# The Advanced Monitoring System Initiative: Optimizing Delivery and Application of New Sensor and Monitoring Solutions

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# Advanced Monitoring Systems Initiative (AMSI)

- Operated by:
  - Nevada Site Office of the U.S. DOE and
  - Bechtel Nevada
- Funds provided by:
  - DOE EM Office of Science and Technology
- Mission:
  - Accelerate the development and ***application*** of advanced monitoring systems

# AMSI Operating Characteristics

- Focuses its resources on high-impact solutions to end-user needs and is driven by end-user application requirements.
- Looks for strong end-user support, including
  - co-funding of the proposed work and
  - commitment to include in end-user baseline.
- Emphasizes partnership to accomplish its work.
- Emphasizes late stage engineering, test and evaluation in end-user application conditions
- Does not fund research projects.

# AMSI Emphases

- Emphasizes the importance of remote and automated, unattended operation
- Emphasizes internet communication in sensor and monitoring system operation, for
  - Data recording, display, and summarization
  - Information sharing
  - Instrument control
- Employs the spiral development model,
  i. e., build-a-little, test a little, repeat.

# AMSI Resources


**Nevada Test Site**


**HazMat Spill Center**

# AMSI Resources

- **Nevada Test Site (NTS)**
  - **Hazardous Materials (HazMat) Spill Center**
    - a one-of-a-kind facility permitted for releases of hazardous materials for training and testing under controlled conditions
  - **National Center for Combating Terrorism (NCCT)**
    - newly created center for training first responders to terrorist acts
    - no other place in the U.S. where all combating terrorism activities can be addressed in an integrated manner

# Other AMSI Resources

- Industry
- Universities
- National Laboratories
- *Bechtel Nevada*
- *Special Technologies Laboratory*
- *Remote Sensing Laboratory*
- *Desert Research Institute*
- *Nevada Universities*

# AMSI Monitors for Rads & Metals

- **Tritium**
  - in the vadose zone
  - in groundwater
- **Technetium-99 in groundwater**
- **Strontium-90 in groundwater**
- **Wireless sensor platform**
  - Landfill performance
- **Universal sensor platform**
  - Cr(VI) in groundwater

