Oak Ridge Field Research Center

FRC Workshop Tour
October 24, 2005

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http://www.esd.ornl.gov/nabirfrc/

Agenda

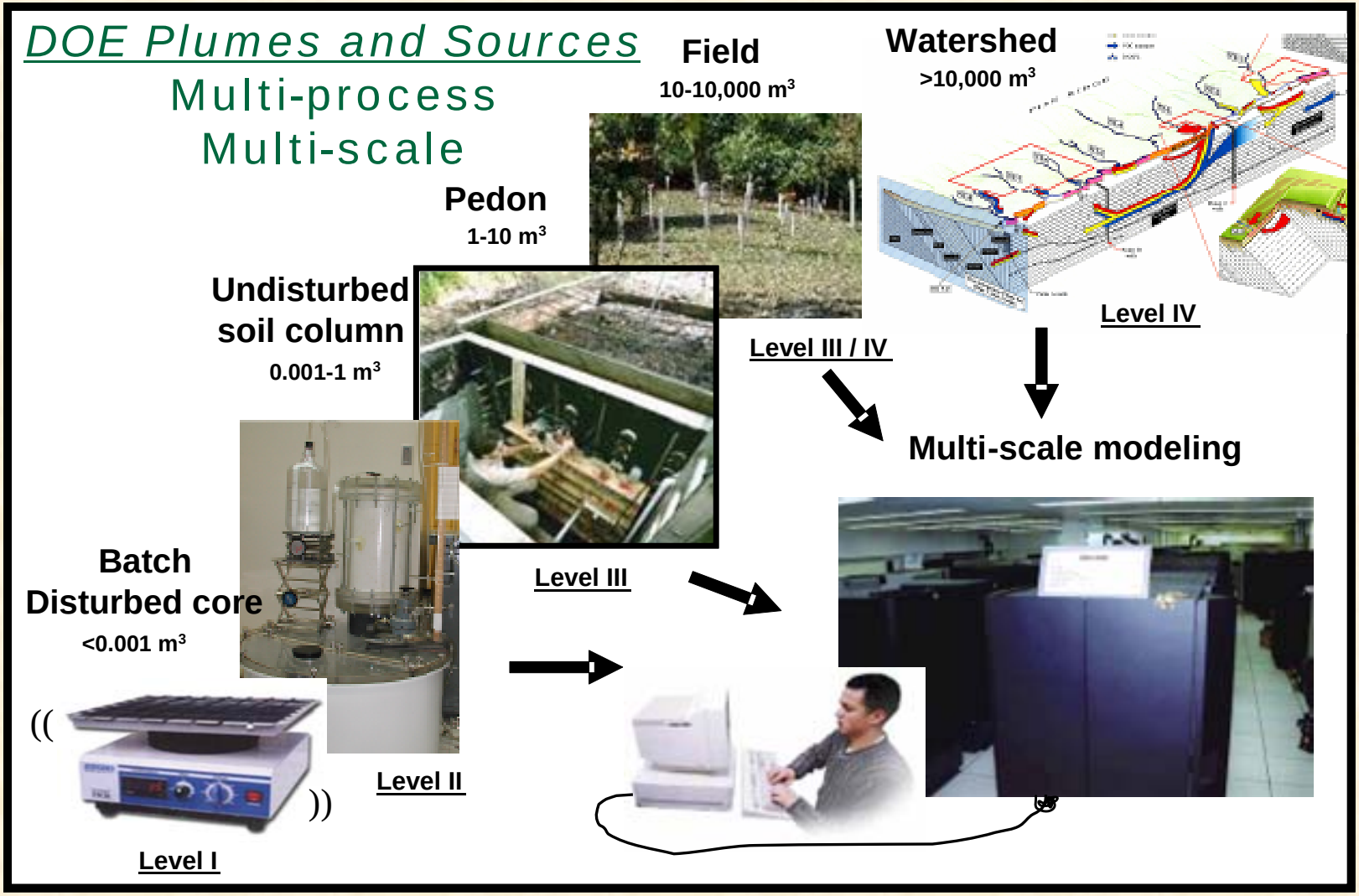
- **Overview**
  - **FRC research opportunities**
  - **Summary of site setting**
  - **Description of multi-disciplinary *in situ* bioremediation field research projects**
  - **Sample requests and distribution**
  - **Sources of information**
- **Tour**

Original NABIR FRC Research Focus

- **Objectives**
  - **Understand fundamental biogeochemical processes influencing the use of bioremediation approaches for cleaning up, managing, or understanding fate and transport of metals and radionuclides at DOE's contaminated legacy waste sites**
- **Field Laboratory**
  - **Source of subsurface samples for ERSD and other investigators (NABIR, EMSP, GTL, JGI)**
  - **Evaluation of new characterization and monitoring methods, and predictive approaches**
  - **In situ accelerated bioremediation research**
  - **Mercury samples and studies**
  - **Source of humic material**

The ERSD Oak Ridge Field Research Center

Advancing Scientific Understanding



Fate and Transport

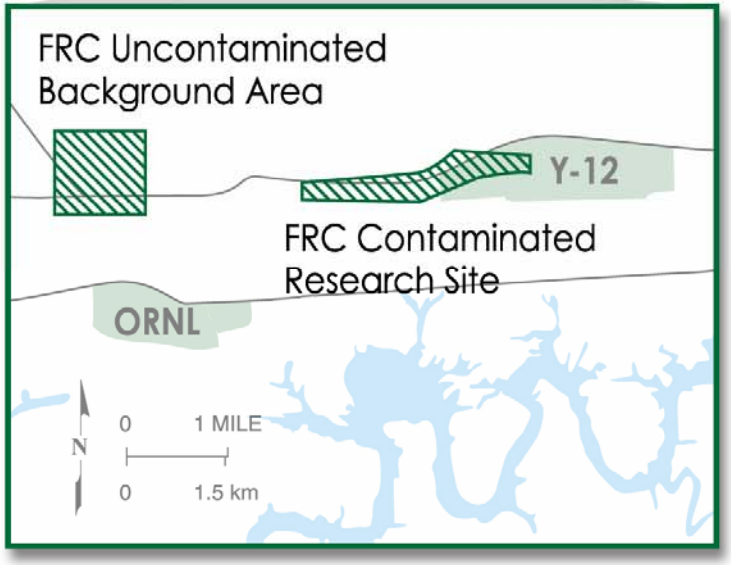
Monitoring and Characterization

Remediation, Stabilization, and Stewardship

NABIR FRC Facilities

Glove Bag with 5 ft Airlock at Field Trailer

Drill Rigs



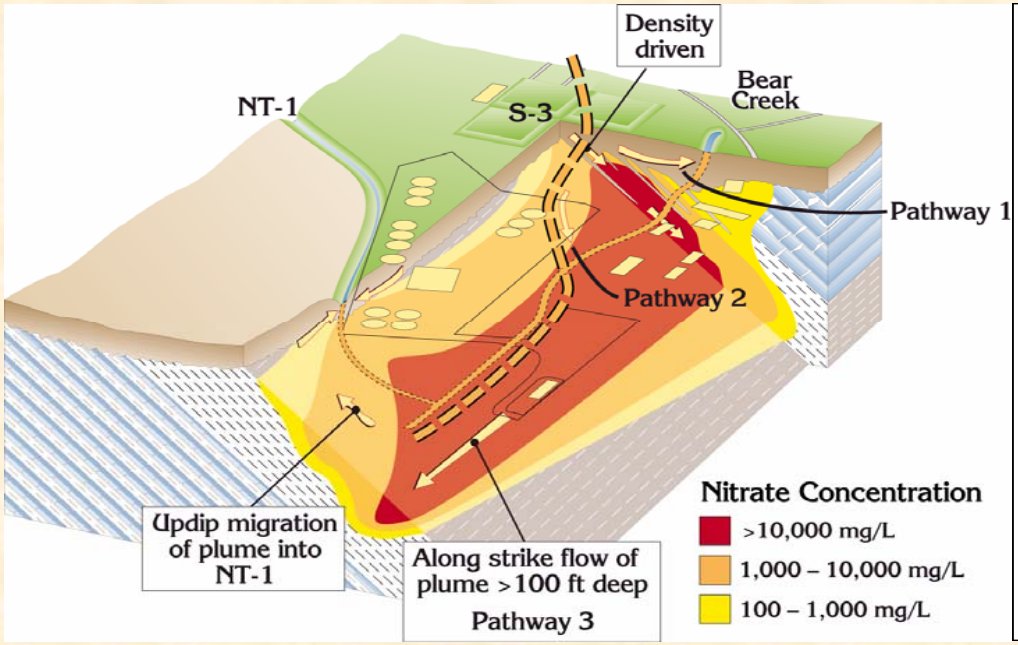
FRC Site
Y-12 Plant looking west

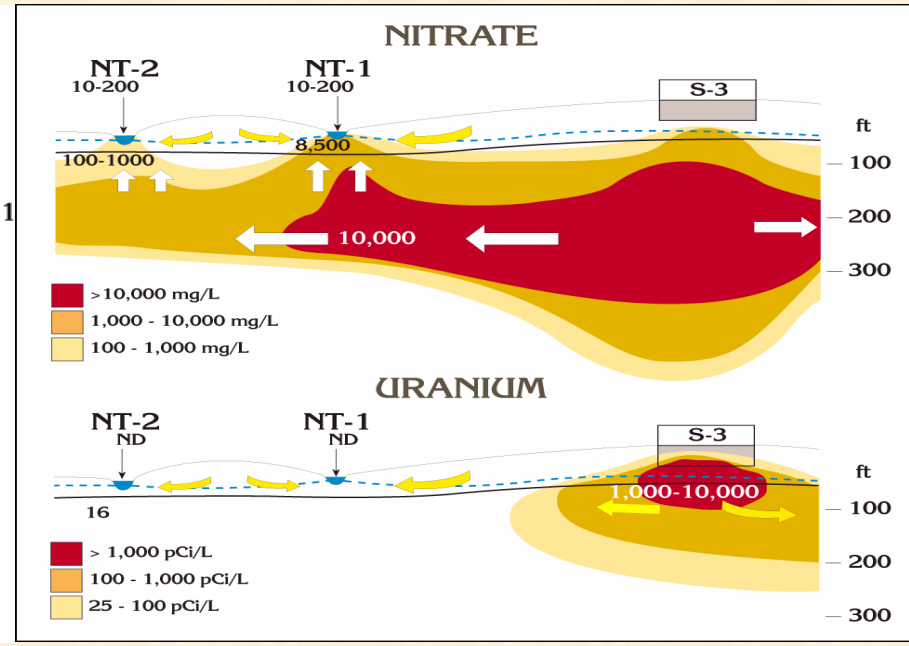
- Operated from 1951 to 1983
- 400 ft x 400 ft x 17 ft deep
- Over 2.5 million gallons waste/year
- Wastes contained nitrate, uranium, Tc-99, metals, VOCs, high TDS, and low pH (<2.0)
- Neutralized in 1984 capped in 1988

