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FINAL UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN GEOPHYSICAL CLASSIFICATION FOR MUNITIONS RESPONSE ADVANCED GEOPHYSICAL CLASSIFICATION INVESTIGATION FOR MILCON P-815 MOVING TARGET MORTAR RANGE SOUTH NAS OCEANA VA

06/01/2015

CH2M HILL

Final

Uniform Federal Policy Quality Assurance Project Plan Geophysical Classification for Munitions Response Advanced Geophysical Classification Investigation for MILCON P-815 Moving Target Mortar Range, South

Naval Air Station Oceana Dam Neck Annex
Virginia Beach, Virginia

Contract Task Order WE1L

June 2015

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

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

Prepared by

CH2MHILL

Virginia Beach, VA

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Executive Summary

This Geophysical Classification for Munitions Response (GCMR) Quality Assurance Project Plan (QAPP) supports the activities associated with the Military Construction (MILCON) Support P-815 being performed at the Moving Target Mortar Range-South (MTMR-S), unexploded ordnance (UXO) 07, at Dam Neck Annex (DNA) of Naval Air Station (NAS) Oceana, Virginia Beach, Virginia, and serves as a guideline for the field activities and data quality assessment. CH2M HILL prepared this document under the Department of the Navy (Navy) Comprehensive Long-term Environmental Action – Navy (CLEAN) 8012 Contract N62470-11-D-8012, Contract Task Order WE1L, for submittal to Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic and the Virginia Department of Environmental Quality (VDEQ). VDEQ is the lead regulatory agency. Implementing the procedures in this GCMR-QAPP will help ensure that the data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. This GCMR-QAPP is intended to be the primary work-planning document for the advanced classification activities being performed at MTMR-S.

This GCMR-QAPP is an attachment to the *Munitions and Explosives of Concern Quality Assurance Project Plan Amendment, Moving Target Mortar Range-South (UXO 07) Dam Neck Annex Remedial Investigation, Naval Air Station Oceana Dam Neck Annex, Virginia Beach, Virginia, Contract Task Order WE69, November 2014.* (MEC-QAAP).

The MTMR-S range was used as a small arms firing range and moving target mortar range in the 1940s and 1950s. A moving target machine gun range was present in the southeastern portion of Dam Neck Annex, as observed on 1942 and 1943 maps. The firing point was located 575 feet west of the moving target tracks, and the firing direction was east towards the Atlantic Ocean. Reportedly, the range was later replaced by a mortar range. Based on the range boundaries and period of use, probable munitions used at the MTMR-S include .30- and .50-caliber small arms projectiles and practice 60-millimeter (mm) and 81-mm mortars. It was initially thought that only practice mortars were believed to have been used, based on the distance between the probable firing point and impact area. However, findings from the 2014 Remedial Investigation (RI) indicate that high explosive mortars may also have been fired at the MTMR-S.

The Advanced Geophysical Classification survey will be performed in two phases in coordination with the planned demolition and construction activities: Phase 1 will be executed prior to demolition of the existing structures and Phase 2 will be executed post-demolition/pre-construction in areas that were inaccessible due to the existing structures. The general activities to be performed during each phase to accomplish this objective include:

1. Use the Time-domain Electro-Magnetic Multi-sensor Towed Array Detection System (TEMTADS) 2x2, an advanced electromagnetic induction system, for dynamic geophysical surveys in accessible areas using global positioning system (GPS) and/or robotic total station (RTS), to detect metallic items in the subsurface that may be targets of interest (TOI) (e.g., munitions).
2. Perform Advanced Detection on the dynamic data set to identify anomaly sources that are potential TOI. Unlike conventional Amplitude Response anomaly selection where all anomalous responses above a set threshold are selected, Advanced Detection is a process that uses all of the data available from advanced EMI sensors to find and select targets[1] based upon the anomaly *source* characteristics (size and wall-thickness). This manner significantly reduces effort expended investigating anomalies caused by sources that are far too small or too thin-walled to be a TOI.
3. Perform cued interrogation of anomaly sources identified in the dynamic survey to collect data to classify the metallic items as TOI or non-TOI on the dig list. Cued interrogation involves using the TEMTADs in static mode.

[1] Note that the terms “target” and “anomaly source” are used interchangeably in Advanced Geophysical Classification parlance.

4. Perform cluster analysis and "analyst calibration digs" in order to assist the data processing approach by determining whether certain signatures should be added to the library from the cluster analysis and to refine the dig list.
5. Intrusively investigate the anomaly sources identified as TOI on the refined dig list, along with a set of validation investigations of additional anomaly sources. These intrusive investigations will be performed by CH2M HILL. Procedures for the intrusive investigation and subsequent management of munitions and explosives of concern (MEC) are provided in the MEC-QAPP.

Contents

Tables

Figures

Acronyms and Abbreviations

A/E/C	Architecture, Engineering, Construction
AGC	Advanced Geophysical Classification
AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
AQM	Activity Quality Manager
CA	corrective action
CAP	Corrective Action Plan
CAR	Corrective Action Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action-Navy
cm	centimeter
CM	Construction Manager
CSM	conceptual site model
DDESB	Department of Defense Explosives Safety Board
DFW	definable feature of work
DGM	digital geophysical mapping
DMM	discarded military munitions
DoD	Department of Defense
DQO	data quality objectives
EM	Engineering Manual
EMI	electromagnetic induction
EOD	Explosive Ordnance Disposal
ESRI	Environmental System Research Institute
ESS	Explosives Safety Submission
EZ	exclusion zone
FGDC	Federal Geographic Data Committee
FP	Follow-up Phase
FTL	Field Team Leader
FTP	file transfer protocol
GCMR-QAPP	Geophysical Classification for Munitions Response Quality Assurance Project Plan
GIS	geographic information system
GPS	global positioning system
HSM	Health and Safety Manager
H&S	Health and Safety
IAW	in accordance with
ID	Identifier
IDQTF	Intergovernmental Data Quality Task Force
IP	Initial Phase
ISO	industry standard object
IVS	instrument verification strip

m	meter
MDAS	material documented as safe
MEC	munitions and explosives of concern
MILCON	Military Construction
mm	millimeter
MPC	measurement performance criteria
MPPEH	material potentially presenting an explosive hazard
MQO	measurement quality objective
MR	Munitions Response
MRP	Munitions Response Program
MRS	Munitions Response Site
MRSIMS	MRS Information Management System
MTMRS	Moving Target Mortar Range-South
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCR	Non-Conformance Report
NSSDA	National Standard for Spatial Data Accuracy
NTR	Navy Technical Representative
OSHA	Occupational Safety and Health Administration
PDF	portable document format
PLS	Professional Land Surveyor
PM	project manager
PP	Preparatory Phase
PPE	personal protective equipment
QA	quality assurance
QAO	quality assurance officer
QAPP	Quality Assurance Project Plan
QC	quality control
RCA	Root Cause Analysis
RI	Remedial Investigation
RPM	Remedial Project Manager
RTK	Real-time Kinematic
RTS	Robotic Total Station
SDSFIE	Spatial Data Standards for Facilities, Infrastructure, and Environment
SI	Site Inspection
SNR	Signal to noise ratio
SOP	Standard Operating Procedure
SSHP	Site-Specific Health and Safety Plan
SUXOS	Senior Unexploded Ordnance Supervisor
TBD	to be determined
TEMTADS	Time-domain Electro-Magnetic Multi-sensor Towed Array Detection System
TOI	Target of Interest
TP	Technical Paper

UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
UTM	Universal Transverse Mercator
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VDEQ	Virginia Department of Environmental Quality

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QAPP Worksheet #1 & 2: Title and Approval Page

1. Project Identifying Information

Site name/project name	Moving Target Mortar Range, South - Dam Neck Annex
Site location/number	Naval Air Station Oceana Virginia Beach, Virginia
Client	Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic
Contractor	CH2M HILL
Contract number	N62470-11-D-8012, Contract Task Order WE1L

2. Department of Defense (DoD) Organization

DoD Contracting Officer Representative (COR) (name/title/signature/date)

Krista Parra Contracting Officer Representative (COR) ____

DoD Construction Manager (CM) (name/title/signature/date)

Lee Jennings, NAVFAC Construction Manager (MILCON) ____

DoD Quality Manager (name/title/signature/date)

Mike Green, MR Quality Assurance Officer (QAO) ____
NAVFAC Atlantic

3. Contractor

Contractor PM (name/title/signature/date)

Steve Falatko, PM
CH2M HILL ____

Contractor Quality Assurance Manager (name/title/signature/date)

George DeMetropolis, Quality Manager
CH2M HILL ____

4. Federal Regulatory Agency (name/title/signature/date)

N/A

5. State Regulatory Agency (name/title/signature/date)

Stephen Mihalko, RPM
Virginia Department of Environmental Quality (VDEQ) ____

QAPP Worksheet #1 & 2: Title and Approval Page (continued)

6. Other Stakeholders (as needed)

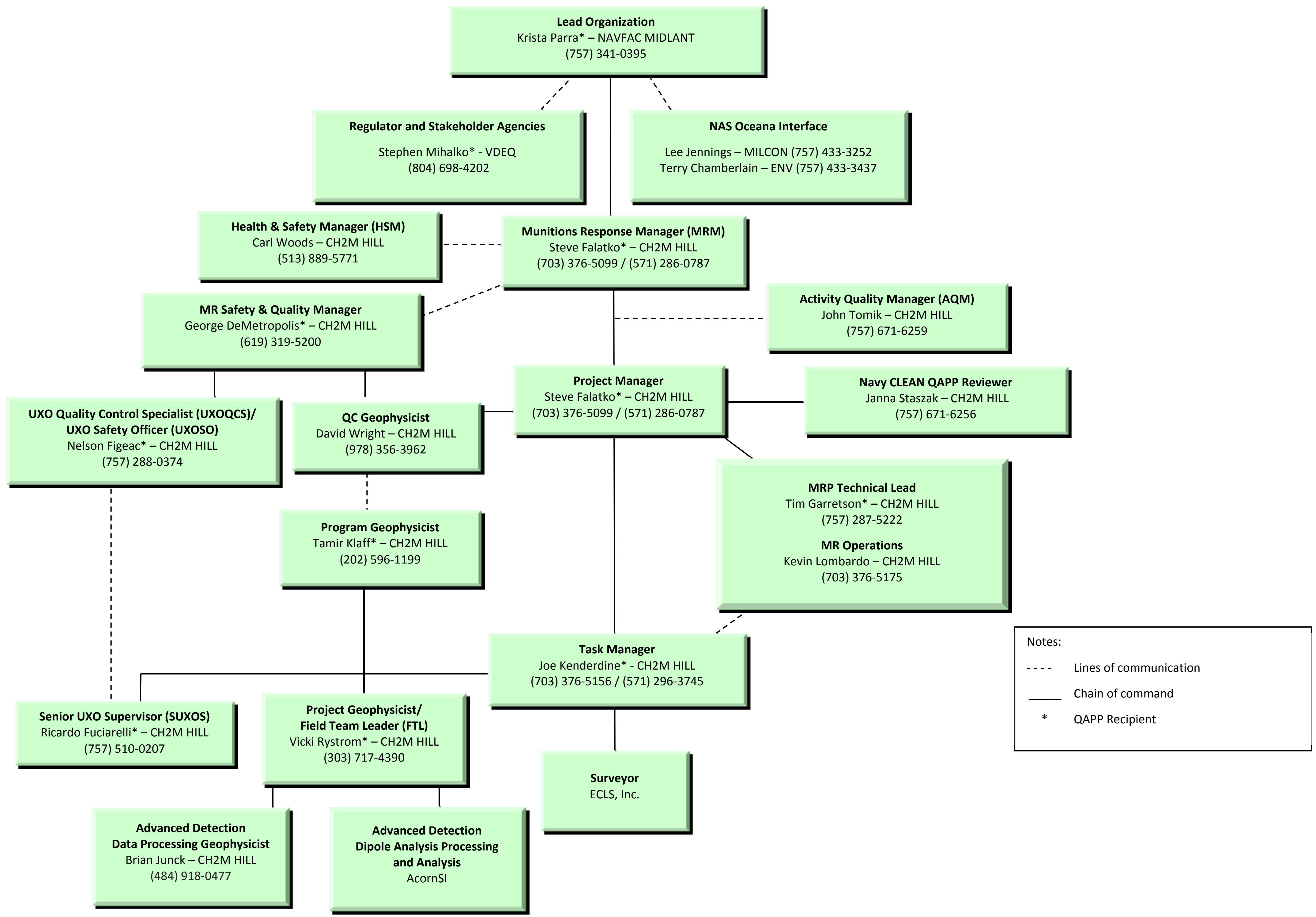
(None)

7. List plans and reports from previous investigations relevant to this project

Title	Author/Date
Final Preliminary Assessment, Naval Air Station Oceana, Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Virginia.	Malcolm Pirnie/October 2008
Draft Final Geophysical Investigation Plan, Site Inspection Munitions Response Program, Fleet Combat Training Center, Dam Neck Annex, Naval Air Station Oceana, Virginia Beach, Virginia.	CH2M HILL/March 2010
Final Site Inspection Report, Munitions Response Program, Munitions Response Sites at Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Naval Air Station Oceana, Virginia Beach, Virginia.	CH2M HILL/February 2011
Technical Memorandum, Expanded Site Inspection Results and Proposed Remedial Investigation Approach for the Moving Target Mortar Range – South, Dam Neck Annex – Naval Air Station Oceana, Virginia.	CH2M HILL/November 2012
Final Munitions and Explosives of Concern, Quality Assurance Project Plan, Remedial Investigation, Moving Target Mortar Range South	CH2M HILL/November 2014

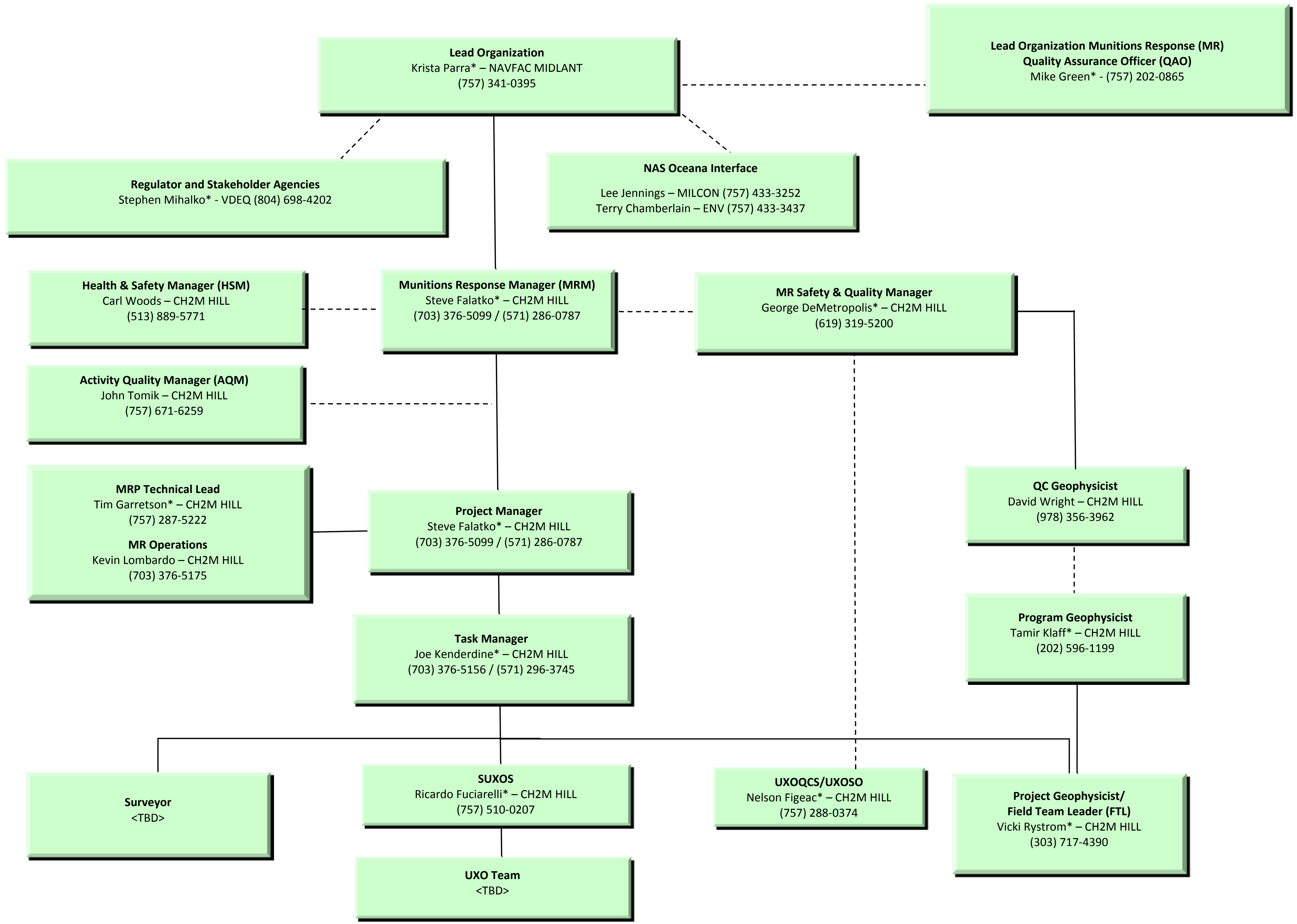
QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution

FIGURE 3-1
Geophysical Survey Organizational Structure



QAPP Worksheet #3 & 5: Project Organization and QAPP Distribution (continued)

FIGURE 3-2
Explosive Operations Organizational Structure



QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet

TABLE 4-1
Geophysical Survey Organization

Name	Project Title	Education/Experience/Specialized Training/Licenses/Certifications	Role	Signature/ Date[1]
Stephen Falatko	PM	BS, Chemistry CECOS, Munitions Response Site Management CECOS, Advanced Munitions Response Site Management OSHA 8-hour 29 Code of Federal Regulations (CFR) 1910.120(e)(4) Refresher OSHA 8-hour CFR 1910.120(3)(4) Site Supervisor OSHA 40-hour CFR 1910.120(e)(3) OSHA 30-hour CFR 1926 USACE Construction Quality Management for Contractors (CQMC)	Serves as the primary contact for CH2M HILL. Develops the project scope, schedule, and budget. Provides day-to-day management of the CH2M HILL team and schedule and lead meetings and review conferences. Responsible for the safe, efficient, and quality execution of the project and for ensuring the subcontractors deliver their work safely, to specifications and to quality standards. Authority includes making process, procedure, and managerial decisions regarding specific project issues; negotiating with subcontractors; approving subcontractor deliverable performance and invoices; developing and implementing the Project Management Plan, Site Safety and Health Plan (SSHP), and Quality Assurance Project Plan (QAPP). Reports to the CH2M HILL Program Manager for the contract.	
George DeMetropolis	Health and Safety (H&S)/ Quality Control (QC) Manager	PhD, Business Administration (Management) MBA (Management) BS, Political Science/French Cardiopulmonary resuscitation (CPR) and First Aid Training OSHA 8-hour 29 CFR 1910.120(e)(4) Refresher OSHA 8-hour CFR 1910.120(3)(4) Site Supervisor OSHA 40-hour CFR 1910.120(e)(3) American Society for Quality Certified Quality Auditor & Certified Manager of Quality/Organizational Excellence Former Military Master Explosive Ordnance Disposal (EOD) Technician United States Army Corps of Engineers (USACE) UXO Resume Database: 0421 USACE Construction Quality Management for Contractors (CQMC)	Responsible for overall safe execution of all work and for compliance with all USACE safety requirements. Ensures that procedures described in this Geophysical Classification MR (GCMR)-QAPP are safe and that all safety requirements are implemented in the field. Conducts safety audits. Provides overall program quality management and implementation on the project. Responsibility for identifying quality problems and will initiate, recommend, and/or provide corrective measures to those problems. Verifies the implementation of corrective measures and conducts senior-level reviews of contract deliverables. Monitors activities at the work sites and coordinates activities with the PM, Site Manager, and UXO QC Specialist (UXOQCS). Approves all plans and all changes or deviations from established procedures or techniques.	

[1] Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

TABLE 4-1
Geophysical Survey Organization

Name	Project Title	Education/Experience/Specialized Training/Licenses/Certifications	Role	Signature/ Date[1]
Ricardo Fuciarelli	Senior Unexploded Ordnance Supervisor (SUXOS)	Qualifications Established by DoD Explosives Safety Board (DDESB)Technical Paper (TP) 18	Primary point of contact for communications during operational efforts for issues relating to field actions and daily schedules. Serves as the Site Manager during field work activities. Responsible for management and leadership of the project during its operational cycles and will be onsite to provide direct oversight of field activities. Maintains a field log of daily activities, records of anomaly excavations, and disposal documentation (if applicable). Submits daily progress report to CH2M HILL PM. Essential for performing tasks within an exclusion zone (EZ) while munitions and explosives of concern (MEC) activities are being conducted, pursuant to Engineering Manual (EM) 385-1-97 (USACE, 2008).	
Nelson Figeac	UXOSO/ UXOQCS	Qualifications Established by DDESB TP 18	Implements the approved H&S program in compliance with applicable DoD policy and federal, state, and local H&S statutes, regulations, and codes. Schedules the daily safety briefings. Analyzes operational risks, explosive hazards, and safety requirements. Establishes and ensures compliance with all site-specific explosives operations safety requirements. Enforces personnel limits and safety EZs for explosives-related operations. Conducts, documenting, and reporting the results of safety inspections to ensure compliance with all applicable explosives safety policies, standards, regulations, and codes. Ensures all protective works and equipment used within the EZ are operated in compliance with applicable DoD policy, and federal, state, and local H&S statutes, regulations, and codes. Is responsible for oversight of placement and documentation of QC seed items by CH2M HILL UXO personnel and professional land surveying subcontractor in accordance with applicable standard operating procedures (SOPs). Provides required documentation on QC seed placement to the QC Geophysicist on a daily basis during the seeding event. Conducts and documents QC audits for compliance with established procedures and identifies, documents, reports, and ensures completion of all corrective actions (CAs) to ensure operations comply with requirements. Essential, pursuant to EM 385-1-97 (USACE, 2008), for performing tasks within an EZ while MEC activities are being conducted.	

[1] Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

TABLE 4-1
Geophysical Survey Organization

Name	Project Title	Education/Experience/Specialized Training/Licenses/Certifications	Role	Signature/ Date[1]
Tamir Klaff	Program Geophysicist	BA, Geology, Franklin & Marshall College, Lancaster, Pennsylvania, 1991 MS, Engineering Geology and Hydrogeology (focus in near surface geophysics) More than 20 years of project management and technical experience designing, implementing and managing geophysical operations and 18 years focused on MR projects (hundreds of sites). Significant training and experience with advanced electromagnetic induction (EMI) data collection and processing. Experienced in management and design of environmental investigations and remedial actions (Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) and UXO/chemical warfare materiel clearance and disposal programs Professional Geophysicist, 2001, California No. GP 1036 Professional Geologist since 1998, Current registration: Virginia 2801001878 UX Analyze courses OSHA 40-hour, Current on 8-hour Refresher, OSHA Supervisor	Overall responsibility for design, implementation, and management of geophysical investigations required for the work. Ensures proper oversight of field geophysical operations. Approves use of geophysical equipment, reviews and approves field data. Provides CH2M HILL PM with status updates on geophysical data collection, processing, and QC. Informs CH2M HILL PM of deviations from QAPP, if necessary. Communicates relevant project and schedule updates to geophysical field team. Reviews and approves geophysical project deliverables and documents (including root cause analysis [RCA] and CAs, if necessary).	

[1] Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

TABLE 4-1
Geophysical Survey Organization

Name	Project Title	Education/Experience/ Specialized Training/Licenses/Certifications	Role	Signature/ Date[1]
Vicki Rystrom	Project Geophysicist/FTL	MS, Geology (Geophysics Concentration), University of Colorado, Boulder BA, Economics, University of Lethbridge, Alberta 18 years' experience as a geophysicist, over 12 years in munitions response geophysics Conducted geophysical operations on MR sites within the U.S. and abroad, with extensive experience in design and execution of field surveys, planning, QC of DGM data, and oversight of field operations, including advanced EMI surveys. Professional Geologist, CO OSHA 40-hour, Current on 8-hour Refresher	Kicks off field investigation and is responsible for continued oversight of geophysical field operations. Conducts training of field geophysical personnel as needed. Ensures data are transferred daily to Project Geophysicist for review and analysis. Ensures field documentation is completed in accordance with (IAW) the QAPP prior to upload for data processing. Assists with preparation and compilation of geophysical project deliverables and documents (including RCAs and CAs, if necessary).	
David Wright	QC Geophysicist	BA, Philosophy, University of Guelph, Guelph ON 1983 More than 25 years of experience in practical geophysics, performing and managing a diverse array of geophysical investigations using airborne, terrestrial, and marine based systems. Significant involvement in developing and demonstrating innovative technologies for MR detection/classification including playing lead role in developing airborne and marine UXO detection arrays and led the development of a dual mode magnetometer/EMI handheld device. Experienced in performing as project geophysicist for a number of recent Advanced Geophysical Classification demonstrations. Active in supporting the Environmental Security Technology Certification Program (ESTCP) Program Office in development of formalized Quality Management for Advanced Geophysical Classification.	Is responsible for reviewing QC seed placement process and documentation from UXOSO/UXOQCS for compliance with applicable SOPs. Is responsible for reviewing data provided by professional land surveying subcontractor for compliance with applicable SOPs and to confirm that position accuracies are within specification. Reviews geophysical data packages for compliance with the QAPP. Ensures geophysical data processing is being performed IAW with QAPP. Performs QC of geophysical data in timely manner and communicates QC concerns or problems to Project Geophysicist. Ensures QC documentation is completed IAW the QAPP.	

[1] Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

TABLE 4-1
Geophysical Survey Organization

Name	Project Title	Education/Experience/ Specialized Training/Licenses/Certifications	Role	Signature/ Date[1]
Brian Junck	Data Processing Geophysicist	M.Sc., Fluvial Geomorphology & Geophysics (focus and Master's Thesis on near-surface geophysics), University of Calgary, Calgary Alberta 2009 B.Sc., Cartography, University of Wisconsin 2000 Conducted geophysical operations and data processing on MR sites within the U.S. and U.S. territories, with extensive experience in geophysical data processing and analysis including advanced EMI surveys, has also provided QC of digital geophysical mapping (DGM) data. OSHA 40-hour, Current on 8-hour Refresher	Overall responsibility for processing DGM and advanced EMI data and classifying anomaly sources Responsible for QC of data received from the field team Communicates QC issues to Project Geophysicist and Field Team Leader (FTL) Ensures geophysical data meet the measurement quality objectives (MQOs) Ensures data packages are complete prior to transmitting to the QC Geophysicist Assists with preparation and compilation of geophysical project deliverables and documents (including RCAs and CAs, if necessary).	

QAPP Worksheet #4, 7 & 8: Personnel Qualifications and Sign-off Sheet (continued)

TABLE 4-2
Explosive Operations Organization

Name	Project Title	Education/Experience/ Specialized Training/Licenses/Certifications	Role	Signature/Date[1]
In addition to personnel listed in Table 4-1:				
TBD	UXO Team	Qualifications Established by DDESB TP 18	Execute field work activities as directed by the SUXOS and UXOSO	

Note:
TBD = to be determined

[1] Signatures indicate personnel have read and agree to implement this QAPP as written.

QAPP Worksheet #6: Communication Pathways and Procedures

Communication Driver	Initiator (name, title/role, and contact info)	Recipient (name, title/role, and contact info)	Procedure (timing, pathway, documentation)
Regulatory agency interface	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	Stephen Mihalko VDEQ RPM 804-698-4202 stephen.mihalko@deq.virginia.gov	Navy RPM provides weekly project update memorandum to Regulator via email
NAS Oceana interface	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil OR Steve Falatko CH2M HILL PM 703-376-5099 stephen.falatko@ch2m.com	Lee Jennings MILCON CM 757-433-3252 hollis.jennings@navy.mil	Activities requiring facility input or coordination, such as dig permits
Stop work due to safety issues	Ricardo Fuciarelli / Nelson Figeac CH2M HILL SUXOS or UXOSO 757-288-0374 nelson.figeac@ch2m.com	Steve Falatko CH2M HILL PM 703-376-5099 stephen.falatko@ch2m.com	As soon as possible following discovery, SUXOS/UXOSO informs CH2M HILL PM by phone of critical safety issues and generates follow-up Stop Work Memorandum
Minor QAPP changes during project execution (field CA)	George DeMetropolis CH2M HILL QC Manager 619-272-7239 george.demetropolis@ch2m.com OR Steve Falatko CH2M HILL PM 703-376-5099 stephen.falatko@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	CH2M HILL prepares a Non-Conformance Report (NCR) (Form 4-12 in **Appendix A**) and, as applicable, a Corrective Action Request (CAR) (Form 4-9 in Appendix A) and Corrective Action Plan (CAP) (Form 4-10 in **Appendix A)**. CH2M HILL PM provides to Navy RPM for review and approval and informs regulators upon approval.
Major QAPP changes during project execution	Steve Falatko CH2M HILL PM 703-376-5099 stephen.falatko@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	Within 24 hours, CH2M HILL PM submits field change request form to Navy RPM for approval. Following approval, Navy RPM informs regulator via email.
Field progress reports	Steve Falatko CH2M HILL PM 703-376-5099 stephen.falatko@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	At end of each day of field work, CH2M HILL PM provides daily QC reports to Navy RPM via email.

QAPP Worksheet #6: Communication Pathways and Procedures (continued)

Communication Driver	**Initiator (name, title/role, and contact info)**	**Recipient (name, title/role, and contact info)**	**Procedure (timing, pathway, documentation)**
Geophysical QC variances	David Wright CH2M HILL QC Geophysicist 978-356-3962 david.wright@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	CH2M HILL team prepares a NCR (Form 4-12 in **Appendix A**) and, as applicable, a CAR (Form 4-9 in Appendix A) and CAP (Form 4-10 in **Appendix A**). CH2M HILL PM provides to Navy RPM for review and approval.
Data verification issues, for example, incomplete records	Tamir Klaff CH2M HILL Program Geophysicist 202-596-1199 tamir.klaff@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	CH2M HILL team prepares a NCR (Form 4-12 in **Appendix A**) and conducts an RCA of the verification issue. A CAR (Form 4-9 in **Appendix A**) and CAP (Form 4-10 in **Appendix A**) will be prepared, as applicable. CH2M HILL PM provides to Navy RPM for review and approval
Data review CA	David Wright CH2M HILL QC Geophysicist 978-356-3962 david.wright@ch2m.com	Krista Parra Navy RPM 757-341-0395 krista.parra@navy.mil	CH2M HILL team prepares a NCR (Form 4-12 in **Appendix A**) and conducts an RCA of the data issue. A CAR (Form 4-9 in **Appendix A**) and CAP (Form 4-10 in **Appendix A**) will be prepared, as applicable. CH2M HILL PM provides to Navy RPM for review and approval.

QAPP Worksheet #9: Project Planning Session Summary

Date of planning session: January 7, 2015

Location: Public Works Office – NAS Oceana

Purpose: Determine the UXO activities to support the MILCON project

Participants:

Name	Organization	Title/Role	Phone / Email
Krista Parra	NAVFAC	RPM	757-341-0395 krista.parra@navy.mil
Lee Jennings	NAVFAC	MILCON CM	757-433-3252 hollis.jennings@navy.mil
Steve Falatko	CH2M HILL	MRM	703-376-5099 stephen.falatko@ch2m.com
Tamir Klaff	CH2M HILL	Program Geophysicist	202-596-1199 tamir.klaff@ch2m.com

Notes/Comments

Lee provided a conceptual overview of the MILCON project and Steve summarized the results of the munitions response investigations to date at the MTMR-S. Tamir explained the typical anomaly investigation and removal process that includes; land survey, digital geophysical mapping, reacquisition, intrusive investigation and management of MEC. He also suggested that this site, has good characteristics, that is, relatively small size, flat topography, and limited munitions types (60mm and 81mm mortars), for applying an advanced classification technique. Tamir then presented a proposal as to how the project work between the UXO and General Contractor could be sequenced. Parties agreed that this site was a good candidate for application for advanced classification investigation technique, that is, TEMTADS.

Parties also developed a scheme to provide anomaly avoidance support during site preparation activities and munitions support during construction. In between, the UXO contractor would perform an advanced classification digital mapping and subsequent intrusive investigation and removal of MEC.

Objective of the Advanced Geophysical Classification Investigation

- Identify the locations of TOI in the developed portion of MTMR-S to facilitate the removal of munitions and explosives of concern (MEC)[2] within the capabilities of the equipment and measurement performance criteria defined in this QAPP. The project site is 2.87 acres; the Phase 1 area is 1.34 acres, and is based on the horizontal and vertical limits of disturbance provided by NAVFAC in December 2014.

Planning

- A Work Plan will have to be prepared using the Uniform Federal Policy (UFP) QAPP
  - Use Intergovernmental Data Quality Task Force (IDQTF) Template "Geophysical Classification for MR (GCMR)". This QAPP is based on the beta draft template dated September 30, 2014.
  - This plan will be an attachment to the existing MEC-QAPP.
- The Explosives Safety Submission (ESS) will have to be amended for the MILCON and TEMTADS activities.

[2] Note that the term MEC, in the context of this document, means unexploded ordnance (UXO) and discarded military munitions (DMM).

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QAPP Worksheet #10: Conceptual Site Model

Field Effort

- The project will include two phases:
  - Phase 1 will include the removal of asphalt and concrete from the parking lot, vegetation removal for the chiller line and other areas as necessary, followed by construction of new building on the northern portion of the site.
  - Phase 2 will include the demolition of existing structure and construction of new supporting features on the remaining portion of the site.

Site Background and History

The Conceptual Site Model is discussed in detail in the MEC-QAPP. New information since the publication of the MEC-QAPP is listed below.

December 2013 - March 2014 Remedial Investigation

In December 2013 and March 2014, a RI was conducted that included surface removal of MPPEH and non-munitions related debris, a DGM survey, and intrusive investigation of selected geophysical anomalies. The MRS was divided into four areas of investigation, namely: Firing Line, Suspected Impact Area, Grassy Dunes Area, and Beach Area. Items found at the site during the RI included:

Firing Line:

- 63 expended .50 caliber small arms ammunition items
- One 7.62 mm case small arms ammunition item

Suspected Impact Area:

- 40 mortar tail fin segments
- 32 expended .50 caliber small arms ammunition items
- 1 mortar fuze
- 2 expended 25-pound practice bombs (BDU 33) - both items were transferred to the Dive Bombing Target site at Naval Auxiliary Landing Field Fentress for demilitarization
- 1 (partial fuze), intact, high explosive, 60-mm mortar, fired, classified as MEC; demolition operations were performed in accordance with demolition practices outlined in the ESS

Grassy Dunes:

- 7 mortar tail fin segments
- One 81-mm mortar tail fin segment
- 22 expended .50 caliber small arms ammunition items
- 1 expended small arms ammunition item

Beach:

- None

A total of 77 pounds of MPPEH that was inspected and further classified as material documented as safe (MDAS) were removed from the site through intrusive investigation.

QAPP Worksheet #10: Conceptual Site Model

General Investigation Approach

This task order is to perform a UXO soil clearance at the MTMR-S at Dam Neck Annex, in Virginia Beach, Virginia (**Figure 10-1**) in order to reduce the risk to construction workers performing the construction of P-815. An Advanced Geophysical Classification (AGC) survey will be performed in the investigation area to identify and remove the TOI for the MILCON of P-815.The project site is 2.87 acres; the Phase 1 area is 1.34 acres, and is based on the horizontal and vertical limits of disturbance provided by NAVFAC in December 2014.

The AGC survey will be conducted in the areas within and adjacent to the MTMR-S as shown on **Figure 10-1.**

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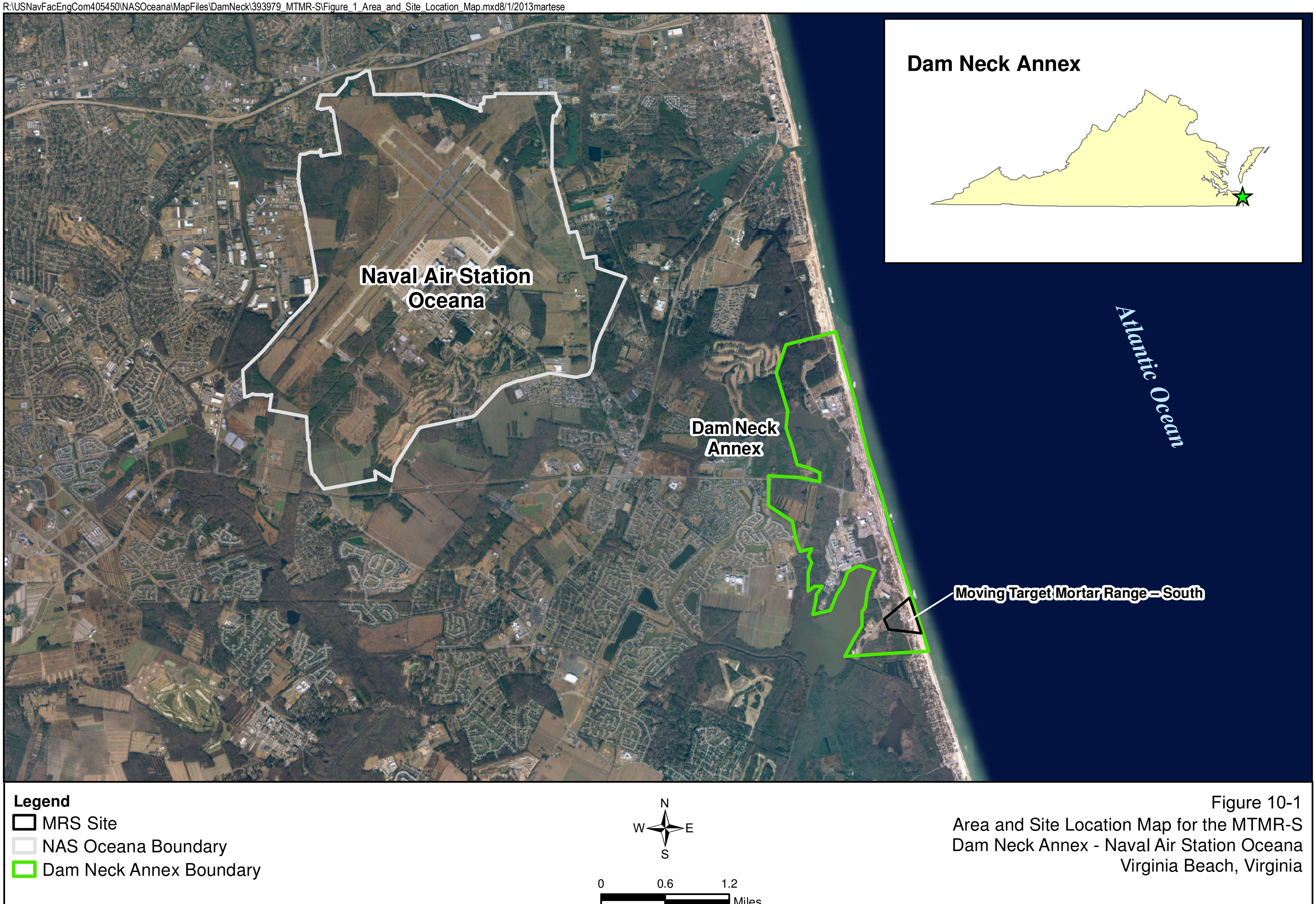

Figure 10-1
Area and Site Location Map for the MTMR-S
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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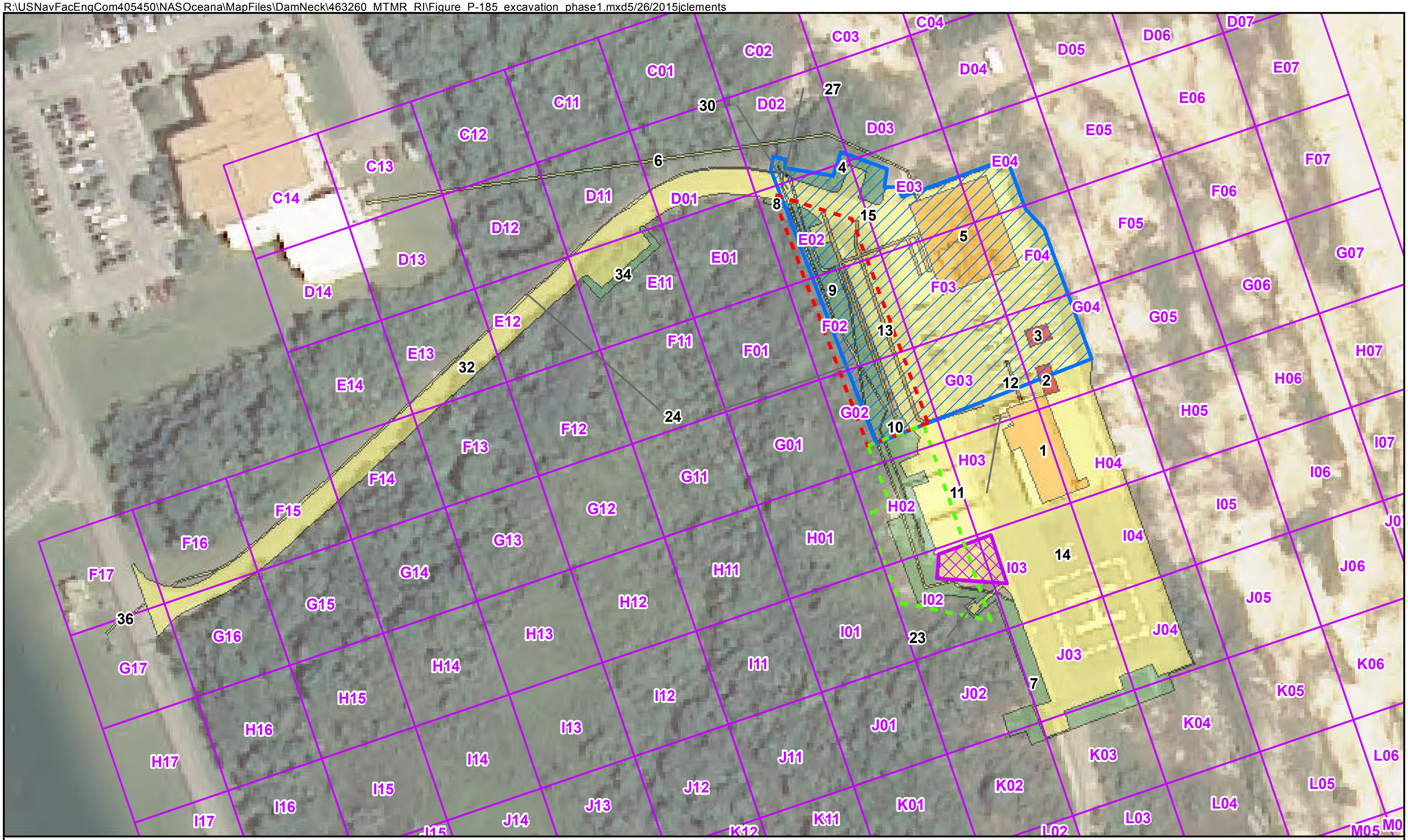

Legend

Excavation Depths

- 0.75 ft
- 3 ft
- 5 ft
- 16 ft
- Phase 1
- Trailer Laydown
- Vegetatoin Reduction
- Vegetation Reduction (Optional)
- Grid 30m x 30m

N W E S

0 25 50 Meters

Aerial Imagery - 2008

Figure 10-2
Survey Areas for P815 MILCON Project
Dam Neck Annex - Naval Air Station Oceana
Virginia Beach, Virginia

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QAPP Worksheet #11: Project Quality Objectives

Step 1: State the Problem.