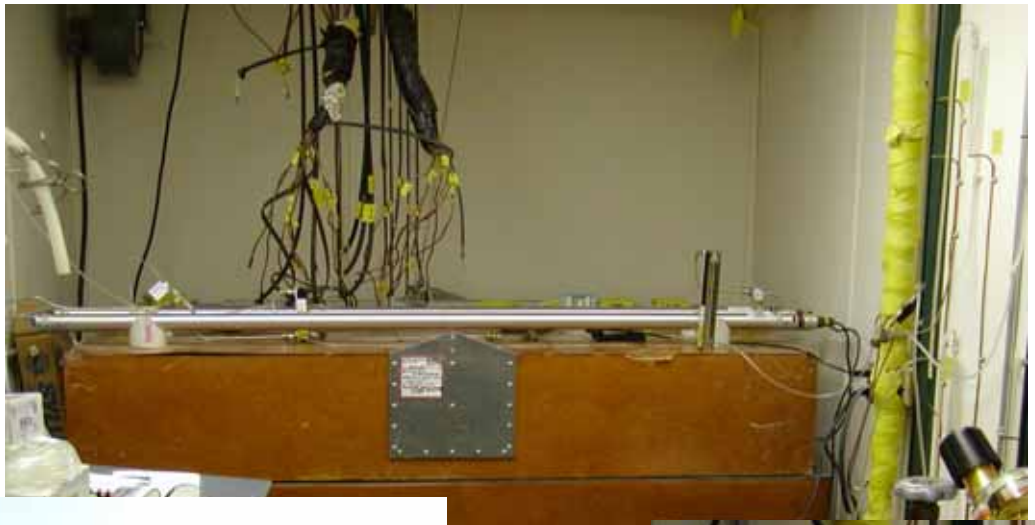
# Monitoring Tritium in Vadose Zone

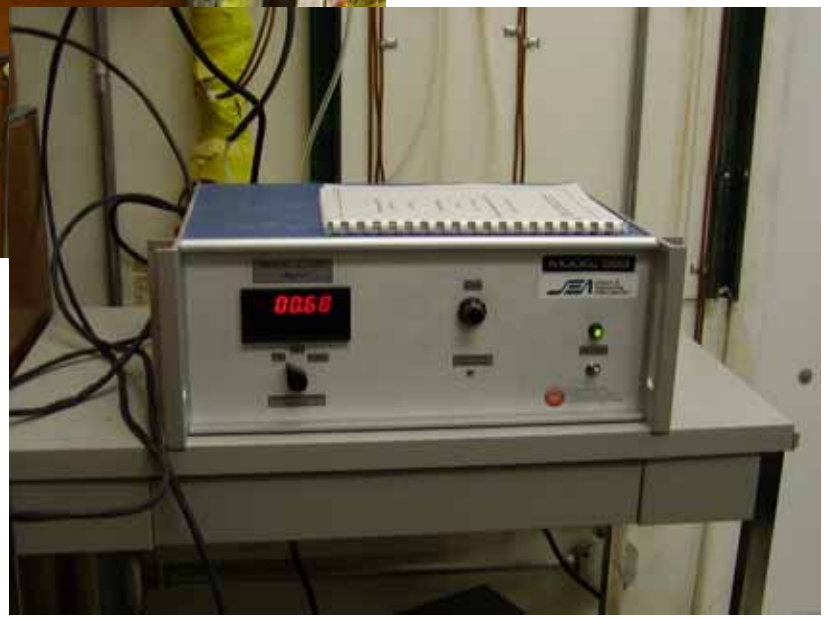
- **Purpose**
  - Monitor for escape/migration of tritium from nuclear waste containments
- **Benefit**
  - Early detection can stimulate early action to stop the escape/migration; avoid higher remediation and potential health costs
- **Customer**
  - NTS, SRS, Hanford, BNL are potential customers

# Monitoring Tritium in Vadose Zone

- **Developer**
  - Science and Engineering Associates, Inc., Santa Fe, NM
- **Technology Characteristics**
  - Uses gas proportional counting
  - LOD < 100,000 pCi/liter water
  - Future: Condense water vapor & use Proton Exchange Membrane to separate H and T from Oxygen prior to counting

# Monitoring Tritium in Vadose Zone





At NTS Greater Confinement Disposal site
AMSI

# Monitoring Tritium in Groundwater

- **Purpose**
  - Monitor for migration of tritium and contamination of groundwater
  - #1 need identified in the metals & rads sessions of the Long-Term Monitoring Sensor and Analytical Methods Workshop, Orlando, FL, June 2001
- **Benefit**
  - Estimated savings of $65K/well/y in avoidance of mobilization of personnel and equipment for sampling and analysis to fulfill regulatory requirements (FFCAs & COs)

# Monitoring Tritium in Groundwater

- **Customer**
  - NTS Groundwater Monitoring Program.
  - Other potential customers include LBNL and SRS.
- **Developer**
  - Science and Engineering Associates, Inc., Santa Fe, NM
  - Univ. of Nevada, Reno

# Monitoring Tritium in Groundwater

- **Technology Characteristics**
  - Needs daily measurement at 800 to 5000 bgs and at tritium levels of 1000 (300) to 200,000 pCi/L
  - UNR reacts water with NaK to produce H & T gas; uses a proportional counter to measure beta decay of the tritium; finally captures H & T on getter. Requires replenishment every 50-100 days
  - SEA will condense water and HTO from the sparge sampling stream (P10) and use a Proton Exchange Membrane module to separate H and T from oxygen prior to counting. Target LOD < 20,000 pCi/l = DWS

# Monitoring Tc-99 in Groundwater

- **Purpose**
  - in situ monitoring of Tc-99 to monitor plume migration and performance of remediation activities.
- **Benefit**
  - faster, cheaper method of monitoring plume migration and effectiveness of Tc-99 remediation processes at the Hanford site (approx. one day turnaround vs 30 to 45 day turnaround for baseline method; no mobilization for sampling).

