Geophysical Test Plot Results and Anomaly Section Criteria Memorandum

Parker Flats Phase II MRA, Former Fort Ord

MEMORANDUM

Date: May 21, 2009

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Subject: **Residential Quality Assurance Pilot Study - Geophysical Test Plot Results and Anomaly Selection Criteria**

Introduction

On January 15, 2009, the Fort Ord Reuse Authority (FORA) Environmental Services Cooperative Agreement Remediation Program (ESCA RP) Team demonstrated to representatives of the U.S. Environmental Protection Agency (EPA) and the California Department of Toxic Substances Control (DTSC) instrumentation and processes that will be implemented in the field during digital geophysical mapping (DGM) surveys associated with the Residential Quality Assurance (RQA) Pilot Study. The demonstration was conducted in support of the Draft RQA Pilot Study Modification White Paper and the Final Group 1 Remedial Investigation/Feasibility Study Work Plan (ESCA RP Team 2008c and 2008d, respectively). The demonstration was conducted at a pre-established geophysical test plot (GTP) located in the northern portion of the MRS-Seaside.2 within the Seaside Munitions Response Area (MRA) and was identified as Test Plot 1. The GTP was described in the Final Geophysical Test Plot Report, dated June 5, 2008 (ESCA RP Team 2008b).

In addition to the GTP demonstration, a second demonstration was conducted over a test strip containing inert 37 millimeter (mm) projectiles and 1- by 4-inch hollow steel pipe nipples designed to represent 37 mm projectiles (proposed industry standard targets).

The objectives of the demonstrations at the GTP and test strip were the following:

- optimize the configuration and height of the EM61-MK2 sensors on the towed array FORA ESCA Sled
- obtain information to validate proposed geophysical sensor functionality, navigation instrumentation accuracy, and personnel protocols to operate the instrumentation
- confirm that the scope and proposed metrics are attainable and sufficient to meet the intended goals for RQA (ESCA RP Team 2008d)

Test Plot and Test Strip Design

The following sections provide brief descriptions of the GTP design for the two demonstrations.

Test Plot

The area used to test the towed array FORA ESCA Sled was identified as Test Plot 1, which was established in the northern portion of MRS-Seaside.2. This is one of the two test plots used to evaluate geophysical instruments and processes prior to conducting the Phase II Seaside MRA removal action (ESCA RP Team 2008a). The Final Geophysical Test Plot Report provided the location and details of the test plot design (ESCA RP Team 2008b).

Test Strip

The test strip contained five targets: two inert 37 mm projectiles and three 1- by 4-inch hollow steel pipe nipples (proposed industry standard targets). The five targets were buried at approximately 18 inches below ground surface (bgs) and were oriented in the least favorable orientation, which was horizontal with the long axis perpendicular to the Sled's direction of travel. The targets were buried approximately 20 feet apart in a straight line.

Instrumentation

The EM61-MK2 surveys were conducted using a Geonics, Ltd., EM61-MK2™ high sensitivity ferrous and nonferrous metal detector. The EM61-MK2 is battery-powered and operates at a maximum output of 10,000 millivolts (mV). When conductive objects are present below the instrument, the amplitude and decay time of the induced eddy currents vary in response to the size, mass, and orientation of the objects. The EM61-MK2 sensor coils are normally elevated approximately 16.5 inches above the ground surface on a cart with wheels to traverse rough terrain. A new EM61-MK2 towed array platform ("the FORA ESCA Sled") was designed and tested to replace the standard EM61-MK2 towed array cart. Features of the FORA ESCA Sled include the following:

- Coils mounted with the long axis along the direction of travel, thereby increasing the power density introduced to the ground for the same area of coverage (i.e., 3 coils for an area 1 meter wide versus 3 coils for an area over 3 meters wide)
- Coils were lowered to a height of approximately 20 centimeters (cm) above ground surface
- Platform was a heavy plastic sled to minimize coil rocking due to surface irregularity (rough terrain)
- Sled had a hinge on the tow bar to reduce lifting of the EM61-MK2 sensors due to terrain differences between the sled and tow vehicle
- Coils were carried in a reconfigurable tray so total sensor width and height could be adjusted for terrain and the number of coils available; however, height remained consistent for the RQA DGM surveys.

