common Ground-Dove	Rolita	*Columbina passerina*
	Mourning Dove	Tórtola Rabilarga	*Zenaida macroura*
	White-winged Dove	Tórtola Aliblanca	*Zenaida asiatica*
	Zenaida Dove	Tórtola Cardosantera	*Zenaida aurita*
	Puerto Rican Plain pigeon (P)	Paloma Sabanera (P)	*Patagioenas inornata wetmorei*
	Scaly-naped Pigeon	Paloma Turca	*Patagioenas squamosa*

Family	English Name	Spanish Name	Scientific name
	White-crowned Pigeon	Paloma Cabeciblanca	*Patagioenas leucocephala*
	Bridled Quail-dove	Paloma Perdiz de Martinica	*Geotrygon mystacea*
	Key west Quail-dove	Paloma Perdiz Aurea	*Geotrygon chrysia*
	Ruddy Quail-dove	Paloma Perdiz Rojiza	*Geotrygon montana*
CUCULIDAE	Mangrove Cuckoo	Pájaro Bobo Menor	*Coccyzus minor*
	Yellow-billed Cuckoo	Pájaro Bobo Piquiamarillo	*Coccyzus americanus*
	Smooth-billed Ani	Judío	*Crotophaga ani*
CAPRIMULGIFORMES	Antillean Nighthawk	Querequequé	*Chordeiles gundlachi*
	Chuck-will's-widow	Guabairo de la Carolina	*Caprimulgus carolinensis*
TROCHILIDAE	Antillean Crested Hummingbird	Zumbadorcito Crestado	*Orthorhynchus cristatus*
	Green-throated Carib	Zumbador Pechiazul	*Eulampis holosericeus*
ALCEDINIDAE	Belted Kingfisher	Martín Pescador	*Ceryle alcyon*
PICIDAE	Puerto Rican Woodpecker	Carpintero de Puerto Rico	*Melanerpes portoricensis*
TYRANNIDAE	Caribbean Elaenia	Juí Blanco	*Elaenia martinica*
	Gray Kingbird	Pitirre	*Tyrannus dominicensis*
	Loggerhead Kingbird	Clérigo	*Tyrannus caudifasciatus*
	Puerto Rican Flycatcher	Juí de Puerto Rico	*Myarchus antillarum*
HIRUNDINIDAE	Caribbean Martin	Golondrina de Iglesias	*Progne dominicensis*
MIMIDAE	Northern Mockingbird	Ruiseñor	*Mimus polyglottos*
	Pearly-eyed Thrasher	Zorzal Pardo	*Margarops fuscatus*
STURNIDAE	Hill Myna	Maina de Colinas	*Gracula religiosa*
PARULIDAE	Adelaide's warbler	Reinita Mariposera	*Dendroica adelaidae*
	Yellow Warbler	Canario de mangle	*Dendroica petechia*
	Bananaquit	Reinita Común	*Coereba flaveola*
EMBERIZIDAE	Black faced Grassquit	Gorrión Negro	*Tiaris bicolor*
	Yellow-faced Grassquit	Gorrión Barba Amarilla	*Tiaris olivacea*
	Grasshopper Sparrow	Gorrión Chicharra	*Ammodramus savannarum*
	Indigo Bunting	Gorrion Azul	*Passerina cyanea*

Family	English Name	Spanish Name	Scientific name
ICTERIDAE	Yellow-shouldered Blackbird (P)	Mariquita de Puerto Rico (P)	*Agelaius xanthomus*
	Greater Antillean Grackle	Chango	*Quiscalus niger*
	Shiny Cowbird	Tordo lustroso	*Molothrus bonariensis*
ESTRILDAE	Bronze Mannikin	Diablito	*Lonchura cucullata*

Source: U.S. Navy Draft Environmental Impact for Vieques, 1979; Raffaele, H. 1989; Saliva, 1994; Puerto Rico Conservation Trust, 2002; Oberle, M. 2003; Unpublished personal observations from Refuge Manager, 2005.

P= Probability that species occurs on refuge and/or have unconfirmed reports (Probabilidad que estas especies existan en el refugio y/o hay reportes aun no confirmados)

Fish / Peces

Family	English Name	Spanish Name	Genus & Species
SERRANIDAE	Rock hind	Cabramora	*Epinephelus adscensionis*
	Nassau grouper	Cherna	*Epinephelus striatus*
	Graysby	Cherna enjambre	*Epinephelus cruentatus*
	Coney	Mantequilla	*Epinephelus fulva*
	Red hind	Mero cabrilla	*Epinephelus guttatus*
	Red grouper	Mero guasa	*Epinephelus morio*
	Harlequin bass	Guaseta harlequin	*Serranus tigrinus*
	Butter hamlet	Vaca	*Hypoplectrus unicolor*
GRAMMIDAE	Fairy basslet	Gramma	*Gramma loreto*
APOGONIDAE	Flamefish	Cardenal candela	*Apagon maculatus*
	Belted cardinal fish	Cardenal listado	*Apagon maculatus*
	Belted cardinalfish	Cardenal listado	*Apagon townsendi*
PRIACANTHIDAE	Bigeye	Rey	*Priacanthus arenatus*
	Glasseye snapper	Toro	*Priacanthus cruentathus*

Family	English Name	Spanish Name	Genus & Species
HOLOCENTRIDAE	Squirrelfish	Candil	*Holocentrus rufus*
	Dusky squirrelfish	Gallito	*Holocentrus vexillarius*
	Long jaw squirrelfish	Gallo	*Holocentrus adscencionis*
	Long spine squirrelfish	Gallo bocón	*Holocentrus marianus*
	Reef squirrelfish	Gallo de arrecifes	*Holocentrus coruscus*
	Black bar soldier fish	Toro	*Myripristis jacobus*
POMADASYIDAE	White grunt	Boquicolorado	*Haemulon plumieri*
	Spanish grunt	Colombiano	*Haemulon macrostomum*
	French grunt	Condenado	*Haemulon flavolineatum*
	Cotton wick	Jeniguana	*Haemulon melanurum*
	Tomtate	Mulita	*Haemulon aurolineatum*
	Blue stripped grunt	Ronco amarillo	*Haemulon sciurus*
	Smallmouth grunt	Saboga	*Haemulon chrysargyreum*
	Margate	Viuda	*Haemulon album*
SPARIDAE	Jolt head porgy	Bajonado	*Calamus bajonado*
KYPHOSIDAE	Bermuda chub	Chopa blanca	*Kyphosus sectatrix*
MULLIDAE	Yellow goatfish	Salmonete amarrillo	*Mulloidichthys martinicus*
PEMPHERIDAE	Glassy sweeper	Barrigón clareado	*Pempheris schomburgki*
CHAETODONTIDAE	Four eye butterfly fish	Mariposa	*Chaetodon capistratus*
	Banded butterfly fish	Mariposa rayada	*Chaetodon striatus*
POMACANTHIDAE	Queen angelfish	Isabelita	*Holocanthus ciliaris*
	Gray angelfish	Isabelita gris	*Pomacantus arcuathus*

Family	English Name	Spanish Name	Genus & Species
	Rock beauty	Isabelita medioluto	*Holocanthus tricolor*
	French angelfish	Isabelita negra	*Pomacantus paru*
POMACENTRIDAE	Long fin damselfish	Damisela aletilarga	*Pomacentrus diencaeus*
	Three spot damselfish	Damisela amarrilla	*Pomacentrus planiformes*
	Cocoa damselfish	Damisela chocolate	*Pomacentrus variailis*
	Yellowtail damselfish	Damisela coliamarilla	*Microspathodon chrysurus*
	Blue chromis	Burrito	*Chromis cyanea*
	Beaugregory	Gregorio	*Pomacentrus leucostictus*
	Brown chromis	Jaqueda parda	*Chromis multileneata*
	Dusky damselfish	Leopoldito	*Pomacentrus dorsopunicans*
	Sargeant major	Sargento	*Abudefduf saxatilis*
	Night sargeant	Vieja prieta	*Abudefduf taurus*
LABRIDAE	Hogfish	Capitán	*Lachnolaimus maximus*
	Spanish hogfish	Loro capitán	*Bodianus rufus*
	Pudding wife	Capitán de piedras	*Halichoeres radiatus*
	Slippery dick	Doncella	*Halichoeres bivittatus*
	Yellow head wrasse	Doncella cabeciamarilla	*Halichoeres garnoti*
	Blue head	Doncella cabeciazul	*Thalassoma bifasciatum*
	Black ear wrasse	Doncella orejinegra	*Halichoeres poeyi*
	Clown wrasse	Doncella payasa	*Halichoeres maculipinna*
	Painted wrasse	Doncella pintada	*Halichoeres caudalis*
	Pearly razor fish	Navajón perlado	*Hemipteronotus novacula*

Family	English Name	Spanish Name	Genus & Species
SCARIDAE	Blue parrotfish	Brindao	*Scarus coeruleus*
	Stoplight parrotfish	Chaporra	*Sparisoma viride*
	Stripped parrotfish	Cotorro	*Scarus croicensis*
	Rainbow parrotfish	Guacamayo	*Scarus guacamaia*
	Midnight parrotfish	Judío	*Scarus coelestinus*
	Yellowtail parrotfish	Loro coliamarillo	*Sparisoma rubripinne*
	Redband parrotfish	Loro banda colorada	*Sparisoma aurofrenatum*
	Redtail parrotfish	Loro colirojo	*Sparisoma chrysopterum*
	Bucktooth parrotfish	Loro dientón	*Sparisoma radians*
	Princess parrotfish	Princesa	*Scarus taeniopterus*
	Queen parrotfish	Reina	*Scarus vetula*
BLENNIIDAE	Red lip blenny	Blenio Boquicolorado	*Ophioblennius atlanticus*
GOBIIDAE	Bridled goby	Gobio brida	*Coryphopterus glaucofraenum*
	Goldspot goby	Gobio dorado	*Gnatholepsis thompsoni*
	Sharknose goby	Gobio hocicudo	*Gobiosoma evelynae*
	Masked goby	Gobio mascara	*Coryphopterus personatus*
BALISTIDAE	Queen triggerfish	Peje puerco	*Balistes veluta*
	Black durgon	Japonesa	*Melichthys niger*
ACANTHURIDAE	Blue tang	Barbero	*Acanthurus coeruleus*
	Doctor fish	Cirujano	*Acanthurus chirurgus*
	Ocean surgeon fish	Médico	*Acanthurus bahianus*
MONACANTHIDAE	Orange spotted filefish	Lija motas naranja	*Cantherhinea pullus*

