DATA ITEM DESCRIPTION

Title: Geophysics

Number: WERS-004.01 **Approval Date:** 20100428
AMSC Number: **Limitation:**
DTIC Applicable: No **GIDEP Applicable:** No
Office of Primary Responsibility: CEHNC-ED-CS-G

Applicable Forms: Attachment A – Field Data Sheet, Attachment B – DID_Tables Access Database, Attachment C - Geophysical Submittals & Due Dates, Attachment D – QC Requirements and Acceptance Sampling

Use/Relationship: This Data Item Description contains instructions for preparing Work Plan chapters and data requirements when addressing geophysical investigations for Munitions Response or other munitions related projects. This DID specifies naming and formatting conventions for data deliverables associated with geophysical activities. This DID shall be used in association with EM 1110-1-4009 Chapters 6-9. Additional references include the Ordnance and Explosives Digital Geophysical Mapping Guidance- Operational Procedures and Quality Control Manual (USAESCH, 2003).

Requirements:
1. Geophysical Investigation Plan. The Contractor shall prepare a Geophysical Investigation Plan (GIP) that provides details of the approach, methods, and operational procedures to be employed to perform geophysical investigations at Munitions Response or other munitions related projects. The GIP shall describe how the geophysical investigation and related activities will meet the project's Data Quality Objectives (DQOs). The DQOs shall include statements identifying the specific MEC target objectives, their anticipated or expected burial depths, and the detection and removal objectives for the project. Geophysical data needs and operating procedure requirements shall be identified and specified to support all project DQOs. Additionally, the following topics shall be addressed in the GIP:
   a. Specific Area(s) to be investigated, including a Survey Mission Plan Map.
   b. Account for and address all known project specific constraints, adverse conditions or features potentially affecting geophysical investigations (i.e. vegetation, geology, soil type, background geophysical noise, man-made features, site accessibility, etc.)
   c. Geophysical Survey type(s), equipment and field procedures (required for both analog and digital detectors)
   d. Required field documentation (see Attachment A for a sample Field Data Sheet template)
   e. Data processing, corrections and advanced analysis (see EM 1110-1-4009 section 8-12)
   f. Anomaly identification and ranking/prioritization criteria, and dig selection criteria (see EM 1110-1-4009 section 8-6)
   g. Anomaly reacquisition and resolution procedures (see EM 1110-1-4009 section 8-7 & 8-8b)
   h. Descriptions of final data formats and final map formats.

2. Geophysical Prove-out (GPO) Plan & Letter Report. The Contractor shall prepare a GPO Plan to address those elements described in EM 1110-1-4009 sections 8-11 and 8-12. The PDT, including the contractor's and government's geophysicists, will define the GPO size and scope necessary to meet the project needs. After the GPO field effort, the Contractor shall prepare a GPO Letter Report to contain all information required by the PDT to support their selection decisions, including the following:
   a. As-built drawing of the GPO plot
   b. Pictures of all seed items
   c. Geophysical data maps
   d. Summary of the GPO results

e. Proposed geophysical equipment, techniques, and methodologies
f. Anomaly identification and ranking/prioritization criteria, and dig selection criteria (see EM 1110-1-4009 section 8-6), and
g. Instrument specific and process specific criteria for defining the quality of the geophysical data.
h. Any other pertinent data/information used in decision making.

A CD shall be delivered with the letter report containing the following files:
a. The GPO Letter Report (Microsoft Word format);
b. All raw and processed geophysical data;
c. Geophysical maps in their native format (Surfur®, Geosoft Oasis montaj™, Intergraph, or ESRI ArcView format) and as raster bit-map images such as BMP, JPEG, TIFF or GIF;
d. Seed item location table (Microsoft Excel or Access format);
e. Microsoft Access Tables in accordance with Attachment B (all are required except Intrusive_Results_Table). The Seed_Item_Table shall include entries for all corresponding Target_IDs per dataset (i.e. GPO_Dataset1_TargetID, GPO_Dataset2_TtargetID, etc.).
f. Table (Microsoft Access format) of all control points, survey points and benchmarks established or used during the Location Surveying task.

The GPO Letter Report shall be included in future work plans and reports associated with the survey area. If the contractor proceeds with production geophysical mapping prior to the Government's acceptance of their GPO letter report, they will proceed at their own risk. If the Government rejects any portion of the Contractor's GPO letter report pertaining to geophysical mapping procedures, quality control or detection capabilities, all data collected by the Contractor at their own risk will be rejected and the Contractor shall re-collect the data at zero cost to the Government.

3. Quality Control (QC) Plan. The geophysics sections (digital and analog) of the QC plan shall be developed in accordance with EM 1110-1-4009 Chapter 9 (Quality Control of Geophysical Systems and Related Operations). The quality control plan shall identify meaningful and reasonable QC checking and testing procedures to define and document the quality achieved by the work processes performed and in the data generated. The QC plan shall include procedures for performing root-cause analyses when failures occur. Results of QC tests, numerical and pass/fail, shall be reported in an Access database or spreadsheet table, using the naming and formatting conventions found in the database template provided by USAESCH and as described in Attachment B. Contact the USAESCH Geotechnical Branch for the current database template. This database provides the format for reporting common QC tasks, it does not specify QC requirements. The tables are not all-inclusive and additions may be made to support project specific needs. Project specific QC metrics and QC requirements shall be defined and the QC Plan shall specify how they will be calculated and the frequency they will be calculated.

4. Data Format Requirements. The formats specified in this paragraph are REQUIRED to be exactly followed, although the Contractor may choose to submit the data in additional formats as well. All geophysical data shall be accompanied by metadata in the form of a read-me file or a database or spreadsheet table documenting the field activities associated with the data, the processing performed, and correlation of data file names to grid names used by other project personnel. Metadata shall be generated for each logical grouping of data (e.g., names and contents of all files generated to map a grid, or names and contents of all files generated from a towed platform during a mapping session.) Metadata shall fully describe all measurements recorded in each data file, and shall include all information necessary to successfully associate all geophysical system measurements to their correct geographical location. At the discretion of the PDT, the metadata can be limited to provide references to where this information is located. Appendix B identifies naming and reporting conventions that shall be used to deliver information associated with geophysical activities, such as function test results, QC assessment information and

results, anomaly characteristics, dig lists, reacquisition information and intrusive investigation results. Separate reporting formats and conventions are provided for analog and digital geophysical activities. The appendix also provides templates for reporting metadata. Not all information described in Appendix B is mandatory, required fields are identified by solid circles (•) in front of the field name.

