N60200.AR.004991
NAS CECIL FIELD, FL
5090.3a

WORK PLAN ADDENDUM 25 REVISION 1 MUNITIONS RESPONSE AND EXCAVATION OF CONTAMINATED SOIL AT OPERABLE UNIT 5 (OU 5) SITE 15 BLUE 10 ORDNANCE DISPOSAL AREA NAS CECIL FIELD FL

3/24/2008

CH2MHILL CONSTRUCTORS INC

WORK PLAN REVISION

REVISION NO: 01

PROJECT NAME:	Former Naval Air Station (NAS) Cecil Field, Jacksonville, Florida	CTO NO:	0063
SITE/TASK:	Geophysical Investigation Plan/Geophysical Prove-out Work Plan	WORK PLAN DATE:	February 2008
WORK PLAN NAME:	Munitions Response and Excavation of Contaminated Soil at Site 15, Blue 10 Ordnance Disposal Area, Former Naval Air Station Cecil Field, Jacksonville, Florida	DATE OF REVISION	March 24, 2008
REVISION PREPARED BY:	Jeffery Marks		

Modifications/Revisions:

Item No.	Description of Modifications/Revisions
001	CTO No. 0063 Work Plan Addendum No. 25, Revision 01 is being revised to include the procedures necessary to conduct the geophysical prove-out (GPO) and document the required parameters and procedures in conducting the Geophysical Investigation Plan (GIP). The GIP is being provided as Appendix J and the GPO is being provided as Appendix K.

Reasons for the Modifications/Revisions:

Item No.	Reasons for the Modifications/Revisions
001	This revision is prepared to provide details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at Site 15, Blue 10 Ordnance Disposal Area located at former Naval Air Station Cecil Field, Jacksonville, Florida.

Jeffery D. Marks		04/01/2008
CTO Project Manager	Signature	Date
Michael D. Halil		04/01/2008
Deputy Program Manager	Signature	Date
U.S. Navy Responsible Authority	Signature	Date

Document Control Distribution

Barbara Nwokike, BRAC PMO SE	David Grabka, FDEP	Arthur Mosley, FEAD
Doyle Brittain, EPA	Mark Speranza, TtNUS	Project File No. 355222

Appendix J
Geophysical Investigation Plan

Final

Geophysical Investigation Plan

Former Naval Air Station Cecil Field
Jacksonville, Florida

Revision No. 00

Contract No. N62467-98-D-0995
Contract Task Order No. 0057

Contract No. N62467-01-D-0331
Contract Task Order No. 0063

Submitted to:

U.S. Naval Facilities Engineering Command Southeast

Prepared by:

CH2MHILL Constructors, Inc.

Northpark 400
1000 Abernathy Road
Suite 1600
Atlanta, GA 30328

March 2008

APPENDIX J

Geophysical Investigation Plan

This Geophysical Investigation Plan (GIP) provides details of the equipment, approach, methods, operational procedures and quality control to be used in performing the geophysical investigations at Site 15, Blue 10 Ordnance Disposal Area (Site 15) located at former Naval Air Station (NAS) Cecil Field, Jacksonville, Florida. The following topics are covered in the GIP subsections: safety issues; geophysical data quality objectives (DQOs); description of the site; anticipated Munitions and Explosives of Concern (MEC) types, quantities, compositions, and depths; site physical conditions (e.g., geology and topography); adverse geophysical conditions; site utilities and manmade features that may affect the geophysical operation; data acquisition and reporting; and geophysical program QC requirements.

J.1 Geophysical Operations Overview

Geophysical instruments will be used during digital geophysical mapping (DGM) survey operations. DGM operations use instruments that record instrument response digitally, allowing for the subsequent download and interpretation of the data. DGM instruments will be operated by the DGM subcontractor. Geophysical instruments used during operations such as clearance of locations for emplacement of survey stakes will be analog, meaning these instruments will be used to detect metallic items in the subsurface on a real-time basis and the instrument response will not be recorded. Generally analog instruments indicate the presence of metallic anomalies through sound or visual display. The analog instruments will be operated by unexploded ordnance (UXO) technicians.

J.2 Safety Issues

Because MEC and MPPEH items may be present in the survey area, DGM survey personnel are prohibited from touching, handling, moving, or investigating any item that resembles MEC or Material Potentially Presenting an Explosive Hazard (MPPEH). Upon encountering such an item, survey personnel will immediately inform the Senior UXO Supervisor (SUXOS) or a UXO technician. In the event that such an item is discovered, either inside or outside the controlled project boundaries, and no UXO-qualified personnel are present, survey personnel will conspicuously mark and secure a perimeter around the item and immediately contact the SUXOS. DGM survey personnel should not remain within 200 feet of any suspected MEC or MPPEH item.

DGM survey personnel will not access areas that have not been previously surface cleared by a UXO technician. Personnel will also be required to adhere to the project Health and Safety Plan (refer to Appendix B of the Contract Task Order [CTO] No. 0063 Work Plan Addendum [WPA] No. 25).

J.3 DGM Personnel Qualifications

DGM operations will be conducted by personnel experienced in MEC geophysical operations and led by a qualified MEC geophysicist. All DGM support personnel onsite will have documentation of 40-hour Occupational Safety and Health Administration (OSHA) certification, any necessary re-certification (8-hour refresher), and OSHA-compliant medical monitoring physical exams. Throughout DGM operations, DGM support personnel will strictly adhere to the general practices given in this WPA, GIP, and specifically in the project Health and Safety Plan (refer to Appendix B of the CTO No. 0063 Work Plan Addendum No. 25).

J.4 Areas to be Investigated

The areas to be investigated are shown in Figure J-1.

A system of grids will be established across the survey area to track progress and data processing. Control points will be placed on the ground using either RTK GPS or conventional survey equipment as required to use the DGM system validated through the GPO process.

