EARTH COVERED-MAGAZINES STRUCTURAL INTEGRITY ASSESSMENTS (ECMSIA)

U.S. Army Engineering and Support Center, Huntsville

Prepared by Jeff Coulston

09 August 2018

"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."

US Army Corps of Engineers

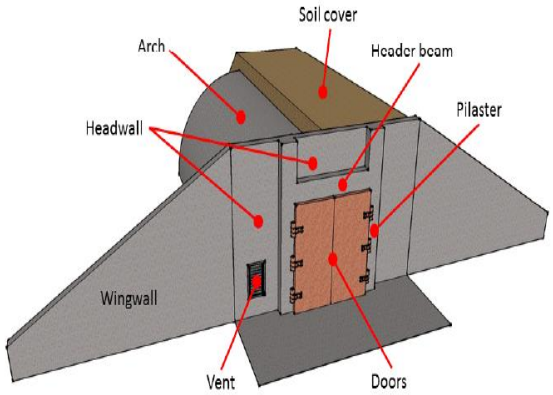
U.S.ARMY

OVERVIEW OF PRESENTATION

- Need for Assessments
- ECM Structural Integrity Assessments: What is it?
- Approach – Three Phased Approach
  - Phase 1 (Three Parts): ECM Structural Health Integrity Assessments
  - Structural Health Guidelines/Ratings
  - Assessment Reports/Deliverable
- Back-Up Information

WHY IS AN ECMSIA NEEDED?

- To determine “structural health” of aging storage magazines
  - Approximately 25,000 ECMs in DoD
  - Most are 75+ years old
  - Located on installations with varying environmental/operational conditions



- To assess if U.S. munition storage is at risk
  - Has aging structurally degraded the ECMs to a point where they do not meet ECM structural designation criteria set forth in DoD 6055.09-M?

- To provide input to Munitions-Related Infrastructure Recapitalization Plan
  - Monitor,
  - Repair,
  - Replace,
  - Re-warehouse

US Army Corps of Engineers.

U.S.ARMY

ECMSIA: WHAT IS IT?

- A hands-on assessment that will assist the Army in developing a status system (Green, Amber, Red, Black) for ECMs;
- ECMSIA Team will:
  - Use a common structural checklist to ensure consistency of results;
  - Will include engineers and safety professionals with specialized experience in:
    - Inspection of concrete structures; and
    - Explosives safety standards for ECM
- ECMSIA will:
  - Provide a base line for the structural health and integrity of the ECMs that may be used for scheduling maintenance and developing recapitalization plans; and
  - Assess the adequacy of each structure to safely store the net explosive weight (NEW) currently authorized for storage

US Army Corps of Engineers.

U.S.ARMY

ECMSIA APPROACH

- Army supports this DDESB funded effort (FY19 - FY23) – Planned start date March 2019
- Multi-organization Government Team

DDESB, DA, AMC, JMC, DAC, USATCES, USACE, NOSSA, NAVFAC-Atlantic

- Three Phase Approach
  - Phase 1: Earth Covered-Magazine Structural Integrity Assessment
    - **Part 1 - Facilities Assessment: establish types/quantity of ECMs**
    - **Part 2 - Structural Health Visual Inspection (SHVI): establish 'Structural Health' Rating**
    - **Part 3- Concrete Coring/Testing: project remaining service life**
  - Phase 2: Site Planning (ESQD Analysis)
  - Phase 3: Load Plan Analysis (Account for stockpile)
- Initial Installations (approximately 5,000 ECMs)
  - Crane Army Ammunition Activity (CAAA)
  - McAlester Army Ammunition Plant (MCAAP)
  - Tooele Army Depot (TEAD)

US Army Corps of Engineers.

U.S.ARMY

ECMSIA
PHASE 1, PART 1: FACILITIES ASSESSMENT

Establish types and quantity of ECMs:

- ESMSIA will visit and walk through 100% of the ECMs to capture and confirm physical dimensions and construction type
- Information captured on an Facilities Assessment Record provided by NAVFAC-Atlantic
- ECMs will be categorized by types (physical dimensions and construction type) and quantities of each type will be developed
- ***A baseline of each types and associated quantity will be established***
- ESMSIA will use the information gathered during Phase I, Parts 2 and 3; and Phases 2 and 3

US Army Corps of Engineers.