Quality Control (QC) function checks were performed following the instrument-operating manuals and standard industry practices (discussed below). The EM61-MK2 sensors on the FORA ESCA Sled were set to record and store data in a field laptop computer at 10 readings per second (10 Hertz). Since this system was not nulled to zero background in the field, data corrections were made during the post-processing stage.

Data Quality Objectives and Quality Control

This section summarizes the data quality objectives (DQOs) established for the geophysical tests. DQOs are an integral part of quality assurance/quality control (QA/QC) and are used to specify the acceptable limits for decisions that establish the quality and quantity of data needed to support production surveys. Details regarding these standard activities were provided in the Final Geophysical Test Plot Report (ESCA RP Team 2008b) and included the following:

- Mean Speed - The metric for mean speed was less than 3 miles per hour
- Along-Track Spacing - The metric for along-track spacing was less than 0.5 foot
- Cross-Track Spacing - The metric for cross-track spacing was 2.5 feet, excluding gaps due to surface obstructions
- Munitions and Explosives of Concern (MEC) Detection - The metric for MEC detection was a 37 mm projectile buried at approximately 18 inches bgs for the RQA Pilot Study

Quality Control

Instrument Function Testing

Static background, static spike, and vibration/cable connection tests were performed daily before and after surveying and during power-on and power-off cycles to confirm the equipment was functioning properly throughout the survey period. The EM61-MK2 was tested at a designated QC area during the pre- and post-survey instrument function tests.

Instrument Latency

To determine temporal lags (or latency effects) inherent to the instrument, single- and multi-point bidirectional navigation tests were performed. The EM61-MK2 tests utilized steel bolts (one for each sensor) in two surveyed lines up and back over the bolts. These tests allowed the processing geophysicist to determine the appropriate time lags and corrections needed to accurately position the collected data. In addition to identifying instrument latency effects, the single-point tests quantified navigational accuracy of the Global Positioning System (GPS). Latency results were recorded on the processing notes, which will be included in the RQA Pilot Study Technical Information Paper.

Navigational Accuracy

A new survey-grade monument was established by a licensed California surveyor prior to test plot geophysical activities to geo-reference the geophysical data to North American Datum 83 California Zone IV US survey feet units. The Real-Time Kinematic (RTK) GPS base station was set up over one of the existing survey monuments with the supplied northing and easting coordinates. The base station then provided differentially corrected data to the rover unit mounted above the EM61-MK2 within centimeter accuracy. As an additional check, geophysical data were collected over known locations (surveyor nail/monument) in the test plot during the survey to validate navigational precision.

Six-Line Tests

Six-Line Tests were used to determine background noise and temporal time lags inherent to the geophysical system by collecting data at varying speeds. The results of the six-line tests will be included in the RQA Pilot Study Technical Information Paper.

Data Processing

Geophysical data pre- and post-processing were conducted in accordance with the Final Geophysical Test Plot Report (ESCA RP Team 2008b).

Test Plot DGM Survey Results

The DGM survey at Test Plot 1 demonstrated that the MEC detection metric was achieved (Figure 1). Note that four locations were identified as targets, which were selected based on the target selection threshold of 20 mV (discussed below); however, there were no seeds at the four locations.