Site-specific problem statement: Previous investigations at MTMR-S (**Worksheet #10**) have identified MEC at the site. Therefore, the potential remains for additional munitions items to be present in the subsurface at the site. These items may present an unacceptable explosive hazard to site workers, visitors, trespassers, and recreational and educational users. Advanced geophysical classification will be used to 1) detect anomalies resulting from DMM, UXO, and other metallic debris and 2) classify the source[3] of each anomaly so that informed decisions can be made as to whether the item is a TOI and should be investigated, is a non-TOI and may be left in place, or cannot be classified based on the data and must be investigated to determine the nature of the source.

Step 2: Identify the goals of the data collection.

Identify the principal question: Are there metal objects in the subsurface within the construction area that can be detected and classified as either TOI or non-TOI using AGC methodologies, and if so, what are their precise locations and depths?

Identify alternative outcomes: Alternative outcomes would need to be considered in the event that anomaly densities identified during the detection surveys are too high for reliable selection of individual targets (for example, presence of saturated response areas). Additional scenarios that would warrant consideration of alternative outcomes include site conditions that restrict access with the TEMTADS 2x2 or restrict how the sensor is deployed in the field. In these scenarios, potential alternative outcomes to be discussed with the project team include, but are not limited to, the following:

- No further investigations within the high density area and designate it as a potential EZ
- Perform instrument aided detection and dig operations
- Perform instrument aided detection and dig operations with follow-up additional AGC surveys
- Perform limited and focused intrusive investigations, as required during the course of the project, using construction support

State how the data will be used in solving the problem: Geophysical data collected in dynamic mode using a TEMTADS 2x2 will be used to initially detect and document the locations of geophysical anomalies. Data positioning will be performed using a Real-time Kinematic (RTK) global positioning system (GPS) and/or a Robotic Total Station (RTS). Responses indicating the presence of potential TOI will be used to generate a list of targets.

Traditional detection as performed with conventional electromagnetic DGM instruments (e.g. EM61-MK2) uses the geophysical response amplitude to indicate the presence of potential TOI. Peak responses above a predetermined signal-to-noise ratio (SNR) threshold are used to indicate the locations of potential TOI. Because the signal amplitude is very sensitive to distance (depth) of the targets, the detection threshold must be set low enough to capture the smallest TOI at depth. In so doing, many smaller metal objects closer to the surface are also detected. The TEMTADS 2x2 sensor provides a much richer data set, allowing for a process referred to as Advanced Detection to be used to reject many of these smaller, shallower sources. Because of this richer data set, Advanced Detection also has the advantage of an increased depth of detection of TOIs in support of munitions response investigations. Advanced Detection works by identifying anomaly sources (rather than just the anomaly) and features related to these sources (primarily size and wall thickness) are estimated from the data and used to reject those sources that are too small to be viable TOI. Advanced Detection will be used for the TEMTADS 2x2 data to identify anomalies that will be further evaluated in the cued survey.

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[3] Note that the terms "target" and "anomaly source" are used interchangeably in Advanced Geophysical Classification parlance.

QAPP Worksheet #11: Project Quality Objectives (continued)

Geophysical data recorded with the TEMTADS 2x2 in cued (static) mode will then be used to classify the source of each anomaly as follows:

1. TOI, i.e., highly likely to be a munitions item or a possible munitions item;
2. Non-TOI, i.e., highly unlikely to be a munitions item; or
3. Can't Analyze

Detected items classified as "TOI" and "Can't Analyze" will be targeted for intrusive investigation and removal. The results of geophysical detection, classification, and intrusive investigation will be conducted in accordance with measurement quality objective to evaluate the achievement of the investigation goals and answer the primary investigation question.

Step 3: Identify Information Inputs

Data and information needed to satisfy the goals of the investigation are listed below.

- Current conceptual site model (CSM) and findings of previous studies described in **Worksheet #10**, including:
  - Site history and uses
  - Range boundaries
  - Types and quantities of MEC known or suspected to be present
  - Expected distribution of MEC present (area, expected maximum depth, depth distribution, anomaly density, etc.)
  - Topography, geology, vegetation
  - Land use considerations
  - Reasonably anticipated future uses
  - Current and future receptors
  - Exposure pathways
  - Access restrictions or other obstacles to investigation
  - Endangered species, sensitive habitats, and historic or cultural resources that could be affected by traffic or other disturbances occurring during the investigation
  - Locations of underground utilities
  - Assumptions, data gaps, and sources of uncertainty
- Site Preparation Information
  - MRS boundary
  - Surveyed locations of cultural features not shown on existing maps
  - Temporary benchmark details
  - Surveyed locations of grid corners
  - Surface sweep results
  - Surveyed validation and QC seed locations

QAPP Worksheet #11: Project Quality Objectives (continued)

- Detection survey results, including:
  - Dynamic survey footprint
  - System QC test results
  - IVS results
  - Data collection point responses and locations
  - Data analysis results, including
    - Anomaly locations for follow-up cued survey
    - Unique anomaly identification numbers
    - Z-component amplitude and advanced detection features for each anomaly
    - Potential background locations for use during cued survey
    - Dynamic Data Analysis and Target Selection Memorandum
    - Advanced Detection Target Selection Memorandum
- Cued survey results, including:
  - System QC results
  - IVS results
  - Background measurements and usability assessment
  - Unique anomaly identification numbers and locations
  - Site-specific munitions classification library
  - Cued survey measurements
  - Classification of anomaly sources as TOI, non-TOI, or "Can't Analyze", with confidence metric
  - Preliminary Prioritized Dig List based on fit coherence with library matches
  - Cluster analysis and identification of analyst calibration dig locations
  - Refinement, as needed, of site-specific munitions classification library based on findings of analyst calibration digs
  - Cued Data Analysis and Final Dig List Technical Memorandum with identification of the 'stop dig' point (point beyond which dig list contains clutter items)
- Intrusive investigation results, including
  - Excavation results at analyst calibration dig locations, TOI and "can't analyze" locations, and "validation dig" locations (to verify the stop dig threshold, beyond which anomaly sources are considered clutter items).[4]
    - Database records (Munitions Response Site Information Management System [MRSIMS])
    - Photos
    - Disposal records
    - Seed performance evaluation
    - Anomaly Selection Validation
    - Library-Match Threshold Validation

[4] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #11: Project Quality Objectives (continued)

- Cluster Analysis Validation
- Feature Analysis Validation
- Final data usability assessment

Step 4: Define the Boundaries of the Project

Target population: The target population for this survey includes the munitions items listed in **Worksheet #10** from the previous investigations conducted in 2008, 2010, 2012 and 2014. Exceptions for this survey include small arms and pieces of munitions items (for example, tail fins and mortar bases). Small arms are not MEC; therefore, for this investigation the smallest munition item of interest will initially be the 60-mm mortar (as presented in **Worksheet #10**) unless a smaller item is identified through the AGC process (i.e. cluster analysis) or additional items or information indicating the potential presence of items is discovered.

Characteristics of interest: The physical characteristics of interest are the size, symmetry around the long axis, aspect ratio, and wall composition and thickness that will be used by the data analysts to evaluate whether the source of an anomaly is a likely TOI or non-TOI. These characteristics are primarily investigated by comparison with a library of candidate TOI.

Spatial and temporal boundaries: The investigation area at MTMR-S is illustrated on **Figure 10-2** and comprises approximately 2.87 acres (Phase 1 area is 1.34 acres). The investigation area was designed to encompass the limits of disturbance provided by NAVFAC. The intent is that the investigation area will at a minimum encompass these limits of disturbance with an additional 10-foot buffer where possible. The horizontal boundaries of the project are shown on **Figure 10-2**. The vertical boundary for each munition is the munition-specific maximum depth of detection and will be based on the evaluation of site-specific background responses, sensor noise levels, the geophysical responses measured during the dynamic survey, and the measurements of the geophysical anomalies obtained during the cued survey.

The schedule for the survey is presented in **Worksheet #16**. The work will be conducted in two phases: Phase 1 will be the northern portion of the site currently covered by the parking lot, the chiller line and the northern section of Bullpup Street. Phase 2 will be post-demolition surveying. Each phase will include a round of dynamic surveying followed by cued surveying, analyst calibration digs, classification, generation of the final prioritized dig list, TOI digs and validation digs[5].

Step 5: Develop the Project Data Collection and Analysis Approach

The TEMTADS 2x2 advanced EMI sensor will be used to collect data in dynamic mode to detect and document the locations of potential subsurface TOI. Data positioning will be through RTK GPS and/or RTS.

This project will use Advanced Detection (advanced geophysical data analysis) to make decisions about the likely sources of anomalies detected during the geophysical detection survey (those data collected with the TEMTADS 2x2 in dynamic mode). This Advanced Detection analysis will be performed in areas of varying anomaly densities in order to resolve individual target locations that may be detected with overlapping response signatures.

[5] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #11: Project Quality Objectives (continued)

Geophysical data from the TEMTADS 2x2 will be interpreted using Geosoft Oasis montaj's UX Analyze module, which contains physics-based models to estimate the physical attributes of the sources of anomalies, and classifier models to estimate the likelihood that the sources of the anomalies are TOI. Geophysical data from TEMTADS 2x2 cued data mode over each potential TOI identified in the dynamic survey will be used to classify each anomaly source as TOI, Non-TOI or Can't Analyze.

The final product will be a prioritized dig list (ranked anomaly list) that classifies each anomaly source through a transparent, quantitative approach, and identifies whether the anomaly source should be intrusively investigated.

Detection Phase

This phase is designed to detect and correctly classify all potential TOI exceeding the detection threshold and meeting measurement criteria within the investigation area.

Parameters of interest: For the detection survey, the parameters of interest are:

- the initial dipole coherence metric (a unit-less number representing the correlation between the observed data [1 m x 1 m data chips extracted every 0.1 m grid node] and a modelled dipole at each position). This metric is used to identify dipole response regions in the survey area
- the derived 'size' and 'decay' values for each source identified using three invocations of a dipole fit routine (positing 1, 2 and 3 sources respectively) used to investigate all dipole response regions

Type of inference: Measurements meeting the established criteria noted above will be considered to be potential TOI and selected as targets for further evaluation using Advanced Detection analysis and cued surveying with the TEMTADS 2x2.

Decision rules:

1. If the dipole fit coherence is above the project dipole region detection threshold, the indicated regions will be selected for three invocations of the n-dipole fit routine (positing 1, 2 and 3 sources respectively). The established detection threshold will be a function of the site specific noise levels.
2. All sources identified using the n-dipole fit routines as being large enough and having a long decay (indicative of being thick-walled) will be identified as potential TOI and will be placed on the Advanced Detection Anomaly List. The size and decay cutoff thresholds will be determined by the smallest TOI.

Cued Phase

Parameters of interest: For the cued survey, the parameters of interest are the cued measurement SNR, inversion fit coherence, inversion outputs of intrinsic (β1, β2, β3) and extrinsic (x, y, and z) source features, and the fit correlation of the intrinsic features to a library of TOI items. Cued measurements will be recorded for each anomaly selected from the dynamic survey results.

Type of inference: If any of the following three criteria are met, the anomaly source will be selected as a TOI: 1) the intrinsic features (β1,β2, and β3) match (within specifications established on Worksheet #22) that of an item in the project-specific TOI library, 2) estimates of the size, shape, symmetry, and wall thickness calculated from the intrinsic features, indicates the item is a large, cylindrical, and thick-walled, or 3) a group of anomaly sources having similar intrinsic features after further investigation are discovered to be TOI.

QAPP Worksheet #11: Project Quality Objectives (continued)

Decision rules:

1. If an anomaly source is classified as TOI, it will be placed on the Final Dig List.
2. If an anomaly source is classified as non-TOI, then the anomaly will not be investigated (unless it is selected for investigation through the validation process).
3. If an anomaly source is classified as "can't analyze", it will be placed on the Final Dig List and will be intrusively investigated.
4. If the cluster analysis and/or results of analyst calibration digs indicate a type of munition that is not in the library, that item will be added to the library.
5. A subset of targets with decision statistics below the "stop dig" threshold will be identified for "validation digs" to validate the stop dig threshold, beyond which anomaly sources are considered clutter items. The "validation dig" locations will be provided in the final Validation Plan and placed on the dig list.
6. If a portion of the investigation area is determined to have an anomaly density too high for cued analysis of individual anomaly sources then an alternative approach will be developed and proposed to the project team.

Step 6: Specify Project-specific Measurement Performance Criteria

Project-specific measurement performance criteria (MPC) are presented in **Worksheet #12**. Project-specific MPCs are the criteria that collected data must meet to satisfy the MQOs in **Worksheet #22**.

Step 7: Survey Design and Project Work Flow

Worksheet #17 presents the survey design and work flow for the geophysical investigation at MTMR-S.

QAPP Worksheet #12: Measurement (Project) Performance Criteria

Definable Feature of Work (DFW)	Data Quality Indicator	Specification	Activity Used to Assess Performance
Site Preparation (Surface QC seeding)	Representativeness/ Completeness	Surface blind QC seeds placed at site. Blind QC seeds will consist of small Schedule 40 ISOs and located throughout the survey boundary defined in the MQOs. Approximately 10 QC seeds will be placed on the surface IAW SOP MR-AC-20-01.	Comparison of actual placement data (quantity and survey coordinates) to specifications in QAPP
Surface Sweep	Completeness	Not more than five pieces of exposed or partially exposed metallic objects exceeding 2 inches (5 centimeters) in any dimension, within a 0.2-acre area.	Visual inspection by UXOQCS of approximately 10% of each grid.
Surface Sweep	Completeness	100% of accessible portions of study area is covered.	Confirm all surface QC seeds have been returned to UXOQCS
Site Preparation (Subsurface QC Seeding)	Representativeness/ Completeness	Subsurface blind QC seeds placed at site. Blind QC seeds will consist of medium Schedule 40 ISOs and, if available, inert munitions of the types anticipated at the site, and will be located throughout the survey area. The medium ISOs will be used as subsurface QC seeds because they can be picked above sensor noise levels, the signatures are in the UX-Analyze library, are similar in size to the TOI at the site, and are easily obtained in sufficient quantities. They are also logistically feasible to place at varying burial depths up to their maximum detection depth in the subsurface. Approximately 7 QC seeds will be placed in the subsurface. This total ensures that at least one seed will be placed for every team day of dynamic and cued interrogation surveys anticipated. The seeds will be placed at depths up to but not exceeding the maximum detectable depth determined for each of the types of QC items, with a distribution of items from just below the surface to that depth in the horizontal (most difficult to detect) position. The maximum expected detection depths, burial depths, and justification for these depths will be addressed in the QC Seeding Technical Memorandum after initial site-specific data are gathered and sensor-specific noise levels can be quantified.	Comparison of actual placement data (quantity and recorded depths and orientations) to specifications in QAPP
Site Preparation (Subsurface QC Seeding)	Precision	Seed location positions will be recorded to specifications per MR-AC-20-01 and MR-AC-21-01 QAPP **Worksheet #17**. Once the sensor-specific noise levels and site-specific background responses are understood, the seeds will be placed at depth consistent with the threshold required to detect them at 8x the nominal sensor noise level.	Comparison of actual placement data (locations and survey coordinates) to specifications in QAPP
Dynamic Detection Survey (TEMTADS 2x2)	Completeness	100% of accessible portions of survey area is sampled.	Confirm in-line measurement spacing IAW **Worksheet #22** MQOs

QAPP Worksheet #12: Measurement (Project) Performance Criteria (continued)

Definable Feature of Work (DFW)	Data Quality Indicator	Specification	Activity Used to Assess Performance
Dynamic Detection Survey (TEMTADS 2x2)	Sensitivity	The detection threshold will be 8x the nominal sensor noise levels. The sensor-specific noise levels will be determined during initial data gathering efforts.	Confirm initial and ongoing IVS surveys and QC (blind) seed detection IAW **Worksheet #22** MQOs. Analysis of background variability across the site.
Dynamic Detection Survey (TEMTADS 2x2)	Accuracy/ Completeness	100% of validation and QC seeds must be detected.	Review of validation and QC seed detection results per survey unit
Dynamic Detection Survey (TEMTADS 2x2)	Precision/Bias	Derived positions of targets are within 0.82 feet (0.25 meters) of ground truth	Confirm initial and ongoing IVS surveys and QC (blind) seed detection IAW **Worksheet #22** MQOs
Dynamic Detection Survey (TEMTADS 2x2)	Completeness	Geosoft databases and target lists delivered	Inspection/acceptance of data deliverables
Classification Survey	Completeness/ Comparability	Library will include signatures for munitions known or suspected to be present at the site (IAW **Worksheet #10**) for which a reliable, inert item exists. Exceptions include small arms and flares.	Inspection of site-specific library used for classification
Classification survey	Representativeness/ Accuracy	Background data will be collected at least once every two hours of cued survey data collection. Background locations will be selected such that background data will be representative of the various subsurface conditions expected to be encountered within each survey unit at the site.	Data verification/data validation
Classification Survey	Completeness	All detected anomaly sources classified as: • TOI • Non-TOI • Can't analyze	Inspection/acceptance of data deliverables

QAPP Worksheet #12: Measurement (Project) Performance Criteria (continued)

Definable Feature of Work (DFW)	Data Quality Indicator	Specification	Activity Used to Assess Performance
Intrusive Investigation	Accuracy	Inversion results correctly predict one or more physical properties (e.g. size, symmetry, or wall thickness) of the recovered non-TOI item (specific tests and test objectives established during project planning).	Visual inspection and qualitative evaluation of recovered items from the validation digs
Intrusive Investigation	Accuracy/ Completeness	Cued survey must correctly classify (as “DIG” or “NO DIG”) 100% of all validation seeds.	Review of validation seed classification results
Intrusive Investigation	Accuracy/ Comparability	All TOI are correctly identified for intrusive investigation	Inspection of classification results for all known TOI (QC and validation seed performance, IVS, and recovered analyst calibration dig TOI) IAW **Worksheet #22** MQOs
Intrusive Investigation	Completeness	All anomaly sources are removed from the subsurface at locations identified for intrusive investigation[1]	The UXOQCS will inspect at least 10 percent of the intrusively investigated anomaly locations using an all-metals detector to determine whether all detectable metallic items within a 1.3-feet (0.4-meters) radius of the hole for TEMTADS detected anomaly sources have been removed. The locations checked will be distributed in a spatially representative sample across each target list
Intrusive Investigation	Accuracy	100% of predicted non-TOI that are intrusively investigated are confirmed to be non-TOI [1]	Validation sampling IAW **Worksheet #22** MQOs
Intrusive Investigation	Completeness/ Comparability	Complete Intrusive Investigation Database (unless performed by others)	Data verification Data validation
Intrusive Investigation	Completeness	In addition to Geosoft® database, inversion results delivered as portable document format (PDF) files illustrating (at a minimum) the three estimated primary axis polarizabilities, the polarizabilities of the best library match, quality indicators for measured data, quality indicators for inversion results, and quantitative classification metrics	Inspection/acceptance of data deliverables

[1] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

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QAPP Worksheet #14/16: Project Tasks & Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Phase 1 – Prior to Building Demolition					
Site Preparation including Surface Sweep	CH2M HILL	6/15/15	6/18/15	Surface Sweep Technical Memorandum	6/24/15
Seeding and IVS Construction	CH2M HILL	6/15/15	6/18/15	QC Seeding Technical Memorandum Initial IVS Technical Memorandum	6/24/15
Detection Survey	CH2M HILL	6/22/15	6/26/15	Advanced Detection Target Selection Technical Memorandum	7/14/15
Data Processing, Verification, Validation and Usability Evaluation (Detection Phase)	CH2M HILL	6/22/15	7/10/15	Advanced Detection Target Selection Technical Memorandum	7/14/15
Advanced Detection Dipole Analysis	AcornSI and CH2M HILL	6/22/15	7/10/15	Advanced Detection Target Selection Technical Memorandum	7/14/15
Reacquisition Cued Survey Locations	CH2M HILL	7/15/15	7/21/15	Reacquisition Cued Survey Locations Technical Memorandum	7/24/15
Cued Survey	CH2M HILL	7/22/15	8/4/15	IVS Technical Memorandum	7/24/15
Data Processing, Verification, Validation, Classification and Usability Evaluation (Cued Phase)	CH2M HILL	7/22/15	8/18/15	Cued Data Analysis and Final Dig List Technical Memorandum	8/20/15
Intrusive – Analyst calibration digs	CH2M HILL	8/25/15	8/27/15	Intrusive Training Technical Memorandum	TBD
Intrusive – TOI Digs [1]	CH2M HILL	9/8/15	9/15/15	Intrusive TOI Technical Memorandum	TBD
Intrusive – Validation Digs [1]	TBD	TBD	TBD	TBD	TBD

[1] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #14/16: Project Tasks & Schedule (continued)

Activity	Responsible party	Planned start date	Planned completion date	Deliverable(s)	Deliverable due date
Phase 2 – Post Demolition/Preconstruction					
Site Preparation including Surface Sweep	CH2M HILL	TBD	TBD	Surface Sweep Technical Memorandum	TBD
Seeding and IVS Construction	CH2M HILL	TBD	TBD	QC Seeding Technical Memorandum Initial IVS Memorandum	TBD
Detection Survey	CH2M HILL	TBD	TBD	Advanced Detection Target Selection Technical Memorandum	TBD
Data Processing, Verification, Validation and Usability Evaluation (Detection Phase)	CH2M HILL	TBD	TBD	Advanced Detection Target Selection Technical Memorandum	TBD
Advanced Detection Dipole Analysis	AcornSI and CH2M HILL	TBD	TBD	Advanced Detection Target Selection Technical Memorandum	TBD
Cued Survey	CH2M HILL	TBD	TBD	IVS Technical Memorandum	TBD
Data Processing, Verification, Validation, Classification and Usability Evaluation (Cued Phase)	CH2M HILL	TBD	TBD	Cued Data Analysis and Final Dig List Technical Memorandum	TBD
Intrusive – Analyst calibration digs	TBD	TBD	TBD	TBD	TBD
Intrusive – TOI Digs [1]	TBD	TBD	TBD	TBD	TBD
Intrusive – Validation Digs [1]	TBD	TBD	TBD	TBD	TBD
Final Report Preparation	CH2M HILL	TBD	TBD	Final Report	TBD

Note: The tentative dates identified in the schedule above will be refined by the project team going forward. In addition, the total number of anomaly sources will impact the schedule for the cued survey, processing, and intrusive dig elements identified above.

TBD = to be determined

[1] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #17: Survey Design and Project Work Flow

DFW	Associated Activities (see Appendix B for referenced SOPs)	Supporting Document(s)
1. Pre-Mobilization Activities	Prepare GCMR-QAPP Prepare Blind Seed Firewall Plan Prepare Draft Validation Plan Prepare APP Set up Geographic Information System (GIS) Set up MRSIMS	See **Worksheet #10**
2. Conduct Site Preparation	Mobilize staff Mobilize equipment Kickoff/Safety Meeting Perform boundary survey with anomaly avoidance Perform grid corner establishment survey 30 meter x 30 meter with anomaly avoidance Perform surface sweep (MR-AC-22-01) Prepare Surface Sweep Technical Memorandum	GCMR-QAPP APP SSHP AHAs
3. Conduct Validation Seeding, QC Seeding, and Construct IVS	Place surface QC seeds (CH2M HILL) (MR-AC-20-01) Place subsurface QC seeds (CH2M HILL) and quality assurance (QA) Seeds (Navy) with UXO/anomaly avoidance and survey locations (MR-AC-21-01) Establish IVS Prepare QC Seeding Technical Memorandum	GCMR-QAPP APP SSHP AHAs
4. Assemble and Verify Correct Operation of Geophysical Sensor to be Used for Detection Survey	Assemble TEMTADS 2x2 for dynamic survey and verify operation (MR-AC-01-01) Provide assembly checklist	GCMR-QAPP APP SSHP AHAs
5. Dynamic Detection Survey	Perform initial dynamic IVS survey and prepare Initial IVS Technical Memorandum (MR-AC-02-01) Perform dynamic detection survey (MR-AC-03-01)	GCMR-QAPP APP SSHP AHAs
6. Process Dynamic Survey Data and Document Anomaly Locations	Process dynamic data and prepare Dynamic Data Analysis and Target Selection Technical Memorandum (MR-AC-04-01)	GCMR-QAPP APP SSHP AHAs
7. Assemble Advanced Geophysical Sensor and Test Sensor at IVS	Assemble TEMTADS 2x2 for cued survey and verify operation (MR-AC-01-01) Perform initial cued IVS survey and prepare IVS Technical Memorandum (MR-AC-05-01) Provide assembly checklist	GCMR-QAPP APP SSHP AHAs
8. Classification (Cued Interrogation) Survey	Reacquire and flag anomaly sources Perform cued survey with TEMTADS 2x2 (MR-AC-06-01)	GCMR-QAPP APP SSHP AHAs

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

DFW	Associated Activities (see Appendix B for referenced SOPs)	Supporting Document(s)
9. Validate Advanced Sensor Data	Perform QC on daily cued interrogation survey (MR-AC-06-01) Verify that MQOs are met with daily data set Provide QC documentation	GCMR-QAPP APP SSHP AHAs
10. Conduct Cued Data Processing	Process cued survey data (MR-AC-07-01)	GCMR-QAPP APP SSHP AHAs
11. Classify Anomaly sources and Make Dig/No-Dig Decisions	Classify anomaly sources and generate TOI/non-TOI classification spreadsheet (MR-AC-07-01) Prepare Preliminary Prioritized Dig List Prepare Advanced Detection Target Selection Memorandum	GCMR-QAPP APP SSHP AHAs
12. Intrusive Investigation (analyst calibration digs and validation digs)	Reacquire and flag anomaly sources selected for intrusive investigation (MR-AC-08-01) Investigate anomaly sources identified as analyst calibration digs (TBD SOP-03) Prepare Cued Data Analysis and Final Dig List Technical Memorandum after evaluation of analyst calibration digs but prior to TOI and validation digs. Investigate anomaly sources identified as TOI digs or validation digs (TBD SOP-03)[1]	GCMR-QAPP APP SSHP AHAs
13. Verify Recovered non-TOI are Consistent with Predictions of non-TOI	Review Results of Validation Digs[1] Finalize Validation Plan	GCMR-QAPP APP SSHP AHAs
14. Conduct Final Data Usability	Compile and analyze field results Perform Final Data Usability Assessment Perform Cost Analysis Prepare Final Report	GCMR-QAPP

Notes:

AHA = Activity Hazard Analyses

APP = Accident Prevention Plan

[1] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.1 Pre-Mobilization Activities

17.1.1 Prepare Blind Seed Firewall Plan

A Blind Seed Firewall Plan is provided in **Appendix C** detailing CH2M HILL's approach to limiting distribution of the information on the types, depths and locations of QC seeds placed at the site.

17.1.2 Prepare Draft Validation Plan

A Draft Validation Plan, designed to provide assurance that there are no TOI classified as non-TOI, is provided in **Appendix D.** The plan details CH2M HILL's approach to validation, including validation of appropriate anomaly selection methods, thresholds for library matching, cluster analysis and feature analysis. The document will be made 'Final' after completion of the final TOI and non-TOI databases have been delivered to the Navy and prior to performance of validation digs.

17.1.3 Prepare Accident Prevention Plan

The APP and SSHP, along with associated AHAs are provided in a separate document.

17.1.4 Geographic Information System

A project GIS has been established and all relevant geospatial-related data and information will be contained in the GIS.

17.1.4.1 Location Surveying and Mapping

CH2M HILL uses the Federal Geographic Data Committee (FGDC) Geospatial Positioning Accuracy Standards, Part 3: National Standard for Spatial Data Accuracy (NSSDA), and Part 4: Standards for Architecture, Engineering, Construction (A/E/C) and Facility Management, which are found at **www.fgdc.gov/standards/standards_publications** for any point positioning such as GPS.

Navigational data will be correlated with horizontal control based upon a local Third Order Class 1 (1:10,000) or better, monument or survey marker. Survey data will be provided in North American Datum 1983 (NAD83), Universal Transverse Mercator (UTM) 18N, meters. Our Virginia registered Professional Land Surveyor (PLS) will document compliance with all accuracy specifications.

17.1.4.2 Geographic Information System Incorporation

The final submittal in electronic format will contain all required project files and layout files for all drawings that are presented in the final report.

Environmental Systems Research Institute, Inc. (ESRI)–compliant formats (shape files, coverages, or geodatabases) will be used to present GIS data during the project, with supporting tabular data provided in Microsoft Excel format, Microsoft Access format, or both, as needed.

In addition, each GIS data set will be accompanied by metadata conforming to FGDC's Content Standard for Digital Geospatial Metadata (CSDGM) and be provided in a geodatabase that is compliant with the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE). The horizontal accuracy of GIS data created by CH2M HILL will be tested in accordance with the NSSDA and the results will be recorded in the metadata.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.1.4.3 Mapping

The location, identification, coordinates, and elevations of all control points that are recovered and/or established at the site will be plotted on one or more site maps. Each control point will be identified on the map by its name and number and the final adjusted coordinates.

Each map will include a legend showing the standard symbols used for the mapping, a north arrow, and a title block.

17.1.4.4 Digital Data

Location information will be collected as part of the geophysical surveys to approximate the position of each anomaly in the GIS.

17.1.4.5 Computer Files and Digital Data Sets

All final document files, including reports, figures, and tables, will be submitted in electronic format. These files will be compatible with Microsoft Office 97 or later formats and in PDF on CD-ROM.

All geospatial data will conform to the Computer-Aided Drafting and Design (CADD)/GIS Technology Center Spatial Data Standards for Facilities Infrastructure and Environment (DISDI Group, 2013) and will be provided in metric units.

17.1.5 Munitions Response Site Information Management System

CH2M HILL will utilize its MRSIMS for recording field notes, data file names, site conditions, and other relevant information during field operations. Information is entered into a forms-based operating system using tablet PCs in the field for use by data processing and QC personnel. MRSIMS is described in greater detail in **Worksheet #29**.

17.2 Conduct Site Preparation

A mobilization period will include mobilizing staff and securing and deploying equipment. Mobilization activities will include general activities and a kickoff and safety meeting.

17.2.1 Mobilization

17.2.1.1 General Activities

The general activities to be performed as part of mobilization include the following:

- Identify/procure, package, ship, and inventory project equipment
- Coordinate with local agencies, including police, hospital, and fire department, as appropriate
- Coordinate communications with logistical support
- Finalize operating schedules
- Test and inspect equipment (See **Worksheet #22** for details)
- Assemble and transport the work force
- Conduct site-specific training on the QAPP and MEC procedures and hazards
- Verify that all forms and project documentation are in order and CH2M HILL Team members understand their responsibilities with regard to completion of project reporting requirements

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.2.1.2 Kickoff/Safety Meeting

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

17.2.2 Boundary Survey

The PLS will locate/establish the area boundaries and control points used for data positioning. The PLS will use either a RTK GPS or a conventional survey system (total-station) to perform all survey work. A qualified UXO Technician will escort the survey team and check the locations where wooden stakes are to be inserted below ground surface to ensure that a metallic item is not present at the location. The UXO Technician will use a White's XLT electromagnetic all-metals detectors, or equivalent to scan the location in advance of stake placement.

Daily information will be recorded in field book format. Copies of all field book information and any data collector information will be kept by CH2M HILL in the project files. All level and horizontal traverse networks will be closed to the starting point or other known published control, and the errors recorded. If the errors are above the standards outlined in Section 17.1.4.1, the PLS will re-run the horizontal and vertical traverses until the errors are within the acceptable range. Check shots and post processing reports will be provided where GPS is used. Field notes will include the date, names of the crew, equipment used, written documentation that QC tests were conducted and the results thereof, weather conditions, barometric pressure, and all collected survey data information.

Navigational data will be correlated with horizontal control based upon a local Third Order Class 1 (1:10,000) or better, monument or survey marker. Survey data will be provided in North American Datum 1983 (NAD83), Universal Transverse Mercator (UTM) 18N, meters. The surveyor is responsible for tying new temporary benchmarks established for this survey into this coordinate system.

17.2.3 Establishment of Operational Grid

The PLS will establish a 30 m by 30 m operational grid for use by field personnel for lane control and to separate the survey into manageable units. All survey files and field notes will reference the appropriate grids, as appropriate. A qualified UXO Technician will escort the survey team and check the locations where wooden stakes are to be inserted below ground surface to ensure that a metallic item is not present at the location. The UXO Technician will use a White's XLT electromagnetic all-metals detectors, or equivalent to scan the location in advance of stake placement. The southwestern-most stake associated with each grid will be labeled with the grid identifier (ID).

17.2.4 Surface Sweep/Preparation of Surface Sweep Technical Memorandum

CH2M HILL UXO Technicians will perform a surface sweep in accordance with SOP MR-AC-22-01 (see **Appendix B**). Any munitions items encountered will be dealt with per the DDESB approved ESS. Non-munitions related metallic items having a dimension of at least 5 centimeters in any dimension will be removed from the surface of the survey area. All MPPEH on the surface will be managed by CH2M HILL during the surface preparation.

A technical memorandum will be prepared upon completion of the surface sweep. The memorandum will present the findings of the surface sweep, including the nature and quantity of objects identified on the surface within the operational grids and the surface sweep QC results. The memorandum will also summarize the procedures undertaken during disposition of objects found on the surface.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.3 Conduct Validation Seeding, Quality Control Seeding, and Construct Instrument Verification Strip

17.3.1 Surface Quality Control Seeding

The CH2M HILL UXOQCS will place QC seeds on the surface across the survey area in accordance with SOP MR-AC-20-01 (see **Appendix B**) prior to the performance of surface sweeps. The seeds will consist of small schedule 40 ISOs. Approximately 5 QC seeds will be placed on the surface IAW SOP MR-AC-20-01.

17.3.2 Subsurface Quality Control Seeding

The CH2M HILL UXOQCS will place QC seeds in the subsurface across the survey area in accordance with SOP MR-AC-21-01 (see **Appendix B**). The QC seeds will be comprised of both inert munitions items, if available, and medium, schedule 40 industry standard objects (ISOs). The medium ISOs have been selected as they are an item that will be picked out of the data as a target of interest (the medium ISO signature is in the UX-Analyze library), are similar in size to the TOI at the site, and they are easily obtained. They are also logistically feasible to place in significant quantities and at burial depths up to their maximum detection depth in the subsurface. Approximately 7 QC seeds will be placed in the subsurface. This total ensures that at least one seed will be placed for every team day of dynamic and cued interrogation surveys. The seeds will be placed at depths up to but not exceeding the maximum detectable depth determined for each of the types of QC items, with a distribution of items from just below the surface to that maximum depth.

The information on the seeds will be documented and provided to the Navy prior to starting the dynamic detection surveys.

17.3.3 Validation Seeding

The Navy will develop the approach to validation seeding and physically place the seeds within the survey area if they desire. The types of validation seeds, quantity, depths, and locations will remain unknown to CH2M HILL. It is expected that the validation seeding would be performed in a manner consistent with the subsurface QC seeding; information regarding sensor noise levels, site-specific background responses will be provided to the Navy for use in development of the validation seeding plan.

17.3.4 Establish Instrument Verification Strip

During the Phase 1 survey, an IVS will be established within close proximity to the survey area for TEMTADS 2x2 testing and validation prior to use for both the dynamic and cued surveys.

The IVS will be established as described in SOP MR-AC-02-01 (see **Appendix B**). Part of the IVS establishment process includes the collection of a background (i.e., pre-seeded) survey with the TEMTADS 2x2 at the intended IVS location in order to first assess the location's suitability for construction of the IVS. Seed items placed within the IVS will be located at least 3.3 feet (1 meter) from geophysical anomalies (if any) identified in the pre-seeded survey. The IVS will remain in place throughout the Phase 1 effort in order to be used for additional surveying planned during Phase 2. In particular, the IVS will be used for twice daily testing during the dynamic and cued interrogation surveys as part of the QC program. Twice daily testing, where specified in **Worksheet #22** Tables 22-1 and 22-2, will include a minimum of testing at the start and end of each day data are collected. Additional tests may be conducted at the IVS as needed during the course of each survey.

17.4 Assemble and Verify Correct Operation of Geophysical Sensor to be used for Detection Survey

The TEMTADS 2x2 system will be assembled as described in SOP MR-AC-01-01 (see **Appendix B**).

17.5 Dynamic Detection Survey

17.5.1 Initial Dynamic Survey IVS

In order to test the TEMTADS system and verify that it is set up and functioning properly, an initial dynamic IVS survey will be performed as described in SOP MR-AC-02-01 (see **Appendix B**). This dynamic IVS survey will be completed as part of Phase 1 and Phase 2. The IVS will include two inert munitions items (if available), two schedule 40 medium ISOs (four if the two inert items are not available), and one 'blank' location (nothing buried). All of the items will be buried horizontally, perpendicular to the transect, at approximately 15 centimeters.

After performance of the initial dynamic IVS, the *Initial IVS Technical Memorandum* will be prepared detailing the IVS setup, surveys and results, including documentation of compliance with the dynamic IVS MQOs provided in **Worksheet #22**. The Initial IVS Technical Memorandum will be provided to the project team for review and concurrence.

17.5.2 Perform Dynamic Detection Survey

After performance of the initial dynamic IVS, dynamic TEMTADS will be collected in order to identify the locations of metallic objects in the subsurface for cued interrogation. The dynamic detection survey will be performed as described in SOP MR-AC-03-01 (see **Appendix B**). The operational 30 m by 30 m grid system established over the investigation area will be used by the field team to set up survey lanes appropriate to meet the lane spacing MQOs provided in **Worksheet #22**. The intended lane spacing for the dynamic survey is 0.5 m.

17.6 Process Dynamic Survey Data and Document Anomaly Locations

The dynamic TEMTADS will be processed as described in SOP MR-AC-04-01 **(see Appendix B)**. Anomaly sources identified for cued interrogation will be selected from the data using the Advanced Detection approach where the entire TEMTADS data set is used to identify all sources that are potential TOI. In addition, potential background locations will be identified from the monostatic, z component dynamic response data for use during the cued survey phase.

The dynamic TEMTADS 2x2 data will be passed to an Advanced Detection target picking routine and all anomaly sources identified as potential TOI will be placed on the Advanced Detection Anomaly List. The implementation of the advanced geophysical analysis is presented in **Worksheet #11**.

The *Dynamic Data Analysis and Target Selection Technical Memorandum* will include a summary of the dynamic data processing and anomaly selection approach as well as the Advanced Detection Anomaly List. This memorandum will also identify potential background locations for use during the cued survey, a summary of survey area coverage and relative anomaly density, and stipulate whether the MQOs have been met thus far.

If a portion of the survey area is determined to have an anomaly density too high for cued interrogation of individual anomalies then an alternative approach for these areas will be proposed to the project team as part of the *Dynamic Data Analysis and Target Selection Technical Memorandum*.

The dynamic TEMTADS 2x2 data will be passed to an Advanced Detection target picking routine and all anomaly sources identified as potential TOI will be placed on the Advanced Detection Anomaly List. The implementation of the advanced geophysical analysis is presented in **Worksheet #11**.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.7 Assemble Advanced Geophysical Sensor and Test Sensor at IVS

17.7.1 Assemble TEMTADS 2x2 for Cued Survey and Verify Operation

Because the cued surveys require a slightly different setup than the dynamic surveys, the TEMTADS systems will be modified per SOP MR-AC-01-01 (see **Appendix B**).

17.7.2 Perform Initial Cued IVS Survey and Prepare IVS Technical Memorandum Addendum

After setup of the TEMTADS systems for cued surveys, the IVS previously established for the dynamic surveys will used to perform an initial cued IVS for each system in accordance with SOP MR-AC-05-01 (see **Appendix B**) to confirm that it is set up and functioning properly.

After performance of the initial cued IVS, an *IVS Technical Memorandum Addendum* will be prepared detailing the cued IVS surveys and results, including documentation of compliance with the cued IVS MQOs provided in **Worksheet #22**. This memorandum will be provided to the project team for review and concurrence.

17.8 Classification (Cued Interrogation) Survey

17.8.1 Reacquire and Flag Anomaly Locations

Anomaly sources identified for cued interrogation will be reacquired and marked using vinyl-stem surveyor flags. Reacquisition will be performed using RTK GPS or conventional survey methods (total station) in areas where GPS coverage is not reliable in accordance with SOP MR-AC-06-01. The anomaly ID will be written in indelible marker on a surveyor flag placed at the anomaly location. Possible background locations identified from the dynamic survey will also be re-acquired and marked in the field using a different color vinyl-stem flag than those used to identify the geophysical anomalies; spray paint may also be used to identify the proposed background locations. The coordinates of all reacquired locations will be recorded and downloaded for daily comparison against intended locations by the reacquisition field team. Flag locations with offsets greater than 10 centimeters from the intended locations will be reacquired again and marked prior to collection of cued data.

A real-time navigation capability may also be implemented in lieu of this reacquisition step. In this case, the MQO for array measurement locations vs target location will serve to ensure that the target is properly interrogated.

17.8.2 Perform Cued Interrogation Survey with TEMTADS 2x2

Prior to conducting cued surveys, the background locations identified during the dynamic data processing will be processed and checked for usability as a background location. These locations will be checked in accordance with SOP MR-AC-06-01 (see **Appendix B**). All Anomaly sources identified for cued interrogation will be surveyed in accordance with SOP MR-AC-06-01 (see **Appendix B**).

17.8.3 Validate Advanced Sensor Data

QC checks will be performed in accordance with SOP MR-AC-07-01 (see **Appendix B**). Data will be evaluated to assess whether the MQOs were met in **Worksheet #22**. An RCA/CA will be conducted and implemented, as necessary, when MQOs are not met.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

17.10 Conduct Cued Data Processing

Data processing will be performed in accordance with SOP MR-AC-07-01 (see **Appendix B**).

17.11 Classify Anomaly Sources and Make Dig/No-Dig Decisions

Upon completion of data processing, each anomaly source will be classified as TOI, non-TOI or "can't analyze". If an anomaly source is classified as TOI or "can't analyze", it will be placed on the DIG (intrusive investigation) list. If an anomaly source is classified as non-TOI, then it will not be investigated (unless it is selected later for investigation through the validation process). A preliminary database of anomaly source classifications will be provided to the Navy after completion of the initial classification.

17.12 Intrusive Investigation

The intrusive investigation will include reacquisition and flagging of anomaly sources selected for intrusive investigation and the intrusive investigation of those items. Anomaly sources to be intrusively investigated will include those identified as analyst calibration digs, anomaly sources on the Final Prioritized Dig List and anomaly sources selected as part of the various validation processes[2]. All intrusive operations will be performed in accordance with the intrusive investigation subcontractor SOPs and approved ESS.

17.12.1 Reacquire and Flag Anomaly Sources Selected for Intrusive Investigation

Anomaly sources selected for intrusive investigation will be reacquired using an RTK GPS or conventional survey methods (total station) in areas where GPS coverage is not reliable, in accordance with SOP MR-AC-08-01. Flags will be placed at the 'fit' location derived through the data processing and classification process. The anomaly ID will be written in indelible marker on a surveyor flag placed at the anomaly source location. (The flag will be a different color than that used for the reacquisition performed for the cued interrogation surveys.) Surveyor paint may be used to spray the location if the field team has concerns that the survey flags may be blown out of place. The coordinates of all reacquired locations will be recorded and downloaded for daily comparison against intended locations by the reacquisition field team. Flag locations with offsets greater than 4 inches (10 centimeters) from the intended locations will be reacquired again and marked prior to collection of cued data.

17.12.2 Investigate Anomaly sources

After reacquisition of the anomaly sources selected for intrusive investigation they will be intrusively investigated and documented per TBD-SOP-03 (see **Appendix B**). Documentation of the intrusive investigation results will incorporate electronic tablet data collection and transfer.

- The initial anomaly sources to be investigated will be those selected for 'Analyst calibration digs' in order to assist the data processing approach by determining whether certain signatures should be added to the library from the cluster analysis and to refine the Preliminary Prioritized Dig List (see the Draft Validation Plan in **Appendix D**).