# Monitoring Tc-99 in Groundwater

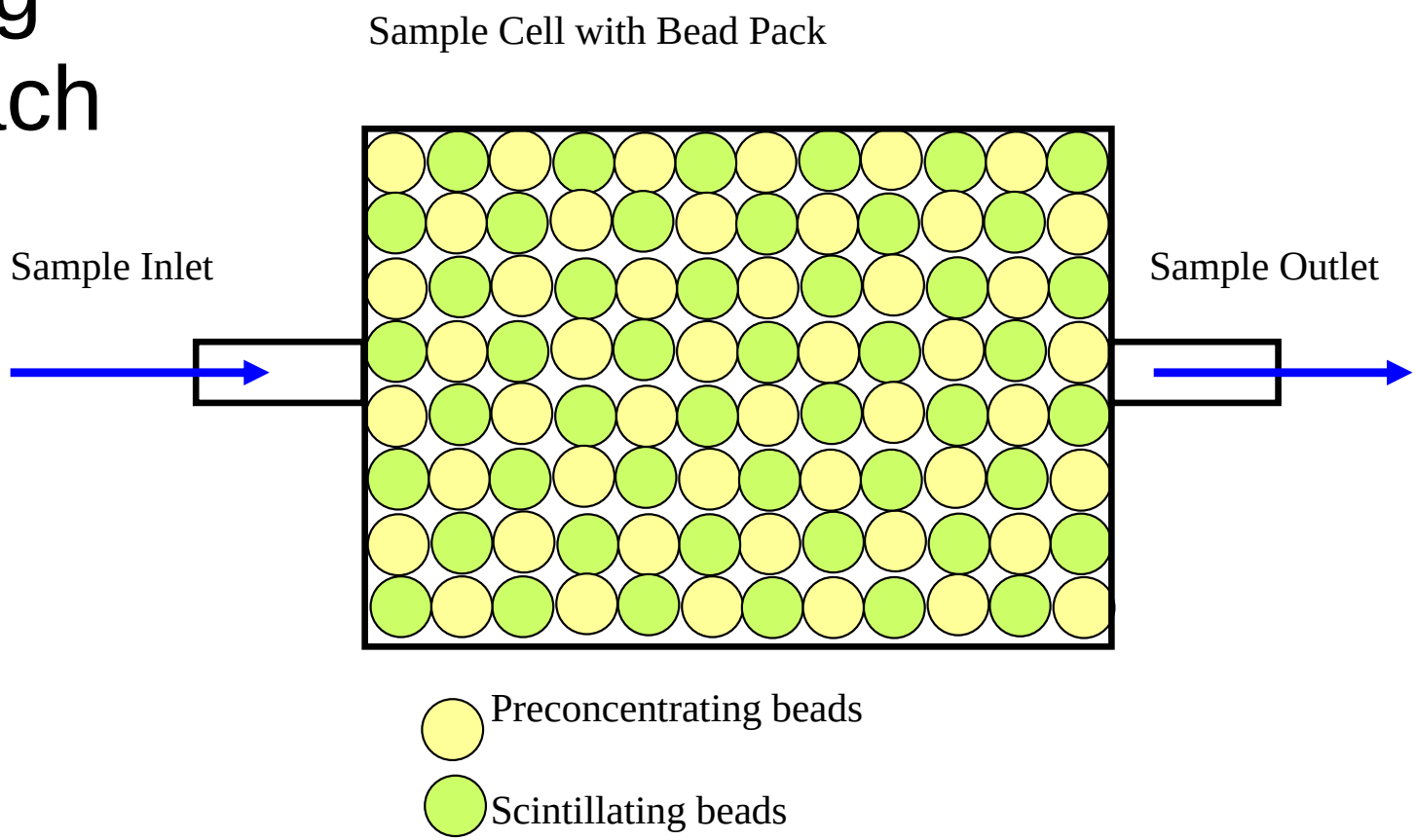
- **Customer**
  - Hanford Ground Water Monitoring Program
  - Potential customers include Fernald, Paducah
- **Developer**
  - Pacific Northwest National Laboratory (Oleg Egorov, John Hartman, Jay Grate, et al)

# Monitoring Tc-99 in Groundwater

- **Technology Characteristics**
  - Selectively and reversibly concentrates technetium (pertechnetate ion) on anion exchange absorption beads; measures light from scintillator beads that emit light when struck by beta particles from the decay of Tc-99.
  - LOD for 10 minute counting period = 7 Bq/L
  - Regulatory limit = 33.3 Bq/L.

# Monitoring Tc-99 in Groundwater

## Tc-99 Sensing Approach



# Monitoring Sr-90 in Groundwater

- **Purpose**
  - in situ monitoring of Sr-90 in groundwater
- **Benefit**
  - faster, better, cheaper method of monitoring the effectiveness of Sr-90 remediation (barrier plus pump-and-treat plus phytoremediation) at the Hanford N-Reactor site
    (approx. one day turnaround vs 30 to 45 days for baseline method; no mobilization for sampling)
- **Customer**
  - Hanford Groundwater Monitoring Program

