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UNIFORM FEDERAL POLICY-SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING AND QUALITY ASSURANCE PROJECT PLAN) PRELIMINARY ASSESSMENT SITE INSPECTION UNEXPLODED ORDNANCE (UXO) SITE UXO 24 CAMP GEIGER BURIAL AREA MCB CAMP LEJEUNE

5/1/2013

CH2MHILL

SAP Worksheet #1—Title and Approval Page

Final

Uniform Federal Policy-Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Preliminary Assessment/Site Inspection Unexploded Ordnance (UXO) Site UXO-24 – Camp Geiger Burial Area

Marine Corps Installations East - Marine Corps Base Camp Lejeune Jacksonville, North Carolina

Contract Task Order 0014

May 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

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Review Signatures:

Dan Hockett 5/24/13

Dan Hockett, P.G.
CH2M HILL – Project Manager

Thomas M. Roth 5/24/2013

Thomas M. Roth, P.E.
CH2M HILL – Senior Technical Consultant

Other Approval Signatures:

David T. Cleland 23 May 2013

Dave Cleland
NAVFAC Mid-Atlantic – Remedial Project Manager

Gena D. Townsend 5/23/2013

Gena Townsend
USEPA Region 4 – Remedial Project Manager

W. R. McElveen 5/23/2013

Randy McElveen
NCDENR – Remedial Project Manager

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Executive Summary

This document presents the plan for the Preliminary Assessment/Site Inspection (PA/SI), including research of archival records, use of data from previous investigations, and environmental sampling, at United States (U.S.) Marine Corps Munitions Response Program Site Unexploded Ordnance (UXO) 24, Camp Geiger Burial Area, herein referred to as Site UXO-24, located at Marine Corps Installations East-Marine Corps Base Camp Lejeune (MCIEAST-MCBCAMLEJ or the Base) in Jacksonville, North Carolina.

CH2M HILL prepared this document under the U.S. Navy, Naval Facilities Engineering Command (NAVFAC) Atlantic, Comprehensive Long-Term Environmental Action - Navy (CLEAN) 1000 Contract N62470-08-D-1000, Contract Task Order (CTO) 0014, in accordance with the Navy's Uniform Federal Policy-Sampling and Analysis Plan (UFP-SAP) policy guidance to ensure that environmental data collected are scientifically sound, of known and documented quality, and suitable for intended uses. The *Site Management Plan, Fiscal Year 2010, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina* (CH2M HILL, 2010) provides additional information and background on MCIEAST-MCBCAMLEJ. This PA/SI will be conducted under CTO 0014, Modification 7.

Site UXO-24 is being investigated under the Military Munitions Response Program (MMRP) because of the discovery of subsurface munitions at the site. In addition, pesticides and herbicides were detected in soils above screening levels at the site during previous investigation activities in conjunction with the Site 37 Confirmatory Sampling Assessment, requiring additional assessment activities.

Objectives of this PA/SI are to assess if sources of geophysical anomalies represent potential munitions and explosives of concern (MEC)/ material potentially presenting an explosive hazard (MPPEH) and to evaluate whether a release of munitions constituents (MC) occurred within the 9-acre investigation area of Site UXO-24. Activities for the PA/SI include surveying, intrusive investigation of up to 1,000 anomalies in the western portion of the site that represent potential subsurface MEC, and environmental sampling of surface and subsurface soil, sediment, surface water, and groundwater. The collected samples will be used to evaluate the presence and nature of MC at the site.

An additional objective is to delineate the extent of pesticides and herbicides previously detected in soil at the site above site screening criteria. Soil samples will be collected and analyzed for pesticide and herbicide constituents. The collected samples will be used to evaluate the presence and extent of pesticides and herbicides at the site. Analytical data from PA/SI sampling activities will be used to determine if additional assessment or interim action is warranted.

Uniform Federal Policy-Sampling and Analysis Plan Outline

This UFP-SAP consists of 37 worksheets specific to the UFP-SAP. All tables are embedded within the worksheets. All figures are included at the end of the document. Field standard operating procedures (SOPs) are included in **Attachment 1**. Data management guidelines are included in **Attachment 2**, and the laboratory's Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) letter is included in **Attachment 3**. **Attachment 4** presents the Environmental Protection Plan. Upon approval of this Draft UFP-SAP, the sampling activities will be scheduled and executed.

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SAP Worksheets

Attachments

Figures

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Acronyms and Abbreviations

°C	degrees Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
AHA	Activity Hazard Analysis
AM	Activity Manager
APP	Accident Prevention Plan
bgs	below ground surface
BHC	benzene hexachloride
BIP	blow in place
C/D	class/division
CA	corrective action
CAS	Chemical Abstract Service
CCB	continuing calibration blank
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-Term Environmental Action - Navy
COC	contaminant of concern
COPC	contaminant of potential concern
CSA	confirmatory sampling assessment
CSM	conceptual site model
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DCC	dynamic current-offset calibration
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDESB	Department of Defense Explosives Safety Board
DDT	dichlorodiphenyltrichloroethane
DGM	digital geophysical mapping
DL	detection limit
DMM	discarded military munitions
DNA	dinitroaniline
DO	dissolved oxygen
DoD	Department of Defense
DoDI	Department of Defense Instruction
DPT	direct-push technology
DQI	data quality indicator
DU	decision unit
DUP	duplicate sample
DV	Data Validator
EDS	Environmental Data Services
ELAP	Environmental Laboratory Accreditation Program
EMD	Environmental Management Division
EOD	Explosive Ordnance Disposal
EODB	Explosive Ordnance Disposal Bulletin
ERA	Ecological Risk Assessor
ERS	Ecological Risk Screening

ESQD	explosives safety-quantity distance
ESS	Explosives Safety Submission
EZ	exclusion zone
FP	Follow-up Phase
FTL	Field Team Leader
g	gram
GC	gas chromatography
GIS	geographic information system
GPS	global positioning system
H&S	health and safety
HDPE	high density polyethylene
HHRA	Human Health Risk Assessor
HHRS	Human Health Risk Screening
HPLC	high performance liquid chromatography
HSP	Health and Safety Plan
IAS	Initial Assessment Study
IBD	inhabited building distance
IC	ion chromatography
ICAL	initial calibration
ICB	initial calibration blank
ICP	inductively coupled plasma
ICS	interference check solution
ICV	initial calibration verification
ID	inner diameter
IDW	investigation-derived waste
IP	Initial Phase
IR	Installation Restoration
L	liter
L/min	liter per minute
lb	pound
LC	liquid chromatography
LCS	laboratory control sample
LIMS	Laboratory Information Management System
LOD	limit of detection
LODV	limit of detection verification
LOQ	limit of quantitation
LTM	long-term monitoring
MC	munitions constituents
MCBCAMLEJ	Marine Corps Installations East-Marine Corps Base Camp Lejeune
MCE	maximum credible event
MCIEAST	Marine Corps Installations East
MCL	maximum contaminant level
MCPA	2-methyl-4-chlorophenoxyacetic acid
MCPP	methylchlorophenoxypropionic acid
MD	munitions debris
MDAS	material documented as safe
MDL	method detection limit
MEC	munitions and explosives of concern
MFD	maximum fragment distance

mg/L	milligram per liter
MGFD	munition with the greatest fragmentation distance
ml	milliliter
mm	millimeter
MMRP	Military Munitions Response Program
MPC	measurement performance criteria
MPP	Master Project Plan
MPPEH	material potentially presenting an explosive hazard
MR	Munitions Response
MRS	Munitions Response Site
MS	mass spectrometer
MS/MSD	matrix spike/matrix spike duplicate
MSA	method of standard addition
MSD	minimum separation distance
mV	millivolt
NA	not applicable
NAVFAC	Naval Facilities Engineering Command
NC 2L	North Carolina 2L Groundwater Quality Standards
NC SSL	North Carolina Soil Screening Level
NC	no criteria
NCAC 2B	North Carolina Surface Water and Wetland Standards
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCGWQS	North Carolina Groundwater Quality Standards
NCHWS SSL	North Carolina Hazardous Waste Section Soil Screening Level
NEW	net explosive weight
NIRIS	Naval Installation Restoration Information Solution
NRWQC	National Recommended Water Quality Criteria
NTR	Navy Technical Representative
ORP	oxidation reduction potential
ORR	Operational Readiness Review
Osage	Osage of Virginia
oz	ounce
PA/SI	Preliminary Assessment/Site Inspection
PAL	project action level
PC	Project Chemist
PCB	polychlorinated biphenyl
PE	Professional Engineer
PETN	pentaerythritol tetranitrate
PG	Professional Geologist
PM	Project Manager
POC	point of contact
PP	Preparatory Phase
PPE	personal protective equipment
PQL	practical quantitation limit
PQO	project quality objective
PTR	public traffic route
PVC	polyvinyl chloride

QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SBO	Safe Behavior Observation
SOP	standard operating procedure
SRA	saturated response area
STC	Senior Technical Consultant
SUXOS	Senior Unexploded Ordnance Supervisor
SVOC	semivolatile organic compound
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TCMX	tetrachloro-m-xylene
TM	Task Manager
TP	technical paper
TSD	team separation distance
U.S.	United States
UAESCH	U.S. Army Engineering and Support Center, Huntsville Corps of Engineers, Huntsville Center
UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VOC	volatile organic compound
WQP	water quality parameter

SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Site UXO-24 – Camp Geiger Burial Area

Operable Unit: N/A

Contractor Name: CH2M HILL

Contract Number: N62470-08-D-1000

Contract Title: Navy Comprehensive Long-Term Environmental Action - Navy (CLEAN) 1000

Work Assignment Number (optional): Contract Task Order (CTO) 0014, Modification 7

1. **This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of:**

   Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) (United States Environmental Protection Agency [USEPA], 2005)

   USEPA *Guidance for QAPPs, USEPA QA/G-5, Quality Assurance Management Section (QAMS)* (USEPA, 2002)

   USEPA *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006a)

2. **Identify regulatory program:** Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

3. **This SAP is a Project-specific SAP**

4. **List dates of scoping sessions that were held:**

Scoping Session	Date
Partnering Sessions	August 17, 2011 and September 12, 2012

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

Title	Date
Draft Confirmatory Sampling Report Sites 18, 37, 46, and 51, Marine Corps Base Camp Lejeune, North Carolina (Osage of Virginia [Osage])	February 2011

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

   North Carolina Department of Environment and Natural Resources (NCDENR) – regulatory stakeholder

   USEPA Region 4 – regulatory stakeholder

   Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic – lead organization

   Marine Corps Installations East-Marine Corps Base Camp Lejeune (MCIEAST-MCBCAMLEJ) – site owner

7. **Lead organization:**

   United States (U.S.) Department of the Navy – Lead Agency

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

Crosswalk table is excluded, as all required information is provided in this SAP.

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Dave Cleland	Navy Technical Representative (NTR)	NAVFAC Mid-Atlantic	(757) 322-4851	david.t.cleland@navy.mil
Charity Rychak	Environmental Engineer	MCIEAST-MCBCAMLEJ - Environmental Management Division (EMD)	(910) 451-9386	charity.rychak@usmc.mil
Gena Townsend	Remedial Project Manager (RPM)	USEPA Region 4	(404) 562-8538	townsend.gena@epa.gov
Randy McElveen	RPM	NCDENR	(919) 707-8341	Randy.McElveen@ncdenr.gov
Matt Louth	Activity Manager (AM)	CH2M HILL	(757) 671-6240	matt.louth@ch2m.com
Tom Roth	Senior Technical Consultant		(404) 474-7640	tom.roth@ch2m.com
Teg Williams	Senior Technical Consultant		(704) 543-3297	tegwyn.williams@ch2m.com
Dan Hockett	Project Manager (PM)		(704) 543-3264	daniel.hockett@ch2m.com
Brett Doerr	Navy CLEAN Program UFP-SAP Reviewer/Quality Assurance Officer (QAO)		(757) 671-6219	brett.doerr@ch2m.com
Carl Woods	Health & Safety (H&S) Manager		(513) 889-5771	carl.woods@ch2m.com
Roni Warren	Human Health Risk Assessors (HHRA)		(814) 364-2454	roni.warren@ch2m.com
Jonathon Weier	Ecological Risk Assessor (ERA)		(770) 485-7503	jonathon.weier@ch2m.com
Simon Kline	Assistant PM		(910) 622-4344	simon.kline@ch2m.com
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	(757) 671-6218	anita.dodson@ch2m.com
Bianca Kleist	Project Chemist (PC)		(704) 543-3274	bianca.kleist@ch2m.com
Molly Nguyen	PM/Laboratory	EMAX	(310) 618-8889	mnguyen@emaxlabs.com
Kenette Pimentel	QAO	EMAX	(310) 618-8889	kpimentel@emaxlabs.com
Nancy Weaver	Data Validator (DV)	Environmental Data Services (EDS)	(757) 564-0090	nweaver@env-data.com

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SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/ e-mail receipt	Section Reviewed	Date SAP Read
Charity Rychak	MCIEAST-MCBCAMLEJ/EMD	(910) 451-9386			
Matt Louth	CH2M HILL/AM	(757) 671-6240			
Brett Doerr	CH2M HILL/Navy CLEAN Program UFP-SAP Reviewer	(757) 671-6219			
Teg Williams	CH2M HILL/Senior Technical Support	(704) 543-3297			
Roni Warren	CH2M HILL/HHRA	(814) 364-2454			
Jonathon Weier	CH2M HILL/ERA	(770) 485-7503			
Carl Woods	CH2M HILL/H&S Manager	(513) 889-5771			
Anita Dodson	CH2M HILL/Navy CLEAN Program Chemist	(757) 671-6218			
Bianca Kleist	CH2M HILL/PC	(704) 543-3274			
Molly Nguyen	EMAX/PM	(310) 618-8889			
Kenette Pimentel	EMAX/QAO	(310) 618-8889			
Nancy Weaver	EDS/Validator	(757) 564-0090			
TBD	UXO Tech	TBD			

Notes:
The personnel sign-off sheet will be retained in the project file.

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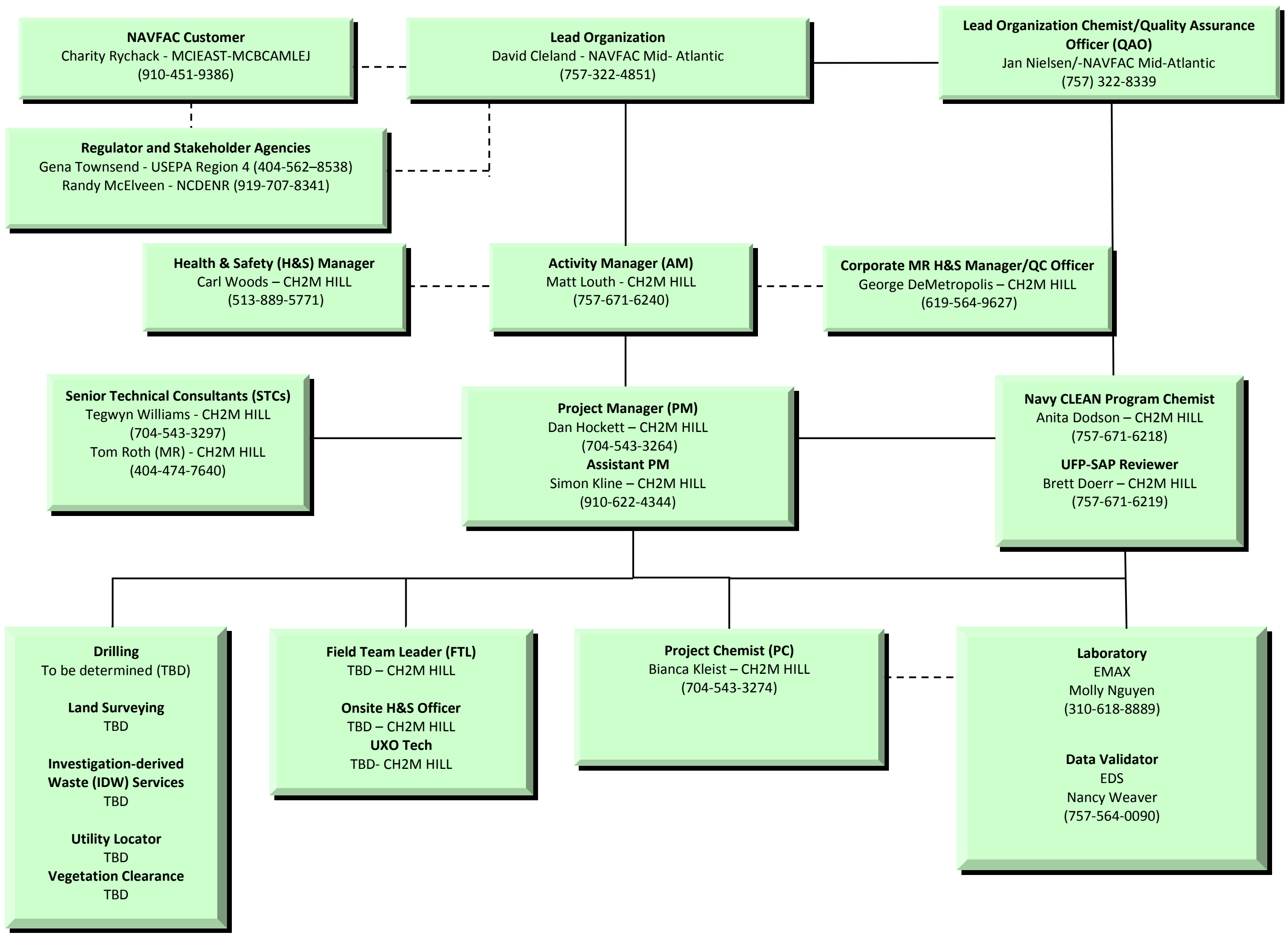
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure, Pathway, etc.
Communication with Navy (lead agency)	Navy NTR/RPM	David Cleland	david.t.cleland@navy.mil	Primary point of contact (POC) for Navy; can delegate communication to other internal or external points of contact. RPM will notify USEPA and NCDENR via e-mail or telephone call within 24 hours if field changes affecting the scope or implementation of the design occur. Navy will have 30 days for work plan review. All sampling data will be presented and discussed during partnering meetings.
Communication with USEPA Region 4	EPA Region 4 RPM	Gena Townsend	townsend.gena@epa.gov	Primary POC for EPA; can delegate communication to other internal or external points of contact. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings.
Communication with NCDENR	NCDENR RPM	Randy McElveen	Randy.McElveen@ncdenr.gov	Primary POC for NCDENR; can delegate communication to other internal or external points of contact. Upon notification of field changes, NCDENR will have 24 hours to approve or comment on the field changes.
Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and NCDENR	CH2M HILL AM	Matt Louth	matt.louth@ch2m.com	Oversees project and will be informed of project status by the PM. If field changes occur, AM will work with the Navy RPM to communicate field changes to the team via e-mail within 24 hours. All data results will be communicated to the project team during the first partnering meeting following data receipt.
Technical communications for project implementation, and data interpretation	CH2M HILL Senior Technical Consultants	Tom Roth Teg Williams	tom.roth@ch2m.com tegwyn.williams@ch2m.com	Contact Senior Technical Consultant regarding questions/issues encountered in the field, input on data interpretation, as needed. Senior Technical Consultants will have 24 hours to respond to technical field questions as necessary. Additionally, Senior Technical Consultants will review data as necessary prior to partnering team discussion and reporting review.
Communications regarding project management and implementation	PM	Dan Hockett	daniel.hockett@ch2m.com	All information and materials about the project will be forwarded to the Navy, AMs, and Senior Technical Consultants as necessary. POC for field sampling team.
Coordinate activities between PM and Field Team/Sub-contractors	Asst. PM	Simon Kline	simon.kline@ch2m.com	All field team and reporting activities will be forwarded to PM for further dissemination if necessary. Responsible for field team members' and subcontractors adherence to work plan.

SAP Worksheet #6—Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure, Pathway, etc.
Work Plan changes in field. QAPP Field Changes/Field Progress Reports	FTL	TBD	TBD	Documentation of deviations from the Work Plan will be made in the field log book (made with the approval of AM and/or QAO), and the PM will be notified immediately. Provide daily progress reports to PM. Deviations will be made only with approval from the PM.
Communication regarding risk assessments	Human Health and ERAs	Roni Warren (Human Health) Jonathan Weier (Ecological)	roni.warren@ch2m.com jonathon.weier@ch2m.com	Responsible for conducting risk assessments. Technical questions regarding this project must be answered within 24 hours.
H&S	Onsite H&S Officer	TBD	TBD	Responsible for field team members' adherence to the site safety requirements described in the Accident Prevention Plan/Health and Safety Plan (APP/HSP). Will report H&S incidents and near losses to PM.
Reporting laboratory data quality issues	Laboratory PM	Molly Nguyen	mnguyen@emaxlabs.com	All QA/Quality Control (QC) issues with project field samples will be reported within 2 days to the PC by the laboratory.
Reporting data validation issues	DV	Nancy Weaver	nweaver@env-data.com	All data validation issues regarding resubmissions from the laboratory will copy the CH2M HILL PC on communications. The data validation report will be due to CH2M HILL within 14 calendar days of data receipt. The NAVFAC RPM will be notified of any field data quality issues. Any significant lab issues will be reported to NAVFAC LANT QAO or Chemist to ensure that the issues do not have the potential to impact other Navy projects.
Field and analytical corrective actions (CAs); release of analytical data; data tracking from field collection to database upload	PC	Bianca Kleist	bianca.kleist@ch2m.com	Any CAs for field and analytical issues will be determined by the FTL and/or the PC and reported to the PM within 4 hours. No analytical data can be released until validation of the data is completed and has been approved by the PC. The PC will review analytical results within 7 days of receipt for release to the project team. The NAVFAC Mid-Atlantic chemist will be notified should there be data quality issues identified that will prevent data quality objectives from being met or will severely impact project schedule. Responsible for tracking data from sample collection through database upload.
Field CAs	Asst. PM and PM	Simon Kline Dan Hockett	simon.kline@ch2m.com daniel.hockett@ch2m.com	Field and analytical issues requiring CA will be determined by the Task Manager (TM) and/or PM; the PM will ensure QAPP requirements are met by field staff
UXO Safety	UXO Tech	TBD	TBD	Responsible for anomaly avoidance activities.

SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities	Education and Experience Qualifications (Optional)
Dave Cleland	NTR	NAVFAC Mid-Atlantic	Oversees project	
Charity Rychak	Base EMD	MCIEAST-MCBCAMLEJ	Oversees project	
Janice Nielsen	Chemist/QA Officer	NAVFAC Mid-Atlantic	Navy CLEAN Program UFP-SAP Reviewer	
Matt Louth, Professional Geologist (PG)	AM	CH2M HILL	Oversees project activities	B.S., Geology 16 years of experience
Dan Hockett, PG	PM	CH2M HILL	Manages project and coordinates project tasks and project staff	M.E.M., Environmental Chemistry B.S., Zoology 17 years of experience
Brett Doerr	Navy CLEAN Program UFP-SAP Reviewer	CH2M HILL	Navy CLEAN Program UFP-SAP Reviewer	M.S., Environmental Science/Hydrogeology B.S., Chemistry 18 years of experience
Tom Roth, Professional Engineer (PE)	Activity Quality Manager	CH2M HILL	Provides senior Munitions Response (MR) technical support for remedial action design and implementation	B.S., Geological Engineering 25 years of experience
Tim Garretson	Senior Technical Support	CH2M HILL	Provides senior MR technical support for Munitions and Explosives of Concern (MEC)	Naval School, Explosive Ordnance Disposal 30 years of experience
Tegwyn Williams, PG	Senior Technical Support	CH2M HILL	Provides senior technical support for field investigations and implementation	B.S., Earth Science 20 years of experience
Carl Woods	H&S Manager	CH2M HILL	Prepares HSP; manages H&S for all field activities	M.S., Occupational Safety and Health 15 years of experience
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	Program-level review of UFP-SAP	B.S., Chemistry 19 years of experience
Bianca Kleist	PC	CH2M HILL	Provides UFP-SAP project delivery support and performs data evaluation and QA oversight; Data management: manages sample tracking; communicates with laboratory and DV	B.S., Chemistry 3 years of experience
Simon Kline, PG	Asst. PM	CH2M HILL	Coordinates all field activities and sampling	M.S., Earth Sciences B.S., Geosciences 7 years of experience
TBD	Site H&S Officer	CH2M HILL	Oversees H&S for all field activities	
TBD	UXO Tech	CH2M HILL	Responsible for UXO anomaly avoidance activities	

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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
UXO Avoidance (3R Munitions Safety Awareness Training)	UXO Safety Training Package	Registered training CH2M HILL Online	Annually	PM and all field staff	FTL, field team members/ CH2M HILL	
Explosives Safety	Explosive Ordnance Disposal (EOD) or UXO Formal Training Course	Graduate of a military EOD school of the United States; or a graduate of a military EOD school of Canada, Great Britain, Germany, or Australia; or a graduate of a commercial formal UXO Technician I course		UXO-qualified personnel and UXO technicians	SUXOS, UXOQCS, UXOSO, UXO Technician (All Levels)/ CH2M HILL, USAE	CH2M HILL HSE

[a] - Training records for field personnel are available on the CH2M HILL Virtual Office.

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SAP Worksheet #9—Project Scoping Session Participants Sheet

Project Name: CTO-0014 Preliminary Assessment/Site Inspection (PA/SI) of Site UXO-24					
Projected Date(s) of Sampling: January 2013			**Site Name:** MCIEAST-MCBCAMLEJ		
PM: Dan Hockett			**Site Location:** MCIEAST-MCBCAMLEJ, Jacksonville, North Carolina		
Dates of Session: August 17, 2011 **Scoping Session Purpose:** The purpose of the scoping session was to present the Site UXO-24 PA/SI scope of work to the MCIEAST-MCBCAMLEJ Partnering Team and reach a consensus on the project approach.					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
Dave Cleland	RPM	NAVFAC Mid-Atlantic	(757) 322-4851	david.t.cleland@navy.mil	Primary Navy POC
Charity Rychak	RPM	EMD EMC MCIEAST-MCBCAMLEJ	(910) 451-9386	charity.rychak@usmc.mil	MCIEAST-MCBCAMLEJ Navy POC
Gena Townsend	RPM	USEPA	(404) 562-8538	townsend.gena@epa.gov	EPA oversight lead
Marti Morgan	RPM	NCDENR	(919) 707-8342	martha.morgan@ncdenr.gov	NCDENR Military Munitions Response Program (MMRP) oversight lead
Randy McElveen	RPM	NCDENR	(919) 707-8341	randy.mcelveen@ncdenr.gov	NCDENR
Matt Louth	MCIEAST-MCBCAMLEJ AM	CH2M HILL	(757) 671-8311 x417	matt.louth@ch2m.com	AM for MCIEAST-MCBCAMLEJ projects; coordinates CH2M HILL projects at MCIEAST-MCBCAMLEJ with Navy contacts
Kim Henderson	Deputy MCIEAST-MCBCAMLEJ AM	CH2M HILL	(757) 671-8311	kim.henderson@ch2m.com	Deputy AM for MCIEAST-MCBCAMLEJ projects

Comments/Decisions:

For the UFP-SAP, the Partnering Team agrees to the investigation strategy for the Site UXO-24 PA/SI, which includes the following:

- Conduct a digital geophysical mapping (DGM) investigation of anomalies within the approximate 2-acre area of the western portion of the site and intrusively investigate up to 9 test pits in the DGM investigation area.
- Soil Sampling – Collect up to 18 soil samples in the intrusive investigation area and analyze samples for explosives, perchlorate, and metals. The number and location of samples will be based on observed potential releases of munitions constituents (MC). Collect up to nine soil samples to confirm potential ecological risks identified during the Site 37 Confirmatory Sampling Assessment (CSA) and analyze samples for pesticides and herbicides.
- Groundwater Sampling – Install up to three shallow monitoring wells upgradient, downgradient, and adjacent to disposal areas and analyze samples for MC.

Action Items: Prepare a UFP-SAP for review by the Partnering Team.

Consensus Decisions: The Partnering Team agreed that the general approach for investigating Site UXO-24 is acceptable.

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

Project Name: CTO-014 PA/SI of Site UXO-24	
Projected Date(s) of Sampling: January 2013	**Site Name:** MCIEAST-MCBCAMLEJ
PM: Dan Hockett	**Site Location:** MCIEAST-MCBCAMLEJ, Jacksonville, North Carolina

Dates of Session: September 12, 2012

Scoping Session Purpose: The purpose of the scoping session was to present the Site UXO-24 PA/SI scope of work to the MCIEAST-MCBCAMLEJ Partnering Team and reach a consensus on the project approach.

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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Comments/Decisions:

For the UFP-SAP, the Partnering Team agrees to the investigation strategy for the UXO-24 Preliminary Assessment/Site Inspection (PA/SI) which includes the following:

- Based on results from May 2012 DGM activities, conduct a UXO intrusive investigation in the DGM investigation area
- Soil Sampling - Collect up to 10 soil samples from intrusive investigation locations and analyze samples for explosives, perchlorate and metals. The number and location of samples will be based on observed potential releases of MC. Collect up to 4 surface samples and 6 subsurface soil samples to confirm potential ecological risks identified during Installation Restoration (IR) Site 37 CSA investigation and analyze samples for pesticides and herbicides. Collect up to 1 surface water and sediment sample downgradient from the intrusive investigation area if surface water is present at the time of investigation. Surface water and sediment samples will be analyzed for MC (i.e., explosives, perchlorate, and metals), pesticides and herbicides.
- Groundwater Sampling - Install up to 3 shallow monitoring wells upgradient, downgradient, and adjacent to intrusive investigation locations and analyze samples for explosives, perchlorate and metals.

Action Items: Prepare a SAP for review by the Partnering Team

Consensus Decisions: The Partnering Team agreed that the general approach for investigating Site UXO-24 is acceptable.

SAP Worksheet #10—Conceptual Site Model

The objective of this SAP is to guide the assessment of potential environmental impacts related to MC, pesticides, and herbicides resulting from historical waste management practices within Site UXO-24 and to evaluate whether potential impacts warrant further assessment. This objective will be addressed by sampling and analysis of environmental media for MC, pesticides, and herbicides; an intrusive anomaly investigation; and conducting a Human Health Risk Screening (HHRS) and an Ecological Risk Screening (ERS).

Site UXO-24 – Camp Geiger Burial Area

The objective of this PA/SI is to evaluate whether subsurface MEC is present, and if so, if a release of MC occurred within the 9-acre investigation area of Site UXO-24. An additional objective is to evaluate whether pesticides and herbicides are present in soil at the site above site screening criteria. Site UXO-24 covers an area of approximately 9 acres of mostly wooded land east of G Street in the Camp Geiger area of MCIEAST-MCBCAMLEJ (**Figure 10-1**). Site UXO-24 also encompasses the majority of Installation Restoration (IR) Site 37, the Camp Geiger Surface Dump (**Figure 10-2**).

Prior to the 1950s, the site was completely wooded. Between 1950 and 1951, IR Site 37 was used as a surface dump for items such as wood, tires, and scrap metal (Osage, 2011). During the late 1950s, the site was partially cleared for the construction of a carpenter shop, lumber rack, and paint shop in the northern portion of the site. A confirmatory sampling investigation of the surface dump area (IR Site 37) was conducted in March 2010 by Osage. This investigation included subsurface soil and groundwater sampling activities throughout IR Site 37. The results of this investigation indicated that pesticides and herbicides are present in subsurface soil at concentrations exceeding screening criteria.

In 2010, the base discovered that discarded military munitions (DMM) had been buried at the site east of Building TC-611 (**Figure 10-1**). A limited visual site inspection conducted by base EOD personnel found additional DMM and material potentially presenting an explosive hazard (MPPEH) in the area surveyed. These activities were conducted separate from the CSA investigation conducted by Osage.

The boundaries of two additional IR sites, IR-35 and IR-36, are adjacent to UXO-24. Both sites are monitored as part of the Installation Restoration Long-Term Monitoring (LTM) program, and downgradient groundwater monitoring sentinel wells associated with these sites are located within the UXO-24 boundary (**Figure 10-3**).

Previous Site Investigations

IR Site 37

IR Site 37, the Camp Geiger Surface Area Dump, was used between 1950 and 1951 for the disposal of wastes such as wood, tires, and scrap metal (Osage, 2010). The site encompasses approximately 4 wooded acres and is divided by a gas and power line easement. The northeast border of the site extends across the U.S. Highway 17 bypass (**Figure 10-2)**.

IR Site 37 was initially identified in the base's Initial Assessment Study (IAS) (Water and Air Research, Inc. [WAR], 1983). Based on the initial lack of evidence of hazardous substances present at the site, further assessment was not recommended (Osage, 2010). In March 2010, Osage conducted confirmatory sampling at the site to validate the original "no further assessment" recommendation for the site. During the investigation, surface debris was identified, including rubber tires, tiles, and scrap steel. The investigation involved the collection of eight subsurface soil and three groundwater samples, and all samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, pesticides, polychlorinated biphenyl (PCBs), and herbicides. Sample locations are presented on **Figure 10-3.**

Confirmatory sampling activities resulted in the detection of pesticides, metals, and herbicides in subsurface soils at the site. Two pesticides (4,4'-dichlorodiphenyltrichloroethane [DDT] and dieldrin) had concentrations that exceeded the North Carolina Hazardous Waste Section Soil Screening Levels (NCHWS SSLs) and base background concentrations.

SAP Worksheet #10—Problem Definition (continued)

Pesticide concentrations exceeded soil screening criteria at subsurface soil sample locations IR37-SB05, IR37-SB06, and IR37-SB07. One sample (IR37-SB-04) had an herbicide (methylchlorophenoxypropionic acid [MCPP]) concentration that exceeded the Adjusted Residential Soil Regional Screening Level (RSL). Aluminum, arsenic, and chromium were detected in subsurface soil samples at levels that exceeded the Adjusted RSLs, but did not exceed base background. Chromium and iron were detected in subsurface soil samples at levels that exceeded NCHWS SSLs, but also did not exceed background. VOCs and SVOCs were detected, although no concentrations exceeded screening criteria. PCBs were the only constituent group not detected in any of the subsurface soil samples. Only one target analyte metal, iron, was detected in groundwater at a concentration above base background and the North Carolina 2L (NC 2L) groundwater quality standard (NCGWQS). SVOCs, pesticides, herbicides, and PCBs were not detected in any groundwater samples. One VOC (p-isopropyltoluene) was detected at a concentration of 5.2 micrograms per liter (µg/L); however, no screening criteria are currently available.

An HHRS and an ERS were conducted using data from the IR Site 37 CSA. The ERS identified 4,4'-DDT, dieldrin, and MCPP as contaminants of potential concern (COPCs) in subsurface soil. No COPCs were identified for groundwater. The HHRS concluded that there were no potentially unacceptable human health risks from exposure to subsurface soil or groundwater.

The CSA investigation report recommended that IR Site 37 remain closed and that ecological risks be further evaluated concurrently with the investigation of Site UXO-24, including assessment of pesticides and herbicides in surface and subsurface soils.

Initial EOD Site Investigation at Site UXO-24

On March 19, 2010, two ammunition cans containing unexpended small arms ammunition were discovered on the ground surface adjacent to a small hand-dug excavation located east of Building TC-611 (**Figure 10-1**). Following the discovery of the excavation and ammunition, the base EOD unit conducted a surface sweep of the area and found several small hand-dug excavations containing munitions, including the following:

- Grenade, hand: smoke, M18, expended
- Signal, illumination, ground: cluster, Red Star, M158, unexpended
- Cartridge, 40-millimeter (mm), practice, M781, unexpended

A subsequent search of the remaining wooded area located the following items:

- (2,207) 5.56 mm blank rounds
- (33) 9 mm AA12 rounds
- (5) 9 mm AA21 rounds
- (22) 5.56 mm tracer rounds
- (79) 5.56 mm ball rounds
- (3) 7.62 mm ball rounds
- (16) 7.62 mm blank rounds
- 25 mm casing
- AK74 blank rounds (quantity unspecified)

Based on the discovery of DMM and MPPEH at the site, the site was identified by the base for investigation under the MMRP (Commanding Officer, 2010).

Digital Geophysical Mapping

DGM was conducted from April 30 to May 3, 2012, over 100 percent of accessible portions of a 2.5-acre area of Site UXO-24 **(Figure 10-4)**. The DGM survey area was chosen based on reported munitions disposal activities. The objective of the DGM was to identify subsurface anomalies potentially indicative of MEC within the survey boundary. Prior to the DGM survey, vegetation was cleared, and a North Carolina-licensed professional land surveyor delineated the DGM survey boundary area. Wooden stakes were used to mark 50- by 50-meter grids over the survey area.

SAP Worksheet #10—Problem Definition (continued)

Results of the survey indicate that a total of 1,512 anomalies and 11 saturated response areas (areas with higher concentration of anomalies from potential underground utilities or higher concentration of metal debris/materials) are present in the subsurface (CH2M HILL, 2012a). Anomalies are distributed throughout the area of investigation with no discernible pattern that would bias the investigation to specific areas.

Conceptual Site Model

A conceptual site model (CSM) is critical to the development of an investigation strategy. The following sections describe the site features, potential source areas and release mechanisms, and their relationship with surrounding environmental media and receptors. **Figure 10-5** is a graphical representation of the CSM for Site UXO-24.

Physical Characteristics

The surface topography within the area of investigation consists of relatively level terrain. Vegetative cover consists of coniferous and deciduous woodland separated by a gas and power line easement, which extends northwest to southeast. A small creek, which appears to be a tributary to a wetland south of the site, is present in the southern portion of the site and flows north to south. Stormwater runoff from Site UXO-24 is expected to flow in a south or southeasterly direction toward the wetland south of the site (**Figure 10-2**).

Shallow sediments underlying the site to a depth of 10 feet below ground surface (bgs) consist of fine silty sands and clays. Dark grey to dark brown silty sand and clay, with traces of organic matter and shell hash were encountered from 10 to 20 feet bgs. The depth to groundwater ranged from roughly 4 to 18 feet bgs. The direction of shallow groundwater flow is northeast toward Brinson Creek (Osage, 2010).

Potential Sources

Potential sources of contamination include munitions discarded within shallow hand-dug burial pits that could potentially leach MC into underlying soils and groundwater. Since the site is not a former range, the types of munitions that may still be present are unknown; therefore, it is not known which specific MC are likely to be COPCs. The sources of pesticides and herbicides are unknown and could potentially be associated with past disposal practices.

Fate and Transport

The degradation of the discarded munitions within the boundary of UXO-24 could lead to the release of MC consisting of metals, explosives residues, and perchlorate within subsurface soils. These MC could become dissolved by rain water and subsequently leach through the vadose zone, reaching the water table. Thereafter, the dissolved MC could be transported through the aquifer by groundwater flux. The rate and direction of migration would be dependent on the aquifer properties and chemical-specific characteristics.

In addition, the MC could be transported by erosional forces (surface water runoff and wind) to drainage features (e.g., wetlands) and deposited with sediments.

Pesticides and herbicides were detected in subsurface soil during the CSA investigation and could potentially be present in the surface soil. Pesticides present within soil could potentially become dissolved by precipitation and subsequently leach through the vadose zone, reaching the water table. Thereafter, the pesticides could be transported through the aquifer by groundwater flux. Pesticides may be taken up from soil into plant roots and translocated into leaves. Because of the slow degradation and persistence of pesticides, in the environment, pesticides could potentially cause unacceptable risk to onsite receptors into the future even though the release of pesticide likely occurred many decades prior to detection (Crosby, 1998).

SAP Worksheet #10—Problem Definition (continued)

Potential Receptors

The potential receptors and exposure pathways at Site UXO-24 are as follows:

- MCIEAST-MCBCAMLEJ personnel and future construction workers who may be exposed to contaminated soils, surface water, and groundwater, and MEC during potential future building activities, including excavations. The potential exposure pathways include adsorption through dermal contact, accidental ingestion, and inhalation.
- Site visitors and trespassers who may be exposed to MEC, or contaminated surface or subsurface soils through dermal contact, accidental ingestion, or inhalation.
- Ecological receptors such as plants through root uptake from soils, groundwater, and surface water runoff.

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

Problem Definition

An Archival Records Search was conducted as part of this UFP-SAP. No information was found during the records search indicating that historical range activities had been conducted at the site, or that pesticides or herbicides were used or disposed of at the site. However, surface inspections conducted by the base EOD in 2010 found that MPPEH and unexpended small arms rounds are present at the site. Results from a separate CSA investigation also indicate the presence of pesticide and herbicide constituents in subsurface soil. If one or more releases of MC have occurred, it is unknown whether they pose a potentially unacceptable risk to human health and/or ecological receptors; therefore, further assessment is warranted.

What is the question that is being answered?

1. **What are the sources of the anomalies identified during May 2012 DGM survey activities?**

   An intrusive investigation will be performed on up to 1,000 of the geophysical anomalies identified as potential MEC/MPPEH, located on the western edge of the site. The intrusive investigation will be limited to a maximum depth of 2 feet bgs, based on limits of hand excavation activities. Unidentified anomalies found at greater depths during the investigation will be identified for future potential investigation activities. The preliminary assessment will be limited to the investigation of up to 1,000 anomalies. Additional intrusive activities may be proposed in the future based on results from the investigation. Excavation of overburden covering individual anomaly sources will be performed using hand-excavation tools, such as shovels, spades, trowels, and pry bars, or earth-moving equipment. Confirmed MEC/MPPEH will be disposed of by controlled detonation using blow-in-place (BIP) methods or relocated for controlled detonation and/or consolidated shots if the item is safe to move, according to the approved Explosives Safety Submission (ESS). Following demolition or removal of the MEC/MPPEH item, the area will be rechecked with an appropriate geophysical instrument to ensure that another item was not hidden beneath the removed item. The excavation team will then record the results of the excavation, record the geophysical instrument response during checking of the hole post-investigation, and backfill the hole.

2. **Have there been releases of MC, pesticides, or herbicides to soil?**

   This question will be addressed by collecting up to 10 composite subsurface soil samples from within the base of intrusive investigation excavation locations where evidence of leaking MEC/MPPEH filler is observed to assess potential impacts from MC to subsurface soil. Subsurface soil samples will be collected from above the water table at a depth not to exceed 2 feet bgs (maximum depth of excavations) using the incremental sampling method (TR-02-1 method) and analyzed for explosives residues, including pentaerythritol tetranitrate (PETN), nitroglycerin, and 3,5-dinitroaniline (DNA), perchlorate; cyanide; and TAL metals (including hexavalent chromium), which together constitute the full suite of potential MC. Because of the unknown nature of historical MPPEH disposal at UXO-24, analysis of the full suite of potential MC will be conducted to ensure accurate and complete identification of human health and ecological COPCs. If leaking MEC/MPPEH filler is not observed in intrusive investigation excavation locations, then the subsurface samples will not be collected.

   Additional surface soil samples will be collected immediately adjacent to previous CSA subsurface soil locations that had detections of pesticides or herbicides exceeding screening criteria (**Figure 10-6**). Up to 4 grab surface soil samples will be collected and will be analyzed for pesticides and herbicides. Surface soil samples from these locations will be used for human health and ecological screening purposes.

   In addition, subsurface soil samples will be collected from areas adjacent to previous CSA subsurface soil locations that had detections of pesticides or herbicides that exceeded screening criteria. Up to 6 grab samples will be collected above the water table at depths not exceeding 5 feet bgs from areas around former sample locations IR37-SB04 and IR37-SB06 (**Figure 10-6**). Sample collection depths above 5 feet are required for ecological risk screening purposes. These samples will be analyzed for pesticides and herbicides.

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

3. **Did BIP or controlled detonation of MEC/MPPEH encountered during the intrusive investigation result in impact to surface soil?** If BIP occurs during the intrusive investigation, then soil from the crater of the BIP event and soil from outside of the crater will be collected and analyzed for the presence of munitions-related contaminants. If controlled detonation occurs during the intrusive investigation, then a composite sample will be collected of the surface soil in the controlled detonation area and will be analyzed for the presence of munitions-related contaminants. Soil samples will be collected using the TR-02-1 method.

4. **Have there been releases of MC to groundwater?** This question will be addressed by collecting and analyzing groundwater samples from up to three new monitoring wells screened within the surficial aquifer. The monitoring wells will be constructed in areas hydraulically downgradient from intrusive investigation locations where evidence of leaking MEC/MPPEH filler is observed. If leaking MEC/MPPEH filler is not observed, monitoring wells will not be installed. The actual monitoring well locations may be adjusted slightly to accommodate site conditions (e.g., to avoid potential MEC/MPPEH items and utilities). The groundwater samples will be analyzed for explosives residues, including PETN, nitroglycerin, and 3,5-DNA; perchlorate; cyanide; and dissolved and total TAL metals, including hexavalent chromium.

5. **Have there been releases of MC, pesticides, and herbicides to surface water and sediment?** To address this question, one co-located sediment and surface water sample will be collected from the creek in the southern portion of the site. The sample will be collected from a likely depositional area that contains standing water within the creek. The exact location will be determined in the field, but an approximate location is shown in **Figure 10-7**. The surface water and sediment sample will be analyzed for explosives residues including PETN, nitroglycerin, and 3,5-DNA; perchlorate; cyanide; TAL dissolved metals (surface water only) and total metals; pesticides and herbicides; and hardness (surface water only).

6. **If releases are identified through environmental sampling and analysis, what is the appropriate next step?**

   This determination will be made based on an evaluation of the analytical data in accordance with the decision analysis flow chart shown in **Worksheet #11.**

   This section presents the project quality objectives (PQOs) for the PA/SI.

What are the project action levels (PALs)?

The PALs were developed by the project team and are based on established criteria, as summarized as follows:

Groundwater

1. Groundwater analytical results will be compared to NCGWQS (NCDENR, 2012). If a standard for a substance is less than the laboratory practical quantitation limit (PQL), the laboratory PQL will substitute for the standard and the detection of that substance at or above the PQL would be considered above the NCGWQS.

2. Groundwater analytical results also will be compared to the USEPA RSLs for tap water (USEPA, 2012) and drinking water maximum contaminant levels (MCLs). The RSLs based on noncarcinogenic effects will be adjusted by dividing by 10 to account for exposure to multiple constituents; the RSLs based on carcinogenic effects will be used as presented in the USEPA RSL table.

3. Groundwater analytical results will also be compared to the MCIEAST-MCBCAMLEJ background groundwater data from the *Final Expanded Groundwater Background Study Report* (CH2M HILL, 2012b*)*, as agreed by the Partnering Team. In order to be considered an exceedance of the PALs, the sample concentration must be greater than the regulatory standard and the background.

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

Soil

1. Surface and subsurface soil analytical results also will be compared to the USEPA RSLs for industrial and residential soil (USEPA, 2012), adjusted as defined above.
2. Surface and subsurface soil analytical results also will be compared to the NCDENR SSLs (NCDENR, 2012).
3. The soil analytical data will also be compared to the MCIEAST-MCBCAMLEJ background soil data from the *Final Expanded Soil Background Study Report* (CH2M HILL, 2011b), as agreed by the Partnering Team.

Surface Water

1. Surface water analytical results will be compared to the NCAC 2B Surface Water and Wetlands Standards (NCSWS) surface water quality standards for human health and water supply, if available.
2. Concentrations of surface water constituents also will be compared to the National Recommended Water Quality Criteria (NRWQC) for human health (USEPA, 2006b), if available. Results from dissolved metals analysis will be used for ERS purposes and compared to freshwater ecological screening values.
3. If no NCSWS or NRWQC is available for a detected constituent, the USEPA tap water RSL (adjusted as defined above) will be used for comparison, as agreed by the Partnering Team.

Sediment

Concentrations of analytes detected in sediment samples will be compared to the USEPA RSLs for residential soil. The adjusted USEPA soil RSLs are the established screening criteria for sediment at MCIEAST-MCBCAMLEJ.

The environmental data will be used to evaluate the following:

- Human health and ecological risk, the nature of any contamination, the significance of its release, and (if a release had occurred) whether further assessment or interim action would be warranted.

What types of data are needed?

- MEC intrusive investigation activities will be conducted at up to 1,000 anomaly locations within the DGM survey area to determine if MEC and/or MPPEH is present. Results from intrusive investigation activities will aid in determining locations for soil and groundwater samples.
- Project information (such as personnel, teams, instrument serial numbers, grid identification numbers, and locations)
- FTL notes (such as safety meetings, log books, and field requests to management)
- Demolition tracking
- QC records (such as QC on notes, processing, data, and comparison of DGM results to intrusive results and field activities)
- **Worksheet #10** defines the sample media and target analytes to be used during this investigation. Since the purpose of this PA/SI is to identify the potential presence of MC, the target analytes will include constituents potentially released from MEC items. The target analytes are consistent with PA/SIs conducted across the base under the MMRP. The purpose of this PA/SI also is to confirm whether a pesticide/herbicide release occurred.
- Water quality parameters (WQPs), including field testing for pH, conductivity, oxidation-reduction potential [ORP], dissolved oxygen (DO), temperature, and turbidity, will be measured during the purging of the monitoring wells at Site UXO-24 to verify that monitoring wells have been sufficiently purged for sampling.
- Lithologic logging of soil cuttings will be conducted during drilling operations. The logging activities will facilitate selection of well screen intervals and will supplement the CSM.

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

- Surface and subsurface soil sample locations will be recorded by hand-held global positioning system (GPS) devices during environmental sampling activities (both drilling and intrusive investigations). Following sample collection, the monitoring well locations and elevations will be surveyed by a North Carolina-licensed surveyor. Field activities will be recorded in a field note book to document adherence to the approved work plan. The CH2M HILL Preparing Field Log Books Standard Operating Procedure (SOP) located in **Attachment 1** describes the documentation required for log book completion.

Are there any special data quality needs to support environmental decisions?

The primary objective of the intrusive investigation is to identify the source of up to 1,000 geophysical anomalies located in the western portion of the site in order to determine the presence of MEC/MPPEH within the top 2 feet of soil.

The specific QC audit procedures for the definable features of work to be employed at Site UXO-24, including the phase during which it is performed, the frequency of performance, the pass/fail criteria, and actions to take if failure occurs, are presented in **Worksheet #12-2**.

Laboratory analytical data will be distributed to a third-party validator for data quality evaluation. Data validation procedure requirements are detailed in **Worksheet #34-36**. The data need to be of sufficient quality for determining the concentration of constituents in media samples collected at Site UXO-24 such that the project objectives can be achieved.

Visual observations (e.g., soil saturation, staining) will be used at Site UXO-24 to help select subsurface soil sampling intervals and determine appropriate well screen placement for groundwater sampling. Subsurface soil grab samples will be collected from above the water table at depths not to exceed 5 feet. Soil samples collected from intrusive anomaly excavations will be collected from within each excavation using the TR-02-1 method in areas where leaking MEC/MPPEH filler is observed.

The groundwater sampling activities must result in the collection of samples that are representative of the water-bearing formation. This will be ensured, in part, by installing and developing the groundwater monitoring wells in accordance with the CH2M HILL Installation of Shallow Monitoring Wells SOP (**Attachment 1**).

In addition to correct installation procedures, monitoring wells must be purged to allow for a representative sample to be collected. Purging will be considered complete when the WQPs (temperature, pH, specific conductance, DO, turbidity, and ORP) have stabilized for three consecutive readings (every 3 to 5 minutes), and at least one well volume has been purged with minimal drawdown. Stabilization is achieved when the WQPs meet the following criteria:

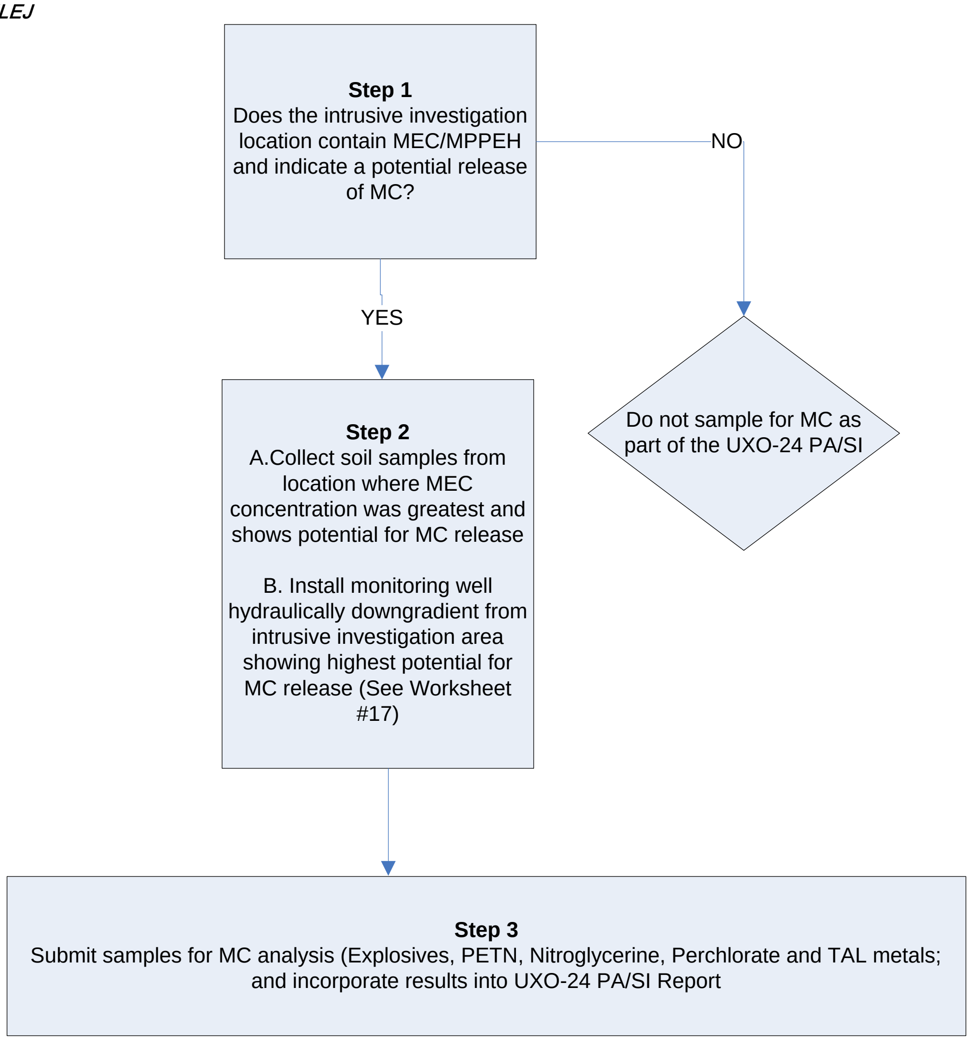
- Temperature: within 1 degree Celsius (°C)
- pH: within 0.1 pH unit
- Specific conductance: within 3 percent
- DO: within 10 percent
- Turbidity: within 10 percent or as low as practicable given sampling conditions
- ORP: within 15 millivolts (mV)

Groundwater sampling procedures are detailed in **Worksheet #14**.

During the PA/SI, QA/QC samples will be collected along with the various media samples as a check on sampling and analytical protocol. **Worksheet #20** describes the QA/QC quantities and analyses for this UFP-SAP.

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

FIGURE 11-1
Environmental MC Sample Strategy Decision Flow Chart: CTO 0014 Site UXO-24
MCIEAST-MCBCAMLEJ



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

- The MC environmental samples will be collected within the boundary of the DGM survey area based on observed evidence of leaking MEC/MPPEH filler. The DGM investigation area is shown on **Figure 10-4.**

  The pesticide/herbicide subsurface soil samples will be collected at locations shown on **Figure 10-6.** The soil borings will be located within 40 feet of and surrounding the former soil boring locations where pesticides and herbicides were previously detected above screening levels. The surface soil pesticide/herbicide samples will be collected at the former soil boring locations where pesticides and herbicides were previously detected above screening levels.

- The proposed investigation will be conducted in the spring of 2013.

- The environmental samples will be collected in accordance with the SOPs presented in **Worksheet #21**.

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

Intrusive anomaly investigations will be conducted by UXO Technicians and supervised by a Senior UXO Supervisor (SUXOS). All work that involves intentional contact with MEC or MPPEH, or handling of explosives, will be conducted under an approved ESS.

- CH2M HILL staff will collect all environmental samples as outlined in **Worksheets #10 and #18**.
- Borehole drilling, monitoring well installation, and well development will be performed by a North Carolina-licensed well drilling subcontractor with oversight provided by CH2M HILL staff and MEC avoidance performed by a UXO Technician.
- Laboratory analytical services for Site UXO-24 will be provided by a qualified analytical laboratory under subcontract to CH2M HILL.
- Once generated, analytical data will be submitted to a qualified data validation company for validation against analytical methodology requirements and measurement performance criteria (MPC) presented in this UFP-SAP.
- CH2M HILL will receive validated data and upload the data into a centralized electronic database used for Navy projects by the project team.
- Data will be reported in the PA/SI report, which will be submitted to the Navy as a draft for review prior to distribution to the NCDENR and USEPA for review and approval.

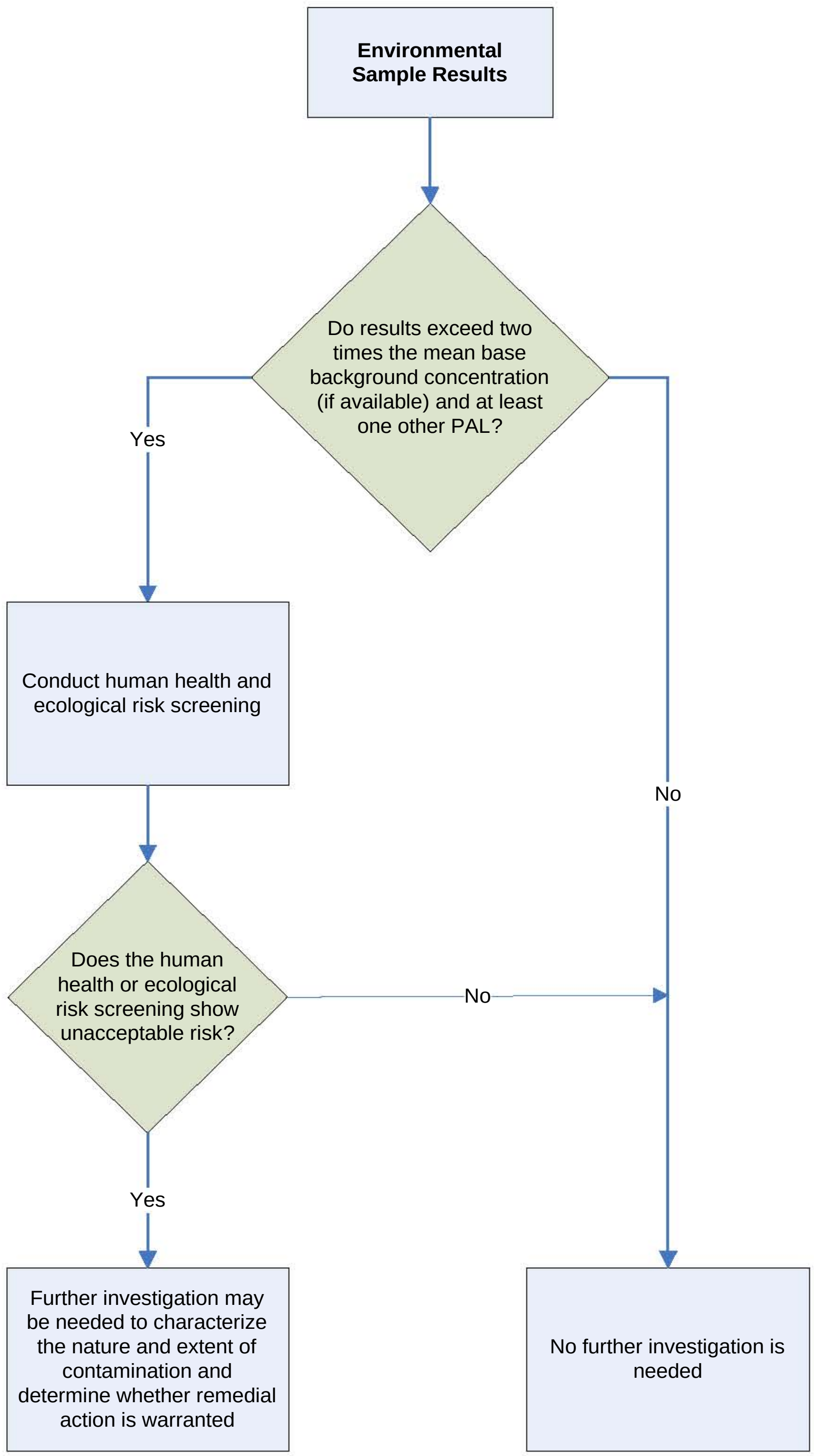
PQOs listed in the form of if/then qualitative and quantitative statements.

The decision analysis process depicted on **Figure 11-2** represents the PQOs for the environmental media sample data collected at the site. The general objective of the decision analysis process is to evaluate whether a CERCLA-related release occurred and, if so, whether the release warrants further investigation or action.

Additional PQOs related to the analysis of existing DGM data are presented on **Figure 11-3**. Existing DGM data will be used to select identified anomalies representing potential subsurface MEC as targets for the intrusive investigation. Anomalies with responses above 2.5 mV will be identified as targets for potential intrusive investigation activities. This threshold was chosen because it is the lowest amplitude at which a metallic item can be positively distinguished from signal noise using the EM-61 instrumentation.

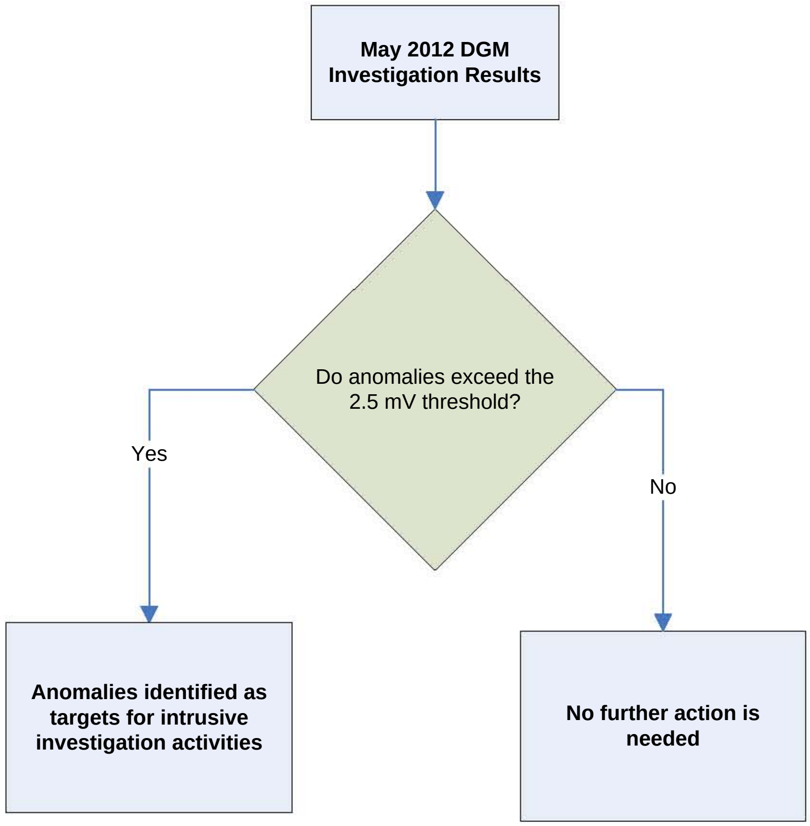
SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements (continued)

FIGURE 11-2
PQOs Decision Flow Chart: CTO 0014 Site UXO-24
MCIEAST-MCBCAMLEJ



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

FIGURE 11-3
DGM PQOs Decision Flow Chart: CTO 0014 Site UXO-24
MCIEAST-MCBCAMLEJ



SAP Worksheet #12-1—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

The analytical methods selected in this UFP-SAP and their respective MPC are acceptable for this investigation.