[2] Investigation of anomaly sources on the Final Prioritized Dig List and anomaly sources identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be incorporated into the Final Report.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

- After completion of the analyst calibration digs and refinement, as needed, of the site-specific classification library and prioritized dig list, the *Cued Data Analysis and Final Dig List Technical Memorandum* will be prepared and provided to the project team for review. The memorandum will include the Final Prioritized Dig List.
- The intrusive team will then proceed to investigate the remainder of the TOI digs identified on the Final Prioritized Dig List[3].
- The final set of anomaly sources to be investigated will be those selected as part of the validation process[1] approved in the Final Validation Plan (see section 17.13). Any anomaly source investigated from the validation dig list that is identified as a TOI will trigger an RCA and CA as appropriate.

17.13 Verify Recovered non-Target of Interest are Consistent with Predictions of non-Target of Interest

The Draft Validation Plan will be evaluated and revised as necessary for final review and approval by the Navy prior to the performance of the validation digs. Additional anomaly sources beyond the 'Stop Dig' point, the cutoff threshold for the library match metric, will be defined in the *Final Validation Plan* and placed on the Validation List to verify that the 'Stop Dig' point was selected at an appropriate cutoff point.

17.14 Final Report

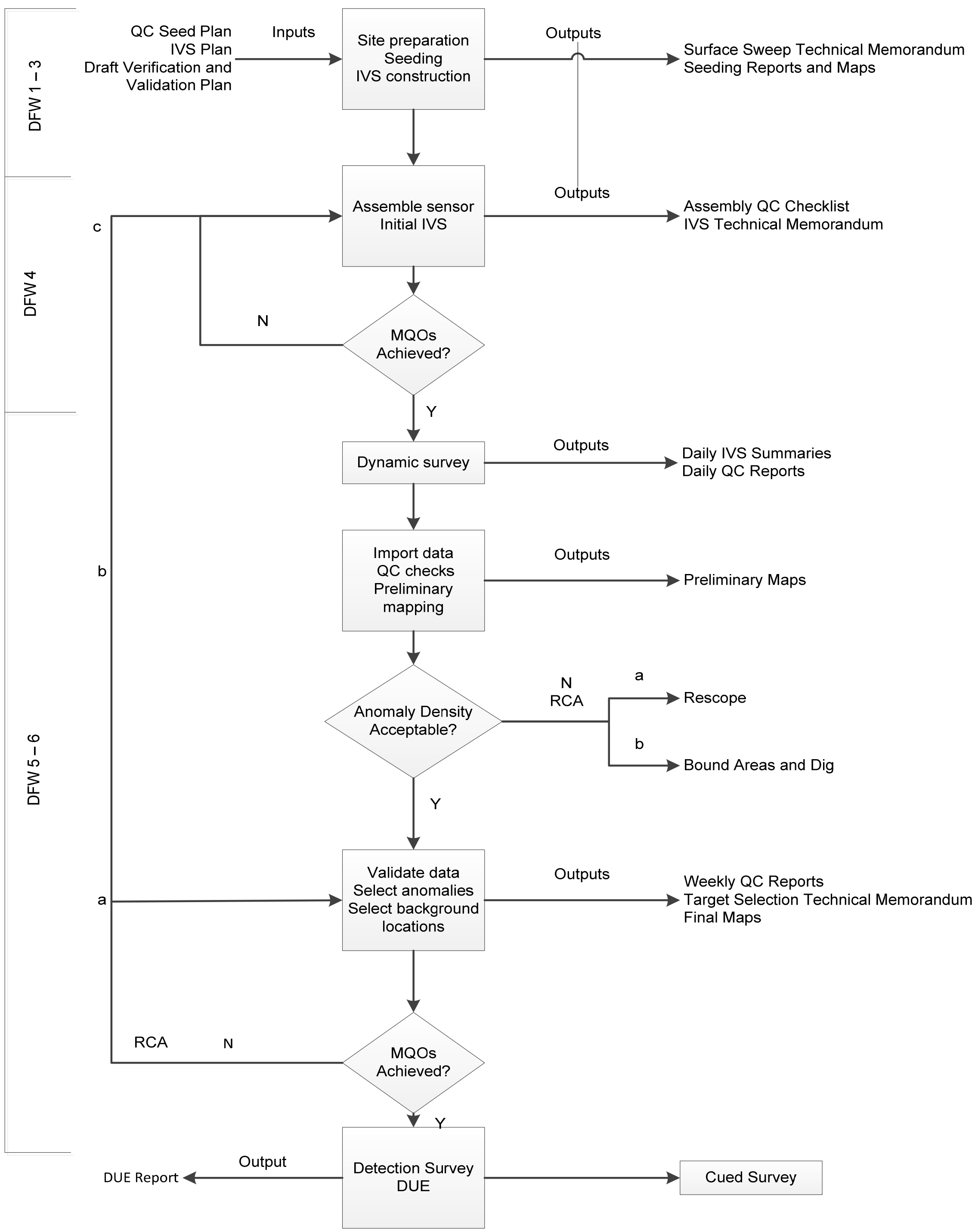
Results of the survey will be compiled and analyzed by CH2M HILL and presented in the *Final Report*. The report will present the updated CSM detailing site conditions and MEC characteristics, discuss the investigation approach/field effort, and present the results including QA/QC. The report will discuss validation anomaly sources and provide key contacts and will include an in-depth Advanced Geophysical Classification process report as an appendix, providing a separate post-analysis of the detection and cued surveys and will provide data summaries as additional appendices.

[3] Investigation of anomaly sources on the Final Prioritized Dig List and anomaly sources identified for validation digs may be performed by others although the data will be provided to CH2M HILL to be evaluated and incorporated into the Final Report.

QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

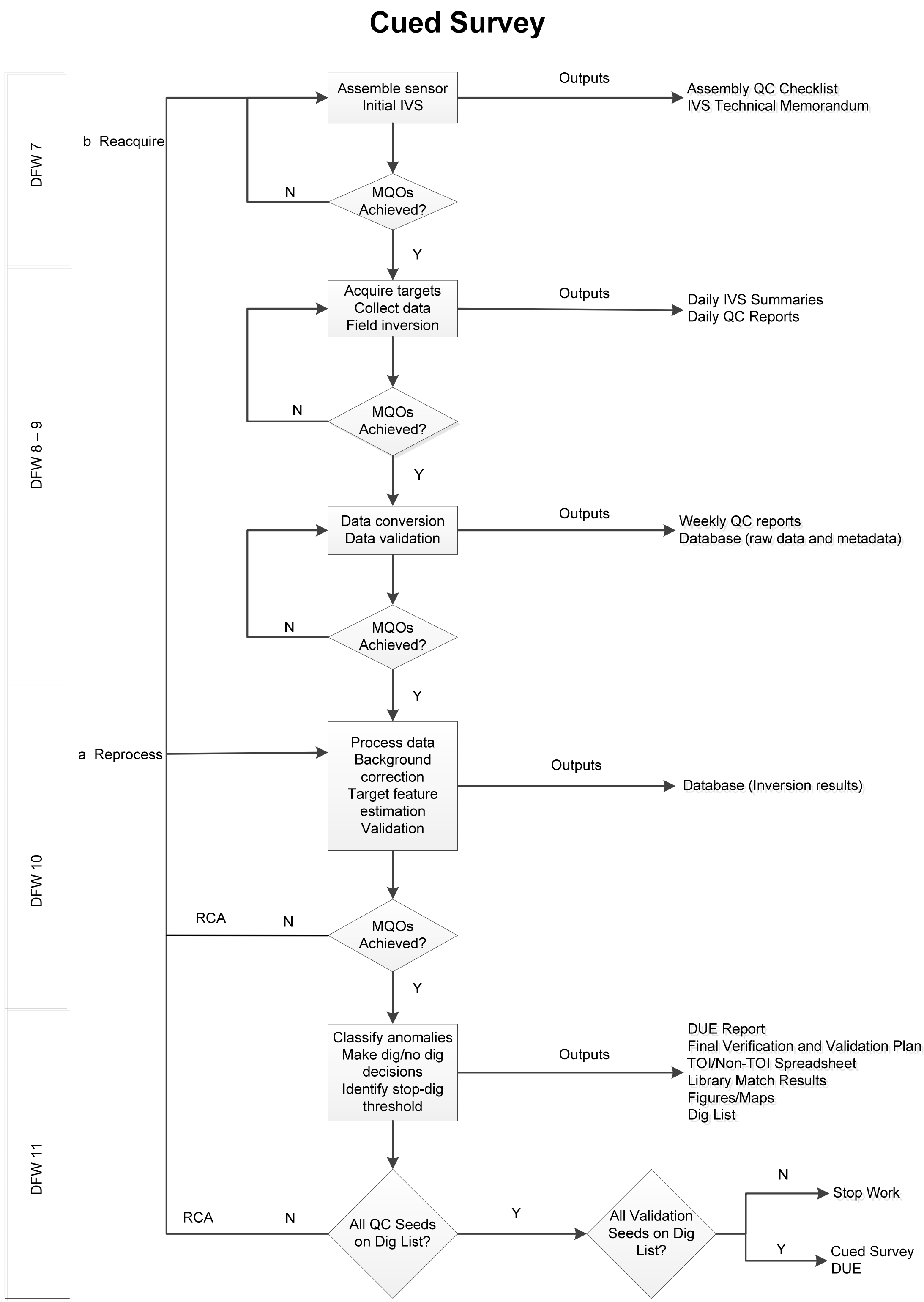
FIGURE 17-1
Geophysical Classification Decision Tree

Preliminary Tasks and Anomaly Detection Survey



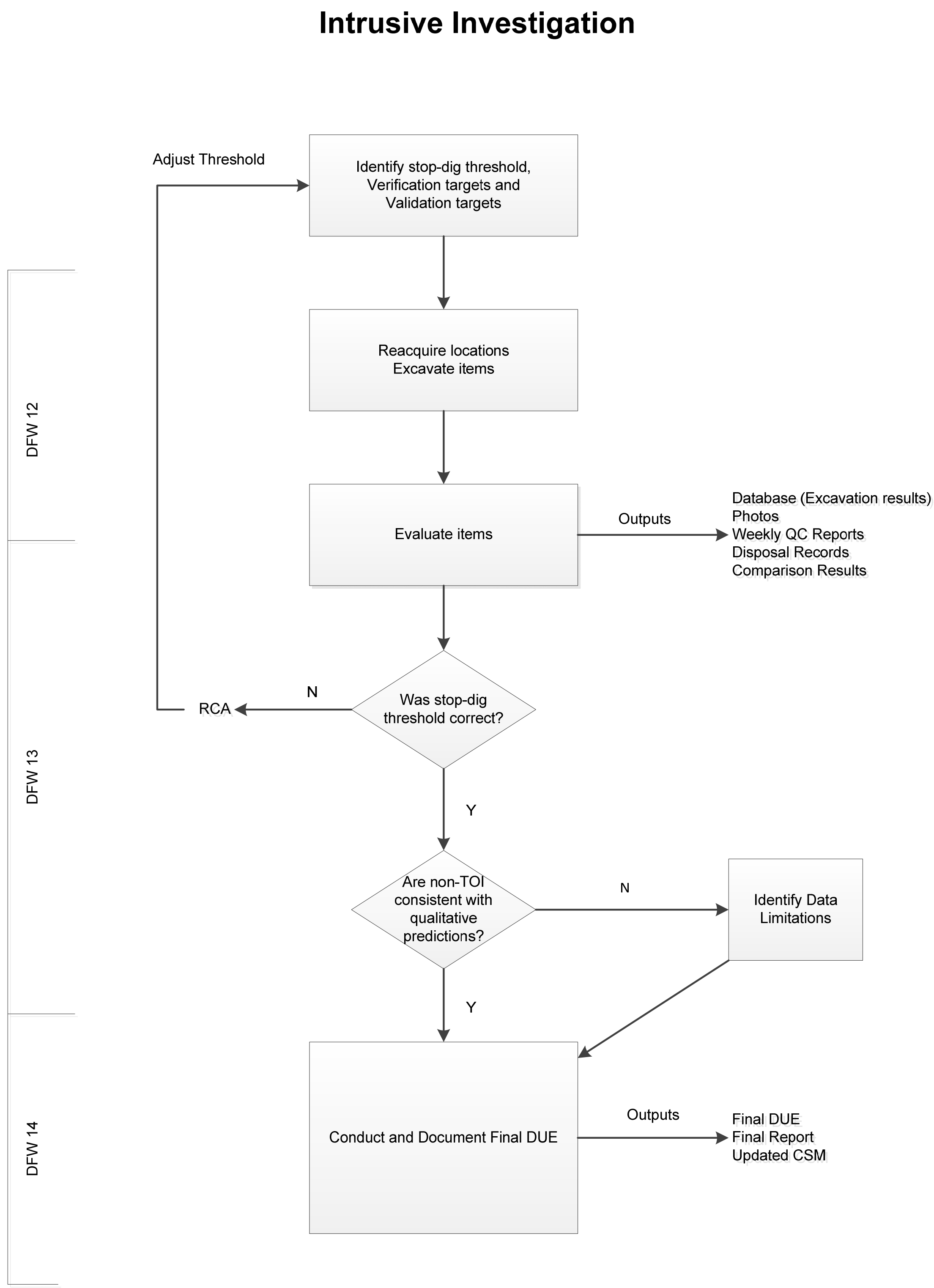
QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

FIGURE 17-1
Geophysical Classification Decision Tree (continued)



QAPP Worksheet #17: Survey Design and Project Work Flow (continued)

FIGURE 17-1
Geophysical Classification Decision Tree (continued)



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QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control

This worksheet documents procedures for performing testing, inspections and QC for all field equipment. References to the applicable DFW and SOPs are included. Where appropriate the failure response will proscribe a CA. Otherwise, an RCA and CA is required.

TABLE 22-1
Dynamic Survey (Instrument: TEMTADS 2x2)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Verify correct assembly	Dynamic Detection Survey MR-AC-01-01	Once following assembly	Field Geophysicist/ Preparatory TEMTADS Assembly QC Checklist/QC Geophysicist	As specified in MR-AC-01-01	CA: Make necessary adjustments, and re-verify
Initial TEMTADS 2x2 Function Test (Instrument response amplitudes)	Dynamic Detection Survey MR-AC-02-01	Once following assembly	Field Geophysicist/ Initial IVS Technical Memorandum/QC Geophysicist	Response (mean static spike minus mean static background) within 20%of predicted response for Schedule 40 medium ISO for all monostatic Tx/Rx combinations	CA: Make necessary adjustments, and re-verify
Initial dynamic positioning accuracy (TEMTADS 2x2)	Dynamic Detection Survey MR-AC-02-01	Once prior to start of dynamic data acquisition	Data Processing Geophysicist/Initial IVS Technical Memorandum/QC Geophysicist	Derived positions of IVS target(s) are within 0.82 feet (0.25 meters) of the ground truth locations	CA: Make necessary adjustments, and re-verify
Initial dynamic detection response amplitudes (TEMTADS 2x2)	Dynamic Detection Survey MR-AC-01-01	Once prior to start of dynamic data acquisition	Data Processing Geophysicist/Initial IVS Technical Memorandum/QC Geophysicist	Response amplitudes of IVS targets are within 30% of predicted amplitudes	CA: Make necessary adjustments, and re-verify

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-1
Dynamic Survey (Instrument: TEMTADS 2x2)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Ongoing Instrument Function Test (TEMTADS 2x2 response amplitudes)	Dynamic Detection Survey MR-AC-03-01	Once prior to start of dynamic collection of each grid. Function tests will also be performed at the start and end of each day of data collection or after each time the instrument is turned on.	Data Processing Geophysicist/daily report, running summary/QC Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	RCA/CA CA assumption: Dataset for sortie fails (Advanced Detection uses all Tx/Rx combinations so all components must pass)
Ongoing dynamic positioning precision (IVS, TEMTADS 2x2)	Dynamic Detection Survey MR-AC-03-01	Beginning and end of daily survey operations.	Data Processing Geophysicist/daily report, running summary/ QC Geophysicist	Derived positions of IVS target(s) within 0.82feet (0.25 meters) of the average locations	RCA/CA
Ongoing dynamic detection response amplitudes (IVS)		Beginning and end of daily survey operations.	Data Processing Geophysicist/daily report, running summary/ QC Geophysicist	Response amplitudes within 30% of initial response	RCA/CA
In-line measurement spacing (TEMTADS 2x2)	Dynamic Detection Survey MR-AC-03-01	Verified for each survey unit using existing UX Detect tools based upon monostatic Z coil data positions	Data Processing Geophysicist/ grid block summary report (MRSIMS)/QC Geophysicist	98% ≤ 0.82 feet (0.25 meters) between successive measurements (excluding site specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA CA assumption: data set fails, (recollect portions that fail)
Coverage (TEMTADS 2x2)	Dynamic Detection Survey MR-AC-03-01	Verified for each survey unit using existing UX Detect tools based upon monostatic Z coil data	Data Processing Geophysicist/ grid block summary report (MRSIMS)/QC Geophysicist	100% at ≤2.5 feet (0.75 meters) cross-track measurement spacing with intended spacing of 1.6 feet (0.5 meters) (excluding site specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA CA assumption: Gaps require fill-in lines to achieve required coverage

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-1
Dynamic Survey (Instrument: TEMTADS 2x2)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
TEMTADS 2x2 TX current	Dynamic Detection Survey MR-AC-04-01	Per measurement	Data Processing Geophysicist/ grid block summary report (MRSIMS)/QC Geophysicist	Peak transmit current ≥5.5 amps	CA: out of spec data rejected
Dynamic detection performance (TEMTADS 2x2)	Dynamic Detection Survey MR-AC-04-01	Evaluated by survey unit	QC Geophysicist/grid block summary report/Program Geophysicist	All blind seeds must be detected and positioned within 1.3 feet (0.4 meters) radius of ground truth	RCA/CA
Sensor response within valid range	Dynamic Detection Survey MR-AC-04-01	Per measurement	Data Processing Geophysicist/ Daily QC Report, tracking summary/QC Geophysicist	Values must be within ± 4.5 Volts	RCA/CA
TEMTADS 2x2 Valid position data	Dynamic Detection Survey MR-AC-04-01	Per measurement	Data Processing Geophysicist/QC Report, tracking summary/QC Geophysicist	Orientation data valid	RCA/CA

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-2
Cued Survey (Instrument: TEMTADS 2x2; Classification tool: UX-Analyze)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Verify correct assembly	Cued Classification Survey MR-AC-01-01	Once following assembly	Data Processing Geophysicist/ Preparatory TEMTADS Assembly QC Checklist/QC Geophysicist	As specified in MR-AC-01-01,	CA: Make necessary adjustments, and re-verify
Initial sensor function test	Cued Classification Survey MR-AC-01-01	Once following assembly	Data Processing Geophysicist/ Initial IVS Technical Memorandum/QC Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: make necessary repairs/ adjustments and re-verify
Initial IVS background measurement (five background measurements, one centered at the flag and one offset 40 centimeters (cm) in each cardinal direction)	Cued Classification Survey MR-AC-05-01	Once during initial system IVS test	Data Processing Geophysicist/ Initial IVS Technical Memorandum/QC Geophysicist	Data from each offset location, when added to background corrected signal for the project 'item/depth objective' results in a library match metric ≥0.9	CA: reject/replace BG location
Initial derived polarizabilities accuracy (IVS)	Cued Classification Survey MR-AC-05-01	Once during initial system IVS test	Data Processing Geophysicist/ Initial IVS Technical Memorandum/QC Geophysicist	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA
Initial derived target position accuracy (IVS)	Cued Classification Survey MR-AC-05-01	Once during initial system IVS test	Data Processing Geophysicist/ Initial IVS Technical Memorandum/QC Geophysicist	All IVS item fit locations within 0.82 feet (0.25 meters) of ground truth locations	RCA/CA
Ongoing IVS background measurements	Cued Classification Survey MR-AC-06-01	Beginning and end of each day as part of IVS testing	Data Processing Geophysicist/ Daily QC Report, tracking summary/QC Geophysicist	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	RCA/CA CA assumption: rejection of BG measurement (unless RCA indicates system failure)

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-2
Cued Survey (Instrument: TEMTADS 2x2; Classification tool: UX-Analyze)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Ongoing derived polarizabilities precision (IVS)	Cued Classification Survey MR-AC-06-01	Beginning and end of each day as part of IVS testing	Data Processing Geophysicist/ Daily QC Report, tracking summary/QC Geophysicist	Library Match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing derived target position precision (IVS)	Cued Classification Survey MR-AC-06-01	Beginning and end of each day as part of IVS testing	Data Processing Geophysicist/ Daily QC Report, tracking summary/QC Geophysicist	All IVS items fit locations within 0.82 feet (0.25 meters) of average of derived fit locations	RCA/CA
Initial measurement of production area background locations (five background measurements: one centered at the flag and one offset 40 cm in each cardinal direction)	Cued Classification Survey MR-AC-06-01	Once per background location	Data Processing Geophysicist/ background location report/QC Geophysicist	Data from each offset location, when added to BG corrected signal for the project 'item/depth objective' results in a library match metric ≥0.9	CA: reject BG location and find alternate
Ongoing production area background measurements	Cued Classification Survey MR-AC-06-01	Backgrounds collected once every 2 hours during production	FTL/failures noted in field log and tracking summary/Project Geophysicist	All decay amplitudes lower than project threshold and qualitatively agree with initial measurement	CA: BG measurement rejected and recollected, cued data with no valid BG are rejected
Ongoing instrument function test	Cued Classification Survey MR-AC-06-01	With each background measurement and each time instrumen is restarted	FTL/tracking summary/Project Geophysicist	Response (mean static spike minus mean static background within 20% of predicted response for all monostatic Tx/Rx combinations	CA: make necessary repairs and re-verify
TEMTADS 2x2 TX current	Cued Classification Survey MR-AC-06-01	Evaluated for each sensor measurement	Data Processing Geophysicist/ Measurement QC summary/QC Geophysicist	Peak transmit current ≥5.5 amps	CA: reject data collected with current levels outside of the given range and halt data collection if problem is persistent. Resume collection when problem remedied.

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-2
Cued Survey (Instrument: TEMTADS 2x2; Classification tool: UX-Analyze)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Initial anomaly location interrogated	Cued Classification Survey MR-AC-06-01	Evaluated for each flag position	Data Processing Geophysicist/ Measurement QC summary/QC Geophysicist	For each anomaly a measurement must be collected with the center of the array <1.0 feet (0.3 meters) from the anomaly location.	CA: Recollect at anomaly location – (if no collection within spec, anomaly is classified as "Can't Analyze" and marked for intrusive investigation)
Position data are valid (2 of 2)	Cued Classification Survey MR-AC-07-01	Evaluated for each sensor measurement	Data Processing Geophysicist/ Measurement QC summary/ QC Geophysicist	Orientation data valid	RCA/CA
Confirm inversion model supports classification (1 of 3)	Cued Classification Survey MR-AC-07-01	Evaluated for all models derived from a measurement (i.e. single item and multi-item models)	Data Processing Geophysicist/ Measurement QC summary/QC Geophysicist	Derived model response must fit the observed data with a fit coherence ≥ 0.8	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (2 of 3)	Cued Classification Survey MR-AC-07-01	Evaluated for derived target	Data Processing Geophysicist/ Measurement QC summary/QC Geophysicist	Fit location estimate of item ≤ 1.31ft (0.4 meters) from center of sensor	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (3 of 3)	Cued Classification Survey MR-AC-07-01	Evaluated for all seeds	QC Geophysicist/ Inversion model QC summary/QC Geophysicist	100% of predicted seed positions ≤ 0.82 feet (0.25 meters) from known position (x, y, z) if single source anomaly locations and ±3 cm accuracy positioning of the seed locations recorded upon placement and discovery.	RCA/CA

QAPP Worksheet #22: Equipment Testing, Inspection, and Quality Control (continued)

TABLE 22-3
Intrusive Investigation

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Confirm all anomaly sources classified	Cued Classification Survey MR-AC-07-01	Evaluated for each anomaly (flag) location	Data Processing Geophysicist/ Measurement QC summary/ QC Geophysicist	100% of anomaly sources are classified as: TOI Non-TOI Can't Analyze	CA: assign category to anomaly (category 0 [Can't Analyze] if no valid classification results are available)
Confirm reacquisition equipment (GPS or total station) precision	Intrusive investigation MR-AC-08-01	Daily	Daily QC Report/QC Geophysicist	Benchmark positions repeatable to within 4 inches (10 centimeters)	RCA/CA
Confirm derived features match ground truth (1 of 2)	Intrusive investigation TBD-SOP-03	Evaluated for all recovered items	QC Geophysicist/QC reports/Program Geophysicist	100% of recovered item positions < 1.3 feet (0.4 meters) from predicted position (excluding those in "Can't Analyze" category or multi-target scenarios)	RCA/CA
Confirm derived features match ground truth (2 of 2)	Intrusive investigation TBD-SOP-03	Evaluated for all recovered items	UXO Dig Team/ Dig List and intrusive database/ Project or QC Geophysicist	100% of recovered object size estimates (excluding "Can't Analyze" category) qualitatively match predicted size	RCA/CA
Validation of TOI/non-TOI threshold [1]	Intrusive investigation TBD-SOP-03	Dig 200 anomaly sources beyond last TOI on Dig List	QC Geophysicist/QC reports/Program Geophysicist	100% of predicted non-TOI intrusively investigated are non-TOI and 100% of seed items are correctly placed on the dig list.	RCA/CA (most likely CA will be to adjust threshold)
Classification validation [1]	Intrusive investigation TBD-SOP-03	Random selection of 200 non-TOI	QC Geophysicist/QC reports	100% of predicted intrusively investigated non-TOI match predictions for non-TOI occurrence.	RCA/CA Document in Data Usability Assessment

[1] Investigation of anomalies on the Final Prioritized Dig List and anomalies identified for validation digs may be performed by others although the data will be provided to CH2M HILL for evaluation of performance and to be incorporated into the Final Report.

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QAPP Worksheet #29: Data Management, Project Documents, and Records

Part 1: Data Management Specifications

GIS: An existing project-specific GIS will be used to store and manage relevant geospatial-related data and information collected as part of the MTMR-S survey. All geospatial data will conform to the FGDC Geospatial Positioning Accuracy Standards, Part 2: NSSDA, and Part 4: Standards for A/E/C and Facility Management. Each GIS data set will be accompanied by metadata conforming to the FGDC CSDGM and provided in a database that complies with the SDSFIE. The final GIS submittal will contain all required ArcGIS.mxd files and layout files for all drawings contained in the final report.

All data will be correlated with navigational data based upon a local third-order (1:5,000) monument or survey marker. All data will be provided in NAD83 CONUS, UTM 18N meters.

The location, identification, coordinates, and elevations of control points (newly established or existing) will be plotted on relevant site plans and tabulated in relevant reports submitted throughout the geophysical investigation. Each control point will be identified on the map by its unique ID.

ESRI-compliant formats (shapefiles, coverages, or geodatabases) will be used to present GIS data, with supporting tabular data provided in Microsoft Excel, Microsoft Access, or both, as needed.

Computer Files and Digital Data: Final document files, including reports, figures, and tables, will be submitted in electronic format (both Microsoft Office 2013 [or later], and PDF via email transmission, secure file transfer protocol (FTP) or secure SharePoint sites. If necessary due to access limitations or file sizes, information will be provided on DVD. FTP and SharePoint sites will be maintained by CH2M HILL. FTP sites will only be used for the transfer of information as needed during the field investigations for the project. The project-specific SharePoint and CH2M HILL secure network servers will be utilized for long-term data storage and secure back-up of information.

Native geophysical data files will be provided in accordance with the deliverables requirements in this QAPP and associated SOPs for the various DFWs. Images will be presented in standard graphics formats (.PNG, .JPG) for insertion into documents. The native files may include the following:

- Raw geophysical sensor files
- Raw sensor files formatted for input into Geosoft oasis montaj (Geosoft)
- Geosoft database (.GDB) files containing raw data channels and processed data channels
- Geosoft grid (.GRD) and packed map (.MAP) files for data sets where gridding and contouring will be performed as part of generation of a false-color results map.
- Exported database files (.XYZ or .CSV) in format readable by Geosoft, including target lists
- Images of QC test results, sensor function test results, background location evaluations (for cued survey)
- Images of polarizabilities and library matching for cued measurements recorded twice daily at the IVS and at anomaly sources selected throughout the investigation area.

QAPP Worksheet #29: Data Management, Project Documents, and Records (continued)

Part 2: Control of Documents, Records, and Databases

Record	Responsible Party for Generation	Responsible Party for Verification	Format(s)/Storage Location
Field Records/Databases			
Geophysical Team Leader Logbook (paper or digital records)	Field Geophysicists	Project Geophysicist	MRSIMS Database, PDF/CH2M HILL Network
QC/Safety Daily Reports (including QC audits)	UXOSO/QCS	Task Manager, CH2M HILL PM	Microsoft Word Files/ CH2M HILL Network
SUXOS Daily Reports	SUXOS	Task Manager, CH2M HILL PM	Microsoft Word Files/ CH2M HILL Network
Photo Documentation	Various	Task Manager, CH2M HILL PM	JPG/CH2M HILL Network
QC Seed Types, Depths, Location	UXOQCS, Surveyor	QC Geophysicist	Microsoft Excel Files/Local drive and Secure SharePoint library (limited to QC personnel)
Validation Seed Types, Depths, Location	Navy	Navy, QC Geophysicist	Microsoft Excel Files/Client storage location (limited to Navy personnel until after intrusive investigation of training and validation digs is performed)
Instrument Assembly Checklists (dynamic and cued surveys)	Field Geophysicists	Project Geophysicist, QC Geophysicist	Microsoft Word, PDF Files/ CH2M HILL Network
IVS Technical Memoranda (dynamic and cued surveys)	QC Geophysicist	Program Geophysicist, CH2M HILL PM	CH2M HILL Network and Secure SharePoint library
UXO Team Leader Logbook (paper or digital records)	UXO Team Leader	Task Manager, UXOQCS, CH2M HILL PM	MRSIMS Database, PDF/CH2M HILL Network
Raw Geophysical Data Packages	Field Geophysicists, Project Geophysicist	Data Processing Geophysicists, QC Geophysicist	Various/CH2M HILL Secure SharePoint library and Network
Processed Geophysical Data Packages for Delivery	Data Processing Geophysicists, QC Geophysicist	Program Geophysicist, CH2M HILL PM	Various/CH2M HILL Secure SharePoint library and Network
Nonconformance, RCA and CA reports	UXOQCS, QC Geophysicist, Program Geophysicist, CH2M HILL PM	QC Manager	Various/CH2M HILL Secure SharePoint library and Network
Equipment and Instrument Check Logs	Field Geophysicists/ UXO Team Leader	Task Manager, QC Geophysicist,	Various/CH2M HILL Secure SharePoint library and Network
Deliverables (Plans, Technical Memoranda, Reports, Databases)			
Blind Seed Firewall Plan	Program Geophysicist	Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Surface Sweep Technical Memorandum	SUXOS	Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
QC Seeding Technical Memorandum	QC Geophysicist	Task Manager, Program Geophysicist, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
IVS Technical Memoranda	QC Geophysicist	Task Manager, Program Geophysicist, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library

QAPP Worksheet #29: Data Management, Project Documents, and Records (continued)

Part 2: Control of Documents, Records, and Databases (continued)

Record	Responsible Party for Generation	Responsible Party for Verification	Format/Storage Location/ Archive Requirements
Data processing logs (Dynamic and Cued Surveys)	Project Geophysicist, Data Processing Geophysicists	Task Manager, QC Geophysicist, Program Geophysicist, CH2M HILL PM	MRSIMS Database, Various/ CH2M HILL Secure SharePoint library and Network
Final data delivery packages (Dynamic and Cued Surveys)	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	Various/CH2M HILL Secure SharePoint library and Network
Target Lists for Reacquisition	QC Geophysicist	QC Geophysicist, Task Manager, CH2M HILL PM	Microsoft Excel Files/CH2M HILL Network and Secure SharePoint library
Dynamic Data Analysis and Target Selection Technical Memorandum	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Advanced Detection Target Selection Memorandum	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Cued Data Analysis and Final Dig List Technical Memorandum	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Supporting classification images	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	PDF and graphic (.PNG, .JPEG) Files/ CH2M HILL Network and Secure SharePoint library
Prioritized Dig List (Preliminary and Final)	QC Geophysicist	Program Geophysicist, Task Manager, CH2M HILL PM	Microsoft Excel Files/CH2M HILL Network and Secure SharePoint library
Validation Plan (Draft and Final)	Program Geophysicist	Task Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Disposal records	Task Manager, UXOQCS	QC Manager, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Final Report	Program Geophysicist, Task Manager	CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Final data archives	Task Manager, Program Geophysicist, SUXOS	CH2M HILL PM	Various/CH2M HILL Secure SharePoint library and Network
Project Assessments			
Field audit checklists	UXOQCS	Task Manager, Program Geophysicist, CH2M HILL PM	Microsoft Word Files/CH2M HILL Network and Secure SharePoint library
Verification checklists	Field Geophysicist	Task Manager, QC Geophysicist	Microsoft Word, PDF Files/CH2M HILL Network and Secure SharePoint library
QC summary reports and tracking summaries during geophysical data processing	Data Processing Geophysicists, QC Geophysicist	Task Manager, Program Geophysicist, CH2M HILL PM	Various/CH2M HILL Secure SharePoint library and Network

QAPP Worksheet #29: Data Management, Project Documents, and Records (continued)

Part 2: Control of Documents, Records, and Databases (continued)

Daily QC Reports

Daily work activity summary reports will be maintained by the UXOQCS. These daily reports may include, but are not limited to, the following items:

- QC reports and findings
- H&S reports
- Training logs
- SUXOS reports (including activity log)
- Reports on any emergency response actions
- MEC discovery and classification of the item
- Records of site work and progress

The daily QC reports will be recorded on Form 4-11, provided in **Appendix A**. The daily QC reports provide backup information and are intended to aid in the preparation of the weekly QC report discussed below.

Weekly QC Report

The UXOQCS is responsible for preparing and submitting a weekly QC report to the Program QC Manager and CH2M HILL PM. The weekly QC report is to be submitted to the Program QC Manager on the first work day following the dates covered by the report. The weekly QC report is to provide an overview of QC activities during the week, including those performed by subcontractors. The QC reports must present an accurate and complete picture of QC activities by reporting both conforming and deficient conditions, and the reports should be precise, factual, legible, and objective. Copies of supporting documentation, such as checklists and surveillance reports, are to be attached.

QC and H&S staff input for the weekly QC report is to be provided in writing to the SUXOS at a previously agreed-upon time and place, generally no later than 1 hour before normal close of business. For the sake of simplicity and completeness, the format for QC staff input should follow the same format as the weekly QC report, with only the relevant sections completed.

Copies of weekly QC reports with attachments and field QC logs no longer in use are to be maintained in the project QC file. Upon project closeout, all QC reports are to be included in the project QC file.

Field Log Books

The SUXOS, UXOQCS, and each FTL is responsible for maintaining paginated, bound, and dated hard copy field log books or records in MRSIMS handheld devices to record activities that occur each work day. (MRSIMS is described in **Figure 29-1**) UXO teams performing escort, surface sweep, and intrusive investigation activities will use MRSIMS handheld devices to digitally capture, track, and upload data daily into the data management system. Reports will be generated from the data entered so the team leaders can review their entries and correct any discrepancies. Each log book entry will be event-, area- or site-specific and clearly noted accordingly. At the conclusion of the project, log book entries will become a permanent part of the contract record.

QAPP Worksheet #29: Data Management, Project Documents, and Records (continued)

Part 2: Control of Documents, Records, and Databases (continued)

Safety Log Book

The UXOSO will also maintain a log book that summarizes daily safety activities. This safety log book (which may be combined with the QC logbook) will document compliance with the APP. Safety log books will be maintained as paginated, bound, and dated hard copy logs or records in MRSIMS handheld devices. The safety log books will record such information as the date, the start and stop times of work, weather conditions, the names of field team personnel, specific description of the work being conducted, break times, names and times of visitors to the site, and any incidents or other unusual events that occurred that day. This includes documentation of the performance and content of daily H&S meetings. The APP provides additional details on the safety log book.

These log books will describe conditions or activities leading up to or contributing to a safety incident or lost time due to safety. Safety log books will be turned over to the CH2M HILL PM and become a permanent part of the contract record.

Quality Control Log Book

The UXOQCS will maintain a QC log book (which may be combined with the safety logbook) that summarizes field QC inspections. This log book will document compliance with this QAPP and specify workmanship acceptability. QC log books will be maintained as paginated, bound, and dated hard copy logs or records in MRSIMS handheld devices. The area, the DFW being inspected, and the date will be recorded. Each log book entry will be event-, area- or site-specific and clearly noted accordingly. QC log books will be turned over to the CH2M HILL PM and will become a permanent part of the contract record, in addition to the completed specific QC forms specified above.

Test and Maintenance Records

Any equipment test or maintenance task will be documented in MRSIMS or on an appropriate subcontractor form or field log book by the individual performing the task. Testing and maintenance of equipment will be performed according to the manufacturer’s specifications, this QAPP, and applicable SOPs. Geophysical detection equipment will be tested daily when in use. At a minimum, the test or maintenance log will contain the date and time of the task, equipment name and identification numbers, name of individual performing the task, and results of the task. Upon project closeout, all tests and maintenance records will be included in the project QC file.

The UXOQCS is responsible for ensuring that the tests are performed and that the results are summarized and provided with the weekly QC report. To track each failing test for future retesting, the failing test must be noted on the deficiency log. Resolution of the failing test is complete when retesting is performed and the CA is verified on a deficiency log.

Training Records

The SUXOS will maintain a file for each site employee to document qualifications and the successful completion of the required training courses for that particular employee. The documentation may be a certificate, letter, memorandum, or other written form of documentation but must include the training completion date(s). If any required refresher training courses do not take place by the anniversary date of the employee’s initial training, there should be a record in the employee’s file indicating why the training has been delayed and when the training will be completed. The SUXOS will complete Form 4-2 to document employee qualifications and training.

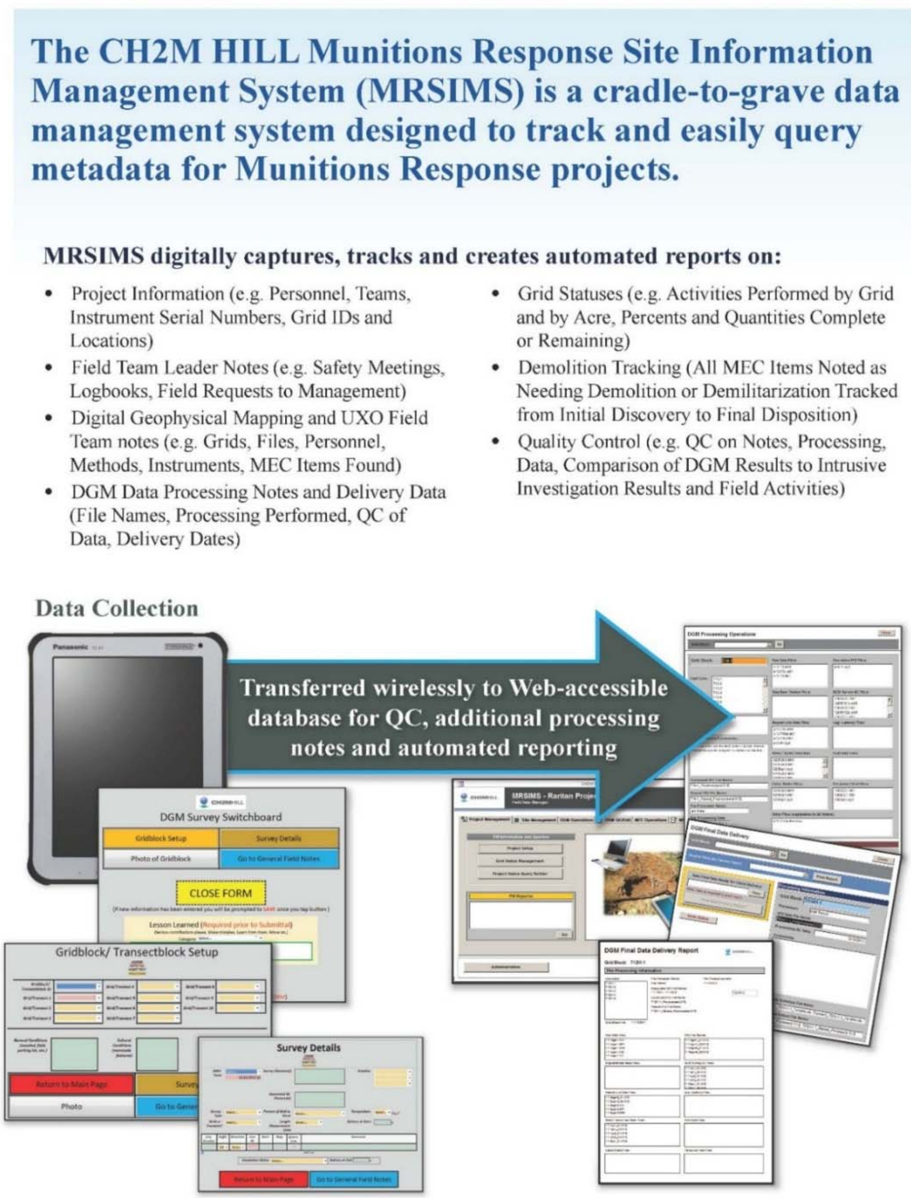
QAPP Worksheet #29: Data Management, Project Documents, and Records (continued)

Part 2: Control of Documents, Records, and Databases (continued)

Photographic Log Book

Maintaining a photographic log book will document the history and evolution of the project. The log book will be used by the SUXOS, team leaders, and UXOQCS to document the location, date, and subject of each photo taken. MRSIMS forms recording this same information may take the place of or supplement this log book.

FIGURE 29-1
Description of CH2M HILL Munitions Response Site Information Management System



QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action

This worksheet documents procedures for performing testing, inspections and QC for all field equipment. References to the applicable DFW and SOPs are included. Where appropriate the failure response will proscribe a CA. Otherwise, an RCA and CA is required.

Three Phases of Control

The UXOQCS is responsible for verifying onsite compliance with this portion of the QAPP through implementation of a three-phase control process, which ensures that project activities comply with the approved plans and procedures. The QC Geophysicist is responsible for compliance with portions of the QAPP which address achievement of MQOs and QC requirements pertaining to geophysical data. The CH2M HILL PM is responsible for overall compliance with the QAPP. The specific QC monitoring requirements for each DFW are discussed below. This section specifies the minimum requirements that must be met and to what extent QC monitoring must be conducted and documented by the responsible party.

The responsible parties will ensure that the three-phase control process is implemented for each DFW. Each phase is considered relevant for obtaining necessary product quality. However, the preparatory and initial inspections are particularly invaluable in preventing problems. Work will not be performed on a DFW until the preparatory and initial phase inspections have been completed and any non-conformance issues are resolved.

Preparatory Phase Inspection

The Preparatory Phase (PP) comprises the planning and design process leading up to the actual field activities. The UXOQCS, QC Geophysicist, CH2M HILL PM, or other designated responsible party will perform a PP inspection before beginning each DFW. The purposes of this inspection are to review applicable specifications and plans to verify that the necessary resources, conditions, and controls are in place and compliant before work activities start. Upon completion of the inspection, the UXOQCS will be responsible for completion of the PP Inspection Checklist (Form 4-3) provided in **Appendix A**.

To perform the inspection, the responsible parties will review the appropriate sections of the QAPP. The CH2M HILL PM will verify that required plans and procedures have been approved and are available to the field staff; field equipment is appropriate, available, functional, and properly tested for its intended/stated use; staff responsibilities have been assigned and communicated; the staff members have the necessary knowledge, expertise, and information to perform their jobs; arrangements for support services have been made; training in accordance with the requirements of this QAPP has occurred; and the prerequisite mobilization tasks have been completed.

