Data Quality Considerations in Munitions Response

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Why Quality is Important

Big Picture

We would like to make sustainable and defensible decisions using geophysical data. We currently have the tools to do this, but we need to ensure we are producing data of the necessary quality to be successful.

Topics

- Necessary Data Quality
- Decisions
- Tools
- Establishing Quality Systems
- Establishing Project Quality Needs

Data Quality

- What do I mean by “necessary quality”?
  - ~~Good~~ quality
  - ~~Best~~ quality
  - Programs/Projects need to define the quality needed to make their decisions
  - Must consider the needs of the data’s:
    - Accuracy
    - Completeness
    - Consistency
    - Reliability
    - Reconstructability

Data Quality

- Regulator acceptable
- Defensibility
- Confidence/ Uncertainty
- Best practice

Data Quality

- Satisfy customers
- Long-term revenue and profitability
  - Minimize rework
- Adaptability
- Flexibility
- Higher productivity
- Better Risk Management

Technology

- Previous technology limitations did not lend itself to quality system
  - Too many variables that were not controlled
  - No record of measurement
  - No record of completeness
  - Lack of selectivity
  - Lack of reproducibility
- Analog technology non-systematic

Technology

- Advanced Geophysical Classification
  - Record of completeness
  - Selectivity
  - Reproducibility
  - Systematic

Establishing Quality Systems

- Develop and implement a quality system based on national and international standards for the performance of Advanced Classification at DoD Munitions Response Sites
- Develop quality systems documentation for the 3rd-party accreditation of organizations performing advanced classification
  - Implements ISO/IEC 17025
- Develop a Quality Assurance Project Plan toolkit using the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)
  - Implements ANSI/ASQ E4

Establishing Quality Systems
DAGCAP

- Third-party Accreditation Bodies (ABs) conduct assessments (ISO/IEC 17011)
- Applies to use of geophysical classification at all munitions response sites
- Develop Internal Quality Systems Manual i/a/w DoD QSR
  - DoD QSR based on ISO ISO/IEC 17025:2017, "General requirements for the competence of testing and calibration laboratories"
  - As used by ISO/IEC, "laboratory" refers to any organization that conducts testing or calibrations
- Undergo quality systems and technical assessments

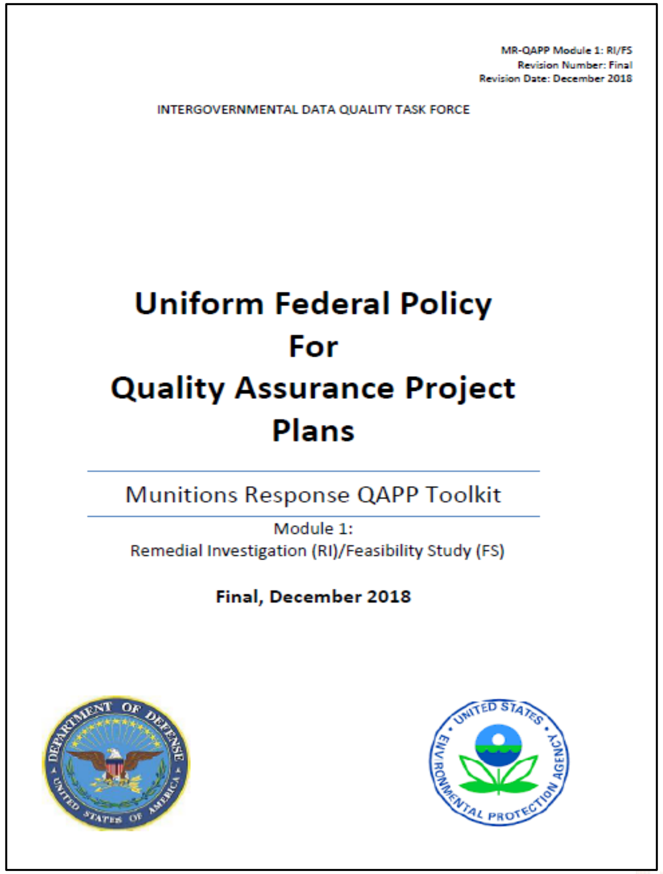
Establishing Quality Systems
MR-QAPP Toolkit Overview

- Planning tool for characterization and remediation of buried munitions and explosives of concern (MEC) at MRS
- Module 1: RI/FS; Module 2: RA
- Based on Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP, IDQTF, 2005)
- Implements a systematic planning process (SPP)

Black text = minimum recommended requirements

Blue text = examples

Green text = instructions


MR-QAPP Module 1: RI/FS
Revision Number: Final
Revision Date: December 2018

INTERGOVERNMENTAL DATA QUALITY TASK FORCE

Uniform Federal Policy For Quality Assurance Project Plans

Munitions Response QAPP Toolkit

Module 1:
Remedial Investigation (RI)/Feasibility Study (FS)

Final, December 2018

Establishing Quality Systems

- MR-QAPP establishes quality assurance and quality control for the implementation of varying technologies
  - Seeds
    - QC
    - Validation
  - All thresholds are validated
- DoD Advanced Geophysical Accreditation Program (DAGCAP)
  - Implements ISO/IEC 17025
  - Ensures GCOs have a quality system and the technical ability to use AGC

Establishing Project Quality Needs

- Root Cause
  - The cause of a non-conformance
- Root-Cause Analysis (RCA)
  - A systematic process for identifying the cause of a non-conformance. Sometimes referred to as the “5 Whys”
- Corrective Action (CA)
  - Improvements to processes taken to correct a non-conformance and prevent it from becoming systemic

Summary

- Data quality is essential for making informed decisions
- Having a quality system not only assists with meeting regulatory requirements, but it is important for effective management

Weight-of-Evidence Decision Making

Outline

- The weight-of-evidence approach
- Real-life examples
- Using the weight-of-evidence approach during a Munitions RI/FS

Weight-of-Evidence Approach

- Weight-of-evidence decision making is the process of **assembling, weighing, and evaluating** evidence to come to a scientifically defensible conclusion
  - Used when scientific questions can only be answered using several lines of evidence, e.g., *risk assessment*
  - Involves both quantitative and qualitative approaches
- Weight-of-evidence consists of systematically weighing and evaluating evidence, leading to a conclusion best supported by ALL the evidence
  - Considers data **relevance**, **strength** and **reliability**

Weight-of-Evidence Considerations

- **Relevance**
  - Do data pertain to the specific population of interest within the study boundaries?
- **Strength**
  - Is there a sufficient quantity of data?
  - Has uncertainty been managed and documented appropriately?
  - Are data internally consistent and consistent with other lines of evidence?
- **Reliability**
  - Are data of sufficient quality? Have MQOs been met?
  - Was data collection performed according to accepted methods by appropriately trained personnel?

