Final
January 2013

Geophysical System Verification Report

Non-Time Critical Removal Action (NTCRA)
Operable Unit B-2 (OU B-2)
Various Remedial Action Areas

Former Naval Air Facility

Adak, Alaska

Department of the Navy
Naval Facilities Engineering Command Northwest
1101 Tautog Circle
Silverdale, WA 98315

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FINAL Geophysical System Verification Report
Non-Time Critical Removal Action at OU B-2, Adak, Alaska
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GEOPHYSICAL SYSTEM VERIFICATION (GSV) REPORT

NON-TIME CRITICAL REMOVAL ACTION
OPERABLE UNIT B-2 (OU B-2) VARIOUS REMEDIAL ACTION AREAS

FORMER ADAK NAVAL AIR FACILITY
ADAK, ALASKA

January 2013

Prepared For:

Department of the Navy
Naval Facilities Engineering Command, Northwest
1101 Tautog Circle
Silverdale, WA 98315

Prepared By:

USA Environmental, Inc.
720 Brooker Creek Boulevard
Suite 204
Oldsmar, FL 34677

Prepared Under:

Adak OU B-2, NTCRA Munitions Clearance
Contract Number N44255-12-C-3003

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2x std. dev.	2 times the standard deviation
ARA	Adak Recreation Area
BSI	blind seed item
cm	centimeter
DGM	digital geophysical mapping
DGPS	Differential Global Positioning System
DQO	data quality objective
EM	electromagnetic
ft	foot, feet
GIS	Geographic Information System
GPS	global positioning system
GSV	Geophysical System Verification
in	inch, inches
ISO	industry standard object
IVS	instrument verification strip
m	meter
MEC	munitions and explosives of concern
mV	millivolt
NAF	Naval Air Facility
NRL	Naval Research Laboratory
NTCRA	Non-Time Critical Removal Action
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAA	Remedial Action Area
RMS	root mean square
RTK DGPS	Real Time Kinematic Differential Global Positioning System
SOP	Standard Operating Procedure
USA	USA Environmental, Inc.
UXOQCS	UXO Quality Control Specialist
UXOTII	UXO Technician II

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1.0 INTRODUCTION

USA Environmental, Inc. (USA) conducted Geophysical System Verification (GSV) Installation activities in three Remedial Action Areas (RAAs) within Operable Unit B-2 at the former Naval Air Facility (NAF), Adak, Alaska, during the period of 21 September 2012 through 29 September 2012 in support of the non-time critical removal action (NTCRA) for munitions and explosives of concern (MEC). This work was performed in accordance with the final GSV Installation Plan [Munitions and Explosives of Concern Quality Assurance Project Plan (MEC QAPP), Appendix G].

The GSV installation consisted of two main components:

- Installation and testing of an instrument verification strip (IVS) in each of the three RAAs (RAA-02, RAA-03 and RAA-04) to verify that the digital geophysical mapping (DGM) instrumentation (sensors and positioning), instrument operators, data acquisition methodologies, and data processing and analysis procedures meet the specific data quality objectives (DQOs) established for the project. Each test strip consists of a center line with five small industry standard objects (ISOs) and an offset background noise line. Secondary lines were installed at 2.5-ft and 1.25-ft offsets to simulate data collection and to verify half line response amplitude for blind seed verification (see Figure 1-1).
- Installation of blind seed items (BSI) in the survey areas of each RAA as a quality control (QC) measure for geophysical data collection, target selection, and anomaly resolution.

USA deployed a total of eight personnel for the GSV installation. The project teams included:

- Management Team
  - Project Manager, Mr. Manok Synakorn
  - UXO Safety Officer, Mr. Frank Magner
  - UXO Quality Control Specialist (UXOQCS), Mr. Robert Shauger
- IVS Team
  - Site Geophysicist, Mr. Richard MacNeil
  - UXO Technician II (UXOTII), Mr. Charles Haggerty
  - Geophysical Instrument Operator, Mr. Ted Pate
- BSI Team
  - Field Engineer, Mr. Scott Crandall
  - UXOTII, Mr. Richard Moyer

For the IVS installation, USA deployed the following equipment:

- A Trimble 5800 Real Time Kinematic Differential Global Positioning System (RTK DGPS) base station and 5800 RTK DGPS rover
- A Geonics EM61-MK2A with the 1.0- x 0.5-m coil and a T6000 field data logger configured in the two-person stretcher mode with a rigidly mounted DGPS antenna mount centered over the middle of the bottom coil. (Figure 1-1).
- White's DFX300 all metals detector (White's DFX300)
- Trimble GeoXT DGPS
- A laptop computer with:
  - Geonics' sensor software for downloading and exporting electromagnetic (EM) data
  - Geosoft's Oasis Montaj software v7.5 for initial processing and field analysis

Figure 1-1: EM61-MK2A in Stretcher Mode with Rigid Global Positioning System (GPS) Mount

For the BSI installation, USA deployed the following equipment:

- A Trimble R8 GNSS RTK DGPS base station and rover
- White's DFX300
- Trimble GeoXT DGPS.

The project team utilized two base stations during GSV operations. One base station was located in RAA-03 (RAA03 Base), see Figure 1-2, and the other base station, Adak Recreation Area (ARA Base), was located on the Eastern edge of Andrew Lake, South of RAA-04. These points were located and established using Tidal Bench Mark 18 (PID UW7919) as the reference point and back-checked on historic Benchmark BR-6 near the radar domes. All data is reported in NAD83 Alaska State Plane (10), US Survey feet. A list of control monuments is provided in Table 1-1. Daily GPS checks all passed the performance metric of 0.164-ft and are provided in Table 1-2.

Table 1-1: USA Control Monuments

NAD83 Alaska State Plane Zone 10 US Survey Feet				
Monument	**Easting (US ft)**	**Northing (US ft)**	**Elevation (US ft)**	**Comment**
Bench Mark 18	3135925.289	315129.185	38.96	Control Point
BR-06	3128679.075	318792.887	404.673	Control Point
ADK-401	3135732.455	334516.414	285.936	Control Point
ADK-401 BC	3135732.995	334497.841	286.008	Back Check
RAA03 Base	3132871.712	340487.023	74.627	Control Point
RAA03 BC	3132885.27	340474.075	73.57	Back Check
ARA Base	3142011.549	345457.498	108.803	Control Point
ARA BC	3142015.412	345429.809	108.444	Back Check

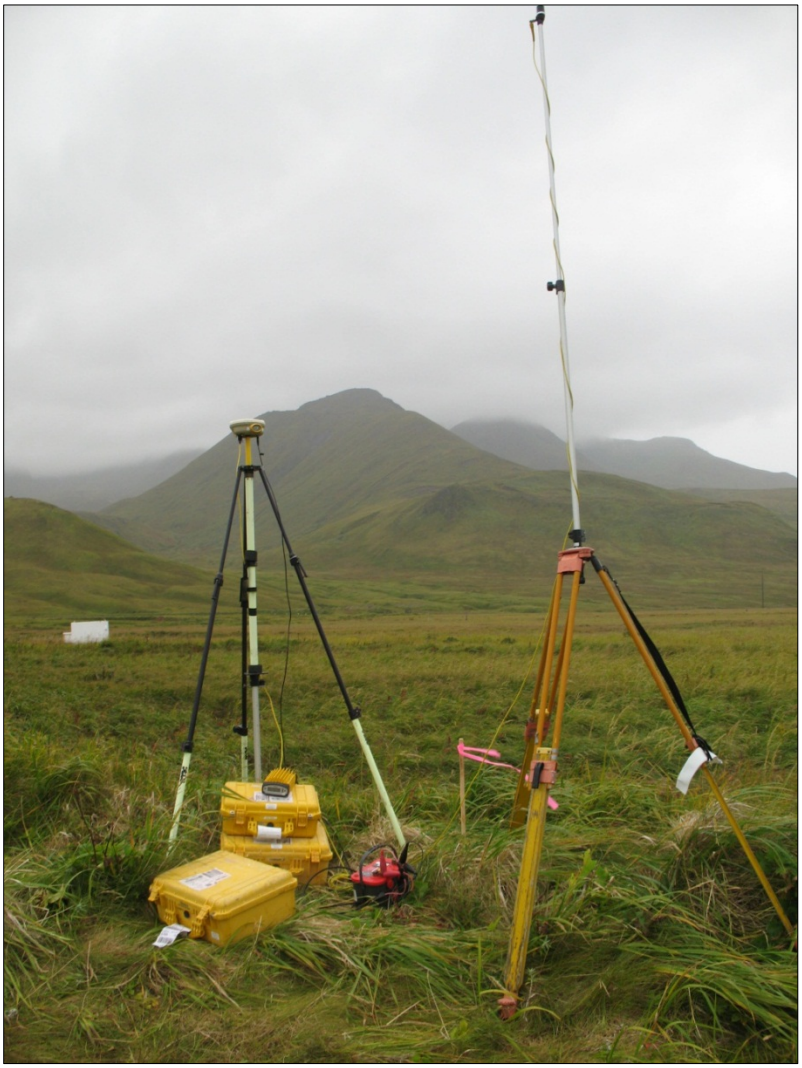

Figure 1-2: RAA-03 Base Station Setup

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Table 1-2: Daily RTK-DGPS Checks

GPS Checks	NAD83 Alaska State Plane, Zone 10, US Survey Feet								
Date	Team	Check Point	Known Y	Known X	Measured Y	Measured X	Offset (ft)	Metric (ft)	Status
9/21/2012	BSI	BR-06	318792.887	3128679.075	318792.902	3128679.062	0.0198	0.164	Pass
9/22/2012	BSI	RAA03 BC	340474.075	3132885.27	340474.095	3132885.266	0.0204	0.164	Pass
9/23/2012	BSI	RAA03 BC	340474.075	3132885.27	340474.064	3132885.244	0.0282	0.164	Pass
9/24/2012	BSI	RAA03 BC	340474.075	3132885.27	340474.052	3132885.237	0.0402	0.164	Pass
9/25/2012	BSI	RAA03 BC	340474.075	3132885.27	340474.025	3132885.279	0.0508	0.164	Pass
9/26/2012	BSI	ARA BC	345429.809	3142015.412	345429.727	3142015.435	0.0852	0.164	Pass
9/22/2101	DGM	RAA03 BC	340474.075	3132885.27	340473.997	3132885.247	0.0813	0.164	Pass
9/23/2101	DGM	RAA03 BC	340474.075	3132885.27	340473.995	3132885.333	0.1018	0.164	Pass
9/25/2012	DGM	ARA BC	345429.809	3142015.412	345429.777	3142015.375	0.0489	0.164	Pass
9/26/2012	DGM	ARA BC	345429.809	3142015.412	345429.844	3142015.385	0.0442	0.164	Pass
9/27/2012	BSI	ARA BC	345429.809	3142015.412	345429.858	3142015.396	0.0515	0.164	Pass

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2.0 RAA-02 IVS INSTALLATION

Installation and testing of the RAA-02 IVS was conducted during the period from 25-26 September 2012.

2.1 NARRATIVE OF INSTALLATION LOGISTICS

On 25 September 2012 the IVS team located the idealized area for the RAA-02 IVS using a Trimble GeoXT. The team then selected a section with similar terrain, vegetation, and geology as the investigation area and performed a background survey using a White's DFX300. The UXOTII confirmed that the site was sufficiently anomaly free. An area approximately 100-ft by 18-ft was then staked out and a background survey was performed using the EM61-MK2A in stretcher mode. The site geophysicist processed the background survey data on-site and confirmed that the area was suitable for the IVS installation to begin. An 80-ft center line was laid out using tape measures and then the offset and background noise lines were installed. Large non-metallic plastic stakes were installed at the ends of each line and high visibility rope was secured along each line between the plastic stakes. The team then installed the small ISOs at the pre-determined points along the center line as described in the GSV Plan. The small ISOs are standard 1-in pipe nipples, intended to simulate 37-mm projectiles. Each ISO was placed horizontal, worst-case inclination, and was oriented either along IVS centerline or across the IVS centerline. The height of the tundra overburden was measured and recorded at each IVS seed item location. Each seed item was emplaced at the approved depth in the mineral soil. The full distance from the tundra surface and mineral soil surface to the center of the IVS seed item was measured with a tape measure and recorded. Prior to burial, the ISOs were photographed (in-place) using the survey tape for orientation reference, and the ISO position (x, y, and depth to center) were measured with the RTK DGPS. A second RTK DGPS measurement was made over each IVS seed item at the walking surface height. The end points of all lines were also measured and recorded with the RTK DGPS.

On 26 September 2012 the IVS team returned to the RAA-02 IVS to conduct all five DGM surveys of the RAA-02 IVS. A morning static and response test was performed according to Standard Operating Procedure (SOP) 2 prior to survey activities and the coil height of the EM61-MK2A was confirmed to be 15-in above the walking surface. After instrument warm-up, five separate files were collected with the EM61-MK2A over the RAA-02 IVS. Data was down loaded and preliminary processing was done on-site by the site geophysicist. An end of the day static and response test was performed before leaving the site.

2.2 IVS AREA MAP AND COORDINATES [FROM GEOGRAPHIC INFORMATION SYSTEM (GIS)]

The RAA-02 IVS was installed inside the proposed IVS radius as described in the GSV plan. The RAA-02 IVS location has similar terrain, vegetation, and geology as the survey portion of the site. The RAA-02 IVS site location map and boundary and lane coordinates are provided in Figure 2-1.

2.3 BACKGROUND DGM AND DISCUSSION

A White's DFX300 was utilized to perform an initial assessment of the idealized IVS location. The UXOTII determined that the planned location was sufficiently free of anomalies and the IVS team laid out a 100-ft by 18-ft grid. The team then surveyed the IVS area using the EM61-MK2A in stretcher mode. The area was shown to be sufficiently clear to enable the installation of the IVS. Background root mean square (RMS) noise for the grid was 0.754-mV on time gate 1. A color shaded grid map of the EM61-MK2A leveled time gate 1 data is shown in Figure 2-2.

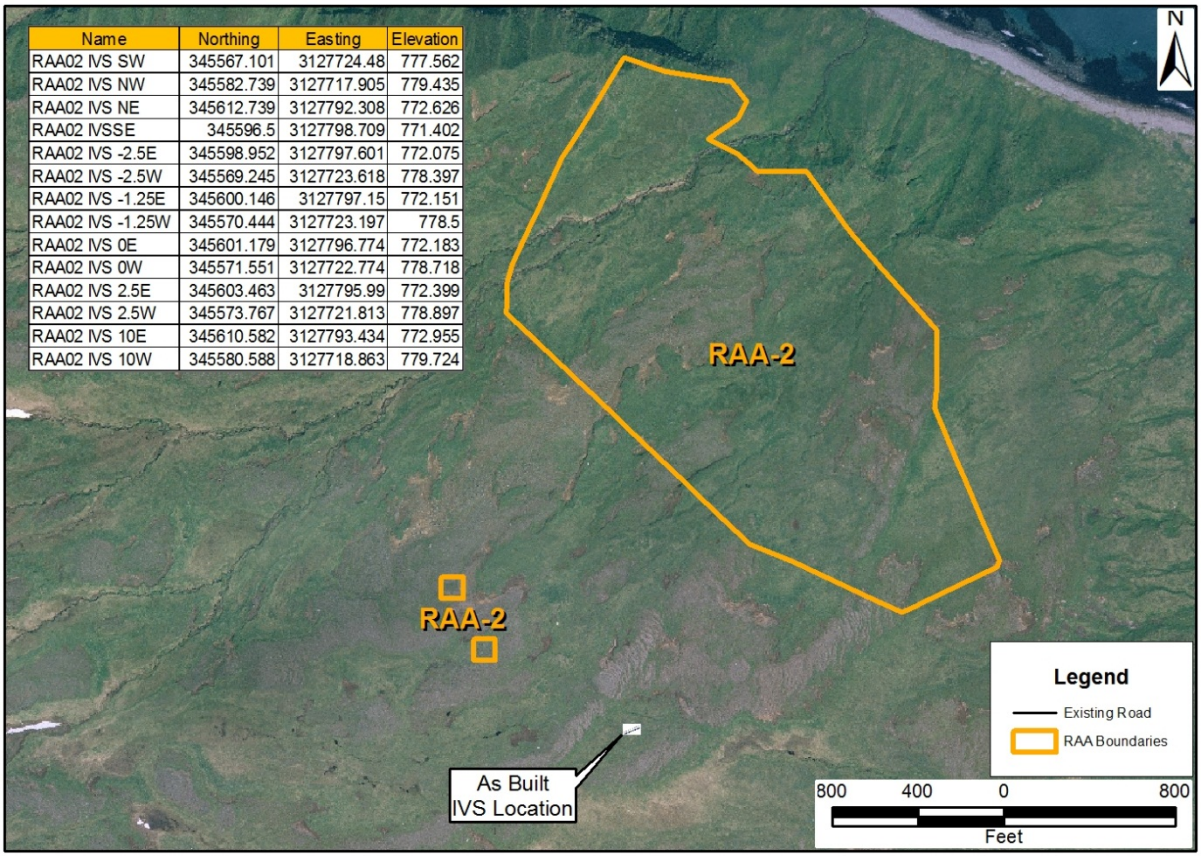

Figure 2-1: Location and "As Built" Coordinates for IVS Located in RAA-02

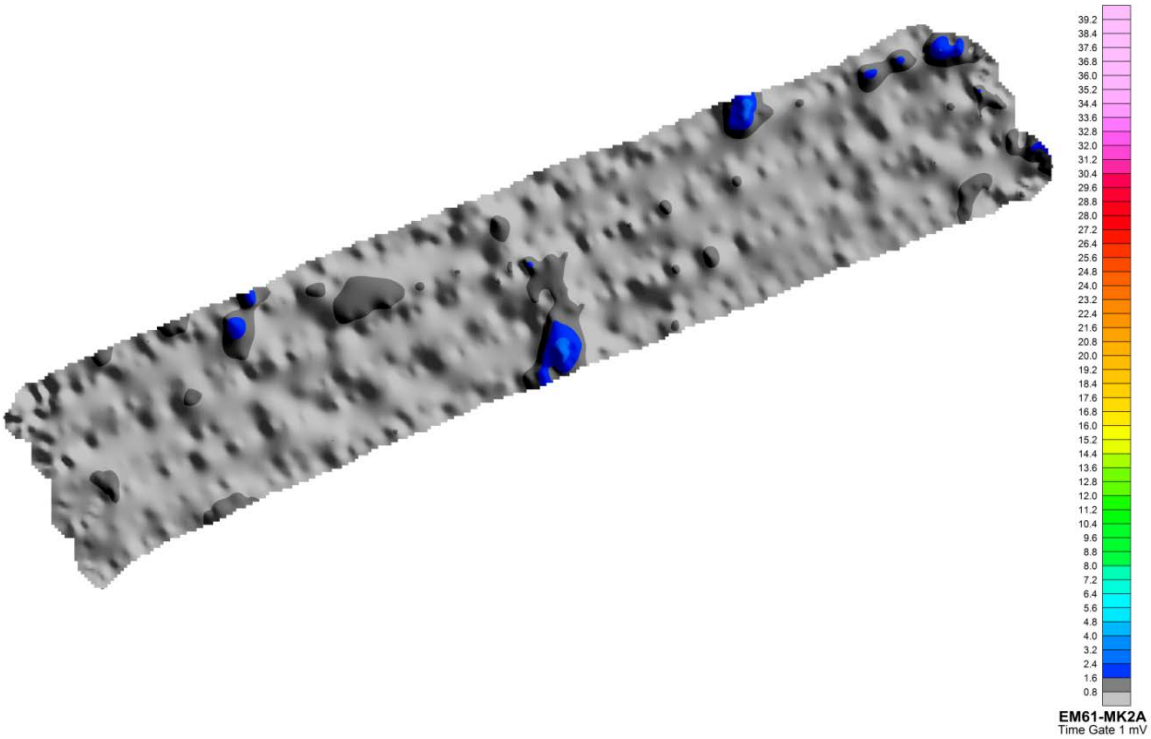

Figure 2-2: Background Survey Results for RAA-02 IVS Leveled Time Gate 1

2.4 PHOTOGRAPHS AND COORDINATES OF SEED ITEMS

After the background survey was approved by the site geophysicist, the IVS team installed the IVS seed items, as described in Section 2.1, above. Prior to burial, the ISOs were photographed, in-place, using the survey tape for orientation reference (see Figure 2-3), and the ISO positions (x, y, and depth to center) were measured with the RTK DGPS (see Table 2-1).