Figure 1 – Test Plot 1 EM61-MK2 Seeded Survey with FORA ESCA Sled (January 15, 2009)

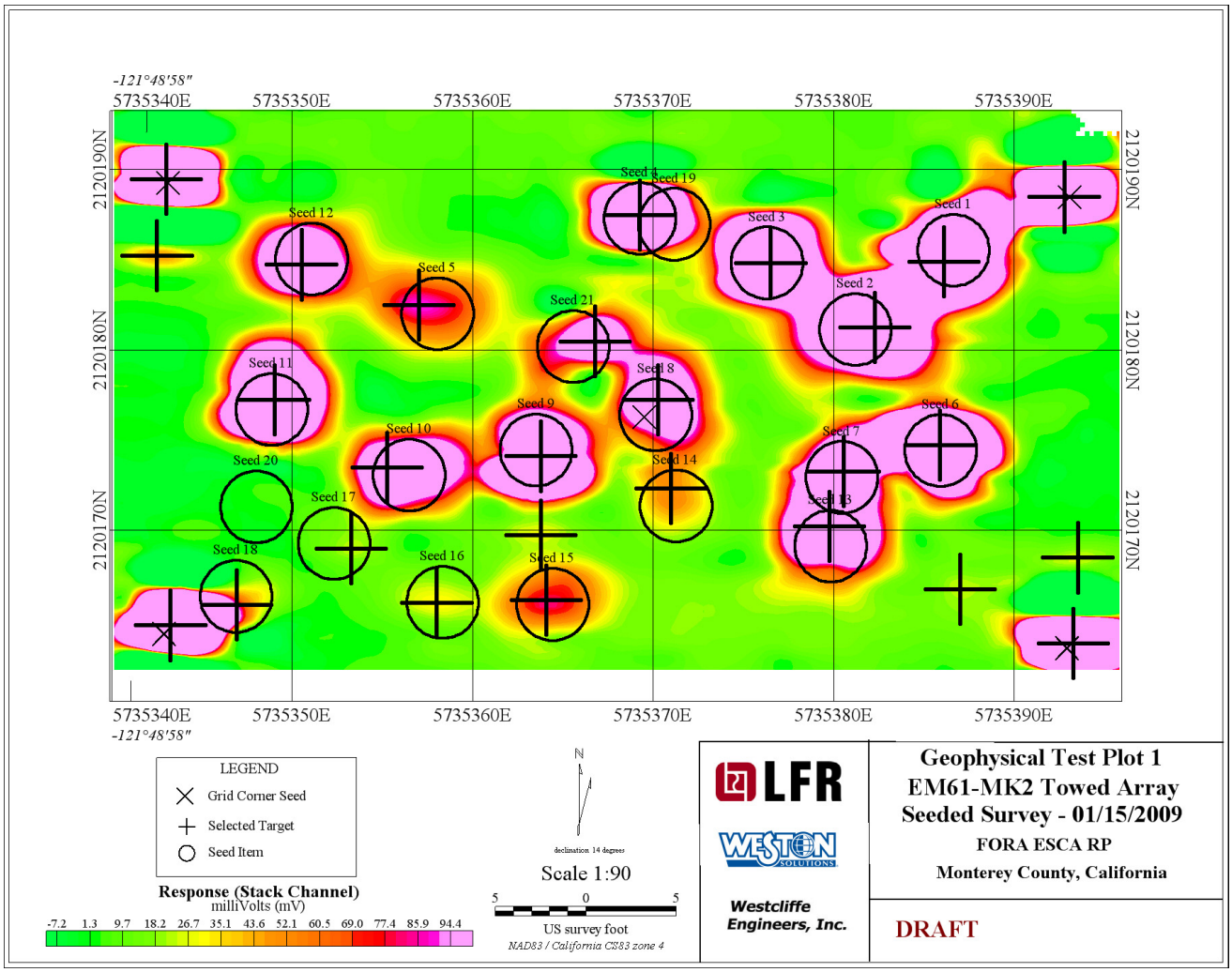


Table 1 compares the signal response between the FORA ESCA Sled and the standard towed array cart that was used to evaluate geophysical instruments and processes for conducting the Phase II Seaside MRA removal action. As shown in Table 1, an increase in signal response was observed for each target when using the FORA ESCA Sled. Note that Seeds 19 and 20 in Figure 1 represent small metal scrap (<1 ounce) and, therefore, were not used as part of this evaluation.

