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Real-Time Adaptive Sampling and Analysis Approaches to Cleanup: Challenges, Benefits, Technical & Cost Successes

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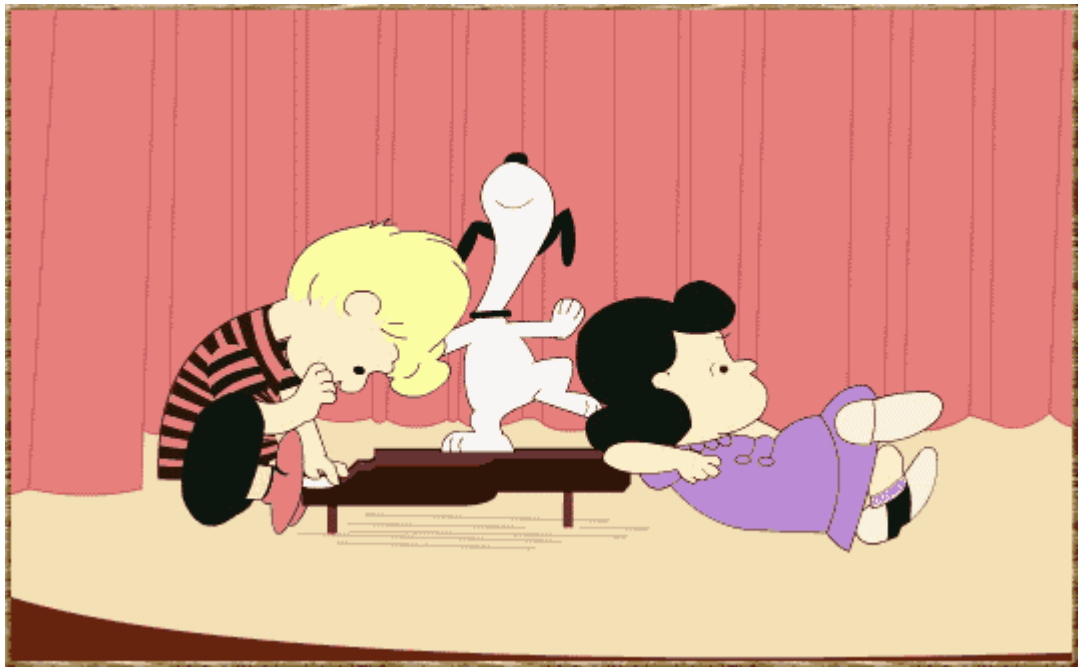
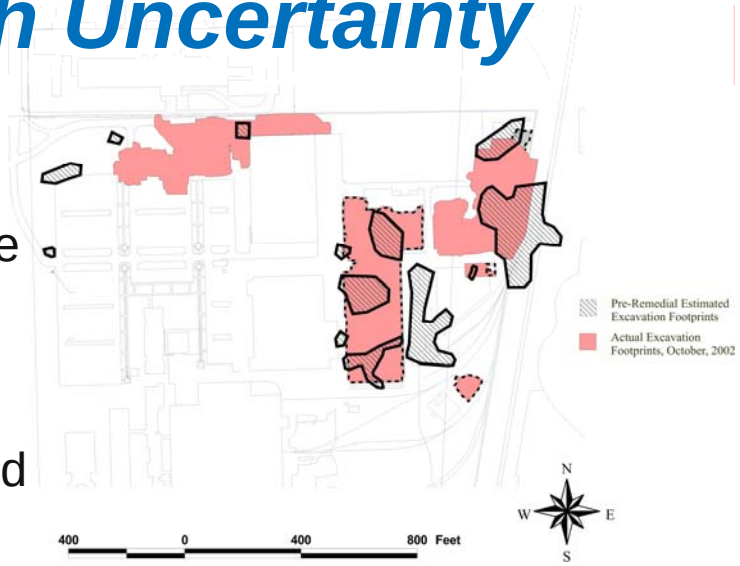
Happy Birthday Steve Meiners!!!!!