J.5 Past, Current, and Future Site Uses

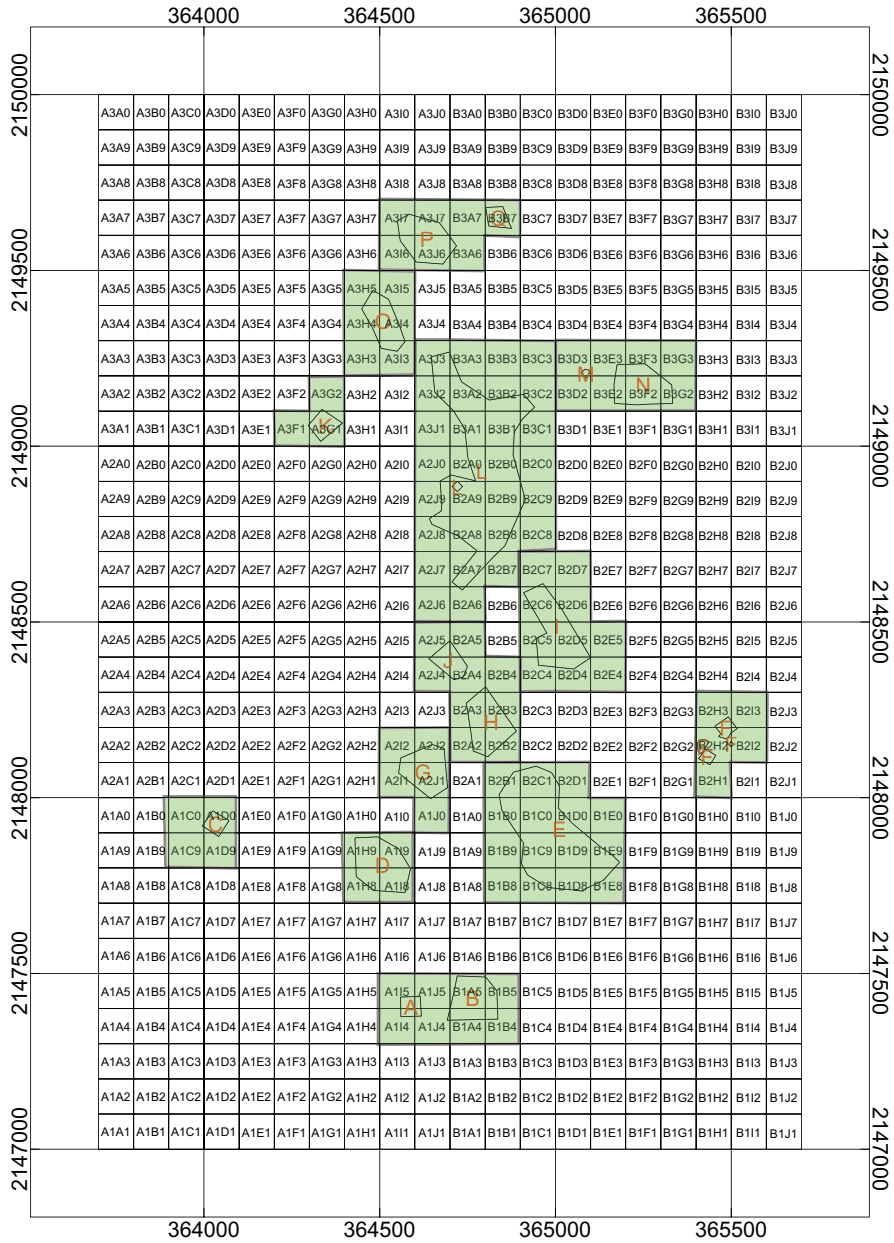
A site history is provided in Section 2 of this WPA.

J.6 Anticipated MEC Types, Composition, and Quantities

The majority of munitions disposed of at the site were burned and included small arms munitions, 20-millimeter (mm) projectiles (believed to be target practice), parachute and distress flares, Mark IV signal cartridges, rocket igniters, cartridge activated devices (CADs), 2.75-inch rockets, and 5-inch rockets. An estimated 350 tons of munitions were disposed of at the site while in operation. It is unknown whether items remain at the site.

J.7 Anticipated Depth of MEC Items

The anticipated depth of potential MEC items is from near-surface to greater than 4 feet (if buried in disposal pits).



113 grids
grids = 100' x 100'
Total Area = 25.94 Acres

Conversion
43,560 sf = 1 acre

Figure J-1
DGM Areas to be Investigated

Cecil Field

Duval County, Florida

250 0 250 500 750
US survey foot
*NAD83 / *StatePlane Florida East FIPS 0901 Feet*

J.8 Vegetation and Topography

The site comprises two land cover classes, based on the Florida Land Use and Cover Classification System (FLUCCS); shrub and brushland (320) and coniferous plantation (421). Common vegetative species in the shrub and brushland community include gallberry (*Ilex glabra*), slash pine saplings (*Pinus elliottii),* saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), sand blackberry *(Rubus cuneifolius*), wiregrass (*Aristida stricta*), broomsedge (*Andropogon virginicus*), narrowleaf cudweed (*Gnaphalium falcatum),* wild grape (*Vitis* sp.), and greenbrier (*Smilax* spp.). The dense vegetative growth suggests the absence of fire in recent years. Excavation Areas D, E, G, H, and J are located in the shrub and brushland community. Dominant vegetative species in the coniferous plantation are slash pine and loblolly pine (*Pinus taeda*), with sparse understory and groundcover strata. Excavation Areas A, B, C, F, I, K, L, M, N, O, P, and Q are located within the planted pine community.

J.9 Geologic Conditions

The Olustee Fine Sand, Leon Fine Sand, and Ridgeline Fine Sand are distributed relatively equal over the Site 15 area. Each of the soil types is described as a nearly level, poorly drained soil found in broad flatwood areas (ABB Environmental Services, Inc. [ABB], 1997).

J.10 Shallow Groundwater Conditions

Three water-bearing systems are present in the former NAS Cecil Field Area according to the Florida code of hydrostratigraphic nomenclature as described in Florida Geologic Survey (FGS) Special publication 28 (FGS, 1986). These units include, in descending order, the surficial aquifer system, the intermediate aquifer or secondary artesian aquifer and confining units, and the Florida aquifer system (ABB, 1997).

The surficial aquifer is composed predominantly of sand from land surface to an approximate depth of 66 feet below land surface (bls). The water table is unconfined at Site 15 and may range between 1 and 4 feet bls. In previous monitoring well installation activities sand was reported from land surface to a depth of 14 feet bls (ABB, 1997).

Aquifer performance test conducted at former NAS Cecil Field by the USGS indicate that a hydraulic conductivity of 3 feet/day is a representative K value for the surficial aquifer. Using the estimated value of 3 feet/day for K and an estimated effective porosity of 0.20, a hydraulic gradient of 0.0028 feet/feet and 0.0064 feet/feet was calculated from April and September 1995 water level data for Site 15. The seepage velocities (using the estimated K values) are somewhat less than seepage velocities with site-specific K values. When site-specific values are used, the estimated seepage velocities for Site 15 increase to 26 to 28 feet/year. Hydrogeologic parameters are summarized in Table J-1 (ABB, 1997).

TABLE J-1
Summary of Aquifer Characteristics for the Upper Zone of the Surficial Aquifer

Parameter	Estimates
Hydraulic gradient (feet per foot)	0.0028 to 0.0030
Average hydraulic conductivity (feet per day)	5.1
Effective porosity	0.20
Groundwater seepage velocity (estimated) feet per year	15 to 16
Groundwater seepage velocity (site-specific) feet per year	26 to 28

J.11 Adverse Geophysical Conditions

There are no known adverse geophysical conditions that might affect DGM operations.