Currently a parking lot

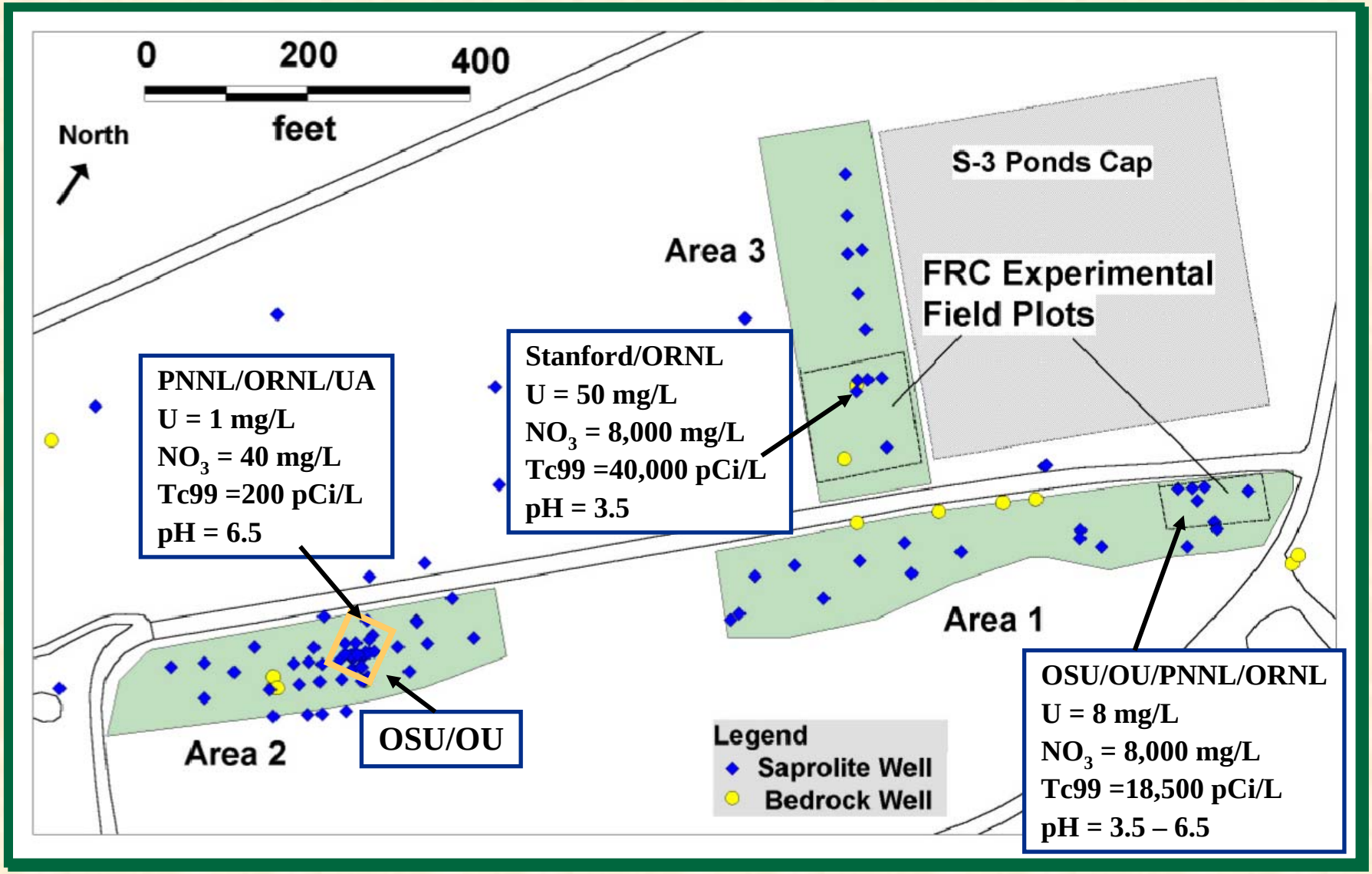
S-3 Disposal Ponds During Denitrification

Conceptual Model of Contaminant Transport at the S-3 Ponds Site





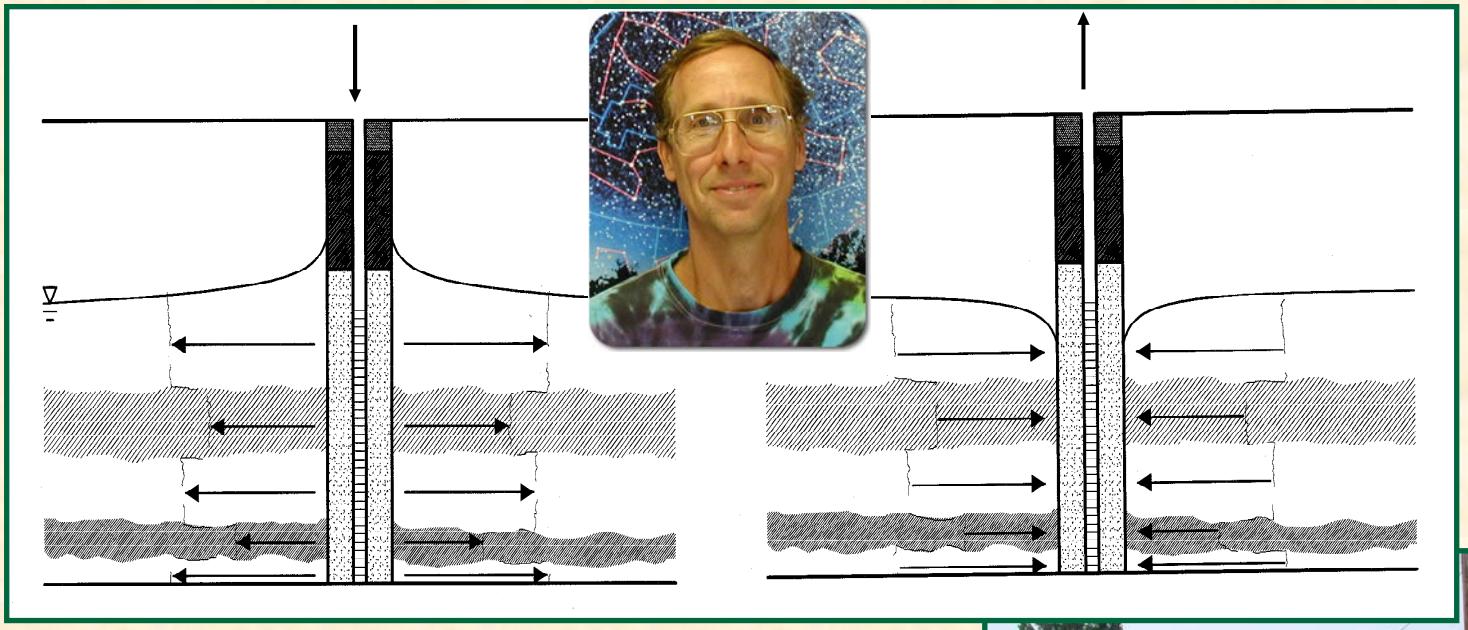
Field Plots in Contaminated Area



Multi-disciplinary in Situ Accelerated Bioremediation Field Research Projects

- ***In situ* uranium reduction experiments using push-pull techniques** (Oregon State University, Oklahoma University, PNNL, ORNL located in Areas 1 and 2)
- ***In situ* immobilization of uranium in structured porous media via biomineralization at the fracture/matrix interface** (PNNL, ORNL, and University of Alabama, located in Area 2)
- **Field-scale bioreduction of uranium** (Stanford and ORNL, located in Area 3)