Experience Has Demonstrated that Cleanup Work Is Filled with Uncertainty

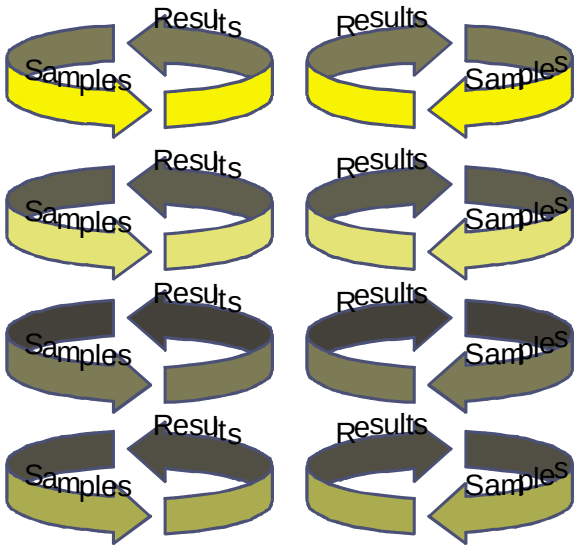
- Hog-and-haul for contaminated sediments and soils
  - Removed volumes always greater than those estimated during the design phase
- Recent DOE Ohio experience:
  - Fernald, 817,500 yd^3 more soil than expected requiring off-site disposal
  - West Jefferson, three times as much soil as expected
  - Mound, twice as much soil as expected
- Complicates:
  - Program planning
  - Cost estimation
  - Remedial design and implementation



Data Collection to Support Decisions is Critical for Addressing Those Uncertainties

CERCLA *(Comprehensive Environmental Response, Compensation and Liability Act*

- Discovery; Preliminary Assessment (PA)
- Site Investigation (SI)
- Extended Site Investigation (ESI)
- Remedial Investigation/Feasibility Study (RI/FS)
- Remedial Action



RCRA *(Resource Conservation and Recovery Act)*

- Discovery
- RCRA Facility Assessment (RFA)
- RCRA Facility Investigation (RFI)
- Corrective Measures Study (CMS)
- Corrective Measures Implementation (CMI)

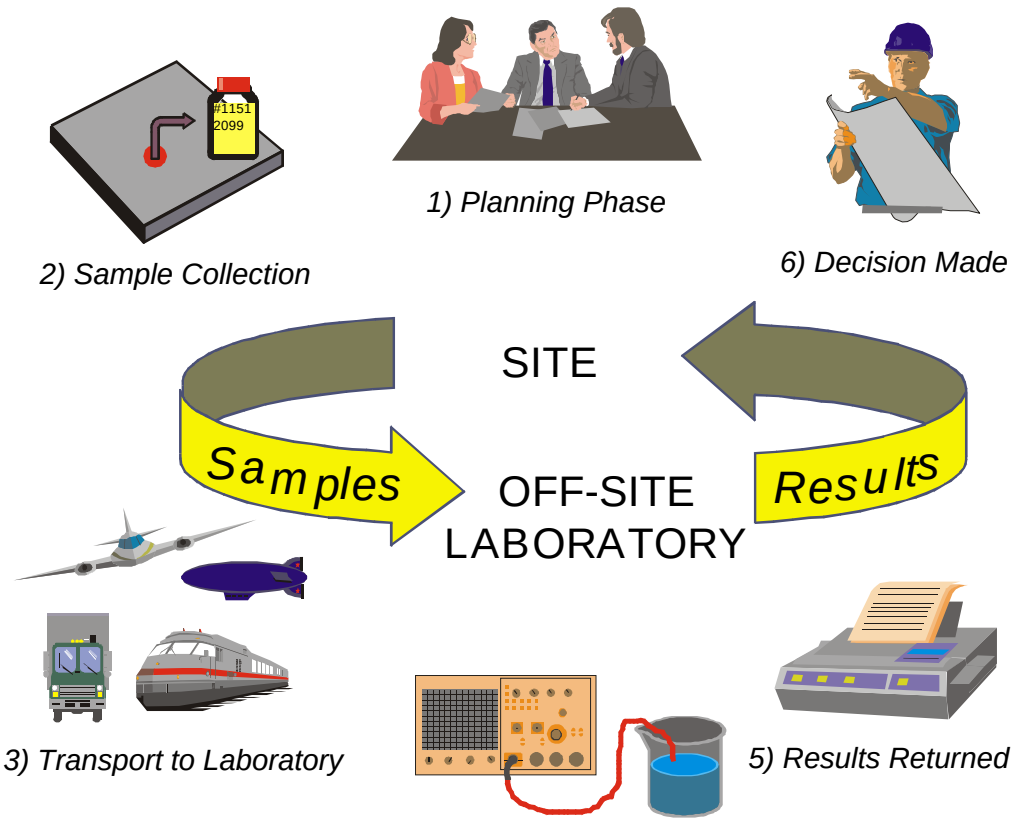
Standard Sampling and Analysis Programs Are Expensive & Problematic

