Applying Advanced Geophysical Classification Technology to Remedial Investigations and Feasibility Studies

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ESTCP MR-201232 – Classification as part of RI/FS demonstrated at three sites:

- Former Motlow Range

- Hawthorne Army Depot

- Pueblo Chemical Depot

Former Motlow Range Complex - Tullahoma, TN

- 3,646 acres – western artillery firing range for former Camp Forrest

- Suspected munitions for demonstration area:
  - 37mm, 105mm, 155mm projectiles
  - 60mm, 81mm, 3in Stokes mortars
  - 2.36in rockets

- Broken up into 3 areas:
  - Area 1 – Prior Removal Action Areas. MEC may have been present but has now been removed
  - Area 2 – Former Range and Firing Points. Strong evidence of prior munitions use so MEC potential present
    - 2a – possible impact areas
    - 2b – possible firing points
  - Area 3 – Buffer Areas and Small Arms Ranges. Minimal/no evidence of MEC

- Cued TEMTADS collection performed primarily in Area 2a, where highest MEC density was expected

- Over 49mi of EM61 transects collected for anomaly density, then grid collection in HD areas. EM61 used for detection surveys for 6.5 acres of grids
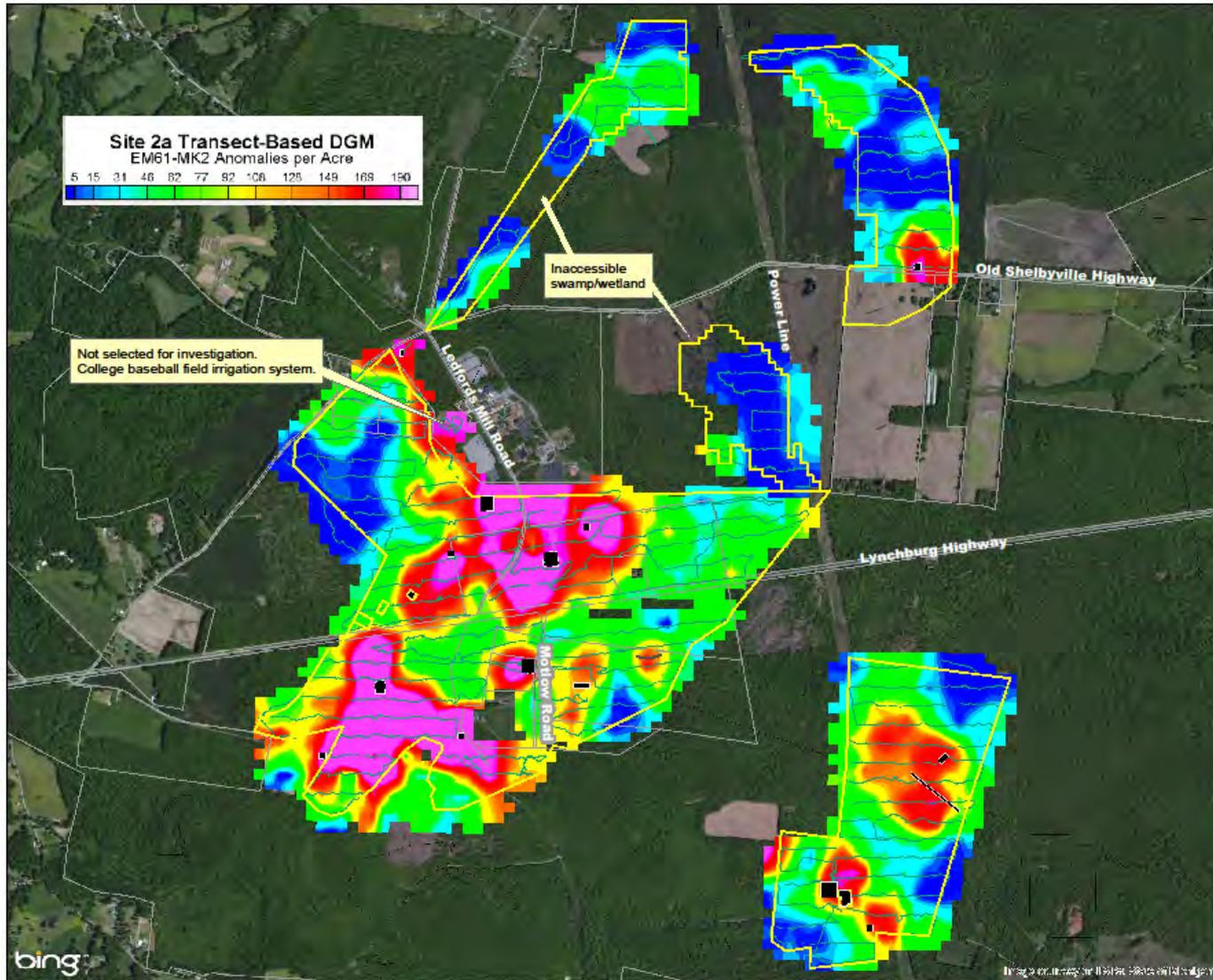
- 37mm projectile – smallest munition of concern