Matrix: Surface Soil, Subsurface Soil, Sediment, Intrusive Investigation Soil Samples
Analytical Group: Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN
Concentration Level: Low

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S + A)
Equipment Rinseate Blank	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	One per day of sampling	Bias/Contamination	No analyte detected > 1/2 limit of quantitation (LOQ)	S + A
Ambient Field Blank		One per week of sampling	Bias/Contamination		S + A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy/Representativeness	0-6°C	S
Field Duplicate		One per 10 samples per matrix	Precision	Relative percent difference (RPD) < 30%	S + A

SAP Worksheet #12-2—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Sediment, Intrusive Investigation Soil Samples
Analytical Group: Perchlorate
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S + A)
Equipment Rinseate Blank	Perchlorate	One per day of sampling	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Ambient Field Blank		One per week of sampling	Bias/Contamination		S + A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy/Representativeness	0-6°C	S
Field Duplicate		One per 10 samples per matrix	Precision	RPD < 15%	S + A

SAP Worksheet #12-3—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Sediment, Intrusive Investigation Soil Samples
Analytical Group: Pesticides
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Equipment Rinseate Blank	Pesticides	One per day	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Blank		One per week	Bias/Contamination		S + A
Temperature Blank		One per cooler	Accuracy/Representativeness	0-6°C	S
Field Duplicate		One per 10 field samples	Precision	%RPD ≤ 30%	S + A

SAP Worksheet #12-4—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Sediment, Soil Samples
Analytical Group: Herbicides
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Equipment Rinseate Blank	Herbicides	One per day	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Blank		One per week	Bias/Contamination		S + A
Temperature Blank		One per cooler	Accuracy/Representativeness	0-6°C	S
Field Duplicate		One per 10 field samples	Precision	%RPD ≤ 30%	S + A

SAP Worksheet #12-5—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Sediment, Intrusive Investigation Soil Samples
Analytical Group: TAL Metals and Cyanide
Concentration Level: Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S + A)
Equipment Rinseate Blank	TAL Metals and Cyanide	One per day of sampling	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Ambient Field Blank		One per week of sampling	Bias/Contamination		S + A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy/Representativeness	0-6°C	S
Field Duplicate		One per 10 samples per matrix	Precision	RPD < 20%	S + A

SAP Worksheet #12-6—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Explosive Residues including 3,5-DNA, Nitroglycerin, and PETN
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	One per cooler	Accuracy/Representativeness	0-6°C	S
Equipment Rinseate Blank, Field Blank		One each per day for disposable equipment	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Duplicate		One per 10 field samples	Precision	RPD ≤ 30%	S + A

SAP Worksheet #12-7—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Perchlorate
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Perchlorate	One per cooler	Accuracy/Representativeness	0-6°C	S
Equipment Rinseate Blank, Field Blank		One each per week for disposable equipment	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Duplicate		One per 10 field samples	Precision	RPD ≤ 15%	S + A

SAP Worksheet #12-8—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Pesticides
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Pesticides	One per cooler	Accuracy/Representativeness	0-6°C	S
Equipment Rinseate Blank, Field Blank		One each per week for disposable equipment	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Duplicate		One per 10 field samples	Precision	RPD ≤ 30%	S + A

SAP Worksheet #12-9—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Herbicides
Concentration Level: Low

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	Herbicides	One per cooler	Accuracy/Representativeness	0-6 C	S
Equipment Rinseate Blank, Field Blank		One each per week for disposable equipment	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Duplicate		One per 10 field samples	Precision	RPD ≤ 30%	S + A

SAP Worksheet #12-10—Measurement Performance Criteria Table – Field QC Samples – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: TAL Metals and Cyanide
Concentration Level: Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC	QC Sample Assesses Error for Sampling (S), Analytical (A), or both (S&A)
Cooler Temperature Blank	TAL Metals and Cyanide	One per cooler	Accuracy/Representativeness	0-6°C	S
Equipment Rinseate Blank, Field Blank		One each per week for disposable equipment	Bias/Contamination	No analyte detected > 1/2 LOQ	S + A
Field Duplicate		One per 10 field samples	Precision	RPD ≤ 30%	S + A

QAPP Worksheet #12-11—Measurement Performance Criteria Table (MR)

Definable Feature of Work Data Type	Geophysical Anomaly Measurement DQI	QC Sample and/or Activity to Assess Measurement Performance	MPC	Frequency
QC Seed Recovery	Accuracy	Recover 100% of QC seed items.	100% of QC seed items recovered.	During the intrusive investigation.

QAPP Worksheet #12-12—Definable Features of Work Auditing Procedure

Definable Feature of Work	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Pre-mobilization Activities	Geographic Information System (GIS) Setup	Verify GIS system is functional and ready for site data.	Preparatory Phase (PP)	Once	GIS system has been set up and is ready for site data.	Do not proceed with field activities until criterion is passed.
	Document Management and Control	Verify appropriate measures are in place to manage and control project documents.	PP	Once	Appropriate measures are in place to manage and control project documents.	Do not proceed with field activities until criterion is passed.
	Data Management	Verify appropriate measures are in place to manage and control project data.	PP	Once	Appropriate measures are in place to manage and control project data.	Do not proceed with field activities until criterion is passed
	Subcontractor Procurement	Ensure procurement of subcontractors and verify qualifications, training, and licenses.	PP/Initial Phase (IP)	Once	Subcontractors' qualifications, training, and licenses are up to date and acceptable.	Ensure subcontractor provides qualifications, training, and licenses or change subcontractor.
	ESS	Verify the ESS has been developed and approved.	PP/IP	Once	ESS has been approved.	Do not proceed with field activities until criterion is passed.
	Work Plan	Verify the Project Work Plan has been developed and approved.	PP/IP	Once	Work Plan has been prepared and approved; all parties agree to the technical and operational approach.	Do not proceed with field activities until criterion is passed.

QAPP Worksheet #12-12—Definable Features of Work Auditing Procedure (continued)

Definable Feature of Work	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Mobilization/ Site Preparation	Onsite Document Review	Verify Project Plans are approved, reviewed with project team, and have acquired appropriate signatures.	PP/IP	Once	Document is approved and has been reviewed and acknowledged by appropriate project team members.	Personnel who are not familiar with the Project Plans may not proceed with field activities until criteria are passed.
	Establish Communication and Logistics	Verify coordination and functionality of communications equipment and logistical support.	PP/IP	Once per site	Communications and other logistical support are coordinated.	Do not proceed with field activities until criteria are passed.
	Local Agencies and Emergency Services Notification	Verify local agencies and emergency services have been notified of site activities.	PP/IP	Once per site	Emergency services and local agencies are aware of site activities.	Do not proceed with field activities until criteria are passed.
	Verify Site-specific Training	Verify all site-specific training has been performed and acknowledged.	PP/IP	Once for each team member	Site-specific training is performed and acknowledged.	Do not proceed with field activities until criteria are passed.
	Site Boundary and Grid Establishment	Verify area/boundary and grids.	PP/IP	Once per site	Area/boundary is correct and grids are appropriate.	Stop activities until area/boundary/grid approach is verified.

QAPP Worksheet #12-12—Definable Features of Work Auditing Procedure (continued)

Definable Feature of Work	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Intrusive Investigation	Equipment Testing	Verify equipment and personnel are operating in accordance with MEC SOPs.	IP/Follow-up Phase (FP)	Daily/Each Occurrence	Equipment passed functionality test as required by this QAPP.	Repair or replace instrument.
	Work Methods	Verify separation distance is as established.	IP/FP	Daily	Team separation distance if appropriate for work being performed.	Stop activities until the appropriate separation distance is achieved.
	Anomaly Recovery	Verify the item recovered is appropriate to amplitude of initial anomaly detected.	IP/FP	Daily	Recovered item is appropriate to the amplitude of the initial anomaly detected during DGM.	Return to item location to determine if additional anomalies are present. Perform root-cause analysis if the item recovered is inappropriate for the amplitude detected during DGM.
	QC Seed Recovery	Verify QC seeds are recovered.	IP/FP	Each Occurrence	All QC seed items in area of operation recovered.	A root-cause analysis must be performed and the project team must meet to discuss and determine appropriate action.
	QC Checks	Verify operations are conducted in accordance with QAPP, MEC Removal SOPs, and the HSP: -Surveys/sweeps -MEC/MPPEH surface sweeps -Analog detection and removal actions -DGM anomaly investigation -Ammunition and explosives transportation -Explosives storage and accountability -Disposal/demolition operations -Scrap inspection operations	IP/FP	Daily	Work performed in accordance with QAPP, referenced MEC SOPs, and the HSP.	Stop activity until full compliance can be ensured and any activities not performed within compliance are re-evaluated and re-performed if necessary.
	MPPEH/Munitions Debris (MD) Management	Verify inspection/certification/disposal is conducted per QAPP	IP/FP	Daily	Work performed in accordance with QAPP, SOPs, and the HSP.	Stop work until activities are corrected and in compliance with the QAPP and the SOPs.

QAPP Worksheet #12-12—Definable Features of Work Auditing Procedure (continued)

Definable Feature of Work	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Demobilization	Demobilize from the Site	Verify equipment and personnel have been demobilized from the site and the site is returned to pre-mobilization condition.	FP	Once	All personnel and equipment have been demobilized and the site is in pre-construction condition.	Restore site to preconstruction condition, package and ship all equipment offsite, and demobilize crew.

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SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How The Data Will Be Used	Limitations on Data Use
Letter from 1st Lt Brendan Neagle to the Commanding Officer, School of Infantry-East	United States Marine Corps, *Preliminary Inquiry into the Circumstances Surrounding the Two (2) Ammunition Cans of Loose 5.56 mm ball rounds and one (1) Unexpended Pop-up 40 mm trainer and one (1) Expended Smoke Grenade to Include Loose 5.56 Ball Rounds on the Ground Located in the Tree Line Ditch Behind the Headquarters and Support Battalion Ammunition Dunnage Warehouse, School of Infantry-East, Training Command, Camp Lejeune.* March 24 2011.	Base personnel statements from Marines involved in incident	Planning and sample location selection	Exact locations of discarded ammunition unknown.
2010 Confirmatory Sampling Work Plan, IR Site 37	Osage, *Confirmatory Sampling Work Plan, Sites IR-19, IR-37, IR-46, and IR-51*	Osage	Planning and sample location selection at Site UXO-24; historical information about IR Site 37	Data are limited to 4 acres of the 9-acre investigation area.
2010 Confirmatory Sampling Report, IR Site 37	Osage, *Confirmatory Sampling Report Sites 18, 37, 46, and 51*	Osage	Planning and sample location selection at Site UXO-24	Data are limited to 4 acres of the 9-acre investigation area.

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SAP Worksheet #14—Summary of Project Tasks

Pre-Field Tasks

- Procure subcontractors.
- Write project instructions.
- Schedule field and support staff.
- Procure or rent all equipment and bottleware.
- Conduct an Operational Readiness Review (ORR) to determine that all SOPs and the APP/HSP are in place for field tasks.

Field Tasks

The field investigation will accomplish the project objectives through the following activities, which will be conducted in accordance with CH2M HILL SOPs, the MMRP Master Project Plans (MPPs), the ESS, and the APP/HSP.

Mobilization

A mobilization period will include identifying, briefing, and mobilizing staff, as well as securing and deploying equipment.

General Activities

General Site Investigation Activities will include, but are not limited to, those activities outlined below.

- Identify/procure, package, ship, and inventory project equipment, including GPS equipment, hand tools, and supplies.
- Coordinate with local agencies, including the Marine Corps, Base staff, police, and fire department, as appropriate.
- Coordinate communications and other logistical support.
- Finalize operating schedules.
- Test and inspect equipment.
- Conduct site-specific training on the UFP-SAP, APP/HSP, and MEC avoidance procedures and hazards.
- Review subcontractor Activity Hazard Analysis (AHA) forms.
- Verify that all forms and other project documentation are in order and that project team members understand their responsibilities regarding project-reporting requirements.

Kickoff/Safety Meeting

During mobilization, a kickoff and site safety meeting will be conducted. This meeting will include a review of this UFP-SAP and review and acknowledgment of the APP/HSP by all site personnel. Additional meetings will occur as needed, as new personnel, visitors, and/or subcontractors arrive at the site.

Utility Clearance

Within 48 business hours prior to any intrusive investigation, NC One Call will be notified and all providers with utilities in the investigation area will have the opportunity to mark all utilities.

Prior to initiation of intrusive sampling activities, all buried utilities within 20 feet of each sampling location will be identified by a subcontracted utility locator.

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

Land Surveying

Land surveying services will be conducted in accordance with Section 7.4 of the MMRP MPPs. MEC anomaly avoidance will be practiced according to the project Accident Prevention Plan/Health and Safety Plan (APP/HSP). The surveying at Site UXO-24 will consist of a site perimeter survey and a survey of coordinates of monitoring wells (including elevations).

Vegetation Clearance

Vegetation clearance will be conducted over approximately 2.5-acres of the site to provide access for intrusive investigation and sampling activities. Vegetation less than 6 inches in diameter will be removed to within 6 inches of the ground surface. Vegetation clearing will be accomplished using mechanical methods and hand tools where necessary.

UXO technicians will conduct MEC avoidance activities in the vegetation removal areas according to the MEC avoidance procedures included in the APP/HSP. The brush and trees will be mulched and left in place. Trees greater than 6 inches in diameter will not be removed.

Vegetation clearance will be conducted in accordance with the Environmental Protection Plan (**Attachment 4**).

Geospatial Information and Electronic Submittals

Methods, equipment, accuracy, and submittal requirements for survey locations and mapping are described in Section 7.4 of the MMRP MPPs.

MEC Removal Operations

One thousand anomalies identified during the 2012 DGM investigation as representing potential subsurface MEC will be reacquired to an exact location using real-time kinetic GPS and a handheld magnetometer. After locating the approximate anomaly position with the GPS, the magnetometer will be used to confirm the exact position of the anomaly. If the anomaly is not immediately intrusively investigated, the location will be flagged using a polyvinyl chloride (PVC) flag with the unique identifier number recorded in indelible ink. The location will be flagged 1 foot north of the actual field location of each reacquired anomaly shown on the tracking sheet. MEC removal operations will be conducted in accordance with the approved ESS.

Excavation of individual geophysical anomalies will be performed by UXO technicians. The UXO teams performing this work will be composed of UXO technicians supervised by a UXO Technician III.

Hand tools will be used for excavation of all anomalies, which generally are expected to be found near the surface. The following basic technique will be used for anomaly excavation:

- The UXO technician will investigate within a 1-meter radius of the flagged anomaly with an appropriate geophysical instrument.
- Until identified otherwise, the anomaly is assumed to be MEC. Excavation will be initiated adjacent to the subsurface anomaly. The excavation will continue until the excavated area has reached a depth below the top of the anomaly as determined by frequent inspection with an appropriate geophysical instrument.
- Using progressively smaller and more delicate tools to remove the soil carefully, the excavation team will expand the sidewall to expose the metallic item for inspection and identification without moving or disturbing the item.
- If the item is MEC, a positive identification will be documented and confirmed by another UXO Technician. If confirmed, the MEC item will be disposed of by BIP methods, or, if the item is safe to move (as confirmed by the SUXOS), the item may be moved for controlled detonation and/or consolidation.
- Excavation will be conducted to a maximum depth of 2 feet.

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

- Following anomaly source removal or BIP MEC demolition, the area will be rechecked with the EM61-MK2 to ensure that another item was not hidden beneath the removed item or that other metal is not within the 2 foot excavation depth. The excavation team will then annotate the results of the excavation on the dig sheet and move on to the next marked geophysical anomaly.

Removal Verification

The following is the procedure to be followed during QC inspections of the MEC intrusive investigation:

- After the dig team intrusively investigates an anomaly location, the hole is to be left open to the depth investigated and the PVC flag placed in the hole or bent after the investigation is completed.
- The UXO QC Specialist (UXOQCS) will inspect the intrusively investigated anomaly locations using an appropriate geophysical instrument to determine whether all detectable metallic items within a 1-meter radius of the hole to a depth of 2 feet bgs have been removed. The locations checked will be distributed in a spatially representative sample across each transect.
- All holes related to intrusive investigations will be filled back to original grade or covered before departing the project site each day.
- Anomaly locations inspected, along with results of the inspection and CAs planned in the event that the UXOQCS determines that inspection results require a change in intrusive team procedures or a re-performance of any work, will be documented by the subcontractor and provided to the CH2M HILL Geophysicist.
- Additional QC analysis of intrusive results vs. original amplitude of geophysical anomalies will be performed by the CH2M HILL Geophysicist. Anomaly locations that are determined to need re-investigation through this process will be re-inspected.

Procedures for Reporting and Disposition of MEC and MPPEH Items

This section discusses the procedures for reporting and disposing of MEC/MPPEH items encountered during the project, including the responsibilities of personnel, overall safety precautions, data reporting, transportation, safe holding areas, operations in populated/sensitive areas, demolition operations, and required engineering controls and exclusion zones (EZs) for intrusive operations and intentional detonations.

Overall Safety Precautions

General work practices outlined in *United States Army Corps of Engineers (USACE) Engineering Manual (EM) 385-1-97, Explosives Safety and Health Requirements Manual* (USACE, 2008) will be followed. Other basic precautions are as follows:

- The work periods for UXO technicians are limited to maximums of 10 hours per day and 40 hours per week.
- The field team will consist of a UXO Technician III and six or fewer team members.
- The SUXOS will oversee no more than 10 UXO Technician IIIs.

  Qualified UXO personnel will dispose of all MEC/MPPEH items using demolition procedures provided in this QAPP. During detonation, unnecessary personnel will be restricted from the area to limit unnecessary exposure. At all times the UXO Safety Officer (UXOSO) will be present to confirm that all demolition materials are handled and prepared correctly and that Work Plan procedures are followed. Each demolition team member has the authority to stop operations if he/she observes an unsafe condition. Demolition operations will not commence until the unsafe condition has been made safe to the satisfaction of the SUXOS, UXOSO, and the demolition team members performing the operation. Prior to demolition operations, the SUXOS will notify and coordinate with local emergency services to reduce public exposure, maintain safety, and keep the public informed.

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

Data Reporting

Data reporting will be conducted as described in **Worksheet # 11.**

Exclusion Zones and Separation Distances

Based on the history of the site, there should be no fragmenting MEC items. Therefore, there would be no primary munition with the greatest fragmentation distance (MGFD), although a contingency MGFD has been calculated. The contingency MGFD is the 25-mm M792 projectile (NEW-0.06614 lb HMX). In order to calculate the explosives safety-quantity distance (ESQD) arcs, the maximum credible event (MCE) will be used instead of the MGFD, and the MCE will be based on the largest net explosive weight (NEW) or pyrotechnic filler weight. The primary MCE is the M18 Smoke Grenade.

EZs for the MPPEH Collection Point are based on a NEW of 0.5 pound (lb) of class/division (C/D) 1.1 explosives. Therefore, the EZ associated with the MPPEH Collection Point is 236 feet (Table 7-9, OP-5, Volume 1, 7th Revision [NAVSEA, 2010]).

If, during the course of this project, a MEC/MPPEH item with a fragmentation distance greater than that of the contingency MGFD is encountered, then work will stop and an ESS amendment will be submitted.

A detailed discussion of Exclusion Zones (EZs) and Separation Distances, including the team separation distance (TSD), the minimum separation distance (MSD), the public traffic route (PTR) distance, and the inhabited building distance (IBD) distance for bare explosives and MPPEH under specified scenarios, is provided in the ESS (CH2M HILL, 2012c).

MEC and MPPEH Hazards Classification, Storage, and Transportation

Hazards Classification

All MEC/MPPEH will be classified as C/D 1.1. A systematic approach will be used for collecting, inspecting, and segregating site debris. The approach is designed so that materials undergo a continual evaluation/inspection process from the time they are acquired until the time they are removed from the site. Segregation procedures begin at the time the item is discovered by the UXO Technician. At this point, the UXO Technician makes a preliminary determination as to the classification of the item into one of three categories and the UXO Technician III confirms the item to be MEC, MPPEH, or other debris.

Storage

MEC will not be stored onsite. MEC demolition will be accomplished by controlled detonation using BIP or consolidation (if safe to move) methods.

MPPEH will be stored in a locked and secured container at the MPPEH Collection Point. This container will be labeled "MPPEH."

EZs for the MPPEH Collection Point are based on a NEW of 0.5 lb of C/D 1.1 explosives. Therefore, the EZ associated with the MPPEH Collection Point is 236 feet (Table 7-9, OP-5, Volume 1, 7th Revision [NAVSEA, 2010]).

A separate locked and secured container will be used for storage of material documented as safe (MDAS). This container will be labeled "MDAS" and will be separated from the MPPEH Collection Point container by a minimum of 50 feet. Items in the MDAS container will only contain items that have undergone two 100 percent visual inspections by qualified personnel and have been documented as not presenting an explosive hazard. The authorization letter to inspect and certify MPPEH will be maintained onsite. Chain-of-custody will be maintained on the MDAS container until it is transported off-base and through final disposal.

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

Transportation

MEC/MEPPH will not be transported outside of the munitions response site (MRS). MPPEH will be transported within the MRS to the MPPEH Collection Point. Safe-to-move MEC may be transported within the MRS for controlled detonation. The SUXOS and the UXOSO will determine whether MEC/MPPEH is safe to move. The decision about whether MEC/MPPEH is safe to move will be documented in writing prior to movement. Under no circumstances will any MEC be moved in an attempt to make a definitive identification.

MPPEH that is determined to be safe to move will be transported to the MPPEH Collection Point located within the site until it can be processed.

MEC Disposition

MEC will be disposed of by controlled detonation. If the item is not safe to move, it will be BIP. If the item is safe to move, it may be may be relocated for demolition and/or consolidated with other safe-to-move items within the MRS. If consolidated shots are utilized, for purposes of calculating the intentional detonation EZ, the maximum fragment distance (MFD) of the consolidated shot will be increased by 33 percent in accordance with Department of Defense (DoD) Explosives Safety Board (DDESB) Technical Paper (TP)-16 (2009) to account for interaction effects.

Prior to onsite movement, MEC/MPPEH must be evaluated and determined to be safe to move as follows:

- For MEC, including suspect munitions items, the SUXOS and UXOSO must determine that the risk associated with movement is acceptable and that the movement is necessary for the efficiency of the activities being conducted or the protection of people, property, or critical assets. In such cases, the responsible SUXOS and UXOSO must agree with the risk determination and document this decision in writing prior to movement of the MEC or munitions item.
- UXO-qualified personnel may determine that MPPEH is safe for onsite movement. Written documentation and concurrence of the UXOSO is not required.

Every effort will be made to complete explosive demolition operations by the end of the workday. If explosive demolition operations cannot be completed by the end of the workday, guards will be posted to secure the item, and the disposal will occur as soon as possible.

Demolition operations will be conducted in accordance with Explosive Ordnance Disposal Bulletin (EODB) 60A 1-1-31 and OP 5 Volume I (NAVSEA, 2010). If engineering controls are used, they will conform to DDESB TP-16 Revision 2 and the U.S. Army Engineering and Support Center, Huntsville Corps of Engineers, Huntsville Center (USAESCH), *Use of Sandbags for Mitigation of Fragment and Blast Effects Due to Intentional Detonation of Munitions, HNC-ED-CS-S-98-7,* dated August 1998 and approved by DDESB on February 23, 1999 (USAESCH, 1998).

Donor explosives will not be stored onsite. A local vendor will provide explosives on an on-call basis and will remove all unused explosives from the site following demolition activities. The explosives vendor will follow all applicable Department of Transportation regulations regarding the transportation of explosives, and the vendor's employees will have the proper training and certifications. The contractor (or the contractor's UXO subcontractor) will not transport explosives. The contractor will coordinate with the installation's Explosives Safety Officer to obtain proper approvals to bring civilian explosives onto the installation.

Prior to intentional detonation, the EZ will be evacuated. Appropriate personnel will be notified to block any roads that may be impacted. Notifications will be made to Base personnel before intentional detonations in accordance with approved ESS and safety plans.

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

MPPEH Disposition

MPPEH will be visually inspected and independently re-inspected for explosive hazards in accordance with the requirements of DoD Instruction (DoDI) 4140.62 (DoD, 2008); DoD 4160.21-M, Chapter 4, Paragraph B (DoD, 1997); and OP-5 Volume 1, Chapters 13–15 (NAVSEA, 2010).Only UXO-qualified personnel will perform these inspections. A UXO Technician III will perform the 100-percent inspection and document that the MPPEH is free of explosive hazards. Per OP-5, Section 13-15.7.2 (NAVSEA, 2010), and/or DoDI 4140.62 (DoD, 2008), a second UXO Technician III qualified person will conduct the re-inspection and document that the MPPEH is free of explosive hazards. The authorization letter to inspect and certify MPPEH will be maintained onsite.

If necessary, demilitarization of the MDAS will be conducted. DD Form 1348-1 (series) will be used as 100 percent inspection and 100 percent re-inspection documentation. All DD Form 1348-1 (series) forms will clearly show the following information in typed or printed letters:

- Name of SUXOS and the government representative
- Organization
- Two signatures not in the same chain of command (such as a UXO Technician III and the UXOQCS)
- Contractor's office
- Field office phone number(s) of the persons performing the inspection and independent re-inspection of the MDAS
- Basic material content (type of metal - for example, steel or mixed)
- Estimated weight
- Unique identification of each sealed container
- Location where MDAS was obtained
- Seal identification, if different from the unique identification of the sealed container
- As part of the transfer of MDAS to an off-base facility for final disposition, the following statement will be entered on each DD Form 1348-1 (series) and will be signed by the SUXOS and the UXOQCS:

  "The material listed on this form has been inspected or processed by DDESB-approved means, as required by DOD policy, and to the best of knowledge and belief does not pose an explosive hazard."

Geospatial Information and Electronic Submittals

Methods, equipment, accuracy, and submittal requirements for survey locations and mapping are described in Section 7.4 of the MMRP MPPs.

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

Incremental Soil Sampling

The use of explosives during the MEC intrusive investigation could impact the soils ejected from the crater. Surface soil samples will be collected outside the crater using the incremental sampling method. The decision unit (DU) for the post-BIP samples collected outside the crater (outside the 1-meter × 1-meter TR-02-1 sampling area) will be roughly circular and centered upon the crater, with a radius of up to 15 meters to encompass the visible ejecta pattern. The maximum radius of 15 meters is based on work conducted by the United States Army Engineer Research and Development Center entitled *Explosive Residues from Blow-in-Place Detonations of Artillery Munitions* (Pennington, 2008). This paper concluded that the majority of the explosives residue mass falls within 15 meters of the detonation center. The soil samples will be collected in accordance with the *Incremental Sampling* SOP in Appendix C of the MMRP MPPs (CH2M HILL, 2008). At least 30 aliquots of soil will be collected from 0 to 2 inches bgs and homogenized in accordance with the SOPs in Appendix C of the MRP MPP.

Soil samples will be collected at locations where controlled detonations/BIP operations are conducted. One composite surface soil sample will be collected using the TR-02-1 sampling approach in the resulting crater, and the incremental sampling method will be utilized to collect one surface soil sample from outside of the crater.

The TR-02-1 sampling method is used to assess shallow soil conditions in areas constrained by development or dense vegetation. Each sampling location will be defined as an area 1 by 1 meter in size. Soil samples will be collected by compositing a minimum of 30 sample increments from random locations within each 1- by 1-meter sampling location. The sample increments will be approximately equal in the amount of soil, which will be collected from depths of 0-2 inches. The sample increments at each location will be composited into a single sample following the *Homogenization of Soil and Sediment Samples* SOP in Appendix C of the MRP MPPs (CH2M HILL, 2008).

Environmental Sampling

Subsurface Soil

- Subsurface soil samples will be collected using the incremental sampling method (TR-02-1) at intrusive investigation locations (up to 10) where leaking MEC/MPPEH filler is observed. Samples will be collected above the water table at depths not to exceed 2 feet, following the Soil Sample Collection SOP located in **Worksheet #21** of the UFP-SAP. These samples will be analyzed for MC only.
- Six additional grab subsurface soil locations will be collected above the water table at depths not to exceed 5 feet using hand augers or direct-push (**Figure 10-6**). These samples will be analyzed for pesticides and herbicides only to confirm the findings of the CSA conducted by Osage and further characterize the site.
- The proposed locations for each borehole will be uploaded to a hand-held GPS unit to accurately locate each sampling location. The field team will make reasonable efforts to collect samples from the proposed sampling locations; however, the sampling locations may be slightly adjusted to a field-suitable location (area free of poison ivy, debris, etc.). The actual coordinates of the sampling locations will then be recorded by the GPS unit. The coordinates will also be recorded in the field log book. Soil borings not used for monitoring well installation will be backfilled with the soil cuttings.

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

- MEC avoidance will be practiced during all intrusive sampling activities as described in the APP/HSP. At the start of each borehole, a UXO technician will hand auger to a depth of 5 feet, checking the borehole with a down-hole magnetometer at 1-foot increments.

  Soil borings will be advanced to a depth of no greater than 5 feet bgs, or to the water table, whichever is shallower. Soil cuttings will be examined and described using the Unified Soil Classification System. The soil sample will be collected from a depth of 1 to 5 feet bgs, or above the water table (if encountered less than 5 feet bgs). Soil samples intended for laboratory analysis should not be collected from the saturated zone, but should be logged throughout the anticipated screen interval for any boreholes selected for monitoring well installation. Down-hole sampling equipment will be decontaminated between each sample location.

Surface Soil Sampling

- Four grab surface soil samples will be collected between 0 and 2 inches bgs.
- Samples will be collected in accordance with the shallow soil sampling SOP located in **Worksheet #21**.
- The proposed locations for each sample will be uploaded to a hand-held GPS unit, and used in the field to accurately locate the correct sampling site. The field team will make reasonable efforts to collect samples from the proposed sampling locations; however, the sampling locations may be slightly adjusted to a field-suitable location (area free of poison ivy, debris, etc.). The actual coordinates of the sampling locations will then be recorded by the GPS unit, and documented in the field log book.
- The surface soil samples will be analyzed for pesticides and herbicides.

Controlled Detonation Surface Soil Sampling

- One surface soil sample will be collected between 0 and 2 inches bgs from within the detonation crater and one surface soil sample will be collected between 0 and 2 inches bgs from outside the crater.
- Samples will be collected using the incremental method (TR-02-1) and analyzed for MC.

Monitoring Well Installation

- Shallow groundwater monitoring wells will be constructed to allow collection of groundwater samples. Each well will be constructed of 2-inch-inner-diameter (ID), Schedule 40 PVC. Wells will be constructed using 10-foot lengths of 2-inch ID, 0.010-inch machine slotted Schedule 40 PVC screen with a bottom cap. The wells will be installed in accordance with the Monitoring Well Installation SOP located in **Worksheet #21**. The well screen will be installed to bracket the water table. Each well will be completed with a #2 filter pack from the bottom of the well to 2 feet above the top of the screen interval. A 2-foot layer of bentonite will be installed above the filter pack and allowed to hydrate for 2 hours prior to grouting with a bentonite/Portland cement slurry to ground surface. Each well will be completed with a flush-mounted, traffic-rated manhole and locking well cap.
- The monitoring wells will be developed by the drilling contractor. The primary purpose of well development is to reduce turbidity.
- Static groundwater elevations will be measured in all monitoring wells using a water level indicator or oil/water interface probe, as appropriate. The depth from the top of casing to fluid level will be recorded to the nearest 0.01 foot. The indicator will be decontaminated after use in each well.

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

Groundwater Sampling

Groundwater samples will be collected using low-flow sampling protocol, and analyzed for parameters as detailed on **Worksheet #20** and the Groundwater Sampling SOP located in **Worksheet #21**.

- WQPs, including specific conductance, pH, turbidity, temperature, DO, and ORP, will be measured and recorded prior to sampling using a multi-parameter water quality meter. The meter will be calibrated on a daily basis and thereafter as warranted. Sampling will begin when the WQPs have stabilized: pH within 0.1 pH units, specific conductance within 3 percent, DO within 10 percent, ORP within 15 mV, and turbidity within 10 percent or as low as practicable for three consecutive readings. Depth to water, purge volume, WQPs, and total well depth measurements will be recorded in the field log book.

Surface Water and Sediment Sampling

- WQPs (e.g., DO, temperature, specific conductance, and pH) will be measured prior to sample collection. The surface water sample will then be collected by submersing the sampling container directly into the surface water body or by using a "thief" type sampler and then transferring the sample to the sample container. If the volume of surface water encountered is insufficient to allow the direct submersion of the sampling containers, a glass interim vessel will be used to transfer the surface water sample to the sample containers. The glass interim vessel will be laboratory cleaned to the same specifications as the sample containers.
- The sediment sample will be collected in the same location as surface water samples. Sediment and surface water sampling will follow the SOPs listed in **Worksheet #21**. Surface water samples will always be collected first at each location to minimize turbidity and agitation caused by sediment collection. Sediment will be collected using a decontaminated trowel and bowl, drained of excess water, and placed into the appropriate sample containers.

Surface water and sediment sample location coordinates will be determined using a hand-held GPS in the field. All coordinates will be recorded in the field log book.

Decontamination and IDW Handling

- All non-disposable sampling equipment will be decontaminated before use and immediately after each use in accordance with applicable SOPs referenced in **Worksheet #21**. The water level indicator will be cleaned with a Liquinox solution spray and rinsed with deionized water between each measurement.
- Wastes generated during the investigation of potentially contaminated sites, including liquid and soil wastes, are classified as IDW and will be managed to protect human health and the environment, as well as to meet legal requirements. IDW will be managed in accordance with the Waste Management Plan. The FTL will be responsible for the documentation, containerization, and transportation to the appropriate on-base storage facility. The containers will be labeled in accordance with the Waste Management Plan either with an indelible marker or preprinted label. Trash will be placed in opaque, black garbage bags and placed into on-base trash receptacles.
- Liquid and soil IDW generated during field work activities will be sampled for IDW characterization. Samples will be analyzed for toxicity characteristic leaching procedure (TCLP) analysis, including TCLP VOCs, TCLP SVOCs, TCLP Metals, TCLP Pesticides, and TCLP Herbicides. In addition to TCLP analysis, IDW samples will be tested for reactive sulfide and cyanide, ignitability, and corrosivity.

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

Demobilization

Full demobilization will occur when the project is completed and appropriate QA/QC checks have been performed. Personnel no longer needed during field operations may be demobilized prior to the final project completion date. The following will occur prior to demobilization:

- Chain-of-custody records will be reviewed to ensure that all samples were collected as planned and submitted for appropriate analyses.
- Restoration of the site to an appropriate level (e.g., repair of deep ruts) will be verified by the CH2M HILL FTL.
- All equipment will be inspected, packaged, and returned to the appropriate location.

Analyses and Testing Tasks

- The analytical laboratory will process and prepare samples for analyses and will analyze all samples for various groups of parameters in accordance with **Worksheet #20**.

Quality Control Tasks

- SOPs for field and laboratory activities will be implemented.
- QC samples are described in **Worksheet #20**.

Secondary Data

- Secondary data (**Worksheet #13**) provided by CH2M HILL will be incorporated into subsequent reports, as needed.

Data Validation, Review, and Management Tasks

- Procedures for recording data, including guidelines for recording and correcting data:
  - See the Navy CLEAN **Data Management Plan** in the **Data Management Guidelines** presented in **Attachment 2** of this UFP-SAP.
- Computerized and manual procedures for data from generation to final use and storage and QC checks for error detection to ensure data integrity:
  - See the Navy CLEAN **Data Management Plan** in the **Data Management Guidelines** presented in **Attachment 2** of this UFP-SAP.
- Guidance on data management steps such as data recording, data transformation, data reduction, data transfer and transmittal, data analysis, and data review:
  - See the Navy CLEAN **Data Management Plan** in the **Data Management Guidelines** presented in **Attachment 2** of this UFP-SAP.
- Procedures for data tracking, storage, archiving, retrieval, and security for both electronic and hardcopy data:
  - See the Navy CLEAN **Data Management Plan** in the **Data Management Guidelines** presented in **Attachment 2** of this UFP-SAP for more information.
  - The PC, Bianca Kleist, is responsible for data tracking and storage.
  - CH2M HILL will coordinate archiving and retrieval of data.
- Perform data validation via third party subcontractor (EDS) as per **Worksheets #34-36**.

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

Documentation and Reporting

- Work and data will be documented in the draft PA/SI report.

Assessment/Audit Tasks

- See **Worksheets #31** and **#32**.

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SAP Worksheet #15-1—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, and Intrusive Investigation Soil Samples

Analytical Group: Explosive Residues including 3,5-DNA, Nitroglycerin, and PETN

Analyte	Chemical Abstract Service (CAS) Number	Project Action Limit (micrograms per kilogram [µg/kg])	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	Limits of Detection (LODs) (µg/kg)	Detection Limits (DLs) (µg/kg)
1,3,5-Trinitrobenzene	99-35-4	220000	RSL Residential	110000	400	100	50
1,3-Dinitrobenzene	99-65-0	610	RSL Residential	305	400	100	50
2,4,6-Trinitrotoluene	118-96-7	3600	RSL Residential	1800	400	100	50
2,4-Dinitrotoluene	121-14-2	1.6	NC SSL	0.80	400	100	55
2,6-Dinitrotoluene	606-20-2	6100	RSL Residential	3050	400	100	56
2-Amino-4,6-dinitrotoluene	35572-78-2	15000	RSL Residential	7500	400	100	50
2-Nitrotoluene	88-72-2	2900	RSL Residential	1450	400	100	76
3,5-DNA	618-87-1	NC	NA	200	400	200	94
3-Nitrotoluene	99-08-1	610	RSL Residential	305	400	100	95
4-Amino-2,6-dinitrotoluene	19406-51-0	15000	RSL Residential	7500	400	100	50
4-Nitrotoluene	99-99-0	24000	RSL Residential	12000	400	100	99
HMX	2691-41-0	380000	RSL Residential	190000	400	100	50
Nitrobenzene	98-95-3	4800	RSL Residential	2400	400	100	50
Nitroglycerin	55-63-0	610	RSL Residential	305	1000	250	125
PETN	78-11-5	12000	RSL Residential	6000	1000	250	125
Perchlorate	14797-73-0	5500	RSL Residential	2750	2	1	0.5
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5600	RSL Residential	2850	400	100	50
Tetryl	479-45-8	24000	RSL Residential	12000	400	100	57

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.

Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

NC SSL values are from the North Carolina Soil Screening Levels (February 2012).

Shading represents instances where the PQL Goal is lower than the LOD. Non-detects will not be treated as exceedances, although they will be reported at a value greater than the PQL Goal.

SAP Worksheet #15-2—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Soil

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
4,4'-DDD	72-54-8	6.49	Base Background SS	3.245	2	0.4	0.2
4,4'-dichlorodiphenyldichloroethene (DDE)	72-55-9	78.4	Base Background SS	39.2	2	0.4	0.2
4,4'-DDT	50-29-3	49.8	Base Background SS	24.9	2	0.4	0.2
Aldrin	309-00-2	3.3	NC SSL	1.65	2	0.4	0.2
alpha-benzene hexachloride (BHC)	319-84-6	0.319	Base Background SS	0.1595	2	0.4	0.2
alpha-Chlordane	5103-71-9	4.81	Base Background SS	2.405	2	0.4	0.2
beta-BHC	319-85-7	1.2	NC SSL	0.6	2	0.4	0.2
delta-BHC	319-86-8	270	RSL Residential	135	2	0.4	0.273
Dieldrin	60-57-1	0.81	NC SSL	0.405	2	0.4	0.2
Endosulfan I	959-98-8	5600	NC SSL	2800	2	0.4	0.2
Endosulfan II	33213-65-9	5600	NC SSL	2800	2	0.4	0.2
Endosulfan sulfate	1031-07-8	3.08	Base Background SS	1.54	2	0.4	0.2
Endrin	72-20-8	2.39	Base Background SS	1.195	2	0.4	0.2
Endrin aldehyde	7421-93-4	810	NC SSL	405	2	0.4	0.354
Endrin ketone	53494-70-5	810	NC SSL	405	2	0.4	0.2
gamma-BHC (Lindane)	58-89-9	1.8	NC SSL	0.9	2	0.4	0.2
gamma-Chlordane	5103-74-2	2.54	Base Background SS	1.27	2	0.4	0.2
Heptachlor	76-44-8	0.449	Base Background SS	0.2245	2	0.4	0.2

SAP Worksheet #15-2—Reference Limits and Evaluation Table – Site UXO-24 (continued)

Matrix: Surface Soil

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
Heptachlor epoxide	1024-57-3	0.82	NC SSL	0.41	2	0.4	0.2
Methoxychlor	72-43-5	22000	NC SSL	11000	10	4	2
Toxaphene	8001-35-2	46	NC SSL	23	50	10	5

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
Base background values are from the CamLej background values as applicable to developed surface soil – combined soil types (August 2011).

NC SSL values are from the North Carolina Soil Screening Levels (February 2012).

The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

Shading represents instances where the PQL Goal is lower than the LOD. Non-detects will not be treated as exceedances, although they will be reported at a value greater than the PQL Goal.

SAP Worksheet #15-3—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Subsurface Soil and Intrusive Investigation Soil Samples

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
4,4'-DDD	72-54-8	240	NC SSL	120	2	0.4	0.2
4,4'-DDE	72-55-9	2.46	Base Background SB	1.23	2	0.4	0.2
4,4'-DDT	50-29-3	4.5	Base Background SB	2.25	2	0.4	0.2
Aldrin	309-00-2	3.3	NC SSL	1.65	2	0.4	0.2
alpha-BHC	319-84-6	0.36	NC SSL	0.18	2	0.4	0.2
alpha-Chlordane	5103-71-9	0.419	Base Background SB	0.2095	2	0.4	0.2
beta-BHC	319-85-7	1.2	NC SSL	0.6	2	0.4	0.2
delta-BHC	319-86-8	0.505	Base Background SB	0.2525	2	0.4	0.273
Dieldrin	60-57-1	0.81	NC SSL	0.405	2	0.4	0.2
Endosulfan I	959-98-8	5600	NC SSL	2800	2	0.4	0.2
Endosulfan II	33213-65-9	5600	NC SSL	2800	2	0.4	0.2
Endosulfan sulfate	1031-07-8	8000	NC SSL	4000	2	0.4	0.2
Endrin	72-20-8	810	NC SSL	405	2	0.4	0.2
Endrin aldehyde	7421-93-4	810	NC SSL	405	2	0.4	0.354
Endrin ketone	53494-70-5	810	NC SSL	405	2	0.4	0.2
gamma-BHC (Lindane)	58-89-9	1.8	NC SSL	0.9	2	0.4	0.2
gamma-Chlordane	5103-74-2	0.281	Base Background SB	0.1405	2	0.4	0.2

SAP Worksheet #15-3—Reference Limits and Evaluation Table – Site UXO-24 (continued)

Matrix: Subsurface Soil and Intrusive Investigation Soil Samples

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
Heptachlor	76-44-8	0.473	Base Background SB	0.2365	2	0.4	0.2
Heptachlor epoxide	1024-57-3	0.82	NC SSL	0.41	2	0.4	0.2
Methoxychlor	72-43-5	22000	NC SSL	11000	10	4	2
Toxaphene	8001-35-2	46	NC SSL	23	50	10	5

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
Base background values are from the CamLej background values as applicable to developed surface soil – combined soil types (August 2011).

NC SSL values are from the North Carolina Soil Screening Levels (February 2012).

Shading represents instances where the PQL Goal is lower than the LOD. Non-detects will not be treated as exceedances, although they will be reported at a value greater than the PQL Goal.

SAP Worksheet #15-4—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, and Intrusive Investigation Soil Samples

Analytical Group: Herbicides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
2,4,5-T	93-76-5	61000	RSL Residential	30500	10	5	3
2,4,5-TP (Silvex)	93-72-1	380	RSL Residential	190	10	5	2.5
2,4-D	94-75-7	320	RSL Residential	160	10	5	2.5
2,4-DB	94-82-6	49000	RSL Residential	24500	10	5	4.7
4-Nitrophenol	100-02-7	4800	RSL Residential	2400	10	5	3.5
Dalapon	75-99-0	810	NC SSL	405	10	5	3.1
Dicamba	1918-00-9	180000	RSL Residential	90000	10	5	2.5
Dichloroprop	120-36-5	NC	NA	5	10	5	3.9
Dinoseb	88-85-7	630	NC SSL	315	10	5	3.2
2-methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6	3100	RSL Residential	1550	2000	1000	500
MCPP	93-65-2	6100	RSL Residential	3050	2000	1000	670
Pentachlorophenol	87-86-5	31	NC SSL	15.5	10	5	3.4

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).
NC SSL values are from the North Carolina Soil Screening Levels (February 2012).

SAP Worksheet #15-5—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Soil

Analytical Group: TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (mg/kg)	Laboratory-specific		
					LOQs (mg/kg)	LODs (mg/kg)	DLs (mg/kg)
Aluminum	7429-90-5	7700	RSL Residential	3850	100	10	5
Antimony	7440-36-0	0.9	NC SSL	0.45	0.5	0.2	0.1
Arsenic	7440-38-2	0.39	RSL Residential	0.195	0.5	0.1	0.05
Barium	7440-39-3	33.8	Base Background SS	16.9	0.5	0.1	0.072
Beryllium	7440-41-7	NC	NA	0.1	0.5	0.1	0.05
Cadmium	7440-43-9	0.517	Base Background SS	0.2585	0.5	0.1	0.057
Calcium	7440-70-2	3790	Base Background SS	1895	100	20	17
Chromium	7440-47-3	0.29	RSL Residential	0.145	0.5	0.1	0.05
Cobalt	7440-48-4	NC	NA	0.1	0.5	0.1	0.05
Copper	7440-50-8	2.5	Base Background SS	1.25	0.5	0.2	0.1
Cyanide	57-12-5	NC	NA	0.2	1	0.2	0.11
Iron	7439-89-6	150	NC SSL	75	100	10	5
Lead	7439-92-1	20.2	Base Background SS	10.1	0.5	0.1	0.05
Magnesium	7439-95-4	NC	NA	20	100	20	10
Manganese	7439-96-5	18.3	Base Background SS	9.15	0.5	0.2	0.153
Mercury	7439-97-6	0.121	Base Background SS	0.0605	0.1	0.02	0.01
Nickel	7440-02-0	2.73	Base Background SS	1.365	0.5	0.1	0.063
Potassium	7440-09-7	NC	NA	20	100	20	10
Selenium	7782-49-2	0.896	Base Background SS	0.448	0.5	0.1	0.05
Silver	7440-22-4	NC	NA	0.1	0.5	0.1	0.05
Sodium	7440-23-5	79.7	Base Background SS	39.85	100	20	10
Thallium	7440-28-0	NC	NA	0.1	0.5	0.1	0.05
Vanadium	7440-62-2	6	NC SSL	3	0.5	0.25	0.19
Zinc	7440-66-6	16.2	Base Background SS	8.1	2	1	0.683

Notes:
1 PALs were developed to be protective of human health and the environment.
2 PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
Base Background values were taken from two times the mean base background concentrations at MCIEAST-MCBCAMLEJ.
Base background values are from the CamLej background values as applicable to developed surface soil - combined soil types (August 2011).
NC SSL values are from the North Carolina Soil Screening Levels (February 2012).
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

SAP Worksheet #15-6—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Subsurface Soil and Intrusive Investigation Samples

Analytical Group: TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (mg/kg)	Laboratory-specific		
					LOQs (mg/kg)	LODs (mg/kg)	DLs (mg/kg)
Aluminum	7429-90-5	7700	RSL Residential	3850	100	10	5
Antimony	7440-36-0	0.9	NC SSL	0.45	0.5	0.2	0.1
Arsenic	7440-38-2	0.39	RSL Residential	0.195	0.5	0.1	0.05
Barium	7440-39-3	53.2	Base Background SB	26.6	0.5	0.1	0.072
Beryllium	7440-41-7	NC	NA	0.1	0.5	0.1	0.05
Cadmium	7440-43-9	1.3	Base Background SB	0.65	0.5	0.1	0.057
Calcium	7440-70-2	720	Base Background SB	360	100	20	17
Chromium	7440-47-3	0.29	RSL Residential	0.145	0.5	0.1	0.05
Cobalt	7440-48-4	1	Base Background SB	0.5	0.5	0.1	0.05
Copper	7440-50-8	6.61	Base Background SB	3.305	0.5	0.2	0.1
Cyanide	57-12-5	NC	NA	0.2	1	0.2	0.11
Iron	7439-89-6	150	NC SSL	75	100	10	5
Lead	7439-92-1	14.4	Base Background SB	7.2	0.5	0.1	0.05
Magnesium	7439-95-4	732	Base Background SB	366	100	20	10
Manganese	7439-96-5	16.9	Base Background SB	8.45	0.5	0.2	0.153
Mercury	7439-97-6	0.148	Base Background SB	0.074	0.1	0.02	0.01
Nickel	7440-02-0	8.86	Base Background SB	4.43	0.5	0.1	0.063
Potassium	7440-09-7	1020	Base Background SB	510	100	20	10
Selenium	7782-49-2	0.948	Base Background SB	0.474	0.5	0.1	0.05
Silver	7440-22-4	NC	NA	0.1	0.5	0.1	0.05
Sodium	7440-23-5	81.1	Base Background SB	40.55	100	20	10
Thallium	7440-28-0	NC	NA	0.1	0.5	0.1	0.05
Vanadium	7440-62-2	6	NC SSL	3	0.5	0.25	0.19
Zinc	7440-66-6	16.6	Base Background SB	8.3	2	1	0.683

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
Base background values are from the CamLej background values as applicable to developed subsurface soil - combined soil types (August 2011).
NC SSL values are from the North Carolina Soil Screening Levels (February 2012).
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

SAP Worksheet #15-7—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Sediment

Analytical Group: Explosive Residues including 3,5-DNA, Nitroglycerin, and PETN

Analyte	CAS Number	PAL (µg/kg)	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
1,3,5-Trinitrobenzene	99-35-4	220000	RSL Residential	110000	400	100	50
1,3-Dinitrobenzene	99-65-0	610	RSL Residential	305	400	100	50
2,4,6-Trinitrotoluene	118-96-7	3600	RSL Residential	1800	400	100	50
2,4-Dinitrotoluene	121-14-2	1600	RSL Residential	800	400	100	55
2,6-Dinitrotoluene	606-20-2	6100	RSL Residential	3050	400	100	56
2-Amino-4,6-dinitrotoluene	35572-78-2	15000	RSL Residential	7500	400	100	50
2-Nitrotoluene	88-72-2	2900	RSL Residential	1450	400	100	76
3,5-DNA	618-87-1	NC	NA	200	400	200	100
3-Nitrotoluene	99-08-1	610	RSL Residential	305	400	100	95
4-Amino-2,6-dinitrotoluene	19406-51-0	15000	RSL Residential	7500	400	100	50
4-Nitrotoluene	99-99-0	24000	RSL Residential	12000	400	100	99
HMX	2691-41-0	380000	RSL Residential	190000	400	100	50
Nitrobenzene	98-95-3	4800	RSL Residential	2400	400	100	50
Nitroglycerin	55-63-0	610	RSL Residential	305	1000	250	125
PETN	78-11-5	1200	RSL Residential	250	1000	250	125
Perchlorate	14797-73-0	5500	RSL Residential	2750	2	1	0.5
RDX	121-82-4	5600	RSL Residential	2800	400	100	50
Tetryl	479-45-8	24000	RSL Residential	12000	400	100	57

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

SAP Worksheet #15-8—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Sediment

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
4,4'-DDD	72-54-8	2000	RSL Residential	1000	2	0.4	0.2
4,4'-DDE	72-55-9	1400	RSL Residential	700	2	0.4	0.2
4,4'-DDT	50-29-3	1700	RSL Residential	850	2	0.4	0.2
Aldrin	309-00-2	29	RSL Residential	14.5	2	0.4	0.2
alpha-BHC	319-84-6	77	RSL Residential	38.5	2	0.4	0.2
alpha-Chlordane	5103-71-9	1600	RSL Residential	800	2	0.4	0.2
beta-BHC	319-85-7	270	RSL Residential	135	2	0.4	0.2
delta-BHC	319-86-8	270	RSL Residential	135	2	0.4	0.273
Dieldrin	60-57-1	30	RSL Residential	15	2	0.4	0.2
Endosulfan I	959-98-8	37000	RSL Residential	18500	2	0.4	0.2
Endosulfan II	33213-65-9	37000	RSL Residential	18500	2	0.4	0.2
Endosulfan sulfate	1031-07-8	37000	RSL Residential	18500	2	0.4	0.2
Endrin	72-20-8	1800	RSL Residential	900	2	0.4	0.2
Endrin aldehyde	7421-93-4	1800	RSL Residential	900	2	0.4	0.354
Endrin ketone	53494-70-5	1800	RSL Residential	900	2	0.4	0.2
gamma-BHC (Lindane)	58-89-9	520	RSL Residential	260	2	0.4	0.2
gamma-Chlordane	5103-74-2	1600	RSL Residential	800	2	0.4	0.2
Heptachlor	76-44-8	110	RSL Residential	55	2	0.4	0.2
Heptachlor epoxide	1024-57-3	53	RSL Residential	26.5	2	0.4	0.2
Methoxychlor	72-43-5	31000	RSL Residential	15500	10	4	2
Toxaphene	8001-35-2	440	RSL Residential	220	50	10	5

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

SAP Worksheet #15-9—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Sediment

Analytical Group: Herbicides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/kg)	Laboratory-specific		
					LOQs (µg/kg)	LODs (µg/kg)	DLs (µg/kg)
2,4,5-T	93-76-5	61000	RSL Residential	30500	10	5	3
2,4,5-TP (Silvex)	93-72-1	49000	RSL Residential	24500	10	5	2.5
2,4-D	94-75-7	69000	RSL Residential	34500	10	5	2.5
2,4-DB	94-82-6	49000	RSL Residential	24500	10	5	4.7
4-Nitrophenol	100-02-1	4800	RSL Residential	2400	10	5	3.5
Dalapon	75-99-0	180000	RSL Residential	90000	10	5	3.1
Dicamba	1918-00-9	180000	RSL Residential	90000	10	5	2.5
Dichloroprop	120-36-5	NC	NA	5	10	5	3.9
Dinoseb	88-85-7	6100	RSL Residential	3050	10	5	3.2
MCPA	94-74-6	3100	RSL Residential	1550	2000	1000	500
MCPP	93-65-2	6100	RSL Residential	3050	2000	1000	670
Pentachlorophenol	87-86-5	890	RSL Residential	445	10	5	3.4

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).

SAP Worksheet #15-10—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Sediment

Analytical Group: TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (mg/kg)	Laboratory-specific		
					LOQs (mg/kg)	LODs (mg/kg)	DLs (mg/kg)
Aluminum	7429-90-5	7700	RSL Residential	3850	100	10	5
Antimony	7440-36-0	3.1	RSL Residential	1.55	0.5	0.2	0.1
Arsenic	7440-38-2	0.39	RSL Residential	0.195	0.5	0.1	0.05
Barium	7440-39-3	1500	RSL Residential	750	0.5	0.1	0.072
Beryllium	7440-41-7	16	RSL Residential	8	0.5	0.1	0.05
Cadmium	7440-43-9	7	RSL Residential	3.5	0.5	0.1	0.057
Calcium	7440-70-2	NC	NA	20	100	20	17
Chromium	7440-47-3	0.29	RSL Residential	0.145	0.5	0.1	0.05
Cobalt	7440-48-4	2.3	RSL Residential	1.15	0.5	0.1	0.05
Copper	7440-50-8	310	RSL Residential	155	0.5	0.2	0.1
Cyanide	57-12-5	4.7	RSL Residential	2.35	1	0.2	0.11
Iron	7439-89-6	5500	RSL Residential	2750	100	10	5
Lead	7439-92-1	400	RSL Residential	200	0.5	0.1	0.05
Magnesium	7439-95-4	NC	NA	20	100	20	10
Manganese	7439-96-5	180	RSL Residential	90	0.5	0.2	0.153
Mercury	7439-97-6	2.3	RSL Residential	1.15	0.1	0.02	0.01
Nickel	7440-02-0	150	RSL Residential	75	0.5	0.1	0.063
Potassium	7440-09-7	NC	NA	20	100	20	10
Selenium	7782-49-2	39	RSL Residential	19.5	0.5	0.1	0.05
Silver	7440-22-4	39	RSL Residential	19.5	0.5	0.1	0.05
Sodium	7440-23-5	NC	NA	20	100	20	10

SAP Worksheet #15-10—Reference Limits and Evaluation Table – Site UXO-24 (continued)

Matrix: Sediment

Analytical Group: TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (mg/kg)	Laboratory-specific		
					LOQs (mg/kg)	LODs (mg/kg)	DLs (mg/kg)
Thallium	7440-28-0	0.078	RSL Residential	0.039	0.5	0.1	0.05
Vanadium	7440-62-2	39	RSL Residential	19.5	0.5	0.25	0.19
Zinc	7440-66-6	2300	RSL Residential	1150	2	1	0.683

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
PAL and PQL assumes dry weight basis.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The Residential Soil RSLs were adjusted from the USEPA RSLs Table (November 2012).
Shading represents instances where the PQL Goal is lower than the LOD. Non-detects will not be treated as exceedances, although they will be reported at a value greater than the PQL Goal.

SAP Worksheet #15-11—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Groundwater

Analytical Group: Explosive Residues including 3,5-DNA, Nitroglycerin, and PETN

Analyte	CAS Number	PAL (µg/L)	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
1,3,5-Trinitrobenzene	99-35-4	46	RSL Tapwater	23	1	0.2	0.1
1,3-Dinitrobenzene	99-65-0	0.15	RSL Tapwater	0.075	1	0.2	0.1
2,4,6-Trinitrotoluene	118-96-7	0.76	RSL Tapwater	0.38	1	0.2	0.16
2,4-Dinitrotoluene	121-14-2	0.2	RSL Tapwater	0.1	1	0.2	0.12
2,6-Dinitrotoluene	606-20-2	1.5	RSL Tapwater	0.75	1	0.2	0.1
2-Amino-4,6-dinitrotoluene	35572-78-2	3	RSL Tapwater	1.5	1	0.2	0.1
2-Nitrotoluene	88-72-2	0.27	RSL Tapwater	0.135	1	0.2	0.11
3,5-DNA	618-87-1	NC	NA	0.5	2	0.5	0.14
3-Nitrotoluene	99-08-1	0.13	RSL Tapwater	0.065	1	0.2	0.16
4-Amino-2,6-dinitrotoluene	19406-51-0	3	RSL Tapwater	1.5	1	0.2	0.2
4-Nitrotoluene	99-99-0	3.7	RSL Tapwater	1.85	1	0.2	0.1
HMX	2691-41-0	78	RSL Tapwater	39	1	0.2	0.1
Nitrobenzene	98-95-3	0.12	RSL Tapwater	0.06	1	0.2	0.1
Nitroglycerin	55-63-0	0.15	RSL Tapwater	0.075	125	62.5	33
PETN	78-11-5	3	RSL Tapwater	1.5	125	62.5	31
Perchlorate	14797-73-0	1.1	RSL Tapwater	0.55	2	1	0.5
RDX	121-82-4	0.61	RSL Tapwater	0.305	1	0.2	0.164
Tetryl	479-45-8	6.1	RSL Tapwater	3.05	1	0.2	0.1

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).
Shading represents instances where the PQL Goal is lower than the LOD. Non-detects will not be treated as exceedances, although they will be reported at a value greater than the PQL Goal

SAP Worksheet #15-12—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Groundwater

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
4,4'-DDD	72-54-8	0.1	NC2L	0.05	0.1	0.01	0.005
4,4'-DDE	72-55-9	0.2	RSL Tapwater	0.1	0.1	0.01	0.005
4,4'-DDT	50-29-3	0.0171	Base Background - Surficial	0.00855	0.1	0.01	0.005
Aldrin	309-00-2	0.004	RSL Tapwater	0.002	0.1	0.01	0.005
alpha-BHC	319-84-6	0.0062	RSL Tapwater	0.0031	0.1	0.01	0.005
alpha-Chlordane	5103-71-9	0.19	RSL Tapwater	0.095	0.1	0.01	0.005
beta-BHC	319-85-7	0.0189	Base Background - Surficial	0.00945	0.1	0.01	0.007
delta-BHC	319-86-8	0.0219	Base Background - Surficial	0.01095	0.1	0.01	0.007
Dieldrin	60-57-1	0.0015	RSL Tapwater	0.00075	0.1	0.01	0.005
Endosulfan I	959-98-8	7.8	RSL Tapwater	3.9	0.1	0.01	0.008
Endosulfan II	33213-65-9	7.8	RSL Tapwater	3.9	0.1	0.01	0.005
Endosulfan sulfate	1031-07-8	7.8	RSL Tapwater	3.9	0.1	0.01	0.005
Endrin	72-20-8	0.17	RSL Tapwater	0.085	0.1	0.01	0.008
Endrin aldehyde	7421-93-4	0.17	RSL Tapwater	0.085	0.1	0.01	0.005
Endrin ketone	53494-70-5	0.17	RSL Tapwater	0.085	0.1	0.01	0.005
gamma-BHC (Lindane)	58-89-9	0.03	NC2L	0.015	0.1	0.01	0.005
gamma-Chlordane	5103-74-2	0.00423	Base Background - Surficial	0.002115	0.1	0.01	0.005
Heptachlor	76-44-8	0.0018	RSL Tapwater	0.0009	0.1	0.01	0.007
Heptachlor epoxide	1024-57-3	0.0033	RSL Tapwater	0.00165	0.1	0.01	0.005
Methoxychlor	72-43-5	2.7	RSL Tapwater	1.35	1	0.1	0.05
Toxaphene	8001-35-2	0.013	RSL Tapwater	0.0065	2	0.5	0.25

Notes:

[1] PALs were developed to be protective of human health and the environment.

[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.

Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

NC 2L values are from the North Carolina Groundwater Quality Standards (February 2012).

The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).

Base Background values are from the CamLej background values for GW (Surficial).

Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances.

SAP Worksheet #15-13—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Groundwater

Analytical Group: Herbicides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
2,4,5-T	93-76-5	12	RSL Tapwater	6	0.4	0.2	0.1
2,4,5-TP (Silvex)	93-72-1	8.4	RSL Tapwater	4.2	0.4	0.2	0.1
2,4-D	94-75-7	13	RSL Tapwater	6.5	0.4	0.2	0.1
2,4-DB	94-82-6	9.1	RSL Tapwater	4.55	0.4	0.2	0.1
4-Nitrophenol	100-02-7	0.12	RSL Tapwater	0.06	0.4	0.2	0.125
Dalapon	75-99-0	46	RSL Tapwater	23	0.4	0.2	0.175
Dicamba	1918-00-9	44	RSL Tapwater	22	0.4	0.2	0.109
Dichloroprop	120-36-5	NC	NA	0.2	0.4	0.2	0.137
Dinoseb	88-85-7	1.1	RSL Tapwater	0.55	0.4	0.2	0.108
MCPA	94-74-6	0.57	RSL Tapwater	0.285	40	20	10
MCPP	93-65-2	1.2	RSL Tapwater	0.6	40	20	14
Pentachlorophenol	87-86-5	0.035	RSL Tapwater	0.0175	0.4	0.2	0.126

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The RSL Tapwater values were adjusted from the USEPA RSLs Table (May 2012).
Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances.