Why Use Weight-of-Evidence Approach for Munitions Response?

- Unlike traditional chemical cleanups, munitions sites do not have a clearly defined endpoint based on regulatory standards or acceptable risk
- Munitions cleanup decisions must therefor rely on a weight-of-evidence approach
  - Familiar concept found in scientific and regulatory literature
  - Avoids relying solely on any one piece of information
  - Allow us to make informed defensible decisions

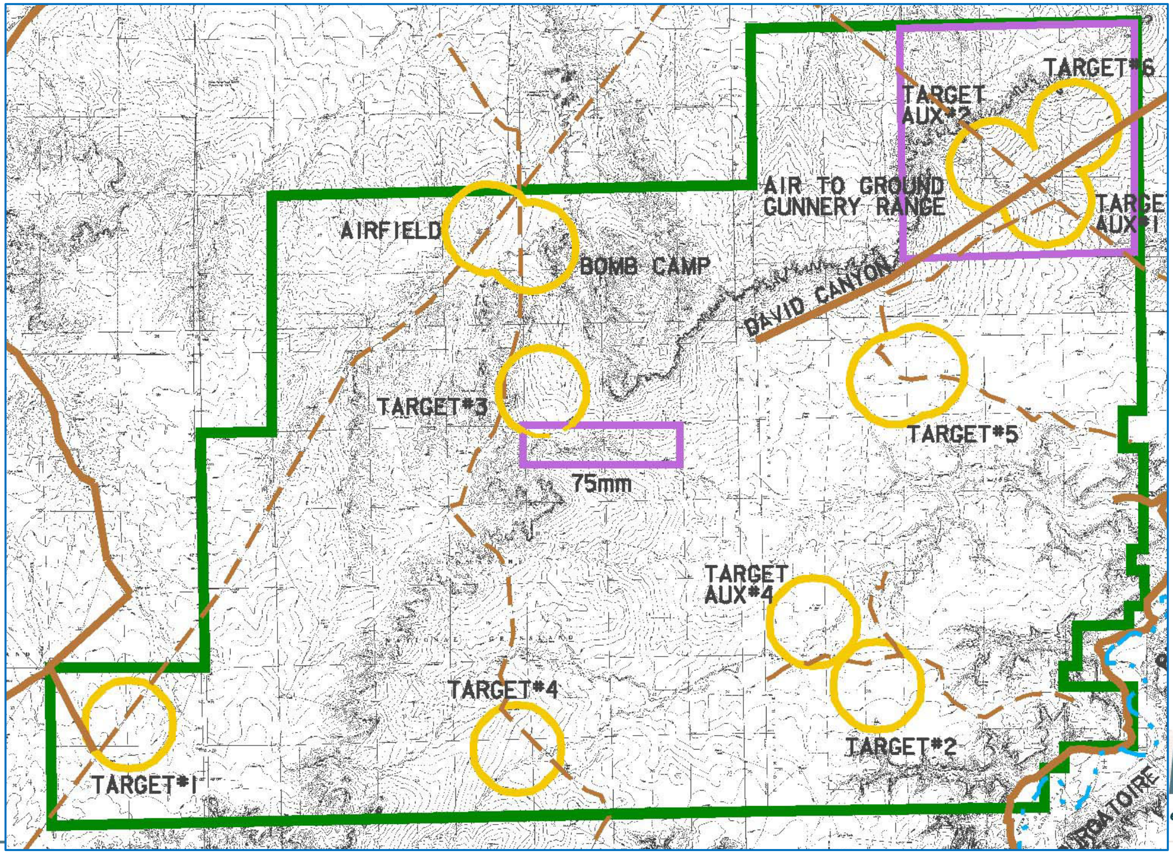
Conceptual Site Model (CSM) documents information and lines of evidence to support decision making

Data Usability Assessment (DUA) evaluates evidence to reach RI conclusions

Example: Weight-of-Evidence Considerations Scoping of RI Preliminary Site Characterization

Decision: Determine the scope and boundaries for the remedial investigation of a former WWII bombing range

- Historical documents
  - Property records
  - Range maps (2 sets)
  - Property owner interviews
  - Newspaper clippings and reports of UXO incidents "on the range"
- PA/SI data
  - Limited site inspection data on portions of the property



Example: Weight-of-Evidence Considerations Scoping of RI Preliminary Site Characterization