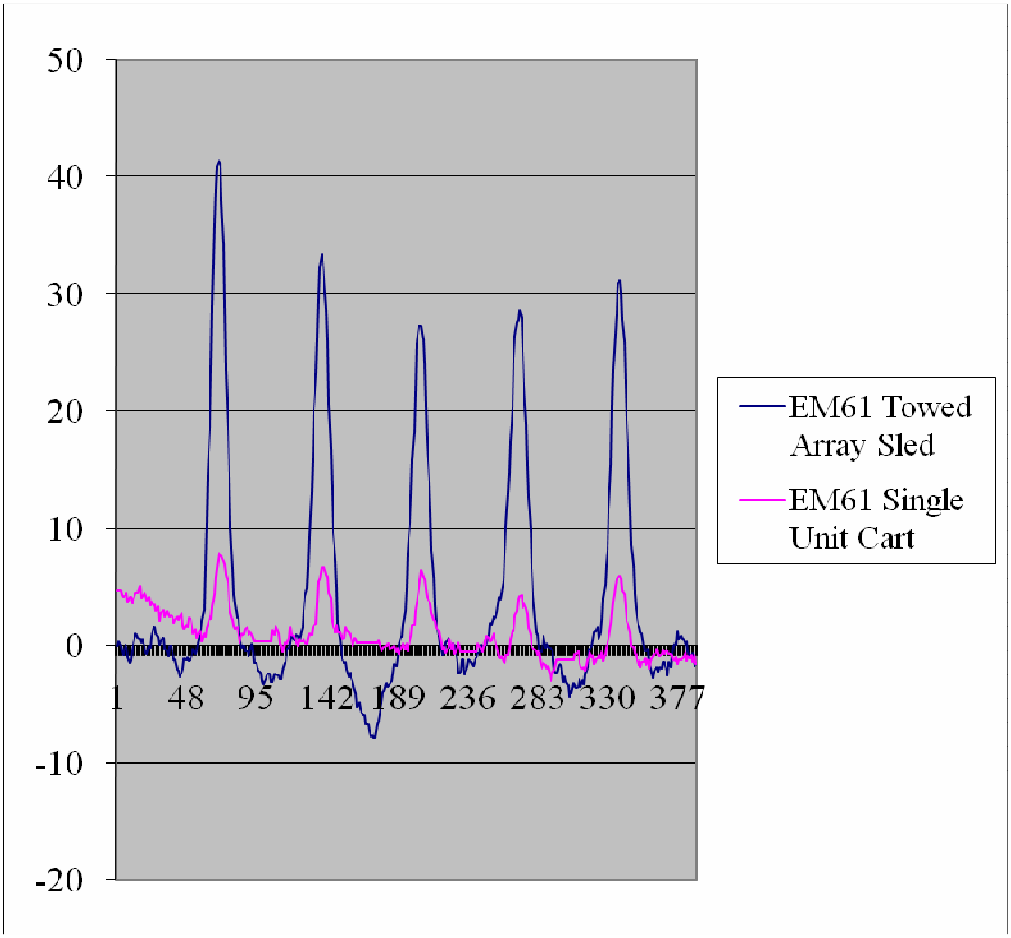
Table 1 – Test Plot 1 EM61-MK2 Results Comparison for FORA ESCA Sled and Towed Array Cart

Seed Item	Target Description	Depth (inches bgs)	FORA ESCA Sled (mV)	Towed Array Cart (mV)
Seed 1	70 mm (pipe)	12	638.60	550.40
Seed 2	70 mm (pipe)	24	569.80	242.30
Seed 3	57 mm	6	416.10	277.30
Seed 4	57 mm	12	914.30	363.50
Seed 5	57 mm	24	92.80	24.10
Seed 6	37 mm (pipe)	6	507.60	393.40
Seed 7	37 mm (pipe)	12	296.60	259.80
Seed 8	37 mm (pipe)	18	228.00	32.60
Seed 9	37 mm (pipe short)	6	242.50	215.20
Seed 10	37 mm (pipe short)	12	233.40	115.00
Seed 11	37 mm (pipe short)	6	534.00	153.00
Seed 12	70 mm (pipe)	36	242.40	92.30
Seed 13	Grenade	6	335.00	150.30
Seed 14	Grenade	24	50.70	4.20
Seed 15	Grenade	12	80.80	35.30
Seed 16	Grenade Fuze Assembly	3	31.80	9.90
Seed 17	Grenade Fuze Assembly	3	22.80	13.70
Seed 18	Grenade Fuze Assembly	1	89.30	12.10
Seed 21	Steel Scrap	9	215.10	65.70