SAP Worksheet #15-14—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Groundwater

Analytical Group: Total and Dissolved TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
Aluminum	7429-90-5	1600	RSL Tapwater	800	100	20	10
Antimony	7440-36-0	0.6	RSL Tapwater	0.3	1	0.5	0.25
Arsenic	7440-38-2	0.045	RSL Tapwater	0.0225	1	0.2	0.1
Barium	7440-39-3	290	RSL Tapwater	145	1	0.5	0.25
Beryllium	7440-41-7	0.874	Base Background -Surficial	0.437	1	0.1	0.05
Cadmium	7440-43-9	0.69	RSL Tapwater	0.345	1	0.2	0.1
Calcium	7440-70-2	179000	Base Background -Surficial	89500	100	25	13
Chromium	7440-47-3	0.031	RSL Tapwater	0.0155	1	0.2	0.1
Cobalt	7440-48-4	0.47	RSL Tapwater	0.235	1	0.2	0.1
Copper	7440-50-8	6.59	Base Background -Surficial	3.295	1	0.5	0.25
*Cyanide	57-12-5	0.93	RSL Tapwater	0.465	10	5	2.5
Iron	7439-89-6	300	NC2L	150	100	10	5
Lead	7439-92-1	8.92	Base Background -Surficial	4.46	1	0.1	0.05
Magnesium	7439-95-4	13500	Base Background -Surficial	6750	100	10	5
Manganese	7439-96-5	32	RSL Tapwater	16	1	0.2	0.1
Mercury	7439-97-6	0.43	RSL Tapwater	0.215	0.5	0.1	0.054
Nickel	7440-02-0	11.8	Base Background -Surficial	5.9	1	0.2	0.1
Potassium	7440-09-7	5590	Base Background -Surficial	2795	100	20	10
Selenium	7782-49-2	7.8	RSL Tapwater	3.9	1	0.3	0.15
Silver	7440-22-4	0.724	Base Background -Surficial	0.362	1	0.2	0.1
Sodium	7440-23-5	22700	Base Background -Surficial	11350	100	50	25
Thallium	7440-28-0	0.016	RSL Tapwater	0.008	1	0.2	0.1
Vanadium	7440-62-2	7.8	RSL Tapwater	3.9	1	0.5	0.25
Zinc	7440-66-6	41.2	Base Background -Surficial	20.6	20	10	5

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
*Total Cyanide analysis only, groundwater samples will not be analyzed for Dissolved Cyanide
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
NC 2L values are from the North Carolina Groundwater Quality Standards (February 2012).
The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).
Base Background values are from the CamLej background values for GW (Surficial).
Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances.

SAP Worksheet #15-15—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Water

Analytical Group: Explosive Residues including 3,5-DNA, Nitroglycerin, and PETN

Analyte	CAS Number	PAL (µg/L)	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
1,3,5-Trinitrobenzene	99-35-4	46	RSL Tapwater	23	1	0.2	0.1
1,3-Dinitrobenzene	99-65-0	0.15	RSL Tapwater	0.075	1	0.2	0.1
2,4,6-Trinitrotoluene	118-96-7	0.76	RSL Tapwater	0.38	1	0.2	0.16
2,4-Dinitrotoluene	121-14-2	0.2	RSL Tapwater	0.1	1	0.2	0.12
2,6-Dinitrotoluene	606-20-2	1.5	RSL Tapwater	0.75	1	0.2	0.1
2-Amino-4,6-dinitrotoluene	35572-78-2	3	RSL Tapwater	1.5	1	0.2	0.1
2-Nitrotoluene	88-72-2	0.27	RSL Tapwater	0.135	1	0.2	0.11
3,5-DNA	618-87-1	NC	NA	0.5	2	0.5	0.14
3-Nitrotoluene	99-08-1	0.13	RSL Tapwater	0.065	1	0.2	0.16
4-Amino-2,6-dinitrotoluene	19406-51-0	3	RSL Tapwater	1.5	1	0.2	0.2
4-Nitrotoluene	99-99-0	3.7	RSL Tapwater	1.85	1	0.2	0.1
HMX	2691-41-0	78	RSL Tapwater	39	1	0.2	0.1
Nitrobenzene	98-95-3	0.12	RSL Tapwater	0.06	1	0.2	0.1
Nitroglycerin	55-63-0	0.15	RSL Tapwater	0.075	125	62.5	33
PETN	78-11-5	3	RSL Tapwater	1.5	125	62.5	31
Perchlorate	14797-73-0	1.1	RSL Tapwater	0.55	2	1	0.5
RDX	121-82-4	0.61	RSL Tapwater	0.305	1	0.2	0.164
Tetryl	479-45-8	6.3	RSL Tapwater	3.15	1	0.2	0.1

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).
Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances

SAP Worksheet #15-16—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Water

Analytical Group: Pesticides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
4,4'-DDD	72-54-8	0.00031	NRWQC	0.000155	0.1	0.01	0.005
4,4'-DDE	72-55-9	0.00022	NRWQC	0.00011	0.1	0.01	0.005
4,4'-DDT	50-29-3	0.0002	NC2B	0.0001	0.1	0.01	0.005
Aldrin	309-00-2	0.000049	NRWQC	2.45E-05	0.1	0.01	0.005
alpha-BHC	319-84-6	0.0026	NRWQC	0.0013	0.1	0.01	0.005
alpha-Chlordane	5103-71-9	0.0008	NRWQC, NC2B	0.0004	0.1	0.01	0.005
beta-BHC	319-85-7	0.0091	NRWQC	0.00455	0.1	0.01	0.007
delta-BHC	319-86-8	0.022	RSL Tapwater	0.011	0.1	0.01	0.007
Dieldrin	60-57-1	0.00005	NC2B	0.000025	0.1	0.01	0.005
Endosulfan I	959-98-8	7.8	RSL Tapwater	3.9	0.1	0.01	0.008
Endosulfan II	33213-65-9	7.8	RSL Tapwater	3.9	0.1	0.01	0.005
Endosulfan sulfate	1031-07-8	7.8	RSL Tapwater	3.9	0.1	0.01	0.005
Endrin	72-20-8	0.059	NRWQC	0.0295	0.1	0.01	0.008
Endrin aldehyde	7421-93-4	0.17	RSL Tapwater	0.085	0.1	0.01	0.005
Endrin ketone	53494-70-5	0.17	RSL Tapwater	0.085	0.1	0.01	0.005
gamma-BHC (Lindane)	58-89-9	0.036	RSL Tapwater	0.018	0.1	0.01	0.005
gamma-Chlordane	5103-74-2	0.0008	NRWQC, NC2B	0.0004	0.1	0.01	0.005
Heptachlor	76-44-8	0.000079	NRWQC	3.95E-05	0.1	0.01	0.007
Heptachlor epoxide	1024-57-3	0.000039	NRWQC	1.95E-05	0.1	0.01	0.005
Methoxychlor	72-43-5	2.7	RSL Tapwater	1.35	1	0.1	0.05
Toxaphene	8001-35-2	0.00028	NRWQC	0.00014	2	0.5	0.25

Notes:

[1] PALs were developed to be protective of human health and the environment.

[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.

Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.

NRWQC values are from the National Recommended Water Quality Criteria for human health (USEPA, 2006b).

NC2B values in the table are applicable to Human Health and Water Supply.

The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).

Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances

SAP Worksheet #15-17—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Water

Analytical Group: Herbicides

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L)	LODs (µg/L)	DLs (µg/L)
2,4,5-T	93-76-5	12	RSL Tapwater	6	0.4	0.2	0.1
2,4,5-TP (Silvex)	93-72-1	8.4	RSL Tapwater	4.2	0.4	0.2	0.1
2,4-D	94-75-7	13	RSL Tapwater	6.5	0.4	0.2	0.1
2,4-DB	94-82-6	9.1	RSL Tapwater	4.55	0.4	0.2	0.1
4-Nitrophenol	100-02-7	0.12	RSL Tapwater	0.06	0.4	0.2	0.125
Dalapon	75-99-0	47	RSL Tapwater	23.5	0.4	0.2	0.175
Dicamba	1918-00-9	44	RSL Tapwater	22	0.4	0.2	0.109
Dichloroprop	120-36-5	NC	NA	0.2	0.4	0.2	0.137
Dinoseb	88-85-7	1.1	RSL Tapwater	0.55	0.4	0.2	0.108
MCPA	94-74-6	0.57	RSL Tapwater	0.285	40	20	10
MCPP	93-65-2	1.2	RSL Tapwater	0.6	40	20	14
Pentachlorophenol	87-86-5	0.17	RSL Tapwater	0.085	0.4	0.2	0.126

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).
Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances

SAP Worksheet #15-18—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Water

Analytical Group: Total and Dissolved TAL Metals and Cyanide

Analyte	CAS Number	PAL	PAL Reference[1]	PQL Goal[2] (µg/L)	Laboratory-specific		
					LOQs (µg/L\)	LODs (µg/L)	DLs (µg/L)
Aluminum	7429-90-5	1600	RSL Tapwater	800	100	20	10
Antimony	7440-36-0	0.6	RSL Tapwater	0.3	1	0.5	0.25
Arsenic	7440-38-2	0.018	NRWQC	0.009	1	0.2	0.1
Barium	7440-39-3	290	RSL Tapwater	145	1	0.5	0.25
Beryllium	7440-41-7	1.6	RSL Tapwater	0.8	1	0.1	0.05
Cadmium	7440-43-9	0.69	RSL Tapwater	0.345	1	0.2	0.1
Calcium	7440-70-2	NC	NA	25	100	25	13
Chromium	7440-47-3	0.031	RSL Tapwater	0.0155	1	0.2	0.1
Cobalt	7440-48-4	0.47	RSL Tapwater	0.235	1	0.2	0.1
Copper	7440-50-8	62	RSL Tapwater	31	1	0.5	0.25
*Cyanide	57-12-5	0.93	RSL Tapwater	0.465	10	5	2.5
Iron	7439-89-6	300	NRWQC	150	100	10	5
Lead	7439-92-1	15	RSL Tapwater	7.5	1	0.1	0.05
Magnesium	7439-95-4	NC	NA	10	100	10	5
Manganese	7439-96-5	32	RSL Tapwater	16	1	0.2	0.1
Mercury	7439-97-6	0.43	RSL Tapwater	0.215	0.5	0.1	0.054
Nickel	7440-02-0	25	NC2B - Water Supply	12.5	1	0.2	0.1
Potassium	7440-09-7	NC	NA	20	100	20	10
Selenium	7782-49-2	7.8	RSL Tapwater	3.9	1	0.3	0.15
Silver	7440-22-4	7.1	RSL Tapwater	3.55	1	0.2	0.1
Sodium	7440-23-5	NC	NA	50	100	50	25
Thallium	7440-28-0	0.016	RSL Tapwater	0.008	1	0.2	0.1
Vanadium	7440-62-2	7.8	RSL Tapwater	3.9	1	0.5	0.25
Zinc	7440-66-6	470	RSL Tapwater	235	20	10	5

Notes:
[1] PALs were developed to be protective of human health and the environment.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
* Total Cyanide analysis only, groundwater samples will not be analyzed for Dissolved Cyanide
Refer to **Worksheets #10 and #11** for a detailed discussion on development of PALs.
NC – No Criteria. Refer to **Worksheets #10 and #11** for a discussion on how data will be used in the absence of applicable criteria.
NRWQC values are from the National Recommended Water Quality Criteria for human health (USEPA, 2006b).
The NC2B value presented in the table is applicable to Water Supply.
The RSL Tapwater values were adjusted from the USEPA RSLs Table (November 2012).
Shading indicates instances where the PAL is less than the LOD. Although non-detects will be reported at a value greater than the PAL, non-detects will not be considered exceedances

SAP Worksheet #15-19—Reference Limits and Evaluation Table – Site UXO-24

Matrix: Surface Water

Analytical Group: Hardness

Analyte	CAS Number	Laboratory-specific		
		LOQs (milligrams per liter [mg/L])	LODs (mg/L)	DLs (mg/L)
Hardness	HARDNESS[1]	10	10	10

Notes:
[1]This is a contractor-specific identifier.
There are no PALs for hardness. Hardness is to be analyzed for use in the risk assessments.

SAP Worksheet #16—Project Schedule/Timeline Table

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Work Plan preparation	CH2M HILL	10/8/2012	2/14/2013	Draft UFP-SAP	2/14/2013
Work Plan reviewed by Navy	Navy	2/14/2013	3/14/2013	Comments	3/14/2013
Work Plan – address Navy comments	CH2M HILL	3/14/2013	4/8/2013	Draft UFP-SAP	4/8/2013
Work Plan review and approval by regulatory agencies	NCDENR, USEPA Region IV	4/8/2013	5/8/2013	Comments	5/8/2013
Comment resolution	Navy, CH2M HILL	5/8/2013	5/10/2013	Draft UFP-SAP	5/10/2013
Final acceptance	Navy, NCDENR, USEPA Region IV	5/10/2013	5/10/2013	Final UFP-SAP	5/10/2013
Subcontracting	CH2M HILL	4/19/2013	4/27/2013	Subcontractor contracts	4/27/2013
Surveying and veg. clearance	Subcontractor w/ CH2M HILL	5/10/2013	5/10/2013	Clearance and surveying	5/10/2013
Field sampling and investigation activities	CH2M HILL	5/13/2013	5/31/2013	Intrusive investigation, environ. samples	5/29/2013
Laboratory analyses and data validation	CH2M HILL	5/30/2013	7/12/2013	Analytical and DV Reports	7/12/2013
Data management and report preparation	CH2M HILL	6/1/2013	7/31/2013	PA/SI Draft Report	8/1/2013

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SAP Worksheet #17—Sampling Design and Rationale

General Approach: The general approach for sampling was developed to meet Navy, USEPA, and NCDENR requirements for the preliminary investigation of environmental media that may have been impacted by munitions residuals, pesticides, and herbicides. The objectives of this PA/SI are to evaluate whether MEC/MPPEH is present, and if CERCLA-related releases of MC, pesticides, and herbicides have occurred, and if so, whether the releases warrant further investigation or action.

The site investigation will draw upon historical information and the results of the previous and ongoing investigations to guide the selection of areas for sample collection.

The general approach is as follows:

- Conduct intrusive investigation on up to 1,000 anomalies that may represent MEC/MPPEH in the western portion of the site. Collect subsurface soil samples where evidence of MEC/MPPEH leaking filler is observed to assess if a release of MC has occurred to the soil.
- Collect surface and subsurface soil samples to confirm and expand upon findings of the CSA conducted by Osage.
- Install permanent monitoring wells adjacent to intrusive investigation locations where the presence of MEC/MPPEH filler are observed to determine potential groundwater impacts of anomalies throughout the site.
- Collect surface water and sediment samples to assess potential impact of MC, herbicides, and pesticides to these media.

Sample Matrices: Sample matrices will include surface soil, subsurface soil, groundwater, surface water, and sediment.

Analytical Groups: The target analytical groups will be explosives residues (including PETN, nitroglycerin, 3,5-DNA), perchlorate, cyanide, total TAL metals (Refer to **Worksheets #15** for list of specific analytes), dissolved TAL metals (groundwater and surface water), cyanide, pesticides (surface soil, subsurface soil, surface water, and sediment only), herbicides (surface soil, subsurface soil, surface water, and sediment only),and hardness (surface water only).

The rationale for the selection of the target analytical groups is based on discovery of MEC at the site and on historical pesticide concentrations in subsurface soil.

Site Sample Numbers and Locations: The sampling approach, the rationale for the matrices to be sampled, the number of samples per matrix, the analytical groups, and the relevant concentration action levels are discussed in **Worksheets #10, #11**, **#14, and #15**. Exact sampling locations will be determined based on potential for a release resulting from the presence of MEC/MPPEH filler.

Sampling Frequency and Seasonal Considerations: The field sampling activities will be completed in multiple mobilizations. Since the objective of this PA/SI is only to identify the presence of potential environmental impacts, the assessment activities will not evaluate seasonal influences.

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

Site UXO-24

Matrix	Depth of Samples	Analysis	Method	Number of Samples	Rationale	Sampling Strategy
Groundwater	Middle of well screen	Explosives Residues (including PETN, Nitroglycerin, and 3,5-DNA)	SW-846 USEPA Method 8330/8332	Up to 3	Evaluate if shallow groundwater quality has been impacted by potential MC releases. Dissolved metals results will be used for ERS purposes. Up to three monitoring wells will be installed where the presence of MEC/MPPEH filler are observed during intrusive investigation activities. The number of monitoring wells will be selected to provide sufficient monitoring of groundwater quality within the DGM survey area, based on the observance of the potential for a release of MC.	The monitoring well locations will be hydraulically downgradient of potential MC release locations. Sampled using low-flow sampling techniques.
		Perchlorate	SW-846 USEPA Method 6850	Up to 3		
		TAL Metals	SW-846 USEPA Method 6020A/7470	Up to 3		
		Dissolved TAL Metals	SW-846 USEPA Method 6020A/7470	Up to 3		
		Cyanide	SW-846 USEPA Method 9014	Up to 3		
Surface Soil	0-2 inches bgs	Pesticides	SW-846 USEPA Method 8081	Up to 4	Evaluate if surface soils have been impacted by pesticide and herbicide releases. Samples will be located at former subsurface soil sample locations where pesticides/ herbicides were detected above screening criteria.	See **Figure 10-6** for proposed sampling locations. Grab sample collection.
		Herbicides	SW-846 USEPA Method 8151	Up to 4		

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

Matrix	Depth of Samples	Analysis	Method	Number of Samples	Rationale	Sampling Strategy
Subsurface Soil	Base of intrusive investigation location	Explosives Residues (including PETN, Nitroglycerin, and 3,5-DNA	SW-846 USEPA Method 8330/8332	Up to 10	Evaluate if subsurface soils have been impacted where the presence of MEC/MPPEH filler is observed during intrusive investigation activities. Refer to **Worksheet #11** and **Figure 11-1** for rationale.	Manual excavation, MEC avoidance. Sample collection from base of excavation using incremental sampling method.
		Perchlorate	SW-846 USEPA Method 6850	Up to 10		
		TAL Metals	SW-846 USEPA Method 6020A/7471A	Up to 10		
		Cyanide	SW-846 USEPA Method 9014	Up to 10		
	Above the water table and not exceeding a depth of 5 feet	Pesticides	SW-846 USEPA Method 8081	6	Evaluate if subsurface soils have been impacted by pesticide and herbicide application or releases. Samples collected within 40 feet of and surrounding former soil boring locations where pesticide/ herbicides were observed in order to confirm impacts to surrounding subsurface soil.	Samples to be hand augered or advanced with direct-push within the bounds of IR-37, MEC avoidance. Sample collection from above the water table.
		Herbicides	SW-846 USEPA Method 8151	6		

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

Matrix	Depth of Samples	Analysis	Method	Number of Samples	Rationale	Sampling Strategy
Sediment	Samples will be collected from 0 to 2 inches into the surface water/soil interface if free standing water is present.	Explosives Residues (including PETN, Nitroglycerin, and 3,5-DNA)	SW-846 USEPA Method 8330/8332	Up to 1	Evaluate if sediment has been impacted by contaminated runoff or shallow groundwater discharging in the creek. The sample will be collected approximately 50 feet downgradient from the DGM survey area. The sample will also be analyzed for pesticides and herbicides because some of those constituents have been detected in soil at the site.	Samples to be collected by hand within the unnamed small tributary of the site; MEC avoidance.
		Perchlorate	SW-846 USEPA Method 6850	Up to 1		
		TAL Metals	SW-846 USEPA Method 6020A/7471A	Up to 1		
		Pesticides	SW-846 USEPA Method 8081	Up to 1		
		Cyanide	SW-846 USEPA Method 9014	Up to 1		
		Herbicides	SW-846 USEPA Method 8151	Up to 1		
Surface Water	Samples will be collected directly from the surface water at each sampling location.	Explosives Residues (including PETN, Nitroglycerin, and 3,5-DNA)	SW-846 USEPA Method 8330/8332	Up to 1	Evaluate if surface water has been impacted by contaminated runoff or shallow groundwater discharging in the creek. Dissolved metals results will be used for ERS purposes. The sample will be collected approximately 50 feet downgradient from the DGM survey area. The sample will also be analyzed for pesticides and herbicides because some of those constituents have been detected in soil at the site.	One grab surface water sample will be collected along the unnamed small tributary within the site boundary; MEC avoidance.
		Perchlorate	SW-846 USEPA Method 6850	Up to 1		
		TAL Metals	SW-846 USEPA Method 6020A/7470A	Up to 1		
		Dissolved Metals	SW-846 USEPA Method 6020A/7470	Up to 1		
		Cyanide	SW-846 USEPA Method 9014	Up to 1		
		Pesticides	SW-846 USEPA Method 8081	Up to 1		
		Herbicides	SW-846 USEPA Method 8151	Up to 1		
		Hardness	SM 2340C	Up to 1		

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

Sample ID and Location[1]	Matrix	Analytical Group	Number of Samples	Sampling SOP Reference
Site UXO-24				See **Worksheet #21**
MR24-SS01-12B through MR24-SS04-12B **Figure 10-6**	Surface Soil	Pesticides and Herbicides	4	
MR24-TP01-#-#-12B through MR24-TP10-#-#-12B	Intrusive Investigation Subsurface Soil	Explosives Residues, Perchlorate, Metals, and Cyanide	Up to 10	
MR24-IS01-##-12B through MR24-IS06-##-12B **Figure 10-6**	Subsurface Soil	Pesticides and Herbicides	6	
MR24-MW01-12B through MR24-MW03-12B	Groundwater	Explosives Residues, Perchlorate, Metals, Dissolved Metals, and Cyanide	Up to 3	
MR24-SD01-12B and MR24-SD02-12B **Figure 10-7**	Sediment	Explosives Residues, Perchlorate, Metals, Pesticides, and Herbicides	1	
MR24-SW01-12B and MR24-SW02-12B **Figure 10-7**	Surface Water	Explosives Residues, Perchlorate, TAL Metals, Dissolved Metals, Pesticides, Herbicides, and Hardness	1	

Notes:
[1]Sample locations will be chosen based on DGM results if figure is not noted and field conditions.
[2] For subsurface soil samples, the depth interval will be indicated in the sample ID by “##-##”, e.g., “5-7”, or “50-55.”

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/SOP Reference	Containers[1]	Sample Volume	Preservation Requirements	Maximum Holding Time
Surface Soil, Subsurface Soil, Sediment, Intrusive Investigation Soil Samples	Explosives Residues	SW846 8330A/EMAX-8330	8 ounce (oz) Glass Jar	5 grams (g)	Cool to 6ºC	14 days to extraction/ 40 days to analysis
	Nitroglycerin and PETN	SW846 8332/EMAX-8332		2 g		14 days to extraction/ 40 days to analysis
	Perchlorate	SW846 6850/EMAX-6850		1.0 g		28 days
	Pesticides	SW846 8081A/EMAX-3520-8081		30 g		14 days to extraction/ 40 days to analysis
	Herbicides	SW846 8151A/EMAX-8151		10 g		14 days to extraction/ 40 days to analysis
	Metals	SW846 6020A/EMAX-6020	8 oz Glass Jar	2.0 g		180 days
	Mercury	SW846 7471A/EMAX-7471		1.0 g		28 days
	Cyanide	SW846 9014/EMAX-9014		0.5 g		14 days to extraction/ 40 days to analysis
Groundwater, Surface Water	Explosives Residues	SW846 8330A/EMAX-8330	1 liter (L) Amber Glass	200 milliliter (ml)	Cool to 6ºC	7 days to extraction/ 40 days to analysis
	Nitroglycerin and PETN	SW846 8332/EMAX-8332	1 L Amber Glass	4.0 ml		7 days to extraction/ 40 days to analysis
	Perchlorate	SW846 6850/EMAX-6850	250 ml High Density Polyethylene (HDPE), sterile filtration (option)	1.0 ml		28 days
	Pesticides	SW846 8081A/EMAX-3520-8081	1 L Amber Glass	1000 ml	Cool to 6ºC	7 days to extraction/ 40 days to analysis
	Herbicides	SW846 8151A/EMAX-8151	1 L Amber Glass	500 ml		7 days to extraction/ 40 days to analysis
	Total Metals	SW846 6020A/EMAX-6020	500 ml HDPE	50 ml	HNO3 Cool to 6ºC	180 days
	Total Mercury	SW846 7470A/EMAX-7470A		50 ml	HNO3 Cool to 6ºC	28 days
	Dissolved Metals	SW846 6020A/EMAX-6020	500 ml HDPE	50 ml	HNO3 Cool to 6ºC	180 days
	Dissolved Mercury	SW846 7470A/EMAX-7470A		50 ml	HNO3 Cool to 6ºC	28 days
	Cyanide	SW846 9014/EMAX-9014	250 ml HDPE	6 ml	NaOH Cool to 6ºC	14 days
Surface Water	Hardness	SM2340C/EMAX-2340C	No additional container necessary. Sufficient sample in the 500 ml HDPE for Total Metals and Total Mercury.	50 ml	HNO3, Cool to 6ºC	180 days

Notes:
[1]Merged cells indicate that this quantity of bottleware will be sufficient for all associated analyses, not that the type of bottleware is required per analysis.
Three times the required volume should be collected for samples designated as Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples.
Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted (not validated time of sample receipt).

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Field Blanks	No. of Equip. Blanks	Total No. of Samples to Lab
Surface Soil	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	4	1	1/1	1	1	9
	Perchlorate	4	1	1/1	1	1	9
	Total Metals	4	1	1/1	1	1	9
	Cyanide	4	1	1/1	1	1	9
	Pesticides	4	1	1/1	1	1	9
	Herbicides	4	1	1/1	1	1	9
Intrusive Investigation Soil Samples	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	10	3	2/2	1	3	21
	Perchlorate	10	3	2/2	1	3	21
	Total Metals	10	3	2/2	1	3	21
	Cyanide	10	3	2/2	1	3	27
Subsurface Soil	Pesticides	6	1	1/1	1	2	12
	Herbicides	6	1	1/1	1	2	12
Sediment	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	1	1	1/1	1	1	6
	Perchlorate	1	1	1/1	1	1	6
	Total Metals	1	1	1/1	1	1	6
	Cyanide	1	1	1/1	1	1	6
	Pesticides	1	1	1/1	1	1	6
	Herbicides	1	1	1/1	1	1	6

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

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Field Blanks	No. of Equip. Blanks	Total No. of Samples to Lab
Groundwater	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	3	1	1/1	1	1	8
	Perchlorate	3	1	1/1	1	1	8
	Total Metals	3	1	1/1	1	1	8
	Dissolved Metals	3	1	1/1	1	1	8
	Cyanide	3	1	1/1	1	1	8
	Pesticides	3	1	1/1	1	1	8
	Herbicides	3	1	1/1	1	1	8
Surface Water	Explosives Residues including 3,5-DNA, Nitroglycerin, and PETN	1	1	1/1	1	1	6
	Perchlorate	1	1	1/1	1	1	6
	Total Metals	1	1	1/1	1	1	6
	Dissolved Metals	1	1	1/1	1	1	6
	Cyanide	1	1	1/1	1	1	6
	Pesticides	1	1	1/1	1	1	6
	Herbicides	1	1	1/1	1	1	6
	Hardness	1	-	-	-	-	1

Notes:
Sample counts on this table represent maximums. Refer to **Worksheet #10** for discussion of sample count variations.
Matrix QA/QC sample counts are dependent on the number of sampling locations, and blank sample counts are dependent on the number of days of sampling, and may vary. Refer to **Worksheet #12** for details of field QA/QC sampling frequency. Refer to **Worksheet #28** for MS/MSD frequency.

SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Number and/or Date	Organization	Equipment Type	Modified for Project Work?	Comments
SOP-001	Completing Log Books, rev. 8/2012	CH2M HILL	Log book, indelible pen	No	
SOP-002	Locating and Clearing Underground Utilities, rev. 8/2012		Electromagnetic inductance		
SOP-003	Surface Water Sampling, rev. 8/2012		Sample containers, tripline		
SOP-004	Sediment Sampling, rev. 8/2012		Stainless steel spoon and bowls		
SOP-005	Soil Boring and Abandonment, rev. 8/2012		Drill rig		
SOP-006	Installation of Shallow Monitoring Wells, rev. 8/2012		Drill rig	Yes	Monitoring well installation through hollow-stem auger drilling techniques
SOP-007	Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using a Multi Parameter Water Quality Meter with Flow through Cell, rev. 08/2012		Water quality meter with flow-though cell	Yes	
SOP-008	Low-Flow Groundwater Sampling from Monitoring Wells, rev. 08/2012		Peristaltic pump or bladder pump, plastic tubing		Include purging a minimum of one well volume per NCDENR
SOP-009	Decontamination of Personnel and Equipment, rev. 8/2012		Reusable sampling equip.	No	
SOP-010	Decontamination of Drilling Rigs and Equipment, rev. 8/2012		Steam cleaner and decon pad		
SOP-011	Disposal of Waste Solids and Fluids, rev. 8/2012		5-gallon buckets with on-base disposal		
SOP-012	Equipment Blank and Field Blank Preparation, rev. 3/2010		Lab-provided blank liquid and sample bottles		
SOP-013	Packaging and Shipping Procedures for Low-Concentration Samples, rev. 08/2012		Lab-supplied coolers		
SOP-014	Chain-of-Custody, rev. 08/2012		Chain-of-Custody Form		
SOP-015	UXO Contacts		Staff Form		
SOP-016	DPT Soil Sample Collection 08/2012		Direct-push technology (DPT) rig		
SOP-017	Soil Sampling During Excavations, rev. 08/2012		Stainless steel spoon and bowls		Soil sampling will be done by hand method
SOP-018	Logging of Soil Borings, rev. 08/2012		Log form, Uniform Soil Classification System (USCS) guide		
SOP-019	GPS, rev. 08/2012		Trimble GPS unit		
SOP-020	Sample Contents of Tanks and Drums, rev. 08/2012		Rubber mallet, bung wrench, socket		
SOP-021	Shallow Soil Sampling, rev. 05/2011		Hand auger, stainless trowel		

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

Field Equipment	Activity[1]	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference[2]	Comments
Peristaltic Pump/ProActive Mini-Monsoon Submersible Pump/Bladder Pump	Maintenance	As needed, regularly	Specific per model/instruction manual	Rental and/or manufacturer support for pump malfunctions	FTL	SOP-008	
Water Quality Meter	Calibrate probes	Daily, as needed	Parameter specific per model/instruction manual	Manufacturer technical support for calibration errors	FTL	SOP-07	

Notes:
1 Activities may include calibration, verification, testing, and maintenance.
2 See **Worksheet #21**.

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SAP Worksheet #23—Analytical SOP References Table

All SOPs from the laboratories are reviewed yearly. If no revisions are needed to the SOP, the revision date is not updated.

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to Quality Systems Manual (QSM)	Modified for Project Work? (y/n)
EMAX-8081	Organochlorine Pesticides By Gas Chromatography (GC), Revision 7 (last reviewed date: 11/12/12)	Definitive	Organic – GC in Water Soil	GC	EMAX	None	N
EMAX-8151	Chlorinated Herbicides, Revision 3 (last reviewed date: 08/30/12)	Definitive	Organic – GC in Water Soil	GC	EMAX	None	N
EMAX-8330	Nitroaromatics & Nitramines By High Performance Liquid Chromatography (HPLC), Revision 7 (last review date: 02/15/12)	Definitive	Organic – HPLC in Water Soil	HPLC	EMAX	None	N
EMAX-8332	Nitroglycerin & PETN, Revision 1 (last review date: 06/29/12)	Definitive	Organic –HPLC in Water Soil	HPLC	EMAX	None	N
EMAX-9014	Cyanide, Total, Rev 6. (last reviewed date: 08/14/12)	Definitive	Wet Chem in Water Soil	Spectrophotometer	EMAX	None	N
EMAX-6020	Trace Metals By Inductively Coupled Plasma-Mass Spectrometer (ICP-MS), Revision 7 (last review date: 11/14/12)	Definitive	Metals in Water Soil	ICP-MS	EMAX	None	N
EMAX-7470	Mercury, Revision 7 (last review date: 12/11/12)	Definitive	Metals in Water	Cold Vapor	EMAX	None	N
EMAX-7471	Mercury, Revision 7 (last review date: 12/11/12)	Definitive	Metals in Soil	Cold Vapor	EMAX	None	N
EMAX-6850	Perchlorate By HPLC-MS, Revision 0 (last review date: 12/28/12)	Definitive	Inorganic – HPLC in Water Soil	HPLC-MS	EMAX	None	N
EMAX-QS00	Quality Systems Manual, Revision 4 (last review date: 09/01/12)	NA	QA/QC	NA	EMAX	None	N
EMAX-SM01	Sample Management, Revision 6 (last review date: 04/30/12)	NA	Sample Management	NA	EMAX	None	N
EMAX-SM02	Sample Receiving, Revision 7 (last review date: 06/14/12)	NA	Sample Management	NA	EMAX	None	N
EMAX-SM03	Waste Disposal, Revision 5 (last reviewed date: 01/18/12)	NA	Sample Management	NA	EMAX	None	N
EMAX-2340C	Hardness, Total, Revision 2 (last review date: 04/18/12)	Screening	Hardness in Water	Titration	EMAX	None	N

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
GC/HPLC/ion chromatography (IC) (Explosives Residues, Pesticides, Herbicides)	Initial calibration (ICAL)	ICAL prior to sample analysis and as needed	One of the following options: 1) Relative Standard Deviation (RSD) for all analytes ≤ 20% 2) linear – least squares regression r > =0.995 3) non-linear – COD > 0.990 (6 points shall be used for second order, 7 points shall be used for third order	Locate the source of the problem. If expected RSD is not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem, then repeat ICAL.	Analyst	EMAX-8330, EMAX-8332, EMAX-8081, EMAX-8151
	Initial calibration verification (ICV)	Once after each ICAL	All project analytes within established retention time windows. GC Methods: All project analytes within ±20% of expected value from ICAL. HPLC/IC Methods: All project analytes within ±15% of expected value from ICAL.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.		
	Continuing calibration verification (CCV)	Daily, before sample analysis, after every 10 field samples, and at the end of analysis sequence	All project analytes within established retention time windows. GC Methods: All project analytes within ±20% of expected value from ICAL. HPLC/IC Methods: All project analytes within ±15% of expected value from ICAL.	Diagnose problem. Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem. Reanalyze all samples since last successful CCV. If problem persists, repeat ICAL.		
Liquid chromatography (LC)-MS (Perchlorate)	ICAL	ICAL prior to sample analysis and as needed	One of the following options: 1) RSD for all analytes ≤ 20% 2) linear – least squares regression r > =0.995	Locate the source of the problem. If expected RSD is not met, check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem, then repeat ICAL.	Analyst	EMAX-6850/ DoD QSM
	Second source calibration verification	Once after each ICAL	Value of second source for all analytes within ±15% of expected value (initial source).	Prepare fresh standard and reanalyze second source to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance, and rerun ICAL and second source verification standard. If problem continues, new standards may need to be purchased, prepared, and analyzed.	Analyst	EMAX-6850/ DoD QSM

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
LC-MS (Perchlorate) (cont.)	Continuing calibration	Daily, before sample analysis, every 12 hours, and at the end of analysis sequence	Within ±15% of expected value.	Diagnose problem. Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem. Reanalyze all samples since last successful CCV.	Analyst	EMAX-6850/DoD QSM
	LOD verification (per batch); perchlorate spike concentration approximately 2 x LOD.	Prior to sample analysis and at the end of the sequence	Within ±30% of expected value.	Diagnose and correct problem. If problem persists, perform instrument adjustment and/or maintenance to correct the problem. Reanalyze all samples since last successful LOD verification (LODV). If a sample with a perchlorate result between reporting limit (RL) and LOD is bracketed by a failing LODV, it must be re-analyzed. Samples with concentrations above the LOQ can be reported.		
	Isotope Ratio 35Cl/37Cl	Every sample, batch QC and standard	Monitor for either the parent ion at masses.	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.).		EMAX-6850/DoD QSM
ICP/ICP-MS (TAL Metals and Cyanide)	ICAL	Daily	If more than one calibration standard is used, r >= 0.995.	Locate the source of the problem. Check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem and then repeat ICAL.	Analyst	EMAX-6010, EMAX-6020/ DoD QSM
	Low level calibration check standard	Once after each ICAL	Value of all project analytes within 20% of true value.	Diagnose the problem. Prepare fresh standard and re-analyze to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-6010, EMAX-6020/ DoD QSM
	ICV	Once after each ICAL	Value of all project analytes within 10% of true value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-6010, EMAX-6020/DoD QSM
	CCV	After every 10 field samples, and at the end of analysis sequence	Value of all project analytes within 10% of true value.	Diagnose problem. Prepare fresh standard and re-analyze CCV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem. Reanalyze all samples since last successful CCV. If problem persists, repeat ICAL.		

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

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Cold Vapor Atomic Absorption (CVAA) (Mercury)	ICAL	Daily	r >= 0.995	Locate the source of the problem. Check for standard degradation or perform instrument adjustment and/or maintenance to correct the problem and then repeat ICAL.	Analyst	EMAX-7470, EMAX-7471/ DoD QSM
CVAA (Mercury)	ICV	Once after each ICAL	Value of all project analytes within 10% of true value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-7470, EMAX-7471/ DoD QSM
CVAA (Mercury)	CCV	After every 10 field samples, and at the end of analysis sequence	Value of all project analytes within 20% of true value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument adjustment and/or maintenance to correct the problem and repeat ICAL.	Analyst	
Spectrometer (Cyanide)	ICAL	Daily	Correlation Coefficient (r2) >0.995	Locate the source of the problem. If outliers exist, prepare fresh calibration standards and repeat ICAL. If problem persists, perform Photometric Linearity Check. If maximum absorbance is non-compliant, replace the spectrometer lamp and repeat the ICAL.	Analyst	EMAX-9014
Spectrometer (Cyanide)	ICV	After ICAL	All analytes within + 15% of expected value.	Prepare fresh standard and re-analyze ICV to rule out standard degradation or inaccurate injection. If problem persists, perform instrument maintenance to correct the problem and repeat ICAL.	Analyst	EMAX-9014
Spectrometer (Cyanide)	CCV	Daily before sample analysis	All analytes within + 15% of expected value.	Repeat calibration and reanalyze all samples.	Analyst	EMAX-9014
	Distilled Standards (one high one low)	One per calibration	All analytes within + 15% of expected value.	Investigate issue and repeat distilled standards.		

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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	CA	Responsible Person	SOP Reference
LC-MS (Explosives Residues)	Parameter setup	Physical check	Check that the autosampler is functioning as expected.	Initially; prior to each use	Autosampler must move to the expected position when activated.	Reset to SOP setup if parameter checks reveal deviations. Notate all adjustments in Daily Maintenance Log.	Laboratory Chemist	EMAX-8330
GC (PETN and Nitroglycerin)	Parameter setup	Physical check	Check that the autosampler is functioning as expected.	Initially; prior to each use	Refer to instrument optimize temperature program setup.	Reset to SOP set-up, if parameter checks reveal deviations. Notate all adjustments in Daily Maintenance Log.	Laboratory Chemist	EMAX-8332
LC-MS (Perchlorate)	Tune check	Instrument performance	Conformance to instrument tuning.	Initially; prior to dynamic current-offset calibration (DCC)	Compliance to ion abundance criteria as specified by the method.	Repeat tune check to rule out standard degradation or inaccurate injection. If problem persists, perform retune the instrument and repeat tune check.	Laboratory Chemist	EMAX-6850
LC-MS (Perchlorate)	ICS	Instrument performance and interference	Conformance to interference limits.	At minimum daily and once per batch	Within 30% of true value.	Terminate analysis, reanalyze ICS to rule out standard degradation or inaccurate injection. If problem persists, perform instrument maintenance, repeat calibrations and reanalyze all associated samples. Potential issues include cleanup columns and analytical column.		
GC (Pesticides)	Parameter setup	Physical check	Check that temperature program is set at the most recently determined optimum condition.	Initially; prior to each use	Refer to instrument optimize temperature program setup.	Reset to optimized temperature setup (e.g., if temperature program is optimized at the following conditions): Initial Temperature=40°C, hold for 1 minute, Ramp=6°C, Final Temperature= 200°C, Injection port=160°C, Interface=250°C, then instrument setting must be on that condition when checked.	Laboratory Chemist	EMAX-8081
GC (Pesticides)	Endrin and DDT breakdown check	Instrument performance	Conformance to breakdown limits.	Every 12 hours	Degradation ≤°15% of each analyte.	Clean or replace the injection liner and repeat breakdown check.	Laboratory Chemist	EMAX-8081

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table **(continued)**

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
HPLC (Herbicides)	Parameter setup	Physical check	Check that temperature program is set at the most recently determined optimum condition.	Initially; prior to each use	Refer to instrument optimize temperature program setup.	Reset autosampler; if problem persists, perform autosampler troubleshooting prior to instrument use.	Laboratory Chemist	EMAX-8151
ICP (TAL Metals)	ICS	Instrument performance	Conformance to interference check.	Prior to sample analysis	Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified impurity from a spiked analyte).	Terminate analysis; reanalyze ICS to rule out standard degradation or inaccurate injection. If problem persists, perform instrument maintenance, repeat calibrations and reanalyze all associated samples.	Laboratory Chemist	EMAX-6010
ICP-MS (TAL Metals)	Parameter setup	Physical check	Check that the autosampler is functioning as expected. Check pump rate, nebulizer gas flow, and rinse bottle.	Initially; prior to each use	Autosampler must move to the expected position when activated. Pump rate: 0.08-0.12 revolutions per second Nebulizer gas flow: 1.05-1.25 liters per minute (L/min) Rinse bottle: filled to mark	Reset autosampler; if problem persists, perform autosampler troubleshooting prior to instrument use. Adjust pump rate if necessary otherwise perform pump trouble-shooting. Adjust gas flow as needed otherwise perform instrument troubleshooting. Fill rinse bottle to mark.	Laboratory Chemist	EMAX-6020
ICP-MS (TAL Metals)	Tune check	Instrument performance	Conformance to instrument tuning.	Initially; prior to DCC	Compliance to ion abundance criteria as specified by the method.	Repeat tune check to rule out standard degradation or inaccurate injection. If problem persists, retune the instrument and repeat tune check.	Laboratory Chemist	EMAX-6020

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table **(continued)**

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference
ICP-MS (TAL Metals)	Interference check solution (ICS)	Instrument performance	Conformance to interference check	Prior to sample analysis	+ 20% of expected value	Terminate analysis; reanalyze ICS to rule out standard degradation or inaccurate injection. If problem persists, perform instrument maintenance, repeat calibrations, and reanalyze all associated samples.	Laboratory Chemist	EMAX-6020
ICP-MS (TAL Metals)	Continuing calibration blank (CCB)	Instrument performance	Instrument contamination check	Verification – Before samples, after every 10, and at the end of sequence.	No analytes detected > LOD	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank, and all associated samples.	Laboratory Chemist	EMAX-6020
CVAA (Mercury)	Initial calibration blank (ICB)/CCB	Instrument performance	Instrument contamination check	After every calibration. Verification – Before samples, after every 10, and at the end of sequence.	No analytes detected ≥ LOD	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.	Laboratory Chemist	EMAX-7470, EMAX-7471
Spectrometer (Cyanide)	ICB/CCB	Instrument performance	Instrument contamination check	After every calibration verification	No analytes detected > RL	Determine possible source of contamination and apply appropriate measure to correct the problem. Reanalyze calibration blank and all associated samples.	Laboratory Chemist	EMAX-9014

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SAP Worksheet #26—Sample Handling System

Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): TBD/CH2M HILL
Sample Packaging (Personnel/Organization): TBD/CH2M HILL
Coordination of Shipment (Personnel/Organization): TBD/CH2M HILL
Type of Shipment/Carrier: Overnight Carrier/FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Jonathan Luna/EMAX
Sample Custody and Storage (Personnel/Organization): Indra Patel/EMAX
Sample Preparation (Personnel/Organization): Marina Lyudmirskaya/EMAX
Sample Determinative Analysis (Personnel/Organization): Dr. Tu Nisamaneepong/EMAX
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days after delivery of report
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 90 days after delivery of report
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Richard Beauvil/EMAX
Number of Days from Analysis: 14-28 days after release from archives

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SAP Worksheet #27—Sample Custody Requirements Table

Sample Labeling Procedures

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, preservative, analysis group or method, and sampler's initials. A standardized nomenclature system will be used to ensure accurate data retrieval of all samples collected. Each sample will be designated by an alphanumeric code that will identify the facility, site, station ID, matrix sampled, and/or date and depth sampled. QA/QC samples will have a unique sample designation. Nomenclature for samples and field QA/QC is specified on **Worksheet #18**. The field log book will identify the sample ID with the location, depth, date/time collected, and the parameters requested.

Field Sample Custody Procedures (Sample Collection, Packaging, Shipment, and Delivery to Laboratory)

Field samples will be collected by the field team members under the supervision of the FTL. As samples are collected, they will immediately be placed in the appropriate containers and labeled, as outlined above. The labels will be filled out in the field by the field crew at the time of sample collection and checked before being placed into the cooler, at which time the sample will be logged in on the chain of custody form and field log book. The integrity of the sample labels will be maintained through the practice of placing sample containers in watertight, resealable, plastic bags.

Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples below 6°C until they are received by the laboratory. The chain of custody will also be placed into the cooler. Coolers will be shipped to the laboratory via FedEx, with the airbill number indicated on the chain of custody (to relinquish custody). The FTL is responsible for the care and custody of samples until they are shipped or otherwise delivered to the laboratory custodian as described in Section 4.3 of the MPPs (CH2M HILL, 2008). Upon delivery, the laboratory will log in each cooler and report the status of the samples, discussed as follows.

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 log book to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management System (LIMS) database for each sample.

Laboratory Sample Custody Procedures (Receipt of Samples, Archiving, Disposal)

The laboratory receiving samples will comply with all sample custody requirements outlined in the laboratory SOPs referenced in **Worksheet #23**.

All samples from Site UXO-24 will be shipped to EMAX Laboratories in Torrence, California.

Sample Integrity

A sample tracking system will be followed to ensure sample authenticity and data defensibility. The PC will notify the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. The PC will ensure samples arrive to the lab in the appropriate timeframe and the condition of samples upon receipt is satisfactory. If samples are not delivered to the lab in the acceptable timeframe or condition, the PM will be notified and the decision will be made whether to recollect samples.

The PC is responsible for checking the chain-of-custody forms against the field log book and field project instructions to verify the sample ID, times, analyses, and methods are correct on the chain-of-custody form. Any discrepancies will be resolved with the field team and relayed to the lab. These actions will be documented by both the lab and the PC. The lab is responsible for providing the PC with sample login sheets the day of sample receipt in order for the PC to verify the lab has accounted for all samples shipped and has correctly logged the samples into its software system.

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SAP Worksheet #28-1—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Explosives Residues
Analytical Method/SOP Reference: SW846 8330A/EMAX-8330

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and re-prep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½ RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-1A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-1A**, based on DoD QSM v.4.2.
Laboratory Control Sample (LCS)	One per preparation batch		Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-1A—Laboratory QC Limits

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Explosives Residues

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
1,3,5-Trinitrobenzene	75	125	30	50
1,3-Dinitrobenzene	80	125	30	50
2,4,6-Trinitrotoluene	55	140	30	50
2,4-Dinitrotoluene	80	125	30	50
2,6-Dinitrotoluene	80	120	30	50
2-Amino-4,6-dinitrotoluene	80	125	30	50
2-Nitrotoluene	80	125	30	50
3,5-DNA	50	135	30	50
3-Nitrotoluene	75	120	30	50
4-Amino-2,6-dinitrotoluene	80	125	30	50
4-Nitrotoluene	75	125	30	50
HMX	75	125	30	50
Nitrobenzene	75	125	30	50
RDX	70	135	30	50
Tetryl	10	150	30	50
Surrogate				
1,2-Dinitrobenzene	60	140		

SAP Worksheet #28-2—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment

Analytical Group: Explosives Residues – Nitroglycerin and PETN

Analytical Method/SOP Reference: SW846 8332/EMAX-8332

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-2A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-2A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-2A—Laboratory QC Limits

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Explosives Residues – Nitroglycerin and PETN

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
Nitroglycerin	50	150	30	50
PETN	50	150	30	50
Surrogate				
1,2-Dinitrobenzene	60	140		

SAP Worksheet #28-3—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Perchlorate
Analytical Method/SOP Reference: SW846 6850/EMAX-6850

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and re-prep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
LCS	One per preparation batch	Recovery of 80-120%	Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.		Accuracy/Bias	Recovery of 80-120%
MS/MSD	Project Designated sample in matrix QC	Recovery of 80-120%, RPD 15%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/ reanalyze the sample.		Accuracy/Bias/Precision	Recovery of 80-120%, RPD 15%

SAP Worksheet #28-4—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment

Analytical Group: Perchlorate

Analytical Method/SOP Reference: SW846 6850/EMAX-6850

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and re-prep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
LCS	One per preparation batch	Recovery of 80-120%	Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.		Accuracy/Bias	Recovery of 80-120%
MS/MSD	Project Designated sample in matrix QC	Recovery of 80-120%, RPD 15%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	Recovery of 80-120%, RPD 15%

SAP Worksheet #28-5—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment

Analytical Group: Pesticides

Analytical Method/SOP Reference: SW846 8081/EMAX-8081

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-5A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-5A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC.		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-5A—Laboratory QC Limits

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Pesticides

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
4,4'-DDD	30	135	30	50
4,4'-DDE	70	125	30	50
4,4'-DDT	45	140	30	50
Aldrin	45	140	30	50
alpha-BHC	60	125	30	50
alpha-Chlordane	65	120	30	50
beta-BHC	60	125	30	50
delta-BHC	55	130	30	50
Dieldrin	65	125	30	50
Endosulfan I	15	135	30	50
Endosulfan II	35	140	30	50
Endosulfan sulfate	60	135	30	50
Endrin	60	135	30	50
Endrin aldehyde	35	145	30	50
Endrin ketone	65	135	30	50
gamma-BHC (Lindane)	60	125	30	50
gamma-Chlordane	65	125	30	50
Heptachlor	50	140	30	50
Heptachlor epoxide	65	130	30	50
Methoxychlor	55	145	30	50
Surrogate				
Decachlorobiphenyl	55	130		
tetrachloro-m-xylene (TCMX)	70	125		

SAP Worksheet #28-6—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment

Analytical Group: Herbicides

Analytical Method/SOP Reference: SW846 8151/EMAX-8151

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-6A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-6A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Re-prep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC.		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-6A—Laboratory QC Limits

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment
Analytical Group: Herbicides

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
2,4,5-T	45	135	30	30
2,4,5-TP (Silvex)	45	125	30	30
2,4-D	35	145	30	30
2,4-DB	50	155	30	30
4-Nitrophenol	30	150	30	30
Dalapon	20	160	30	30
Dicamba	55	110	30	30
Dichloroprop	75	140	30	30
Dinoseb	20	130	30	30
MCPA	20	160	30	30
MCPP	40	160	30	30
Pentachlorophenol	40	130	30	30
Surrogate				
DCPAA	30	140		

SAP Worksheet #28-7—Laboratory QC Samples Table – Site UXO-24

Matrix: Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment

Analytical Group: TAL Metals including Mercury

Analytical Method/SOP Reference: SW846 6020, 7471/EMAX-6020, EMAX-7470

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
LCS	One per preparation batch	Recovery of 80-120%	Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.	Laboratory Chemist	Accuracy/Bias	Recovery of 80-120%
MS/MSD	Project Designated sample in matrix QC	Recovery of 75-125%, RPD 20%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.	Laboratory Chemist	Accuracy/Bias/Precision	Recovery of 75-125%, RPD 20%
Dilution Test	Per sample preparation batch.	1:5 dilution must agree within +-10% of the original determination	Perform post digestion spike addition.	Analyst	Accuracy/Bias	1:5 dilution must agree within +-10% of the original determination
Analytical Spike	When dilution test fails or analyte concentration in all samples < 50 x LOD	Recovery within 75-125% of expected value	Run all samples by method of standard addition (MSA).	Analyst	Interferences - Accuracy/Bias - Precision	Recovery within 75-125% of expected value

SAP Worksheet #28-8—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water

Analytical Group: Explosives Residues

Analytical Method/SOP Reference: SW846 8330A/EMAX-8330

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-8A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-8A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-8A—Laboratory QC Limits

Matrix: Groundwater, Surface Water
Analytical Group: Explosives Residues

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
1,3,5-Trinitrobenzene	65	140	20	30
1,3-Dinitrobenzene	45	160	20	30
2,4,6-Trinitrotoluene	50	145	20	30
2,4-Dinitrotoluene	60	135	20	30
2,6-Dinitrotoluene	60	135	20	30
2-Amino-4,6-dinitrotoluene	50	155	20	30
2-Nitrotoluene	45	135	20	30
3,5-DNA	45	135	20	30
3-Nitrotoluene	50	130	20	30
4-Amino-2,6-dinitrotoluene	55	155	20	30
4-Nitrotoluene	50	130	20	30
HMX	80	115	20	30
Nitrobenzene	50	140	20	30
RDX	50	160	20	30
Tetryl	20	175	20	30
Surrogate				
1,2-Dinitrobenzene	60	140		

SAP Worksheet #28-9—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water

Analytical Group: Explosives Residues – Nitroglycerin and PETN

Analytical Method/SOP Reference: SW846 8332/EMAX-8332

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Laboratory Chemist	Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.
LCS	One per preparation batch	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.	Re-prep and reanalyze LCS and all samples processed with the non-conforming LCS.	Laboratory Chemist	Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.
MS/MSD	Project Designated sample in matrix QC	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.	Laboratory Chemist	Accuracy/Bias/ Precision	Refer to QC limits presented on **Worksheet #28-9A**, based on DoD QSM v.4.2.

SAP Worksheet #28-9A—Laboratory QC Limits

Matrix: Groundwater, Surface Water
Analytical Group: Explosives Residues – Nitroglycerin and PETN

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
Nitroglycerin	50	150	20	30
PETN	50	150	20	30
Surrogate				
1,2-Dinitrobenzene	60	140		

SAP Worksheet #28-10—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Perchlorate
Analytical Method/SOP Reference: SW846 6850/EMAX-6850

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
LCS	One per preparation batch	Recovery of 80-120%	Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.		Accuracy/Bias	Recovery of 80-120%
MS/MSD	Project Designated sample in matrix QC	Recovery of 80-120%, RPD 15%	If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	Recovery of 80-120%, RPD 15%

SAP Worksheet #28-11—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Pesticides
Analytical Method/SOP Reference: SW846 8081/EMAX-8081

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-11A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-11A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Reprep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-11A—Laboratory QC Limits

Matrix: Groundwater, Surface Water
Analytical Group: Pesticides

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
4,4'-DDD	25	150	20	30
4,4'-DDE	35	140	20	30
4,4'-DDT	45	140	20	30
Aldrin	25	140	20	30
alpha-BHC	60	130	20	30
alpha-Chlordane	65	125	20	30
beta-BHC	65	125	20	30
delta-BHC	45	135	20	30
Dieldrin	60	130	20	30
Endosulfan I	50	110	20	30
Endosulfan II	30	130	20	30
Endosulfan sulfate	55	135	20	30
Endrin	55	135	20	30
Endrin aldehyde	55	135	20	30
Endrin ketone	75	125	20	30
gamma-BHC (Lindane)	25	135	20	30
gamma-Chlordane	60	125	20	30
Heptachlor	40	130	20	30
Heptachlor epoxide	60	130	20	30
Methoxychlor	55	150	20	30
Surrogate				
Decachlorobiphenyl	30	135		
TCMX	25	140		

SAP Worksheet #28-12—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Herbicides
Analytical Method/SOP Reference: SW846 8151/EMAX-8151

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparation batch	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.	Determine cause of contamination and reprep and reanalyze method blank and all samples processed with the non-conforming method blank.	Laboratory Chemist	Contamination	No analytes detected > ½°RL. For common laboratory contaminants, no analytes detected > RL. Blank result must not otherwise affect sample results.
Surrogates	Every analytical sample	Refer to QC limits presented on **Worksheet #28-12A**, based on DoD QSM v.4.2.	Correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	Refer to QC limits presented on **Worksheet #28-12A**, based on DoD QSM v.4.2.
LCS	One per preparation batch		Re-prep and reanalyze LCS and all samples processed with the non-conforming LCS.			
MS/MSD	Project Designated sample in matrix QC		If result is indicative of matrix interference, discuss in case narrative. Otherwise check for possible source of error, and extract/reanalyze the sample.		Accuracy/Bias/ Precision	

SAP Worksheet #28-12A—Laboratory QC Limits

Matrix: Groundwater, Surface Water
Analytical Group: Herbicides

Analyte	LCS/MS – Lower Limit	LCS/MS – Upper Limit	LCS – RPD	MS – RPD
2,4,5-T	35	110	30	30
2,4,5-TP (Silvex)	50	115	30	30
2,4-D	35	115	30	30
2,4-DB	45	130	30	30
4-Nitrophenol	30	150	30	30
Dalapon	40	110	30	30
Dicamba	60	110	30	30
Dichloroprop	70	120	30	30
Dinoseb	20	100	30	30
MCPA	60	145	30	30
MCPP	30	150	30	30
Pentachlorophenol	30	150	30	30
Surrogate				
DCPAA	30	140		

SAP Worksheet #28-13—Laboratory QC Samples Table – Site UXO-24

Matrix: Groundwater, Surface Water
Analytical Group: Hardness
Analytical Method/SOP Reference: SM 2340 C

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct the problem. If required, reprep and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/ Laboratory Area Supervisor	Contamination/ Bias	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.
LCS	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits. 80-120%	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for the failed analyte, if sufficient sample material is available.	Analyst/ Laboratory Area Supervisor	Accuracy/Bias	QC acceptance criteria specified in DoD QSM v4.1, if available. Otherwise use in-house limits.
Sample Duplicate (DUP)	One per preparatory batch of up to 20 samples.	Use in-house recovery limits for LCS. RPD $\leq$ 20% (between MS and MSD or sample and sample duplicate).	If both the LCS and DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/ Laboratory Area Supervisor	Precision/ Accuracy/Bias	Use in-house recovery limits for LCS. RPD $\leq$ 20% (between MS and MSD or sample and sample duplicate).

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SAP Worksheet #29—Project Documents and Records Table

Sample Collection Documents and Records	Onsite Analysis Documents and Records	Offsite Analysis Documents and Records	Data Assessment Documents and Records	Other
• Field Note books • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables • Identification of QC Samples • Meteorological Data from Field (logging daily weather) • Sampling Locations and Sampling Plan • Sampling Notes	• No onsite analysis will take place	• Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample Disposal Records • Extraction/Cleanup Records • Raw Data (stored on disk)	• Fixed Laboratory Audit Checklists • Data Validation Reports • CA Forms • Laboratory QA Plan • Method Detection Limit (MDL) Study Information	

Sample collection documents and records will be scanned and saved on the network server. Field parameters will be loaded into the database using the Field Data Entry Tool.

Offsite analysis documents and records will be archived after a period of 6 months. Hardcopy deliverables from the DV as well as other data assessment documents and records will be archived.

Laboratory data will be loaded in the Navy NIRIS system.

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/ Organization[1]
Surface Soil, Subsurface Soil, Intrusive Investigation Soil Samples, and Sediment	Explosives Residues	See **Worksheet°#18**	SW846 8330	28 calendar days	EMAX Laboratories, Inc. Molly Nguyen 1835 West 205th Street Torrance, CA 90501 (310) 618-8889	TBD
	Nitroglycerin and PETN		SW846 8332			
	Perchlorate		SW846 6850			
	Pesticides		SW846 8081			
	Herbicides		SW846 8151			
	Total Metals		SW846 6020A/7471A			
	Cyanide		SW846 9014			
Groundwater and Surface Water	Explosives Residues		SW846 8330			
	Nitroglycerin and PETN		SW846 8332			
	Perchlorate		SW846 6850			
	Pesticides		SW846 8081			
	Herbicides		SW846 8151			
	Total/Dissolved Metals		SW846 6020A/7470A			
	Cyanide		SW846 9014			
	Hardness[2]		SM2340A			

[1]If circumstances arise that render a lab unable to provide analytical services, a backup laboratory will be chosen at that time.
[2]Surface water only.

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Field Performance Audit	One during sampling activities	Internal	CH2M HILL	Dan Hockett PM CH2M HILL	FTL CH2M HILL	Dan Hockett PM CH2M HILL	Dan Hockett PM CH2M HILL
Offsite Laboratory Technical Systems Audit	Laboratory must have current DoD Environmental Laboratory Accreditation Program (ELAP) evaluation letter, which will identify the period of performance. The laboratory must be re-evaluated prior to expiration of the period of performance.	External	Third Party Accrediting Body	TBD, Third Party Accrediting Body	Kenneth Pimentel EMAX	EMAX Laboratories QA Officer	Anita Dodson, Program Chemist, CH2M HILL
Safe Behavior Observation	One/week during field activities	Internal	CH2M HILL	Site Safety Coordinator CH2M HILL	Field Team Member observed CH2M HILL	Carl Woods H&S Manager CH2M HILL	Site Safety Coordinator 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	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	FTL CH2M HILL	Within 1 day of audit	Verbal and Memorandum	FTL CH2M HILL	Within 1 day of receipt of Correction Action Form
Laboratory Performance and Systems Audits	Written Audit Report	EMAX Laboratories QA Officer	Within 2 months of audit	Memorandum	DoD ELAP Auditor	Within 2 months of receipt of initial notification
Safe Behavior Observation (SBO)	Safe Behavior Observation Form	Carl Woods H&S Manager CH2M HILL	Within 1 week of SBO	Memorandum	Field Team Member CH2M HILL	Immediately

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SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating CA ______________________________ **Date** ______________

Description of problem and when identified: ______________________________

____

____

____

____

Cause of problem, if known or suspected: ______________________________

____

____

____

____

<u>Sequence of CA:</u> (including date implemented, action planned and personnel/data affected) ______________

____

____

____

____

CA implemented by: ______________________________ **Date:** ______________

CA initially approved by: ______________________________ **Date:** ______________

Follow-up date: ______________________________

Final CA approved by: ______________________________ **Date:** ______________

Information copies to:

<u>Anita Dodson, CH2M HILL Navy CLEAN Program Chemist</u>

____

____

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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 ___ 2) 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 ______________________

____

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

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

____

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

____

Yes ___ No ___ 7) Are photographs taken and documented?
Comments ____

____

Document Control

Yes ___ No ___ 1) Have any accountable documents been lost?
Comments ____

____

Yes ___ No ___ 2) Have any accountable documents been voided?
Comments ____

____

Yes ___ No ___ 3) Have any accountable documents been disposed of?
Comments ____

____

Yes ___ No ___ 4) Are the samples identified with sample tags?
Comments ____

____

Yes ___ No ___ 5) Are blank and duplicate samples properly identified?
Comments ____

____

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

____

Yes ___ No ___ 7) Is chain-of-custody documented and maintained?
Comments ____

____

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Field Audit Report	One during sampling activities	Submitted with Final Report	Dan Hockett PM CH2M HILL	Included in project files.