Figure 5.1

Investigation Area 2a
Anomaly Density
Formerly Used Defense Site
Motlow Range
FUDS Project # G04TN019506
Tullahoma, TN

Legend

Area 2a Investigation Area

DGM Transect

Intrusive Grid Location*

Parcel Boundaries

Note = * Intrusive grid locations placed within the high density areas based on discussions with USACE geophysicist

Site 2a Transect-Based DGM
EM61-MK2 Anomalies per Acre
5 15 31 46 62 77 92 108 125 149 169 190

Inaccessible swamp/wetland

Not selected for investigation. College baseball field irrigation system.

Old Shelbyville Highway

Power Line

Ledfords Mill Road

Lynchburg Highway

Motlow Road

N

Projection: Tennessee State Plane, NAD83, Feet

1,500   750   0   1,500   Feet

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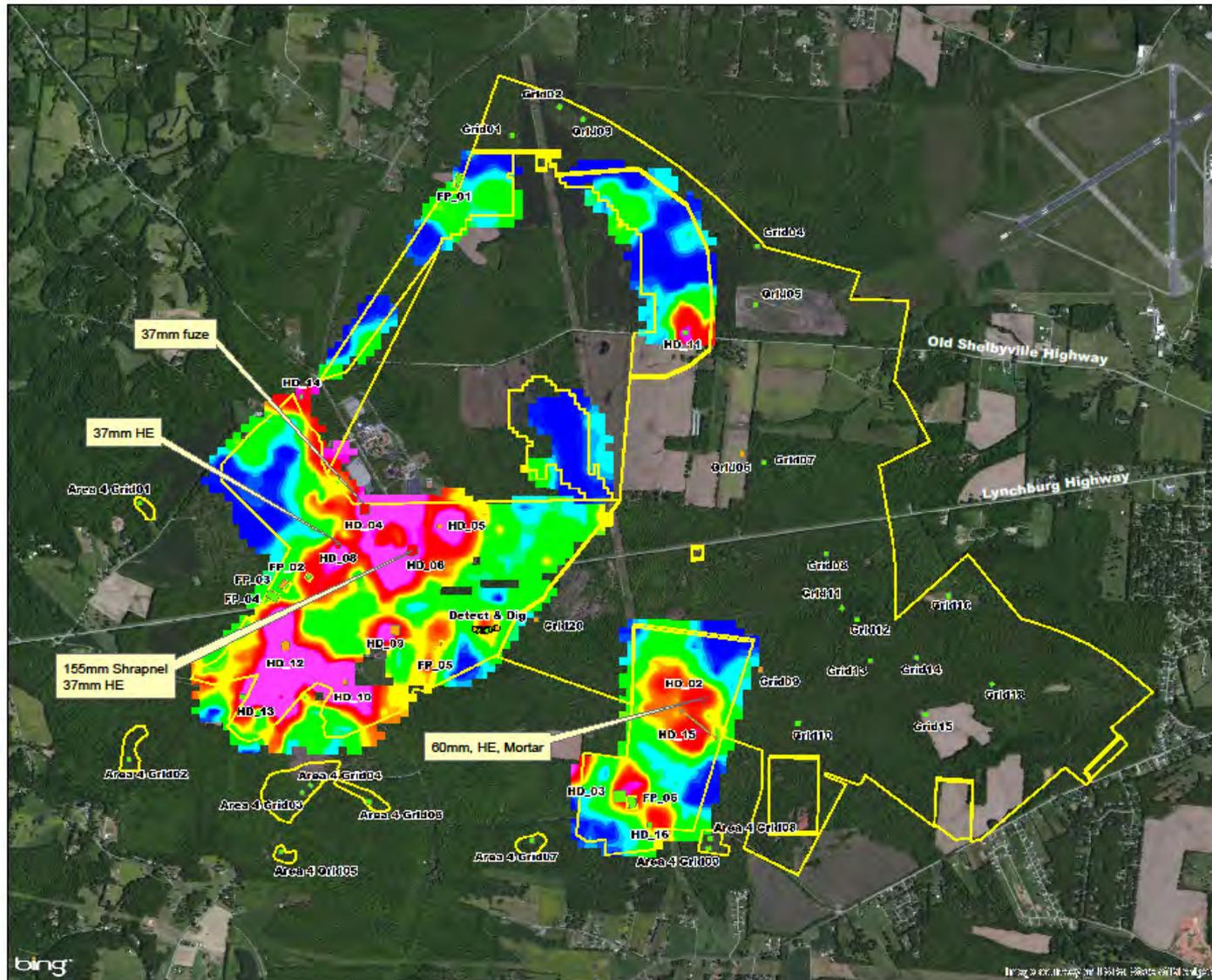|	
DESIGNED BY: CR	Motlow Range
DRAWN BY: CR	
CHECKED BY: CtB	SCALE: As Shown PROJECT NUMBER: 748683
SUBMITTED BY: CtB	DATE: Sept. 2013 PAGE NUMBER:
	FILE: S:\ED\shared\Motlow\GIS\RI Report \Fig5_1_Grid_Results.mxd