# Monitoring Sr-90 in Groundwater

- **Developer**
  - Pacific Northwest National Laboratory (Ron Brodzinski)
- **Technology Characteristics**
  - Measures Cherenkov light produced in water by high-energy beta particles from decay of Y-90 daughter of Sr-90
  - Drinking water standard is 8 pCi/l
  - Lab prototype sensitivity = 14 pCi/l
  - Target is 1.4 pCi/l (larger cell; longer times)

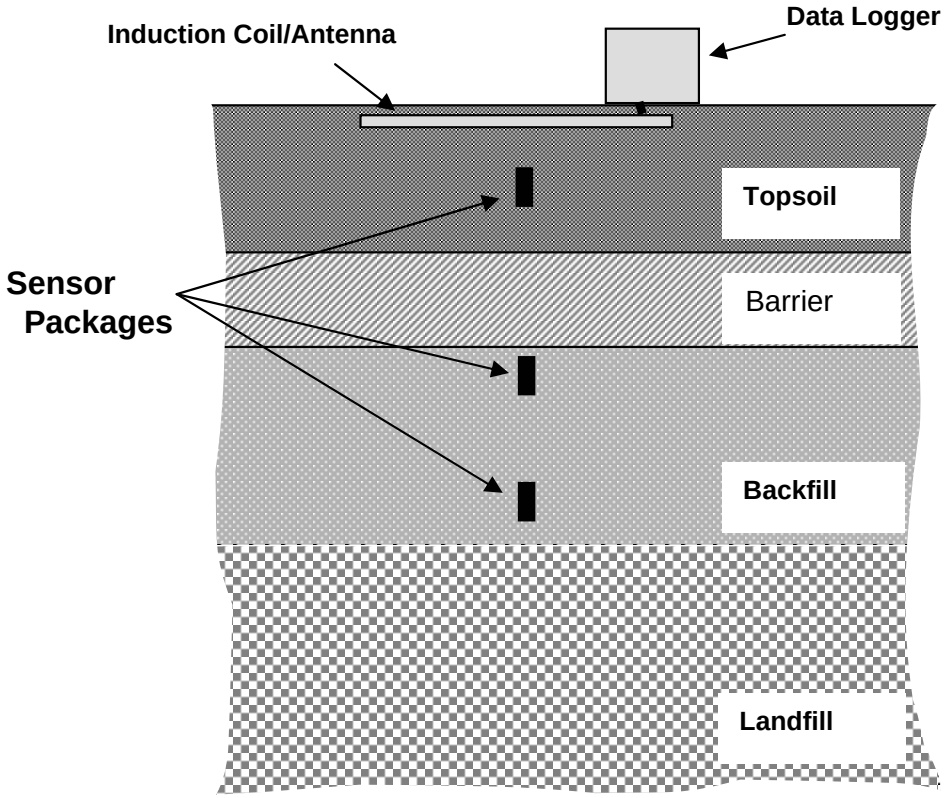
# Wireless Sensor Platform (Monitoring moisture in landfill covers)

- Purpose
  - Wireless means of powering and “reading” sensors embedded in landfill covers (e. g., volumetric soil content and soil water potential)
- Benefit
  - Monitor barrier performance, provide early notice of degradation, need for maintenance
  - No wires need penetrate to the subsurface

# Wireless Sensor Platform (Monitoring moisture in landfill covers)

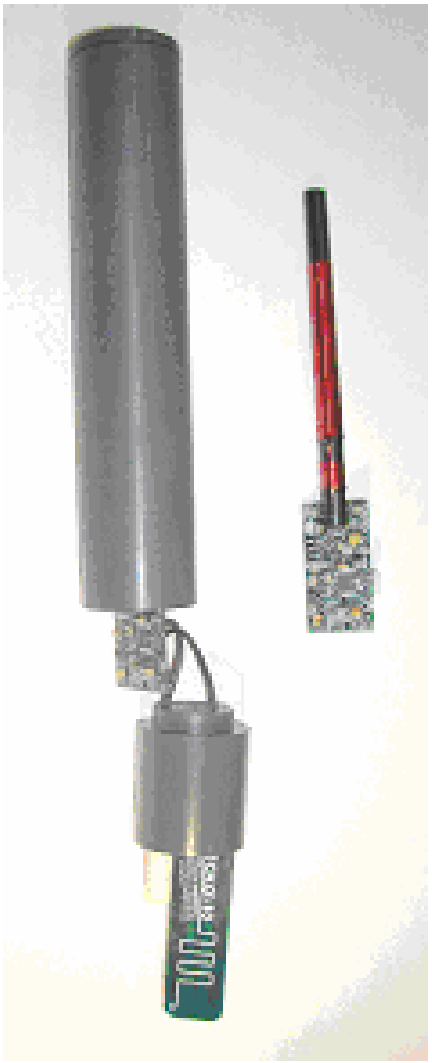
- **Customer**
  - Idaho National Engineering and Environmental Laboratory
  - Other western DOE sites are potential customers
- **Developer**
  - INEEL (Dennis Kunerth, John Svoboda)
- **Technology Characteristics**
  - An induction coil both powers the sensors and collects the sensor output via rf signal generated by embedded microprocessor
  - Prototype functional to 8 ft bgs in dry Idaho soil

