HANFORD IFC QUARTERLY REPORT

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I. Overview and Highlights

The Hanford IFC project has been operational since March 2007 when funding from ERSD was received. We have been busy since that time. An investigators meeting was held soon after project dollars arrived at PNNL to overview the site background, science theme, and research concept; to confirm the scope and nature of contribution of each participant; and to discuss an overall modeling strategy for the project. The meeting initiated the subcontracting process for external participants who were not slated to receive funding until FY 08. [The exception to this was Roelof Versteeg (INL) who received funding in FY 07 for data base development and geophysical measurement support]. Soon after this investigators meeting, IFC participants lead a break-out session on the project at ERSD's annual P.I. meeting (April 2007).

The core IFC team received funding in FY 07 for project initiation. Over the first 6 months of the project the primary objectives for this team were to: i.) write necessary project documents, ii.) complete NEPA documentation and begin the permitting process for injection wells and experiments, iii.) develop a website, iv.) place subcontracts with project participants, v.) perform geophysical characterization to aid in experimental site placement, vi.) design and begin installation of the field experimental site and monitoring system, and vii.) initiate data base development. These diverse activities have required a functional team with varied skills that we have successfully assembled. Significant progress has therefore been made toward these objectives that are summarized below.

II. Significant Changes

There have been no significant changes to the project science theme, scope, or approach since the project recost and scope revision in February 2007. At that time, we eliminated our proposed experimental campaign focused on the groundwater river interface (Hypothesis 3 in the original proposal) because of financial considerations. However, we continue to believe that this particular biogeochemical zone, and another target in the deeper Ringold formation, afford potentially fruitful opportunities for research. Continued experimentation at the site by EM-20, EM-40, and ERSD researchers since proposal submission has affirmed the importance of the mass transfer theme, and is providing important new information that is helping in experimental design.

Since the initiation of the Hanford IFC, the EM-20 Polyphosphate Demonstration Project has come into full swing, performing one non-reactive tracer experiment and one massive polyphosphate injection experiment involving over 10^6 gallons. The planning of IFC site has benefited significantly from these experiments, as we have coordinated closely with them. Their results have improved understanding of seasonal groundwater flow paths and velocities in the central region of the U-plume. The rapid progress of the EM-20

team, and the extent to which they seek scientific input to refine and improve their methodology may impact the eventual scope of our Hypothesis 4 experimentation. Hypothesis 4 is focused on the role of field-scale mass transfer in controlling the long-term effectiveness of the polyphosphate concept, and its alternative if proven to be ineffective. Decisions on the manner in which we partner with EM-20 will be made over the course of FY 08 in collaboration with ERSD management.

III. Management & Operations

We have developed a Hanford IFC Website that is now under review by the Laboratory. The Website is described in more detail below under "Task 3 Website and Data Management." The PNNL review team address issues pertaining to clearance, copyrights, and other information rights issues, as well as adherence to overall DOE and PNNL requirements. The review should be completed in early November so that the Website can be used during the upcoming teleconference in November.

All subcontracts with project participants, except one, have been placed or are in their final negotiation stages. The delay in the one outstanding subcontract (U.S. Geological Survey) results from recent changes in the subcontracting procedure between DOE National Labs and other agencies. These changes forced us to wait until the new fiscal year for closure.

A team meeting is being scheduled for January in Richland, WA. The objectives of the meeting will be to: i.) finalize the field site characterization plan, ii.) review and finalize the first four phase 1 injection experiments, and preliminary plans for phase 2; iii.) test the data base system and its various attributes; and iv.) initiate data and other necessary information exchanges to begin hydrologic and reactive transport modeling (for Task 7 Modeling and Interpretational Program) at the different participant institutions.

IV. Quarterly Highlights

For the purposes of this quarterly report and subsequent reporting activities we establish the following as reportable project tasks: 1. Project Management, 2. Site Design and Installation, 3. Web Site and Data Management, 4. Field Site Characterization, 5. Vadose Zone Experiments, 6. Saturated Zone Experiments, 7. Modeling and Interpretation, and 8. ERSD Outreach.

<u>Task 1. Project Management</u>
Draft versions of the QA/QC, Site Management, and Health and Safety Plans have been completed and are posted on the Hanford IFC Website. A final Project Management Plan (PMP) as required by PNNL has also been completed and posted.

<u>Task 2. Site Design and Installation</u>
Significant progress has been made on this essential task. First, we have worked through necessary NEPA documentation, and have received a categorical exclusion for the

development of our IFC experimental field site. The original signed documents from DOE-Richland Operations for this exclusion are in permanent project files.