U.S.ARMY

ECMSIA
PHASE 1, PART 2: STRUCTURAL HEALTH VISUAL INSPECTIONS (SHVI)

SHVI will establish a structural health rating for the ECMs based on representative sampling

- Will be representative of the totality of ECMs at an installation
- Will use the baseline of types and number established in Part 1
- Use Simple Proportion Sampling Method from Miller and Freund's Probability and Statistics for Engineers
  - Goal is to obtain a 95% confidence level in results;
  - Confidence level consistent with private industry standard practice
- Quantity will be 20% to 30% of total number of ECMs from the Part 1 baseline
- Different quantities of each 'type" strongly influences the number of ECMs to be inspected (sampled)

US Army Corps of Engineers

U.S.ARMY

ECMSIA
PHASE 1, PART 2 (CONTINUED)

- Numerical Code: (0 – 9)
- Assigned indicates an overall structural health rating for the ECM
- Used to assign a rating ‘similar’ to an Installation Status Rating (ISR) adapted to ECM use
  - **Green** (7 to 9): continue to use, but monitor minor deterioration noted
  - **Amber** (5 to 6): continue to use, but make noted repairs to prevent further deterioration
  - **Red** (3 to 4): discontinue use until noted repairs are made
  - **Black** (0 to 2): un-repairable, do not use
- Rating provides a recommendation for the installation’s and Army’s consideration for planning and management
- Repair costs and methods provided

US Army Corps of Engineers

U.S.ARMY

ECMSIA
OBSERVATIONS FROM PREVIOUS ASSESSMENTS

Spalling

Spalling: Exposed Rebar in Sidewall

Transverse @ Sidewall

Transverse @ Arch

US Army Corps of Engineers

U.S.ARMY

ECMSIA
PHASE 1, PART 3: CONCRETE CORE EXTRACTIONS/TESTING

- Establish structural properties; and
- Project remaining service life
- ECMSIA Team will:
  - Sample a representative quantity of each type and quantity based on the baseline established in Part 1
  - Use Miller and Freund's Simple Proportion Sampling Method from Probability and Statistics for Engineers
    - Goal is to obtain a 70% confidence level in results;
    - Quantity will be 8% to 12% of total number of ECMs established in Part 1

US Army Corps of Engineers.

U.S.ARMY

ECMSIA - PHASE 1, PART 3 (CONTINUED)

- Close coordination with the installation's explosives safety manager is required
- Extract cores from 'empty' ECMs when possible
- Take measures to prevent the need to handle munitions (e.g., re-warehouse or move)
- Use Ground Penetrating Radar (GPR) to find and confirm all reinforcement prior to core drilling
- Core Drilling is a 'wet' process
- Lab Testing per ASTM test methods

ECMSIA - SAMPLE RETRIEVAL

Ground Penetrating Radar

Concrete Coring

ECMSIA - DELIVERABLES

- **Executive Summary**
  - Project Background
  - Parts 1, 2 and 3 Summary
- **Part 1 Report**
  - Summary spreadsheet
  - Form for each type of ECM
  - Site Map with each type indicated with legend
- **Part 2 Report**
  - Inspection form for each ECM with Structural Health rating
  - Recommended Repair Methods with Costs
  - Site Map with structural health rating indicated with legend
- **Part 3 Report**
  - Report for each site
  - Lab results
  - Projected remaining service life
  - Site Map with service life indicated with legend
- **Electronic Data Base (OTS Software)**

US Army Corps of Engineers

U.S.ARMY

Questions/Comments

Backup

ECMSIA
STRUCTURAL HEALTH 'COLOR' RATINGS CATEGORIES

- Green: ECM receiving a rating of 7 or above. **New condition, minor nonstructural issues identified, no significant deterioration**. Structural Health is adequate for the assigned structural designation. **Continued to use**.
- Amber: ECM receiving a rating of 5 or 6. **Primary structural components are sound, some minor section loss, cracking and spalling**. Structural Health is adequate for the assigned structural designation. Continued use is as is, but **needed repairs should be completed to prevent further deterioration.**
- **Red**: ECM receiving a rating of 3 or 4. **Significant deterioration** of primary structural components, advanced section loss and spalling. Structural Health is **not adequate for the assigned structural strength** designation. **Do not use until repairs are made**.
- **Black**: magazines receiving a of 0, 1 or 2. **Major deterioration or sections have lost critical structural components**. **Beyond repair, do not use for munitions storage**.

US Army Corps of Engineers.