Characteristics:

- **Preplanned Sampling**
- **Off-Site Lab Analyses**

Problems:

- **High cost per sample**
- **Surprise results**
- **Pressure to over-sample**
- **Multiple trips to the field**



The Alternatives Go by Many Names…

- Observational Approach (geotechnical engineering)
- Adaptive Sampling and Analysis Programs (ANL)
- Expedited Site Characterization (ANL)
- Sequential sampling programs
- Directed sampling programs
- EPA Technology Innovation Program's Triad Approach

…But All Share Common Themes:

- **Systematic Planning** (pulling together all information for a site to influence sampling program design, including specification of exactly what decision needs to be made)

- **Dynamic Work Strategies** (emphasis not on dictating sample numbers and locations, but on how these decisions will be supported in the field)

- **“Real-Time” Measurements** (providing data quickly enough to influence the outcome of the program)

Adaptive Sampling and Analysis Programs Can Cut Costs Significantly

Characteristics:

- Real-time sample analysis
- Rapid field decision-making

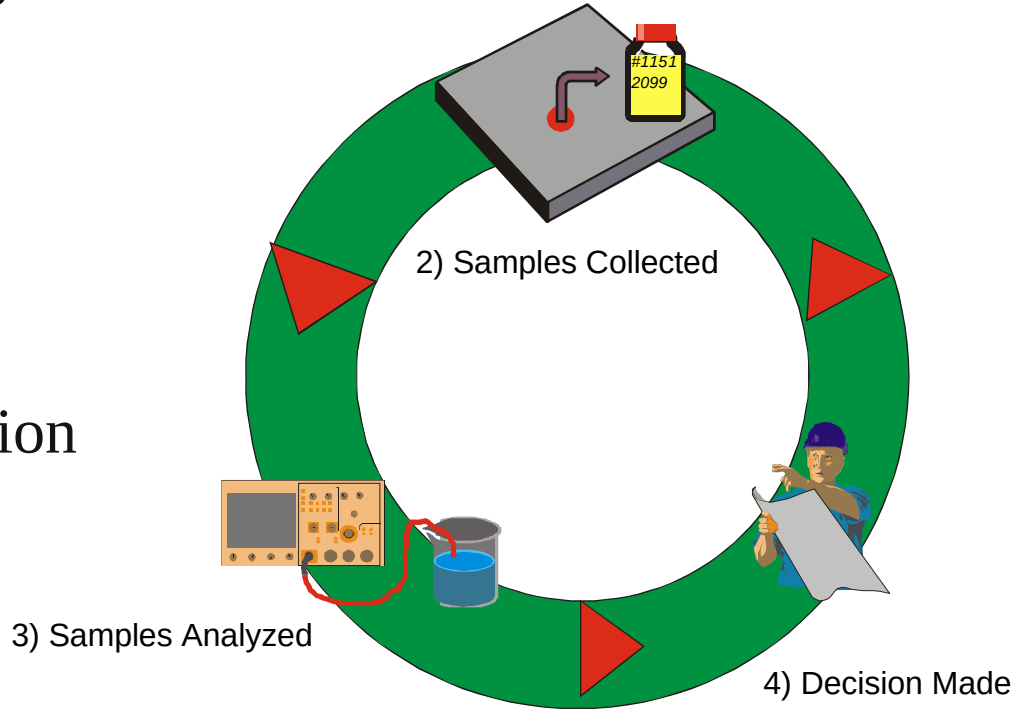
Advantages:

- Reduce cost per sample
- Reduce # of samples
- Reduce # of programs
- Achieve better characterization

Requirements:

- Real-time method
- Decision support in the field

1) Planning Phase



Argonne's Experience Shows Consistent Results Across a Wide Range of Settings

Sandia National Laboratories

- Subsurface chromium contamination
- Estimation of contaminated soil volumes;
- Number of bores reduced by 40%, samples by 80%.

Kirtland Air Force Base

- Mixed waste burial trenches;
- Estimation of contaminated soil volumes;
- Number of bores reduced by 30%, samples by 50%.

Argonne National Laboratory

- Near surface VOC soil contamination;
- Estimation of extent;
- Number of samples reduced by 60%.

Brookhaven National Laboratory

- Subsurface mixed waste contamination;
- Estimation of contaminated soil volumes;
- Cost estimates for removal action reduced from $40M to $8M.

Fernald Site

- Radionuclide soil contamination;
- Support excavation design and execution;
- Expected to reduce $80M sampling to less than $40M.

Joliet Army Ammunition Plant

- Surface TNT soil contamination;
- Estimation of contaminated soil volumes;
- Per sample costs reduced by 80%.

FUSRAP Painesville Site

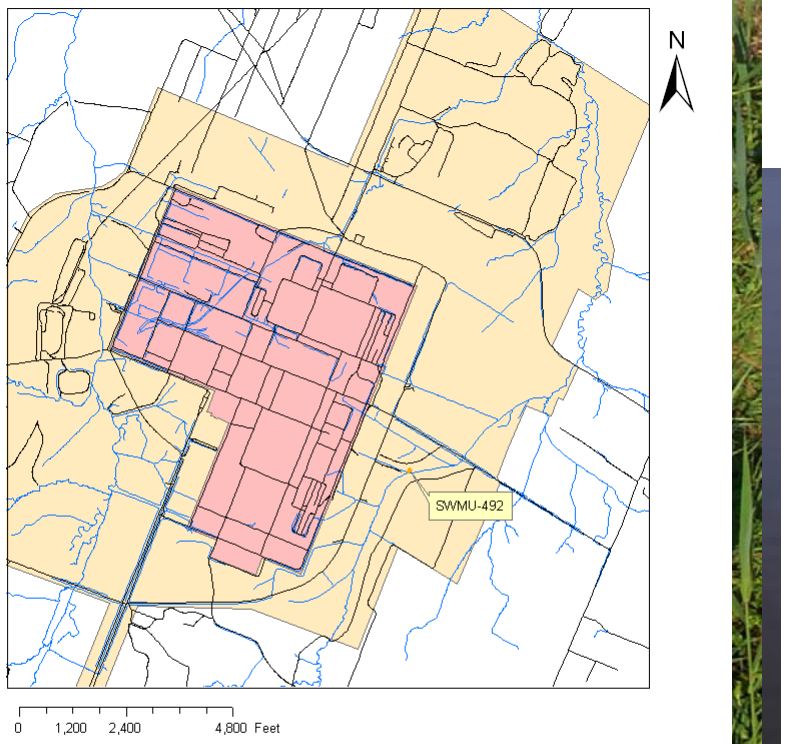
- Mixed waste soil contamination;
- EE/CA support;
- Overall project savings estimated at $10M.