.A second RTK DGPS measurement was made over each IVS seed item at the walking surface height. These second depth measurements are provided in Table 2-2. Due to the lower accuracy on the Z component (elevation) of the RTK DGPS, the tape measured depth was utilized to document seed item burial depth. Photographs of all IVS seed items are found in Appendix A of this report.

Figure 2-3: Example Photograph of IVS Seed Item RAA-02 IVS_04 at 4-in Below Mineral Surface

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Table 2-1: RAA-02 IVS Seed Item Locations

IVS Seed Item	Item	X (ft)	Y (ft)	Inclination	Orientation	Depth to Center Mass below Mineral Surface (in) *	Depth to Center Mass below Walking Surface (in)	Easting (US ft)	Northing (US ft)
IVS_1	Small ISO	10	0	Horizontal	Across-Track	4.0	7.0	3127787.601	345597.492
IVS_2	Small ISO	25	0	Horizontal	Across-Track	9.2	12.2	3127773.620	345591.863
IVS_3	Small ISO	40	0	Horizontal	Across-Track	6.6	9.6	3127759.797	345586.399
IVS_4	Small ISO	55	0	Horizontal	Along-Track	4.0	6.0	3127745.822	345580.808
IVS_5	Small ISO	70	0	Horizontal	Along-Track	9.2	11.2	3127731.931	345575.320

* Installed depths in accordance with the Final GSV Installation Plan

Table 2-2: RAA-02 IVS Seed Item Walking Surface Depth Measurement Comparison

Seed Item	RTK DGPS Measurements				Tape Measured Depth (in)
	Mineral Surface Elevation (US ft)	Walking Surface Elevation (US ft)	Depth (ft)	Depth (in)	
IVS_1	771.921	772.443	0.522	6.264	7.0
IVS_2	772.781	773.758	0.977	11.724	12.2
IVS_3	775.252	775.966	0.714	8.568	9.6
IVS_4	776.32	776.813	0.493	5.916	6.0
IVS_5	776.641	777.54	0.899	10.788	11.2

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3.0 POST-INSTALLATION DGM SURVEY

Following IVS seed item installation and recording, the IVS team conducted five post-installation DGM surveys. The surveys were conducted along the lines/transects as described in Table 3-1, using SOP 2, Digital Geophysical Surveying, as guidance.

After the five surveys were completed, the data was downloaded by the site geophysicist for on-site review and editing. Proprietary software supplied by the instrument's manufacturer (DAT61) was used to convert the data files from binary to ASCII format.

After data file conversion, the data was uploaded to Geosoft's Oasis Montaj software. The local coordinates were converted to the project coordinate system and units. All data was leveled using a 30-point rolling de-median filter. A latency correction of 0.3-sec was applied to adjust the timing between EM61-MK2A data and the logged RTK DGPS data for all datasets. Data were then gridded, contoured, and displayed on a map using the minimum curvature gridding algorithm. Targets were selected manually for each IVS dataset, using the leveled Time Gate 1 channel of Line 2, the IVS centerline. For IVS seed items 1 through 3, oriented across-track, the single peak amplitude nearest response center was recorded. For IVS seed items 4 and 5, oriented along-track, the trough amplitude nearest response center between the seed items' twin peaks was recorded. The average recorded response values of all five IVS surveys was used to determine the response peak mean value for each IVS seed item (see Appendix E for the IVS data processing and seed item selection form).

Table 3-1: RAA-02 IVS Survey Line/Transect Direction

Line	Direction (ft)	Offset (ft)	Comment
Line 0	0 to 80	-2.5	Simulated grid
Line 1	80 to 0	-1.25	Half line spacing [Blind Seed Item (BSI) range]
Line 2	0 to 80	0	Simulated grid
Line 3	80 to 0	2.5	Simulated grid
Line 4	0 to 80	10	Dynamic background

3.1 DGM DATA OF ALL REPEATS ON ALL TRANSECTS

A post installation survey of RAA-02 IVS was conducted five times by the IVS team to validate the installation, and to build a basis for computing average peak response values (mV) for each seed item. Results from the five surveys and the response peak mean for each IVS seed item are provided in Table 3-2.

Table 3-2: RAA-02 IVS Post Installation Survey Results

File	Seed Item Leveled Time Gate 1 Response Peaks (mV)				
	IVS_01	IVS_02	IVS_03	IVS_04	IVS_05
RAA02_GSV_01	15.55	4.88	21.49	23.94	8.9
RAA02_GSV_02	19.36	5.19	24.79	22.33	10.35
RAA02_GSV_03	18.86	6.29	21.66	25.02	10.65
RAA02_GSV_04	23.79	8.65	25.75	27.69	9.96
RAA02_GSV_05	17.59	6.2	20.71	23.03	9.59
Mean	19.0	6.2	22.9	24.4	9.9

3.2 EXAMPLE MAPS/PROFILES OF DATA

All data sets were gridded using the minimum curvature gridding algorithm with cell spacing set to 0.3 ft and a 2.5 blanking distance. The map of RAA-02_GSV_01 seeded survey is shown in Figure 3-1 and a profile plot of the centerline is provided in Figure 3-2. Note that Z1_Lev is the leveled Time Gate 1 profile, Z2_Lev is the leveled Time Gate 2 profile, etc.

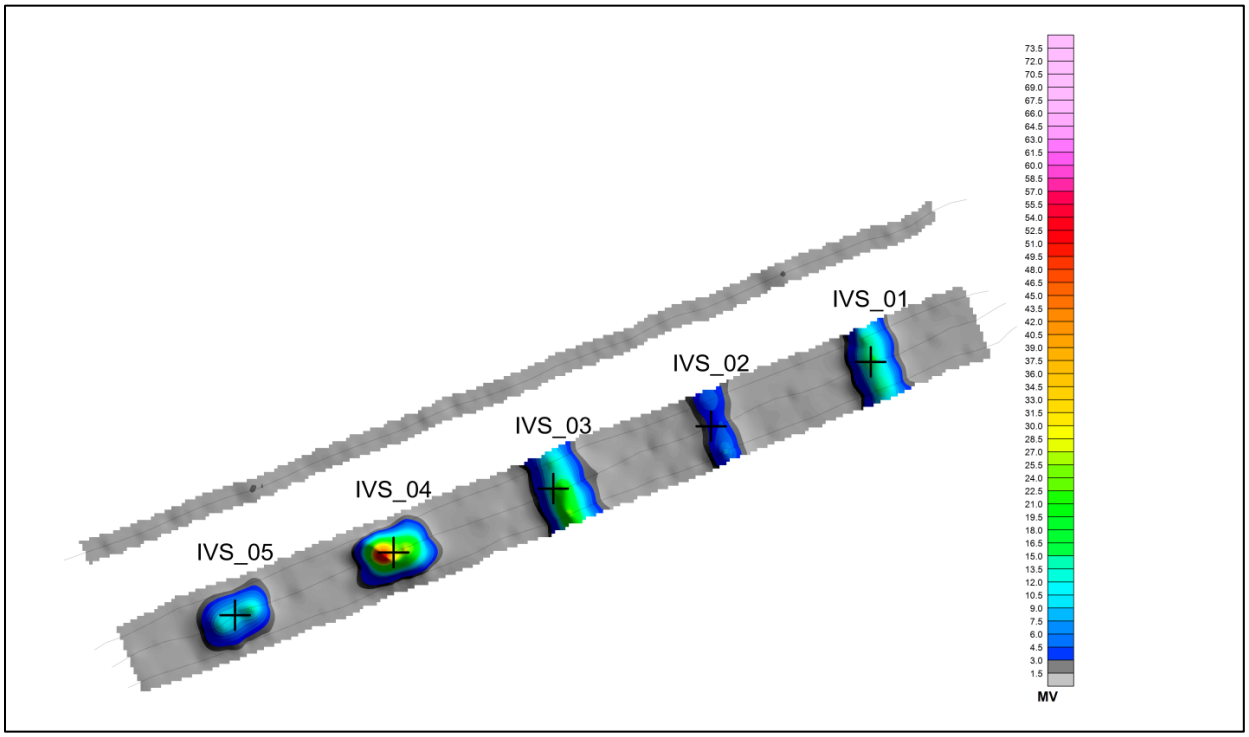

Figure 3-1: RAA-02_GSV_01 Installation Survey Map of Leveled Time Gate 1 (mV)

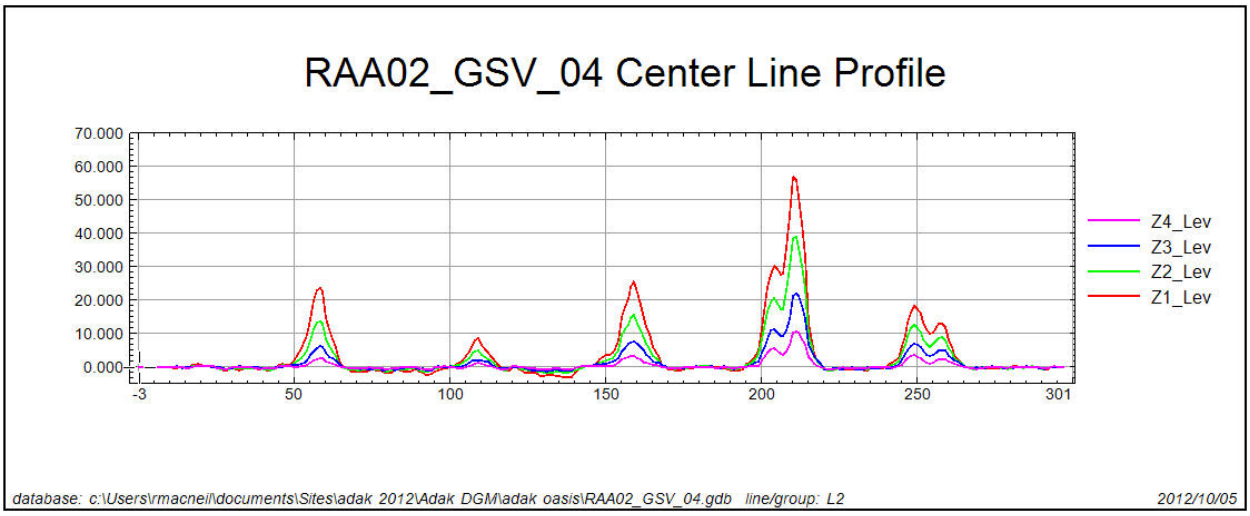

Figure 3-2: RAA-02_GSV_04 Centerline (Line 2) Profile Example

3.3 DISCUSSION OF LOGISTICS

RAA-02 IVS was located in a relatively flat, open space near the survey area. Mobilization to the RAA required approximately 45 minutes from the road near Andrew Lake in Area 4. Survey time for all five lines of the IVS is less than 5 minutes after instrument warm-up. Survey time for center line and background noise line only should be less than 2 minutes after instrument warm-up.

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4.0 DGM DATA ANALYSIS

Each IVS database was analyzed for data density along-track with the results documenting that 0% exceeded the designed along-track sample density of 0.6-ft (0.183-m). The performance metric of <5% sample separation exceeding 0.6-ft was achieved. An example along-track plot is provided in Figure 4-1.

DGM coverage of the RAAs is planned for 100% site coverage at 3.0-ft (0.9-m) line spacing except around known obstacles. To achieve this coverage metric, field teams are instructed to collect data on 2.5-ft line spacing. The IVS databases were analyzed for footprint coverage. Using the planned 2.5-ft line spacing to collect the IVS data, achieved 100% coverage at 3.0-ft (0.9-m) metric. An example across-track coverage plot is provided in Figure 4-2.

All datasets were reviewed for proper time gate response (e.g., gate 1 > gate 2 > gate 3 > gate 4) over anomaly peaks.

