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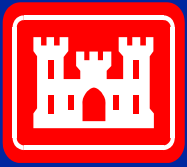
Terry L. Walker

**JOINT ERAF/TSERAWG
MEETING**

27-29 JANUARY 2009

**MULTI-INCREMENT
SAMPLING: What It Is
And What It Does For
Site Characterization
And Risk Assessment**

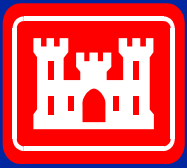




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PREVIEW

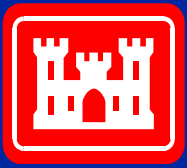
- **MIS history, approach, and benefits**
- **Sampling design issues**
- **Laboratory issues**
- **Risk Assessment issues**
- **Available Guidance**
- **Summary**



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APPENDIX A to SW846 METHOD 8330B



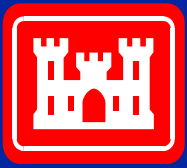


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HISTORY OF MIS

- MIS developed by the mining industry
- Initially advocated by USEPA in the soil screening guidance
- Studies at explosives-contaminated sites (USACE CRREL)
 - Sampling error was at least 10 times greater than analytical error
 - Major source of analytical error was found to be sample processing and subsampling
- Method 8330B released in Nov 2006

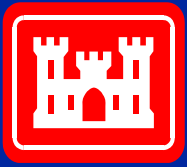




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WHAT IS THE MIS APPROACH?

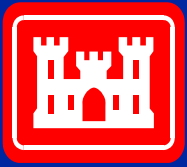
- Pooling of several individual increments from within the decision unit (can you say “composite”????)
- Intended to provide a more reliable estimate of the AVERAGE concentration
- Collection of field replicate samples (typically three) to provide an estimate of total variability



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RESULTS OF THE MIS APPROACH

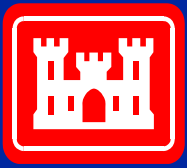
- **Minimizes sampling and subsampling errors**
- **Normalizes data distribution (?)**
- **Reduces analytical costs compared with multiple discrete samples (?)**



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MULTI-INCREMENT SAMPLING VIDEO

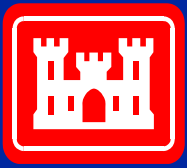




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SAMPLING ERRORS ADDRESSED BY MIS

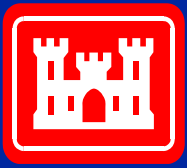
- **Compositional heterogeneity: not all particles within a population have the same concentration of target analytes**
 - Maximum when analyte is present as a few discrete particles of pure material
- **Distributional heterogeneity: contaminant particles scattered across the site unevenly**
 - Maximum when a single discrete sample is used to estimate the mean for a large decision unit



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BENEFITS OF MIS

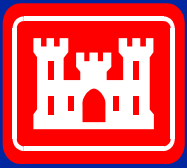
- **Reduces field sampling and laboratory subsampling processing induced errors**
- **Improves data reliability and better represents site characteristics**
- **Enables fewer samples for risk analysis (?)**
- **Reduces number of samples for lab analysis (?)**
- **Less chance for missed contaminants**



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SAMPLING DESIGN ISSUES

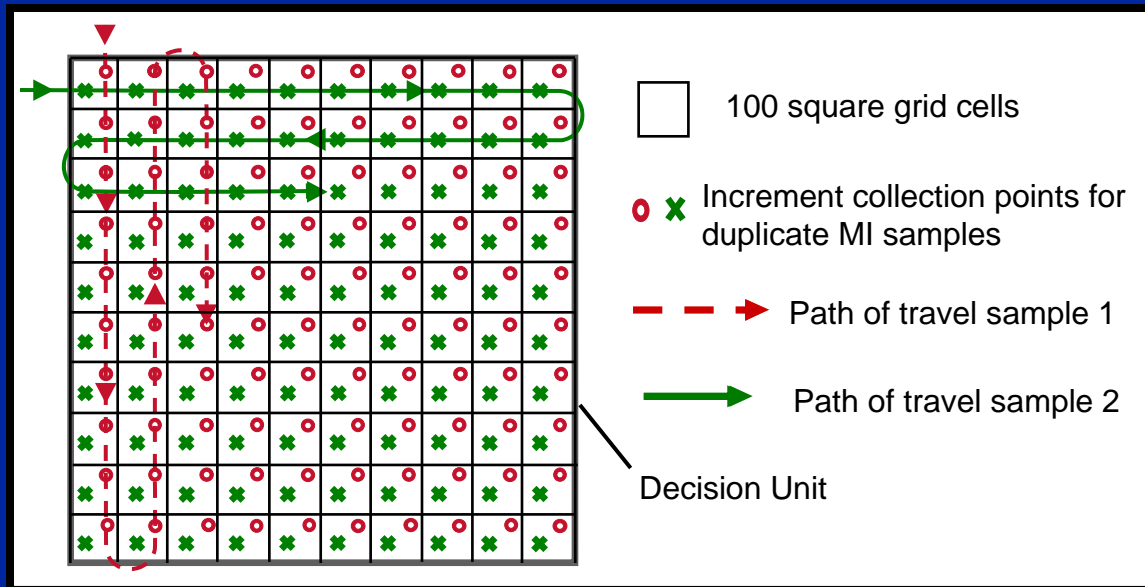
- **How is decision unit established?**
- **What should the sampling depth be?**
- **Three replicate samples recommended (is that enough?)(statistics?)**
- **May mask areas of “high concentrations” (i.e., hot spots)(do we care?)**
- **What are appropriate “action levels” based on multi-incremental samples?**