Project personnel must correct or resolve discrepancies, as needed, between existing conditions and the approved QAPP identified during the PP inspection. The appropriate responsible party will verify that unsatisfactory and/or nonconforming conditions have been corrected before beginning work.

Initial Phase Inspection

The Initial Phase occurs at the startup of field activities associated with a specific DFW. At the onset of a particular DFW, the responsible parties will perform an Initial Phase inspection, and the UXOQCS will be responsible for completion of the Initial Phase Inspection Checklist (Form 4-4) provided in **Appendix A**. The main objectives of the inspection are to check preliminary work for compliance with procedures and specifications, establish an acceptable level of workmanship, check for omissions, and resolve differences of interpretation. The Initial Phase inspection will also verify that the SSHP adequately identifies all hazards associated with actual field conditions and promulgates the appropriate safe work practices. The inspection results will be documented by the UXOQCS

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

in the daily report. Should results of the inspection be unsatisfactory, the Initial Phase will be rescheduled and performed again.

During the Initial Phase inspection, the appropriate responsible party will ensure that discrepancies between site practices and approved plans or specifications are identified and resolved. The resolution of discrepancies is a critical step in the Initial Phase inspection. As applicable, other team members (Project Geophysicist, QC Geophysicist, SUXOS, etc.) will guide the CH2M HILL PM and UXOQCS in resolving discrepancies. If discrepancies arise in establishing the baseline quality for a DFW, the responsibility for resolution falls to the CH2M HILL PM. If the discrepancy cannot be resolved in a manner that satisfies the project requirements, it will be elevated to the program level (to the Activity Manager or Activity Quality Manager) and an NCR will be issued. With concurrence of the CH2M HILL team, the appropriate responsible party may direct a cessation of work activity if an unresolved discrepancy jeopardizes the results of the DFW or puts the project at risk of non-conformance.

Follow-up Phase Inspection

Completion of the Initial Phase of QC activity leads directly into the Follow-up Phase (FP), which covers the routine day-to-day activities at the site. Responsible parties will perform a FP Phase inspection at regular intervals while a particular DFW is performed. This inspection ensures continuous compliance and verifies an acceptable level of workmanship. To conduct and document these inspections, the UXOQCS will complete the FP Phase Inspection Checklist (Form 4-5) provided in **Appendix A**. The UXOQCS will monitor onsite practices and operations taking place and verify continued compliance with the specifications and requirements of this QAPP and approved amendments. Information documented on the FP Phase Inspection forms may be accompanied by Field QC Inspection Form (Form 4-6) provided in **Appendix A**. The UXOQCS will also verify that daily H&S inspections are performed and documented as prescribed in the SSHP. As applicable, other team members (Project Geophysicist, QC Geophysicist, SUXOS, etc.) will guide the CH2M HILL PM and UXOQCS in resolving discrepancies. Discrepancies between site practices and approved plans/procedures will be resolved, and CAs for unsatisfactory and nonconforming conditions or practices will be resolved by the appropriate responsible party before continuing work.

Additional Inspections

Additional inspections performed on a particular DFW may be required at the discretion of the Navy, the CH2M HILL PM, the SUXOS, the Project and QC Geophysicists, or the UXOQCS. Additional preparatory and initial inspections would be warranted under the following conditions: unsatisfactory work, as determined by CH2M HILL or the Navy; changes in key personnel; resumption of work after a substantial period of inactivity (2 weeks or more); or changes to the project scope of work. These additional inspections will be documented on the appropriate inspection checklist forms and in the QC Daily Report.

Final Phase Inspection

The Final Phase inspection is performed upon conclusion of the DFW and before closeout to verify that project requirements relevant to the particular DFW have been satisfied. Outstanding and nonconforming items will be identified and documented on the Final Inspection Checklist (Form 4-7) provided in **Appendix A**.

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

Notification of Definable Features of Work and Three Phases of Control

The appropriate responsible party will ensure that the three-phase control process is implemented for each DFW listed in **Table 31-1**. Implementation and tracking of the DFWs will be accomplished through the use of Form 4-8 (Inspection Schedule and Tracking Form) provided in **Appendix A.** The assessment schedule, responsible parties, and idealized time frames for completing assessments are also provided in **Table 31-1**.

Audit Procedures

The CH2M HILL PM is responsible for verifying compliance with this QAPP through audits and surveillance. The CH2M HILL PM is required to inspect/audit the quality of work being performed for each DFW and verify that the work practices conform to the specifications of this QAPP, unless the CH2M HILL PM designates another responsible party to perform inspections and audits. Discrepancies are to be communicated to the responsible individual and documented in the daily and weekly QC reports. CAs are to be verified by the proper responsible party and recorded in the weekly QC report.

The Inspection Schedule and Tracking Form (Form 4-8, **Appendix A**) is to be used by the CH2M HILL PM for planning, scheduling, and tracking the progress of audits. The information on the form is to be current and reviewed by the CH2M HILL PM. Audit activities and CAs are to be documented by the CH2M HILL PM as described with this section and the audit records are to be maintained as part of the project QC file.

Preventative and Corrective Actions

The preventative and corrective actions incorporated within this QAPP are designed to prevent and correct quality problems that may arise during the survey. The procedures facilitate process improvements and describe the available mechanisms to identify, document, and track discrepancies until a CA has been verified.

Continual Improvement

A continual improvement process will be implemented for the project. Project staff at all levels will be encouraged to provide recommendations for improvements in established work processes and techniques. The intent is to identify activities that are compliant but can be performed in a more efficient or cost-effective manner. Typical quality improvement recommendations include identifying an existing practice that can and should be improved (e.g., a bottleneck in production) and/or recommending an alternative practice that provides a benefit without compromising prescribed standards of quality. Project staff should bring their recommendations to the attention of the responsible party through verbal or written means.

Deviations from established protocols will not to be implemented without prior written approval.

Deficiency Identification and Resolution

While deficiency identification and resolution occurs primarily at the operational level, QC audits provide a backup mechanism to address problems that either are not identified or cannot be resolved at the operational level. Through implementation of the audit program prescribed in this QAPP, the CH2M HILL Team is responsible for verifying that deficiencies are identified and documented as prescribed herein and corrected in a timely manner. Deficiencies identified by the CH2M HILL Team are to be corrected by operational staff and documented by the appropriate responsible party.

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

Corrective Action Request

A CAR (**Appendix A**) can be issued by any member of the CH2M HILL Team, including subcontractor employees. If the individual issuing the CAR is also responsible for correcting the problem, then he/she should document the results on Part B of the CAR. Otherwise, the CAR should be forwarded to the CH2M HILL PM who is then responsible for evaluating the validity of the request, formulating a resolution and developing a corrective strategy, assigning personnel and resources, and specifying and enforcing a schedule for CAs. Once a CA has been completed, the CAR and supporting information will be forwarded to the Program QC Manager for closure. Sufficient information will be provided to allow the QC reviewer to verify the effectiveness of the CAs.

The recommendations provided in the CARs and implemented on the project will be reviewed during Follow-Up QC inspections. The purposes of this CAR review are to ensure that established protocols are implemented properly; verify that CA commitments are met; ensure that CAs are effective in resolving problems; identify trends within and among similar work units; and facilitate system RCA of larger problems.

The CH2M HILL PM will determine whether a written CAP (**Appendix A**) is necessary, based on whether or not any of the following are met: the CAR priority is high; deficiency requires a rigorous CA planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent recurrence. The CAP will be developed by the CH2M HILL PM and approved and signed by the CH2M HILL PM. The CAP will indicate whether it is submitted for informational purposes or for review and approval. In either event, operational staff are encouraged to discuss CA strategy with the UXOQCS throughout the process.

Corrective Action Request Tracking

Each CAR will be given a unique identification number and tracked until CAs have been implemented in the field, documented in Part B of the CAR form (**Appendix A**) and the CAR is submitted to the CH2M HILL PM for verification and closure.

Lessons Learned and Other Documentation

The lessons learned through the discrepancy management process are documented on CARs and CAPs. To share the lessons learned, these documents will be submitted to the Navy through a Weekly QC Report, which summarizes the week’s QC activities and includes a grouping of applicable Daily QC Reports (**Appendix A**) and any other pertinent reports created during the week.

CARs will be cited in the Weekly QC Report. Minor deficiencies identified during a QC audit that are readily correctable and can be verified in the field will be documented in the QC logbook and Weekly QC Report without initiating a CAR. Discrepancies that cannot be readily corrected will be documented by the UXOQCS on a CAR and in the Weekly QC Report. As applicable, other team members (Project Geophysicist, QC Geophysicist, SUXOS, etc.) will guide the UXOQCS in documenting these occurrences. Copies of CARs will be referenced in and attached to the Weekly QC Report. CAPs will also be attached to Weekly QC Reports to document the final outcome of the deficiency. Similar or related deficiencies may be addressed on a single CAP.

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Pre-mobilization Activities	PP	GCMR QAPP, SSHP	UXOQCS	Once	Verify the Project QAPP and SSHP have been developed and approved	Documents approved, all parties agree to the technical and operational approach	Do not proceed with field activities until criterion is passed	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); Daily UXOQCS Report	Day of audit	CH2M HILL PM	RCA/CA; Email or other Written Communication, As Appropriate Within 3 days	CH2M HILL PM	UXOQCS
	PP	GIS Setup	UXOQCS	Once	Verify GIS system is functional and ready for site data	GIS system has been set up and is ready for site data	Do not proceed with field activities until criterion is passed		Day of audit	CH2M HILL PM		CH2M HILL PM	Program Geophysicist
	PP	MRSIMS Setup	UXOQCS	Once	Verify MRSIMS system is functional and ready for site data	MRSIMS system has been set up and is ready for site data	Do not proceed with field activities until criterion is passed		Day of audit	Project Geophysicist		Project Geophysicist	Program Geophysicist
	PP/Initial Phase (IP)	Subcontractor Procurement	UXOQCS	Once	Ensure procurement of subcontractors and verify qualifications, training, licenses	Subcontractors' qualifications, training, and licenses are up to date and acceptable	Be sure subcontractor provides qualifications, training, and licenses or change subcontractor		Day of audit	CH2M HILL PM		CH2M HILL PM	UXOQCS
Mobilization/ Site Preparation	PP/IP/FP	Daily UXO Safety Briefing	UXOQCS	Daily	Confirm that the UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged by signature	UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged it by signature.	Those personnel not receiving a safety briefing are not authorized in the exclusion zone until it is received and acknowledged by signature.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	SUXOS	RCA/CA Within 1 day	UXOSO	UXOQCS
	PP/IP	Onsite Document Review	UXOQCS	Once	Verify QAPP and SSHP approved and review with project team and get appropriate signatures	Documents approved and reviewed and acknowledged by appropriate project team members	Personnel who are not familiar with the QAPP may not proceed with field activities until criterion are passed		Day of audit	CH2M HILL PM, Program Geophysicist, SUXOS	RCA/CA; Email or other Written Communication, As Appropriate Within 3 days	CH2M HILL PM, Project Geophysicist, SUXOS	UXOQCS, Program Geophysicist
	PP/IP	Establish Communication and Logistics	UXOQCS	Once	Verify functionality of communications equipment and logistical support is coordinated	Communications and other logistical support are coordinated	Do not proceed with field activities until criterion is passed		Day of audit	CH2M HILL PM, SUXOS		CH2M HILL PM, SUXOS	UXOQCS
	PP/IP	Local Agencies and Emergency Services Notification	UXOQCS	Once	Verify that local agencies and emergency services have been notified of site activities	Emergency services and local agencies are aware of site activities	Do not proceed with field activities until criterion is passed		Day of audit	CH2M HILL PM, SUXOS		CH2M HILL PM, SUXOS	UXOQCS

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Mobilization/ Site Preparation (con't)	PP/IP	Verify site-specific training	UXOQCS	Once	Verify that all site-specific training has been performed and acknowledged	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Day of audit	CH2M HILL PM, SUXOS	RCA/CA; Email or other Written Communication, As Appropriate Within 3 days	CH2M HILL PM, SUXOS	UXOQCS
	PP/IP	Site Boundary and Grids Establishment	UXOQCS	Once	Verify area/ boundary and grids have been properly established	Area/boundary is correct, grids are correct and stakes are appropriately labeled	Stop activities until area/ boundary/ grids are verified as correct		Day of audit	Project Geophysicist		Project Geophysicist	UXOQCS
	PP/IP	MDAS Storage Area	UXOQCS	Once	Verify the MDAS storage area is established, containers are marked and securable and personnel have been trained on its proper use.	Inspect and document the MDAS storage area meets Federal and State requirements	Do not proceed with intrusive activities until criterion is passed.		Day of audit	SUXOS	RCA/CA; Email or other Written Communication, As Appropriate Within 1 day	SUXOS	UXOQCS
Surface Sweep	IP/FP	Daily UXO Safety Briefing	UXOQCS	Daily	Confirm that the UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged by signature	The UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged it by signature.	Those personnel not receiving a safety briefing are not authorized in the exclusion zone until it is received and acknowledged by signature.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	SUXOS	RCA/CA Within 1 day	UXOSO	UXOQCS
	IP/FP	Handheld Metal Detector Daily Checks	UXOQCS	Daily	Verify personnel conduct equipment checks and the detector is serviceable by visually observing the checks by team members and documenting the checks in the logbook.	Personnel did conduct equipment check, the detector is serviceable, detector functioning is acceptable and the team leader has made the logbook entry.	Repair or replace a malfunctioning instrument. Make the logbook entries.		Daily if performed	SUXOS/UXO Team Leader	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOQCS
	IP/FP	Personnel are wearing proper personal protective equipment (PPE) for the task to be performed	UXOSO, UXOQCS	Daily	Confirm personnel are wearing appropriate PPE for the assigned task. UXOQCS or UXOSO to perform daily spot checks.	Personnel are wearing appropriate PPE for the assigned task. UXOQCS has filled out the QC Inspection Checklist documenting the spot check(s).	Stop the activities until personnel are wearing the proper PPE. Make the logbook entries. Notify the UXOSO of the violation.		Weekly	CH2M HILL PM, SUXOS	RCA/CA Within 1 day	CH2M HILL PM, SUXOS	UXOSO/UXOQCS

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Surface Sweep (con't)	IP/FP	Surface Clearance	UXOQCS	Daily	Verify performed in accordance with QAPP and associated SOPs. Confirm that MEC/MPPEH, metal pieces ≥ 2" in any dimension and surface QC seeds placed in the area worked were located and returned to the UXOQCS.	QC failure if 1 seed, MEC or MPPEH; or ≥5 metal pieces ≥ 2" in any dimension found in a transect	UXOQCS meet with SUXOS and UXO Team Leader, issues NCR to UXO Team Leader, RCA. UXO Team resweeps the failed work area; reinspection failure requires CAR and CAP. Repeated failures may result in stop work order.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily if performed	SUXOS/UXO Team Leader	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOQCS
	IP/FP	Recovery of QC seeds	UXOQCS	Daily	Confirm that all surface QC seeds in area worked were recovered and returned to the UXOQCS.	QC failure if a surface QC seed in the area worked is not recovered and returned to the UXOQCS	UXOQCS meet with SUXOS and UXO Team Leader, issues NCR to UXO Team Leader, RCA. UXO Team resweeps the failed work area; reinspection failure requires CAR and CAP. Repeated failures may result in stop work order.		Daily if performed	SUXOS/UXO Team Leader	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOQCS
	IP/FP	EZ Boundaries	UXOSO, UXOQCS	Daily	UXOSO verify that signs are in place to identify the work site exclusion zone. UXOQCS to perform daily spot checks.	Signs are in place to identify the work site exclusion zone.	Stop operations until signs are put in place.		Daily if performed	CH2M HILL PM, SUXOS	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOQCS
Conduct Validation Seeding, QC Seeding, and Construct IVS	PP/IP	Placement of QC Seeds (surface)	UXOQCS; QC Geophysicist	Once/ Daily/As Required	Verify QC seeds have been properly placed and their positions properly recorded	QC seeds have been properly placed and positions recorded by the UXOQCS	Do not proceed with surface sweep for an area that does not have QC seeds appropriately placed and locations recorded	PP Inspection Checklist (Form 4-3);IP Inspection Checklist (Form 4-4); Daily UXOQCS Report	Daily if performed	Project Geophysicist	Email or other Written Communication Within 1 day	UXOQCS; QC Geophysicist	CH2M HILL PM; Program Geophysicist
	PP/IP	Placement of QC Seeds (subsurface)		Once/Daily/ As Required	Verify QC seeds have been properly placed and their positions properly recorded	QC seeds have been properly placed, covered, documented, and surveyed by the PLS	Do not proceed with dynamic surveys until QC seeds have been appropriately placed and recorded		Daily if performed				

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Conduct Validation Seeding, QC Seeding, and Construct IVS (con't)	PP	Instrument Verification Strip Construction		Once	Verify that IVS is constructed in accordance with QAPP	IVS constructed in accordance with QAPP	Do not proceed with IVS until IVS is properly constructed or alternate construction is approved by Navy RPM	PP Inspection Checklist (Form 4-3);IP Inspection Checklist (Form 4-4); Daily UXOQCS Report	Once	Project Geophysicist	Email or other Written Communication Within 1 day	UXOQCS; QC Geophysicist	CH2M HILL PM; Program Geophysicist
Assemble and Verify Correct Operation of Geophysical Sensor to be Used for Detection Survey	PP	Assemble sensor	UXOQCS; Lead Field Geophysicist; QC Geophysicist	Once/As Required	Observe assembly and initial function testing of TEMTADS and completion of checklist	System assembled in accordance with SOP	Do not proceed with IVS until system is properly assembled	PP Inspection Checklist (Form 4-3); Daily UXOQCS Report; SOP MR-AC-01-01 Checklist	Within 24 hrs of Completion of Each Event	Project Geophysicist	Email or other Written Communication Within 1 day	UXOQCS; Lead Field Geophysicist	CH2M HILL PM; QC Geophysicist
Dynamic Detection Survey	PP/IP/FP	Daily UXO Safety Briefing	UXOQCS	Daily	Confirm that the UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged by signature	UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged it by signature.	Those personnel not receiving a safety briefing are not authorized in the exclusion zone until it is received and acknowledged by signature.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	SUXOS	RCA/CA Within 1 day	UXOSO	UXOQCS
	PP/IP/FP	Personnel are wearing proper PPE for the task to be performed	UXOSO, UXOQCS	Daily	Confirm personnel are wearing appropriate PPE for the assigned task. UXOQCS or UXOSO to perform daily spot checks.	Personnel are wearing appropriate PPE for the assigned task. UXOQCS has filled out the QC Inspection Checklist documenting the spot check(s).	Stop the activities until personnel are wearing the proper PPE. Make the logbook entries. Notify the UXOSO of the violation.		Daily if performed	CH2M HILL PM, SUXOS	RCA/CA Within 1 day	CH2M HILL PM, SUXOS	UXOSO/UXOQCS
	IP/FP	Instrument Verification Strip Performance	QC Geophysicist	Daily/ As Required	Verify that IVS related MQOs are being met	MQOs are being met	RCA/CA		Daily if performed	Lead Data Processor	RCA/CA Within 1 day	Lead Field Geophysicist; Lead Data Processor	CH2M HILL PM; QC Geophysicist
	IP/FP	Dynamic detection survey	QC Geophysicist	Daily/ As Required	Verify that dynamic detection related MQOs are being met	MQOs are being met	RCA/CA		Daily if performed	Lead Data Processor	RCA/CA Within 1 day	Lead Field Geophysicist; Lead Data Processor	CH2M HILL PM; QC Geophysicist
Process Dynamic Survey Data and Document Anomaly Locations	IP/FP	Process and interpret dynamic data	QC Geophysicist	Daily	Verify that MQOs are being met	MQOs are being met	RCA/CA	Delivered Geophysical Data Sets Having Undergone QC	Within 3 working days of data collection	Lead Data Processor	RCA/CA Within 1 day	Lead Data Processor	CH2M HILL PM; QC Geophysicist
Assemble Advanced Geophysical Sensor and Test Sensor at IVS	PP	Assemble sensor	UXOQCS; Lead Field Geophysicist; QC Geophysicist	Once/As Required	Observe assembly and initial function testing of TEMTADS in cued interrogation mode and completion of checklist	System assembled in accordance with SOP	Do not proceed with IVS until system is properly assembled	PP Inspection Checklist (Form 4-3); Daily UXOQCS Report; SOP MR-AC-01-01 Checklist	Within 24 hrs of Completion of Each Event	Project Geophysicist	Email or other Written Communication Within 1 day	UXOQCS; Lead Field Geophysicist	CH2M HILL PM; QC Geophysicist

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Cued Survey	PP/IP/FP	Daily UXO Safety Briefing	UXOQCS	Daily	Confirm that UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged by signature	UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged it by signature.	Those personnel not receiving a safety briefing are not authorized in the exclusion zone until it is received and acknowledged by signature.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	SUXOS	RCA/CA Within 1 day	UXOSO	UXOQCS
	IP/FP	Instrument Verification Strip	QC Geophysicist	Once/Daily/ As Required	Verify IVS related MQOs are being met	MQOs are being met	RCA/CA		Daily if performed	Lead Data Processor	RCA/CA Within 1 day	Project Geophysicist; Lead Data Processor	CH2M HILL PM; QC Geophysicist
	IP/FP	Cued survey	QC Geophysicist	Once/Daily/ As Required	Verify cued survey related MQOs are being met	MQOs are being met	RCA/CA		Daily if performed	Lead Data Processor	RCA/CA Within 1 day	Project Geophysicist; Lead Data Processor	CH2M HILL PM; QC Geophysicist
Validate Advanced Sensor Data	IP/FP	QC and Evaluation of Cued data	QC Geophysicist	Daily	Verify cued data are being reviewed daily and that MQOs are being met	MQOs are being met.	RCA/CA	Delivered Geophysical Data Sets Having Undergone QC	As Delivered	Lead Data Processor	RCA/CA Within 1 day	Lead Data Processor; QC Geophysicist	CH2M HILL PM; Project Geophysicist
Conduct Cued Data Processing	IP/FP	Process and interpret Cued data	QC Geophysicist	Once/Daily/ As Required	Verify cued processing related MQOs are being met	MQOs are being met	RCA/CA	Delivered Geophysical Data Sets Having Undergone QC	Within 3 working days of data collection	Lead Data Processor	RCA/CA Within 1 day	Lead Data Processor	CH2M HILL PM; QC Geophysicist
Intrusive investigation	PP/IP/FP	Daily UXO Safety Briefing	UXOQCS	Daily	Confirm UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged by signature	UXOSO or representative conducted a daily safety briefing and all field personnel acknowledged it by signature.	Those personnel not receiving a safety briefing are not authorized in the exclusion zone until it is received and acknowledged by signature.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	SUXOS	RCA/CA Within 1 day	UXOSO	UXOQCS
	IP/FP	Reacquire and flag anomaly sources selected for intrusive investigation	UXOQCS	Once/Daily/ As Required	Verify reacquisition performed in accordance with QAPP and associated SOPs	Reacquisition is being performed in accordance with QAPP and appropriate SOP	RCA/CA		Daily if performed	SUXOS	RCA/CA Within 1 day	UXOQCS	UXOQCS
	PP/IP/FP	Handheld Metal Detector Daily Checks	UXOQCS	Daily	Verify personnel conduct equipment checks and the detector is serviceable by visually observing the checks by team members and documenting the checks in the logbook.	Personnel did conduct equipment check, the detector is serviceable, detector functioning is acceptable and the team leader has made the logbook entry.	Repair or replace a malfunctioning instrument. Make the logbook entries.		Daily if performed	SUXOS/UXO Team Leader	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOQCS

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Intrusive investigation (con't)	PP/IP/FP	Personnel are wearing proper PPE for the task to be performed	UXOSO, UXOQCS	Daily	Confirm personnel are wearing appropriate PPE for the assigned task. UXOQCS or UXOSO to perform daily spot checks.	Personnel are wearing appropriate PPE for the assigned task. UXOQCS has filled out the QC Inspection Checklist documenting the spot check(s).	Stop the activities until personnel are wearing the proper PPE. Make the logbook entries. Notify the UXOSO of the violation.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Weekly	CH2M HILL PM, SUXOS	RCA/CA Within 1 day	CH2M HILL PM, SUXOS	UXOSO/UXOQCS
	PP/IP/FP	EZ Boundaries	UXOSO, UXOQCS	Daily	UXOSO verify that signs are in place to identify the work site exclusion zone as shown in the ESS. UXOQCS to perform daily spot checks.	Signs are in place to identify the work site exclusion zone.	Stop operations until signs are put in place.		Daily if performed	CH2M HILL PM, SUXOS	RCA/CA Within 1 day	SUXOS/UXO Team Leader	UXOSO
	IP/FP	Investigate anomaly sources	UXOQCS/ UXOSO	Once/Daily/ As Required	Verify intrusive investigation performed in accordance with ESS, MEC-QAPP and associated SOPs. Select random locations turned over by intrusive team for QC inspection to determine whether metallic anomaly sources remain uninvestigated.	QC failure if ≥1 MEC, or ≥1 MPPEH, or ≥5 metal pieces ≥ 2" in any dimension found within 2' radius of anomaly location turned over by the dig team for QC	UXOQCS meet with SUXOS and UXO Team Leader, issues NCR to UXO Team Leader, RCA. UXO Team reinvestigates all locations from same day of operation; reinspection failure requires CAR and CAP. Repeated failures may result in stop work order.		Daily if performed	SUXOS	RCA/CA Within 1 day	UXOQCS/ UXOSO	UXOQCS
	IP/FP	Recovery of QC seeds	UXOQCS	Daily	Confirm that subsurface QC seeds placed in the area worked were located and returned to the UXOQCS.	All QC seeds in area worked each day are recovered and returned to UXOQCS.	UXOQCS meet with SUXOS and UXO Team Leader, issues NCR to UXO Team Leader, RCA. UXO Team reinvestigates all locations from same day of operation; reinspection failure requires CAR and CAP. Repeated failures may result in stop work order.		Daily if performed	SUXOS	RCA/CA Within 1 day	UXOQCS/ UXOSO	UXOQCS

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Intrusive investigation (con't)	PP/IP/FP	Demilitarization/ Demolition of MDAS	UXOQCS	Each occurrence	SUXOS to verify that demilitarization operations are performed according to ESS and SOPs. UXOQCS will audit the proper demilitarization of material and document the results in the logbook.	Demilitarization is performed according to ESS, MEC-QAPP and the SOP. The SUXOS has reviewed the demil procedures and is satisfied that they comply with ESS. QC has audited the demilitarized material and documents that it meets DoD requirements.	Stop activity until full compliance can be assured and any activities not performed within compliance are re- evaluated and re-done if necessary.	PP Inspection Checklist (Form 4-3); IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily if performed	SUXOS	RCA/CA Within 1 day	SUXOS/ UXOQCS	UXOQCS
	PP/IP/FP	Post-demolition site cleanup	UXOQCS	Each event	SUXOS to verify the demolition site was checked, all of the explosive items were destroyed and any MPPEH remaining was collected, inspected, removed and recycled and the disposal site was backfilled and leveled to grade. The SUXOS will document the post-demolition check and cleanup as a logbook entry.	The demolition site was checked, all explosive items were destroyed. MPPEH remaining was inspected, removed and recycled. The disposal site was backfilled and leveled to grade. The post-demolition activities were documented in the logbook.	Retrain personnel. Recheck the disposal site. Verify that the MEC was destroyed and remove remaining munitions debris, inspect it and recycle. Backfill and restore the site. Make the data entry in the logbook.		When performed	SUXOS	RCA/CA Within 1 day	SUXOS/ UXOQCS	UXOQCS
	PP/IP/FP	Backfilling Holes	UXOQCS	Daily, grid certification	Verify that all excavations are backfilled, seedbed (plug) was replaced, leveled to grade. UXOQCS to document checks during Follow-on inspections and completion during final grid certification.	All holes backfilled and leveled to grade. UXOQCS will document completion during final grid certification. Failures are reported to QA.	QA will conduct RCA and recommend a CA		Daily if performed	SUXOS	RCA/CA Within 1 day	SUXOS/ UXOQCS	UXOQCS
	IP/FP	Database updates	UXOQCS; QC Geophysicist	Once/Daily/ As Required	Confirm database is updated on a daily basis with intrusive investigation results	Database is updated on a daily basis with intrusive investigation results	RCA/CA		Daily if performed	Project Geophysicist	RCA/CA Within 1 day	UXOQCS; QC Geophysicist	UXOQCS; QC Geophysicist

QAPP Worksheet #31, 32 & 33: Assessments and Corrective Action (continued)

TABLE 31-1
Assessment Schedule; Assessment Response and Corrective Action

DFW	QC Phase	Task with Auditable Function	Responsibility for Conducting Audit	Frequency of Audit	Audit Procedure	Pass/Fail Criteria	Action if Failure Occurs	Audit Deliverable	Audit Deliverable Due Date	Responsibility for responding to assessment findings	Assessment Response Documentation and Timeframe	Responsibility for Implementing CA	Responsible for Monitoring CA implementation
Intrusive investigation (con't)	IP/FP	Investigate anomaly sources	UXOQCS; QC Geophysicist	With each provided dig list	Confirm results of validation digs are non-TOI	Intrusive investigation results confirm predictions on identification of non-TOI as non-TOI	RCA/CA	IP Inspection Checklist (Form 4-4); FP Inspection Checklist (Form 4-5); Field QC Inspection Form (Form 4-6); Final Inspection Checklist (Form 4-7; Daily UXOQCS Report	Daily	Project Geophysicist	RCA/CA Within 1 day	UXOQCS; QC Geophysicist	CH2M HILL PM; Project Geophysicist

QAPP Worksheet #34: Data Verification, Validation, and Usability Inputs

This worksheet is used to list the inputs that will be used during data verification, validation, and usability assessment. Inputs include all requirements documents (e.g. contracts, SOPs, planning documents), field records (both hard-copy and electronic), and interim and final reports. Data verification is a completeness check that all specified activities involved in data collection and processing have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements.

Requirements/Specifications:

Item	Description	Verification (completeness)	Validation (conformance to specifications)	Usability (achievement of data quality objectives [DQOs] and MPCs)
Field Records				
1	PP/IP/FP and Final Inspection Checklists (Forms 4-3 through 4-7, **Appendix A**)	X	X	
2	Daily QC Report (Form 4-11, **Appendix A**)	X	X	
3	Weekly QC Report	X	X	
4	Field logbooks (Safety and Data Collection)	X		
5	Photographs	X		
6	Instrument Assembly Checklist (Detection Survey)	X	X	X
7	IVS Construction Details	X	X	
8	IVS Construction Checklist	X	X	
9	Digital Field Notes (MRSIMS entries)	X		
10	Instrument Assembly Checklist (Cued Survey)	X	X	
Electronic Data				
11	Raw TEMTADS (.TEM) data files (EMI, GPS, and inertial measurement unit	X	X	
12	Converted TEMTADS (ASCII.csv) files	X	X	
13	Data Processing and QC Log (Detection Survey)	X	X	X
14	Digital Field Notes	X	X	X
15	Mapped Detection Metric Data	X	X	X
16	Target Anomaly Lists (Advanced Detection Match and/or Response Amplitude)	X	X	
17	Final Data Archive (for each delivered subset)	X	X	

QAPP Worksheet #34: Data Verification, Validation, and Usability Inputs (continued)

Requirements/Specifications:

Item	Description	Verification (completeness)	Validation (conformance to specifications)	Usability (achievement of data quality objectives [DQOs] and MPCs)
Interim & Final Reports/Deliverables				
18	SOPs	X		X
19	Blind Seed Firewall Plan	X		X
20	Draft Validation Plan	X		X
21	Final Validation Plan	X		X
22	Surface Sweep Technical Memorandum	X	X	X
23	QC Seeding Technical Memorandum	X	X	X
24	Initial IVS Technical Memorandum	X	X	X
25	Dynamic Data Analysis and Target Selection Technical Memorandum	X		X
26	Advanced Detection Target Selection Memorandum	X		X
27	IVS Technical Memorandum	X	X	X
28	Cued Data Analysis and Final Dig List Technical Memorandum	X		X

QAPP Worksheet #35: Data Verification and Validation Procedures

This worksheet documents procedures that will be used to verify and validate project data. Data verification is a completeness check to confirm that all required activities were conducted, all specified records are present, and the contents of the records are complete. Data validation is the evaluation of conformance to stated requirements.

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
Field logbooks	QAPP	A QC log book (which may be combined with the safety logbook) will summarize field efforts and QC inspections. All information is complete for each day of field activities. Required signatures are present.	UXOQCS; Lead Field Geophysicist	Daily QC Report
Validation and QC Seeding	QAPP	Seed items are buried IAW specifications in QAPP. Seed item details (ID, type, orientation, depth) are documented and items are photographed prior to burial. Seed item locations are surveyed and covered prior to geophysical data collection.	UXOQCS; Project Geophysicist	Daily QC Report; Digital file (.XLS or .CSV) tabulated seed details and locations.
Digital Field Notes	QAPP	Digital field notes for geophysical survey activities may be submitted in conjunction with (or in lieu of) hard copy notes, when applicable. All information is complete for each day of field activities	Lead Field Geophysicist	MRSIMS Entries; Digital notes files in .CSV format
Instrument Assembly	QAPP; SOP 01-01	Instrument Assembly has completed according to SOP 01-01 for both dynamic detection and cued surveys. MQOs have been achieved, with any exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	Lead Field Geophysicist	SOP 01-01 Checklist, Daily QC Report
IVS Construction and Initial Dynamic and Cued Surveys at IVS	QAPP; SOP 02-01	Initial IVS Survey has been constructed and surveyed according to SOP 02-01. Checklist 02-01 has been completed. All specifications have been achieved, or exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	Lead Field Geophysicist	SOP 02-01 Checklist, Daily QC Report
Detection Survey	QAPP; SOP 03-01	Detection survey has been completed according to SOP 03-01. QC and function tests conducted IAW SOP 03-01. If appropriate, CAs have been completed. Signatures and dates are present.	Lead Field Geophysicist	Daily QC Report; Raw data files; MRSIMS Entries
Detection Survey Data Processing	QAPP; SOP 04-01	Detection survey data processing has been completed according to SOP 04-01. Seed performance has been conducted. All specifications have been achieved, or exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	QC Geophysicist	Daily QC Report; Processed data files, processing and QC logs; Target lists; MRSIMS Entries

QAPP Worksheet #35: Data Verification and Validation Procedures (continued)

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
Cued Survey	QAPP; SOP 07-01	Cued survey has been completed according to SOP 07-01. QC and function tests conducted IAW SOP 07-01. If appropriate, CAs have been completed. Signatures and dates are present.	Lead Field Geophysicist	Daily QC Report; Raw data files
Cued Survey Data Processing	QAPP; SOP 07-01	Cued survey data processing has been completed according to SOP 07-01. Preliminary prioritized dig list has been generated. Seed performance has been conducted. All specifications have been achieved, or exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	QC Geophysicist	Daily QC Report; Processed data files, processing and QC logs; Preliminary Prioritized Dig List
Reacquisition of Targets Prior to Intrusive Investigations	QAPP; SOP 08-01	Target reacquisition has been performed according to SOP 08-01. Flag locations placed during reacquisition process will be stored in the RTK GPS or total station data collector. Recorded measurements will be downloaded daily and compared to supplied target locations derived from data processing. MQOs have been achieved, with any exceptions noted. If appropriate, CAs have been completed.	Lead Field Geophysicist or Surveyor Crew Chief, as appropriate	Daily QC report; Downloaded data collector files
Intrusive Investigation (Analyst calibration digs)	QAPP, TBD-SOP-03	Intrusive Investigation conducted IAW TBD-SOP-03. Anomaly sources identified as analyst calibration digs have been dug and findings have been communicated to project team. All specifications have been achieved, or exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	UXOQCS	Daily QC Report, MRSIMS Entries
Data Validation	QAPP	Findings of analyst calibration digs have been reviewed. If no additional analyst calibration digs are needed, classification is performed again and final prioritized dig list is generated. All specifications have been achieved, or exceptions noted to this point. Signatures and dates are present.	QC Geophysicist	Revised processed files and QC logs; Final Prioritized Dig List
Intrusive Investigation (Validation Digs and TOI Digs)	QAPP; TBD-SOP-03	Intrusive Investigation conducted IAW TBD-SOP-03. Anomaly sources listed in “DIG” section of final prioritized dig list have been excavated along with validation digs. Findings have been communicated to project team. All specifications have been achieved, or exceptions noted. If appropriate, CAs have been completed. Signatures and dates are present.	UXOQCS	Daily QC Report, MRSIMS Entries

QAPP Worksheet #36: Geophysical Classification Process Validation

This worksheet documents procedures that will be used to validate the overall anomaly detection and classification approach as it is implemented at the site. The purpose of process validation is to provide added confidence in the ability of the sample design to 1) select anomaly sources meeting the project-specific detection threshold for further investigation, and 2) correctly classify anomaly sources to distinguish between TOI and non-TOI.

The validation approach involves testing the thresholds for both anomaly detection and anomaly classification in two ways: 1) Placing "blind" validation and QC seeds and the site before the project begins, to confirm that the seeds can be detected and correctly classified, and 2) Conducting "validation digs", i.e., the excavation of additional anomaly sources (non-TOI) just beyond the thresholds used for detection and classification, to confirm that they are, in fact, non-TOI. Validation digs are conducted at the end of the project, following the intrusive investigation. Any validation failures (i.e., failure to detect and correctly classify seeds or failure to correctly classify an actual TOI as TOI), will require an RCA and appropriate CA.

Process validation approach:

The draft Validation Plan is included as **Appendix D** of this QAPP. The draft Validation Plan describes how each of the decision-making thresholds for detection and classification will be tested and identifies how anomaly sources will be selected for the validation digs. It addresses both CH2M HILL QC seeding plan and validation digs. The final number and distribution of validation digs depends on the MQOs, as well as actual performance in the field against established MPCs. For that reason, the validation approach evolves as the project is implemented. The validation plan is revised following cued data processing, and finalized following the intrusive investigation.

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QAPP Worksheet #37: Data Usability Assessment

This worksheet documents procedures that will be used to perform the data usability assessment. The data usability assessment will be performed as part of the Final Report. It involves a qualitative and quantitative evaluation of the collected data to determine if the project data are of the right type, quality, and quantity to support the decisions that need to be made. It involves a retrospective review of the systematic planning process to evaluate whether underlying assumptions are supported, sources of uncertainty have been managed appropriately, data are representative of the population of interest, and the results can be used as intended, with the acceptable level of confidence.

Personnel responsible for participating in the data usability assessment preparation or review:

Name	Title	Organization	Role in Usability Assessment
Stephen Falatko	PM	CH2M HILL	Reviewer
George DeMetropolis	QC and H&S Program Manager	CH2M HILL	Reviewer
Tamir Klaff	Program Geophysicist	CH2M HILL	Reviewer
David Wright	QC Geophysicist	CH2M HILL	Preparation
Vicki Rystrom	Project Geophysicist (Lead)	CH2M HILL	Preparation
Brian Junck	Data Processing Geophysicist	CH2M HILL	Preparation

Documents used as input to the data usability assessment:

- QAPP
- Contract Specifications
- Final Validation Plan
- Weekly QC Reports
- CARs
- Production Area Seed Memorandum
- IVS Memoranda
- Dynamic Data Analysis and Target Selection Technical Memorandum
- Site-Specific Munitions Classification Library
- Advanced Detection Target Selection Memorandum Prioritized Target “Dig” Lists (Preliminary and Final)
- Cued Data Analysis and Final Dig List Technical Memorandum

QAPP Worksheet #37: Data Usability Assessment (continued)

Data usability will be discussed in the Final Report. The steps included in performing an assessment of the data usability will include the following:

Step 1	**Review the project's objectives and sampling design** Review the DQOs. Are underlying assumptions valid? Were the project boundaries appropriate? Review the sampling design as implemented for consistency with stated objectives. Were sources of uncertainty accounted for and appropriately managed? Summarize any deviations from the planned sample design.
Step 2	**Review the data verification/validation outputs and evaluate conformance to MPCs documented on Worksheet #12** Review the site-specific project library for completeness. Review available QA/QC reports, including weekly QC reports, assessment reports, CARs, and the data validation report. Evaluate the implications of unacceptable QC results. Evaluate conformance to MPCs documented on **Worksheet #12**. Summarize the impacts of non-conformances on data usability.
Step 3	**Document data usability, update the CSM, and draw conclusions** Determine if the data can be used as intended, considering implications of deviations and CAs. Assess the performance of the sampling design and Identify any limitations on data use. Update the CSM and document conclusions.
Step 4	**Document lessons learned and make recommendations** Summarize lessons learned and make recommendations for changes to DQOs or the sampling design for future similar studies. Prepare the data usability summary report.

References

CH2M HILL, 2011. *Final Site Inspection Report, Munitions Response Program, Munitions Response Sites at Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Naval Air Station Oceana, Virginia Beach, Virginia, February.*

CH2M HILL, 2012. *Technical Memorandum, Expanded Site Inspection Results and Proposed Remedial Investigation Approach for the Moving Target Mortar Range – South, Dam Neck Annex – Naval Air Station Oceana, Virginia.*

CH2M HILL, 2013*. Final Munitions and Explosives of Concern, Quality Assurance Project Plan, Remedial Investigation, Moving Target Mortar Range South, November.*

CH2M HILL, 2014*. Final Munitions and Explosives of Concern, Quality Assurance Project Plan - Amendment, Remedial Investigation, Moving Target Mortar Range South, November.*

Department of Defense Explosives Safety Board (DDESB). 2004. Technical Paper (TP) 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel. 20 December.

Intergovernmental Data Quality Task Force (IDQTF). 2012. Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets. March.

Malcolm Pirnie, 2008*. Final Preliminary Assessment, Naval Air Station Oceana, Dam Neck Annex and Naval Auxiliary Landing Field Fentress, Virginia.*

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Appendix A
Quality Control Forms

FORM 4-1	CH2M HILL DAILY TAILGATE MEETING LOG
FORM 4-2	UXO PERSONNEL QUALIFICATION AND VERIFICATION FORM
FORM 4-3	PREPARATORY PHASE INSPECTION CHECKLIST (Part I)
FORM 4-3	PREPARATORY PHASE INSPECTION CHECKLIST (Part II)
FORM 4-4	INITIAL PHASE INSPECTION CHECKLIST
FORM 4-5	FOLLOW-UP PHASE INSPECTION CHECKLIST
FORM 4-6	FIELD QC INSPECTION FORM
FORM 4-7	FINAL INSPECTION CHECKLIST (Part I)
FORM 4-7	FINAL INSPECTION CHECKLIST (Part II)
FORM 4-8	INSPECTION SCHEDULE AND TRACKING FORM
FORM 4-9	CORRECTIVE ACTION REQUEST(1) PAGE 1 OF 2
FORM 4-10	CORRECTIVE ACTION PLAN PAGE 1 OF 1
FORM 4-11	DAILY QC REPORT
FORM 4-12	NONCONFORMANCE REPORT
FORM 4-13	ROOT CAUSE ANALYSIS FORM
FORM 4-14	MAGAZINE DATA CARD
FORM 4-15	EXPLOSIVE VEHICLE INSPECTION

Form 4-1 CH2M HILL DAILY TAILGATE MEETING LOG

Project. ______________________________ Date: ____________

TOPICS DISCUSSED:

1.
2.
3.
4.
5.
6.

MEETING CONDUCTED BY: SIGNATURE:

MEETING ATTENDEES	
Name/Company	Signature
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
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21.	
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24	
25.	