J.12 Site Utilities

No site utilities are expected in the areas where DGM will be performed.

J.13 Manmade Features Potentially Affecting Geophysical Operations

No manmade features are expected in the areas where DGM will be performed

J.14 Site-Specific Dynamic Events

No site-specific dynamic events (e.g., unusually strong winds, harsh weather conditions) that might affect the DGM survey operations at the site are anticipated. Although it is possible that weather conditions may impede operations at some time during the project, no significant delays or effects on geophysical instruments resulting from weather are expected.

J.15 Overall Site Accessibility and Impediments

The survey areas are readily accessible via dirt roads and access impediments are not anticipated.

J.16 Potential Worker Hazards

No potential worker hazards are apparent at the site other than those associated with conducting project fieldwork, which are addressed in the project Health and Safety Plan (refer to Appendix B of the CTO No. 0063 Work Plan Addendum No. 25).

J.17 Geophysical Prove-out

A site-specific Geophysical Prove-out (GPO) will be compared to project DQOs (discussed in Attachment B1, the GPO Work Plan) to validate the geophysical system selected for the DGM surveys.

J.18 DGM Data Quality Objectives

The primary objective of the DGM activities at the site is to identify metallic anomalies that may be MEC or MPPEH. DQOs specific to the DGM surveys at the site are in the GPO Work Plan.

J.19 Geophysical Instrumentation

J.19.1 Analog Geophysical Instruments

The analog geophysical instruments to be used during non-DGM operation where a geophysical instrument is needed to detect metallic items will be a Schonstedt GA-52/Cx magnetometers and White's XLT metal detectors.

J.19.2 DGM Instruments

The actual instrumentation and system configuration to be used for DGM operations at the site will be determined through the GPO process.

J.20 Data Acquisition, Processing and Reporting

J.20.1 Field Data Sheets

Field data sheets will be recorded in the Munitions Response Site Information System (MRSIMS) field devices (Trimble GeoXT) and will include:

- Site ID
- Grid ID (or other identifier of surveyed area)
- Field team leader name
- Field team members' names
- Date of data collection
- Instrument used
- Positioning method used
- Instrument serial numbers
- File names in data recorders
- Data collection sampling rate
- Line numbers, survey direction, fiducial locations, start and end points
- Weather conditions
- Grid conditions
- Terrain conditions
- Cultural conditions

- Survey area sketch
- Associated QC data file names
- Field notes (other)

J.20.2 Data Processing

Instrument-specific software will be used for initial data processing and the output will be imported into Geosoft Oasis Montaj™ for additional processing, graphical display, anomaly selections and QA/QC. Types of processing will be system specific, but the general processing steps that may be performed on the data include the following:

- Positional offset correction
- Sensor bias, background leveling and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

J.20.3 Interpretation/Anomaly Selection

MEC-experienced data processing geophysicists will use the following criteria, supplemented by site- and system-specific criteria established during the GPO, for selecting and locating anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Decay curve characteristics
- Location of the response with respect to the edge of the grid, unsurveyable areas, land features, cultural features, or utilities within or adjacent to the grid
- Potential distortions in the response due to interference from nearby cultural features

J.20.4 Dig Locations

The target analysis process culminates in the creation of digital dig locations (a shape file imported into the MRSIMS field devices for use by the intrusive investigation team), which contain target information location, amplitude.

J.20.5 Grid Maps

With each dig sheet, the DGM subcontractor will also provide a grid map, which contains the following:

- Client
- Project
- Contractor
- Map creator
- Map approver
- Date map was created
- Map file name (full path and file extension)
- Scale
- Grid identification
- Grid corner locations
- Contoured data
- Anomaly locations with unique identification numbers
- North arrow, legend, title block, etc.

J.20.6 Records Management

All files will be made available for QC verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

J.20.7 Final Reports, Maps, and Geophysical Mapping Data

No later than 3 work days after collection, the DGM subcontractor will provide each day's data for QC inspection via the Internet using a File Transfer Protocol (FTP) site, electronic mail (email) attachments for small files under 5 megabytes, or digital compact disk (CD). Such data are considered to be in raw form. These data will be corrected for sensor offsets, diurnal variations, latency, heading error (if magnetometer is used), and drift. Also provided will be a digital planimetric map, in Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map.

All geophysical field data will be provided to CH2M HILL in delineated fields as x, y, z, v1, v2, and so on, where x and y are UTM Grid Plane Coordinates in Easting (meters) and Northing (meters) directions, z (elevation is an optional field in feet), and v1, v2, v3, and so on are the instrument readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. No individual file may be more than 100 megabytes in size and no more than 600,000 lines long. Each grid of data will be logically and sequentially named so that the file name can be easily correlated with the grid name used by other project personnel.

Within 5 working days of data collection, the processed geophysical field data, all final maps, and supporting geophysical interpretations will be provided to CH2M HILL. All geophysical data will be accompanied by a report (standard report format out of MRSIMS) documenting the field activities associated with the data and the processing performed. Information provided by the MRSIMS report is summarized in Table J-2.

TABLE J-2
Processing Documentation Requirements

Information Type	"Raw" Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	
Positioning method used	X	X	
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	
Grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	
Processed data file names associated with delivery	X	X	
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency/lag correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details		X	
PDF document showing graphical results of each field quality control test	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Geosoft ".xyz" file for unit of survey being delivered (e.g. grid or area agreed upon with MR Geophysicist)		X	

TABLE J-2
Processing Documentation Requirements

Information Type	"Raw" Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Geosoft ".grd" file for unit of survey being delivered		X	
Geosoft ".map" file for unit of survey being delivered		X	
PDF of Geosoft map for unit of survey being delivered		X	
Geosoft ".map" mosaic of all processed data to date		X	
PDF mosaic of Geosoft map of all processed data to date		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, a land surveyor will establish a minimum of two new monuments or survey markers with a minimum of third-order accuracy.

J.21 DGM Systems Quality Control

An extensive QC program will be applied to the DGM operations at the site. Figure J-2 shows an overall chart of the QC steps, and details for those steps are provided in the following subsections.