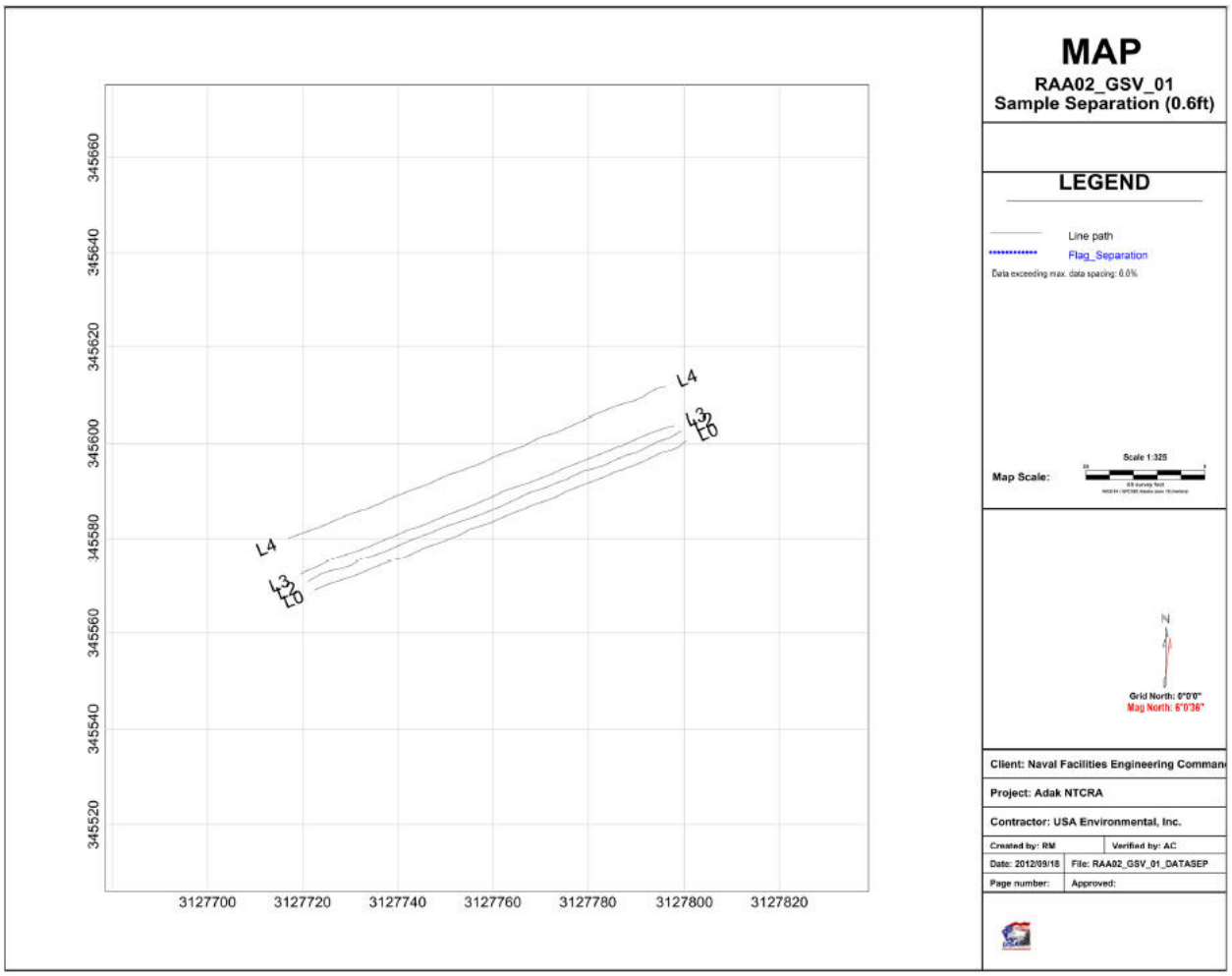

Figure 4-1: Data Separation QC Plot for RAA-02_GSV-01 Example

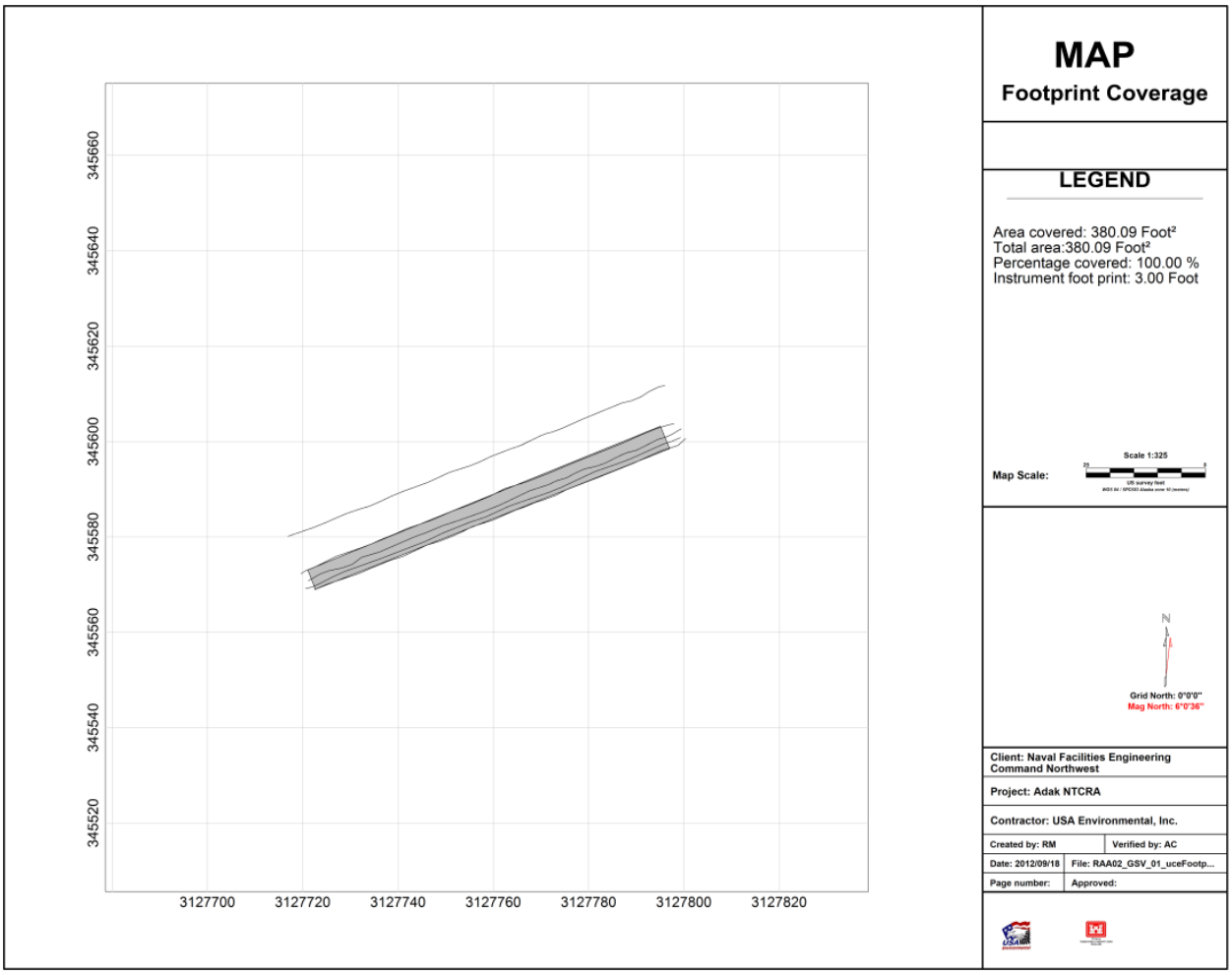

Figure 4-2: Footprint Coverage QC Plot for RAA-02_GSV_01

4.1 DISCUSSION AND QUANTIFIED RESULTS FOR LATENCY/LAG

All datasets were adjusted for latency corrections using a 0.3-sec correction to ensure no zig-zag features were present in the final gridded data.

4.2 EM61-MK2 RESPONSE OVER ISOs AND COMPARISON TO MODEL RESULTS

Each RAA-02 IVS seed item was evaluated to the published Naval Research Laboratory (NRL, 2008; NRL, 2009) ISO response tables for the adjusted depth to walking surface. All RAA-02 IVS seed items were within the published curves and repeatability was established during the five surveys of the RAA-02 IVS. Response values, averages, background noise statistics, and comparison charts are included in the RAA02 IVS Seed Response with Plots.xls spreadsheet that is included in Appendix B of this report. Horizontal error bars have been added for uncertainty in seed item burial depth (±2-in), and vertical error bars, computed as twice the noise value (±2-mV), have been added for uncertainty in signal to noise. An example comparison chart is provided in Figure 4-3.

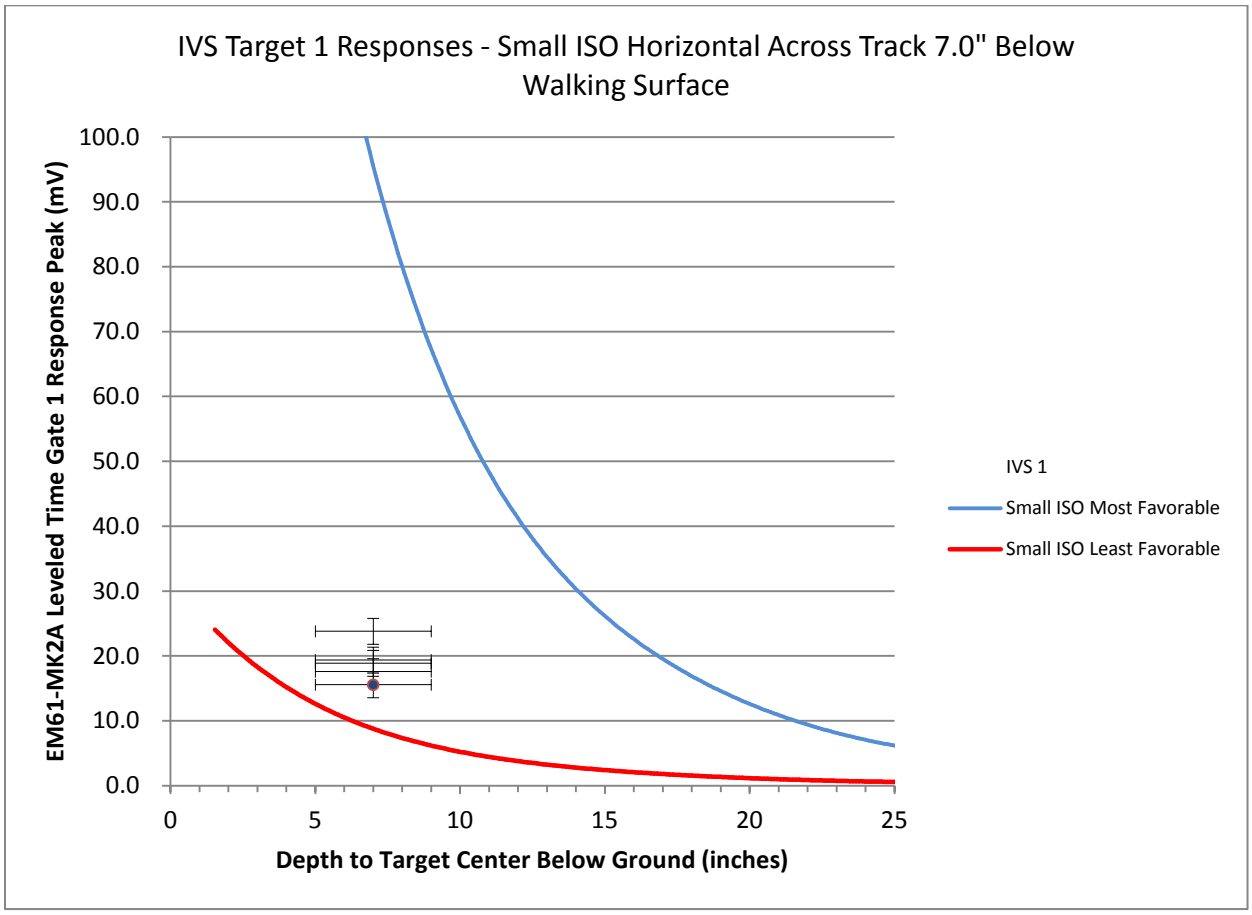

Figure 4-3: RAA-02 IVS Seed 1 EM61-MK2A Time Gate 1 Response Plots

Each IVS seed item peak response was also evaluated in a cumulative plot showing amplitude and failure criteria limits of ±20% (per the GSV Installation Plan) of the five-run average. An example plot for seed item #1 is shown in Figure 4-4. A second set of failure criteria lines have been added, based on ± two times the standard deviation (±2x std. dev.) of the five-run seed item response amplitudes, which represents a 95% confidence interval. USA noted that not all RAA-02 IVS seed item responses met the ±20% failure criteria; however, all RAA-02 IVS seed item responses passed a metric based on the larger of ± 20% or ±2x std. dev. of the five-run average. Seed item 1, a small ISO buried 4-in below mineral surface, oriented across-track, response, on the 4th pass, exceeded the response limit (within 20% of the average of the first five passes) by 4.8-mV (25%) on Time Gate 1. This was caused, most likely, by a dip in coil height. Seed item 2, a small ISO buried 9.2-in below mineral surface, oriented across-track, failed to meet the 20% metric twice, on pass 1 and pass 4. On the first pass, the response was below the metric by -1.4-mV (-21.8%). The 4th pass response was 2.41-mV (38.6%) above the metric. The most likely cause for these failures was normal, minor lowering and raising in coil height. Because this is a relatively low-amplitude anomaly, the 20% failure limit appears to be too stringent to be reliably met for this seed item. All other seed items met the 20% response metric. Based on this evaluation, the more robust IVS seed item response metric based on the larger of ±20% or ±2x std. dev. is recommended.

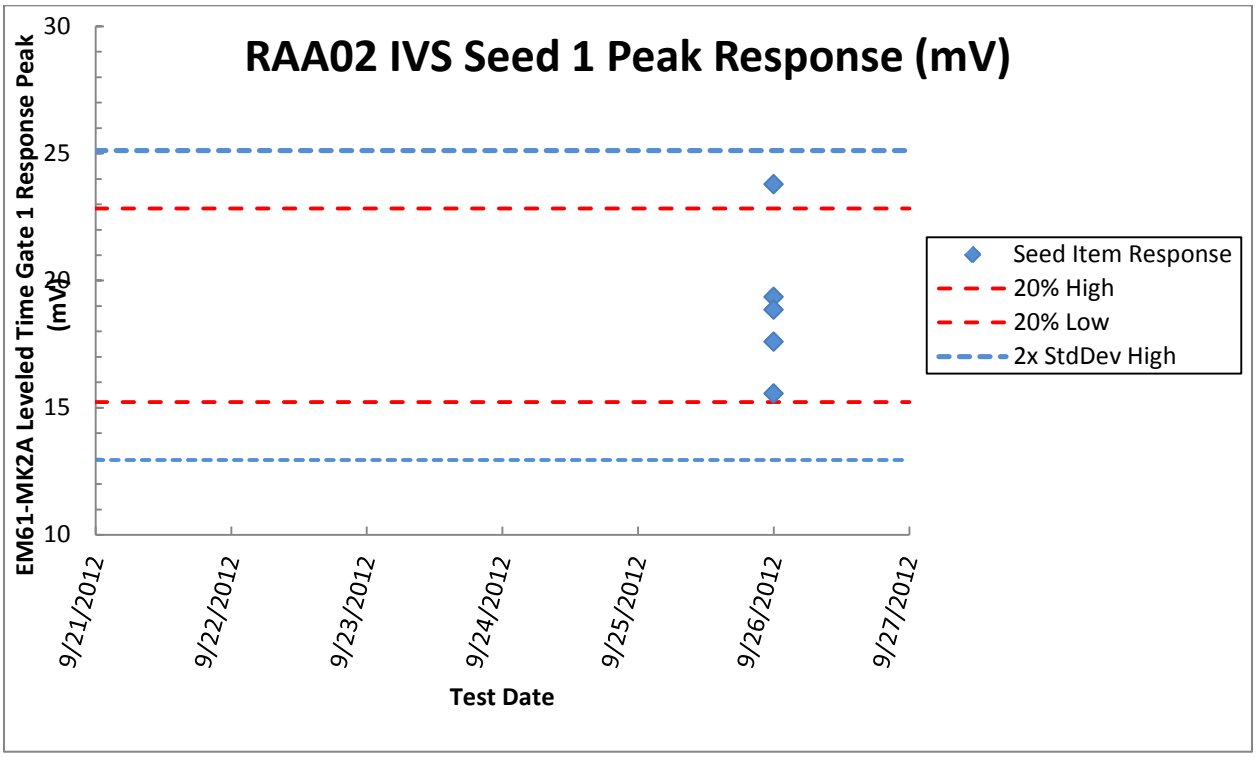

Figure 4-4: Cumulative Plot of IVS Seed Item Amplitudes with ±20% and ±2x std. dev. Failure Criteria Limits

4.3 DGM ANOMALY LOCATION VS. KNOWN LOCATION OF ISOs

A spreadsheet showing positioning of ISOs from the DGM interpretation compared to the known positions, and cumulative plots of the variance with time (also showing failure criteria limits) was created for RAA-02 IVS data. Figure 4-5 shows a cumulative plot for RAA-02 IVS_01 seed item #1. All RAA-02 IVS seed items passed the location metric within 25-cm.

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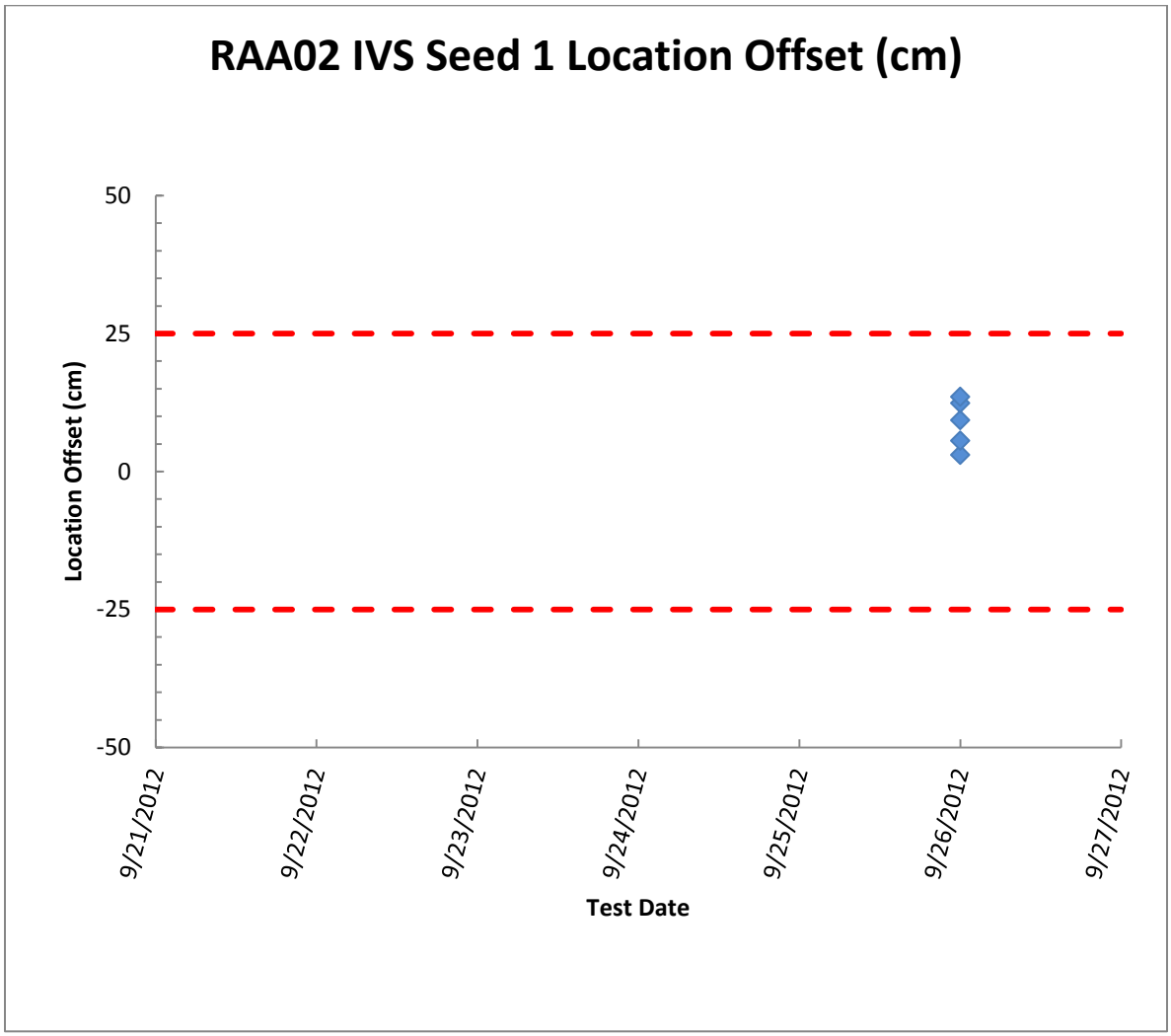

Figure 4-5: Cumulative Plot of Difference between Interpreted (DGM) and Known Surveyed ISO Position with ±25-cm Failure Criteria

4.4 BACKGROUND NOISE

A background noise line was installed 10-ft from the center line and data were collected five times. These results (±0.6-mV) are consistent with the other RAAs and previous DGM efforts on Adak. The results are shown in Table 4-1.

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Table 4-1: RAA-02 Background Noise Line Statistics for Leveled EM61-MK2 Time Gate 1 (Z1_Lev).

Date	File Name	Leveled Time Gate 1 (std. dev.)
9/22/2012	RAA02_GSV_01	0.568
9/26/2012	RAA02_GSV_02	0.687
9/26/2012	RAA02_GSV_03	0.787
9/26/2012	RAA02_GSV_04	0.477
9/26/2012	RAA02_GSV_05	0.536
	Mean Background	0.611

4.5 EFFECT OF RAA-02 IVS LOCATION ON ISO AMPLITUDE

No effect on ISO amplitude was encountered at this RAA IVS due to geology or clutter. The low dynamic background noise indicates that good signal to noise can be expected at the RAA-02 IVS, and may extend to RAA-02.

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5.0 RAA-03 IVS INSTALLATION

Installation and testing of the RAA-03 IVS was conducted during the period of 22-23 September 2012 and 26 September 2012.