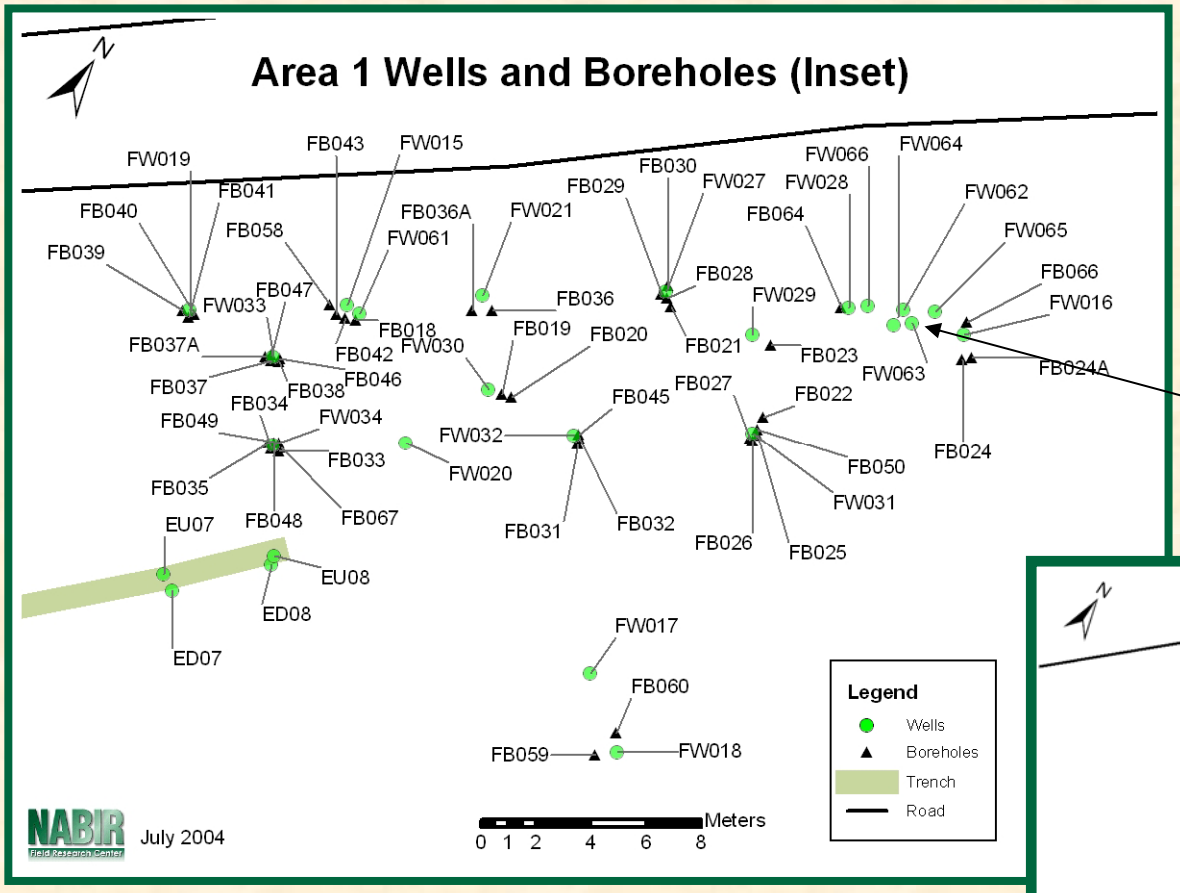
OSU Push-Pull test methodology



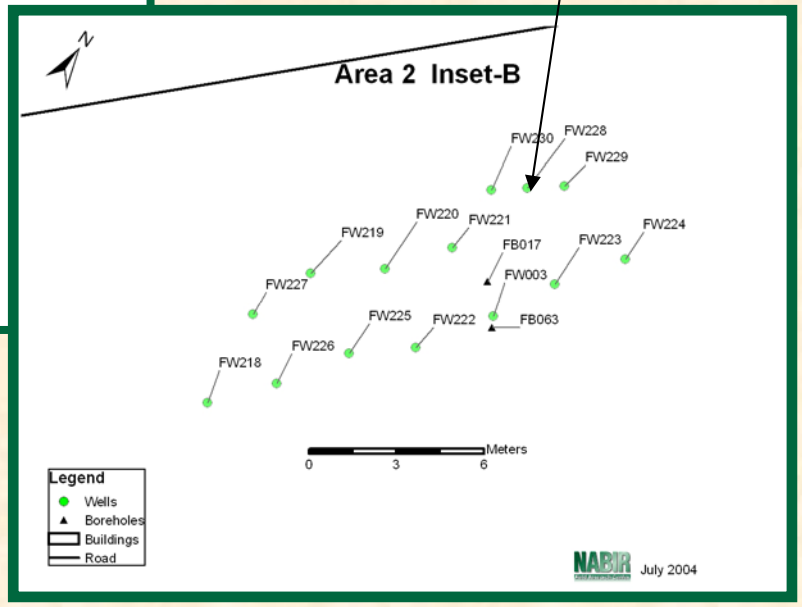
Field push-pull tests (left) injection "push" phase (right) extraction "pull" phase

To test for microbial activity, site groundwater is mixed with tracers and nutrients in drums and injected into monitoring wells. Many tests can be run relatively quickly to test hypothesis.