Form 4-2 UXO PERSONNEL QUALIFICATION and VERIFICATION FORM

CANDIDATE: ____________________ POSITION/LEVEL: ____________________

CONTRACT: ____________________

REVIEW ITEMS		CANDIDATE QUALIFICATIONS	VERIFIED BY/DATE
EXPERIENCE	REQUIRED: AREA AND YEARS		
	ACTUAL: AREA AND YEARS		
EDUCATION	REQUIRED		
	ACTUAL		
CERTIFICATIONS & REGISTRATIONS	REQUIRED		
	ACTUAL		
TRAINING	REQUIRED		
	ACTUAL		
OTHER	REQUIRED		
	ACTUAL		

Form 4-3 PREPARATORY PHASE INSPECTION CHECKLIST
(Part I)

Project : ______________________________ Date: ____________________

TITLE AND NO. OF TECHNICAL SECTION: ______________________________

____

____

____

Work Plan Reference : ______________________________

A. Planned Attendants:

	Name	**Position**	Company
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			
9)			
10)			
11)			

B. Submittals required to begin work:

	Item	Submittal No.	Action Code
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			

I hereby certify, that to the best of my knowledge and belief, that the above required materials delivered to the job site are the same as those submitted and approved.

____

____
Project QC Specialist

(continued):

Form 4-3 PREPARATORY PHASE INSPECTION CHECKLIST
(Part I)

Project : ______________________________ Date: ____________________

C. Equipment to be used in executing work:

1) ____
2) ____
3) ____
4) ____
5) ____

D. Work areas examined to ascertain that all preliminary work has been completed:

____

____

E. Methods and procedures for performing Quality Control, including specific testing requirements:

____

____

Form 4-3 PREPARATORY PHASE INSPECTION CHECKLIST
(Part II)

A. Persons in attendance: See Meeting Attendance Sheet (attached)

The above methods and procedures have been identified from the project plans and will be performed as specified for the Definable Feature of Work.

Project QC Specialist

Form 4-4 INITIAL PHASE INSPECTION CHECKLIST

Project.: ______________________________ Date: ______________

Title and No. of SSWP Section: ______________________________

Description and Location of Work Inspected: ______________________________

A. Key Personnel Present:

Name	Position	Company

B. Materials being used are in strict compliance with the contract plans and specifications: ☐Yes ☐No

If not, explain:

C. Procedures and/or work methods witnessed are in strict compliance with the contract specifications: ☐Yes ☐No

If not, explain: ______________________________

D. Workmanship is acceptable: ☐Yes ☐No

State where improvement is needed: ______________________________

E. Workmanship is free of safety violations: ☐Yes ☐No

If no, corrective action taken:

____

Project Quality Control Specialist

Form 4-5 FOLLOW-UP PHASE INSPECTION CHECKLIST

CONTRACTOR QUALITY CONTROL DAILY REPORT CONTINUATION SHEET
(ATTACH ADDITIONAL SHEETS IF NECESSARY)

Date: ____________________

Contractor: ____________________

Project: ____________________

Y=YES; N=NO; SEE REMARKS BLANK=NOT APPLICABLE	
WORK COMPLIES WITH WORK PLAN AS APPROVED IN INITIAL PHASE	

IDENTIFY DEFINABLE FEATURE OF WORK, LOCATION, AND LIST PERSONNEL PRESENT

INSPECTIONS PERFORMED & WHO PERFORMED TEST

Project QC Specialist ____________________ Date ____________________

Form 4-6 FIELD QC INSPECTION FORM

I **Project:**
Date:
QC Inspection Team Leader:
Inspection Remarks:
1.)
2.)
3.)
4.)
5.)
6.)

Inspected by	Date

Form 4-7 FINAL INSPECTION CHECKLIST
(PART I)

Project: ________________________ Date: ______________

Area of Inspection: ________________________

A. Definable Feature Of Work: Status of Inspection:

I hereby certify, that to the best of my knowledge and belief, that the work inspected is complete and all materials and equipment used and work performed were completed in accordance with plans submitted and approved.

____

____
Project QC Specialist

(continued):

Form 4-7 FINAL INSPECTION CHECKLIST
(PART II)

MEETING ATTENDANCE LIST

Meeting:		Date:
Name	**Organization**	**Phone Number**

Form 4-8 INSPECTION SCHEDULE AND TRACKING FORM

Project:		Project Manager:				Project QC Mgr/Staff:				
		Preparatory		Initial		Follow-Up		Completion		
Reference Number	Definable Feature of Work	Date Planned	Actual Date	Date Planned	Actual Date	Planned Begin/End	Actual Dates	Planned Begin/End	Actual Dates	Status

Form 4-8 INSPECTION SCHEDULE AND TRACKING FORM

Project:		Project Manager:				Project QC Mgr/Staff:				
Reference Number	Definable Feature of Work	Preparatory		Initial		Follow-Up		Completion		
		Date Planned	Actual Date	Date Planned	Actual Date	Planned Begin/End	Actual Dates	Planned Begin/End	Actual Dates	Status

Form 4-9 CORRECTIVE ACTION REQUEST[1]

[2]CAR #:	[3]PRIORITY: ☐HIGH ☐NORMAL	[4]DATE PREPARED:

PART A: NOTICE OF DEFICIENCY

[5]PROJECT:		
[6]PROJECT MANAGER:	[7]QC MANAGER/STAFF:	
[8]CONSTRUCTION MANAGER:	[9]MEC MANAGER:	
[10]ISSUED TO (INDIVIDUAL & ORGANIZATION):		
[11]REQUIREMENT & REFERENCE:		
[12]PROBLEM DESCRIPTION & LOCATION: [13]CAP REQUIRED? ☐YES ☐NO	[14]RESPONSE DUE:	
[15]ISSUED BY (PRINTED NAME & TITLE): SIGNATURE:	DATE:	[16]MANAGEMENT CONCURRENCE:

PART B: CORRECTIVE ACTION

[17]PROPOSED CORRECTIVE ACTION/ACTION TAKEN: NOTE: SUPPORTING DOCUMENTATION MUST BE LISTED ON THE BACK OF THIS FORM AND ATTACHED.		
[18]PART B COMPLETED BY (NAME & TITLE): SIGNATURE:	DATE:	[19]QC CONCURRENCE:

PART C: CORRECTIVE ACTION VERIFICATION

[20]CAR VERIFICATION AND CLOSE-OUT: (CHECK ONLY ONE & EXPLAIN STIPULATIONS, IF ANY) ☐APPROVED FOR CLOSURE WITHOUT STIPULATIONS ☐APPROVED FOR CLOSURE WITH FOLLOWING STIPULATIONS COMMENTS/STIPULATIONS: [21]CLOSED BY (PRINTED NAME & TITLE): SIGNATURE:	DATE:

CORRECTIVE ACTION REQUEST (CAR) INSTRUCTION SHEET

(1) QC Manager: Verify that the total number of pages includes all attachments.

(2) QC Manager: Fill in CAR number from CAR log.

(3) CQC System Manager: Fill in appropriate priority category. High priority indicates resolution of deficiency requires expediting corrective action plan and correction of deficient conditions noted in the CAR and extraordinary resources may be required due to the deficiencies impact on continuing operations. Normal priority indicates that the deficiency resolution process may be accomplished without further impacting continuing operations.

(4) CAR Requestor: Fill in date CAR is initiated.

(5) CAR Requestor: Identify project name, number, CTO, and WAD.

(6) CAR Requestor: Identify Project Manager

(7) CAR Requestor: Identify CQC System Manager.

(8) CAR Requestor: Identify project organization, group, or discrete work environment where deficiency was first discovered.

(9) CAR Requestor: Identify line manager responsible for work unit where deficiency was discovered.

(10) QC Manager: Identify responsible manager designated to resolve deficiency (this may not be work unit manager).

(11) CAR Requestor: Identify source of requirement violated in contract, work planning document, procedure, instruction, etc; use exact reference to page and, when applicable, paragraph.

(12) CAR Requestor: Identify problem as it relates to requirement previously stated. Identify location of work activities impacted by deficiency.

(13) QC Manager: Identify if Corrective Action Plan (CAP) is required. CAP is typically required where one or more of the following conditions apply: CAR priority is High; deficiency requires a rigorous corrective action planning process to identify similar work product or activities affected by the deficiency; or deficiency requires extensive resources and planning to correct the deficiency and to prevent future recurrence.

(14) QC Manager: Identify date by which proposed corrective action is due to QC for concurrence.

(15) QC Manager: Sign and date CAR and forward to responsible manager identified in (10) above.

(16) Responsible Manager: Initial to acknowledge receipt of CAR.

(17) Responsible Manager: Complete corrective action plan and identify date of correction. Typical corrective action response will include statement regarding how the condition occurred, what the extent of the problem is (if not readily apparent by the problem description statement in [12]), methods to be used to correct the condition, and actions to be taken to prevent the condition from recurring. If a CAP is required, refer to CAP only in this section.

(18) Responsible Manager: Sign and date corrective action response.

(19) QC Manager: Initial to identify concurrence with corrective action response from responsible manager.

(20) QC Manager: Check appropriate block to identify if corrective action process is complete so that CAR may be closed. Add close-out comments relevant to block checked.

(21) QC Manager: Indicate document closeout by signing and dating.

Form 4-10 CORRECTIVE ACTION PLAN
Page 1 of 1

Attach clarifications and additional information as needed. Identify attached material in appropriate section of this form.

PART A: TO BE COMPLETED BY PROJECT MANAGER OR DESIGNEE

(1)PROJECT:		
(2)PROJECT MANAGER:	(3)QC MANAGER:	
(4)CAR NO(S) AND DATE(S) ISSUED:		
(5)DEFICIENCY DESCRIPTION AND LOCATION:		
(6)PLANNED ACTIONS	(7)ASSIGNED RESPONSIBILITY	(8) COMPLETION DUE DATE
(9)PROJECT MANAGER SIGNATURE: DATE:		

PART B: TO BE COMPLETED BY CQC SYSTEM MANAGER OR DESIGNEE

(10)CAP REVIEWED BY:	DATE:
(11)REVIEWER COMMENTS:	
(12)CAP DISPOSITION: (CHECK ONLY ONE AND EXPLAIN STIPULATIONS, IF ANY) ☐ APPROVED WITHOUT STIPULATIONS ☐ APPROVED WITH STIPULATIONS ☐ APPROVAL DELAYED, FURTHER PLANNING REQUIRED COMMENTS:	
(13)QC MANAGER SIGNATURE: DATE:	

Form 4-11 DAILY QC REPORT

Project. ________________________________ Date: ______________

LOCATION OF WORK: ________________________________

DESCRIPTION OF WORK: ________________________________

WEATHER: ☐(CLEAR) ☐(FOG) ☐(P.CLOUDY) ☐(RAIN) ☐(WINDY)

TEMPERATURE: MIN: _____°F MAX: _____°F

1. Work completed today by subcontractor:

____

____

____

2. Work completed today by QC inspection staff :

____

____

3. All work performed in conformance with Work Plan requirements? ________________

If not, explain: ________________________________

____

____

4. Non-conformances/deficiencies reported: ________________

____

5. Comments: ________________________________

____

____

____

CERTIFICATION: I certify that the above report is complete and correct and that I, or my representative, have inspected all work identified on this report and have determined to the best of my knowledge and belief that noted work activities are in compliance with work plans and specifications, except as may be noted above.

____

Project QC Specialist

Form 4-12 NONCONFORMANCE REPORT

PROJECT: To: ORIGINAL—Please return to CH2M HILL	NCR No.	Date: Page1
Item: Work Plan Reference : Requirement: **Nonconformance:**		
Issued by: Name:	Title: UXOQC	Organization:
Date:		
Disposition: ______ Accept _______ Reject		
Details		
Disposition Approvals:		
UXOQCS Date	FCR Required? Yes No	
Project Manager Date	Distribution:	
Remarks:		

Form 4-13 ROOT CAUSE ANALYSIS FORM

Root Cause Analysis (RCA)

Root Cause Categories (RCC): Select the RCC numbered below that applies for the root cause (RC) and/or contributing factor (CF) in the first column, then describe the specific root cause and corrective actions in each column.

1. **Lack of skill or knowledge**
2. **Lack of or inadequate operational procedures or work standards**
3. **Inadequate communication of expectations regarding procedures or work standards**
4. **Inadequate tools or equipment**
5. **Correct way takes more time and/or requires more effort**
6. **Short-cutting standard procedures is positively reinforced or tolerated**
7. **Person thinks there is no personal benefit to always doing the job according to standards**

RCC #	Root Cause(s)	Corrective Actions	RC[1]	CF[2]	Due Date	Date Completed	Date Verified

[1] RC = Root Cause; [2] CF = Contributing Factors (check which applies)

Investigation Team Members

Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date

Determination of Root Cause(s)

For minor losses or near losses the information may be gathered by the supervisor or other personnel immediately following the loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, to determine the root cause, and to develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must use the Root Cause Analysis Flow Chart to assist in identifying the root cause(s) of a loss. Any loss may have one or more "root causes" and "contributing factors". The "root cause" is the primary or immediate cause of the incident, while a "contributing factor" is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the *person* involved in the loss, his or her peers, or the supervisor should be referred to as "personal factors". Causes that pertain to the *system* within which the loss or injury occurred should be referred to as "job factors".

<u>Personal Factors</u>

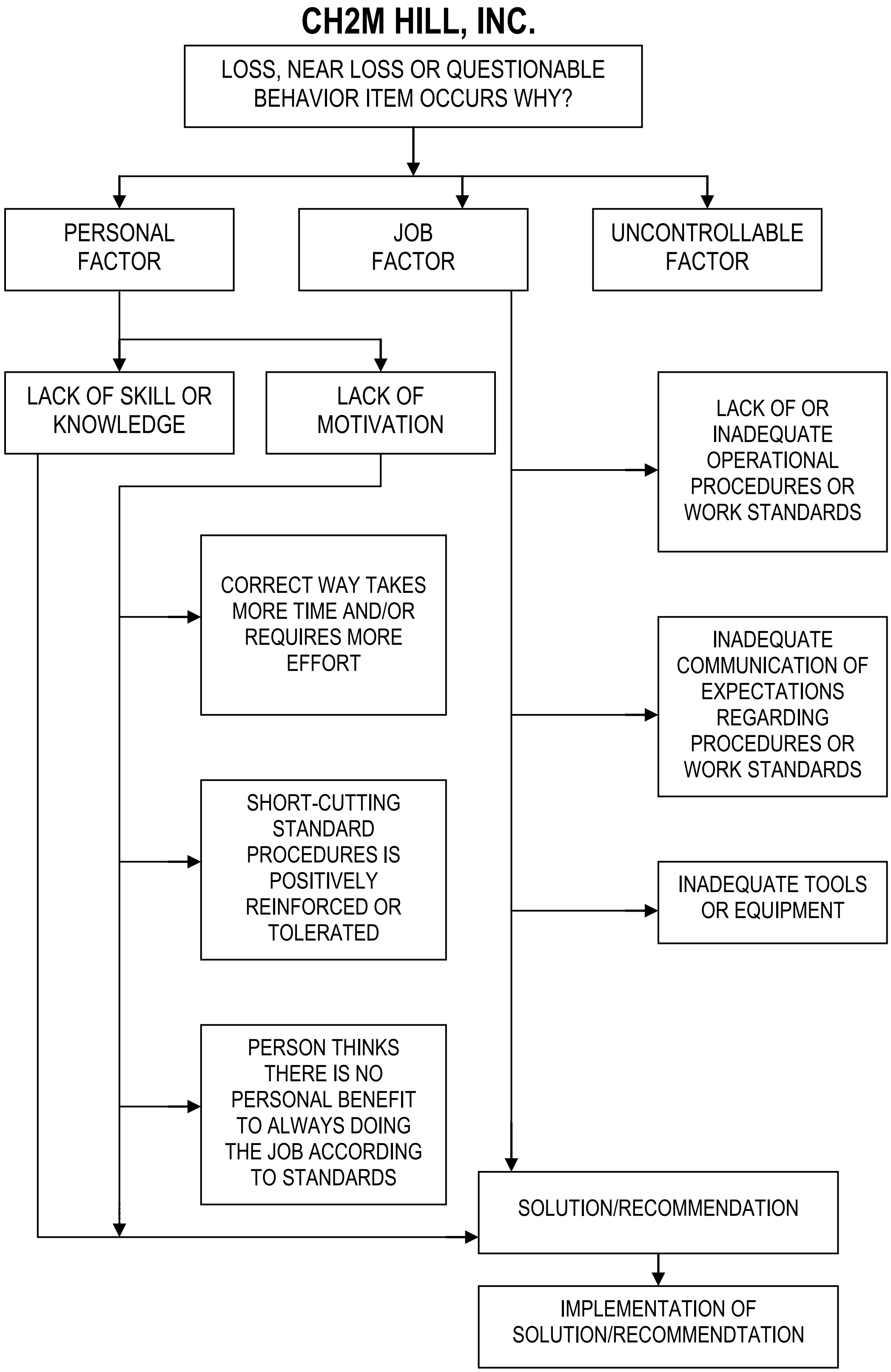
- Lack of skill of knowledge
- Correct way takes more time and/or requires more effort
- Short-cutting standard procedures is positively reinforced or tolerated
- Person thinks that there is no personal benefit to always doing the job according to standards

<u>Job Factors</u>

- Lack of or inadequate operational procedures or work standards.
- Inadequate communication of expectations regarding procedures or standards
- Inadequate tools or equipment

The root cause(s) could be any one or a combination of these seven possibilities or some other "uncontrollable factor". In the vast majority of losses, the root cause is very much related to one or more of these seven factors. Uncontrollable factors should be used rarely and only after a thorough review eliminates "all" seven other factors.

Root Cause Analysis
Flow Chart



FORM 4-14
Magazine Data Card

Nomenclature: ____________________

Lot Number: ____________________

Unit of Issue: _____________________________

Date	**Name**	**Received**	**Issued**	**Balance**	**Checkers Initials**

Form 4-15 EXPLOSIVE VEHICLE INSPECTION

Explosive Vehicle Inspection, ON-SITE

This form must be filled out for any vehicle carrying explosives, prior to loading.
This form is for use on site only, if traveling on public highways use DD Form 626

DRIVERS NAME ____________________ LICENSE NUMBER ____________________

COMPANY ____________________

TYPE OF VEHICLE ____________________ VEHICLE NUMBER ____________________

INSPECTION DATE/TIME ____________________ INSPECTOR ____________________

PART INSPECTED	**SAT.**	**UNSAT.**	COMMENT
HORN			
STEERING SYSTEM			
WIPERS			
MIRRORS			
FIRE EXTINGUISHERS (10 ABC, 2 EACH)			
REFLECTORS			
EMERGENCY FLASHERS			
LIGHTS			
ELECTRIC WIRING			
FUEL SYSTEM			
EXHAUST SYSTEM			
BRAKE SYSTEM			
SUSPENSION			
CARGO SPACE			
TIRES, WHEELS, RIMS			
TAILGATE			
TARPAULIN			

INSPECTION RESULTS (INSPECTOR INITIAL) ACCEPTED ____________

REJECTED ____________

REMARKS ____

DRIVERS SIGNATURE/DATE INSPECTORS SIGNATURE/DATE

OMB No. 1140-0026 (07/31/2014)

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Report of Theft or Loss-Explosive Materials

For ATF Use Only

Date Received	Date Faxed to JSOC & Field Division	Unique Identifier Case Number

To Be Completed By Person Making Report

Upon discovery of any theft or loss of any of your explosive materials:
- First, contact ATF toll free at 1-800-461-8841 between 8:00 a.m. - 5:00 p.m. EST or after hours and weekends contact ATF at 1-800-800-3855 to report the theft or loss;
- Second, contact your local law enforcement office to report the theft or loss to obtain a police report; and
- Third, complete this form and attach any additional reports, sheets or invoices necessary to provide the required information, and fax the form with additional material(s) to the ATF U.S. Bomb Data Center (USBDC) at 866-927-4570 or email to USBDC@atf.gov.

1. Date

2. Type of Report *(Check one)*: ☐ Theft ☐ Loss ☐ Attempted Theft/Suspicious Activity ☐ Supplement

3. Full Name of Person Making the Report *(Last, First, Middle)*

4a. Licensee or Permittee Name

4b. Federal Explosives License or Permit Number

5a. Office Address *(Street Address, City, State, and Zip Code)*

5b. Telephone Number

5c. E-mail Address

6. Actual Location of Theft or Loss *(If different from item 5a)*

7. Theft or Loss	Date	Time
a. Discovered		
b. When Was the Magazine Last Checked		
c. Occurred *(Show approximate if exact not known)*		
d. Reported to ATF by Telephone		
e. Reported to Local Authorities		

8. Name of Local Law Enforcement Officer to Whom Reported

9. Name and Address of Local Authority to Whom Reported

10. Telephone Number

11. Police Report Number

12. Explosive Materials Lost or Stolen *(Attach invoices or additional sheets, if necessary)*

a. Manufacturer and/or Importer	b. Brand Name	c. Date Shift Code	d. Size *(Length & Diameter)*	e. Quantity *(Pounds of Explosives, Number of Dets)*	f. Type and Description *(Dynamite, Blasting Agents, Detonators, etc. Include for each type, size, MS delay or length of legwire, as applicable)*

13. Theft or Loss Occurred from *(Check applicable box on each row)*

a. Magazine Type:

☐ 1 ☐ 2 ☐ 2 Det. Box ☐ 3 Day Box ☐ 4 ☐ 5

☐ Outdoor ☐ Indoor

☐ Permanent ☐ Portable ☐ Mobile Truck ☐ Mobile Trailer

☐ Overnight Storage ☐ Day Storage

b. Types of Locks *(Check all that apply)*:

☐ Padlock ☐ Mortise ☐ 3-Point ☐ Puck Lock ☐ Other *(Explain)* ____________

c. Location Description/Type:

☐ Licensed/Permitted Premises ☐ Remote Storage ☐ Work Site ☐ In Transit ☐ During Operations

14. Method of Entry:

☐ Door

Was a Key Used? ☐ Yes ☐ No

Suspected Employee-Involved Theft? ☐ Yes ☐ No

☐ Wall(s) ☐ Roof ☐ Floor/Bottom

Lock(s) Defeated? *(If yes, check additional appropriate boxes)* ☐ Yes ☐ No

☐ Lock Shackle Cut *(How?)* ____________________

☐ Lock Left Unlocked

☐ Keyway Drilled Out

☐ Other *(Explain)* ____________________

☐ Lock Pried, Twisted or Levered

☐ Lock Picked or Shimmed

☐ Lock Body Drilled Out or Cut

Manufacturer and Model of Lock:	Location of Magazine Keys: ☐ Office ☐ Employee ☐ Other *(Address)* ____________________	Are All Keys Accounted For? ☐ Yes ☐ No

15. Hood Defeated? *(If yes, check all applicable)* ☐ Yes ☐ No

☐ Hood Cut

☐ Other *(Explain)* ____________________

☐ Hood Removed

☐ Hood Broken

Hood Width *(Inches)* ____________________ Hood Length (Inches) ____________________

Hood Depth *(Inches)* ____________________ Hood Thickness (Inches) ____________________

16. Other Information Pertinent to the Theft, Loss or Suspicious Activity *(Any details you can provide)*

16a. Was Theft or Loss Disclosed During an ATF Inspection or Being Reported as a Result of Inspection? ☐ Yes ☐ No

16b. Additional Security Measures in Place?

☐ Alarm ☐ Security System/Service ☐ Fencing ☐ Lighting ☐ Other *(Explain)* ____________________

17. Signature and Title of Person Making Report	18. Date

Reporting Instructions

Email or fax this completed form to the ATF address listed below or call if no fax is available:

Bureau of Alcohol, Tobacco, Firearms and Explosives
U.S. Bomb Data Center
99 New York Ave., N.E. 8.S-295
Washington, DC 20226
Toll Free Fax: 1-866-927-4570
Email Address: USBDC@atf.gov

Questions regarding the completion of this form should be referred to the U.S. Bomb Data Center toll free at 1-800-461-8841.

Privacy Act Information

The following information is provided pursuant to section 3 of the Privacy Act of 1974 (5 U.S.C. § 522a(e)(3).

1. **Authority.** Solicitation of this information is made pursuant to Title XI of the Organized Crime Control Act of 1970 (18 U.S.C. Chapter 40). Disclosure of a theft or loss of explosive materials is mandatory pursuant to 18 U.S.C. § 842(k) for any person who has knowledge of such theft or loss from his stock.

2. **Purpose.** The purpose for the collection of this information is to give ATF notice of the theft or loss of explosive materials, and to furnish ATF with the pertinent facts surrounding such theft or loss. In addition, the information is used to confirm and verify prior notification of this theft or loss of explosive materials.

3. **Routine Uses.** The information will be used by ATF to aid in the administration of laws within its jurisdiction concerning the regulation of explosive materials and other related areas. In addition, the information may be disclosed to other Federal, State, foreign, and local law enforcement of laws within their jurisdiction. System of records notice Justice/ATF-008 Regulatory Enforcement Record System FR Vol.68 No.16 Page 3558 dated January 24, 2003.

4. **Effects of not supplying information requested.** 18 U.S.C. § 842(k) makes it unlawful for any person, who has knowledge of the theft or loss of explosive materials from his stock, to fail to report such theft or loss within twenty-four hours of discovery thereof, to the Secretary and to appropriate local authorities. The penalty for violation of this section is a fine of not more than $1,000 or imprisonment for not more than one year, or both. 18 U.S.C. § 844(b).

Paperwork Reduction Act Notice

This request in accordance with the Paperwork Reduction Act of 1995. The purpose of this information collection is to report the theft or loss of explosive materials. The information is used for investigative purposes by ATF officials. This information is mandatory by statute. (18 U.S.C. § 842)

The estimated average burden associated with this collection of information is 1 hour and 48 minutes per respondent or recordkeeper, depending on individual circumstances. Comments concerning the accuracy of this burden estimate and suggestions for reducing this burden should be addressed to Reports Management Officer, Document Services, Bureau of Alcohol, Tobacco, Firearms and Explosives, Washington, DC 20226.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Appendix B
Standard Operating Procedures

Standard Operating Procedures List

SOP	Title
ES-S01-503-P	Material Potentially Presenting an Explosive Hazard (MPPEH) Processing (CH2M HILL)
MR-AC-01-01	Assemble the TEMTADS 2x2 System for Dynamic Collection and Verify Operation (CH2M HILL)
MR-AC-02-01	Perform Initial Dynamic Instrument Verification Strip (IVS) Survey – TEMTADS 2X2 (CH2M HILL)
MR-AC-03-01	Perform Dynamic Surveys with TEMTADS 2x2 (CH2M HILL)
MR-AC-04-01	Process Dynamic Survey Data - TEMTADS 2x2 (CH2M HILL)
MR-AC-05-01	Perform Initial Cued Instrument Verification Strip (IVS) Survey – TEMTADS 2x2 (CH2M HILL)
MR-AC-06-01	Perform Cued Surveys with TEMTADS 2x2 (CH2M HILL)
MR-AC-07-01	Process Cued Surveys with TEMTADS 2x2 (CH2M HILL)
MR-AC-08-01	Re-Acquisition of Targets Prior to Intrusive Investigation (CH2M HILL)
MR-AC-20-01	Surface Sweep Quality Control Seeding (CH2M HILL)
MR-AC-21-01	Production Area Quality Control Seeding (CH2M HILL)
MR-AC-22-01	Surface Clearance (CH2M HILL)
TBD SOP-01	Explosive Demolition & Demilitarization Operations (CH2M HILL)
TBD SOP-02	Material Potentially Presenting an Explosive Hazard (MPPEH) Processing and Management (CH2M HILL)
TBD SOP-03	Anomaly Investigation (CH2M HILL)

ES-S01-503-P
Material Potentially Presenting an Explosive Hazard (MPPEH) Processing

Rev. No.	Effective Date	Revision Description	Procedure Owner Approval	Process Owner Approval
001	8.22.11	Original Issue	John Bowles	Andy Strickland

A. PURPOSE

This Procedure outlines the requirements for CH2M HILL Munitions Response (MR) personnel when processing Material Potentially Presenting an Explosive Hazard (MPPEH).

B. SCOPE

1. This procedure is to be used during MR projects directly performed by CH2M HILL UXO Technicians engaged in MPPEH processing. The objectives of such operations typically include inspection, re-inspection, verification, and certification of MPPEH into either Material Documented as Safe (MDAS) or Material Documented as an Explosive Hazard (MDEH).

2. This SOP does not include processes and requirements associated with surface clearance or subsurface excavation of MEC or explosive demolition operations of MEC/MDEH. The procedure for handling MEC/MDEH is ES-S01-501-P, Subsurface Clearance and Subsurface Excavation of MEC. It is also intended that the procedures included herein apply specifically to land-based MR operations. Please see Please see ES-S01-505-P, Munitions Response in Marine and Underwater Environments, for activities performed in a marine or underwater environment. There are also data management requirements associated with explosive demolition operations which are addressed by ES-S01-506-P, Munitions Response Site Information Management System (MRSIMS).

C. INPUTS

1. ES-S01-500-P Munitions Response Self Performance Policy

2. ES-S01-501-P, Surface Clearance and Subsurface Excavation of MEC

3. ES-S01-502-P, Explosive Demolition Operations

4. ES-S01-504-P, Munitions Response Technical Risk Evaluation

5. ES-S01-505-P, Munitions Response in Marine and Underwater Environments

6. ES-S01-506-P, Munitions Response Site Information Management System (MRSIMS).

7. SOP HSE 307, Excavation and Trenching Safety

8. HSE 601, Explosive Usage and Munitions Response

9. There are also many other references that guide the general requirements within this SOP. Due to the inherent and hazardous nature of military munitions, most of these references are issued under the cognizance of the U.S. Department of Defense through administration of its Military Munitions Response Program (MMRP) and the Component Services that execute the MMRP. While some of these references will be cited later in this SOP, it is the obligation of all CH2M HILL MR personnel to stay apprised of such requirements and their revisions. Additionally, MPPEH processing conducted for DoD projects will strictly comply with all requirements articulated in approved Explosives Site Plans (ESP) or Explosives Safety Submissions (ESS) and Project Managers will ensure ESPs/ESSs are amended appropriately whenever necessary.

10. As a provider of worldwide MR Services it is important to note that other countries administer similar programs and that their guidance, while generally very similar, is unique and we're contractually bound to understand and comply with this guidance. Where specific requirements may differ and matters of explosives safety are concerned, it is the policy of the Enterprise in the delivery of MR Services to observe those requirements providing the highest degree of safety to our personnel. For example, in Canada the government currently has material documented as safe (MDAS) shipped to a government-managed storage facility pending future disposal.

D. DEFINITIONS

Note: Definitions other than those provided below may apply for MR work performed outside U.S. jurisdictions. Check contractual references to ensure correct definitions are applied.

- **Material Document as Safe (MDAS).** Material that has been assessed and documented as not presenting an explosive hazard and for which the chain-of-custody has been established and maintained. This material is no longer considered MPPEH per DoD Instruction 4140.62 (see References).

- **Material Documented as an Explosive Hazard (MDEH).** MPPEH that cannot be documented as MDAS that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present, and for which the chain-of custody has been established and maintained. This material is no longer considered to be MPPEH per DoD Instruction 4140.62 (see References). (The MDEH characterization only addresses the explosives safety status of the material.)
- **Munitions and Explosives of Concern (MEC).** This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (A) Unexploded ordnance (UXO), as defined in 10 U.S.C. 101(e)(5); (B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (C) Munitions constituents (e.g., TNT, RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.
- **Material Potentially Presenting an Explosive Hazard (MPPEH).** Material owned or controlled by the Department of Defense that, prior to determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris) or potentially contains a high enough concentration of explosives that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are munitions within the DoD-established munitions management system and other items that may present explosion hazards (e.g., gasoline cans and compressed gas cylinders) that are not munitions and are not intended for use as munitions per DoD Instruction 4140.62 (see References).
- **Munitions Debris (MD).** A military munition or components thereof that do not contain explosives or pyrotechnics. Examples include practice munitions without spotting charges, inert training munitions, expended ejection munitions, and fragments of exploded/destroyed military munitions that do not contain explosives or pyrotechnics.

E. FLOWCHART

None

F. DETAILS

1. General Roles and Responsibilities

1.1. **MR Operations Director :** Ensures CH2M HILL MR personnel shall be qualified in accordance with DDESB Technical Paper (TP) 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel and are certified to perform the job assigned and that certifications are current. Prior to MR operations, the MR Operations Director will verify training, medical qualification statements by physicians, and conformance to substance abuse testing and reporting programs. The MR Operations Director will maintain a personnel qualification and certification program for MR personnel consistent with the requirements for UXO personnel at various levels of responsibility as specified in DDESB TP 18.

1.2. **Project Manager (PM):** Provides the project leadership and direction to ensure that the project is performed within the scope, schedule and budget, ensures quality, risk management, safety and contract compliance. The PM will ensure that site-specific work plans, safety plans, and/or SOPs that adequately address site-specific hazards and control measures are in place prior to the start of work. The PM will integrate MR staff for technical planning, field project execution, document reviews and to anticipate and resolve any technical MR issues relevant to project execution and delivery. **Senior UXO Supervisors and Unexploded Ordnance Technicians III or II:** Supervise the operational resources necessary to implement, and accomplish the procedures and requirements set forth within the Work, Health, Safety, Quality and Accident Prevention Plans of MR projects. They are required on all MR projects, and authorized to stop work at anytime to prevent accidents, remedy unsafe conditions, stop an unsafe act, or question the safety of a process or procedure or observe non-conformance to this SOP and/or plans. UXO Team Leaders shall also be responsible for recording data in MRSIMS and their log books. The SUXOS shall ensure Explosives Safety Quantity Distances (ESQD) are properly determined and enforced, as well as brief MR and project-essential personnel on communications, security, emergency/medical response, evacuation, rally points using project instructions and plans. This person shall inform personnel to prevent disclosure of classified work, site observations, or information.

1.3. **MR HSSE Manager:** Assists and advises the MR and project staff to plan, staff, and execute the MR safety program. Audits and evaluates MR field projects and safety programs to verify that HSSE requirements and practices are implemented and effective.

1.4. **Unexploded Ordnance Quality Control Specialist (UXOQCS):** Assists with the implementation of this SOP. Reports to the Munitions Response Quality Control Manager. Monitors conformance to this SOP and Work, Health, Safety, Quality, and Accident Prevention Plans. This individual ensures that quality control processes and procedures are executed in accordance with the Quality Control Plan (QCP) and or project instructions.

1.5. **Unexploded Ordnance Safety Officer (UXOSO) and/or UXOQCS** (may be a dual-hatted position for small or unique projects when specifically approved during the Munitions Response Technical Risk Evaluation (MRTRE), is required on each project covered in the scope of this SOP and reports to the Munitions Response Health, Safety and Quality Manager). The UXOSO provides a Daily Site Specific Tailgate Safety Briefing to include MEC, construction, industrial, environmental, and natural safety hazard awareness and provides the plan of the day. As applicable, they provide a Hazardous Materials briefing for items used, consumed, or required for this SOP. The UXOSO performs risk assessment to determine the number of visitors permitted, provides a safety briefing, and verifies training and medical surveillance qualifications of personnel. Responsible to implement health and safety/ activity hazard analysis, accident prevention plan requirements, assist the SUXOS to provide daily tailgate safety briefing, and enact emergency contingency plans as identified in plans.

2. **MPPEH Processing.**

The objective of these procedures is to ensure that a complete visual inspection of the exterior and interior surfaces of all recovered MPPEH is conducted by qualified personnel in accordance with applicable DoD regulations to ensure they are accurately categorized as either “material documented as safe (MDAS)” or “material documented as an explosive hazard (MDEH).” It should be noted that MPPEH as discussed within this SOP is understood to be material determined to be safe or acceptable to move. As the material potentially presents an explosive hazard, it is to be handled with extreme care and not subjected to heat, shock or friction during the evaluation process.

2.1 Personnel Specific Duties and Responsibilities

Unexploded Ordnance (UXO) Sweep Personnel will only mark suspected items and will not be allowed to perform any assessment of a suspect item to determine its status.

Unexploded Ordnance (UXO) Tech I can tentatively identify a located item as MPPEH, followed by a required confirmation by a UXO Tech II or III.

UXO Technician II will:

a. Perform a 100% inspection of each item as it is recovered and determine the following:
   (1) Whether the item is a UXO, DMM, munitions debris or range-related debris;
   (2) Whether the item contains explosives hazards or other dangerous fillers;
   (3) Whether the item requires disposal by detonation (MDEH);
   (4) Whether the item requires demilitarization (demil) for disfigurement or to vent/expose potential dangerous fillers;
   (5) Whether the item requires draining of engine fluids, illuminating dials and other visible liquid hazardous, toxic or radiological waste (HTRW) materials.
b. Segregate items requiring demil or venting procedures from those items ready for documentation as MDAS.
c. Items determined to contain explosive hazards or other dangerous fillers will be processed IAW applicable procedures and in compliance with ESP/ESS requirements.

UXO Technician III will:

a. Perform a 100% re-inspection of all recovered items to determine if free of explosives hazards or other dangerous fillers and engine fluids, illuminating dials and other visible liquid HTRW materials.
b. Supervise disposal of items found to contain explosive hazards or other dangerous fillers and venting/demil procedures using demolition procedures established in the ES-S01-01-502P Explosive Demolition Operations.
c. Supervise the consolidation of MPPEH for containerization and sealing. Munitions Debris and Range-related Debris will be segregated.

UXO Quality Control Specialist (UXOQCS) will:

a. Conduct daily audits of the procedures used by UXO teams and individuals for processing MPPEH.

b. Perform and document random sampling (by pieces, volume or area) of all MPPEH collected from the various teams to ensure no items with explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials are identified as munitions debris or range-related debris as required for completion of the Requisition and Turn-in Document, DD Form 1348-1A.

UXO Safety Officer (UXOSO) will:

a. Ensure the specific procedures and responsibilities for processing MPPEH for documentation as munitions debris or range- related debris specified in the WP are being followed.

b. All procedures for processing MPPEH are being performed safely and consistent with applicable regulations.

Senior UXO Supervisor (SUXOS) will:

a. Be responsible for ensuring work and QC plans specify the procedures and responsibilities for processing MPPEH for final disposition as munitions debris or range-related debris.

b. Ensure a requisition and turn-in document, DD Form 1348- 1A is completed for all munitions debris and range-related debris to be transferred for final disposition.

c. Perform random checks to satisfy that the munitions debris and range -related debris is free from explosive hazards necessary to complete the Form, DD 1348-1A.

d. Certify all munitions debris and range-related debris as free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials.

e. Be responsible for ensuring that inspected debris is secured in a closed, labeled and sealed container and documented as follows:

(1) The container will be closed and clearly labeled on the outside with the following information: The first container will be labeled with a unique identification that will start with USACE, AFCEE, NAVFAC or other client identifier followed by installation name, contractor's name and sequential numerical identifier (e.g. NAVFAC/Installation Name/Contractor's Name/0001/Seal's unique identification) and continue sequentially.

(2) The container will be closed in such a manner that a seal must be broken in order to open the container. A seal will bear the same unique identification number as the container or the container will be clearly marked with the seal's identification if different from the container.

(3) A documented description of the container will be provided by the contractor with the following information for each container; contents, weight of container; location where munitions or range- related debris was obtained; name of contractor, names of certifying and verifying individuals; unique container identification; and seal identification, if required. The contractor in a separate section of the final report will also provide these documents.

2.2 Munitions Debris (MD) Certification and Verification

MPPEH will be properly inspected IAW the procedures in paragraph 2.1 above. Only personnel who are qualified UXO personnel will perform these inspections. The SUXOS will certify the debris is free of explosive hazards and the Ordnance and Explosives Safety Specialist (OESS) or Navy Technical Representative (NTR) will verify the MPPEH inspection process has been followed. If an OESS/NTR is not on-site, the UXOQCS, or a similarly trained and authorized individual can be delegated to verify the MPPEH process.

DD form 1348-1A will be used as certification/verification documentation. All DD 1348-1A must clearly show the typed or printed names of the contractor's SUXOS and the OESS/NTR, organization, signature, and contractor's home office and field office phone number(s) of the persons certifying and verifying the debris as free of explosive hazards.

Local directives and agreements may supplement these procedures. Coordination with the local concerns will identify any desired or requested supplementation to these procedures.

In addition to the data elements required and any locally agreed to directives, the DD 1348-1A must clearly indicate the following for scrap metal:

a. Basic material content (Type of metal; e.g., steel or mixed);

b. Estimated weight;

c. Unique identification of each of the containers and seals stated as being turned over;

d. Location where munitions debris or range-related debris was obtained;

e. Seal identification, if different from the unique identification of the sealed container;

The following certification/verification will be entered on each DD 1348-1A for turnover of munitions debris or range- related debris and will be signed by the SUXOS and the USACE OESS. This statement will be used on any ranges where Range Related Debris is being processed along with munitions debris:

"This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTRW materials."

The following certification/verification will be entered on each 1348-1A for turnover of munitions debris and will be signed by the SUXOS on properties where only munitions debris is being processed:

"This certifies that material listed has been 100 percent properly inspected and to the best of our knowledge and belief, is inert and/or free of explosives or related materials."

2.3 Maintaining the Chain of Custody and Final Disposition

The chain of custody and final disposition of the certified and verified materials will be maintained. The certified and verified material will only be released to an organization that will:

a. Upon receiving the unopened labeled containers each with its unique identified and unbroken seal ensuring a continued chained of custody, and after reviewing and concurring with all the provided supporting documentation, sign for having received and agreeing with the provided documentation that the sealed containers contained no explosive hazards when received. This will be signed on company letterhead and stating that the contents of these sealed containers will not be sold, traded or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

b. Send notification and supporting documentation to the sealed container-generating contractor documenting the seal containers have been smelted and are now only identifiable by their basic content.

c. This document will be incorporated by the contractor into the final report as documentation for supporting the final disposition of munitions debris and range-related debris.
d. If the chain of custody is broken, the affected MPPEH must undergo a second 100 percent inspection, a second 100 percent re-inspection, and be documented to verify its explosives safety status (identified as either munitions debris or range related debris).
e. Material that has been documented as safe in no longer considered MPPEH as long as the chain of custody remains intact. A legible copy of inspection, re-inspection, and documentation must accompany the material through final disposition and be maintained for a period of three (3) years thereafter.

G. TOOLS

1. Cellular
2. Magnetometer capable of monitoring to a depth of two-feet below ground surface for ferrous items
3. All metals detector capable of monitoring to a depth of 6-inches below ground surface for non-ferrous items
4. Multi colors of marking flags, ribbon, and tape
5. Batteries
6. First –Aid Kit (25 person)
7. Water
8. Camera/Tape Measure/Ruler/Calipers/Paper Pencil
9. Hand tools, (hammer, general purpose tools, etc.)

H. OUTPUTS

Data collected regarding MPPEH processing operations will be recorded in MRSIMS and reported in accordance with project planning documents or other specific requirements.

I. ATTACHMENTS

None

J. REFERENCES

- DoD Instruction 4140.62, "Management and Disposition of Material Potentially Presenting an Explosive Hazard," November 5, 2008;

- DOD 6055.09-M, Ammunition and Explosives Safety Standards, August 2010;
- DDESB TP-18 Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, December 2004
- DA Engineering Manual (EM) 385-1-97 Explosives, Safety and Health Requirements Manual, September 2008;

MR-AC-01-01
Assemble the TEMTADS 2x2 System for Dynamic Collection and Verify Operation

Assemble the TEMTADS 2x2 System for Dynamic Collection and Verify Operation

1 Purpose and Scope

The purpose of this SOP is to identify the methods to be employed when assembling the TEMTADS 2x2 sensor system for dynamic collection and verifying that all components are correctly assembled, operating normally, and are capable of acquiring data of sufficient quality.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- TEMTADS 2x2 sensor coupled with a real-time kinematic Global Positioning System (RTK GPS) or Robotic Total Station (RTS) and Inertial Measurement Unit (IMU) for orientation measurements
- A schedule 40 small Industry Standard Object (small ISO40) in the Delrin mounting ring for sensor function testing
- Digital camera

2.1 Personnel and Qualification

The following individuals will be involved in the assembly verification of the TEMTADS:

- Project Geophysicist
- Field Geophysicist
- Data Processor
- Quality Control (QC) Geophysicist

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP) Quality Assurance Project Plan, Geophysical Classification for Munitions Response (GCMR QAPP), Worksheet #7.