5.1 NARRATIVE OF INSTALLATION LOGISTICS

On 22 September 2012, the IVS team located the idealized area for the RAA-03 IVS using a Trimble GeoXT. Following an extensive search, due to a high cultural debris density, the team then selected a section with similar terrain, vegetation, and geology as the investigation area and performed a background survey using a White's DFX300. The UXOTII confirmed that the site was sufficiently anomaly free, although still cluttered. On 23 September 2012 the IVS team returned to RAA-03; an area approximately 125-ft by 25-ft was staked out and a background survey was performed using the EM61-MK2A in stretcher mode. The site geophysicist processed the background survey data on-site. Several anomalies were present along the survey edges and after consulting with the Quality Assurance (QA) geophysicist on site, a second background survey was performed to show repeatability. The site geophysicist processed the second background survey on-site and QA geophysicist approved the area as suitable for the IVS installation to begin, following anomaly avoidance procedures. Note that due to the avoidance of background anomalies, the noise line offset was decreased from 10-ft to 9-ft from the IVS centerline. RAA-03 IVS installation followed the procedures documented in Section 2.1, above. After installation was finalized, a morning static and response test was performed according to SOP 2 prior to survey activities and the coil height of the EM61-MK2A was confirmed to be 15-in above the walking surface. After instrument warm-up, one run of the IVS was collected with the EM61-MK2A over the RAA-03 IVS. Data was downloaded and preliminary processing was done on-site by the site geophysicist. An end-of-the-day static and response test was performed.

On the afternoon of 26 September 2012, the IVS team returned to the RAA-03 IVS to conduct additional DGM of the IVS. A morning static and response test was performed according to SOP 2 prior to survey activities and the coil height of the EM61-MK2A was confirmed to be 15-in above the walking surface. After instrument warm-up, four separate files were collected with the EM61-MK2A over the RAA-03 IVS. Data was downloaded and preliminary processing was done on-site by the site geophysicist. An end-of-the-day static and response test was performed.

5.2 IVS AREA MAP AND COORDINATES (FROM GIS)

The RAA-03 IVS was installed inside the proposed IVS radius as described in the GSV plan. The RAA-03 IVS location has similar terrain, vegetation, and geology as the survey portion of the site. The RAA-03 IVS site location map and boundary and lane coordinates are provided in Figure 5-1.

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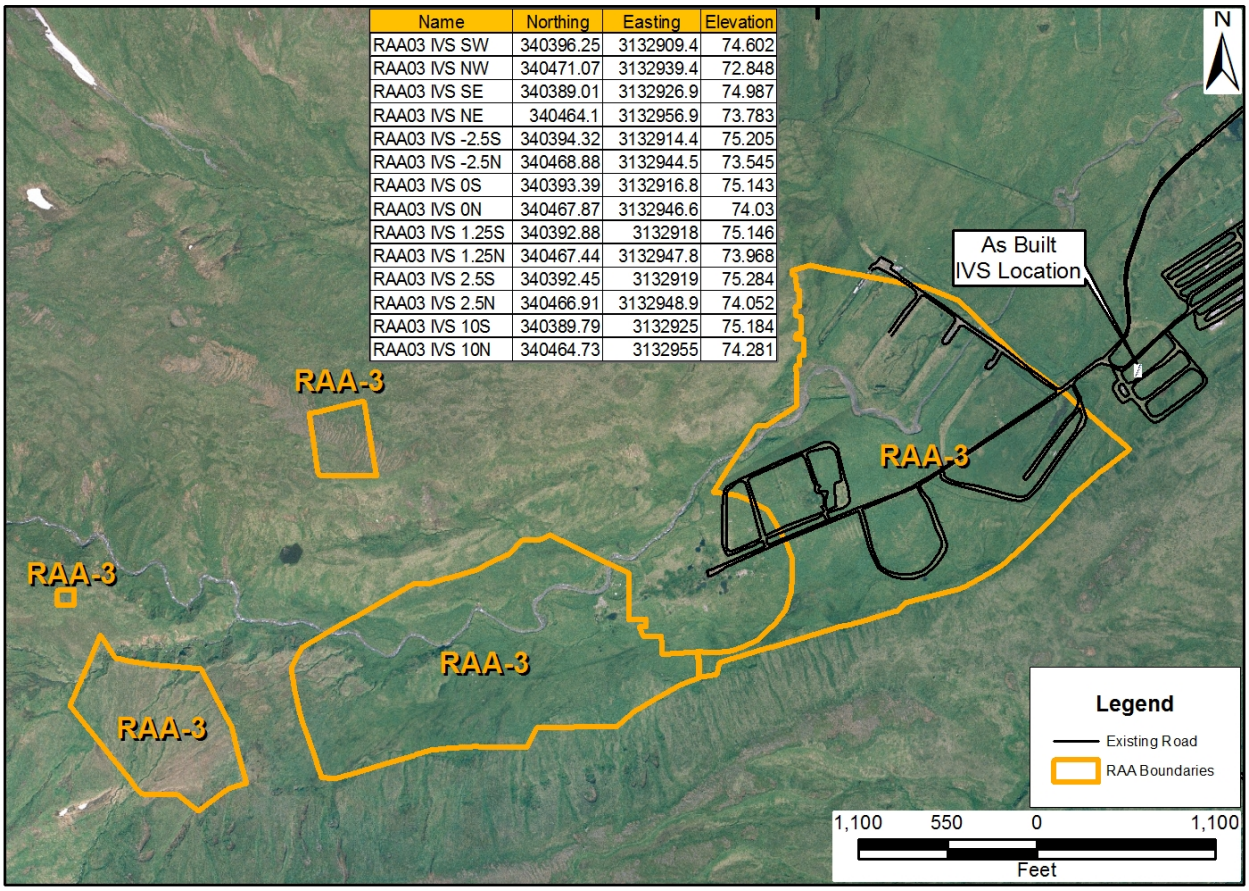

Figure 5-1: Location Map and "As Built" Coordinates for RAA-03 IVS

5.3 BACKGROUND DGM AND DISCUSSION

A White's DFX300 detector was utilized to perform an initial assessment of the idealized RAA-03 IVS location. The UXOTII determined that the planned location was sufficiently free of anomalies and the IVS team laid out a 125-ft by 25-ft grid. The team then surveyed the RAA-03 IVS area using the EM61-MK2A in stretcher mode. Several anomalies were present along the survey edges and after a second background survey was performed to show repeatability, the QA geophysicist approved the area as suitable for the IVS installation. Background RMS noise for the IVS portion of the grid was 0.849-mV on time gate 1. Color shaded grid maps of the leveled EM61-MK2A time gate 1 for both background surveys are shown in Figure 5-2.

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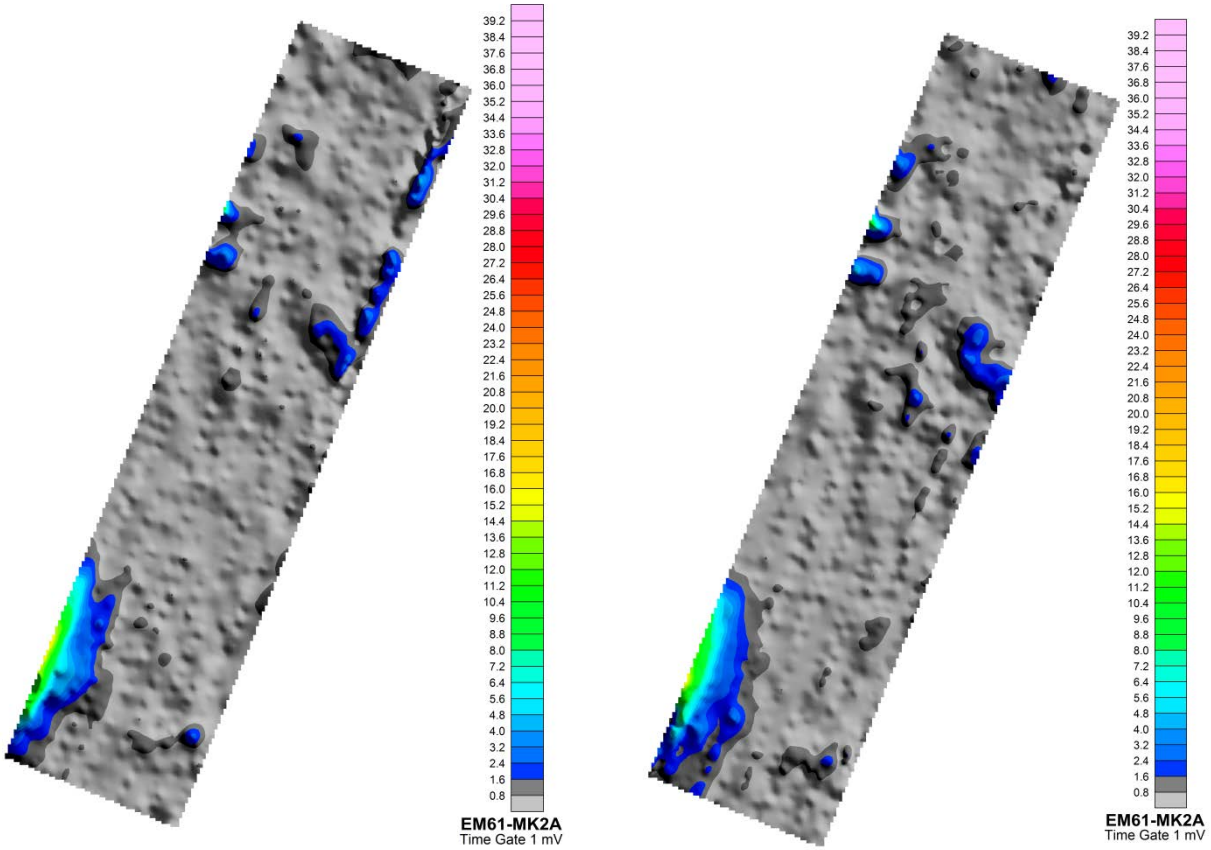

Figure 5-2: Background Survey Results for RAA-03 IVS Leveled Time Gate 1

5.4 PHOTOGRAPHS AND COORDINATES OF SEED ITEMS

After the background survey was approved by the site geophysicist, the IVS team installed the IVS seed items, as documented in Section 2.1, above. Prior to burial, the ISOs were photographed, in-place (see Figure 5-3), using the survey tape for orientation reference, and the ISO positions (x, y, and depth to center) were measured with the RTK DGPS (see Table 5-1).

A second RTK DGPS measurement was made over each IVS seed item at the walking surface height. These second depth measurements are provided in Table 5-2. Due to the lower accuracy on the Z component (elevation) of the RTK DGPS, the tape measured depth was utilized. Photographs of all IVS seed items are found in Appendix A of this report.

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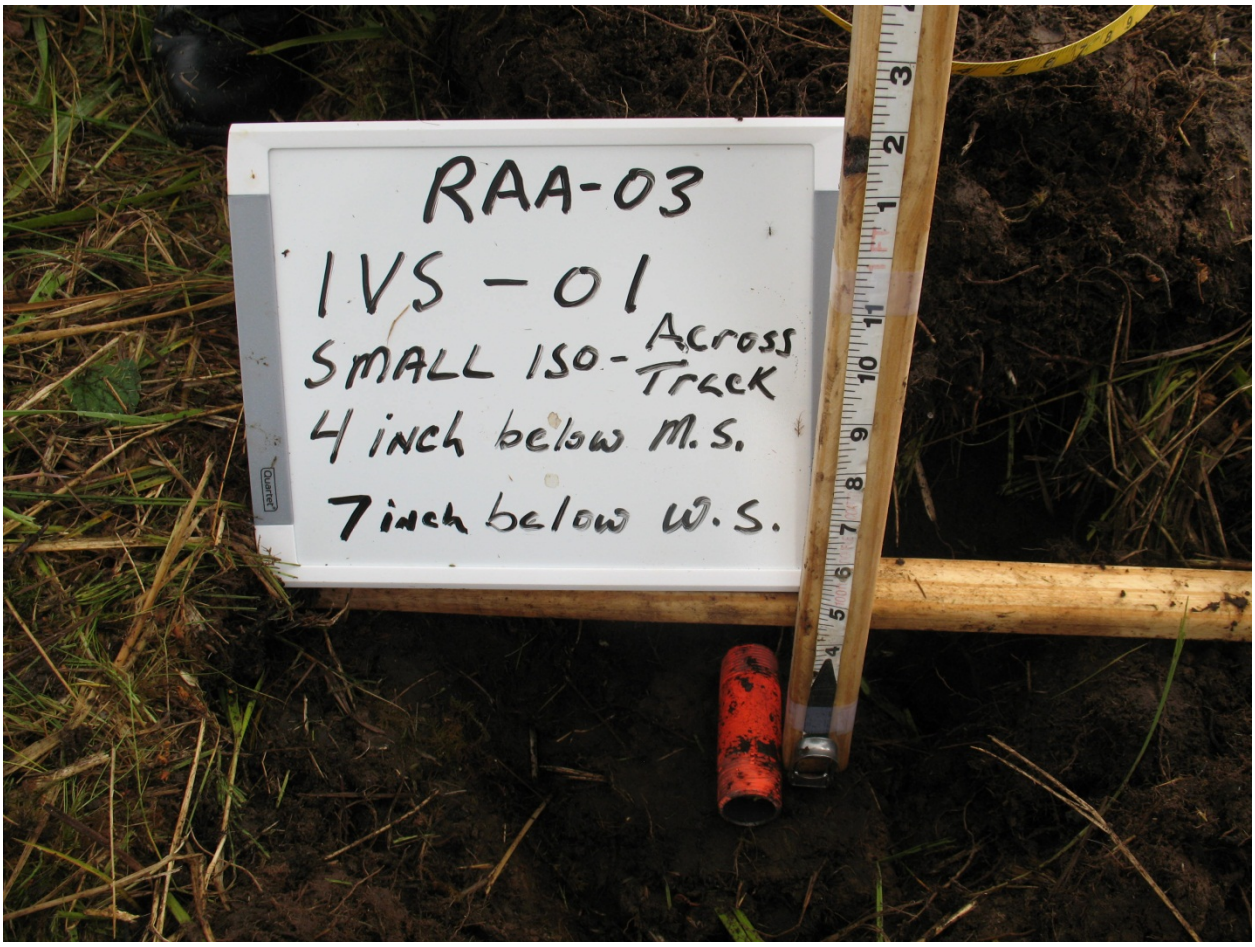

Figure 5-3: Example Photograph of RAA-03 IVS Seed 01, 4-in Below Mineral Surface

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Table 5-1: RAA-03 IVS Seed Item Locations

IVS Seed Item	Item	X (ft)	Y (ft)	Inclination	Orienta-tion	Depth to Center Mass below Mineral Surface (in) *	Depth to Center Mass below Walking Surface (in)	Easting (US ft)	Northing (US ft)
IVS_1	Small ISO	10	0	Horizontal	Across-Track	4.0	7.0	3132944.190	340461.662
IVS_2	Small ISO	25	0	Horizontal	Across-Track	9.2	12.2	3132939.331	340449.323
IVS_3	Small ISO	40	0	Horizontal	Across-Track	6.6	9.6	3132931.515	340429.650
IVS_4	Small ISO	55	0	Horizontal	Along-Track	4.0	7.0	3132927.382	340419.409
IVS_5	Small ISO	70	0	Horizontal	Along-Track	9.2	12.2	3132920.536	340402.398
* Installed depths IAW the Final GSV Installation Plan									

Table 5-2: RAA-03 IVS Seed Item Walking Surface Depth Measurement Comparison

Seed Item	RTK-DGPS Measurements				Tape Measured Depth
	Mineral Surface Elevation (US ft)	Walking Surface Elevation (US ft)	Depth (ft)	Depth (in)	Depth (in)
IVS_01	73.168	73.637	0.469	5.628	7.0
IVS_02	72.985	73.928	0.943	11.316	12.2
IVS_03	73.721	74.358	0.637	7.644	9.6
IVS_04	73.683	74.279	0.596	7.152	7.0
IVS_05	73.859	74.906	1.047	12.564	12.2

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6.0 POST-INSTALLATION DGM SURVEY

Following IVS seed item installation and recording, the IVS team conducted five post-installation DGM surveys. The surveys were conducted along the lines/transects as described in Table 6-1, using SOP 2, Digital Geophysical Surveying, as guidance.

After all five surveys were completed over 2 days, the data was downloaded by the site geophysicist for on-site review and editing. Proprietary software supplied by the instrument's manufacturer (DAT61) was used to convert the data files from binary to ASCII format.

After data file conversion, the data was uploaded to Geosoft's Oasis Montaj software. The local coordinates were converted to the project coordinate system and units. All data was leveled using a 30 point rolling de-median filter. A latency correction of 0.3-sec was applied to adjust the timing between EM61-MK2A data and the logged RTK DGPS data for all datasets. Data were then gridded, contoured, and displayed on a map using the minimum curvature gridding algorithm. Targets were selected manually for each IVS dataset, as described in Section 3.0 above.

Table 6-1: RAA-03 IVS Survey Line/Transect Direction

Line	Direction (ft)	Offset (ft)	Comment
Line 0	0 to 80	-2.5	Simulated grid
Line 1	80 to 0	-1.25	Half line spacing [Blind Seed Item (BSI) range]
Line 2	0 to 80	0	Simulated grid
Line 3	80 to 0	2.5	Simulated grid
Line 4	0 to 80	-9	Dynamic background

6.1 DGM DATA OF ALL REPEATS ON ALL TRANSECTS

A post-installation survey of RAA-03 IVS was conducted five times by the IVS team to validate the installation, and to build a basis for computing average response values. Results from the five surveys and the response peak mean for each IVS seed item are provided in Table 6-2.

Table 6-2: RAA-03 IVS Post Installation Survey Results

File	Seed Item Leveled Time Gate 1 Response Peaks (mV)				
	IVS_01	IVS_02	IVS_03	IVS_04	IVS_05
RAA03_GSV_01	12.38	5.82	12.46	16.09	10.2
RAA03_GSV_02	13.77	6.45	15.8	20.48	11.36
RAA03_GSV_03	14.66	6.67	15.7	19.99	12.65
RAA03_GSV_04	15.29	7.68	16.18	20.15	12.58
RAA03_GSV_05	17.14	6.98	17.39	22.89	12.14
Average	14.65	6.72	15.51	19.92	11.79

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6.2 EXAMPLE MAPS/PROFILES OF DATA

All data sets were gridded using the minimum curvature gridding algorithm with cell spacing set to 0.3-ft and a 2.5 blanking distance. The map of RAA03_GSV_01 is shown in Figure 6-1 and a profile plot of the centerline is provided in Figure 6-2. Note that Z1_Lev is the leveled Time Gate 1 profile, Z2_Lev is the leveled Time Gate 2 profile, etc.