a. Raw Geophysical Field Data Format and Storage. Raw field data will be stored in a logical file directory (folder) structure to facilitate its management and dissemination to PDT members. Raw field data is defined as all digital data generated from the geophysical system, and includes geophysical, positioning, heading, tilt, and any other peripheral or instrument measurements collected or recorded during data acquisition. All raw field data shall have a time stamp associated with each measurement event. At the discretion of the PDT, raw field data may include geophysical system data that has been checked, corrected and processed into ASCII files, either individually by instrument or merged with positioning data. Metadata for raw geophysical data shall include instructions for generating ASCII formatted data from all raw data for use in computer processing systems**.**

b. Final Processed and Advanced Processed Data Format and Storage. Final and Advanced (as required) processed data shall be produced and presented in ASCII formatted files and native geophysical processing software formats (e.g. Geosoft GDB). Final processed data is defined as data that represents, to the best of the Contractor's ability, the true potential field that exists at each actual location measured by the geophysical system. Final processed data shall have all corrections applied needed to correct for positioning offsets, instrument bias (including instrument latency), instrument drift, roll-pitch-yaw-angle offsets, and diurnal magnetic variations. Advanced processed data is defined as Final Processed data that has been subjected to additional advanced processing (e.g. filtering) techniques and was used in the anomaly selection process. All corrections and processing steps will be documented. Metadata for final processed and advanced processed data shall include UTM zone and coordinate units (the PDT or PWS may require additional coordinate units and projections be included), and descriptions and units of all "z" values, which are the data associated with each measurement event. All measurement events shall have a time stamp. Unprocessed, interim-processed, final processed, and advanced processed (if used) "z" values shall be included in a single file. Data file size should be limited to 100 megabytes or less, and the file length should be limited to 600,000 lines or less. Each data file will be logically and sequentially named so that the file name can be easily correlated with the project-specific naming conventions used by the PDT.

c. Anomaly Table, Dig Selection Table, Reacquisition Table & Intrusive Results Table formats. The Anomaly, Dig Selection, & Intrusive Results Tables shall be submitted digitally in a Microsoft Access Database in accordance with Attachment B. The Anomaly Table shall include all anomalies above background or above a basic selection threshold, and shall include entries for all optional columns used in making dig decisions (e.g. Size, SNR, Fit_MagneticMoment, etc). The Dig Selection Table shall include all anomalies from the Anomaly Table that have been selected for intrusive investigation. The Reacquisition and Intrusive Results Tables shall include all information tabulated for each target during those phases

d. Additional QC Table formats. The following tables are required with each DGM data submittal, and shall follow the Attachment B format: Background_Noise_Table, Coverage_Table, Positioning_Repeatability_Table, Repeatability_Table, Sample_Separation_Table, Speed_Table, Seed_Item_Table, Static_Background_Table, and Static_Response_Table. The following tables are required for analog surveys, and shall follow the Attachment B format: Function_Test_Table, Coverage_Seeding_Table, Detection_Seeding_Table, and Grid_QC_Table.

e. Map Format. For submittals, the contractor shall provide maps in editable form if available (e.g. Geosoft .map) and map images in a common image format (e.g. JPEG) for viewing without the software

used to produce the maps. Maps will include all the following basic map features in addition to any other necessary site information.

(1) General: All selected anomalies and known features shall be marked with symbols on the map. Map scales should be even multiples of the base units presented in the map. Map sizes should be designed to fit standard printer or plotter sizes. Grid ticks or grid lines should be visible and labeled.

(2) Title block: Include Figure number, the map Title and sub-title (e.g. instrument and type/component) and the location of the information being presented (e.g. site/area name and property/grid ID).

(3) Legend: All objects/symbols shown on the map should be identified in the legend. Map Scale bar, coordinate system and North arrow shall be included. Color scale bars should use a color scheme that clearly differentiates between anomalies and background readings. Background values should be plotted in white or gray, so as not to distract the viewer. A classic "cold to hot" color scale should be used with negative values plotted in blue and high positive values plotted in red/pink. The range of values should be "fixed" so that the same color scale is utilized across the site. The region of major interest is almost always near the detection/background limit, not the maximum or minimum values of the data set.

(4) Additional Project Information: minimum requirements are to have boxes for the following information: Client, Project, Contractor, Map creator, Map approver, Date created.

5. Data Submittals

The Contractor shall furnish all geophysical data, geophysical maps and dig sheets to USAESCH, via internet using FTP, E-mail attachment for small files under 5 Mb, CD/DVD or other approved method, for inspection. All geophysical data shall be accompanied by metadata as described in Section 4. The delivery schedule shall be in accordance with Attachment C, unless otherwise established by the PDT. The Contractor shall also provide a digital planimetric map in ESRI ArcView, Geosoft, or other approved 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. Each data submittal shall include the Attachment B tables to identify the quality of the data and whether it is meeting project objectives. Any QC failures shall be identified and the corrective action that is being taken shall be described. The final report deliverable shall include two copies on CD/DVD of all project data.

6.0 Contractor Minimum Performance And QC Requirements

The Contractor shall include in their QC plan specific tests that are itemized below. The values listed in the various requirements listed in Tables D-1 and D-2 for Remedial Investigations, Tables D-3 and D-4 for Removal Actions below may be adjusted upon request, provided the Contractor supplies supporting documentation and rationales for Government concurrence. Table D-5 provides acceptance sampling parameters. All reported QC results from these tests will be reviewed as part of government QA. In the event a requirement is not met and the contractor submits the data to the Government, the contractor shall provide rationales for accepting them. All such rationales will be reviewed as part of government QA. If the rationales are either insufficient or technically unfeasible, or are attempts to justify non-conformances that should be corrected to meet project needs, the Government will issue a Corrective Action Request to the contractor and the submittal(s) will be rejected. Some performance standards are default values and may be changed by the PDT to suit project needs, potentially as a result of TPP decisions. These requirements are marked with an asterisk (*). These QC requirements supersede the required QC entries in the Access Database in Attachment B. The database template shall be used; however, the required

fields will change based on these tables. Included in the assumptions for these requirements is that the data will be used to develop ‘costs to complete’ and that grids will be fully investigated.

7. End of DID WERS-004.01.

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Attachment A

Field Data Sheet

Project Name: _____ **Project Location:** _____

Geophysical Contractor: _____ **Field Team:**_____

Coordinate System (w/ units): _____ **Survey Type:**_____

Survey Area ID: _____ **Date:** _____

Raw Data File Name: _____ **Repeat Data File Name:**_____

Geophysical Instrumentation: _____ **Serial Number:** _____

Navigation Method: _____ **Serial Number:** _____

Additional Comments:_____

Sketch of Survey Area- include North arrow, Approximate scale, brief description of terrain, site conditions, and any surface features potentially affecting the data quality or coverage.

