CH2MHILL

CA Department of Toxic Substances Control

Geophysical Classification at Former Camp San Luis Obispo

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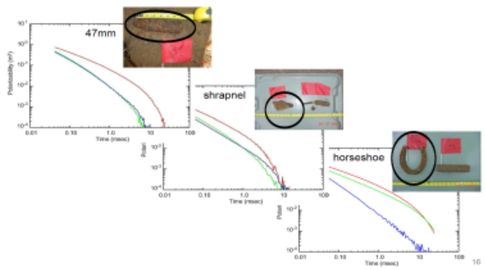
Goals of Presentation

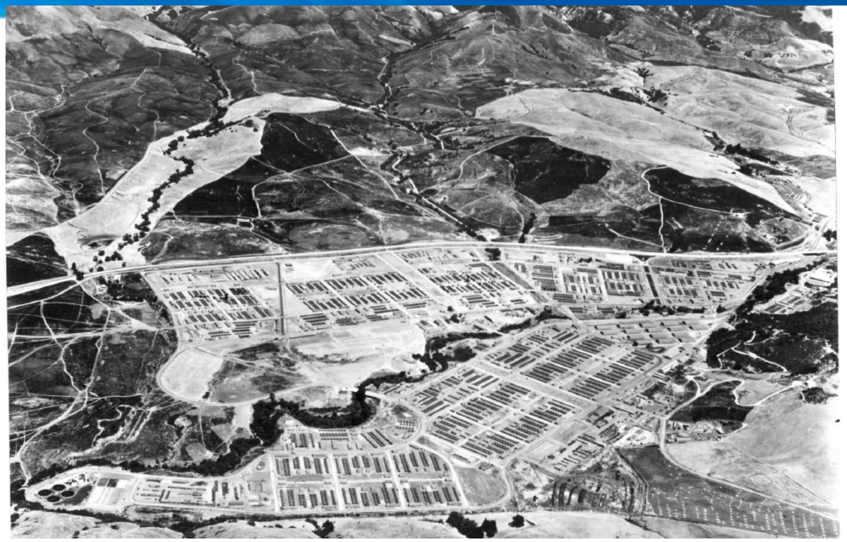
Present the Geophysical Classification Treatability Study at San Luis Obispo

- Planning phase
- Detection phase
- Classification phase
- QC challenges
- Lessons Learned



Site History

- 14,959 acres
- Surface sweep in 1946
- Preliminary Assessment (PA) in 1986 and 1993
- Time-Critical Removal Action (TCRA) in 1992 on a portion of MRS-01/02
- Archive Search Report (ASR) in 1994
- Supplement to the ASR in 2004
- Draft Preliminary HRR in 2006
- Site Inspection in 2007
- ESTCP Wide Area Assessment (WAA) in 2009;
- TCRA in 2010 on a portion of MRS-05
- Remedial Investigation and Feasibility Study in 2013 (report currently under review)
- MRS-01,MRS-02 53 Acres
- MRS-05 2,500 Acres



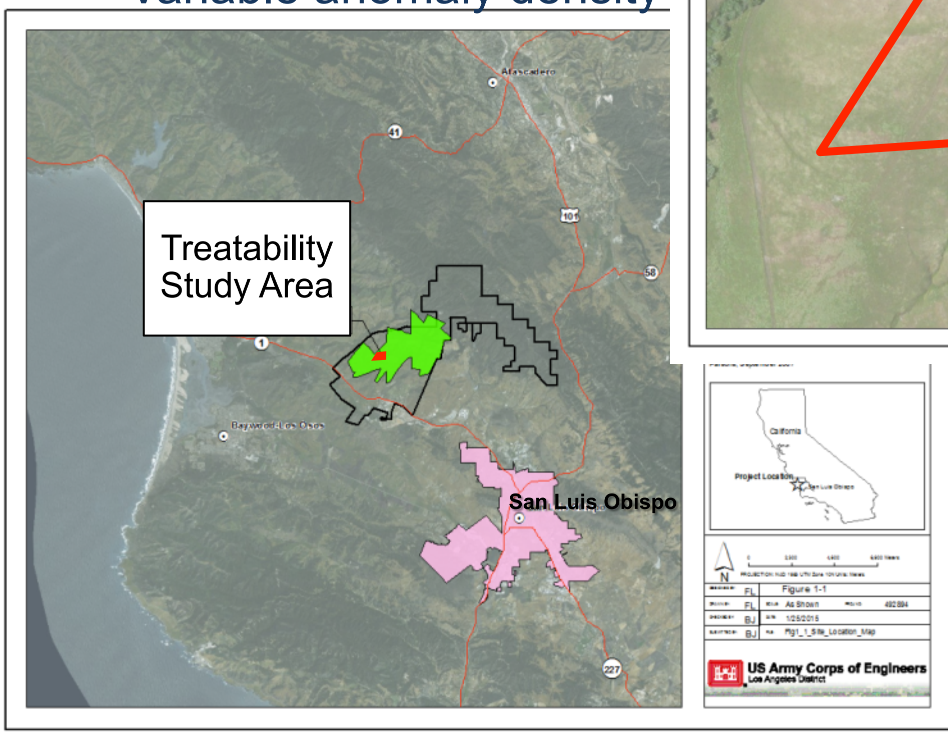
Remedial Investigation Munitions Items

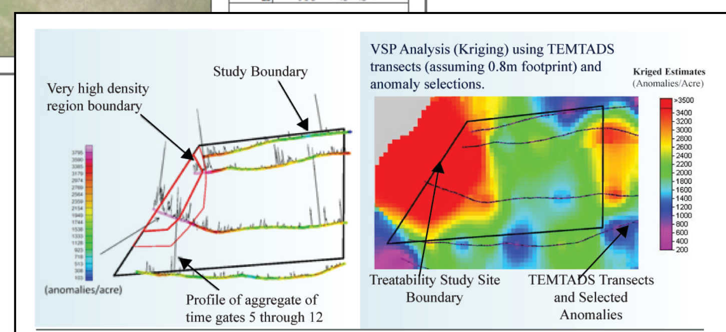
Item Identification	Quantity
2.36-inch rocket warhead	2
M43, 81 millimeter (mm) High Explosives (HE) mortar	3
MK3, 4.5-inch HE Barrage Rocket (BR)	1
M38, 37mm Low Explosive (LE) projectile (practice)	2
2.36-inch High Explosive Anti-Tank (HEAT) rocket	1
M38, 37mm HE projectile	1
M49, 60mm HE mortar	1
MK3, 4.5-inch BR fuze (MK145 w/booster)	1
M1, practice mine w/spotting charge	1
M485, 155mm illumination projectile	1
M64, 75mm white phosphorus (WP) or sulfuric oxide smoke mixture projectile	1*
3-inch Stokes mortars	18*