Figure 5.2

**Anomaly Intrusive
Investigation Results
Formerly Used Defense Site
Motlow Range
FUDS Project # G04TN019506**
Tullahoma, TN

Legend

Grid Data

- **MEC**
- **MD (no MEC)**
- **No MEC or MD found**

FP = Firing Point
HD = High Density

Projection: Tennessee State Plane, NAD83, Feet

1,500 750 0 1,500 Feet

Motlow Results

- **Aggressive List**
  - 312/903 (35%) marked as "dig", including 58/59 TOI
  - 70% reduction in clutter digs

- **Conservative List**
  - 417/903 (46%) marked as "dig", and 59/59 TOI
  - 57% reduction in clutter digs

- **6 MEC items recovered by dig teams**
  - 3) AP 37mm projectiles, 1) HE 37mm projectile, 1) 37mm projectile fuze
  - 1) 155mm shrapnel projectile
  - All except 37mm fuze considered TOI for project (too small to produce response that can be meaningfully inverted)

Motlow Lessons

- TEMTADS arrived damaged, diagnosis and replacement of transmitter took 6 days, requiring trip out to site from NRL personnel

- TEMTADS worked after repair, but was never 100% functional

- Very tight timeline to next assigned usage of sensor
  - First 81 flags were located with EM61 peak response. Remaining flags placed over picked EM61 targets to expedite reacquisition. Likely contributed to more anomaly recollection.
  - 903 instead of planned 1000 cued targets collected

- Working in growing wheat fields, flags were difficult to see to sensor operators

- One ROE revoked during intrusive operations
  - 794/903 targets were intrusively investigated