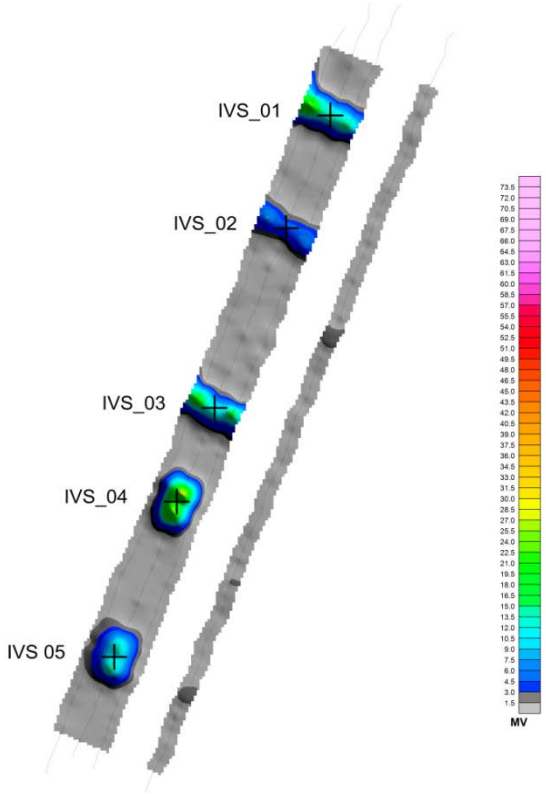

Figure 6-1: RAA-03 GSV_01 Post Installation Survey Map of Leveled Time Gate 1 (mV)

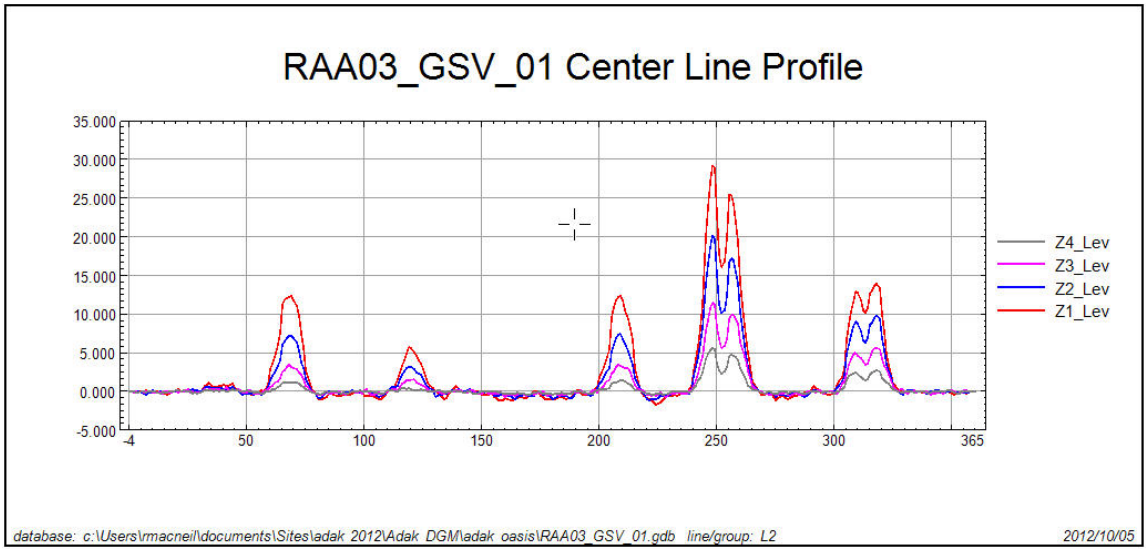

Figure 6-2: RAA-03 GSV_01 Centerline (Line 2) Profile

6.3 DISCUSSION OF LOGISTICS

RAA-03 IVS was located in a relatively flat, open space near the survey area. Mobilization to the RAA required approximately 20 minutes from the city of Adak. Survey time for all five lines of the IVS is less than 5 minutes after instrument warm-up. Survey time for center line and background line only should be less than 2 minutes after instrument warm-up.

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7.0 DGM DATA ANALYSIS

Each IVS database was analyzed for data density along-track with the results documenting that 0% exceeded the designed along-track sample density of 0.6-ft (0.183-m). Therefore, the planned performance metric of <5% sample separation exceeding 0.6-ft is recommended for production DGM. An example along-track plot is provided in Figure 7-1.

DGM coverage of the RAAs is planned for 100% site coverage at 3.0-ft (0.9-m) line spacing except around known obstacles. To achieve this coverage metric, field teams are instructed to collect data on 2.5-ft line spacing. The IVS databases were analyzed for footprint coverage. Using the planned 2.5-ft line spacing to collect the IVS data, achieved 99.99% coverage at 3.0-ft (0.9-m) metric. An example across-track coverage plot is provided in Figure 7-2.

All datasets were reviewed for proper time gate response (e.g., gate 1 > gate 2 > gate 3 > gate 4) over anomaly peaks.

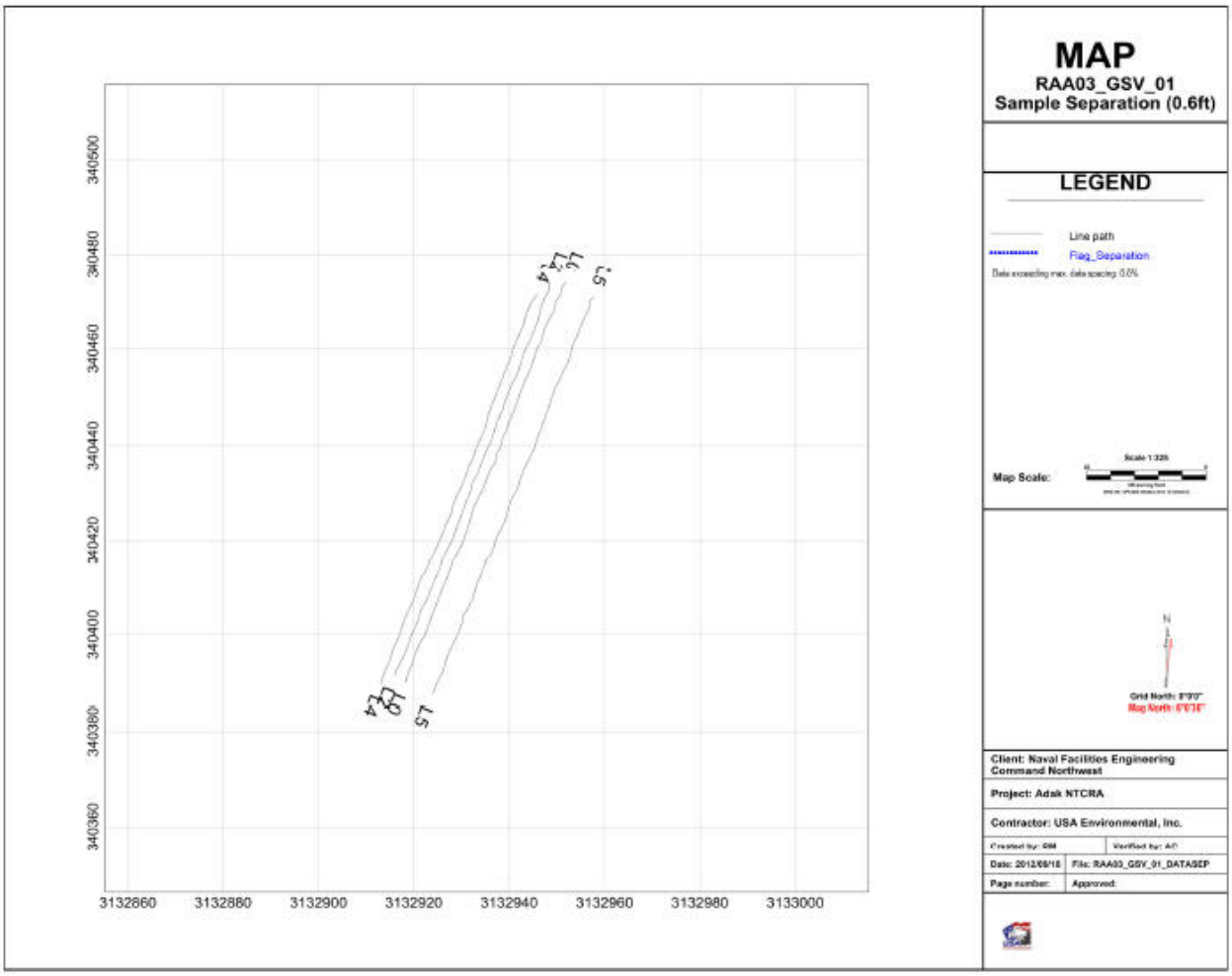

Figure 7-1: Data Separation QC Plot for RAA-03 GSV_01

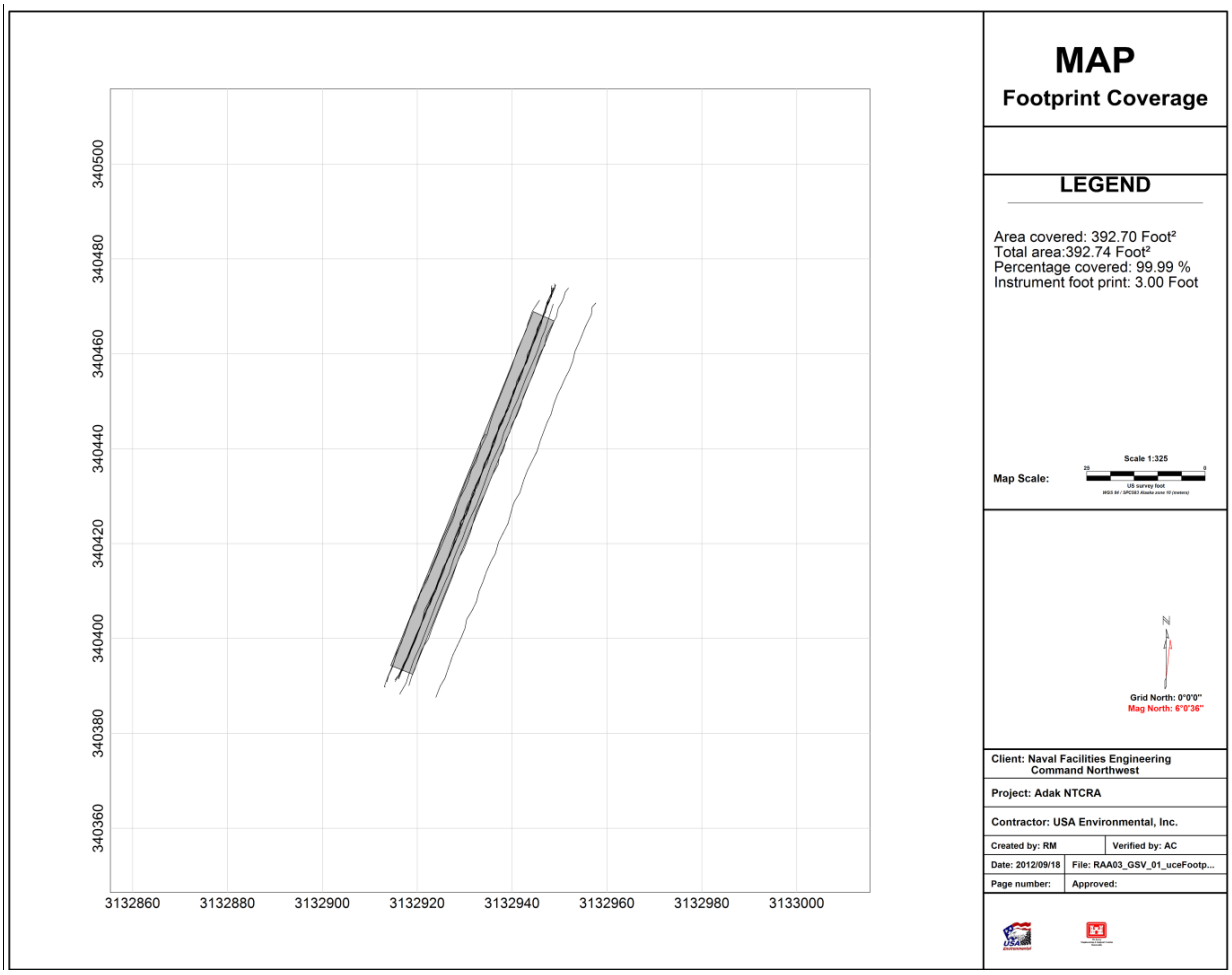

Figure 7-2: Footprint Coverage QC Plot for RAA-03 GSV_01

7.1 DISCUSSION AND QUANTIFIED RESULTS FOR LATENCY/LAG

All datasets were adjusted for latency corrections using a 0.3-sec correction to ensure no zig-zag features were present in the final gridded data.

7.2 EM61 MK2 RESPONSE OVER ISOs AND COMPARISON TO MODEL RESULTS

Each IVS seed item was evaluated to the published Naval Research Laboratory (NRL, 2008; NRL, 2009) ISO response tables for the adjusted depth to walking surface. All IVS seed items in RAA-03 were within the published curves and repeatability was established during the five surveys of the IVS. Response values, averages, background noise statistics and comparison charts are included in the RAA-03 IVS Seed Response with Plots.xls spreadsheet (see Appendix B). An example comparison chart is provided in Figure 7-3. All RA-03 IVS seed item response values fell within the published curves.

Each IVS seed item was also evaluated in a cumulative plot showing amplitude and failure criteria limits of ±20% of the five-run average. An example plot for seed item #1 is shown in Figure 7-4. Note that the ± 2x std. dev. failure criteria lines have also been added. All RAA-03 IVS seed items met the response metric within 20% of the initial five-run average.

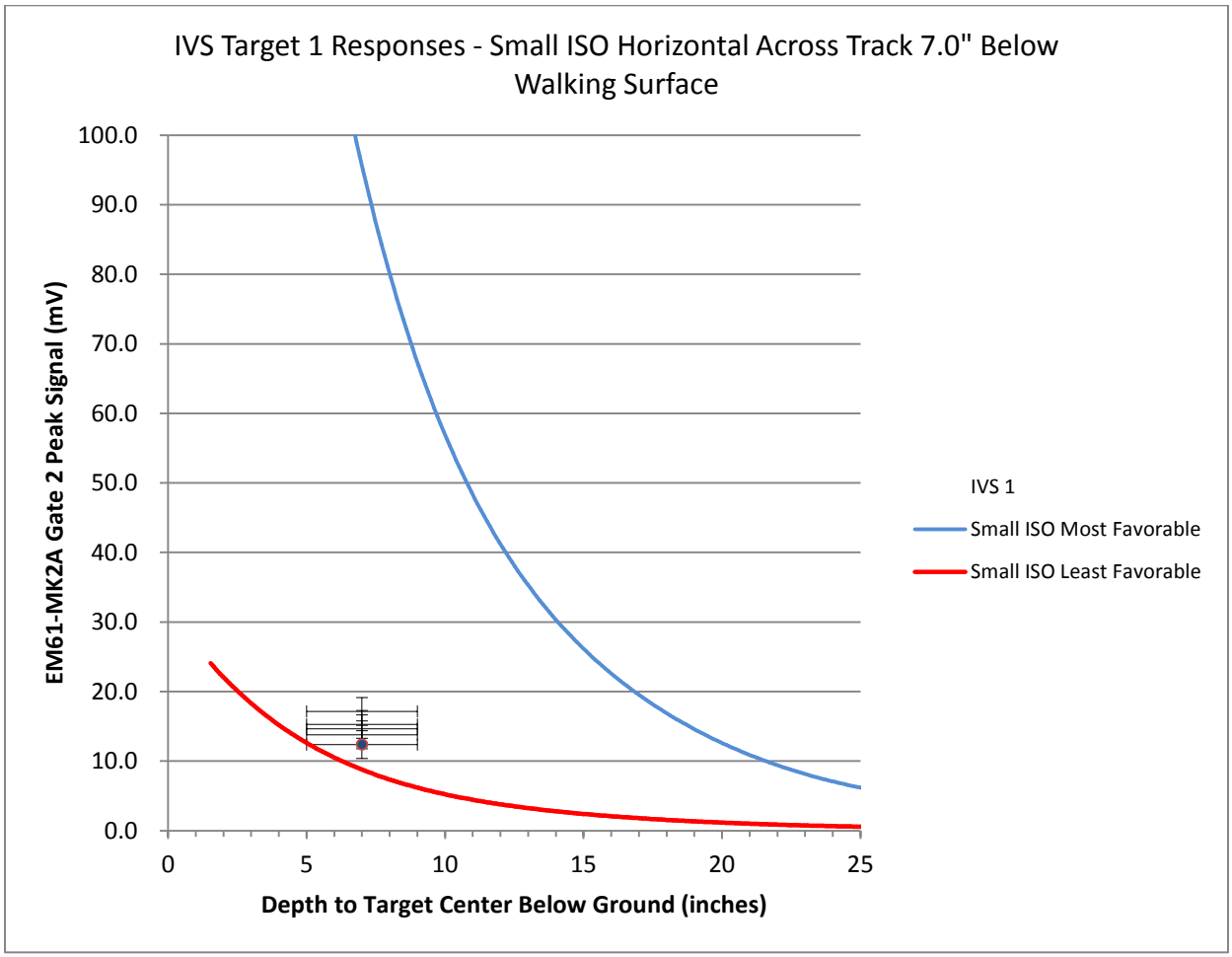

Figure 7-3: RAA-03 EM61-MK2A Time Gate 1 Response for IVS_01 Seed Item

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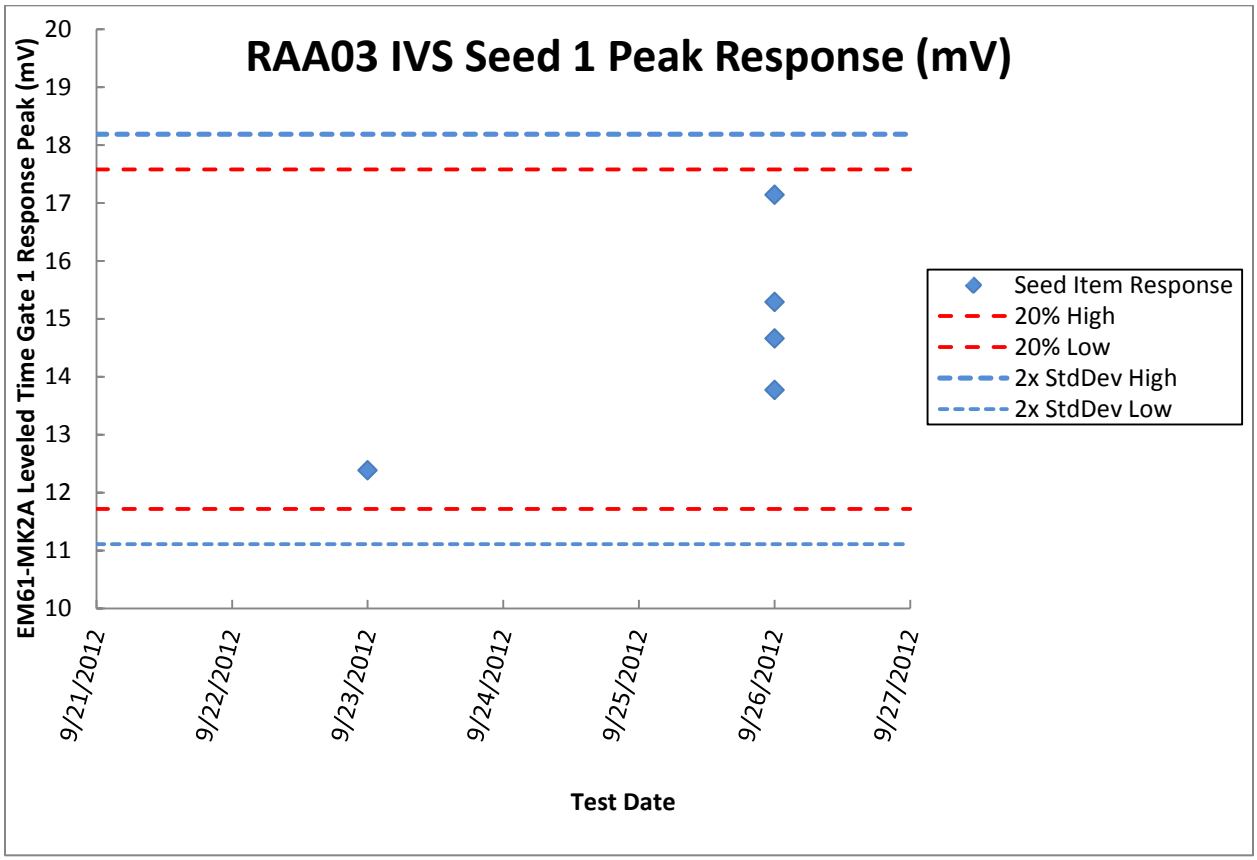