Project Description

Treatability Study

- 7 acres
- Hill-side
- Grassland
- Variable anomaly density

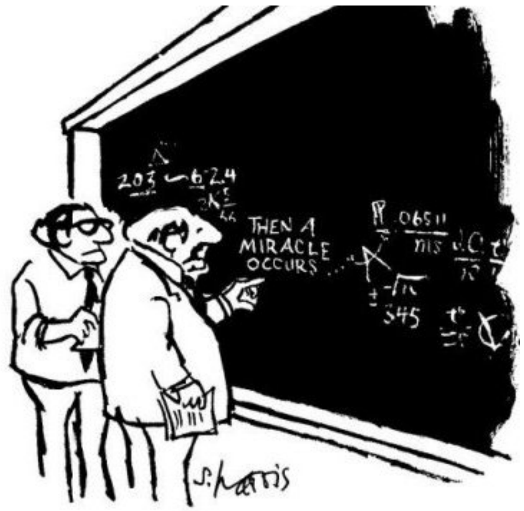




Project Planning:

Extensive and inclusive planning process:

- USACE Project Team (John Jackson, Andy Schwartz, Lloyd Godard, B.J. Allen, …)
- ESTCP (Herb Nelson, Anne Andrews)
- DTSC (Ed Walker, Roman Racca, Jim Pastorick)
- Cal Poly, SLO (Dave Ragsdale)
- Cal Fire - San Luis Obispo Unit (Laurie Donnelly)
- Acorn SI (Tom Furuya)
- CH2M HILL (George DeMetropolis, Tamir Klaff, David Wright)
- EDQW Advanced Geophysical Classification Subgroup (Jordan Adelson, Ed Corl, Carla Garbarini)



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Project Planning:

SLO Quality Assurance Project Plan (QAPP)

- A forerunner to the Geophysical Classification for Munitions Response (GCMR) QAPP Template
- Detailed plans guiding:
  - Project Objectives
  - Measurement Quality Objectives
  - Responses to QC Failures
  - Reporting Requirements
- An important planning tool

Treatability Study Objective

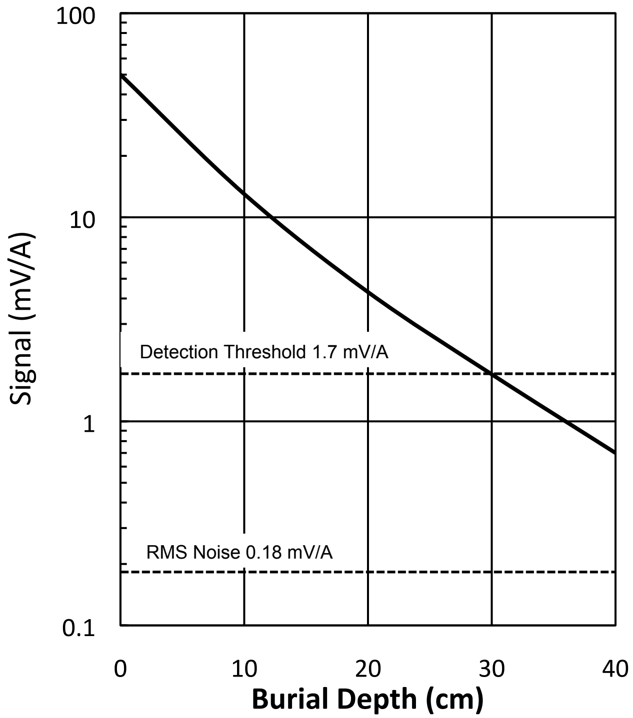
The overall objective of the treatability study is to **evaluate the Geophysical Classification process as an effective and efficient treatability option** for potential future removal actions at the former SLO.

The Geophysical Classification goal is to recover all Targets of Interest (TOI) that can be detected using advanced EMI technologies while excavating the least number of non-hazardous items in the process.

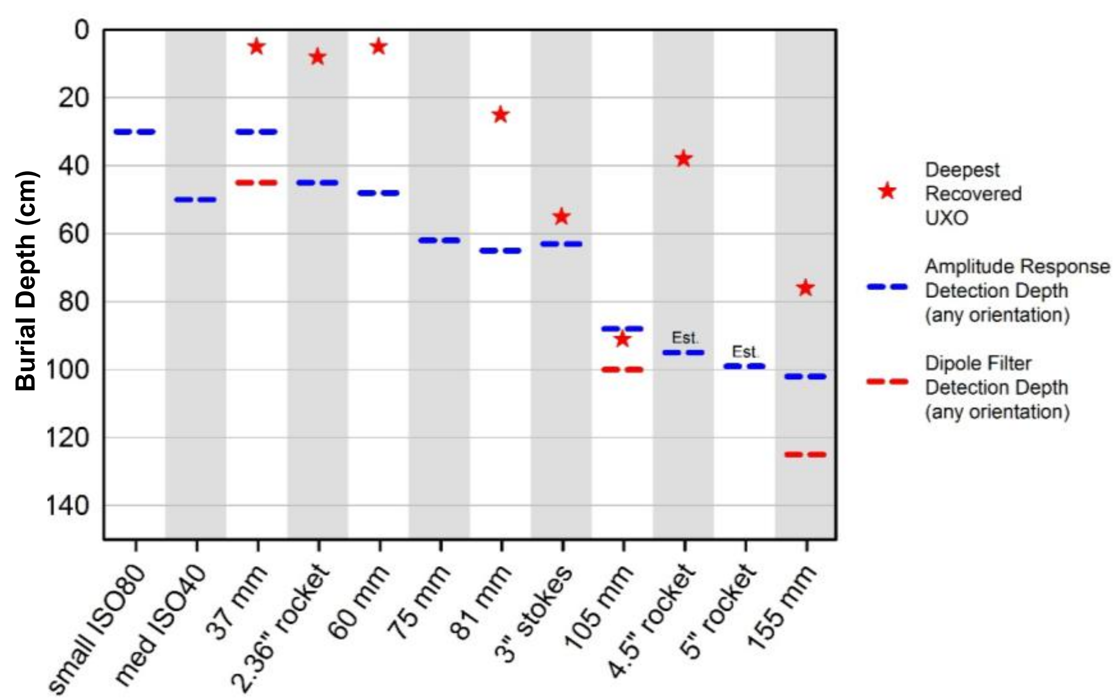
Treatability Study Detection Threshold

Detection Objective: equivalent of 37mm projectile at 30 cm (1.7 mV/A)

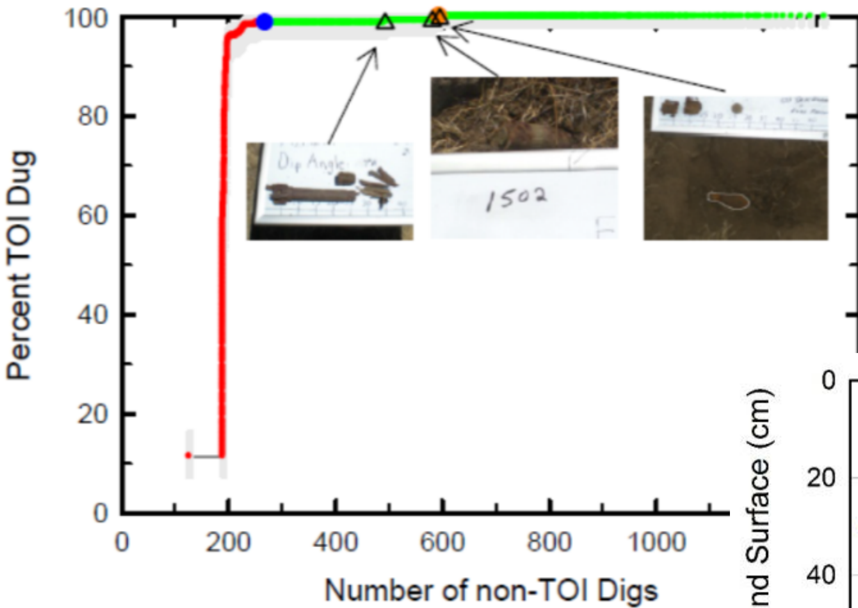
37mm Response Curve for
Dynamic TEMTADS 2x2
(0.137 msec Time Gate)



