NABIR Field Research Center
Oak Ridge, Tennessee

NABIR PI Meeting
March 17, 2004

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

Presentation Outline

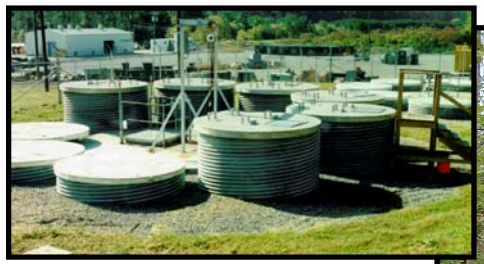
- Objectives
- Summary of site setting
- Overview of field projects and facilities
- General update
  - Working Groups
  - Revamped website
  - FRC modeling
- Update on FRC characterization
- Site characterization plan addendum
  - Preliminary results

FRC Objectives

- **Objective - Understand fundamental biogeochemical processes that would allow for the use of bioremediation approaches for cleaning up, managing, or understanding fate and transport at DOE's contaminated legacy waste sites.**
  - **Source of subsurface samples for NABIR investigators**
  - **Evaluation of new characterization and monitoring methods**
  - **Intrinsic bioremediation analyses (including natural attenuation)**
  - **In situ accelerated bioremediation research**
- **Advantages – Promote coordination and efficient use of resources, and facilitate comparison and integration of data.**

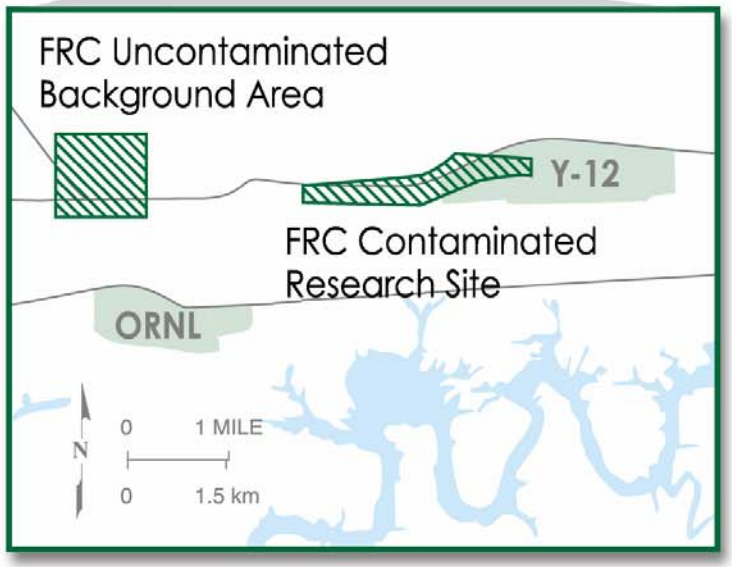
NABIR FRC Facilities

Lysimeters



Drill Rigs

Background Area

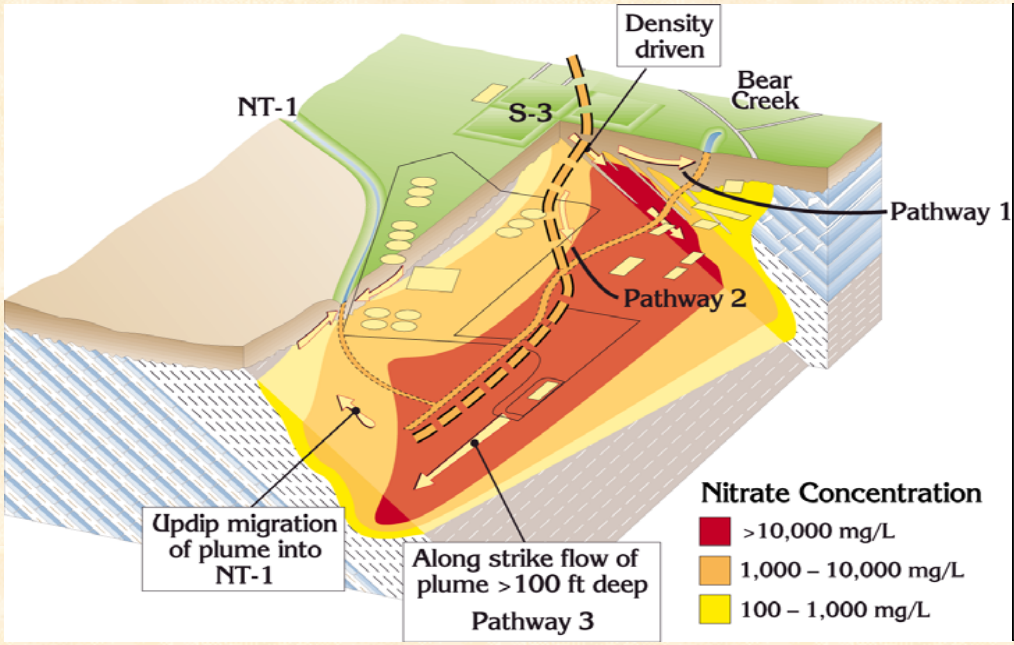


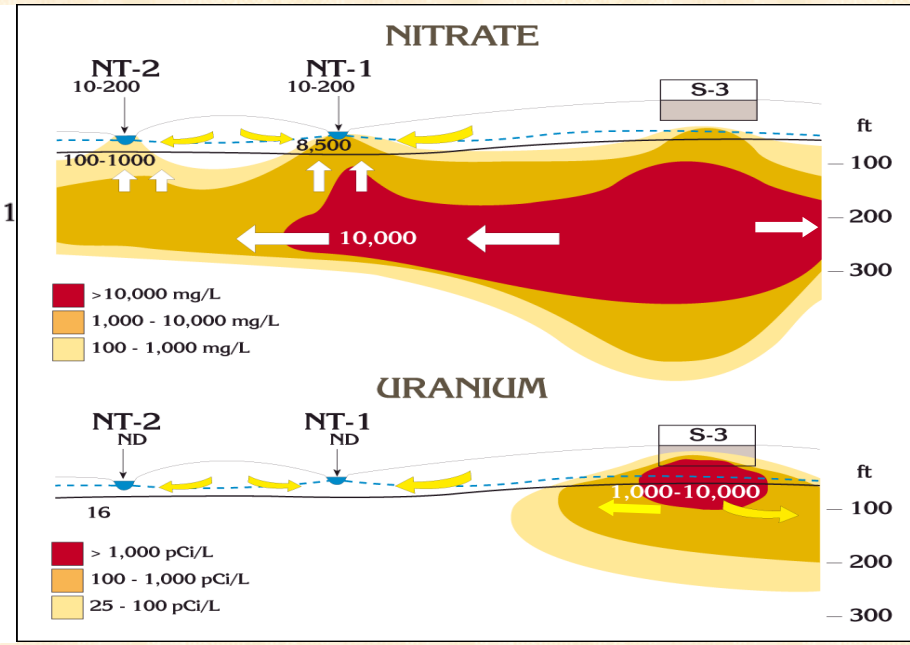
- Operated from 1951 to 1983
- 400 ft x 400 ft x 17 ft deep
- Over 2.5 million gallons waste/year
- Wastes contained nitrate, uranium, Tc-99, metals, VOCs, high TDS, and low pH (<2.0)
- Neutralized in 1984 capped in 1988

Currently a parking lot

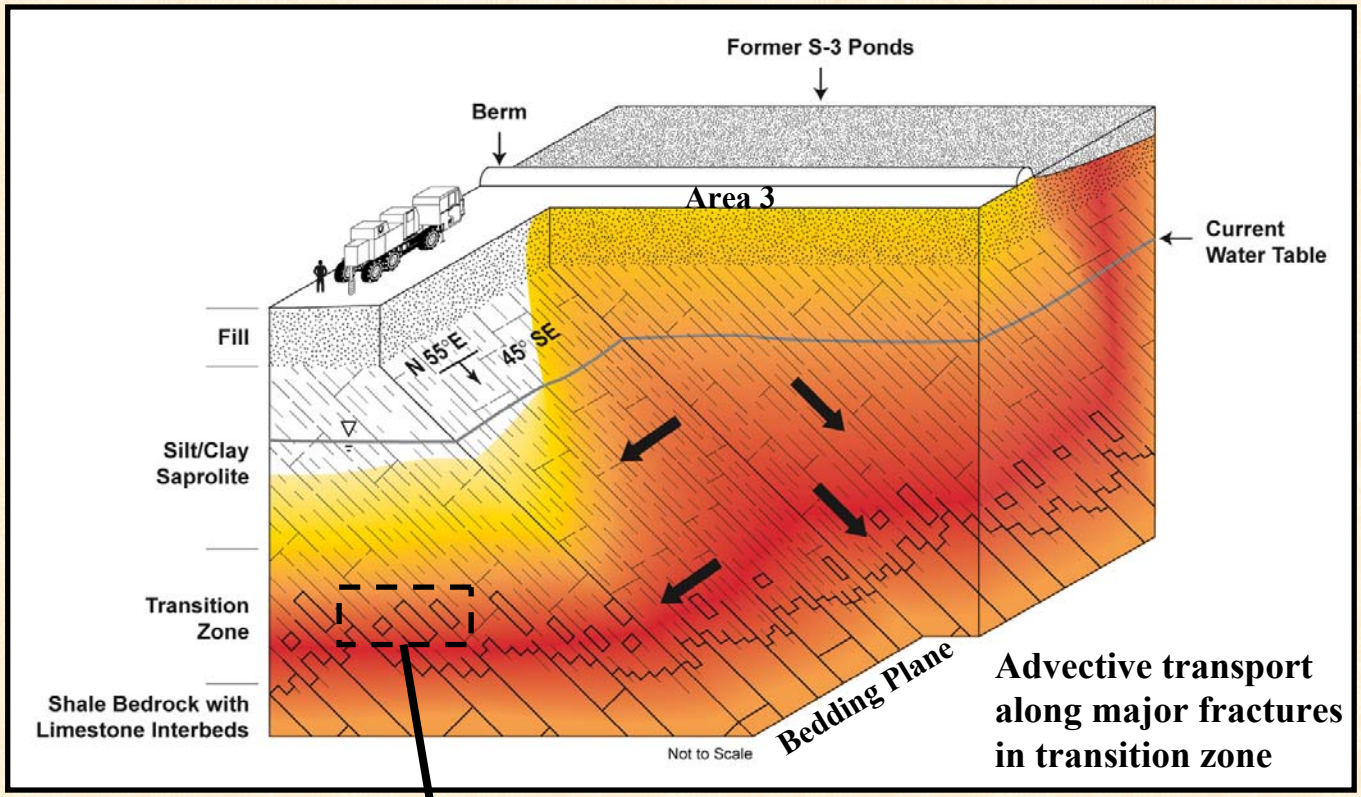
S-3 Disposal Ponds During Denitrification