Figure 7-4: Cumulative Plot of RAA-03 IVS_01 Amplitudes with ±20% and ±2x std. dev. Failure Criteria

7.3 ANOMALY LOCATION VS KNOWN LOCATION OF ISOs

A spreadsheet (see Appendix B) showing downline positioning of ISOs from the DGM interpretation compared to the known positions, and cumulative plots of the variance with time (also showing failure criteria limits) was created for RAA-03 IVS data. Figure 7-5 shows a cumulative plot for RAA-03 IVS_01 seed item #1. All RAA-03 IVS seed items passed the location metric within 25-cm.

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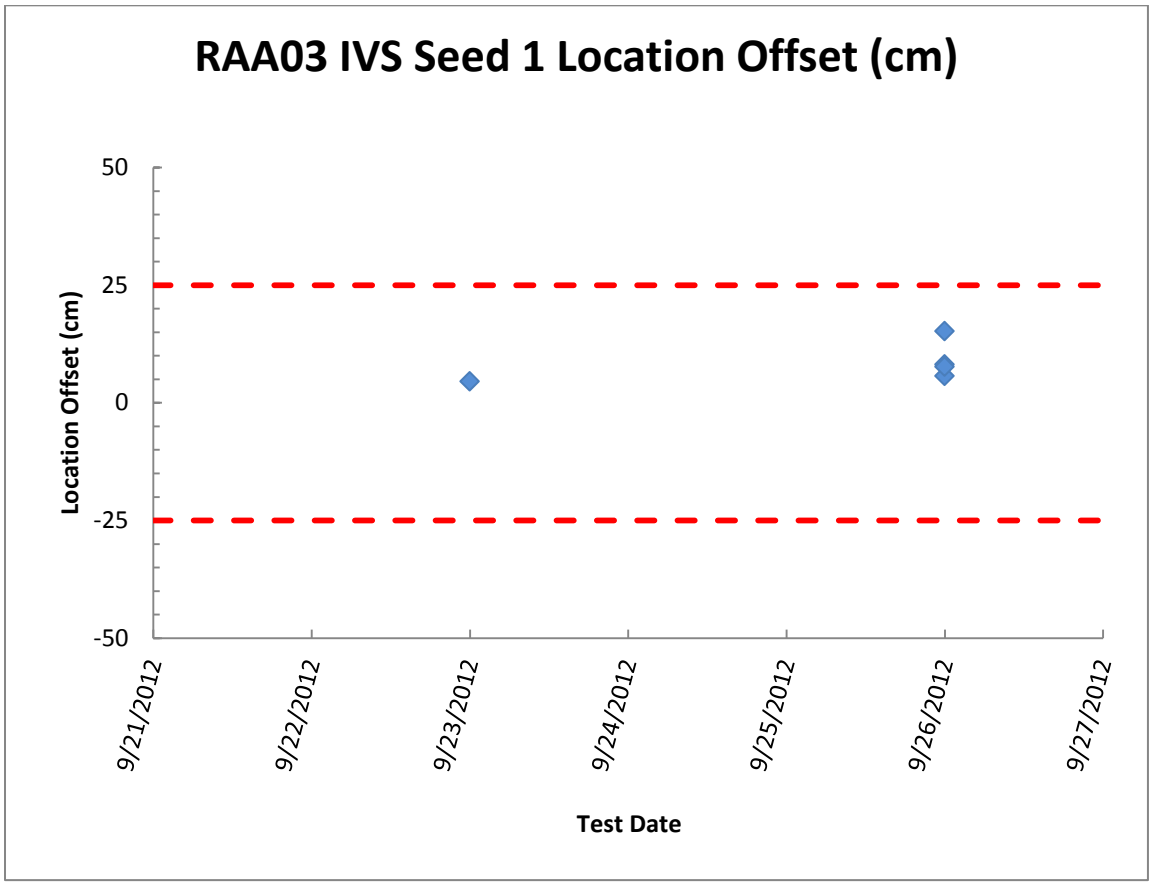

Figure 7-5: Cumulative Plot of Difference between Interpreted (DGM) and Known (Surveyed) Location, with Failure Criteria

7.4 BACKGROUND NOISE

A background noise line was installed 10-ft from the center line and data were collected five times. These results (±0.65-mV) are consistent with the other RAAs and previous DGM efforts on Adak. The results are shown in Table 7-1.

Table 7-1: RAA-03 Background Noise Line Statistics for Time Gate 1

Date	File Name	Leveled Time Gate 1 (std. dev.)
9/22/2012	RAA03_GSV_01	0.714
9/26/2012	RAA03_GSV_02	0.705
9/26/2012	RAA03_GSV_03	0.551
9/26/2012	RAA03_GSV_04	0.632
9/26/2012	RAA03_GSV_05	0.641
	Mean Background	0.6486

7.5 EFFECT OF RAA-03 IVS LOCATION ON ISO AMPLITUDE

No effect on ISO amplitude was encountered at this RAA IVS due to geology or clutter. The low dynamic background noise indicates that good signal to noise can be expected at the RAA-03 IVS, and may extend to RAA-03.

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8.0 RAA-04 IVS INSTALLATION

Installation and testing of the RAA-04 IVS was conducted during the period of 24-26 September 2012.

8.1 NARRATIVE OF INSTALLATION LOGISTICS

On 24 September 2012 the IVS team located the idealized area for the RAA-04 IVS using a Trimble GeoXT. The team then selected a section with similar terrain, vegetation, and geology as the investigation area just to the East of the idealized IVS boundary and performed a background survey using a White's DFX300. The UXOTII confirmed that the site was sufficiently anomaly free. An area approximately 115-ft by 21-ft was then staked out and a background survey was performed using the EM61-MK2A in stretcher mode.

Due to extremely high winds, the RTK DGPS base station for RAA-04 IVS was not set up the morning of 24 September. The first background survey was run using line/station/fiducials to characterize the site location. The site geophysicist processed the background survey data on-site and confirmed that the area was suitable for the IVS installation to begin. The RAA-04 IVS area was staked as documented in Section 2.1.

On 25 September the IVS team returned to the RAA-04 IVS after establishing the RTK DGPS base station at ARA base, South of RAA-04. The IVS team then performed a second background survey with the EM61-MK2A in stretcher mode with RTK data positioning. The site geophysicist processed the background survey data on-site and confirmed that the area was suitable for the IVS installation to resume. The same IVS seed item placement procedures, described in Section 2.1, were followed. Note that the water table at the RAA-04 IVS location was high. Seed item 2, a small ISO buried 9.2-in below mineral surface, was nearly covered with water. Seed Item 3, a small ISO buried 6.6-in below mineral surface, had water in the bottom of the hole. Seed item 4, a small ISO buried 4-in below mineral surface, had water in the bottom of the hole. Seed item 5, a small ISO buried 9.2-in below mineral surface, also had water in the bottom of the hole (see photographs in Appendix A). The RAA-04 IVS survey 01 was collected, along with the end-of-day static test.

On 26 September 2012, the IVS team returned to RAA-04 IVS to conduct four additional DGM surveys of the IVS. A morning static and response test was performed according to SOP 2 prior to survey activities and the coil height of the EM61-MK2A was confirmed to be 15-in above the walking surface. After instrument warm-up, four separate files were collected with the EM61-MK2A over the RAA-04 IVS. Data was downloaded and preliminary processing was done on-site by the site geophysicist. An end-of-the-day static and response test was performed.

8.2 IVS AREA MAP AND COORDINATES (FROM GIS)

The RAA-04 IVS was installed approximately 90-ft east of the proposed IVS radius boundary as described in the GSV Plan. The IVS location has similar terrain, vegetation, and geology as the survey portion of the site. The RAA-04 IVS site location map with boundary and lane coordinates is provided in Figure 8-1.

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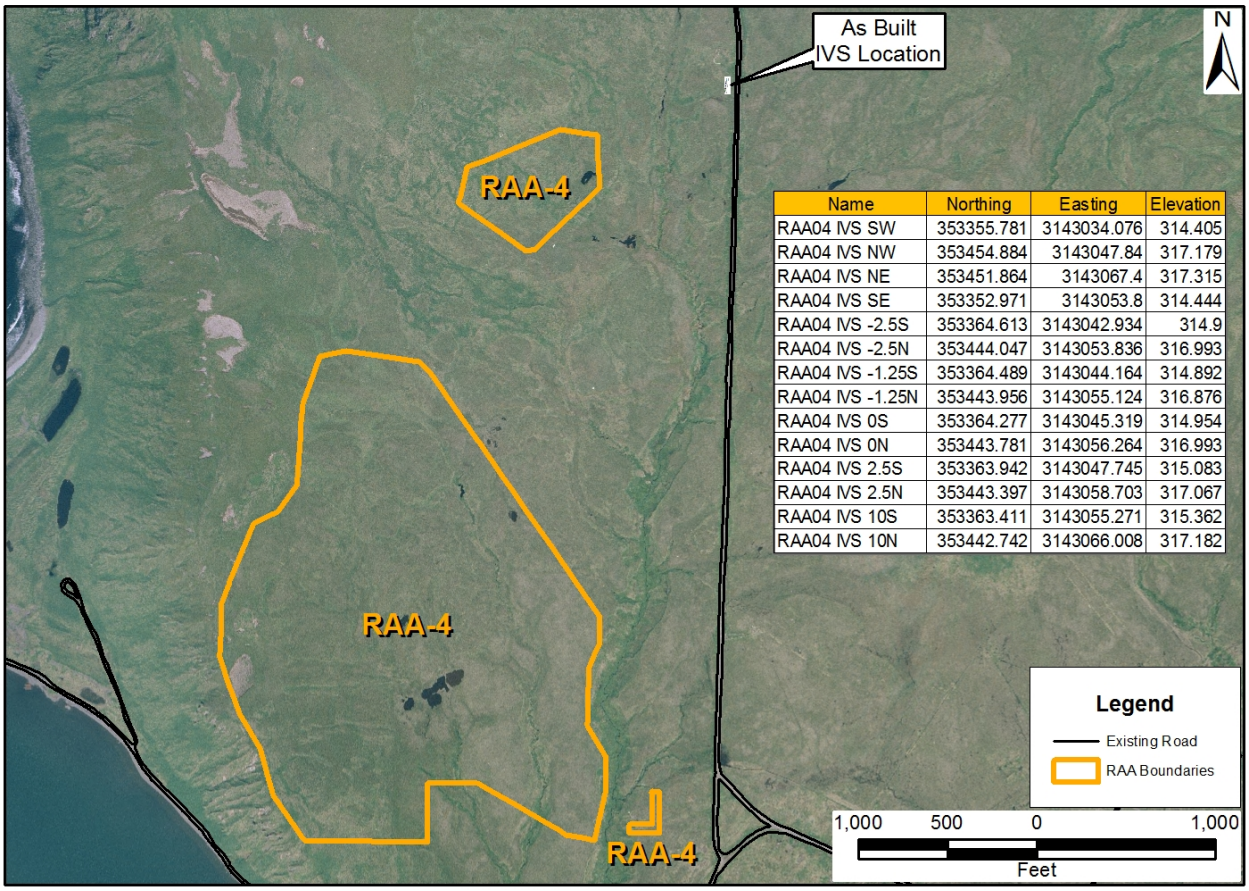

Name	Northing	Easting	Elevation
RAA04 IVS SW	353355.781	3143034.076	314.405
RAA04 IVS NW	353454.884	3143047.84	317.179
RAA04 IVS NE	353451.864	3143067.4	317.315
RAA04 IVS SE	353352.971	3143053.8	314.444
RAA04 IVS -2.5S	353364.613	3143042.934	314.9
RAA04 IVS -2.5N	353444.047	3143053.836	316.993
RAA04 IVS -1.25S	353364.489	3143044.164	314.892
RAA04 IVS -1.25N	353443.956	3143055.124	316.876
RAA04 IVS 0S	353364.277	3143045.319	314.954
RAA04 IVS 0N	353443.781	3143056.264	316.993
RAA04 IVS 2.5S	353363.942	3143047.745	315.083
RAA04 IVS 2.5N	353443.397	3143058.703	317.067
RAA04 IVS 10S	353363.411	3143055.271	315.362
RAA04 IVS 10N	353442.742	3143066.008	317.182

Figure 8-1: Location Map and "As Built" Coordinates for RAA-04 IVS

8.3 BACKGROUND DGM AND DISCUSSION

A White's DFX300 was utilized to perform an initial assessment of the idealized IVS location. The UXOTII determined that the planned location was sufficiently free of anomalies and the IVS team laid out a 115-ft by 21-ft grid. The team then surveyed the IVS area using the EM61-MK2A in stretcher mode. The area was shown to be sufficiently clear to enable the installation of the IVS. Background RMS noise for the grid was 1.212-mV on time gate 1. A color shaded grid map of the EM61-MK2A leveled time gate 1 data is shown in Figure 8-2.

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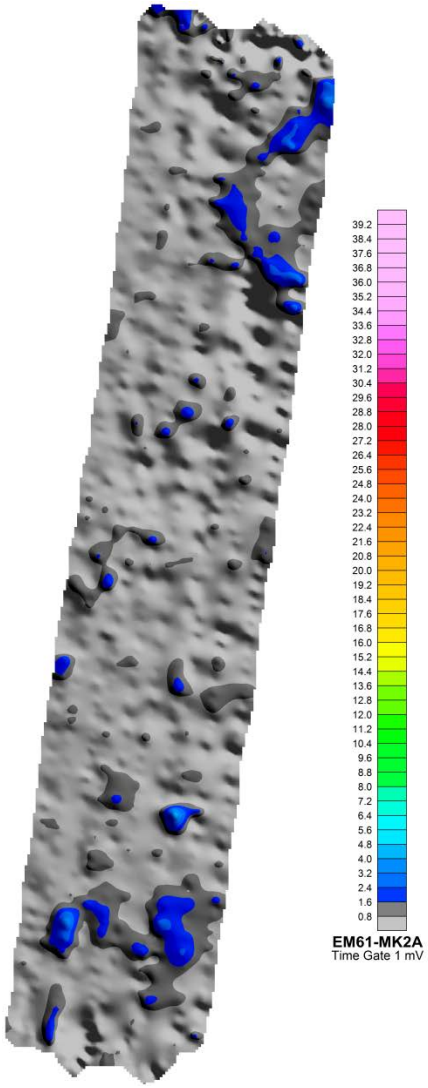

Figure 8-2: Background Survey Results for RAA-04 IVS

8.4 PHOTOGRAPHS AND COORDINATES OF SEED ITEMS

After background survey was approved by the site geophysicist, the IVS team installed the IVS seed items, as described in Section 2.1. Prior to burial, the ISOs were photographed, in place (Figure 8-3), using the survey tape for orientation reference, and the ISO positions (x, y, and depth to center) were measured with the RTK DGPS (see Table 8-1).

A second RTK DGPS measurement was made over each IVS seed item at the walking surface height. These second depth measurements are provided in Table 8-2. Due to the lower accuracy on the Z component (elevation) of the RTK DGPS, the tape measured depth was utilized.

Note: Water in the bottom of the hole.