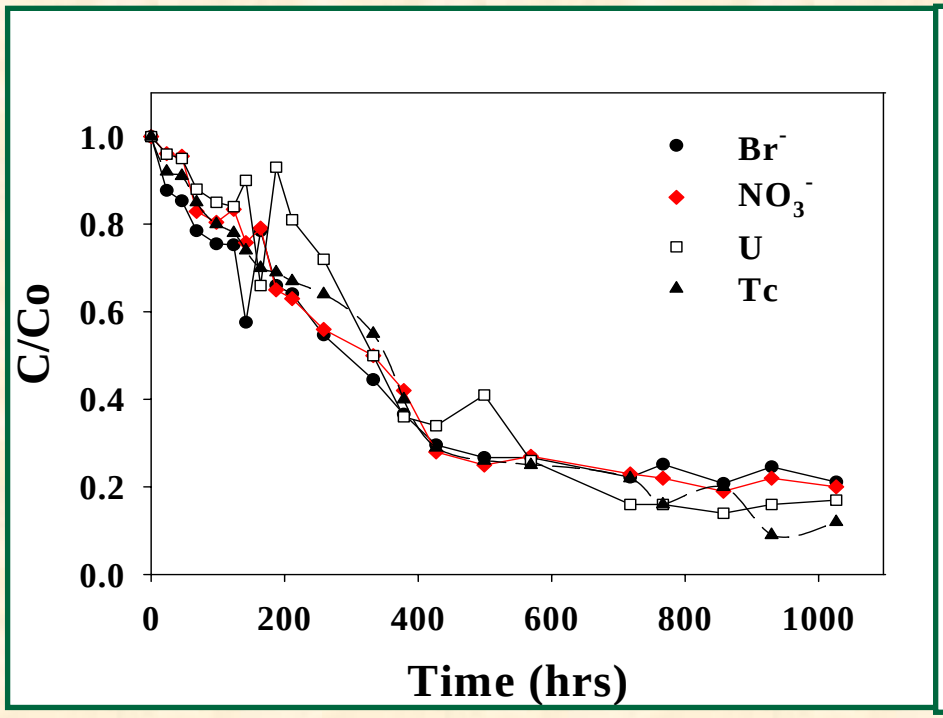
OSU Testing at Areas 1 and 2



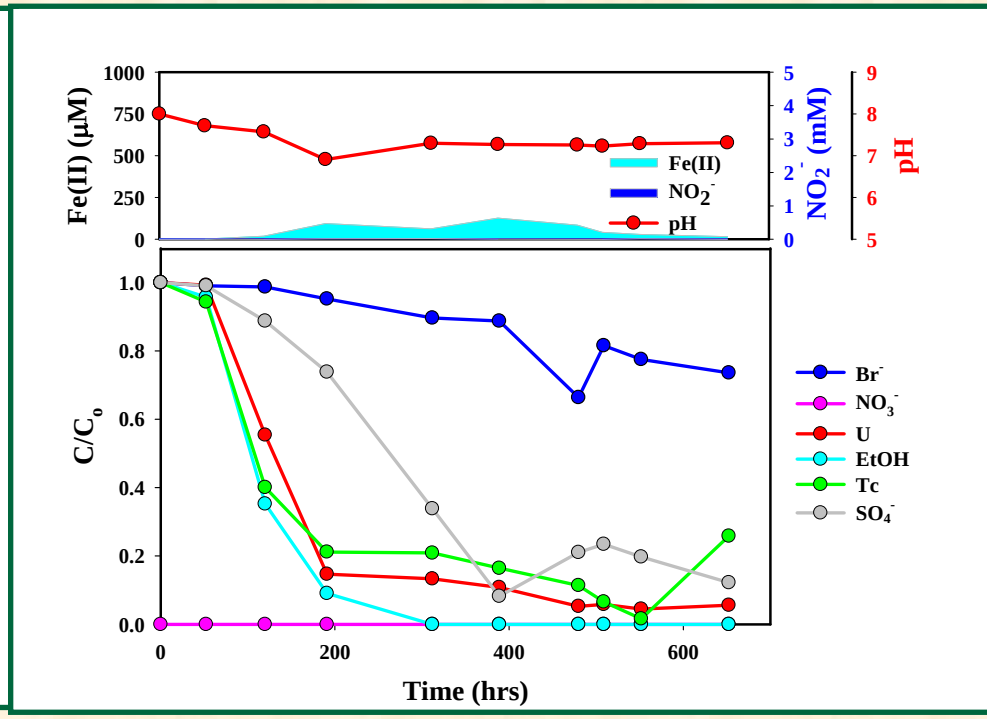
LBNL cross-borehole geophysics



OSU/OU Push-Pull test results

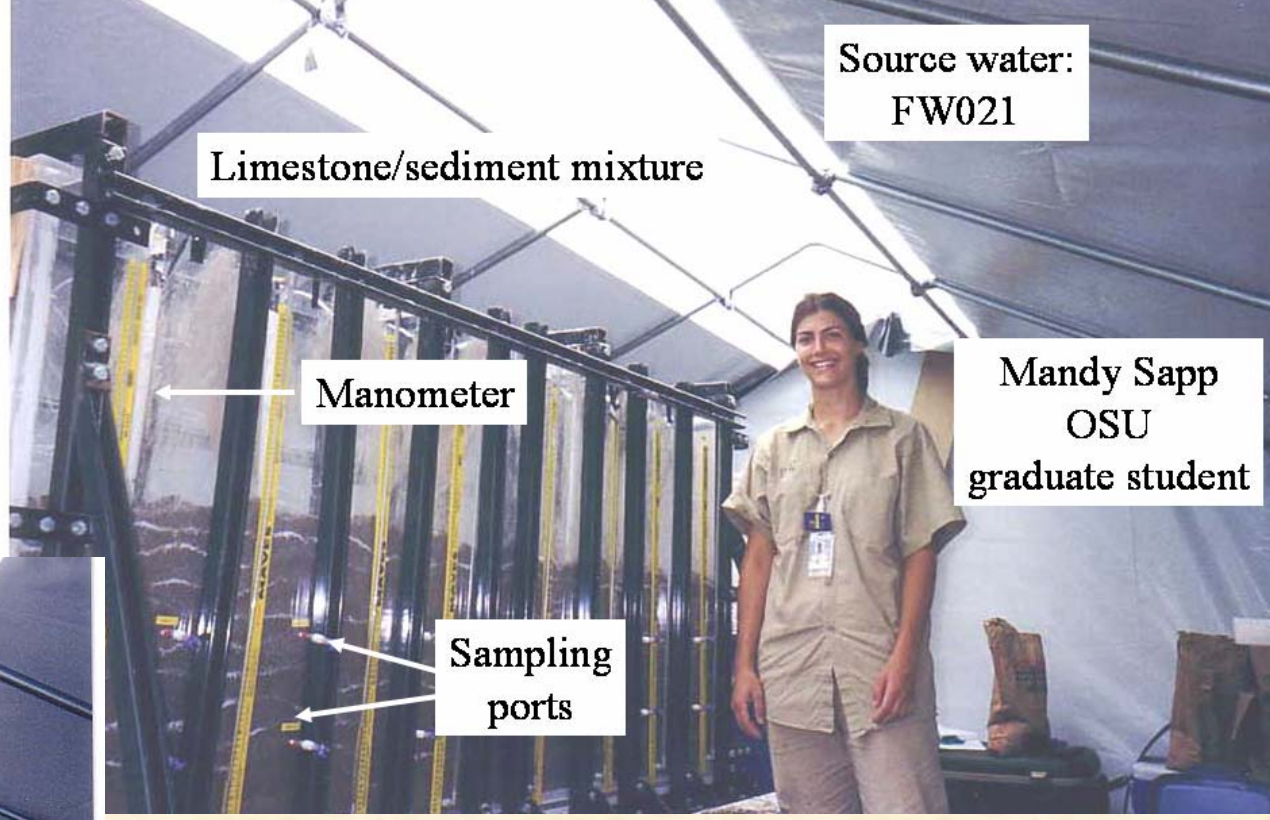


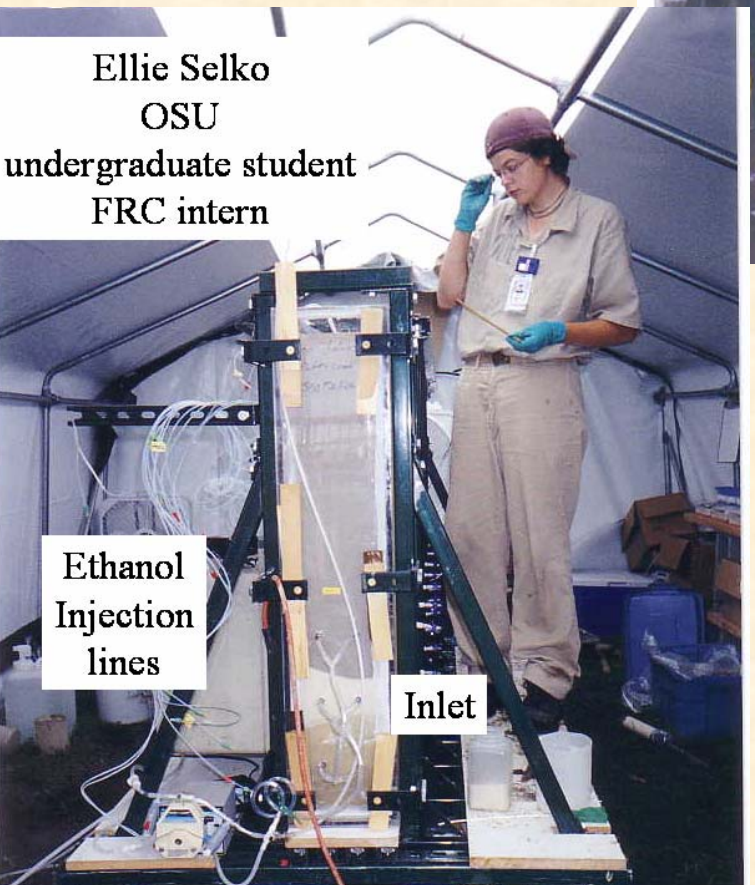
Control well with no electron donor shows no reaction



Simultaneous uranium (U) and technetium (Tc) immobilization during field push-pull tests with addition of electron donor (ethanol)

Observing U and Tc reduction in flow cells



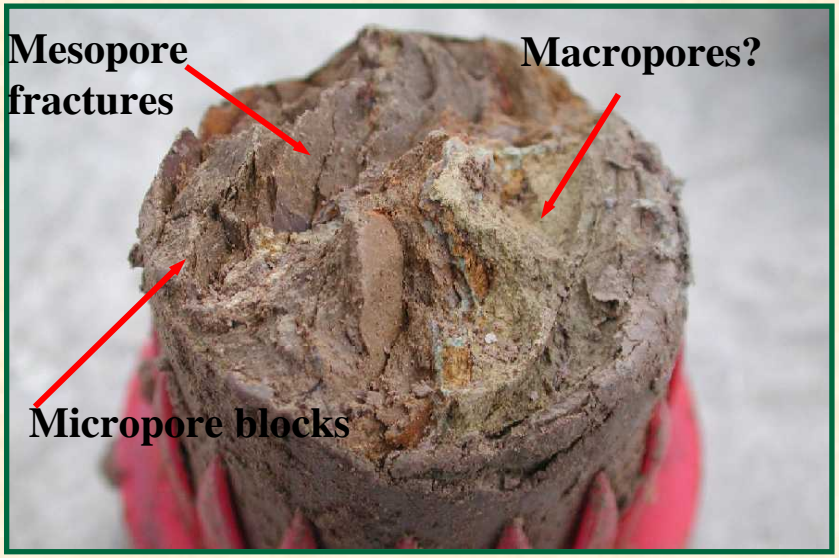


OSU Flow-Through Cells

- **Simulating biocurtain**
- **Two Cells at Areas 1 and 2**
- **Test and control cells**
- **Long-term operation**

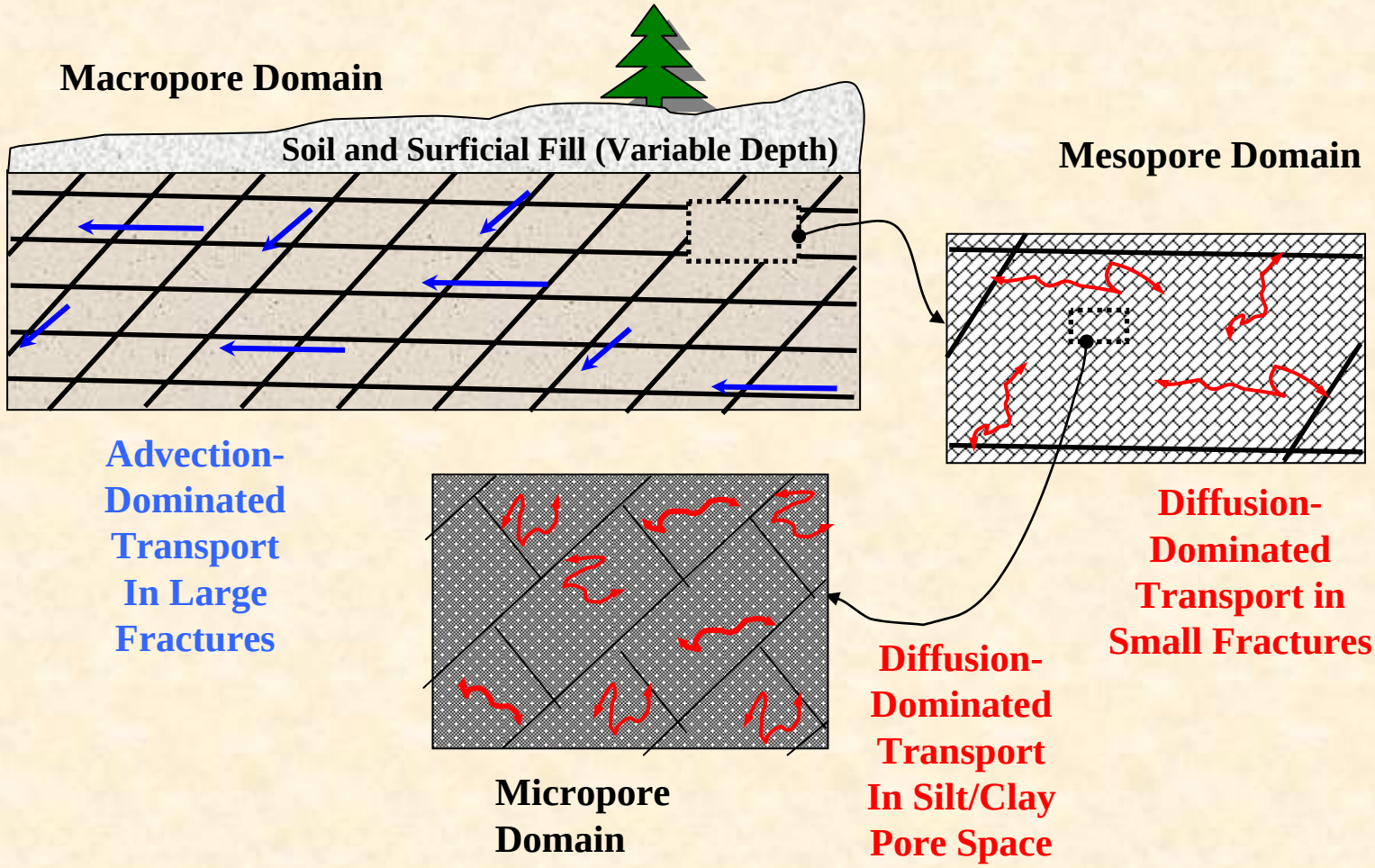
PNNL/ORNL/UA Project Hypothesis

- **Micropores act as a reservoir for contaminants like uranium and Tc99.**
- **Contaminated groundwater, migrates by diffusion from smaller to larger pores**
- **Microorganisms important for bioremediation are too big to fit in micropores, but small enough to live in mesopores and macropores.**
- **Hypothesis - by stimulating these bacteria in place, uranium can be immobilized in subsurface macropore and mesopore regions. These boundaries will act as localized, distributed semi-permeable barriers that serve to prevent the movement of mobile uranium VI from the micropores to mesopores and macropores.**



All Pores are not created equal.

Schematic diagram of three conceptualized pore domains.



PNNL/ORNL/UA *in situ* Experimental Design

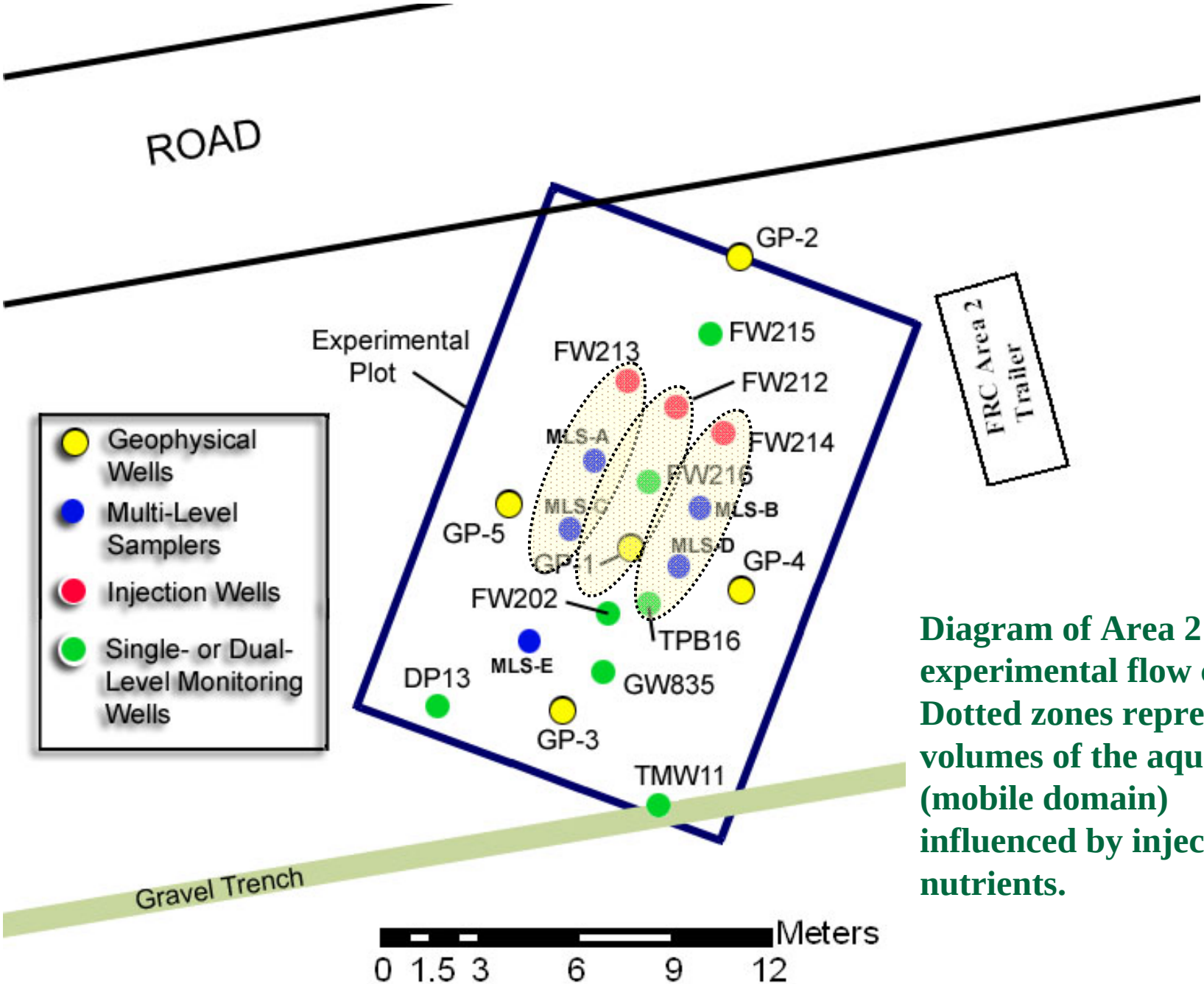


Diagram of Area 2 field experimental flow cell. Dotted zones represent volumes of the aquifer (mobile domain) influenced by injected nutrients.