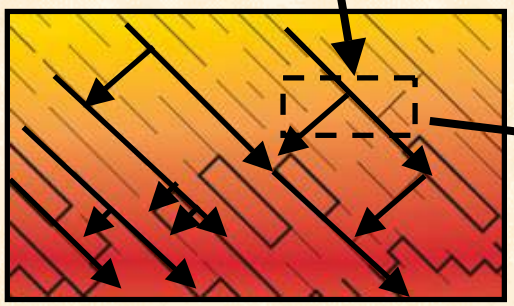
Conceptual Model of Contaminant Transport at the S-3 Ponds Site



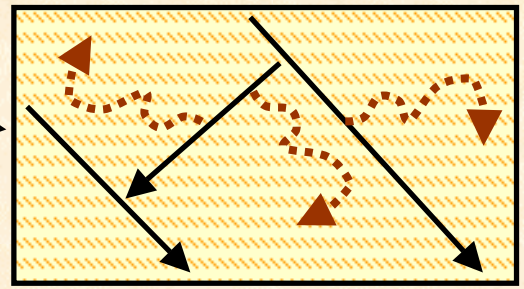


Conceptual Model – Flow Paths



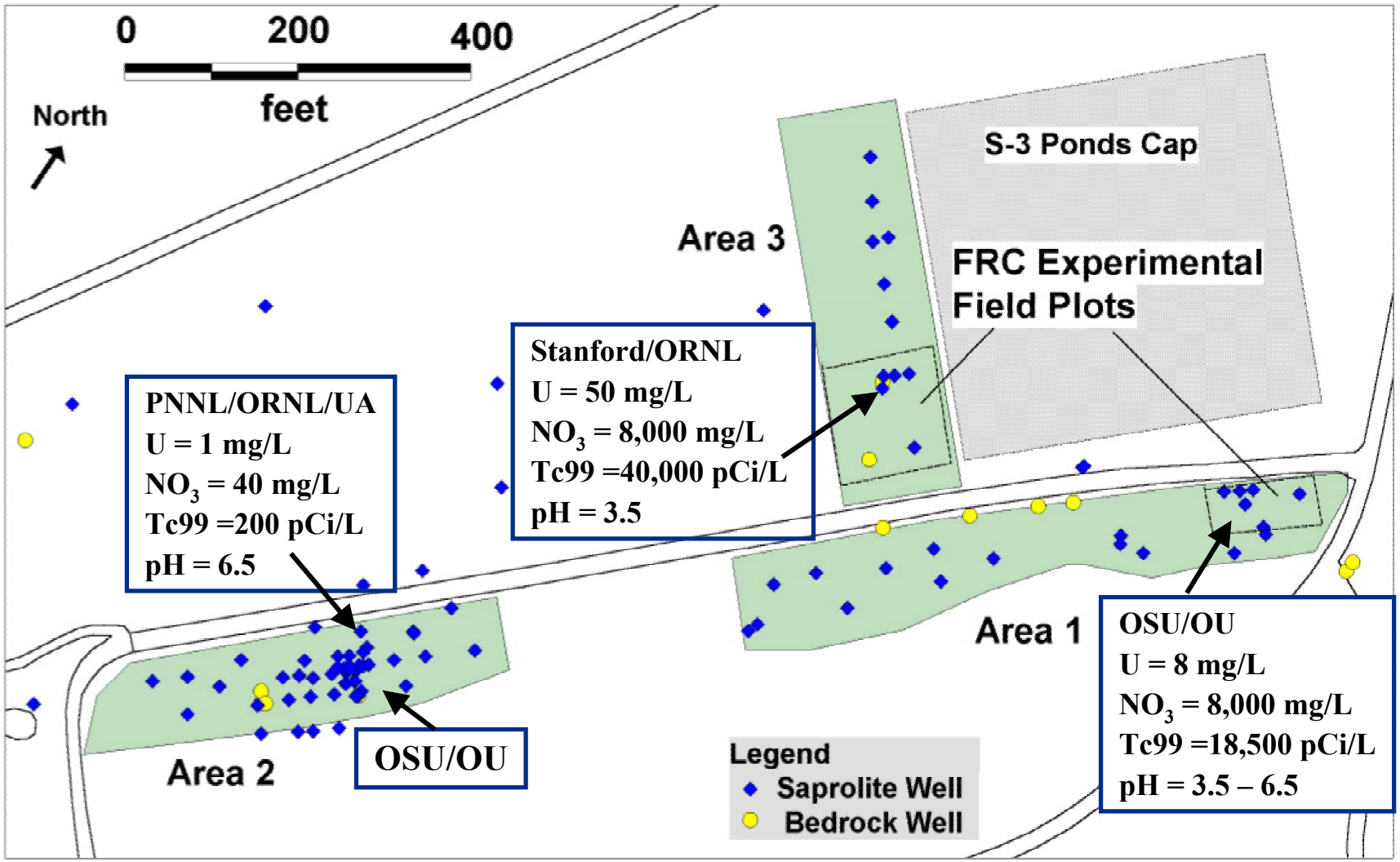


Diffusion along small fractures



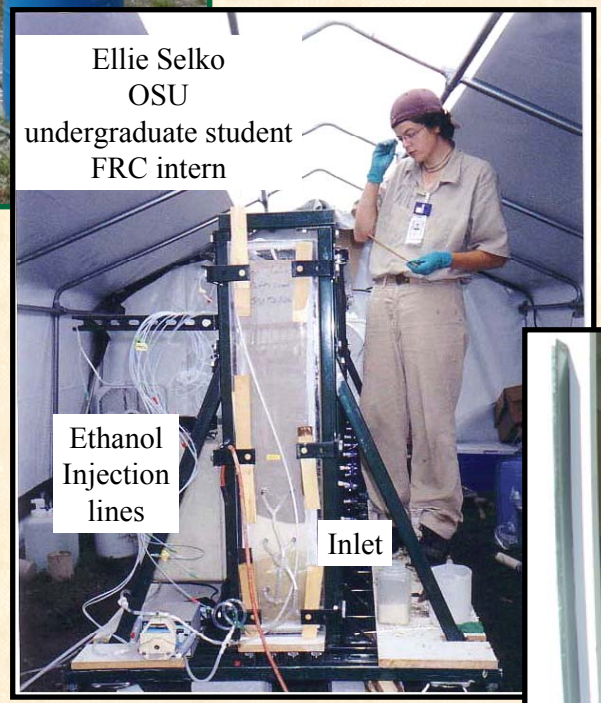
Diffusion into silt/clay/shale pores

Field Plots in Contaminated Area



In-situ Uranium Reduction Experiments Using Push-Pull Techniques (Oregon State University and Oklahoma University located in Area 1 and 2)