Test Strip

Figure 2 shows the data collected directly over the test strip targets using the standard EM61-MK2 single unit cart and the EM61-MK2 towed array FORA ESCA Sled. The targets in order from left to right were an inert 37 mm projectile, an inert 37 mm projectile, a 1- by 4-inch steel pipe nipple, a 1- by 4-inch steel pipe nipple, and a 1- by 4-inch steel pipe nipple. The targets were buried at approximately 18 inches bgs and were oriented in the least favorable orientation, which was horizontal with the long axis perpendicular to the direction of travel.

Figure 2 – Test Strip EM61-MK2 Seeded Survey with FORA ESCA Sled and Single Unit Cart



As shown in Figure 2, the FORA ESCA Sled design resulted in an average improvement of signal strength of approximately 430% for the five targets in the test strip. Table 2 compares the signal response between the FORA ESCA Sled and the standard single unit cart.

Table 2 – Test Strip EM61-MK2 Results Comparison for FORA ESCA Sled and Single Unit Cart

Target Description	FORA ESCA Sled (mV)	Single Unit Cart at a Standard Height of 16.5 inches (mV)
37 mm	40	7
37 mm	33	5
1x4-inch pipe nipple	27	6
1x4-inch pipe nipple	28	6
1x4-inch pipe nipple	30	6

The noise level was determined by calculating the standard deviation of the signal when not positioned over a target item. The standard deviation was 1.78 mV for the single unit cart and 2.03 mV for the FORA ESCA

Sled. Using these values in conjunction with the peak responses observed from the targets (Table 2), the average Signal to Noise Ratio (SNR) (Peak Signal / 3 x Standard Deviation of Noise) was calculated. A 37 mm projectile seeded at approximately 18 inches bgs had a SNR with the standard single unit cart of 1.11 and the SNR with the FORA ESCA Sled was 5.97.

Anomaly Selection Threshold

Due to the improvement in signal response using the FORA ESCA Sled, the anomaly selection threshold was revised from the threshold initially established in the Final Geophysical Test Plot Report (ESCA RP Team 2008b). Based on the results of the tests performed for the RQA Pilot Study and utilizing physics-based response curves based on the 37 mm projectile, a 20 mV (summed channels) threshold was selected to conservatively bound the lowest response anticipated from a 37 mm projectile buried at 18 inches bgs. This allows for potential fluctuations in background noise as well as data collection variables during the RQA Pilot Study DGM surveys that may influence peak response of buried conductive items.

Figure 3 shows the industry standard curves for the signal response for the proposed industry standard target (1- by 4-inch pipe nipple identified in the figure as a "Small Seed") and a variety of other munitions items for an EM61-MK2 coil mounted at 6 inches above ground surface, consistent with the towed array FORA ESCA Sled.