DID_Tables Access Database

This Appendix identifies naming and reporting conventions that shall be used to deliver information associated with geophysical activities. Tables for reporting information are separated by common functions or activities and include reporting specification for function test results, QC assessment information and results, anomaly characteristics, dig lists, reacquisition information and intrusive investigation information. Separate reporting formats and conventions are provided for analog and digital geophysical activities in Figures B1 and B2, respectively. This appendix also provides templates for reporting metadata (Project_Table and Dataset_Table). Not all information described in this appendix is mandatory, required fields are identified by solid circles (•) in front of the field name. Refer to the field descriptions in the electronic version of each table to learn the intended contents and use of each table.

Where appropriate, a "QCStatus" field is included in a table to indicate whether all associated QC assessments and tests have been performed and accepted or rejected by QC personnel. Site specific QC metrics and requirements shall be developed by the PDT. Those metrics and requirements can be appended to these tables to simplify reporting and checking activities, and their format and use should be defined collaboratively by the PDT.

Figure B1: DGM DID_Tables Access Database Tables & Relationships (blue dots indicate required fields)

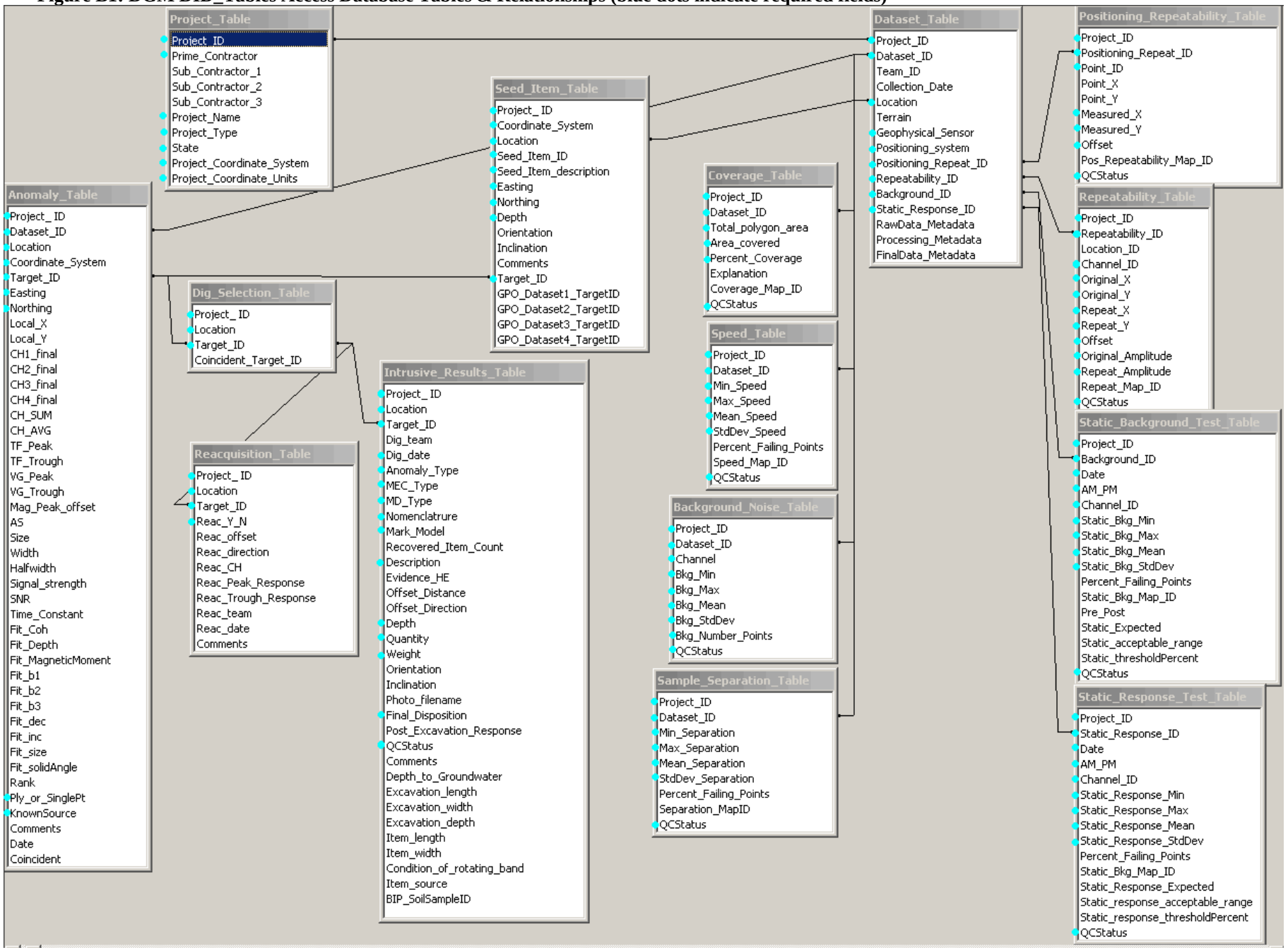
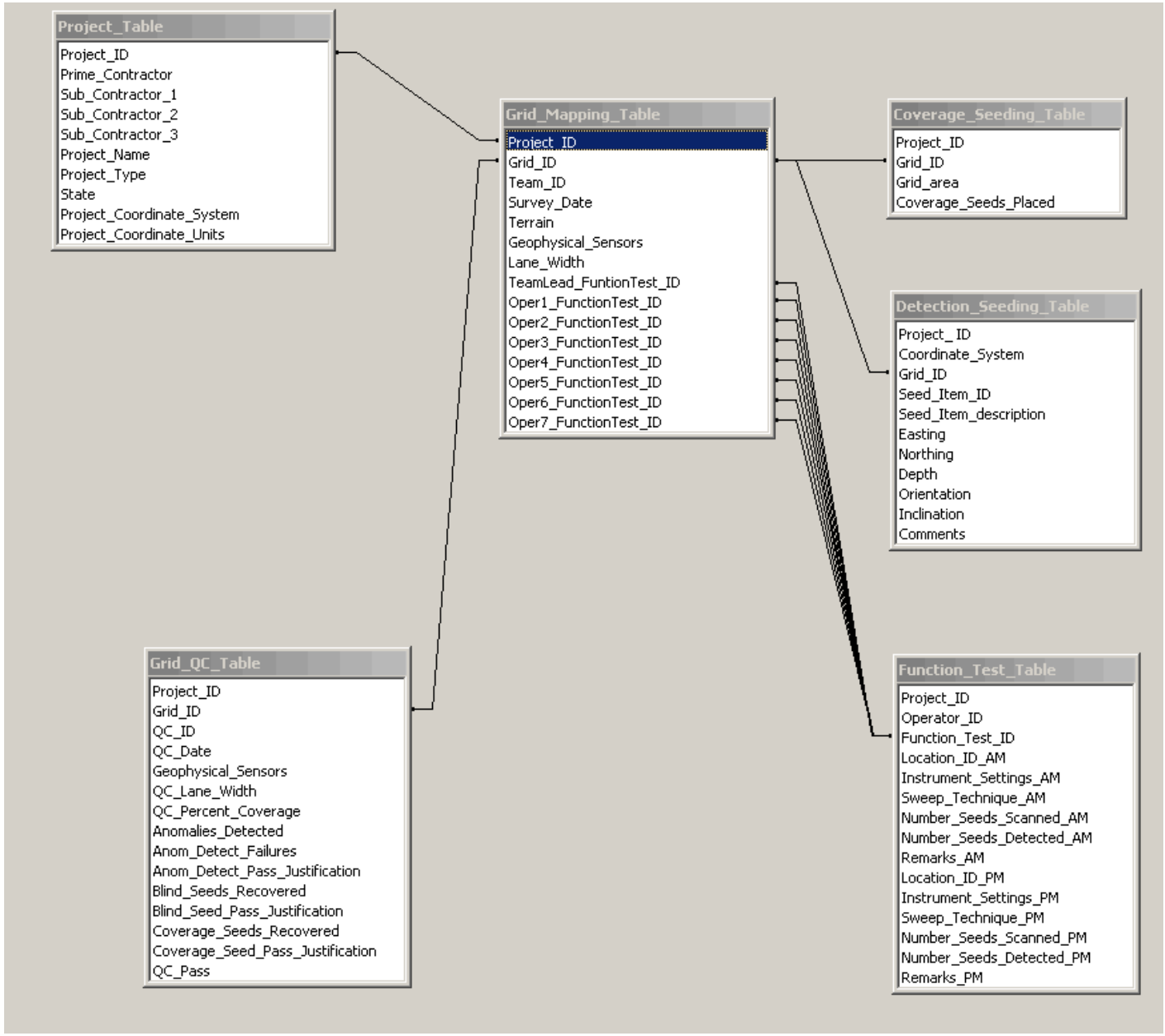