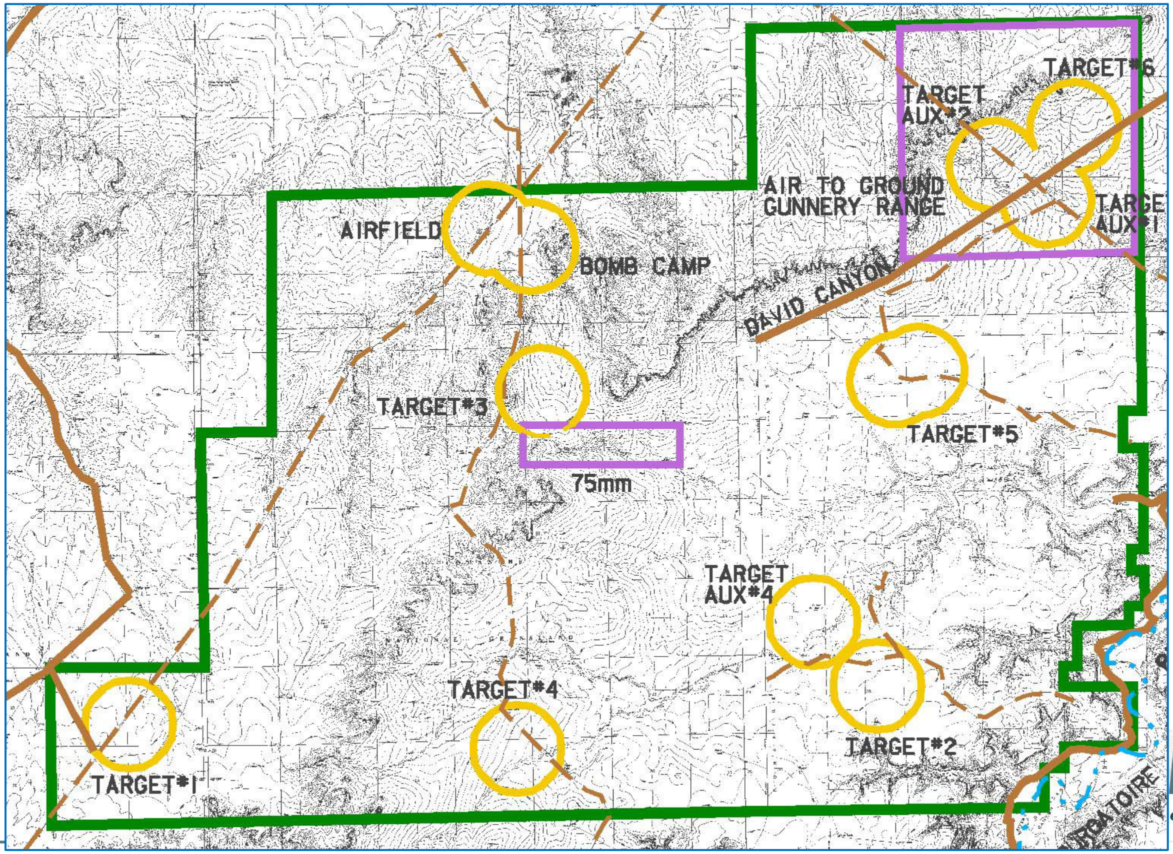
Decision: Determine the scope and boundaries for the remedial investigation of a former WWII bombing range

- **Historical Range Maps**
  - Two detailed historical range maps available
  - Maps from different years with different target configurations

Relevance?

Strength?

Reliability?



Example: Weight-of-Evidence Considerations Scoping of RI Preliminary Site Characterization

Weighing "new" evidence: Use of 75-mm projectiles on a WWII precision bombing range site

- Property owner interview
  - Rancher recalls watching aerial gunnery practice
  - Rancher's 75-mm projectile
  - Unsure of exact location, identifies general area
- Relook at historical use
  - B-17 precision bombing
  - B-24 & B-25 training
  - B-25G Mitchell fired 75-mm from nose cannon

Example: Weight-of-Evidence Considerations Scoping of RI Preliminary Site Characterization

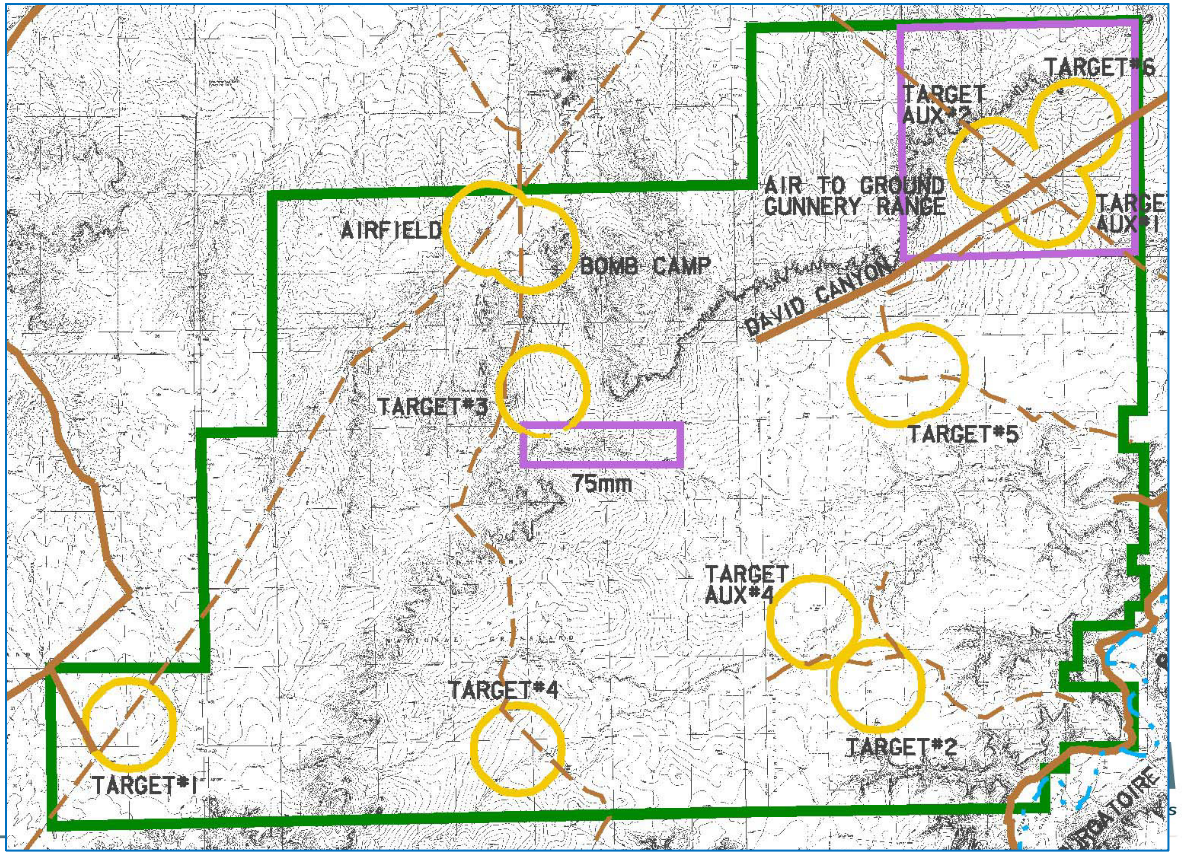
Weighing "old" evidence: Evaluation of MRS boundaries from Preliminary Assessments & Site Inspections

- PA/SI data
  - SI field team confirmed evidence of munitions use at multiple target sites
    - Target features
    - Bomb debris, craters
  - Team was unable to reach all identified target areas

Relevance?