Area 1 field plot and new tent



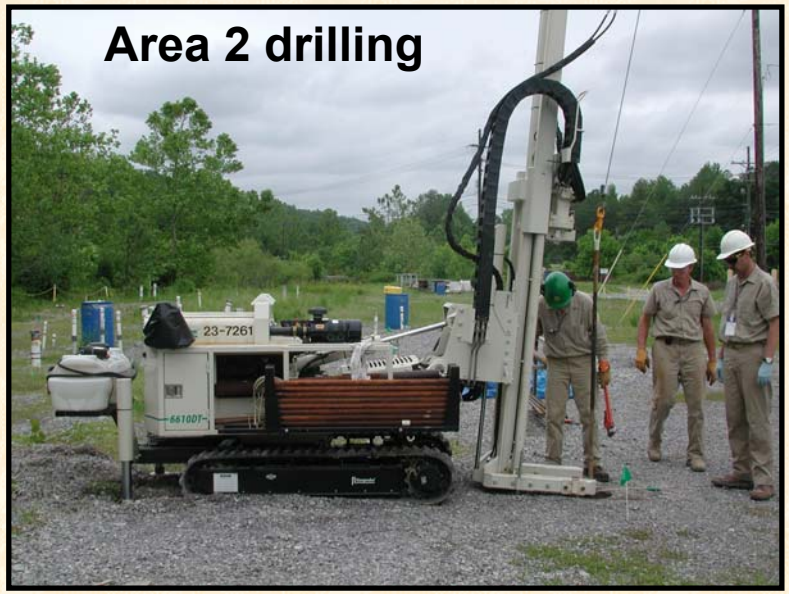
New flow cell in Area 1

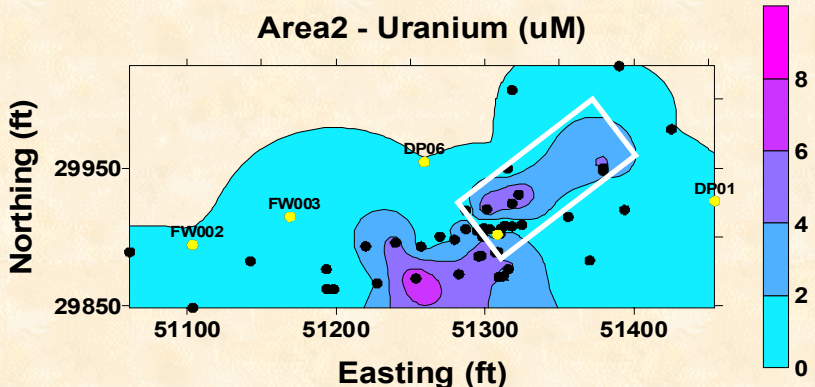
New flow cell and trailer in Area 2

NABIR *Field Research Center*

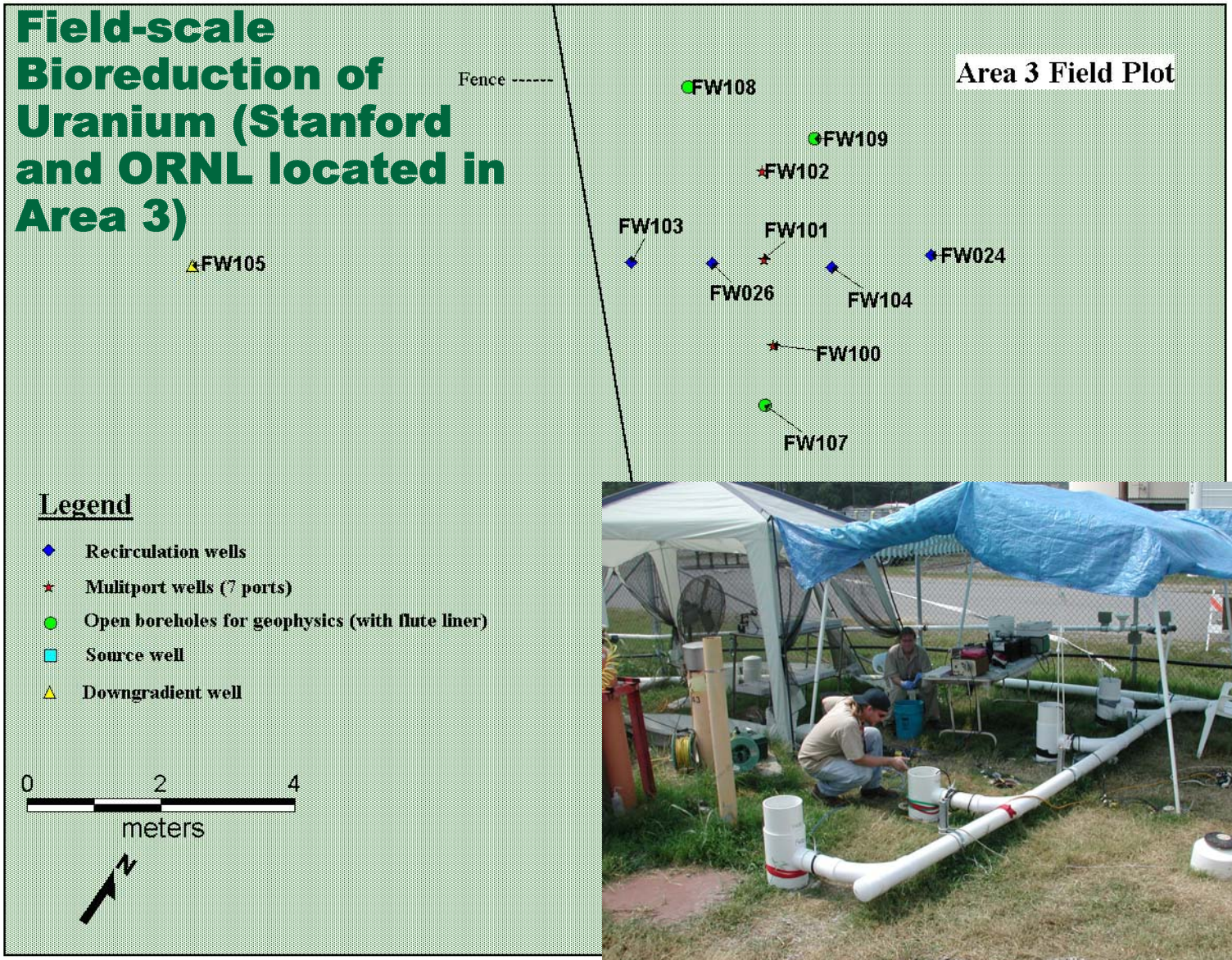
In situ Immobilization of Uranium in Structured Porous Media via Biomineralization at the Fracture/Matrix Interface (PNNL, ORNL, and University of Alabama located in Area 2)

Excavating Intact core in test pit at Background Area



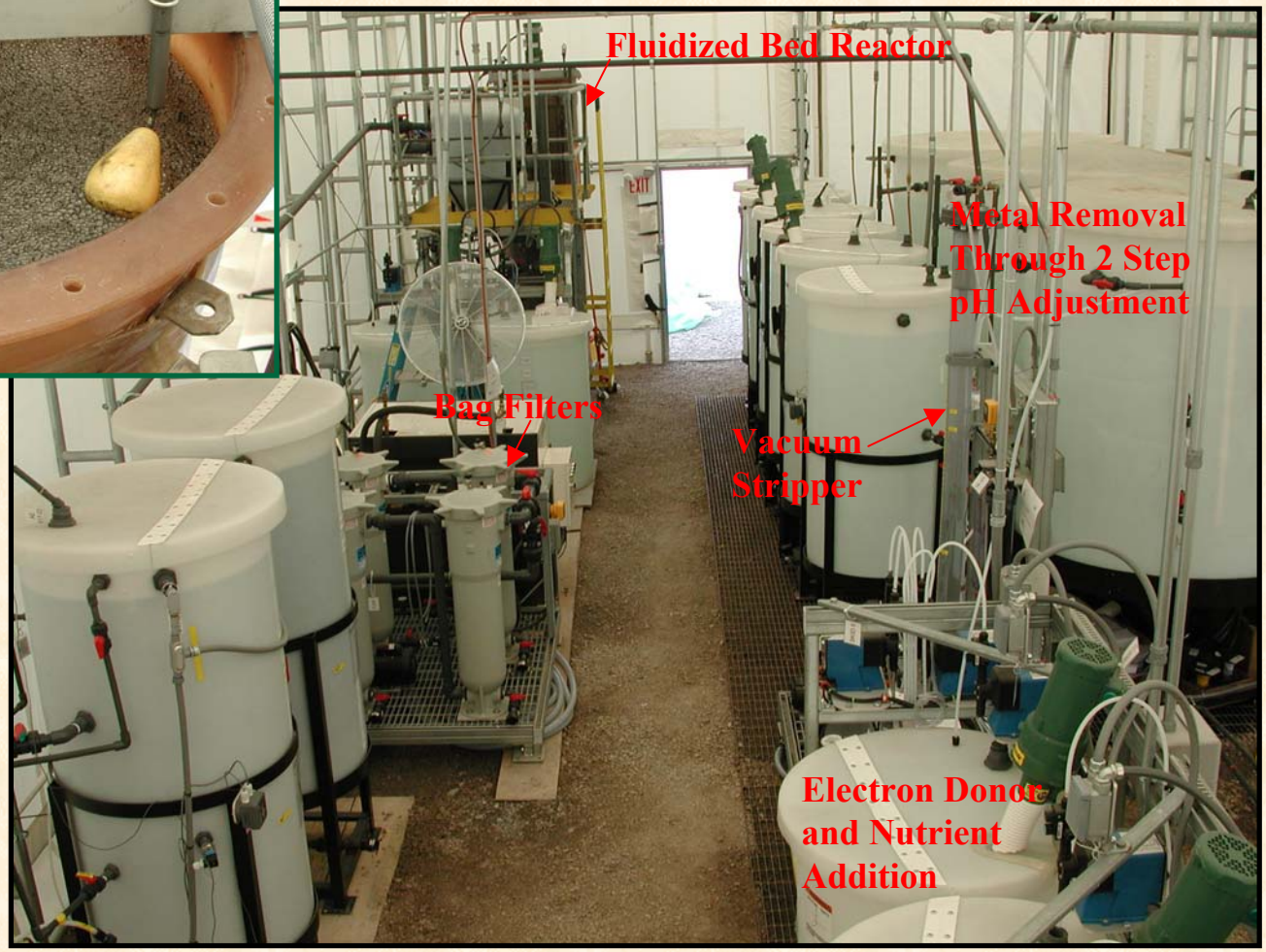


Field-scale Bioreduction of Uranium (Stanford and ORNL located in Area 3)



