HANFORD'S GROUNDWATER/VADOSE ZONE INTEGRATION PROJECT "PROTECTING THE COLUMBIA RIVER"

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ABSTRACT

The Hanford Groundwater/Vadose Zone Integration Project (Integration Project) was established in late 1997 to provide further assurance that cleanup actions and decisions at Hanford are protective of the Columbia River. Under Secretary of Energy, Dr. Ernest J. Moniz, directed the Integration Project to be science-based, to include strong participation from National Laboratories, to incorporate rigorous technical review, and to engage diverse stakeholders in a meaningful way.

The Integration Project will provide the technical and scientific basis required to inform and influence important Hanford cleanup decisions. These decisions must be supported by DOE and the regulators (Washington Department of Ecology and U.S. Environmental Protection Agency, Region X), and will continue to require stakeholder support and technical defensibility.

Important decisions that the Integration Project will inform and influence include:

- Single- and double-shell tank retrieval and closure
- Remediation of 200 Area (Hanford's central plateau) waste sites
- Final Hanford closure and endstate plans and projections
- Interim actions to protect groundwater
- Operational practices to protect water resources and the Columbia River

The Integration Project brings benefits and products to Hanford's cleanup mission. The five endeavors or objectives listed below reflect the sitewide, strategic approach and some of the expected benefits of the Integration Project.

1. **Sitewide integration** of vadose zone characterization, assessments, modeling, and monitoring.
   - Duplication of effort and overlaps between Hanford's multiple projects are being identified and eliminated.
   - Critical data gaps have been identified and prioritized for additional characterization work and science.
   - Technical inconsistencies are being identified and reconciled.
   - Hanford's technical cleanup planning baseline and multiple regulatory drivers have been compiled and evaluated. Opportunities for regulatory and schedule integration have been prepared in cooperation with the regulators.

2. Develop the **capability to assess** the cumulative long-term impact of Hanford-derived contaminants on the Columbia River and the Northwest Region.
   - The System Assessment Capability (SAC) is developing sitewide assessment tools to assist in making well informed, scientifically defensible closure and cleanup decisions.

- The SAC includes an expanded evaluation and way to communicate "risk" to include human, ecological, cultural, and socioeconomic health.

3. Apply **science and technology** (S&T) to critical Hanford vadose zone, groundwater, and Columbia River needs.
   - A sitewide S&T Roadmap has been prepared to link funding to support key Hanford decision points, and to help fill critical gaps in scientific understanding about Hanford's subsurface and Columbia River impacts.
   - Key S&T work was launched, and DOE-Headquarters (HQ) funds provided support.

4. Provide early and meaningful **public involvement** to build trust and understanding and to allow maximum input into the decision making process.
   - Create routine, open, and inclusive ways to share information and provide input on Integration Project direction and products.
   - Bring all of Hanford's vadose zone, groundwater, and Columbia River public involvement opportunities together into a common forum to better serve the stakeholders, State of Oregon, Tribal Nations, regulators, and the Hanford Projects.

5. Build **technical review** capabilities to support all Hanford vadose zone, groundwater, and Columbia River work.
   - An Expert Panel was established and is assisting the Integration Project in protecting the Columbia River.

BACKGROUND AND INTRODUCTION

To provide a bold, new approach for protecting the Columbia River the Department of Energy established the Integration Project in late 1997. Dr. Ernest Moniz, the DOE Undersecretary of Energy, directed the Integration Project to be science-based, to include strong participation from DOE's national laboratories, to incorporate rigorous technical reviews, and to engage diverse stakeholders in a meaningful way in Integration Project decisions.

A contractor team, led by Bechtel Hanford, Inc., with support from the Pacific Northwest National Laboratory (PNNL), is responsible for implementation of the Integration Project. Support for the Integration Project also comes from Lockheed Martin Hanford Co. (LMHC), for work being done in the tank farms, and from Fluor Daniel Hanford, Inc. (FDH), for other site-wide activities (such as waste and infrastructure management).

ORGANIZATION AND FOCUS

The Integration Project is focused on five endeavors: site-wide integration of fieldwork; the System Assessment Capability (SAC); Science & Technology (S&T); public involvement; and technical review.

Integration of Fieldwork and Assessments in the Vadose Zone, Groundwater, and Columbia River

The Integration Project is responsible for the integration of all fieldwork related to the subsurface and river. This includes field work associated with performance assessments, characterization of soil and groundwater, monitoring, remedial/interim actions, and closure work scopes. The S&T

needs, as well as regulatory requirements, are also factored into the planning and conduct of all field work related to protection of the Columbia River, and the Hanford Site water resources, in order to gain efficiencies wherever possible.