3 Procedures and Guidelines

The TEMTADS 2x2 is an advanced electromagnetic induction sensor designed for the detection and classification of buried metal objects. The sensor consists of four sensor elements arranged on 40-centimeter (cm) centers in a 2x2 array. Each sensor element consists of a 35-cm square transmit coil for target illumination with an 8-cm three-axis receive cube centered in the transmit coil. The transmitters are energized in sequence and the decay curve is recoded up to 25 milliseconds after the transmitters are turned off for each of the 12 (4 cubes with 3 axes each) receive channels. A schematic of the sensor coil configuration is shown on Figure 1.

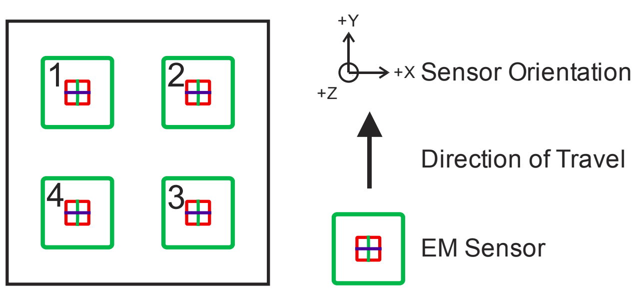
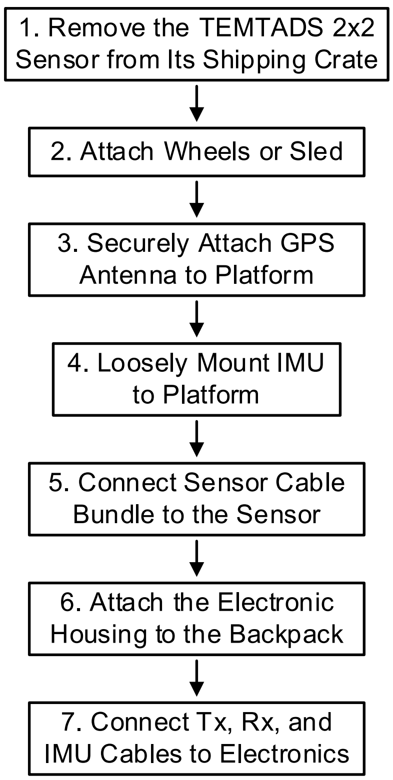


Figure 1. Orientation of the Four TEMTADS 2x2 Sensor Elements

Positioning of the TEMTADS 2x2 is accomplished using an RTK GPS or RTS. The TEMTADS 2x2 orientation is measured using a six-degree-of-freedom IMU. For proper functioning it is important to verify that the IMU has been mounted to the TEMTADS 2x2 in the correct orientation.

3.1 Assemble the TEMTADS 2x2

Figure 2. Overview of the TEMTADS Assembly Process



All assembly operations are described in the TEMTADS 2x2 unpacking instructions and user guide available from the Naval Research Laboratory (NRL) and the detailed instructions contained there should be followed precisely. Figure 2 shows a schematic overview of the assembly steps which are briefly described below:

1. Remove the sensor assembly from the packing crate following the instructions in the unpacking guide.
2. Attach the wheels or sled.
3. Securely attach the GPS antenna or RTS prism to the top of the mounting platform.
4. Set the IMU onto its position below the GPS or RTS prism. The attachment will be secured after correct IMU orientation is verified.
5. Connect the sensor cable bundle to the sensor. This includes the sensor TX and RX cables and the cables to the GPS (if using GPS) and IMU.
6. Remove the electronic housing from its shipping container and attach it to the backpack.
7. Attach the Tx, Rx, and IMU cables to the electronics box. The GPS cable (if using GPS) will be attached after booting the computer.

3.2 Turn On and Initialize the Data Acquisition Computers

Following the instructions in Section 5 of the TEMTADS 2x2 Users Guide, start the data acquisition system. After the main computer in the electronics housing boots, if using GPS, plug the GPS cable into the electronics. If GPS cable was attached prior to the full boot of the main computer, turn the system off, unplug the GPS cable and reboot main computer. The last step in Section 5 involves observing the IMU output. Leave the system in this state for the next operation.

3.3 Verify IMU Orientation

The procedure to verify the correct orientation of the IMU is shown on Figure 3 and instructions for this test follow.

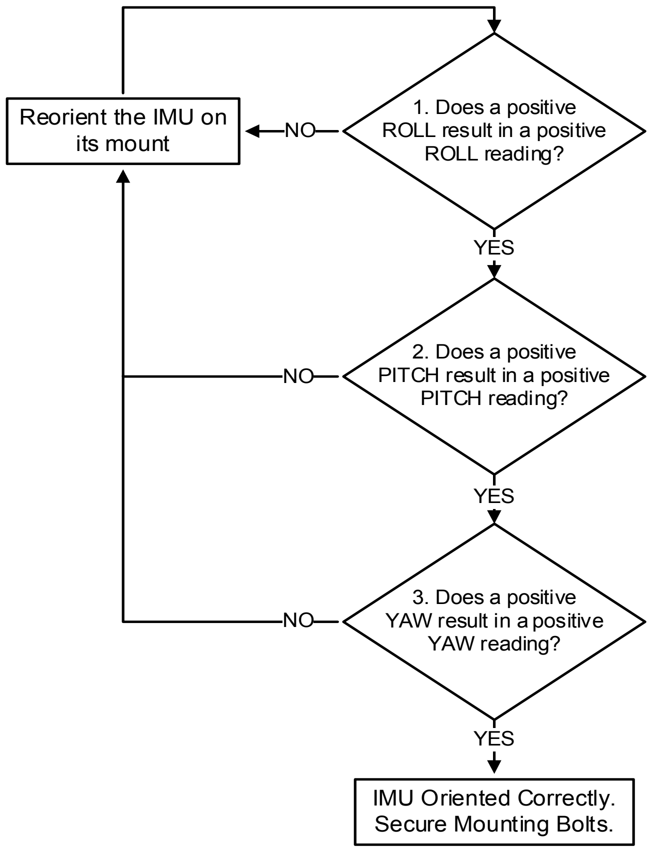


Figure 3. Procedure for Verifying IMU Orientation

1. Facing the direction of travel, rotate the IMU around the along-track axis to produce a positive ROLL as shown in Figure 4. Verify that the data acquisition system records a positive ROLL, Figure 5. If it does not, reorient the IMU on its mount and test again.

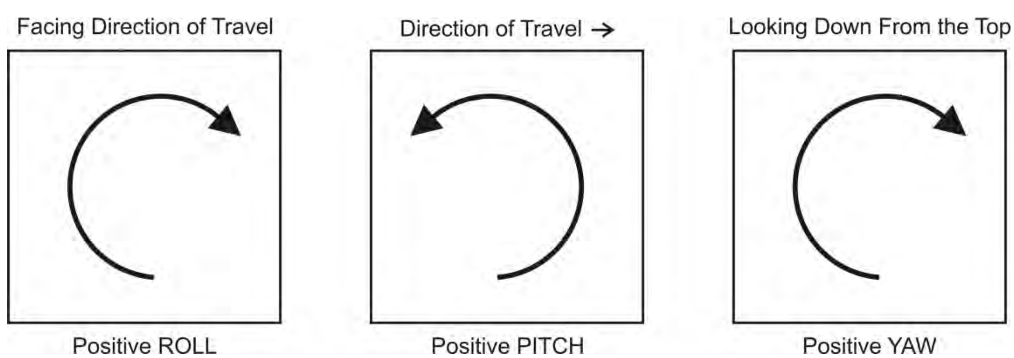


Figure 4. Positive ROLL, PITCH, and YAW Rotations of the IMU

Figure 5. Electronics Box Screen Showing Orientation Inputs

2. Standing on the side of the sensor with the direction of travel to your right, rotate the IMU around the cross-track axis to produce a positive PITCH as shown in Figure 4. Verify that the data acquisition system records a positive PITCH. If it does not, reorient the IMU on its mount and return to step 1.
3. Looking down on the sensor from above, rotate the IMU around the vertical axis to produce a positive YAW as shown in Figure 4. Verify that the data acquisition system records a positive YAW. If it does not, reorient the IMU on its mount and return to step 1.

3.4 Photograph the Sensor

Using a cell phone or other camera, photograph the installed sensor. Verify that the photograph(s) shows the locations and orientations of the GPS or RTS prism and IMU sensors.

3.5 Set up the Data Acquisition Parameters

In preparation for the sensor function test, use the [Setup] tab in TEMDataLogger or TEMTablet to set the correct data acquisition parameters for the dynamic survey. The easiest way to accomplish this is to use [Standard Dynamic] or [Standard Cued] button, Figure 6. The standard parameters are listed in Table 1.

Table 1. Standard Data Acquisition Parameters

Parameter	Cued Survey	Dynamic Survey
Acq Mode	Decimated	Decimated
Gate Width	5%	20%
Stacks	18	1
Repeats	9	3
Stack Period	0.9	0.033

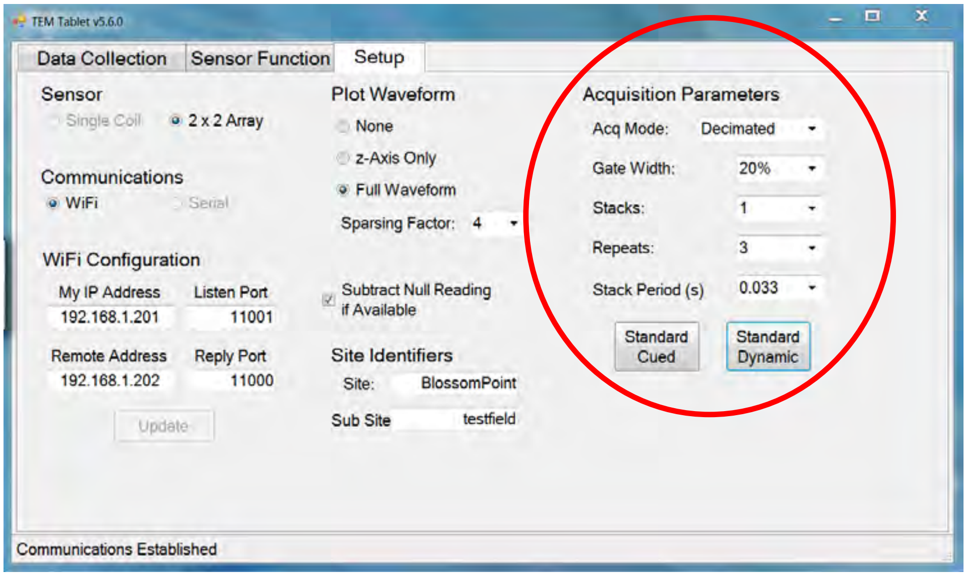


Figure 6. Standard Acquisition Parameters for Dynamic Surveys

3.6 Perform a Sensor Function Test

If there is a reference response for the combination of hardware and data acquisition parameters you are using, the [Sensor Function] tab will be available on the data acquisition computer. Access that tab to perform a sensor function test.

1. Position the sensor in a spot known to be clear of buried metal. Collect a background measurement from [Sensor Function] tab of the data acquisition software.
2. Without moving the sensor, mount the ISO80 test item in the hole on the top of the sensor housing (Figure 7, right panel)

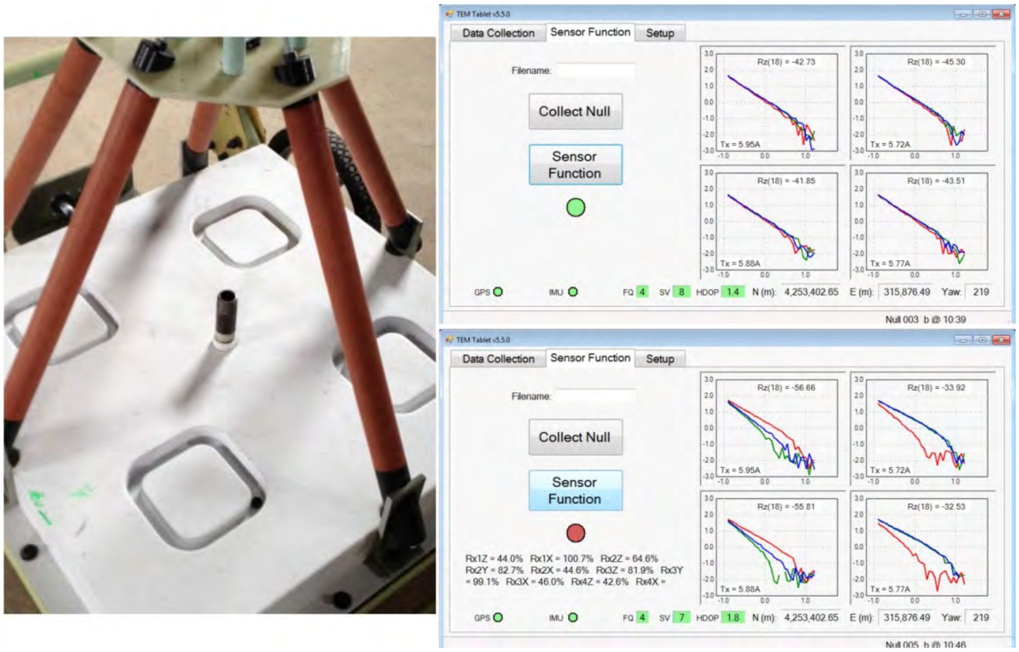


Figure 7. Test item Positioned for a Sensor Function Test (left panel) and Examples of the Test Results (right panels)

3. Collect sensor function data. If the results agree with the reference values, a green LED is displayed. If they do not agree, a red LED is displayed and a summary of the incorrect results is displayed.
4. Transfer the background and sensor function data files to the QC Geophysicist for archiving.

4 Data Management

The following sections describe the data that is needed to perform this SOP and the resulting data.

4.1 Input Data Required

Input data consists of the assembly and operation instructions for the TEMTADS 2x2 contained in the unpacking instructions and user guide available from NRL.

4.2 Output Data

The sensor function test described in Section 3.6 will be saved in the project database. Also, the QC checklist in Attachment 1 of this SOP will be completed, signed, and filed with the assembly photograph(s) as proof of correct assembly.

5 Quality Control

As this definable feature of work is accomplished only during the preparatory phase, only preparatory QC checks will be performed on this activity. QC consists of performing the inspections on the Preparatory Phase Quality Control Checklist that is included as Attachment 1 to this SOP. This checklist will be completed by the Field or Project Geophysicist and will be reviewed by the QC Geophysicist who will document the implementation of this SOP.

5.1 Measurement Quality Objectives (MQOs)

The MQO (QAPP Worksheet #22) for this SOP is verification that the assembly instructions have been followed. The TEMTADS 2x2 will not be tested on the IVS (SOP MR-AC-02-01) until this has been documented as described below.

5.2 Reporting

Achievement of the Sensor Assembly MQO will be documented by the Field or Project Geophysicist by completion of the Preparatory QC Checklist in Attachment 1 to this SOP and will be verified by the QC Geophysicist.

The delivered data package for the assembled and tested TEMTADS will be included in a section of the IVS Letter Report titled “TEMTADS Assembly and Operation Verification” and will include:

- A brief description of the assembly and test process along with the photograph(s) required by Section 3.4 of this SOP
- The completed Preparatory QC Checklist signed by the Project or Field Geophysicists and checked by the QC Geophysicist verifying the assembly and orientation tests described above
- The sensor Function Test results

Attachment 1

SOP 1 Preparatory TEMTADS Assembly QC Checklist

This checklist is to be completed by the Project or Field Geophysicist and checked by the QC Geophysicist during assembly and initial testing of the TEMTADS.

QC Step	QC Process and Guidance Reference	Yes/No	Initial of Field or Project Geophysicist
1. Assembly	Is the TEMTADS assembled in accordance with the published instructions and in the sequence specified in Section 3.1?		
2. Testing: IMU orientation verification	Has the procedure and tests for verification of the IMU orientation been completed (Section 3.3)?		
3. Photograph the installation	Was a photograph showing the placement and orientation of the GPS or RTS prism and IMU taken?		
4. TEMTADS sensor function test	Was the TEMTADS sensor function test performed in accordance with Section 3.6 and were the results saved in the project database?		

Project or Field Geophysicist: ____________________________Date:___________

QC Geophysicist:______________________________________ Date:____________

MR-AC-02-01
Perform Initial Dynamic Instrument Verification Strip (IVS) Survey – TEMTADS 2X2

Perform Initial Dynamic Instrument Verification Strip (IVS) Survey – TEMTADS 2X2

1 Purpose and Scope

The purpose of this standard operating procedure (SOP) is to identify the means and methods to be employed when verifying the operation of an advanced digital geophysical mapping system prior to and during site surveys. The Instrument Verification Strip (IVS) is constructed of a series of buried inert munitions and/or industry standard objects (ISO). During the IVS process the advanced electromagnetic induction sensor system measures the amplitude response of each item in the IVS in dynamic mode and collects background noise data for leveling magnitude responses.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Naval Research Laboratory (NRL) TEMTADS 2x2 (TEMTADS) sensor coupled with a real-time kinematic Global Positioning System (RTK GPS) and Inertial Measurement Unit (IMU) for orientation measurements.
- Tablet PC
- Seed objects to place in the IVS
- Hand tools including shovels, pick axes, breaker bars, etc. to construct the IVS
- Tape measure (with centimeter scale)
- Digital camera
- White board with markers and eraser
- Wooden stakes and/or vinyl-stem pin flags (no red or white colors)*
- RTK GPS staff and data collector for recording positions of buried items

*These colors have specific designations when working on munitions response sites and should not be used for geophysical surveying

Information in this SOP assumes that an RTK GPS and IMU will be used with the system during data collection. If the TEMTADS is used for data collection in an area not suitable for use with GPS (e.g. under tree canopy), sections of this SOP pertaining to the RTK GPS will not apply. Similarly, if an IMU is not available for use with the system, sections of this SOP pertaining to the IMU will not apply.

2.1 Personnel and Qualification

The following individuals will be involved in the assembly verification of the TEMTADS:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

- UXO Personnel will be responsible for overall daily site access and safety aspects of the project, compiling subcontractor health and safety documents, conducting daily safety briefings and performing MEC avoidance, as needed, in the field. Information on the specific qualifications for various UXO personnel support roles can be found in the project Health and Safety Plan.

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP) Quality Assurance Project Plan, Geophysical Classification for Munitions Response (GCMR QAPP), Worksheet #7.

3 Procedures and Guidelines

3.1 Advanced Digital Geophysical Mapping System

The advanced digital geophysical mapping (DGM) will be conducted using the TEMTADS sensor developed by NRL. This sensor has been extensively validated in a series of demonstrations conducted by the Department of Defense's Environmental Security Technology Certification Program (ESTCP). The TEMTADS is an advanced electromagnetic induction sensor designed for the detection and classification of buried metal objects. The sensor consists of four sensor elements arranged on 40-cm centers in a 2x2 array. Each sensor element consists of a 35-cm square transmit coil for target illumination with an 8-cm three-axis receive cube centered in the transmit coil. The transmitters are energized in sequence and the decay curve is recoded up to 25 ms after the transmitters are turned off for each of the 12 (4 cubes with 3 axes each) receive channels.

Positioning of the TEMTADS will be accomplished using RTK GPS. With adequate satellite visibility, RTK GPS can provide antenna locations with accuracies typically 5 cm or better. The TEMTADS orientation is measured using a six-degree-of-freedom IMU. Combining the sensor orientation and location measurements in this manner typically results in derived target locations within 15 cm of the ground truth.

3.2 Instrument Verification Strip Construction

Validation of the DGM system is accomplished using an IVS. Multiple IVS locations may be constructed during the project for convenience (for example, to avoid long travel times to reach the IVS on large sites). The construction details and verification procedures described in this document apply to each IVS location.

Location and Length of the IVS

IVS locations will be determined during initial site reconnaissance by the DGM field team. The IVS should be established in an area that is easily accessible, not prone to flooding and other weather-related phenomena, and is determined to be relatively free of subsurface metal objects. The IVS is constructed along a single transect approximately 30 m long. The IVS items, types and quantity to be determined and documented in the QAPP, including a blank, will be buried/established at approximate 5m intervals along this transect. The IVS site should be wide enough to accommodate transects on either side of the established IVS line at the project line spacing as well as an additional transect established 5m to the side to serve as a representative noise assessment line.

Seed Objects

Seed objects for the IVS can be either actual inert munitions or ISOs, or a combination of the two when inert munitions items are available for use. Using inert munitions that match those expected to be found on the site is often preferable as this demonstrates to stakeholders that the system is able to accurately classify the exact munitions type(s) of concern. However, using an ISO is the technical equivalent and can be confidently used instead when inert munitions for the items of concern at a site are not available.

An ISO, if used, should approximate the size of the munitions type(s) expected to be found on the site (if possible) and more than one type of ISO may be used if MEC of various sizes are expected. Either small, medium or large ISO, singly or in combination, can be selected. Table 1 shows the specifications for the three possible ISO and Figure 1 is a photograph of the three ISO.

Table 1. Industry Standard Objects Characterized for Use as Munitions Surrogates

Item	Nominal Pipe Size	Outside Diameter	Length	Part Number[1]	ASTM Specification
Small ISO	1"	1.315" (33 mm)	4" (102 mm)	44615K466	A53/A773
Medium ISO	2"	2.375" (60 mm)	8" (204 mm)	44615K529	A53/A773
Large ISO	4"	4.500" (115 mm)	12" (306 mm)	44615K137	A53/A773

[1] Part number from the McMaster-Carr catalog (http://www.mcmaster.com/).

Figure 1. Small, Medium, and Large Industry Standard Objects (ISOs)

IVS Procedures

Figure 2 illustrates the overall IVS process and the procedures to be followed during the site selection, emplacement, and use of the IVS.

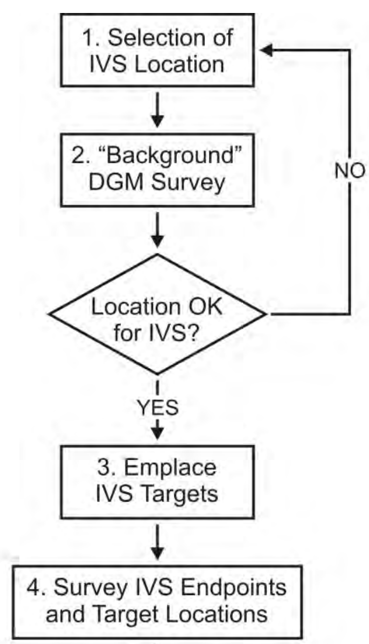


Figure 2. IVS Site Selection, Emplacement, and Documentation

1. An IVS location 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 DGM survey area.
   - 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 separation and preferably greater) 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 TEMTADS or other DGM instrument using RTK GPS. The purpose of this step is to document the appropriateness of the location (e.g. few existing anomalies), and will verify that IVS targets are not seeded near existing anomalies. The data from this IVS pre-survey will be processed and provided to the Project, Field and QC Geophysicists for evaluation.

3. Once the IVS area is deemed suitable for use, (i.e. free of significant subsurface anomalies or containing anomalies that are clearly identified so that they can be avoided during seeding), the targets shall be buried at depths below ground surface of approximately 3 and 7 times their diameter, unless otherwise specified in the QAPP. (These depths are intended to provide adequate signal to noise ratio for detecting the targets.) Some of the items should be placed horizontally (most difficult to detect) and some vertically (easiest to detect). The generalized diagram of the seeded IVS transect is presented as Figure 3, using an example of 4 targets and a blank space.

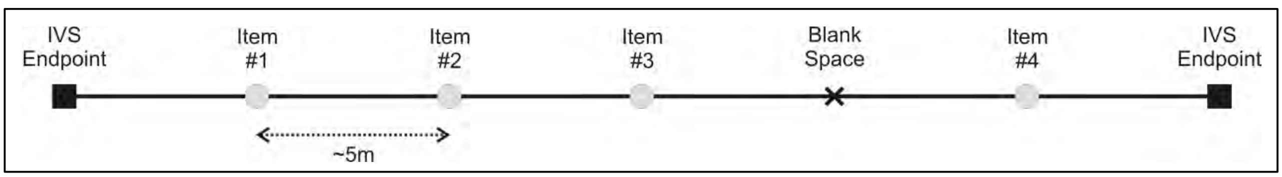


Figure 3. Example Layout of the IVS

Measurements of the item depths will be to the center of mass of each item. On-site personnel will bury the IVS targets using shovels to dig the holes to the appropriate depths for burial of the seed items in coordination with the QC Geophysicist. UXO personnel will implement MEC avoidance procedures using analog instruments during installation. The background survey data and anomaly avoidance techniques will be reviewed so that transect start and end stakes and the seed items are not placed on top of or near existing anomalies. IVS construction personnel will bury the ISOs and record the following information:

- Transect endpoints
- Target type(s)
- Target emplacement locations
- Target emplacement depths
- Target emplacement orientations

4. The holes will then be filled with soil and a wooden survey stake or other suitable non-metallic marker will be placed at each buried item location as well as the start and end location of the IVS. Wooden stakes will not extend more than 3 inches above the ground surface to prevent interference with the TEMTADS when passing over them.

3.3 Initial IVS Survey

The initial IVS survey will be completed prior to collecting production data. The TEMTADS assembly and function tests presented in SOP MR-AC-01-01 will be completed.

During the initial IVS survey, a total of 4 dynamic data transects will be collected with the TEMTADS over the IVS and one dynamic data transect performed over the background area (which should be between 3-5 meters offset from the IVS) as depicted on **Figure 4**. Three of the IVS transects will be performed at the intended survey line spacing, with the center of these three directly over the IVS targets (transects A, B, and D on **Figure 4).** The fourth transect will be performed offset from the IVS by ½ the intended line spacing to assess detection capability of targets situated between lines.

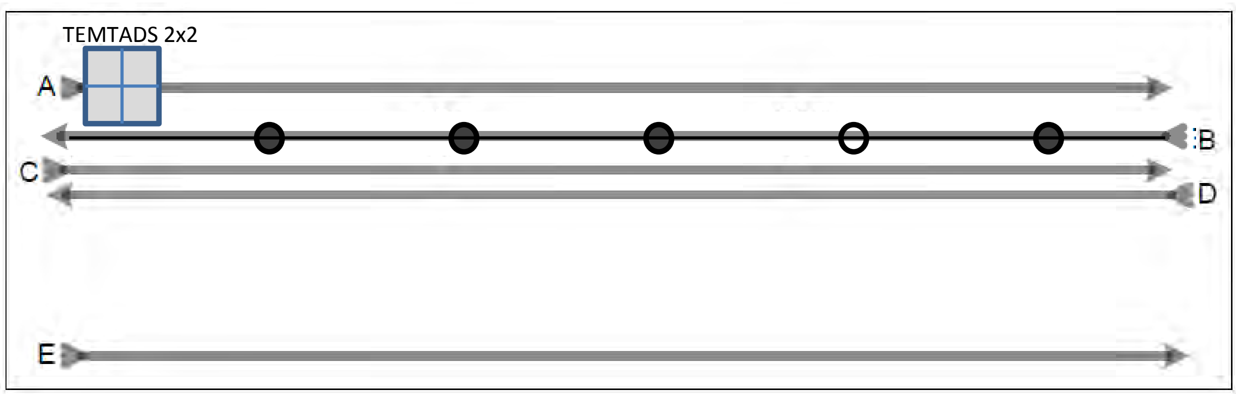


Figure 4. Dynamic Transect Locations for the Initial IVS Survey

The data from these transects will be processed in the same manner as the detection survey data and will be used to verify that the MQOs presented in QAPP Worksheet #22 for the initial IVS survey are met. Once the initial IVS survey MQOs have been met, the IVS survey will be complete and the system and operators verified for field data collection.

4 Data Management

The IVS construction details (IVS item description, location, depth and orientation) will be archived in digital form. The raw and processed IVS background data well as the raw and processed initial IVS survey data will be archived in a suitable format and summarized in the IVS Technical Memorandum.

5 Quality Control

Quality control (QC) for this activity will be achieved through completion of the checklist presented as Attachment 1. This checklist will be filled out and signed by the Field Geophysicist(s), Project Geophysicist, and Data Processor.

The activities described in this SOP are being performed in support of QC for an advanced sensor detection survey. The MQOs for the initial IVS survey are presented in Worksheet #22 of the QAPP. The TEMTADS will not be used for field data collection until it is able to meet these MQOs or until an appropriate corrective action (CA) is determined, the project team agrees to the CA, and it is successfully implemented.

6 Reporting

The IVS construction and initial survey results will be documented in an IVS Technical Memorandum. This report will include information on the following:

- IVS location and setup
- IVS item descriptions including types, locations, depths and orientation
- Sensor(s) system performance against the MQOs established for the initial IVS survey including response amplitude, item position, and system noise levels
- Completed checklists from SOPs MR-AC-01-01 and MR-AC-02-01

Attachment 1

SOP MR-AC-02-01 Dynamic Instrument Verification Strip (IVS) Survey QC Checklist

This checklist is to be completed by the Field Geophysicist(s) or Project Geophysicist during construction and initial survey of the IVS.

QC Step	QC Process	Yes/No	Initial of Field or Project Geophysicist
1. IVS Construction	Has an appropriate location for the IVS been selected and verified as suitable using a background geophysical survey?		
2. IVS Construction	Have appropriate IVS seed targets been selected and procured?		
3. IVS Construction	Were the target seeds buried appropriately, backfilled and marked?		
4. IVS Construction	Is the required data on the IVS construction from Section 3.2 recorded for inclusion in the IVS Technical Memorandum?		
5. Initial IVS Survey	Is the IVS data collected in accordance with Section 3.3?		
6. Initial IVS Survey	Have the MQOs for the initial IVS survey on Worksheet #22 been achieved?		

Field Geophysicist: ____________________________Date:__________

Project Geophysicist: __________________________Date:__________

Data Processor: ______________________________Date:__________

MR-AC-03-01
Perform Dynamic Surveys with TEMTADS 2x2

Perform Dynamic Surveys with TEMTADS 2x2

1 Purpose and Scope

The purpose of this Standard Operating procedure (SOP) is to identify the means and methods to be employed when performing dynamic surveys using a TEMTADS 2x2 (TEMTADS) advanced electromagnetic induction (EMI) sensor for target detection.

Dynamic TEMTADS data collection involves navigating the sensor along transects at a transect spacing designed to meet the project objectives with respect to detection performance of suspected targets of interest (TOI) in the subsurface. The detection objectives and resultant transect spacing are identified in the QAPP.

The observed signal measured by the TEMTADS is composed of 1) the EMI response of potential buried targets, 2) the self-signature of the sensor system, and 3) any response from the ambient environment in which the target is buried. To isolate responses associated with buried discrete metal objects, a background model comprised of the latter two contributing signals must be derived and removed from the raw data. The resulting 'leveled' signal data, (raw data – background model) are used as inputs into a detection algorithm where anomalous responses due to potential targets of interest are mapped and selected for further investigation. Details of the data processing and analysis of dynamic data are covered in MR-AC-04-01.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment, and materials required to implement this SOP.

2.1 Personnel and Qualifications

The following individuals will be involved in the collection of dynamic survey data:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP) Quality Assurance Project Plan, Geophysical Classification for Munitions Response (GCMR QAPP), Worksheet #7.

2.2 Equipment

The following is a list of required equipment and materials:

- TEMTADS sensor coupled with a real-time kinematic Global Positioning System (RTK GPS) or Robotic Total Station (RTS) and orientation sensor
- Tablet PC
- Field survey grade tape measure

2.3 Materials

Non-metallic materials to use for maintaining line spacing (e.g. traffic cones, marking paint, bean bags, etc.)

3 Procedures and Guidelines

3.1 Survey Grid Preparation

Grid preparation involves demarking the site boundaries and survey transects required to achieve the coverage specified in the GCMR QAPP. The site will be subdivided into grids with sizes depending upon the site conditions such that the sensor can be precisely navigated along the desired transect.

3.2 Function Test Measurements

Function test measurements (described in SOP MR-AC-01-01) will be performed prior to each sortie to confirm that all transmit and receive components of the TEMTADS sensor are operational.

3.3 Daily Instrument Verification Strip Survey

Prior to the start and at the end of each day of data collection, measurements of the set of Instrument Verification Strip (IVS) Survey targets will be performed (described in SOP MR-AC-03-01).

3.4 Dynamic Data Collection

Dynamic survey for DGM involves collecting data along transects across the survey area. In combination with SOPs for sensor assembly (SPO MR-AC-01-01) and testing at the IVS (SOP MR-AC-02-01), in-motion data is collected along each transect at a spacing appropriate to the site and project needs, as defined in the GCMR QAPP. Data collection is controlled by the user with the EM-3D software, which allows the user to assign a numerical ID to each transect line and start/stop data collection at the beginning/end of each transect. When an obstacle is encountered along a transect, the obstacle can be avoided by either altering the path of the transect or stopping data collection when the obstacle is encounter and resuming a new ID transect on the other side of the obstacle. Data gaps that are the result of obstacles should be recorded by the field geophysicist and submitted to the data processor. Data gaps that are the result of line spacing over the defined acceptable spacing will be determined by the data processor and provided to the field geophysicist for recollection. Data acquisition will be performed using the following steps:

1. **Start-up and test the TEMTADS.** The geophysical and navigation systems are started and a function test is performed prior to every data collection sortie. In addition the data acquisition software is monitored to ensure that all data streams (EMI, GPS or RTS, and inertial measurement unit [IMU]) are valid and being recorded.
2. **Navigate and collect data along transects**. Navigation along transects is performed visually with the assistance of markers, which are determined at the discretion of the field geophysicist (see Section 2.3). This can be accomplished by marking the track of the inside wheels as the sensor moves along a transect. Positioning in the data is captured through the use of the RTK GPS or RTS system and the IMU. Data collection along each transect will start and end at least one full TEMTADS 2x2 sensor length beyond the edge of the grid. This process facilitates full coverage of the survey grids and minimizes the occurrence of data gaps at grid edges. In addition, at the start of each new grid, data

collection will begin with the last transect fully contained within the adjacent grid. This overlap data is used primarily to support advanced geophysical analysis of the dynamic survey data. For survey grids along the survey area boundary, dynamic data collection will include at least one transect collected fully beyond the outer edge of the subject grid.

3. **Verify the integrity and quality of the collected data.** During data acquisition, the integrity and quality of the data will be verified by the operator by inspection of the TEMTADS data collection screen to ensure that:
   - The data collection start and stops in coordination with the beginning and end of each transect
   - Each transect is assigned a unique numerical identifier (ID) or file name in EM3D Acquire, in sequential order
   - The amplitude responses measured by each receiver coil appear reasonable (i.e., not 'flat-lined')
4. **Verify complete coverage of survey area.** 100% coverage surveys will require appropriate line spacing (presented in GCMR QAPP Worksheet #12). Data gaps resulting from obstacles or inaccessible terrain will be marked and verified by the field geophysicist. Data gaps exceeding the MQOs identified in GCMR QAPP Worksheet #22 will be reacquired using RTK GPS or RTS and recollected.

4 Data Management

4.1 Data inputs

The data inputs required for performing a cued advanced analysis data acquisition are:

- A list of coordinates identifying the site boundaries
- A list of IVS transect start and end points

4.2 Data Outputs

The data outputs of the cued advanced analysis data acquisition are:

- Dynamic TEMTADS transect data over the IVS line and survey area
- Function test measurement data
- Raw field notes (pdf images of hand written notes)
- Digital field notes (an excel or other digitally recorded table presenting data filenames as delivered and rectified field notes [i.e. differences between delivered digital filenames and field notes are resolved])

5 Quality Control

Practical considerations limit the real-time quality control (QC) of the dynamic data acquisition activities to qualitative assessments. Quantitative QC and assessment of the collected data will be performed as part of SOP MR-AC-04-01 dealing with the processing of dynamic TEMTADS detection data. Results documenting QC checks performed on the dynamic data are provided as part of the delivered data package for each sortie. This documentation includes the results of the QC tests, name, and date of the review performed by the QC Geophysicist.

5.1 Measurement Quality Objectives (MQOs)

The MQOs for dynamic data acquisition are presented in Worksheet #22 of the GCMR QAPP. Performance relative to the MQOs will be assessed during the processing of the collected data (SOP MR-AC-04-01). If it is determined during data processing that an MQO has not been met for the dynamic survey, a root cause analysis (RCA) will be performed and a corrective action (CA) determined. Dynamic TEMTADS data will not be used to select targets until the project team agrees on the CA and it is successfully implemented. Dynamic TEMTADS data will not be used to detect targets until these MQOs are met or until the project team agrees on modifications to these MQOs.

6 Reporting

Reporting of the activities associated with this SOP will consist of the digital copies of the field notes and data files submitted to the Data Processor.

MR-AC-04-01
Process Dynamic Survey Data - TEMTADS 2x2

Process Dynamic Survey Data - TEMTADS 2x2

1 Purpose and Scope

The purpose of this Standard Operating procedure (SOP) is to identify the means and methods to be employed when processing dynamic survey data collected using a TEMTADS 2x2 (TEMTADS) advanced electromagnetic induction (EMI) sensor for target detection.

Dynamic TEMTADS data collection involves navigating the sensor along transects at a transect spacing designed to meet the project objectives with respect to detection performance of suspected targets of interest (TOI) in the subsurface. The detection objectives and resultant transect spacing are identified in the Uniform Federal Policy (UFP) Geophysical Classification for Munitions Response (GCMR) Quality Assurance Project Plan (QAPP). Processing the dynamic data involves processing and assessing all Quality Control (QC) tests (including daily function tests and Instrument Verification Strip [IVS] surveys), leveling the raw data to remove EMI signal due to the self signature of the sensor systems and the ambient EMI soil response, and target selection.

A set of QC measurements are conducted upon initial commissioning of the system and on a daily basis to validate the operation of the various components of the TEMTADS dynamic survey system.

In the dynamic survey data, the observed signal measured by the TEMTADS is composed of 1) the EMI response of potential buried metallic objects, 2) the self-signature of the sensor system, and 3) any response from the ambient environment in which the target is buried. To isolate responses associated with buried discrete metal objects, a background model comprised of the latter two contributing signals must be derived and removed from the raw data. The resulting 'leveled' signal data, (raw data – background model) are used as inputs into a detection algorithm where anomalous responses due to potential TOI are mapped and selected for further investigation.

2 Personnel and Equipment

This section describes the personnel and equipment required to implement this SOP.

2.1 Personnel and Qualifications

The following individuals will be involved in the collection of dynamic data:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

The qualifications of the personnel implementing this SOP are documented in the UFP GCMR QAPP, Worksheet #7.

2.2 Equipment

The only required equipment is a data processing computer suitable for and equipped to run the processes provided in the UXA-advanced module of Geosoft's Oasis Montaj geophysical processing environment.

3 Procedures and Guidelines

This section describes the procedures used to process the dynamic production data including positioning and leveling of the data, process/assess the QC activities related to dynamic data collection, and select target anomalies from the final processed data.

3.1 Processing of Dynamic TEMTADS data

The processing of dynamic TEMTADS data is achieved in the following steps:

1. Data import and QC
2. Data positioning and background removal
3. Target selection

3.1.1 Data Import/initial QC

The raw *.TEM data files are converted to ASCII *.csv files and imported into a Geosoft Database (*.gdb) using a purpose built utility in UXA-Advanced. Once imported the data are inspected and assessed against the measurement quality objectives (MQOs) provided in Worksheet #22 for:

1. Transmit (Tx) current within limits
2. Global positioning system (GPS) or Robotic Total Station (RTS) fit quality
3. Valid inertial measurement unit (IMU) data
4. EMI response signal not saturated

Data measurements that do not pass the MQOs are automatically identified by a series of scripts that are used to default the position data where the MQOs are not met. This maintains the chronologic integrity of the EMI data but prevents the out-of-specification data from being mapped and used for detection.

3.1.2 Data Positioning and Leveling

A second purpose-built software routine automatically assigns the monostatic, Z-component EMI measurements positions based upon the GPS antenna location (or RTS prism), platform geometry and platform attitude (IMU) data. A site-specific de-median filter is applied to the raw monostatic, Z-component data to derive an estimate of the background model. This model is subtracted from the raw data to provide a background removed or 'leveled' data set. Figure 1 shows an example of raw data (top panel, red trace), the background model derived from these data (top panel, green trace) and the resulting background removed data.

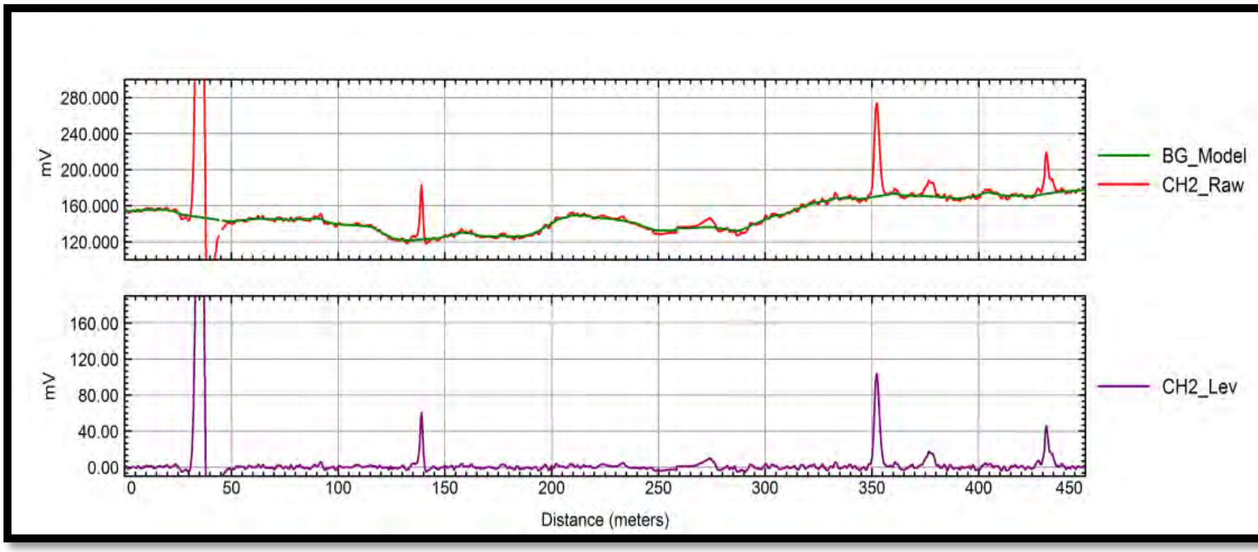


Figure 1. Example of Raw Data

The leveled monostatic data are gridded and mapped using conventional Geosoft tools. The mapped monostatic Z-component data are then used for amplitude response based target selection whereby the position of peak responses in the data that exceed the project threshold are selected and identified as target anomalies for further analysis.

The gridded and mapped monostatic Z-component data are also suitable for use to select background locations, which in turn can be used to level all of the 48 Tx/Receive (Rx) coil combination data in a manner similar to that used for background removal of cued target measurements.

3.1.3 Target Selection

Target selection using the TEMTADS dynamic data is performed using the traditional amplitude response metric using the mapped Z-component data described above. Alternately a dipole response filter approach can be used.

Response Amplitude Detection:

Traditional anomaly selection is based almost entirely on signal response amplitude. Using the TEMTADS dynamic survey monostatic Z-component response amplitude as a detection metric is essentially the same as using a Geonics EM61 response amplitude detection. After the data have been gridded, the Geosoft automatic grid peak detection algorithm is used to extract locations of all grid peaks that are above the project detection threshold. These target anomaly locations are review by the project geophysicist and manual additions and deletions are made to this list. The final list is reviewed by the QC geophysicist prior to finalization of the target list.