Stanford/ORNL field project above ground conditioning

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



FRC Sample Distribution

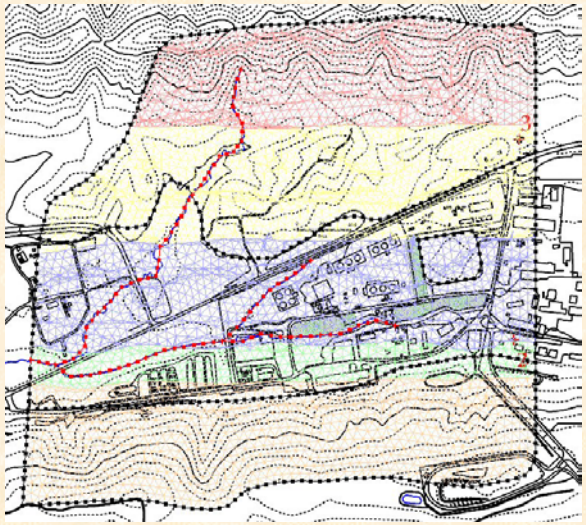
- Hundreds of groundwater and sediment samples (cores and composites) have been collected and shipped from the background and contaminated site for use by over 8 National Labs and 17 Universities
- Samples being provided to GTL and EMSP Researchers
- Samples shipped internationally

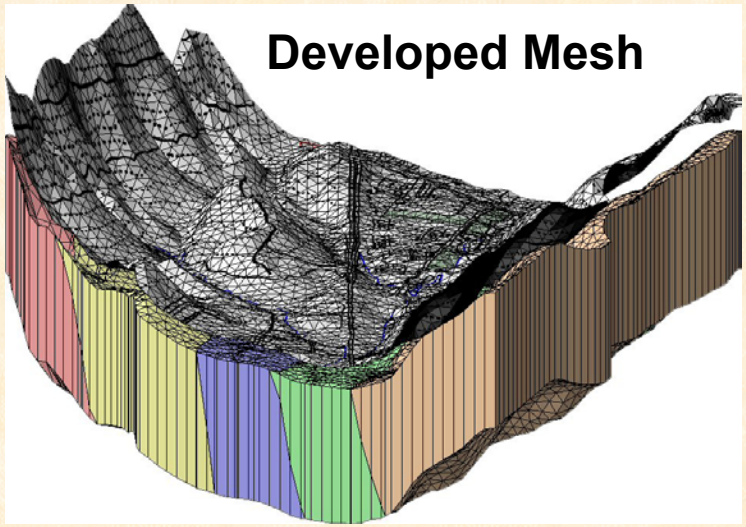
Working Groups

- Science Advisor – P. Jardine
- Working Groups
  - Geochemical/Geophysical Characterization - P. Jardine
  - Microbial Community Analysis - J. Kostka
  - Rates and Mechanisms of Microbially-Mediated Metal Reduction - B. Burgos
  - Numerical Modeling - J. Parker

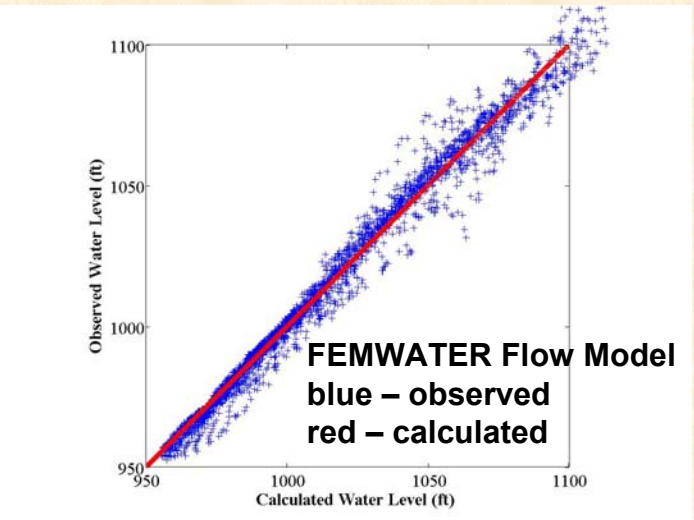
FRC Numerical Model (Jack Parke and Eungyu Park)

Geology and Conceptual Model





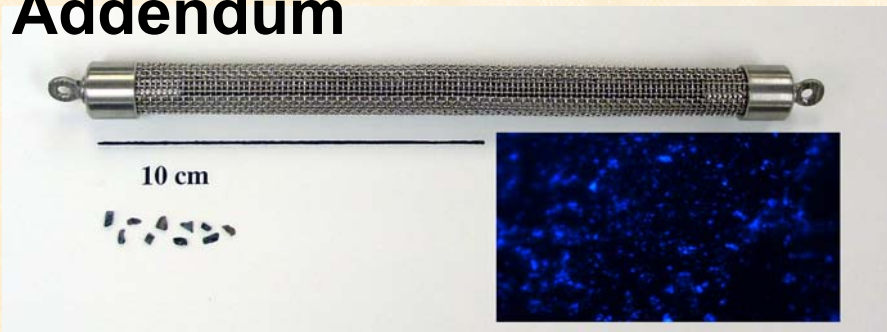
Observed versus Calculated Water Levels



FRC Website Revised

Characterization Update

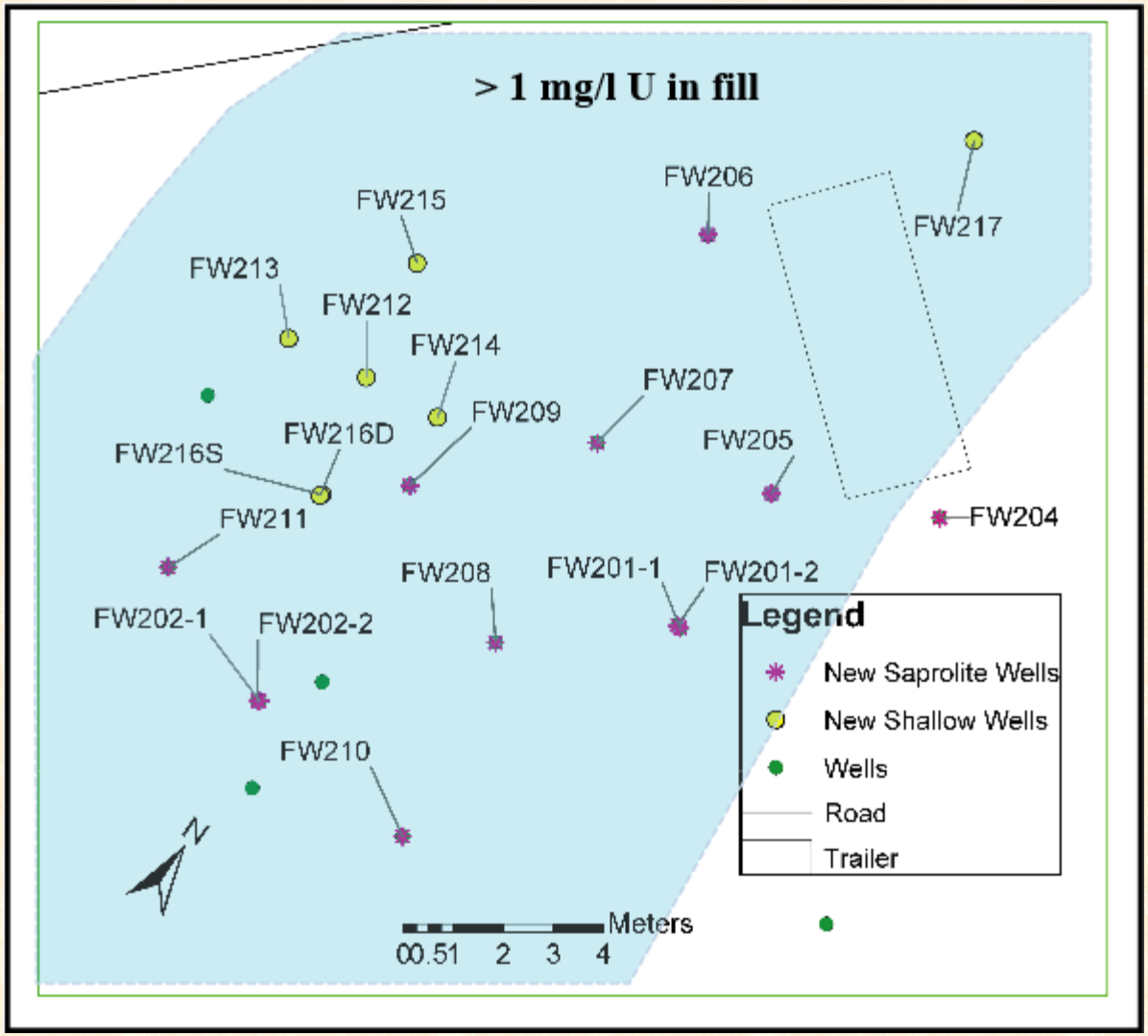
- New wells and groundwater data all areas
- Mineralogical and geochemical evaluations
  - ECEC and other data now available on core at all areas
- Geophysics Evaluations
  - Electromagnetic borehole profiling – ORNL
  - Surface resistivity and seismic tomography- ORNL
  - Crosswell Seismic and Radar - LBNL
  - Geoprobe electrical conductivity probing
  - Gamma counting - Thorium 232 finding
- Humics – Background Area forested surface soils
  - Spectroscopic characterization (Baohua Gu)
- Coupons – Microbial analysis INL and UT
- Site Characterization Plan Addendum