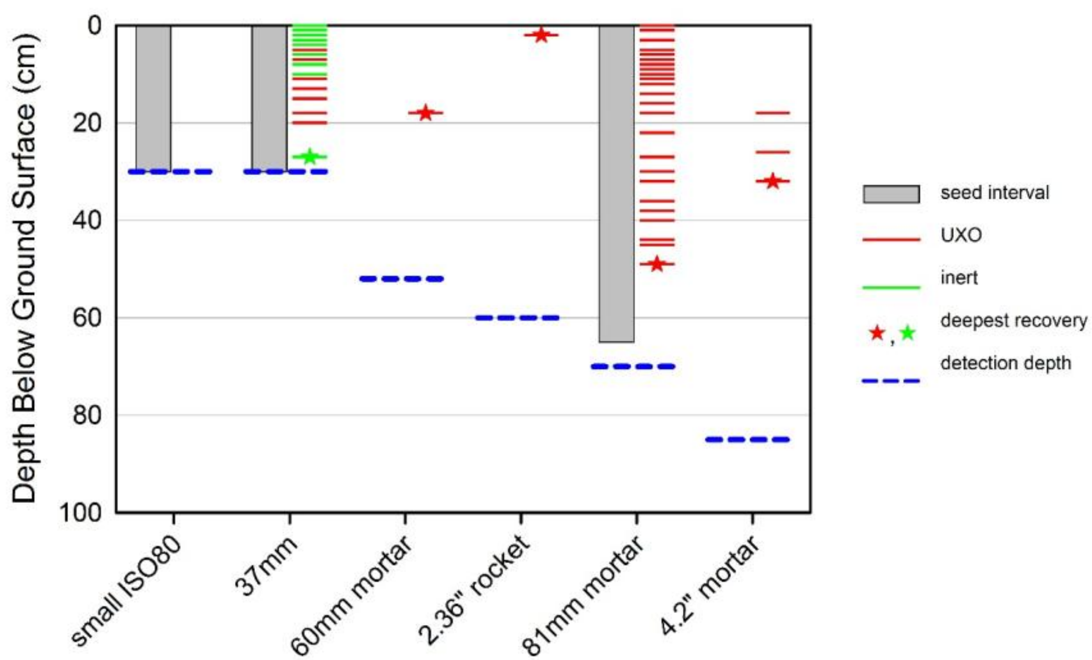
Detection Depth Predictions with
Conceptual Site Model Recovery Depths



QA Seed Plan



Percent TOI Dug
Number of non-TOI Digs
100
80
60
40
20
0
0
200
400
600
800
1000
1502



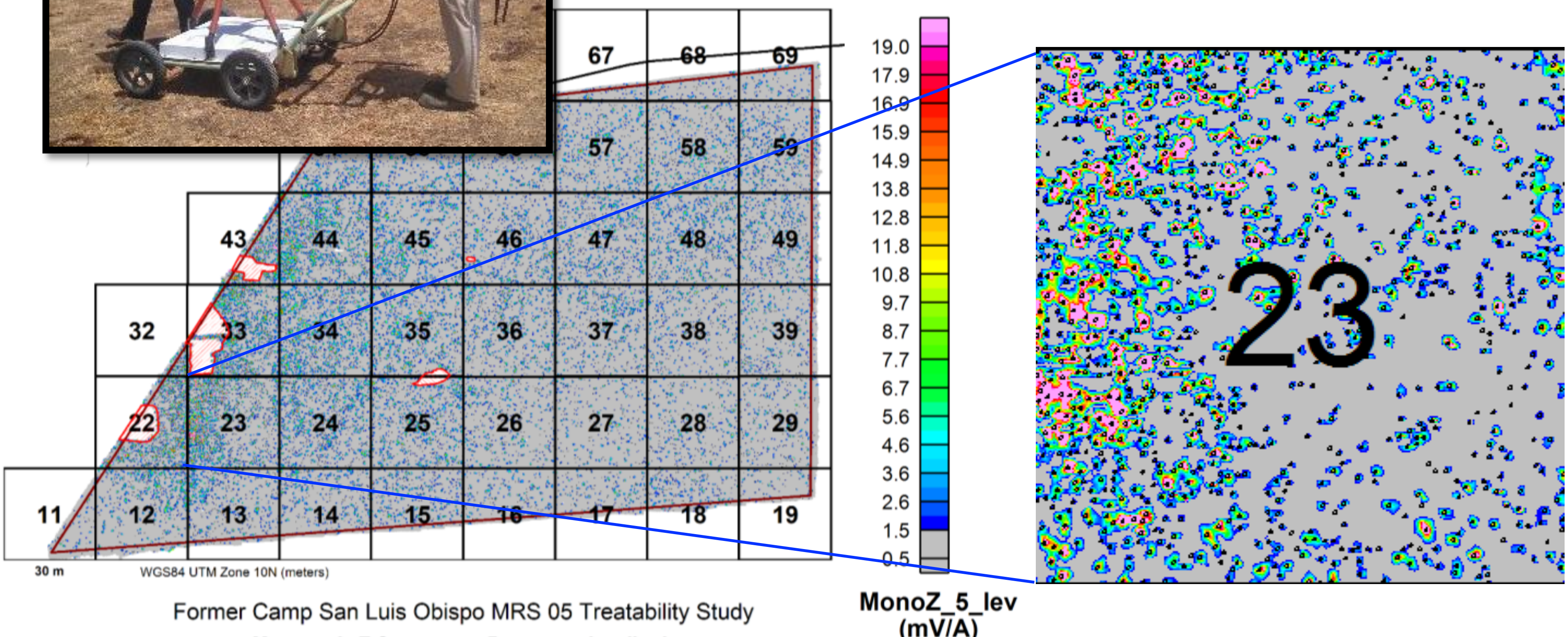
Depth Below Ground Surface (cm)
0
20
40
60
80
100
small ISO80
37mm
60mm mortar
2.36" rocket
81mm mortar
4.2" mortar
seed interval
UXO
inert
deepest recovery
detection depth

State Prospective on Project Management :

- QAPP Monthly project updates
  - Surface Sweep Memorandum (Compare against CSM)
  - QA Seed Plan / Blind Seeding Technical Memorandum (Agreement on quantity type and depth interval)
  - IVS Memorandum (Site Visit and Equipment Familiarization)
  - Submit Final DGM Data/Classification and Technical Memorandum (Technical Review of Project Specific Detection and Classification Process)
  - Provide Final TOI and non-TOI database and Technical Memorandum
  - Final Verification Plan (check all decision points and select additional targets to build stakeholder confidence)
  - Investigation Results Technical Memorandum