Strength?

Reliability?



Preliminary Conceptual Site Model

- A working, iterative model depicting current understanding of sources, pathways, and receptors
  - Facility profile (historic uses, ranges, previous investigation findings)
  - Release profile (munitions uses and expected distributions)
  - Land use and exposure profile (current/future uses, accessibility, receptors)
  - Physical profile (topography, geology, climate)
  - Ecological and cultural resources profile (habitat, natural resources)
- CSM for RI/FS is usually based on the PA/SI
  - First step is to evaluate the CSM – basis, assumptions, data gaps, uncertainty
  - Working version of CSM is updated throughout the RI/FS project
  - Evidence added during RI to support FS and remedy selection (ROD)
- CSM for RD/RA is based on the ROD

Changing Roles of the CSM

- RI collects evidence to build and refine the CSM
  - Projection of what the site looks like
- ROD relies on the CSM to support cleanup decisions
  - CSM of known and sufficient quality
- Cleanup relies on the CSM for design assumptions
  - RA technical approach based on RI CSM
  - Continuous evaluation of new information that may either confirm or change the CSM

Data Usability Assessment

- DUA used to evaluate data, consider WoE, and draw conclusions
  - Qualitative and quantitative evaluation to determine if data are the right type/quality/quantity to support project-specific decision making
  - Evaluates multiple lines of evidence compiled in the CSM
  - Considers the weight of evidence - ***Relevance, Strength, Reliability***
  - Draws conclusions based on evaluation of **ALL** evidence
- DUA occurs continuously throughout investigation and remediation, wherever decision-making occurs
- Involves key members of the project team

Role of WoE & DUA in Remedy Implementation

- Weight-of-evidence used to demonstrate effectiveness of the implemented remedy
  - Remedy was implemented correctly
  - Remediation goals were achieved – site is protective
  - Remedy supports UU/UE recommendation, when appropriate
- What builds the weight of evidence?
  - Adherence to QAPP and MPCs
  - No Surprises – Consistency with CSM to demonstrate the project accomplished the goals
  - Constantly back check on CSM assumptions
- Data Usability Assessment
  - Revisit every assumption
  - Evaluate every MPC

Systematic Planning

Outline

- Systematic Planning Process
  - QAPP Introduction
- Key MR-QAPP Worksheets
- Terminology
- Project-Planning Process Example
- Summary

Systematic Planning Process

- The QAPP is a structured planning document that documents the Systematic Planning Process
- Follows the "*Scientific Method*"
  1. Problem Statement
  2. Hypothesis or theory
  3. Testing
  4. Observations
  5. Conclusion and communication of results
- Ensures collected data will support intended uses

Terminology

Data Quality Objectives (DQOs)

- Qualitative and quantitative statements describing the type, quantity, and quality of data needed to support decision-making
- Developed during a systematic planning process based on EPA's seven-step DQO Process

Terminology

Data Quality Objectives (DQOs)

Step 1: State the Problem

Step 2: Identify the data collection goals

Step 3: Identify information inputs

Step 4: Define the project boundaries

Step 5: Develop the Project Data Collection and Analysis Approach (Decision Rules)

Step 6: Specify Project-specific Measurement Performance Criteria (MPC)

Step 7: Develop Sampling Design (Survey Design and Project Workflow)

Key MR-QAPP Worksheets

WS #6: Communication Pathways and Procedures

WS #9: Project Planning Sessions

WS #10: Conceptual Site Model (CSM)

WS #11: Data Quality Objectives (DQO)

WS #12: Measurement Performance Criteria (MPC)

WS #17: Sampling Design and Project Workflow

WS #22: Measurement Quality Objectives (MQO)

WS #37: Data Usability Assessment (DUA)

Terminology

Measurement Performance Criteria (MPCs)

- *"Project-level Criteria" MR-QAPP WS12*
- *Sampling design* specifications
- Expressed in terms of "data quality indicators":

Accuracy, Representativeness, Completeness, Comparability, Sensitivity

Terminology

Measurement Quality Objectives (MQOs)

- *Sampling process* specifications
  - *Component-level criteria* MR-QAPP WS22
  - Controls and documents measurement uncertainty
  - Catches and fixes problems before they impact results

Terminology

Data Usability Assessment (DUA)

- The structured, systematic, evaluation of data, performed by key members of the project team, to determine if data are of the right type, quantity, and quality to satisfy project-specific MPCs and DQOs
- A “total picture” evaluation of the CSM, DQOs, QA/QC, assumptions, and results
- Determines whether data can be used as intended, with an acceptable level of confidence

