Site Characterization for Improved Remediation

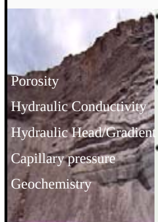
FRTR June 25, 2015

Stephen Dyment
EPA OSRTI
703-603-9903
dyment.stephen@epa.gov

Recent Experience Leads to New Thinking

Optimization and Technical Support → Identify challenges and opportunities

Good characterization- series of best practices → A set of methods or techniques found to be the most effective and practical means in achieving an objective while making the optimum use of resources



- **Historical perspective**
  - Soil- EPA Superfund has historically focused on high quality analytical samples collected at discrete soil locations
  - Groundwater- EPA has historically used monitoring wells, pump tests, etc. to characterize and monitor sites
- **Challenges encountered**
  - Discrete soil sampling designs do not address matrix variability/heterogeneity- resulting in highly variable or statistically uncertain decision making
  - Large scale averages of aquifer materials obscure primary contaminant transport and mass storage areas
- **New thinking**
  - Soil- Incremental and composite techniques that provide large scale averages are better suited to represent exposure scenarios, control matrix variability/ sample heterogeneity, and make statistically confident decisions
  - Groundwater- large scale averages derived from aquifer materials can be misleading resulting in poorly performing or applied remedies. HRSC techniques provide measurements at scales more appropriate for remedy design.

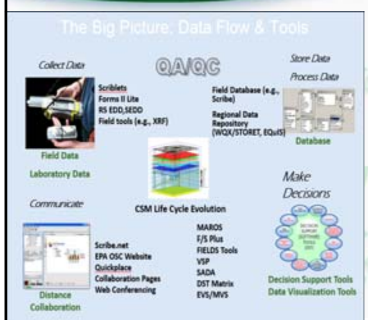
Recent Successes Highlight Focus Areas

Comprehensive team formation | Adaptive site management | Project life cycle CSM | Stakeholder outreach | Systematic planning | Dynamic work strategies | Real-time measurement technologies | Demonstration of method applicability | High resolution collaborative data | 3-D visualization and analysis | Data management and communication | Optimization

- **Data management**
  - Historically reports as mechanism to exchange information, now data as deliverable, active data management
  - Data warehouse, data interoperability, economies of scale
- **High Resolution Site Characterization**
  - Direct sensing tools, scale appropriate measurements
  - Collaborative data approaches
- **Real-time data visualization**
  - Conceptual Site Model (CSM) lifecycle management

Data Management is Key

Plans required- Region, Site, Project

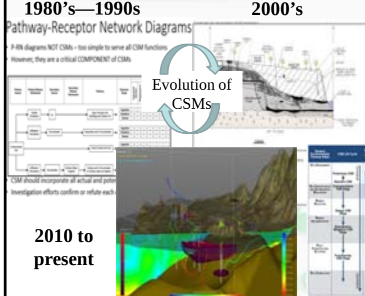


- **Data acquisition**
  - Occurs quickly, involves large amounts of data
  - Data must be integrated into CSM quickly to inform continued data acquisition while mobilized
- **Data input**
  - Automatic/manual systems to QC at point of generation accurately transfer to databases
- **Decision Support**
  - Statistical, visualization, modeling
- **Communicate**
  - Force interpretation, compress timeframes

Data Management Leads to A Robust Conceptual Site Model

"As we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say we know there are some things we do not know. But there are also unknown unknowns, the ones we don't know we don't know."