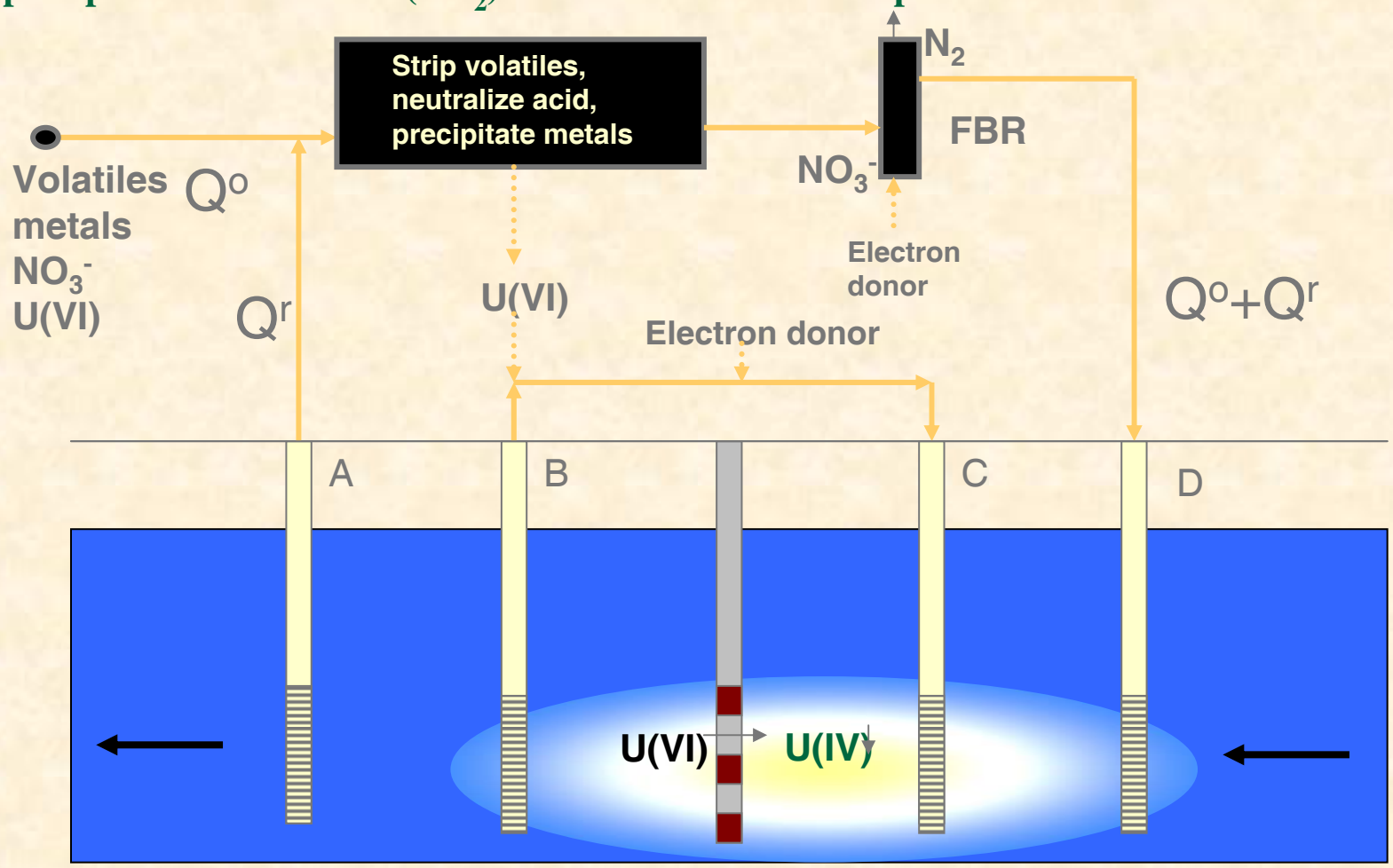
PNNL/ORNL/UA project intact core experiments

Background Area test pit showing:
A) Remnant bedding structure exposed on test pit wall
B) Melanie Mayes of ORNL carving down a waxed saprolite column
C) Waxed and epoxy coated saprolite core in PVC casing

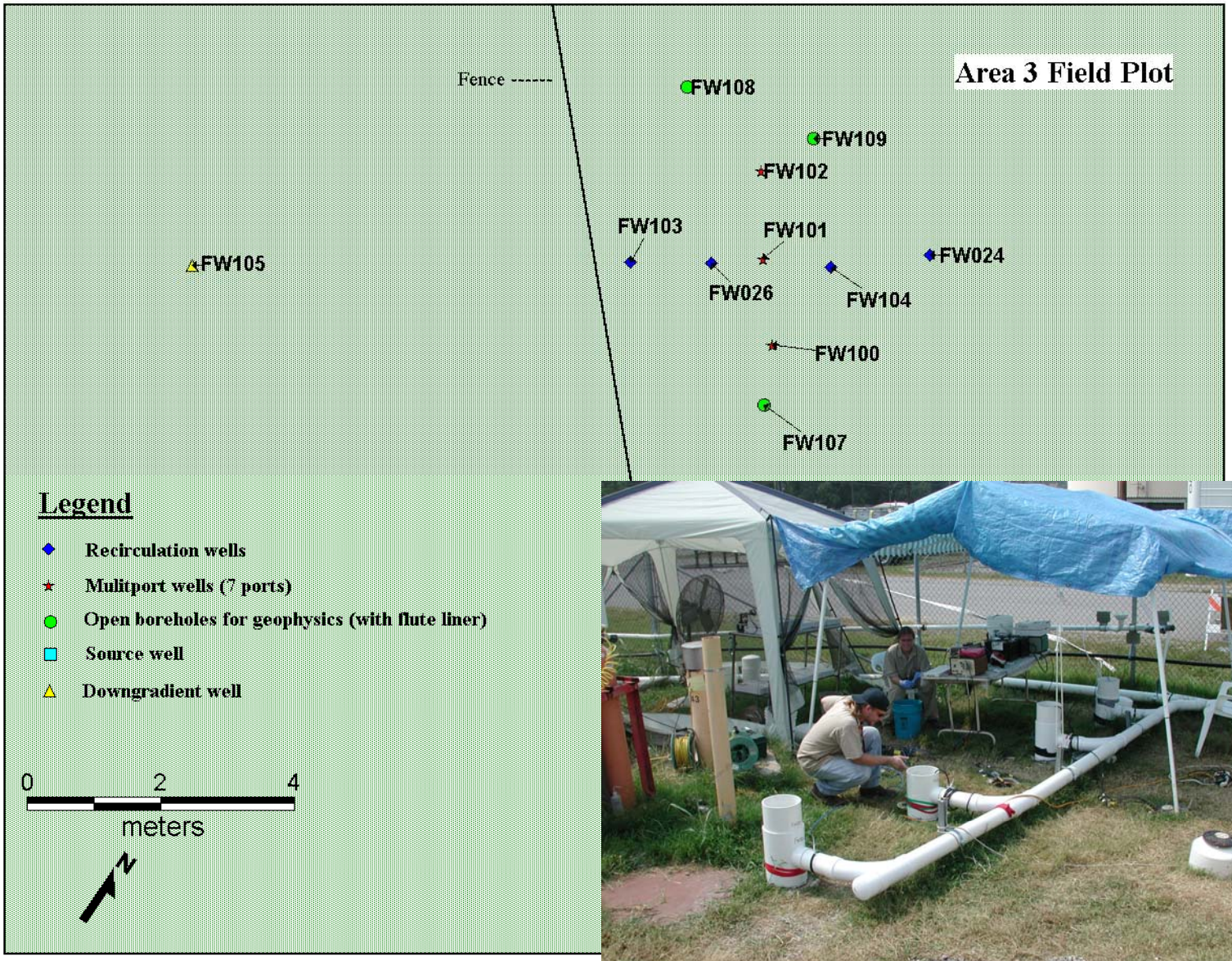
Stanford/ORNL Project U bioreduction strategy

After the hydraulic flow field reaches steady state, electron donor and minimal nutrients will be injected into the inner domain to stimulate microorganisms. Nitrate and toxins are removed from the outer loop.

U(IV) precipitates as uraninite (UO_2) via in situ bioreduction processes.