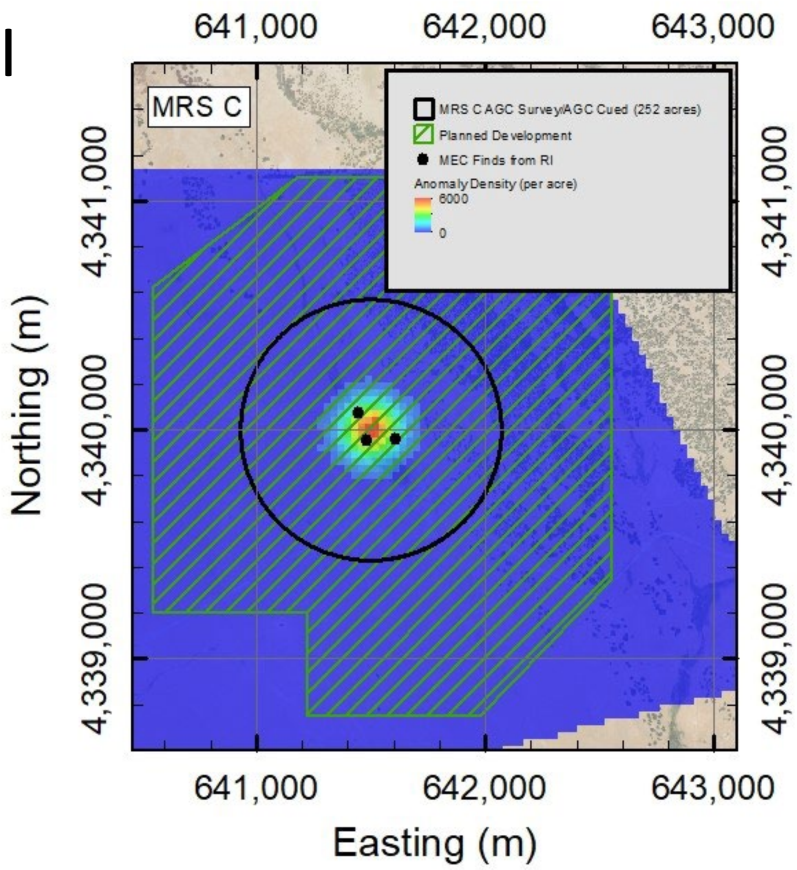
Data Usability Example 1

1. Conducting the data usability assessment at a key decision point in the remedial action
2. Considering the weight of evidence in decision-making

WWII Bombing Target

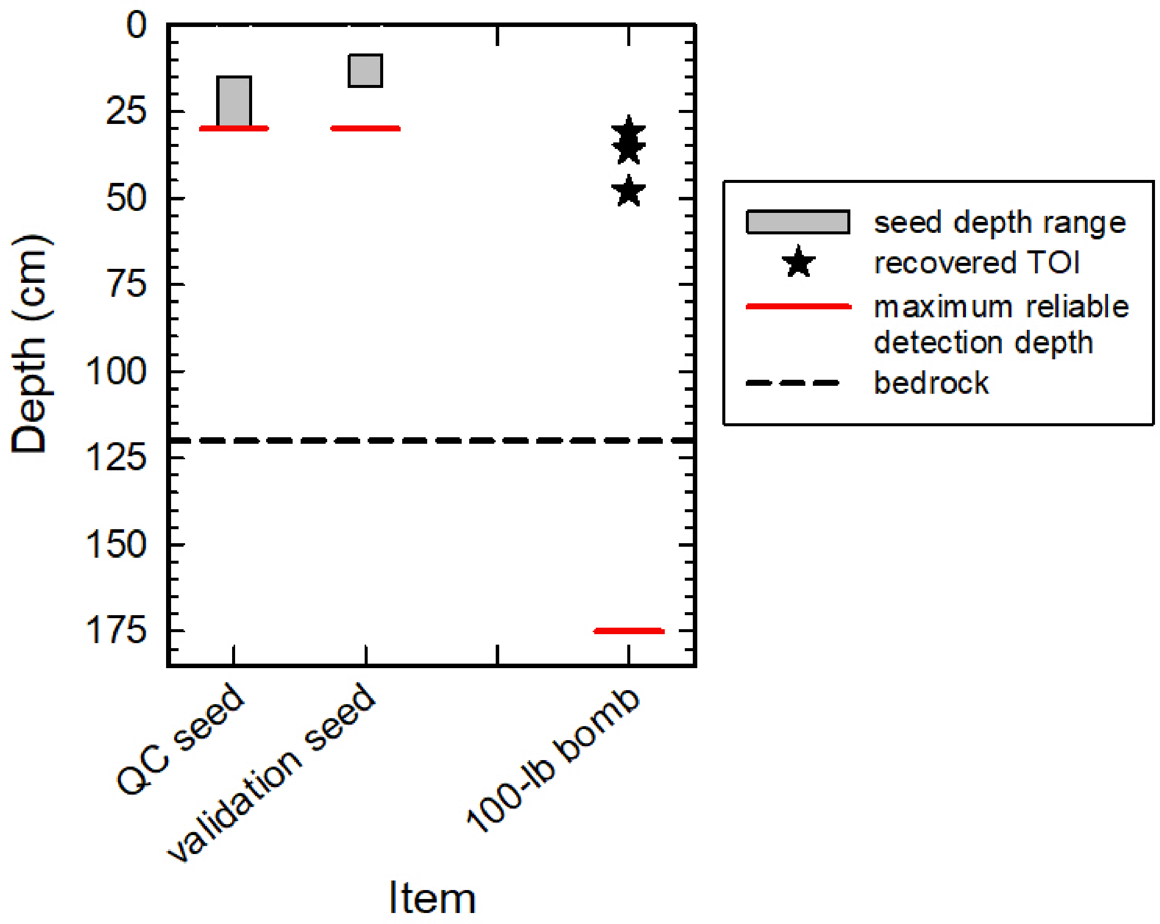
Site Background Information from CSM

- Target used for bombing training during WWII
- Continued use by Air Force during 1950s
- Munitions Items of Concern (IOC)
  - 100-lb HE bombs
  - Associated nose & tail fuzes
- Land Use
  - Current use for cattle grazing
  - Future use proposed residential development
- Shallow bedrock across site
  - 0 to 1.2 m, with visible outcrops



Munitions Depth Profile from post-RI CSM

- All MD recovered during RI/FS was consistent with HE and practice bombs
- High anomaly density in center of impact area



Remedial Action being Implemented

- MEC surface and subsurface removal using dynamic AGC detection and cued AGC classification