Figure 3 - Sensor Response Curves
EM61-MK2 with 6-Inch Coil Height

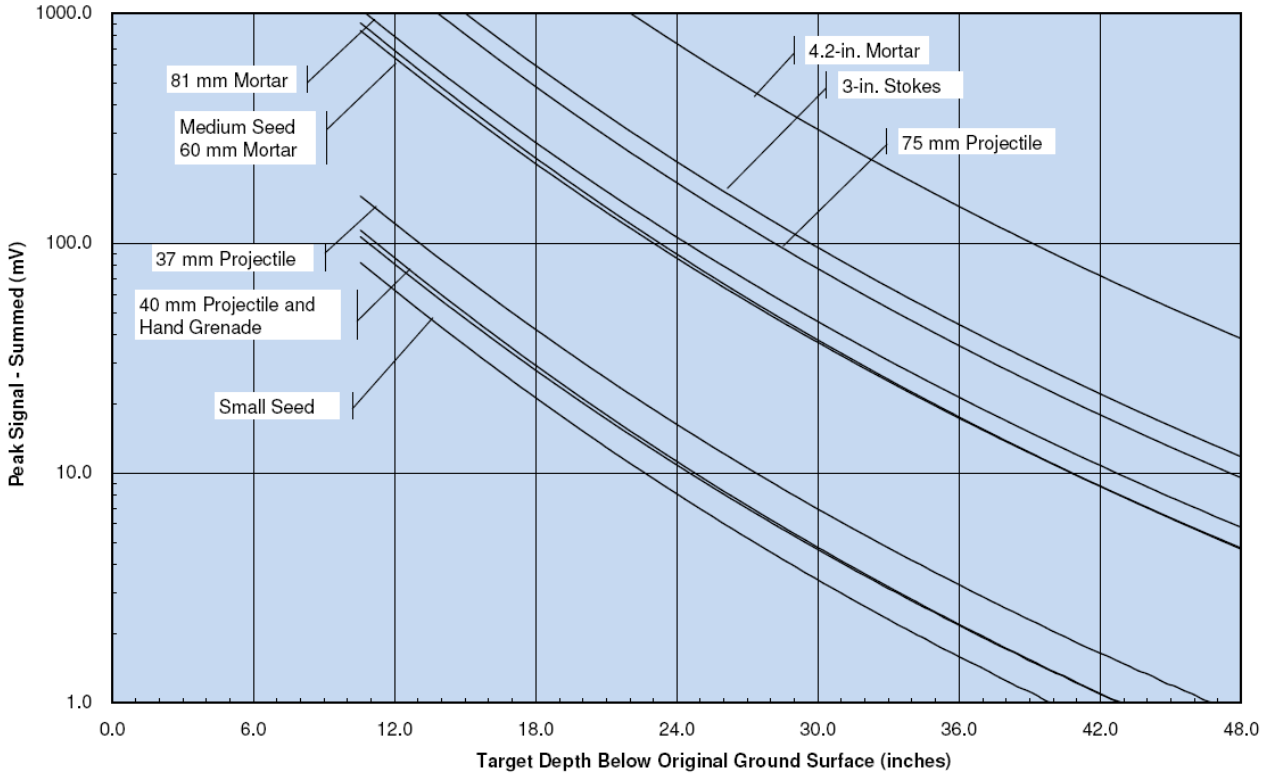
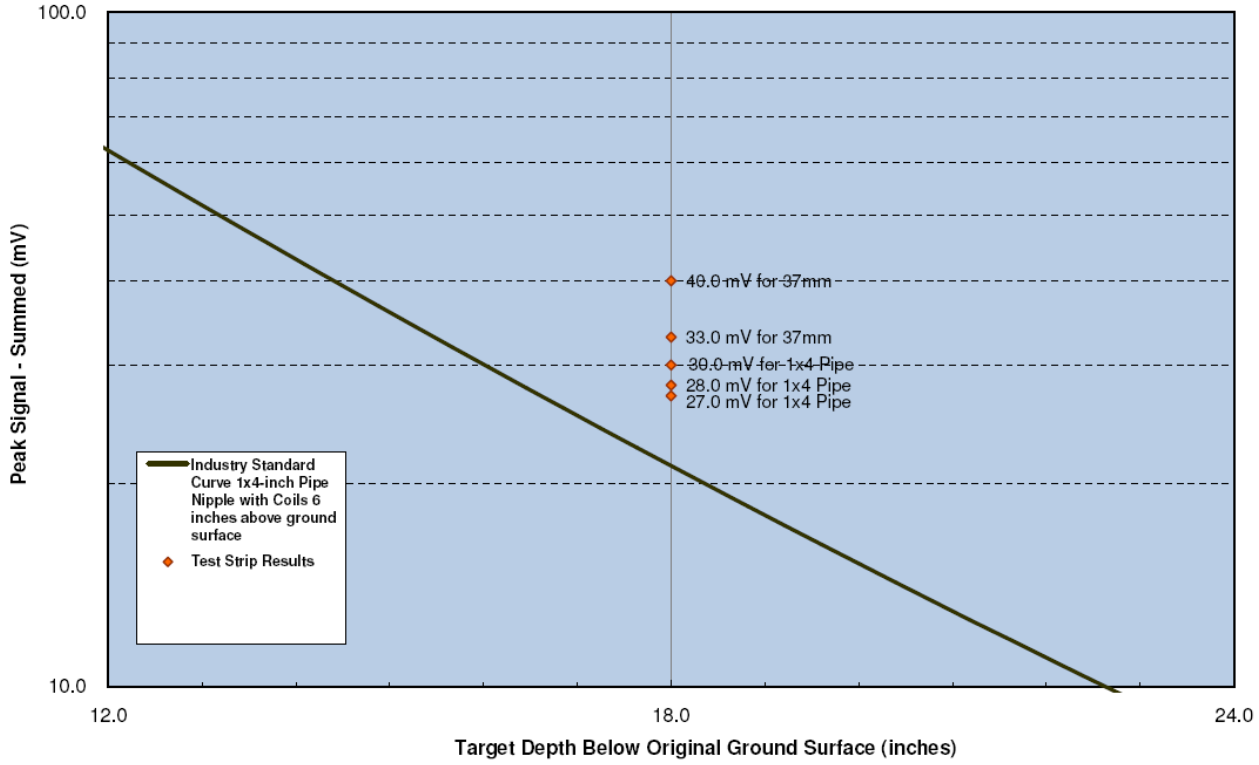