We have been performing geophysical surveys [electromagnetic induction (EM), ground penetrating radar (GPR), and electrical resistance tomography (ERT)], and groundwater modeling of hypothetical injection experiments to refine our identification of an optimal location for the IFC experimental site. The geophysical surveys provide information on the topography of the Hanford – Ringold formation contact, consequent locations of transmissive subsurface channels, and the approximate content of fines in the saturated Hanford formation that is targeted for field injection experiments. Groundwater modeling has evaluated potential trajectories and advective velocities of injected tracers at different candidate IFC sites, and the nearby polyphosphate field demonstration site during periods of high and low Columbia River stage. These calculations have sought to identify IFC site locations that are not influenced by the polyphosphate experiments, and that provide suitably long travel paths for evaluation of mass transfer hypothesis.

The experimental site has been designed in terms of number of wells (8 – 4", and 20 – 2") and their configuration and spacing (overall distance of ~200 ft), well construction and development, and in-situ sampling and monitoring equipment. A subcontract has been negotiated with Flour Hanford for well drilling, sampling, and completion. This subcontract was based on our drilling specifications as described in "Well Installations in the 300 Area to Support PNNL's Integrated Field-Scale Subsurface Research Challenge (IFC) Project" (see Website). Each well will include electrodes for the collection of electrical resistivity/IP data, temperature sensors, multiple vadose zone or groundwater samplers, and in-well multi-sensor assemblies for continuous monitoring of temperature, electrical conductivity, and water level. Monitoring equipment is currently being ordered with arrival to coincide with the well drilling campaign in December.

Applications for permitting of our vadose zone and saturated zone injection wells are currently being drafted, and will be submitted within the next month pending completion of our preliminary field experimental plan.

Task 3. Website and Data Management

A Website has been developed for the Hanford IFC that will hopefully be used in our first teleconference as a means of communication. The Website contains comprehensive background information about the 300 A uranium plume; vita of project participants; background and project scientific publications; project documents of different sorts including required and optional project and experiment plans, designs, etc.; inventories of samples available to project participants and ERSD investigators; schedules, objectives, and descriptions of planned field experiments; a password protected link to the project data base at INL; and a lot of other information.

The data management task has also been initiated at INL. This was accomplished by identifying a series of prototype data sets of geologic, hydrophysical, geochemical, and other measurement types on 300 A materials (collected by ERSD and EM-40 investigators) that represent i.) data needs by current project investigators and ii.) data

structures likely to be developed by future IFC project research. The INL data management system is now being modified to allow the incorporation, manipulation, and visualization of these data sets as a fundamental tool for project participants to exchange measurements, data, and results, and for ERSD to monitor progress in data collection and posting. The performance of the data base will be reviewed by the project team for utility and flexibility at our January team meeting.

Task 4. Field Site Characterization

Plans are under development for characterization of field site core materials obtained during the well drilling campaign. The current site design calls for eight – 4" wells to be drilled with a sonic technique (at 6") and continuous split spoon sampling; and twenty – 2" wells drilled by cable tool or Becker hammer (at 6") with associated grab sampling of retrieved sediments. The continuous core materials will be valuable and limited in total mass. It is therefore important that measurements on the core sediments be well rationalized and performed with essential goals in mind. These direct measurements on borehole materials, in combination with surface, down-hole, and cross-hole geophysical measurements, will drive our construction of a 3-D geo-statistical model of the experimental domain. The characterization measurements will include: i.) geologic, hydrophysical, and geochemical properties; ii.) uranium distribution in the vadose zone and saturated zone, and iii.) microbiology. Microbiologic characterization is to be performed on aseptically collected sediments from a single deep borehole that will be double the depth of the others, and that will traverse both the Hanford and Ringold formations to the top of basalt. The characterization plans will be finalized at least a month before drilling operations commence.

Task 5. Vadose Zone Experimental Program

A sequence of proposed saturated zone experiments is currently under planning in terms of objective/hypothesis, injection volume, tracer identity and concentration, uranium concentration, density of analytical measurements, and schedule. This sequence and the associated information will: i.) drive accurate cost estimates for field experimentation, ii.) allow permitting of the injection wells prior to their construction, iii.) support permitting of the injection experiments, and iv.) inform external ERSD investigators about field experiment opportunities. The experimental sequence will be reviewed and debated by all project participants in January, 2008.

The IFC project has also made preliminary agreements to use the injection experiment equipment of the PNNL-EM injection team. This equipment includes large tanks for injectate solutions, various pumps for tracer mixing and for injection, and a specialized field trailer. This agreement will allow leveraging of relatively expensive field equipment by multiple projects, and afford the IFC considerable cost savings.

Task 6. Saturated Zone Experimental Program

A sequence of proposed saturated zone experiments is currently under planning in terms of objective/hypothesis, injection volume, tracer identity and concentration, uranium concentration, density of analytical measurements, and schedule. This sequence and the associated information will: i.) drive accurate cost estimates for field experimentation, ii.)

allow permitting of the injection wells, iii.) support permitting of the injection experiments, and iv.) inform external ERSD investigators about field experiment opportunities.

Task 7. Modeling and Interpretational Program
No reportable progress.

Task 8. ERSD Outreach
No reportable progress.