Family	English Name	Spanish Name	Genus & Species
OSTRACIIDAE	Smooth trunkfish	Chapín liso	*Lactophrys tirqueter*
TETRAODONTIDAE	Sharp nose puffer	Tamboril narizón	*Canthigaster rostrata*
DIODONTIDAE	Porcupine fish	Puerco espín	*Diodon hystrix*
SYNODONTIDAE	Sand diver	Doncella	*Snynodus intermedius*
MALACANTHIDAE	Sand tilefish	Jolocho	*Malacanthus plumieri*
BOTHIDAE	Peacock flounder	Lenguado lunado	*Bothus lunatus*
MURAENIDAE	Spotted moray	Morena moteada	*Gymnothorax moringa*
AULOSTOMIDAE	Trumpet fish	Trompetero	*Aulostomus maculatus*
CARANGIDAE	Blue runner	Cojinúa	*Caranx crysos*
	Bar jack	Guaymen blanco	*Caranx ruber*
	Greater amberjack	Medregal	*Seriola drumerili*
	Rainbow runner	Salmón	*Elagatis bipinnulata*
GERREIDAE	Yellow fin mojarra	Muniama	*Gerres cinereus*
LUTJANIDAE	Mahogany snapper	Arrayado de yerbas	*Lutjanus mahagoni*
	Schoolmaster	Pargo amarillo	*Lutjanus apodus*
	Mutton snapper	Sama	*Lutjanus analis*
	Yellow tail snapper	Colirrubia	*Ocyurus chrysurus*
SCIAENIDAE	High hat	Verdugo rayado	*Equetus acuminatus*
SPHYRAENIDAE	Great barracuda	Picúa	*Phyraena barracuda*
SCOMBRIDAE	Spanish mackarel	Sierra	*Scomberomorus maculatus*
DASYATIDAE	Southern ray	Raya	*Dasyatis americana*
MYLIOBATIDAE	Spotted eagle ray	Raya moteada	*Aetobatus narinari*
MOBULIDAE	Manta ray	Manta raya	*Manta birostris*

Family	English Name	Spanish Name	Genus & Species
CARCHARHINIDAE	Bull shark	Tiburón toro	*Carcharhinus leucas*
	Reef shark	Tiburón de arrecife	*Carcharhinus perezi*
	Lemon shark	Tiburón limon	*Negaprion brevirostris*
	Tiger shark	Tiburón tigre	*Galeocerdo cuvieri*
ORECTOLOBIDAE	Nurse shark	Tiburón gata	*Ginglymostoma cirratum*
SPHYRNIDAE	Great hammer head shark	Tiburón martillo	*Sphyrna mokarran*
	Smooth hammer head shark	Cornuda	*Sphyrna zygaena*
ALBULIDAE	Bonefish	Macabi	*Albula vulpes*
ELOPIDAE	Tarpon	Sábalo	*Megalops atlanticus*
CENTROPOMIDAE	Fat snook	Robalo	*Centropomus parallelus*

Source: U.S. Navy Draft Environmental Impact for Vieques, 1979; Peterson Field Guides-Atlantic Coast Fishes, 1986; Puerto Rico Conservation Trust, 2002; Unpublished personal communications, 2005.

Mammals / Mamiferos

Family	English Name	Spanish Name	Genus & Species
MOLOSSIDAE	Velvet free-tailed bat	Murciélago de techos	*Molossus molussus*
	Brazilian fee-tailed bat (P)	Murciélago viejo	*Tadarida brasiliensis*
NOCTILIONIDAE	Fishing bat	Murciélago pescador	*Noctilio leporinus*
PHYLLOSTOMIDAE	Cave bat (P)	Murciélago hocico de cerdo	*Brachyphylla cavernarum*
	Fruit bat	Murciélago frutero común	*Artibeus jamaicensis*
	Red fruit bat	Murciélago frutero nativo	*Stenoderma rufum*
VESPERTILIONIDAE	Big brown bat (P)	Murciélago alí-oscuro	*Eptesicus fuscus*
CANIDAE	Dog (F/I)	Perro	*Canis familiaris*
FELIDAE	Cat (F/I)	Gato	*Felis catus*
VIVERRIDAE	Mongoose (I)	Mangosta	*Herpestes javanicus*
EQUIDAE	Horse (F/I)	Caballo	*Equus caballus*
BOVIDAE	Cow (F/I)	Vaca	*Bos taurus*
MURIDAE	Mouse (F/I)	Ratón	*Mus spp.*
	Rat (F/I)	Rata	*Rattus spp.*
BALAENOPTERIDAE	Fin whale (M)	Ballena de aleta	*Balaenoptera physalus*
	Humpback whale (M)	Ballena jorobada	*Megaptera novaeangliae*
	Sei whale (M)	Ballena sei	*Balaenoptera borealis*
DELPHINIDAE	Atlantic Spotted Dolphin (M)	Delfin moteado	*Stenella frontalis*
	Bottle-nose dolphin (M)	Bufeo	*Tursiops truncatus*
	Short fin pilot whale (M)	Ballena piloto	*Globichephala macrorhyncus*
PHYSETERIDAE	Sperm whale (M)	Cachalote	*Physeter macrocephalus*
TRICHECHIDAE	Antillean manatee (M)	Manatí	*Trichechus manatus manatus*

Source: U.S. Navy Draft Environmental Impact for Vieques, 1979; Saliva, 1994; Mignucci, 2001; Puerto Rico Conservation Trust, 2002; Unpublished personal communications, 2005.

F= Feral species (Especies domesticas que retornan a un estado salvaje)
I= Introduced species (Especies introducidas)
M= Marine species (Especies marinas)
P= Probability that species occurs on refuge and/or have unconfirmed reports (Probabilidad que estas especies existan en el refugio y/o hay reportes aun no confirmados)

vieques INRMP

Navy Lands on Vieques

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

PLAN YEARS: 2003-2012

FINAL DRAFT

Table 2-7

Federal and Commonwealth Listed Plants And Animals of Vieques Island, Puerto Rico

Common Name (*Scientific Name*)	Federal Status	Commonwealth Status	General Habitat Description	Areas of Known Occurrence at or in the Coastal Waters Surrounding NLV
CORAL				
Elkhorn coral (*Acropora palmata*)	Candidate[2]	Rare[3]	Nearshore marine areas; inner waters of the continental shelf and the coasts	In various coastal waters of Vieques (exact locations currently not known)
Staghorn coral (*Acropora cervicornis*)	Candidate[2]	Rare[3]	Nearshore marine areas; inner waters of the continental shelf and the coasts	In various coastal waters of Vieques (exact locations currently not known)
PLANTS				
Cobana negra (*Stahlia monosperma*)	Threatened	Threatened	Seasonally flooded wetlands in association with mangroves; are limited to drier, elevated soil not occupied by mangroves	Laguna Yanuel (Ensenada Honda)
Thomas' lidflower (*Calyptranthes thomasiana*)	Endangered	Endangered	Moist deciduous formation of the inner hills and slopes that include semi-evergreen forests at 300 feet to 800 feet altitude	Monte Pirata
(*Chamaecrista glandulosa*)	Endangered	Endangered	Grows on almost pure sands with no organic layer, and frequently in open areas	Bahía Corcho
(*Eugenia woodburyana*)	Endangered	Endangered	Subtropical dry forest zones, which are either deciduous or semi-evergreen seasonal forests	Monte Pirata
Beautiful goetzea (*Goetzea elegans*)[1]	Endangered	Endangered	Moist limestone and moist coastal semi-evergreen forests at 200 feet to 600 feet	None
(*Tillandsia lineatispica*)	Candidate[2]	Rare[3]	Rocky outcrops and bases of trees	Monte Pirata
(*Mariscus urbanii*)	Candidate[2]	Rare[3]	Grassy banks and woodlands at higher elevations	None
(*Maytenus cymosa*)	Candidate[2]	Rare[3]	Coastal moist forests below 984 feet altitude	Monte Pirata
FISH				
Goliath grouper (*Epinephelus itajara*)	Candidate[2]	Rare[3]	Found on rock, coral, or mud bottoms; shallow, inshore areas; to depths of 330 feet	None
Nassau grouper (*Epinephelus striatus*)	Candidate[2]	Rare[3]	Shoreline to at least 295 feet of depth; usually close to caves; juveniles are common in seagrass beds	None
REPTILES				
Hawksbill sea turtle (*Eretmochelys imbricata*)	Endangered	Endangered	Rocky areas, reefs, lagoons, and narrow creeks; seldom found in water deeper than 65 feet; nests on vegetated beaches between spring and late fall with peak activity between July and October; nesting may occur year-round	Blue, Jalovita, Yellow, Bahía Jalova, Bahía Salina del Sur, Tamarindo Sur, Playa de Barco, Playa Brava, Playa Blanca, and Yellow beaches
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Endangered	Nest on open sand beaches backed with vegetation, sufficiently included, and close to deep water; nesting season occurs during spring and summer in Puerto Rico	Blue, Brava, Fanduca, Fosil, Jalova, Purple, Red, Salina Sur, Playa Brava, Punta Icacos, and Yellow beaches
Green sea turtle (*Chelonia mydas*)[4]	Threatened	Threatened	Warm, quiet, shallow waters; abundance of submerged vegetation; close to nearshore reefs or rocky areas; sloped open beaches with minimal disturbance; occurs during all seasons in Puerto Rico; nests from March to August with peak nesting from June to August	Playa Brava, Playa de Barco, Tortuga, Playa Blanca, Tamarindo Sur, Conservation Zone, Yellow beaches
Loggerhead sea turtle (*Caretta caretta*)	Threatened	Threatened	Nest in warm temperate regions on open beaches or along narrow bays; feed near coral reefs, rocky places, and shipwrecks; nesting in this region is rare	None
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Endangered	Worldwide warm temperate waters; no records of nesting activity, not expected to occur	None
Olive ridley sea turtle (*Lepidochelys olivacea*)[5]	Threatened	Threatened	Worldwide warm temperate waters; no records of nesting activity; not expected to occur	None
BIRDS				
Arctic peregrine falcon (*Falco peregrinus tundrius*)	Threatened	Endangered	Canyons/coastlines used for foresting/breeding; tall towers, bridges	None
Brown pelican (*Pelicanus occidentalis*)	Endangered	Endangered	Sand pits and offshore sandbars; shallow estuarine waters no more than 20 miles out to sea; nesting occurs between June and October	Most of the coastline of Vieques Island; most often at Laguna Monte Largo, and Cayo Conejo
Caribbean coot (*Fulica caribaea*)	Candidate[2]	Threatened	Nests near freshwater and in the winter can be found in both freshwater and saltwater habitats	Laguna Salina del Sur, Laguna Anones, Laguna El Gato, Laguna Matias, and Laguna Monte Largo
Roseate tern (*Sterna dougallii*)	Threatened	Endangered	Coastal waters and estuaries; nests on beaches, bare ground, and grassy areas and under boulders primarily on islands; nesting occurs between April and August	Cayo Conejo, Cayo Yallis, and Punta Este
North American ruddy duck (*Oxyura jamaicensis*)	Candidate[2]	Threatened	Marshes with extensive areas of emergent vegetation, stable water levels, and open water to take off and land	Laguna Matias and Laguna Monte Largo
West Indian whistling duck (*Dendrocygna arborea*)	Candidate[2]	Threatened	Forested swamps such as mangroves and waterside banks; nests in palm trees, tree cavities, and dry places among bushes	No specific location, although it is known to occur on the western end of the island and may occur on the eastern end
White-cheeked pintail (*Anas bahamensis*)	Candidate[2]	Rare[3]	Prefers brackish or saltwater habitats; nests on the ground among waterside vegetation, often hidden in tree roots	Laguna Gato, Bahía Icacos, and a unnamed lagoon on the east side of Fanduca Peninsula
MARINE MAMMALS				
Blue whale (*Balaenoptera musculus*)	Endangered	Endangered	All major oceans of the world	None
Fin whale (*Balaenoptera physalus*)	Endangered	Endangered	Worldwide distribution, most commonly sighted where deep water approaches the coast	None
Humpback whale (*Megaptera novaeangliae*)	Endangered	Endangered	Associated with banks and other shallow waters with low sea floor relief; occasionally utilize deep water	All coastal waters surrounding the eastern end of the island near the LIA
Sei whale (*Balaenoptera borealis*)	Endangered	Endangered	Open ocean, not often seen close to shore; from the tropics to polar zones	None
Sperm whale (*Physeter macrocephalus*)	Endangered	Endangered	Deep water passages between the islands and along continental slopes	Has been recorded as occurring near Vieques; however, no specific locations have been identified
West Indian manatee (*Trichechus manatus*)	Endangered	Endangered	Shallow coastal areas, shelter from oceanic wave action, and availability of vegetation and freshwater are important elements of manatee habitat	Ensenada Honda, Punta Conejo, Bahía Salina del Sur, and Bahía Mosquito
DESIGNATED CRITICAL HABITAT				
Green sea turtle: the waters extending seaward 3 nautical miles from the mean high water line of Culebra Island, Puerto Rico[6]				
Hawksbill sea turtle: the waters extending seaward 3 nautical miles from the mean high water line of Mona and Monito Islands, Puerto Rico				