# Wireless Sensor Platform (Monitoring moisture in landfill covers)




- Measurement concept, with multiple sensor packages.
- Each package contains multiple sensors and can be individually interrogated.
- The surface data logger is portable but it can be left in place.

# Wireless Sensor Platform (Monitoring moisture in landfill covers)



- The red coil is the platform power receiver and data transmission antenna.
- The PC board attached to the antenna is the microprocessor and A to D converter.
- A partially assembled system shown at the left includes (at the bottom):
  - A heat dissipation sensor (beige) for measuring soil water potential
  - A TDR sensor (green) for measuring volumetric water content
- The sensors are commercially available.

# Testing the INEEL Wireless Sensor Platform at the NTS

Note loop antenna
and data logger box
for charging / readout

# Monitoring Cr(VI) Using Universal Sensor Platform

- Purpose
  - Provide in situ real-time monitoring of Cr(VI) in groundwater
- Benefit
  - Much better temporal monitoring coverage without much greater cost.

# Monitoring Cr(VI) Using Universal Sensor Platform

- Customer
  - Hanford Groundwater Monitoring Project
    - Accurately monitor Cr(VI) in the pore water of Columbia River sediments and gravel beds (salmon spawning area), which are fed by contaminated groundwater from the DOE Hanford site
    - Ensure that groundwater remediation activities are producing desired consequences for protection of aquatic species (salmon)

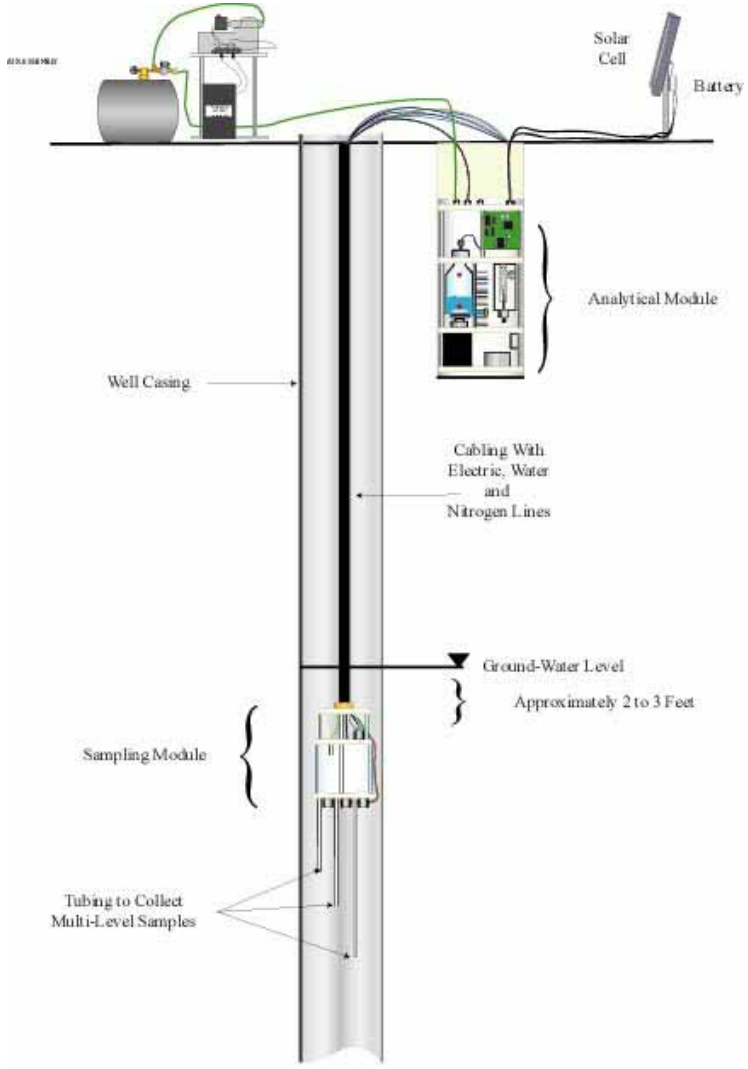
# Monitoring Cr(VI) Using Universal Sensor Platform