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

Data Review Input	Description	Responsible for Verification (name, organization)	Step I and IIa/IIb[1]	Internal/ External[2]
Field Note books	Field note books will be reviewed internally and placed into the project file for archival at project closeout.	FTL (TBD)/CH2M HILL	I	Internal
Chains of Custody and Shipping Forms	Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody form will be initialed by the reviewer, a copy of the chain-of-custody form retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chain-of-custody forms will also be reviewed for adherence to the SAP by the PC.	FTL (TBD)/CH2M HILL PC: Bianca Kleist/ CH2M HILL	I	Internal and External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.	PC: Bianca Kleist/ CH2M HILL	I	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative, which becomes part of the final hardcopy data package.	PC: Bianca Kleist/CH2M HILL	I	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10 percent check).	PC: Bianca Kleist/ CH2M HILL	I	External
Case Narrative	Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages.	Data Validation Subcontractor: EDS	I	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Laboratory QA Officer (EMAX Laboratories)	I/IIa	Internal
Laboratory Data	The data will be verified for completeness by the PC.	PC: Bianca Kleist/CH2M HILL	I	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	PM: Dan Hockett/CH2M HILL PC: Bianca Kleist/CH2M HILL	I	Internal
CA Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM: Dan Hockett/CH2M HILL PC: Bianca Kleist/CH2M HILL	I	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	PC: Bianca Kleist/CH2M HILL	IIa	External
TCL and TAL	Ensure the laboratory reported all analytes from each analysis group.	PC: Bianca Kleist/CH2M HILL	I/IIa	External

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

Data Review Input	Description	Responsible for Verification (name, organization)	Step I and IIa/IIb[1]	Internal/ External[2]
RLs	Ensure the laboratory met the project-designated quantitation limits (QLs). If QLs were not met, the reason will be determined and documented.	PC: Bianca Kleist/CH2M HILL	IIb	External
Field SOPs	Ensure that all field SOPs were followed.	FTL: TBD	IIa	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Laboratory QA Officer (EMAX Laboratories)	IIa	Internal
Raw Data	10 percent review of raw data to confirm laboratory calculations.	Data Validation Subcontractor: EDS	IIa	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	FTL: TBD	IIb	Internal
Documentation of Method QC Results	Establish that all required QC samples were run.	Data Validation Subcontractor: EDS	IIa	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run.	PC: Bianca Kleist	IIb	Internal
DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP Certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC: Bianca Kleist/CH2M HILL	IIb	External
All analytical groups on **Worksheet #20** for Surface Soil, Subsurface Soil, Groundwater, Sediment and Surface Water (all analytical groups except hardness)	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in *National Functional Guidelines for Organic Data Review* (USEPA, 1999), or *National Functional Guidelines for Inorganic Data Review* (USEPA, 2004). National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Data Validation Subcontractor: EDS	IIa	External
Surface Water: hardness	Analytical methods will not undergo third-party data validation, but are subject to all other data review protocols detailed above.	NA	NA	NA

[1] Verification (Step I) is a completeness check that is performed before the data review process continues in order to determine whether the required information (complete data package) is available for further review. Validation (Step IIa) is a review that the data generated are in compliance with analytical methods, procedures, and contracts. Validation (Step IIb) is a comparison of generated data against MPC in the SAP (both sampling and analytical).

[2] Internal or external is in relation to the data generator.

SAP Worksheet #37—Usability Assessment

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

- Non-detected site contaminants will be evaluated to ensure that project required LODs (**Worksheet #15**) were achieved. If LODs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- The third-party DV 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.
- For statistical comparisons, non-detect values will be represented by a concentration equal to one-half the sample LOD. For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data have been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.

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

- To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be reconciled with MPC following validation and review of DQIs.
- If significant biases are detected with laboratory QA/QC samples, they will be evaluated to assess impact on decision-making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between lab and field precision, the cause will be further evaluated to assess impact on decision-making.

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

- Data tables will be produced to reflect detected and non-detected site contaminants of concern (COCs) and geochemical parameters. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- Figures will be produced to reflect areas of investigation including DGM anomaly detection and environmental sampling locations and results. A data quality evaluation will be provided as part of the supplemental investigation technical memorandum prepared to assess site conditions.
- If needed, a technical memorandum will be produced that will identify any data usability limitations and make recommendations for CA.

Identify the personnel responsible for performing the usability assessment.

The CH2M HILL team, including the PM and PC will review the data and compile a presentation for the MCIEAST-MCBCAMLEJ Partnering Team. The MCIEAST-MCBCAMLEJ Partnering Team as a whole will assess the usability of the data.

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Figures

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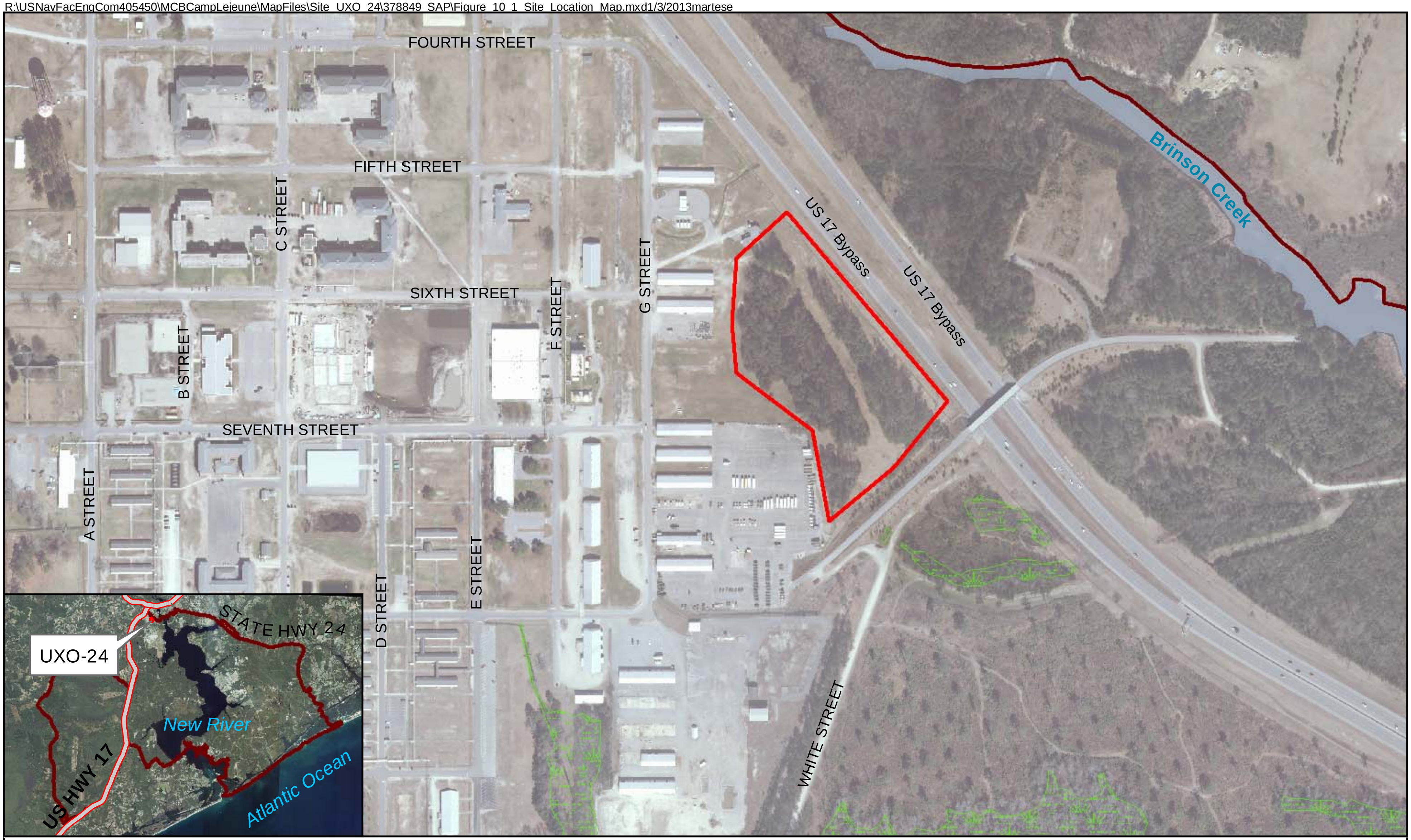

Legend
UXO-24 Boundary
Installation Boundary

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 10-1
Site Map
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

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Legend
- Site 37 Boundary
- UXO-24 Boundary
- Installation Boundary
- Wetlands

N

0 300 600 Feet

1 inch = 300 feet

Figure 10-2
Site UXO-24 and IR Site 37 Boundaries
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

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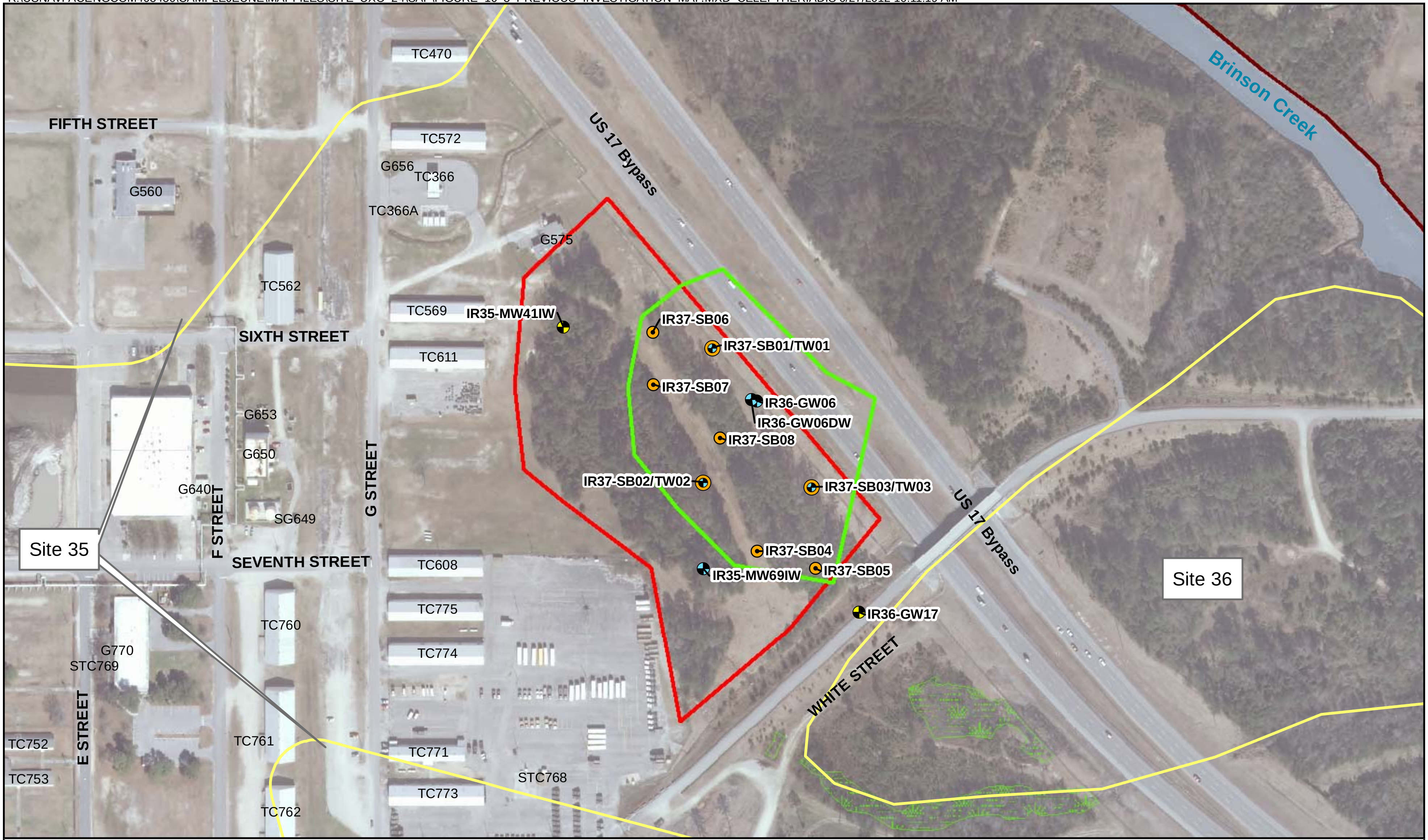

Legend

- Monitoring Wells
- Abandoned Monitoring Wells
- Soil Sample Location
- Soil/Groundwater Sample Location
- Site 37 Boundary
- UXO-24 Boundary
- Installation Boundary
- Wetlands
- IR Sites

N

0 300 600 Feet

1 inch = 300 feet

Figure 10-3
Previous Investigation Map
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

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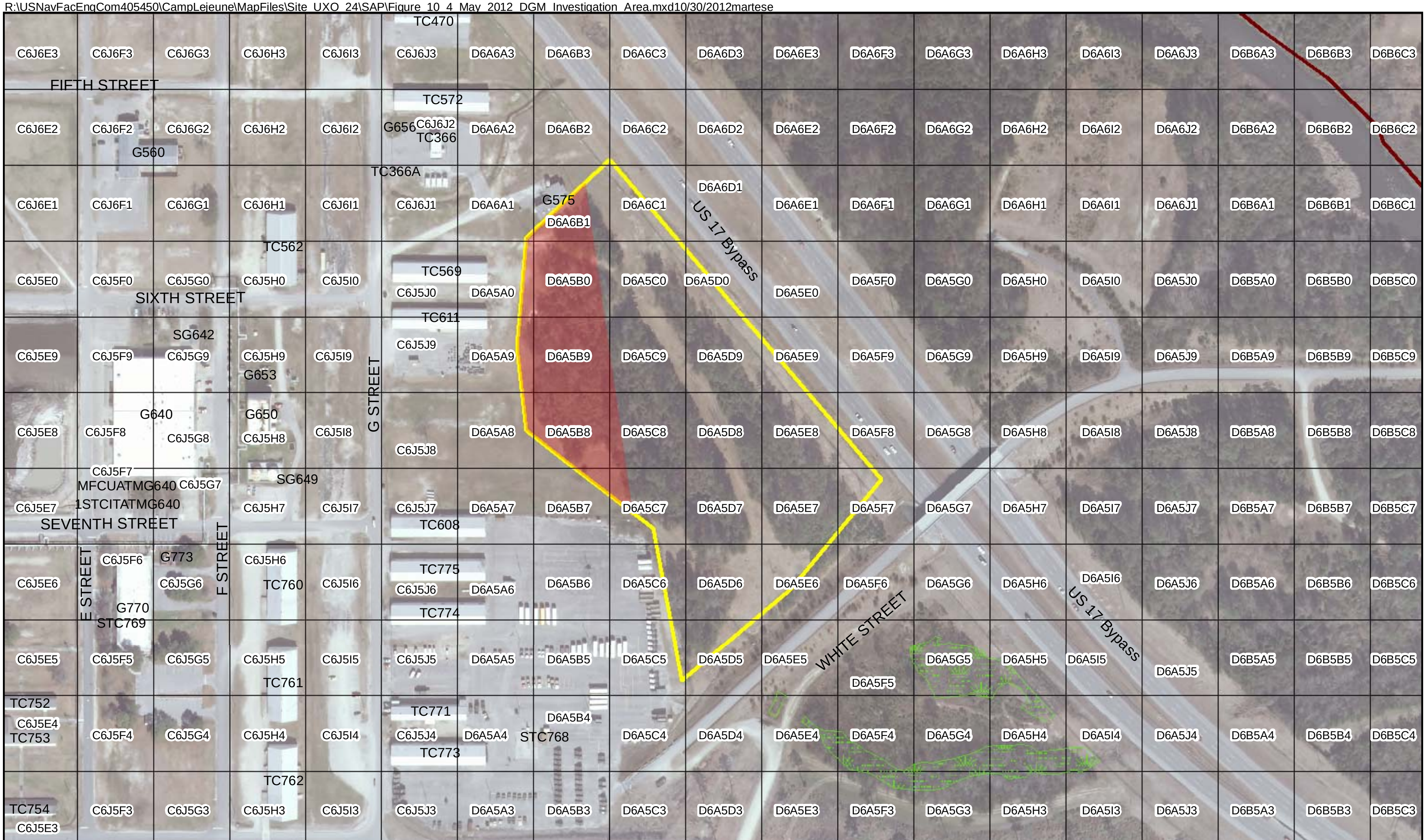

Legend
- UXO-24 Boundary
- Installation Boundary
- 50x50 meter grid
- Wetlands
- DGM Survey Area

N

0 150 300 600 Feet

1 inch = 300 feet

Figure 10-4
May 2012 DGM Investigation Area
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

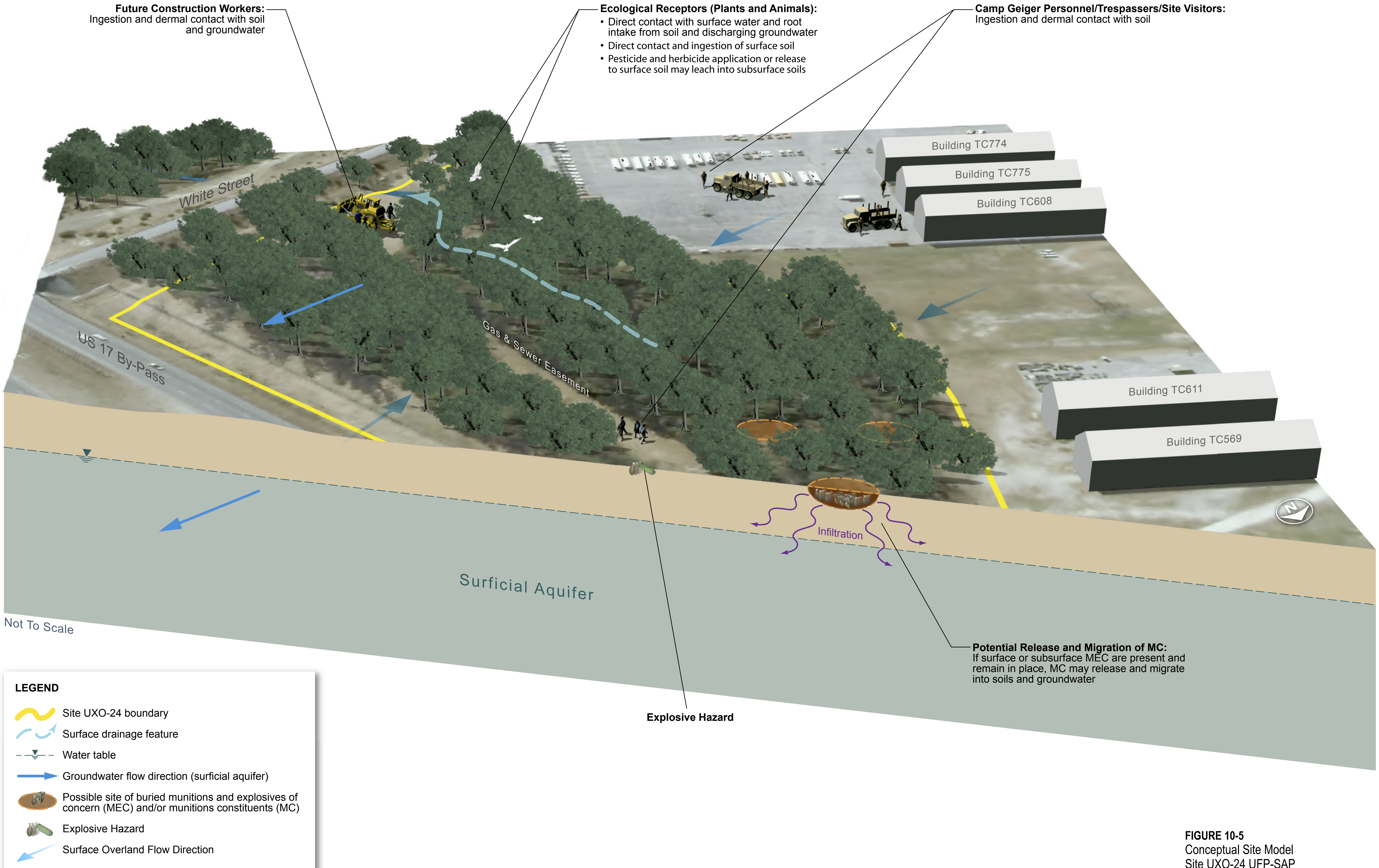

FIGURE 10-5
Conceptual Site Model
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL.

R:\USNAVFACENGCOM405450\CAMPLEJEUNE\MAPFILES\SITE_UXO_24\SAP\FIGURE_10_6_PROPOSED_SS_AND_SB_LOCATIONS.MXD CELEFTHERIADIS 6/27/2012 10:17:55 AM

Legend

- Proposed Subsurface Soil Sample Locations
- IR37 CSA Subsurface Soil Sample Locations
- IR 37 CSA Subsurface and Proposed Surface Soil Sample Locations
- Site 37 Boundary
- UXO-24 Boundary
- Installation Boundary
- Wetlands

N

0 300 600 Feet

1 inch = 300 feet

Figure 10-6
Proposed Surface Soil and Subsurface Soil Locations Map
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

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Legend

- Proposed Surface Water and Sediment Location
- Stream
- Wetlands
- UXO-24 Boundary
- Installation Boundary

N

0 150 300 600 Feet

1 inch = 300 feet

Figure 10-7
Proposed Surface Water and Sediment Location
Site UXO-24 UFP-SAP
MCIEAST-MCBCAMLEJ
North Carolina

CH2MHILL

Attachment 1
Field Standard Operating Procedures—CH2M HILL

WHERE TO GO FOR MR PROJECT SUPPORT
March 2008

CH2MHILL

CH2M HILL OE Team- March 2008

- Ben Redmond/KNV – MR Market Segment Director
- George DeMetropolis/SDO – MR Western Region MR Market Segment Manager
- Brint Bixler/WDC – MR Northeastern Region MR Market Segment Manager
- Kyra Donnell/KNV - MR Southeastern Region MR Market Segment Manager
- Steve Romanow/WDC – MR Project Delivery Manager
- Kevin Lombardo/WDC- MR Operations Manager
- Dan Young/NVR – MR H&S&E Manager
- Tamir Klaff/WDC - MR Geophysicist
- Tim Garretson/VBO – MR EOD Lead for Navy CLEAN

CH2MHILL

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

   - Company name and address
   - Log-holders name if log book was assigned specifically to that person
   - Activity or location

- Project name
- Project manager's name
- Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified,

and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

- Description of the general sampling area – site name, buildings and streets in the area, etc.
- Station/Location identifier
- Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
- Sample matrix and type
- Sample date and time
- Sample identifier
- Draw a box around the sample ID so that it stands out in the field notes
- Information on how the sample was collected – distinguish between "grab," "composite," and "discrete" samples
- Number and type of sample containers collected
- Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)
- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C.**

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These "dig permit" requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor’s experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the “Miss Utility” service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1)** ***a 20-ft radius of the XX proposed soil boring locations*** **(OR)** ***within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint** ***(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) ***The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.***

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

   The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Buried Utility Location Tracking Form

(Submit to CH2M HILL PM within 24 hrs of location activities)

Project Location:
CH2M HILL Project No.:
CH2M HILL Project Manager: Name/Phone:
Fax:
Email:
CH2M HILL Field Team Leader: Name/Phone:

CH2M HILL Purchase Order:

Utility Location Subcontractor:
Subcontractor POC:

Dates of location activities:

	Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.																	
Station ID	**Gas (Yellow)**	**Electric (Red)**	**Fiber optic (Orange)**	**Cable (Orange)**	**Water (Blue)**	**San. Sewer (Green)**	**Storm Sewer (Green)**	**Steam (Yellow)**	**Petroleum (Yellow)**	**Compressed air (Yellow)**	**Other ____**	**Other ____**	**Other ____**	**Other ____**	**Date completed**	**Technician initials**	Notes (methods/tools used)

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.

______________________________ ____________
Subcontractor's Signature Date

STANDARD OPERATING PROCEDURE

Surface Water Sampling

I. Purpose and Scope

This procedure presents the techniques used in collecting surface water samples. Materials, equipment, and procedures may vary; refer to the Field Sampling Plan and operators manuals for specific details.

II. Materials and Equipment

Materials and equipment vary depending on type of sampling; the Field Sampling Plan should be consulted for project-specific details. Typical equipment required includes:

- Open tube sampler
- Dip sampler
- Weighted bottle sampler
- Hand pump
- Kemmerer or Van Dorn sampler
- Depth-integrating sampler
- Peristaltic pump
- Sample containers
- Meters for specific conductance, temperature, pH, and dissolved oxygen

III. Procedures and Guidelines

Before surface water samples are taken, all sampler assemblies and sample containers are cleaned and decontaminated as described in SOP *Decontamination of Personnel and Equipment*. Surface water samples collected from water bodies tidally influenced should be collected at low tide and under low flow conditions to minimize the dilution of potential contaminants. Methods for surface water sample collection are described below.

A. Manual Sampling

Surface water samples are collected manually by submerging a clean glass, stainless steel, or Teflon container into the water body. Samples may be collected at depth with a covered bottle that can be removed with a tripline. The most common sampler types are beakers, sealable bottles and jars, pond samplers, peristaltic pumps, and weighted bottle samplers. Pond samplers have a fixed or telescoping pole attached to the sample container. Weighted bottle samplers are lowered below water surface, where the attached bottle is opened, allowed to fill, and pulled out of the water. When retrieved, the bottle is tightly capped and removed from the sampler assembly. Specific types of weighted bottle samplers include Kemmerer or Van Dorn and are acceptable in most instances.

A sample is taken with the following specific steps:

1. The location and desired depth for water sampling are selected.

2. The sample site is approached from downstream in a manner that avoids disturbance of bottom sediments as much as possible. The sample bottle is gently submerged with the mouth pointed upstream and the bottle tilted slightly downstream. Bubbles and floating materials should be prevented from entering the bottle. If using a Peristaltic pump, lower the tubing into the water to the desired depth.

3. For weighted bottle samplers, the assembly is slowly lowered to the desired depth. The bottle stopper is unseated with a sharp tug and the bottle is allowed to fill until bubbles stop rising to the surface.

4. When the bottle is full, it is gently removed from the water. If sample transfer is required, it should be performed at this time.

5. Measure dissolved oxygen, specific conductance, temperature, and pH at the sampling location.

IV. Attachments

None.

V. Key Checks and Items

- Start downstream, work upstream
- Log exact locations using permanent features
- Beware of hidden hazards

STANDARD OPERATING PROCEDURE

Sediment Sampling

I. Purpose

These general outlines describe the collection and handling of sediment samples during field operations.

II. Scope

The sediment sampling procedures generally describe the equipment and techniques needed to collect representative sediment samples. Operators manual, if available, should be consulted for specific details

III. Equipment and Materials

- Sample collection device (hand corer, scoop, dredge, grab sampler, or other suitable device)
- Stainless steel spoon or spatula or plastic disposable scoop for media transfer
- Measuring tape
- Log book
- Personal protection equipment (rubber or latex gloves, boots, hip waders, etc.)
- Materials for classifying soils, particularly the percentage of fines
- Sample jars, including jars for Total Organic Carbon and pH, as appropriate

IV. Procedures and Guidelines

1. Field personnel will start downstream and work upstream to prevent contamination of unsampled areas. In surface water bodies that are tidally influenced, sampling will be performed at low tide and under low flow conditions to minimize the dilution of possible contaminants. Sediment sampling activities will not occur immediately after periods of heavy rainfall.
2. 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. Whenever possible, include measured distances from such identifying features. Also include depth and width of waterway, rate of flow, type and consistency of sediment, and point and depth of sample removal (along shore, mid-channel, etc).

3. Note in the field book any possible outside sources of contamination; for example, the outlet to a drainage culvert in the water body near your sampling location.

4. Transfer sample into appropriate sample jars with a stainless steel utensil or plastic disposable scoop. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the 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 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.

5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.

6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.

7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.

8. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.

9. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

V. Attachments

None.

VI. Key Checks and Items

- Start downstream, work upstream.
- Log exact locations using permanent features.
- Beware of hidden hazards.

Soil Boring Drilling and Abandonment

I. Purpose and Scope

The purpose of this guideline is to describe methods to obtain samples of subsurface soil using either hollow-stem auger, rotary or sonic drilling methods, or tripod-mounted rig and then backfill boreholes to the surface. The guideline covers both split-spoon sampling and thin-walled tube sampling and includes soil borings through surface casings installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units.

II. Equipment and Materials

- Truck-mounted drilling rig, skid rig, or tripod rig
- Hollow-stem augers and associated equipment or either rotary-drilling or sonic-drilling equipment
- Black iron steel or Schedule 80 PVC casing, at least 6-inch inside diameter (if surface casing is required), or sonic rig with telescoping casing
- Split-spoon or thin-walled tube samplers
- Downhole compacting tool (e.g., a pipe with a flat plate attached to the bottom)
- Cement
- Bentonite

III. Procedures and Guidelines

A. Drilling

Continuous-fight hollow-stem augers (HSA) with an inside diameter of at least 3.25 inches typically are used. The use of water or other fluid to assist in hollow-stem drilling will be avoided. Rotary drilling will be with a similar minimum diameter.

The bit of the auger or drill is placed on the ground at the location to be drilled and then turned with the drilling or soil-coring rig. The drilling is advanced to a depth just above the top of the interval to be sampled. For sonic drilling, a continuous core is collected and the sample interval is selected from the length of core run.

While advancing the auger or drill to the full borehole depth, the soils removed from the boring will be screened using a portable volatile organics detector.

A tripod drilling rig is generally a tripod equipped to collect soil samples using a hammer-driven sampler. The soil sample collection will be the same as that outlined for hollow-stem and rotary drilling. Borehole collapse due to soft sediments may occur when collecting samples using a tripod drilling rig.

Temporary surface casing may be installed where soil borings will penetrate a confining layer. The surface casing will be installed to prevent potential contamination in shallow water-bearing units from migrating downward into deeper units. Typically, surface casing has a 6-inch inside diameter (ID).

If the split-spoon sampling is to be advanced with a 3.25-inch ID and 7.25-inch outside diameter (O.D.) HSA, it will be necessary to pull the 3.25-inch augers and ream the hole with a minimum 10.25-inch ID HAS for the installation of the temporary surface casing. Alternatively, if the split-spoon sampling is advanced with mud-rotary drilling, it would require a 10.25-inch rotary bit to make room for the 6-inch I.D. surface casing.

The surface casing will be seated at least 5 feet into an underlying clay or silt layer and will be sealed in place using a bentonite slurry or bentonite pellets. This seal will prevent movement of groundwater downward from the shallow water-bearing unit but will allow the casing to be removed easily when the split-spoon sampling is completed. The split-spoon sampling will then be advanced with a 6-inch mud-rotary bit.

B. Sampling

Using the drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded on the boring log and/or field notebook. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations. Samples will be collected from the soil borings at 2-foot to 5-foot intervals. For sonic drilling, a continuous core is collected and the sample interval is selected from the length of core run.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. Samples may be collected for chemical analysis. These samples are collected in either decontaminated stainless-steel split-spoon samplers or new plastic sleeves for sonic drilling. Sampling the soil for chemical analysis is described in SOP *Soil Boring Sampling – Split Spoon.*

Undisturbed fine-grained samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes). 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 and then sealed with end caps and heavy tape. The sample designation, data 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, which could disrupt the undisturbed nature of the sample. Samples for geochemical analysis normally are not collected from thin-walled tube samples. More details are provided in the ASTM D 1587 standard (attached).

C. Abandonment

The borehole will be grouted from total depth to the surface with bentonite-cement grout. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface. When installing grout in soil borings, the grout will be installed through a tremie pipe that is placed inside the augers or to the bottom of the borehole. The grouting will be completed before the augers or any temporary casing or drilling mud is removed.

D. Decontamination and Waste Disposal

Before sampling begins, equipment will be decontaminated according to the procedures identified in SOPs *Decontamination of Personnel and Equipment* and *Decontamination of Drilling Rig and Equipment.* The location to be sampled is cleared of debris and trash, and the location is noted in the logbook.

The soil cuttings are to be drummed and managed as described in SOP *Disposal of Waste Fluids and Soils* and the investigation-derived waste management plan.

IV. Attachments

ASTM D 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*

ASTM D 1587 *Standard Practice for Thin-Walled Tube Sampling of Soils*

V. Key Checks and Preventative Maintenance

- Check that the drilling rig or soil-coring rig is in working order.
- Check that the borehole is grouted to the ground surface at the completion of drilling and sampling.

STANDARD OPERATING PROCEDURE

Installation of Shallow Monitoring Wells

I. Purpose and Scope

The purpose of this guideline is to describe methods for drilling and installation of shallow monitoring wells and piezometers in unconsolidated or poorly consolidated materials using hollow stem augers, air rotary, or mud rotary. Installing monitoring wells in unconsolidated materials using sonic drilling is discussed in SOP *Installation of Monitoring Wells Using Sonic Drilling*. Methods for drilling and installing bedrock monitoring wells and deep, surface-cased wells in unconsolidated materials are presented in SOPs *Installation of Bedrock Monitoring Wells* and *Installation of Surface-Cased Monitoring Wells,* respectively.

II. Equipment and Materials

Drilling

- Drilling rig (hollow stem auger, air rotary or mud rotary) and associated tools and equipment

Well Riser/Screen and Associated Materials

- Polyvinyl chloride (PVC), Schedule 40, minimum 2-inch ID, flush-threaded riser; alternatively, stainless-steel riser
- PVC, Schedule 40, minimum 2-inch ID, flush-threaded, factory slotted screen; alternatively, stainless-steel screen
- PVC bottom cap, threaded to match the well screen; alternatively, stainless steel
- PVC or stainless-steel centering guides (if used)
- Above-grade well completion: PVC well cap, threaded or push-on type, vented
- Flush-mount well completion: PVC well cap, locking, leak-proof seal
- Stainless steel to be used as appropriate

Sand

- Clean silica sand, provided in factory-sealed bags, well-rounded, containing no organic material, anhydrite, gypsum, mica, or calcareous material; primary (coarse – e.g., Morie #1) filter pack, and secondary (fine sand seal) filter pack. Grain size determined based on sediments observed during drilling.

Bentonite

- Pure, additive-free bentonite pellets or chips

- Pure, additive-free powdered bentonite
- Coated bentonite pellets; coating must biodegrade within 7 days
- Cement-Bentonite Grout: proportion of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage.

Protective Casing

- Above-grade well completion: 6-inch minimum ID black iron steel pipe with locking cover, diameter at least 2 inches greater than the well casing, painted with epoxy paint for rust protection; heavy duty lock; protective posts if appropriate
- Flush-mount well completion: Morrison 9-inch or 12-inch 519 manhole cover, or equivalent; rubber seal to prevent leakage; locking cover inside of road box

Well Development

- Surge block
- Well-development pump and associated equipment
- Calibrated meters to ensure pH, temperature, specific conductance, ORP, and dissolved oxygen of development water
- Containers (e.g., DOT-approved 55-gallon drums) for water produced from well.

III. Procedures and Guidelines

A. Drilling Method

Typically, continuous-flight hollow-stem augers with a minimum 4.25-inch inside diameter (ID) will be used to drill shallow monitoring well boreholes for 2-inch diameter monitoring wells. Alternatively, air or mud rotary may be used.

The bit of the auger is placed at the ground surface and then turned with the drilling rig. To collect split spoon samples, the auger is advanced to the top of the sampling depth, and the split-spoon sample is collected from below the auger head. The split spoon is advanced through repeated blows from a 140- or 300-pound hammer dropped from a height of 30 inches. Thin-walled tube samplers are advanced by pressing down on the rods with the weight of the drilling rig. Split-spoon samples may be collected at selected intervals for chemical analysis and/or lithologic classification. Soil sampling procedures are detailed in SOPs *Soil Boring Sampling – Split Spoons* and *Soil Sampling*.

The use of water to assist in hollow-stem auger drilling for monitoring well installation will be avoided, unless required for such conditions as running sands.

Hollow-stem augers, drilling bits, rods, split-spoon samplers, and other downhole drilling tools will be properly decontaminated prior to the initiation of drilling activities and between each borehole location. Split-spoon samplers and other downhole soil sampling equipment will also be properly decontaminated before and after each use. SOP *Decontamination of Drill Rigs and Equipment* details proper decontamination procedures.

Drill cuttings and decontamination fluids generated during well drilling activities will be contained according to the procedures detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan (IDWMP).

Air or mud rotary drilling may be used instead of hollow-stem augers. The use of added mud should be kept to a minimum.

B. Monitoring-Well Installation

Shallow monitoring wells will be constructed inside the hollow-stem augers, once the borehole has been advanced to the desired depth, or in the mudded borehole once the drilling rods have been withdrawn. If the borehole has been drilled to a depth greater than that at which the well is to be set, the borehole will be backfilled with bentonite pellets or chips or a bentonite-cement slurry to a depth approximately 1 foot below the intended well depth. Approximately 1 foot of clean sand will be placed on top of the bentonite to return the borehole to the proper depth for well installation.

The appropriate lengths of well screen, nominally 10 feet (with bottom cap), and casing will be joined watertight and lowered inside the augers to the bottom of the borehole. Centering guides, if used, will be placed at the bottom of the screen and above the interval in which the bentonite seal is placed.

Selection of the filter pack and well screen intervals for the shallow monitoring wells shall be made in the field.

A primary sand pack consisting of clean Morie No. 00 (or DSI No.1) silica sand for 10-slot screen and Morie No. 01 (or DSI No.2) for 20-slot screen silica sand will be placed around the well screen. The sand will be placed into the borehole at a uniform rate, in a manner that will allow even placement of the sand pack. The augers will be raised gradually during sand pack installation to avoid caving of the borehole wall; at no time will the augers be raised higher than the top of the sand pack during installation. During placement of the sand, the position of the top of the sand will be continuously sounded. The primary sand pack will be extended from the bottom of the borehole to a minimum height of 2 feet above the top of the well screen. A secondary, finer-grained (fine sand seal), sand pack will be installed for a minimum of 1 foot above the coarse sand pack. Heights of the coarse and fine sand packs and bentonite seal may be modified in the field to account for a shallow water table and a small saturated thickness of the surficial aquifer.

A bentonite seal at least 2 feet thick will be placed above the sand pack. The seal will be placed into the borehole in a manner that will prevent bridging. The position of the top of the bentonite seal will be verified using a weighted tape measure. If all or a portion of the bentonite seal is above the water table, clean water will be added to hydrate the bentonite. A hydration period of at least 30 minutes will be required following installation of the bentonite seal.

Above the bentonite seal, an annular seal of cement-bentonite grout will be placed. The cement-bentonite grout will be installed continuously in one operation from the bottom of the space to be grouted to the ground surface through a tremie pipe. The tremie pipe must be plugged at the bottom and have small openings along the sides of the bottom 1-foot length of pipe. This will allow the grout to diffuse laterally into the borehole and not disturb the bentonite pellet seal.

C. Well Completion

For monitoring wells that will be completed above-grade, a locking steel protective casing set in a concrete pad will be installed. The steel protective casing will extend at least 3 feet into the ground and 2 feet above ground but should not penetrate the bentonite seal. The concrete pad will be square, approximately 2 feet per side (unless otherwise specified in the project plans), and poured into wooden forms. The concrete will be sloped away from the protective casing.

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12 inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

D. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring-well construction (MWSingleDiag.xls)

STANDARD OPERATING PROCEDURE

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Horiba or YSI Water Quality Parameter Meter with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality parameter meter (e.g., Horiba® or YSI) for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The YSI instrument does not measure turbidity. A separate turbidity meter (i.e., Hanna Turbidity Meter) will need to be used in conjunction with the YSI meter. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Parameter Meter such as a Horiba® Water Quality Monitoring System or YSI with flow-though cell
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. Parameters and Specifications:

Parameter	Range of measurement	Accuracy
pH	0 to 14 pH units	+/- 0.1 pH units
Specific conductance	0 to 9.99 S/m	+/- 3 % full scale
Turbidity	0 to 800 NTU	+/- 5 % full scale
Dissolved oxygen	0 to 19.99 mg/l	+/- 0.2 mg/l
Temperature	0 to 55 ^{o}C	+/- 1.0 ^{o}C
ORP	-999 to +999 mV	+/- 15 mV
Salinity	0 to 4 %	+/- 0.3 %

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution.

Horiba Calibration procedure:

1. Fill a calibration beaker with standard solution to the recommended fill line.
2. Insert the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on and allow some time for the machine to warm-up prior to starting the calibration. When the initial readings appear to stabilize the instrument is ready to calibrate.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly the instrument readings, while immersed in the standard solution, will match the standard solution values provided on the solution container. The typical standard solution values are: pH = 4.0 +/- 3%, conductivity 4.49 mS/cm +/- 3%, and turbidity = 0 NTU +/- 3%.
7. Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

YSI Calibration procedure:

1. Press the **On/off** key to display the run screen
2. Press the **Escape** key to display the main menu screen
3. Use the arrow keys to highlight the **Calibrate**
4. Press the **Enter** key. The Calibrate screen is displayed
5. Choose the parameter to calibrate

A. Conductivity Calibration:

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1) Use the arrow keys to highlight the **Conductivity** selection
2) Press **Enter.** The Conductivity Calibration Selection Screen is displayed.
3) Use the arrow keys to highlight the Specific Conductance selection.
4) Press **Enter.** The Conductivity Calibration Entry Screen is displayed.
5) Place the correct amount of conductivity standard (see Instrument Manual) into a clean, dry or pre-rinsed transport/calibration cup.
6) Carefully immerse the sensor end of the probe module into the solution.

7) Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.
   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from the Instrument Manual Calibration Volumes should ensure that the vent hole is covered.
8) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
   NOTE: Do not over tighten as this could cause damage to the threaded portions.
9) Use the keypad to enter the calibration value of the standard you are using.
   NOTE: Be sure to enter the value in **mS/cm at 25°C**.
10) Press **Enter**. The Conductivity Calibration Screen is displayed.
11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
12) Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
13) Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen
14) Press **Escape** to return to the calibrate menu.
15) Rinse the probe module and sensors in tap or purified water and dry.

B. Dissolved Oxygen Calibration:

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1) Go to the calibrate screen as described in Section
   NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.
2) Use the arrow keys to highlight the **Dissolved Oxygen** selection.
3) Press **Enter**. The dissolved oxygen calibration screen is displayed.
4) DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).
5) Use the arrow keys to highlight the **DO mg/L** selection.
6) Press **Enter**. The DO mg/L Entry Screen is displayed.
7) Place the probe module in water with a known DO concentration.
   NOTE: Be sure to completely immerse all the sensors.
8) Use the keypad to enter the known DO concentration of the water.
9) Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.
10) Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.
11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
12) Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
13) Press **Enter**. This returns you to the DO calibration screen.
14) Press **Escape** to return to the calibrate menu.

15) Rinse the probe module and sensors in tap or purified water and dry.

C. pH Calibration:

1) Go to the calibrate screen.
2) Use the arrow keys to highlight the **pH** selection.
3) Press **Enter**. The pH calibration screen is displayed.
    - Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
    - Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
    - Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
4) Use the arrow keys to highlight the **2-point** selection.
5) Press **Enter**. The pH Entry Screen is displayed.
6) Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

    NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.
    NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
7) Carefully immerse the sensor end of the probe module into the solution.
8) Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

    NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.
9) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

    NOTE: Do not over tighten as this could cause damage to the threaded portions.
10) Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

    NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.
11) Press **Enter**. The pH calibration screen is displayed.

12) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
13) Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
14) Press **Enter**. This returns you to the Specified pH Calibration Screen.
15) Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
16) Repeat steps 6 through 13 above using a second pH buffer.
17) Press **Enter**. This returns you to the pH Calibration Screen.
18) Press **Escape** to return to the calibrate menu.
19) Rinse the probe module and sensors in tap or purified water and dry.

D. ORP Calibration:

1) Go to the calibrate screen.
2) Use the arrow keys to highlight the **ORP** selection.
3) Press **Enter**. The ORP calibration screen is displayed.
4) Place the correct amount of a known ORP solution into a clean, dry or pre-rinsed transport/calibration cup.

   NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.
5) Carefully immerse the sensor end of the probe module into the solution.
6) Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

   NOTE: The sensor must be completely immersed.
7) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
8) Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.
9) Press **Enter**. The ORP calibration screen is displayed.
10) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
11) Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
12) Press **Enter**. This returns you to the Calibrate Screen.
13) Rinse the probe module and sensors in tap or purified water and dry.

    Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

C. Sample Measurement:

Horiba measurement procedure:

As water passes through the flow-through the flow cell, press MEAS to obtain reading;

record data in a field notebook.

YSI measurement procedure:

As water passes through the flow-through the flow cell, the readings are displayed for each parameter. Record the water quality parameter data in a field notebook. In addition, the data is recorded in the YSI and can be downloaded to a computer following completion of the sampling event.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

V. References

YSI 556 Multi Probe System Operator Manual

STANDARD OPERATING PROCEDURE

Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures. Operations manuals should be consulted for specific calibration and operating procedures.

II. Equipment and Materials

- Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump
- Horiba® U-22 or equivalent water quality meters to monitor pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature
- Flow-through cell with inlet/outlet ports for purged groundwater and watertight ports for each probe
- Generator or alternate power source depending on pump type
- Water-level indicator
- Disposable Teflon, Teflon-lined polyethylene tubing or polyethylene tubing for metals and other inorganics
- Plastic sheeting
- Well-construction information
- Calibrated container and stopwatch to determine flow rate
- Sample containers
- In-line disposable 0.45µm filters (QED® FF8100 or equivalent)
- Shipping supplies (labels, coolers, and ice)
- Field book

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments according to manufacturer's instructions.
3. The well number, site, date, and condition are recorded in the field logbook.

4. Plastic sheeting is placed on the ground, and the well is unlocked and opened. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. To avoid cross-contamination, do not let any downhole equipment touch the ground.

5. All sampling equipment and any other equipment to be placed in the well is cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.

6. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.

7. Attach and secure the tubing to the low-flow pump. Lower the pump slowly into the well and set it at approximately the middle of the screen. Place the pump intake in the middle of the saturated screen length and should be at least two feet above the bottom of the well to avoid mobilization of any sediment present in the bottom.

8. Insert the measurement probes into the flow-through cell. The purged groundwater is directed through the cell, allowing measurements to be collected before the water contacts the atmosphere.

9. If using a generator, locate it 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.

10. Start purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.

11. The water level should be monitored during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1- to 0.2-liter per minute) to avoid affecting well drawdown. If the water level is drawn down by more than 0.3 feet, purging should be conducted in accordance with SOP *Groundwater Sampling from Monitoring Wells*.

12. During purging, the field parameters are measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:

    - pH: within 0.1 pH units
    - Specific conductance: within 10 percent

- Turbidity: <10 NTU or within 10 percent
- Temperature: constant

B. Sample Collection

Once purging is complete the well is ready to sample. The elapsed time between completion of purging and collection of the groundwater sample should be minimized. Typically, the sample is collected immediately after the well has been purged, but this is also dependent on well recovery.

Samples will be placed in sample containers that have been cleaned to laboratory standards and are preserved in accordance with the analytical method. The containers are typically pre-preserved, if required.

VOC samples are normally collected first and directly into pre-preserved sample containers (see Special Conditions for Sampling with Peristaltic Pumps).

The steps to be followed for sample collection are as follows:

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured from the bailer or discharged from the pump so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing,, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container. If a bailer is used, filtration may be driven by a peristaltic pump.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus.
5. The bottle is capped and clearly labeled.
6. Samples are placed in appropriate containers and, if necessary, packed with ice in coolers as soon as practical.
7. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

The following information, at a minimum, will be recorded in the log book:

1. Sample identification (site name, location, and project number; sample name/number and location; sample type and matrix; time and date; sampler's identity)
2. Sample source and source description

3. Field observations and measurements (appearance, volatile screening, field chemistry, sampling method), volume of water purged prior to sampling, number of well volumes purged, and field parameter measurements
4. Sample disposition (preservative; laboratory name, date and time sent; laboratory sample number, chain-of-custody number, sample bottle lot number)
5. Additional remarks

Special Conditions for Sampling with Peristaltic Pumps
It is not acceptable to collect samples for organic compounds analyses through the flexible tubing used in the pump head. When collecting samples for organic compound analyses it is necessary to use a vacuum container, placed between the pump and the well for sample collection.

The following step-by-step procedures describe the process of sampling with a peristaltic pump and vacuum jug (see note following these procedures for collection of VOC samples):

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.
2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.
3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand-tighten both fittings.
4. Turn the pump on. Water should begin to collect in the transfer container (typically a 1-liter "Boston round" glass sample container) within a few minutes. If water does not begin to flow into the container within several minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table (limit of suction).
5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers.
6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume.

NOTE: Samples for volatile organic compound analyses cannot be collected using the vacuum jug method. If samples for VOC analyses are required, they must be collected with a bailer or by other approved methods, such as the "soda straw" method. The "soda straw" method involves allowing the tubing to fill, by either lowering it into the water column (A) or by filling it via suction applied by the pump head (B). If method (A) is used, the tubing is removed from the well after filling and the captured sample is allowed to drain into the sample vial. If method (B) is used, after running the pump and filling the tubing with sample, the pump speed is reduced and the direction reversed to push the sample out of the tubing into the vials. Avoid completely emptying the tubing when filling the sample vials when using method (B) to prevent introducing water that was in contact with the flexible pump head tubing. Either method is repeated, as necessary, until all vials are filled.

Samples for some constituents, primarily inorganic analytes such as metals and cyanide, may be collected directly from the peristaltic pump head tubing. This method is acceptable under the following conditions:

- The pump head tubing must be changed between sampling locations;
- An equipment rinsate blank must be collected by pumping de-ionized water through a piece of the tubing.

C. Additional remarks

1. If the well goes dry during purging, wait until it recovers sufficiently to remove the required volumes to sample all parameters. It may be necessary to return periodically to the well but a particular sample (e.g., large amber bottles for semivolatile analysis) should be filled at one time rather than over the course of two or more visits to the well.
2. Disposable tubing is disposed of with PPE and other site trash.

IV. Attachments

White paper on reasons and rationale for low-flow sampling.

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.
- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization.

- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
    - Inspect sampling pump regularly and replace as warranted
    - Inspect quick-connects regularly and replace as warranted
    - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

Attachment to the SOP on Low-Flow Sampling Groundwater Sampling from Monitoring Wells

White Paper on Low-Flow Sampling

EPA recommends low-flow sampling as a means of collecting groundwater samples in a way that minimizes the disturbance to the natural groundwater flow system and minimizes the introduction of contamination into the samples from extraneous sources. The following are details about these issues.

When a pump removes groundwater from the well at the same rate that groundwater enters the well through the screen, the natural groundwater-flow system around the well experiences a minimum of disturbance. Some disturbance is bound to occur because you are causing groundwater to flow to the well in a radial fashion that otherwise would have flowed past it. However, the resulting low-flow sample provides the most-representative indication we can get of groundwater quality in the immediate vicinity of the well.

Normally, when a well is pumped at an excessive rate that drops the water level in the well below the water level in the aquifer, the water cascades down the inside of the well screen when it enters the well. The turbulence from this cascading causes gases such as oxygen and carbon dioxide to mix with the water in concentrations that are not representative of the native groundwater and are higher than expected. This causes geochemical changes in the nature of the water that can change the concentrations of some analytes, particularly metals, in the groundwater sample, not mention it's effect on the dissolved oxygen levels that then will be measured in the flow-through cell. Such turbulence also may cause lower-than-expected concentrations of volatile organic compounds due to volatilization.

For wells in which the water level is above the top of the screen, the water up in the riser is out of the natural circulation of the groundwater and, therefore, can become stagnant. This stagnant water is no longer representative of natural groundwater quality because its pH, dissolved-oxygen content, and other geochemical characteristics change as it contacts the air in the riser. If we minimize the drawdown in the well when we pump, then we minimize the amount of this stagnant water that is brought down into the well screen and potentially into the pump. As a result, a more-representative sample is obtained.

Typically, wells contain some sediment in the bottom of the well, either as a residue from development that has settled out of the water column or that has sifted through the sand pack and screen since the well was installed. This sediment commonly has adsorbed on it such analytes as metals, SVOCs, and dioxins that normally would not be dissolved in the groundwater. If these sediments are picked up in the groundwater when the well is disturbed by excessive pumping, they can:

- Make filtering the samples for metals analysis more difficult
- Add unreasonably to the measured concentration of SVOCs and other organic compounds

The SOP for low-flow sampling has been modified recently and should be consulted for additional information about low-flow sampling and ways of dealing with wells in which the water level cannot be maintained at a constant level.

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

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

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

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

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

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

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

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

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

4. Remove respirator (if worn).

5. Remove inner gloves and discard.

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

7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.

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

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

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

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

6. Rinse with 1 gallon of tap water.

7. Rinse with 1 gallon of deionized water.

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

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

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

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

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

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

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

E. SAMPLE CONTAINER DECONTAMINATION

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

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved 55-gallon drum or with solid waste in garbage bags, dependent on Facility/project requirements.

F. HEAVY EQUIPMENT AND TOOLS

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

1. Set up a decontamination pad in area designated by the Facility
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

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

STANDARD OPERATING PROCEDURE

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this SOP; refer to the site safety plan and SOP *Decontamination of Personnel and Equipment*. Sample bottles will not be field decontaminated; instead they will be purchased with certification of laboratory sterilization.

II. Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Liquinox®
- Buckets
- Brushes
- Isopropanol, pesticide grade
- Personal Protective Equipment as specified by the Health and Safety Plan
- ASTM–Type II grade water or Lab Grade DI Water
- Aluminum foil

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, before drilling through permanent isolation casing, and before leaving the site, heavy equipment and machinery will be decontaminated by steam cleaning at a designated area. The steam-cleaning area will be designed to contain decontamination wastes and waste waters and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontaminated water from the pad to drums.

Surface casings may be steam cleaned in the field if they are exposed to contamination at the site prior to use.

B. Downhole Drilling Tools

Downhole tools will be steam cleaned before the onset of drilling, prior to drilling through permanent isolation casing, between boreholes, and prior to leaving the site. This will include, but is not limited to, rods, split spoons or similar samplers, coring equipment, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for physical characterization, the sampler shall be cleaned by scrubbing with a detergent solution followed by a potable water rinse.

Before the use of a sampling device such as a split-spoon sampler for the collection of a soil sample for chemical analysis, the sampler shall be decontaminated following the procedures outlined in the following subsection.

C. Field Analytical Equipment

1. Water Level Indicators

Water level indicators that consist of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

a. Rinse with tap water
b. Rinse with de-ionized water
c. Solvent rinse with isopropanol
d. Rinse with de-ionized water

2. Probes

Probes, for example, pH or specific ion electrodes, geophysical probes, or thermometers that would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise. For probes that make no direct contact, for example, OVM equipment, the probe will be wiped with clean paper-towels or cloth wetted with isopropanol.

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- The effectiveness of field cleaning procedures may be monitored by rinsing decontaminated equipment with organic-free water and submitting the rinse water in standard sample containers for analysis.

STANDARD OPERATING PROCEDURE

Disposal of Waste Fluids and Solids

I. Purpose and Scope

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

II. Equipment and Materials

A. Fluids

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

B. Solids

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

III. Procedures and Guidelines

A. Methodology

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

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

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

B. Labels

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

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

C. Fluids

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

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

D. Solids

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

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

E. Storage and Disposal

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

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

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

STANDARD OPERATING PROCEDURE

Equipment Blank and Field Blank Preparation

I. Purpose

To prepare blanks to determine whether decontamination procedures are adequate and whether any cross-contamination is occurring during sampling due to contaminated air and dust.

II. Scope

The general protocols for preparing the blanks are outlined. The actual equipment to be rinsed will depend on the requirements of the specific sampling procedure.

III. Equipment and Materials

- Blank liquid (use ASTM Type II or lab grade water)
- Millipore™ deionized water
- Sample bottles as appropriate
- Gloves
- Preservatives as appropriate

IV. Procedures and Guidelines

A. Decontaminate all sampling equipment that has come in contact with sample according to SOP *Decontamination of Personnel and Equipment.*

B. To collect an equipment blank for volatile analysis from the surfaces of sampling equipment other than pumps, pour blank water over one piece of equipment and into two 40-ml vials until there is a positive meniscus, then seal the vials. Note the sample number and associated piece of equipment in the field notebook as well as the type and lot number of the water used.

For non-volatiles analyses, one aliquot is to be used for equipment. For example, if a pan and trowel are used, place trowel in pan and pour blank fluid in pan such that pan and trowel surfaces which contacted the sample are contacted by the blank fluid. Pour blank fluid from pan into appropriate sample bottles.

Do not let the blank fluid come in contact with any equipment that has not been decontaminated.

C. When collecting an equipment blank from a pump, run an extra gallon of deionized water through the pump while collecting the pump outflow into appropriate containers. Make sure the flow rate is low when sampling VOCs. If a Grundfos Redi-Flo2 pump with disposable tubing is used, remove the disposable tubing after sampling but before decon. When decon is complete, put a 3- to 5-foot segment of new tubing onto the pump to collect the equipment blank.

D. To collect a field blank, slowly pour ASTM Type II or lab grade water directly into sample containers.

E. Document and ship samples in accordance with the procedures for other samples.

F. Collect next field sample.

V. Attachments

None.

VI. Key Checks and Items

- Wear gloves.
- Do not use any non-decontaminated equipment to prepare blank.
- Use ASTM-Type II or lab grade water.

STANDARD OPERATING PROCEDURE

Packaging and Shipping Procedures for Low-Concentration Samples

I. Purpose and Scope

The purpose of this guideline is to describe the packaging and shipping of low-concentration samples of various media to a laboratory for analysis.

II. Scope

The guideline only discusses the packaging and shipping of samples that are anticipated to have low concentrations of chemical constituents. Whether or not samples should be classified as low-concentration or otherwise will depend upon the site history, observation of the samples in the field, odor, and photoionization-detector readings.

If the site is known to have produced high-concentration samples in the past or the sampler suspects that high concentrations of contaminants might be present in the samples, then the sampler should conservatively assume that the samples cannot be classified as low-concentration. Samples that are anticipated to have medium to high concentrations of constituents should be packaged and shipped accordingly.

If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

III. Equipment and Materials

- Coolers
- Clear tape
- "This Side Up" labels
- "Fragile" labels
- Vermiculite
- Ziplock bags or bubble wrap
- Ice
- Chain-of-Custody form (completed)
- Custody seals

IV. Procedures and Guidelines

Low-Concentration Samples

A. Prepare coolers for shipment:

- Tape drains shut.
- Affix "This Side Up" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
- Place mailing label with laboratory address on top of coolers.
- Fill bottom of coolers with about 3 inches of vermiculite or absorbent pads.

B. Arrange decontaminated sample containers in groups by sample number. Consolidate VOC samples into one cooler to minimize the need for trip blanks.

C. Affix appropriate adhesive sample labels to each container. Protect with clear label protection tape.

D. Seal each sample bottle within a separate ziplock plastic bag or bubble wrap, if available. Tape the bag around bottle. Sample label should be visible through the bag.

E. Arrange sample bottles in coolers so that they do not touch.

F. If ice is required to preserve the samples, cubes should be repackaged in zip-lock bags and placed on and around the containers.

G. Fill remaining spaces with vermiculite or absorbent pads.

H. Complete and sign chain-of-custody form (or obtain signature) and indicate the time and date it was relinquished to Federal Express or the courier.

J Close lid and latch.

K. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.

L. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Cover custody seals with tape to avoid seals being able to be peeled from the cooler.

M. Relinquish to Federal Express or to a courier arranged with the laboratory. Place airbill receipt inside the mailing envelope and send to the sample documentation coordinator along with the other documentation.

Medium- and High-Concentration Samples:

Medium- and high-concentration samples are packaged using the same techniques used to package low-concentration samples, with potential additional restrictions. If applicable, the sample handler must refer to instructions associated with the shipping of dangerous goods for the necessary procedures for shipping by Federal Express or other overnight carrier. If warranted, procedures for dangerous-goods shipping may be implemented. Dangerous goods and hazardous materials pose an unreasonable risk to health, safety, or property during transportation without special handling. As a result only employees who are trained under CH2M HILL Dangerous Goods Shipping course may ship or transport dangerous goods. Employees should utilize the HAZMAT ShipRight tool on the Virtual Office and/or contact a designated CH2M HILL HazMat advisor with questions.

V. Attachments

None.

VI. Key Checks and Items

- Be sure laboratory address is correct on the mailing label
- Pack sample bottles carefully, with adequate vermiculite or other packaging and without allowing bottles to touch
- Be sure there is adequate ice
- Include chain-of-custody form
- Include custody seals

STANDARD OPERATING PROCEDURE

Chain-of-Custody

I Purpose

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

II Scope

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

III Definitions

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

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

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

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

IV. Procedures

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

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

Sample Identification

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

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

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

Measurements and observations shall be recorded using waterproof ink.

Sample Label

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

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 08/21/12).

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

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

Chain-of-Custody Procedures

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

Field Custody Procedures

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

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

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

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

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

Transfer of Custody and Shipment

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

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

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

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

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

V Quality Assurance Records

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

VI Attachments

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

VII References

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

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STANDARD OPERATING PROCEDURE

Direct-Push Soil Sample Collection

I. Purpose

To provide a general guideline for the collection of soil samples using direct-push (e.g., Geoprobe®) sampling methods.

II. Scope

Standard direct-push (e.g., Geoprobe®) soil sampling methods.

III. Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Sampling tubes and acetate liners
- Pre-cleaned sample containers and stainless-steel sampling implements
- Personal Protective Equipment as specified by the Health and Safety Plan

IV. Procedures and Guidelines

1. Decontaminate sampling tubes and other non-dedicated downhole equipment in accordance with SOP *Decontamination of Personnel and Equipment*.
2. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
3. Remove the rods and sampling tube from the borehole and remove the sampling tube from the lead rod.
4. Cut open the acetate liner using a specific knife designed to slice the acetate liners (see below).

5. Fill all sample containers, beginning with the containers for VOC analysis, using a decontaminated or dedicated sampling implement. For the VOC samples, place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core®** or **Terra Core®** sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. Label the vials and place on ice for shipment to the laboratory.

6. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with SOP *Decontamination of Personnel and Equipment*.

7. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

V. Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.

2. Ensure that the direct-push operator thoroughly completes the decontamination process between sampling locations.

3. Verify that the borehole made during sampling activities has been properly backfilled.

STANDARD OPERATING PROCEDURE

Soil Sampling During Excavations

I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of subsurface soils during excavations, soil stockpiles, and import fill sources using hand tools or heavy equipment.

