Environmental Remediation Sciences

INTEGRATED FIELD CHALLENGE SITE

Hanford 300 Area

U.S. Department of Energy Office of Science

Environmental Remediation Sciences Program

Experimental Site Layout, Well Installation, Injection Experiment Design, and Characterization Plans

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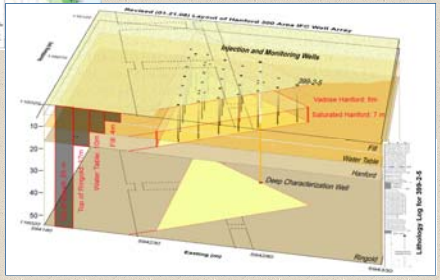
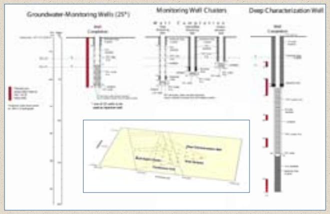
IFC LOCATION, WELL LAYOUT AND INSTALLATION



The well field consists of an equilateral triangular array of wells, oriented with one side approximately north-south, with an overall length along a side of approximately 60 m. There will be 35 wells, at a nominal spacing of 10 m, completed through the saturated zone in the Hanford Fm., occurring over a depth of approximately 10-17 m. In addition, three, three-well clusters will be installed within the well field footprint to allow depth-discrete water sampling in the Hanford Fm. A single deep characterization well will be completed through the Ringold Fm. into the top of the Columbia River Basalts.

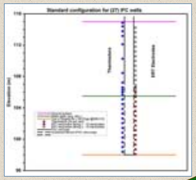
Sampling During Borehole Construction

- The completed wells will be 4 inches in diameter
- For a subset, continuous core will be collected in lexan liners for detailed description, analysis, and experimentation with continuous materials
- Grab samples will be collected at each 2' interval, described and catalogued for further analysis and distribution to interested researchers
- At the vadose zone infiltration site, the wells will be completed with porous cups to allow monitoring and sampling during infiltration experiments
- Each well will include a centrally controlled water sampling pump, and an array of conductivity, pH, bromide, pressure, and temperature electrodes, installed within the screen



Annular Borehole Sensors

- Installed during well completion
- ERT sensors will be installed in two strings in each well, in the vadose and saturated zones.
- Thermistors will be installed to provide 0.6 m vertical resolution during river-water tracer experiments, 0.3 m vertical resolution in the capillary fringe, and variable resolution in the vadose zone for use in ERT measurements



BACKGROUND

The 300 Area IFC is located at the former site of a waste pond that contained residue from reactor fuels fabrication. The pond fill was excavated and backfilled, but uranium persisted in the vadose zone beneath the pond footprint and migrated in groundwater to the Columbia River. The well field layout and construction plan was designed to accommodate the following objectives: *i.* Provide sediment samples at spacing sufficient to characterize the distribution of reactive phases within the test plot; *ii.* Allow injection and monitoring over the predominant flow directions; *iii.* Permit detection and monitoring of an injection plume during its reaction with the aquifer phases, including its spatial resolution and its chemical evolution; *iv.* Allow rapid sample collection and automated electrode measurements of injected plumes, with the ability to adapt data collection to changing experimental needs.

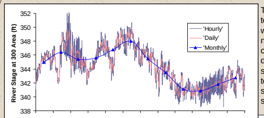
SEDIMENT SAMPLE CHARACTERIZATION

Initial sample characterization will be driven by needs for reactive transport modeling. The total number of samples examined will be limited by the nature of the Hanford Fm: bulk mineralogy is relatively uniform, with local lithologic variations imposed by changes in depositional energy during catastrophic flooding.

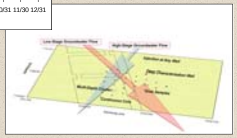
- Grain size distribution and porosity will be measured directly on a representative set of samples and indirectly by geophysical methods on cores and *in situ*.
- Mineralogy will be determined for a geographically distributed set representing each grain size class (defined by the results of grain size measurements).
- Geochemical measurements will be made on each grain size class, e.g., CEC, extractable Fe, carbonate, etc.
- Geochemical experiments will be conducted to determine each class's reactive transport properties, using batch and column methods.
- The physical and geochemical parameters will be propagated to the sediment system within the IFC using the *in situ* and direct measurements described above.
- The accuracy of the characterization methods and their large-scale application will be tested against experimental field data, and adapted and changed as needed.

PROPOSED TRACER AND INJECTION EXPERIMENTS

Targeted Groundwater Flow Regimes



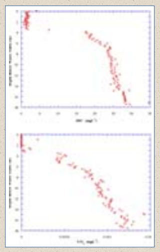
The site is influenced by the short and long term rise and fall of the Columbia River, which cause river water infiltration into the near shore environment, and significant changes to the hydraulic gradient and flow direction beneath the IFC. At low river stage, groundwater flow is predominantly toward the southwest, but at high river stage, flow is predominantly toward the southeast.

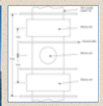


Experiments and River Stage

- River stage varies by 2 m
- River temperatures
  - February: 2º C
  - September: 20º C
- Groundwater: 16.5º C
- Ambient-T river water injection can trace water movement and mixing via the thermistor network

Pre-Test Groundwater Profiles

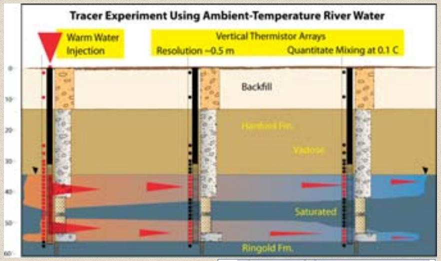




Passive Multilevel Sampling

- Profile the vertical composition of the aquifer prior to tracer or solute injection
- May be deployed in advance and withdrawn on short notice
- Uses dialysis to sample aquifer at 15 cm intervals
- Example data from the Hanford Plateau illustrates
  - Spatial resolution of measurements
  - Trace-level detection

Tracer and Reactive Transport Experiments



- Use river stage to determine groundwater flow direction
  - Target seasonal southeast and southwest flows
- Pre-deploy MLS, then collect samples for vertical aqueous-phase characterization at test period
- Choose injection site within well field according to groundwater flow
- Pump and return river water to establish temperature control on injection solutions
- Determine tracer or reactive solute composition to be added to injection water
- Divert metered river water to injection well, and meter solute at known and desired concentration
- Monitor injection water movement and mixing using thermistor network
- Sample water within well network
  - In-well electrode readings
  - Pumped water samples from wells to field laboratory for flow cell electrode measurement and direct aqueous sampling for selected analytes
- Thermal tracer tests, MLS analyses, sediment-sample characterization experiments, and aqueous samples provide information for reactive transport modeling.

Injection Design

- River water filtered and pumped to injection site
- Returned to river to maintain constant T
- Diverted to injection well
  - Metered
  - Amended as needed during injection