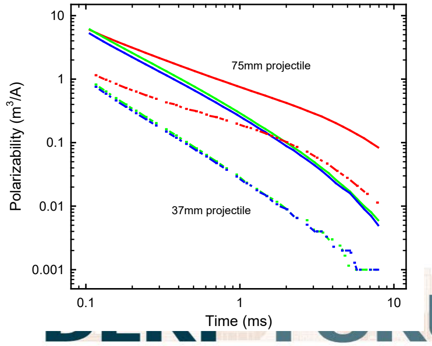
Selected Remedy	Remedial Action Objectives	Selected Remedy Components		
		MEC Removal	Treatment	LUCs
Alternative 2: MEC surface and subsurface removal using dynamic AGC followed by cued AGC with interim LUC	Remove MEC from the surface & subsurface Achieve UU/UE <u>MEC removal remediation goal</u>: • 100-lb HE bombs to bedrock • Fuzes to 0.3 m • Any other munitions present on the site that are detectable at the anomaly selection criteria	• Surface sweep • Dynamic AGC anomaly detection • Cued AGC TOI selection • TOI investigation and source removal using manual and backhoe-assisted excavation	• All recovered MEC to be detonated in place or otherwise destroyed on-site	• Interim LUCs if specified in applicable decision document • Upon successful remediation, LUCs will be removed

Most RODs won't look like this!

AGC Dynamic Survey → Cued AGC

- Dynamic AGC survey
  - 100% coverage
  - Informed Source Selection to locate anomalies and screen out those with characteristics that cannot result from items we care about
- Cued AGC survey
  - Reacquire anomaly locations
  - Interrogate in stationary mode
  - Perform classification analysis
  - Make dig/no-dig decisions

#	Match Metric	Amp
1	Highest	5
2		10
…	Threshold	3
1500		4
…		5
1699		10
1700		15
…		1
9999	Lowest	3



Classification Results

Step	Requirements
Site Preparation	- Ensure consistency with CSM
Surface Sweep	- Ensure consistency with CSM
AGC Dynamic Survey	- Ensure consistency with CSM - Site can support AGC - Meet MQOs and MPCs
AGC Cued Survey	- Ensure consistency with CSM - Meet MQOs and MPCs
Dig List Excavation	- Ensure consistency with CSM - Meet MQOs and MPCs

Classification Analysis Results

- Surface Sweep munitions-related items recovered
  - Debris from HE bombs, munitions components including fuzes
- AGC Dynamic Survey
  - 22,293 anomaly locations selected for cued data collection
- AGC Cued Survey & Classification Analysis
  - 2,845 locations classified as TOI and placed on initial dig list
  - All TOI matched to expected IOC (bombs & fuzes), with one exception
  - Single item identified with characteristics of munitions, but no library match
  - Cued data analysis performed using the full library (rather than site IOC), the one signature matched to a 105-mm projectile

DUA After AGC Classification Analysis

DUA Step 1 Review Objectives & Sampling Design	DUA Step 2 Review Data	DUA Step 3 Document Usability & Draw Conclusions	DUA Step 4 Lessons Learned & Recommendations

Are underlying assumptions valid?

- The munitions-related items recovered during the surface sweep are consistent with the CSM
- When the cued data analysis was performed using the just the site IOC, all except one TOI matched to expected bombs and fuzes
- When the cued data analysis was performed using the full library (rather than site IOC), one signature matched to a 105-mm projectile and will need to be investigated

DUA After AGC Classification Analysis

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Was the sampling plan valid?

- The possibility of an unexpected 105-mm projectile would change the CSM – assumptions may no longer be valid
- Still need to complete the DUA to determine what decisions, if any, can be supported
- Field specifications, dynamic AGC target selection criteria and target selection criteria were valid for IOC to ROD-required depths
- All potential munitions and hazardous components identified in the CSM were included in the AGC TOI library.
- Seeded items and depths were appropriate to represent the munitions recovered.

What is the impact of the potential 105 mm?

DUA at Conclusion of RA

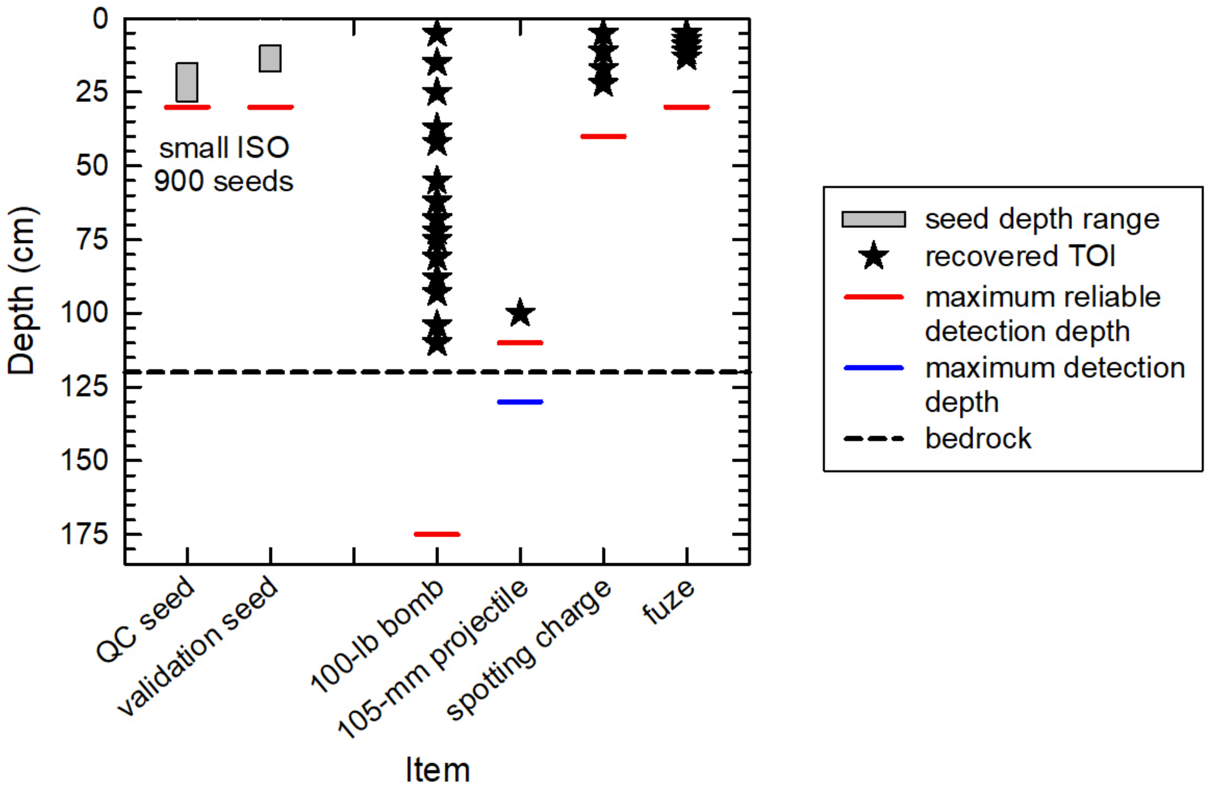
DUA Step 1 Review Objectives & Sampling Design	DUA Step 2 Review Data	DUA Step 3 Document Usability & Draw Conclusions	DUA Step 4 Lessons Learned & Recommendations