II. Equipment and Materials

- Stainless-steel trowel, shovel, disposable plastic scoop, coring device, hand auger, or other appropriate hand tool
- Excavator with bucket
- Stainless-steel pan or bowl or disposable sealable bags
- Sample bottles

III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

A. Surface and Shallow Subsurface Sampling by Hand Methods

Either a shovel, post-hole digger, or trowel, will be used to remove soil immediately above the interval to be sampled. Once the desired sample interval is exposed, a decontaminated sampling tool (shovel, post-hole digger, trowel, disposable plastic scoop, etc) will be used to collect the sample. Soil that will be analyzed for semi-volatile organic compounds (SVOC) and inorganic analyses will be placed in a stainless steel sample bowl or disposable plastic scoop and will be homogenized using a stainless steel spoon or plastic disposable scoop. Procedures detailing the homogenization process are provided in SOP *Homogenization of Soil and Sediment Samples*. Note that during homogenization, pieces of gravel, asphalt, and metal should be removed as they do not make up the soil fraction of the sample and may produce erroneous results following chemical analysis. The homogenized sample will then be placed in the sample containers for chemical analysis. Soil samples that will be analyzed for volatile organic compounds (VOC) will not be composited, but will be placed directly into the sample containers for chemical analysis.

During sample collection, sampling personnel will also record the following information in a bound field notebook:

- Lithology of the material encountered (including soil type, color, grain-size, moisture content, and a record of any foreign material encountered (concrete, asphalt, metal, plastic, etc.)
- Sampling interval,
- Date and time the sample was collected
- Results of screening measurements (i.e., photo ionization detector, etc.)
- Presence of odors or staining

Logbook entry procedures are described in detail in SOP *Preparing Field Log Books.*

B. Sampling Using Excavator Bucket

The following procedures will be used when collecting soil samples from the bucket of an excavator:

- Using an excavator bucket, scoop a volume of soil from the sampling location which is large enough to collect sample soil that did not come into direct contact with the surfaces of the bucket.
- Once the soil is removed, use a decontaminated trowel or shovel to remove the upper few inches of soil in the center of the bucket to expose a "fresh" sample. Once exposed use a decontaminated trowel, spoon, disposable plastic scoop, or shovel to collect a soil sample for chemical analysis. Samples collected for volatiles analysis should be placed directly into the sample containers. Material for samples for all other parameters should be removed to a decontaminated stainless steel bowl, tray, or disposable sealable bag. Samples that will be analyzed for SVOCs and inorganic will be homogenized as previously described in Section A above, and follow the procedures provided in SOP *Homogenization of Soil and Sediment Samples*.

Additionally, the logbook entry procedures summarized in Section A above and detailed in SOP *Preparing Field Log Books* will be followed during sample collection.

C. Stockpile and Import Fill Sampling

Procedure for Collecting Volatile Fractions

Using an auger, split spoon, or other device, retrieve a core from the stockpile or borrow source area to be sampled. Remove the core from the auger, split spoon, or other device and place the sample into a pre-preserved VOA vial or direct sample container such as an **En Core**® sampler or **Terra Core®** Sampler and seal the cap tightly. Ideally, the operation should be completed in one minute. After filling the required VOA vials, fill a 4-ounce jar with the remaining core sample. (This will be used by the laboratory to determine percent moisture.)

Label the vials and place on ice for shipment to the laboratory.

Procedure for Collecting Non-Volatile Samples

From five randomly selected sample locations, use a stainless steel spoon to collect equal amounts of soil for the required samples and place the soils into a stainless steel bowl or tray. The volume of soil collected should be sufficient to completely fill all sample containers requested by the laboratory. Homogenize the five samples by following the procedures provided in SOP *Homogenization of Soil and Sediment Samples*. Fill each required sample container with the required volume of homogenized soils. Complete the sample labels and place the sample containers on ice for shipment to the laboratory.

IV. Attachments

None

V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough

STANDARD OPERATING PROCEDURE

Logging of Soil Borings

I. Purpose and Scope

This SOP provides guidance to obtain accurate and consistent descriptions of soil characteristics during soil-sampling operations. The characterization is based on visual examination and manual tests, not on laboratory determinations.

II. Equipment and Materials

- Indelible pens
- Tape measure or ruler
- Field logbook
- Spatula
- HCL, 10 percent solution
- Squirt bottle with water
- Rock- or soil-color chart (e.g., Munsell)
- Grain-size chart
- Hand lens
- Unified Soil Classification System (USCS) index charts and tables to help with soil classification (attached)

III. Procedures and Guidelines

This section covers several aspects of soil characterization: instructions for completing the CH2M HILL soil boring log Form D1586 (attached), field classification of soil, and standard penetration test procedures.

A. Instructions for Completing Soil Boring Logs

Soil boring logs will be completed in the field log books or on separate soil boring log sheets. Information collected will be consistent with that required for Form D1586 (attached), a standard CH2M HILL form (attached), or an equivalent form that supplies the same information.

The information collected in the field to perform the soil characterization is described below.

Field personnel should review completed logs for accuracy, clarity, and thoroughness of detail. Samples also should be checked to see that information is correctly recorded on both jar lids and labels and on the log sheets.

B. **Heading Information**

Boring/Well Number. Enter the boring/well number. A numbering system should be chosen that does not conflict with information recorded for previous exploratory work done at the site. Number the sheets consecutively for each boring.

Location. If station, coordinates, mileposts, or similar project layout information is available, indicate the position of the boring to that system using modifiers such as "approximate" or "estimated" as appropriate.

Elevation. Elevation will be determined at the conclusion of field activities through a survey.

Drilling Contractor. Enter the name of the drilling company and the city and state where the company is based.

Drilling Method and Equipment. Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger). Information on the drilling equipment (e.g., CME 55, Mobile B61) also is noted.

Water Level and Date. Enter the depth below ground surface to the apparent water level in the borehole. The information should be recorded as a comment. If free water is not encountered during drilling or cannot be detected because of the drilling method, this information should be noted. Record date and time of day (for tides, river stage) of each water level measurement.

Date of Start and Finish. Enter the dates the boring was begun and completed. Time of day should be added if several borings are performed on the same day.

Logger. Enter the first and last name.

C. **Technical Data**

Depth Below Surface. Use a depth scale that is appropriate for the sample spacing and for the complexity of subsurface conditions.

Sample Interval. Note the depth at the top and bottom of the sample interval.

Sample Type and Number. Enter the sample type and number. SS-1 = split spoon, first sample. Number samples consecutively regardless of type. Enter a sample number even if no material was recovered in the sampler.

Sample Recovery. Enter the length to the nearest 0.1-foot of soil sample recovered from the sampler. Often, there will be some wash or caved material above the sample; do not include the wash material in the measurement. Record soil recovery in feet.

Standard Penetration Test Results. In this column, enter the number of blows required for each 6 inches of sampler penetration and the "N" value, which is the sum of the blows in the middle two 6-inch penetration intervals. A typical standard penetration test involving successive blow counts of 2, 3, 4, and 5 is recorded as 2-3-4-5 and (7). The standard penetration test is terminated if the sampler encounters refusal. Refusal is a penetration of less than 6 inches with a blow count of 50. A partial penetration of 50 blows for 4 inches is recorded as 50/4 inches. Penetration by the weight of the slide hammer only is recorded as "WOH."

Samples should be collected using a 140-pound hammer and 2-inch diameter split spoons. Samples may be collected using direct push sampling equipment. However, blow counts will not be available. A pocket penetrometer may be used instead to determine relative soil density of fine grained materials (silts and clays).

Sample also may be collected using a 300-pound hammer or 3-inch-diameter split-spoon samples at the site. However, use of either of these sample collection devices invalidates standard penetration test results and should be noted in the comments section of the log. The 300-pound hammer should only be used for collection of 3-inch-diameter split-spoon samples. Blow counts should be recorded for collection of samples using either a 3-inch split-spoon, or a 300-pound hammer. An "N" value need not be calculated.

Soil Description. The soil classification should follow the format described in the "Field Classification of Soil" subsection below.

Comments. Include all pertinent observations (changes in drilling fluid color, rod drops, drilling chatter, rod bounce as in driving on a cobble, damaged Shelby tubes, and equipment malfunctions). In addition, note if casing was used, the sizes and depths installed, and if drilling fluid was added or changed. You should instruct the driller to alert you to any significant changes in drilling (changes in material, occurrence of boulders, and loss of drilling fluid). Such information should be attributed to the driller and recorded in this column.

Specific information might include the following:

- The date and the time drilling began and ended each day
- The depth and size of casing and the method of installation
- The date, time, and depth of water level measurements
- Depth of rod chatter
- Depth and percentage of drilling fluid loss
- Depth of hole caving or heaving
- Depth of change in material
- Health and safety monitoring data
- Drilling interval through a boulder

D. Field Classification of Soil

This section presents the format for the field classification of soil. In general, the approach and format for classifying soils should conform to ASTM D 2488, Visual-Manual Procedure for Description and Identification of Soils (attached).

The Unified Soil Classification System is based on numerical values of certain soil properties that are measured by laboratory tests. It is possible, however, to estimate these values in the field with reasonable accuracy using visual-manual procedures (ASTM D 2488). In addition, some elements of a complete soil description, such as the presence of cobbles or boulders, changes in strata, and the relative proportions of soil types in a bedded deposit, can be obtained only in the field.

Soil descriptions should be precise and comprehensive without being verbose. The correct overall impression of the soil should not be distorted by excessive emphasis on insignificant details. In general, similarities rather than differences between consecutive samples should be stressed.

Soil descriptions must be recorded for every soil sample collected. The format and order for soil descriptions should be as follows:

1. Soil name (synonymous with ASTM D 2488 Group Name) with appropriate modifiers. Soil name should be in all capitals in the log, for example "POORLY-GRADED SAND."
2. Group symbol, in parentheses, for example, "(SP)."
3. Color, using Munsell color designation
4. Moisture content
5. Relative density or consistency
6. Soil structure, mineralogy, or other descriptors

This order follows, in general, the format described in ASTM D 2488.

E. Soil Name

The basic name of a soil should be the ASTM D 2488 Group Name on the basis of visual estimates of gradation and plasticity. The soil name should be capitalized.

Examples of acceptable soil names are illustrated by the following descriptions:

- A soil sample is visually estimated to contain 15 percent gravel, 55 percent sand, and 30 percent fines (passing No. 200 sieve). The fines are estimated as either low or highly plastic silt. This visual classification is SILTY SAND WITH GRAVEL, with a Group Symbol of (SM).
- Another soil sample has the following visual estimate: 10 percent gravel, 30 percent sand, and 60 percent fines (passing the No. 200 sieve). The fines are estimated as low plastic silt. This visual classification is SANDY SILT. The gravel portion is not included in the soil name because the gravel portion was estimated as less than 15 percent. The Group Symbol is (ML).

The gradation of coarse-grained soil (more than 50 percent retained on No. 200 sieve) is included in the specific soil name in accordance with ASTM D 2488. There is no need to further document the gradation. However, the maximum size and angularity or roundness of gravel and sand-sized particles should be recorded. For fine-grained soil (50 percent or more passing the No. 200 sieve), the name is modified by the appropriate plasticity/elasticity term in accordance with ASTM D 2488.

Interlayered soil should each be described starting with the predominant type. An introductory name, such as "Interlayered Sand and Silt," should be used. In addition, the relative proportion of each soil type should be indicated (see Table 1 for example).

Where helpful, the evaluation of plasticity/elasticity can be justified by describing results from any of the visual-manual procedures for identifying fine-grained soils, such as reaction to shaking, toughness of a soil thread, or dry strength as described in ASTM D 2488.

F. Group Symbol

The appropriate group symbol from ASTM D 2488 must be given after each soil name. The group symbol should be placed in parentheses to indicate that the classification has been estimated.

In accordance with ASTM D 2488, dual symbols (e.g., GP-GM or SW-SC) can be used to indicate that a soil is estimated to have about 10 percent fines. Borderline symbols (e.g., GM/SM or SW/SP) can be used to indicate that a soil sample has been identified as having properties that do not distinctly place the soil into a specific group. Generally, the group name assigned to a soil with a borderline symbol should be the group name for the first symbol. The use of a borderline symbol should not be used indiscriminately. Every effort should be made to first place the soil into a single group.

G. Color

The color of a soil must be given. The color description should be based on the Munsell system. The color name and the hue, value, and chroma should be given.

H. Moisture Content

The degree of moisture present in a soil sample should be defined as dry, moist, or wet. Moisture content can be estimated from the criteria listed on Table 2.

I. Relative Density or Consistency

Relative density of a coarse-grained (cohesionless) soil is based on N-values (ASTM D 1586 [attached]). If the presence of large gravel, disturbance of the sample, or non-standard sample collection makes determination of the in situ relative density or consistency difficult, then this item should be left out of the description and explained in the Comments column of the soil boring log.

Consistency of fine-grained (cohesive) soil is properly based on results of pocket penetrometer or torvane results. In the absence of this information, consistency can be estimated from N-values. Relationships for determining relative density or consistency of soil samples are given in Tables 3 and 4.

J. Soil Structure, Mineralogy, and Other Descriptors

Discontinuities and inclusions are important and should be described. Such features include joints or fissures, slickensides, bedding or laminations, veins, root holes, and wood debris.

Significant mineralogical information such as cementation, abundant mica, or unusual mineralogy should be described.

Other descriptors may include particle size range or percentages, particle angularity or shape, maximum particle size, hardness of large particles, plasticity of fines, dry strength, dilatancy, toughness, reaction to HCl, and staining, as well as other information such as organic debris, odor, or presence of free product.

K. Equipment and Calibration

Before starting the testing, the equipment should be inspected for compliance with the requirements of ASTM D 1586. The split-barrel sampler should measure 2-inch or 3-inch O.D., and should have a split tube at least 18 inches long. The minimum size sampler rod allowed is "A" rod (1-5/8-inch O.D.). A stiffer rod, such as an "N" rod (2-5/8-inch O.D.), is required for depths greater than 50 feet. The drive weight assembly should consist of a 140-pound or 300-pound hammer weight, a drive head, and a hammer guide that permits a free fall of 30 inches.

IV. Attachments

Soil Boring Log (Sample Soil Boring Log.xls)

CH2M HILL Form D1586 and a completed example (Soil_Log_Examp.pdf)

ASTM D 2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* (ASTM D2488.pdf)

ASTM 1586 *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586.pdf)

Tables 1 through 4 (Tables 1-4.pdf)

V. Key Checks and Preventive Maintenance

- Check entries to the soil-boring log and field logbook in the field; because the samples will be disposed of at the end of fieldwork, confirmation and corrections cannot be made later.
- Check that sample numbers and intervals are properly specified.
- Check that drilling and sampling equipment is decontaminated using the procedures defined in SOP *Decontamination of Drilling Rigs and Equipment*.

STANDARD OPERATING PROCEDURE

Global Positioning System

I. Purpose

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

II. Scope

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

III. Definitions

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

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

IV. Procedures and Guidelines

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

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

A. Calibration

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

B. Operations for surveying coordinates of a location

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

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

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

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

D. Preventive Maintenance

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

STANDARD OPERATING PROCEDURE

Sampling Contents of Tanks and Drums

I. Scope and Application

This procedure provides an overview approach and guidelines for the routine sampling of drums and tanks. Its purpose is to describe standard procedures and precautions which are applied in sampling drums and tanks. Procedures for opening drums with the individual instruments are included in Attachment D.

The samples obtained may be used to obtain physical chemical or radiological data. The resulting data may be qualitative or quantitative in nature, and are appropriate for use in preliminary surveys as well as confirmatory sampling.

II. Summary of Methods

Drums are generally sampled by means of sampling tubes such as glass sample tubes or COLIWASA samplers. In either case, the sampling tube is manually inserted into the waste material. A sample of the drum contents is withdrawn by the sampling device. Should a drum contain bottom sludge, a glass tube will be used to retrieve a sample of this as well.

Storage tank and tank trailers, because of their greater depths, require sampling devices that can be lowered from the top, filled at a particular depth, then withdrawn. Such devices are a COLIWASA, a Kemmerer depth sampler, or a Bacon Bomb. Where samples of bottom sludge are desired, a gravity corer can be utilized. This heavy tube with a tapered nose piece will penetrate the sludge as it free falls through the tank.

III. Comments

The sampling of tanks, containers, and drums present unique problems not associated with environmental samples. Containers of this sort are generally closed except for small access ports, manways, or hatches on the larger vessels, or taps and bungs on smaller drums. The physical size, shape, construction material, and location of access limit the types of equipment and methods of collection that can be used.

When liquids are contained in sealed vessels, gas vapor pressure can build up, sludges can settle out, and density layerings (stratification) can develop. Bulging drums may be under pressure and extreme caution should be exercised. The potential exists for explosive reactions or the release of noxious gases when containers are opened. All vessels should be opened with extreme caution. Check the HSP for the level of personnel protection to be worn. A preliminary sampling of any headspace gases is warranted. As a minimum, a preliminary check with an explosimeter and an organic vapor analyzer may be of aid in selecting a sampling method.

In most cases it is impossible to observe the contents of these sealed or partially sealed vessels. Since some layering or stratification is likely in any solution left undisturbed over time, a sample must be taken that represents the entire depth of the vessel.

IV. Required Equipment and Apparatus

A. **Health and safety equipment/materials**: As listed in the site safety plan.

B. **Sampling equipment**: COLIWASA, glass sample tubes, Kemmerer depth sampler, Bacon Bomb, gravity corer.

C. **Tools**: Rubber mallet, bung wrench, speed wrench with socket, etc., (all non-sparking), paint marker.

D. **Heavy equipment**: Backhoe equipped with explosion shield, drum grappler, and 3-foot copper-beryllium (non-sparking) spike with 6-inch collar (to puncture top of drums for sampling, if necessary).

E. **Sample Containers**: As specified in the field sampling plan.

V. Procedures

A. Drums

NOTE: DO NOT open more than one drum at a time. Each drum must be handled and sampled as a separate entity to reduce vapors in the sampling area.

1. Drums will be sampled on an area-by-area basis. Drums will be sampled after they have been placed in overpack drums but before they are transferred from the excavation to the onsite storage area.
2. Record, in logbook, all pertinent information from visual inspection of drum (e.g., physical condition, leaks, bulges, and labels). Label each drum with a unique identifying number.
3. If possible, stage drums for easy access.
4. If necessary, attach ground strap to drums and grounding point.
5. Remove any standing material (water, etc.) from container top.
6. Using non-sparking tools, carefully remove the bung or lid while monitoring air quality with appropriate instruments. If necessary (and as a last resort), the non-sparking spike affixed to the backhoe can also be used to puncture the drum for sampling. See Attachment D for method of drum opening. Record air-quality monitoring results.

7. When sampling a previously sealed vessel, a check should be made for the presence of bottom sludge. This is accomplished by measuring the depth to apparent bottom, then comparing it to the known interior depth.

8. Agitation to disrupt the layers and rehomogenize the sample is physically difficult and almost always undesirable. If the vessel is greater than 3 feet in depth (say, a 55-gallon drum), the appropriate sampling method is to slowly lower the sampling device (i.e., suction line of peristaltic pump, glass tube) in known increments of length. Discrete samples can be collected from various depths, then combined or analyzed separately. If the depth of the vessel is greater than the lift capacity of the pump, an at-depth water sampler, such as the Kemmerer or Bacon Bomb type, may be required.

9. Extract a representative sample from the drum using a glass rod, COLIWASA, Bacon Bomb, Kemmerer bottle, or gravity corer (See Attachments). Ensure that the entire depth of material is penetrated. Depending on the size of the opening of the drum, three to four takes should be collected from random locations across the drum surface, to ensure a representative sample. Any observed stratification must be recorded in logbook, including number and thickness of the layers and a conceptualized sketch.

10. Record a visual description of the sample (e.g., liquid, solid, color, viscosity, and percent layers).

11. When possible, sampling equipment (like glass tubes) should be expendable and be left inside the drum for disposal with drum contents, once sampling is completed.

12. Place lid, bung, cap, etc., back in place on drum. Tighten hand tight. If necessary, the sampling port can be sealed using a cork.

13. Wipe up spilled material with lab wipes. Wipe off sample containers.

14. Mark the drum with a unique sample identification number and date using a paint marker.

15. Samples will be handled as high hazard samples. Samples will be placed in containers defined according to the analytical needs, wiped clean, and then packed in paint cans for shipping. Packaging, labeling, and preparation for shipment procedures will follow procedures as specified in the field sampling plan.

B. Underground Storage Tanks

1. A sampling team of at least two people is required for sampling—one will collect samples, the other will relay required equipment and implements.

2. Sampling team will locate a sampling port on the tank. Personnel should be wearing appropriate protective clothing at this time and carrying sampling gear.

3. Do not attempt to climb down into tank. Sampling MUST BE accomplished from the top.

4. Collect a sample from the upper, middle, and lower section of the tank contents with one of the recommended sampling devices.

5. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

6. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

C. Tank Trailers or Above-Ground Storage Tanks

1. A sampling team of two is required. One will collect samples, the other will relay required equipment and implements.

2. Samples will be collected through the manhole (hatch) on top of the tanker or the fill port. Do not open valves at the bottom. Before opening the hatch, check for a pressure gauge or release valve. Open the release valve slowly to bring the tank to atmospheric pressure.

3. If tank pressure is too great, or venting releases large amounts of toxic gas, discontinue venting and sampling immediately. Measure vented gas with organic vapor analyzer and explosimeter.

4. If no release valve exists, slowly loosen hatch cover bolts to relieve pressure in the tank. (Again, stop if pressure is too great.)

5. Once pressure in tank has been relieved, open the hatch and withdraw sample using one of the recommended sampling devices.

6. Sample each trailer compartment.

7. If compositing is necessary, ship samples to laboratory in separate containers for laboratory compositing.

8. Samples will be handled as hazardous. Samples will be placed in appropriate containers and packed with ice in a cooler. Packaging, labeling, and preparation for shipment will follow procedures specified in the field sampling plan.

D. Refer to Attachment B for procedures for sampling with appropriate devices as follows:

<u>Drum</u>

Glass tube — Procedure 1

COLIWASA	—	Procedure 2

<u>Storage Tank and Tank Trailer</u>

COLIWASA	—	Procedure 2
Bacon Bomb	—	Procedure 3
Gravity Corer (for bottom sludge)	—	Procedure 4

VI. Contamination Control

Sampling tools, instruments, and equipment will be protected from sources of contamination prior to use and decontaminated after use as specified in SOP *Decontamination of Personnel and Equipment*. Liquids and materials from decontamination operations will be handled in accordance with the waste management plan. Sample containers will be protected from sources of contamination. Sampling personnel shall wear chemical resistant gloves when handling any samples. Gloves will be decontaminated or disposed of between samples.

VIII. Attachments

A. Collection of Liquid-Containerized Wastes Using Glass Tubes

B. Sampling Containerized Wastes Using the Composite Liquid Waste Sample (COLIWASA)

C. Sampling Containerized Wastes Using the Bacon Bomb Sampler

D. Gravity Corer for sampling Sludges in Large Containers

E. Construction of a Typical COLIWASA

F. Drum Opening Techniques and Equipment

IX. References

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U.S. Environmental Protection Agency, *Characterization of Hazardous Waste Sites — A Method Manual: Volume II, Available Sampling Methods*, USEPA Environmental Monitoring Systems Laboratory, Las Vegas, EPA-600/4-84-076, December, 1984.

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X. Field Checklist

_______ Sampling Instruments

_______ Tools

_______ Rubber Mallet

_______ Logbook

_______ Safety Glasses or Monogoggles

_______ Safety Shoes

_______ Ice/Cooler, as required

_______ Custody Seals, as required

_______ Chain-of-Custody Forms

_______ Drum Labels, as required

_______ Paint Marker, if drum sampling

_______ Black Indelible Pen

_______ Monitoring Instruments

_____ Labels

_____ Sampling and Analysis Plan

_____ Health and Safety Plan

_____ Decontamination Equipment

_____ Lab Wipes

_____ Lab Spatulas or Stainless Steel Spoons

_____ Chemical Preservatives, as required

_____ Appropriate Containers for Waste and Equipment

_____ Duct Tape

_____ Plastic Sheeting

Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

Discussion

Liquid samples from opened containers (i.e., 55-gallon drums) are collected using lengths of glass tubing. The glass tubes are normally 122 centimeters long and 6 to 16 millimeters inside diameter. Larger diameter tubes may be used for more viscous fluids if sampling with the small diameter tube is not adequate. The tubing is broken and discarded in the container after the sample has been collected, eliminating difficult cleanup and disposal problems. This method should not be attempted with less than a two-person sampling team.

Uses

This method provides for a quick, relatively inexpensive means of collecting concentrated containerized wastes. The major disadvantage is from potential sample loss that is especially prevalent when sampling low-viscosity fluids. Splashing can also be a problem and proper protective clothing should always be worn.

Note: A flexible tube with an aspirator attached is an alternative method to the glass tube, and allows various levels to be sampled discretely.

Procedures for Use

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 centimeters extend above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the tube with a safety-gloved thumb or a stopper.
5. Carefully remove the capped tube from the drum. If the tube has passed through more than one layer, the boundary should be apparent in the glass tube.
6. Insert the bottom, uncapped end into the sample container.
7. Partially release the thumb or stopper on the top of the tube and allow the sample to slowly flow into the sample container. If separation of phases is desired, cap off tube before the bottom phase has completely emptied. It may be advisable to have an extra container for “waste,” so that the fluid on either side of the phase boundary can be directed into a separate container, allowing collection of pure phase liquids in the sample containers. The liquid remaining after the boundary fluid is removed is collected in yet a third container. NOTE: It is not necessary to put phases in separate containers if analysis of separate phases is not desired.
8. Repeat steps 2 through 6 if more volume is needed to fill the sample container.
9. Remove the tube from the sample container and replace the tube in the drum, breaking it, if necessary, in order to dispose of it in the drum.

Optional Method (if sample of bottom sludge is desired)

1. Remove the cover from the container opening.
2. Insert glass tubing slowly almost to the bottom of the container. Tubing should be of sufficient length so that at least 30 cm extends above the top of the container.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Gently push the tube towards the bottom of the drum into the sludge layer. Do not force it.
5. Cap the top of the tube with a safety-gloved thumb or stopper.
6. Carefully remove the capped tube from the drum and insert the uncapped end into the sample container.
7. Release the thumb or stopper on the top of the tube and allow the sample container to fill to approximately 90 percent of its capacity. If necessary, the sludge plug in the bottom of the tube can be dislodged with the aid of the stainless steel laboratory spatula.
8. Repeat if more volume is needed to fill sample container and recap the tube.

Note:

1. If a reaction is observed when the glass tube is inserted (violent agitation, smoke, light, etc.), the investigators should leave the area immediately.
2. If the glass tube becomes cloudy or smoky after insertion into the drum, the presence of hydrofluoric acid maybe indicated, and a comparable length of rigid plastic tubing should be used to collect the sample.
3. When a solid is encountered in a drum (either layer or bottom sludge) the optional method described above may be used to collect a core of the material, or the material may be collected with a disposable scoop attached to a length of wooden or plastic rod.

Attachment B: Sampling Containerized Wastes using the Composite Liquid Waste Sampler (COLIWASA)

Discussion

The COLIWASA is a much-cited sampler designed to permit representative sampling of multiphase wastes from drums and other containerized wastes. The sampler is commercially available or can be easily fabricated from a variety of materials, including PVC, glass, or Teflon. In its usual configuration it consists of a 152 cm by 4 cm (inside diameter) section of tubing with a neoprene stopper at one end attached by a rod running the length of the tube to a locking mechanism at the other end. Manipulation of the locking mechanism opens and closes the sampler by raising and lowering the neoprene stopper. See Attachment E: Construction of a COLIWASA.

Uses

The COLIWASA is primarily used to sample containerized liquids. The PVC COLIWASA is reported to be able to sample most containerized liquid wastes except for those containing ketones, nitrobenzene, dimethylforamide, mesityloxide, and tetrahydrofuran. A glass COLIWASA is able to handle all wastes unable to be sampled with the plastic unit except strong alkali and hydrofluoric acid solutions. Due to the unknown nature of many containerized wastes, it would therefore be advisable to eliminate the use of PVC materials and use samplers composed of glass or Teflon.

The major drawback associated with using a COLIWASA is concern for decontamination and costs. The sampler is difficult, if not impossible, to decontaminate in the field, and its high cost in relation to alternative procedures (glass tubes) makes it an impractical throwaway item. It still has applications, however, especially in instances where a true representation of a multiphase waste is absolutely necessary.

Procedures for Use

1. Check to make sure the sampler is functioning properly. Adjust the locking mechanism, if present, to make sure the neoprene rubber stopper provides a tight closure.

2. Put the sampler in the open position by placing the stopper rod handle in the T-position and pushing the rod down until the handle sits against the sampler's locking block.

3. Slowly lower the sampler into the liquid waste. Lower the sampler at a rate that permits the levels of the liquid inside and outside the sampler tube to be about the same. If the level of the liquid in the sample tube is lower than that outside the sampler, the sampling rate is too fast and will result in a non-representative sample.

4. When the sampler stopper hits the bottom of the waste container, push the sampler tube downward against the stopper to close the sampler. Lock the sampler in the closed position by turning the T-handle until it is upright and one end rests tightly on the locking block.

5. Slowly withdraw the sampler from the waste container with one hand while wiping the sampler tube with a laboratory wipe with the other hand. A phase boundary, if present, can be observed through the tube.

6. Carefully discharge the sample into a suitable sample container by slowly pulling the lower end of the T-handle away from the locking block while the lower end of the sampler is positioned in a sample container.

7. Unscrew the T-handle of the sampler and disengage the locking block.

Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

Discussion

The Bacon Bomb is designed for the withdrawal of samples from various levels within a storage tank. It consists of a cylindrical body with an internal tapered plunger that acts as a valve to admit the sample. A line attached to the top of the plunger is used to open and close the valve. A removable cover provides a point of attachment for the sample line and has a locking mechanism to keep the plunger closed after sampling. The Bacon Bomb is usually constructed of chrome-plated brass and bronze with a rubber O-ring acting as the plunger-sealing surface. Stainless steel versions are also available. The volumemetric capacity is 8, 16, or 32 oz (237, 473, or 946 ml).

<u>Uses</u>

The Bacon Bomb is a heavy sampler suited best for viscous materials held in large storage tanks or in lagoons. If a more non-reactive sampler is needed, the stainless steel version would be used, or any of the samplers could be coated with Teflon.

<u>Procedures for Use</u>

1. Attach the sample line and the plunger line to the sampler.
2. Measure and then mark the sampling line at the desired depth.
3. Gradually lower the sampler by the sample line until the desired level is reached.
4. When the desired level is reached, pull up on the plunger line and allow the sampler to fill for a sufficient length of time before releasing the plunger line to seal off the sampler.
5. Retrieve the sampler by the sample line, being careful not to pull up on the plunger line, thereby accidentally opening the bottom valve.
6. Wipe off the exterior of the sampler body.
7. Position the sampler over the sample container and release its contents by pulling up on the plunger line.

Attachment D: Gravity Corer for Sampling Sludges in Large Containers

Discussion

A gravity corer is a metal tube with a replaceable tapered nosepiece on the bottom and a ball or other type of check valve on the top. The check valve allows water to pass through the corer on descent but prevents a washout during recovery. The tapered nosepiece facilitates cutting and reduces core disturbance during penetration. Most corers are constructed of brass or steel and many can accept plastic liners and additional weights.

Uses

Corers are capable of collecting samples of most sludges and sediments. They collect essentially undisturbed samples that represent the strata profile that may develop in sediments and sludges during variations in the deposition process. Depending on the density of the substrate and the weight of the corer, penetration to depths of 75 cm (30 in.) can be attained. Exercise care when using gravity corers in vessels or lagoons that have liners because penetration depths could exceed those of the substrate; this could result in damage to the liner material.

Procedures for Use

1. Attach a precleaned corer to the required length of sample line. Solid braided 5-mm (3/16-in.) nylon line is sufficient; however, 20-mm (3/4-in.) nylon is easier to grasp during hand hoisting. An additional weight can be attached to the outside of the corer if necessary.
2. Secure the free end of the line to a fixed support to prevent accidental loss of the corer.
3. Allow corer to free fall through the liquid to the bottom.
4. Retrieve corer with a smooth, continuous, up-lifting motion. Do not bump corer because this may result in some sample loss.
5. Remove nosepiece from corer and slide sample out of corer into stainless steel or Teflon pan (preferred).
6. Transfer sample into appropriate sample bottle with a stainless steel lab spoon or laboratory spatula.

Attachment E: Construction of a Typical COLIWASA

The sampling tube consists of a 1.52-m (5-ft) by 4.13-cm (1-5/8 in) I.D. translucent plastic pipe, usually polyvinyl chloride (PVC) or borosilicate glass plumbing tube. The closure-locking mechanism consists of a short-length, channeled aluminum bar attached to the sampler's stopper rod by an adjustable swivel. The aluminum bar serves both as a T-handle and lock for the samplers' closure system. When the sampler is in the open position, the handle is placed in the T-position and pushed down against the locking block. This manipulation pushes out the neoprene stopper and opens at the sampling tube. In the closed position, the handle is rotated until one leg of the T is squarely perpendicular against the locking block. This tightly seats the neoprene stopper against the bottom opening of he sampling tube and positively locks the sampler in the closed position. The closure tension can be adjusted by shortening or lengthening the stopper rod by screwing it in or out of the T-handle swivel. The closure system of the sampler consists of a sharply tapered neoprene stopper attached to a 0.95-cm (3/8-in) O.D. rod, usually PVC. The upper end of the stopper rod is connected to the swivel of the aluminum T-handle. The sharply tapered neoprene stopper can be fabricated according to specifications by plastic-products manufacturers at an extremely high price, or it can be made in-house by grinding down the inexpensive stopper with a shop grinder.

COLIWASA samplers are typically made out of plastic or glass. The plastic type consists of translucent plastic (usually PVC) sampling tube. The glass COLIWASA uses borosilicate glass plumbing pipe as the sampling tube and a Teflon plastic stopper rod. For purpose of multiphase sampling, clear plastic or glass is desirable in order to observe the profile of the multiphase liquid.

The sampler is assembled as follows:

a. Attach the swivel to the T-handle with the 3.18-cm (1-1/4 in) long bolt and secure with the 0.48-cm (3/16-in) National Coarse (NC) washer and lock nut.

b. Attach the PFTE stopper to one end of the stopper rod and secure with the 0.95-cm (3/8-in) washer and lock nut.

c. Install the stopper and stopper rod assembly in the sampling tube.

d. Secure the locking block sleeve on the block with glue or screw. This block can also be fashioned by shaping a solid plastic rod on a lathe to the required dimension.

e. Position the locking block on top of the sampling tube such that the sleeveless portion of the block fits inside the tube, the sleeve sits against the top end of the tube, and the upper end of the stopper rod slips though the center hole of the block.

f. Attach the upper end of the stopper rod to the swivel of the T-handle.

g. Place the sampler in the close position and adjust the tension on the stopper by screwing the T-handle in or out.

Attachment F: Drum Opening Techniques and Equipment [1]

I. Introduction

The opening of closed drums prior to sampling entails considerable risk if not done with the proper techniques, tools, and safety equipment. The potential for vapor exposure, skin exposure due to splash or spraying, or even explosion resulting from sparks produced by friction of the tools against the drum, necessitate caution when opening any closed container. Both manual drum opening and remote drum opening will be discussed in the following paragraphs. When drums are opened manually risks are greater than when opened remotely; for this reason, the remote opening of drums is advised whenever possible.

Prior to sampling, the drums should be staged to allow easy access. Also, any standing water or other material should be removed from the container top so that the representative nature of the sample is not compromised when the container is opened. There is also the possibility of encountering a water-reactive substance.

II. Manual Drum Opening

A. Bung Wrench

A common method for opening drums manually is using a universal bung wrench. These wrenches have fittings made to remove nearly all commonly encountered bungs. They are usually constructed of cast iron, brass, or a bronze-beryllium (a non-sparking alloy formulated to reduce the likelihood of sparks). The use of bung wrenches marked “NON SPARKING” is encouraged. However, the use of a “NON SPARKING” wrench does not completely eliminate the possibility of spark being produced. Such a wrench only prevents a spark caused by wrench-to-bung friction, but it cannot prevent sparking between the threads on the drum and the bung.

A simple tool to use, the fitting on the bung wrench matching the bung to be removed is inserted into the bung and the tool is turned counterclockwise to remove the bung. Since the contents of some drums may be under pressure (especially, when the ambient temperature is high), the bung should be turned very slowly. If any hissing is heard, the person opening the drum should back off and wait for the hissing to stop. Since drums under pressure can spray out liquids when opened, the wearing of appropriate eye and skin protection in addition to respiratory protection is critical.

B. Drum Deheader

One means by which a drum can be opened manually when a bung is not removable with a bung wrench is by using a drum deheader. This tool is constructed of forged steel with an alloy steel blade and is designed to cut the lid of a drum off or part way

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[1] Taken from EPA Training Course: “Sampling for Hazardous Materials,” U.S. Environmental Protection Agency, Office of Emergency and Remedial Response Support Division, March 24, 1987.

off by means of a scissors-like cutting action. A limitation of this device is that it can be attached only to closed head drums (i.e., DOT Specification 17E and 17F drums); drums with removable heads must be opened by other means.

Drums are opened with a drum deheader by first positioning the cutting edge just inside the top chime and then tightening the adjustment screw so that the deheader is held against the side of the drum. Moving the handle of the deheader up and down while sliding the deheader along the chime will enable the entire top to be rapidly cut off if so desired. If the top chime of a drum has been damaged or badly dented it may not be possible to cut the entire top off. Since there is always the possibility that a drum may be under pressure, the initial cut should be made very slowly to allow for the gradual release of any built-up pressure. A safer technique would be to employ a remote pressure release method prior to using the deheader.

C. Hand Pick or Spike

When a drum must be opened and neither a bung wrench nor a drum deheader is suitable, then it can be opened for sampling by using a hand pick, pickaxe, or spike. These tools are usually constructed of brass or a non-sparking alloy with a sharpened point that can penetrate the drum lid or head when the tool is swung. The hand picks or pickaxes that are most commonly used are commercially available, whereas the spikes are generally uniquely fabricated 4- foot long poles with a pointed end. Often the drum lid or head must be hit with a great deal of force in order to penetrate it. Because of this, the potential for splash or spraying is greater than with other opening methods and therefore this method of drum opening is not recommended, particularly when opening drums containing liquids. Some spikes used for drum opening have been modified by the addition of a circular splash plate near the penetrating end. This plate acts as a shield and reduces the amount of splash in the direction of the person using the spike. Even with this shield, good splash gear is essential.

Since drums, some of which may be under pressure, cannot be opened slowly with these tools, “sprayers” may result and appropriate safety measures must be taken. The pick or spike should be decontaminated after each drum is opened to avoid cross contamination and/or adverse chemical reaction from incompatible materials.

III. Remote Opening

A. Backhoe Spike

The most common means used to open drums remotely for sampling is the use of a metal spike attached or welded to a backhoe bucket. In addition to being very efficient, this method can greatly reduce the likelihood of personnel exposure.

Drums should be “staged,” or placed in rows with adequate aisle space to allow ease in backhoe maneuvering. Once staged, the drums can be quickly opened by punching a hole in the drum head or lid with the spike.

The spike should be decontaminated after each drum is opened to prevent cross contamination. Even though some splash or spray may occur when this method is used, the operator of the backhoe can be protected by mounting a large shatter-resistant shield in front of the operator's cage. This, combined with the normal sampling safety gear, should be sufficient to protect the operator. Additional respiratory protection can be afforded by providing the operator with an on-board airline system. The hole in the drum can be sealed with a cork.

B. Hydraulic Devices

Recently, remotely operated hydraulic devices have been fabricated to open drums remotely. One such device is discussed here. This device uses hydraulic pressure to pierce through the wall of a drum. It consists of a manually operated pump that pressurizes oil through a length of hydraulic line. A piercing device with a metal point is attached to the end of this line and is pushed into the drum by the hydraulic pressure. The piercing device can be attached so that a hole for sampling can be made in either the side or the head/lid of the drum. Some of the metal piercers are hollow or tube-like so that they can be left in place, if desired, and serve as a permanent tap or sampling port. The piercer is designed to establish a tight seal after penetrating the container.

C. Pneumatic Devices

Pneumatically-operated devices utilizing compressed air have been designed to remove drum bungs remotely. A pneumatic bung remover consists of a compressed air supply (usually SCBA cylinders) that is controlled by a heavy-duty, 2-stage regulator. A high pressure air line of desired length delivers compressed air to a pneumatic drill that is adapted to turn a bung fitting (preferably, a bronze-beryllium alloy) selected to fit the bung to be removed. An adjustable bracketing system has been designed to position and align the pneumatic drill over the bung. This bracketing system must be attached to the drum before the drill can be operated. Once the bung has been loosened, the bracketing system must be removed before the drum can be sampled. This attachment and removal procedure is time- consuming and is the major drawback of this device. This remote bung opener does not permit the slow venting of the container, and therefore appropriate precautions must be taken. It also requires the container to be upright and relatively level. Bungs that are rusted shut cannot be removed with this device.

IV. Summary

The opening of closed containers is one of the most hazardous site activities. Maximum efforts would be made to ensure the safety of the sampling team. Proper protective equipment and a general wariness of the possible dangers will minimize the risk inherent to sampling operations. Employing proper drum opening techniques and equipment will also safeguard personnel. The use of remote sampling equipment whenever feasible is highly recommended.

STANDARD OPERATING PROCEDURE

Shallow Soil Sampling

I. Purpose

To provide general guidelines for the collection and handling of surface soil samples during field operations.

II. Scope

The method described for surface soil sampling is applicable for loosely packed earth and is used to collect disturbed-soil samples.

III. Equipment and Materials

- Sample jars.
- A hand auger or other device that can be used to remove the soil from the ground. Only stainless steel, Teflon, or glass materials should be used. The only exception is split spoons, which are most commonly available in carbon steel; these are acceptable for use only if they are not rusty.
- A stainless steel spatula or disposable plastic scoop should be used to remove material from the sampling device.
- Unpainted wooden stakes or pin flags
- Fiberglass measuring tape (at least 200 feet in length)
- GPS Unit (if available)

IV. Procedures and Guidelines

A. Wear protective gear, as specified in the Health and Safety Plan.

B. To locate samples, identify the correct location using the pin flags or stakes. Proceed to collect a sample from the undisturbed soil adjacent to the marker following steps C and D. If markers are not present, the following procedures will be used.

   1. For samples on a grid:

      a. Use measuring tape to locate each sampling point on the first grid line as prescribed in the sampling plan. As each point is located, drive a numbered stake in the ground and record its location on the site map and in the logbook.

b. Proceed to sample the points on the grid line.

c. Measure to location where next grid line is to start and stake first sample. For subsequent samples on the line take two orthogonal measurements: one to the previous grid line, and one to the previous sample on the same grid line.

d. Proceed to sample the points on the grid line as described in Section C below.

e. Repeat 1c and 1d above until all samples are collected from the area.

f. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

2. For non-grid samples:

a. Use steel measuring tape to position sampling point at location described in the sampling plan by taking two measurements from fixed landmarks (e.g., corner of house and fence post).

b. Note measurements, landmarks, and sampling point on a sketch in the field notebook, and on a site location map.

c. Proceed to sample as described in Section C below.

d. Repeat 2a through 2c above until all samples are collected from the area.

e. Or, a GPS unit can be used to identify each location based on map coordinated, if available.

C. To the extent possible, differentiate between fill and natural soil. If both are encountered at a boring location, sample both as prescribed in the field sampling plan. Do not locate samples in debris, tree roots, or standing water. In residential areas, do not sample in areas where residents’ activities may impact the sample (e.g., barbecue areas, beneath eaves of roofs, driveways, garbage areas). If an obstacle prevents sampling at a measured grid point, move as close as possible, but up to a distance of one half the grid spacing in any direction to locate an appropriate sample. If an appropriate location cannot be found, consult with the Field Team Leader (FTL). If the FTL concurs, the sampling point will be deleted from the program. The FTL will contact the CH2M HILL project manager (PM) immediately. The PM and Navy Technical Representative (NTR) will discuss whether the point should be deleted from the program. If it is deleted, the PM will follow-up with the NTR in writing.

D. To collect samples:

1. Use a decontaminated stainless steel scoop/trowel or disposable plastic scoop to scrape away surficial organic material (grass, leaves, etc.) adjacent to

the stake. New disposable scoops or trowels may also be used to reduce the need for equipment blanks.

2. If sampling:

   a. Surface soil: Obtain soil sample by scooping soil using the augering scoop/trowel, starting from the surface and digging down to a depth of about 6 inches, or the depth specified in the workplan.

   b. Subsurface soil: Obtain the subsurface soil sample using an auger down to the depths prescribed in the field sampling plan.

3. Take a photo ionization detector (PID) reading of the sampled soil if organics are anticipated to be present and record the response in the field notebook. Also record lithologic description and any pertinent observations (such as discoloration) in the logbook.

4. Empty the contents of the scoop/trowel into a decontaminated stainless steel pan or dedicated sealable bag.

5. Repeat this procedure until sufficient soil is collected to meet volume requirements.

6. For TCL VOC and field GC aliquots, fill sample jars directly with the trowel or scoop or specialized sampling equipment (i.e. Encore® or Terra Core® sampler) and cap immediately upon filling. DO NOT HOMOGENIZE.

7. For TCL pesticides/PCBs and SVOCs, TAL metals, and field XRF aliquots, homogenize cuttings in the pan using a decontaminated stainless steel utensil in accordance with SOP *Decontamination of Drilling Rigs and Equipment*.

8. Transfer sample for analysis into appropriate containers with a decontaminated utensil.

9. Backfill the hole with soil removed from the borehole. To the extent possible, replace topsoil and grass and attempt to return appearance of sampling area to its pre-sampled condition. For samples in non-residential, unmowed areas, mark the sample number on the stake and leave stake in place. In mowed areas, remove stake.

V. Attachments

None.

VI. Key Checks and Items

- Use phthalate-free latex or surgical gloves and other personal protective equipment.
- Transfer volatiles first, avoid mixing.
- Decontaminate utensils before reuse, or use dedicated, disposable utensils.

Attachment 2
Data Management Guidelines

Version 1

Navy CLEAN
Data Management Plan

Prepared for

Navy CLEAN & Joint Venture Programs

June 2010

CH2MHILL

Preface

This document presents the standardized six-step workflow process for environmental data management being performed for the Navy Comprehensive Long-Term Environmental Action - Navy (CLEAN) and Joint Venture Programs. Included in Appendix A is the responsible, approve, support, consult, and inform (RASCI) diagram along with the associated roles and responsibilities, which is the basis for the Navy CLEAN and Joint Venture Programs Data Management Plan (DMP). Following are the six steps in the workflow process:

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation and loading
5. Data management
6. Data evaluation and reporting

Figure P-1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs. The various steps in the flow process are numbered 1 to 26. Figure P-2 presents, in more detail, the tools used in each step of the process.

Appendix B contains a data flow diagram that outlines the tools that used to help collect data for all program and project activities. CH2M HILL uses the Sample Tracking Program (STSP) to initiate the sample collection, documentation, and tracking processes. During the laboratory analysis and data validation phase, the CH-Analyzer and Validation Data Management System (VDMS) software will be used to help evaluate the quality of the data. At the data management step, the CH-ERPTool will be used to format the data and the CH-IMPTool will be used to transfer the data into the Navy CLEAN data warehouse. At the data evaluation stage, the XTabReports Tool will be used to query data from the data warehouse, and the Crosstab Cleanup Tool and RDE Formatting Tool will produce and format data tables and comparisons to project action levels. The Site Information Management System Visual Interface to the data warehouse is an application that is often used to access and query data. Appropriate section(s) of the DMP include additional details on each of the tools used.

Change Management

This DMP is a "living" document and content may be revised or amended to accommodate changes in the scope of environmental investigations or data management requirements that affect the entire Navy CLEAN Program. In addition, the DMP appendices will be subject to modification as new or improved methods of data management are developed and implemented.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user's responsibility to conform to revised portions of the DMP.

Amendments will be versioned and released according to the following naming scheme: [Document Name_v#.#_yymmdd]. If a significant change is made to any of these files, the version number will increase by one integer. The revision history is shown in the following table.

REVISION HISTORY

Navy CLEAN and Joint Venture Programs Data Management Plan

Revision Date	Initiator	Purpose

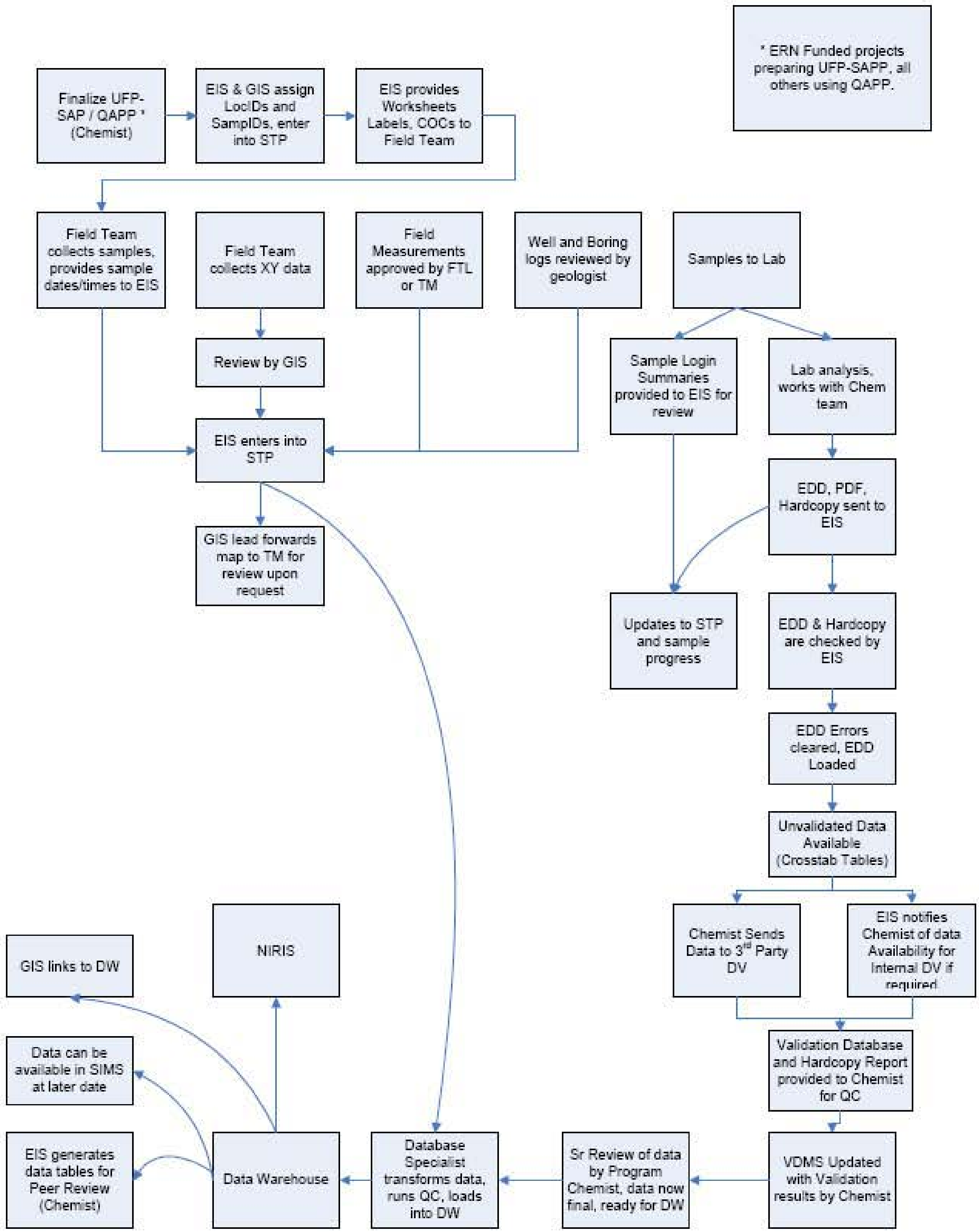

FIGURE P-1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

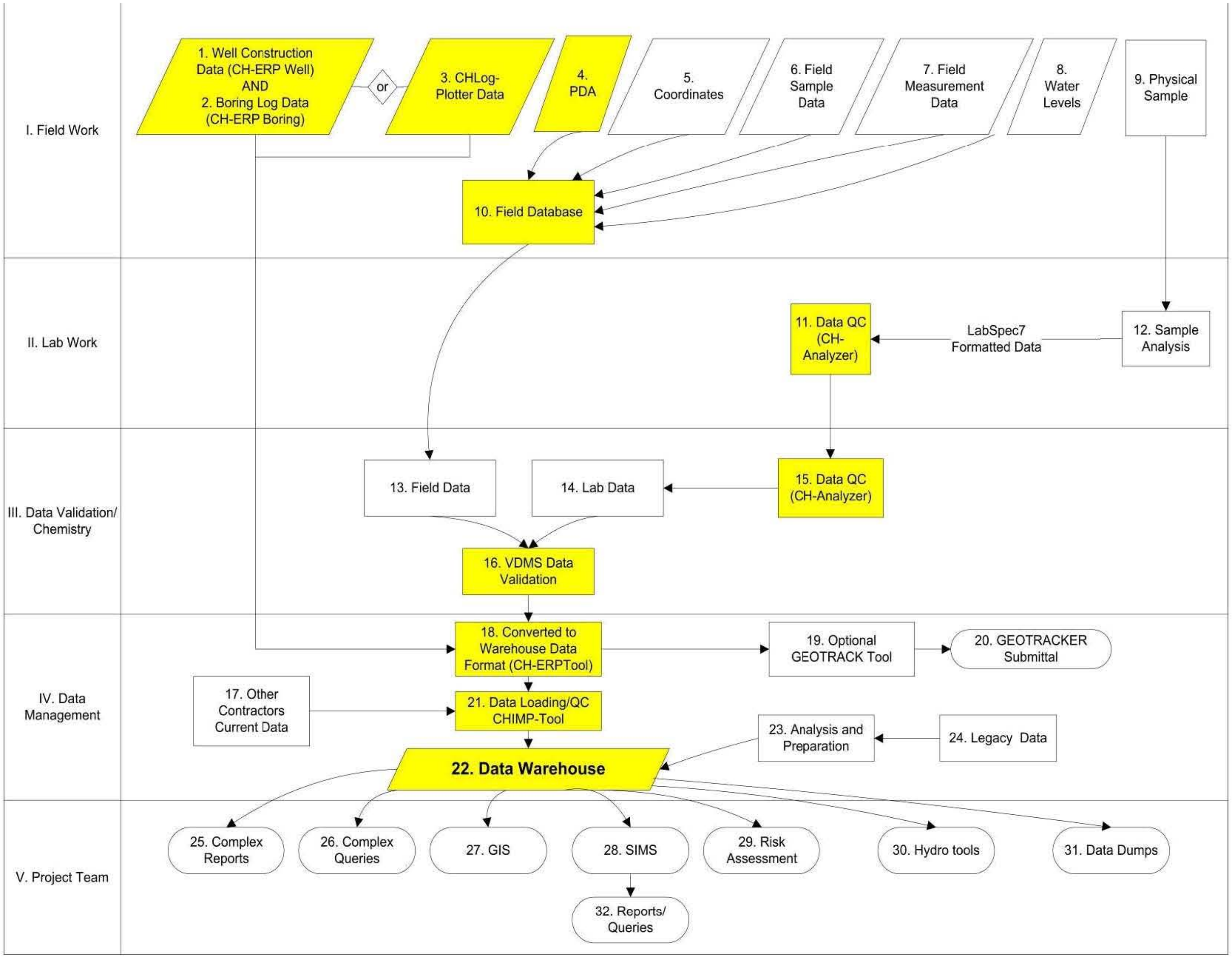

FIGURE P-2
DBMS PROCESS

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Acronyms and Abbreviations

AFCEE	Air Force Center for Engineering and the Environment
AM	Activity Manager
CAD	computer-aided design
COC	chain-of-custody
DBMS	Database Management System
DBS	Database Specialist
DMP	Data Management Plan
EDD	electronic data deliverable
EDM	Environmental Data Management
EIS	Environmental Information Specialist
EMS	Enterprise Management Solutions
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
EVS	Environmental Visualization System
FD	field duplicate
FTL	Field Team Leader
GA	GIS Analyst
GIS	geographic information system
ID	identification
IDW	investigation-derived waste
IRP	Installation Restoration Program
MS	matrix spike
MSD	matrix spike duplicate
N/FD	normal/field duplicate
NAVFAC	Naval Facilities Engineering Command
NEDD	Naval Installation Restoration Information Solution Electronic Data Deliverable

NIRIS	Naval Installation Restoration Information Solution
ODBC	open database connectivity
PC	Project Chemist
PCL	Program Chemistry Lead
PDL	Program Data Management Lead
PGDB	personal geodatabase
PGL	Program GIS Lead
PM	Project Manager
QA	quality assurance
QC	quality control
RASCI	responsible, approve, support, consult, and inform
RDM	Regional Database Manager
SDG	Sample Delivery Group
SIMS	Site Information Management System
SOP	standard operating procedure
STSP	Sample Tracking Program
VDMS	Validated Data Management System

SECTION 1
Introduction

This Data Management Plan (DMP) describes the methods CH2M HILL will use to manage and present environmental data to support work it is conducting for the Navy CLEAN and Joint Venture Programs. These processes and procedures are part of an overall environmental data management system called the Validation Data Management System (VDMS) hosted by CH2M HILL.

Project members and any subcontractors supporting program data needs for site characterization and remediation activities can use this DMP. It is a living document that is flexible enough to meet the dynamic needs of the teams and stakeholders. Data management program details and procedures are included in the appendices.

1.1 Purpose and Objective

This document outlines how environmental data for the Navy CLEAN and Joint Venture Programs will be obtained and managed using an Enterprise Management Solutions (EMS) approach. The systematic approach will facilitate the retrieval of data from project files and the data warehouse when they are needed, help ensure that the required data are collected and are of the appropriate quality, and help ensure that data records are not lost during transfer to the central program database repository.

The EMS objectives critical to the success of the DMP are as follows:

- **Standardize and facilitate data collection.** Use standard field forms and database applications; provide guidance and standard operating procedures (SOPs) for formatting, reviewing, and transferring data collected in the field to the Database Management System (DBMS).
- **Provide the ability to capture electronic field data directly or indirectly.** Items that will be captured through standardized forms or applications include chains-of-custody (COCs), field parameter information, groundwater elevation data, and sample tracking records.
- **Minimize the uncertainties associated with the data.** Implement quality assurance (QA) and quality control (QC) measures to provide accurate representation of all data collected and stored in the DBMS. QA/QC procedures include restricting data import or entry to specific valid value lists that will not allow incorrect data to be included in the DBMS.
- **Provide a structured, yet flexible data set.** The DBMS will store all types of environmental data and provides a standard framework for all projects within the Navy CLEAN Program to use. The DBMS is organized and structured, yet flexible enough to allow additional data and data types to be added at any time over the life of the program.
- **Provide data that are well documented.** Retain enough descriptive and source information for technical defensibility and legal admissibility of the data.

- **Provide end-users with tools to gain access to the data.** Provide reporting and delivery support from a single DBMS source and allow relatively simple and rapid access to stored data for environmental characterization, report generation, modeling, geographic information system (GIS) mapping, statistical analyses, and risk assessments.
- **Provide data visualization capabilities.** Allow accurate representation of data used in models, GIS, boring log programs (Environmental Visualization System [EVS), computer-aided design (CAD), graphics, and other software used for mapping, graphing, charting, analyzing, and displaying environmental data.
- **Provide the ability to compare data electronically.** Allow electronic comparison of project data to specific reference or screening criteria.
- **Provide the ability to transfer data to different formats.** Provide the ability to reformat, convert, and transfer the data to any format as required by specific end-user applications.

1.2 Scope of the Data Management Plan

The scope of the data management activities addressed by this plan includes the following:

- Definition of staff roles and responsibilities (Appendix A).
- Flow diagrams illustrating how environmental data are collected, reviewed, and entered into the DBMS (Appendix B)
- SOPs (Appendix C).
- Description and use of data outputs (Appendix D).
- Electronic data deliverable (EDD) format specifications that analytical laboratories are required to use to transfer analytical data electronically to CH2M HILL. (Provided to laboratories via a scope of work.)
- Management and archive procedures for hard copy and electronic project documentation.

SECTION 2

Roles and Responsibilities

The Navy CLEAN and Joint Venture Programs Environmental Data Management (EDM) team will work together to properly execute the DMP and ensure that the project objectives and scope are realized. The EDM team is composed of environmental, data, GIS, and EMS resources. The EDM team is responsible for all aspects of planning, execution, and reporting environmental data. Data are derived from sampling events related to investigative and remedial activities for Navy CLEAN and Joint Venture projects.

Responsibilities related to data management and information solutions functions are grouped into roles, as listed in Table 1. Checklist_VDMS-DM-Process_20090615 in Appendix C documents the specific responsibilities associated with each of these roles.

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Navy CLEAN Activity Manager (AM)	Various	Various	Various	Various
Navy CLEAN Project Manager (PM)	Various	Various	Various	Various
Field Team Leader (FTL)	Various	Various	Various	Various
Program EMS Team Lead	John Kochanowski 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6227	757-497-6885	jkochanowski@ch2m.com
Program Chemistry Lead (PCL)	Anita Dodson 5700 Cleveland Street Suite 101 Virginia Beach, VA 23462	757-671-6218	757-497-6885	adodson@ch2m.com
Project Chemist (PC)	Mike Zamboni 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5111	703-376-5801	mzamboni@ch2m.com
Project Chemist (PC)	Megan Hilton 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	401-619-2657	703-376-5801	mhilton@ch2m.com
Project Chemist (PC) / Environmental Information Specialist (EIS)	Bianca Kleist 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6281	757-497-6885	bkleist@ch2m.com
Database Specialist (DBS)	Bhavana Reddy 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703- 462-3784	703- 376-5010	breddy@ch2m.com

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
Program Data Management Lead (PDL)	Chelsea Leigh 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6208	773-695-1378	cleigh@ch2m.com
Environmental Information Specialist (EIS)	Genevieve Moore 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6284	757-497-6885	gmoore@ch2m.com
Environmental Information Specialist (EIS)	Emma Brower 15010 Conference Center Dr. Suite 200 Chantilly, VA 20151	703-376-5305	703-376-5805	ebrower@ch2m.com
Environmental Information Specialist (EIS)	Rebekha Shaw 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6279	757-497-6885	rshaw22@ch2m.com
Environmental Information Specialist (EIS)	Gwendolyn Buckley 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-8311	757-497-6885	Gbuckle1@ch2m.com
Environmental Information Specialist (EIS)	Kyle Block 25 New Chardon Street. Suite 300 Boston, MA 02114	617-626-7013		kblock@ch2m.com
Environmental Information Specialist (EIS)	Victoria Brynildsen 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462		757-497-6885	vbrynildsen@ch2m.com
Program GIS Lead (PGL)	Mike Dierstein 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6216	757-497-6885	mdierstein@ch2m.com

TABLE 1
Navy CLEAN and Joint Venture Environmental Data Management Program Team
The Navy CLEAN Program Data Management Plan

Title	Name/Address	Phone	Fax	E-mail
GIS Analyst (GA)	Blake Hathaway 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6230	757-497-6885	bhathawa@ch2m.com
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GIS Analyst (GA)	Mark Unwin 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6261	757-497-6885	munwin@ch2m.com
GIS Analyst (GA)	Chris Bowman 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6276	757-497-6885	cbowman@ch2m.com
GIS Analyst (GA)	Matt Rissing 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6243	757-497-6885	mrissing@ch2m.com
GIS Analyst (GA)	Forrest Cain 5700 Cleveland Street. Suite 101 Virginia Beach, VA 23462	757-671-6271	757-497-6885	fcain@ch2m.com

SECTION 3

Data Management System Description

During field investigation, monitoring, and remedial activities, CH2M HILL will collect a variety of environmental information to support data analysis, reporting, and decision-making activities. To meet current regulatory QA requirements, a complete audit trail of the information flow must be implemented. The six steps in the workflow process are:

1. Project planning and database setup
2. Sample collection and management
3. Laboratory analysis
4. Data validation
5. Data management and loading
6. Data evaluation and reporting

Each step in the data management process must be adequately planned, executed, and documented. Figure 1 presents a simplified presentation of the workflow process specific to the Navy CLEAN and Joint Venture Programs. Figure 2 presents, in more detail, the tools used in each step of the process.