Dipole Response Filter Detection:

The 'dipole response filter' approach to anomaly detection makes use of the rich data set output of the advanced sensors. This target selection routine takes advantage of all the measured data – not just the monostatic Z component – by employing an automated dipole inversion routine to estimate the source locations. The process involves:

1. Assuming a target's location (at every 10 centimeter [cm] spaced grid node across the site)
2. Extracting data within a specified sensor footprint

3. Inverting for dipole polarizations
4. Extracting the 'goodness-of-fit parameter' as the detection metric

The 'goodness-of-fit' filter output is the squared correlation between the full multi-axis, multi-static TEMTADS data set and a dipole model fit to those data. This filter output is mapped in the same manner as the amplitude response and peaks in the detection metric indicate target locations as illustrated by Figure 2.

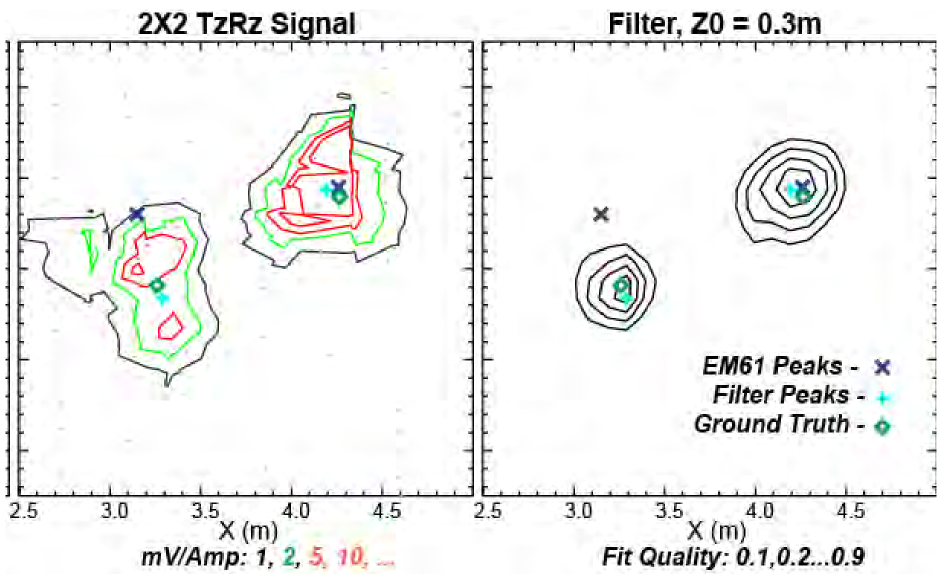


Figure 1. Data subset showing mapped response amplitude (left) and mapped filter response output (right) with ground truth information superimposed. Contour line values are provided in the legend.

Accordingly, target selection using the dipole filter fit coherence metric is accomplished in the same manner as for the amplitude response approach. After running the automatic peak detection routine, the target list will be reviewed and manual additions/deletions will be made.

3.2 Assessment of Quality Control of Dynamic Survey Data

During the course of a dynamic survey, QC measurements are performed on a daily basis to verify the operation of the sensor and associated components. These tests are comprised of function tests (described in SOP MR-AC-01-01) and transects along the IVS. The successful completion of these tests on a daily basis is required to validate the survey data collected on that day.

3.2.1 Function Test Measurement Processing

Function test measurements (described in SOP MR-AC-01-01) are performed prior to each sortie to confirm that all transmit and receive components of the TEMTADS sensor are operational. The data from each function test are assessed relative to the MQOs presented in GCMR QAPP Worksheet #22, compiled and presented in graphical form for review. Results that do not pass the MQOs are identified and the appropriate action specified in GCMR QAPP Worksheet #22 are taken.

3.2.2 Daily IVS Survey Processing

Prior to the start and at the end of each day of data collection, measurements of the set of IVS targets are performed (described in SOP MR-AC-03-01). These data are processed in the same manner as the production survey data with regard to positioning and background removal. The data from each IVS test are assessed relative to the MQOs presented in GCMR QAPP Worksheet #22, compiled and presented in graphical form for review. Results that do not pass the MQOs are identified and the appropriate action specified in GCMR QAPP Worksheet #22 (root cause analysis [RCA]/corrective action [CA]) are taken. Depending upon the findings of the RCA, the survey data associated with the IVS MQO failure may need to be re-collected.

4 Data Management

4.1 Data inputs

The data inputs required for processing dynamic TEMTADS data are:

1. A list of coordinates identifying the site boundaries
2. Raw Dynamic TEMTADS data files
3. Amplitude response minimum detection threshold (derived from the GCMR QAPP)

4.2 Data Outputs

The data outputs of the processing of dynamic TEMTADS data are:

1. QC reports summarizing daily QC measurement results
2. Mapped detection metric data (Z-component amplitude and dipole response coherence) in ASCII (x,y,z) format
3. Target anomaly list (identifier [ID], X, Y)
4. Letter report detailing processing approach including leveling and target selection procedures

5 Quality Control

Results documenting QC checks performed on the dynamic data are provided as part of the delivered data package for each sortie. This documentation includes the results of the QC tests, name, and date of the review performed by the QC Geophysicist.

5.1 Measurement Performance Criteria (MQOs)

The MQOs for processing dynamic TEMTADS data are presented in Worksheet #22 of the GCMR QAPP. Performance relative to the MQOs will be assessed during the processing of the data. If it is determined during data processing that an MQO has not been met, an RCA will be performed and a CA determined. Dynamic TEMTADS data will not be used to select targets until the project team agrees on the CA and it is successfully implemented.

6 Reporting

Reporting of the activities associated with this SOP will consist of the following:

- Digital Field notes
- Data processing log detailing the following for each sortie (chronologically contiguous data collection set):
  - Survey date

- % invalid data with regard to transmit (Tx) current, GPS or RTS fit quality, IMU data quality, EMI response within range
- Standard quality control checks performance
  - correct coordinates for grids
  - coverage
  - line gaps
  - background response
  - dropouts
  - downline density
  - appropriate leveling
  - appropriate anomaly selection
- Associated Function Test filename
- Associate IVS Test filename(s)
- Area subset (grid ID)

- QC report summarizing daily QC results (Function tests and IVS tests)
- Target List – final list of identified anomalies for delivered area subset
- Final data archive (gdb or xyz format) for delivered area subset
- Final grids of Z-component amplitude response for delivered area subset
- Final grids of detection metric (if not amplitude response) for delivered area subset
- Processing/data selection letter report

MR-AC-05-01
Perform Initial Cued Instrument Verification Strip (IVS) Survey – TEMTADS 2x2

Perform Initial Cued Instrument Verification Strip (IVS) Survey – TEMTADS 2x2

1 Purpose and Scope

The purpose of this SOP is to identify the means and methods to be employed when verifying the operation of an advanced digital geophysical mapping system prior to and during site surveys. The Instrument Verification Strip (IVS) is constructed of a series of buried inert munitions and/or industry standard objects (ISO). During the IVS process the advanced electromagnetic induction sensor system measures the amplitude response of each item in the IVS in dynamic mode and collects background noise data for leveling magnitude responses.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- TEMTADS 2x2 (TEMTADS) sensor coupled with a real-time kinematic Global Positioning System (RTK GPS) or Robotic Total Station (RTS) and Inertial Measurement Unit (IMU) for orientation measurements.
- Tablet PC
- Inert munitions (if available), ISOs, and surrogates to place in the IVS
- Hand tools including shovels, pick axes, breaker bars, etc. to construct the IVS
- Tape measure (with centimeter scale)
- Digital camera
- White board with markers and eraser
- Wooden stakes and/or vinyl-stem pin flags (no red or white colors)*
- RTK GPS or RTS staff and data collector for recording positions of buried items

*These colors have specific designations when working on munitions response sites and should not be used for geophysical surveying

Information in this SOP assumes that an RTK GPS or RTS and IMU will be used with the system during data collection. If the TEMTADS is used for data collection in an area not suitable for use with GPS or RTS, sections of this SOP pertaining to the RTK GPS and RTS will not apply. Similarly, if an IMU is not available for use with the system, sections of this SOP pertaining to the IMU will not apply.

2.1 Personnel and Qualification

The following individuals will be involved in the assembly verification of the TEMTADS:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

- UXO Personnel will be responsible for overall daily site access and safety aspects of the project, compiling subcontractor health and safety documents, conducting daily safety briefings and performing MEC avoidance, as needed, in the field. Information on the specific qualifications for various UXO personnel support roles can be found in the project Health and Safety Plan.

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP) Geophysical Classification for Munitions Response (GCMR) Quality Assurance Project Plan (QAPP), Worksheet #7.

3 Procedures and Guidelines

3.1 Advanced Digital Geophysical Mapping System

The advanced digital geophysical mapping (DGM) will be conducted using the TEMTADS sensor. This sensor has been extensively validated in a series of demonstrations conducted by the Department of Defense's Environmental Security Technology Certification Program (ESTCP). The TEMTADS is an advanced electromagnetic induction sensor designed for the detection and classification of buried metal objects. The sensor consists of four sensor elements arranged on 40-cm centers in a 2x2 array. Each sensor element consists of a 35-cm square transmit coil for target illumination with an 8-cm three-axis receive cube centered in the transmit coil. The transmitters are energized in sequence and the decay curve is recoded up to 25 ms after the transmitters are turned off for each of the 12 (4 cubes with 3 axes each) receive channels.

Positioning of the TEMTADS will be accomplished using RTK GPS or RTS. With adequate satellite visibility, RTK GPS can provide antenna locations with accuracies on the order of 5 cm. The TEMTADS orientation is measured using a six-degree-of-freedom IMU. Combining the sensor orientation and location measurements in this manner typically results in derived target locations within 15 cm of the ground truth.

3.2 Instrument Verification Strip Construction

Validation of the DGM system is accomplished using an IVS. Multiple IVS locations may be constructed during the project for convenience (for example, to avoid long travel times to reach the IVS on large sites). The construction details and verification procedures described in this document apply to each IVS location.

Location and Length of the IVS

IVS locations will be determined during initial site reconnaissance by the DGM field team. The IVS should be established in an area that is easily accessible, not prone to flooding and other weather-related phenomena, and is determined to be relatively free of subsurface metal objects. The IVS is constructed along a single transect approximately 30 m long. The IVS items, types and quantity to be determined and documented in the QAPP, including a blank, will be buried/established at approximate 5m intervals along this transect. The IVS site should be wide enough to accommodate additional parallel transects on either side of the IVS seeded transect at spacings of 0.25 m and 0.5 m as well as an additional transect spaced approximately 5m from the seeded transect to serve as a representative noise assessment line.

Seed Objects

Seed objects for the IVS can be either actual inert munitions or ISOs, or a combination of the two when inert munitions items are available for use. Using inert munitions that match those expected to be found on the site is often preferable as this demonstrates to stakeholders that the system is able to accurately classify the exact munitions type(s) of concern. However, using an ISO is the technical equivalent and can be confidently used instead when inert munitions for the items of concern at a site are not available.

An ISO, if used, should approximate the size of the munitions type(s) expected to be found on the site (if possible) and more than one type of ISO may be used if MEC of various sizes are expected. Either small, medium or large ISO, singly or in combination, can be selected. Table 1 shows the specifications for the three possible ISO and Figure 1 is a photograph of the three ISO.

Table 1. Industry Standard Objects Characterized for Use as Munitions Surrogates

Item	Nominal Pipe Size	Outside Diameter	Length	Part Number[1]	ASTM Specification
Small ISO	1"	1.315" (33 mm)	4" (102 mm)	44615K466	A53/A773
Medium ISO	2"	2.375" (60 mm)	8" (204 mm)	44615K529	A53/A773
Large ISO	4"	4.500" (115 mm)	12" (306 mm)	44615K137	A53/A773

[1] Part number from the McMaster-Carr catalog (http://www.mcmaster.com/).

Figure 1. Small, Medium, and Large Industry Standard Objects (ISOs)

IVS Procedures

Figure 2 illustrates the overall IVS process and the procedures to be followed during the site selection, emplacement, and use of the IVS.

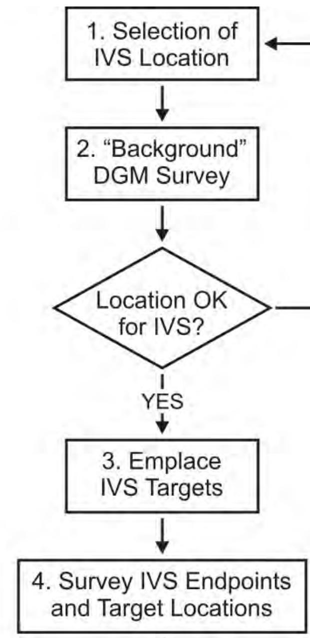


Figure 2. IVS Site Selection, Emplacement, and Documentation

1. An IVS location 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 DGM survey area
   - 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 separation and preferably greater) of the ISO items to avoid ambiguities in data evaluation
   - Readily accessible to project personnel
   - Proximity to the actual survey site (if not within the site)
2. A background DGM survey will be performed with the TEMTADS or other DGM instrument using RTK GPS. The purpose of this step is to document the appropriateness of the location (e.g., few existing anomalies), and will verify that IVS targets are not seeded near existing anomalies. The data from this IVS pre-survey will be processed and provided to the Project, Field and QC Geophysicists for evaluation.

3. Once the IVS area is deemed suitable for use, (i.e., free of significant subsurface anomalies or containing anomalies that are clearly identified so that they can be avoided during seeding), the targets shall be buried at depths below ground surface of approximately 3 and 7 times their diameter, unless otherwise specified in the QAPP. (These depths are intended to provide adequate signal to noise ratio for detecting the targets.) Some of the items should be placed horizontally (most difficult to detect) and some vertically (easiest to detect). The generalized diagram of the seeded IVS transect is presented as Figure 3, using an example of 4 targets and a blank space.

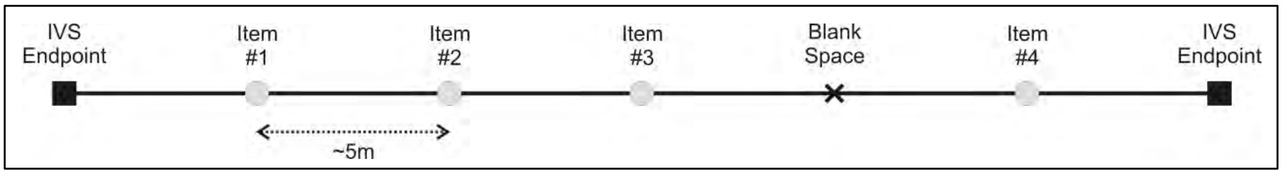


Figure 3. Example Layout of the IVS

Measurements of the item depths will be to the center of mass of each item. Onsite personnel will bury the IVS targets using shovels to dig the holes to the appropriate depths for burial of the seed items in coordination with the QC Geophysicist. UXO personnel will implement MEC avoidance procedures using analog instruments during installation. The background survey data and anomaly avoidance techniques will be reviewed so that transect start and end stakes and the seed items are not placed on top of or near existing anomalies. IVS construction personnel will bury the ISOs and record the following information:

- Transect endpoints
- Target type(s)
- Target emplacement locations
- Target emplacement depths
- Target emplacement orientations

4. The holes will then be filled with soil and a wooden survey stake or other suitable non-metallic marker will be placed at each buried item location as well as the start and end location of the IVS. Wooden stakes will not extend more than 3 inches above the ground surface to prevent interference with the TEMTADS when passing over them.

5. Measurements need to be collected precisely over the seeded item, and the instrument needs to be positioned with the cart at the same heading, regardless of operator. If the IVS is on a slope, the wheels will be secured to prevent accidental movement of the cart during measurements. This can be accomplished by adding additional wooden stakes or non-metallic markers that would enable the TEMTADS 2x2 to be repeatedly positioned in as close to the same location each time the IVS seed items are measured.

3.3 Initial IVS Survey

The initial IVS survey will be completed prior to collecting production data. The TEMTADS assembly and function tests presented in SOP MR-AC-01-01 will be completed.

In addition to the original background survey, the background location will be verified as suitable by collection of a series of 5 measurements: the first centered at the location and the next four offset by ½ sensor spacing in each cardinal direction. Significant deviation in responses between these measurements will indicate a localized source at this location, rendering it unsuitable as a background location. If this is the case an alternative location will be identified and confirmed using the same procedure.

After confirming the suitability of the background location, a set of static cued measurements will be collected over each of the IVS items. Using the standard cued acquisition parameters presented in SOP MR-AC-01-01, recording time is approximately 90 seconds per item plus an additional 2 seconds for the GPS (or RTS) and IMU samples to be averaged from the time the TEMTADS 2x2 operator initiates the data acquisition sequence.

The data from these measurements will be processed in the same manner as planned for the cued production survey data and will be used to verify that the MQOs presented in QAPP Worksheet #22 for the initial cued IVS survey are met. Once the initial IVS survey MQOs have been met, the IVS survey will be complete and the system and operators verified for field data collection.

4 Data Management

The IVS construction details (IVS item description, location, depth and orientation) will be archived in digital form. The raw and processed IVS background data well as the raw and process initial IVS survey data will be archived in a suitable format and summarized in the IVS Technical Memorandum.

5 Quality Control

Quality control (QC) for this activity will be achieved through completion of the checklist presented as Attachment 1. This checklist will be filled out and signed by the Field Geophysicist(s), Project Geophysicist, and Data Processor.

The activities described in this SOP are being performed in support of QC for a static cued advanced classification survey. The MQOs for the initial IVS survey are presented are presented in QAPP Worksheet #22 of the QAPP. The TEMTADS will not be used for field data collection until it is able to meet these MQOs or an appropriate corrective action (CA) is determined, the project team agrees to the CA, and it is successfully implemented.

6 Reporting

The IVS construction and initial survey results will be documented in an IVS Technical Memorandum. This report will document the following:

- IVS item description including type, location, depth and orientation
- Sensor system performance against the MQOs established for the initial IVS survey including response amplitude, item position, and system noise levels
- Acquisition parameters set in the data collection interface and utilized for cued measurements

Attachment 1

SOP MR-AC-05-01 Initial Cued Instrument Verification Strip (IVS) Survey QC Checklist

This checklist is to be completed by the Field Geophysicist(s) or Project Geophysicist during construction and initial survey of the IVS.

QC Step	QC Process	Yes/No	Initial of Field or Project Geophysicist
1. IVS Construction	Has an appropriate location for the IVS been selected and verified as suitable using a background geophysical survey?		
2. IVS Construction	Have appropriate IVS seed targets been selected and procured?		
3. IVS Construction	Were the target seeds buried appropriately, backfilled and marked?		
4. IVS Construction	Is the required data on the IVS construction from Section 3.2 recorded for inclusion in the IVS Technical Memorandum?		
5. Initial Cued IVS	Is the IVS data collected in accordance with Section 3.3?		
6. Cued Acquisition Parameters	Have the cued acquisition parameters set in the data collection interface been recorded in accordance with Section 6?		
7. Initial Cued IVS	Have the MQOs for the initial IVS survey on QAPP Worksheet #22 been achieved?		

Field Geophysicist: ______________________________Date:___________

Project Geophysicist: ____________________________Date:___________

Data Processor: ________________________________Date:___________

MR-AC-06-01
Perform Cued Surveys with TEMTADS 2x2

1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the means and methods to be employed when performing cued surveys using a TEMTADS 2x2 (TEMTADS) advanced electromagnetic induction (EMI) sensor for target classification. Cued surveys include the collection of cued data over predetermined target locations and background locations. Cued measurements are also performed over instrument verification strip (IVS) targets for quality control (QC) purposes.

The observed signal in a cued measurement using advanced sensors is composed of 1) the EMI response of the buried target, 2) the self-signature of the sensor system, and 3) any response from the ambient environment in which the target is buried. The objective of taking background measurements is to independently measure the last two contributors to the overall EMI response. These “non-target” values can then be subtracted from the overall signal response to determine the signal response from only the unknown buried object being evaluated. For this to be successful the background measurements must be collected in an area without any buried targets and with a geology representative of that where the unknown items are located. They must also be taken throughout the survey day because environmental changes such as large changes in ambient temperature, significant changes in background moisture (morning dew evaporating, rain showers passing through, etc.), or significant changes to the sensor itself (cable replacement, new global positioning system [GPS] antenna, etc.) will cause the sensor or environmental contribution to the background reading to change.

Cued data collection involves navigating the sensor to the precise anomaly location or background location, collecting static, advanced electromagnetic sensor data at this location, and verification/validation of the collected data. If the collected data are not complete or do not the initial qualitative inspection, a second measurement will be performed. If the derived target position estimate from the sensor falls outside a predetermined threshold, the sensor will be repositioned and a second data collection event will be performed.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

2.1 Personnel and Qualifications

The following individuals will be involved in the collection of cued advanced classification data:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP) Quality Assurance Project Plan, Geophysical Classification for Munitions Response (GCMR QAPP), Worksheet #7.

2.1 Equipment

- TEMTADS sensor coupled with a Robotic Total Station System (RTS) and orientation sensor.

2.2 Materials

- Pin flags (two colors, one for anomaly locations and the second for background locations)
- Permanent marker (prefer clicking retractable Sharpie)
- Spray paint
- Field Notebook

3 Procedures and Guidelines

3.1 Target and Background Location Marking

- Targets (anomaly locations) and Background locations will be staked out according to SOP MR-AC-08-01 (Reacquisition of Subsurface Target Locations).

3.2 Collect Background Measurements

A background measurement will be collected prior to any IVS or target anomaly measurements and nominally every two hours throughout the survey day. Additional background measurements will be taken if the Project Geophysicist or Field Geophysicist(s) determine that changes made to the sensor or natural environmental changes may have caused the sensor or environmental contribution to the background reading to change. Careful field notes should be made to document the reasons for extra background readings to guide the Data Processor in choosing the correct background for each cued data set.

One or more locations for background measurements will be planned at each site. The number and location of the background measurements will be influenced by the following considerations:

- The background measurements should be collected at locations that are similar to that of the production survey area with regard to geophysical noise, terrain, geology, and vegetation. If these factors change appreciably, additional background measurements, taken at a more representative location, will be required.
- The background measurements should be collected at locations devoid of buried metal objects. If a suitable object free area cannot be identified, attempts should be made to create a “clear” 2-meter (m) square area by surveying and removing all metal objects. Once cleaned, the background measurements should be re-collected in the “clear” area.
- For efficiency, background measurements should be collected in areas that are close to the survey area(s) to minimize travel time.

Prior to using a selected background location, it must be validated as being suitable by collecting a series of 5 measurements: the first centered at the location and the next four offset by ½ sensor spacing in each cardinal direction. Significant deviation in responses between these measurements will indicate a localized source at this location, rendering it unsuitable as a background location. If this is the case this location will be removed from the list of suitable background locations.

The procedure for taking background measurements is as follows:

1. Return the sensor to one of the previously validated background measurement locations taking care to positioning the sensor as closely as possible to the initial location and orientation.
2. Collect a background measurement.

3. Compare the measured decays to previous measurements at this location. If there are significant deviations in the measured amplitudes, repeat the measurement.
4. If the deviations persist, document the environmental changes that may have led to this deviation in the field notes.

3.3 Function Test Measurements

Function test measurements (described in SOP MR-AC-01-01) will be performed in conjunction with the background measurements to confirm that all transmit and receive components of the TEMTADS sensor are operational.

3.4 Daily IVS Survey

Prior to the start and at the end of each day of data collection, measurements of the set of IVS targets will be performed. (Described in SOP MR-AC-05-01).

3.5 Cued Target Anomaly Survey

Cued investigation for target classification involves positioning the sensor and collecting static measurements over a pre-identified set of anomalies. In combination with SOPs for sensor assembly (SOP MR-AC-01-01) and Initial testing at the IVS (SOP MR-AC-05-01), a set of static data measurements are collected using the TEMTADS over each anomaly. At each anomaly the data acquisition will be performed using the steps shown in Figure 1.

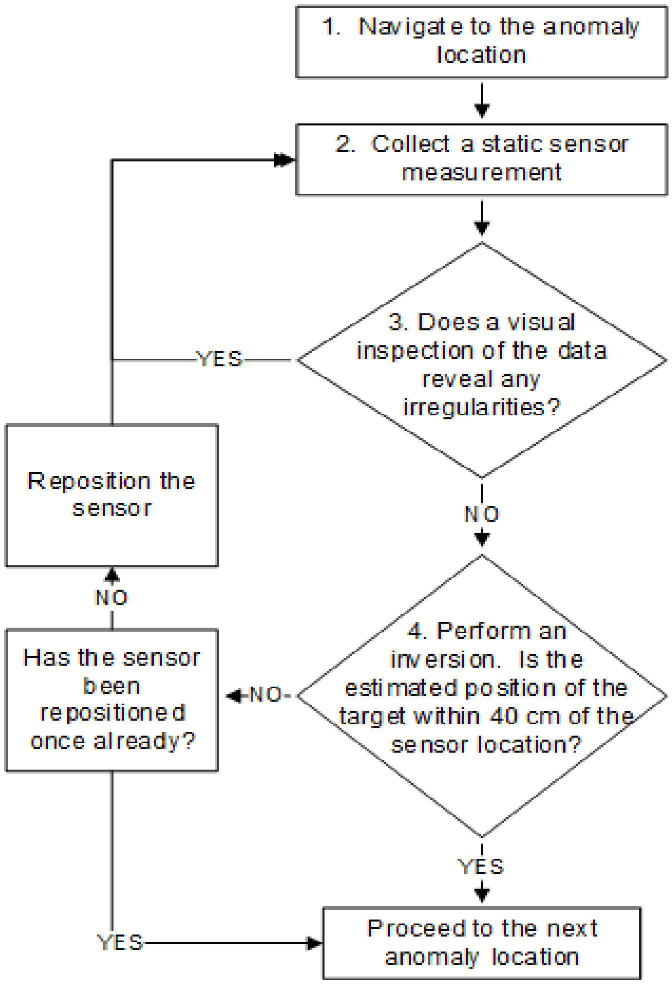


Figure 1. Procedure to Collect a Cued Target Measurement

The following is a description of each of the steps shown above:

1. **Navigate to the Anomaly Location**. Navigation to the anomaly location may be performed visually or through the use of the RTS positioning system. Visual navigation requires marking the anomalies (usually with survey pin flags) in advance. Although some sensors may have the ability to direct the operator to an anomaly location based upon the geophysical signal received, the first measurement will be taken at the predetermined anomaly location as indicated by visual alignment with the pin flag or RTS position relative to the predetermined position.

   To implement this step the sensor will be transported to the anomaly location and the center of the sensor precisely positioned (within 5-cm) over the provided anomaly location.

   If the TEMTADS 2x2 field team finds a target flag has come out of the ground, the flag will be reacquired using the RTS prior to collection of cued data.

2. **Collect a set of static sensor measurements**. Initiate the collection of a set of measurements. During this measurement, care will be taken to ensure that the sensor does not move, and all external sources of electromagnetic signals (i.e. metal) are kept away from the sensor.

Any metal associated with the sensor and deployment mechanism (e.g. console, support structures) that cannot be reasonably distanced from the sensor must be kept in the same physical relation with the sensor as was maintained during background measurements. The recording time for each cued measurement using the acquisition parameters presented in SOP MR-AC-01-01 is approximately 90 seconds per item plus an additional 2 seconds for the RTS and IMU samples to be averaged from the time the TEMTADS 2x2 operator initiates the data acquisition sequence.

3. **Verify the collected data.** Immediately after data acquisition, the integrity and quality of the data will be verified by the operator by inspection of the TEMTADS data collection screen to ensure that:
   - The data acquisition cycle completed properly;
   - The transmit current for each transmitter was within acceptable range (as specified in project work planning documents); and
   - The decay curves measured by each receiver coil appear reasonable (i.e., not 'flat-lined').
   - The IMU display shows the proper YAW prior to collection, if the reading was 777, the data packet was not captured and the collection must be repeated.
4. **Validate the collected data.** Valid inversion results require that the target is located within a 40-cm radius of the center of the sensor. The initial target horizontal position may be significantly offset from the center of the sensor for the following reasons:
   - Positioning errors in the initial detection survey
   - Imprecision in the derivation of the anomaly position from the detection survey data set
   - Imprecision in the reacquisition and flagging of the anomaly
   - Imprecision in positioning the sensor
   - The presence of multiple anomaly sources in relatively close proximity

   This step includes performance of an in-field inversion and inspection of the results to validate that the estimated horizontal target location is within the 40-cm specification. After initiating the in-field inversion algorithm an estimate of the target location relative to the center of the sensor is provided. If the offset is greater than 40 cm, position the sensor over the target location estimate provided by the in-field inversion (visually or using the RTS data) and repeat **Steps 2** and **3**.

   This recollection should only be performed once. Assuming the repositioning was performed accurately, if the subsequent position estimate is still > 40cm from the sensor center the cause is likely to be multiple anomaly sources and additional data collection and data analysis may be required after further analysis by the QC geophysicist.

4 Data Management

4.1 Data inputs

The data inputs required for performing a cued advanced analysis data acquisition are:

- A list of target anomalies including identifier (ID) and position (X, Y)
- A list of Background locations (ID, X, Y)
- A list of IVS locations (ID, X, Y)

4.2 Data Outputs

The data outputs of the cued advanced analysis data acquisition are:

- Cued measurement data over IVS targets, background locations and target anomaly locations
- Function test measurement results
- Raw field notes (pdf images of hand written notes)
- Digital field notes (an excel or other digital format table presenting data filenames as delivered and rectified field notes [i.e., differences between delivered digital filenames and field notes are resolved])

5 Quality Control

Practical considerations limit the quality control (QC) of the cued investigation data acquisition activities to qualitative assessments. Quantitative QC and assessment of the collected data will be performed as part of SOP MR-AC-07-01 dealing with the processing of cued advanced analysis data. Results documenting QC checks performed on the dynamic data are provided as part of the delivered data package for each sortie. This documentation includes the results of the QC tests, name, and date of the review performed by the QC Geophysicist.

5.1 Measurement Quality Objectives (MQOs)

The MQOs for cued target measurements are presented in Worksheet #22 of the GCMR-QAPP. Performance relative to the MQOs will be assessed during the processing of the collected data (SOP MR-AC-07-01). If it is determined during data processing that an MQO has not been met during the cued survey, a root cause analysis (RCA) will be performed and a corrective action (CA) determined. Dynamic TEMTADS data will not be used to select targets until the project team agrees on the CA and it is successfully implemented.

6 Reporting

Reporting of the activities associated with this SOP will consist of the digital copies of the field notes and data files submitted to the Data Processor.

MR-AC-07-01
Process Cued Surveys with TEMTADS 2x2

1 Purpose and Scope

The purpose of this Standard Operating procedure (SOP) is to identify the means and methods to be employed when processing cued measurements collected using a TEMTADS advanced electromagnetic induction (EMI) sensor for target classification. Cued surveys include the collection of cued data over predetermined target locations and background locations. Cued measurements are also performed over instrument verification strip (IVS) targets for quality control (QC) purposes. This SOP details the steps required to verify the quality of these measurements, process these measurements to derive features related to the physical characteristic of the target, and use these features to classify the targets.

2 Personnel, Equipment and Materials

This section describes the personnel and equipment required to implement this SOP.

2.1 Personnel and Qualifications

The following individuals will be involved in the processing of cued TEMTADS data for advanced analysis:

- Project Geophysicist
- QC Geophysicist
- Field Geophysicist(s)
- Data Processor

The qualifications of the personnel implementing this SOP are documented in the Uniform Federal Policy (UFP), Geophysical Classification for Munitions Response (GCMR) Quality Assurance Project Plan (QAPP), Worksheet #7.

2.2 Equipment

The only required equipment is a data processing computer suitable for and equipped to run the processes provided in the UXA-advanced module of Geosoft's Oasis Montaj geophysical processing environment.

3 Procedures and Guidelines

3.1 Data Import/Initial QC

The raw *.TEM data are converted to ASCII *.csv files using a purpose built software utility supplied by the Naval Research Lab (NRL). The data are then imported into Geosoft's UXAnalyze-Advanced (UXA) purpose built processing environment. This process results in three separate databases that contain:

- Target anomaly measurement data
- Background measurement data
- Target list

The cued measurements from the TEMTADS go into the target anomaly or background databases and the Target list is where the derived feature and classification information for each target are summarized.

Once imported the data are inspected and assessed against the measurement quality objectives (MQOs) provided in QAPP Worksheet #22 for:

- Transmit (Tx) current within limits
- Global positioning system (GPS) fit quality
- Valid inertial measurement unit (IMU) data
- EMI response signal not saturated

3.2 Background Corrections

Background corrections are used to remove the self signature of the TEMTADS system and the soil response from the measured anomaly data. Background measurements are taken at locations selected from the detection survey data set. Prior to utilizing these locations for background measurements, they need to be validated to be devoid of metal. Additionally each background measurement needs to be validated as suitable prior to using it for background correction of the target measurement data.

3.2.1 Background Location Validation

Each background location is validated by comparing a set of 5 measurements taken at the intended location: one measurement at the location and one more with the sensor offset by ½ sensor spacing in each cardinal direction. Next, the forward model of the most challenging project-specific target of interest / depth scenario is added to the center background measurement and the background is validated by separately subtracting each of the 4 offset backgrounds and performing a library match to the target of interest. The background location is considered valid if the library match from all 4 offsets exceeds 0.9. These images will be saved and presented in a background summary report.

3.2.2 Background Measurement Validation

Individual background measurements must be validated prior to their use for background corrections. Background measurements will be compared to the initial background validation measurement, and using the same decay plot utility, functionality qualitatively validated. These images will be saved and presented in a background summary report. Invalid measurements will be removed from background database to ensure that they are not used.

3.2.3 Background Corrections

Background corrections are applied using a purpose built tool in UXA that automatically finds the closest background (chronologically and spatially) and will only apply the background corrections that were collected within a preset time limit relative to the target measurement. This preset time limit will be set to 2 hours. The background corrected data are stored in the channel “UXA_Data_Lev”. This is the data channel that is submitted to the inversion processes to derive target features. This data channel will not be populated for those target measurements that do not have a suitable background measurement within the 2 hour time limit.

3.3 Function Test Measurements

Function test measurements (described in SOP MR-AC-01-01) are performed in conjunction with the background measurements to confirm that all transmit and receive components of the TEMTADS sensor are operational. These data are background corrected, then the monostatic components are compared to a benchmark set of values to confirm that all components are fully operational. This comparison is performed in the field and the results are provided in real time. The data processor should perform the same background corrections and log the results for QC/quality assurance (QA) purposes.

3.4 Target Feature Estimation

After background corrections are applied, intrinsic and extrinsic features are estimated for the target anomalies as well as the daily QC measurements collected at the IVS.

Single target and multi-target inversion routines in UXA-Advanced are used to determine the parameters of a target (single-target inversion), or constellations of targets (multi-target inversion), that would produce responses that closely match the observed responses. These parameters include extrinsic parameters (location and orientation) as well as the intrinsic parameters (principal axis polarizabilities) related to the object size shape and composition. The intrinsic parameters, otherwise known as betas (β) are used for classification.

As the names suggest, the single-target inversion solves for a single target and the multi-target inversion posits multiple targets. The multi-source solver not only presupposes multiple sources, it will also produce a number of candidate 'realizations' of targets. Each candidate realization proposes a configuration of targets whose modeled response reasonably fits the observed data. For example, one candidate realization may have three targets, while a second candidate realization for the same measurement may have two or four targets. This process reflects the fact that, with an unknown number of potential targets of difference sizes and shapes, a number of different models can closely match the observed data. A separate fit coherence value is derived for each candidate realization as well as for the single solver.

Model results will only be used for classification if they pass the MQOs identified to confirm that they support classification (QAPP Worksheet #22).

3.5 Daily IVS Survey

Prior to the start and at the end of each day of data collection, measurements of the set of IVS targets are performed (described in SOP MR-AC-05-01). These measurements are processed as described above and the derived features are assessed against the MQOs presented in QAPP Worksheet #22. These results are documented and summarized in a QC report to be generated for each delivered prioritized list.

3.6 Classification

Classification of targets will be based upon objective, numeric criteria. Using these criteria, a prioritized list is created with high likelihood target of interest (TOI) placed at the top of the dig list (just after digs classified as "training data" and "can't analyze") and high likelihood non-TOI placed at the bottom of the list. The primary method for classification will be library matching, supplemented by cluster analysis and feature space analysis.

3.6.1 Site Specific Munitions Library

A site specific library of βs for candidate munitions items identified in the conceptual site model (CSM) will be used for classification. Entries in existing libraries will be confirmed as representative (i.e. the same caliber, model and configuration) of the munitions items presented in the table by a qualified unexploded ordnance (UXO) Technician. Intrinsic parameters for items listed in the CSM not confirmed to be in the existing library will be derived from test measurements prior to the start of the classification process.

3.6.2 Library Matching

Classification is based primarily on the goodness of fit metric (values from 0.0 to 1.0) generated by UXA during a comparison of the β values estimated for each surveyed target and the β values in the munitions library developed for the project. This comparison is performed via the library match utility in UXA. The goodness of fit metric is a measure of the fit correlation between a target and the library entry that best fits that target, with higher values indicating a better fit between the target and the corresponding item in the library. The library fit analysis matches the following four combinations of βs to those of the candidate library TOIs:

- β1, β1/β2, β1/β3
- β1, β1/β2
- β1/β2, β1/β3
- β1

The confidence metrics for each fit combination are averaged to derive a 'decision metric'.

This library matching process is performed for each single-solver model and every target in each of the multi-source solver candidate realization models. For each flag position, the best library fit from the single-solver and multi-solver targets is used as the decision metric. This decision metric is used to rank and classify the target list. Values below the analysts threshold (nominally 0.8) are considered non-TOI.

A set of training digs are identified by the analyst. The intrusive investigation results of these digs as well as decision metrics derived for other known TOI (IVS and Seed items) are used to finalize the analyst threshold.

3.6.3 Cluster Analysis/Feature space Analysis

Cluster analyses are performed whereby the clusters of anomalies with similar β signatures are identified using the self match utility in UXA. For each identified cluster, a representative sample is intrusively investigated as part of the training data. If the intrusive investigation identifies a hazardous item, a representative signature is placed in the site specific library and the matching process will be repeated to ensure that all similar items are classified as TOI.

Individual items that do not match any library items but have βs that indicate a large, axially symmetric, thick-walled object are identified and investigated as part of the training data and added to the library if they are identified as TOI.

4 Data Management

4.1 Data inputs

The data inputs required for performing a cued advanced analysis data acquisition are:

- A list of target anomalies including identifier (ID) and position (X, Y)
- A list of Background locations (ID, X, Y)
- A list of IVS locations (ID, X, Y)
- TEMTADS Measurement data including those for Target anomalies, daily IVS, Backgrounds, and Function tests
- Digital field notes for all data collection activities
- Site specific library signatures and/or test stand measurements of intended site specific library items

4.2 Data Outputs

The data outputs of the cued advanced analysis data processing for each delivered survey unit (contiguous subset of the survey site) are:

- QC report including documenting performance relative to QAPP WS 22 for:
    - IVS results
    - Function Test Results
    - Background measurements
    - Target Anomaly Measurements
- Prioritized target list
- Target classification report
- Revised validation plan
- Target Measurement Data, Background Measurement Data, and Target Feature Databases
- Supporting documents for classification (PDF images)

5 Quality Control

The data processing log and a QC report will contain the results of the QC checks performed during cued surveys. The results and processing log will be provided as part of the data package delivered with each sortie. The QC report will be delivered in accordance with the frequency listed in the QAPP.

5.1 Measurement Quality Objectives (MQOs)

The MQOs for cued target measurements are presented in Worksheet #22 of the QAPP. Performance relative to the MQOs will be assessed during the processing of the collected data. If it is determined during data processing that an MQO has not been met, a root cause analysis (RCA) will be performed and a corrective action (CA) determined. Dynamic TEMTADS data will not be used to select targets until the project team agrees on the CA and it is successfully implemented.

6 Reporting

Reporting of the activities associated with this SOP will consist of:

- QC Report - detailing the daily system performance against the MQOs identified on QAPP Worksheet #22 (including MQOs for daily IVS and Function Test performance as well as for individual measurement metrics).
- Classification Report – detailing specific approach to classification including final library make-up, cut-off threshold, cluster analysis approach and results, and feature space analysis approach and results

MR-AC-08-01
Reacquisition of Targets prior to Intrusive Investigation

Reacquisition of Targets Prior to Intrusive Investigations

1 Purpose and Scope

The purpose of this SOP is to identify the means and methods to be employed when reacquiring target locations prior to intrusive investigations. This SOP specifically addresses targets derived from analysis of cued interrogation data collected using advanced electromagnetic induction (EMI) sensors (e.g. TEMTADS 2x2).

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

Personnel:

- Field geophysicists or other staff experienced in operation of a Real Time Kinematic (RTK) Global Positioning System (GPS) or Robotic Total Station (RTS)
- Professional Land Surveyor (PLS) and field support staff
- UXO personnel (1 UXO technician per reacquisition team)

Note: When reacquisition is required in areas where use of RTK GPS may not be reliable (e.g. wooded sites), reacquisition will be performed by a licensed PLS in good standing with the state where field work will be performed. When reacquisition can be performed using RTK GPS, CH2M HILL will perform reacquisition, unless otherwise noted in the project work planning documents. RTS may also be used by CH2M HILL where feasible.

Equipment and Materials:

- RTK GPS or Total Station, as appropriate
- Survey pole (bi-pole or monopole) with level bubbles in proper working condition
- List of targets to reacquire
- Non-metallic vinyl-stem flags
- Permanent marker (retractable Sharpie is optimal)
- Hip or waist tool belt to hold flags, pens, extra GPS batteries
- Tool to loosen hard ground (awl or screwdriver) if allowed by SUXOS (optional)

2.1 Personnel and Qualification

The following individuals will be involved in the reacquisition of targets prior to and during intrusive activities:

- Field Geophysicist(s) or other staff experienced in operation of RTK GPS will be responsible for uploading targets to RTK GPS data collector, operation and maintenance of field equipment, reacquisition of targets and placement of flags, and daily downloading and quality control (QC) checks.
- UXO Personnel will be responsible for overall daily site access and safety aspects of the project, compiling subcontractor health and safety documents (as appropriate), conducting daily safety briefings and performing subsurface anomaly avoidance during placement of flags or other activities that may involve ground disturbance.

- Professional Land Surveyor field staff or CH2M HILL will be responsible for operation of total station (or robotic total station) equipment, uploading targets to instrument data collector, operation and maintenance of field equipment, reacquisition of targets and placement of flags, and daily downloading and QC checks.
- Data Processing Geophysicist(s) will be responsible for providing target lists to the field team for reacquisition. The Data Processing Geophysicists will also be responsible for verification of the field efforts as well as performing additional QC checks on daily downloaded RTK GPS or total station instrument files.

3 Procedures and Guidelines

3.1 Target Reacquisition Prior to Intrusive Activities

The Data Processing Geophysicist will be responsible for delivery of current target lists (in Microsoft Comma Separated Variable [.CSV] format) to the reacquisition field team leader (CH2M HILL or PLS). These lists will be comprised of the actual target location (i.e. will not be offset by any safety factor) and will be provided in the project-specific projection, datum, and units.

The field team leader will open the supplied data file and compare the number of listed targets versus the quantity stipulated by the Data Processing Geophysicist. If a discrepancy is noted, the field team leader will resolve the discrepancy with the Data Processing Geophysicist prior to stakeout of targets.

The targets will be loaded into the instrument data collector. Targets will be loaded such that the Target ID provided in the supplied list is assigned to the recorded measurement at the time of flag placement.

The target location will be marked with paint and a flag will be placed at a predetermined distance north of the anomaly (this can be easily measured using a ruler or stick cut to the required offset distance. The field teams will write the Target ID legibly on the flag in marker. If a mistake is made during writing the IDs, a new flag will be used and the erroneous flag discarded (as opposed to crossing or scribbling out incorrect IDs).

The ‘as-staked’ location of the flag will be surveyed in and recorded for QC review. Once the ‘as-staked’ flag location is stored, the target will be removed from the active reacquisition list to avoid accidental navigation to the wrong target.

