Monitoring Techniques and Sensors

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Outline

- Where long-term monitoring is headed
- Available sensor/monitoring technologies
- Emerging technologies and strategies

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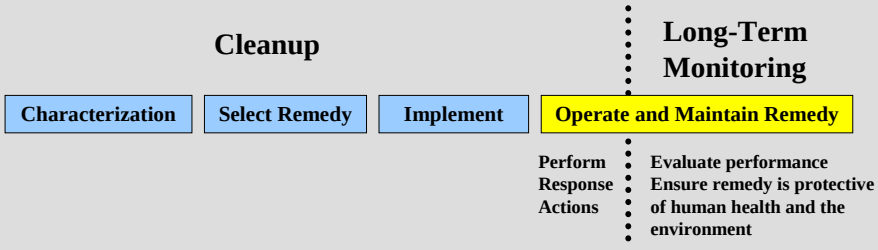
Time Line for Waste Site Cleanup



Modified from DOE, 2001

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Where LTM might be headed

Picture taken by Robert Del Tredici
Granite Marker, Cook County, Illinois
This granite block marks the location of buried radioactive materials that include wastes relocated from Enrico Fermi's uranium-graphite pile at the University of Chicago.

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DOE Sponsored Resources Available for Consideration

Long-term Monitoring Sensor and Analytical Methods Workshop Orlando, FL June 13-15, 2001

Long-term Stewardship Study, October 2001, US Dept of Energy

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DOE Technical Targets

In 2002, DOE identified 14 critical technical targets for completing the Environmental Mission at its sites. One technical target was ***Methods to Verify and Validate Performance*** which includes the Long-term Monitoring concept.

Ref. Technical Targets Document, DOE 2002

Verify and Validate Performance

Recognizes the need to deploy better short term performance monitoring systems and develop alternative verification and monitoring techniques to ensure long-term stability of past waste sites.

Ref. Technical Targets Document, DOE 2002

Overall LTM Strategy

- Characterization of system
- Prediction of contaminant fate and movement
- Monitoring system to verify and validate

Ref. Technical Targets Document, DOE 2002

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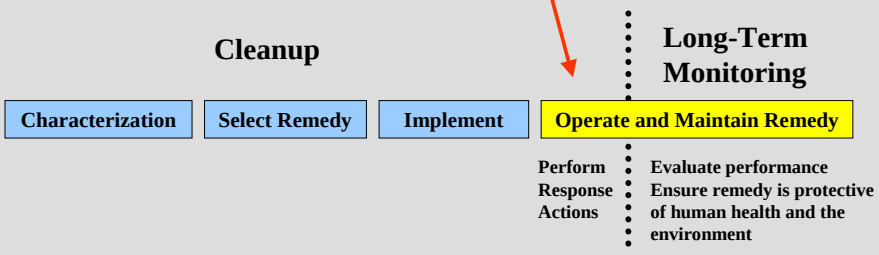
Time Line for Waste Site Cleanup

"Initial phase" performance monitoring tools



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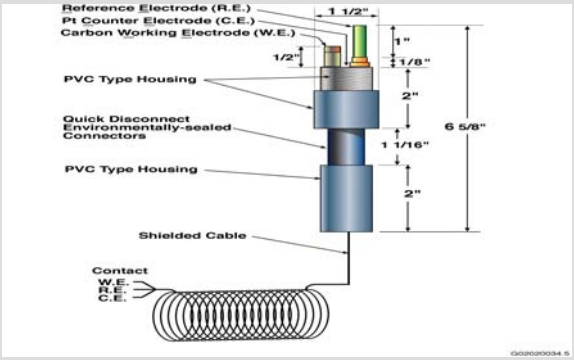
TNT Sensor

Electrochemical Sensor able to measure Nitroaromatic explosives (TNT and tetryl) and TNB in aqueous solutions.



Technology Maturity
- ✘ Laboratory
- Field tested
- Deployed

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Microsparger

Accurately measures VOC in the field in real-time.

Based on the conversion of dissolved volatiles into the vapor phase where it can be measured with commercial VOC gas analyzers