[1] Recent discovery (NSRR 2000a)
[2] Candidate species are not protected under the Endangered Species Act (ESA), but concerns about their status indicate that they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.
[3] A species that is naturally scarce, as opposed to one that once was abundant, but whose numbers have fallen drastically due to natural or human-induced changes in its environment.
[4] Green turtles are listed as threatened, except in Florida and on the Mexican Pacific coast where green turtle nesting populations are listed as endangered.
[5] Olive ridleys are listed as threatened, except for olive ridley nesting populations on the Mexican Pacific coast that are listed as endangered.
[6] Culebra is approximately 8.6 miles (7.5 nautical miles) to the north of Vieques' north shoreline.

Sources: Caldwell and Erdman 1969; Rainey 1979; Witzell 1983; Ross et al. 1989; Eckert et al. 1992; Ernst et al. 1994; DON 1996, 2001; NSRR 2001a; Trent 2003

Zone 1 - No Restrictions
Zone 2 - Minor Restrictions
Zone 3 - Major Restrictions
25-Meters from Edge of Woody Vegetation
20-Meters from Edge of Woody Vegetation
10-Meters from Edge of Woody Vegetation
10-Meters from Dune Crest
5-Meters
5-Meters from Dune Crest
Boundaries
Beach Reference No.
0 500 1,000 1,500 Feet
0 100 200 300 Meters
N
Ista Yallis
Punta Salinas
Fosil Beach
Playa Blanca
Bahia Icacos
Bahia Salinas
Playa Brava
Playa Blanca
Bahia Salina del Sur
Tamarindo Sur
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MAP AREA
FORMER NASD
EMA
SIA
LIA
ECA
VIEQUES ISLAND
GMI

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Attachment E
Final Response to EPA and EQB Comments

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Final Responses to

EPA Comments on the Draft Remedial Investigation Sampling and Analysis Plan Eastern Conservation Area, Former Vieques Naval Training Range, Vieques, Puerto Rico

May 2010

General Comments

1. Please confirm that the highest reported result of the replicates will be used as the result for that sampling unit for that chemical.

   Navy Response:

   A bullet has been added to Worksheet 37 that reads: "The greater of results between field duplicates (discrete sampling) or field triplicates (for multi-incremental sampling) are used for each constituent when making comparisons to screening levels and in risk assessment calculations."

2. A geologic map of the ECA should be included in the report (or include geologic units on the topographic map - Figure 5).

   Navy Response:

   The geologic unit has been added to Figure 5.

Specific Comments

3. Worksheet # 9a – Project Scoping Session Participants Sheet, page 17: Under "Project Role" for Mindy Pensak please include review of ecological risk assessments.

   Navy Response:

   The Project Scoping Session Participants Sheet has been updated as indicated above.

4. Worksheet # 10 – Problem Definition, General Problems to Address, page 43: In the third paragraph, the following sentence is not clearly understood: "Incremental sampling reduces the impacts of soil heterogeneity on laboratory analytical results by providing an average concentration over an exposure area rather than at a discrete point (i.e., reduces field sampling and laboratory processing errors), and also has less a greater chance of identifying potential contamination." Please restate this sentence to clearly indicate that incremental sampling provides a better chance of identifying contamination.

Navy Response:

The above sentence has been changed to read: "Incremental sampling reduces the impacts of soil heterogeneity on laboratory analytical results by providing an average concentration over an exposure area rather than at a discrete point (i.e., reduces field sampling and laboratory processing errors), and has a higher likelihood of detecting contamination than discrete sampling if the location of contamination is unknown."

5. Worksheet # 10 – Problem Definition, General Problems to Address, page 44: In the third paragraph it is indicated that lagoon surface water and sediment sample analyses will not include inorganics, because a background data set is not available for comparison. Lagoon sediment and surface water will need to be analyzed for metals. Metals are munitions- related constituents, in addition to explosives. As indicated in Table 1 "MEC/MD Items Encountered in the ECA and Their Constituents," inorganics including iron, aluminum, copper, zinc and magnesium may be associated with the explosives identified in the ESA. If metals are found to be elevated above ecological screening values, lacking any available background data, additional analyses would be warranted to establish whether there are risks associated with the levels found to be present in the sediment/surface water. These could include AVS/SEM analysis, sediment toxicity testing and analysis of biota from the lagoon.

Navy Response:

Metal concentrations are expected to be elevated (with respect to risk-based screening levels) in the lagoon due to natural conditions. The lagoon is evaporative in nature, a depositional environment for surrounding eroded sediments, and influenced by sea spray. During dry conditions, evaporate-rich sediments (salt flats) are observed at the surface of the lagoon. Naturally occurring metals will accumulate in the lagoon as they are concentrated in the surface salts.

Since a reference lagoon is not available on Vieques for comparison to the site surface water and sediment data and potential future biota data, it will not be possible to distinguish naturally occurring metals concentrations from those potentially attributable to historic releases, which could lead to falsely considering them to be site-related. The UFP-QAPP process is designed to ensure data are collected that can be used for their intended purpose. If the commenter can provide a technically defensible methodology that can be used to distinguish naturally occurring metals concentrations in the lagoon from metals concentrations potentially attributable to historic releases, the Navy would be willing to collect the samples. Stating that lagoon samples need to be collected for metals analysis without providing a means by which the data can be appropriately interpreted is not acceptable rationale for collecting the samples and is contrary to the fundamentals of the UFP-QAPP.

On the Vieques Technical Subcommittee conference call held on October 21, 2010, representatives from the Navy, EPA, PREQB, FWS, NOAA (and associated contractors) discussed this topic because both EPA and PREQB want the surface water and sediment samples collected from the ECA lagoon to be analyzed for

metals in addition to the explosives analyses that are proposed in the Draft SAP. EPA and PREQB recognize the potential difficulty in interpreting metals data from the lagoon given that the source would include natural phenomena (parent rock/soil, recurring evaporation that can concentrate metals) and may include contamination associated with munitions. EPA recommended determining if there are other hypersaline lagoons on Vieques, mainland Puerto Rico, or elsewhere in the US Virgin Islands that could be used as reference. CH2M HILL responded that there are no other known lagoons of this nature on Vieques (other than in the LIA) and that utilizing a lagoon off Vieques would introduce an unknown level of uncertainty.

EPA suggested the following lines of evidence to potentially help interpret metals data from the lagoon:

- background concentrations of metals in background data set from the background report on east side of the island
- metals concentrations and distribution from soil samples collected from the perimeter of the lagoon
- metals concentrations in the surface water samples
- distribution (uniformity) of metals concentrations detected in lagoon sediment
- ratio/fingerprint of metals associated with munitions compared to metals likely to be present from surface water and sediments

CH2M HILL stated that the lines of evidence suggested by EPA would not necessarily be appropriate or applicable under all potential scenarios of resulting metals data. CH2M HILL proposed an alternative approach to collect the data as proposed in the SAP, which includes metals analysis in the terrestrial areas, and use the information to help determine whether metals are of concern because the release mechanisms in the lagoon and the terrestrial areas would be the same (e.g., deteriorating metal). However, the regulatory agencies do not feel the release mechanisms would be the same, or would at least not occur at a comparable rate.

Further discussion was held regarding various aspects, options, and challenges regarding analyzing surface water and sediment samples for metals, but ultimately no consensus was achieved on collecting surface water and sediment samples from the lagoon for metals analysis. EPA noted that it is unlikely to make final decisions for the site unless these analyses are conducted. However, since no consensus was reached during the call, the Technical Subcommittee concurred on implementing the existing RI SAP (without metals analysis on surface water and sediment samples) while inter-agency discussions continue in an attempt to reach consensus. In addition, additional sediment volume will be collected and archived at the laboratory in case consensus on analyzing the samples for metals is reached in the future. Worksheet #14 has been modified to indicate that at each sediment sampling location, an additional 8-oz wide-mouth glass jar will be collected, placed on ice,

shipped to the laboratory, and archived for possible future analysis of metals should consensus be reached.

The following paragraph has been added to the end of the Executive Summary:

"Although it is recognized that historic releases at the ECA may have contributed metals to the lagoon contained within the ECA, analysis of surface water and sediment during the investigation covered by this SAP is limited to explosives even though EPA and PREQB have requested the samples also be analyzed for metals. If metals analysis was to be performed, evaluation of metals data from the lagoon may be complicated by the absence of a suitable reference lagoon. This may make it impossible or difficult to distinguish metals concentrations in the ECA lagoon as a result of a release from metals concentrations attributable to background, which would ultimately impair the ability to make determinations of whether remedial action is warranted. The Vieques Technical Subcommittee, comprising the Navy, EPA, PREQB, FWS, and NOAA, will continue discussions in an attempt to reach consensus on this subject while moving forward with collection of the data outlined in this SAP."

6. Worksheet # 11 – Project Quality Objectives/Systematic Planning Process Statements, page 47: If the Method Detection Limit (MDL) will be used for comparisons to the action levels, the Navy should request that its laboratory report their results to the (MDL). It should be noted that results near the MDL (to around 5-10 times the MDL) should be used with caution.

Navy Response:

Although all nondetect results (U-Values) are reported at the QL, the laboratory reports all detected results that are at or greater than the MDL. This is a standard and typical approach. All detected results less than the QL (but greater than the MDL) are used with caution; they are qualified by both the laboratory and the data validator as estimated.