3.2 Recording Item Locations during Intrusive Activities

The reacquisition field team accompanies the dig teams and records the precise in-situ locations of the dig findings. Each recorded measurement shall have the full Target ID and a letter for each object uncovered per dig location. If multiple subsurface items are found at a dig location, each item will be recorded, and the Target IDs will be appended with a sequential letter, starting with “A.”

3.3 Subsurface Anomaly Avoidance

A UXO technician will be assigned to each reacquisition teams. UXO personnel will perform subsurface anomaly avoidance at each intended flag location using handheld analog geophysical instruments (which will undergo daily function checks).

If a subsurface anomaly prevents safe placement of the flag at the supplied target location (i.e. the offset location from the geophysical anomaly location), the field team leader will make note of the condition, place the flag as close as safely possible to the supplied location, record the measurement, and annotate the finding in the daily field notes provided to the Data Processing Geophysicist. The Data Processing Geophysicist and field team leader will evaluate whether the "as-staked" location is sufficient for placement of the TEMTADS 2x2 during follow-up cued surveys or if a new offset distance and/or direction is warranted. In any case, the Data Processing Geophysicist and reacquisition field team leader will inform the TEMTADS 2x2 cued survey team of the deviation from the offset protocol established for the project in order to facilitate proper position and alignment of the TEMTADS 2x2 sensor during the cued interrogation survey.

4 Quality Control

4.1 Daily Instrument Position Accuracy Check

At the beginning of each day, the instrument used for reacquisition will undergo a field QC check for positional accuracy. A known, previously-established point (e.g. benchmark, control point) shall be loaded into the instrument data collector, and a daily measurement shall be performed at this point. The measured coordinates will be compared to the previously-established coordinates. The Measurement Quality Objective (MQO) is the measured coordinates are within 4 inches (10 centimeters) of the known coordinates.

4.2 Data Verification

After downloading and prior to submitting the instrument data collector files, the reacquisition field team leader will be responsible for comparing the number of recorded measurements to the daily field notes in order to check for completeness of the records. Discrepancies will be resolved by the field teams (CH2M HILL, PLS, UXO personnel) prior to submittal of the information to the Data Processing Geophysicist. Necessary adjustments to file names, Target IDs, or other information will be performed prior to submittal of the information to the Data Processing Geophysicist.

4.3 Comparison of Recorded Flag Locations to Supplied Target Coordinates

During reacquisition in advance of intrusive investigations, daily QC checks will be performed on the recorded flag locations by comparing the measured flag locations to the target locations supplied by the Data Processing Geophysicist. Below is an example of the comparison (note that the offset is accounted for in the calculation of the x and y errors):

TARGET_ID	FIT_X	FIT_Y	Safety Offset	Flag_X	Flag_Y	X err (m)	Y err (m)	Dist err (m)
1220038_001_01	704935.21	3914585.22	0.50	704935.31	3914585.73	0.10	0.01	0.10
1320065_001_04	704965.77	3914588.12	0.50	704965.82	3914588.61	0.05	-0.01	0.05
1420101_001_02	705012.23	3914584.66	0.50	705012.30	3914585.16	0.07	0.00	0.07

The MQO for this check is 4 inches (10 centimeters). If the difference between the measured flag location and supplied target is >4 inches (10 centimeters), the target will be reacquired in the field and resolve prior to conducting the intrusive investigation.

5 Reporting

Instrument data collector files will be downloaded daily and submitted by the reacquisition field team leader (CH2M HILL or PLS) to the Data Processing Geophysicist via the established communication pathways (email, Share Point, File Transfer Protocol). Information will not be submitted to the Data Processing Geophysicist until discrepancies in Target IDs, quantities, or other relevant information is resolved by the field teams. Daily field notes shall be provided with the data delivery package.

MR-AC-20-01
Surface Sweep Quality Control Seeding

Surface Sweep Quality Control Seeding

1 Purpose and Scope

The purpose of this SOP is to identify the methods to be employed when emplacing surface QC seeds in the area to be subjected to a surface sweep. The purpose of emplacing QC seeds is to serve as a verification of the surface sweep coverage. To achieve this the Unexploded Ordnance Quality Control Specialist (UXOQCS) places controlled "seed" objects in the production area without the knowledge of the locations of the seeds by members of the surface sweep team. The seeding program serves as a continuous indicator of the surface sweep coverage and compliance with the requirements for items being removed from the surface.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Metallic objects meeting the size criteria established for the project.
- Indelible markers and/or weatherproof labels.

2.1 Personnel and Qualification

The following individuals will be involved in the Surface Sweep QC Seeding:

- UXOQCS

3 Procedures and Guidelines

This SOP constitutes the surface sweep seed plan. The following procedures should be followed.

3.1 Seed Emplacement

Table 1 provides the parameters for the surface sweep seeds.

Table 1. Surface Sweep Seed Parameters

Parameter	Implementation
Number of seeds	Seeds will be placed in accordance with the QC seeding checklist.
Type of seeds	Metallic objects meeting the size criteria for the specific project.
Seed Labeling	Seeds should either be directly labeled with an indelible marker or a weather proof label attached to the item. Labels should be of a type that does not call particular attention to the location of the seed.
Location Measurement	The UXOQCS must use a method of recording the locations of the seeds with enough accuracy that, should a seed not be returned after the area has been swept, they can return to the location to verify that the item was not picked up.

4 Documentation

The UXOQCS must record the locations of the seed items, and the type of item along with its unique identifier, in QC logbook or digital record. This information must not be shared with operational personnel.

5 Quality Control

Surface sweep area seeding is performed by the UXOQCS prior to a surface sweep being performed in any particular unit (e.g., grid). Therefore, this is a preparatory QC process and is guided by the Preparatory QC Checklist in Attachment 1. If control of the seed information is compromised this should be evaluated and consideration should be given to removal and re-emplacement of the seeds.

5.1 Measurement Quality Objective (MQOs)

The MQOs for detection of surface seeds are presented in Worksheet #12 of the Quality Assurance Project Plan (QAPP).

5.2 Reporting

The UXOQCS should report the surface sweep seeding activities and results from the operations (i.e., whether the seeds were found and returned).

Attachment 1

SOP MR-AC-01-01 Preparatory Surface Sweep Area Seeding QC Checklist

This checklist is to be completed by the QC Geophysicist when performing production area seeding.

QC Step	QC Process and Guidance Reference	Yes/No	UXOQCS Initials
1. Determine seed parameters	**Number of seeds:** (A) Anticipated Production Rate for Team: _______acres/day (B) Total Personnel on Team: _________________ (C) Quantity of targets to be placed per acre: B* 2/A = ________________		
2. Labels	Are the seed labeled as required by this SOP?		
3. Documentation	Are the emplacement data recorded as required by this SOP?		
4. Data management and reporting	Is the seeding information in location kept unavailable to the production surface sweep personnel?		
5. MPC Documentation	Have the MPCs for from Worksheet 12 been achieved for the surface sweep seeds?		

UXOQCS: ____________________________Date:___________

MR-AC-21-01
Production Area Quality Control Seeding

1 Purpose and Scope

The purpose of this SOP is to identify the methods to be employed when emplacing quality control (QC) seeds in the production area for an advanced electromagnetic induction (EMI) classification project. The purpose of emplacing QC seeds is to serve as controlled tests and demonstrations of the capabilities of the geophysical classification program on the actual site and under the actual conditions of the production geophysical processes. To achieve this the controlled "seed" objects are buried in the production area without the knowledge of the production geophysicists. The quality of the data collected on the controlled seeds is, therefore, indicative of the quality of the data being collected in general. Thus, the seeding program serves as a continuous indicator of the adequacy of the production geophysical program. As such, adequate performance on the seeds that are not known to be seeds to the production geophysics team (known as "blind" seeds) is a strong indicator that overall production data collection and analysis quality is also adequate.

2 Personnel, Equipment and Materials

This section describes the personnel, equipment and materials required to implement this SOP. The following is a list of required equipment and materials:

- Appropriate inert munitions and schedule 40 medium ISOs (medium ISO40) to serve as seeds. Figure 1 shows and example of this item from the McMaster-Carr Catalog.
- Hand tools including shovels, pick axes, breaker bars, etc. to bury the seeds. Excavators may be used in the event that large and deep MEC are expected to be found onsite as indicated by the CSM in the Uniform Federal Policy (UFP) Quality Assurance Project Plan, Geophysical Classification for Munitions Response (GCMR QAPP) Worksheet #10.

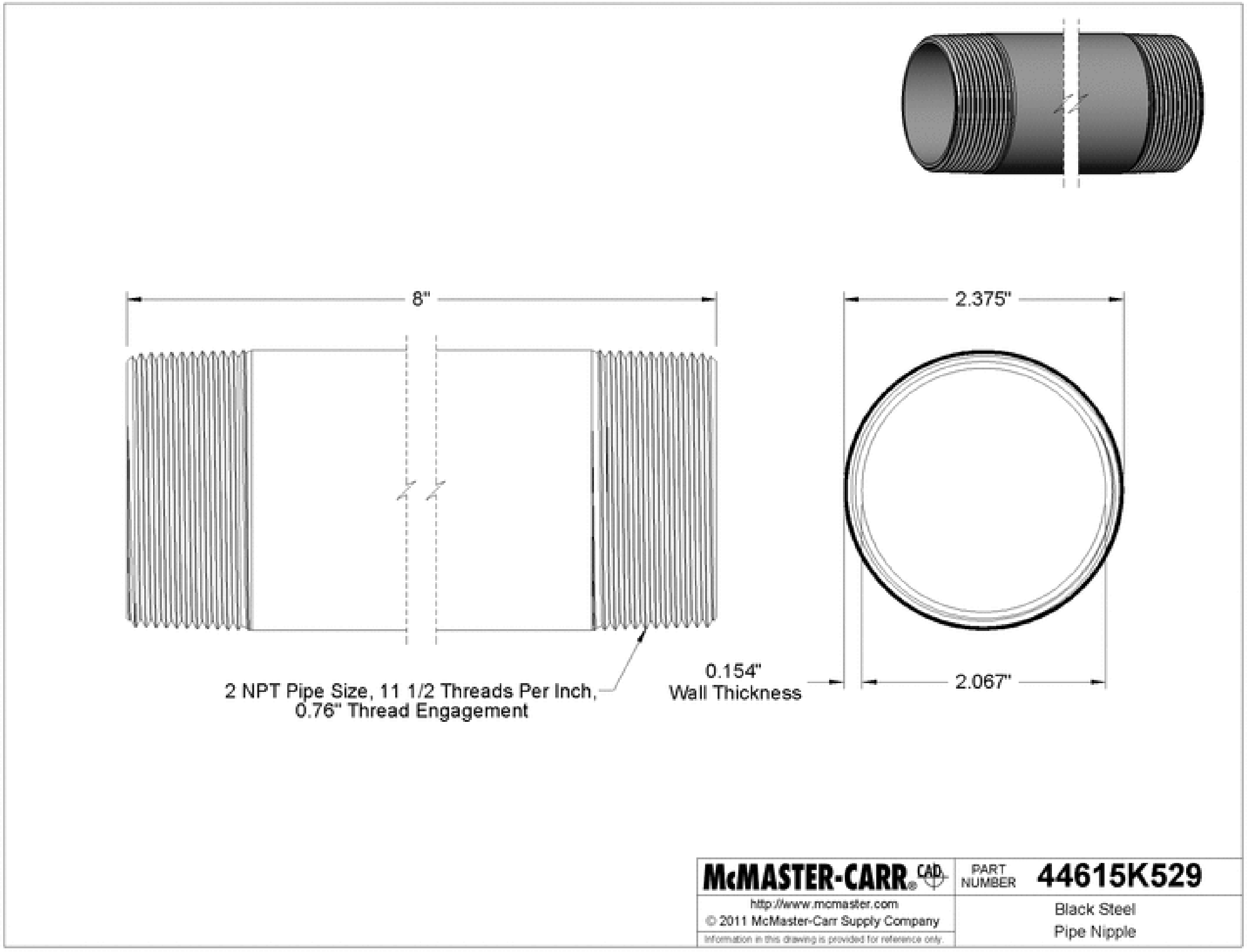


Figure 1. Medium Industry Standard Object – Schedule 40

2.1 Personnel and Qualifications

The following individuals will be involved in the QC seeding:

- QC Geophysicist
- Unexploded Ordnance Quality Control Specialist (UXOQCS) or his designee (a UXO Qualified Technician)
- Professional Land Surveyor

The qualifications of the personnel implementing this SOP are documented in the UFP-GCMR QAPP, Worksheet #7.

3 Procedures and Guidelines

The following procedures should be followed.

3.1 Anomaly Avoidance

Important note: The emplacement of QC seeds requires performing intrusive excavation in areas that are likely to contain munitions and explosives of concern (MEC). Therefore, all activities involving digging into MEC survey areas is required by DoD guidance to be supported by an Unexploded Ordnance (UXO) Anomaly Avoidance Plan. Development and implementation of this plan is not covered in this SOP. However, it is the responsibility of the QC Geophysicist directing the emplacement of the seeds to ensure that operations are not performed within areas potentially containing MEC without appropriate UXO escorts operating under a UXO Anomaly Avoidance Plan developed in accordance with the requirements of Department of Defense Manual 6055.9-M, Volume 7, *DoD Ammunition and Explosives Safety Standards: Criteria for Unexploded Ordnance, Munitions Response, Waste Military Munitions, and Material Potentially Presenting an Explosive Hazard* (August 4, 2010), Section V7.E3.4.3 or other applicable guidance developed by the military component managing the MR geophysical classification project.

3.2 Seed Emplacement

The purpose of the MR geophysical classification project is to reconstruct the physical parameters of the buried targets including the target location, depth, inclination, azimuth, and size. Therefore it is critical for the success of the study to survey, as accurately and precisely as possible, the ***actual locations*** of the buried seeds. To that end, the emplacement team should dig in a fashion to minimize seed migration (e.g., settling) after burial.

The parameters identified in Table 1 should be used to develop the seed burial parameters. The intended burial locations are given to 1-cm precision, with the intended depths to 5-cm precision and the intended inclinations and azimuths to 10-degree precision. The locations and placement of the final burials should be surveyed relative to the cm-level control points.

Table 1. Production Seed Burial Parameters

Parameter	Implementation
Number of seeds	Sufficient to ensure encountering at least 1 blind seed/work day. Calculate the average number of targets that will be subjected to data collection during a full work day and divide the total number of targets by the average daily number. Multiply this resulting number by 1.2 to achieve the total number of blind seeds to be emplaced. Record this number on the Preparatory QC Checklist in Attachment 1 to this SOP.
Type of seeds	Determine the type of seeds to be used based on the CSM for the project site. It is noted that this is a physics-based approach and the results achieved using only small ISOs buried at a standard depth is equally effective as using a variety of ISOs buried at various depths. However, using a more complex mix of seed size and depth may be beneficial for demonstrating the full capabilities of the geophysical classification program and consideration should be given to including some larger and deeper seeds to increase stakeholder confidence. The use of inert munitions items is also beneficial for demonstrating the full capabilities of the geophysical classification program, although their use is contingent upon availability of inert items. Record the type of seeds to be used on the Preparatory QC Checklist in Attachment 1 to this SOP.
Location and depth of seeds	Randomly placed throughout the production work area to achieve the likely encountering of at least one seed/day by the production geophysics team. Approximately 50% of each available seed type will be buried at equal depth intervals extending to the maximum burial depth established for a specific project site. In addition, approximately 50% of each seed type buried at each depth interval will be oriented horizontally and 50% oriented vertically. Use GPS to record the location and depth of each seed in a separate QC data file that is not available to the production geophysics team. See additional details in this section below.

The parameters developed should be viewed as a ***guide*** for seed emplacement. The emplacement team may allow small deviations from the intended burial parameters recorded on the QC Checklist in Attachment 1 due to changes caused by actual field conditions (for example, if the UXO escorts will not allow intrusive activities at the planned location due to MEC hazards). Variation is acceptable as long as the exact burial data is recorded.

After emplacing a seed in the ground, but before covering it with dirt, the following information should be carefully recorded and maintained in a QC data file that is not available to the production geophysics team:

- The x, y, and z coordinates for the center of the seed, with coordinates reported in the project-specific coordinate system, datum, and units;
- The depth of the seed, measured as the vertical distance from the bottom of a straight edge placed across the opening of the hole down to the center of the seed; and,
- A photograph of the seed, showing its serial number. A ruler or similar scale should also be included in the photograph.

For each seed, the emplacement team should also:

- Ensure the seed is marked with blue paint to identify it as inert;

- Replace any ambient metallic items that were found in the hole to simulate the natural local environment;
- Replace dirt in the hole as completely and naturally as possible;
- Level the burial location; and,
- Replace the grass plug over the burial location (if applicable).

4 Data Management

The following sections describe the data that is needed to perform this SOP and the resulting data.

4.1 Input Data Required

The production area seed plan (developed in accordance with this SOP and recorded on the QC Checklist in Attachment 1) which contains the initial parameters for the seeds is required for implementation of this SOP.

4.2 Output Data

The output data from this SOP are:

1. The QC data files recording the data on each seed (type, location, depth, etc.) as required by Section 3.2 above.
2. The Production Area Seed Report. This report consists of a brief narrative describing the seed emplacement, the ideal seed placement parameters, the actual QC data files from #1 above and a discussion of significant deviations from the seed plan. The bulk of the report consists of a seed location table that includes the "as emplaced" identity, location, depth, and orientation of each of the emplaced seeds accompanied by a photograph of the item in the ground before being covered.

5 Quality Control

Production area seeding is performed once by the QC Geophysicist prior to production area geophysics. Therefore, this is a preparatory QC process and is guided by the Preparatory QC Checklist in Attachment 1. This activity is performed solely by the QC Geophysicist or a QC designee (who has no involvement in the production data collection or processing) with the assistance of UXO specialists as safety escorts and the data on the production areas seeds should be restricted and not made available to the production geophysics team. If control of the seed files is compromised this should be evaluated and consideration should be given to removal and re-emplacement of the seeds.

5.1 Measurement Performance Criteria (MPCs)

The MPCs for this activity are presented in Worksheet 12 of the GCMR-QAPP.

5.2 Reporting

The QC Geophysicist should compile the Production Area Seed Report as described in Section 4.2 above. This report will be shared with the DoD managers if they desire to receive it. Otherwise, it will be password protected and maintained by the QC Geophysicist to be included in the Project Report as an attachment.

Attachment 1

SOP MR-AC-21-01 Preparatory Production Area Seeding QC Checklist

This checklist is to be completed by the QC Geophysicist when performing production area seeding.

QC Step	QC Process and Guidance Reference	Yes/No	Initial of QC Geophysicist and UXO Technician
1. Determine seed parameters	**Number of seeds:** Average number of targets daily: _________________ Total targets ÷ average daily X 1.2: ________________ The number above is the minimum number of seeds.		
2. Determine seed parameters	**Type of seeds:** Are inert munitions available for use as seed items:________ Are medium ISOs appropriate for use: _____________ If not, develop alternative seeds based on CSM and list here:____ ____		
3. Safety	Is a qualified UXO escort assigned and are they operating under an approved UXO Avoidance Plan (see Section 3.1)?		
4. Documentation	Are the emplacement data recorded as required by Sections 3.2 and 4.2?		
5. Data management and reporting	Is the Production Area Seed Report prepared and maintained in a password protected file available only to the QC Geophysicist?		
6. MPC Documentation	Have the MPCs for seeding from Worksheet 10 been achieved?		

UXO Technician: ____________________________Date:___________

QC Geophysicist: __________________________Date:___________

MR-AC-22-01
Surface Clearance

1 Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the methods to be employed when performing a surface clearance (also known as a surface sweep) for Munitions and Explosives of Concern (MEC). This SOP is to be used during munitions response (MR) projects directly performed by CH2M HILL Unexploded Ordnance (UXO) Technicians engaged in surface clearance. A surface clearance is a visual clearance of MEC, Material Potentially Presenting an Explosive Hazard (MPPEH) and Munitions Debris (MD) from a specified geographic surface by qualified UXO Technicians. Surface clearances may also be aided by handheld detectors in vegetated areas where visibility of the surface is reduced. These clearances are frequently performed in advance of digital geophysical mapping surveys to reduce the number of resultant target anomalies. They also serve to reduce the risks associated with explosive hazards on the ground surface. Surface clearances frequently employ a grid-based approach to define the boundary of the geographic area to be cleared. MEC and MPPEH items that are deemed unacceptable to move are flagged for subsequent disposal operations. Extreme care will be taken during surface clearances to avoid moving or otherwise disturbing items which are assumed to be MEC or MPPEH until determined acceptable or safe to move by UXO Technicians Level II or above. MEC, MPPEH and MD items that are acceptable to move are usually collected and placed in a designated corner of the grid to await further evaluation and processing. Surface clearances are typically coordinated by a Senior UXO Supervisor (SUXOS) and conducted by a UXO Tech Level III UXO Team Leader who leads a team of UXO Tech Level IIs and Is. CH2M HILL teams will consist of a minimum of two people. A UXO Quality Control Specialist (UXOQCS) will perform an independent evaluation of the surface clearance in accordance with the Quality Assurance Project Plan (QAPP). All will be supported by the observations and advice provided by the UXO Safety Officer (UXOSO) using the QAPP and Site Specific Health & Safety Plan.

This SOP does not include processes and requirements associated with explosive demolition of MEC or the evaluation processes related to MPPEH. It is also intended that the procedures included herein apply specifically to land-based MR operations. There are many references that guide the general requirements within this SOP. Due to the inherent and hazardous nature of military munitions, most of these references are issued under the cognizance of the U.S. Department of Defense through administration of its Military Munitions Response Program (MMRP) and the Component Services that execute the MMRP. While some of these references will be cited later in this SOP, it is the obligation of all CH2M HILL MR personnel to stay apprised of such requirements and their revisions. Additionally, surface clearance and subsurface excavation of MEC operations conducted for Department of Defense (DoD) projects will strictly comply with all requirements articulated in approved Explosives Site Plans (ESP) or Explosives Safety Submissions (ESS) and Project Managers will ensure ESPs/ESSs are amended appropriately whenever necessary.

2 Definitions

Note: Definitions other than those provided below may apply for MR work performed outside U.S. jurisdictions. Check contractual references to ensure correct definitions are applied.

- **Material Documented as Safe (MDAS).** Material that has been assessed and documented as not presenting an explosive hazard and for which the chain-of-custody has been established and maintained. This material is no longer considered MPPEH per DoD Instruction 4140.62 (see References).

- **Material Documented as an Explosive Hazard (MDEH).** MPPEH that cannot be documented as MDAS that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present, and for which the chain-of custody has been established and maintained. This material is no longer considered to be MPPEH per DoD Instruction 4140.62 (see References). (The MDEH characterization only addresses the explosives safety status of the material.)
- **Munitions and Explosives of Concern (MEC).** This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks means: (A) Unexploded ordnance (UXO), as defined in 10 U.S.C. 101(e)(5); (B) Discarded military munitions (DMM), as defined in 10 U.S.C. 2710(e)(2); or (C) Munitions constituents (e.g., TNT, RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.
- **Material Potentially Presenting an Explosive Hazard (MPPEH).** Material owned or controlled by the Department of Defense that, prior to determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris) or potentially contains a high enough concentration of explosives that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are munitions within the DoD-established munitions management system and other items that may present explosion hazards (e.g., gasoline cans and compressed gas cylinders) that are not munitions and are not intended for use as munitions per DoD Instruction 4140.62 (see References).
- **Munitions Debris (MD).** A military munition or components thereof that do not contain explosives or pyrotechnics. Examples include practice munitions without spotting charges, inert training munitions, expended ejection munitions, and fragments of exploded/destroyed military munitions that do not contain explosives or pyrotechnics.

3 Personnel, Equipment and Materials

3.1 Personnel and Qualifications

The following individuals will be involved in the Surface Clearance:

- **MR Operations Director**: Ensures CH2M HILL MR personnel shall be qualified in accordance with DDESB Technical Paper (TP) 18, Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel and are certified to perform the job assigned and that certifications are current. Prior to MR operations, The MR Operations Director will verify training, medical qualification statements by physicians, and conformance to substance abuse testing and reporting programs. The MR Operations Director implements a personnel qualification and certification program for MR personnel consistent with the requirements for UXO personnel at various levels of responsibility as specified in DDESB TP 18.
- **Project Manager (PM)**: Provides the project leadership and direction to ensure that the project is performed within the scope, schedule and budget, ensures quality, risk management, safety and contract compliance. The PM will ensure that site-specific work plans, safety plans, and/or SOPs that adequately address site-specific hazards and control measures are in place prior to the start of work.

- **MR HSSE Manager**: Assists and advises the MR and project staff to plan, staff, and execute the MR safety program. Audits and evaluates MR field projects and safety programs to verify that HSSE requirements and practices are implemented and effective.
- **Senior UXO Supervisors and Unexploded Ordnance Technicians III or II**: Supervise the operational resources necessary to implement, and accomplish the procedures and requirements set forth within the Work, Health, Safety, Quality and Accident Prevention Plans of MR projects. They are required on all MR projects, and authorized to stop work at any time to prevent accidents, remedy unsafe conditions, stop an unsafe act, or question the safety of a process or procedure or observe non-conformance to this SOP and/or plans. UXO Team Leaders shall also be responsible for recording data in MRSIMS and their log books. The SUXOS shall ensure Explosives Safety Quantity Distances (ESQD) are properly determined and enforced, as well as brief MR and project-essential personnel on communications, security, emergency/medical response, evacuation, rally points using project instructions and plans. This person shall inform personnel to prevent disclosure of classified work, site observations, or information.
- **Unexploded Ordnance Quality Control Specialist (UXOQCS)**: Assists with the implementation of this SOP. Reports to the Munitions Response Quality Control Manager. Monitors conformance to this SOP and Work, Health, Safety, Quality, and Accident Prevention Plans. This individual ensures that quality control processes and procedures are executed in accordance with the Quality Control Plan (QCP) and or project instructions.
- **Unexploded Ordnance Safety Officer (UXOSO) and/or UXOQCS (may be a dual-hatted position for small or unique projects when specifically approved during the Munitions Response Technical Risk Evaluation (MRTRE), is required on each project covered in the scope of this SOP and reports to the Munitions Response Health, Safety and Quality Manager):** The UXOSO provides a Daily Site Specific Tailgate Safety Briefing to include MEC, construction, industrial, environmental, and natural safety hazard awareness and provides the plan of the day. As applicable, they provide a Hazardous Materials briefing for items used, consumed, or required for this SOP. The UXOSO performs risk assessment to determine the number of visitors permitted, provides a safety briefing, and verifies training and medical surveillance qualifications of personnel.

3.2 Equipment and Materials

This section describes the equipment and materials required to implement this SOP.

- Surveyor tapes or ropes to mark sweep lanes
- Metal detector (if instrument-assisted clearance) appropriate to types of metal required to be found and removed from the surface
- Digital camera or other device capable of taking photos
- Bound logbook, tablet with digital logbook, or other means of recording results

4 Procedures and Guidelines

This SOP constitutes the surface sweep plan. The following procedures should be followed:

- Operations will be conducted during daylight hours only.
- Access to operating areas will be limited to only those personnel necessary to accomplish the specific operation.

- UXO will only be handled by qualified UXO Technicians.
- During UXO operations the minimum separation distance (MSD) between UXO and non-UXO operations is the fragmentation distance of the munition with the greatest fragmentation distance (MGFD), as stated in the Explosives Site Plan (ESP).
- All personnel will attend the daily safety briefing (tailgate safety briefing) prior to entering the operating area.
- Anyone can stop operations for an unsafe act or situation.
- Safety violations and/or unsafe acts will be immediately reported to the UXO Safety Officer (UXOSO).
- The field team will systematically sweep the area, traversing each transect, or series of transects until the area has been completely swept.
  - Sweep operations will be performed under the direct supervision of a qualified UXO Technician III.
  - The lanes may or may not be established prior to sweeping. If temporary lanes are marked prior to sweeping it will be done by a UXO technician to ensure safety.
  - If individual lanes (5 feet apart) are pre-marked then qualified UXO technicians sweep the lane (using an approved metal detector if performing an instrument-assisted sweep) until the lane has been completed.
  - If individual lanes are not premarked, the Team Leader (UXO Technician III) will assemble the team members into a sweep line and direct their movement across the survey area.
  - Team members will be spaced approximately 5 feet apart and, at the direction of the Team Leader, move through the grid on line abreast.
  - When an item is encountered, the individual team members call out "hold the line", the line will stop and the UXO Technician will inspect the object to determine if it is MEC or scrap and either pick the item up (if safe to move) or mark the item with the appropriate colored Pin Flag. The line will not move again until directed by the Team Leader.
    - When flags are used, red will demarcate a MEC item, blue will demarcate munitions debris, and green will demarcate non-munitions related scrap.
  - As the team moves forward the sweeper at the edge of the grid will use the grid stakes as one sweep lane boundary, the sweeper on the opposite end of the line will mark the limit of the sweep lane with White Pin Flags. These flags become the guide for the return sweep and define the limits of the previously cleared lane.
  - This procedure is continued until the grid is completely swept.
  - If an item requiring disposal is required, OTIEX SOP-01 will be used.

5 Documentation

The UXOQCS must record the locations of the seed items, and the type of item along with its unique identifier, in QC logbook or digital record. This information must not be shared with operational personnel.

Munitions debris located on the surface will be recorded on a per unit (i.e. grid, transect, etc.) basis and documented. The GPS coordinates for all UXO will be recorded and documented. Photographs of representative types of munitions debris and all UXO items will be taken and documented.

6 Quality Control

Surface sweep area seeding is performed by the UXOQCS prior to a surface sweep being performed in any particular unit (e.g., grid). Therefore, this is a preparatory QC process and is guided by the Preparatory QC Checklist in Attachment 1. If control of the seed information is compromised this should be evaluated and consideration should be given to removal and re-emplacement of the seeds.

6.1 Measurement Quality Objective (MQOs)

The MQOs for detection of surface seeds are presented in Worksheet #12 of the Quality Assurance Project Plan (QAPP).

6.2 Reporting

The UXOQCS should report the surface sweep seeding activities and results from the operations (i.e., whether the seeds were found and returned).

7 References

- DoD Instruction 4140.62, "Management and Disposition of Material Potentially Presenting an Explosive Hazard," November 5, 2008.
- DOD 6055.09-M, Ammunition and Explosives Safety Standards, August 2010.
- DDESB TP-18 Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel, December 2004.
- DA 385-64, Ammunition and Explosive Safety Standards, August 2008.
- DA Engineering Manual (EM) 385-1-97 Explosives, Health and Safety, September 2008.

Attachment 1

SOP MR-AC-22-01 Preparatory Surface Sweep Area Seeding QC Checklist

This checklist is to be completed by the QC Geophysicist when performing production area seeding

QC Step	QC Process and Guidance Reference	Yes/No	Initial of UXOQCS
1. Determine seed parameters	**Number of seeds:** (A) Anticipated Production Rate for Team: _______acres/day (B) Total Personnel on Team: _________________ (C) Quantity of targets to be placed per acre: B* 2/A = ________________		
2. Labels	Are the seed labeled as required by this SOP?		
3. Documentation	Are the emplacement data recorded as required by this SOP?		
4. Data management and reporting	Is the seeding information in location kept unavailable to the production surface sweep personnel?		
5. MPC Documentation	Have the MPCs for from Worksheet 12 been achieved for the surface sweep seeds?		

UXOQCS: ____________________________Date:___________

TBD-SOP-01
Explosive Demolition & Demilitarization Operations

This SOP will be provided when a vendor for this service is procured.

TBD-SOP-02
Material Potentially Presenting an Explosive Hazard (MPPEH) Processing and Management

This SOP will be provided when a vendor for this service is procured.

TBD-SOP-03
Anomaly Investigation

This SOP will be provided when a vendor for this service is procured.

Appendix C
Blind Seed Firewall Plan

Blind Seed Firewall Plan

Prepared for

Department of the Navy
Naval Facilities Engineering Command, Mid Atlantic

June 2015

CH2MHILL®

15010 Conference Center Drive
Suite 200
Chantilly, VA 20151

Blind Seed Firewall Plan

Introduction

This Blind Seed Firewall Plan has been developed to describe procedures for 'firewalling' the locations of 'blind' quality control (QC) seeds placed for the MILCON Support P-815 activities being performed at the Moving Target Mortar Range – South (MTMR-S) located at Dam Neck Annex. This MR site is associated with Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. The intent is to describe the approach to keeping a firewall between CH2M HILL personnel needing to know the types, depths and locations of the QC seeds placed for QC evaluation purposes and those who cannot know this information as it would compromise the integrity of their data processing and classification.

Quality Control Personnel

CH2M HILL team personnel involved in data collection, processing/classification and intrusive investigation activities on the project will be firewalled from having access to information on the types, depths and locations of seeds buried at each QC seed location until they have performed their data analysis, classification, and/or intrusive investigation tasks. The information will be provided to them only as needed for post-classification analyses, such as a root-cause analysis (RCA), and only after documented permission to share the information has been received from NAVFAC project manager. The following personnel from the CH2M HILL team are the only members of the team who will have access to the information:

- Land Survey personnel from TBD
- CH2M HILL Unexploded Ordnance Safety Officer/Quality Control Specialist (UXOSO/QCS) (Nelson Figeac)
- CH2M HILL Project Manager (Steven Flatko)
- CH2M HILL Task Manager (Joe Kenderdine)
- CH2M HILL Senior Geophysicist to assist with mapping in Geosoft Oasis Montaj as needed (Tamir Klaff)
- CH2M HILL Quality Control Manager (George DeMetropolis)
- CH2M HILL team Geographic Information System (GIS) technician (name TBD) (for preparing maps for reporting purposes)

Information Transfer/Storage

The QC seed data and associated information will be recorded by land survey staff and the CH2M HILL UXOSO/QCS staff upon placement of the seeds in the field. Unless and until permission is received from the NAVFAC PM to share with other members of the team, data files will be transferred only between the individuals identified in the Personnel section of this document. The information and data will be stored only on local drives and in a protected folder on the project website accessible only to the staff identified herein.

Commitment to Integrity of the Firewall

All staff identified in this document, or others added with the NAVFAC PM's permission, will be required to provide a written (either email or hard copy) commitment to comply with the requirements established in this document. This commitment will be kept on record by the CH2M HILL PM and added to the project files.

Appendix D
Draft Validation Plan

Advanced Classification Validation Plan

Prepared for

Department of the Navy
Naval Facilities Engineering Command, Mid-Atlantic

June 2015

CH2M HILL, Inc.
15010 Conference Center Drive
Suite 200
Chantilly, VA 20151

Advanced Classification Validation Plan

Introduction

This Advanced Classification Validation Plan has been developed to describe procedures for validating the classification results obtained from Advanced Geophysical Classification activities being performed in support of MILCON P-815 (Phase 1) at the Moving Target Mortar Range – South (MTMR-S) located at Dam Neck Annex. This MR site is associated with Naval Air Station (NAS) Oceana, Virginia Beach, Virginia. The intent is to provide assurance that there are no native target of interest (TOI) classified as non-TOI. The validation process will be performed through the selection of a number of 'validation digs' designed to test the assumptions inherent in the classification approach.

This plan is intended to describe the validation rationale and a description of the initial approach. The final number and distribution of validation digs required will be dependent upon a number of factors including, but not limited to, the details of the classification approach, performance against the quality control (QC) and quality assurance (QA) seeds, and the quality of the partial receiver operating characteristic (ROC) curves derived from the intrusive investigations. It is anticipated that this plan will be amended prior to implementation based upon the above factors.

Background

Geophysical data collected in dynamic mode using a TEMTADS 2x2 will be used derive a target[1] list for the cued investigations. Conventional 'Amplitude Response' detection is based upon finding anomalies with peak amplitudes beyond a set threshold. Because of the rich data set available with the dynamic TEMTADS survey, we will use an alternate approach selection called Advanced Detection'. Advanced Detection will be used to identify anomaly sources (rather than just the anomaly) and derive estimates of features related to these sources (primarily size and wall thickness). These features are used to reject those sources that are too small or too thin-walled to be viable TOI. A list of sources that are potential TOI will be generated and further evaluated in the TEMTADS 2x2 cued survey. From the cued survey results, there are three ways for a target to be classified as a TOI:

1. Match any of the candidate TOI items in the project-specific classification library
2. Be a member of a cluster or group of similar polarizabilities (βs) that are identified as TOI through analyst calibration digs
3. Have features that are typical of TOI (axial symmetry, thick walled, large)

Because the goal of the validation process is to demonstrate that no TOI were classified as non-TOI, it is instructive to restate the above in terms of how anomalies are classified as non-TOI. From this perspective anomalies are classified as non-TOI by:

1. The anomaly selection process (anomalies below threshold are by default, non-TOI)
2. Not matching any of the candidate TOI in the library
3. Not belonging to an identified cluster of anomalies with similar βs that are subsequently found to be TOI through 'analyst calibration digs'
4. Not having features that indicate the item is large, axially symmetric, and thick walled

The following discussion presents an initial approach to classification validation for each stage of classification (including initial selection), with emphasis on describing what thresholds will be tested and the

[1] 'Target' is used to refer to any location that has been identified for further investigation. A target may refer to an anomaly peak location (from conventional detection approaches), a 'source' location (from Advanced Detection), or an intrusive investigation location (from Advanced Classification). 'Anomaly' refers to the anomalous geophysical response caused by a metal 'source'.

rational for these tests. Any validation failures will require a root cause analysis (RCA) and appropriate corrective action (CA) developed and implemented in consultation with the Navy.

Anomaly Selection Validation

Advanced Detection

CH2M HILL will be using the Advanced Detection approach to anomaly detection that makes use of the rich data set output of the advanced sensors. The Advanced Detection approach has been shown to have improved signal to noise ratio (S/N) performance over the 2x2 monostatic Z component response amplitude data (example depicted in **Figure 1**).

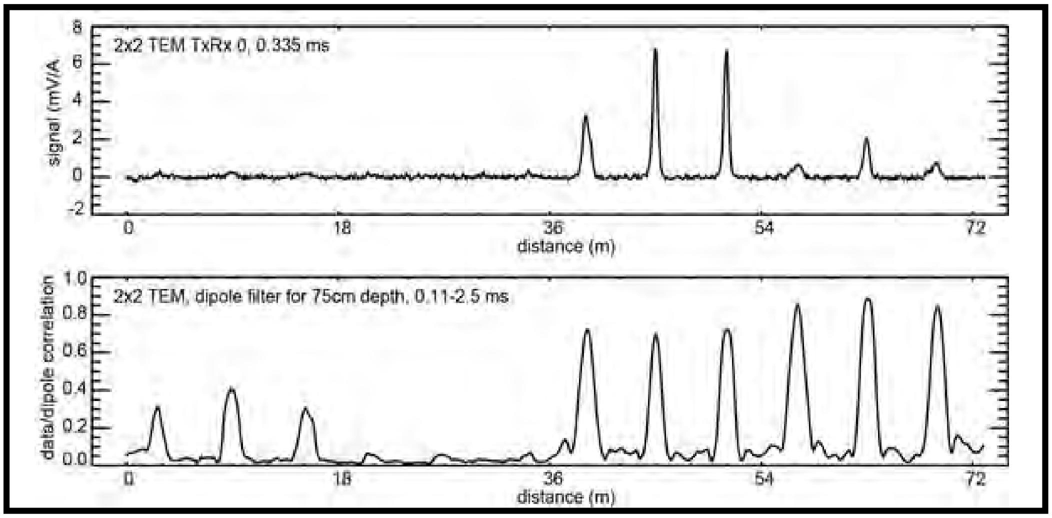


Figure 1. TEMTADS 2x2 data collected along a line over a set of 60 millimeter (mm) mortars at Blossom Point, MD by the Naval Research Laboratory (NRL). The targets at 75 centimeter (cm) depth are barely discernible in the noise for the 2x2 monostatic Z component response amplitude data. The bottom panel shows the Advanced Detection dipole filter output and the 75 cm deep mortar signals become clearly visible.

The Advanced Detection approach is summarized as follows:

- At every 0.1m grid node, the surrounding data (from a 1m x 1m box) will be submitted to a dipole analysis inversion. The match between the measured data and the derived dipole model (i.e. the fit coherence) will be as the initial detection metric with a high fit coherence indicating the presence of a metal source.
- Peaks in the fit coherence metric will be identified (similar to Amplitude Response peaks) and a subset of data around this peak will be inverted in separate passes for one, two, or three dipole sources, enabling spatial resolution for multiple sources within the footprint of the original dipole response region.
- Resulting sources will be culled (based upon conservative size/decay metrics) to only sources that could be a TOI.
- Sources within 0.2 m of each other (expected from the multiple inversion runs) will be merged into single targets and compiled in a target list for the cued interrogation phase.

The initial detection metric threshold will be determined as a function of signal to noise and will be presented and validated in the Initial Dynamic IVS Detection technical memorandum. The size and decay cut-off thresholds will be based upon the known library responses for the smallest TOI and thinnest-walled TOI and will be validated by performing cued investigations of a set a targets beyond each threshold.

Library-match Threshold Validation:

Classification will be based primarily on the goodness of fit metrics generated by the Geosoft Oasis Montaj UX Analyze module (UXA) during a comparison of the β values estimated for each surveyed target and the β values in the munitions library developed for the project. The goodness of fit metric indicates the fit correlation between a target and the best fit item in the library, with higher metrics indicating a better fit between the target and the corresponding item in the library. The library fit analysis will match the following four combinations of βs to those of the candidate library TOIs:

1. β1, β1/β2, β1/β3
2. β1, β1/β2
3. β1/β2, β1/β3
4. β1

The average of these fit metrics will be combined to provide the 'decision metric'. This library matching process will be performed for each single-solver model and every target model in each of the multi-solver candidate realizations. For each flag position, the highest value decision metric (i.e. most likely TOI) from the combined set of single-solver and multi-solver targets will be used as the decision metric for that position.

A cut-off threshold will be determined based upon review of the decision metrics derived for the known targets (QC seeds, bench measurements and training dig results). This threshold will be used to rank and classify the target list where values above the threshold will be considered TOI, and values below the decision metric will be considered non-TOI. The decision metric and cutoff threshold will be presented in the *Final Validation Plan* for review by the project team.

The threshold used to declare an anomaly as non-TOI will be confirmed by sampling through intrusive investigation beyond this threshold. The number of digs required to achieve this confirmation will depend to a large degree on the dig results – particularly the results for anomalies that were ranked just prior to the analyst cut-off threshold. Partial receiver operating characteristic (ROC) curves showing a steep ascent early in the prioritized list (indicating most targets are TOI), followed by a small section of 'flat line response' indicating the absence of TOI in the latter part of the prioritized list are indicative of successful classification. Partial ROC curves that do not display a distinct inflection point between the TOI and non-TOI sections, and have TOI in close proximity (on the prioritized list) to the cut-off threshold will require more validation digs. A validation failure will result if any TOI are found in the set of validation investigations.

Cluster Analysis Validation

The cluster analysis is designed to detect unexpected TOI that are ubiquitous to the site. This is achieved by first identifying groups of items with similar βs, then sampling these clusters to determine if they are comprised of TOI or non-TOI. The underlying assumption is that within a cluster the items will all be very similar in size, shape and composition. Clusters that are identified as TOI will result in an additional entry into the library, the items in this cluster being classified as TOI. Accordingly, the validation for these will proceed with validation of the rest of the library match results (described above). For each cluster that is not found to be comprised of TOI, additional validation digs will be performed to confirm the finding that the population of this cluster is not comprised of TOI. A validation failure will result if any TOI are found in the set of validation investigations.

Feature Analysis Validation

Finally, additional validation digs will be performed to verify that the cut-off thresholds for feature space identification of potential TOI will be performed. Values related to size, axial symmetry and decay (longer decays are indicative of thick walled objects) are calculated from the βs. A set of validation digs will be derived to test the cut-off threshold used for each of these parameters. A validation failure will result if any TOI are found in the set of validation investigations.