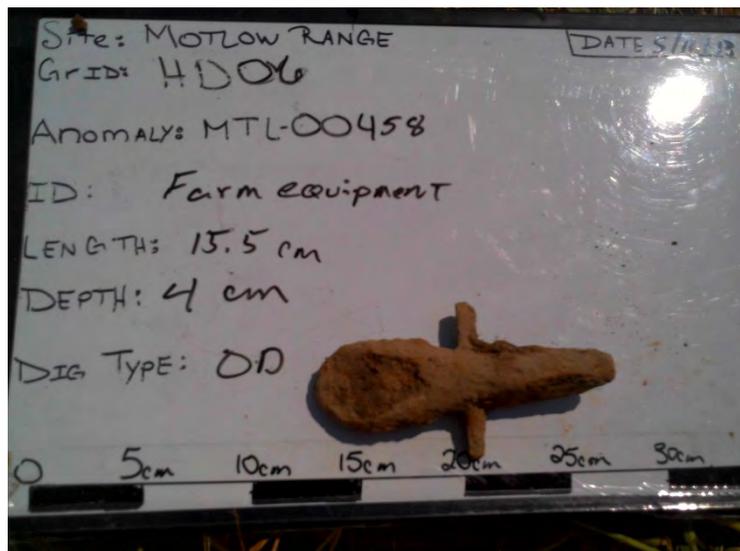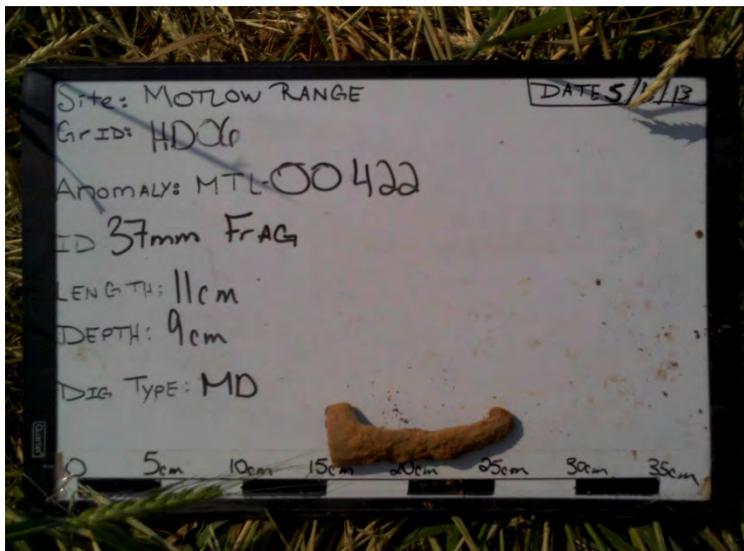- Some farm equipment debris similar in size to 37mm