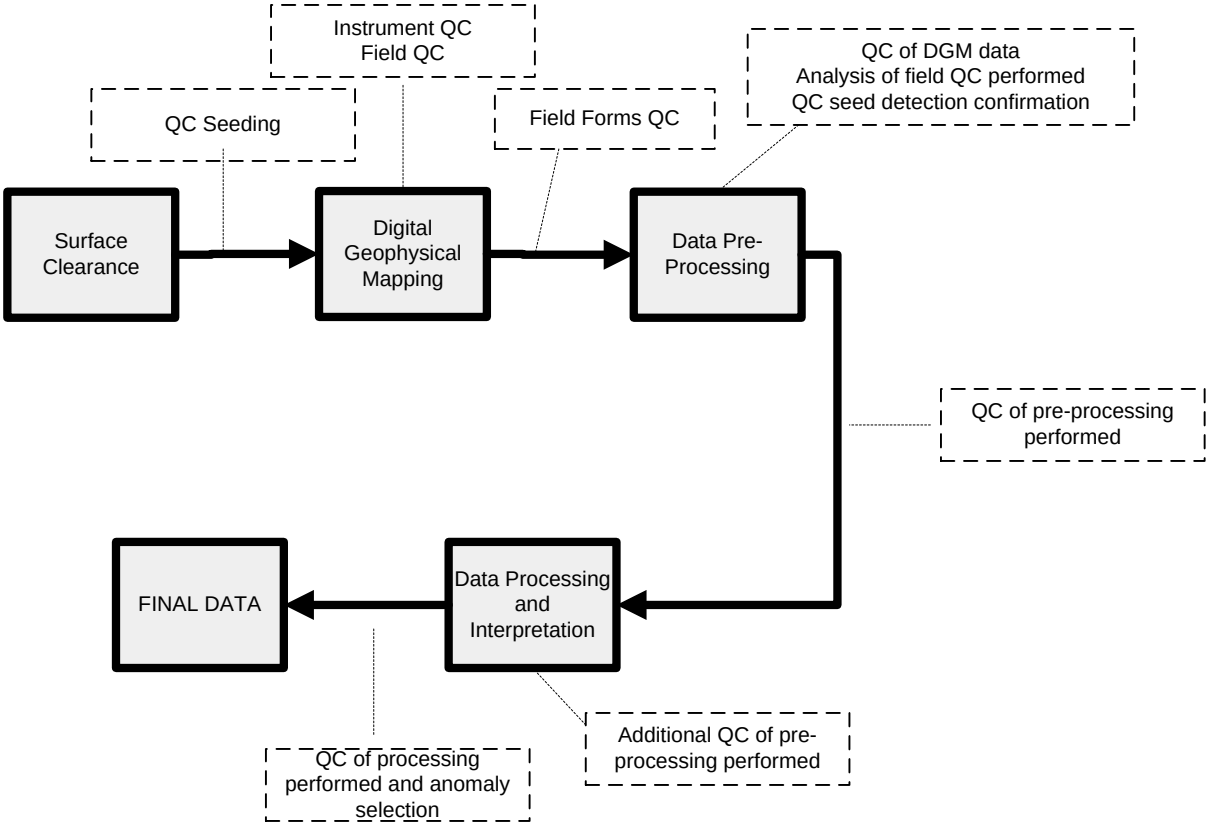


FIGURE J-2
Overview of DGM Process QC

J.22 DGM Instruments Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in Table J-3.

1. **Equipment Warm-up**. This is an instrument-specific activity, although standard warm-up time is 5 minutes. Some geophysical systems require more warm-up time than others. Each system-specific SOP defines the equipment-specific warm-up time. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day.

3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.

4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.

5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 1-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line Test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked; data will be collected along the line. The line will be traversed a total of six times as follows: 1)

normal data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a spike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO analysis process.) The Six Line Test will be conducted the first time a system is used at the site.

7. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated.

TABLE J-3
DGM Instruments Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	First Time Instr. Used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Record Sensor Positions	± 4 inch (2.54 cm)		X			
3	Personnel Test	Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	± 20% of standard item response, after background correction			X		
6	Six Line Test	Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm				X	
7	Repeat Data	Qualitative comparison of data.					X

J.23 QC Seed Items

At least one inert MEC item (or surrogate if necessary) will be seeded per acre. The seed items will be tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. CH2M HILL personnel will perform seeding using hand or mechanical tools, depending on soil conditions. The seed locations will be checked using a hand-held analog geophysical instrument to confirm that no existing anomalies are present at the seed location. Once placed, the locations of all seeded items will be surveyed using an RTK DGPS or conventional survey equipment. The items will be placed at detectable depths (as determined by the GPO). Detection of the QC seed items will be monitored by CH2M HILL and should an item not be detected, a root-cause analysis will be performed and corrective actions determined.

J.24 Quality Control of DGM Data and Deliverables

Both the DGM subcontractor and CH2M HILL will perform QC of geophysical data and data deliverables at each step of the processing path. Figure J-3 shows the processing path and the QC steps performed. Data will not move to the next stage until they have passed the QC check.

QC checks to be performed on field forms, pre-processed data and processed data can be found in Table J-3.

J.25 Corrective Measures

Specific corrective measures are dependent on the type of geophysical equipment used; however, the following are the basic corrective measures to be followed in association with DGM surveying:

- Replacement of sensors if they fail to meet instrument check requirements.
- Resurvey of grids if seeded items are not identified (do not show in the DGM data). In a situation in which there is a failure to select a seed item from the data but the item is clearly present in the DGM data, a resurvey will not be performed, but instead a re-analysis of the DGM data.