As part of Integration Project progress to date, a new borehole was drilled in the SX tank farm; the characterization of the complex 200 Area soil sites was initiated; and a new innovative technology to protect the Columbia River from chromium-contaminated groundwater was implemented.

Develop a System Assessment Capability to determine the cumulative long-term impacts of Hanford-derived contaminants on the Columbia River and the Northwest.
The SAC will provide a cumulative assessment of the impacts and risks associated with Hanford Site contaminants. The SAC begins by studying the complex waste "inventory" (chemical and radioactive) that will remain at Hanford after site closure, and may impact the Columbia River and its users. The SAC involves an expanded evaluation and method to communicate "risk," which includes human, ecological, socio-cultural, and economic health factors. Metrics are being created to help measure cumulative impacts.

Apply Science & Technology to critical Hanford Site Vadose Zone, Groundwater, and Columbia River needs.
The objective of the S&T endeavor is to provide new knowledge, data, tools, and the scientific understanding required to 1) make technically defensible cleanup decisions; and 2) protect water resources, including the Columbia River. These cleanup decisions involve remediation and closure of the tank farms and contaminated soil sites. The S&T activities are conducted in partnership with the SAC and the Hanford Site core projects.

Provide opportunities for early and meaningful Public Involvement, in order to build trust and understanding, and to move toward consensus on the Integration Project path forward. Continue to seek out effective ways to involve regulators, Tribal Nations, the state of Oregon, and stakeholders.
This effort will help to create and maintain routine, open, and inclusive ways for all project participants to share information and provide input on Integration Project direction and products. The public involvement component of the Integration Project will continue to support workgroups that focus on such project issues as a regulatory path forward and the SAC.

The Integration Project will bring all of the Hanford Site's vadose zone, groundwater, and Columbia River related public "opportunities for involvement" together into a common forum, which will better serve the stakeholders and Hanford Site projects. The Integration Project website will link with the core projects to allow easy access to documents during public review periods.

Build Technical Review capabilities to support all Hanford Vadose Zone, Groundwater, and Columbia River work.
The Integration Project Expert Panel (IPEP) was established in 1998, and is advising the Integration Project and core projects. The IPEP meets three or four times per year. The initial

Site-Wide Groundwater Model Peer Review was conducted. The National Academy of Sciences (NAS) will begin to review the Integration Project S&T program in FY00.

KEY ACCOMPLISHMENTS

During the past year, there has been a commitment to move from job planning to field implementation. Renewed emphasis on fieldwork has resulted in significant new data. Of equal importance, however, is the fact that there has been an accompanying culture change in how DOE, the regulators, and contractors work together to identify and address the data needs of multiple projects (and S&T). Areas of particular note include the following:

In the Field

- SX Tank Farm Characterization
  Two major field characterization projects were accomplished in the SX Tank Farm during FY99: 1) the decommissioning and sampling of Borehole 41-09-39; and 2) the drilling of a new borehole near Tank SX-115. These efforts are part of a regulatory corrective action process, and also support the planning necessary to retrieve wastes from tanks.

- Decommissioning of Borehole 41-09-39
  Borehole 41-09-39 was installed in 1996, based on a recommendation from the SX Tank Farm Vadose Zone Expert Panel. The borehole was extended to groundwater in 1997. No contaminants attributable to tank wastes were found in the groundwater taken for this borehole. In the summer of 1999, the borehole was decommissioned (to comply with state regulations) and soil samples were collected (with an emphasis on the region showing the highest gamma radiation readings). The soil concentrations of cesium-137 are consistent with gamma radiation measurements. The cesium-137 was not found as deep as the mobile radionuclide technetium-99. Materials normally thought of as mobile (technetium-99, sodium, chromium, nitrate) have similar depth concentrations, and are concentrated in the vadose zone above a well-cemented rock unit at ~130 to 150 feet below the surface.

- SX-115 Borehole
  The SX-115 Tank has the largest measured leak in the SX Tank Farm. The new borehole was continuously sampled from the surface down to the calcium-rock unit described for Borehole 41-09-39. Three samples were collected between that area and the groundwater. Field measurements of the soil samples showed no gamma radiation beyond that expected from natural materials. However, groundwater samples showed technetium-99 readings that were more that 35 times the groundwater standard that is applied at the Hanford Site. These readings are the highest ever observed in Hanford Site groundwater. However, other typical tank waste contaminants were not found at such high levels. Although the original plan was to immediately decommission the borehole, based on these findings the borehole has been converted to a RCRA-compliant groundwater monitoring well.