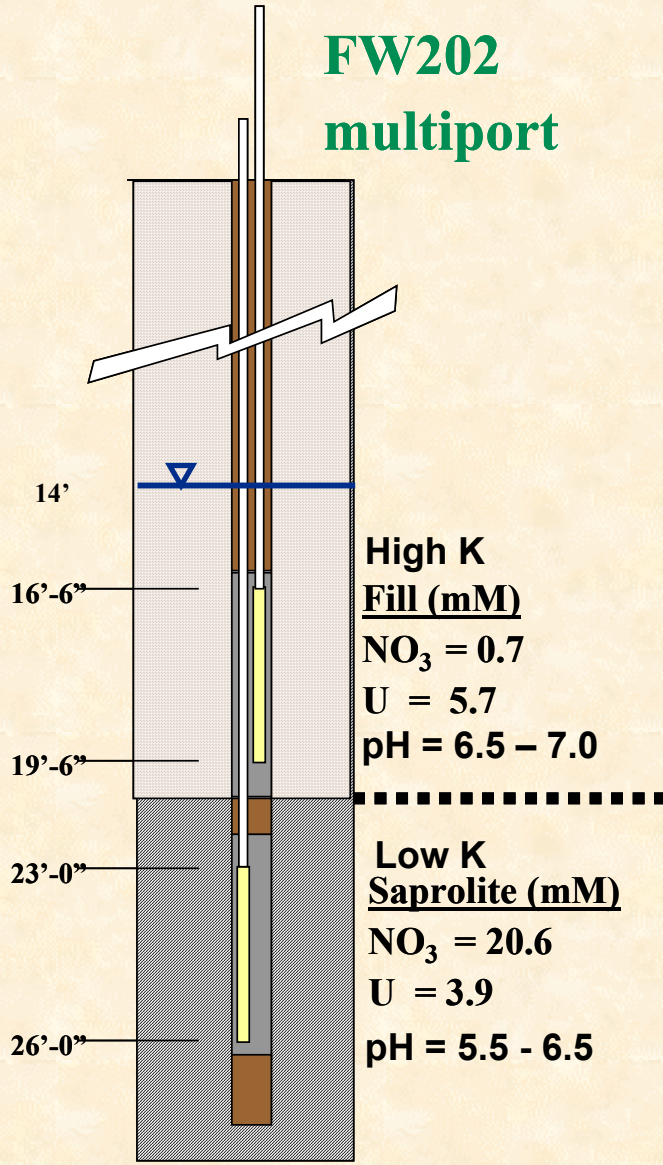


New Wells and Groundwater Data

- Area 1 – 3 new wells for MLS sampling
- Area 2 - 18 new wells installed (3 multiports and 2 for MLS)
- Area 3 – 1 piezometer upgradient of field plot
- Groundwater sampling
  - Cations (ICP/MS)
  - Anions (IC)
  - TOC
  - Field Parameters
- Hydraulic testing (water levels, and pumping and flow meter tests)

Area 2 – New Wells

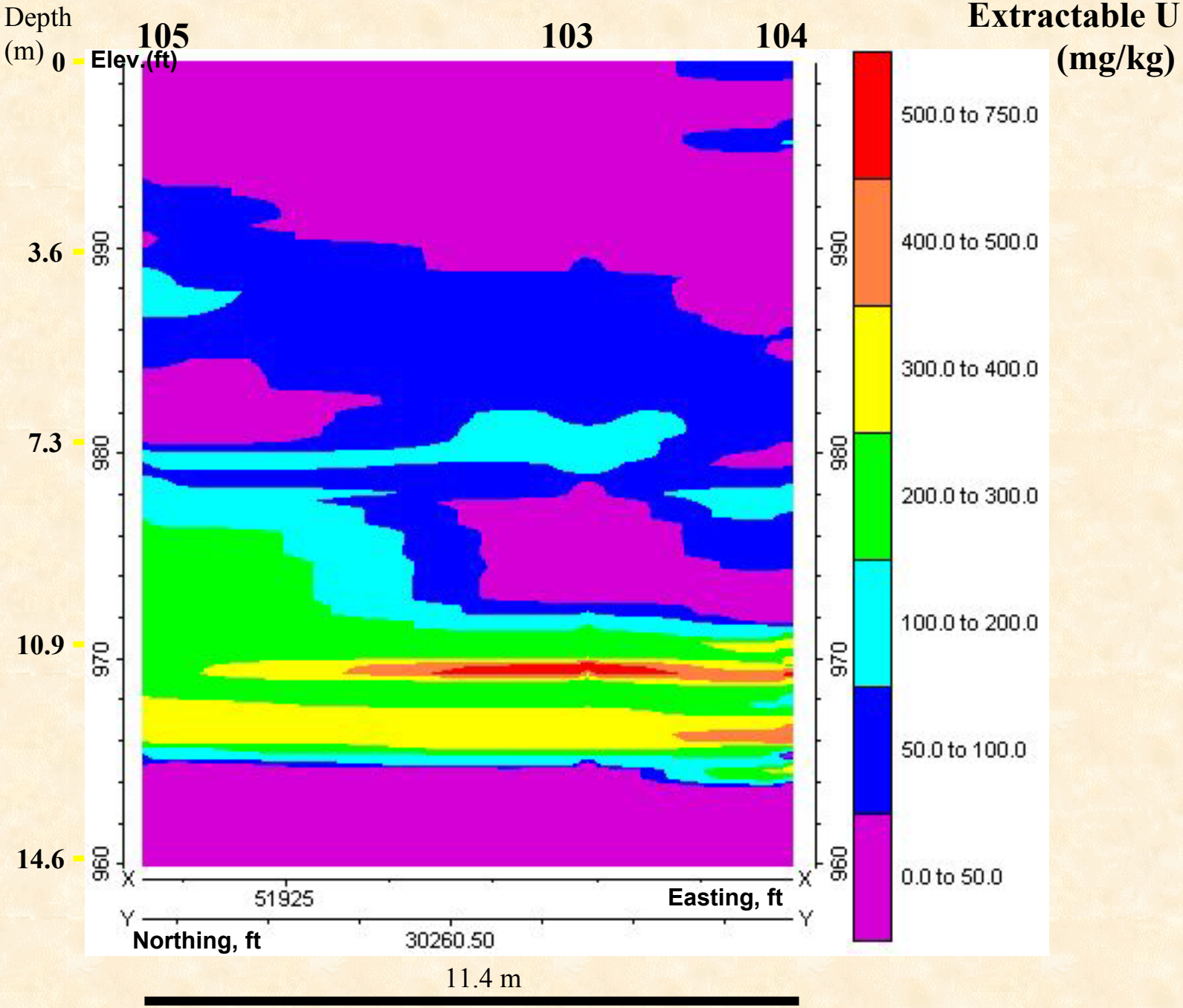




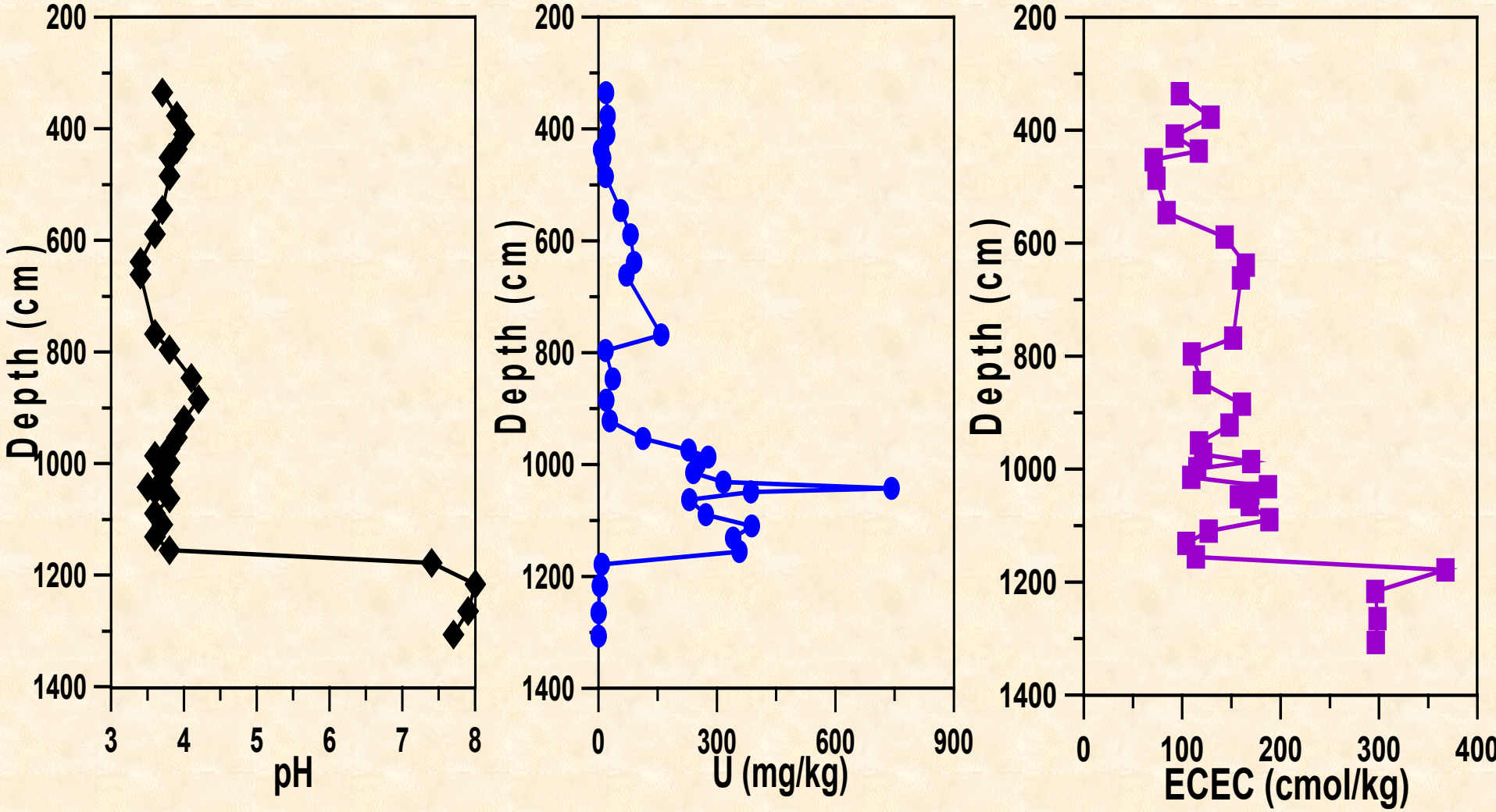
Characterization of FRC Cores (Phillips and Roh)