Figure B2: Analog DID_Tables Access Database Tables & Relationships


Project_Table
Project_ID
Prime_Contractor
Sub_Contractor_1
Sub_Contractor_2
Sub_Contractor_3
Project_Name
Project_Type
State
Project_Coordinate_System
Project_Coordinate_Units
Grid_Mapping_Table
Project_ID
Grid_ID
Team_ID
Survey_Date
Terrain
Geophysical_Sensors
Lane_Width
TeamLead_FuntionTest_ID
Oper1_FunctionTest_ID
Oper2_FunctionTest_ID
Oper3_FunctionTest_ID
Oper4_FunctionTest_ID
Oper5_FunctionTest_ID
Oper6_FunctionTest_ID
Oper7_FunctionTest_ID
Coverage_Seeding_Table
Project_ID
Grid_ID
Grid_area
Coverage_Seeds_Placed
Detection_Seeding_Table
Project_ID
Coordinate_System
Grid_ID
Seed_Item_ID
Seed_Item_description
Easting
Northing
Depth
Orientation
Inclination
Comments
Grid_QC_Table
Project_ID
Grid_ID
QC_ID
QC_Date
Geophysical_Sensors
QC_Lane_Width
QC_Percent_Coverage
Anomalies_Detected
Anom_Detect_Failures
Anom_Detect_Pass_Justification
Blind_Seeds_Recovered
Blind_Seed_Pass_Justification
Coverage_Seeds_Recovered
Coverage_Seed_Pass_Justification
QC_Pass
Function_Test_Table
Project_ID
Operator_ID
Function_Test_ID
Location_ID_AM
Instrument_Settings_AM
Sweep_Technique_AM
Number_Seeds_Scanned_AM
Number_Seeds_Detected_AM
Remarks_AM
Location_ID_PM
Instrument_Settings_PM
Sweep_Technique_PM
Number_Seeds_Scanned_PM
Number_Seeds_Detected_PM
Remarks_PM

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Attachment C

Geophysical Submittals & Due Dates

	With Each Submittal	24 hours after collection	24 hours after request by government representative	By the Following Friday	7 days after completed excavations of each grid	CD/DVD With Final Report
ReadMe File	X					
Index Map	X					
Updated DID_Tables Access Database	X					
First Week's mapping and QC data		X				
Special Request Draft Data			X			
DGM Data Package for each week's data collection (raw and final mapping & QC data, Maps, Field Data Sheets, & updated associated database tables)				X		
Intrusive Results Tables					X	
All Raw & Final Digital Data, Maps, Final Access Database, Final QC documentation						X

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Attachment D

Table D-1 Performance Requirements for RI/FS using DGM Methods [1]

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Static Repeatability (instrument functionality)[3]	All	Response (mean static spike minus mean static background) +-10% of GPO/original value on all channels	Min 1 daily	Day's data fails unless seed item is mapped that day with repeatable anomaly characteristics (see Dynamic Detection Repeatability)
Along Line Measurement Spacing	All	98% <=25cm along line[4]	By dataset	Dataset submittal fails
Speed	Transects without seeds[5]	95% within max project design speed or demonstrated speed	By dataset	Dataset submittal fails unless new max speed successfully demonstrated at GPO.
Coverage(*)	Grids	>90% coverage at project design line spacing.[6]	By dataset or grid[7]	Submittal fails unless gaps filled, additional data collected, or government refund for missing acreage.
Dynamic Detection Repeatability	Grids	Test item anomaly characteristics (peak response and size) repeatable with allowable variation +/-25%.[8]	1 test item per grid or dataset. [7]	Submittal fails
	Transects	(a) #anomalies on repeat segment w/in +-20% or +-8 of original or within range of adjacent sections (b) Test item (in test strip or on transect) anomaly characteristics (peak response and size) repeatable with allowable variation +/-25%. Or Fit coefficient[10] over test strip is acceptable.	(a) repeat 2% per lot[9] or (b) repeat test strip once per system per lot or daily; or 2 test items per system per lot	(a) Lot submittal fails or (b) Lot (or day's data) fails
Dynamic Positioning Repeatability	Grid coverage	Position offset of Test item target <=35cm + 1/2 line spacing[11] (<=50cm + 1/2 line spacing for fiducially positioned data).	1 test item per grid or dataset [7] (same item as Dynamic Detection Repeatability)	submittal fails
	Transects with reacquisition/digging	(a) Demonstrate reacquisition by reproducing randomly chosen anomaly signals (reac amplitude >= original & offset <= 1m) [12]	(a) 2 targets per system per lot or (b) 2 test items per	Lot submittal fails