7. Worksheet # 11 – Project Quality Objectives/Systematic Planning Process Statements, page 49: The associated PQO/decision statements should include a statement regarding the evaluation of sediment and surface water data, in addition to the discussion on soil data.

Navy Response:

SAP worksheet 11 PQOs, page 49, a 4th bullet has been added, after the bullets following the sentence "The associated PQO/decision statements were developed in lieu of a decision tree and include the following:" The bullet states: "Sediment and surface water data will be evaluated in accordance with the Vieques Master Human Health and Ecological Risk Assessment Protocols, unless deviations are warranted, in which case they will be presented in the respective pre-interim and/or interim deliverables."

8. Worksheet # 12 – Measurement Performance Criteria, pages 51-60: In order to avoid confusion, the actual measurement performance criteria should be listed, not a reference to another worksheet.

Navy Response:

All field blank (equipment rinseate blank, etc.) measurement performance criteria (MPCs) must be identical to the corresponding method blanks. Therefore, to prevent redundancy and possible discrepancies, MPCs for field blanks refer to the corresponding method blank MPCs.

9. Worksheet # 17 – Sampling Design Rational, Environmental Media, page 75: In order to provide another line of evidence for determining if any site contamination is potentially impacting groundwater in the ECA, the EPA strongly suggests that subsurface soils (where they exist - i.e., in the lowland area) be sampled during this field effort in the event that a second field mobilization is difficult to implement. It is recommended that four discrete subsurface soil samples be collected from the 2-foot zone just above the water table for each sampling unit in the lowland area (i.e., Lowland 1-5) for a total of 20 samples.

Navy Response:

Where subsurface soils exist in each lowland decision unit to be sampled, and subsurface conditions are conducive for collecting subsurface soil samples, the field team will collect 3 subsurface soil samples in each sampling unit, for a total of 15 subsurface soil samples within the Lowland area. A hand auger or direct push probe will be used to reach the 2-foot interval above the water table or above the bedrock, whichever is shallower, such that a subsurface sample can be collected, as described in the Vieques Soil Sampling Protocol. If insufficient soil exists to collect a 2-foot sample below the surface soil sample depth, the sample will be shortened accordingly. Subsurface soil samples will only be collected if there is greater than 6-inches of soil below the surface soil sampling depth and above the water table or bedrock, whichever is shallower. Up to three attempts will be made to collect each subsurface soil sample in each Lowland sampling unit.

Changes to the SAP as a result of the inclusion of these samples consist of:

Worksheet 10, Environmental Questions to be Answered by the RI:, numbered paragraph 1, second to last sentence has been changed from "Therefore, subsurface soil sampling is not warranted" to "However, to provide another line of evidence to determine if site contamination is potentially impacting groundwater in the ECA, up to 15 subsurface soil samples will be collected, 3 from within each sampling unit within the lowland decision unit. Subsurface soil sample collection will be attempted in the 2-foot interval above groundwater or bedrock surface, whichever is shallower. If insufficient soil exists to collect a 2 foot sample below the surface soil sample depth, the sample will be shortened accordingly. Subsurface soil samples will only be collected if there is greater than 6-inches of soil below the surface soil sampling depth and above the water table or bedrock, whichever is shallower. Up to three attempts will be made to collect each subsurface soil sample at each sampling unit in the lowland decision unit, for a total of up to 15 samples, not including QC. "

Worksheet 12-1a Matrix is now also applicable to Subsurface Soil.

Worksheet 12-2a Matrix is now also applicable to Subsurface Soil.

Worksheet 14 Discrete Soil Sample Collection has been changed to: "Discrete samples from the beach (18 to 24 inches), lagoon fringe (2.5 to 24 inches) upland area (0 to 12 inches at the battery disposal area), and lowland subsurface soil samples (up to a 2 foot interval, excluding the surface soil sampling interval, either the 2 foot interval above the water table or bedrock, whichever is shallower), will be collected with a hand auger, direct push probe or similar sampling devices in accordance with the Master Protocols (detailed in Worksheet #17)."

Worksheet 15-1 Matrix is now also applicable to Subsurface Soil. The project action limit for SB is "RSLs Industrial Soil Adjusted (May, 2010)."

Worksheet 15-2 Matrix is now also applicable to Subsurface Soil. The project action limit for SB is "RSLs Industrial Soil Adjusted (May, 2010)."

Worksheet 17, Environmental Media, the first sentence has been changed to read: "The ECA RI will include the environmental characterization of surface soil, subsurface soil, sediment, and surface water."

Worksheet 17, Environmental Media, second paragraph, after the first sentence has been added "Subsurface soil samples will be analyzed for explosives and inorganic constituents."

Worksheet 17, page 77, Lowland, the paragraph will be changed to read: Five incremental surface soil samples (0 to approximately 2.5 inches) and up to 15 discrete subsurface soil samples (2 feet above bedrock or the water table, whichever is shallower, not to include the surface sample interval) will be collected within the lowland decision unit. Table 2 summarizes the MEC items historically found and removed within the five sampling units. Surface and subsurface soil data will be compared to adjusted RSLs and the ERP Technical Subcommittee will regroup to discuss the results of the individual sampling unit comparisons, how the data should be grouped, and the appropriate path forward to evaluate potential risk to human health (Lowland area and site-wide scenarios) and ecological terrestrial receptors (in combination with upland data) exposed to surface soil.

Worksheet 18, Add to Lowland Decision Unit 15 subsurface samples: first new row: Station ID VEECA-2SB01 Sample ID VEECA-2SB01-TTBB-MMYY Matrix Subsurface soil. Depth (units) 2 foot sample above bedrock or the water table whichever is shallower, not to include the 2.5-inch surface sample interval. Analytical Group EXPLO, METAL (see Worksheet 15) Number of Samples (Identify Field Duplicates) 2 (including 1 duplicate) Sampling SOP Reference SOP A-2

Second new row, Station ID VEECA-2SB02, Sample ID VEECA-2SB02-TTBB-MMYY The remainder of the row is the same as above except the Number of samples is 1

Third new row Station ID VEECA-2SB03, Sample ID VEECA-2SB03-TTBB-MMYY, the remainder of the row is the same as above.

Fourth new row Station ID VEECA-2SB04, Sample ID VEECA-2SB04-TTBB-MMYY, the remainder of the row is the same as above.

Fifth new row Station ID VEECA-2SB05, Sample ID VEECA-2SB05-TTBB-MMYY, the remainder of the row is the same as above.

Rows added for samples VEECA-2SB06 through VEECA-2SB15.

Figure 6, Added 15 subsurface soil sample locations in the lowland decision unit, 3 to each of the 5 lowland sampling units.

Worksheet 19 Discrete soil samples are now also applicable to subsurface soil. Subsurface soil samples are only analyzed for METAL and EXPLO.

Worksheet 20 Five SB Samples (plus one field duplicate, one MS/MSD, one equipment blank; nine total samples to lab) were added to Lowland Sampling for analysis of METAL and EXPLO.

Worksheet 23 Analytical Laboratory SOPs WS-IP-0002, WS-LC-0009, WS-LC-0012, WS-MT-0001, and WS-MT-0003 are now also applicable to subsurface soil.

Worksheet 28-1 Matrix is now also applicable to Subsurface Soil.

Worksheet 28-2 Matrix is now also applicable to Subsurface Soil.

Worksheet 30 Five SB samples were added for analysis of EXPLO by SW-846 8330B, Perchlorate by SW-846 6850, and METALs by SW-846 6010B/6020 at Test America-West Sacramento using 28 calendar-day TAT.

Worksheet 36 Matrix is now also applicable to Subsurface Soil.

10. Worksheet # 17 – Sampling Design Rational, Environmental Media, page 75: See comments #5 regarding the need to analyze lagoon sediment and surface water for inorganics.

Navy Response:

Please see response to EPA Comment #5.

11. Worksheet # 17 – Sampling Design Rational, Background, page 78: The appropriateness of the proposed background incremental soil sampling locations should be supported with data demonstrating that soils are not impacted by former activities at the UXO 15 sites, PI-9 and PI-13 (i.e., provide a table listing the discrete soil sample results from the October 2007 background study if applicable).

Navy Response:

Two tables (surface soil and subsurface soil) of the analytical data from the background site investigation (see Figure 7 of the SAP for locations of the limestone background site investigation soil sample locations) are included with these responses to comments. The tables present the results from the limestone soil samples collected within and outside of UXO-15 (all samples were collected outside of PI-9 and PI-13). The analytical results show that the samples were not impacted by former activities at UXO-15.

Statistical analysis was already conducted on the background samples to determine if the locations were potentially impacted by metals contamination. Outlier tests were performed during the background study to determine if there were outliers, so any outlier data would have already been removed from the dataset. In addition, the release mechanism inside UXO-15 is not detonation; rather, any release would be from leaks or deterioration. Therefore, for any of the background sample locations to have been impacted from potential contaminant sources within UXO-15, they would have to have been impacted by runoff from the contaminant sources. All but one of the background sample locations within UXO-15 are topgraphically upgradient of potential contaminant sources; the metals concentrations of the remaining sample are within the range of the metals concentrations of the other background samples.

12. Worksheet # 18 – ECA Sampling Locations and Methods/SOP Requirements Table, page 83-84: According to this worksheet, the analytical groups for the Lagoon Decision Area are limited to Explosives. It may be premature to discount metals from the lagoon sediments. The Navy has expressed concern that the sediments will yield elevated metals due to the evaporative lagoon conditions. However, certain metals associated with munitions such as lead are not likely to be present at elevated levels due to the evaporative nature of the lagoon. EPA recommends including, at a minimum, a subset of metals focused on those most closely associated with munitions and explosives.

Navy Response:

It is unclear what the comment means by ". . . certain metals associated with munitions such as lead are not likely present at elevated levels due to the evaporative nature of the lagoon." Any metal present in the lagoon will be concentrated by the evaporative nature of the lagoon. Please also see response to EPA Comment #5.

13. Worksheet # 18 – ECA Sampling Locations and Methods/SOP Requirements Table, pages 79-85: The sampling SOP number should be provided for each type of sample collected.

Navy Response:

Worksheet 18 has been updated. For random incremental samples, SOPs A-7, A-2, E-1, H-1, H-4, H-5, and H-6 have been added. For deeper surface soil samples, the same SOPs have been added. The same is true for subsurface soil samples, with the addition of SOP A-1 if a direct push rig or tripod mounted direct push system is required. For sediment, SOPs C-1, E-1, G-2, H-1, H-4, H-5, and H-6 have been added. For surface water, SOPs G-1, H-1, H-4, H-5, and H-6 have been added.

14. Worksheet # 19 – Analytical SOP Requirement Table, page 87: Please include inorganics analysis for lagoon surface water.

Navy Response:

Please see response to EPA Comment #5.

15. Worksheet # 20 – Field Quality Control Summary Table, page 89: Please include inorganics analysis for lagoon sediment and surface water.