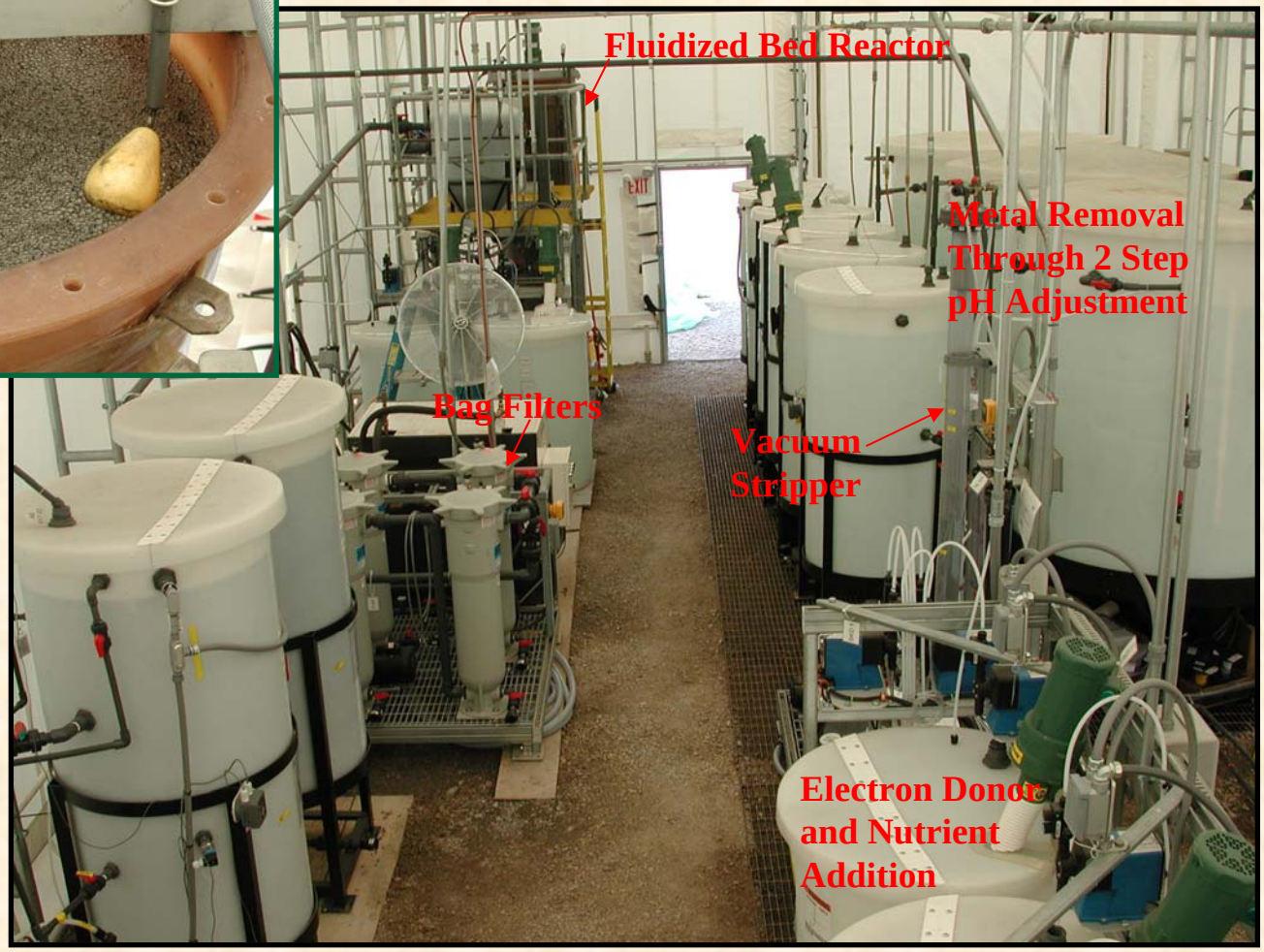


Stanford/ORNL Field Plot in Area 3

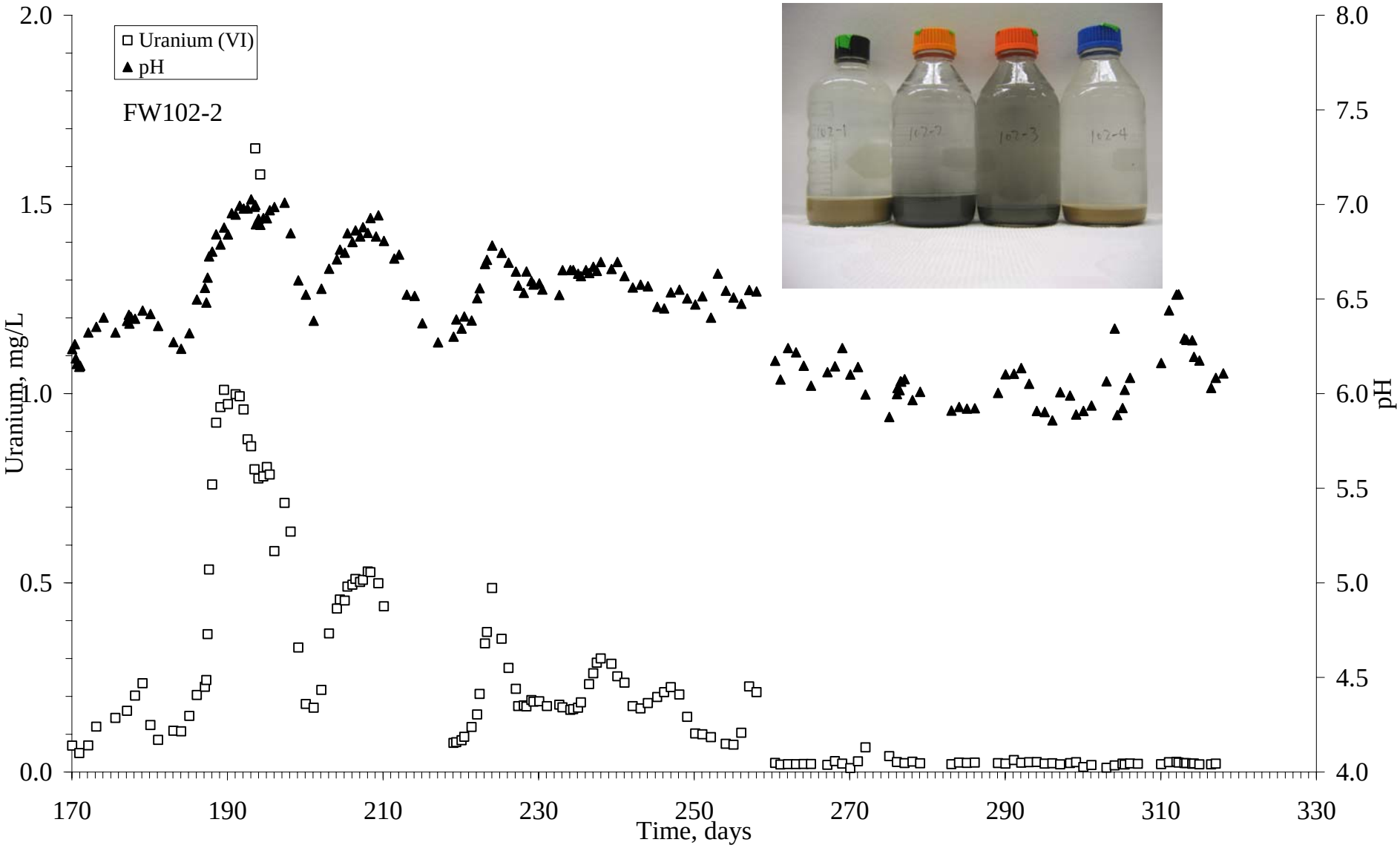


Above ground conditioning

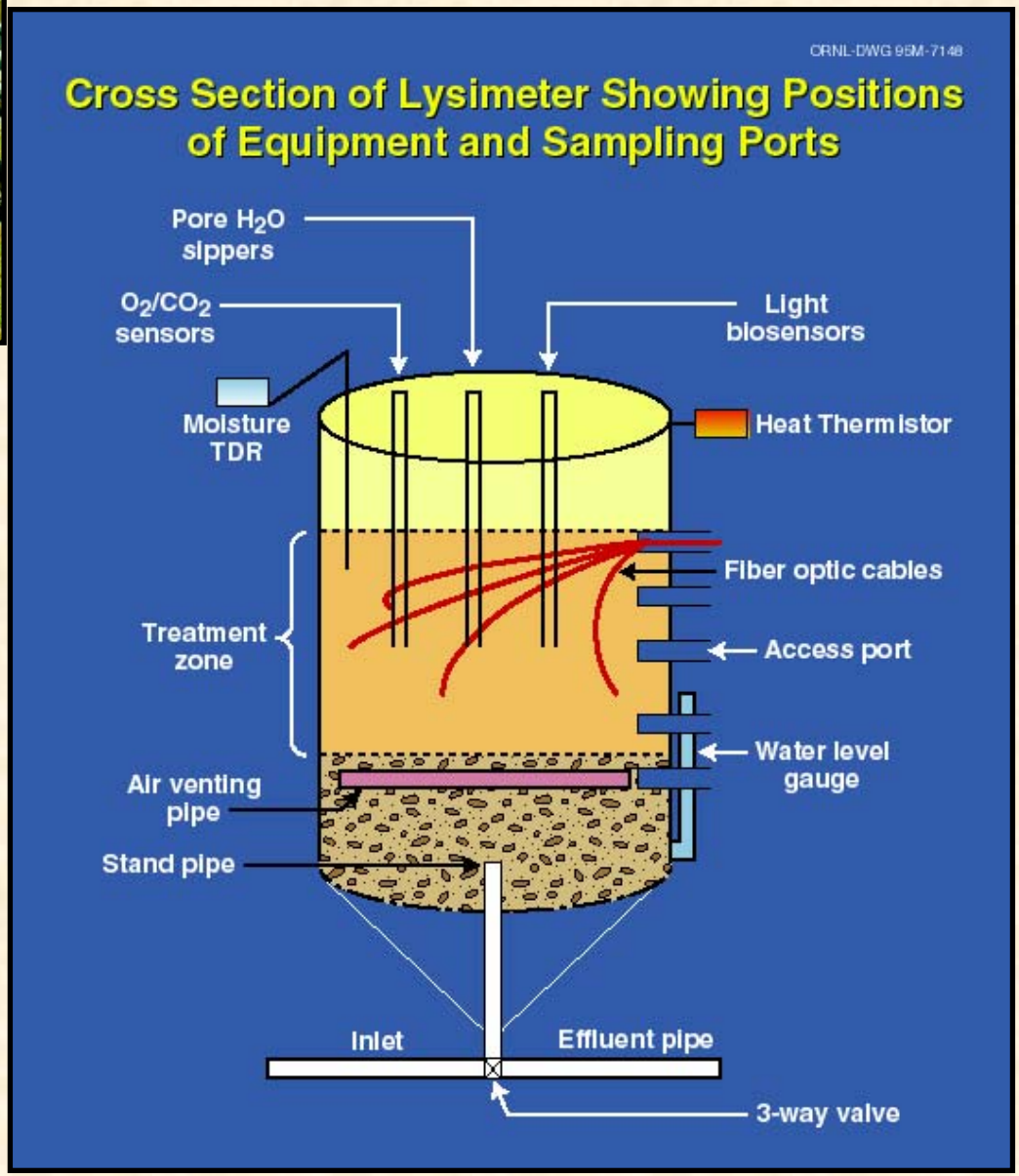
Bubbles in FBR indicating microbial activity is consuming ethanol and removing nitrate