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
		or (b) Test item anomaly characteristics (peak response and size) repeatable with allowable variation +/-25% and position offset <=1m.	system per lot (can be same as detection repeatability test items)	
Target Selection	All	All dig list targets are selected according to project design	By grid or dataset[7]	submittal fails
Anomaly Resolution(*)[13]	Verification checking by DGM re-mapping[14] Or Verification checking with original instrument of anomaly footprint after excavation [15]	If MEC[16]: 70% confidence <10% unresolved anomalies[17] If no MEC: 90% confidence <5% unresolved anomalies Accept on zero.	Rate varies depending on lot size. [18] See Acceptance Sampling Table.	Lot submittal fails
Geodetic Equipment Functionality(*)	All	Position offset of known/temporary control point within expected range as described in the approved work plan. [19]	Daily	Redo affected work or re-process affected data
Geodetic Internal Consistency	Grids with line/fiducial positioning	Grid corners are internally consistent within 30cm on any leg or diagonal.	Per Grid	Redo affected work (corner placement & data collection, or data processing)
Geodetic Accuracy	Points used for RTK or RTS base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network[20]. Project control points that are used more than once must be repeatable to within 5cm	For points used more than once, repeat occupation[21] of each point used, either monthly (for frequently used points) or before re-use (if used infrequently[22]).	Re-set points not located at original locations or resurvey point following approved work plan.
Geodetic Repeatability(*)	Grid centroids or corners/transect points without anomaly reacquisition	Measured locations are reoccupied within 10m. [23]	1 per lot	Lot submittal fails

[1] These are the critical requirements for RI DGM methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.

[2] All failures also require a Root Cause Analysis.

[3] Item should be placed on a jig that ensures consistent geometry between the sensor and item to ensure repeatability, response not to exceed 500 units, or optionally use the Geonics calibration coil. Duration of data collection needed TBD by the contractor. Must compare to original to ensure instrument is consistent throughout the project. .It is recognized that this QC requirement may be redundant and could contradict results from seeding QC, however, in the event of seed failure, information from this test may aid in determining cause of failure, i.e. instrument or processing.

[4] 25cm based on institutional knowledge and common instrument physical dimensions. Assumes speed used achieves detection. This requirement can be relaxed if supporting documentation is provided to the Government for concurrence.

[5] Needed because increase in speed can reduce SNR and increase # false hits (alternatively this test can be supplanted by repeatable anomaly characteristics of seed items within the dataset).

[6] Recommended default line spacing is 0.6m for items of interest the size of 40mm grenades and smaller, else 0.8m

[7] The terms "grid" and "dataset" refer here to logical groupings of data or data collection event. Logical groupings of data are contiguous areas mapped by the same instrument and in the same relative time-frame. These can be grids, acres, or some other unit of area. A data collection event is similar to logical groupings of data but refers to data collected over a contiguous time frame, such as "morning", "afternoon", "battery life", or some other measure of contiguous time. It is recognized that physical marking of corners on the ground is not always beneficial to the government. Additionally, size and shape of the grid is not specified.

[8] A standard test item shall be placed within the survey area (i.e. a small pipe or flat plate with a small area response. Item can be placed flush with the surface or buried at a standard depth and standard orientation). This test does not demonstrate the detection capabilities of the MEC of interest. The standard response to this test item must be defined prior to the start of production field activities. Response repeatability to this standard test item in the mapping data will indicate data quality is consistent and sufficient for detection of the MEC items of interest.

[9] Fit Coefficient means how well the repeated data matches the original data. Method of calculation and acceptance criteria can be proposed by the Contractor, and could be based on the UX-Process repeatability gx value.

[10] Contractor shall propose the lot size and criteria for designation (i.e. woods vs. open)

[11] For 0.8m line spacing, this would be a 0.75m allowable error radius (or 0.9 for fiducial).

[12] Does not necessarily mean the peak response or actual item location (i.e. for transect data the response could still be ramping up off-line). This could also be demonstrated through blind seed items.

[13] Resolved is defined as 1) there is no geophysical signal remaining at the flagged/selected location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.

[14] Mapping shall cover the required number of anomaly locations. This is used in-lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.

[15] This may require leaving flags at excavated locations until QC is complete. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete. As part of this requirement location accuracy must also be demonstrated (i.e. cleared location is within dynamic positioning error radius as described above). Contractor SOPs that incorporate post-excavation inspections using digital geophysical instruments can be used to meet the excavation verification need of this requirement provided appropriate QC protocols are in place to monitor and document the SOPs are followed. Acceptance sampling or alternative QC protocols to monitor and document the reacquisition SOP would be required to demonstrate the correct locations are excavated.

[16] If MEC (or intact or partial training or practice rounds) are not detected in a lot then the information from that lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.

[17] This is a statistical test number. It does not imply there are 10% bad units. It tests there are fewer than 10% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed. Stopping rules will take precedence over this standard (i.e. for high MEC density, decision could be made to stop because the team has enough data for characterization)

[18] For example, if lot size is 500 anomalies, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 43 anomalies must be re-checked. If any one of the 43 is unresolved, then the confidence level has not been met, the lot submittal fails and all anomalies in that lot must be re-checked (i.e. accept on zero). The contractor shall propose the lot size for government concurrence (i.e. The contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, it is based on number of anomalies, not grids.

[19] Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.

[20] The plan for tying the project network to a common reference network must be described in the approved work plan. If monumentation is part of the plan, specific monumentation procedures and data quality objectives will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – “Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products”.

[21] Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

[22] An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.

[23] The exact location of a single transect/grid is not critical when the information is used only for characterization by interpolating over large areas (e.g. transect spacings are larger than geodetic accuracies). The acceptable accuracy may be tightened by the PDT if more exact positioning is needed (e.g. trying to characterize extents of small MRS’s). If specific anomalies/locations must be recovered this metric must be revised to meet project needs and will likely have the same accuracy needs as the Geodetic Accuracy requirement.