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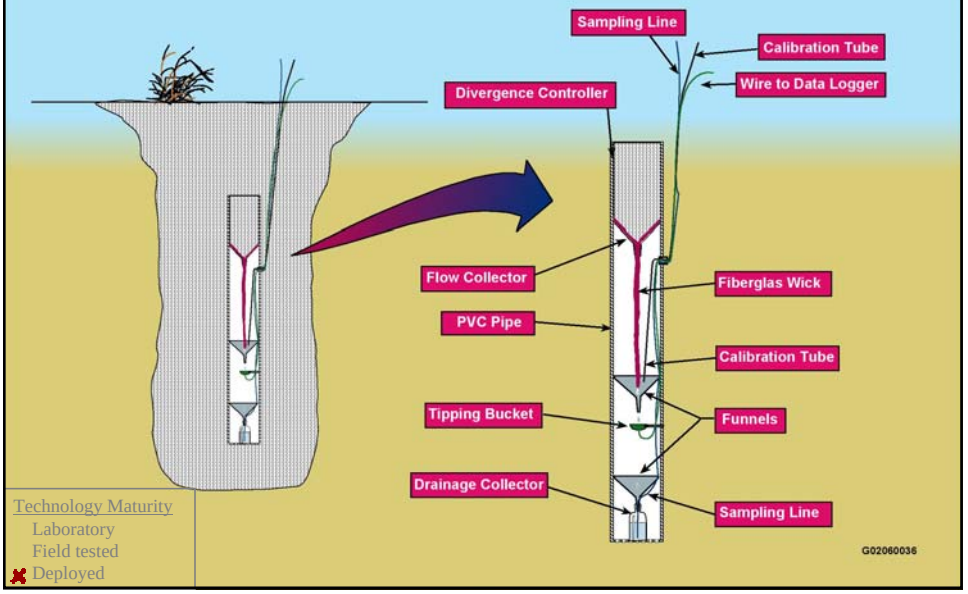
Water-Flux Meter with Solution Collector



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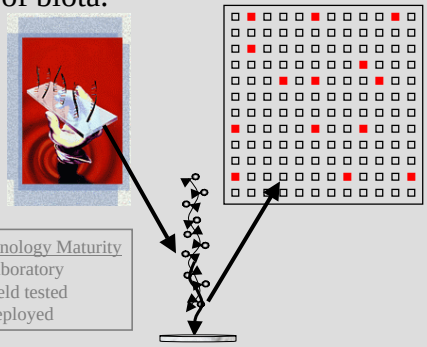
Biological Indicators

Sensors are deployed into hazardous environments to directly measure physiological or toxicological response of biota.



Technology Maturity
- ✘ Laboratory
- Field tested
- Deployed

DNA Microchip Arrays

Non-Animal Toxicity Protocols

Molecular Based Sensors

Sediment Toxicity Sensors

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Listing of Sensor Devices

- ~200 sensors (emerging to deployed)
- Developed for a wide-range of technical areas including
  - environmental
  - atmospheric
  - process monitoring
  - material property sensing
  - national security applications
- Many applicable to LTM, see information at http://www.technet.pnl.gov/sensors/

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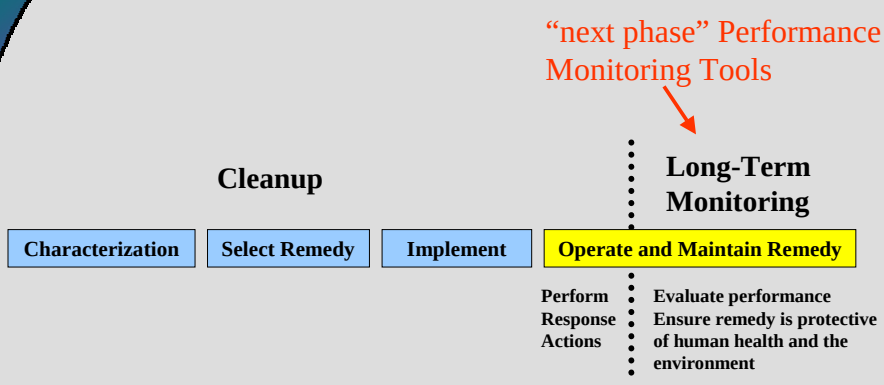
Time Line for Waste Site Cleanup



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Considerations for Long-term Monitoring

- Indicator parameters
- Volumetric/flux measurements
- Failure indicators built into system
- Measurements directly related to risk
- New strategies for monitoring
- Long-term Administration Control

Examples of Built-in Failure Indicators

- Built-in sensors to determine structural integrity of barrier or caps
  - Slope indicators
  - Resistivity of layers
  - Tracers released at failure point

Volumetric Measurements

- Geophysics techniques (changes from baseline)
  - Resistivity
  - Electromagnetic
  - "Whole-earth type sensors"
- Couple point measurements with volumetric measurements to meet requirements with sparser monitoring grids

Change in Monitoring Concept

- False positives as opposed to current false negatives
  - First alert system, "Sentinel"

Current and Continuing Challenges

- There is a need to develop and deploy better short-term performance monitoring systems
- Alternative verification and monitoring technologies and strategies need to be developed for long-term applications

LTM Path Forward

- Capitalize on evolving measurement methods
- Focus LTM on indicator parameters based on fate and transport
- Develop rationale for sampling schedule
- Provide for periodic review of data and revision of sampling program
- Allow for further developments in monitoring technology