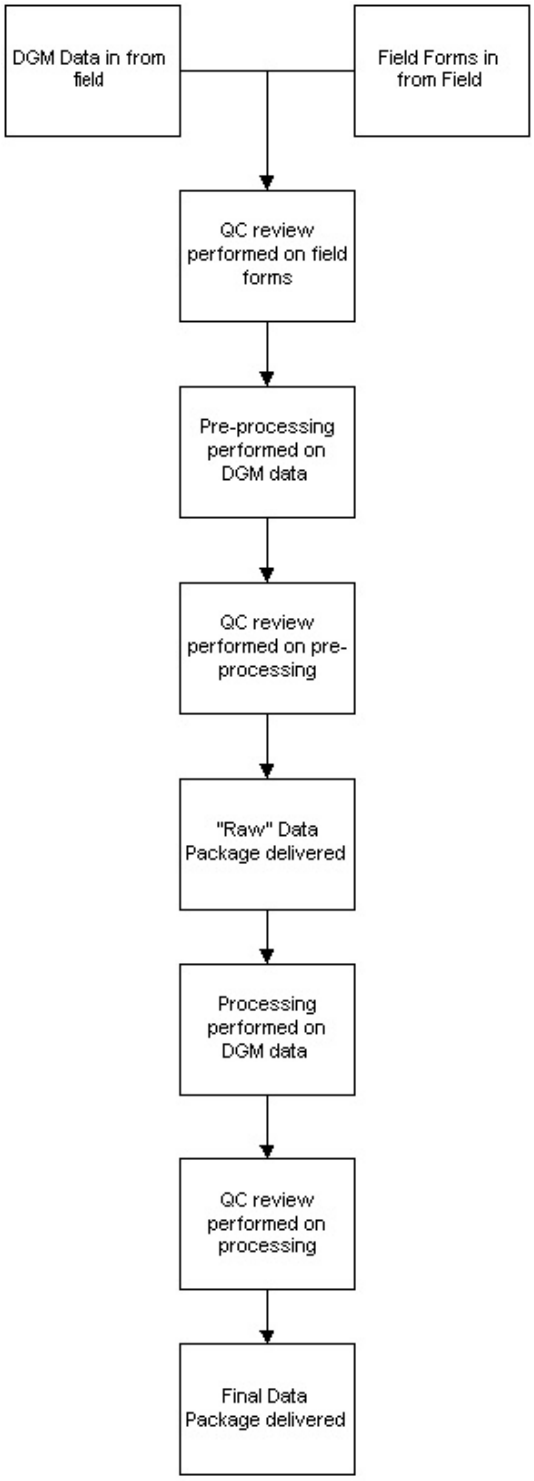


FIGURE J-3
QC of DGM Data – Process Flowpath

J.26 Analog Geophysical Systems Quality Control

QC over the analog geophysical instruments will be accomplished through daily checks that the instruments are functioning prior to using them for field activities. Each instrument will be operated over a small metallic item buried close to the maximum detection depth determined for that item during the GPO. If the instrument is not able to detect the item, it will be taken out of use until it is repaired.

J.27 References

ABB Environmental Services, Inc. 1997. *Remedial Investigation, Operable Unit 5, Naval Air Station Cecil Field, Jacksonville, Florida.* October.

Appendix K
Geophysical Prove-Out Work Plan

Geophysical Prove-Out Work Plan

Former Naval Air Station Cecil Field
Jacksonville, Florida

Revision No. 00

Contract No. N62467-98-D-0995
Contract Task Order No. 0057

Contract No. N62467-01-D-0331
Contract Task Order No. 0063

Submitted to:

U.S. Naval Facilities Engineering Command Southeast

Prepared by:

CH2MHILL Constructors, Inc.
Northpark 400
1000 Abernathy Road
Suite 1600
Atlanta, GA 30328

March 2008

Contents

Contents ..... **iii**
Acronyms and Abbreviations ..... **v**
1.0 Purpose **6**
2.0 Project Data Quality Objectives **6**
2.1 General Geophysical Systems Functioning 8
2.2 DGM Surveys 8
2.3 Data Handling 9
3.0 Personnel and Qualifications **10**
4.0 Procedures **10**
5.0 Quality Control **13**
6.0 Records Management **14**
7.0 Data Delivery **15**
8.0 Reporting **18**

Tables

K-1 Project Data Quality Objectives 3
K-2 Geophysical Instrument Standardization Tests and Acceptance Criteria 13
K-3 Processing Documentation Requirements 16

Figures

K-1 GPO Process 6
K-2 GPO Location Map 9

Acronyms and Abbreviations

CD	Compact Disk
Cm	centimeters
DGM	Digital Geophysical Mapping
DGPS	Differential Global Positioning System
DID	Data Item Description
DQO	Data Quality Objective
FAR	False Alarm Rate
GPO	Geophysical Prove-Out
GPS	Global Positioning System
Mb	megabytes
MEC	Munitions and Explosives of Concern
QC	Quality Control
RLS	Registered Land Surveyor
RTK	Real-Time Kinematic
SOP	Standard Operating Procedure
USACE	U.S. Army Corps of Engineers

1.0 Purpose

This document serves as the Geophysical Prove-Out (GPO) Work Plan for geophysical investigations at Site 15, Blue 10 Ordnance Disposal Area (Site 15) located at former Naval Air Station (NAS) Cecil Field, Jacksonville, Florida. The GPO Work Plan documents GPO activities to be performed as part of the process for validating the digital geophysical mapping (DGM) system to be utilized during the geophysical surveys.

The primary objective of the GPO is to demonstrate and document the site-specific capabilities of a DGM system to operate as an integrated system capable of meeting project data quality objectives (DQOs). For the purposes of this work, a system is considered to include the survey platform, sensors, navigation equipment, data analysis and management, and associated equipment and personnel. Additional objectives of the GPO include:

- Document the consideration given to various geophysical detection instruments, the criteria used to identify geophysical instruments for consideration, and the causes for their respective selection or rejection.
- Document the capabilities and limitations of the geophysical detection instrument selected for consideration.
- Observe the geophysical detection instrument operating in the DGM subcontractor's configuration, using their personnel and methodologies.
- Evaluate the DGM subcontractor's data collection, data transfer quality and data Quality Control (QC) method(s).
- Evaluate the DGM subcontractor's method(s) of data analysis and evaluation.
- Establish anomaly selection criteria.

The GPO objectives will be attained through evaluation of the achievement of the DQOs (discussed below) and observation of the GPO activities by the CH2M HILL Project Geophysicist. A full discussion of the evaluation will be provided in the Geophysical Prove-Out Report (see Section 8.0 for topics to be discussed).

2.0 Project Data Quality Objectives

DGM operations performed in the GPO area will demonstrate the ability of the tested system to achieve specific project DQOs. The project DQOs, measurement performance criteria, and test method to be used during the GPO are discussed in the following sub-sections and summarized in Table K-1.

TABLE K-1
Project Data Quality Objectives

Data Quality Objective	Measurement Performance Criteria	Test Method During GPO
General System Functioning		
Accurate coordinates are being obtained from DGM positioning systems.	Positional error at known monuments will not exceed ±10.2 cm (4 inches).	Results of QC Test #2 (Record Sensor Positions) (see Section 5.0) will be evaluated to ensure compliance.
Repeatable data are being obtained from DGM system.	Response to standardized item will not vary more than ±20%.	Results of QC Test #5 (Static Background and Static Spike) (see Section 5.0) will be evaluated to ensure compliance.
DGM Surveys		
DGM survey system can generally detect MEC to depths of 11*diameter. (Excluding smaller items such as 20mm projectiles.) (Depth is to top of the item.)	Sensor to identify MEC items of 40mm or larger diameter (or their surrogates in the GPO) at depths fitting within the detection depth equation.	Verify that: All of the seed items fitting within the detection depth equation have anomalies selected from the DGM surveys within 1m (3.3ft) of a point on the surface above the item.
Downline data density is sufficient to detect MEC items.	Over 98% of possible sensor readings are captured along a transect. In addition, any transect containing a data gap of 0.6m (2ft) or greater does not meet the DQO.	Results of DGM surveys will be evaluated to ensure compliance.
Coverage over survey area is sufficient to detect MEC items.	Search transect spacing to vary no more than ±20% of spacing specified in sampling design.	Results of DGM surveys with various systems will be evaluated to ensure compliance.
Positioning of detected anomalies is accurate.	95% of all anomaly locations (as shown on the dig sheets) lie within a 1m (3.3ft) radius of a point on the ground surface directly above the source of the anomaly.	Anomalies selected will be compared with known seed item locations to ensure compliance.
Data Handling		
All data must be delivered in a timely manner and in a useable format.	Data packages (see Section 7) are completed and delivered to the CH2M HILL Project Geophysicist within 1 working day of data collection (for the GPO).	Evaluate based on actual delivery of data

2.1 General Geophysical Systems Functioning

2.1.1 DGM System Positioning

The DQO for DGM systems positioning is that the coordinates being obtained from the positioning system is at a sufficient enough accuracy to allow for appropriate relocation of munitions and explosives of concern (MEC) items for intrusive investigation. The measurement performance criterion for this is that the positional error at known monuments will not exceed ±10.2 cm (4 inches). This will be evaluated during the GPO by ensuring that, on a daily basis, the positioning system in use passes QC Test #2 (Record Sensor Positions), as outlined in Section 5.0.