Navy Response:

Please see response to EPA Comment #5.

16. Worksheet # 21 – Project Sampling SOP Reference Table, page 91: SOP # A-7, delineating procedures for MIS sampling should be added to this list.

Navy Response:

SOP A-7 has been added to Worksheet 21.

17. Worksheet # 28 – Laboratory Samples QC Tables, pages 105-118: Field QC and corrective action information should be added to this worksheet. In addition, the measurement performance criteria should be provided, since this information is more closely related to the rest of the information in this Worksheet than to that in Worksheet # 15.

Navy Response:

Worksheet 28 is for laboratory QC; field QC is listed separately on Worksheet 12. In that field QC samples undergo laboratory analysis with other field samples, the laboratory corrective actions listed in Worksheet #28 apply to field QC samples (based on sample type). Post-analysis corrective action based on field QC samples is typically initiated by the data validator as described on Worksheet 35 and as required by the procedures listed in Worksheet 36. Accuracy and Precision (A/P) limits (i.e. for LCS, MS/MSD, etc.) are analyte-specific and it is impractical to re-list all analytes within a cell on Worksheet 28. Because the analytes are already listed on Worksheet 15, the A/P information was added to Worksheet 15 and was then referenced by Worksheet 28. A note has been added to the bottom of each Worksheet #28 that states: "Refer to Worksheet #12 for Field QC samples. In the laboratory, field QC samples undergo the corrective actions (as applicable) listed in Worksheet #28. Post-analysis corrective action based on field QC samples is initiated by the data validator, as described on Worksheet #35, and as required by the procedures listed in Worksheet #36."

18. Worksheet # 28-1 – Laboratory Samples QC Tables, page 105: This section specifies that, for metals analysis, grinding will be performed by hand using ceramic equipment and only for the sub-samples. The SOPs provided for MIS sample sieving and grinding only apply to explosive analyses; a SOP describing the process for sub-sampling, sieving, grinding and other sample preparation information should be included in the SAP.

Navy Response:

Grinding for metals is done as per the grinding procedures in SW-846 8330B with the specifications outlined in Worksheet 28-1. Grinding and subsampling are described in SOPs WS-LC-0009 and WS-QA-0028.

19. Worksheet # 30 – Analytical Service Table, page 121: Please indicate whether data validation time is included in the turn around time.

Navy Response:

"Standard 28 Calendar-day TAT" is for analytical laboratory data only and does not include the TAT for data validation. The standard TAT for data validation is 14 calendar days. The following footnote was added to Worksheet 30: "Standard 28 calendar-day TAT is for analytical laboratory data. Data validation is conducted using a standard 14 calendar-day TAT."

20. SAP Worksheet # 30 – Analytical Service Table, page 121: Please include inorganics analysis for lagoon surface water.

Navy Response:

Please see response to specific comment #5.

21. Worksheet # 36 – Analytical Data Validation (Steps IIa and IIb) Summary Table, page 137: Please note that the Region 2 SOPs referenced as criteria a well as the national functional guidelines were developed for CLP SOWs, not SW-836 methods as will be the case for this project.

Navy Response:

Worksheet 36 describes how data validation will be conducted for this project. Sometimes, a Region II SOP does not exist for a particular analytical method that will be performed. For SW-846 6850, the National Functional Guidelines (NFGs) will be used only as a source for the data validation qualifiers. For SW-846 6010B and 6020, the Region II SOPs (for ILM05) and NFGs will be used only as a source for the data validation qualifiers.

22. Figure 6, Conceptual Sampling Approach: A note in the legend that 100 subsamples per sampling unit is proposed would be helpful. The term "Subsurface Soil Sample" in the legend should be changed in the figure to "Deeper Surface Soil Sample" to be consistent with the text in the document.

Navy Response:

Figure 6. A note has been added to the legend stating "Approximately 100 subsamples per sampling unit is proposed." Also the subsurface soil sample designation in the legend has been changed to "Deep surface soil sample" so that it will not be confused with the 5 subsurface soil sample locations that have been added to the Lowland Decision Unit (see response to EPA Comment #9), and included in the legend.

23. SOP A-7 – Instructions on how to operate a coring tool such as the MIST sampling tool should be included in the SOP. In addition, it is stated that the sampling increments will be transferred to the appropriate sampling containers "…After the entire Decision/Sampling unit has been walked…" The SOP should describe the intermediate container (if any) that will be used while walking the Decision/Sampling Unit.

Navy Response:

SOP A-7 second page, first paragraph, first and second sentences have been changed to: "The sample increments will be approximately equal in the amount of soil, which will be collected from depths of approximately 0-2-inches (up to about 2.5-inches)

below ground surface. While walking the sampling unit grid, subsamples will be stored in a gallon ziplock or equivalent plastic bag, labeled with the sampling unit number. After the Decision/Sampling Unit has been sampled, the individual increment samples will be transferred to the appropriate laboratory-supplied sample containers."

At the end of SOP A-7, before the Attachments section, has been appended the following:

"Follow manufacturer's instructions for use of the sampling tool. For pogo-stick type MIS samplers, insert the appropriate core tip, place the tip on the surface to be sampled, and drive the sampler tip into the ground with the pogo-stick foot pedals. If using both foot pedals at the same time, be careful about balance, and if this method cannot be done safely, discontinue use of both foot pedals simultaneously. To extrude the sample, press on the sample extruder, holding the sample tip over the plastic bag in which the sample is to be collected. Decontaminate sampling equipment that has come in contact with the ground before switching to sample a separate sampling unit. "

24. Attachment D, ECA – Strawman Ecological Risk Assessment Information, Section 1.1.2.4 Receptors, third paragraph, page 7: After the statement regarding the qualitative surveys that will be conducted for fish and invertebrate, the following sentence appears: "One round proposed." Please elaborate to clearly indicate that the surveys will take place over one discrete period of time.

Navy Response:

Attachment D, ECA – Strawman Ecological Risk Assessment Information, Section 1.1.2.1 Receptors, third paragraph, page 7. The sentence "One round proposed." has been replaced with the following: "This aquatic survey will be conducted during a single sampling event lasting approximately 1 week. Long-term or repeated surveying will not be conducted since the purpose is to identify species typically present during a period of inundation, and not to document trends in metrics such as species density or diversity."

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Table 1
Summary of Constituents Detected in Background Surface Soil Samples in and Around UXO 15, Former Vieques Naval Training Range, Vieques, Puerto Rico

Location relative to UXO 15	Inside UXO 15	Inside UXO 15		Inside UXO 15	Outside UXO 15	Outside UXO 15	Outside UXO 15	Inside UXO 15	Outside UXO 15	Inside UXO 15	Outside UXO 15
Station ID	EBGTI-SO01	EBGTI-SO02		EBGTI-SO03	EBGTI-SO04	EBGTI-SO05	EBGTI-SO06	EBGTI-SO07	EBGTI-SO08	EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SS01-06-06B	EBGTI-SS02-06-06B	EBGTI-SS02P-06-06B	EBGTI-SS03-06-06B	EBGTI-SS04-06-06B	EBGTI-SS05-06-06B	EBGTI-SS06-06-06B	EBGTI-SS07-06-06B	EBGTI-SS08-06-06B	EBGTI-SS09-06-06B	EBGTI-SS10-06-06B
Sample Date	06/30/06	06/30/06	06/30/06	07/05/06	07/02/06	06/23/06	06/21/06	06/22/06	07/02/06	06/30/06	07/02/06
Chemical Name											
Explosives											
None detected											
Total Metals (MG/KG)											
Aluminum	26,900	25,800	23,000	41,500	21,700	24,900	10,200	35,300	5,510	12,000	4,600
Antimony	8.6 U	8.7 U	7.6 U	7.6 U	7.8 U	9.2 U	8.2 U	9.7 U	7.1 U	7.6 U	6.6 U
Arsenic	3.3	5.2	4.3	5.1	3.8	5.7 J	3.1 J	5.2 J	2	9.6	2.5
Barium	82.5 J	72.3 J	63.9 J	114	52.8	65.7	55.1	103	38.2	29.1 J	39.7
Beryllium	0.72	0.73	0.65	0.95	0.65 U	0.77 U	0.68 U	0.94	0.59 U	0.64 U	0.55 U
Cadmium	1.4	1.5	1.3	2	1	1.8	1.2	2.1	1.1	1.4 J	0.96
Calcium	67,900 J	76,200 J	70,300 J	23,100	47,700	77,300	210,000	17,800	261,000	219,000	204,000
Chromium	42.7	44.5	39.9	58.8	38.3	29.8	14.2	53.4	6.8	25.9 J	7.3
Cobalt	6.8 J	7.6	6.8	7.6	5.7 J	6.2 J	4.8 J	7.6 J	3.7 J	5 J	3.2 J
Copper	15.6 J	17.8 J	16 J	26 R	19.9 R	17.1	14.7	29	9.7 R	16.2 J	11.6
Cyanide	3.9 U	3.7 U	3.3 U	0.24 J	0.37 J	0.45 J	3.4 U	4.1 U	0.24 J	0.28 J	2.7 U
Iron	22,700 J	24,400 J	22,000 J	33,300	13,400	17,800 J	6,910 J	30,200 J	3,950	9,980 J	4,280 J
Lead	8.6	8.4	7.8	10.6	5.2	6.9	2.8	10.4	5.6	2 J	1.3
Magnesium	3,950 J	3,740 J	3,250 J	4,440 J	5,790 J	5,320 J	10,200 J	4,960 J	13,800 J	30,200 J	9,970 J
Manganese	832 R	660 R	594 R	895	785	631	563	663	137	287 J	218 J
Mercury	0.16	0.15	0.12 J	0.096 J	0.27	0.19	0.097 J	0.11 J	0.087 J	0.1 J	0.091 J
Nickel	11.5	12.1	10.9	17.7	9.3	9.7	6	13.8	2.8 J	9.5 J	3 J
Potassium	6,020	5,910	5,220	8,090	4,140	7,350	1,960	9,050	1,400	1,760	1,020 J
Selenium	5 UJ	5.1 UJ	4.5 UJ	4.5 UJ	4.6 UJ	1.3 J	0.7 J	1.1 J	4.2 UJ	0.36 J	3.8 U
Silver	1.4 U	1.5 U	1.3 U	1.3 U	0.12 J	1.5 U	1.4 U	1.6 U	1.2 U	1.3 U	1.1 U
Sodium	716 U	727 U	637 U	637 U	654 U	765 U	683 U	812 U	593 U	636 U	546 U
Thallium	0.46 U	0.5	0.4 U	0.41	0.42 U	0.46 U	0.41 U	0.49 U	0.38 U	0.13 J	0.046 J
Vanadium	32 J	36.1 J	32.5 J	50.3	27.2	27.5	14.7	40	9	34.5 J	11.2
Zinc	22.7 J	19.8 J	17.2 J	34.6	23.6	22.1 J	13.5 J	27.1 J	18.9	15.3 J	14
Wet Chemistry											
Cation Exchange Capacity (MEQ/100G)	65.7	64.3	45	19.6	11	44.6	2.23	3.42	48.1	59.2	30.7
Redox (MV)	280	281	264	279	207	276	315	336	217	235	249
Total organic carbon (TOC)	45,500	44,200	41,800	40,500	86,800	47,800	58,200	49,000	61,200	68,200	54,900
pH	7.61	8.12	7.87	7.77	8	7.95	7.87	7.79	8.13	8.05	7.89