- *Are underlying assumptions valid?*
- The munitions-related objects recovered in the intrusive investigation include:
  - 15 HE bombs to a depth of 1.1 m.
  - Fragments and debris from HE bombs.
  - Munitions components in including fuzes and spotting charges.
  - Debris from practice bombs.
  - 105-mm artillery shell at a depth of 1.0 m.

Significant change to the CSM

Unexpected Munition Found

- Find unexpected 105-mm projectile
- Impacts:
  - Could be additional 105 mm deeper than MRDD
- Seeking UU/UE all of Bomb Target MRS



Where do we go from here?

Revisit DQOs

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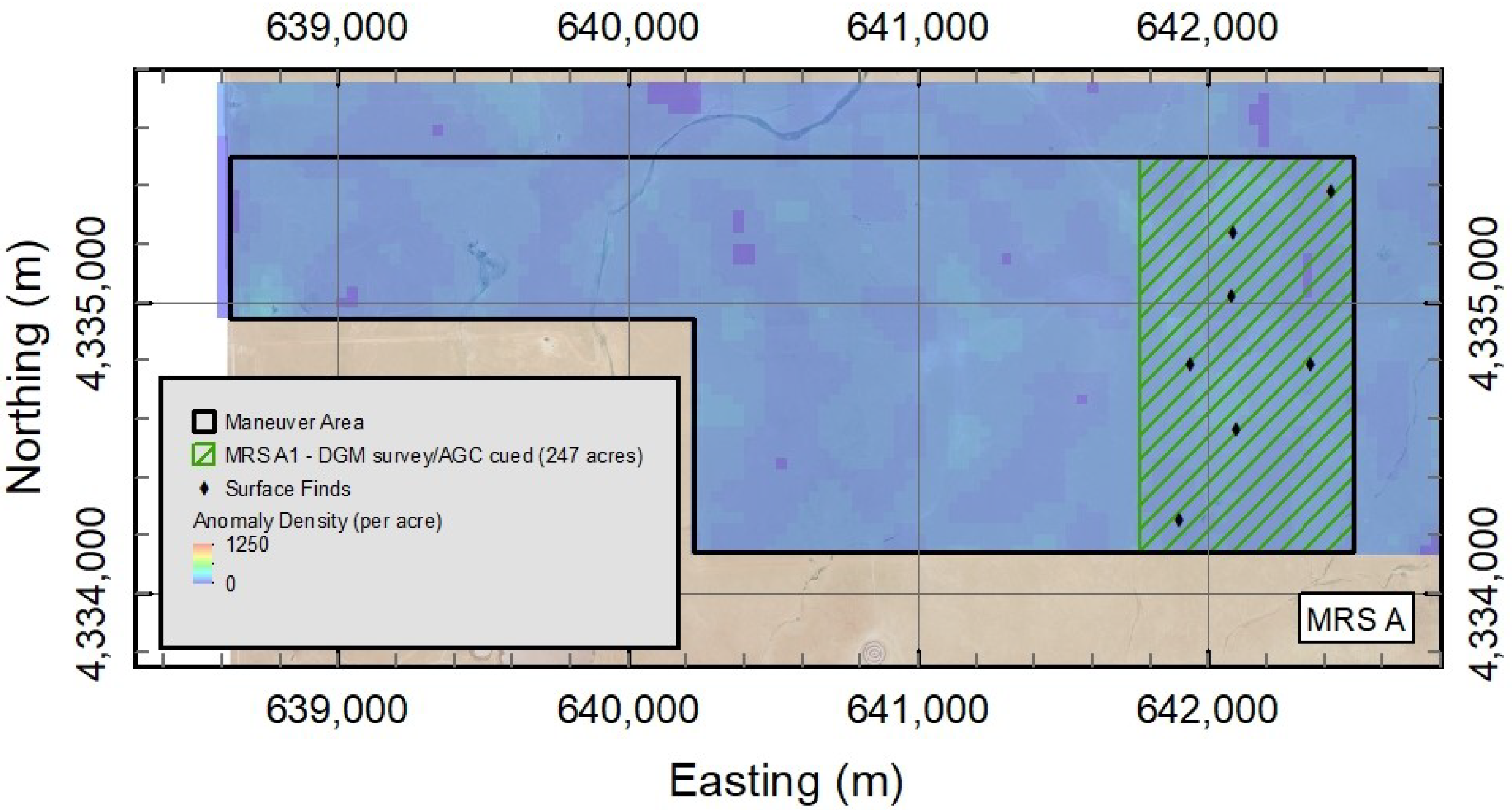
Data Usability Example 2

Maneuver Area CSM

- Used for maneuver
  - Historic Maneuver Area: Used toward end of WWII for troop maneuvering and encampment
  - 2 Artillery Ranges adjacent to the area used toward end of WWII with 75-mm and 105-mm projectiles
- Lands to west are part of still active AFB