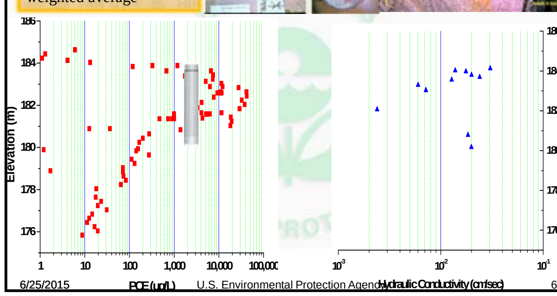
Donald Rumsfeld,
Feb. 12, 2002
U.S. Department of Defense

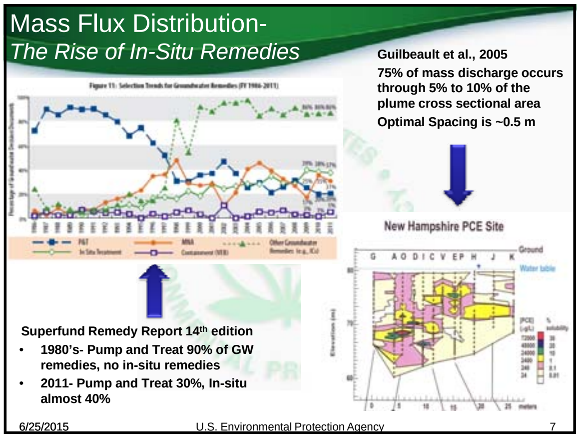


Environmental Cleanup Best Management Practices: Effective Use Of The Project Life Cycle Conceptual Site Model. EPA 542-F-11-011