Figure 8-3: Example Photograph of RAA-04 IVS Seed Item 04 at 4-in Below Mineral Soil Surface

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Table 8-1: RAA-04 IVS Seed Item Locations

IVS Seed Item	Item	X (ft)	Y (ft)	Inclination	Orientation	Depth to Center Mass below Mineral Surface (in) *	Depth to Center Mass below Walking Surface (in)	Easting (US ft)	Northing (US ft)
IVS_1	Small ISO	10	0	Horizontal	Across-Track	4.0	7.0	3143046.683	353374.104
IVS_2	Small ISO	25	0	Horizontal	Across-Track	9.2	12.2	3143048.829	353389.117
IVS_3	Small ISO	40	0	Horizontal	Across-Track	6.6	9.6	3143050.789	353403.826
IVS_4	Small ISO	55	0	Horizontal	Along-Track	4.0	7.0	3143052.939	353418.937
IVS_5	Small ISO	70	0	Horizontal	Along-Track	9.2	12.2	3143054.966	353433.446

* Installed depths IAW the Final GSV Installation Plan

Table 8-2: RAA-04 IVS Seed Item Walking Surface Depth Measurement Comparison

Seed Item	RTK DGPS Measurements				Tape Measured Depth (in)
	Mineral Surface Elevation (US ft)	Walking Surface Elevation (US ft)	Depth (ft)	Depth (in)	
IVS_01	314.541	315.089	0.548	6.576	7.0
IVS_02	314.452	315.169	0.717	8.604	12.2
IVS_03	315.253	315.927	0.674	8.088	9.6
IVS_04	315.665	316.21	0.545	6.54	7.0
IVS_05	315.408	316.419	1.011	12.132	12.2

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9.0 POST-INSTALLATION DGM SURVEY

Following IVS seed item installation and recording, the IVS team conducted five post-installation DGM surveys. The surveys were conducted along the lines/transects as described in Table 9-1, using SOP 2, Digital Geophysical Surveying as guidance.

After all five surveys were completed; the data was downloaded by the site geophysicist for on-site review and editing. Proprietary software supplied by the instrument's manufacturer (DAT61) was used to convert the data files from binary to ASCII format.

After data file conversion, the data was uploaded to Geosoft's Oasis Montaj software. The local coordinates were converted to the project coordinate system and units. All data was leveled using a 30 point rolling de-median filter. A latency correction of 0.3-sec was applied to adjust the timing between EM61-MK2A data and the logged RTK DGPS data for all datasets. Data were then gridded, contoured, and displayed on a map using the minimum curvature gridding algorithm. Targets were selected manually for each IVS dataset, as described in Section 3.0.

Table 9-1: RAA-04 IVS Survey Line/Transect Direction

Line	Direction (ft)	Offset (ft)	Comment
Line 0	0 to 80	-2.5	Simulated grid
Line 1	80 to 0	-1.25	Half line spacing [Blind Seed Item (BSI) range]
Line 2	0 to 80	0	Simulated grid
Line 3	80 to 0	2.5	Simulated grid
Line 4	0 to 80	10	Dynamic background

9.1 DGM DATA OF ALL REPEATS ON ALL TRANSECTS

A post installation survey of RAA-04 IVS was conducted five times by the IVS team to validate the installation, and to build a basis for computing average response values. Results from the five surveys and the response peak mean for each IVS seed item is provided in Table 9-2.

Table 9-2: RAA-04 IVS Post Installation Survey Results

	Seed Item Leveled Time Gate 1 Response Peaks (mV)				
File	IVS_01	IVS_02	IVS_03	IVS_04	IVS_05
RAA04_GSV_01	18.13	3.32	12.79	29.46	9.87
RAA04_GSV_02	19.41	3.32	13.02	22.76	6.85
RAA04_GSV_03	20.62	3.98	13.53	32.27	9.5
RAA04_GSV_04	19.4	5.93	17.42	31.45	11.05
RAA04_GSV_05	22.66	3.6	18.91	33.37	9.95
Average	20.0	4.0	15.1	29.9	9.4

9.2 EXAMPLE MAPS/PROFILES OF DATA

All data sets were gridded using the minimum curvature gridding algorithm with cell spacing set to 0.3-ft and a 2.5 blanking distance. The map of RAA-04_GSV_01 in Figure 9-1 and a profile plot of the centerline are provided in Figure 9-2. . Note that Z1_Lev is the leveled Time Gate 1 profile, Z2_Lev is the leveled Time Gate 2 profile, etc.

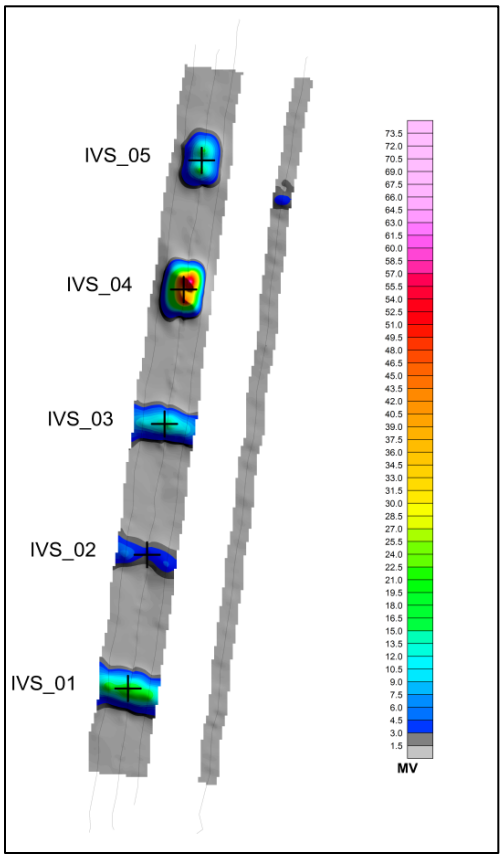

Figure 9-1: RAA-04 GSV_01 Post-Installation Survey Map of Leveled Time Gate 1 (mV)

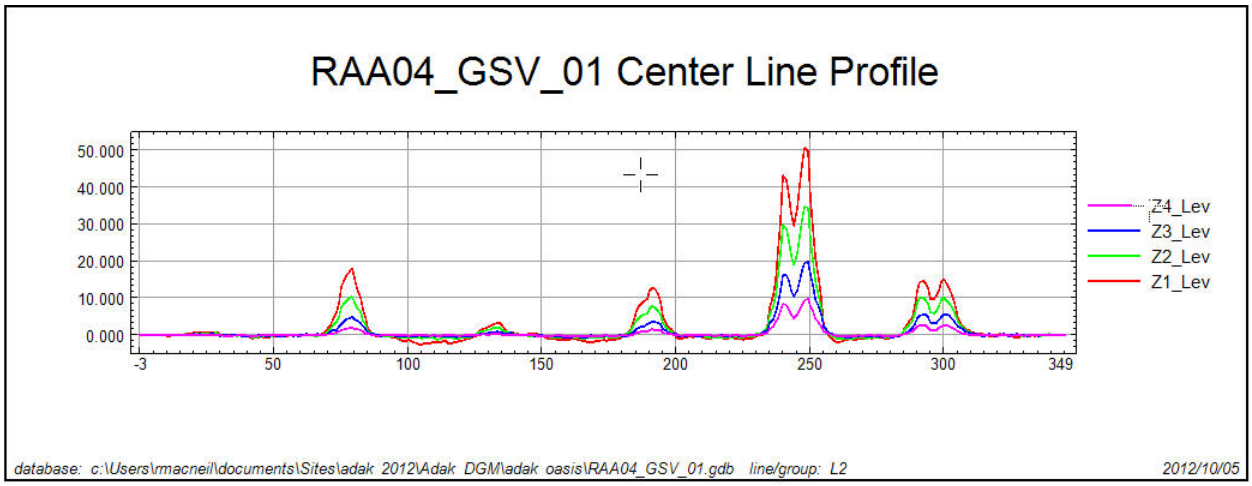

Figure 9-2: RAA-04 GSV_01 Center Line (Line 2) Profile

9.3 DISCUSSION OF LOGISTICS

RAA-04 IVS was located in a relatively flat, open space near the survey area. Mobilization to the RAA required approximately 30 minutes from the city of Adak. Survey time for all five lines of the IVS is less than 5 minutes after instrument warm-up. Survey time for center line and background line only should be less than 2 minutes after instrument warm-up.

10.0 DGM DATA ANALYSIS

Each IVS database was analyzed for data density along-track with the results documenting that 0% exceeded the designed along-track sample density of 0.6-ft (0.183-m). Therefore, the planned performance metric of <5% sample separation exceeding 0.6-ft is recommended for production DGM. An example along-track plot is provided in Figure 10-1.

DGM coverage of the IVS was planned for 100% site coverage at 3.0-ft (0.9-m) line spacing except around known obstacles. To achieve this coverage metric, field teams are instructed to collect data on 2.5-ft line spacing. The IVS databases were analyzed for footprint coverage. Using the planned 2.5-ft line spacing to collect the IVS data, achieved 100% coverage at 3.0-ft (0.9-m) metric. An example across-track coverage plot is provided in Figure 10-2.

All datasets were reviewed for proper time gate response (e.g., gate 1 > gate 2 > gate 3 > gate 4) over anomaly peaks.

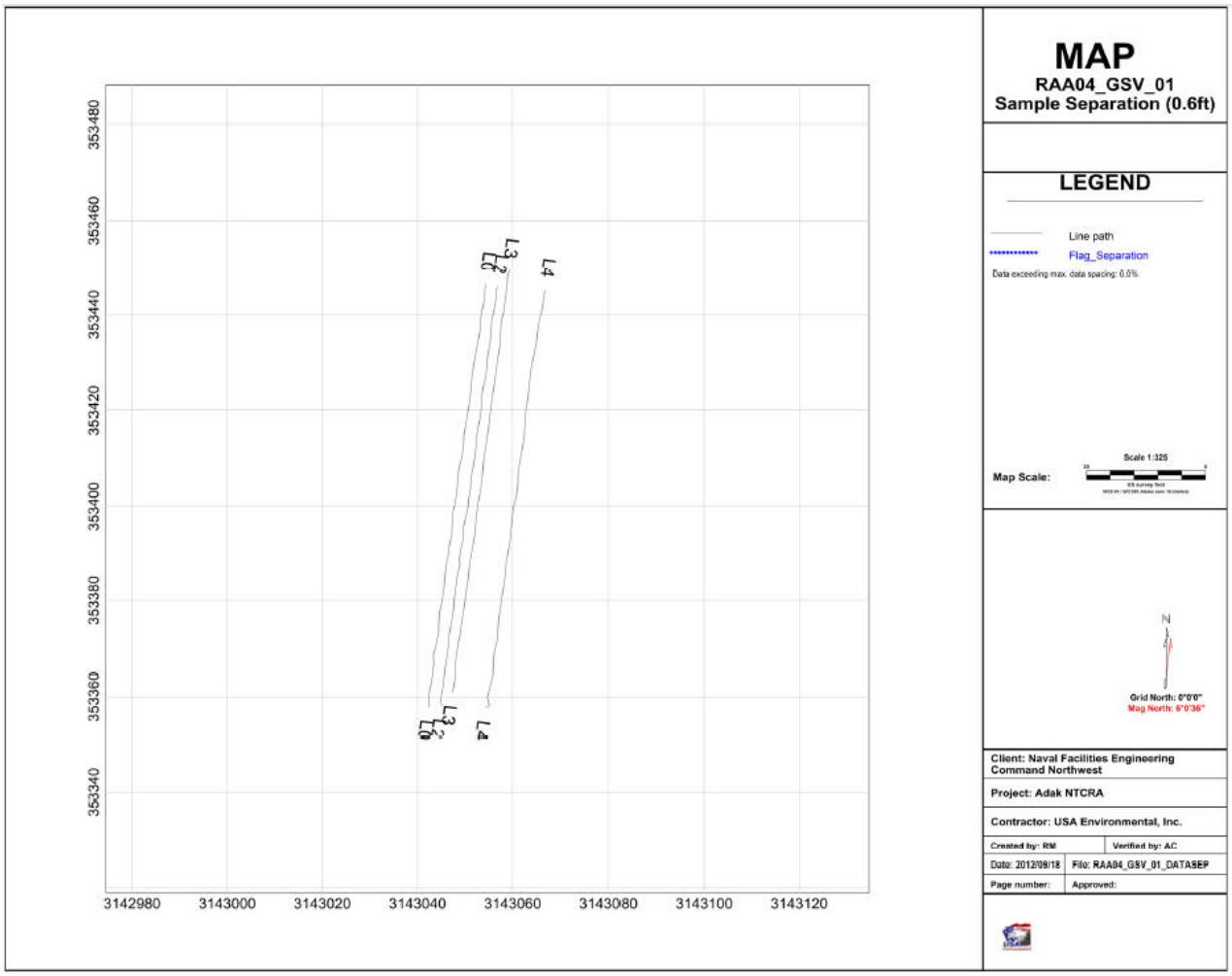

Figure 10-1: Data Separation QC Plot for RAA-04 GSV_01

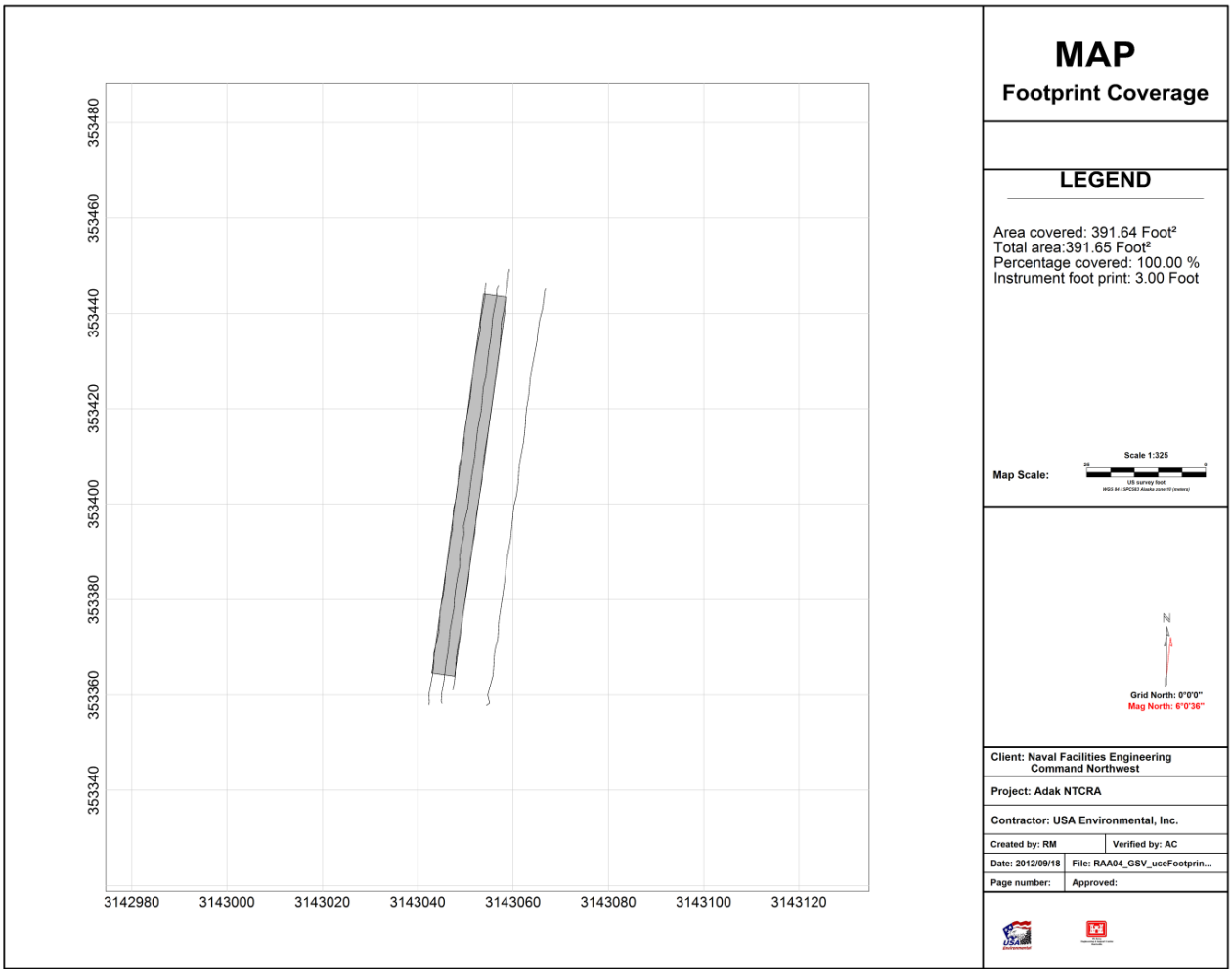

Figure 10-2: Footprint Coverage QC Plot for RAA-04 GSV_01

10.1 DISCUSSION AND QUANTIFIED RESULTS FOR LATENCY/LAG

All datasets were adjusted for latency corrections using a 0.3-sec correction to ensure no zig-zag features were present in the final gridded data.

10.2 EM61 MK2 RESPONSE OVER ISOs AND COMPARISON TO MODEL RESULTS

Each RAA-04 IVS seed item was evaluated to the published Naval Research Laboratory (NRL, 2008; NRL, 2009) ISO response tables for the adjusted depth to walking surface. All IVS seed items in RAA-04 were within the published curves and repeatability was established during the five surveys of the IVS. Response values, averages, background noise statistics and comparison charts are included in the RAA-04 IVS Seed Response with Plots.xls spreadsheet (see Appendix B). An example comparison chart is provided in Figure 10-3.