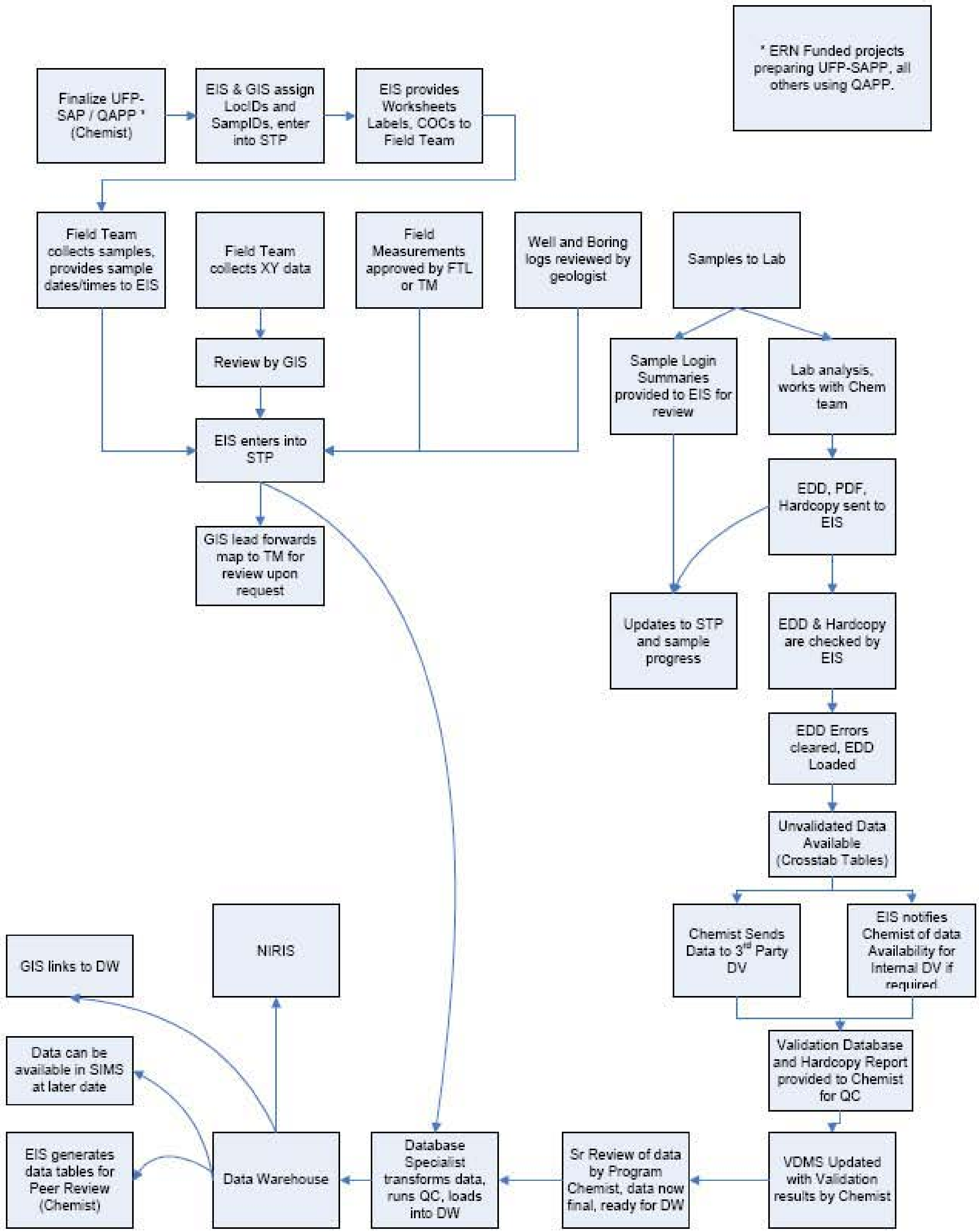

FIGURE 1
ENVIRONMENTAL DATA MANAGEMENT WORKFLOW PROCESS

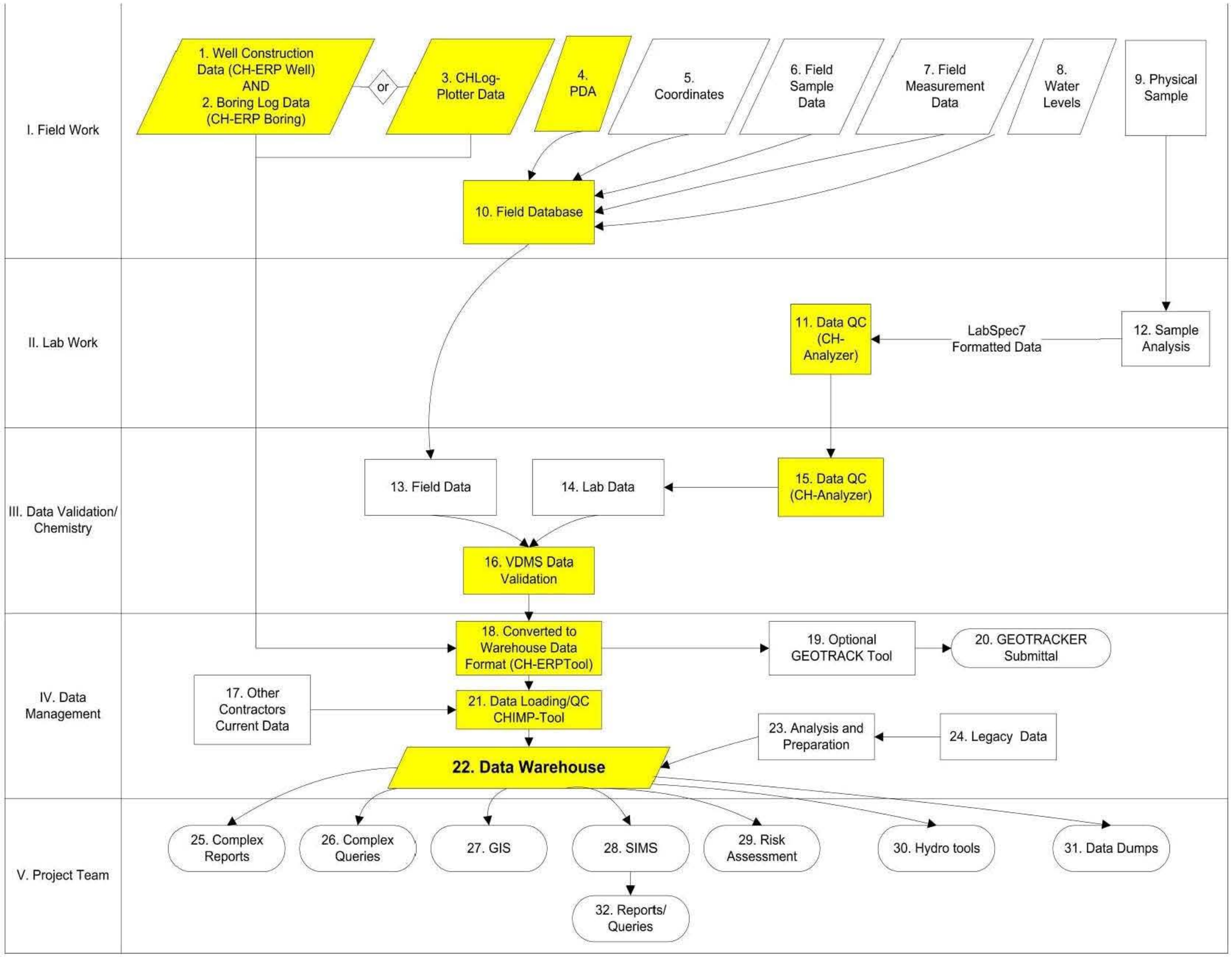

FIGURE 2
DBMS PROCESS

SECTION 4

Phases of Data Management

4.1 Project Planning and Setup

Project planning starts when a new project or task is identified in the program. Evaluation of what is required from the data management and visualization occurs to determine the data needs. The Program EMS Team Lead (EMS Lead) works with the project and/or program manager to determine what is expected and required from the data management and visualization team. Specific items that should be considered are as follows:

- Inputs – Determine what data will be collected and stored in the database. Determine frequency and quantity. Determine what tools will be used to handle data input.
- Historical Data – This is a unique data input and requires special consideration. The Program Data Management Lead (PDL) ***must*** work with the other technical leads to assess what effort will be required. This step is often missed, and the resulting data quality issues created from inadequate planning in this area can plague the project for its entire duration.
- Outputs – Determine what data will need to be presented in reports, figures, and electronic deliverables. Determine frequency and quality requirements. Determine preliminary data, validated data, and what tools will most effectively handle the output requirements. Discuss how the outputs needed by the team will be requested and documented.
- Visualization – Determine necessity for GIS and CAD.

After the information above is determined, the data management scope, schedule, and budget are developed and endorsed by the Project Manager (PM), PDL, and Program Chemistry Lead (PCL). The team can then proceed upon client authorization of the overall project budget. Figure 3 shows the process for project planning.

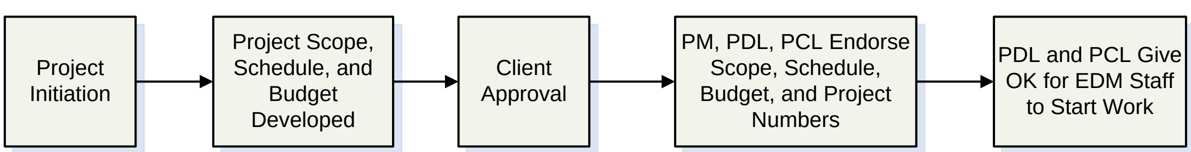

FIGURE 3
PROJECT PLANNING

4.1.1 Database Setup and Administration

CH2M HILL Database

The PDL will oversee the administration of the DBMS, including the design, development, and maintenance of the program database and data management processes. Database and data management process design and development will focus on providing rapid data entry and data retrieval while promoting data integrity through various automated procedures. The PDL will perform the database maintenance, which consists of the following:

- Assisting with the allocation of sufficient system storage for the program database
- Adding, altering, and deleting users, roles, and privileges
- Periodically defragmenting and compacting the database for more efficient operation
- Upgrading database software and associated applications as necessary
- Maintaining an approved list of valid values for data consistency
- Maintaining redundancy control to ensure that each data record is unique and consistent with conventions
- Performing routine virus checks on incoming and outgoing data

The DBMS is comprised of VDMS and the Data Warehouse combined, and will support the storage, analysis, display, and reporting of the Navy's environmental, analytical, and geotechnical data. The DBMS will consist of primary data tables that store the environmental data, dependent tables that store more details related to the data in the primary tables, and look-up tables that store valid values to provide input to the primary tables. The EIS will maintain the table content and the PDL will manage it.

Valid values are critical to any large relational database. Tables 2 and 3 provide examples of valid values for the Navy CLEAN and Joint Venture Programs' sites, stations, and samples. Inconsistencies in naming conventions, subtle analyte or method spelling differences, and the use of non-standard abbreviations can result in lost data and incorrect conclusions. Most tables and forms in the program database will use look-up tables for acceptable valid values and will not allow the entry of data that do not conform.

The primary purpose of managing data in a relational database environment is to ensure that each data record is unique and that the information contained within each field is consistent with conventions defined in other areas of the database. To ensure uniqueness, a key field or fields will be identified for each data record. Key fields define the record as unique. The VDMS architecture supports this approach and eliminates the possibility of data redundancy.

NIRIS Database

All Navy CLEAN and Joint Venture data must be loaded into the Navy's own internal database system, the Naval Installation Restoration Information Solution (NIRIS). NIRIS is a web-based centralized database that has been implemented across all Naval Facilities Engineering Command (NAVFAC) offices and will be used by the Navy and contractors to manage, evaluate, and visualize data, documents and records for Navy and the Marine Corps sites. NIRIS manages all Environmental Restoration Program (ERP) analytical and spatial data, which includes the Munitions Response and Installation Restoration Program (IRP) data, ensuring institutional memory is preserved, land use controls are maintained, and remedial actions are effective.

CH2M HILL will use the VDMS system to track, collect, review, and prepare Navy-related sample and project data for loading into NIRIS. Project data stored in VDMS must be consistent and comparable with data that is loaded and stored within NIRIS. As such, all associations between VDMS and NIRIS valid values, output reports, and data tables will be tracked and maintained.

4.1.2 Data Security Procedures

Some VDMS applications and data are stored in a secure location with login and password protection. Authorized users of the STSP tool and VDMS will have logins and passwords in advance. The PDL will provide security access to these tools. Access2003 must be installed on the computer that the user will be using to run these applications, and proper licenses distributed. Files received from any subcontractors will be scanned for common viruses using industry standard, current virus protection programs. The file servers storing the data must be running current virus software, with automatic virus signature updates.

NIRIS data are stored in a secure location with login and password protection. Users who require access to NIRIS and the data contained therein will need to follow procedures outlined in the SOP Access to NIRIS to procure security certificates, training, and access rights to installation-specific data. Authorized users of NIRIS will be assigned logins and passwords maintained by the Navy.

4.1.3 Data Backup and Recovery

All project data management files will reside on CH2M HILL's terminal server, "Gaia," and will have a tape backup or equivalent created in accordance with CH2M HILL's network server management policy.

4.2 Sample Collection and Management

Sample control during the sampling phase is required to ensure the integrity of the associated data. Sample control must be maintained and documented from the point of collection through the point of disposal. Sample control will be managed both in the field and in the laboratory, and will be documented through the use of field log books and a Chain of Custody (COC). When custody of a sample is transferred from one party to another, the recipient of the sample assumes responsibility for maintaining control of the sample and documenting that control on the COC. Figure 4 shows the process for planning and executing field sampling events.

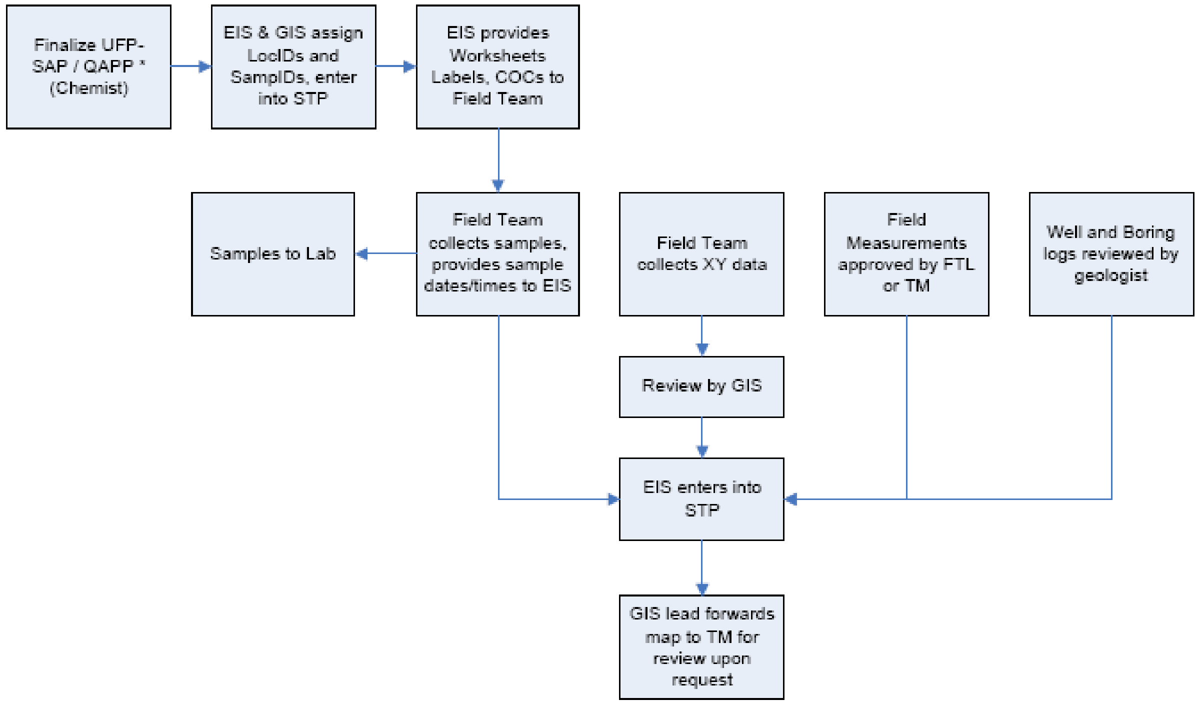

FIGURE 4
FIELD SAMPLING

4.2.1 Sample Tracking Program

During the planning stage, the PM specifies the data requirements for the sampling event. The work plan or similar document will provide project-specific data requirements for a given sampling event. The PC is responsible for reviewing the Sampling and Analysis Plan and ensuring that the FTL is aware of the number of field and laboratory QC samples required for the sampling event (trip blanks, equipment blanks, field blanks, field duplicates, matrix spikes, and matrix spike duplicates). All of this information is to be entered into the STSP.

The STSP tool will be used in advance to develop daily assignments for field crews, identify sampling container and preservation requirements, identify analytical laboratories for samples, print labels for sample bottles before the sampling event, and prepare and print COC forms after sampling is complete.

4.2.2 Sample Nomenclature Guidelines

The following guidelines are provided for sample nomenclature, COC clarification, and eData expectations.

Station ID (Location)

Field station data are information assigned to a physical location in the field at which some sort of sample is collected. For example, a monitoring well that has been installed will require a name that will uniquely identify it with respect to other monitoring wells or other types of sample locations. The station name provides a key in a database to which any samples collected from that location can be linked to form a relational database structure.

Before beginning fieldwork, the FTL will review the proposed level of effort and coordinate a list of unique station identification names, or station IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon station IDs during all field activities.

Each station will be uniquely identified by an alphanumeric code that will describe the station's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, station type, sequential station number, and possibly an additional qualifier as needed. The naming scheme to be used for the identification of a sampling station is documented in Table 2.

For example, if the first sample location at next month's event within Yorktown Site 30 is at a soil location, then the location ID could possibly YS30-SO391 because that was the next available sequence number for soil locations. This should also be reflected in the Sample ID. QC and IDW station IDs must be established for each site that they are associated with.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a station is mislabelled and ensure there are unique identifiers for every sampling location. Required deviations to this format in response to field conditions will be documented in the field logbook.

Sample ID

Field sample data are information assigned to a physical piece of material collected in the field for which some sort of analysis will be run. Before collecting samples, the FTL will review the proposed level of effort and coordinate a list of unique sample identification names, or sample IDs, with the PDL or EIS. The FTL will be responsible for enforcing the use of the standardized ID system and agreed upon sample IDs during all field activities.

Each sample will be uniquely identified by an alphanumeric code that will describe the sample's attributes. These attributes are facility, Area of Concern (AOC)/Site/Operable Unit (OU) number, sample/station type, sequential station number, modifier (as needed), depth (as needed), date, and date modifier (as needed). The naming scheme to be used for the identification of samples is documented in Table 3.

The standardized ID system will identify all samples collected during sampling activities. The system will provide a tracking procedure to ensure accurate data retrieval of all samples taken. For example, a surface soil sample collected from station YS30-SO391 reference above in June of 2009 will result in a sample ID of YS30-SS391-0609.

Please consult with the PDL or EIS should any questions arise. This will avoid complications that could occur if a sample is mislabelled and ensure there are unique identifiers for every sample. Required deviations to this format in response to field conditions will be documented in the field logbook.

Navy Clean

First Segment	**Second Segment**	
Facility, Site Number	Station Type	Station Number, Modifier
AA,ANN	AA	NNN_A

Notes: "A"= alphabetic "N"= numeric

Facility:

A = ABL
AN = Anacostia
BA = Bainbridge
BW = Bloodsworth Island
BR = Bremerton
CA = Cheatham Annex
CH = Cherry Point
CI = Craney Island
CL = Camp Lejeune
CP = Camp Peary
CR = Carderock
DA = Dahlgren
DN = Dam Neck
DR = Driver
IH = Indian Head
LS = Little Creek
NA = Naval Academy
NB = Naval Station Norfolk
NM = NNMC (Bethesda Naval Hospital)
NN = Norfolk Naval Shipyard
NR = Naval Research Laboratory
NWA = Northwest Annex
OC = Oceana
PA = Pax River
PI = Pineros Islands
QU = Quantico
RO = Rota
RR = Roosevelt Roads
SI = Sigonella
SJ = St. Juliens
SS = Sabana Seca
VE = Vieques East
VW = Vieques West
WN = Washington Navy Yard
WO = White Oak
Y = Yorktown

Site/AOC/SWMU Number – Sequential Number:

Site = S01, S02, S03…
Site Screening Area = SA01, SA02, SA03…
AOC = A01, A02, A03…
AOI = AI01, AI02, AI03…
SWMU = W01, W02…
Building = B01, B02, B03…
Range = R01, R02…
LIA – LI Area, East Vieques

BSxx = Background locations outside of site (BS25 = Background Site 25)
BKL = Background locations outside of the facility
BKG = Background locations (inside base)

QC and IDW Stations
Site ID (First Segment) followed by –QC or -IDW

Station Type:

AGT	=	Above Ground Tank
AS	=	Ash
BH	=	Borehole
CO	=	Concrete
DP	=	Direct Push
DR	=	Drill Rig
EW	=	Extraction Well
FG	=	Frog
FS	=	Fish
GB	=	Geotechnical Boring
GP	=	Geoprobe
GV	=	Gas Vent
HP	=	Holding Pond/Lagoon
IDW	=	Investigative Derived Waste
IW	=	Injection Well
LW	=	Leach Well
MA	=	Alluvial Monitoring Well
MB	=	Bedrock Monitoring Well
MU	=	UST Monitoring Well
MW	=	Monitoring Well (GW for Y)
PC	=	Paint Chip
PW	=	Production Well
QC	=	Quality Control
RK	=	Rock
RC	=	Recovery Well
RM	=	Remediation Well
RW	=	Residential Well
SD	=	Sediment Location
SG	=	Soil Gas
SL	=	Storm Sewer Line Sediment
SO	=	Soil Location
SP	=	Seep
ST	=	Storm Water
SU	=	Sump
SV	=	Soil Vapor
SW	=	Surface Water
SWS	=	Surface Water Body (for SW and SD)
UST	=	Underground Storage Tank
TA	=	Tap Water
TD	=	Tidal Station
TI	=	Tissue Sample (general)
TO	=	Tadpole
TP	=	Test Pit
TR	=	Trench Sediment
TS	=	Treatment System
TW	=	Temporary Well
WA	=	Alluvial Extraction Well
WB	=	Bedrock Extraction Well
WL	=	Water Supply Well
WN	=	Pore Water
WP	=	Wipe Sample
WT	=	Water Table Piezometer

Station Number:
Sequential Station Number (i.e., 01, 02, 03…)

Modifier (used selectively):
D = Deep monitoring well
S = Shallow monitoring well

Example Station IDs:

YS01-DP02 = Direct push soil location #2 at Yorktown Naval Weapons Station Site 1
CHR05-MW02S = Shallow monitoring well location 2, at the Cheatham Annex facility, Range 5.
NMBKL-SD02 = Background sediment location #2 located outside of NNMC
CHBS03-SO05 = Soil location #5, located in reference area outside of Site 3 in Cherry Point
VEW04-QC = QC Station at East Vieques SWMU-4
CAA08-IDW = IDW Station at Cheatham Annex AOC-8

TABLE 2
STATION ID SCHEME

<table>
<tr><th colspan="4">Navy Clean</th></tr>
<tr><th>First Segment</th><th>Second Segment</th><th>3rd Segment</th><th>Fourth Segment</th></tr>
<tr><td>Site ID
Facility, AOC Number</td><td>Station/Sample Type, Station Number, Modifier</td><td>Depth
(As Needed)</td><td>Date
(MMYY) $_A$</td></tr>
<tr><td>AA,ANN</td><td>AANNN$_A$</td><td>A</td><td>NNNN$_A$</td></tr>
<tr><td colspan="4">Notes: "A"= alphabetic "N"= numeric</td></tr>
<tr><td>A = ABL
AN = Anacostia
BA = Bainbridge
BW = Bloodsworth Island
BR = Bremerton
CA = Cheatham Annex
CH = Cherry Point
CI = Craney Island
CL = Camp Lejeune
CP = Camp Peary
CR = Carderock
DA = Dahlgren
DN = Dam Neck
DR = Driver
IH = Indian Head
LS = Little Creek
NA = Naval Academy
NB = Naval Station Norfolk
NM = NNMC (Bethesda Naval Hospital)
NN = Norfolk Naval Shipyard
NR = Naval Research Laboratory
NWA = Northwest Annex
OC = Oceana
PA = Pax River
PI = Pineros Islands
QU = Quantico
RO = Rota
RR = Roosevelt Roads
SI = Sigonella
SJ = St. Juliens
SS = Sabana Seca
VE = Vieques East
VW = Vieques West
WN = Washington Navy Yard
WO = White Oak
Y = Yorktown

<u>Site/AOC/SWMU – Sequential Number:</u>

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AOC = A01, A02, A03…
AOI = AI01, AI02, AI03…
SWMU = W01, W02…
Building = B01, B02, B03…
Range = R01, R02…
LIA – LI Area, East Vieques

BSxx = Background locations outside of site (BS25 = Background Site 25)
BKL = Background locations outside of the facility
BKG Background locations (inside base)</td>
<td><u>Sample Type:</u>
AGT = Above Ground Tank
AH = Air - Headspace
AS = Ash
BH = Borehole
CO = Concrete
DR = Drill Rig
DS = Direct Push—Soil
DW = Direct Push—Groundwater
EW = Extraction Well
FG = Frog
FS = Fish
GB = Geotechnical Boring
GP = Geoprobe
GV = Gas Vent
HP = Holding Pond/Lagoon
IW = Injection Well
LF = Free Product
LW = Leach Well
MA = Alluvial Monitoring Well
MB = Bedrock Monitoring Well
MU = UST Monitoring Well
MW = Monitoring Well (GW for Y)
PC = Paint Chip
PW = Production Well
RK = Rock
SW = Surface Water
RC = Recovery Well
RM = Remediation Well
RW = Residential Well
SB = Subsurface Soil
SD = Sediment Location
SG = Soil Gas
SL = Storm Sewer Line Sediment
SO = Soil Location (Composite)
SP = Seep
SS = Surface Soil
SSD = Subsurface Sediment
ST = Storm Water
SU = Sump
SV = Soil Vapor
SW = Surface Water
UST = Underground Storage Tank
TA = Tap Water
TD = Tidal Station
TI = Tissue Sample (general)
TO = Tadpole
TP = Test Pit
TR = Trench Sediment
TS = Treatment System
TW = Temporary Well
WA = Alluvial Extraction Well
WB = Bedrock Extraction Well
WL = Water Supply Well
WN = Pore Water
WP = Wipe Sample
WT = Water Table Piezometer

<u>Station Number:</u>
Sequential Number (e.g., 001, 002, 003)

<u>Modifier (used selectively):</u>
D = Deep monitoring well
S = Shallow monitoring well
P = Duplicate</td>
<td colspan="2"><u>Depth</u>:
Use only if applicable. A sequential letter is used to reflect varying depths, as actual depths can change in the field after sample planning has occurred. E.g. A, B, C…

<u>Sample Number:</u>

1. Duplicate Samples - Use a 'P' modifier in the second segment of the sample ID, directly after the location number to indicate a duplicate sample. E.g. AB01-MW11P-0506

2. MS/MSD Samples – Append a modifier of '-MS' for matrix spike or '-SD' for matrix spike duplicate to the end of the sample ID.

3. QC & IDW Samples (Blank Samples & Waste Char.) - Format consists of Facility, AOC Number, Qualifier Code, Sequential Qualifier Number-Date (AAANN-AANN-MMDDYY). E.g. LSA05-TB02-061106

<u>Qualifier Codes</u>:
TB = Trip Blank
FB = Field Blank
EB = Equipment Blank
WQ = Source Blank
WS = Waste Char. Soil
WW = Waste Char. Water

4. Drill Rig Samples – Format consists of Facility, AOC Number, Station Type, Station Number, Date. E.g. YS12-DR02-020507

5. Multiple samples - Should multiple samples be collected from the same location in a given day/month (affects only samples not differentiated by depth), a sequential letter will be added to the end of the fourth segment (date). E.g. A, B, C…</td></tr>
<tr><td colspan="4"><u>Example Sample IDs:</u>

<u>WNA01-MW102S-0105A</u> = The first shallow groundwater sample collected at monitoring well location 102 in January 2005 in AOC01 at the Washington Navy Yard facility.
<u>PIW01-SW023P-0306</u> = Pineros Island duplicate surface water sample collected at location 23, at SMWU-1 in March 2006.
<u>SSW06-FB01-061106</u> = The first field blank collected on June 11, 2006 at SMWU-6 in Sabana Seca.</td></tr>
</table>

TABLE 3
STATION ID SCHEME

4.2.3 Sample Collection

A photocopy of each field logbook page completed during sampling and of each COC will be made by the FTL and forwarded to the EIS at predefined intervals during sampling events. This information will serve as notification to the EIS of samples being shipped to an offsite lab and of the field crew's sampling progress.

Communication with field and laboratory staff will occur daily during the field event. The EIS will resolve issues that arise in the field (bottle ware shortage, equipment failure, etc). The lab will be informed of the shipment dates and the number of coolers or samples being sent. Laboratory login reports will be reviewed to ensure samples were received in good condition (no breakage, within holding time, within designated temperature). The field crew and PM will be notified if there were problems with shipment.

4.2.4 Chain-of-Custody and eData

A single COC number per project / laboratory / cooler should be generated each day (there can be multiple pages to one COC number). MSs and MSDs will be requested at a set frequency for each project (usually one per 20 samples collected). MS and MSD samples should not be taken from field duplicates (FDs) or field blanks. FDs will be requested at a set frequency for each project (usually one per 10 samples). FDs should not be taken from MSs, MSDs, or field blanks. The MS and MSD samples listed on the COC should be spiked and analyzed by the laboratory.

A 100% QC will be performed on COCs received from the field crew. The field crew and/or lab will be notified if corrections need to be made the COCs or lab login reports. Any corrections or modifications made will be noted in a Corrections-To-File Letter.

Once the field data and samples are collected, information on sampling date and time are to be entered into the STSP by the EIS, and as necessary field measurements, such as water levels and other data collected in the field also should be entered. Any data entered into the STSP must be exported into an excel file to facilitate a manual QC review of the data. The correction of any anomalies should be verified with the PM and PC. The information entered into the STSP will be exported into CH2M HILL's VDMS where field data and laboratory analytical data are linked by location and sample ID. This allows verification that all sample and method combinations have been received and reported by the laboratory.

4.2.5 Sample and Document Tracking

A Sample Tracking Sheet (STS) will be generated from the sample information entered and QC'd in the STSP. The STS should be updated and kept current throughout the data management process. All samples collected, resulting deliverables, and deliverable dates will be tracked throughout the data management process to ensure that the project schedule is met and subcontractor invoices are evaluated correctly.

All documentation acquired during the data management process, including Statements of Work (SOWs), Bids, COCs, Field Notes, Sample Tracking Sheets, Login Reports, Corrections-to-File Letters, FDETool QC tables, Post Load Reports, Invoices, and Communication Logs shall be compiled throughout the process to be stored in the appropriate Activity's Project Notebook.

4.3 Laboratory Analysis

Figure 5 shows the laboratory analysis process. Upon receipt of samples from the field, the laboratory will check that the COC forms correctly cover all samples submitted. Each COC form must be signed with the date and time of receipt by the laboratory. Samples will be logged in by the laboratory using information from the COC forms and the project instructions.

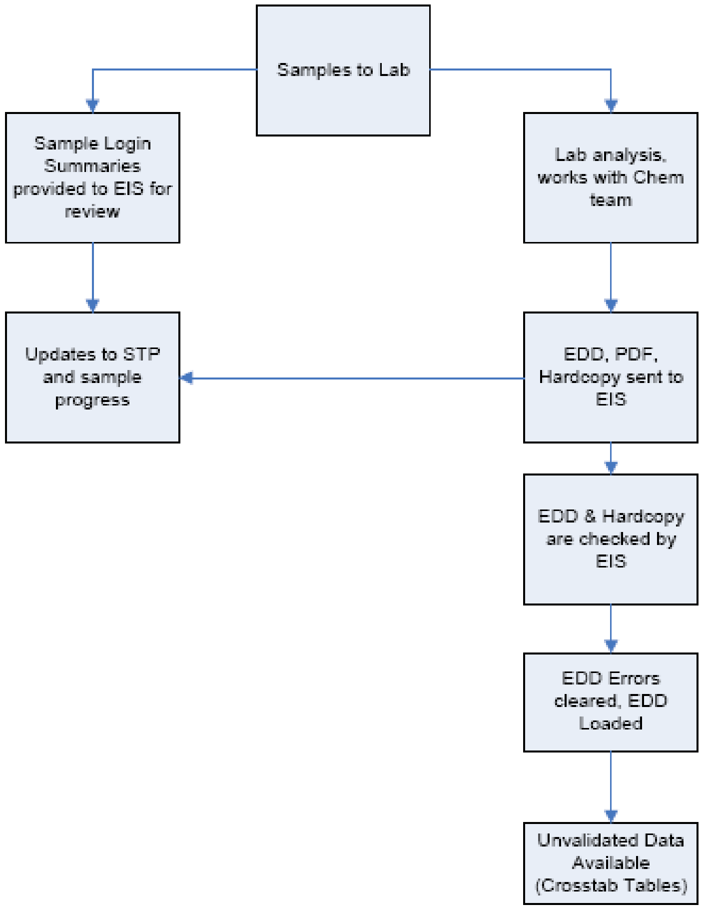


FIGURE 5
LABORATORY ANALYSIS

Samples will be analyzed as specified on the accompanying COC forms and in the Laboratory SOW. Generally, questions or noted inconsistencies identified by the laboratory should be addressed directly to the EIS.

The laboratory will attach the signed COCs to their hard copy data deliverables to officially relinquish control of the data back to the Environmental Contractor within the specified turn around time.

Hard copy data and EDDs will be reviewed to ensure that they are complete and acceptable as outlined in the EIS QC For Unvalidated Data Checklist. A 10% QC check will be performed on the analysis results to ensure that the hard copy data matches the EDD. All detected errors should be resolved with the laboratory.

Preliminary raw and detects tables will be generated following data import into VDMS by querying data with the VDMS XTab Tool and formatting the output with the Crosstab Cleanup and RDE Formatting Tools. A separate table must be created for each matrix, and provided to the PM for review.

Data archiving forms will be generated and affixed to each laboratory report received per Sample Delivery Group (SDG) for cataloguing, tracking, and archiving purposes.

The tools used to QC the laboratory's EDD are as follows:

- **CH-Analyzer**: Before the laboratory analytical data is entered into VDMS, the laboratory EDD must be processed through CH2M HILL's CH-Analyzer Microsoft Access database application. The CH-Analyzer application includes several automated diagnostic checks to verify format and content compliance with EDD specifications. The analytical laboratory must correct any errors before transmitting the EDD to CH2M HILL. The laboratory will forward the CH-Analyzer report, checked EDD, and hard copy of the data to the EIS who will manage the EDD verification process and data entry to VDMS.
- The EDD will be checked again using CH-Analyzer to verify correct format and content. If errors are found, the file will be returned to the laboratory for correction and re-submittal. Even if the formatting of the EDD is completely correct, the data loader may reject the EDD if the contents of the file do not comply with the data library standardization requirements.
- The CH-Analyzer also should be used to compare COCs, hard copy, and EDD content, and resolve discrepancies and document data error issues (for example, EDD re-submissions, turnaround time problems, hard copy incompleteness). These checks ensure the consistency and the validity of the EDD's content before the data are electronically transferred to VDMS. The objective of using the CH-Analyzer is to ensure that the validation process is performed on consistently high-quality data and minimize the chance of finding data errors later in the validation process, which would require the laboratory to resend corrected data and start the validation process over again.
- **VDMS**: Once the EDD verification is complete, it is electronically transferred into CH2M HILL's VDMS tool for data quality verification and validation according to project specifications. During import, the data are checked against a list of valid values. Once all error messages are resolved, validation can begin.

4.4 Data Validation

The data validator will be notified by the PC in advance of when to expect data and of any samples or analyses that should not be validated. (i.e. grain size should not be validated). For internal data validation, the EIS will notify the PC of data availability, and provide the hardcopy data and a QC Association Table.

Upon receipt of data from CH2M HILL, data validation will be performed in accordance with the Data Validation SOW, UFP SAP, and any other documents required. Generally, questions or noted inconsistencies identified by the validator should be addressed directly to laboratory, with the PC notified of issues and resolutions identified.

4.4.1 External Data Validation

For external data validation, a subset of the analytical data will be loaded into the 3rd Party DV Tool, a CH2M HILL Microsoft Access database designed for external data validation. The tool will allow external data validators to configure various with tables with QC information, associated validation logic, and qualifiers applied when QC criteria are not achieved. Qualifier criteria will be based on the Quality Assurance Project Plan.

The hard copy data, 3rd Party DV Tool, and a QC Association Table will be provided to the data validator. The PC will coordinate the return of the data package to CH2M HILL for archiving with the data validator.

Data Validators will provide the following materials to the PC within the required turn around time:

- Hardcopy Data Validation Report
- Validated Version of 3rd Party DV Tool (external validation)
- Validated Version of Data in VDMS (internal validation)

Once returned to CH2M HILL, the data in VDMS will be updated with the results in the 3rd Party DV Tool. The validated data will be reviewed by the PC to ensure that they are complete and acceptable as outlined in the VDMS and Chemist PreLoad Checklist. A 100% QC check will be performed on the validated results to ensure that the hard copy data matches the EDD. All detected errors should be resolved with the data validator.

Data archiving forms will be generated and affixed to each Data Validation Report per SDG received for cataloguing, tracking, and archiving purposes.

Validated raw and detects tables will be generated by querying data with the VDMS XTab Tool and formatting the output with the Crosstab Cleanup and RDE Formatting Tools. A separate table must be created for each matrix, and provided to the PM for review.

4.4.2 Internal Data Validation

VDMS will be operated in a semi-automated mode, which will require the chemist to configure various with tables with QC information, associated validation logic, and qualifiers applied when QC criteria are not achieved. Qualifier criteria will be based on the Quality Assurance Project Plan. A hardcopy data validation report will be generated. Data archiving forms will be generated and affixed to each Data Validation Report per SDG validated for cataloguing, tracking, and archiving purposes

Validated raw and detects tables will be generated by querying data with the VDMS XTab Tool and formatting the output with the Crosstab Cleanup and RDE Formatting Tools. A separate table must be created for each matrix, and provided to the PM for review.

4.4.3 Unvalidated Data Preload Check

Occasionally, unvalidated data will need to be loaded into the database. Although this data will not be validated, it will undergo a basic Preload Check by the PC to ensure laboratory compliance with project guidelines and determine results to be reported as the best result where multiple runs were conducted for a given sample/analysis. The PCL will provide input and oversight to ensure that data flags are applied correctly by the PC.

4.4.4 Senior Review

The PCL will verify that the validated hardcopy data and data contained in VDMS are complete and acceptable. Any identified discrepancies will be resolved with the assistance of the PC, EIS, laboratory, or validator as needed.

4.5 Data Preparation and Loading

Once the data are validated and approved by the PCL, they are exported from VDMS to the project warehouse. Field and laboratory data are merged into a format that is amenable to the warehouse. The backbone is a SQL-server-based data warehouse. Data in the warehouse are accessible through Site Information Management System (SIMS), a Web-based GIS application that allows users to query the data through a graphical interface and the XTabReports Tool.

4.5.1 Data Preparation

As part of the normal process of loading data into the warehouse, data standardization tasks must be completed. A Database Specialist (DBS) will load data into the warehouse using the following two programs: CH-ERPTool and CH-IMPTool. The CH-ERPTool runs an extensive series of logical QC checks and formats the data to be compatible with the data warehouse structure.

4.5.2 Data Loading

CH2M HILL Loading

The CH-IMPTool runs an additional series of QC checks and adds project-specific formatting and valid values, and loads the data into the warehouse. The following tasks need to be completed to load the data for project use:

- **Unit Standardization:** Analytical units and the associated results, reporting limits, and method detection limits will need to be converted to a consistent set of units as required by the project.
- **Resolve Reanalysis and Dilutions:** All samples that had an associated reanalysis or dilution run by the laboratory must have all of the excluded or rejected results marked as not the best result for reporting.
- **Resolve Analytical Overlap and Split Samples:** Analytical overlap occurs when a sample is analyzed by two or more methods that report the same analyte. To resolve this, the following logic is used to select the usable result:
  - If the overlapping results are all non-detections, the lowest non-detection result is selected.
  - If the overlapping results are all detected, the highest detected result is selected.

  - If the overlapping results consist of a mixture of detections and non-detections, the highest detected result is selected.

When data are loaded into the warehouse, an automated script will run to identify the "best" result when more than one analytical result exists.

NIRIS Loading

All Navy CLEAN and Joint Venture data must be loaded into NIRIS. Following the successful loading of data into the data warehouse, the DBS will use the NEDD Creator Tool to generate project NIRIS Electronic Data Deliverables (NEDD) files.

The DBS will use NIRIS's Data Checker Loader Tool to QC and submit the project NEDD files into NIRIS. The NIRIS Regional Database Manager (RDM) will load the data into NIRIS, and will work with the DBS to resolve any potential issue that may arise during loading. Following notification of successful data loading from the RDM, the DBS will query the data from NIRIS for review to ensure data integrity and accuracy.

4.5.3 Data Warehouse

The data warehouse is a Microsoft SQL Server 2005 relational database. This database, and all other "CH" tools used, has a data structure designed to achieve compliance with the Environmental Restoration Program Information Management System (ERPIMS) standard specified by Air Force Center for Engineering and the Environment (AFCEE). ERPIMS is an effective, comprehensive standard for environmental management.

The warehouse will use valid value tables when applying reference attributes to project data. Such reference data include the names of site objects and sampling locations, sampling matrix and method categories, analyte names, units. These reference tables are critical for maintaining the completeness and accuracy of data sets and are essential for accurate querying of the data.

Data are loaded and stored so that relationships among categories of data are enforced. For instance, all sampling records must be associated with a valid site object such as a planned sediment sampling location. The project repository database and collection, analysis, and reporting tools used in the DBMS are designed to enforce, for any project data record, entries in fields that refer to other types of data as required by the overall data model.

The data warehouse will automatically update the SIMS application whenever data are added or changed.

4.6 Data Reporting

Data reporting includes the following tasks:

- Retrieving data from the data warehouse for project deliverables, data visualization, or consumption by third parties
- Reviewing initial data and producing data queries and draft reports to dissect and disassemble the data
- Producing any requested client and regulatory agency data deliverables

Data for project deliverables, data visualization, or consumption by third parties will be retrieved from the warehouse, and will be equivalent to the real-time state of the project repository database. PMs and GIS Analysts (GAs) will work with the EIS and PCL for quality queries and data for reports.

4.6.1 Tables, Figures, and Diagrams

Once the data have been sufficiently analyzed, the list of requested data reports (tables, figures, diagrams) can be developed and finalized by the project team and submitted to the PCL and PM for review.

All requests for figures or graphics are to be directed to the GA assigned as the Point of Contact (POC) for that particular Navy installation. All requests for analytical data (crosstab tables, data dumps, third party deliverables etc) should be directed to the EIS assigned as the POC for that particular Navy installation. The EIS will generate a data deliverable from the data warehouse or NIRIS (as needed) suitable for end use and will provide data support to the end user. All requests for data statistics and calculations should be directed to the Risk Assessor assigned to the project.

4.6.2 GIS

The Navy CLEAN program will utilize ESRI's suite of GIS software for the majority of GIS-related tasks. The GIS data model will consist of one or more geodatabases (GDBs) per installation. Each installation will maintain one common installation GDB, which will store the common infrastructure data such as buildings, roads, topography, hyrdography, utilities, etc. The common installation GDB should adhere, as much as possible, to the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) data model. All project specific GDBs shall be developed and named for ease of interpretation by the GA.

All station location information for each installation will be pulled directly from that installation's data warehouse and stored in the common installation GDB as a data table. The data warehouse must contain valid coordinate information for the locations to be displayed correctly. Valid coordinate information will be maintained in the data warehouse by the EIS, and updated as necessary by the DBS.

ESRI's ArcMap 9.3 (or the latest version available) will be utilized for spatially displaying the environmental data within maps and figures, as well as for spatial analysis. The GA will need to coordinate efforts with the EIS on all requests that require the display of environmental sample data on a map to ensure that the appropriate data is queried from the data warehouse and linked to the appropriate station location table within the GIS.

4.6.3 Site Information Management System

This is currently not being used on the Navy CLEAN and Joint Venture Programs.

SIMS is a tool for publishing data of sufficient quality from the project. However, the project data warehouse will remain the database of record for the project.

SIMS provides many standard report formats, all of which are used in conjunction with the Query Tool feature, to isolate and retrieve information. Users can generate and save their queries using a graphical point-and-click tool. Reports in a wide variety of formats also can be requested and produced.

4.6.4 Legacy Data

Legacy data are those collected from any contractor other than CH2M HILL and data collected by CH2M HILL that have not been managed in accordance with Navy CLEAN and Joint Venture Program requirements. Legacy data are commonly compiled from various electronic and hard copy sources including spreadsheets, databases, technical reports, and laboratory hard copy data reports. When working with legacy data, usability assessment must be completed for the project team to be able to use the data with confidence. In order to assess the data properly, the legacy data needs to be evaluated by skilled professionals that are familiar with the type of data being evaluated so that any errors identified in the data can be corrected when possible or qualified in a manner to reflect the limitations of the data's use.

The PM has overall responsibility for the selection for inclusion of legacy data into the data management process. The PDL and PCL will work with the PM to establish the data review and import process, compile a comprehensive data inventory, and identify staff to facilitate data review.

The PDL and PCL will work with the EIS to determine the appropriate intermediary files and tools used to collect the data. The PDL and PCL will oversee the data review and flagging process and approve the data for upload into the Data Warehouse. The EIS is responsible for assembling the field and laboratory data in formats that facilitate data review, aid the PDL and PCL in overseeing the data review and flagging process, schedule, conversion of the data to the proper data warehouse format, and then loading the data into the Data Warehouse after approval by the PDL and PCL.

The GA, PDL, PCL, and PM have the primary responsibility for reviewing the data in their area of expertise and providing the PCL with data usability flags to be associated with each record.

SECTION 5

Project Closeout

The project completion/closeout phase includes the following:

- Archive hard copy and electronic documents
- Conduct project closeout meeting

5.1 Archive Procedures

A large variety of technical data will be generated during the field investigations. The EIS and PC will collect all hard copy and electronic data they are responsible for and verify that the incoming records are legible and in suitable condition for storage. Record storage will be performed in two stages:

- Storage during the project
- Permanent storage following project completion

During the project, CH2M HILL will store data hardcopy reports in CH2M HILL offices. Physical records will be secured in steel file cabinets or shelves, and labelled with the appropriate project identification. Electronic data will be maintained on CH2M HILL's corporate local area network servers.

Information generated from field activities will be documented on appropriate forms and will be maintained in the project file. These include COC records, field logbooks, well construction forms, boring logs, location sketches, and site photographs. In addition, notes from project meetings and telephone conversations will be filed.

Following project completion, both hard copy and electronic data deliverables will be archived. Team staff will provide all hard copies of laboratory and validation reports to the Data Closeout Coordinator to be prepped and shipped to Stone Mountain for archiving. Final laboratory EDDs and loading files will be provided to the PDL, to be archived on CH2M HILL's corporate local area network servers.

Any modifications made to the tools will be communicated to the project team via e-mail. As revisions are finalized, they will be distributed electronically to all users. After revision, it is the user's responsibility to conform to revised portions of the DMP.

5.2 Invoice Review and Approval

The EIS is responsible for tracking all data deliverables throughout the data management process to ensure that the project schedule is maintained, subcontractors comply with all required turn around times, and data provided are complete and acceptable. Following project completion, EISs are to review and provide comments on all laboratory and data validator invoices regarding data quality and schedule compliance prior to approval by the PM.

5.3 Project Closeout

At the end of each project, the PM will notify team staff of project closeout. The PM will coordinate and verify that all pertinent data has been archived. The PM may also review lessons learned, suggest process improvements, or revisions to the DMP and other project documentation as deemed necessary.

Appendix A

Workflow Process

Environmental Data Management Work Process

1.0 Project Planning & Setup	2.0 Sample Collection & Management	3.0 Lab Analysis	4.0 Data Validation	5.0 Data Management	6.0 Data Evaluation & Reporting
1.1 Project Setup	2.1 Sample Management	3.1 Sample Analysis	4.1 Internal Chemical Data Validation	5.1 CH2M HILL Data	6.1 Data Prep & Processing for Reporting
1.2 QAPP, SAP, DMP, DQOs Integration	2.2 Sample Collection	3.2 EDD Management	4.2 External Chemical Data Validation	5.2 Other Contractor & Legacy Data	6.2 Tabular Data Queries & Reports
1.3 Laboratory Setup	2.3 Sample Data Management	3.3 Hard Copy Management	4.3 Senior Review of Validated Data	5.3 Database Maintenance & Administration	6.3 Field Logs and Graphs
1.4 Database Setup					6.4 GIS Queries and Maps

Appendix B
Life of a Sample

A Sample's Life

Step-by-Step Outline of Navy CLEAN and JV Data Management Process, and Roles & Responsibilities

Step 1 — Planning Phase

- Staffing Schedules
- Kickoff Meeting – Include the EIS & PC
- Project Instructions (PIs)
  - Sample Nomenclature provided in table
  - Reviewed by DMC (Chelsea Bennet) or Database Specialist

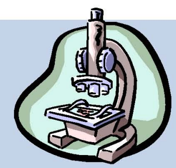
Step 2A — Sample Collection

- Daily collection and shipments of samples
- One COC/cooler; One FedEx slip/cooler
- Coordinate w/ EIS for tracking & Lab notification
- GPS conducted (if applicable)

Step 2B — Sample Tracking

- EIS cross checks COC against PIs
- Also reviews lab confirmation sheets to verify all samples were received and in appropriate condition

Step 3 — Lab Analysis



- Standard 28-day unless otherwise arranged
- EIS reviews data for accuracy and works with lab to resolve discrepancies
- EIS tracks schedule and keeps PM informed
- EIS inputs STSP information from Log Books
- EIS can generate Unvalidated Raw and Detects Data Tables

Step 4 — Data Validation

- PC reviews all data for accuracy against the PIs
- PC sends data from lab to Data Validator
- Delays may occur if there is missing data or data is late from the lab\
- EIS can generate Validated Raw and Detects Data Tables

Step 5 — Data Load

- PCL sends data to Database Specialist to be loaded into Environmental Database (EnDat)
- (Sometimes this involves assistance from PM, FTL, PC, and/or EIS)

Step 6 — Quality Assurance/ Quality Control

- EIS & PC are notified that data is loaded
- EIS verifies info loaded is correct (Sample, Station, Analyses, Result)
- EIS then helps decide whether info needs to be updated or not
- File and archive all Lab and DV deliverables

Step 7 — Report Generation

- Raw, Detects, Exceedance Reports
- Data Requests
- Exceedance Reports (criteria needed prior to this step and selected by PM)
- Human Health Risk Assessment
- Eco Risk Assessment

End of our Sample's Life?

- Data may be used in reports, posted on web, put into GIS, etc
- In that regard, a sample's life doesn't really ever end!
- Hopefully our sample had no exceedances and everyone is happy.

Appendix C

List of Standard Operating Procedures

Checklist - EIS Project Start-up Questions

Checklist - EIS QC for Unvalidated Data

Checklist - Generating RDE Tables

Checklist - Historic Data Cleanup

Checklist - VDMS DM Process

SOP-103 - Sample Tracking Program

SOP-107 - CH-Analyzer

SOP-109 - VDMS Validation

SOP-113 - CHERP Tool

SOP-114 - CHIMPTool

SOP-115 - VDMS Importing

SOP-126 - XTab Reports Tool

SOP - Access To NIRIS

SOP - Cherry Point Exceedance Formatting Wizard

SOP - Corrections To File

SOP - Data Archiving Procedures

SOP - Data Shipping

SOP - NEDD Creator Tool

Attachment 3
DoD ELAP Letter -Analytical Laboratory

LABORATORY
ACCREDITATION
BUREAU

Certificate of Accreditation

ISO/IEC 17025:2005 **Certificate Number L2278**

EMAX Laboratories, Inc

1835 W 205th Street
Torrance, CA 90501

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

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

Accreditation Granted through: January 10, 2014

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 10th of January 2011

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

LABORATORY ACCREDITATION BUREAU

Certificate # L2278

Scope of Accreditation
For
EMAX Laboratories, Inc.

1835 W 205th Street
Torrance, CA 90501
Kenette Pimentel
310-618-8889

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

Accreditation granted through: **January 10, 2014**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	AK101	GRO
GC	AK102	DRO
GC	AK103	RRO
GC	RSK175	Methane
GC	RSK175	Acetylene
GC	RSK175	Ethylene
GC	RSK175	Ethane
GC	RSK175	Propane
GC	RSK175	Carbon dioxide
Spectrometric	SM4500-NH3C	Ammonia
Spectrometric	SM4500-NH3F	Ammonia
Spectrometric	SM4500-NOrgC	TKN
Spectrometric	SM4500-PE	Phosphorus
Electrode	EPA 9040C	pH
Electrode	EPA 9045D	pH
Spectrometric	EPA 9065	Phenols
Pensky-Martens	EPA 1010	Ignitability
ICP	EPA 6010B / 6010C	Aluminum
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
ICP-MS	EPA 6020A	Aluminum
ICP-MS	EPA 6020A	Antimony
ICP-MS	EPA 6020A	Arsenic
ICP-MS	EPA 6020A	Barium
ICP-MS	EPA 6020A	Beryllium
ICP-MS	EPA 6020A	Boron
ICP-MS	EPA 6020A	Cadmium
ICP-MS	EPA 6020A	Calcium
ICP-MS	EPA 6020A	Chromium
ICP-MS	EPA 6020A	Cobalt
ICP-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7470A / 7471A	Mercury
GC	EPA 8015B / 8015C	Gasoline
GC	EPA 8015B / 8015C	Diesel
GC	EPA 8015B / 8015C	Motor Oil
GC	EPA 8015B / 8015C	JP5
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232
GC	EPA 8082 / 8082A	PCB1242
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262

Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8141A	Azinphos-methyl
GC	EPA 8141A	Bolstar
GC	EPA 8141A	Chlorpyrifos
GC	EPA 8141A	Coumaphos
GC	EPA 8141A	Demeton
GC	EPA 8141A	Diazinon
GC	EPA 8141A	Dichlorvos
GC	EPA 8141A	Disulfoton
GC	EPA 8141A	Ethoprop
GC	EPA 8141A	Fensulfothion
GC	EPA 8141A	Fenthion
GC	EPA 8141A	Merphos
GC	EPA 8141A	Mevinphos
GC	EPA 8141A	Naled

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 8141A	Methyl Parathion
GC	EPA 8141A	Phorate
GC	EPA 8141A	Ronnel
GC	EPA 8141A	Stirophos
GC	EPA 8141A	Tokuthion
GC	EPA 8141A	Trichloronate
GC	EPA 8141A	Dimethoate
GC	EPA 8141A	EPN
GC	EPA 8141A	Famphur
GC	EPA 8141A	Malathion
GC	EPA 8141A	Ethyl Parathion
GC	EPA 8141A	O,O,O-Triethylphosphorothioate
GC	EPA 8141A	Sulfotepp
GC	EPA 8141A	Thionazin
GC	EPA 8141A	Tributyl Phosphate
GC-MS	EPA 8260B	Acetone
GC-MS	EPA 8260B	Acrolein
GC-MS	EPA 8260B	Acrylonitrile
GC-MS	EPA 8260B	Benzene
GC-MS	EPA 8260B	Bromobenzene
GC-MS	EPA 8260B	Bromochloromethane
GC-MS	EPA 8260B	Bromodichloromethane
GC-MS	EPA 8260B	Bromoform
GC-MS	EPA 8260B	Bromomethane
GC-MS	EPA 8260B	tert-Butyl alcohol
GC-MS	EPA 8260B	2-Butanone (MEK)
GC-MS	EPA 8260B	n-Butylbenzene
GC-MS	EPA 8260B	sec-Butylbenzene
GC-MS	EPA 8260B	tert-Butylbenzene
GC-MS	EPA 8260B	Carbon disulfide
GC-MS	EPA 8260B	Carbon tetrachloride
GC-MS	EPA 8260B	Chlorobenzene
GC-MS	EPA 8260B	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B	Chloroethane
GC-MS	EPA 8260B	Chloroform
GC-MS	EPA 8260B	1-Chlorohexane
GC-MS	EPA 8260B	Chloromethane
GC-MS	EPA 8260B	2-Chlorotoluene
GC-MS	EPA 8260B	4-Chlorotoluene
GC-MS	EPA 8260B	Isopropyl ether (DIPE)
GC-MS	EPA 8260B	Dibromochloromethane
GC-MS	EPA 8260B	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B	1,2-Dibromoethane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B	Dibromomethane
GC-MS	EPA 8260B	1,1-Dichloroethane
GC-MS	EPA 8260B	1,2-Dichloroethane
GC-MS	EPA 8260B	1,2-Dichlorobenzene
GC-MS	EPA 8260B	1,3-Dichlorobenzene
GC-MS	EPA 8260B	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B	1,4-Dichlorobenzene
GC-MS	EPA 8260B	Dichlorodifluoromethane
GC-MS	EPA 8260B	1,1-Dichloroethene
GC-MS	EPA 8260B	cis-1,2-Dichloroethene
GC-MS	EPA 8260B	trans-1,2-Dichloroethene
GC-MS	EPA 8260B	Dichlorofluoromethane
GC-MS	EPA 8260B	1,1-Dichloropropene
GC-MS	EPA 8260B	1,2-Dichloropropane
GC-MS	EPA 8260B	1,3-Dichloropropane
GC-MS	EPA 8260B	2,2-Dichloropropane
GC-MS	EPA 8260B	cis-1,3-Dichloropropene
GC-MS	EPA 8260B	trans-1,3-Dichloropropene
GC-MS	EPA 8260B	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B	Ethyl Methacrylate
GC-MS	EPA 8260B	Ethylbenzene
GC-MS	EPA 8260B	2-Hexanone (MBK)
GC-MS	EPA 8260B	Hexachlorobutadiene
GC-MS	EPA 8260B	Iodomethane
GC-MS	EPA 8260B	Isopropylbenzene
GC-MS	EPA 8260B	p-Isopropyltoluene
GC-MS	EPA 8260B	Methylene Chloride
GC-MS	EPA 8260B	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B	tert-Butyl methyl ether
GC-MS	EPA 8260B	Naphthalene
GC-MS	EPA 8260B	n-Propylbenzene
GC-MS	EPA 8260B	Styrene
GC-MS	EPA 8260B	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B	Tetrachloroethene
GC-MS	EPA 8260B	Toluene
GC-MS	EPA 8260B	1,1,1-Trichloroethane
GC-MS	EPA 8260B	1,1,2-Trichloroethane
GC-MS	EPA 8260B	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B	Trichloroethene
GC-MS	EPA 8260B	Trichlorofluoromethane

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B	1,2,3-Trichloropropane
GC-MS	EPA 8260B	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B	Vinyl Acetate
GC-MS	EPA 8260B	Vinyl Chloride
GC-MS	EPA 8260B	m-Xylene & p-xylene
GC-MS	EPA 8260B	o-Xylene
GC-MS	EPA 8260B	2-Butanol
GC-MS	EPA 8260B	Cyclohexane
GC-MS	EPA 8260B SIM	Benzene
GC-MS	EPA 8260B SIM	Carbon tetrachloride
GC-MS	EPA 8260B SIM	Chloroform
GC-MS	EPA 8260B SIM	Chloromethane
GC-MS	EPA 8260B SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B SIM	1,2-Dibromoethane
GC-MS	EPA 8260B SIM	1,2-Dichloroethane
GC-MS	EPA 8260B SIM	1,1-Dichloroethene
GC-MS	EPA 8260B SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B SIM	trans-1,2-Dichloroethene
GC-MS	EPA 8260B SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B SIM	Tetrachloroethene
GC-MS	EPA 8260B SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B SIM	Trichloroethene
GC-MS	EPA 8260B SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B SIM	Vinyl Chloride
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-chloroisopropyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2-6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol
GC-MS	EPA 8270C / 8270D	4-Methylphenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	1,3,5-TNB
HPLC	EPA 8330A	1,3-DNB
HPLC	EPA 8330A	Tetryl

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Non-Potable Water		
Technology	**Method**	**Analyte**
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2,4,6-TNT
HPLC	EPA 8330A	4-AM-2,6-DNT
HPLC	EPA 8330A	2-AM-4,6-DNT
HPLC	EPA 8330A	2,6-DNT
HPLC	EPA 8330A	2,4-DNT
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5 Dichlorobenzoic
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	4-Nitrophenol
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex
GC	EPA 8151A	2,4,5-T
Platinum Electrode	EPA 120.1	Specific Conductance
Titrimetric	EPA 130.2	Hardness
Electrode	EPA 150.1	pH
Gravimetric	EPA 160.1	TDS
Gravimetric	EPA 160.2	TSS
Gravimetric	EPA 160.3	Total Residue
Turbidimetric	EPA 180.1	Turbidity
ICP-MS	EPA 200.8	Aluminum
ICP-MS	EPA 200.8	Antimony
ICP-MS	EPA 200.8	Arsenic
ICP-MS	EPA 200.8	Barium
ICP-MS	EPA 200.8	Beryllium
ICP-MS	EPA 200.8	Boron
ICP-MS	EPA 200.8	Cadmium
ICP-MS	EPA 200.8	Calcium