2.1.2 DGM System Data Repeatability

The DQO for DGM system data repeatability is that the system responds consistently from the beginning to the end of an operation. The measurement performance criterion for this is that the response to a standardized item will not vary more than ±20%. This will be evaluated during the GPO by ensuring that, on a daily basis, the geophysical system being used passes QC Test #5 (Static Background and Static Spike) and QC Test #7 (Repeat Data), as outlined in Section 5.0.

2.2 DGM Surveys

2.2.1 MEC Detection

The DQO for MEC detection is to detect all MEC above 40mm diameter to their typical maximum detectable depths. (At all sites, 20mm projectiles are difficult to detect and are rarely detected to the 11X depth [see ESTCP document Survey of Munitions Response Technologies, June 2006.] However, actual maximum detectable depths may vary based on site-specific and munitions-specific parameters, such as: 1) item orientation, 2) site background/noise levels, 3) masking effects from adjacent metallic items, 4) item shape, 5) magnetic conductivity of item materials, and 6) weathering effects on the magnetic conductivity of item materials.

An equation has been developed based on empirical data that describes typical detection depths for most MEC items (USACE DID MR-005-05):

Estimated Detection Depth = 11*diameter
(Depth is to top of the item.)

This relationship reflects the fact that MEC detection capability is reduced with greater item depth and/or decreased item size. The equation assumes worst-case orientations for ordnance items, a ratio of length to width of at least 2:1, and that the item is not thin-walled. Because of these assumptions, though the formula is to be a DQO, a more accurate actual detection depth will be determined during the GPO. The geophysical system and process will be tested to see if they can meet the above DQO. If the system cannot meet the DQO, the system and/or process will be modified to try to meet the DQO. If these changes still don't allow the system and processes to meet the DQO requirement, then a discussion will commence about modifying this DQO.

The actual project detection depth will be determined during the GPO based on the depth and orientation that the item was detectable (using the signal-to-noise ratio, shape of the anomaly,

and width of the anomaly for anomaly selection) without causing an unreasonable false alarm rate (FAR) using the same anomaly selection criteria. It should be noted that there is no absolute rule to determine an acceptable FAR. A high FAR may increase the possibility that the target items will be detected; however, the inefficiencies associated with a high FAR increase field effort, data processing and handling, and the likelihood of errors; and may decrease the overall quality of the GPO and project fieldwork results.

2.2.2 Downline Data Density

The DQO for downline (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The measurement performance criterion for this is that at least 98 percent of possible sensor readings are captured along each transect. In addition, any transect containing a data gap of 2 feet or greater does not meet the DQO. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

2.2.3 Survey Coverage (Lane Spacing)

The DQO for lane spacing is to maintain appropriate lane spacing to provide 100 percent coverage of the survey area at sufficient density to detect all detectable MEC items. The measurement performance criterion for this is that the lane spacing varies no more than ±20 percent of spacing specified in the sampling design. This will be evaluated during the GPO by verifying that all of the DGM data collected and used for anomaly selection meets this standard.

2.2.4 Positioning Accuracy

The DQO for horizontal positioning accuracy is that positioning of detected anomalies is accurate enough to allow for effective reacquisition of the anomaly. The measurement performance criterion for this is that 95 percent of all anomaly locations (as shown on the dig sheets) lie within a 1-meter radius of a point on the ground surface directly above the source of the anomaly. Any anomaly that is selected (coordinates shown on the dig sheets) outside of 1 meter from a point directly above the item will not be considered to be a detection of that item. This will be evaluated during the GPO by verifying that all anomalies selected are within this standard or can be otherwise explained.

2.3 Data Handling

The DQO for data handling is that all data must be delivered in a timely manner and in a useable format. Because of the need for rapid feedback during GPO operations to effectively test potential DGM systems, the measurement performance criterion for data handling during GPO activities will require that data packages of raw data for the GPO (see Section 8) be completed and delivered to the CH2M HILL Project Geophysicist **within 1 working day of data collection**. Final processed data for the GPO shall be delivered to the CH2M HILL Project Geophysicist within 3 working days of data collection. During production surveys, the measurement performance criterion for data handling will require that "draft" (raw) data packages be completed and delivered to the CH2M HILL Project Geophysicist within 3 working days of data collection and the final data packages within 5 working days of data collection. This will be evaluated based on the actual delivery of data during the GPO.

3.0 Personnel and Qualifications

All personnel involved in performance of the GPO and the production geophysical surveys will meet the following qualifications:

- **Project Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 7 years of directly related geophysical experience. This individual will be capable of managing a geophysical data collection and processing project/program including several task orders/sites and will have at least one year of experience in managing geophysical operations on an MEC site.
- **Site Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and have a minimum of 5 years of directly related geophysical experience. This individual will be capable of competently managing personnel, equipment and data on projects requiring multiple (three or more) geophysical field teams and geophysical data processors and will have at least one year of experience in performing geophysical operations on an MEC site.
- **Geophysical Data Processor:** will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have at least 6 months experience in processing geophysical data related to MEC projects.
- **Field Geophysicist:** will have a degree in geophysics, geology, geological engineering, or a closely related field, will have a minimum of 2 years of directly related geophysical experience and will have at least 1 year of experience in performing geophysical operations on an MEC site.
- **Geophysical Technician:** will have at least 6 months of experience in geophysical data collection on MEC related projects.