Sampling Scale and Averaging

Monitoring wells yield a depth integrated flow weighted average




Mass Flux Distribution-
The Rise of In-Situ Remedies
Guilbeault et al., 2005
75% of mass discharge occurs through 5% to 10% of the plume cross sectional area
Optimal Spacing is ~0.5 m
New Hampshire PCE Site
Superfund Remedy Report 14th edition
• 1980's- Pump and Treat 90% of GW remedies, no in-situ remedies
• 2011- Pump and Treat 30%, In-situ almost 40%
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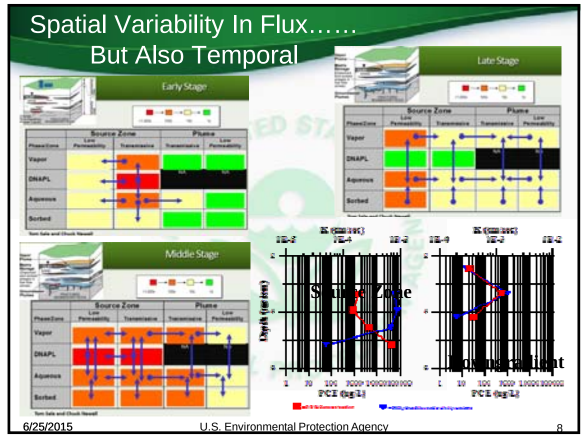
Spatial Variability In Flux……
But Also Temporal
Early Stage
Middle Stage
Late Stage
Source Zone
Plume
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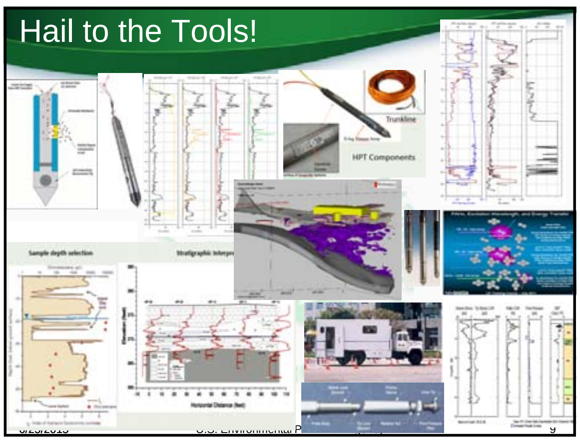
Hail to the Tools!
Trunkline
HPT Components
Sample depth selection
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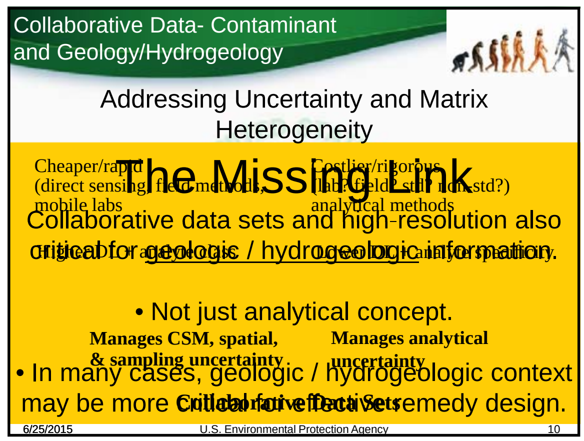
Collaborative Data- Contaminant and Geology/Hydrogeology
Addressing Uncertainty and Matrix Heterogeneity
The Missing Link
Cheaper/rapid (direct sensing, field methods, mobile labs
Costlier/rigorous (lab? field? std? non-std?) analytical methods
Collaborative data sets and high-resolution also critical for geologic / hydrogeologic information.
• Not just analytical concept.
Manages CSM, spatial, & sampling uncertainty
Manages analytical uncertainty
• In many cases, geologic / hydrogeologic context may be more critical for effective remedy design.
Collaborative Data Sets
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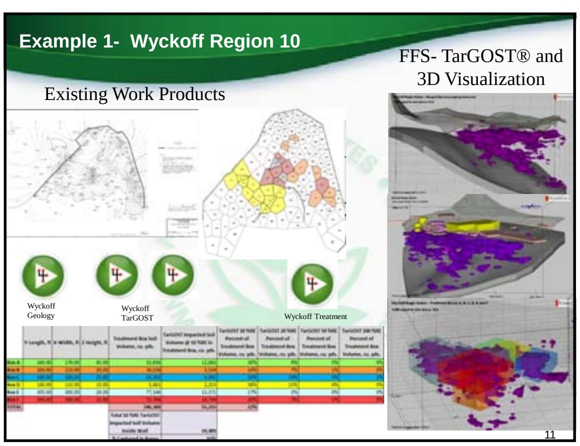
Example 1- Wyckoff Region 10
Existing Work Products
FFS- TarGOST® and 3D Visualization
Wyckoff Geology
Wyckoff TarGOST
Wyckoff Treatment
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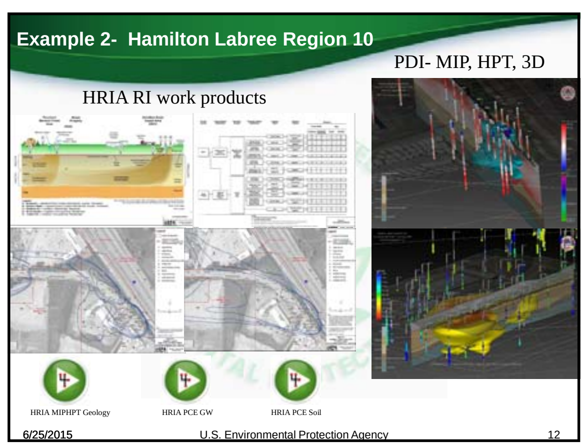
Example 2- Hamilton Labree Region 10
HRIA RI work products
PDI- MIP, HPT, 3D
HRIA MIPHPT Geology
HRIA PCE GW
HRIA PCE Soil
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Conclusions

HRSC and Incremental Sampling
Translated for Remedial Designs

- **In Groundwater**
  - Limit large scale averaging, use scale appropriate measurements
  - Use transects and multi-level sampling
  - Use direct sensing and collaborative data sets
- **In Soil**
  - Use incremental and compositing techniques to control matrix variability, reasonably represent exposure and decision units
  - Many increments and replicate samples provide- good estimate of mean, and ability to calculate UCL/LCL and statistical confidence
- **Real-time CSM Updates/Data Visualization**
  - Forces interpretation not just presentation
  - Includes all decision makers in the process- consensus, streamline
  - Save time and money- fewer repeat mobilizations, early ID of data collection errors
  - Keeps focus on root causes not symptoms- High mass footprint (where to remediate), Matrix distribution (how to remediate)