Detection Survey

Amplitude Response Detection Threshold
1.5 mV - >18000 anomalies

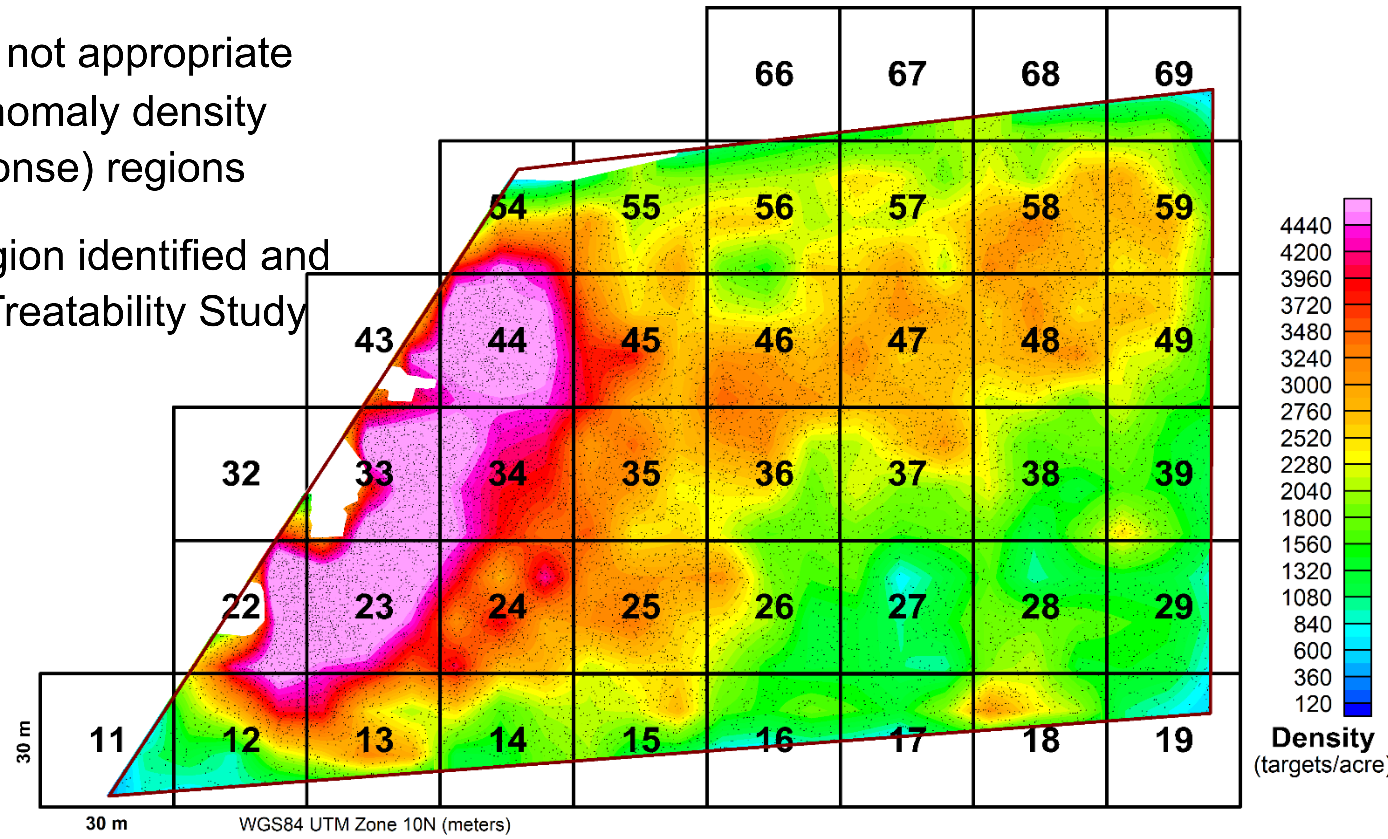


Former Camp San Luis Obispo MRS 05 Treatability Study
Monostatic Z Component Response Amplitude

Detection Survey

High Target Density Regions

- Classification is not appropriate for very high anomaly density (saturated response) regions
- High density region identified and excluded from Treatability Study



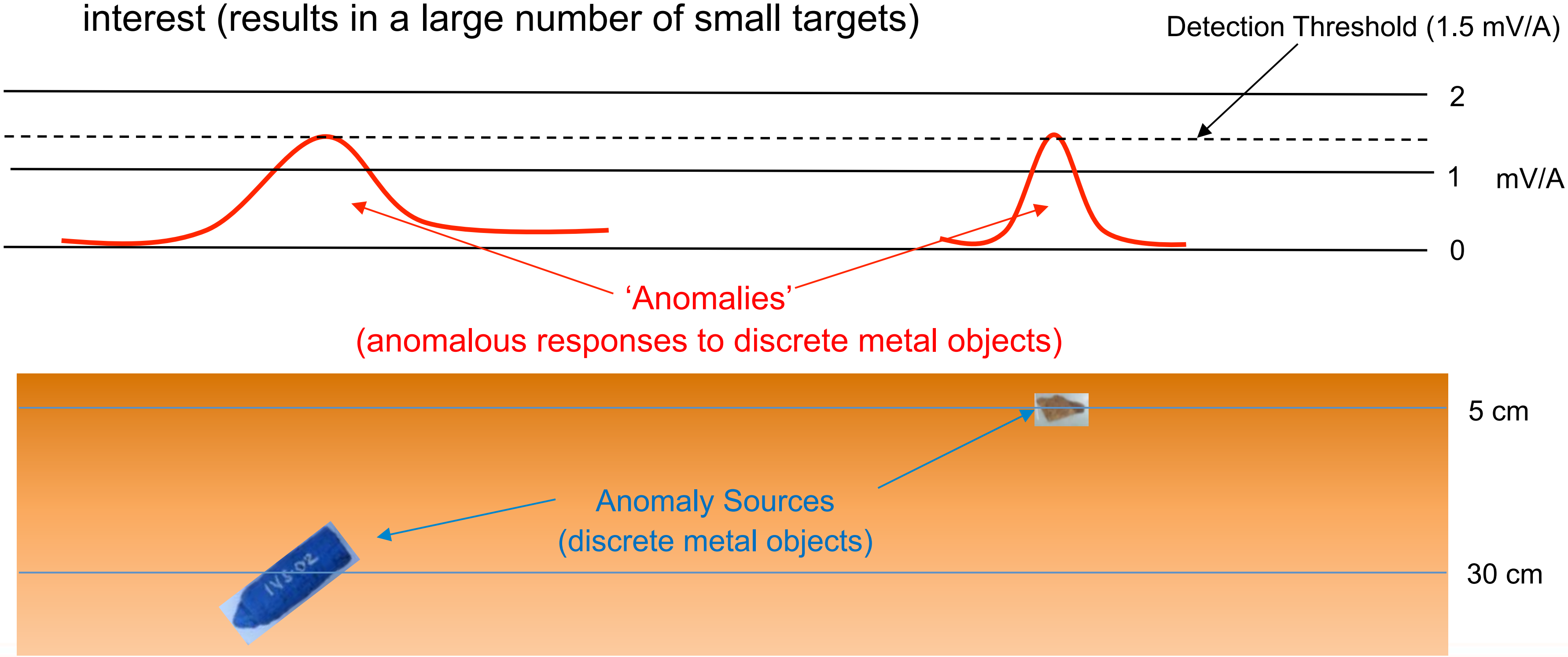
Former Camp San Luis Obispo MRS 05 Treatability Study