- Core material from all 3 areas analyzed
- Analyses
  - Soil description
  - pH
  - Oxalate and CBD extractions (Fe, Mn, Al, U by ICP)
  - Uranium – Nitric acid extractable (ICP)
  - P and other metals (fusion/ICP)
  - S (combustion infrared Leco)
  - ECEC – (Cores from area 1, 2, and 3)
- Mineralogical Analyses
  - Thin sections, XRD and SEM-EDX-BES-Mapping
  - Manganese oxides – On-going analyses
  - EXAFS (ANL – Shelly Kelly and Ken Kemner)

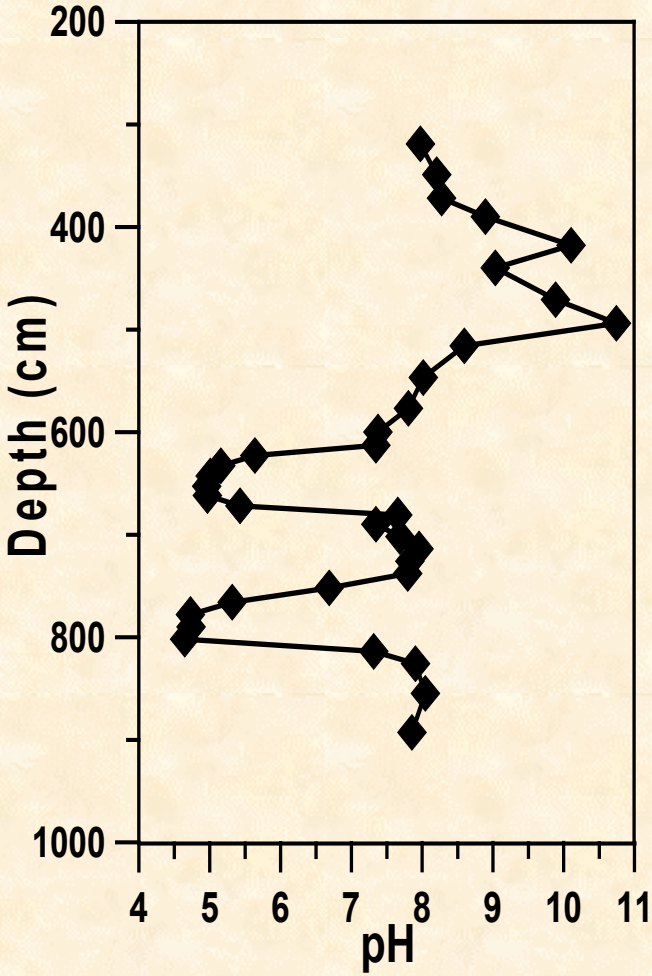
Interpolated Uranium Distribution between the Cores