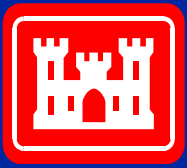
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SAMPLING DESIGN ISSUES

- How should increments be collected?
 - Systematic-random sampling design
 - Collection of replicate samples



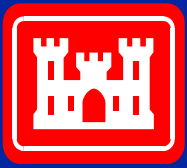
Systematic Random Sampling for collection of duplicate 100-increment MI samples (Figure after CRREL, 2007). Nomenclature per Pitard, (1993, Figure 21.8); CRREL; and EnviroStat, Inc. There are nomenclatural differences in increment collection schemes between those and EPA, 1995 (540/R-95/141) and EPA 1989 (EPA/230/02-89/042).



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SAMPLING DESIGN ISSUES

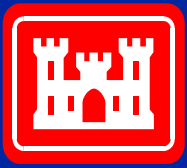
- **What should the sample mass be to overcome compositional heterogeneity?**
 - 1 kg or more
- **How many increments are necessary to overcome distributional heterogeneity within the decision unit?**
 - 30 grabs or more
- **How large of an area can be adequately characterized with a multi-increment sample?**
 - Decision unit is typically 25 to 10,000 m² (~2.5 acres)



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MIS ISSUES

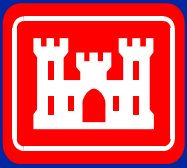
- **Field work requires anomaly avoidance**
- **Limited availability of labs for analysis**
 - “Only game in town” (elevated costs?)
 - Project schedule implications
- **Regulatory “push”**
 - USEPA Region 6
 - State of Alaska
 - State of Hawaii
- **Required by Army MMRP RI/FS guidance (draft)**



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LABORATORY ISSUES

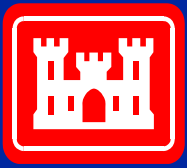
- **Must have space to air dry MI samples**
- **Must have grinding apparatus with adequate dust control to prevent cross-contamination**
- **Grinding may generate heat (volatilization and thermal decomposition)**
- **Must have an SOP for the MIS sub-sampling**



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RISK ASSESSMENT ISSUES

- **Vegetation included (normally removed)**
 - Analytical interferences?
- **Samples are taken at 0-2” (Method 8330B)**
 - Surface soil is normally 0-6” or 0-12”
 - Introduces high bias for the exposure point concentration (EPC)
- **Developed for surface soil sampling**
 - Applicable to subsurface soil sampling?

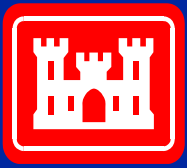


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RISK ASSESSMENT ISSUES

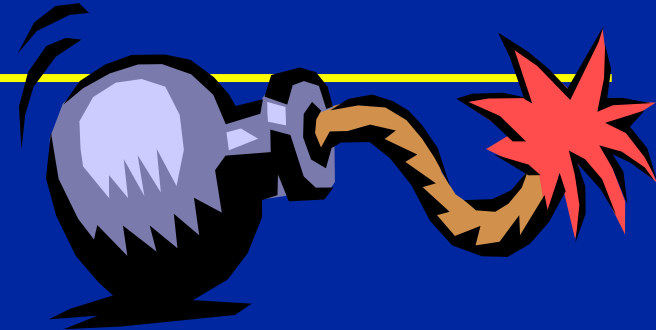
- **Particles >2 mm are removed**
 - Laboratory safety considerations (grinding)
 - Representative of actual exposures?
 - Available for analysis if required
- **Grinding turns soil into “talcum powder”**
 - Representative of actual exposures?