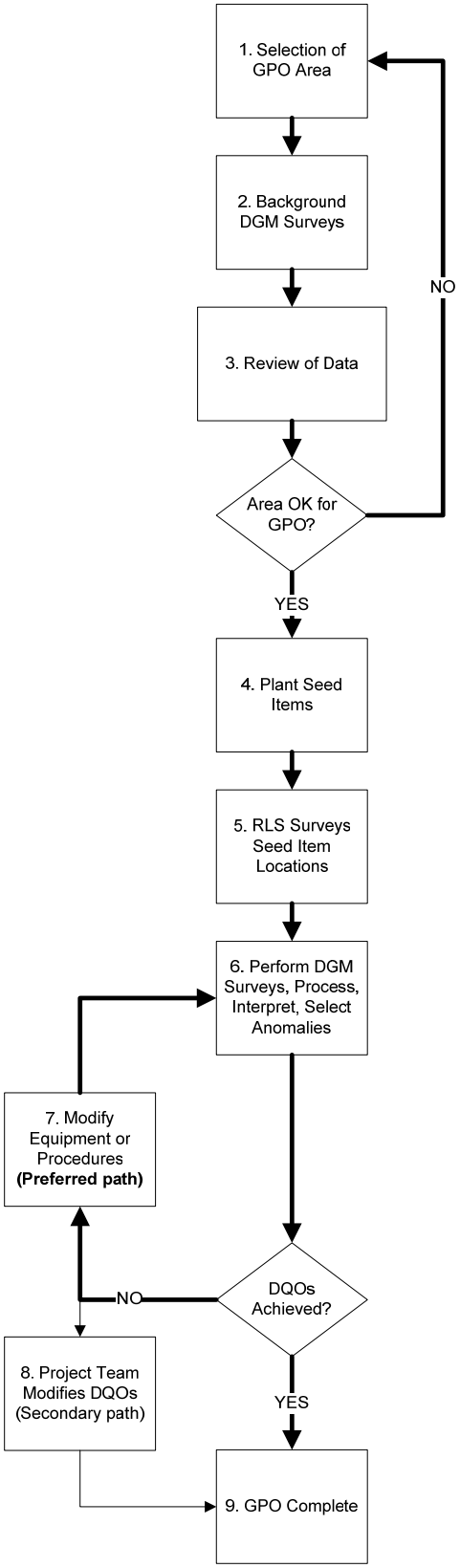
The following individuals will be involved in the GPO.

- CH2M HILL Project Geophysicist
- UXO Technician II (or higher)
- DGM subcontractor's Site Geophysicist
- DGM subcontractor's Field Geophysicist/Data Processor
- DGM subcontractor's Geophysical Technician

4.0 Procedures

A qualified and experienced MEC DGM operations geophysical team (see Section 3.0) will employ the system to be tested on the GPO plot. Figure K-1 illustrates the GPO process and the procedures to be employed (numbered in accordance with the steps shown on Figure K-1) during site work.

FIGURE K-1
GPO Process



`

1. A GPO area will be selected based on:
   (a) Terrain, geology and vegetation similar to that of a majority of the project site.
   (b) Geophysical noise conditions similar to those expected across the survey area.
   (c) Large enough site to accommodate all necessary GPO tests and equipment and for adequate spacing of the seed items to avoid ambiguities in data evaluation.
   (d) Readily accessible to project personnel.
   (e) Close proximity to the actual survey site.
2. A "background" DGM survey will be performed by the DGM subcontractor with the instrument to be tested in the GPO. This step will allow background geophysical conditions to be recorded, will help determine the appropriateness of the location (i.e., few existing anomalies), and will verify that items are not seeded near existing anomalies. The data will be post-processed (i.e., filtered and positions attached to the geophysical data) but the DGM subcontractor will not view the results apart from this.
3. The data will be provided to the CH2M HILL Project Geophysicist for evaluation.
4. A sufficient number of seed items will be buried at a range of depths and orientations to document approximate detection limits within the GPO grid. The targets will include items intended to represent variably sized MEC at the site. The actual items will depend on the types of inert items available for use from scrap collected during other work at the site. Simulated items will be used if the number and size distribution of inert items is not sufficient (or inert items are not available).

   CH2M HILL personnel will construct the GPO using shovels and, if necessary, a mechanical auger or backhoe to dig the holes to the appropriate depths for burial of the seed items. The seed items will be painted blue and tagged with a non-biodegradable label identifying the items as inert and providing a contract reference, a point of contact address, phone number, and a target identifier. The background survey data and anomaly avoidance techniques will be used to ensure that corner stakes and seed items are not placed on top of or near existing anomalies. Personnel will emplace each seed item and record the emplacement data (depth, orientation, and azimuth). All seed items will be photographed prior to burial.
5. A Registered Land Surveyor (RLS) will use a Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) or conventional Total Station survey equipment to record seed item locations to a horizontal accuracy of 3 centimeters (cm), providing an Easting and Northing (in NAD83 UTM 17, meters) for the center and each end (where applicable) of the targets. The location of the four corners of the grid will also be recorded (in UTM meters). All target markings in the GPO grid will be removed. Information on the seeded target's location will not be released to the DGM subcontractor.
6. DGM surveys will be performed by the DGM subcontractor. The data will be processed and interpreted by the DGM subcontractor and anomaly selections made. "Draft-Final" data packages will be provided to the CH2M HILL Project Geophysicist for evaluation.

7. If the initial DQOs have not been met, the CH2M HILL Project Geophysicist will meet with the DGM subcontractor to discuss whether modifications (e.g., sensor spacing) or procedures (e.g., lane spacing) can be made to the DGM system in order to meet the DQOs.
8. If the DQOs cannot be met by the DGM subcontractor, the CH2M HILL Project Geophysicist will meet with the project team, to discuss a resolution (i.e., modification of a DQO) prior to completing the GPO.
9. Once the surveys have been performed and at least one of the configurations has been determined capable of meeting the initial (or modified) DQOs, the GPO will be complete.

5.0 Quality Control

Each of the geophysical systems will be field tested to confirm proper operating conditions. Several basic QC tests will be performed in addition to instrument-specific tests. A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized in Table K-2.

1. **Equipment Warm-up**. This is an instrument-specific activity, although standard warm-up time is 5 minutes. Some geophysical systems require more warm-up time than others. Each system-specific SOP defines the equipment-specific warm-up time. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.
2. **Record Sensor Positions**. Positioning accuracy of the final processed data will be demonstrated by operating the equipment over one or more known points. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which a positioning instrument is held and the displayed position. The sensor position test will be conducted at the beginning of the survey operation for each work day.
3. **Personnel Test.** This test checks the response of instruments to personnel and their clothing/proximity to the system. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to the personnel operating the system. The response will be observed in the field for immediate corrective action and transmitted back to the processor, and analyzed and checked for spikes in the data that can possibly create false anomalies. The personnel test will be conducted at the beginning of the survey operation for each work day.
4. **Vibration Test (Cable Shake).** This test checks the response of instruments to vibration. On a daily basis, the instrument coils/sensors for those instruments being used that day will be checked for their response to vibrations in the cables. The response will be observed in the field for immediate corrective action and transmitted back to the processor and analyzed and checked for spikes in the data that can possibly create false anomalies. The vibration test will be conducted at the beginning of the survey operation for each work day.
5. **Static Background and Static Spike**. Static tests will be performed by positioning the survey equipment within or near the survey boundaries in an area free of metallic contacts and collecting data for (minimally) a 1-minute period. During this time, the instrument will be held in a fixed position without a spike (known standard) and then with a spike. The purpose of the static test is to determine whether unusual levels of instrument or ambient

`

noise exist. The static background and static spike test will be conducted at the beginning and end of each survey operation.