Response Amplitude (>1.5 mV/A) Target Density

'Amplitude Response' Target Selection

Amplitude Response:

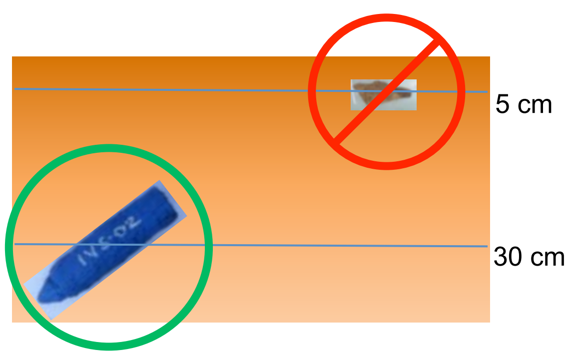
- Uses only Z component, monostatic data (analogous to EM61)
- Selects all anomalous responses > detection threshold - therefore must select shallow small targets to capture deeper targets of interest (results in a large number of small targets)

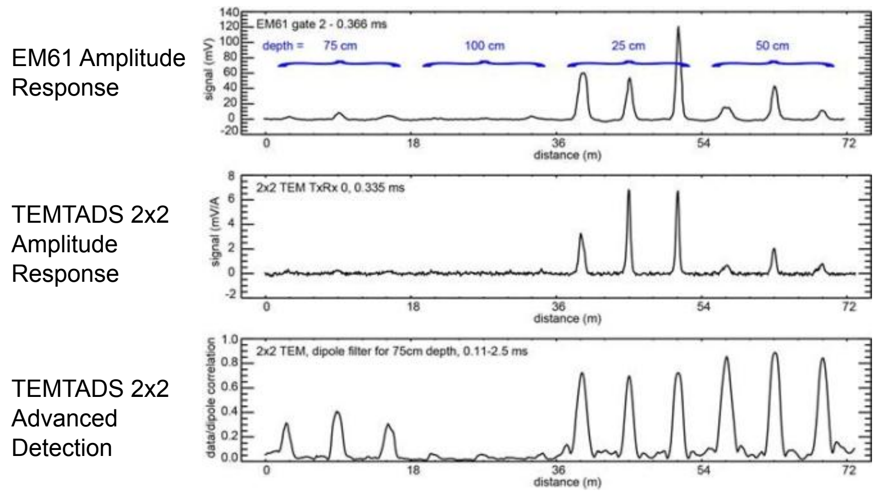


‘Advanced Detection’ vs ‘Amplitude Response’ Detection

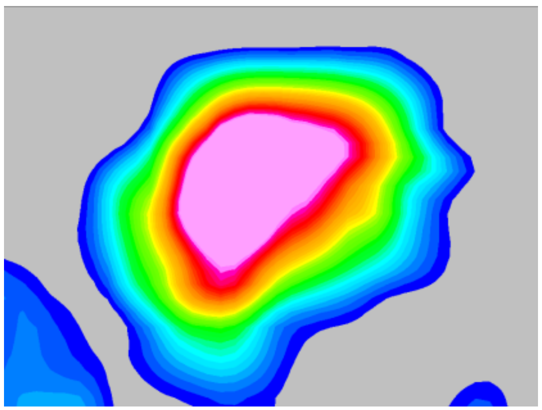
Advanced Detection:

- Uses all 48 Tx/Rx pairs – much richer data set
- Extracts basic features (size, wall thickness) related to source(s) of anomaly
- Selection based upon source features (not anomaly features) – shallow sources too small to be TOI are not selected



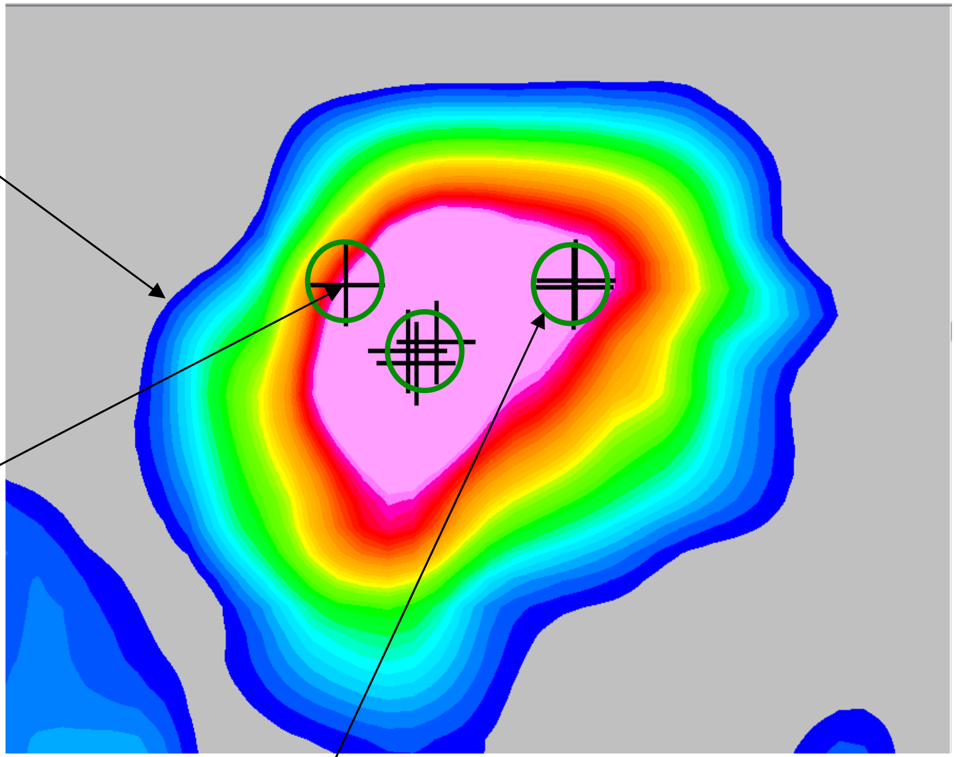


Step 1: Moving window dipole filter (Dipole Fit Coherence is initial ‘detection metric’)