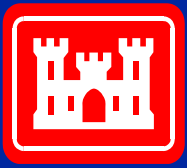


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RISK ASSESSMENT ISSUES



- **Derived for energetics**
 - Applicable to other analytes (i.e., metals)?
- **Grinding – may increase metals concentrations**
 - Due to bowl and puck?
 - Due to additional exposed surface area?
 - Can be duplicated for background samples
- **Does 95% UCL make sense?**



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MI GUIDANCE

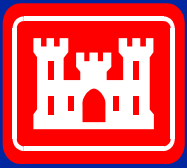
Alaska Dept of Environmental Conservation, Contaminated Sites Program

Draft Guidance on Multi-Increment Soil Sampling

March 2007

- Initially for POL only (GRO, DRO, RRO, BTEX, PAHs).
- Characterization of surface release (i.e., AST)
- Confirmation sampling
- VOC-specific procedures

http://www.dec.state.ak.us/spar/csp/guidance/multi_increment.pdf



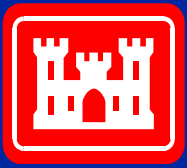
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ALASKA GUIDANCE



“For sites with multiple, similar, decision units, a minimum of one triplicate sample set must be collected for every 10 decision units or at a rate of 10%.

Additional triplicate samples may be required based on site conditions and/or **non-similarity of the decision unit(s).**”

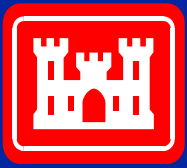


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ALASKA GUIDANCE

- Decision unit is the source area
- Requires triplicate samples
- Calculation of RSD (must be $< 30\%$), assumes normal data distribution
- Calculation of 95% UCL (student t factor)

$$a^2 + b^2 = c^2$$



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MORE MI GUIDANCE

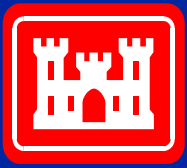


NEW!

State of Hawaii, Department of Health
***TECHNICAL GUIDANCE MANUAL
FOR THE IMPLEMENTATION OF THE
HAWAII STATE CONTINGENCY PLAN***

- Interim Final-November 12, 2008*
- Addendum to Screening for Environmental Concerns at Sites With Contaminated Soil and Groundwater*

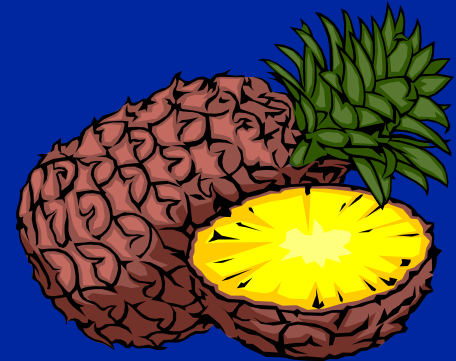
<http://www.hawaiidoh.org/tgm.aspx>

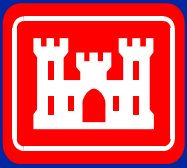


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HAWAII GUIDANCE

- **Decision unit – “an area where a decision is to be made regarding the extent and magnitude of contaminants with respect to the environmental concerns posed by the contaminants”**
- **Environmental concerns:**
 - Direct exposure to the soil
 - Vapor intrusion
 - Leaching to groundwater
 - Toxicity to terrestrial flora and fauna
 - Gross contamination (odors, explosive hazard, etc)



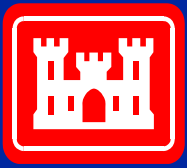


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HAWAII GUIDANCE



- For sites where a multi-increment sampling strategy was used to collect samples, the duplicate and triplicate sample data allows for statistical calculation of several important quantities, including the standard deviation, the relative standard deviation, and the 95 percent (%) upper confidence level (UCL) on the mean.
- If the decision units are heterogeneous, duplicate and triplicate samples must be collected from each decision unit to calculate the 95% UCL for each decision unit.



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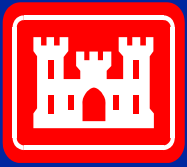
USACE GUIDANCE

Interim Guidance for Implementation of Multi-Increment Soil Sampling (MIS) for the Military Munitions Response Program

Draft, 08 December 2008

- Decision units
- Sample Collection
- Laboratory Considerations

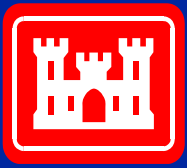
Next revision expected mid February



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MIS SUMMARY

- **Provides an average concentration over the decision unit (95% UCL?)**
- **May mask hot spots**
- **May not be appropriate for all areas, all sites or all contaminants**
- **Systematic Planning Process!!!!!!!!!!!!!!!**
- **Training opportunities available thru Envirostat and CRREL**



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MIS: What It Is And What It Does For Site Characterization And Risk Assessment

QUESTIONS?

Terry L. Walker

Risk Assessor

**Environmental and Munitions Center
of Expertise**

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