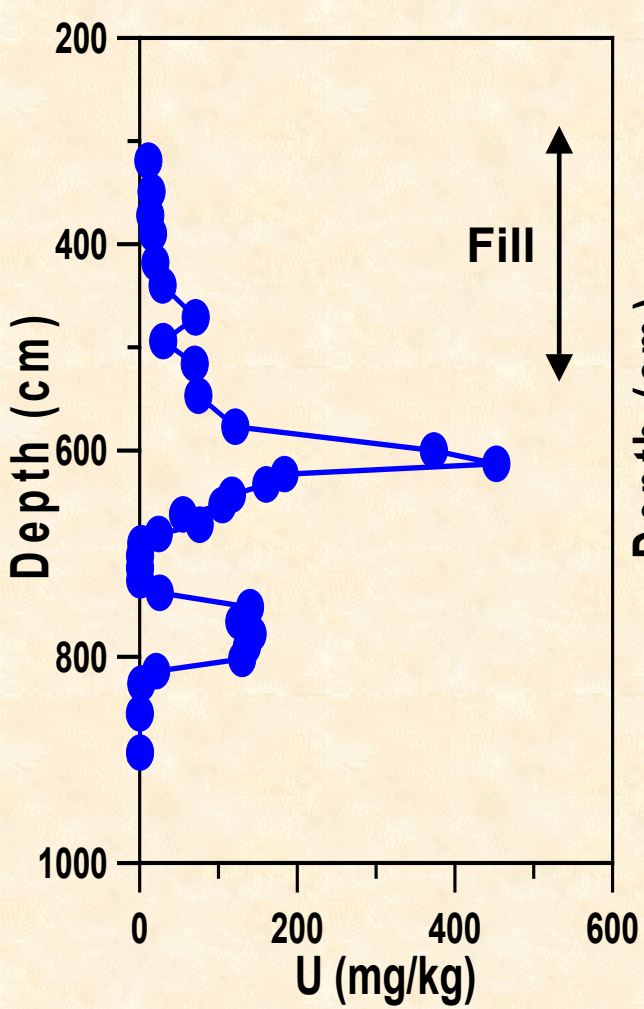


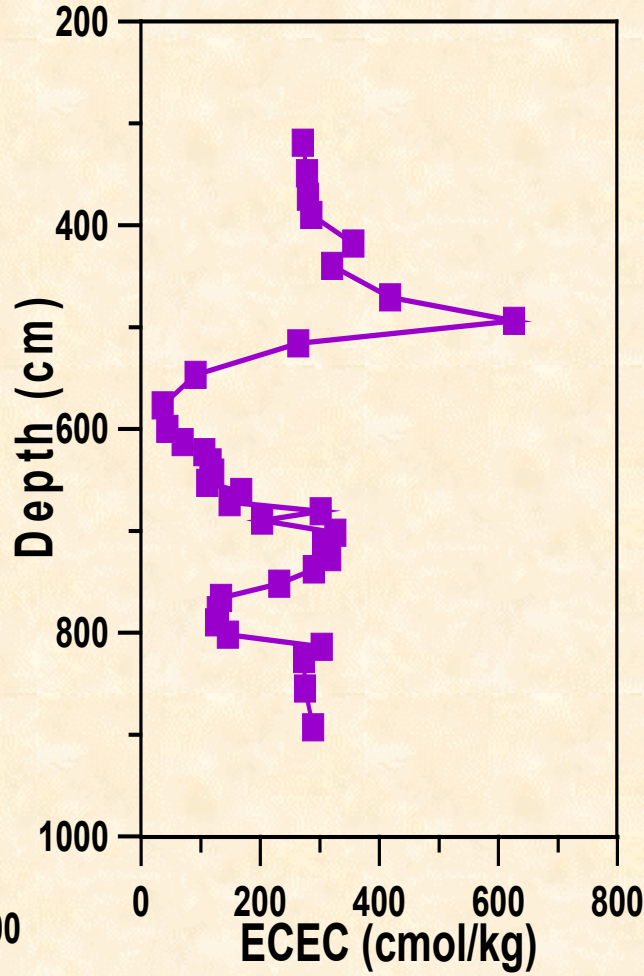
Core FWB103, Area 3, NABIR FRC Site

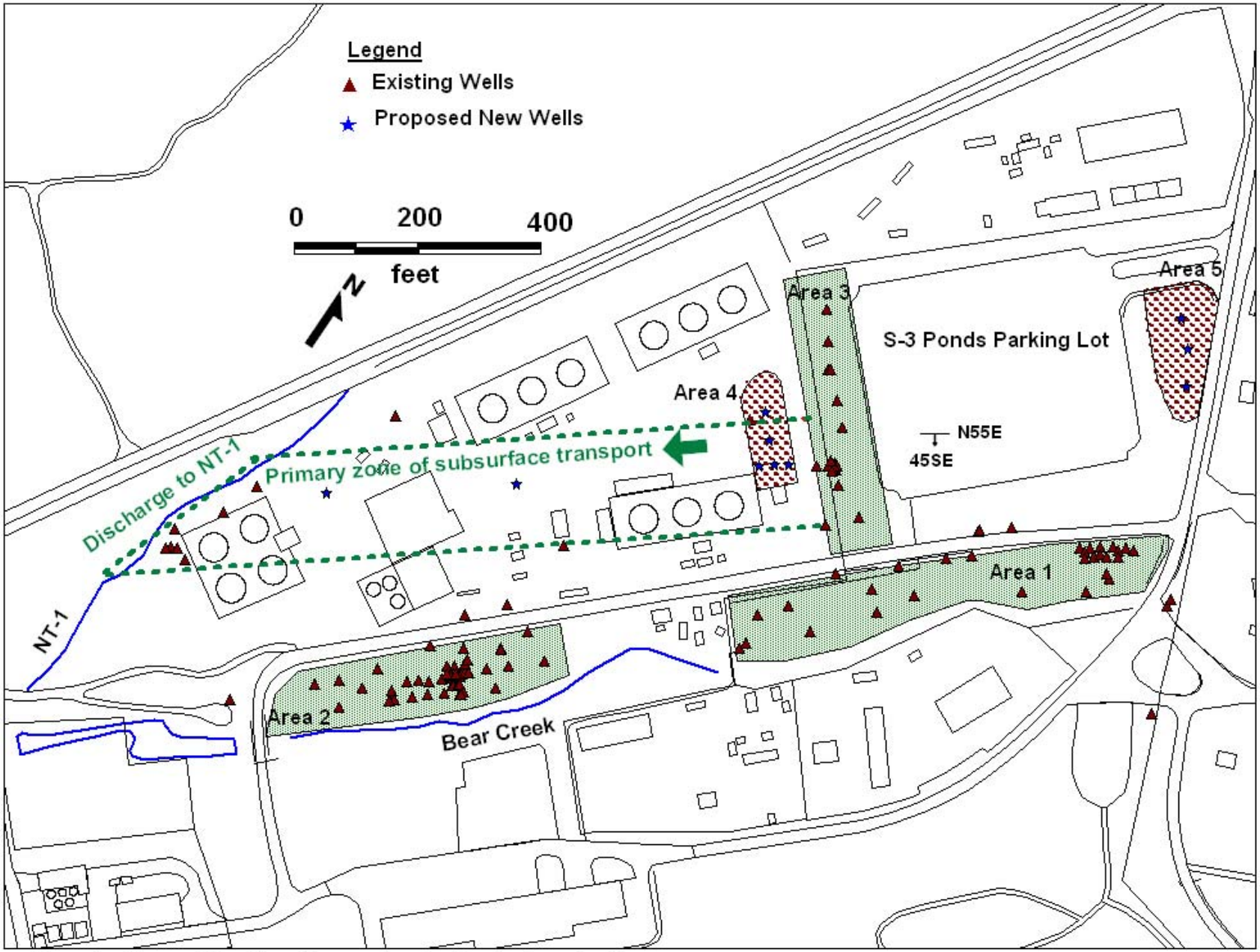


Core FWB200, Area 2, NABIR FRC Site









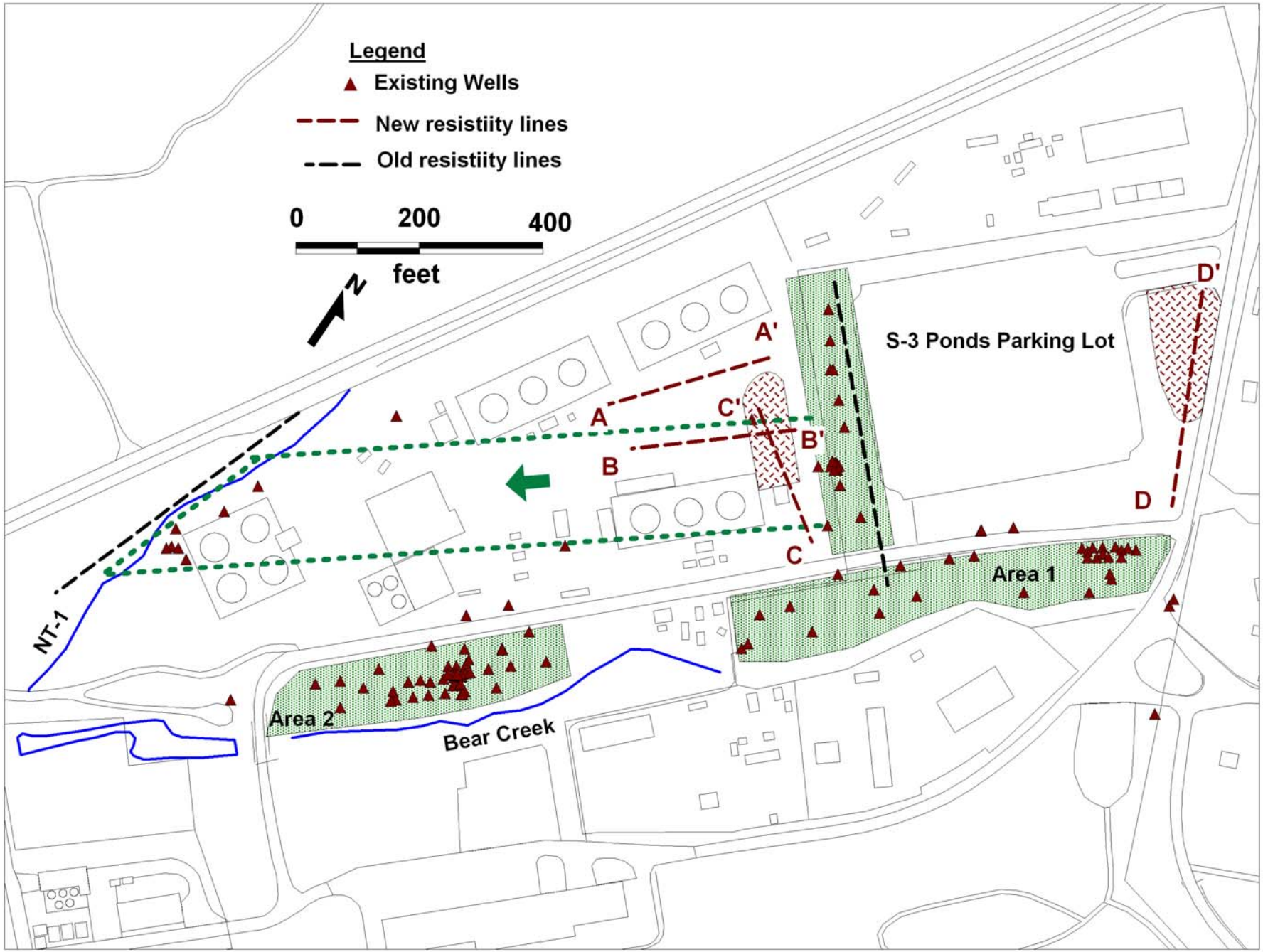
FRC Site Expansion and Characterization

FRC Site Expansion and Characterization

- Objectives
  - Obtain data necessary to determine if Areas 4 and 5 have geochemical characteristics suitable for NABIR research
  - Assess the geochemical and mineralogic changes in groundwater and saprolite along the primary flowpath west of the S-3 Ponds
  - Establish the basic hydraulic characteristics of existing and proposed new sites
  - Provide investigators with the data needed to design experiments and determine whether existing or new sites are suitable for their proposed project

FRC Site Expansion and Characterization

- Scope of work
  - Conductivity probing, and surface geophysics
  - Coring and well installation
  - Core analysis - U, metals (ICP/MS) pH, sequential extractions, mineralogical analysis (SEM, EDX, BSE mapping, XRD), CEC, EXAFS?
  - Groundwater analysis - U, cations (ICP/MS), anions (IC), field parameters
  - Hydraulic testing (pumping tests, flow meter tests, tracer tests, and water levels)


Legend
Existing Wells
New resistiity lines
Old resistiity lines
0
200
400
feet
N
A
A'
B
B'
C
C'
D
D'
S-3 Ponds Parking Lot
Area 1
Area 2
NT-1
Bear Creek