Polarizability curves

Early time noise at beginning of curve was evident for the whole project. Display shows typical time gates used for TEMTADS processing
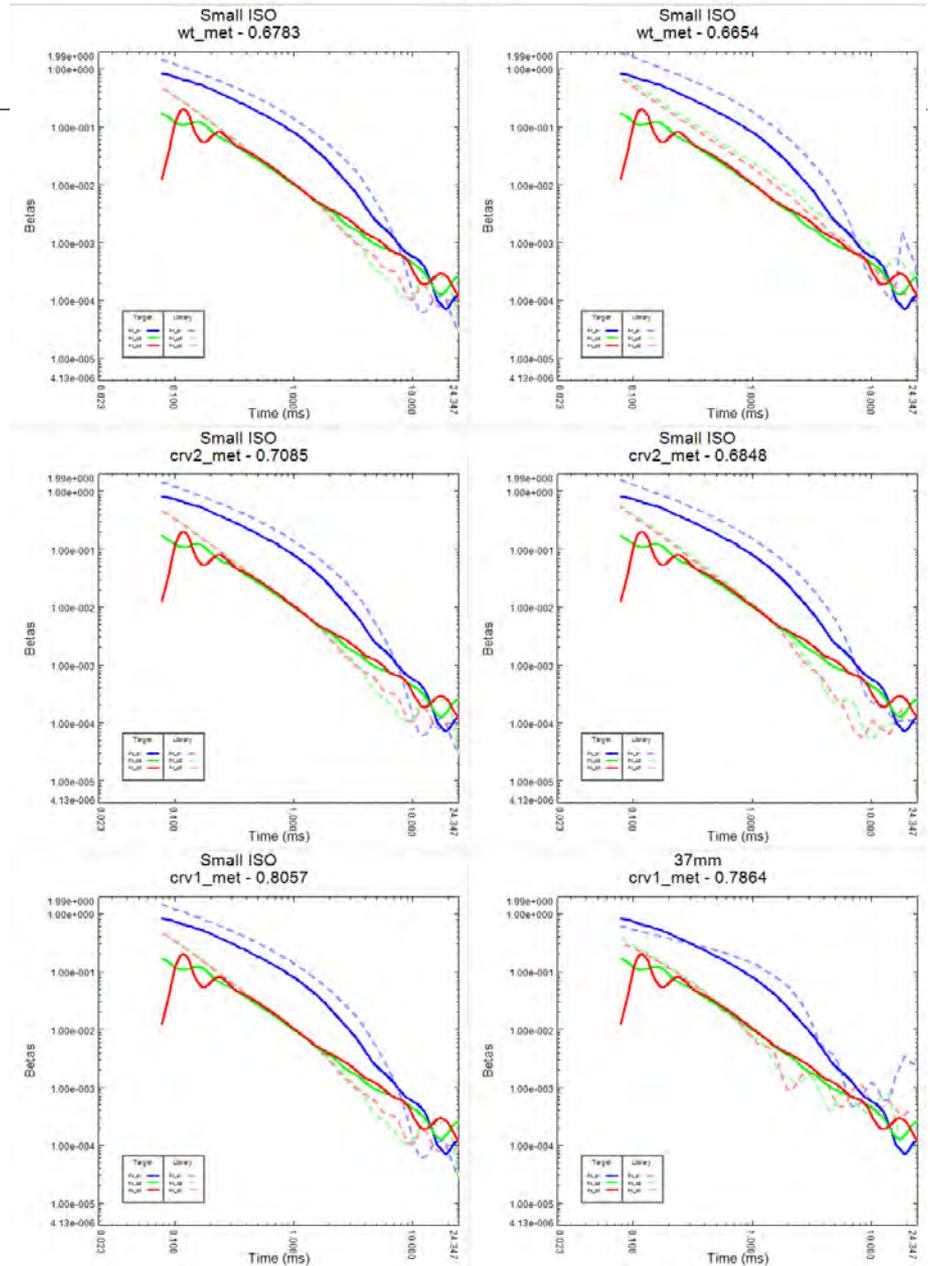
Where's the next flag?

361 pieces of MD and 686 pieces non-MD debris recovered

Motlow Conclusions

- TEMTADS deployed without IMU or GPS. We now use 40cm as a common metric for re-shots vs dynamically located data, RTK-GPS/RTS and IMU integrated into sensors

- Results less than stellar, but costs still projected to be reduced using advanced geophysical classification at Motlow vs a traditional removal action

  - Assumptions 65% reduction in digs on a 10,000 anomaly project – savings of 24%

Hawthorne Army Depot Walker Lake Land Test Range – Mineral County, NV

- 9,210 acres land and water MRS
  - Clearance in 1974 resulted in over 6,000 pieces of munitions debris and weighing over 75 tons

- Suspected munitions for MRS:
  - 2.25in, 2.75in, 3.5in, 4.5in, 5in, 7.2in rockets (of all types)
  - 2.25in rocket – smallest munition of concern

- Demonstration conducted in an area in the MRS immediately to the SW of the completed TCRA areas

- Dynamic and cued MetalMapper data collected. MM deployed on tracked skidsteer/trackloader

Figure 4.1

Proposed Demonstration Area
Walker Lake Land Test Range MRS
Hawthorne Army Depot

Mineral County, Nevada

Legend

- TCRA Work Area
- TCRA MEC
- TCRA Munitions Debris
- Walker Lake Land Test Range MRS Boundary
- High-Anomaly-Density Area
- Proposed Demonstration Area

Projection: UTM Zone 11N WGS84, Map Units in Meters
Background Image Source: Bing Maps Aerial, ©2010
Microsoft Corporation and its data suppliers

DESIGNED BY: BL			
DRAWN BY: BL		Hawthorne Army Depot	
CHECKED BY: GV	SCALE: As Shown	PROJECT NUMBER: 748974	
SUBMITTED BY: ES	DATE: July, 2013	PAGE NUMBER:	

Hawthorne Results

- 9 acres dynamic collection at 1 acre/day rate

- 1,800 cued targets at 225/day average rate (lowered by weather and hardware issues). 300-350/day for "good days"