‘Advanced Detection’ Target Selection

Step 1: Initial Dipole Fit
Coherence detection

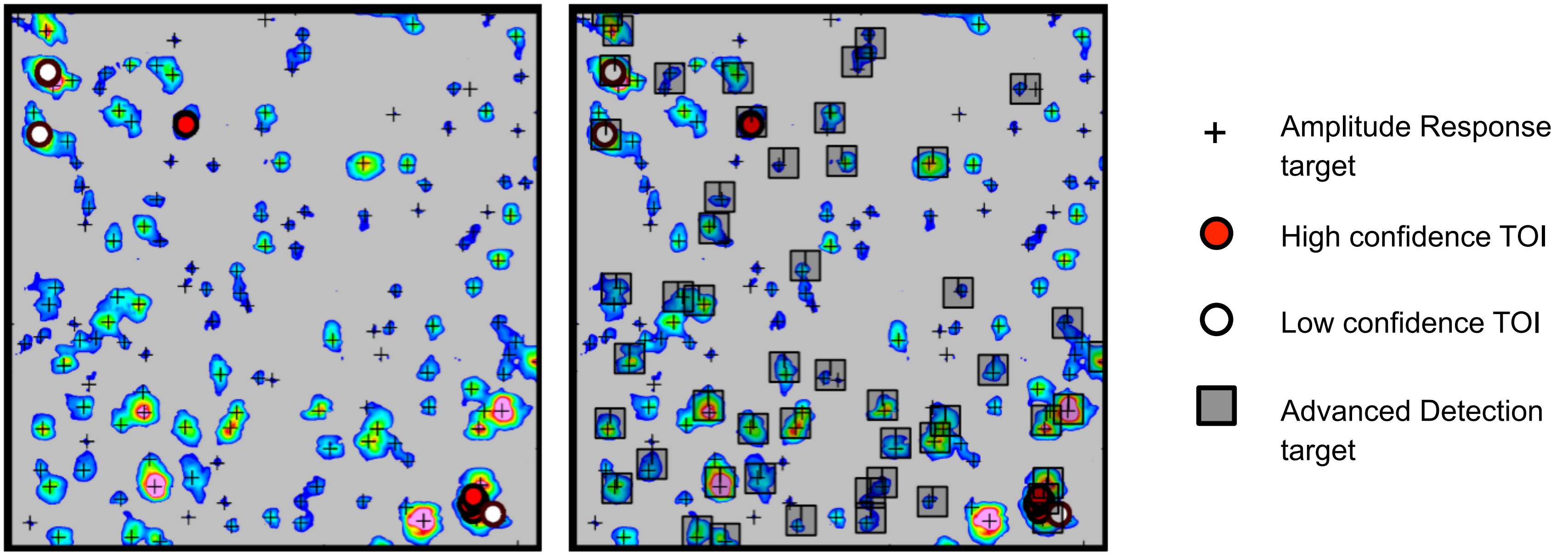


Step 2: 1, 2 and 3 source dipole fit routines to identify all potential sources (‘+’ symbols) and their features (size, wall thickness) within ‘dipole detection area’

Step 3: Merge co-located sources to reduce duplicates to get final ‘Advanced Detection’ targets (‘O’ symbols)’

‘Advanced Detection’ Validation Results

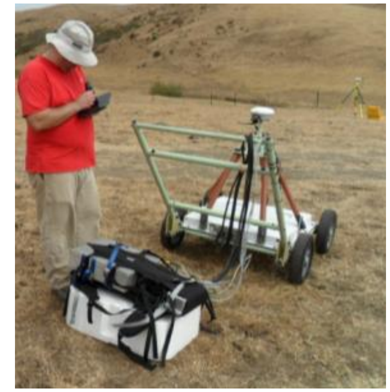
- 8 Subset grids selected – cued TEMTADS collected and analyzed for all ‘Amplitude Response’ targets.
- All potential TOI targets identified were also selected using ‘Advanced Detection’
- Factor of 3 reduction of targets requiring cued investigation



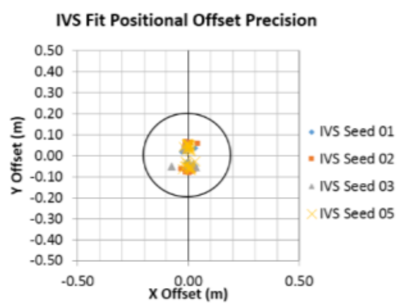
Grid 57: 2 high confidence TOI and 3 low confidence TOI (left panel) covered by advanced detection selections (right panel).

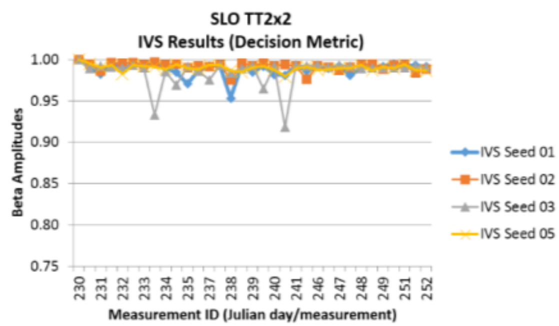
Cued Investigations

- > 6000 Cued investigations performed between July 14 and September 12, 2014
- Two TEMTADS units were used
- Daily QC included IVS testing and system function tests:



System 2





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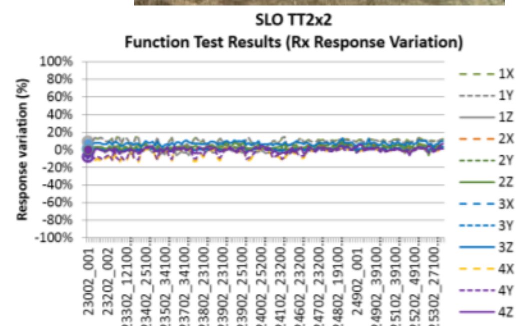
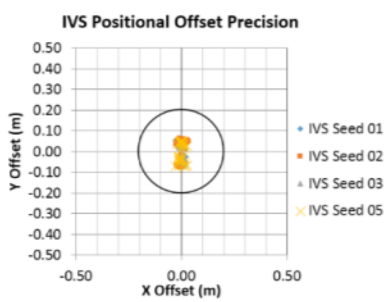
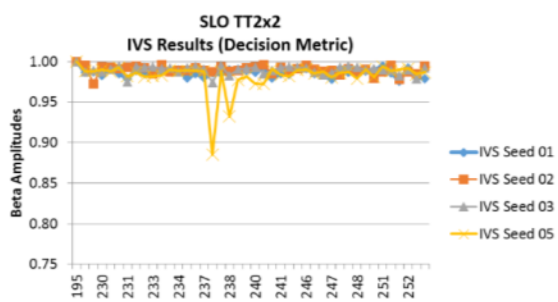