Reduction of U in Inner Cell

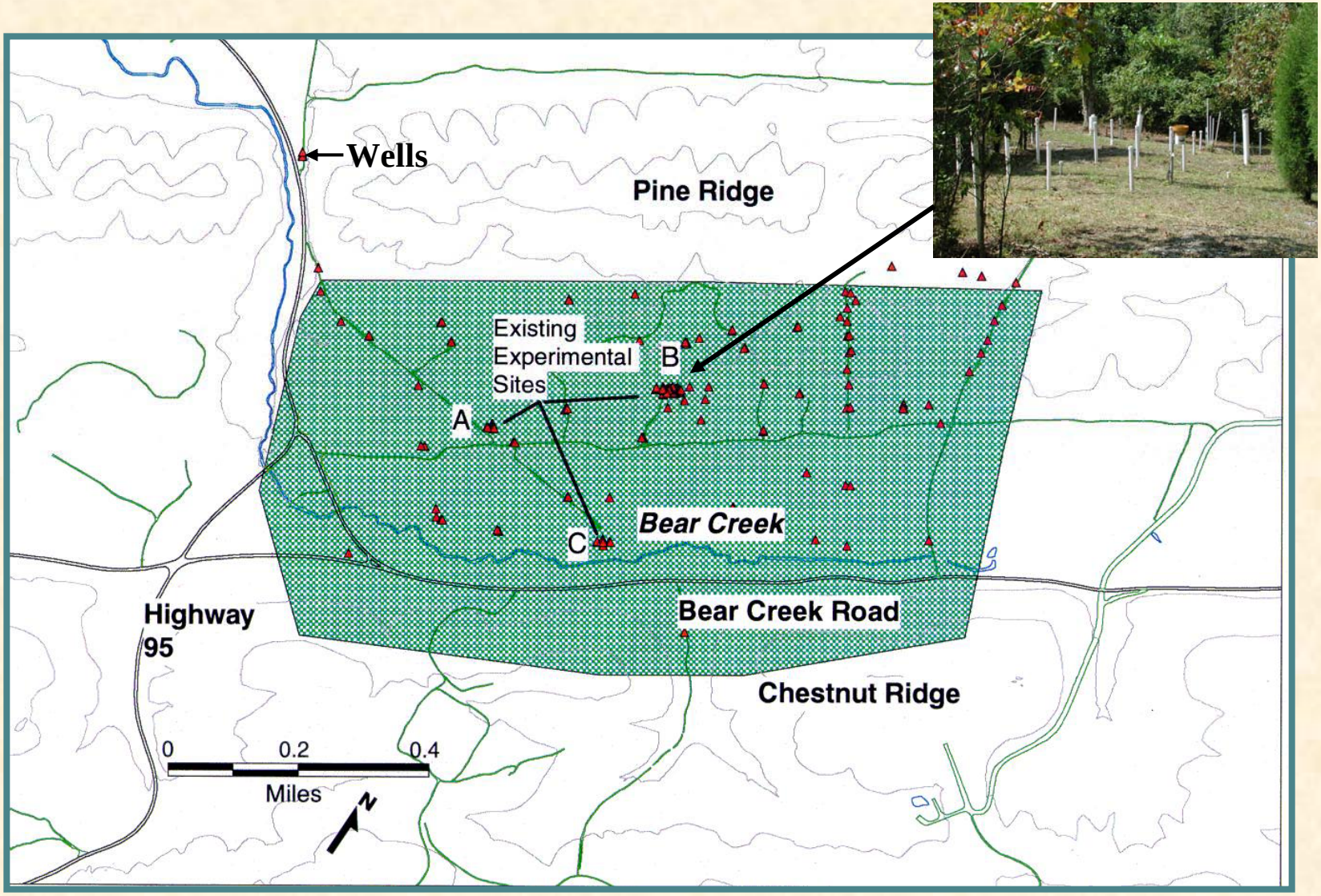


Lysimeters at the FRC



- **Twenty Lysimeters**
  - **17 large 8’ diameter x 12’ deep**
  - **3 small 3’ diameter x 12’deep**
- **Central core access**
- **Permitted to test GEMs**
- **One tank used to test naphthalene degradation**

FRC Background Area



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Reference Materials

- **FRC forested soil humics for lab and field tests**
  - **Data from Istok field tests indicate it helps with shuttle of electrons and increases rates of reduction but also increases reoxidation rate**
- **Kitty Hawk Woods field site humics**
- **Abott Pit**
  - **High and low Fe sediments**

Humics from FRC Background Soils

Sample Collection and Shipping

- **PI Requests Samples From FRC Manager**
  - **FRC sample request form filled out**
- **PI and FRC Manager agree on When and How Samples will be Collected and Shipped**
- **PIs Must Provide Documentation Indicating they can Accept Contaminated Samples (e.g. Rads)**
- **ORNL Conducts Rad License Review and Approval**
- **Sample Transportation Checklist Completed**
- **Green Tags or Yellow Tags Obtained for Any Samples Transported Offsite (i.e., on public roads)**

Sample Collection and Shipping (continued)

- **FRC Provides Notification When Samples Collected and Shipped to NABIR Investigator or Laboratory**
- **Chain of Custody Maintained**
- **Archived Samples Will be Maintained in Refrigeration and/or -80 C Freezer and/or anoxic on Argon if Requested**
- **Confirmation of Sample Receipt by PI or Lab**

Database

- Tracks sample requests and shipments
- Defines associations between samples, analyses, shipping etc
- Repository for
  - Laboratory and field data
  - Well construction data
  - Selected historical data
- Characterization metadata
- Measurement data is Web accessible

Sources of Information

- **Website**
- **User's guide**
- **Brochure**
- **Fact Sheets**

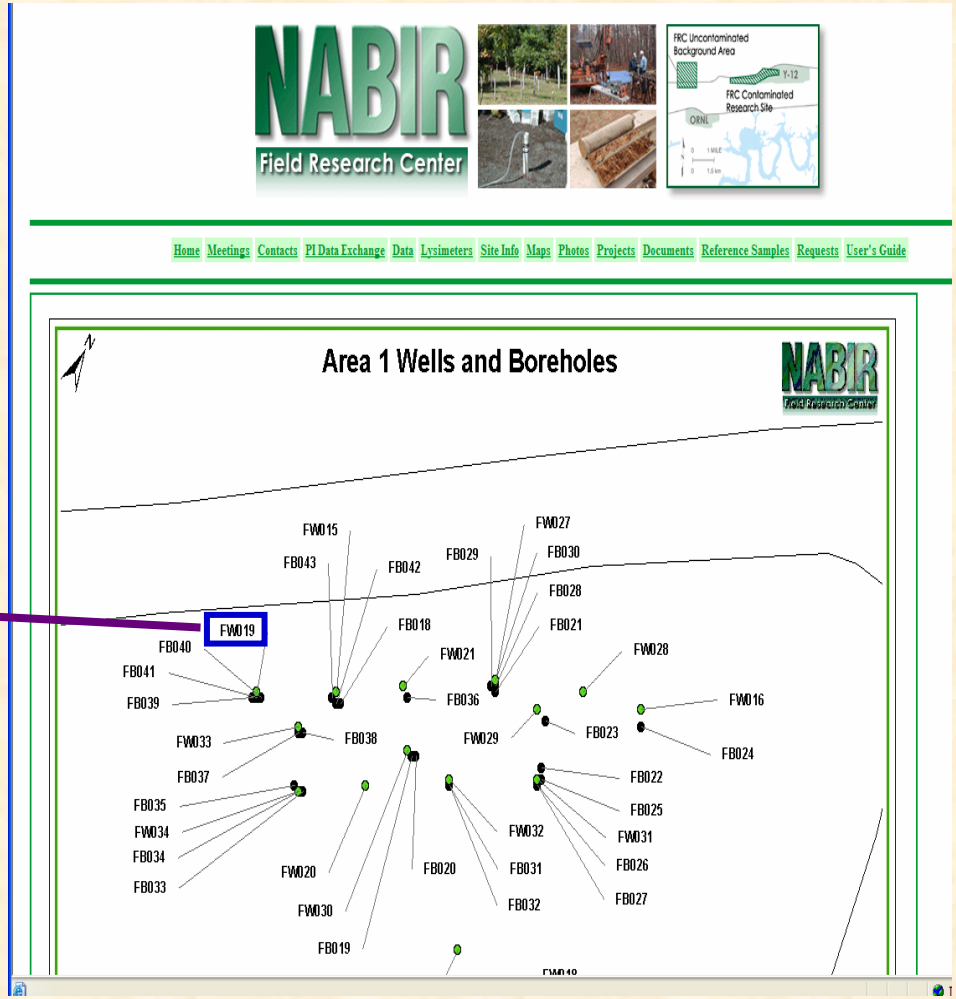
Website

- Overview of FRC
- User's guide and facility description
- Background information
  - Sites
  - Projects
- Documents
- Working groups
- Data retrieval

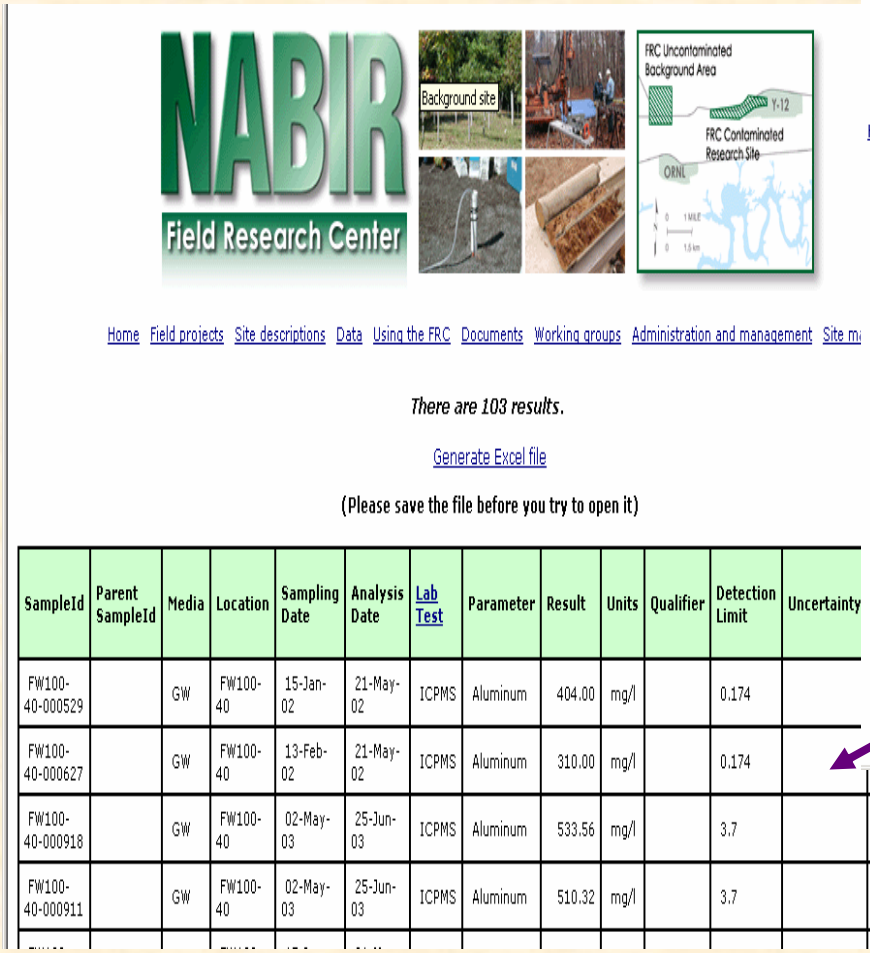
Location-Based Data Retrieval

Location	FW019
FRC Area	Area 1
X-Value/Easting	52368.03
Y-Value/Northing	30120.58
Latitude	35.97768943
Longitude	84.27212703
Type	SP
TOC Stickup	0.79
TOC Elevation	1005.83
Ground Elevation	1005.04
Installation Method	2" Core
Boring Depth	
Boring Refusal	no
Boring Diameter	
Casing Type	
PVC40	