- 200 Area Waste Site Characterization
  An integrated plan for the characterization of over 700 waste sites in the 200 Area was approved by the regulators in April 1999. Under the plan, the waste sites were organized into 23 waste groupings, based on similar chemistry and disposal practices. Fieldwork on the "cooling water" waste grouping began in August 1999. Samples have been collected at 15

test pits. No unusual results were found through field radiological screening. Laboratory results of the samples will be reported in FY00. Twelve additional test pits, and two characterization boreholes, are under way for this waste grouping in FY00. One of the boreholes has been planned to meet the data needs of two projects (CERCLA characterization, and RCRA groundwater monitoring). This will save time and reduce costs.

- Hanford Site Prototype Surface Barrier
  A four-year treatability test of surface barrier performance was completed FY99. The testing included evaluation of barrier performance under both ambient and extreme precipitation (3 times normal annual rainfall and 1,000-year storms). The report concludes that the barrier meets, or exceeds, design specifications for hydrologic performance, water and wind erosion, plant growth, root intrusion, animal intrusion, and barrier stability. Some additional testing monitoring activities are underway.

- In Situ Redox Manipulation (ISRM)
  An innovative technology (ISRM) is being used to remove chromium from groundwater before it reaches the Columbia River. This technology presents a cost-effective alternative to the current practice of groundwater pump-and-treat, because it requires minimal operating costs. ISRM involves creating a permeable subsurface treatment zone (sometimes called the "chemical barrier") to intercept the groundwater and remove the hexavalent chromium (which is toxic to fish). Regulatory agencies have agreed to use ISRM to remediate chromium-contaminated groundwater in the 100-D Area, near the Columbia River. The first segment of the treatment zone has been installed there to treat a "hot spot" of groundwater contamination containing the highest known concentrations of hexavalent chromium detected on the Hanford Site.

System Assessment Capability (SAC)

The SAC will provide a cumulative assessment, including predictive tools and models, to understand the ecological, economic, socio-cultural, and human health effects resulting from Hanford contaminants. As such, the SAC will provide the information needed to guide and complete Hanford Site cleanup, including the preparation of a Final Record of Decision.

The SAC will be developed and improved through iterative cycles. The first iteration (called Revision 0) is due for completion in FY01. The approach and construct to be used in the first iteration has been documented in the Preliminary System Assessment Capability Concepts for Architecture, Platform, and Data Management document, which is available on the Integration Project internet web page (http://www.bhi-erc.com/vadose). Conceptual models for showing waste inventory, contaminant release from waste sites, movement of contaminants through the environment, and the impact of contaminants on living systems and cultures are presented in appendices to this document.

Impacts to human and ecological health, as well as socio-cultural and economic systems, are being evaluated. A "dependency web" approach has been used to obtain stakeholder input on what is valued in terms of water resources and river dependent uses at key locations. Development of an approach to assess cultural impacts involves close interaction with the Tribal Nations technical staff. The task of preparing metrics to measure these comprehensive impacts is

now underway. This is an area where the Integration Project is sometimes "out in front" of existing scientific methods.

A SAC work group has been established to provide an open forum for regulators, Tribal Nations, and stakeholders to work with the Integration Project team on a ongoing basis. The initial task of the group was to review the Columbia River Comprehensive Impact Assessment (CRCIA) Part II document with those who helped create it. This information served as a starting point for planning the SAC. The Defense Nuclear Facilities Evaluation Board in Order 94-2 also directed DOE to evaluate site-wide impacts.

The SAC work group has met throughout 1999 to exchange information on conceptual models for the SAC, and on the approach to be taken during the initial assessment. A related workshop was conducted in October 1999 to bring DOE decision-makers together with the CRCIA Team, in order to discuss issues regarding assessment management, independence, and credibility. The objective of the S&T endeavor is to provide new knowledge, data, tools, and the scientific understanding required to 1) make technically defensible cleanup decisions; and 2) protect the Columbia River and living systems that rely on them. S&T is focused on resolving key technical issues that influence cleanup decisions on remediation, closure of tank farms, contaminated soil sites, and disposal of low-level radioactive waste. The S&T activities are conducted in partnership with the SAC and Hanford core projects.