System 4





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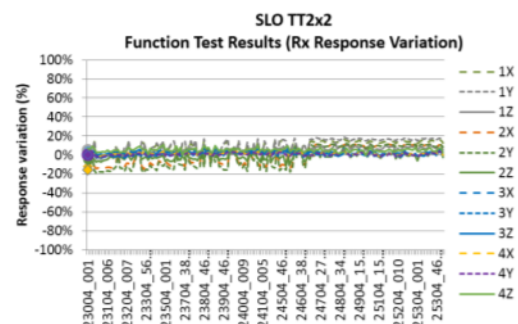
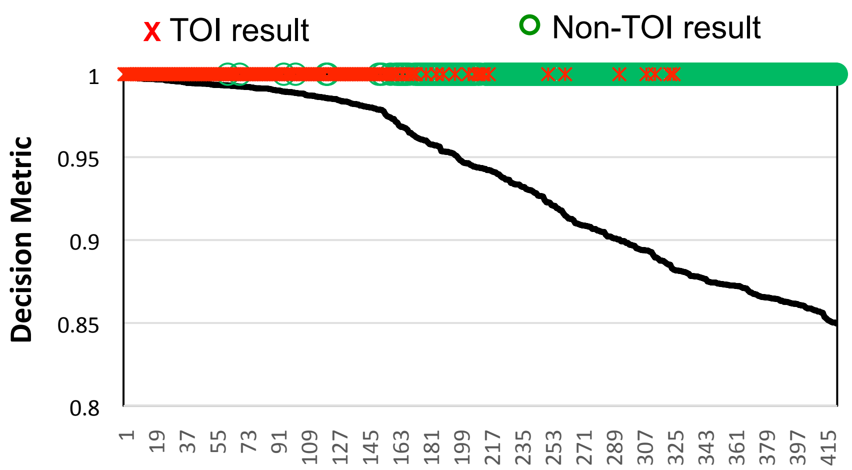
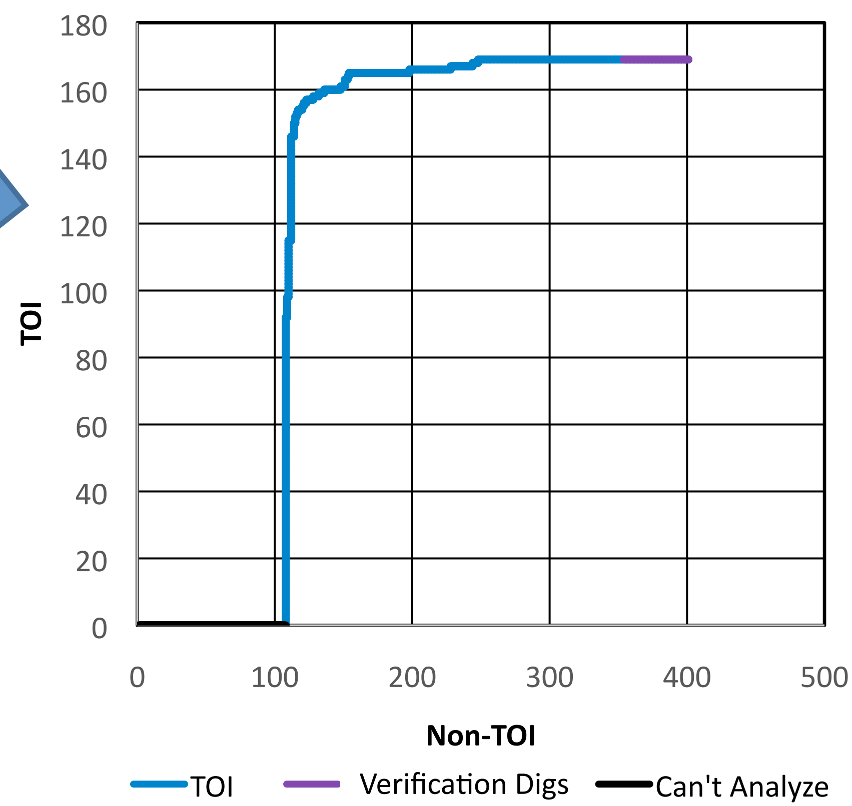


Classification Results

Dig Results with Decision Metric (library match coefficient)



SLO Partial ROC Curve with Threshold Verification Results

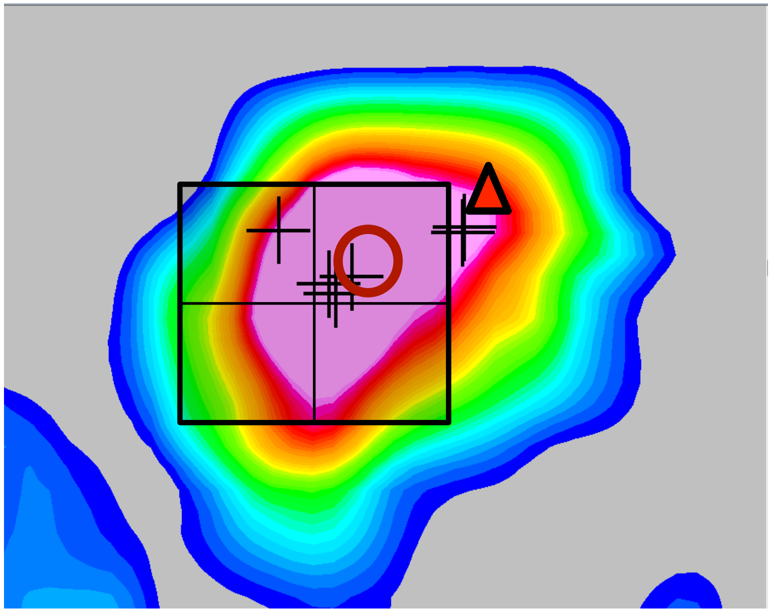


- 6,413 cued investigations
- 575 excavations (plus training digs)
- 169 TOI recovered (two native)

QC Challenges

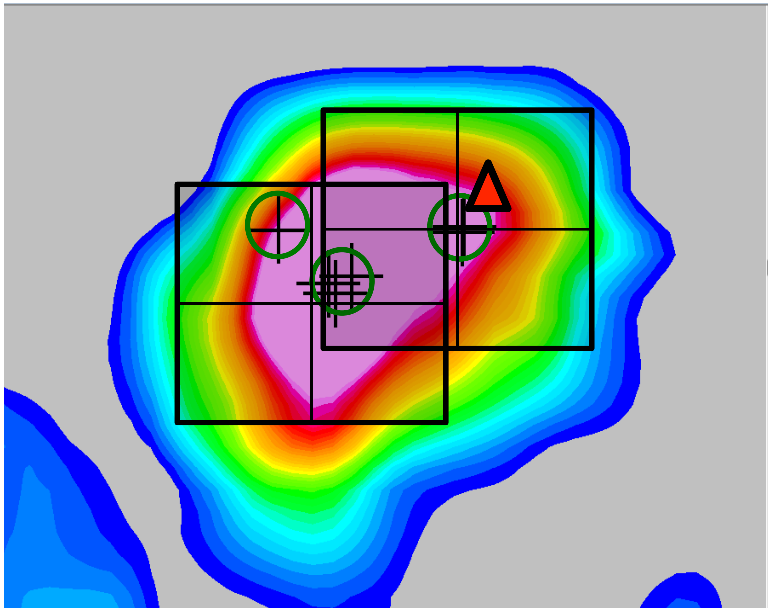
QC Seed not identified as a TOI (caught with internal QC processes)

Root Cause Analysis (RCA)



- Detection (merged target O) was within 0.4 m MQO of seed location
- Array was within 0.2 m MQO of detection location
- Merge using 0.4 m put target location too far from source