Notes:
MG/KG = Milligrams per kilogram
MEQ/100G = Milli-equivalents per 100 grams
MV = Millivolts
J = Analyte present; reported value may or may not be accurate or precise
R = Unreliable result
UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
U = Analyte not detected
Shading represents detect

Table 2
Summary of Constituents Detected in Background Subsurface Soil Samples in and Around UXO 15, Former Vieques Naval Training Range, Vieques, Puerto Rico

Location relative to UXO 15	Inside UXO 15	Inside UXO 15	Outside UXO 15		Outside UXO 15	Outside UXO 15	Inside UXO 15	Outside UXO 15		Inside UXO 15	Outside UXO 15
Station ID	EBGTI-SO02	EBGTI-SO03	EBGTI-SO04		EBGTI-SO05	EBGTI-SO06	EBGTI-SO07	EBGTI-SO08		EBGTI-SO09	EBGTI-SO10
Sample ID	EBGTI-SB02-12-06B	EBGTI-SB03-61-06B	EBGTI-SB04P-62-06B	EBGTI-SB04-62-06B	EBGTI-SB05-61-06B	EBGTI-SB06-12-06B	EBGTI-SB07-61-06B	EBGTI-SB08-62-06B	EBGTI-SB08P-62-06B	EBGTI-SB09-61-06B	EBGTI-SB10-62-06B
Sample Date	06/30/06	07/05/06	07/02/06	07/02/06	06/23/06	06/21/06	06/22/06	07/02/06	07/02/06	06/30/06	07/02/06
Chemical Name											
Explosives											
None detected											
Total Metals (MG/KG)											
Aluminum	6,500	34,000	25,000	25,300	17,400	5,470	21,600	2,340	2,280	10,400	8,460
Antimony	7 U	7 U	9.2 U	8.4 U	7.9 U	7 U	8.4 U	6.4 U	6.8 U	7.4 U	7 U
Arsenic	1.6	4.4	4.4	4.2	3.8 J	1.8 J	3.9 J	1.1	1.3	7.8	3.4
Barium	30.1 J	88.8	60.4	58.2	46	28.6	63.9	36.8	37.6	25.7 J	48.2 J
Beryllium	0.58 U	0.77	0.77 U	0.7 U	0.66 U	0.58 U	0.7 U	0.54 U	0.56 U	0.62 U	0.58 U
Cadmium	1.2 J	2	1.1	1.1	1.6	0.85	1.9	0.98	0.98	1.4 J	1.2 J
Calcium	354,000	76,900	52,900 J	33,800 J	199,000	222,000	190,000	362,000	360,000	222,000	193,000
Chromium	9.1 J	46.3	45.3	45.5	20.2	7.9	30.3	3.4	3.4	22.7 J	11.6 J
Cobalt	4.1 J	6.9	6.7 J	6.5 J	5.2 J	3.2 J	6.2 J	3.3 J	3.3 J	5.1 J	4 J
Copper	7.4 J	19.2 R	20.7 R	20.3 R	9.9	7.4	21.2	2.4 R	2.7 R	13.7 J	15.1 J
Cyanide	0.25 J	0.52 J	0.32 J	3.5 U	3.3 U	2.9 U	3.5 U	0.97 J	1 J	0.71 J	0.48 J
Iron	4,310 J	25,500	15,600	15,900	11,400 J	3,640 J	16,400 J	1,480	1,500	8,360 J	7,410 J
Lead	1.2 J	7.7	5.5	5.1	4.3	1.1 J	5.3	0.78 J	1.2	1.8 J	1.4
Magnesium	3,210 J	3,780 J	5,850 J	5,340 J	4,140 J	14,300 J	3,930 J	11,000 J	12,300 J	32,300 J	12,200 J
Manganese	86.9 J	631	972	916	369	245	327	32.2	31.9	234 J	285 J
Mercury	0.056 J	0.12	0.31	0.2	0.17	0.07 J	0.14	0.039 J	0.088 U	0.11 J	0.059 J
Nickel	2.9 J	14.3	10.8	10.8	6.9	3.2 J	8.8	1.5 J	1.5 J	8.3 J	4.5 J
Potassium	1,500	7,020	4,620	4,610	5,180	951	6,120	535 U	564 U	1,490	2,190
Selenium	4.1 U	4.1 UJ	0.41 J	4.9 UJ	0.71 J	0.38 J	1 J	3.7 UJ	4 UJ	4.3 U	0.31 J
Silver	1.2 U	1.2 U	1.5 U	1.4 U	1.3 U	1.2 U	1.4 U	1.1 U	1.1 U	1.2 U	1.2 U
Sodium	583 U	582 U	765 U	701 U	660 U	583 U	701 U	535 U	564 U	616 U	584 U
Thallium	0.1 J	0.37 U	0.46 U	0.42 U	0.4 U	0.35 U	0.42 U	0.34 U	0.34 U	0.13 J	0.069 J
Vanadium	8.7 J	39	30.7	31.5	20.1	9.5	23.8	4.8 J	4.9 J	31 J	20.2 J
Zinc	4 J	25.7	25.1	25.2	13.4 J	6.8 J	14.7 J	3.2 J	4 J	12.2 J	17.4 J
Wet Chemistry											
Cation Exchange Capacity (MEQ/100G)	13.5	49.5	6.09	10.8	29.7	11.4	21.3	14.7	14	47	47
Redox (MV)	248	300	234	248	294	309	319	208	213	228	283
Total organic carbon (TOC)	37,300	27,900	56,600	73,400	54,200	64,200	58,300	36,500	39,900	45,400	50,900
pH	8.27	7.29	7.8	7.8	8	8.31	7.99	8.42	8.47	7.95	7.69

Notes:
MG/KG = Milligrams per kilogram
MEQ/100G = Milli-equivalents per 100 grams
MV = Millivolts
J = Analyte present; reported value may or may not be accurate or precise
R = Unreliable result
UJ = Analyte not detected; quantitation limit may be inaccurate or imprecise
U = Analyte not detected
Shading represents detect

Final Responses to

PREQB Technical Review of the Draft Sampling and Analysis Plan, Eastern Conservation Area, Former Vieques Naval Training Range, Vieques, Puerto Rico

May 2010

1. SAP Worksheet #3, Distribution List: Several project personnel listed on Worksheets #4, 5, and 31 also need to be included on the SAP distribution list and therefore need to be added to this worksheet. Please revise Worksheet #3 to include the following personnel: Mark Orman, Juan Acaron, John Martin, Barrie Selcoe, Bhavana Reddy, Paul Favara, Jan Nielsen, Stephen Brand, and Dan Young.

   <u>Navy Response:</u>

   Mark Orman, Juan Acaron, John Martin, Barrie Selcoe, Bhavana Reddy, Paul Favara, Stephen Brand, and Dan Young have access to the files on the CH2M HILL server. Field copies will be provided to the field crews. Jan Nielsen received a pre-draft copy for her review, and signed off on the title page when her comments had been accepted; she does not receive a draft, draft final, or final copy.

2. SAP Worksheet #4, Project Personnel Sign-Off Sheet: Please revise the worksheet to include Brett Doerr, Dan Young, and Stephen Brand from CH2M Hill.

   <u>Navy Response:</u>

   SAP Worksheet 4, Brett Doerr, Dan Young, and Stephen Brand have been added to the sign-off sheet: Brett Doerr-CH2M HILL Vieques Environmental Program Manager/SAP review-757-671-6219. Dan Young-CH2M HILL UXO Safety Officer-251-962-2963. Stephen Brand-CH2M HILL Vieques field auditor-757-671-6211.

3. SAP Worksheet #7, Personnel Responsibilities:

   a. Worksheets #3, 4, and 5 state that the Field Team Leader is TBD. However, this worksheet states that John Martin is the Field Team Leader. Please clarify and revise worksheets to be consistent.

      <u>Navy Response:</u>

      Worksheet 7, The FTL role has been changed to Stephen Brand.

   b. The Organizational Affiliation for Bhavana Reddy is Critigen, not CH2M Hill, according to previous worksheets. Please clarify.

Navy Response:

Bhavana Reddy has been changed to Critigen.

4. SAP Worksheet #9, Project Scoping Session Sheet:

   a. Worksheet #2 states that there was a scoping meeting on January 27 and 28, 2010. A worksheet was not included for this scoping meeting. Please clarify.

      Navy Response:

      Key content of the January 28 2010 meeting minutes has been included in scoping session Worksheet 9a. The site visit was conducted on January 27; discussions regarding the site visit were documented in the January 28 meeting minutes.

   b. Worksheet #9d: Page 35: the worksheet states that CH2M Hill will attempt to collect core samples during SAP development to confirm that the method will work on site. Please clarify if this was performed.

      Navy Response:

      The tool was tested in site conditions in the lowlands and highlands and worked successfully where there is sufficient soil thickness.

5. Worksheet #10, Problem Definition:

   a. Page 39, Site Background: The text states that the Eastern Conservation Area (ECA) is 200 acres in size. The ECA is previously described as containing 133 acres (page XI). Please clarify and revise the text as appropriate.

      Navy Response:

      The ECA is 133 acres in size, which has been revised in Worksheet #10.

   b. Page 44, General Problems to Address: Surface water and sediment samples collected from the lagoon are not proposed to be analyzed for inorganics because a background inorganic surface water and sediment data set is unavailable and cannot be obtained from a similar environment. A comparison of site data and background data is conducted during Step 3A of the ecological risk assessment process. Steps 1 and 2 of the ecological risk assessment process (i.e., screening-level ecological risk assessment or SLERA) should initially be conducted before proceeding to Step 3A of the process. Inorganics have been identified along with explosives as potential contaminants from previous activities that have occurred within and adjacent to the ECA. In order to determine whether these constituents are present at concentrations that may potentially present a risk to receptors, please analyze sediment samples and the overlying surface water for inorganics. If inorganic constituents are identified during the SLERA as potentially posing a risk to receptors, then additional evaluations may be conducted to determine the likelihood and magnitude of risk.

Navy Response:

Metal concentrations are expected to be elevated (with respect to risk-based screening levels) in the lagoon due to natural conditions. The lagoon is evaporative in nature, a depositional environment for surrounding eroded sediments, and influenced by sea spray. During dry conditions, evaporate-rich sediments (salt flats) are observed at the surface of the lagoon. Naturally occurring metals will accumulate in the lagoon as they are concentrated in the surface salts.