V. Non-IFC Project Activities

We have been contacted by several ERSD investigators inquiring about the availability of IFC site materials. We have asked these individuals to wait until our drilling campaign is complete in January, as more representative bulk and borehole materials will be available at that time. In the interim, we are striving to establish an inventory of all available 300 A materials collected by past ERSD, EM-20, and EM-40 studies at the site for posting on the web. This posting of materials inventory will be accomplished by early November 2007.

VI. Funding Issues

A total of $1,291 K was intentionally carried over from our FY 07 funding authorization of $2,000 K to FY 08. The carryover was for the following activities: i.) a $1,000 K subcontract to Flour-Hanford for drilling and completion of the vadose zone and saturated zone well monitoring field (subcontract negotiated and committed in FY 07, budgeted as part of FY 07 scope), ii.) $183 K for well instrumentation, in-situ monitoring equipment, and associated materials (well assemblies must be ready for deployment as soon as wells are drilled, budgeted as part of FY 07 scope), and iii.) $45 K to initiate subcontract research by external collaborators, and iv.) $63 K to maintain critical project activities at needed levels in October and early November. Items ii-iv were needed to offset constraints imposed by the continuing resolution.

VII. Upcoming Plans/Issues

The following bulleted items summarize plans for FY 08. Plans for the second half of FY 08 will be further refined in the next quarterly report.

October, 07 – March, 08

- Complete characterization plan for experimental field site (mid-Nov).
- Develop draft multi-year experiment plan and schedule with costing (end-Nov).
- Develop an integrated sampling number system for all new planned wells, their derived samples, and measurements made on them to populate the data base (Nov).
- Begin site installation and well drilling (Nov-Dec).
- Submit permits for first four injection experiments (Dec).

- Identify and order any additional equipment needed for field injection campaigns (Dec-Jan).
- Full IFC investigator meeting (mid-Jan).
- Begin geochemical, hydrophysical, and microbiologic characterization of sediments retrieved from boreholes. Distribute samples to team members (Jan).
- Complete well field and monitoring installation (Feb).
- Perform well testing (pump tests, groundwater flowmeter measurements, Feb)
- Initiate detailed surface and cross-hole geophysical measurements of experimental domain (March).
- Have multiple team-members premodel injection experiments with different codes (March).

April, 08 – September, 08

- Post multi-year experimental plan with objectives and experimental details on the IFC Website (April).
- Continue testing of the well field and associated continuous monitoring system. Integrate all continuous monitoring equipment with Web-based data management system (April-June).
- Continue detailed geophysical measurements of the field experimental site (April-June).
- Continue and complete first-tier hydrophysical and geochemical characterization measurements on all experimental site core samples, post all results to data base (May).
- Continue microbiologic studies of aseptic borehole sediments in collaboration with PNNL SFA.
- Begin assembly of characterization measurements on borehole sediments and detailed geophysical measurements into an integrated geostatistical model of the experimental domain, and an improved hydrologic model for experiment simulation (May-August).
- Perform high-river flow, non-reactive tracer experiment in saturated zone (June-July).
- Perform low-river flow, non-reactive tracer experiment through a vadose zone, capillary fringe, saturated zone flowpath (August-Sept).

VIII. Peer Reviewed Publications, Abstracts, and Presentations

No publications yet from this project. The following are recent publications that resulted from prior ERSD-supported research at this site.

Publications

Arai, Y., M. A. Marcus, N. Tamura, J.A. Davis, and J.M. Zachara. 2007. Spectroscopic evidence for uranium bearing precipitates in vadose zone sediments at the Hanford 300-Area site. *Environ. Sci. Technol.* 41, 4633-4639.

Bond, D. L., Davis, J. A., and Zachara, J. M., 2007. Uranium(VI) release from contaminated vadose zone sediments: Estimation of potential contributions from

dissolution and desorption. In: (Eds., M. O. Barnett and D. B. Kent), *Adsorption of Metals by Geomedia II*, pp. 379-420. Academic Press, San Diego, CA.

Liu, C., J.M. Zachara, N. Qafoku, and Z. Wang. 2007. Scale dependent desorption of uranium in subsurface sediments from the Hanford Site, USA. *Water Resources Research* (Accepted).

Abstracts
None

Presentations
IFC Team. 2007. Breakout Session on the Hanford IFC at the ERSD Annual Program Meeting. April 16-19, 2007; National Conference Center, Lansdowne, VA.

Ward, A. 2007. *Geophysical Measurements to Define Subsurface Conditions within the Vadose and Saturated Zones Associated with the 300 A Uranium Plume.* Presented at the 300-FF-5 Workshop, August 29, 2007, Richland, WA.

Zachara, J. M., R. J. Serne, R. E. Peterson, and W. Um. 2007. *300 A Integrated Hydrogeochemical Conceptual Model for Uranium.* Presented at the 300-FF-5 Workshop, August 29, 2007, Richland, WA.

Zachara, J. M. 2007. *The Hanford 300 A Integrated Field Challenge.* Presented at the 300-FF-5 Workshop, August 29, 2007, Richland, WA.