FUSRAP Ashland 2

- Radionuclide soil contamination;
- Precise excavation support;
- Overall project savings estimated at $10M.

Real-Time Demonstration Project Applies These Approaches to Soils at Paducah

- Primary target is soils and four different real-time technologies:
  - XRF for metals (including uranium)
  - Test kits for PCBs
  - GPS-logged gamma walkover surveys, and
  - In situ gamma spectroscopy
- Target area is currently AOC-492
  - Known PCB and U contamination
  - Part of larger soil piles issue

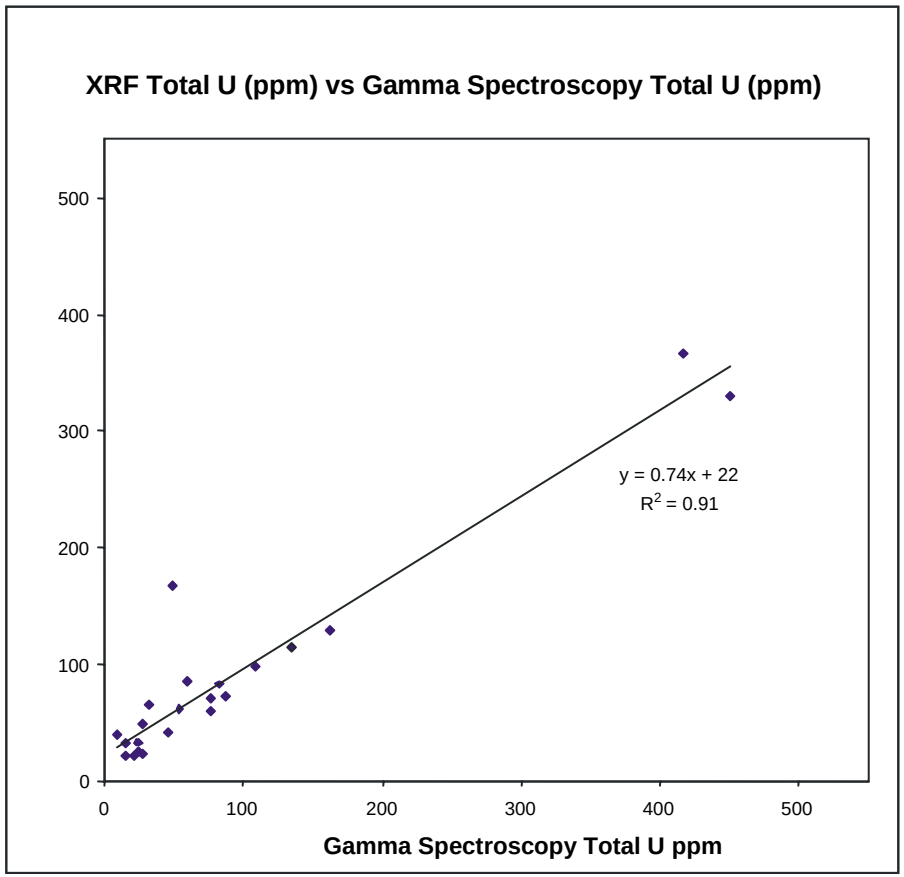


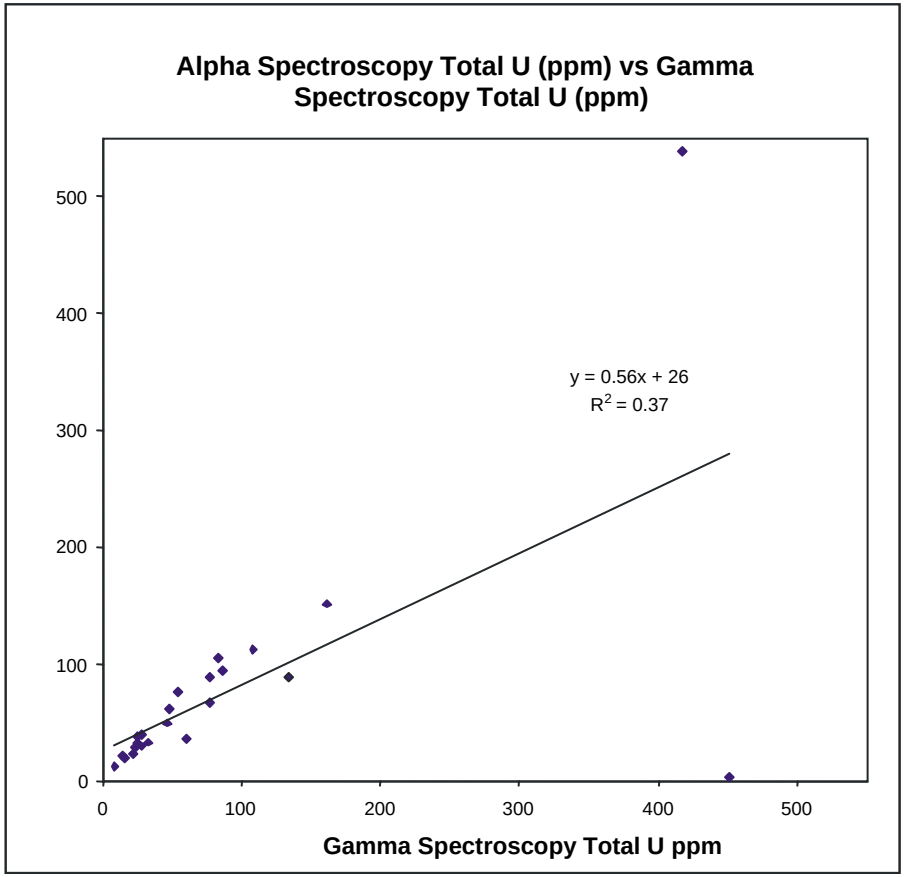
Field Deployable XRF Technologies Provide Significant Advantages for Uranium in Soils

- First used at Ashtabula for uranium in the late 1990s, maturing since
- Costs per measurement are significantly less than traditional laboratory
- Can be deployed for in situ readings, for measuring through bagged samples with minimum sample prep, or on prepared samples
- Measurement times can be as short as 30 seconds, providing “real-time” data
- Detection limits currently in the 10 – 20 ppm range (total U), but dropping
- Off-the-shelf units calibrated for 20+ metals
- Custom calibration required for uranium

Definitive Data, Please Stand Up!

Set of samples analyzed with three different methods for uranium, via XRF (bagged samples), gamma spectroscopy (sample prep, but no extraction), and alpha spectroscopy (sample prep with extraction required)