Since a reference lagoon is not available on Vieques for comparison to the site surface water and sediment data and potential future biota data, it will not be possible to distinguish naturally occurring metals concentrations from those potentially attributable to historic releases, which could lead to falsely considering them to be site-related. The UFP-QAPP process is designed to ensure data are collected that can be used for their intended purpose. If the commenter can provide a technically defensible methodology that can be used to distinguish naturally occurring metals concentrations in the lagoon from metals concentrations potentially attributable to historic releases, the Navy would be willing to collect the samples. Stating that lagoon samples need to be collected for metals analysis without providing a means by which the data can be appropriately interpreted is not acceptable rationale for collecting the samples and is contrary to the fundamentals of the UFP-QAPP.

Also, please see the response to EPA Specific Comment #5.

c. The SAP proposes that a comparison of terrestrial surface soil samples with background surface soil samples can be used to determine whether subsequent surface water and sediment sampling of the lagoon for inorganics is warranted. A review of Figure 6 indicates that the density of MED and munitions scrap items are far greater within the lagoon than in the surrounding uplands. In addition, the lagoon represents a depositional environment and a likely location to detect contaminants that have been transported from the surrounding terrestrial portions of the ECA during storm events. Therefore, please analyze surface water and sediment samples from the lagoon for explosives and inorganics. It is acknowledged that a background dataset for the lagoon is not available. Therefore, once the data is obtained, the ERP Subcommittee can discuss the path forward for evaluating the inorganic data from the lagoon.

Navy Response:

Explosives analyses are proposed for lagoon samples. With respect to inorganics analyses, please see the response to Comment 5b above.

d. Page 44, Environmental Questions to be Answered by RI: Please add text clarifying that surface soil is defined as 0-2 feet, and has been separated into two sampling units for this site, one from 0-2.5 inches and the other from 2.5" to 24 inches.

Navy Response:

Worksheet 10, page 44, Environmental Questions to be Answered by the RI: Following the sentence "Due to the type of potential contaminant sources and release mechanisms at the site, potential contamination is likely to occur primarily within the surface soil, sediment, and/or surface water." has been added "The surface soil interval is identified in the conceptual model as 0-2.5 inches throughout the site except under the following circumstances:

- The beach Decision Unit, where the highly mobile sands that form the beach and turtle nesting habits warrant the beach to be characterized by two separate zones: a 0-2.5-inch zone to be sampled by incremental sampling methods, and an 18-24-inch zone to be discretely sampled.
- The Lagoon Fringe Decision Unit, where the potential for land crab habitat warrant the lagoon fringe to be characterized by two separate zones: a 0-2.5-inch zone to be sampled by incremental sampling methods, and a 2.5-24-inch zone to be discretely sampled.
- The battery disposal area, where Vieques soil sampling protocol requires sampling surface soil under a former potential surface source at a depth of 0-12-inches below ground surface."

6. SAP Worksheet #11, Project Quality Objectives/Systematic Planning Process Statements:

   a. Page 47, What are the Project Action Limits (PALs)?: Please add a discussion of the impact of elevated QLs on the results of the risk assessments and determination of nature and extent of contamination.

   Navy Response:

   The analytical method for arsenic and selenium has been revised to method 6020, which has QLs lower than the PALs. The last sentence of the last paragraph has been replaced with the following: "The explosive constituents tetryl and nitrobenzene for the surface soil, subsurface soil, and sediment samples, and 2-NT, 3-NT, and nitroglycerin for the surface water samples have PALs below QLs, but MDLs below the PALs. Therefore, these constituents could be detected at the PALs and reported as estimated and therefore will not adversely impact the risk assessments. Additionally, the human health PAL is the adjusted RSL for tap water, which is a conservative (and unrealistic) screening criterion for the saline conditions of the surface water at the lagoon."

   b. Page 49, How much data should be collected (number of samples for each analytical group, matrix, and concentration)? Please note that Figure 4 refers to subsurface soil samples in planting and in turtle nesting area. Please ensure consistency in the method for referring to the two sampling units for surface soil, defined as 0-2 feet bgs.

Navy Response:

Figure 4 has been revised to refer to deep surface soil samples in reference to "FWS Workers" and "Sea Turtle Eggs"

7. SAP Worksheet #14, Summary of Project Tasks:

   a. Page 64, Discrete Soil Sample Collection: This section states that the lagoon fringe soil samples will be collected from 2.5-24 inches. However, Worksheet #10 (page 43) states that these samples will be collected from 0-2 feet. Please clarify and revise worksheets to be consistent. This may also affect page 77 of Worksheet #17.

   Navy Response:

   Worksheet #10 First bullet on page 43 has been revised to read "Deeper surface soil – 2.5-inches to 2 feet within the lagoon fringe..."

   b. Page 64, Sample Analysis: This section states that the MIS samples will be analyzed for TOC. However, Worksheet #12-3a states that TOC analysis will only be performed on sediment samples. Please clarify and revise worksheets to be consistent.

   Navy Response:

   MIS samples will be analyzed for TOC as stated in Worksheet 14, Worksheet 18, and Worksheet 12-3. Worksheet 12-3a pertains only to Discrete Surface Soil or Sediment (the Discrete Surface Soil Sample is the sample below the former battery storage area). Footnote 2 "TOC is analyzed in sediment only" refers to the samples in Worksheet 12-3a only (i.e., TOC will not be analyzed in the discrete surface soil sample collected at the former battery storage area). To clarify, footnote 2 has been changed to state: "TOC will not be analyzed in the discrete surface soil sample collected at the former battery storage area."

8. SAP Worksheet #15, Reference Limits and Evaluation Tables:

   a. Worksheet #15-1:

      i. The use of method 6020 (ICP/MS) should be considered for arsenic and selenium in addition to thallium. According to the laboratory's 6020 SOP, the quantitation limits (QLs) for arsenic and selenium by 6020 would allow the achievement of these project action levels.

      Navy Response:

      The analytical methods for arsenic and selenium have been revised to 6020.

      ii. The listed QL for thallium (2 mg/kg) is high considering the analysis is being performed by ICP/MS. The SOP provided by the laboratory lists the QL as 0.1 mg/kg. Please clarify.

Navy Response:

The 6010B QL/MDL for thallium was inadvertently provided. The QL/MDL has been updated to 0.15mg/ kg and 0.05mg/kg on Worksheet 15-1. The shading has been removed.

b. Worksheet #15-2:

i. Some of the listed RSLs do not match the most recent RSL table (May 2010). Please review and correct as needed.

Navy Response:

RSLs were updated the month the draft SAP was produced. RSLs on all applicable Worksheet 15s have been updated to May 2010 values.

ii. Please change the listed units of the RSLs from mg/kg to µg/kg.

Navy Response:

This change has been made.

iii. The worksheet shows a QL of 500 µg/kg for 4-nitrotoluene. The QL cited in the laboratory's SOP is 250 µg/kg. Please clarify.

Navy Response:

The QLs for 4-NT and 3,5-DNA were inadvertently switched. Worksheet 15-2 has been updated to reflect the correct values: 250 µg/kg / 80 µg/kg for 4-NT and 500 µg/kg / 25 µg/kg for 3,5-DNA.

iv. The worksheet shows a QL of 250 µg/kg for 3,5-dinitroaniline. The QL cited in the laboratory's SOP is 500 µg/kg. Please clarify.

Navy Response:

Please refer to the response to Comment 8 b iii, above.

v. The worksheet shows a QL of 0.5 µg/kg for perchlorate. The QL cited in the laboratory's SOP is 5.0 µg/kg. Please clarify.

Navy Response:

The QL/MDL for soil perchlorate has been updated to 5 µg/kg / 0.25 µg/kg.

c. Worksheet #15-6:

i. It is unclear where the Tapwater RSLs came from. Please check these versus the latest RSL table (May 2010). All values are incorrect and some values are listed as NC when there are values that exist in the RSL table.

Navy Response:

The CAS numbers on Worksheet 15-6 have been corrected and the May 2010 tap water RSLs have been placed into the correct column.

ii. The QLs cited in the worksheet are not consistent with the QLs cited in the laboratory's SOP. Please clarify.

Navy Response:

The QLs/MDLs were re-requested from the laboratory and updated in Worksheet 15-6. Shading was removed for NB. Shading was added for 2-NT (see response to Comment 8 c i, above). The QL for HMX was changed from 0.15 to 0.10. The QL for RDX was changed from 0.25 to 0.10. The QL for 1,3-DNB was changed from 0.15 to 0.10. The QL for Tetryl was changed from 0.15 to 0.10. The QL for NB was changed from 0.15 to 0.10. The QL for 2,4,6-TNT was changed from 0.15 to 0.10. The QL for 4-Am-DNT was changed from 0.15 to 0.10. The QL for 2-Am-DNT was changed from 0.3 to 0.2. The QL for 2,4-DNT was changed from 0.15 to 0.10. The QL for 2,6-DNT was changed from 0.15 to 0.10. The QL for 2-NT was changed from 0.15 to 0.5. The QL for 4-NT was changed from 1 to 0.65. All concentrations are in µg/kg.

9. SAP Worksheet #17, Sampling Design and Rationale:

a. Page 75, Environmental Media: This section discusses reviewing soil data to determine the potential for contaminants to leach to groundwater. Please consider including subsurface soil samples in the investigation in areas where deeper soil is present (i.e., below 2 feet bgs) and analyze these samples for explosives and inorganics. The results from these samples can then be used to provide empirical data on whether contaminants, if present, are leaching to groundwater.

Navy Response:

Please see response to EPA Specific Comment #9.

10. SAP Worksheet #18, Sampling Locations and Methods/SOP Requirements Table:

a. VEECA-1SB02: Please change the Number of Samples to "2 (including 1 duplicate)."

Navy Response:

The requested revision has been made.

11. SAP Worksheet #19, Analytical SOP Requirements Table:

a. SMI, SS, and/or SD:

i. For the row for perchlorate, please include a preservation requirement for headspace in the jar. This is in accordance with Section 8.6 of SW-846 method 6850.

Navy Response:

The preservation requirement for perchlorate samples has been revised to "headspace in jar."

ii. Please revise the holding time for pH analysis to be ASAP. This is in accordance with Section 6.0 of the method.

Navy Response:

Because "as soon as possible" is not descriptive, the holding time for pH is provided as "per the laboratory's SOP." The footnote includes the terminology "as soon as possible."

12. SAP Worksheet #20, Field Quality Control Sample Summary Table:

a. SMI and SS: Please replace "WETCHEM" with pH.

Navy Response:

"WCHEM" is the analysis group. To clarify, this has been replaced with "WCHEM (pH)" for SMI and SS.

b. SD: Please replace "WETCHEM" with pH and TOC.

Navy Response:

"WCHEM" is the analysis group. To clarify, this has been replaced with "WCHEM (pH and TOC)" for SD.

13. SAP Worksheet #21, Project Sampling SOP References Table: Please add the SOP A.7 in Attachment A to this table.

Navy Response:

Worksheet #21, Project Sampling SOP Reference Table, SOP A-7 has been added to the table as follows under each column heading: "SOP A-7, Systematic Random Increment Sampling, CH2M HILL, MIS sampler, N.