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP-MS	EPA 200.8	Chromium
ICP-MS	EPA 200.8	Cobalt
ICP-MS	EPA 200.8	Copper
ICP-MS	EPA 200.8	Iron
ICP-MS	EPA 200.8	Lead
ICP-MS	EPA 200.8	Lithium
ICP-MS	EPA 200.8	Magnesium
ICP-MS	EPA 200.8	Manganese
ICP-MS	EPA 200.8	Molybdenum
ICP-MS	EPA 200.8	Nickel
ICP-MS	EPA 200.8	Potassium
ICP-MS	EPA 200.8	Selenium
ICP-MS	EPA 200.8	Silver
ICP-MS	EPA 200.8	Sodium
ICP-MS	EPA 200.8	Strontium
ICP-MS	EPA 200.8	Thallium
ICP-MS	EPA 200.8	Tin
ICP-MS	EPA 200.8	Titanium
ICP-MS	EPA 200.8	Uranium
ICP-MS	EPA 200.8	Vanadium
ICP-MS	EPA 200.8	Zinc
IC	EPA 218.6	Hexavalent Chromium
COLD VAPOR	EPA 245.1	Mercury
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Chloride
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Bromide
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Phosphate
IC	EPA 300.0	Sulfate
IC	EPA 300.0	Bromate
IC	EPA 300M	Lactate
IC	EPA 300M	Acetate
IC	EPA 300M	Propionate
IC	EPA 300M	Butyrate
IC	EPA 300M	Pyruvate
IC	EPA 310.1	Alkalinity
IC	EPA 314.0	Perchlorate
Titrimetric	EPA 330.3	Total Residual Chlorine
Spectrometric	EPA 352.1	Nitrate-N
Spectrometric	EPA 353.3	Nitrate-N
Spectrometric	EPA 354.1	Nitrite-N
Spectrometric	EPA 365.2	Ortho-phosphate

Non-Potable Water		
Technology	**Method**	**Analyte**
Spectrometric	EPA 420.1	Phenols
Spectrometric	EPA 425.1	MBAS
Spectrometric	EPA 335.2	Cyanide
Spectrometric	EPA 350.2	Ammonia
Spectrometric	EPA 351.3	TKN
Spectrometric	EPA 365.2	Phosphorus
Spectrometric	EPA 370.1	Silica
Titrimetric	EPA 376.1	Sulfide
Spectrometric	EPA 376.2	Sulfide
Electrode	EPA 405.1	BOD
Spectrometric	EPA 410.4	COD
Combustion-IR	EPA 415.1	TOC
Turbidimetric	SM 2130B	Turbidity
Titrimetric	SM 2320B	Alkalinity
Titrimetric	SM 2340C	Hardness
Platinum Electrode	SM 2510B	Specific Conductance
Gravimetric	SM 2540C	TDS
Gravimetric	SM 2540D	TSS
Gravimetric	SM 2540B	Total Residue
Combustion-IR	SM5310	TOC
Spectrometric	SM3500-FeD	Ferrous iron
Titrimetric	SM4500-Cl B	Total Residual Chlorine
Spectrometric	SM4500-NO2B	Nitrite-N
Spectrometric	SM4500-NO3E	Nitrate-N
Spectrometric	SM4500PE	Ortho-phosphate
Spectrometric	SM4500-PE(PB5)	Phosphorus
Spectrometric	SM4500-S2D	Sulfide
Titrimetric	SM4500-S2F	Sulfide
Spectrometric	SM4500-SiO2C	Silica
Electrode	SM5210B	BOD
Spectrometric	SM5220B	COD
Combustion-IR	SM 5310B	TOC
Spectrometric	SM5540C	Surfactants (MBAS)
ICP/ICP-MS	SM2340B	Hardness
GC	EPA 608	Aldrin
GC	EPA 608	alpha-BHC
GC	EPA 608	beta-BHC
GC	EPA 608	delta-BHC
GC	EPA 608	gamma-BHC (Lindane)
GC	EPA 608	DDD (4,4)
GC	EPA 608	DDE (4,4)
GC	EPA 608	DDT (4,4)
GC	EPA 608	Dieldrin

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC	EPA 608	Endosulfan I
GC	EPA 608	Endosulfan II
GC	EPA 608	Endosulfan sulfate
GC	EPA 608	Endrin
GC	EPA 608	Endrin Aldehyde
GC	EPA 608	Heptachlor
GC	EPA 608	Heptachlor epoxide
GC	EPA 608	Methoxychlor
GC	EPA 608	alpha-Chlordane
GC	EPA 608	gamma-Chlordane
GC	EPA 608	Endrin Ketone
GC	EPA 608	Toxaphene
GC	EPA 608	Technical Chlordane
GC	EPA 608	PCB1016
GC	EPA 608	PCB1221
GC	EPA 608	PCB1232
GC	EPA 608	PCB1242
GC	EPA 608	PCB1248
GC	EPA 608	PCB1254
GC	EPA 608	PCB1260
GC	EPA 608	PCB1262
GC	EPA 608	PCB1268
GC-MS	EPA 624	Acrolein
GC-MS	EPA 624	Acrylonitrile
GC-MS	EPA 624	Benzene
GC-MS	EPA 624	Bromodichloromethane
GC-MS	EPA 624	Bromoform
GC-MS	EPA 624	Bromomethane
GC-MS	EPA 624	Carbon tetrachloride
GC-MS	EPA 624	Chlorobenzene
GC-MS	EPA 624	2-Chloroethyl vinyl ether
GC-MS	EPA 624	Chloroethane
GC-MS	EPA 624	Chloroform
GC-MS	EPA 624	Chloromethane
GC-MS	EPA 624	Dibromochloromethane
GC-MS	EPA 624	1,1-Dichloroethane
GC-MS	EPA 624	1,2-Dichloroethane
GC-MS	EPA 624	1,2-Dichlorobenzene
GC-MS	EPA 624	1,3-Dichlorobenzene
GC-MS	EPA 624	1,4-Dichlorobenzene
GC-MS	EPA 624	Dichlorodifluoromethane
GC-MS	EPA 624	1,1-Dichloroethene
GC-MS	EPA 624	cis-1,2-Dichloroethene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 624	trans-1,2-Dichloroethene
GC-MS	EPA 624	1,2-Dichloropropane
GC-MS	EPA 624	cis-1,3-Dichloropropene
GC-MS	EPA 624	trans-1,3-Dichloropropene
GC-MS	EPA 624	Ethylbenzene
GC-MS	EPA 624	Methylene Chloride
GC-MS	EPA 624	tert-Butyl methyl ether
GC-MS	EPA 624	Styrene
GC-MS	EPA 624	1,1,2,2-Tetrachloroethane
GC-MS	EPA 624	Tetrachloroethene
GC-MS	EPA 624	Toluene
GC-MS	EPA 624	1,1,1-Trichloroethane
GC-MS	EPA 624	1,1,2-Trichloroethane
GC-MS	EPA 624	1,2,4-Trichlorobenzene
GC-MS	EPA 624	Trichloroethene
GC-MS	EPA 624	Trichlorofluoromethane
GC-MS	EPA 624	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 624	Vinyl Chloride
GC-MS	EPA 624	m-Xylene & p-xylene
GC-MS	EPA 624	o-Xylene
GC-MS	EPA 625	Acenaphthene
GC-MS	EPA 625	Acenaphthylene
GC-MS	EPA 625	Aniline
GC-MS	EPA 625	Anthracene
GC-MS	EPA 625	Azobenzene
GC-MS	EPA 625	Benzidine
GC-MS	EPA 625	Benzo(a)anthracene
GC-MS	EPA 625	benzo(a)pyrene
GC-MS	EPA 625	Benzo(b)fluoranthene
GC-MS	EPA 625	Benzo(e)pyrene
GC-MS	EPA 625	Benzo(g,h,i)perylene
GC-MS	EPA 625	Benzo(k)fluoranthene
GC-MS	EPA 625	Benzoic Acid
GC-MS	EPA 625	Benzyl Alcohol
GC-MS	EPA 625	Biphenyl
GC-MS	EPA 625	bis(2-chloroethoxy)methane
GC-MS	EPA 625	bis(2-chloroethyl)ether
GC-MS	EPA 625	bis(2-chloroisopropyl)ether
GC-MS	EPA 625	bis(2-Ethylhexyl)adipate
GC-MS	EPA 625	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 625	4-Bromophenyl-phenylether
GC-MS	EPA 625	Butylbenzylphthalate
GC-MS	EPA 625	Carbazole

Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 625	4-Chloro-3-methylphenol
GC-MS	EPA 625	4-Chloroaniline
GC-MS	EPA 625	2-Chloronaphthalene
GC-MS	EPA 625	2-Chlorophenol
GC-MS	EPA 625	4-Chlorophenyl-phenylether
GC-MS	EPA 625	Chrysene
GC-MS	EPA 625	Dibenzo(a,h)anthracene
GC-MS	EPA 625	Dibenzofuran
GC-MS	EPA 625	1,2-Dichlorobenzene
GC-MS	EPA 625	1,3-Dichlorobenzene
GC-MS	EPA 625	1,4-Dichlorobenzene
GC-MS	EPA 625	3,3'-Dichlorobenzidine
GC-MS	EPA 625	2,4-Dichlorophenol
GC-MS	EPA 625	Diethylphthalate
GC-MS	EPA 625	2,6-Dimethylnaphthalene
GC-MS	EPA 625	2,4-Dimethylphenol
GC-MS	EPA 625	Dimethylphthalate
GC-MS	EPA 625	Di-n-butylphthalate
GC-MS	EPA 625	4,6-Dinitro-2-methylphenol
GC-MS	EPA 625	2,4-Dinitrophenol
GC-MS	EPA 625	2,4-Dinitrotoluene
GC-MS	EPA 625	2-6-Dinitrotoluene
GC-MS	EPA 625	Di-n-octylphthalate
GC-MS	EPA 625	1,2-Diphenylhydrazine
GC-MS	EPA 625	Fluoranthene
GC-MS	EPA 625	Fluorene
GC-MS	EPA 625	Hexachlorobenzene
GC-MS	EPA 625	Hexachlorobutadiene
GC-MS	EPA 625	Hexachlorocyclopentadiene
GC-MS	EPA 625	Hexachloroethane
GC-MS	EPA 625	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 625	Isophorone
GC-MS	EPA 625	1-Methylnaphthalene
GC-MS	EPA 625	2-Methylnaphthalene
GC-MS	EPA 625	1-Methylphenanthrene
GC-MS	EPA 625	2-Methylphenol
GC-MS	EPA 625	4-Methylphenol
GC-MS	EPA 625	Naphthalene
GC-MS	EPA 625	2-Nitroaniline
GC-MS	EPA 625	3-Nitroaniline
GC-MS	EPA 625	4-Nitroaniline
GC-MS	EPA 625	Nitrobenzene
GC-MS	EPA 625	2-Nitrophenol

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Non-Potable Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 625	4-Nitrophenol
GC-MS	EPA 625	n-Nitrosodimethylamine
GC-MS	EPA 625	n-Nitroso-di-n-propylamine
GC-MS	EPA 625	n-Nitrosodiphenylamine
GC-MS	EPA 625	Pentachlorophenol
GC-MS	EPA 625	Perylene
GC-MS	EPA 625	Phenanthrene
GC-MS	EPA 625	Phenol
GC-MS	EPA 625	Pyrene
GC-MS	EPA 625	Pyridine
GC-MS	EPA 625	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 625	1,2,4-Trichlorobenzene
GC-MS	EPA 625	2,3,4-Trichlorophenol
GC-MS	EPA 625	2,3,5-Trichlorophenol
GC-MS	EPA 625	2,4,5-Trichlorophenol
GC-MS	EPA 625	2,4,6-Trichlorophenol
GC-MS	EPA 625	2,3,5-Trimethylnaphthalene
Gravimetric	EPA 1664A	Oil & Grease
GFAA	CA 939M	Organo Lead
HPLC-MS	EPA 6850	Perchlorate
Preparation	**Method**	**Type**
Purge & Trap	EPA 5030B	Volatiles Prep
Acid Digestion	EPA 3005A / EPA 3010A / EPA 200.8	Metals Prep
Continuous Liquid-Liquid	EPA 3520C	Organic Extraction
Separatory Funnel	EPA 3510B	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
TCLP	EPA 1311	Leaching
SPLP	EPA 1312	Leaching

Drinking Water		
Technology	**Method**	**Analyte**
GC-MS	EPA 524.2	Acetone
GC-MS	EPA 524.2	Benzene
GC-MS	EPA 524.2	Bromobenzene
GC-MS	EPA 524.2	Bromochloromethane
GC-MS	EPA 524.2	Bromodichloromethane
GC-MS	EPA 524.2	Bromoform
GC-MS	EPA 524.2	Bromomethane
GC-MS	EPA 524.2	tert-Butyl alcohol
GC-MS	EPA 524.2	2-Butanone (MEK)

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Drinking Water

Technology	Method	Analyte
GC-MS	EPA 524.2	n-Butylbenzene
GC-MS	EPA 524.2	sec-Butylbenzene
GC-MS	EPA 524.2	tert-Butylbenzene
GC-MS	EPA 524.2	Carbon disulfide
GC-MS	EPA 524.2	Carbon tetrachloride
GC-MS	EPA 524.2	Chlorobenzene
GC-MS	EPA 524.2	Chloroethane
GC-MS	EPA 524.2	Chloroform
GC-MS	EPA 524.2	Chloromethane
GC-MS	EPA 524.2	2-Chlorotoluene
GC-MS	EPA 524.2	4-Chlorotoluene
GC-MS	EPA 524.2	Dibromochloromethane
GC-MS	EPA 524.2	1,2-Dibromo-3-chloropropane
GC-MS	EPA 524.2	1,2-Dibromoethane
GC-MS	EPA 524.2	Dibromomethane
GC-MS	EPA 524.2	1,1-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichloroethane
GC-MS	EPA 524.2	1,2-Dichlorobenzene
GC-MS	EPA 524.2	1,3-Dichlorobenzene
GC-MS	EPA 524.2	1,4-Dichlorobenzene
GC-MS	EPA 524.2	Dichlorodifluoromethane
GC-MS	EPA 524.2	1,1-Dichloroethene
GC-MS	EPA 524.2	cis-1,2-Dichloroethene
GC-MS	EPA 524.2	trans-1,2-Dichloroethene
GC-MS	EPA 524.2	1,1-Dichloropropene
GC-MS	EPA 524.2	1,2-Dichloropropane
GC-MS	EPA 524.2	1,3-Dichloropropane
GC-MS	EPA 524.2	2,2-Dichloropropane
GC-MS	EPA 524.2	cis-1,3-Dichloropropene
GC-MS	EPA 524.2	trans-1,3-Dichloropropene
GC-MS	EPA 524.2	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 524.2	Ethylbenzene
GC-MS	EPA 524.2	2-Hexanone (MBK)
GC-MS	EPA 524.2	Hexachlorobutadiene
GC-MS	EPA 524.2	Isopropyl ether (DIPE)
GC-MS	EPA 524.2	Isopropylbenzene
GC-MS	EPA 524.2	p-Isopropyltoluene
GC-MS	EPA 524.2	Methylene Chloride
GC-MS	EPA 524.2	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 524.2	tert-Butyl methyl ether
GC-MS	EPA 524.2	Naphthalene

Drinking Water

Technology	Method	Analyte
GC-MS	EPA 524.2	n-Propylbenzene
GC-MS	EPA 524.2	Styrene
GC-MS	EPA 524.2	tert-Amyl methyl ether (TAME)
GC-MS	EPA 524.2	1,1,1,2-Tetrachloroethane
GC-MS	EPA 524.2	1,1,2,2-Tetrachloroethane
GC-MS	EPA 524.2	Tetrachloroethene
GC-MS	EPA 524.2	Toluene
GC-MS	EPA 524.2	1,1,1-Trichloroethane
GC-MS	EPA 524.2	1,1,2-Trichloroethane
GC-MS	EPA 524.2	1,2,3-Trichlorobenzene
GC-MS	EPA 524.2	1,2,4-Trichlorobenzene
GC-MS	EPA 524.2	Trichloroethene
GC-MS	EPA 524.2	Trichlorofluoromethane
GC-MS	EPA 524.2	1,2,3-Trichloropropane
GC-MS	EPA 524.2	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 524.2	1,2,4-Trimethylbenzene
GC-MS	EPA 524.2	1,3,5-Trimethylbenzene
GC-MS	EPA 524.2	Vinyl Chloride
GC-MS	EPA 524.2	m-Xylene & p-xylene
GC-MS	EPA 524.2	o-Xylene

Solid and Chemical Materials

Technology	Method	Analyte
GC	AK101	GRO
GC	AK102	DRO
GC	AK103	RRO
GC	RSK175	Methane
GC	RSK175	Acetylene
GC	RSK175	Ethylene
GC	RSK175	Ethane
GC	RSK175	Propane
GC	RSK175	Carbon dioxide
Spectrometric	SM4500-NH3C	Ammonia
Spectrometric	SM4500-NH3F	Ammonia
Spectrometric	SM4500-NOrgC	TKN
Spectrometric	SM4500-PE(PB5)	Phosphorus
Electrode	EPA 9040C	pH
Electrode	EPA 9045D	pH
Spectrometric	EPA 9065	Phenols
Penskey-Martens	EPA 1010	Ignitability
ICP	EPA 6010B / 6010C	Aluminum

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010B / 6010C	Antimony
ICP	EPA 6010B / 6010C	Arsenic
ICP	EPA 6010B / 6010C	Barium
ICP	EPA 6010B / 6010C	Beryllium
ICP	EPA 6010B / 6010C	Boron
ICP	EPA 6010B / 6010C	Cadmium
ICP	EPA 6010B / 6010C	Calcium
ICP	EPA 6010B / 6010C	Chromium
ICP	EPA 6010B / 6010C	Cobalt
ICP	EPA 6010B / 6010C	Copper
ICP	EPA 6010B / 6010C	Iron
ICP	EPA 6010B / 6010C	Lead
ICP	EPA 6010B / 6010C	Magnesium
ICP	EPA 6010B / 6010C	Manganese
ICP	EPA 6010B / 6010C	Molybdenum
ICP	EPA 6010B / 6010C	Nickel
ICP	EPA 6010B / 6010C	Potassium
ICP	EPA 6010B / 6010C	Selenium
ICP	EPA 6010B / 6010C	Silver
ICP	EPA 6010B / 6010C	Sodium
ICP	EPA 6010B / 6010C	Strontium
ICP	EPA 6010B / 6010C	Thallium
ICP	EPA 6010B / 6010C	Tin
ICP	EPA 6010B / 6010C	Titanium
ICP	EPA 6010B / 6010C	Vanadium
ICP	EPA 6010B / 6010C	Zinc
IPC-MS	EPA 6020A	Aluminum
IPC-MS	EPA 6020A	Antimony
IPC-MS	EPA 6020A	Arsenic
IPC-MS	EPA 6020A	Barium
IPC-MS	EPA 6020A	Beryllium
IPC-MS	EPA 6020A	Boron
IPC-MS	EPA 6020A	Cadmium
IPC-MS	EPA 6020A	Calcium
IPC-MS	EPA 6020A	Chromium
IPC-MS	EPA 6020A	Cobalt
IPC-MS	EPA 6020A	Copper
ICP-MS	EPA 6020A	Iron
ICP-MS	EPA 6020A	Lead
ICP-MS	EPA 6020A	Magnesium
ICP-MS	EPA 6020A	Manganese
ICP-MS	EPA 6020A	Molybdenum
ICP-MS	EPA 6020A	Nickel

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP-MS	EPA 6020A	Potassium
ICP-MS	EPA 6020A	Selenium
ICP-MS	EPA 6020A	Silver
ICP-MS	EPA 6020A	Sodium
ICP-MS	EPA 6020A	Strontium
ICP-MS	EPA 6020A	Thallium
ICP-MS	EPA 6020A	Tin
ICP-MS	EPA 6020A	Titanium
ICP-MS	EPA 6020A	Uranium
ICP-MS	EPA 6020A	Vanadium
ICP-MS	EPA 6020A	Zinc
Spectrometric	EPA 7196A	Hex. Chromium
IC	EPA 7199	Hex. Chromium
Cold-Vapor	EPA 7470A / 7471A	Mercury
GC	EPA 8015B / 8015C	Gasoline
GC	EPA 8015B / 8015C	Diesel
GC	EPA 8015B / 8015C	Motor Oil
GC	EPA 8015B / 8015C	JP5
GC	EPA 8081A / 8081B	Aldrin
GC	EPA 8081A / 8081B	alpha-BHC
GC	EPA 8081A / 8081B	beta-BHC
GC	EPA 8081A / 8081B	delta-BHC
GC	EPA 8081A / 8081B	gamma-BHC (Lindane)
GC	EPA 8081A / 8081B	DDD (4,4)
GC	EPA 8081A / 8081B	DDE (4,4)
GC	EPA 8081A / 8081B	DDT (4,4)
GC	EPA 8081A / 8081B	Dieldrin
GC	EPA 8081A / 8081B	Endosulfan I
GC	EPA 8081A / 8081B	Endosulfan II
GC	EPA 8081A / 8081B	Endosulfan sulfate
GC	EPA 8081A / 8081B	Endrin
GC	EPA 8081A / 8081B	Endrin Aldehyde
GC	EPA 8081A / 8081B	Heptachlor
GC	EPA 8081A / 8081B	Heptachlor epoxide
GC	EPA 8081A / 8081B	Methoxychlor
GC	EPA 8081A / 8081B	alpha-Chlordane
GC	EPA 8081A / 8081B	gamma-Chlordane
GC	EPA 8081A / 8081B	Endrin Ketone
GC	EPA 8081A / 8081B	Toxaphene
GC	EPA 8081A / 8081B	Technical Chlordane
GC	EPA 8082 / 8082A	PCB1016
GC	EPA 8082 / 8082A	PCB1221
GC	EPA 8082 / 8082A	PCB1232

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8082 / 8082A	PCB1242
GC	EPA 8082 / 8082A	PCB1248
GC	EPA 8082 / 8082A	PCB1254
GC	EPA 8082 / 8082A	PCB1260
GC	EPA 8082 / 8082A	PCB1262
GC	EPA 8082 / 8082A	PCB1268
GC	EPA 8082 / 8082A	PCB 8
GC	EPA 8082 / 8082A	PCB 18
GC	EPA 8082 / 8082A	PCB 28
GC	EPA 8082 / 8082A	PCB 44
GC	EPA 8082 / 8082A	PCB 52
GC	EPA 8082 / 8082A	PCB 66
GC	EPA 8082 / 8082A	PCB 77
GC	EPA 8082 / 8082A	PCB 81
GC	EPA 8082 / 8082A	PCB 101
GC	EPA 8082 / 8082A	PCB 105
GC	EPA 8082 / 8082A	PCB 114
GC	EPA 8082 / 8082A	PCB 118
GC	EPA 8082 / 8082A	PCB 123
GC	EPA 8082 / 8082A	PCB 126
GC	EPA 8082 / 8082A	PCB 128
GC	EPA 8082 / 8082A	PCB 138
GC	EPA 8082 / 8082A	PCB 153
GC	EPA 8082 / 8082A	PCB 156
GC	EPA 8082 / 8082A	PCB 157
GC	EPA 8082 / 8082A	PCB 167
GC	EPA 8082 / 8082A	PCB 169
GC	EPA 8082 / 8082A	PCB 170
GC	EPA 8082 / 8082A	PCB 180
GC	EPA 8082 / 8082A	PCB 187
GC	EPA 8082 / 8082A	PCB 189
GC	EPA 8082 / 8082A	PCB 195
GC	EPA 8082 / 8082A	PCB 206
GC	EPA 8082 / 8082A	PCB 209
GC	EPA 8141A	Azinphos-methyl
GC	EPA 8141A	Bolstar
GC	EPA 8141A	Chlorpyrifos
GC	EPA 8141A	Coumaphos
GC	EPA 8141A	Demeton
GC	EPA 8141A	Diazinon
GC	EPA 8141A	Dichlorvos
GC	EPA 8141A	Disulfoton
GC	EPA 8141A	Ethoprop

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC	EPA 8141A	Fensulfothion
GC	EPA 8141A	Fenthion
GC	EPA 8141A	Merphos
GC	EPA 8141A	Mevinphos
GC	EPA 8141A	Naled
GC	EPA 8141A	Methyl Parathion
GC	EPA 8141A	Phorate
GC	EPA 8141A	Ronnel
GC	EPA 8141A	Stirophos
GC	EPA 8141A	Tokuthion
GC	EPA 8141A	Trichloronate
GC	EPA 8141A	Dimethoate
GC	EPA 8141A	EPN
GC	EPA 8141A	Famphur
GC	EPA 8141A	Malathion
GC	EPA 8141A	Ethyl Parathion
GC	EPA 8141A	O,O,O-Triethylphosphorothioate
GC	EPA 8141A	Sulfotepp
GC	EPA 8141A	Thionazin
GC	EPA 8141A	Tributyl Phosphate
GC-MS	EPA 8260B	Acetone
GC-MS	EPA 8260B	Acrolein
GC-MS	EPA 8260B	Acrylonitrile
GC-MS	EPA 8260B	Benzene
GC-MS	EPA 8260B	Bromobenzene
GC-MS	EPA 8260B	Bromochloromethane
GC-MS	EPA 8260B	Bromodichloromethane
GC-MS	EPA 8260B	Bromoform
GC-MS	EPA 8260B	Bromomethane
GC-MS	EPA 8260B	tert-Butyl alcohol
GC-MS	EPA 8260B	2-Butanone (MEK)
GC-MS	EPA 8260B	n-Butylbenzene
GC-MS	EPA 8260B	sec-Butylbenzene
GC-MS	EPA 8260B	tert-Butylbenzene
GC-MS	EPA 8260B	Carbon disulfide
GC-MS	EPA 8260B	Carbon tetrachloride
GC-MS	EPA 8260B	Chlorobenzene
GC-MS	EPA 8260B	2-Chloroethyl vinyl ether
GC-MS	EPA 8260B	Chloroethane
GC-MS	EPA 8260B	Chloroform
GC-MS	EPA 8260B	1-Chlorohexane
GC-MS	EPA 8260B	Chloromethane
GC-MS	EPA 8260B	2-Chlorotoluene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B	4-Chlorotoluene
GC-MS	EPA 8260B	Isopropyl ether (DIPE)
GC-MS	EPA 8260B	Dibromochloromethane
GC-MS	EPA 8260B	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B	1,2-Dibromoethane
GC-MS	EPA 8260B	Dibromomethane
GC-MS	EPA 8260B	1,1-Dichloroethane
GC-MS	EPA 8260B	1,2-Dichloroethane
GC-MS	EPA 8260B	1,2-Dichlorobenzene
GC-MS	EPA 8260B	1,3-Dichlorobenzene
GC-MS	EPA 8260B	trans-1,4-Dichloro-2-Butene
GC-MS	EPA 8260B	1,4-Dichlorobenzene
GC-MS	EPA 8260B	Dichlorodifluoromethane
GC-MS	EPA 8260B	1,1-Dichloroethene
GC-MS	EPA 8260B	cis-1,2-Dichloroethene
GC-MS	EPA 8260B	trans-1,2-Dichloroethene
GC-MS	EPA 8260B	Dichlorofluoromethane
GC-MS	EPA 8260B	1,1-Dichloropropene
GC-MS	EPA 8260B	1,2-Dichloropropane
GC-MS	EPA 8260B	1,3-Dichloropropane
GC-MS	EPA 8260B	2,2-Dichloropropane
GC-MS	EPA 8260B	cis-1,3-Dichloropropene
GC-MS	EPA 8260B	trans-1,3-Dichloropropene
GC-MS	EPA 8260B	tert-Butyl ethyl ether (ETBE)
GC-MS	EPA 8260B	Ethyl Methacrylate
GC-MS	EPA 8260B	Ethylbenzene
GC-MS	EPA 8260B	2-Hexanone (MBK)
GC-MS	EPA 8260B	Hexachlorobutadiene
GC-MS	EPA 8260B	Iodomethane
GC-MS	EPA 8260B	Isopropylbenzene
GC-MS	EPA 8260B	p-Isopropyltoluene
GC-MS	EPA 8260B	Methylene Chloride
GC-MS	EPA 8260B	4-Methyl-2-pentanone (MIBK)
GC-MS	EPA 8260B	tert-Butyl methyl ether
GC-MS	EPA 8260B	Naphthalene
GC-MS	EPA 8260B	n-Propylbenzene
GC-MS	EPA 8260B	Styrene
GC-MS	EPA 8260B	tert-Amyl methyl ether (TAME)
GC-MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC-MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B	Tetrachloroethene
GC-MS	EPA 8260B	Toluene
GC-MS	EPA 8260B	1,1,1-Trichloroethane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8260B	1,1,2-Trichloroethane
GC-MS	EPA 8260B	1,2,3-Trichlorobenzene
GC-MS	EPA 8260B	1,2,4-Trichlorobenzene
GC-MS	EPA 8260B	Trichloroethene
GC-MS	EPA 8260B	Trichlorofluoromethane
GC-MS	EPA 8260B	1,2,3-Trichloropropane
GC-MS	EPA 8260B	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	EPA 8260B	1,2,4-Trimethylbenzene
GC-MS	EPA 8260B	1,3,5-Trimethylbenzene
GC-MS	EPA 8260B	Vinyl Acetate
GC-MS	EPA 8260B	Vinyl Chloride
GC-MS	EPA 8260B	m-Xylene & p-xylene
GC-MS	EPA 8260B	o-Xylene
GC-MS	EPA 8260B	2-Butanol
GC-MS	EPA 8260B	Cyclohexane
GC-MS	EPA 8260B SIM	Benzene
GC-MS	EPA 8260B SIM	Carbon tetrachloride
GC-MS	EPA 8260B SIM	Chloroform
GC-MS	EPA 8260B SIM	Chloromethane
GC-MS	EPA 8260B SIM	1,2-Dibromo-3-chloropropane
GC-MS	EPA 8260B SIM	1,2-Dibromoethane
GC-MS	EPA 8260B SIM	1,2-Dichloroethane
GC-MS	EPA 8260B SIM	1,1-Dichloroethene
GC-MS	EPA 8260B SIM	cis-1,2-Dichloroethene
GC-MS	EPA 8260B SIM	trans-1,2-Dichloroethene
GC-MS	EPA 8260B SIM	1,1,2,2-Tetrachloroethane
GC-MS	EPA 8260B SIM	Tetrachloroethene
GC-MS	EPA 8260B SIM	1,1,1-Trichloroethane
GC-MS	EPA 8260B SIM	1,1,2-Trichloroethane
GC-MS	EPA 8260B SIM	Trichloroethene
GC-MS	EPA 8260B SIM	1,2,3-Trichloropropane
GC-MS	EPA 8260B SIM	Vinyl Chloride
GC-MS	EPA 8270C / 8270D	Acenaphthene
GC-MS	EPA 8270C / 8270D	Acenaphthylene
GC-MS	EPA 8270C / 8270D	Aniline
GC-MS	EPA 8270C / 8270D	Anthracene
GC-MS	EPA 8270C / 8270D	Azobenzene
GC-MS	EPA 8270C / 8270D	Benzidine
GC-MS	EPA 8270C / 8270D	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D	Benzo(g,h,i)perylene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D	Benzoic Acid
GC-MS	EPA 8270C / 8270D	Benzyl Alcohol
GC-MS	EPA 8270C / 8270D	Biphenyl
GC-MS	EPA 8270C / 8270D	bis(2-chloroethoxy)methane
GC-MS	EPA 8270C / 8270D	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-chloroisopropyl)ether
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)adipate
GC-MS	EPA 8270C / 8270D	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D	4-Bromophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Butylbenzylphthalate
GC-MS	EPA 8270C / 8270D	Carbazole
GC-MS	EPA 8270C / 8270D	4-Chloro-3-methylphenol
GC-MS	EPA 8270C / 8270D	4-Chloroaniline
GC-MS	EPA 8270C / 8270D	2-Chloronaphthalene
GC-MS	EPA 8270C / 8270D	2-Chlorophenol
GC-MS	EPA 8270C / 8270D	4-Chlorophenyl-phenylether
GC-MS	EPA 8270C / 8270D	Chrysene
GC-MS	EPA 8270C / 8270D	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D	Dibenzofuran
GC-MS	EPA 8270C / 8270D	1,2-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,3-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	1,4-Dichlorobenzene
GC-MS	EPA 8270C / 8270D	3,3'-Dichlorobenzidine
GC-MS	EPA 8270C / 8270D	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D	Diethylphthalate
GC-MS	EPA 8270C / 8270D	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D	Dimethylphthalate
GC-MS	EPA 8270C / 8270D	Di-n-butylphthalate
GC-MS	EPA 8270C / 8270D	4,6-Dinitro-2-methylphenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrophenol
GC-MS	EPA 8270C / 8270D	2,4-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	2-6-Dinitrotoluene
GC-MS	EPA 8270C / 8270D	Di-n-octylphthalate
GC-MS	EPA 8270C / 8270D	Fluoranthene
GC-MS	EPA 8270C / 8270D	Fluorene
GC-MS	EPA 8270C / 8270D	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D	Hexachlorobutadiene
GC-MS	EPA 8270C / 8270D	Hexachlorocyclopentadiene
GC-MS	EPA 8270C / 8270D	Hexachloroethane
GC-MS	EPA 8270C / 8270D	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D	Isophorone

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D	2-Methylphenol
GC-MS	EPA 8270C / 8270D	4-Methylphenol
GC-MS	EPA 8270C / 8270D	Naphthalene
GC-MS	EPA 8270C / 8270D	2-Nitroaniline
GC-MS	EPA 8270C / 8270D	3-Nitroaniline
GC-MS	EPA 8270C / 8270D	4-Nitroaniline
GC-MS	EPA 8270C / 8270D	Nitrobenzene
GC-MS	EPA 8270C / 8270D	2-Nitrophenol
GC-MS	EPA 8270C / 8270D	4-Nitrophenol
GC-MS	EPA 8270C / 8270D	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D	n-Nitrosodiphenylamine
GC-MS	EPA 8270C / 8270D	Pentachlorophenol
GC-MS	EPA 8270C / 8270D	Perylene
GC-MS	EPA 8270C / 8270D	Phenanthrene
GC-MS	EPA 8270C / 8270D	Phenol
GC-MS	EPA 8270C / 8270D	Pyrene
GC-MS	EPA 8270C / 8270D	Pyridine
GC-MS	EPA 8270C / 8270D	2,3,4,6-Tetrachlorophenol
GC-MS	EPA 8270C / 8270D	1,2,4-Trichlorobenzene
GC-MS	EPA 8270C / 8270D	2,3,4-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthene
GC-MS	EPA 8270C / 8270D SIM	Acenaphthylene
GC-MS	EPA 8270C / 8270D SIM	Anthracene
GC-MS	EPA 8270C / 8270D SIM	Azobenzene
GC-MS	EPA 8270C / 8270D SIM	Benzo(a)anthracene
GC-MS	EPA 8270C / 8270D SIM	benzo(a)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(b)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Benzo(e)pyrene
GC-MS	EPA 8270C / 8270D SIM	Benzo(g,h,i)perylene
GC-MS	EPA 8270C / 8270D SIM	Benzo(k)fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Biphenyl
GC-MS	EPA 8270C / 8270D SIM	bis(2-chloroethyl)ether
GC-MS	EPA 8270C / 8270D SIM	bis(2-Ethylhexyl)phthalate
GC-MS	EPA 8270C / 8270D SIM	Carbazole
GC-MS	EPA 8270C / 8270D SIM	4-Chloro-3-methylphenol

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC-MS	EPA 8270C / 8270D SIM	2-Chlorophenol
GC-MS	EPA 8270C / 8270D SIM	Chrysene
GC-MS	EPA 8270C / 8270D SIM	Dibenzo(a,h)anthracene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,6-Dimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2,4-Dimethylphenol
GC-MS	EPA 8270C / 8270D SIM	Fluoranthene
GC-MS	EPA 8270C / 8270D SIM	Fluorene
GC-MS	EPA 8270C / 8270D SIM	Hexachlorobenzene
GC-MS	EPA 8270C / 8270D SIM	Indeno(1,2,3-cd)pyrene
GC-MS	EPA 8270C / 8270D SIM	1-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	2-Methylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1-Methylphenanthrene
GC-MS	EPA 8270C / 8270D SIM	Naphthalene
GC-MS	EPA 8270C / 8270D SIM	n-Nitrosodimethylamine
GC-MS	EPA 8270C / 8270D SIM	n-Nitroso-di-n-propylamine
GC-MS	EPA 8270C / 8270D SIM	Pentachlorophenol
GC-MS	EPA 8270C / 8270D SIM	Perylene
GC-MS	EPA 8270C / 8270D SIM	Phenanthrene
GC-MS	EPA 8270C / 8270D SIM	Phenol
GC-MS	EPA 8270C / 8270D SIM	Pyrene
GC-MS	EPA 8270C / 8270D SIM	2,4,5-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,4,6-Trichlorophenol
GC-MS	EPA 8270C / 8270D SIM	2,3,5-Trimethylnaphthalene
GC-MS	EPA 8270C / 8270D SIM	1,4-Dioxane
HPLC	EPA 8310	Acenaphthene
HPLC	EPA 8310	Acenaphthylene
HPLC	EPA 8310	Anthracene
HPLC	EPA 8310	Benzo(a)anthracene
HPLC	EPA 8310	Benzo(a)pyrene
HPLC	EPA 8310	Benzo(b)fluoranthene
HPLC	EPA 8310	Benzo(g,h,i)perylene
HPLC	EPA 8310	Benzo(k)fluoranthene
HPLC	EPA 8310	Chrysene
HPLC	EPA 8310	Dibenzo(a,h)anthracene
HPLC	EPA 8310	Fluoranthene
HPLC	EPA 8310	Fluorene
HPLC	EPA 8310	Indeno(1,2,3-cd)pyrene
HPLC	EPA 8310	1-Methylnaphthalene
HPLC	EPA 8310	2-Methylnaphthalene
HPLC	EPA 8310	Naphthalene
HPLC	EPA 8310	Phenanthrene
HPLC	EPA 8310	Pyrene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC	EPA 8330A	HMX
HPLC	EPA 8330A	RDX
HPLC	EPA 8330A	1,3,5-TNB
HPLC	EPA 8330A	1,3-DNB
HPLC	EPA 8330A	Tetryl
HPLC	EPA 8330A	Nitrobenzene
HPLC	EPA 8330A	2,4,6-TNT
HPLC	EPA 8330A	4-AM-2,6-DNT
HPLC	EPA 8330A	2-AM-4,6-DNT
HPLC	EPA 8330A	2,6-DNT
HPLC	EPA 8330A	2,4-DNT
HPLC	EPA 8330A	2-Nitrotoluene
HPLC	EPA 8330A	4-Nitrotoluene
HPLC	EPA 8330A	3-Nitrotoluene
HPLC	EPA 8330A	3,5-Dinitroaniline
GC	EPA 8151A	Acifluorfen
GC	EPA 8151A	Bentazon
GC	EPA 8151A	Chloramben
GC	EPA 8151A	2,4-D
GC	EPA 8151A	2,4-DB
GC	EPA 8151A	Dacthal
GC	EPA 8151A	Dalapon
GC	EPA 8151A	Dicamba
GC	EPA 8151A	3,5 Dichlorobenzoic
GC	EPA 8151A	Dichlorprop
GC	EPA 8151A	Dinoseb
GC	EPA 8151A	MCPA
GC	EPA 8151A	MCPP
GC	EPA 8151A	Pentachlorophenol
GC	EPA 8151A	Picloram
GC	EPA 8151A	Silvex
GC	EPA 8151A	2,4,5-T
GFAA	CA 939M	Organo Lead
Preparation	**Method**	**Type**
Purge &Trap	EPA 5030B / EPA 5035	Volatiles Prep
Acid Digestion	EPA 3010 / EPA 3050B	Metals Prep
Alkaline Digestion	EPA 3060A	Hexavalent Chrom
Soxhlet	EPA 3540C	Organic Extraction
Sonication	EPA 3520C / EPA 3550C	Organic Extraction
Waste Dilution	EPA 3580A	Organic Extraction
TCLP	EPA 1311	Leaching
SPLP	EPA 1312	Leaching
Floricil Clean-up	EPA 3520B	Extract Clean-Up

LABORATORY ACCREDITATION BUREAU

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Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GPC Clean-up	EPA 3640A	Extract Clean-Up
Sulfur Clean-up	EPA 3660B	Extract Clean-Up
Acid/Permanganate Clean-up	EPA 3665A	Extract Clean-Up

Air and Emissions		
Technology	**Method**	**Analyte**
GC-MS	TO-15	1,1,1-trichloroethane
GC-MS	TO-15	1,1,2,2-tetrachloroethane
GC-MS	TO-15	1,1,2-Trichloro1,2,2-trifluoroethane
GC-MS	TO-15	1,1,2-trichloroethane
GC-MS	TO-15	1,1-dichloroethane
GC-MS	TO-15	1,1-Dichloroethene
GC-MS	TO-15	1,2,4-trichlorobenzene
GC-MS	TO-15	1,2,4-trimethylbenzene
GC-MS	TO-15	1,2-dibromoethane
GC-MS	TO-15	1,2-dichlorobenzene
GC-MS	TO-15	1,2-dichloroethane
GC-MS	TO-15	1,2-dichloroethene
GC-MS	TO-15	1,2-dichloropropane
GC-MS	TO-15	1,3,5-trimethylbenzene
GC-MS	TO-15	1,3-Butadiene
GC-MS	TO-15	1,3-Butadiene, 1,1,2,3,4,Hexachloro
GC-MS	TO-15	1,3-dichlorobenzene
GC-MS	TO-15	1,4-dichlorobenzene
GC-MS	TO-15	1,4-Dioxane
GC-MS	TO-15	2,2,4-Trimethylpentane
GC-MS	TO-15	4-Ethyltoluene
GC-MS	TO-15	Acetone
GC-MS	TO-15	Acrylonitrile
GC-MS	TO-15	Allyl Chloride
GC-MS	TO-15	Benzene
GC-MS	TO-15	Benzyl Chloride
GC-MS	TO-15	Bromodichloromethane
GC-MS	TO-15	Bromoform
GC-MS	TO-15	Bromomethane
GC-MS	TO-15	Carbon Disulfide
GC-MS	TO-15	Carbon Tetrachloride
GC-MS	TO-15	Chlorobenzene
GC-MS	TO-15	Chloroethane
GC-MS	TO-15	Chloroethene
GC-MS	TO-15	Chloroform
GC-MS	TO-15	Chloromethane

Air and Emissions		
Technology	**Method**	**Analyte**
GC-MS	TO-15	cis-1,3-Dichloropropene
GC-MS	TO-15	Cyclohexane
GC-MS	TO-15	Dibromochloromethane
GC-MS	TO-15	Dichlorodifluoromethane
GC-MS	TO-15	Dichlorotetrafluoroethane
GC-MS	TO-15	Ethyl Acetate
GC-MS	TO-15	Ethylbenzene
GC-MS	TO-15	Isopropyl Alcohol
GC-MS	TO-15	m+p-Xylene
GC-MS	TO-15	Methyl butyl Ketone
GC-MS	TO-15	Methyl Ethyl Ketone
GC-MS	TO-15	Methyl Isobutyl Ketone
GC-MS	TO-15	Methyl Tert-Butyl Ether
GC-MS	TO-15	Methylene Chloride
GC-MS	TO-15	n-Heptane
GC-MS	TO-15	n-Hexane
GC-MS	TO-15	o-Xylene
GC-MS	TO-15	Styrene
GC-MS	TO-15	Tetrachloroethylene
GC-MS	TO-15	Tetrahydrofuran
GC-MS	TO-15	Toluene
GC-MS	TO-15	Trans-1,2-Dichloroethene
GC-MS	TO-15	trans-1,3-Dichloropropene
GC-MS	TO-15	Trichloroethylene
GC-MS	TO-15	Trichloromonofluoromethan
GC-MS	TO-15	Vinyl Acetate
GC-MS	TO-15	Vinyl Bromide

Notes:

1) This laboratory offers commercial testing service.

Attachment 4
Environmental Protection Plan

Draft

Environmental Protection Plan Preliminary Assessment/Site Inspection; Unexploded Ordnance (UXO) Site UXO-24 Camp Geiger Burial Area

Marine Corps Base Camp Lejeune Jacksonville, North Carolina

Contract Task Order 014, Modification 7

January 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command

Under the

CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Raleigh, North Carolina

Contents

SECTION 1

Environmental Protection Plan

This Environmental Protection Plan (EPP) is a supplement to the Marine Corps Base (MCB) Camp Lejeune (CamLej) Master EPP (Section 9 of the MCB CamLej Munitions Response Program [MRP] Master Project Plans [MPP] [CH2M HILL, 2008]) from the MCB CamLej MRP Project Plan (CH2M HILL, 2008) and provides additional site specific details related to the environmental protection procedures to be implemented at the Site UXO-24 Camp Geiger Burial Area, MCB CamLej, North Carolina. Only additional detail, modifications or additions to the information provided in the Master EPP from the MRP MPP are discussed herein.

1.1 Regional Ecological Summary

A summary of the regional ecology is provided in Section 9.1 of the MRP Master Project Plans (CH2M HILL, 2008).

1.2 Endangered/Threatened Species within the Project Site

Many protected species have been sighted in the vicinity of and aboard MCB CamLej, such as American alligator, green sea turtle, loggerhead sea turtle, piping plover, red-cockaded woodpecker (RCW), seabeach amaranth, and rough-leaf loosestrife (USMC, 2006). **Table 1** lists those species that could occur in or adjacent to MCB CamLej that are listed as threatened, endangered, or of special concern by the United States Fish and Wildlife Service (USFWS) under the Endangered Species Act of 1973, as amended.

MCB CamLej has active programs in place to protect the two federally protected avian species (piping plover and RCW) that are known to occur on the Base. UXO-24 is not within the vicinity of any of these management areas. Suitable habitat for the piping plover does not exist at UXO-24. No impacts to this species would result.

MCB CamLej worked with the USFWS to establish guidelines for military training in RCW cluster sites. Additionally, through Section 7 Consultation, the Base implemented measures to properly manage the RCW habitats located on base (loblolly pine [*Pinus taeda*], longleaf [*Pinus palustris*], and pond pine [*Pinus serotina*] areas). These guidelines and measures are presented in the *2007-2011 Integrated Natural Resource Management Plan (INRMP)* (USMC, 2006). MCB CamLej's RCW population has been monitored since 1985. Reproductive success, population demographics, and habitat use are recorded annually to help successfully manage the population while facilitating the military use of the land. Site UXO-24 is not within the vicinity of any current RCW management areas and the closest active RCW habitat is located approximately 2 miles southwest of the site. No impacts to this species would result.

UXO-24 contains no open water habitat and does not connect to the ocean. Therefore, the federally protected marine species (e.g., green sea turtle, leatherback sea turtle, loggerhead sea turtle, West Indian manatee) listed in **Table 1** would not occur in the area. No impacts to these species would result.

The American alligator is listed on the Federal Threatened and Endangered species list due to its similarity of appearance to the American crocodile. There is no potentially suitable habitat for the American alligator in UXO-24 investigation area and the species would not occur in the project area. No impact to this species is expected.

Two of the five federally listed plant species identified in Table 1 have been identified on the Base: rough-leaved loosestrife and seabeach amaranth. Approximately 22 rough-leaved loosestrife sites are found on MCB CamLej with 76 acres buffered and marked to protect this species. Rough-leaved loosestrife sites are visited annually to visually inspect for changes in extent and apparent health. Approximately half of the rough-leaved loosestrife sites occur within protected RCW sites, obviating the need for marking each of these sites individually. The other sites, mostly falling within the Greater Sandy Run Area are marked with white paint around a perimeter that extends 100 ft from the outermost individuals. None of these sites are located on or adjacent to UXO-24. No impacts to rough-leaved loosestrife are expected.

Seabeach amaranth is an annual that has been described as a dune-builder because it frequently occupies areas seaward of primary dunes often growing closer to the high tide line than any other coastal plant. As such, this plant is generally found along Onslow Beach. Seabeach amaranth does not occur on or adjacent to UXO-24 because there is no beach or dune habitat. No impacts to this species would occur.

The eastern cougar is the only federally listed mammal species that could occur in Onslow County. The only extant population of eastern cougar is located in south Florida and the species has not been observed in North Carolina in over 50 years. Suitable habitat for the eastern cougar does not exist at UXO-24 and the level of human activity would tend to make the species avoid the area. Because the eastern cougar has not been verified in the area in more than 50 years and there is human activity at UXO-24, it is very unlikely that the eastern cougar would occur on the site and no impacts are expected.

Environmental reviews completed in preparation for the INRMP determined that the remaining species listed in **Table 1** are not expected to exist at the site. No adverse impacts to listed species are expected to result from the proposed work at UXO-24. Project design features have been developed to prevent impacts to listed species.

1.3 Wetlands Within the Project Site

There are no jurisdictional wetland areas within UXO-24.

1.4 Cultural and Archaeological Resources within the Project Site

The probability that any significant cultural or archeological resources will be impacted by the field investigation is low. Consultation with the Base archaeologist confirmed that no cultural or archaeological resource is known to lie within the UXO-24 boundary. If any unmapped cultural or archaeological materials or resources are discovered within the project investigation area, the Base archaeologist will be notified to provide guidance on performing further work in the area.

1.5 Water Resources within the Project Site

As shown in **Figure 10-1** of the UFP-SAP, a Brinson Creek is approximately 0.3 miles northeast of UXO-24. A small unnamed creek also flows through Site UXO-24.

1.6 Vegetation to be removed within the Project Site

Vegetation clearance will be conducted over approximately 10 percent of the site to provide access for DGM and sampling activities. Vegetation less than 6 inches in diameter will be removed to within 6 inches of the ground surface. Brush clearing will be conducted in approximately 1.2-meter (4-foot) wide paths in order that a 1 meter wide instrument can traverse along the paths. Vegetation clearing will be accomplished using mechanical methods. The brush and trees will be mulched and left in place. Trees greater than 6 inches in diameter will not be removed.

In the event that plant species are encountered that are listed by the United States Fish and Wildlife Service as threatened or endangered, steps will be taken to manage site activities in accordance with this document.

1.7 Existing Waste Disposal Sites within the Project Site

Historically, Site 37 was used for disposal of wastes including motor parts, refuse, and wood, and was used between 1950 and 1951. In March 2010, ammunition was found disposed of within Site UXO-24. Currently, the site is not used for any waste disposal.

1.8 Compliance with Applicable or Relevant and Appropriate Requirements

CH2M HILL will follow all applicable regulations concerning environmental protection, pollution control, and abatement for the proposed project work as described in Section 9.3 of the MRP Master Project Plans (CH2M HILL, 2008). No permits have been determined to be required for the proposed work.

1.9 Detailed Procedures and Methods to Protect and/or Mitigate the Resources/Sites Identified

During the proposed work, a general survey of the project area will be conducted by the field personnel to identify obvious environmental concerns. The PM, in conjunction with a qualified ecologist, will provide instructions to field personnel regarding the protection of onsite environmental resources. Such protective measures will include, but are not limited to, the following:

- Should a federally protected plant species be identified within the project area, specimens will be flagged for easy relocation and verification

- Should cultural or archaeological material or resources be discovered within the project area, the Base archaeologist will be notified to provide guidance on performing further work in the area
- The PM will seek the guidance of a qualified ecologist to determine appropriate mitigation measures in the event that the performed work activities impact an environmental resource

1.10 References

Baker Environmental, Incorporated (Baker). 1993. *Remedial Investigation Report for Operable Unit No. 2 Marine Corps Base Camp Lejeune, North Carolina*. Final.

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Department of Defense (DoD). 1997. *Defense Materiel Disposition Manual.* DoD 4160.21-M. August.

DoD. 2004. *DoD Ammunition and Explosives Safety Standards.* October.

Naval Ordnance Safety and Security Activity (NOSSA). 2009. Instruction 8020.15B, *Explosives Safety Review, Oversight, and Verification of Munitions Responses*.

OHM Remediation Services Corp. 1997. *Final Contractor's Close Out Report for Sites 6 and 82 Source Removal Operable Unit No. 2, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina*

United States Army Corps of Engineers (USACE). 2004. *Basic Safety Concepts and Considerations for Munitions and Explosives of Concern (MEC) Response Action Operations.* Engineer Pamphlet (EP) 385-1-95a. Washington, DC. 27 August.

United States Marine Corps (USMC). 2006. *2007-2011 Integrated Natural Resource Management Plan.*

TABLE 1-1
Species Potentially Occurring on or Adjacent to Camp Lejeune, in Onslow County, Listed as Threatened, Endangered, or of Special Concern by the USFWS
Site UXO-24, Former Munitions Disposal Area
MCB CamLej
Jacksonville, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Anguilla rostrata	American eel	FSC	The American eel is catadromous; it spawns in oceanic waters but uses freshwater, brackish and estuarine systems for most of its developmental life. Migrates in autumn to the Sargasso Sea to spawn. Occurs usually in permanent streams with continuous flow. Hides during the day in undercut banks and in deep pools near logs and boulders.
Chelonia mydas	Green sea turtle	T	Green turtles are generally found in fairly shallow waters (except when migrating) inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae. Open beaches with a sloping platform and minimal disturbance are required for nesting.
Caretta caretta	Loggerhead sea turtle	T	The loggerhead is widely distributed within its range. It may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers.
Dermochelys coriacea	Leatherback sea turtle	E	An open ocean species, it sometimes moves into shallow bays, estuaries and even river mouths.
Trichechus manatus	West Indian Manatee	E	Manatees inhabit both salt and fresh water of sufficient depth (1.5 meters to usually less than 6 meters) throughout their range.
Alligator mississippiensis	American alligator	T(S/A)	Rivers, swamps, estuaries, lakes, and marshes
Charadrius melodus	Piping plover	T	Open, sandy beaches close to the primary dune of the barrier islands and coastlines of the Atlantic for breeding. They prefer sparsely vegetated open sand, gravel, or cobble for a nest site. They forage along the rack line where the tide washes up onto the beach.
Aimophila aestivalis	Bachman's sparrow	FSC	Occurs only in pine forests of the southeastern U.S.
Haliaeetus leucocephalus	American bald eagle	T	A single bald eagle's nest is found on Camp Lejeune- at the junction of Sneads Creek and the New River near the back gate. Three protective buffers have been established at approximately 750', 1000', and 1500' from the nest site.
Laterallus jamaicensis	Black rail	FSC	Marsh/wetlands; The "Eastern" Black Rail can be found in appropriate saltmarsh habitat along the eastern seaboard from Connecticut to Florida and along the Gulf Coast.

TABLE 1-1
Species Potentially Occurring on or Adjacent to Camp Lejeune, in Onslow County, Listed as Threatened, Endangered, or of Special Concern by the USFWS
Site UXO-24, Former Munitions Disposal Area
MCB CamLej
Jacksonville, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Acipenser brevirostrum	Shortnose sturgeon	E	Sturgeon inhabits the lower sections of larger rivers and coastal waters along the Atlantic coast. It may spend most of the year in brackish or salt water and move into fresh water only to spawn. The fish feeds on invertebrates (shrimp, worms, etc.) and stems and leaves of macrophytes.
Rana capito capito	Carolina crawfish frog	FSC	Carolina crawfish frogs live primarily in the sandhills and pine barrens of the North Carolina Coastal Plain. Crawfish frogs are more terrestrial than most frogs, generally only coming to the water to breed. They are also nocturnal, spending daylight hours underground in burrows.
Puma concolor couguar	Eastern cougar	E	No preference for specific habitat types has been noted. The primary need is apparently for a large wilderness area with an adequate food supply. Male cougars of other subspecies have been observed to occupy a range of 25 or more square miles, and females from 5 to 20 square miles.
Passerina ciris ciris	Eastern painted bunting	FSC*	Found mainly in southern states and Mexico, where the brushy, weedy shrub-scrub habitat that this bird prefers abound
Ammodramus henslowii	Eastern Henslow's sparrow	FSC	A species of tallgrass prairies, agricultural grasslands, and pine savannas of the eastern U.S.; the species migrates south to spend the non-breeding season in the native pine savanna habitats of the southeastern U.S.
Ophisaurus mimicus	Mimic glass lizard	FSC	This species is found in the southeastern Coastal Plain. They are most common in pine flatwoods and open woodlands.
Picoides borealis	Red-cockaded Woodpecker	E	For nesting/roosting habitat, open stands of pine containing trees 60 years old and older. Red-cockaded woodpeckers need live, older pines in which to excavate their cavities. Longleaf pines (Pinus palustris) are most commonly used, but other species of southern pine are also acceptable. Dense stands (stands that are primarily hardwoods, or that have a dense hardwood understory) are avoided. Foraging habitat is provided in pine and pine hardwood stands 30 years old or older with foraging preference for pine trees 10 inches or larger in diameter. In good, moderately-stocked, pine habitat, sufficient foraging substrate can be provided on 80 to 125 acres.

TABLE 1-1
Species Potentially Occurring on or Adjacent to Camp Lejeune, in Onslow County, Listed as Threatened, Endangered, or of Special Concern by the USFWS
Site UXO-24, Former Munitions Disposal Area
MCB CamLej
Jacksonville, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Heterodon simus	Southern hognose snake	FSC	These snakes are found in sandy fields and woods of the Coastal Plain, particularly in the Sandhills region.
Agrotis buchholzi	Buchholz's dart moth	FSC	Found in Forested wetlands, scrub-shrub wetlands, shrubland/chaparral and coniferous woodlands This moth is found mostly in recently burned habitats. Populations can persist up to about a decade or rarely two without fire, until litter accumulates sufficiently to cover foodplants. In most cases habitat is probably suboptimal beginning about 5 years after a fire.
Atrytonopsis sp.	a skipper	FSC	One species, the dusteds are fairly rare at the coast but found throughout North Carolina (*A. hianna*). An assumption is made that the genius is generally defined.
Isoetes microvela	A quillwort	FSC	Quillworts are usually restricted to areas of clean water where other plants are absent. Occasionally, quilwort may grow partly or entirely out of the water.
Rhexia aristosa	Awned meadowbeauty	FSC	Found in a variety of wet habitats in the Coastal Plain from New Jersey to Alabama.
Lobelia boykinii	Boykin's lobelia	FSC	Grows in swamps and cypress ponds from the coastal plain of Delaware to Florida. The lower portion is often immersed in water, at least seasonally.
Solidago pulchra	Coastal goldenrod	FSC	Bogs, freshwater habitats, grasslands.
Parnassia caroliniana	Carolina grass-of-parnassus	FSC	Bogs, freshwater habitats, grasslands.
Trillium pusillum var. pusillum	Carolina trillium	FSC	Grows in alluvial woods, pocosin borders and savannahs.
Asplenium heteroresiliens	Carolina (wagner) spleenwort	FSC	Rock outcrops.
Rhynchospora pleiantha	Coastal beaksedge	FSC	Extremely rare, found at fewer than 25 sites throughout its North Carolina-to-Alabama range.
Solidago villosicarpa	Coastal Goldenrod	FSC	Known to occur in only 5 populations in three counties in eastern North Carolina. Three of these populations occur on Camp Lejeune. The other sites occur in Pender and Brunswick Counties. Currently the North Carolina Natural Heritage Program is conducting a survey of likely habitat to look for coastal goldenrod.

TABLE 1-1
Species Potentially Occurring on or Adjacent to Camp Lejeune, in Onslow County, Listed as Threatened, Endangered, or of Special Concern by the USFWS
Site UXO-24, Former Munitions Disposal Area
MCB CamLej
Jacksonville, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Thalictrum cooleyi	Cooley's meadowrue	E	Cooley's meadowrue occurs in moist to wet bogs and savannahs. It grows along fireplow lines, roadside ditches, woodland clearings, and powerline rights-of-way, and needs some type of disturbance to maintain its open habitat.
Carex lutea	Golden sedge	E	Biologists have located golden sedge in only eight locations, all in coastal savannas in Onslow and Pender Counties that are underlain by calcareous, or chalk, deposits.
Sagittaria weatherbiana	Grassleaf arrowhead	FSC	Found in shallow water of brackish swamps
Dichanthelium sp.	Hirst's panic grass	FSC	Worldwide, Hirst's panic grass occurs in four extant populations. Historically, it was found in coastal plain habitats in the states of New Jersey, Delaware, North Carolina and Georgia. Currently Hirst's panic grass is known to exist in one site in Delaware and two known sites in North Carolina, both of which are on Camp Lejeune.
Myriophyllum laxum	Loose watermilfoil	FSC	Riparian habitats.
Calopogon multiflorus	Many-flower grass-pink	FSC	Grasslands, pinelands; typically in wet areas.
Plantago sparsiflora	Pineland plantain	FSC	Savannahs, roadsides and ditches.
Lindera melissifolia	Pondberry	E	Associated with wetland habitats such as bottomland and hardwoods in the interior areas, and the margins of sinks, ponds and other depressions in the more coastal sites. The plants generally grow in shaded areas but may also be found in full sun.
Litsea aestivalis	Pondspice	FSC	Freshwater habitats.
Lysimachia asperulaefolia	Rough-leaved loosestrife	E	Species generally occurs in the ecotones or edges between longleaf pine uplands and pond pine pocosins (areas of dense shrub and vine growth usually on a wet, peaty, poorly drained soil), on moist to seasonally saturated sands and on shallow organic soils overlaying sand. Rough-leaved loosestrife has also been found on deep peat in the low shrub community of large Carolina bays
Amaranthus pumilus	Seabeach amaranth	T	Occurs on barrier island beaches.
Allium sp.	Savanna onion	FSC	Wet savannahs.
Scleria sp.	Smooth-seeded hairy nutrush	FSC	Dry woods, pineland and savannahs (*S. triglomerata*)

TABLE 1-1
Species Potentially Occurring on or Adjacent to Camp Lejeune, in Onslow County, Listed as Threatened, Endangered, or of Special Concern by the USFWS
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MCB CamLej
Jacksonville, North Carolina

Scientific Name	Common Name	Federal Status	Habitat
Rhynchospora decurrens	Swamp forest beakrush	FSC	Swamp forests, very rare.
Solidago verna	Spring-flowering goldenrod	FSC	The only spring-flowering goldenrod that occurs in the Sandhills and Coastal Plain of the Carolinas. It can be found in a wide array of habitats, including pine savannas, pocosins, and pine barrens.
Rhynchospora thornei	Thorne's beaksedge	FSC	Bogs, freshwater habitats, pinelands.
Dionea muscipula	Venus flytrap	FSC	Bogs, pinelands.

E = Endangered—A taxon in danger of extinction throughout all or a significant portion of its range.

T = Threatened—A taxon likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

FSC = Federal species of special concern—species may or may not be listed in the future.

T(S/A)—Threatened due to similarity of appearance (e.g., American alligator)--a species that is threatened due to similarity of appearance with other rare species and is listed for its protection. These species are not biologically endangered or threatened and are not subject to Section 7 consultation.

*Historic record—the species was last observed in the county more than 50 years ago.

Attachment 5
Geophysical System Verification Work Plan

Draft

Geophysical System Verification Work Plan,
Preliminary Assessment/Site Inspection; Unexploded Ordnance (UXO) Site UXO-24
Camp Geiger Burial Area

Marine Corps Base Camp Lejeune Jacksonville, North Carolina

Contract Task Order 014

January 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command

Under the

NAVFAC CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Raleigh, North Carolina

Contents

Acronyms and Abbreviations

cm	centimeter
DGM	digital geophysical mapping
DQO	data quality objective
EM	electromagnetic
GIP	Geophysical Investigation Plan
GPS	global positioning system
GSV	Geophysical System Verification
ISO	industry standard object
IVS	Instrument Verification Strip
m	meter
MEC	munitions and explosives of concern
NRL	Naval Research Laboratory
PVC	polyvinyl chloride
QC	quality control
RTK	real-time kinetic
SOP	standard operating procedure
UXO	unexploded ordnance

Geophysical System Verification

The Geophysical System Verification (GSV) is a physics-based presumptively-selected technology process in which signal strength and sensor performance are compared to known response curves of industry standard objects (ISOs) to verify digital geophysical mapping (DGM) systems prior to and during site surveys. The GSV process is designed to perform initial verification of the proposed DGM system using an instrument verification strip (IVS) followed by a blind seeding program for continued verification throughout the field operations.