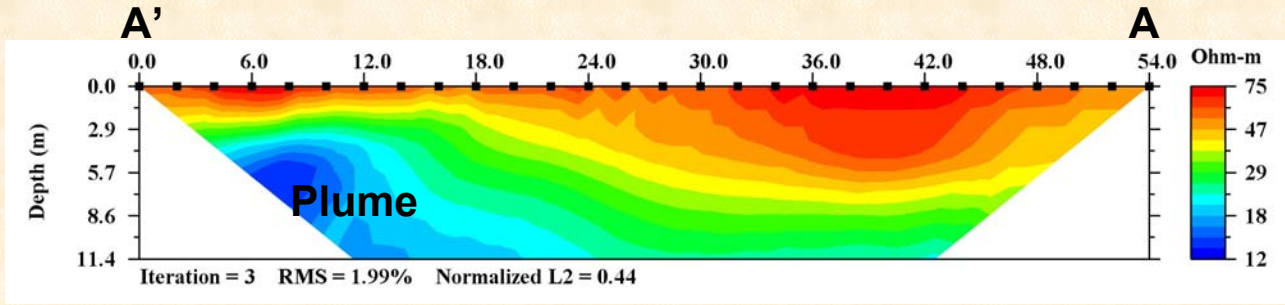
Resistivity Sections Near Area 4

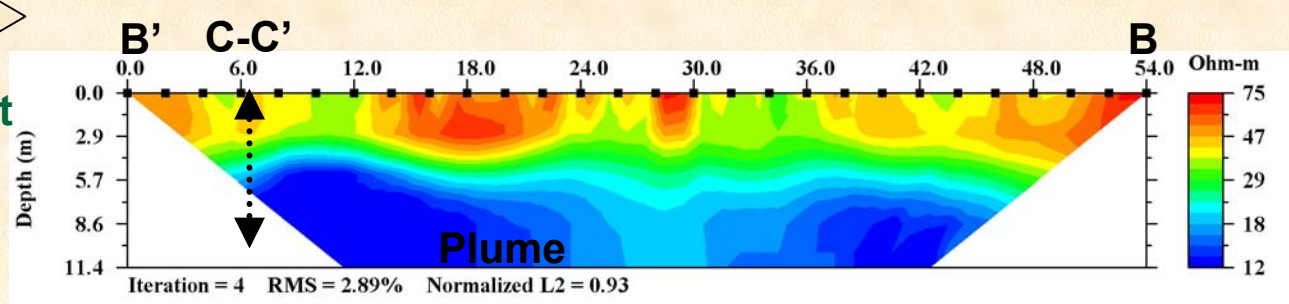
S-3 Ponds source

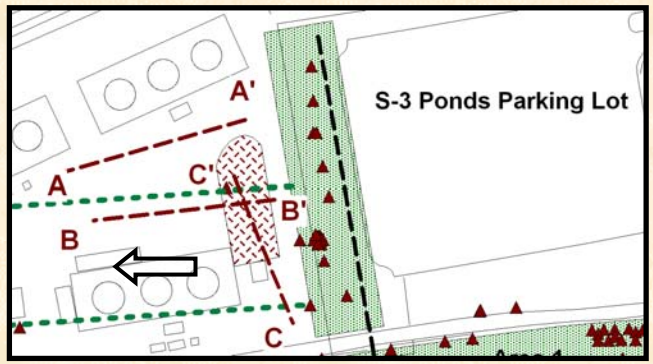
Northern transect outside pathway

Flow direction

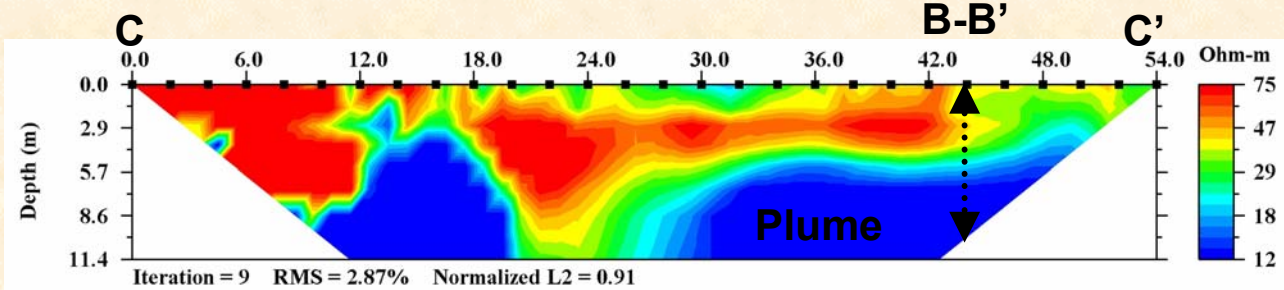
Southern transect inside pathway



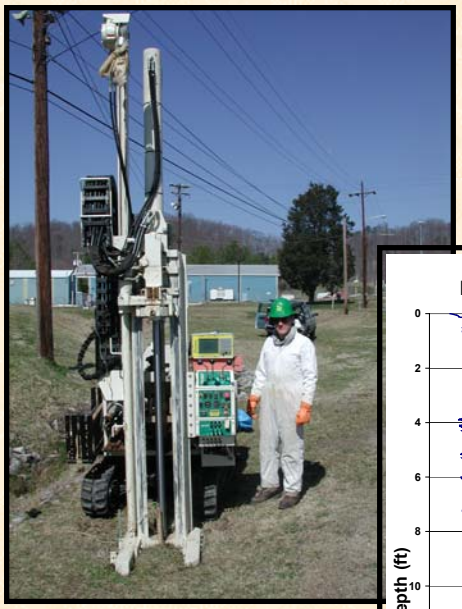


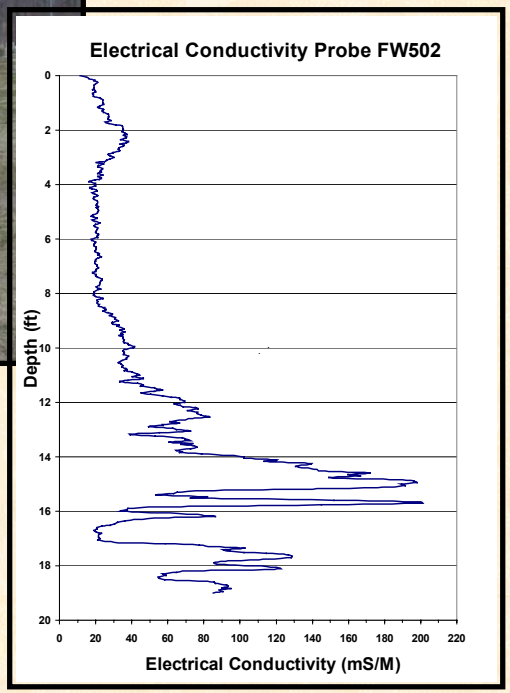


North-South section: Direction of flow into page

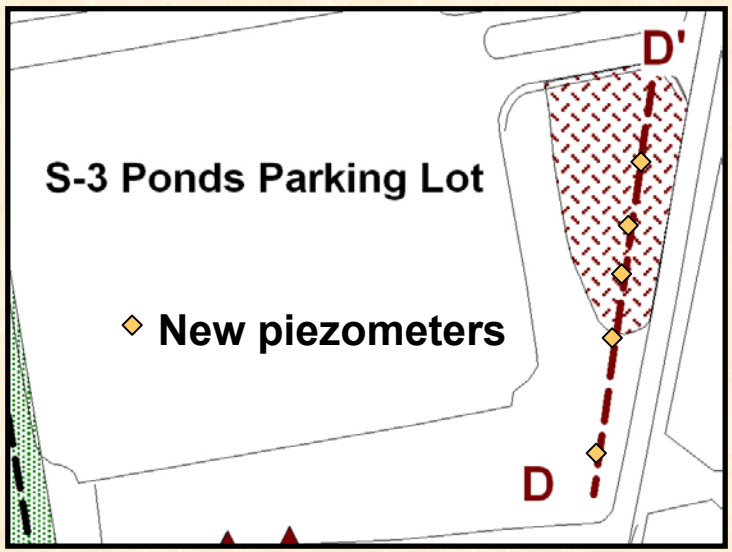


Preliminary Data From Area 5

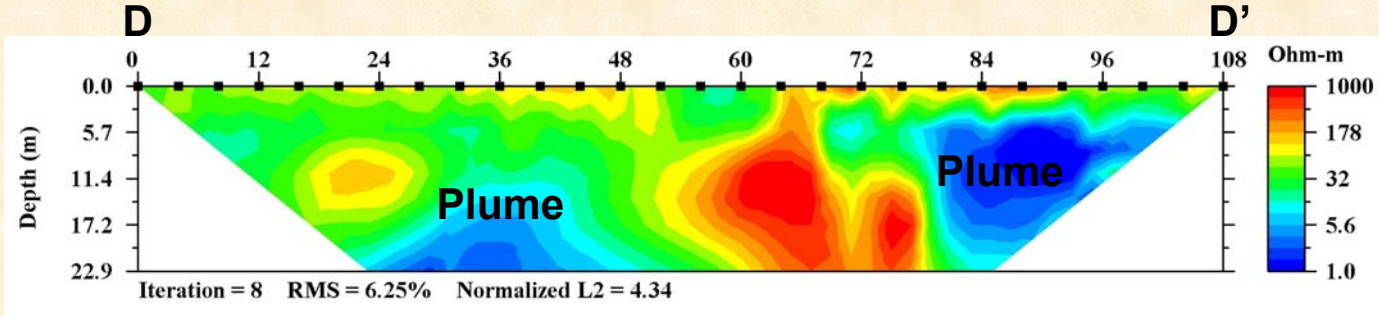




- 5 EC probes and piezometers installed
- Nitrate: 1140 – 6130 ppm
- U: 0.044 – 14.5 ppm
- pH 3.6 – 6.0



North-South section:
Direction of flow
out of page



FRC Contributors

- Sample collection, processing, shipping, and analysis – Tonia Mehlhorn, Barry Kinsall, Kenneth Lowe, Mary Anna Bogle, George Houser, Steve Childs, Kirk Hyderand Norman Farrow
- Geophysics - Bill Doll, Les Beard, Jeff Gamey, and Jacob Sheehan
- Soil Characterization - Debra Phillips and Yul Roh
- Database and website - Craig Brandt, and Susan Holladay
- Regulatory issues - Harry Quarles and Monty Ross
- Geochemistry - Scott Brooks and Philip Jardine
- Microbiology - Susan Pfiffner and Tom Phelps
- Humics- Baohua Gu
- BASIC - Amy Wolfe
- Administrative - Lynda Campbell
- Stanford and ORNL – Craig Criddle, Phil Jardine, Wei-Min Wu, Peter Kitanidis, Mike Fienen, and Susan Hubbard
- OSU/OU – Jack Istok and Lee Krumholz
- PNNL/ORNL/UA – Tim Scheibe, Scott Brooks, Eric Roden
- FRRP – Terry Hazen et. al.
- XAFS – Ken Kemner, Shelly Kelly (ANL)