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Attachment D
Table D-2 QC Requirements for RI/FS using Analog Methods[1]

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Repeatability (instrument functionality)	All	All items in test strip detected (trains ear daily to items of interest)[3]	Min 1 daily[4]	Remedial training and additional remedial measures as described in the approved work plan if due to operator error, or replacement of faulty equipment.[5]
Dynamic Repeatability	Transects used only for density estimates	Repeat a segment of transect & show #Counts repeated w/in the greater of +-20% or +-8, or w/in range of adjacent segments.	2nd party repeat of 2% per lot	Redo lot
	Transects with digging	Repeat a segment of transect & show extra flags/digs not greater than the greater of 20% or 8 flags/digs, or w/in range of adjacent segments.	2nd party repeat of 2% per lot	Redo lot
Coverage(*)	Grids	Blind coverage seeds and blind detection seeds recovered[6]: 75% if MEC 90% if no MEC[7]	Variable rate at 2, 3 or 4 times # operators, per lot.	Redo lot.
Detection & Recovery (*)	No DGM QC remapping	Blind detection seeds recovered: 80% if MEC 100% if no MEC	Per operator per lot: variable 1-2 large/deep and 1-3 small/ shallow[8]	Redo lot
	With DGM QC remapping	If MEC[9]: 70% confidence <10% unresolved anomalies[10] If no MEC: 90% confidence <5% unresolved anomalies Accept on zero. [11]	Rate varies depending on lot size. [Table showing acreage rates per lot size for varying confidence levels will be provided][12]	Redo lot
Anomaly Resolution(*)[13]	Verification checking of excavated locations (analog or digital instrument)	2nd party checks open holes to determine: If MEC: 70% confidence <10% anomalies unresolved[14]	Rate varies depending on lot size. See Acceptance Sampling Table.[15]	Redo lot

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
		If no MEC: 90% confidence <5% anomalies unresolved		
	Verification checking by DGM remapping[16]	Same as Detection & Recovery	Rate varies depending on lot size. See Acceptance Sampling Table.	Redo lot
Geodetic Equipment Functionality (*)	All	Position offset of known/temporary control point within expected range as described in the approved work plan.[17]	Daily	Redo affected work
Geodetic Accuracy	Points used for RTK or RTS base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network[18]. Project control points that are used more than once must be repeatable to within 5cm	For points used more than once, repeat occupation[19] of each point used, either monthly (for frequently used points) or before re-use (if used infrequently[20]).	Re-set points not located at original locations or resurvey point following approved work plan.
Geodetic Repeatability (*)	Grid corners/transect points without anomaly reacquisition	Measured locations are reoccupied within 10m.[21]	1 per lot	Redo affected work

[1] These are the critical requirements for RI analog methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.
[2] All failures also require a Root Cause Analysis.
[3] The requirement is that each operator demonstrates positive detection on a daily basis of the smallest and largest expected MEC of interest when it is placed at both its best and worst orientations and buried between 95% and 100% of their respective maximum consistent detection depth. Maximum consistent detection depth is defined as producing any above background response on a minimum of the first three time gates of the EM61MK2 optimized for site conditions and having a $0.9m^2$ size or more as calculated using the Geosoft Oasis Montaj UCEAnalyseTarget.gx or equivalent routine.
[4] Random blind reconfiguration of test strip is also required (i.e. moving/adding items) at a frequency determined by the contractor and approved in the work plan, to address the potential for simply memorizing seed locations.
[5] Some examples of additional remedial measures are: removal of operator from mapping for one day, retesting on new blind strip meeting the same requirements for seed items (could move location of items in same area), 100% QC re-inspection of initial lanes by that operator, etc.
[6] Coverage seeds are small pieces of metal that will produce relatively large amplitude anomalies over small areas, such as small nails or ball bearings. Known location accuracy of placement is not critical. See endnote #8 for description of blind detection seeds.
[7] If MEC (or intact or partial training or practice rounds) are not detected in a grid/lot then the information from that grid/lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.

[8] Detection and recovery must be consistently demonstrated for the hard to detect items; therefore, the largest expected MEC and the smallest expected MEC shall be placed between 95% and 100% of their respective maximum consistent detection depth

[9] If MEC (or intact or partial training or practice rounds) are not detected in a lot then the information from that lot may be used to support certain decisions where the confidence in the results must be greater than that for grids where MEC are detected.

[10] This is a statistical test number. It does not imply there are 10% bad units. It tests there are fewer than 10% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed. Stopping rules will take precedence over this standard (i.e. for high MEC density, decision could be made to stop because the team has enough data for characterization)

[11] Unresolved anomaly for 'Detection & Recovery Testing' means a significant signal remains without a complete rationale for its presence. Default values for such a 'significant signal' are peak amplitude on sum channel >=30mv & anomaly width >=1.2m or anomaly size >=0.9m^2. This value may change but must be agreed upon by the PDT up front.

[12] The statistical calculations for this test are in progress. This is different from sampling of excavated holes, in that a portion of the acreage is re-mapped, and the amount re-mapped must be statistically valid to show, to some confidence level, that anomalies did not go undetected.

[13] This requires leaving flags at excavated locations until QC is complete. If shovel called to a flag during QC then the failure has already occurred—it is not important that something large or small comes out of the hole. Assumption here is "mapping coverage" is addressed through other means. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete.

[14] Resolved is defined as 1) there is no geophysical signal remaining at the flagged/selected location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.

[15] For example, if lot size is 500, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 43 anomalies must be re-checked. If any one of the 43 is unresolved, then the confidence level has not been met , the lot submittal fails and all anomalies in that lot must be re-checked (i.e. accept on zero). The contractor shall propose the lot size for government concurrence (i.e. The contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, it is based on number of anomalies, not grids.

[16] Mapping shall cover the required number of anomaly locations. This is used in-lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.

[17] Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.

[18] The plan for tying the project network to a common reference network must be described in the approved work plan. If monumentation is part of the plan, specific monumentation procedures and data quality objectives will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – "Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products".

[19] Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

[20] An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.
[21] The exact location of a single transect/grid is not critical when the information is used only for characterization by interpolating over large areas (e.g. transect spacings are larger than geodetic accuracies). The acceptable accuracy may be tightened by the PDT if more exact positioning is needed (e.g. trying to characterize extents of small MRS's). If specific locations must be recovered this metric must be revised to meet project needs and will likely have the same accuracy needs as the Geodetic Accuracy requirement, which is 30cm.

Table D-3 Performance Requirements for RA using DGM Methods [1]

Requirement	**Applicability (Specific to Collection Method/Use)**	**Performance Standard**	**Frequency**	**Consequence of Failure[2]**
Static Repeatability (instrument functionality)[3]	All	Response (mean static spike minus mean static background) +-10% of GPO/original value on all channels	Min 1 daily	Day's data fails unless seed item is mapped that day with repeatable anomaly characteristics (see Dynamic Detection Repeatability)
Along Line Measurement Spacing	All	98% <=25cm along line[4]	By dataset	Dataset submittal fails
Coverage(*)	Data using electronic positioning equipment	>95% coverage at project design line spacing.[5]	By grid or dataset[6]	submittal fails
	Data using fiducial positioning	All blind coverage seeds detected at their emplacement location within the dynamic positioning repeatability metric[7] Or Lay down guidance ropes & perform random inspection	Variable rate at 2, 3 or 4 per system per grid or dataset. [6] Or All have ropes, visual observation minimum once per day	submittal fails
Dynamic Detection Repeatability	All	Test item anomaly characteristics (peak response and size) repeatable within allowable variation +/- 25%.[8]	1 test item per grid or dataset[6]	submittal fails
Dynamic Positioning Repeatability	Data using electronic positioning equipment	Position offset of Test item target <=35cm + 1/2 line spacing.[9]	1 test item per grid or dataset [6] (same item as Dynamic Detection Repeatability)	submittal fails