1. Site Description and History

Site UXO-24 encompasses portions of Installation Restoration (IR) Site 37 (**Figure 1**). Prior to the 1950s, the site had been a wooded area. During the late 1950s, a carpenter shop, lumber rack, and paint shop were located in the northern portion of the site. Between 1950 and 1951, IR Site 37 was used as a surface dump for items such as wood, tires, and scrap metal (Osage, 2011). Osage of Virginia (Osage) conducted a confirmatory sampling investigation of the surface dump area in March 2010, and analyzed subsurface soil and groundwater samples. In 2010, the base discovered that unexpended ammunition had been buried at Site UXO-24 behind building TC-611 (**Figure 1**). Building TC-611 is used as an ammunition dunnage warehouse.

On March 19, 2010, the base reported that ordnance, consisting of two cans containing live small arms, was found on ground surface adjacent to a small excavation behind building TC-611 (**Figure 1**). EOD was contacted and conducted a limited surface sweep of the area and found several holes containing the following unexpended munitions: (1) M-18 Smoke Grenade, (1) Red Star Cluster pop up, and (1) M212 practice grenade. In addition, EOD searched the wooded remaining wooded area of Site UXO-24, and located the following items:

- (1) M-18 smoke grenade
- (1) red star cluster (pop-up flare)
- (1) M212 practice grenade.
- (2207) 5.56 blank rounds
- (33) 9 millimeter (mm) AA12 rounds
- (5) 9 mm AA21 rounds
- (22) 5.56 tracer rounds
- (79) 5.56 mm ball rounds
- (3) 7.62 ball rounds
- (16) 7.62 blank rounds
- 25 mm casing
- AK74 blank rounds

Due to discovery of ordnance at the site, the Base identified the site for investigation under MMRP.

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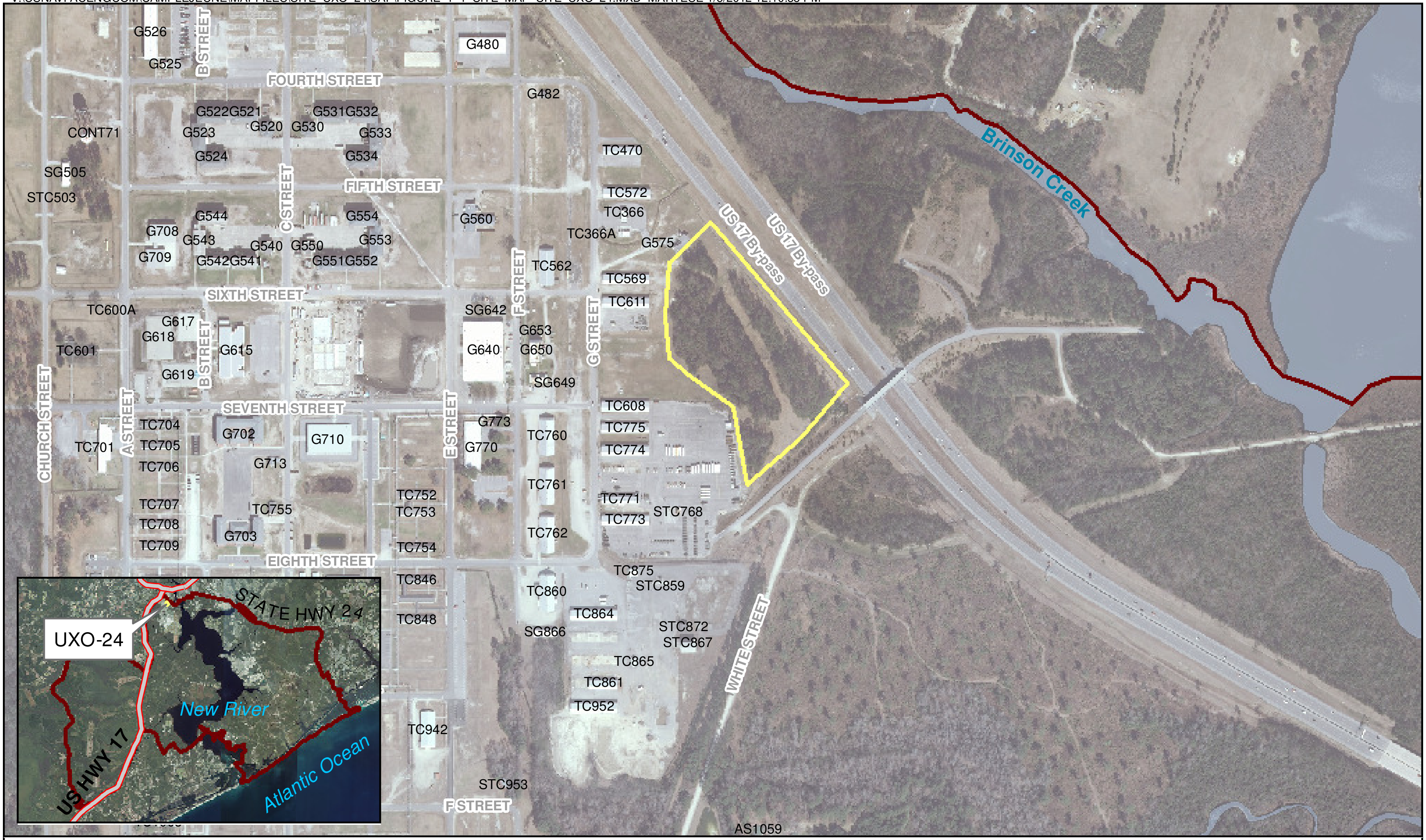


Legend

UXO-24 Boundary

Installation Boundary

N

0 300 600 1,200 Feet

1 inch = 600 feet

Figure 1-1
Site Map
Site UXO-24
MCB CamLej
North Carolina

CH2MHILL

2. Instrument Verification Strip

The initial phase of the investigation to locate munitions and explosives of concern (MEC) as well as non-MEC metallic items in the subsurface at the site will be verification of the selected DGM system using an IVS.

2.1 Personnel and Qualifications

The following individuals will be involved in the IVS:

- Project Geophysicist
- Unexploded Ordnance (UXO) Technician II (or higher) (if within potential MEC area)
- Geophysicist or Geophysical Technician
- Data Processor

Personnel involved in performance of the IVS and the production geophysical surveys will meet the following qualifications:

- The **Project/Quality Control Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 5 years of directly related geophysical experience. This individual will be capable of managing a geophysical data collection and processing project/program including several task orders or sites and will have at least 1 year of experience in managing geophysical operations on a MEC site.
- The **Site Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 2 years of directly related geophysical experience. This individual will be capable of competently managing personnel, equipment, and data on projects requiring multiple geophysical field teams and geophysical data processors and will have at least 1 year of experience in performing geophysical operations on an MEC site.
- The **Field Geophysicist** will have a degree in geophysics, geology, geological engineering, or a closely related field, will have a minimum of 2 years of directly related geophysical experience and will have at least 1 year of experience in performing geophysical operations on an MEC site.
- The **Geophysical Technician** will have at least 6 months of experience in geophysical data collection on MEC-related projects.
- The **Geophysical Data Processor** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 6 months experience in processing geophysical data related to MEC projects.

2.2 Digital Geophysical Mapping System

The DGM system to be verified and used for the production surveys will consist of a single-coil Geonics EM61-MK2 electromagnetic (EM) induction detector[1]. Fiducial positioning methods will be used to position the DGM data. The fiducial method is referenced to survey

[1] The top coil of the EM61-MK2 system will not be used to record data as more useful information can be obtained by collecting all four available data channels within the bottom coil.

stakes emplaced by a licensed surveyor at grid corners. A series of survey lanes are established over a grid, with markers placed at the beginning and end of each lane, and at equal distances along the transect. An operator walks down the lane while the data logger collects sensor readings at a prescribed sampling. As the operator walks past the starting, interim markers and end lines in the survey lane, he/she hits a button on the data logger that places a fiducial time mark in the data stream. By assuming the operator walked in a straight line at a constant velocity, the location of each data point can be calculated. A full description of the positioning method is provided in the Master GIP as part of the Master Work Plan (CH2M HILL, 2008a).

2.3 Location and Length of IVS

An area near or within the site will be selected for the IVS. The exact location of the IVS will be finalized during the initial mobilization to the site. The IVS area will be set up as a strip approximately 25 meters (m) or longer.

2.4 Industry Standard Objects

The ISO items (**Figure 2**) to be used in the IVS are 1-inch by 4-inch (2.54-centimeter [cm] by 10.16-cm) steel pipes (McMaster-Carr part number 44615K466 [http://www.mcmaster.com/]):

Shape: Straight Nipple, Threaded Both Ends
Schedule: 40
Pipe Size: 1 inch (1.315 inch outer diameter [OD])
Length: 4 inches
Finish: Black Welded Steel.

Instrument response curves for this ISO have been developed by the Naval Research Laboratory (NRL) demonstrating their standard response under their best orientation (perpendicular to the EM61-MK2 instrument plane to cause the highest peak amplitude response) and worst orientation (parallel to the instrument plane and perpendicular to the direction of travel to cause the lowest peak amplitude response) at multiple distances from the instrument's bottom transmit/receive coil (NRL/MR/6110--09-9183).

2.5 IVS Procedures

A qualified and experienced MEC DGM operations geophysical team (Section 1.1) will employ the system to be verified over the IVS. **Figure 3** illustrates the IVS process and the procedures to be employed (numbered in accordance with the steps shown on **Figure 3**) during site work.

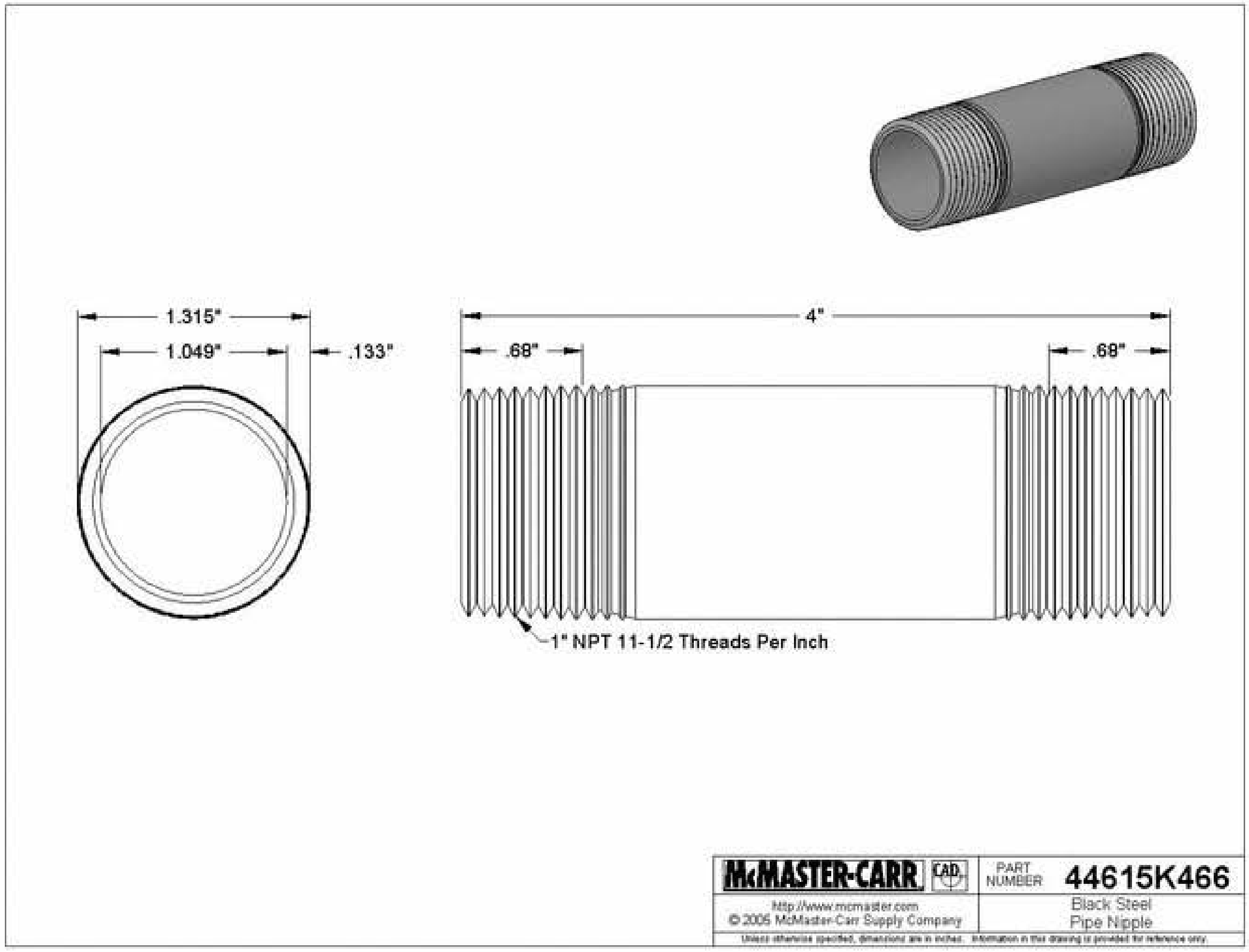
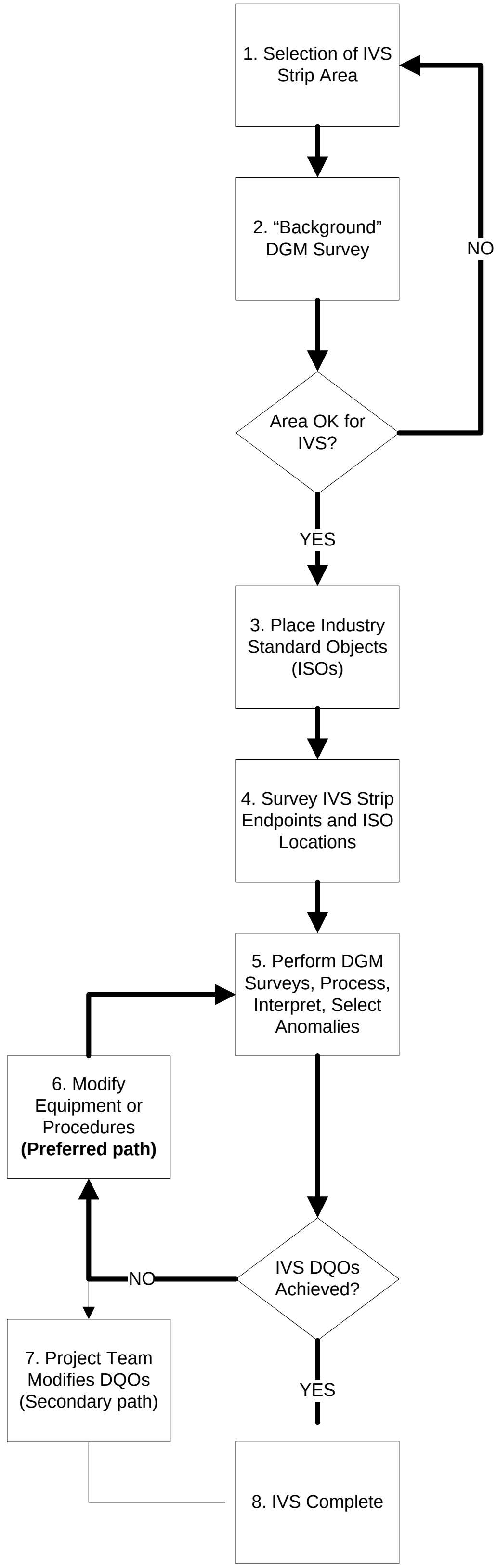


FIGURE 2
Industry Standard Object

FIGURE 3
Instrument Verification Strip Process



1. An IVS area will be selected with preference for the following (although none of the conditions are vital for IVS success):
   – Terrain, geology, and vegetation similar to that of a majority of the project site.
   – Geophysical noise conditions similar to those expected across the survey area.
   – Large enough site to accommodate all necessary IVS tests and equipment and for adequate spacing (at least 3 m) of the ISO items to avoid ambiguities in data evaluation.
   – Readily accessible to project personnel.
   – Close proximity to the actual survey site (if not within the site).
2. A background DGM survey will be performed with the instrument to be validated over the IVS. This step will allow background geophysical conditions to be recorded, will help determine the appropriateness of the location (e.g., few existing anomalies), and will verify that ISOs are not seeded near existing anomalies. The data will be post-processed (e.g., filtered and positions attached to the geophysical data) and provided to the CH2M HILL Project Geophysicist for evaluation.
3. Following verification that the IVS area is clear of subsurface anomalies (or that existing anomalies can be avoided during seeding), two ISO items will be buried at easy to detect depths (in order that a response can be evaluated against the expected response for each item). The approximate IVS setup will be as shown on **Figure 4**.

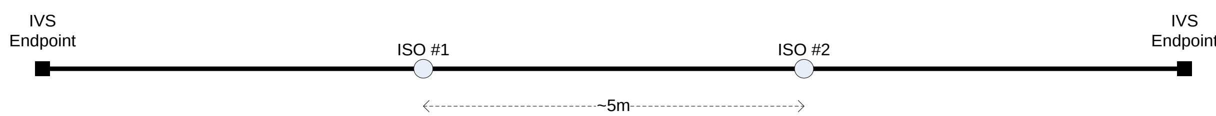


FIGURE 4
Instrument Verification Strip

   Measurements of the item depths will be to the center of mass of each item. CH2M HILL personnel will bury the ISOs using shovels to dig the holes to the appropriate depths for burial of the seed items. The background survey data and anomaly avoidance techniques will be used to ensure that end stakes and ISOs are not placed on top of or near existing anomalies. Personnel will emplace ISOs and record the emplacement data (depth, orientation, and azimuth).

4. A real-time kinematic (RTK) global positioning system (GPS) or conventional total station survey equipment will be used to record the center of each ISO location and the IVS endpoints. The holes will then be filled with soil and a polyvinyl chloride (PVC) surveyor's flag or 6-inch wooden survey stake placed at each ISO location.
5. A fiducial-based DGM survey will be performed over the IVS area, including transects as described in Table 1 and shown on **Figure 5**.

TABLE 1
IVS Instrument Verification Strip Transects Descriptions and Purpose

Transect	Description	Purpose
A	Offset by 0.75 m	Demonstrate horizontal drop off of item response
B	Directly over center of strip	Verify response versus established response curves
C	Offset by 0.37 m (half of intended lane separation) from center of strip	Demonstrate horizontal drop off of item response
D	Offset by 0.75 m (on opposite side of strip from Transect A)	Demonstrate horizontal drop off of item response
E	Offset by ~3 m from strip	Measure background noise

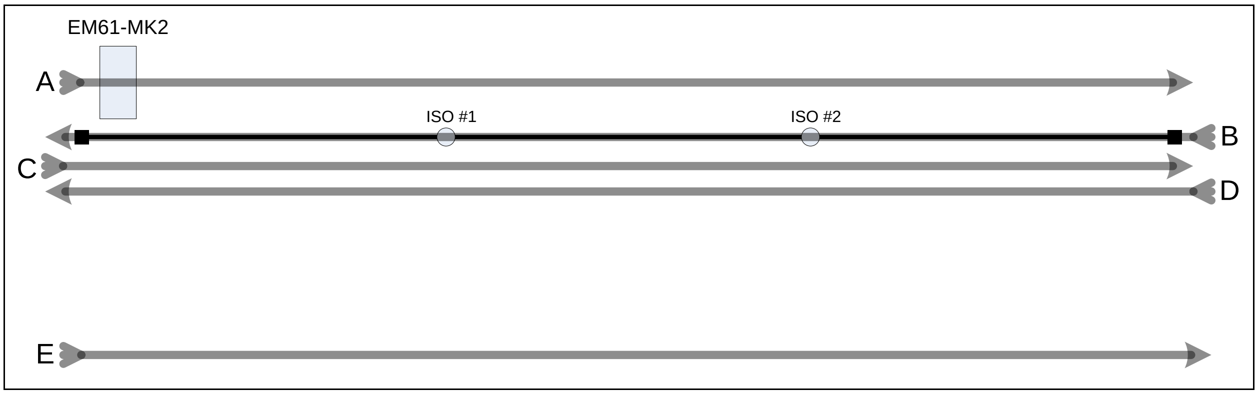


FIGURE 5
Instrument Verification Strip Transects

The data will be processed and interpreted by the data processor and provided to the Project Geophysicist for confirmation within 12 hours of completion of the survey.

- If the initial data quality objectives (DQOs) have not been met, the Project Geophysicist will discuss with the Field Geophysicist whether modifications to instrumentation or procedures can be made to the DGM system in order to meet the DQOs.
- If the DQOs cannot be met, the Project Geophysicist will meet with the project team to discuss a resolution (i.e., modification of a DQO) prior to completing the IVS.
- Once the surveys have been performed and the system has been determined to meet the initial (or modified) DQOs, the IVS will be complete.

2.6 Data Quality Objectives

The testing in the IVS area will verify the ability of the system to achieve the specific DQOs outlined in Table 2. The system will not be used for site surveys until it is able to meet the IVS DQOs or until the project team agrees on reasoning behind a DQO not being met and an appropriate revised DQO.

TABLE 2

IVS Instrument Verification Strip Data Quality Objectives

Data Quality Objective	Measurement Performance Criteria	Test Method During IVS
General System Verification		
DGM System Positioning. Accurate coordinates are being obtained from DGM positioning systems.	Positional error of ISO seeds will not exceed 25 cm (9.8 inches).	Results of IVS DGM survey versus IVS seed locations will be evaluated to ensure compliance.
DGM System Munitions Detection. DGM system response is within industry standards for detection.	Response to ISO is comparable to published or calculated results for that item.	Results of IVS surveys over seed items in strip will be qualitatively reviewed.
	Response to standardized item will not vary more than ±20 percent of expected value in static test.	Results of static test will be quantitatively reviewed to ensure compliance.
Data Handling		
All data must be delivered in a timely manner and in a useable format.	IVS data is completed and delivered within 12 hours.	Evaluate based on actual delivery of data

Additional DQOs for production surveys will be monitored through the ISO blind-seeding program and other quality control tests, as discussed in the Geophysical Investigation Plan (GIP) (Attachment 7 of the UFP-SAP). The IVS DQOs, measurement performance criteria, and test method to be used during the IVS are summarized in Table 2 and discussed in detail in the following subsections.

2.6.1 General System Verification

DGM System Positioning

The DQO for DGM systems positioning is that the coordinates being obtained from the positioning system are at a sufficient accuracy to allow for appropriate relocation of MEC items for intrusive investigation. The measurement performance criterion for this is that the positional error at known monuments will not exceed 25 cm (9.8 inches). This will be evaluated during the IVS by ensuring that the anomalies representing the ISO seeds in the IVS data are positioned within this distance from the measured locations.

DGM System Munitions Detection

The DQO for munitions detection is to demonstrate that the system in use is capable of detecting munitions within industry standards. This is demonstrated through a physics-based presumptively selected technology process in which signal strength and sensor performance are compared to validated industry values. As an example, for the EM61-MK2 this process involves demonstrating that the maximum amplitude response over a standard item falls within the sensor response curve for that item as determined through NRL demonstration tests for that item (**Figure 6**). Once it has been established that the system is responding comparably, a cross correlation of industry experience with detection of munitions items can be assumed. In other words, the depths and orientations of munitions items which the EM61-MK2 has been shown to be effective at detecting under test scenarios[2] and other projects can be expected.

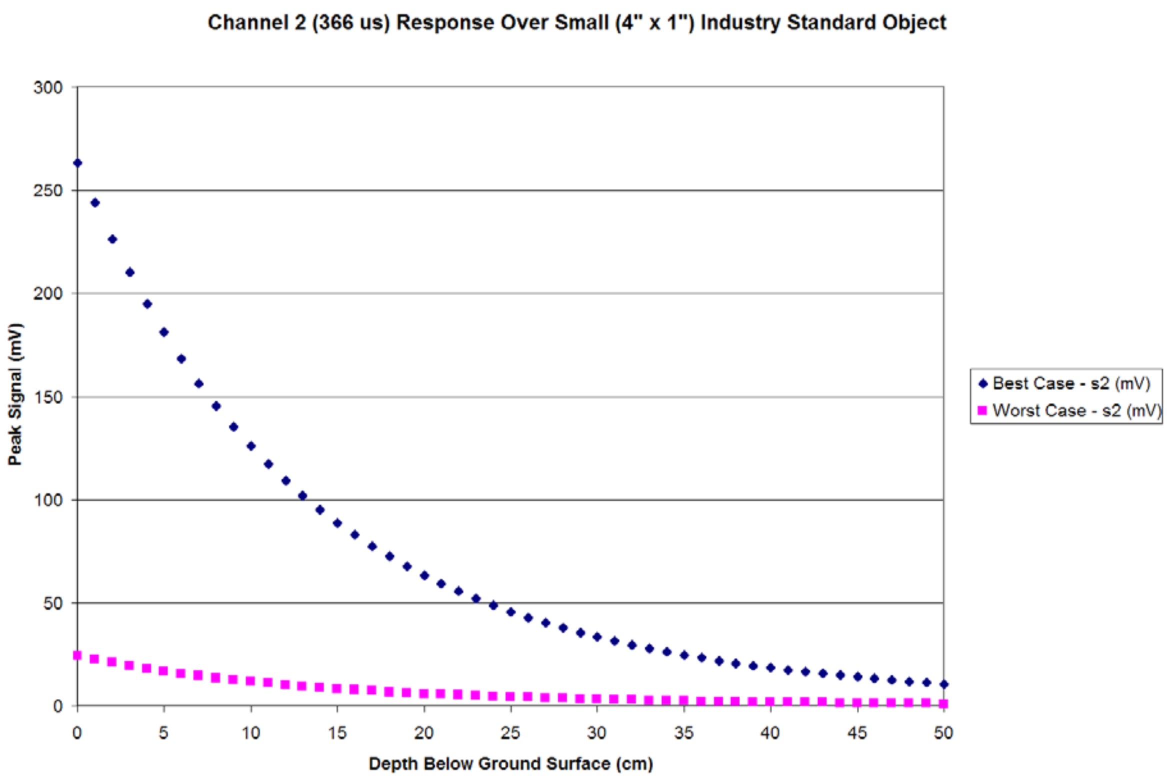


FIGURE 6
Naval Research Laboratory Results for Small (4-inch by 1-inch) Industry Standard Object Tested under EM61-MK2 Bottom Coil
Reference: NRL/MR/6110--09-9183

Because minor changes in the coil height as it passes over the item and slight variations in the path traveled down the IVS can significantly affect the amplitude response received

[2] NRL/MR/6110--08-9155 (EM61-MK2 Response of Standard Munitions Items), Final Report for the Evaluation of Unexploded Ordnance (UXO) Detection Technology at the Standardized UXO Test Sites Aberdeen and Yuma Proving Grounds, Standardized UXO Technology Demonstration Site Program, SERDP, November 2007. Demonstrator scoring results: http://aec.army.mil/usaec/technology/uxo01f.html

from the instrument, the IVS results will be qualitatively evaluated. A determination that the geophysical instrument itself is responding within a specific threshold will be through the spike test results in the GIP wherein the distance from the coil and orientation of the item can be strictly controlled.

2.6.2 Data Handling

The DQO for data handling is that all data must be delivered in a timely manner and in a useable format. Because of the need for rapid feedback during IVS operations to effectively test potential DGM systems, the measurement performance criterion for data handling during IVS activities will require that initial data be completed and delivered to the CH2M HILL Project Geophysicist within 12 hours of data collection. Final processed data for the IVS shall be delivered to the CH2M HILL Project Geophysicist within three working days of data collection. This will be evaluated based on the actual delivery of data during the IVS.

2.7 Quality Control

Achievement of the instrument evaluation DQOs will be verified by the CH2M HILL Quality Control (QC) Geophysicist. The selected IVS area, the process of emplacing the IVS items, and the survey locations will be verified through observation during the IVS. Standard operating procedures (SOPs) will be checked to ensure that equipment and procedures are being checked per standard procedures for the system employed. The QC tests specified in the GIP will be performed on the DGM system being utilized.

2.8 Data Analysis and Interpretation

All data collected at the IVS test strip will be post-processed and analyzed per data processing SOPs.

2.9 IVS Data Evaluation

The QC geophysicist will evaluate the data and validate for the project team whether the selected geophysical system meets the IVS DQOs and QC criteria.

3. Blind Seeding

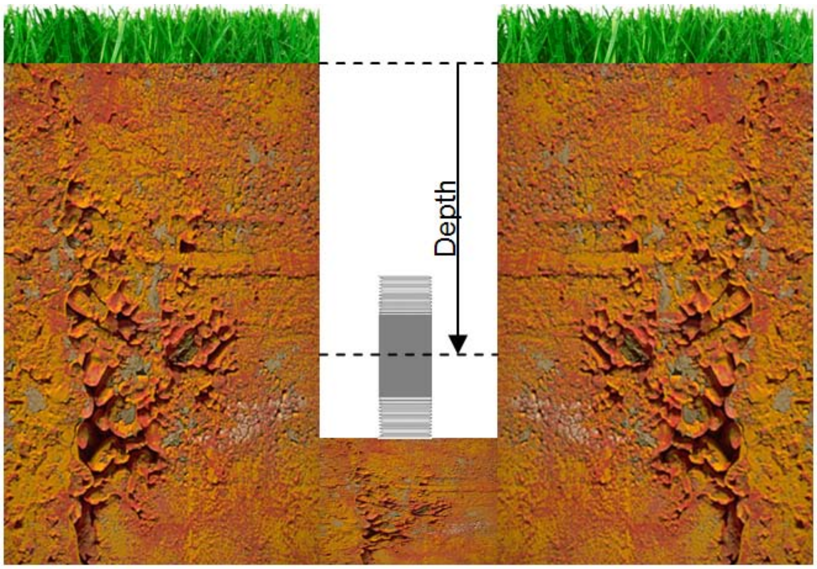
As a continuing part of the GSV process, ISOs will be used as blind QC seeds in the areas to be surveyed to perform ongoing verification that the DGM system is properly functioning and the munitions detection and positioning DQOs are continuing to be met.

3.1 Seeds Placement

Prior to performance of the DGM, QC seeds will be buried across the site. Small ISOs (**Figure 2**) will be used as blind QC seeds in the areas to be surveyed to perform ongoing verification that the DGM system is properly functioning and the munitions detection and positioning DQOs are continuing to be met. Seeds will be placed with the intent of a DGM team encountering at least one every 10,000 feet of transect.

Seeds will be buried vertically at a depth of approximately 6 inches below ground surface, with the depth being measured to the center of mass of the item, as illustrated by **Figure 7**. Depths will be recorded in field notes.

FIGURE 7
Quality Control Seed Burial Illustration



The Field Team Leader will be responsible for labeling each QC seed with a unique identifier. These can either be labeled with a paint pen or with a weather-resistant label taped to or secured within the seed.

The location of blind seeds will not be shared with personnel performing DGM surveys and data processing/interpretation until those tasks have been completed.

3.2 Validation

The CH2M HILL QC Geophysicist will overlay the locations of the blind seeds and verify that the munitions detection and positioning DQOs are continuing to be met. Should an issue be detected (i.e., a data trend indicating a DQO limit is being approached) or a DQO is not met, a comprehensive root-cause analysis will be performed and a corrective action determined.

4. Reporting

Results of the IVS will be included in an IVS technical memorandum prepared after the IVS has been performed. The report will include a summary of the IVS operations, an as-built map of the IVS plot, and IVS results.

References

Commanding Officer. 2010. Letter to Director, Installation and Environmental, Marine Corps Base, Camp Lejeune, North Carolina, requesting a site investigation under the Military Munitions Response Program. April 20.

Osage of Virginia (Osage). 2010. *Confirmatory Sampling Work Plan Sites IR-18, IR-37, IR-46, and IR-51, Marine Corps Base Camp Lejeune, North Carolina*. March.

Osage. 2011. *Draft Confirmatory Sampling Report Sites 18, 37, 46, and 51, Marine Corps Base Camp Lejeune, North Carolina*. February.

Attachment 6
Geophysical Investigation Plan

Draft

Geophysical Investigation Plan
Preliminary Assessment/Site Inspection; Unexploded Ordnance (UXO) Site UXO-24 Camp Geiger Burial Area

Marine Corps Base Camp Lejeune
Jacksonville, North Carolina

Contract Task Order 014

January 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command

Under the

CLEAN 1000 Program
Contract No. N62470-08-D-1000

Prepared by

CH2MHILL

Raleigh, North Carolina

Contents

Figures

Tables

Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	below ground surface
DDESB	Department of Defense Explosives Safety Board
DGM	digital geophysical mapping
DMM	discarded military munition
DQO	data quality objectives
GIP	Geophysical Investigation Plan
GSV	Geophysical System Verification
ISO	industry standard object
IVS	instrument verification strip
m	meter
MARCORSYSCOM	Marine Corps Systems Command
MC	munitions constituent
MCB	Marine Corps Base
MD	munitions debris
MEC	munitions and explosives of concern
MPP	Master Project Plans
MPPEH	material potentially presenting an explosive hazard
MRP	munitions response program
MRS	Munitions Response Site
NOSSA	Naval Ordnance Safety and Security Activity
NRL	Naval Research Laboratory
PA	Preliminary Assessment
QC	quality control
SI	Site Investigation
USCS	Unified Soil Classification System

Geophysical Investigation Plan

This Geophysical Investigation Plan (GIP) is a supplement to the Marine Corps Base (MCB) Camp Lejeune (CamLej) Master GIP (Appendix D of the MCB CamLej Munitions Response Program [MRP] Master Project Plans [MPP] [CH2M HILL, 2008]) from the MCB CamLej MRP Project Plan (CH2M HILL, 2008a) and provides additional site specific details related to the digital geophysical mapping (DGM) operations at the Camp Geiger Burial Area, MCB CamLej, North Carolina. Only additional detail, modifications or additions to the information provided in the Master GIP from the MRP MPP are discussed herein.

1.1 Area of Investigation

The investigation area covered in this GIP is approximately 2.5 acres in size and is located in the Camp Geiger area of MCB CamLej. The site is accessed from G Street to the west of the site (**Figure 1-1**). Access is restricted to military personnel and contractors.

Site UXO-24 encompasses portions of Installation Restoration (IR) Site 37 (**Figure 1-1**). Prior to the 1950s, the site had been a wooded area. During the late 1950s, a carpenter shop, lumber rack, and paint shop were located in the northern portion of the site. Between 1950 and 1951, IR Site 37 was used as a surface dump for items such as wood, tires, and scrap metal (Osage, 2011). Osage of Virginia (Osage) conducted a confirmatory sampling investigation of the surface dump area in March 2010, and analyzed subsurface soil and groundwater samples. In 2010, the base discovered that unexpended ammunition had been buried at Site UXO-24 behind building TC-611 (**Figure 1-1**). Building TC-611 is used as an ammunition dunnage warehouse.

On March 19, 2010, the base reported that ordnance, consisting of two cans containing live small arms, was found on ground surface adjacent to a small excavation behind building TC-611 (**Figure 1-1**). EOD was contacted and conducted a limited surface sweep of the area and found several holes containing the following unexpended munitions: (1) M-18 Smoke Grenade, (1) Red Star Cluster pop up, and (1) M212 practice grenade. In addition, EOD searched the wooded remaining wooded area of Site UXO-24, and located the following items:

- (1) M-18 smoke grenade
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- (2207) 5.56 blank rounds
- (33) 9 millimeter (mm) AA12 rounds
- (5) 9 mm AA21 rounds
- (22) 5.56 tracer rounds
- (79) 5.56 mm ball rounds
- (3) 7.62 ball rounds
- (16) 7.62 blank rounds
- 25 mm casing

- AK74 blank rounds

Due to discovery of ordnance at the site, the Base identified the site for investigation under MMRP (Commanding Officer, 2010).

The area of investigation for the PA/SI of the site covers approximately 9 acres, of which approximately 28 percent (the area directly behind the building where intentional disposal would most likely have occurred) will be surveyed by DGM activities. The DGM investigation area will be subjected to complete coverage DGM surveys across all accessible areas. Ground cover vegetation and trees less than 6 inches in diameter will be removed to a height of approximately 6 inches above ground surface to facilitate access for the DGM team and equipment.

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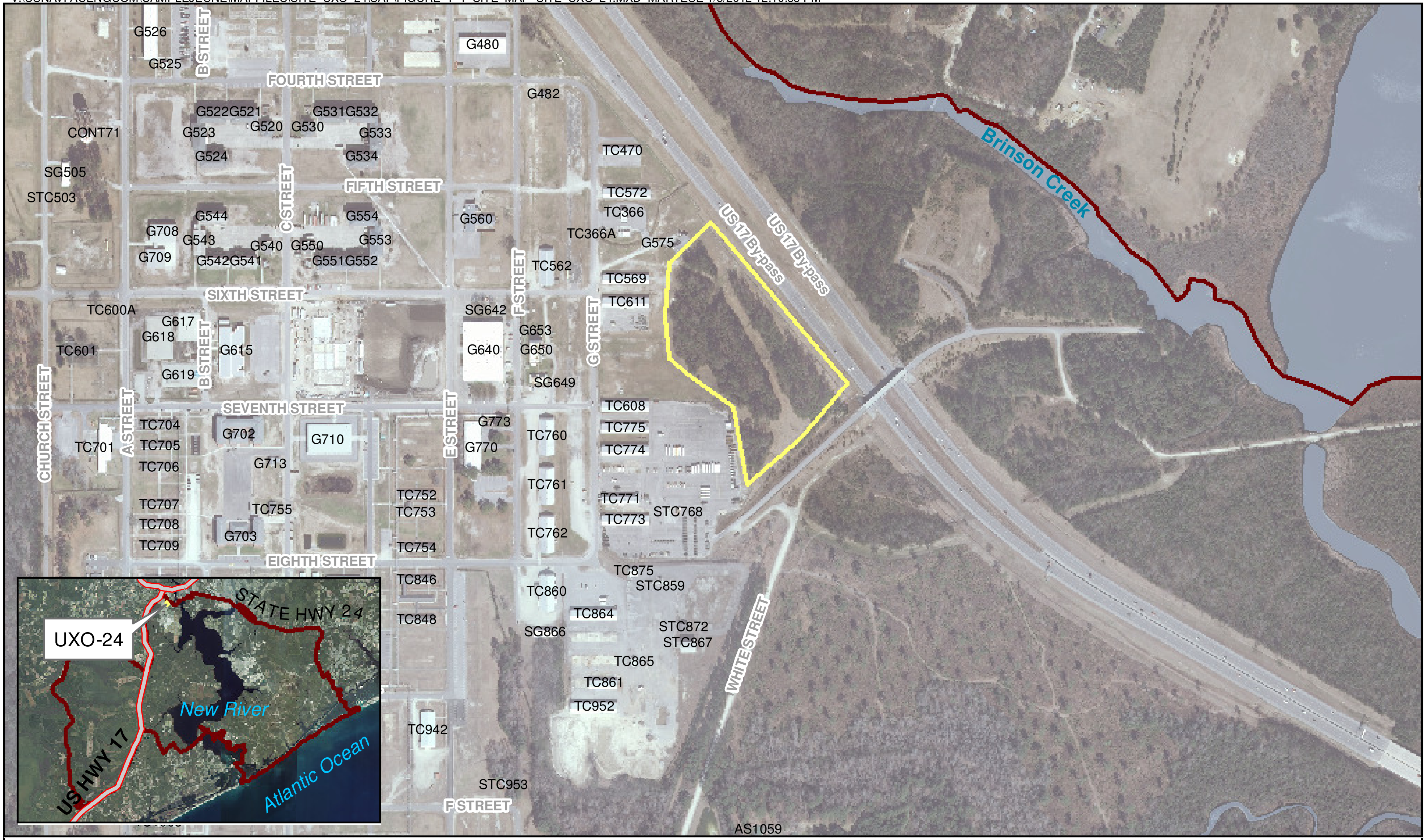

Legend

UXO-24 Boundary

Installation Boundary

N

0 300 600 1,200 Feet

1 inch = 600 feet

Figure 1-1
Site Map
Site UXO-24
MCB CamLej
North Carolina

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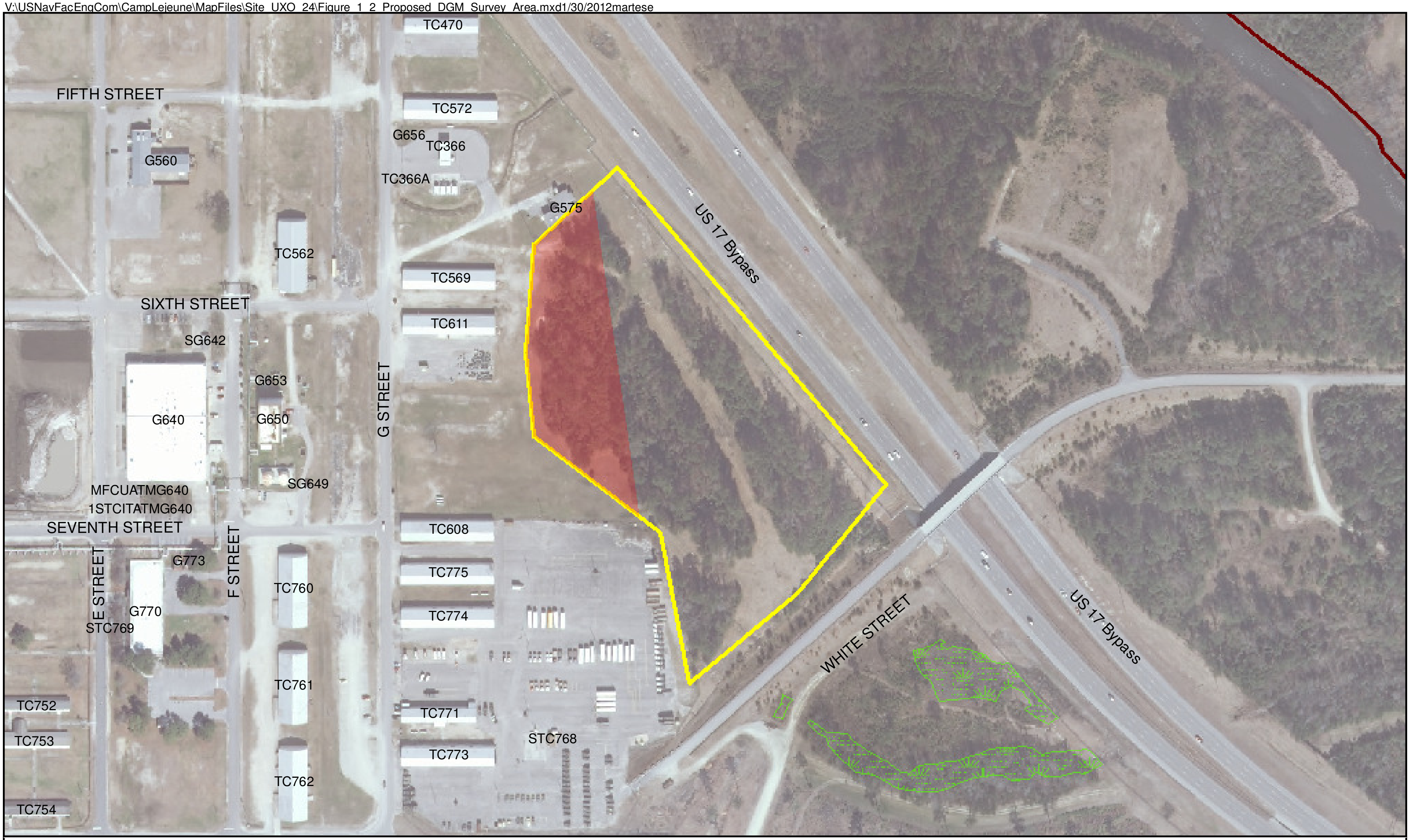

Legend

UXO-24 Boundary
Installation Boundary
Wetlands
DGM Survey Area

N

0 150 300 600 Feet

1 inch = 300 feet

Figure 1-2
Proposed DGM Survey Area
MCB CamLej
North Carolina

CH2MHILL

1.2 Anticipated MEC Types, Composition, Quantities and Depth

The types of MEC potentially present at the site are shown on **Table 1-1**. No chemical warfare materiel was reported to have been used at this site.

The maximum depths at which these items might be found is unknown as the items of interest were not fired but are rather potentially present from being discarded or disposed of at the site. It is not anticipated that items will be located deeper than 2 feet below ground surface (bgs) unless they were intentionally buried for disposal, in which case there should be a larger and more easily detectable accumulation of items.

TABLE 1-1

Anticipated Types of MEC

MEC Type(s)	Composition	Size (mm)	Weight (kg)	Quantities
Grenade, Hand: Smoke, M18	Smoke Composition	64	.54	Unknown
Signal, Illumination, Ground: Cluster, Red Star, M158	Illuminant Composition	42	.59	Unknown
Cartridge, 40-MM, Practice, M781	Propellant	40	.205	Unknown

1.3 Vegetation and Topography

The surface topography within the area of investigation consists of relatively level terrain. Vegetative cover consists of coniferous and deciduous woodland separated by a gas and power line easement, which extends northwest to southeast. A small creek, which appears to be a tributary to a wetland south of the site, is present in the southern portion of the site and flows north to south. Stormwater runoff from Site UXO-24 is expected to flow in a south or southwesterly direction toward the wetland south of the site

Prior to commencement of DGM activities in the DGM investigation area, vegetation less than 6 inches in diameter will be removed, to include removing undergrowth and cutting all trees to 6 inches above of the ground surface. Vegetation will not be removed lower than 6 inches above the ground surface in order to avoid accidently cutting into soil where MEC is potentially present.

1.4 Geologic Conditions

Based on previous investigations, it is anticipated that the surficial aquifer at the site is comprised of fine-grained sands and silty sands with interbedded 1-foot thick clay lenses

(CH2M HILL, 2009). The thickness of the surficial aquifer is at least 16-feet, but the total thickness is undetermined. These soils represent the Quaternary age "undifferentiated" formation which characterizes the shallow water table aquifer. Sands are likely to be fine to coarse-grained and contain varied amounts of silt (5 percent to 50 percent) and clay (5 percent to 20 percent). Results of the standard penetration tests (commonly referred to as "blow counts" [American Society for Testing and Materials (ASTM) 1586]) in other areas of MCB CamLej indicate that the sands will likely have a relative density of loose to dense.

The local geology (interlayered, unconsolidated sediment) is likely to be amenable to either magnetics or electromagnetic detection techniques. No geologic conditions that will impede geophysical operations at the site are known to be present.

1.5 Shallow Groundwater Conditions

Groundwater is anticipated to be relatively shallow, within approximately 2 to 8 feet of ground surface. However, the MEC items, if present at the site, are anticipated to be within 2 feet of the ground surface.

1.6 Adverse Geophysical Conditions

No geophysical conditions, other than those discussed under Section 1.7 and 1.8, that might interfere with electromagnetic near-surface geophysical instrument operation are anticipated.

1.7 Site Utilities

The presence of underground utilities is unknown at the site.

1.8 Man-made Features Potentially Affecting Geophysical Operations

A utility easement consisting of overhead power lines and a subsurface gas line bisects the site and running from the northwest to the southeast.

No site-specific dynamic events (e.g., unusually strong winds, harsh weather conditions) that might affect geophysical operations at the site are anticipated. Although it is possible that weather conditions, including tropical storms or hurricanes, may impede operations at some time during the project, no significant delays or effects on geophysical instruments resulting from abnormally severe weather are expected. If a tropical storm or hurricane does occur during the project, it is possible that work could stop for a significant time.

1.9 Overall Site Accessibility and Impediments

There are no known impediments that will limit access to the work areas at the site. Vegetation within the work areas will be cleared outside of jurisdictional wetlands to within approximately 6 inches of ground surface prior to commencement of geophysical operations. The DGM investigation area will be cleared of vegetation for DGM team and equipment accessibility. Removing undergrowth and cutting all trees (6 inch diameter or less) to a height of approximately 6 inches above ground surface could create potential tripping hazards.

1.10 Potential Worker Hazards

No potential worker hazards are apparent at the site other than those associated with conducting project fieldwork, which are addressed in the Project-specific Health and Safety Plan (Attachment 1 of the UFP-SAP).

1.11 Geophysical System Verification

DGM system validation will be performed using the Geophysical System Verification (GSV) process. The GSV is a physics-based presumptively selected technology process in which signal strength and sensor performance are compared to known response curves of industry standard objects (ISOs) to verify DGM systems prior to and during site surveys. The GSV process is designed to perform initial verification of the proposed DGM system using an instrument verification strip (IVS) followed by a blind seeding program for continued verification throughout the field operations. The GSV Work Plan is provided as Attachment 6 to the UFP-SAP.

1.12 DGM Data Quality Objectives

The primary objective of the DGM activities at the subject site is to identify metallic anomalies that may be MEC or MPPEH. Data quality objectives (DQOs) particular to the DGM surveys are provided in **Table 1-2**.

TABLE 1-2
Project Data Quality Objectives

DQO	Measurement Performance Criteria	Test Method
General System Verification		
DGM System Munitions Detection. DGM system response is within industry standards for detection.	Response to industry standard object will not vary more than ±20% from known response for specific distance from sensors in static test.	Results of QC Test #4 (Static Background and Static Spike) (Section C.15) will be compared to known sensor response curves.
Repeatability. Repeatable and accurate data are being obtained from DGM system.	Response to standardized item will not vary more than ±20% in static test. Response of repeat line is comparable to original line data (qualitative determination.)	Results of QC Test #4 (Static Background and Static Spike) and QC Test #7 (Repeat Data) (see Section C.15) will be evaluated to ensure compliance.

TABLE 1-2
Project Data Quality Objectives

DQO	Measurement Performance Criteria	Test Method
DGM Surveys		
Data Density. Downline data density is sufficient to detect MEC items.	Over 98 percent of possible sensor readings are captured along a transect with a spacing of no greater than 0.7 ft (0.213 m) between points.	Results of DGM surveys will be evaluated to ensure compliance.
Survey Coverage (Lane Spacing). Lane spacing is to maintain appropriate lane spacing to provide 100 percent coverage of accessible portions of the survey area.	Lane spacing is no greater than 1m (the width of the EM61-MK2 system), with an intended lane spacing of 0.75m.	Results of DGM surveys will be evaluated to ensure compliance.
Data Positioning. Positioning of detected anomalies is accurate.	All anomaly locations representing QC seeds lie within a 1 m radius of a point on the ground surface directly above the QC seed.	Anomalies selected will be compared with known seed item locations to ensure compliance.
Data Handling		
All data must be delivered in a timely manner and in a useable format.	Data packages are completed and delivered to the CH2M HILL Project Geophysicist within schedule (3 days pre-processed, 5 days processed).	Evaluated based on actual delivery of data

ft = foot, feet; m = meter; QC = quality control

DGM System Munitions Detection

The DQO for munitions detection is to demonstrate that the system in use is capable of detecting munitions within industry standards. This is demonstrated through a physics-based presumptively selected technology process in which signal strength and sensor performance are compared to validated industry values. As an example, for the EM61-MK2 this process involves demonstrating that the maximum amplitude response over a standard item falls within the sensor response curve for that item as determined through Naval Research Laboratory (NRL) demonstration tests for that item (**Figure 1-3**). Once it has been established that the system is responding comparably, a cross correlation of industry experience with detection of munitions items can be assumed. In other words, the depths and orientations of munitions items which the EM61-MK2 has been shown to be effective at detecting under test scenarios[1] and other projects can be expected.

A determination that the geophysical instrument is responding within a specific threshold will be through the spike test results (QC Test #5, Section 1.15.1) wherein the distance from the coil and orientation of the item can be strictly controlled.

[1] NRL/MR/6110--08-9155 (EM61-MK2 Response of Standard Munitions Items), Final Report for the Evaluation of UXO Detection Technology at the Standardized UXO Test Sites Aberdeen and Yuma Proving Grounds, Standardized UXO Technology Demonstration Site Program, SERDP, November 2007. Demonstrator scoring results: http://aec.army.mil/usaec/technology/uxo01f.html

Repeatability

The DQO for DGM systems data repeatability is that the systems respond consistently from the beginning to the end of an operation. The measurement performance criteria for this is that the response to a standardized item will not vary more than ±20 percent and repeated lines of data are determined qualitatively to be reasonably repeating[2]. This will be evaluated by ensuring that, on a daily basis, the geophysical system being used passes QC Test #5, *Static Background and Static Spike,* and QC Test #6, *Repeat Data*, as outlined in Section 1.15.1.

Data Density

The DQO for downline (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The measurement performance criterion for this is that at least 98 percent of possible sensor readings are captured along each transect at 0.7 feet (0.213 meter [m]) or less. This will be evaluated by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

Survey Coverage (Lane Spacing)

The MQO for lane spacing is to maintain appropriate lane spacing to provide 100 percent coverage of accessible portions of the survey area. The measurement performance criterion for this is that the lane spacing is no greater than 1m (the width of the EM61-MK2 system), with an intended lane spacing of 0.75m. This will be evaluated by verifying that all of the DGM data collected and used for anomaly selection meets this standard, with the exception of locations where trees or other obstructions prohibit such spacing.

Data Positioning

The DQO for data positioning accuracy is that positioning of detected anomalies is accurate enough to allow for effective reacquisition of the anomaly. The measurement performance criterion for this is that 100 percent of all anomaly locations representing QC seeds lie within a 1 m radius of a point on the ground surface directly above the source of the seeded item. Any anomaly that is selected outside of 1 m from a point directly above the item will not be considered to be a detection of that item. This will be evaluated by verifying that data are within this standard or can be otherwise explained. For transect surveys, this DQO is only applicable if the seed item is within the footprint of the instrument as it is not possible to accurately predict the location of items in the transverse direction from the transect if the items lie outside of the instrument footprint.

Data Handling

The DQO for data handling is that all data must be delivered in a timely manner and in a useable format. During production surveys, the measurement performance criterion for data handling will require that “draft” (raw) data packages be completed and delivered to the CH2M HILL Project Geophysicist within 3 working days of data collection and the final data packages within 5 working days of data collection. This will be evaluated based on the actual delivery of data.

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[2] Quantitative measurement is difficult for a repeat line as slight variability in the path traveled by the system will cause significant amplitude differences.

1.13 Geophysical Instrumentation

CH2M HILL will use a single coil EM61-MK2 to map geophysical anomalies that could potentially represent subsurface MEC within the subject site. The EM61-MK2 has been presumptively selected based on prior experience at the site and is described in detail in the Master GIP.

Fiducial positioning methods will be used to position the DGM data. The fiducial method is referenced to survey stakes emplaced by a licensed surveyor at grid corners. A series of survey lanes are established over a grid, with markers placed at the beginning and end of each lane, and at equal distances along the transect. An operator walks down the lane while the data logger collects sensor readings at a prescribed sampling. As the operator walks past the starting, interim markers and end lines in the survey lane, he/she hits a button on the data logger that places a fiducial time mark in the data stream. By assuming the operator walked in a straight line at a constant velocity, the location of each data point can be calculated. A full description of the positioning method is provided in the Master GIP as part of the Master Work Plan (CH2M HILL, 2008a).

1.14 DGM Quality Control

1.15.1 DGM Instruments Quality Control

Geophysical instruments will be field tested frequently by CH2M HILL to ensure that they are operating properly. A description of each test, its acceptance criteria and frequency is provided below and summarized in **Table 1-3**.

- **Equipment Warm-up (Test #1)**. The EM61-MK2 units will be turned on for a minimum of 5 minutes prior to use. Equipment warm-up is performed each time the instrument is first turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to “cool-down.”

- **Personnel Test (Test #2).** This test checks the response of instruments to the personnel and their clothing/proximity to the system. On a daily basis, instrument sensors are checked for their response to the personnel operating the system, with response observed in the field for immediate corrective action. The personnel test is conducted at the beginning of the survey operations for each work day.

- **Vibration Test (Cable Shake) (Test #3)**. This test checks the response of instruments to vibration. On a daily basis, instrument sensors are checked for their response to vibrations through shaking the cables and observing the response in the field for immediate corrective action. The vibration test is conducted at the beginning of the survey operations for each work day.

- **Static Background and Static Spike (Test #4).** Static tests are performed by positioning the survey equipment within or close to the survey boundaries in an area free of metallic contacts and collecting data for a specific period, while holding the instrument in a fixed position without a “spike” (small ISO placed at accurately measured distance and orientation from the transmitter coil, as in the example shown in **Figure 1-2**) and then with a “spike.” The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test are conducted at the beginning and end of each survey operation. This is the test that essentially "opens" and "closes" out a survey area (grid, grid block, set of transects, etc.)

The ISO can be placed above or below the EM61-MK2 transmitter coil as long as the distance is measured from the center of mass of the item to the horizontal plane of the coil (top of coil if item placed above coil, bottom of coil if item placed below), as illustrated in **Figure 1-3**.

FIGURE 1-3
Example Spike Test Setup

- **Repeat Data (Test #5):** This test is performed to ensure repeatability of the data and will be performed after the initial survey over an area. Because of the intrinsic difficulty of following the exact same path for collecting repeat data, this test will be a qualitative comparison as opposed to quantitative. QC Test #4 (Static Background and Static Spike) serves as a quantitative check on data repeatability by the instrument from start to finish of a survey.

TABLE 1-3
Geophysical Instrument Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	1st Time Instr. Used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 minutes)	X				
2	Personnel Test	Personnel, clothing, etc. Should have <2 mV response on Channel 3.		X			

TABLE 1-3
Geophysical Instrument Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	1st Time Instr. Used	2% of Total Area Surveyed
3	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes. Should have <2mv response on channel 3.		X			
4	Static Background and Static Spike	±20% of standard item response, after background correction			X		
5	Repeat Data	Qualitative repeatability of response amplitude					X

mV = millivolt

1.15.2 QC Seed Items

QC seed items are used as part of the GSV process to perform ongoing verification that the DGM system is properly functioning and the munitions detection and positioning DQOs are continuing to be met. ISOs consisting of 1-inch by 4-inch steel pipes, as shown on **Figure 1-4**, are to be placed in the subsurface around the site.

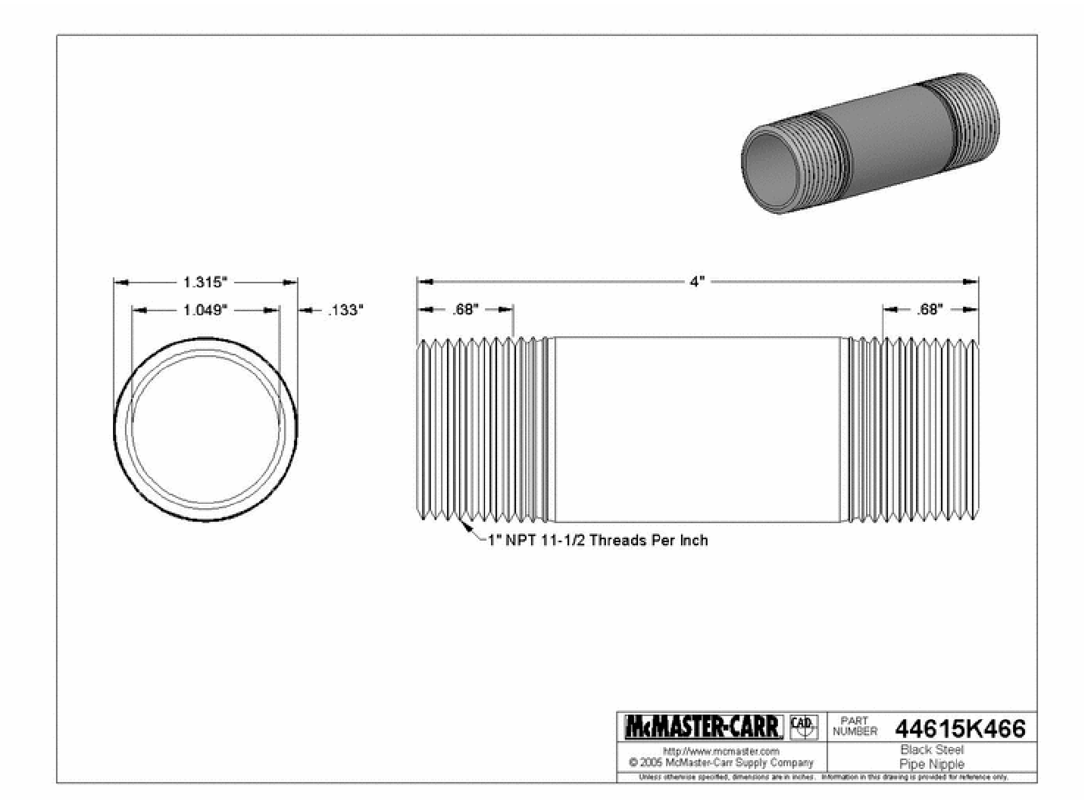

FIGURE 1-4
Small Industry Standard Object

One QC seed will be placed for every 0.75 acres of area to be surveyed in locations at the site that are unknown to the field team and data processor. Seeds will be buried vertically at a depth of approximately 6 inches below ground surface, with the depth being measured to the center of mass of the item, as illustrated by **Figure 1-5**. Depths will be recorded in field notes.

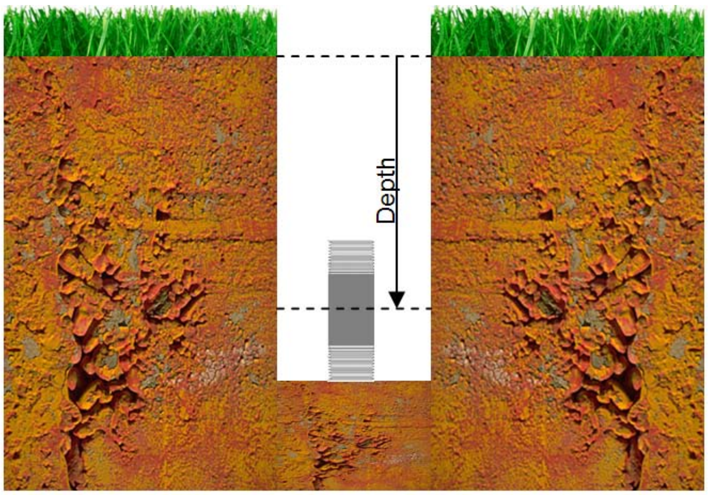

FIGURE 1-5
QC Seed Burial Illustration

The Field Team Leader will be responsible for labeling each QC seed with "UXO-24 QC Seed #" with increasing number. These can either be labeled with a paint pen or with a weather-resistant label taped to or secured within the seed.

The QC seeds will be buried at the time of surveying, which will occur before DGM work begins.

1.15 References

CH2M HILL. 2008a. *Munitions Response Master Project Plan, Marine Corps Base Camp Lejeune, Jacksonville, North Carolina.* May.

Commanding Officer. 2010. Letter to Director, Installation and Environmental, Marine Corps Base, Camp Lejeune, North Carolina, requesting a site investigation under the Military Munitions Response Program. April 20.