U.S.ARMY

ECMSIA (SUMMARY)

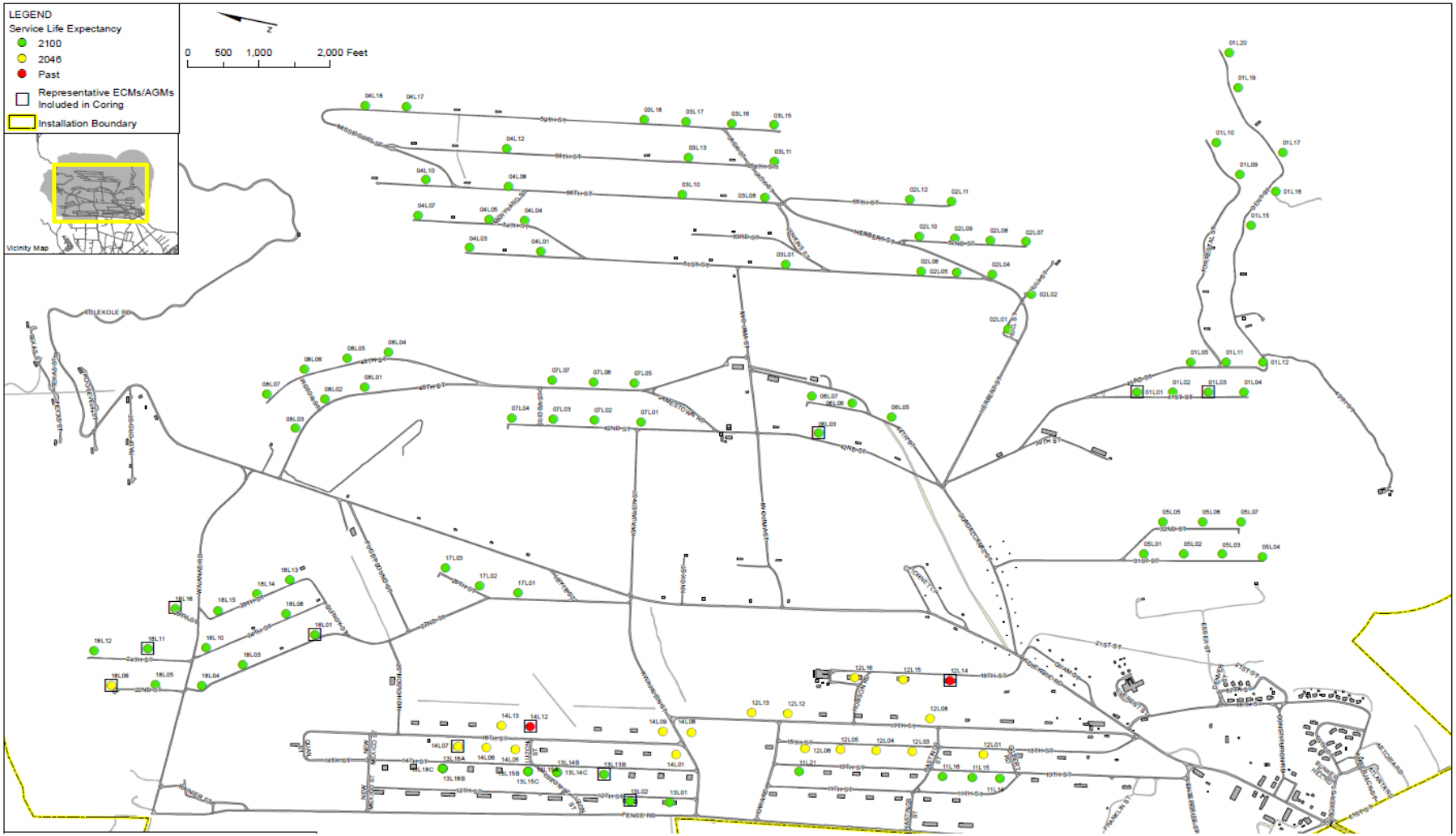
EARTH COVERED MAGAZINE STRUCTURAL HEALTH SUMMARY

Building #	Type *	Year Constructed	Description	Dimensions	Tenant	Use Status	QD siting	Life Expectancy	Structural Designation	Structural Health Rating	Structural Health Description	Date Inspected	Structural Recommendatins
#1	1	1941	Arch	44x32xheight	Army	Empty	ECM	Year TBD	Undefined	Green - 7	Use. None or Minor repairs needed	15-Jan-13	Mark and montitor hairline cracks, repair floor cracks
#2	2	1941	Box	44x32xheight	Army	In Use	ECM	Year TBD	Undefined	Amber - 6	Use. Major Repairs needed	16-Jan-13	Exterior repairs; mark and monitor hairline cracks; repair floor cracks
#3	2a	1941	Box	25x50xheight	Army	In Use	AGM	NA	Undefined	Red - 3	Take out of Use	14-Jan-13	Do not use for AE storage
#2263	5	1942	Arch	25x40xheight	Army	in use	ECM	Year TBD	Underfined	Green - 8		20-Dec-12	Interior and exterior repairs; mark and monitor hairline cracks; repair floor cracks

US Army Corps of Engineers.