- 72 seed items placed (medium and large ISOs, inert 2.75in warhead projectiles) and correctly classified as dig items

- 68/70 TOI classified correctly. Remaining 2 TOI digs were below depth of detection of 60cm
  - 5in rocket warhead at 100cm depth bgs
  - 2.75in rocket at 88cm bgs
  - These appeared as noise in the multi object solver
  - Likely masked by other smaller items above. Recovery positions were below target threshold, but could still be seen in dynamic detection data

- 374/409 non TOIs identified for 92% reduction in digs

Hawthorne Lessons

- Good terrain for MetalMapper, rolling sand/desert and some brush

- MetalMapper could detect some targets below 60cm depth bgs
  - 28 TOI recovered deeper than 60cm depth

- Rockets were large and sometimes deep

- Handful of hardware issues:
  - MM sled too heavy for tractor. Could not safely turn
  - Broken monitor when left installed overnight as hydraulics rested
  - Wore out 2 skid plates and started wearing into sensor bucket
  - Broken pillow blocks and bolts
  - Broken welds on upright strap support on metal "basket" which forced end to cued data collection

Hawthorne Conclusions

- All TOI detected at goal depth of 60cm

- Some TOIs detected deeper, indicating that the MetalMapper can classify items below this depth as long as they are shallow enough to be detected with adequate precision in the dynamic survey

- Things break

Pueblo Chemical Depot SWMU 7 - Pueblo, CO

- Solid Waste Management Unit 7 was used for the open burning of munitions in burn trays and trenches

- Mag and flag removal project in 1997 to depth of 1 foot for all 66 acres
  - 22,835 anomalies, 18 MEC items, ~8 tons of MD and non-MD scrap
  - QA/QC performed on 14/72 total grids, remaining grids had "some" work completed

- Site was selected because of former open burn area as opposed to a firing range

- MetalMapper deployed on trackloader collected 5.4 acres along 8m wide swaths spaced evenly across site

- Suspected munitions
  - Fuze boosters (smallest munition of concern); 75mm+ projectiles; 2.36in, 2.75in, 3.5in rockets; 60mm, 81mm mortars
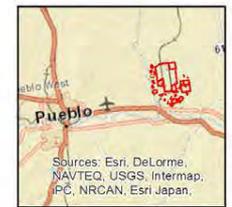
Proposed Transect and
Survey Control Locations
SWMU 7
Pueblo Chemical Depot