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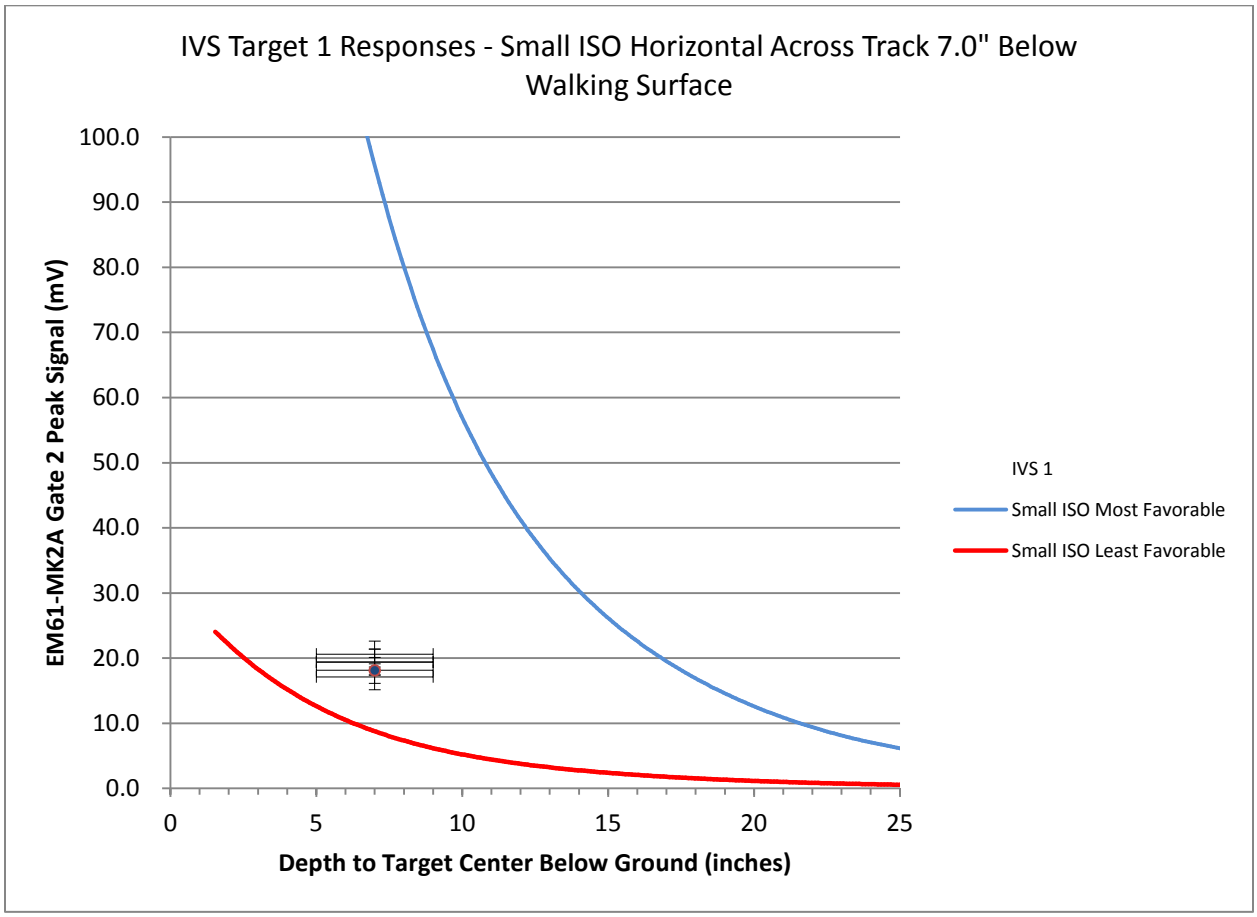

Figure 10-3: RAA-04 EM61-MK2A Time Gate 1 Responses for IVS_01

Each IVS seed item was also evaluated in a cumulative plot showing amplitude and failure criteria limits of ±20% or ±2 x std. dev. of the five-run average as shown for seed item #1 in Figure 10-4.

USA noted that not all RAA-04 IVS seed item responses met the ±20% failure criteria. RAA-04 IVS seed item 2, a small ISO buried 9.2-in below mineral surface, oriented across-track, on pass 4, exceeded the 20% metric by 1.1-mV (36.7%). Seed item 3, a small ISO buried 6.6-in below the mineral surface, oriented across-track, on pass 5 exceeded the 20% metric by 0.7-mV (5%). The most likely cause for this was normal dips and rises in coil height. All other RAA-04 IVS seed items met the response metric, within 20% of the initial five-run average.

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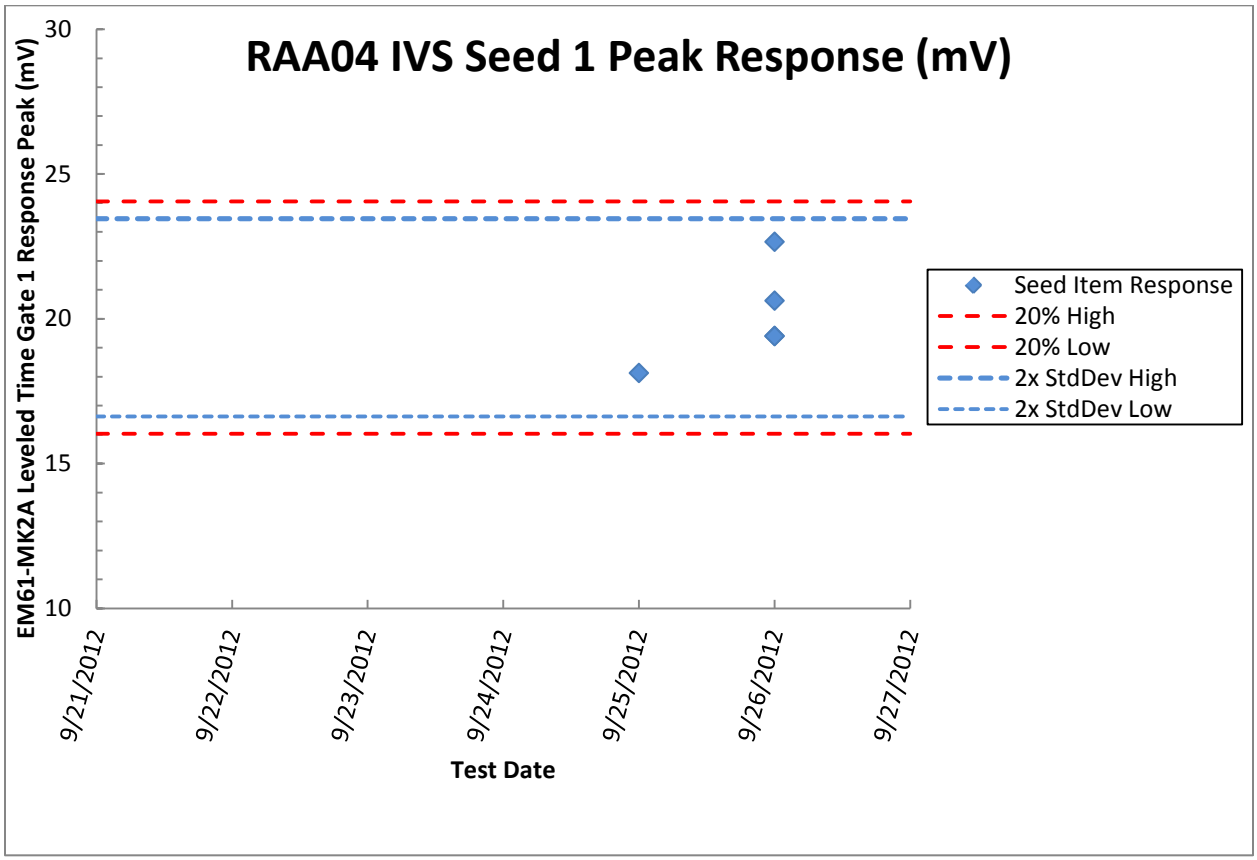

Figure 10-4: Cumulative Plot of RAA-04 IVS_01 Amplitudes with ±20% and ±2x std. dev. Failure Criteria

10.3 ANOMALY LOCATION VS KNOWN LOCATION OF ISOS

A spreadsheet (see Appendix B) showing downline positioning of ISOs from the DGM interpretation compared to the known positions, and cumulative plots of the variance with time (also showing failure criteria limits) was created for RAA-04 IVS data. Figure 10-5 shows an example plot for IVS_01 seed. All RAA-04 IVS seed items passed the location metric within 25-cm.

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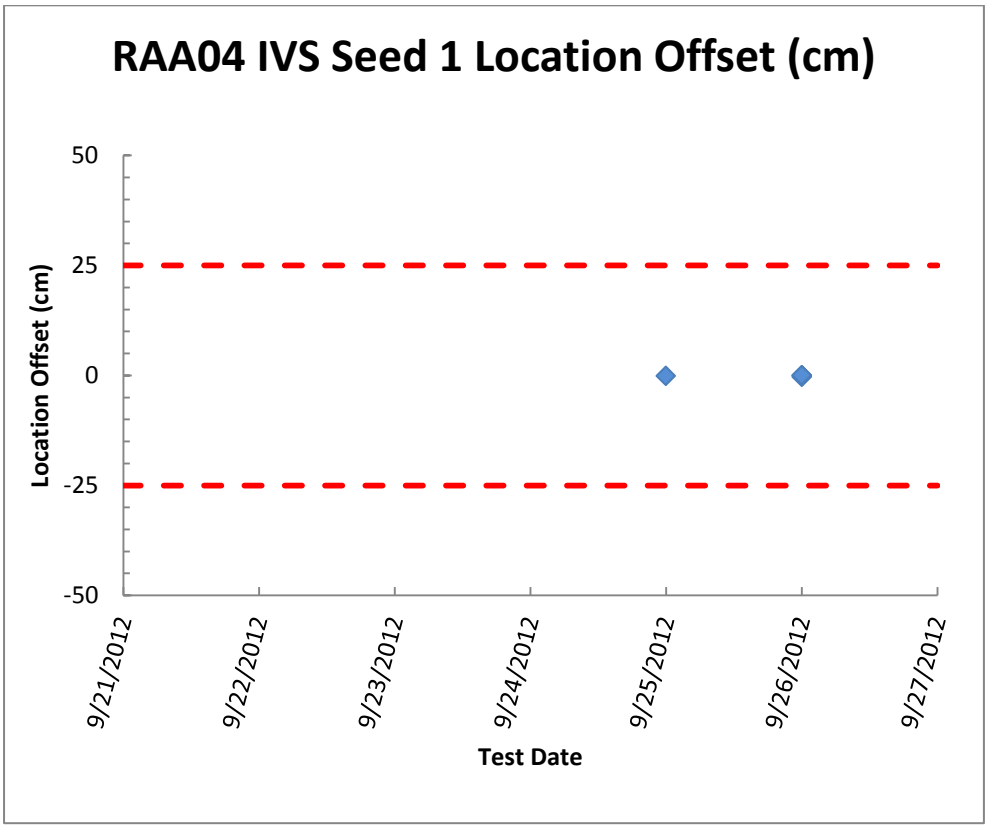

Figure 10-5: Cumulative Plot of Differences between Interpreted (DGM) and Known (Surveyed) Positions with Failure Criteria

10.4 BACKGROUND NOISE

A background noise line was installed 10-ft from the center line and data were collected five times. These results (+/- 0.59 mV) are consistent with the other RAAs and previous DGM efforts on Adak. The results are shown in Table 10-1.

Table 10-1: RAA-04 Background Noise Line Statistics for Time Gate 1

Date	File Name	Z1_Lev (std. dev.)
9/25/2012	RAA04_GSV_01	0.766
9/26/2012	RAA04_GSV_02	0.922
9/26/2012	RAA04_GSV_03	0
9/26/2012	RAA04_GSV_04	0.79
9/26/2012	RAA04_GSV_05	0.493
	Mean Background	0.5942

10.5 EFFECT OF TRANSECT LOCATION ON ISO AMPLITUDE

No effect on ISO amplitude was encountered at this RAA IVS due to geology or clutter. The low dynamic background noise indicates that good signal to noise can be expected at the RAA-04 IVS, and may extend to RAA-04.

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11.0 IVS INSTALLATION SUMMARY

Post-installation DGM surveys verified that the DGM instrumentation (sensors and positioning), instrument operators, data acquisition methodologies, and data processing and analysis procedures met the DQOs established for the project in the GSV Plan and DGM SOPs (e.g., RTK DGPS reoccupation, the along-line data density metric and survey area coverage, and the IVS seed item location accuracy). A comparison table of mean time gate 1 response values by RAA is included in Table 11-1 (yellow highlighted cells show the lowest IVS seed item response value across all three IVSs).

Table 11-1: Comparison Table of Mean Time Gate 1 Response Values by RAA

	RAA-02				RAA-03				RAA-04			
	Min	Max	Mean	2x std. dev.	Min	Max	Mean	2x std. dev.	Min	Max	Mean	2x std. dev.
IVS_1	15.6	23.8	19.0	6.1	12.4	17.1	14.6	3.5	18.1	22.7	20.0	3.4
IVS_2	4.9	8.6	6.2	3.0	5.8	7.7	6.7	1.4	3.3	5.9	4.0	2.2
IVS_3	20.7	25.8	22.9	4.5	12.5	17.4	15.5	3.7	12.8	18.9	15.1	5.7
IVS_4	22.3	27.7	24.4	4.2	16.1	22.9	19.9	4.9	22.8	33.4	29.9	8.4
IVS_5	8.9	10.6	9.9	1.4	10.2	12.6	11.8	2.0	6.8	11.0	9.4	3.1
Background RMS	0.61				0.65				0.59			

Only the IVS seed item response peak within 20% of the five-run average DQO was not consistently met. Out of the 75 IVS seed item response peaks, there were a total of five response peak failures (6.7%) outside 20% of their five-run average response peak value. There were a total of one failure (1.3%) below the 20% metric and four failures (5.3%) above the 20% metric. All five failures occurred on the first three small ISOs oriented across-track (the orientation that is most difficult to detect) All IVS seed item response peaks passed the more robust failure criteria of the larger of ±20% or 2x std. dev. of the five-run average or the previous week's average.

The IVS data from all three IVSs was analyzed for the minimum IVS seed item response in each RAA, grouped by seed item depth (e.g., 3x, 5x, and 7x the outer diameter), to establish a basis for the minimum expected BSI (small ISO) response value. The minimum five-run average IVS seed item response for each depth category was identified, along with the std. dev. A factor of (2x std. dev.) was subtracted from the five-run average as the best predictor of the minimum expected BSI response. Table 11-2 summarizes these results.

Based on these IVS results, it is recommended that the IVS anomaly amplitude failure criteria be modified to the more robust the larger of ±20% or 2x std. dev. of the previous week's average metric that better accounts for the dynamic response uncertainties associated with slight survey line path offsets, minor coil height changes due to terrain, EM61-MK2 sampling intervals, and noise.

No other changes to the DGM metrics are recommended at this time.

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Table 11-2: Minimum Expected BSI Response (EM61-MK2 Leveled Time Gate 1 Channel)

RAA	BSI Depth	Mean (mV)	Std. Dev. (mV)	2x Std. Dev. (mV)	Minimum Expected BSI Response (mV)
RAA-02	3X Diameter	19.03	3.04	6.08	12.9
	5X Diameter	22.88	2.24	4.47	18.4
	7X Diameter	6.24	1.48	2.96	3.3
RAA-03	3X Diameter	14.65	1.77	3.54	11.1
	5X Diameter	15.51	1.83	3.66	11.8
	7X Diameter	6.72	0.68	1.37	5.4
RAA-04	3X Diameter	18.94	1.34	2.67	16.3
	5X Diameter	14.83	2.37	4.73	10.1
	7X Diameter	4.0	1.10	2.19	1.8

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12.0 BLIND SEED ITEM (BSI) INSTALLATION

The BSI effort, on Parcel 4 of Adak, AK, was carried out by the two-man BSI team consisting of a UXOTII (Richard Moyer) and a Field Engineer/Instrument Operator (Scott Crandall). The Quality Control Specialist (Robert Shauger) accompanied the BSI team. The effort took place from Friday, 21 September through Thursday, 27 September 2012, over three RAAs: RAA-02, RAA-03, and RAA-04. On Friday, September 21, the BSI team, in conjunction with the IVS team (led by Ric MacNeil), established survey control points and back check points at RAA-03 and RAA-04 (see Table 1-1). RAA-3 was completed over the course of five production days (21-25 September 2012), using the RAA-03 survey control point. RAA-04 was completed over the course of two production days (25 and 26 September 2012). RAA-02 was completed in one production day (27 September 2012). The RAA-04 and RAA-02 BSI effort used the ARA survey control point. The back check results for each BSI day are provided in Table 1-2.

12.1 BSI INSTALLATION LOGISTICS

The procedure for the BSI installation began with the setup of the RTK Base station and back check. The White's DFX300 was also checked to ensure proper functionality. Once all the equipment was verified to be operating correctly, one BSI was placed in every full grid and one BSI was placed in every equivalent full grid of partial grids. A 3-ft area was checked, with the White's DFX300, around the selected location. If anomalies were detected in the area, a new location within the selected grid was chosen for the BSI. If no anomalies were detected in the area, a hole was dug taking care to leave the tundra intact. The following details of BSI location were then recorded in the data logger:

- BSI number
- BSI type
- Coordinates
- Depth (tundra thickness and depth below mineral surface)
- Orientation (EW or NS)
- Inclination (all Horizontal).

A total of 368 BSIs (small ISOs) were placed at a depth below the mineral surface of 3X, 5X, or 7X, the outside diameter of the BSI (4-, 6.6-, or 9.2-in). Once the BSI was placed at its target depth and orientation the RTK DGPS was placed on the center of the item, leveled up, and the coordinates collected. After all the data was collected, the hole was back filled, taking care to place the tundra back as it was found. The White's DFX300 was then used to ensure that the BSI could be located.

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Figure 12-1: BSI Team Installing Blind Seed in RAA-04

12.2 BSI DATA SUMMARY AND REFERENCE

The collected data was compiled into a password protected spreadsheet, and posted to the QA contractor Sharepoint.

12.3 MINIMUM EXPECTED BSI RESPONSE

The IVS data from all three IVSs was analyzed for the minimum IVS seed item response in each RAA, grouped by seed item depth (e.g., 3x, 5x, and 7x the outer diameter), to establish a basis for the minimum expected BSI response value. A conservative BSI response value of 3.0-mV on the leveled time gate 1 channel is recommended as the minimum threshold for BSI selection as all small ISOs were detected at or above this response value and provided a high signal to noise ratio above background during anomaly selection. RAA anomaly screening thresholds established in the MEC QAPP for each RAA (see Table 12-1) are noted to be higher than the recommended BSI selection threshold for some RAAs. The anomaly screening thresholds were developed based on the MEC and the depths they were encountered in past site investigations and not theoretical detection depths of the geophysical system. To incorporate both the proposed BSI selection threshold and the recommended anomaly selection criteria for each RAA, DGM anomalies in all RAAs will be selected at a 3.0-mV threshold on the leveled time gate 1 channel. The resulting target database will be ranked by response amplitude, with only the anomalies above the RAA screening threshold forwarded for intrusive investigation. However, all of the anomalies at or above the 3.0-mV selection threshold will be used to assess BSI detection that may fall below the anomaly screening threshold but above the BSI selection threshold. QC and QA are able to verify that the BSIs were detected in the event that their mV response is below the RAA specific pick threshold. If any

BSI fails to meet these initial selection criteria, it will be evaluated on a case-by-case scenario, but would not necessarily constitute a grid failure.

Table 12-1: Anomaly Screening Thresholds by RAA

RAA	Time Gate	Threshold	Basis
RAA-01	1	7	40-mm grenade
RAA-02	1	3	20-mm projectile
RAA-03 West	1	4.8	37-mm projectile
RAA-03 East	1	7	40-mm grenade
RAA-03 East (AOC HG-01)	1	7	40-mm grenade
RAA-04	1	3.4	81-mm mortar

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