6. **Six Line Test.** The Six Line Test is a standard response test consisting of a predetermined route (survey line) established on or near the site in an area free of metallic contacts. The beginning, midpoint, and end of the line will be marked; data will be collected along the line. The line will be traversed a total of six times as follows: 1) *normal* data collection speed *without* a spike at the centerpoint; 2) *normal* data collection speed *without* a spike at the centerpoint; 3) *normal* data collection speed *with* a spike at the centerpoint; 4) *normal* data collection speed *with* a spike at the centerpoint; 5) *fast* data collection speed *with* a spike at the centerpoint; 6) *slow* data collection speed *with* a spike at the centerpoint. (Speed of data collection will also be evaluated as part of the GPO analysis process.) The Six Line Test will be conducted the first time a system is used at the site.

7. **Repeat Data.** This test is performed to verify repeatability of the data and will be performed after the initial survey over an area. At least 2% of the survey lines will be repeated.

TABLE K-2
DGM Instruments Standardization Tests and Acceptance Criteria

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day	First Time Instr. Used	2% of Total Area Surveyed
1	Equipment Warm-up	Equipment specific (typically 5 min)	X				
2	Record Sensor Positions	± 4 inch (10.2 cm)		X			
3	Personnel Test	Based on instrument used. Personnel, clothing, etc. should have no effect on instrument response		X			
4	Vibration Test (Cable Shake)	Data profile does not exhibit data spikes		X			
5	Static Background & Static Spike	± 20% of standard item response, after background correction			X		
6	Six Line Test	Repeatability of response amplitude ± 20%, Positional Accuracy ± 20 cm				X	
7	Repeat Data	Qualitative comparison of data.					X

6.0 Records Management

The CH2M HILL Munitions Response Site Information Management System (MRSIMS) will be used to capture and record all field and processing notes. MRSIMS is a cradle-to-grave data management system designed to track and easily query all data for Munitions Response projects. MRSIMS digitally captures, tracks, and creates automated reports on:

- Project Information (e.g. Personnel, Teams, Instrument Serial Numbers, Grid IDs and Locations)
- Field Team Leader Notes (e.g. Safety Meetings, Logbooks, Field Requests to Management)
- Digital Geophysical Mapping and UXO Field Team notes (e.g. Grids, Files, Personnel, Methods, Instruments, MEC Items Found)
- DGM Data Processing Notes and Delivery Data (File Names, Processing Performed, QQ of Data, Delivery Dates)
- Grid Statuses (e.g. Activities Performed by Grid and by Acre, Percents and Quantities Complete or Remaining)
- Demolition Tracking (All MEC Items Noted as Needing Demolition or Demilitarization Tracked from Initial Discovery to Final Disposition)
- Quality Control (e.g. QC on Notes, Processing, Data, Comparison of DGM Results to Intrusive Investigation Results and Field Activities)

MRSIMS operates in a multi-contractor capable environment with tools for digital data capture, storage, analysis, quality control and rapid display to a web-based interface. The result is a near "real-time" turnaround of project data to the management team. Field operations data is captured using GPS-enabled handheld devices running a mobile GIS/Forms based software. The data is transferred to and then validated within a centralized relational database.

The system increases project team communication, provides data visualization tools for remotely based team members, provides secure data tracking and quality control and rapid data access for decision-makers.

7.0 Data Delivery

The DGM data delivery requirements include the following:

- All sensor data will be correlated with navigational data based upon a local "third order" (1:5,000) monument or survey marker. If a suitable point is not available, CH2M HILL will have a professional land surveyor establish a point.
- All sensor data will be preprocessed for sensor offsets, latency corrections, drift corrections, etc., and correlated with navigation data.
- The DGM system will digitally capture the instrument readings into a file coincident with the grid coordinates.
- All raw and final processed data will be delivered corrected and processed in ASCII files.
- Corrections such as for navigation, instrument bias, and diurnal magnetic shift will be applied.
- All corrections will be documented (see Table K-3).
- Data will be presented in delineated fields as x, y, z, v1, v2, etc., where x and y are NAD83 UTM Grid Plane Coordinates in Easting (meters) and Northing (meters) directions, z (elevation is an optional field in meters), and v1, v2, v3, etc., are the instrument readings.
- The last data field should be a time stamp.

`

- Each data field will be separated by a comma or tab.
- No individual file may be more than 100 megabytes (Mb) in size and no more than 600,000 lines long.
- Each grid (or set) of data will be logically and sequentially named so that the file name can easily be correlated with the grid name used by other project personnel.
- Within three working day after collection, the DGM subcontractor will furnish draft data packages for each system's survey via internet using FTP, E-mail attachment for small files under 5 Mb, digital compact disk (CD) or other approved method. Final data packages will be sent similarly within 5 days of field data collection. Final data packages will include the following:
  - Dig sheets (anomaly selections) in Microsoft Excel formats
  - PDF file(s) of color contoured geophysical results with anomaly selections shown and labeled at a readable scale
  - Geosoft format GDB files and packed maps
  - Raw data files
  - Final processed data files
  - All quality control data files associated with the survey files
  - PDF of report from MRP Enterprise documenting the field activities associated with the data, and the processing performed (see Table B1-3)
  - Digital planimetric map, in Geosoft and ArcView format, and coincident with the location of the geophysical survey

TABLE K-3
Processing Documentation Requirements

Information Type	"Raw" Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	
Positioning method used	X	X	
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	
Grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	
Processed data file names associated with delivery	X	X	
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency/lag correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details		X	
PDF document showing graphical results of each field quality control test	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Geosoft ".xyz" file for unit of survey being delivered (e.g. grid or area agreed upon with MR Geophysicist)		X	
Geosoft ".grd" file for unit of survey being delivered		X	
Geosoft ".map" file for unit of survey being delivered		X	
PDF of Geosoft map for unit of survey being		X	

TABLE K-3
Processing Documentation Requirements

Information Type	"Raw" Data Delivery Report	Final Data Delivery Report	Must be in File Headers
delivered			
Geosoft ".map" mosaic of all processed data to date		X	
PDF mosaic of Geosoft map of all processed data to date		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

8.0 Reporting

CH2M HILL will prepare a GPO Report that will include the following elements:

- Color maps of the geophysical data
- Summary of the GPO results
- Geophysical equipment, techniques, and methodologies selected for the production survey
- Sufficient supporting information to justify selection