Requirement	Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
	Data using fiducial positioning	Position offset of Test item target <=50cm + 1/2 line spacing.	1 test item per grid or dataset [6] (same item as Dynamic Detection Repeatability)	submittal fails
Target Selection	All	All dig list targets are selected according to project design	By grid or dataset[6]	submittal fails
Anomaly Resolution(*)[10]	Verification checking by DGM re-mapping[11] Or Verification checking with original instrument of anomaly footprint after excavation [12]	90% confidence <1% unresolved anomalies[13] Accept on zero.	Rate varies depending on lot size. [14] See Acceptance Sampling Table.	Lot submittal fails
Geodetic Equipment Functionality(*)	All	Position offset of known/temporary control point within expected range as described in the approved work plan. [15]	Daily	Redo affected work or re-process affected data
Geodetic Internal Consistency	Grids with line/fiducial positioning	Grid corners are internally consistent within 30cm on any leg or diagonal.	Per Grid	Redo affected work (corner placement & data collection, or data processing)
Geodetic Accuracy	Points used for RTK or TS base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network[16]. Project control points that are used more than once must be repeatable to within 5cm	For points used more than once, repeat occupation[17] of each point used, either monthly (for frequently used points) or before re-use (if used infrequently[18]).	Re-set points not located at original locations or resurvey point following approved work plan.

[1] These are the critical requirements for RA DGM methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.
[2] All failures also require a Root Cause Analysis.
[3] Item should be placed on a jig that ensures consistent geometry between the sensor and item to ensure repeatability, response not to exceed 500 units, or optionally use the Geonics calibration coil. Duration of data collection needed TBD by the contractor. Must compare to original to ensure instrument is consistent throughout the project. .It is recognized that this QC requirement may be redundant and could contradict results from seeding QC, however, in the event of seed failure, information from this test may aid in determining cause of failure, i.e. instrument or processing.
[4] 25cm based on institutional knowledge and common instrument physical dimensions. Assumes speed used achieves detection. This requirement can be relaxed if supporting documentation is provided to the Government for concurrence.
[5] Recommended default line spacing is 0.6m for items of interest the size of 40mm grenades and smaller, else 0.8m.

[6] The terms "grid" and "dataset" refer here to logical groupings of data or data collection event. Logical groupings of data are contiguous areas mapped by the same instrument and in the same relative time-frame. These can be grids, acres, or some other unit of area. A data collection event is similar to logical groupings of data but refers to data collected over a contiguous time frame, such as "morning", "afternoon", "battery life", or some other measure of contiguous time. It is recognized that physical marking of corners on the ground is not always beneficial to the government. Additionally, size and shape of the grid is not specified.

[7] Coverage seeds are small pieces of metal that will produce relatively large amplitude anomalies over small areas, such as small nails or ball bearings. They shall be placed beneath the ground surface so as not to be visible to the operator.

[8] A standard test item shall be placed within the survey area (i.e. a small pipe or flat plate with a small area response. Item can be placed flush with the surface or buried at a standard depth and standard orientation). This test does not demonstrate the detection capabilities of the MEC of interest. The standard response to this test item must be defined prior to the start of production field activities. Response repeatability to this standard test item in the mapping data will indicate data quality is consistent and sufficient for detection of the MEC items of interest.

[9] For 0.8m line spacing, this would be a 0.75m allowable error radius.

[10] Resolved is defined as 1) there is no geophysical signal remaining at the interpreted location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.

[11] Mapping shall cover the required number of anomaly locations. This is used in-lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.

[12] This may require leaving flags at excavated locations until QC is complete. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete. As part of this requirement location accuracy must also be demonstrated (i.e. cleared location is within dynamic positioning error radius as described above). Contractor SOPs that incorporate post-excavation inspections using digital geophysical instruments can be used to meet the excavation verification need of this requirement provided appropriate QC protocols are in place to monitor and document the SOPs are followed. Acceptance sampling or alternative QC protocols to monitor and document the reacquisition SOP would be required to demonstrate the correct locations are excavated.

[13] This is a statistical test number. It does not imply there are 1% bad units. It tests there are fewer than 1% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed.

[14] For example, if lot size is 500 anomalies, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 44 anomalies must be re-checked. If any one of the 44 is unresolved, then the confidence level has not been met, the lot submittal fails and all anomalies in that lot must be re-checked or some other action or actions performed. The contractor shall propose the lot size for government concurrence (i.e. The contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, numbers of anomalies is used and not numbers of grids.

[15] Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.

[16] The plan for tying the project network to a common reference network must be described in the approved work plan. If monumentation is part of the plan, specific monumentation procedures and data quality objectives will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – "Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products".

[17] Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

[18] An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.

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Table D-4 Performance Requirements for RA using Analog Methods[1]

Requirement	Limited Applicability (Specific to Collection Method/Use)	Performance Standard	Frequency	Consequence of Failure[2]
Repeatability (instrument functionality)	All	All items in test strip detected (trains ear daily to items of interest)[3]	Min 1 daily[4]	Remedial training and additional remedial measures as described in the approved work plan if due to operator error, or replacement of faulty equipment.[5]
Coverage(*)	All	All blind coverage seeds and blind detection seeds recovered[6]	Variable rate at 2, 3 or 4 times # operators, per lot.	Redo lot.
Detection & Recovery (*)	No DGM QC remapping	All blind detection seeds recovered	Per operator per lot: variable 1-2 large/deep and 1-3 small/ shallow[7]	Redo lot
	With DGM QC remapping	90% confidence <1% unresolved anomalies. Accept on zero.[8]	Rate varies depending on lot size. [Table showing acreage rates per lot size for varying confidence levels will be provided][9]	Redo lot
Anomaly Resolution(*)[10]	Verification checking of excavated locations (analog or digital instrument)	2nd party checks open holes to determine: 90% confidence <1%[11] unresolved anomalies. [12] Accept on zero.	Rate varies depending on lot size. See Acceptance Sampling Table. [13]	Redo lot
	Verification checking by DGM remapping[14]	Same as Detection & Recovery	Rate varies depending on lot size. See Acceptance Sampling Table.	Redo lot
Geodetic Equipment Functionality(*)	All	Position offset of known/temporary control point within expected range as described in the approved work plan. [15]	Daily	Redo affected work
Geodetic Accuracy	Points used for RTK or RTS base stations	Project network must be tied to HARN, CORS, OPUS or other recognized network[16].	For points used more than once, repeat occupation[17] of each point used, either	Re-set points not located at original locations or resurvey point following approved

		Project control points that are used more than once must be repeatable to within 5cm	monthly (for frequently used points) or before re-use (if used infrequently[18]).	work plan.