Figure 4 shows the industry standard curve for the signal response for the proposed industry standard target (1- by 4-inch pipe nipple), and compares the lower limit of the proposed industry standard target as the curve and the actual signal response values for the FORA ESCA Sled at the test strip described above. This

comparison shows that the target selection threshold of 20 mV is conservative and test strip anomalies having a higher response than the lower limit of the proposed industry stand target.

Figure 4 - Sensor Response Curve Comparison
Proposed Industry Standard Target (1x4-inch Pipe Nipple) to RQA Test Strip Results



Geophysical Test Plot Conclusions and Recommendations

The conclusions and recommendations for the two GTP demonstrations conducted for the RQA Pilot Study include:

- The positioning of the EM61-MK2 coils at approximately 20 cm above ground surface on the FORA ESCA Sled is optimal for use during the RQA Pilot Study
- System is validated by successfully achieving the MEC Detection metric
- The selected threshold exceeds the Final Group 1 Remedial Investigation/Feasibility Work Plan objective of detecting a 37 mm projectile at 12 inches bgs (ESCA RP Team 2008d) and meets the RQA Pilot Study objective of detecting a 37 mm projectile at 18 inches bgs
- The results of surveys at Test Plot 1 and Test Strip provide information about the performance of the reconfigured array. In addition, seeding using proposed industry standard targets are appropriate for use in the RQA Pilot Study DGM survey areas to check sensor performance during production surveys. The concept of the physics-based approach is to capitalize on the known performance of geophysical sensors being used under an approved work plan and monitor the entire mapping effort.

References

Environmental Services Cooperative Agreement Remediation Program Team (ESCA RP Team). 2008a. Final Addendum to the Final OE-15SEA.1-4 Site-Specific Work Plan, Phase II Seaside Munitions Response Area (MRA) Removal Action, Former Fort Ord, Monterey County, California. January 24.

———. 2008b. Final Geophysical Test Plot Report, Phase II Seaside Munitions Response Area Removal Action, Former Fort Ord, Monterey County, California. June 5.

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———. 2008d. Final Group 1 Remedial Investigation/Feasibility Study Work Plan, Seaside Munitions Response Area and Parker Flats Munitions Response Area Phase II (Volumes I and II), Former Fort Ord, Monterey County, California. December 17.