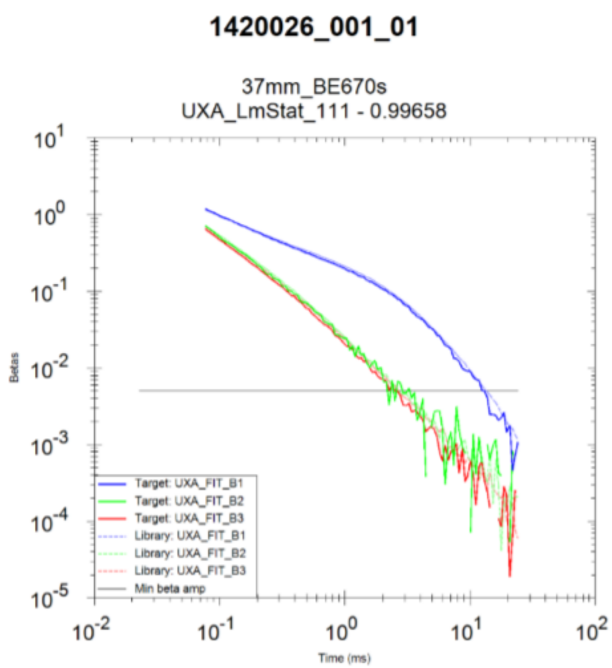
Corrective Action (CA)



- Re-merged sources using 0.2 m (O's)
- Recollected data over any remerged targets not within 0.4 m of center of array

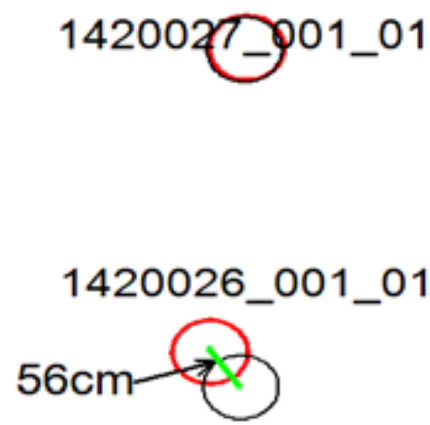
QC Challenges

- QA Seed not recovered during intrusive investigation
  - Caught by internal QC check of dig results vs classification prediction



Root Cause Analysis (RCA)

Imprecision in placement of re-acquisition flag put the seed outside of the 0.4 m dig radius

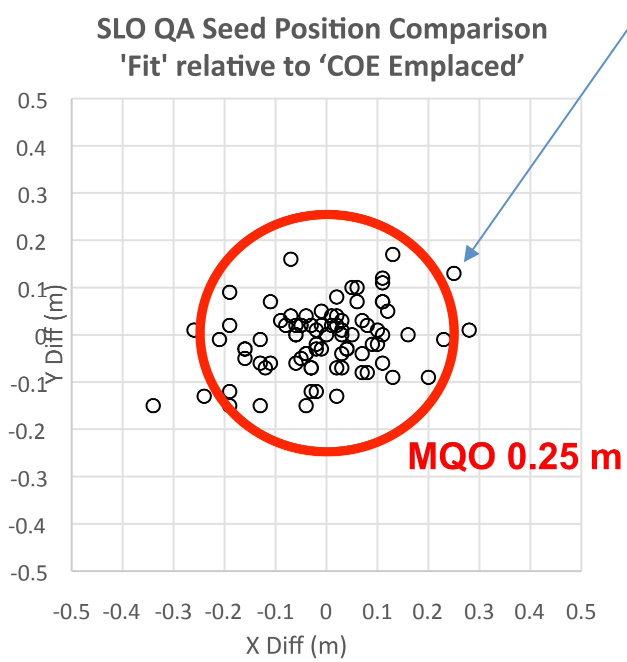


Corrective Action (CA)

Review of recorded flag locations and re-investigation of locations where flag location was greater than 0.15 m from fit location

QC Challenges

Predicted QA Seed positions relative to ground truth do not meet project MQO

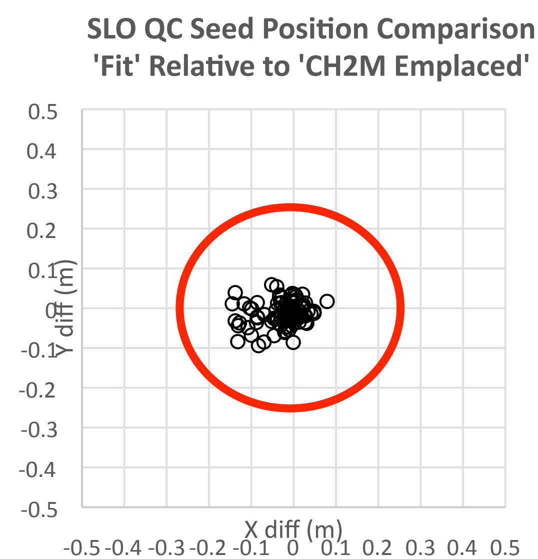


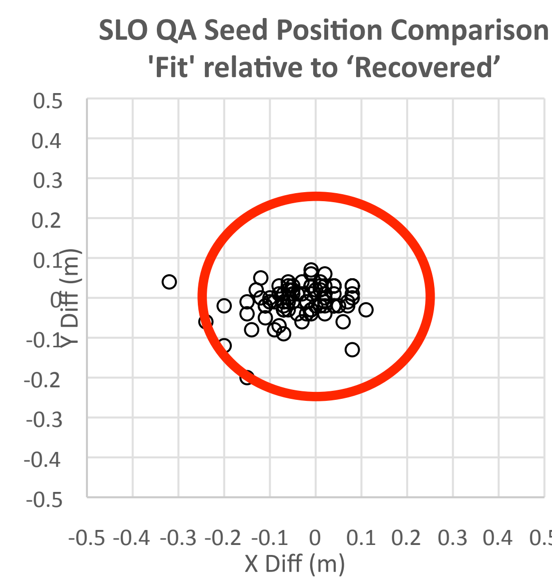
Root Cause Analysis (RCA)

Fit position vs QC seed ground truth and QA seed recovered positions suggests the problem is with the QA seed ground truth collected during emplacement.

An outlier remains when compared to recovered positions but that could be to imprecision in the recovery position measurement process.

Corrective Action (CA) – no immediate CA indicated, but needs to be captured in 'Lessons Learned'…





Lessons Learned

Positioning precision requirements are much more stringent for all phases:

- QC/QA seeding*
- Dynamic data collection
- Target reacquisition for cued investigations
- Cued investigations
- Target reacquisition for intrusive investigations*

* These tasks are often done by personnel not involved in classification – must be retrained

Lessons Learned

Intrusive Investigation might require a separate m

de-mob for 'Analyst Calibration' digs

- Analyst Calibration digs (training digs) are used to finalize the site specific library as well as calibrate the final dig/no-dig threshold.
- The dig program can move through the 'high confidence' TOI digs before the analysis determining the final prioritized list is finished
- 'Haste makes waste'… and mistakes!

Lessons Learned

Early and detailed involvement of all interested parties is a blueprint for success

Early involvement provides a comfort level with the technology and processes.

QC issues are inevitable – communication and transparency of process are critical for buy-in of interested parties

Questions??