14. SAP Worksheet #22, Field Equipment Calibration, Maintenance, Testing and Inspection Table: Please include the requirements for the salinity probe.

Navy Response:

The salinity probe is the Specific Conductance Probe; the value is just a math conversion done by the instrument for the calculation.

15. SAP Worksheet #23, Analytical SOP References Table:

a. Please remove the SW matrix for the SOPs WS-MT-0001 and WS-MT-0003 since metals analyses of surface water samples will not be performed during this investigation.

Navy Response:

SW has been removed from SOPs WS-MT-0001 and WS-MT-0003.

b. SOP WS-IP-0002: Please provide details on how the laboratory will prepare the multi-incremental soil samples for metals analyses, as was done for the explosives analyses (i.e., the air drying, sieving, grinding, and subsampling procedures, grinding blanks, and laboratory triplicate analyses).

Navy Response:

This information is already present at the bottom of Worksheet 28-1. Note that "Refer to Worksheet 28-2" means that the procedure is identical to that for explosives.

c. SOP WS-LC-0009:

i. For the explosives analysis, the laboratory SOP states that 3,5-dinitroaniline coelutes with TNT and Tetryl, depending on which column is used. Please have the laboratory confirm which two columns will be utilized for the analysis of all explosives in order to avoid the coelution problem since all three of these compounds are on the analyte list.

Navy Response:

The sample is initially analyzed using a CarboSorb C-18 column. On this column 3,5-DNA and Tetryl co-elute. If a detection is observed at the retention time for 3,5-DNA and Tetryl, then the sample is re-injected onto a CYANO column on which the compounds are chromatographically separated.

ii. Confirm that the 8330B procedure will be followed for this program as the SOP covers three different analytical methods.

Navy Response:

Confirmed. The required analytical service is SW-846 8330B.

iii. Confirm if the ring and puck mill grinding procedure will be performed.

Navy Response:

Confirmed (for explosives analysis). Hand grinding is done for inorganics.

iv. Section 11.6.7 of the SOP states that nitrocellulose fibers must be finely ground to release the target analytes. Since nitrocellulose is included on Table 1, please confirm what special grinding procedures will be performed.

Navy Response:

Nitrocellulose is not one of the target analytes as it is not part of the 8330B list. Therefore, that part of the SOP is not applicable to this study.

16. SAP Worksheet #24, Analytical Instrument Calibration Table:

    a. HPLC:

        i. The acceptance criterion for the %RSD for the ICAL is listed as ≤15%. However, the SOP lists the acceptance criterion as ≤20%. Please clarify.

        Navy Response:

        For strict DoD QSM compliance, the laboratory will adhere to ≤15% RSD for the ICAL. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

        ii. The acceptance criterion for the ICV is listed as ±20%. However, the SOP lists the acceptance criterion as ±15%. Please clarify.

        Navy Response:

        For strict DoD QSM compliance, the laboratory will adhere to ±20% for the second-source calibration verification. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

        iii. The acceptance criterion for the CCV is listed as ±20%. However, the SOP lists the acceptance criterion as ±15%. Please clarify.

        Navy Response:

        For strict DoD QSM compliance, the laboratory will adhere to ±20% for the continuing calibration verification. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

    b. LC/MS/MS:

        i. The worksheet states that initial calibration is required at method set-up and after major maintenance. However, the SOP states that this is required daily for DOD projects. Please clarify.

        Navy Response:

        For strict DoD QSM compliance, the laboratory must calibrate at method set-up and after major maintenance. The DoD QSM v. 4.1 is significantly more recent than the DoD perchlorate handbook. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

        ii. The worksheet states that the absolute value of the intercept must be ≤LOD. However the SOP states that this must be ≤MDL. Please clarify.

        Navy Response:

        For strict DoD QSM compliance, the concentration corresponding to the absolute value of the calibration curve's Y-intercept must be ≤ LOD. The

DoD Perchlorate handbook also indicates this. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

iii. The worksheet states that the mass calibration is updated on an as-needed basis. However, the SOP states that this is performed daily for DOD projects. Please clarify.

Navy Response:

For strict DoD QSM compliance, the mass calibration is updated on an as-needed basis. The DoD QSM v. 4.1 is significantly more recent than the DoD perchlorate handbook. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

iv. Add the requirements for the Limit of Detection Verification standard, as per Section 10.1.2 of the laboratory's SOP. This standard is required to be spiked at 2x the MDL, analyzed prior to samples and at the end of the analytical sequence, and needs to be ±30% of the true value.

Navy Response:

Requirements for limit of detection verification (LODV) were added as per Table 5-12 in DoD QSM v. 4.1. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

c. ICP-AES and ICP/MS: The worksheet states that the analysis of the high-level check standard is required every 6 months. However, the SOP states that this is required after calibration. Please clarify.

Navy Response:

For strict DoD QSM compliance, the linear dynamic range or high-level check standard is required at a minimum frequency of every six months. This is applicable to both SW-846 6010B and 6020. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

d. pH meter: The worksheet lists only a daily calibration. The laboratory's SOP requires an ICV and CCV. Please update the worksheet to be consistent with the laboratory's SOP.

Navy Response:

Worksheet 24 was updated to include an ICV and CCV as per analytical laboratory SOP WS-WC-0044. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

e. TOC Analyzer:

i. The worksheet requires the analysis of the continuing calibration every 10 samples. However, the SOP requires this be analyzed every 20 samples. Please clarify.

Navy Response:

Worksheet 24 was updated to match analytical laboratory SOP PT-WC-030. The CCV is required every 20 drops and at the end of the analytical sequence. This update is a clarification. A sample consists of two individual drops and so a CCV is still performed every 10 samples.

ii. The worksheet lists the acceptance criterion of the continuing calibration as ±10%. However, the SOP lists the acceptance criterion as ±15%. Please clarify.

Navy Response:

Worksheet 24 was updated to match analytical laboratory SOP PT-WC-030. The acceptance criterion is ±15%.

17. SAP Worksheet #28, Laboratory QC Samples Table:

a. Worksheets #28-1 and 28-5:

i. 6010: The acceptance criteria for the ICS-A states that the absolute value of the concentration for non-spiked analytes must be <LOD. However, the SOP states that these concentrations should be <2x MDL. Please clarify.

Navy Response:

For strict DoD QSM compliance, the absolute value of concentration for all non-spiked analytes must be < LOD. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

ii. 6010 and 6020: The acceptance criteria for the serial dilution states that the evaluation criteria are only applicable to concentrations >50x LOQ. However, the 6010 SOP states that the evaluation criteria are applicable to concentrations >50x the IDL and the 6020 SOP states that the evaluation criteria are applicable to concentrations >100x the MDL. Please clarify.

Navy Response:

For strict DoD QSM compliance, the evaluation criteria are only applicable to concentrations > 50X the LOQ. This is applicable to both SW-846 6010B and 6020. The laboratory has signed a declaration that they will strictly adhere to DOD QSM V. 4.1.

iii. 6020: Add criteria for the internal standards.

Navy Response:

Requirements for internal standards were added to Worksheets 28-1 and 28-5 for SW-846 6020 as per Table 5-8 in DoD QSM v. 4.1.

iv. Worksheet #28-1 only: The worksheet states that a 10 gram aliquot will be used for 6010B and 6020. However, the SOPs and methods state that a 1 gram aliquot is used for metals. Please clarify.

Navy Response:

This is a specific requirement considering that the metals are going to be sub-sampled and ground. The procedure is detailed in Worksheet 28-1 but is also referenced (as a routine subsample size for metals) in section 11.6.10 of analytical laboratory SOP WS-LC-0009.

b. Worksheet #28-2:

i. Method Blank Acceptance Limits: Remove the reference to common laboratory contaminants.

Navy Response:

The reference to "common laboratory contaminants" was removed from the SW-846 8330B section of Worksheet 28-2 and 28-6.

ii. Include the ERA PE sample referenced in the USACE incremental sampling guidance document cited on Worksheet #17 to be prepared and analyzed with each batch of incremental samples.

Navy Response:

The ERA PE sample is described in analytical SOP WS-LC-0009 section 9.8.1.1 and is similar to a second LCS. A row for this QA/QC sample was added to Worksheet 28-2.

iii. The worksheet states that a 30 gram aliquot will be used for explosives. However, the SOP and method state that a 10 gram aliquot is used for explosives. Please clarify.

Navy Response:

The 30 g aliquot, which is necessary for semivolatiles analysis, is not necessary for SW-846 8330B or 6850. Worksheet 28-2 was updated to require a 10 g aliquot for SW-846 8330B.

c. Worksheet #28-3:

i. pH:

1. SOP also includes requirements for an LCS. Please add to the Worksheet.

   Navy Response:

   Requirements for an LCS were added as per section 9.2 of analytical laboratory SOP WS-WC-0044.

2. The worksheet lists the acceptance criterion of the laboratory replicate as RPD ≤20%. However, the SOP lists the acceptance criterion as RPD <0.5 pH units. Please clarify.

   Navy Response:

   The acceptance criterion for laboratory replicate was updated to RPD < 0.5 pH units to match the analytical laboratory SOP.

ii. TOC:

1. The worksheet lists the acceptance criterion for the method blank as <QL. However, the SOP lists the acceptance criterion as <1/2 QL and <1/10 amount measured in samples. Please clarify.

   Navy Response:

   The acceptance criterion for method blank was updated to "no analyte detected > 1/2 the reporting limit and > 1/10 the amount measured in any sample." to match the analytical laboratory SOP.

2. The worksheet lists the acceptance criterion of the LCS as 80-120%. However, the SOP lists the acceptance criterion as 75-125%. Please clarify.

   Navy Response:

   The acceptance criteria for LCS was updated to 75-125% to match the analytical laboratory SOP.

3. The worksheet includes the requirements for the laboratory quadruplicate analysis, as per the Lloyd Kahn method. However, this QC sample is not included in the laboratory's SOP. Please confirm this will be performed by the laboratory.

   Navy Response:

   Confirmed. This requirement is in addition to those listed in the analytical laboratory SOP.

d. Worksheet 28-6: Method Blank Acceptance Limits: Remove the reference to common laboratory contaminants.

Navy Response:

The reference to "common laboratory contaminants" was removed from the SW-846 8330B section of Worksheet 28-2 and 28-6.

18. SAP Worksheet #29, Project Documents and Records Table: Please revise row 7 to state surface water instead of groundwater.

Navy Response:

Row 7 has been revised to state surface water instead of groundwater.

19. SAP Worksheet #30, Analytical Services Table: TOC analysis is listed for the surface soil matrix. However, Worksheet #12 states that TOC analysis is being performed on sediment samples only. Please clarify and revise worksheets to be consistent.

Navy Response:

TOC is not necessary for SS samples. Worksheet 30 has been updated to remove TOC for SS samples.

20. SAP Worksheet #34, Verification (Step I) Process Table: Audit Reports and Corrective Action Reports: Revise the Project Manager to Bill Hannah instead of John Tomik, as per Worksheets 3 through 5.

Navy Response:

John Swenfurth has been updated as Project Manager.

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