Post-RI CSM Maneuver Area



- No digging in the RI
- All MD recovered at the site was consistent with practice hand grenades and smoke and illumination mortars

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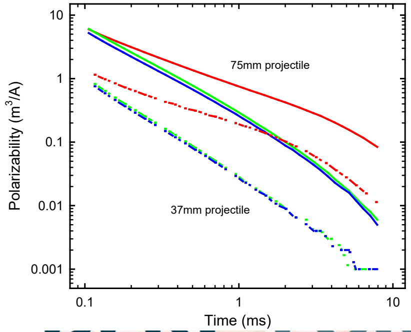

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DUA After AGC Classification Analysis

DUA Step 1 Review Objectives & Sampling Design	DUA Step 2 Review Data	DUA Step 3 Document Usability & Draw Conclusions	DUA Step 4 Lessons Learned & Recommendations

- *Are underlying assumptions valid?*
- The munitions-related objects recovered in the surface sweep include:
  - MD from 60-mm smoke and illumination mortars.
  - MD associated with practice hand grenades.
  - Debris from small arms.
- No evidence of other munitions was found.
- Classification analysis yielded one source that matched to a mortar in the library at a depth of 0.55 m, beyond the MRDD

DUA After AGC Classification Analysis

DUA Step 1 Review Objectives & Sampling Design	DUA Step 2 Review Data	DUA Step 3 Document Usability & Draw Conclusions	DUA Step 4 Lessons Learned & Recommendations

- *Was the sampling plan valid?*
- The possibility of a mortar deeper than its MRDD would change the CSM – assumptions may no longer be valid
- Still need to complete the DUA to determine what decisions, if any, can be supported
- Field specifications, dynamic AGC target selection criteria and target selection criteria were valid for IOC to ROD-required depths
- All potential munitions and hazardous components identified in the CSM were included in the AGC TOI library.
- Seeded items and depths were appropriate to represent the munitions recovered.

What is the impact of the deeper mortar?

DUA at Conclusion of RA

DUA Step 1 Review Objectives & Sampling Design	DUA Step 2 Review Data	DUA Step 3 Document Usability & Draw Conclusions	DUA Step 4 Lessons Learned & Recommendations

- *Was the sampling plan valid?*
- The recovery of a mortar deeper than its MRDD changes the CSM – assumptions are no longer valid
- Still need to complete the DUA to determine what decisions, if any, can be supported
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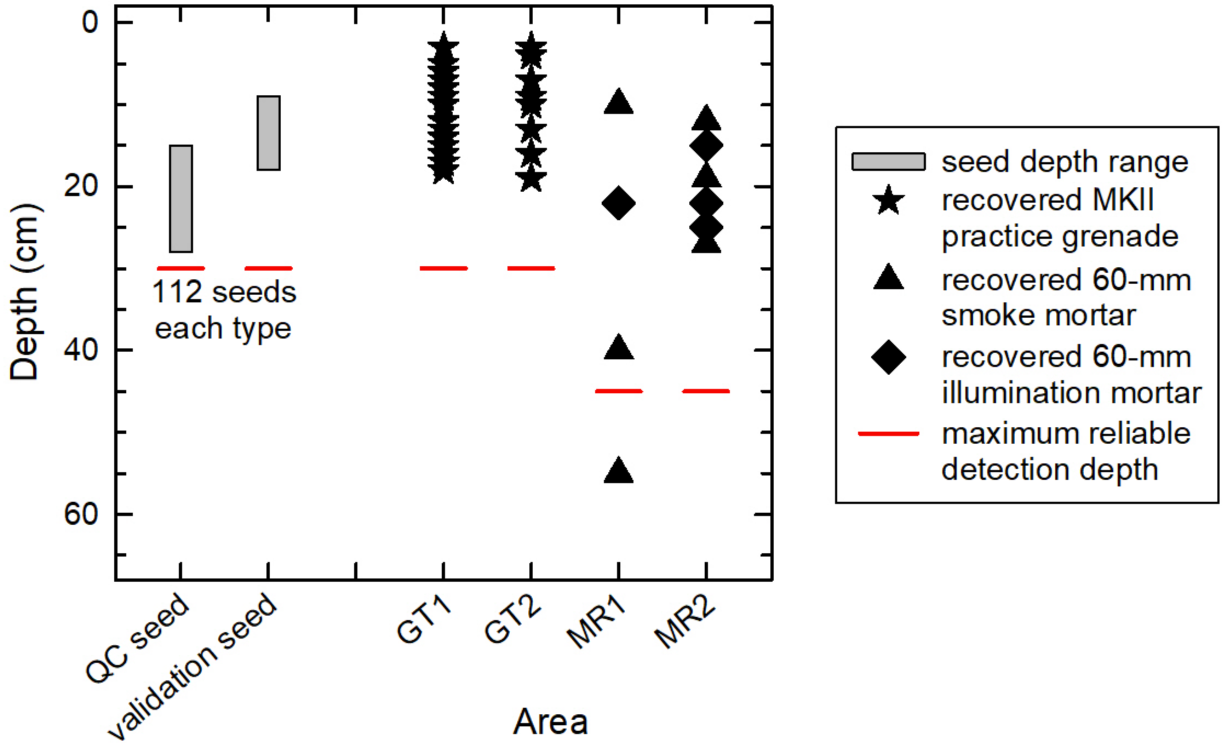
- Seeded items and depths were appropriate to represent the munitions recovered.

Munition Deeper than MRDD

- Find mortar deeper than MRDD
- Impacts:
  - Could be additional mortars deeper than MRDD
- Seeking UU/UE all of MRS Maneuver Area



Where do we go from here?

Revisit DQOs

Summary

- Weight-of-Evidence decision making is critical for the remediation munitions response sites
- Advanced Geophysical Classification can provide the needed data to make sustainable and defensible decisions with the implementation of appropriate quality assurance and quality control
- Data usability assessment is a crucial step
- Getting to UU/UE is possible, but not easy