[1] These are the critical requirements for RA analog methods. Contractors shall use additional methods/frequencies that they deem beneficial and as required in their SOPs.
[2] All failures also require a Root Cause Analysis.
[3] The requirement is that each operator demonstrates positive detection on a daily basis of the smallest and largest expected MEC of interest when it is placed at both its best and worst orientations and buried between 95% and 100% of their respective maximum consistent detection depth. Maximum consistent detection depth is defined as producing any above background response on a minimum of the first three time gates of the EM61MK2 optimized for site conditions and having a $0.9m^2$ size or more as calculated using the Geosoft Oasis Montaj UCEAnalyseTarget.NET or equivalent routine.
[4] Random blind reconfiguration of test strip is also required (i.e. moving/adding items) at a frequency determined by the contractor and approved in the work plan, to address the potential for simply memorizing seed locations.
[5] Some examples of additional remedial measures are: removal of operator from mapping for one day, retesting on new blind strip meeting the same requirements for seed items (could move location of items in same area), 100% QC re-inspection of initial lanes by that operator, etc.
[6] Coverage seeds are small pieces of metal that will produce relatively large amplitude anomalies over small areas, such as small nails or ball bearings. Known location accuracy of placement is not critical. See endnote #5 for description of blind detection seeds.
[7] Detection and recovery must be consistently demonstrated for the hard to detect items; therefore, the largest expected MEC and the smallest expected MEC shall be placed between 95% and 100% of their respective maximum consistent detection depth
[8] Unresolved anomaly for 'Detection & Recovery Testing' means a significant signal remains without a complete rationale for its presence. Default values for such a 'significant signal' are peak amplitude on sum channel >=30mv & anomaly width >=1.2m or anomaly size >=$0.9m^2$. This value may change but must be agreed upon by the PDT up front.
[9] The statistical calculations for this test are in progress. This is different from sampling of excavated holes, in that a portion of the acreage is re-mapped, and the amount re-mapped must be statistically valid to show, to some confidence level, that anomalies did not go undetected.
[10] This requires leaving flags at excavated locations until QC is complete. If shovel called to a flag during QC then the failure has already occurred—it is not important that something large or small comes out of the hole. Assumption here is "mapping coverage" is addressed through other means. It is up to the contractor to indicate which holes knowingly have metal left in them where the PDT has agreed such is acceptable. It is the contractor's responsibility to not put hot material back in the hole before QC is complete.
[11] This is a statistical test number. It does not imply there are 1% bad units. It tests there are fewer than 1% bad units, including zero bad units. Values for confidence levels will be determined by the PDT and are dependent on the information needed.
[12] Resolved is defined as 1) there is no geophysical signal remaining at the flagged/selected location, or 2) a signal remains but it is too low or too small to be associated with UXO/DMM, or 3) a signal remains but is associated with surface material which when moved results in low, or no signal at the interpreted location, or 4) a signal remains and a complete rationale for its presence exists.
[13] For example, if lot size is 500 anomalies, to achieve a 90% confidence that there are less than 5% unresolved anomalies, 44 anomalies must be re-checked. If any one of the 44 is unresolved, then the confidence level has not been met, the lot submittal fails and all anomalies in that lot must be re-checked (i.e. accept on zero). The contractor shall propose the lot size for government concurrence (i.e. The contractor determines the amount of risk they are willing to take. The larger the lot, the less sampling needs to be done, but the larger the risk of increased costs/rework if failure occurs.) For anomaly resolution, in order to use statistics/confidence levels, it is based on number of anomalies, not grids.

[14] Mapping shall cover the required number of anomaly locations. This is used in-lieu of checking individual anomalies for those instances where it is quicker to re-map sections of land rather than return to individual anomalies. Only the data at the anomaly locations is reviewed for resolution.

[15] Most high-accuracy systems should demonstrate repeatability between 5cm and 10cm. Typical accuracies achievable for some high-accuracy systems are: 2cm to sub-centimeter for RTK DGPS and RTS units depending on manufacturer and site conditions. Less accurate systems should demonstrate repeatability within manufacturer published ranges. Typical accuracies for less accurate systems are 5m to sub-meter for WAAS or satellite correction service DGPS units depending on manufacturer, correction service and site conditions, and 30m to 1m for USCG beacon corrected units depending on manufacturer.

[16] The plan for tying the project network to a common reference network must be described in the approved work plan. If monumentation is part of the plan, specific monumentation procedures and data quality objectives will also need to be specified and installation of monumentation or network control points shall follow all guidance and accuracies specified in EC 1110-1-73 – "Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products".

[17] Repeat occupation means demonstrate the control points being used can be recovered and reoccupied and that they have not moved more than the requirement specification. This can be accomplished using the same methodology used to initially tie the local network to a HARN, CORS, OPUS, or other recognized network, or it can be accomplished by other means that achieve this requirement.

[18] An example of frequently used control points would be points used as RTK DGPS base stations. Infrequently used points could be those used during RTS operations where the control point was used during mapping and then again at some later time for reacquisition and QC statistical sampling. Infrequently used points could also include grid corners they are used for line and fiducial positioning and then subsequently re-used for reacquisition or QC statistical sampling.

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Table D-5 Acceptance Sampling Table for Anomaly Resolution

	Lot size = **50** anomalies	**100**	**200**	**500**	**1000**	**2000**	**5000**	**10,000**
70% confidence <**10%** unresolved[1]	11	11	12	12	12	12	12	12
80% confidence <**10%** unresolved	14	15	15	16	16	16	16	16
90% confidence <**10%** unresolved	18	20	21	22	22	22	22	22
95% confidence <**10%** unresolved	22	25	27	28	29	29	29	29
70% confidence <**5%** unresolved	17	21	23	23	24	24	24	24
80% confidence <**5%** unresolved	21	27	30	31	31	32	32	32
85% confidence <**5%** unresolved	23	31	34	36	37	37	37	37
90% confidence <**5%** unresolved[2]	27	37	41	43	44	45	45	45
95% confidence <**5%** unresolved	31	45	51	56	57	58	59	59
80% confidence <**1%** unresolved	40	80	111	138	144	154	158	159
85% confidence <**1%** unresolved	43	85	123	158	172	181	186	187
90% confidence <**1%** unresolved[3]	45	90	137	184	205	217	224	227
95% confidence <**1%** unresolved	48	95	155	225	258	277	290	294

* Gray boxes show number of dug locations to check post-excavation. All must be shown to be resolved to meet confidence values (accept on zero)

[1] Default for RIFS where MEC has been recovered.

[2] Default for RIFS where no MEC has been recovered.

[3] Default for Removal Action.