U.S.ARMY

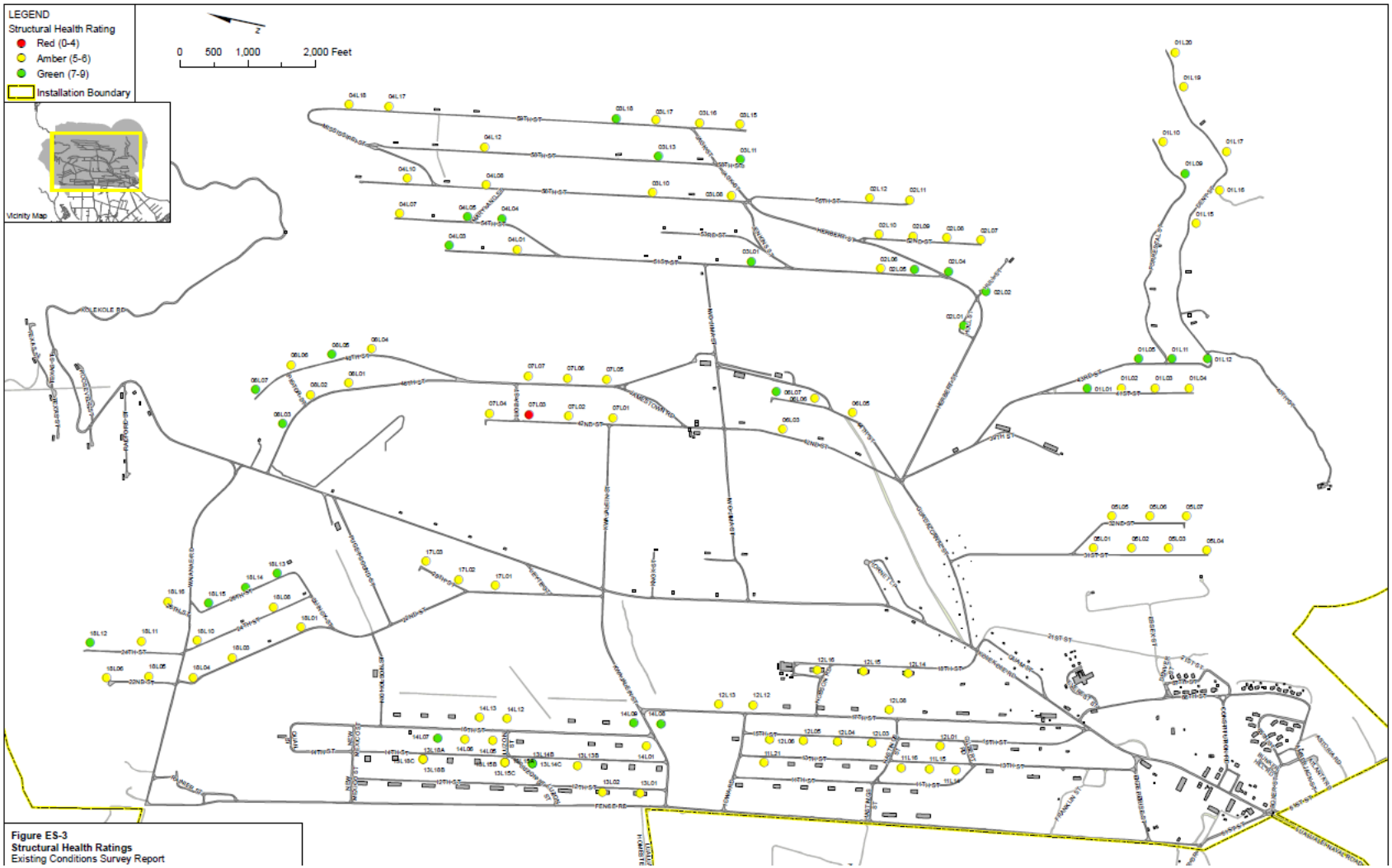
ECMSIA CONDITION ASSESSMENT (SERVICE LIFE EXPECTANCY)



US Army Corps of Engineers

U.S.ARMY

ECMSIA CONDITION ASSESSMENT (STRUCTURAL HEALTH)



US Army Corps of Engineers

U.S.ARMY