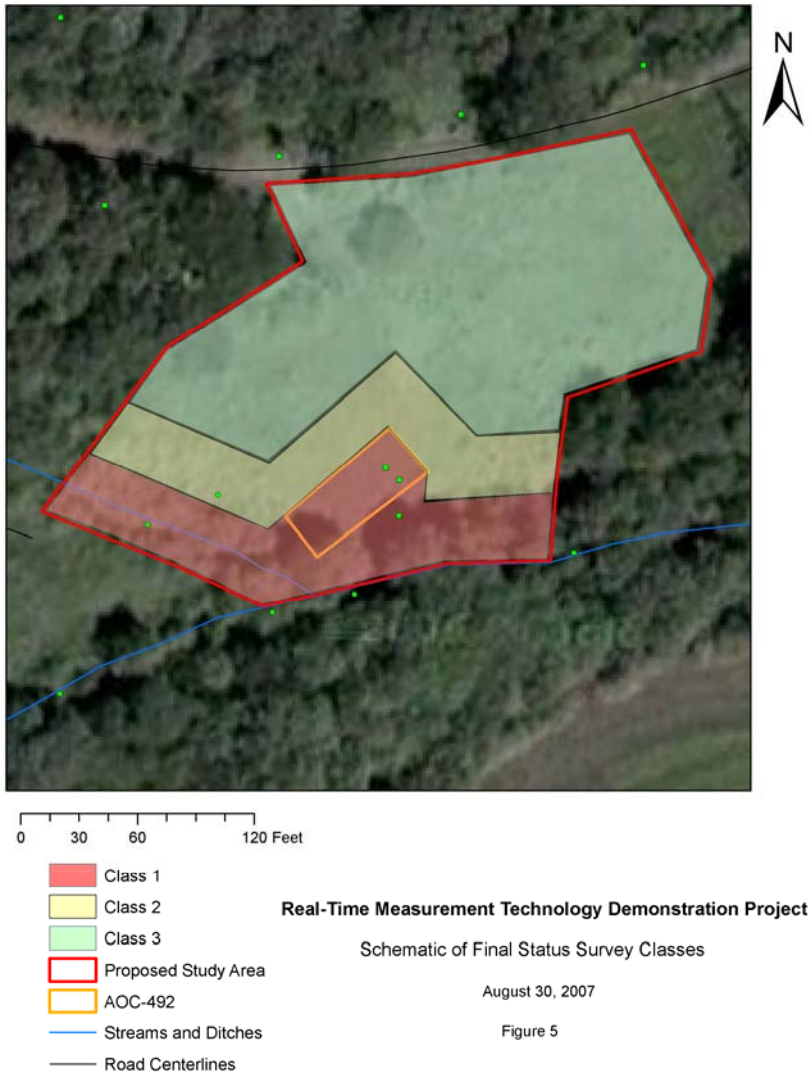


Objectives of the Real-Time Demonstration Work Include:

- Show dynamic work strategies and real-time measurement technologies can be used to:
  - Determine the presence or absence of contamination at levels of concern
  - Support excavation work if required
  - Assist in final status survey decision-making to close out areas
- Establish technology performance parameters in the context of Paducah soils/contaminants and identify optimal deployment strategies
- *Goal is to get as near to no action levels as possible.*

Closure Strategy Modeled After MARSSIM Guidance

- Class 1, 2, and 3 area concepts used
- Data collection graded by area classification
- Demonstrating compliance with both area-averaged cleanup goals and hot spot levels



Proposed Field Work at Paducah Use a Variety of Dynamic Work Strategies

- Targeting specific locations for more intensive sampling
- Carving site into smaller areas where data collection can be customized based on degree of contamination concerns
- Deploying adaptive compositing strategies
- Supporting real-time decision-making during excavation
- Implementing targeted off-site laboratory QC and verification analyses
- Optimizing data collection performance (e.g., how many samples to composite during adaptive compositing, how many XRF measurements to take for bagged samples, best XRF measurement acquisition times, etc.)
- Consolidating characterization, excavation, and closure data collection into one field effort

Significant Data Collection Will Take Place Within Small Window of Time

- Logged GWS of study area, data used to:
  - break study area into three general areas for closure purposes
  - Identify up to 20 locations for targeted sampling/measurement acquisition (XRF, in situ HPGe, test kits analyses)
- Data collected from 20 locations used to:
  - interpret GWS results
  - gain understanding about short-scale heterogeneity associated with contaminated soils
- Implement adaptive compositing strategies for Class 1 and Class 2 areas
  - target PCB hot spot concerns (looking for 25 m^2 areas)
  - compositing more aggressive in Class 2 areas, less so in Class 1
  - screening using real-time techniques, verification with lab analyses
- Support excavation work in areas known to exceed no action level
  - support precise excavation through dig-face screening

Proposed Demonstration Activities Build on Experience PRS is Currently Gaining

- PRS deploying logged gamma walk-over surveys, XRF, PCB test kits, and ex situ HPGe gamma spec as part of Soil Piles efforts
- Soil Piles I work made use of these techniques primarily in “testing” mode
- Hope is that PRS’s experiences and outcomes from this demonstration converge as data collection and soils remediation activities move forward at the site

Questions?