Pueblo County, Colorado
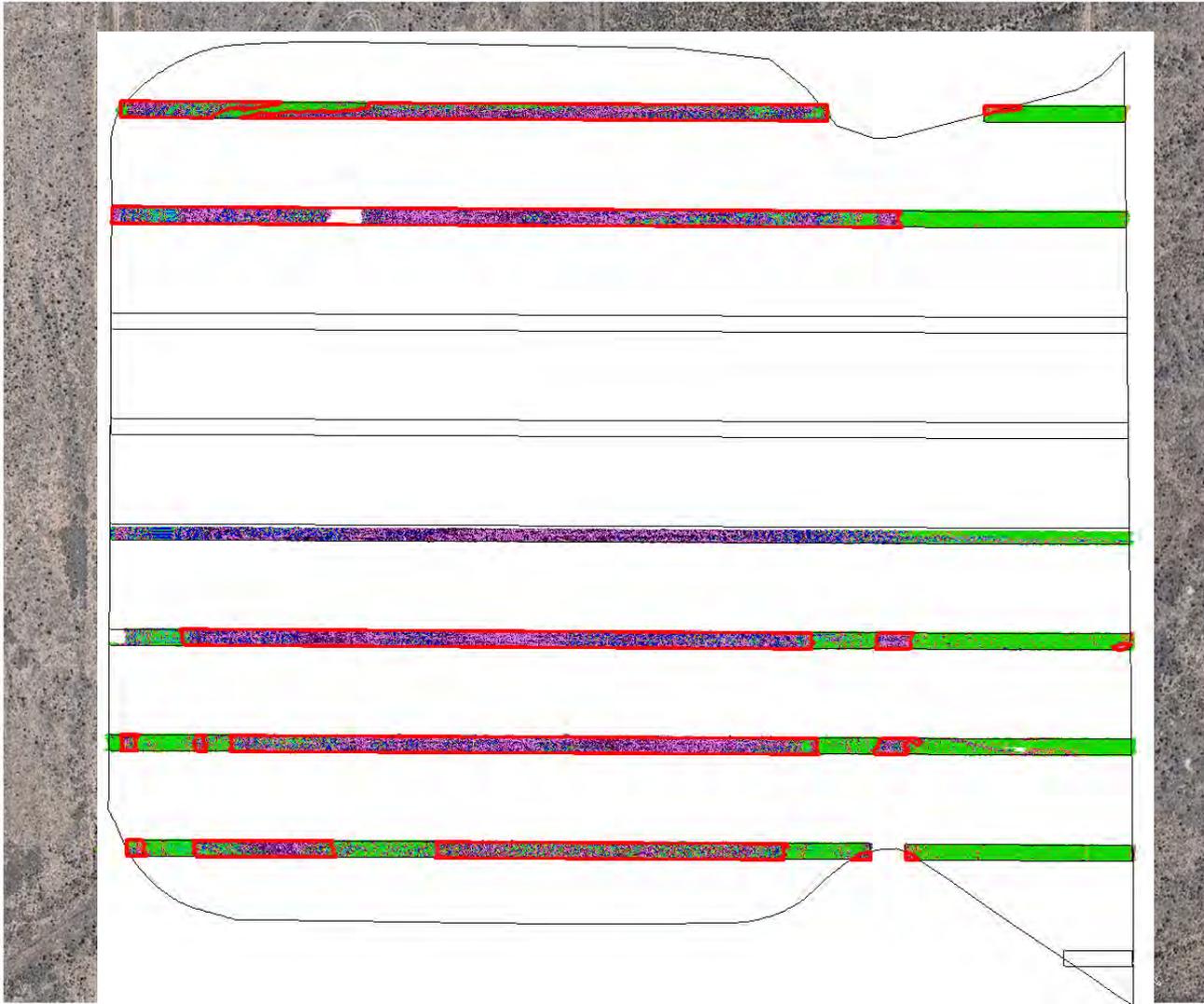
Legend

Proposed Transects

SWMU_7

Proposed Monuments

Sources: Esri, DeLorme,
NAVTEQ, USGS, Intermap,
iPC, NRCAN, Esri Japan,

Projection: UTM Zone 13N WGS84, Map Units in Meters
Background Image Source: Bing Maps Aerial, ©2010
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Meters
50 25 0   50   100

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DESIGNED BY: JB		
DRAWN BY: JB	**Pueblo Chemical Depot**	
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	FILE: PCD ESP Fig 2.mxd	

MetalMapper with Green Sled at SWMU 7

Pueblo Results

- Dynamic survey production rate of 0.8 acres/day

- Cued survey rate 232 targets/day
  - 1,165 cued targets collected
  - All 10 seed items correctly classified as TOI
  - All non-TOI items classified correctly
  - 55 other targets classified as TOI
  - This represents a 95.2% reduction in clutter digs even if all 55 TOI are false positives

Pueblo Lessons

- Site was mostly saturated as it was an old burn site

- SMC was very small which led to many targets

- Brand new Geometrics sled arrived from delivery damaged and unusable

- Dynamic repeatability and function tests not as successful as anticipated

- Dipole filter did not work well do to amount and size of anomalies

- Classification still effective at edges of saturated area. Higher resolution than traditional EM survey, so saturated area extent can be reduced

Damaged blue sled

Where are we now?

- There are now standardized items for function tests

- Emphasis on good background data points procedure

- Standard MQOs and QAPP template which address root causes of past issues/misclassifications

- Much broader stakeholder acceptance in part due to demonstrations like these

- Sensors have evolved and there is another generation out - MM2x2, MPV. Person-portable methods taken a step further

- Learned a lot through these and many other demonstrations and treatability studies, gaining further acceptance

- Still room for improvement on sensor deployment/sleds for dynamic vehicle based surveys

- 2/3 of these sites have moved to removal action phase using AGC methods

Questions?