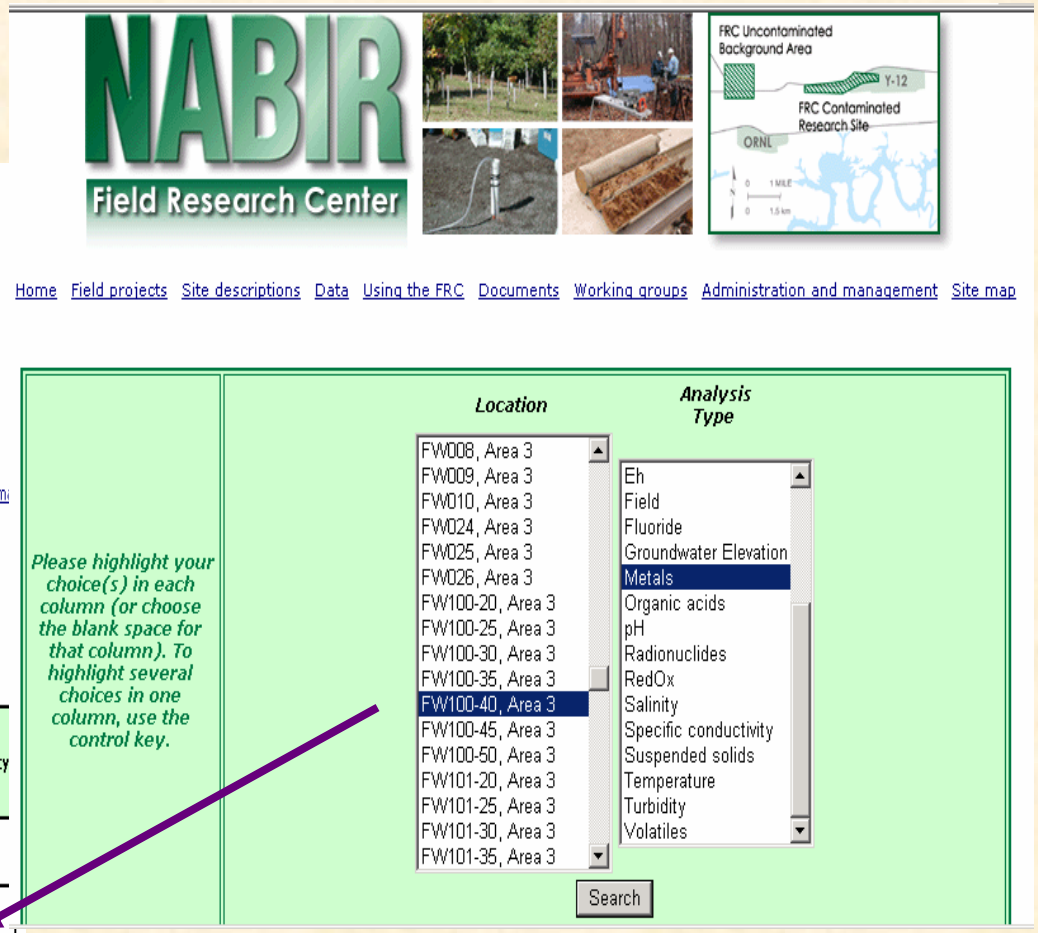
Media	Sampling Date	Analysis Date	Parameter	Result	Units	Qualifier	Detection Limit	Uncertainty	Depth Start	Depth End	Depth Units	Parent SampleId
SO	04-Jan-01		Aluminum	0.250697674	wt %				0	8	in	FWB019-02
SO	04-Jan-01		Aluminum	0.400162009	wt %				6	12	in	FWB019-03
SO	04-Jan-01		Aluminum	0.18297491	wt %				12	18	in	FWB019-03
SO	04-Jan-01		Aluminum	0.323595506	wt %				12	18	in	FWB019-03
SO	04-Jan-01		Aluminum	0.386427146	wt %				8	15	in	FWB019-02
SO	04-Jan-01		Aluminum	0.199546485	wt %				18	24	in	FWB019-03
SO	04-Jan-01		Aluminum	0.132912844	wt %				37	43	in	FWB019-01
SO	04-Jan-01		Aluminum	0.392815307	wt %				24	28	in	FWB019-03
SO	04-Jan-01		Aluminum	0.504945055	wt %				15	23	in	FWB019-02
SO	04-Jan-01		Aluminum	0.093774194	wt %				0	8	in	FWB019-02
SO	04-Jan-01		Aluminum	0.207479508	wt %				28	32	in	FWB019-03



Content-Based Data Retrieval



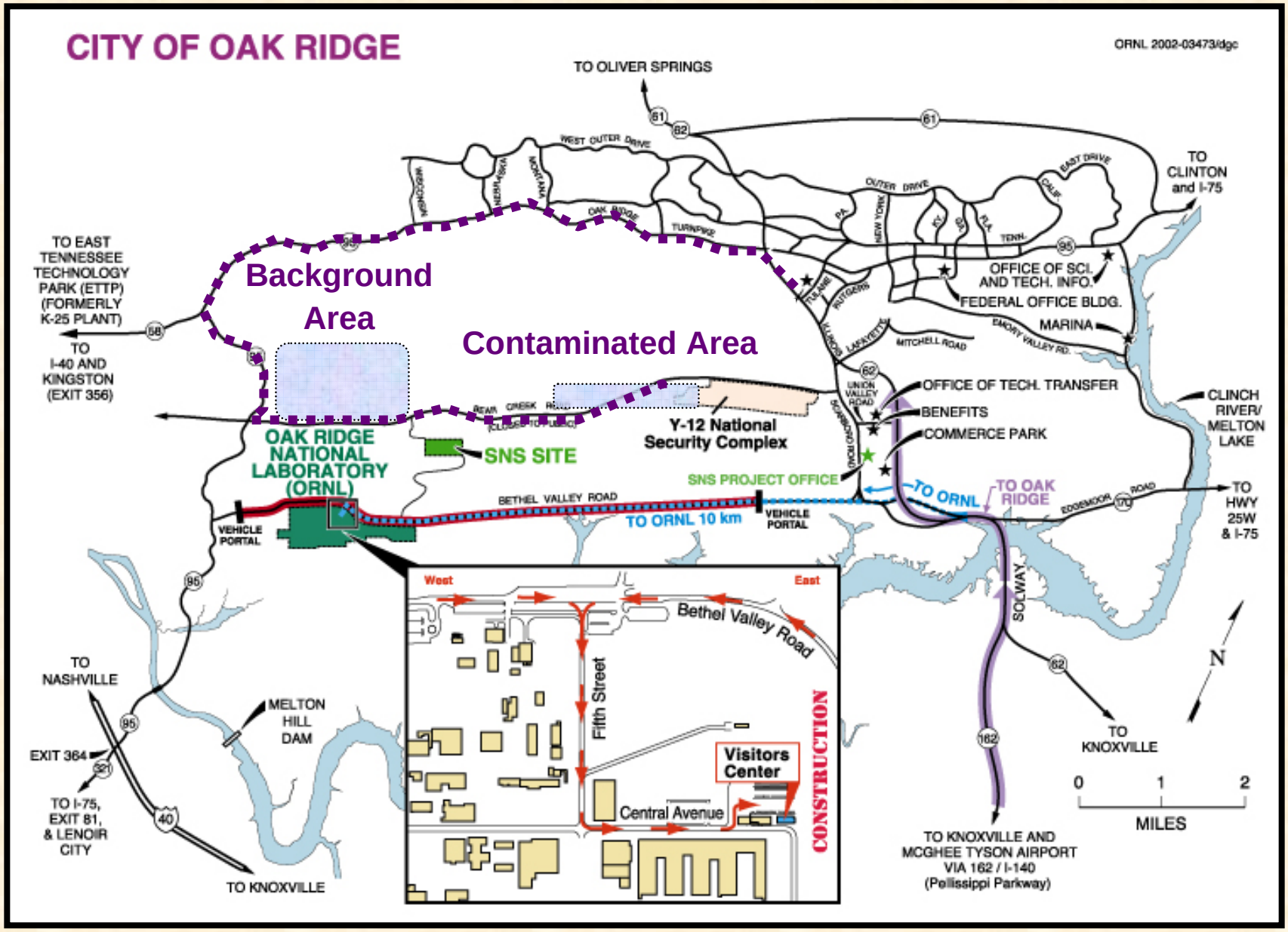
SampleId	Parent SampleId	Media	Location	Sampling Date	Analysis Date	Lab Test	Parameter	Result	Units	Qualifier	Detection Limit	Uncertainty
FW100-40-000529		GW	FW100-40	15-Jan-02	21-May-02	ICPMS	Aluminum	404.00	mg/l		0.174	
FW100-40-000627		GW	FW100-40	13-Feb-02	21-May-02	ICPMS	Aluminum	310.00	mg/l		0.174	
FW100-40-000918		GW	FW100-40	02-May-03	25-Jun-03	ICPMS	Aluminum	533.56	mg/l		3.7	
FW100-40-000911		GW	FW100-40	02-May-03	25-Jun-03	ICPMS	Aluminum	510.32	mg/l		3.7	



Tour

- Drive past Background Area
- S-3 Ponds Parking lot overview
- Tour 3 Field Projects (Stanford, Oregon, and PNNL)
- Tracer test in Area 3
- FRC Trailer
- Geoprobe drilling rig
- Restrictions
  - Cells phones must be turned off and stored
  - No pictures

FRC Tour



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