- Developer
  - Burge Environmental (Scott Burge)
    - Uses a colorimetric reaction with diphenylcarbazide and the Burge “universal” sampling, analysis, and **calibration** system
  - PNNL (John Hartman & Oleg Egorov
    - Cr(VI) determination without reagents, using liquid core optical waveguide and UV/Vis absorption spectrometry

# Monitoring Cr(VI) Using Universal Sensor Platform

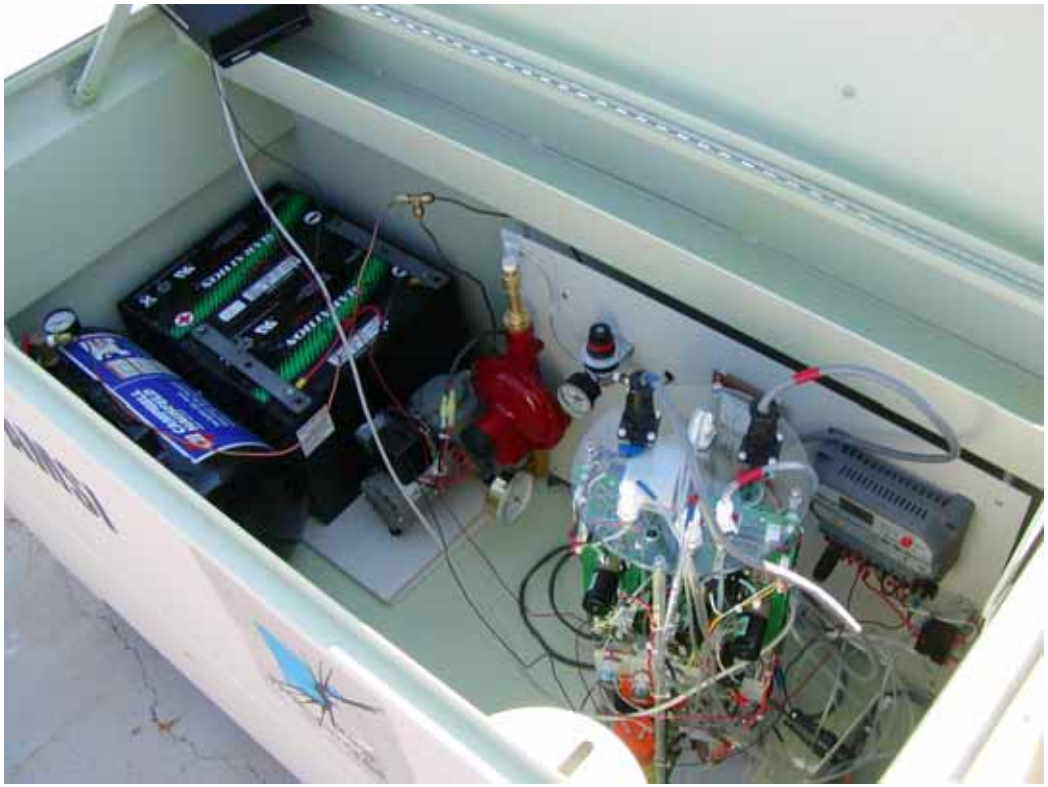
- **Technology Characteristics**
  - Regulatory standard is 11 ppb.
  - Automated hourly measurements.
  - Automated in-field calibration.
  - Duty cycle of at least several days (e. g., to replenish reagent in Burge case).
  - PNNL LOD ~ 1 ppb
  - Burge Environmental LOD ~ 1 ppb. Reagent reservoir ~ 100 analyses (100 hours).

# Monitoring Cr(VI) Using Universal Sensor Platform




GROUND-WATER MONITORING SYSTEM

# Burge Universal Sensor Platform



- Solar power & battery storage
- Sample pumps
- Stirring motor
- Air compressor
- Valves
- Green LED photoabsorption cell
- Field calibration capability
- Laptop computer
- RF modem for remote control & data communication

Models for monitoring chloroform, tricloroethylene are also available.

http://www.burgenv.com/index.html

# Key AMSI Achievements

- Involving end-users
- Getting end-user commitment to include the product in their ***application*** baseline

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