Science and Technology

The Environmental Management Science Program (EMSP) is administered through the DOE Office of S&T, and invests in basic and applied science. In FY99, the EMSP awarded 31 new grants (worth $25 million in work scope over three years), which are directed at subsurface issues relevant to the Hanford Site. The EMSP researchers are working with the Integration Project to share this information.

In FY99, two S&T activities were initiated to gain new knowledge and data: the Soil Inventory Task, and Vadose Zone Transport Field Study. The Soil Inventory Task will develop a methodology for estimating a mass-balanced inventory for four waste site types at the Hanford Site, with associated uncertainty factored into the inventory. The Vadose Zone Transport Field Study will collect data under controlled conditions at uncontaminated vadose zone sites. The outcome will result in an improved understanding of the migration of water and contaminants in the vadose zone, as well as an improved assessment of several advanced characterization tools.

In FY00, two additional vadose zone S&T tasks will be initiated: Field Investigations at Representative Sites, and Vadose Zone Transport Modeling. The Field Investigations at Representative Sites will conduct studies around contaminated vadose zone sites, which will complement sampling and analysis by the Hanford core projects. The outcome will be an enhanced understanding of vadose zone flow and transport, which can be used to guide characterization, remediation, and monitoring. The Vadose Zone Transport Modeling is a tool being used to integrate existing data and new knowledge. The outcome will be an advanced set of vadose zone contaminant transport models to be used in site-specific and site-wide applications.

The Groundwater/River Interface Study will also begin in FY00. This study will enhance the current understanding of contaminant transport through the "zone of groundwater/river interaction" (exploring how contaminants enter the Columbia River). The study will provide a better understanding of how variations in river stage (i.e., the amount of water flowing in the river) impact the concentrations and locations of contaminants that enter the Columbia River.

Work is underway to complete scoping regarding risk S&T needs. The Integration Project has completed a series of meetings with representatives from DOE, the national laboratories, universities, regulators, Tribal Nations, and stakeholders in order to provide input to revisions to the risk-related components of the S&T plan and roadmap.

Hanford's community of affected people is large, passionate, diverse, and geographically dispersed; however, they are all united by a common desire to protect the Columbia River. A fully open, accessible and inclusive involvement process is needed to build the trust and support necessary to move ahead.

Public Involvement

Opportunities for involvement range from the sharing of information, to consultation, to collaboration, and are described below.

Tribal Nations. Technical discussions and ongoing involvement on an informal basis are conducted with Tribal Nations representatives. Consultations, including a more formal interface with the Tribal Nations, are conducted in conjunction with RL's Office of External Affairs (OEA).

Hanford Advisory Board (HAB). Information is provided to the HAB's Environmental Restoration (ER) Committee, and the HAB Public Involvement Committee. The ER Committee determines when project information should be presented to the full HAB for consideration.

One-on-One Outreach Meetings. Discussions with interested individuals and organizations are encouraged. Meetings with regional stakeholder groups, the Oregon Office of Energy, regulators, Tribal Nations, and various conferences have been conducted. This venue has been very effective in gaining input and insight into stakeholder values.

Project Team Meetings. Project team meetings will continue to be held twice monthly to encourage effective two-way communication. Meetings are open to everyone, and meeting minutes are provided. An internet project web site is also maintained, with up-to-date information and documents (http://www.bhi-erc.com/vadose).

Working Groups. Focused working groups are used to bring project participants together with the project team to address critical project issues. These work groups are expected to be of limited duration, and will target technical and policy issues. These meetings are open and inclusive.

Interested parties are encouraged to contact the Integration Project Team, at (509) 372-9236, to become involved or to get more information about the project.

Technical Review

The objective of technical review is to assure that the appropriate level of management and independent technical review is applied to all Hanford Site vadose zone, groundwater, Columbia River, and related work scope. The technical review activities, which support the Integration Project, include the IPEP, NAS, and other project-specific reviews.

The IPEP has been established to provide broad oversight of the Integration Project. The IPEP focuses on problem resolution and technical reviews. The IPEP was selected by DOE-HQ from a field of over 80 names that were submitted by regulators, stakeholders, the DOE, and Tribal Nations. The IPEP has expertise in the areas of environmental management, geophysics, ecological health, radiochemistry, and hydrology. Members of the IPEP are listed below.

- Dr. Edgar Berkey, Chair (Engineering Physics)
- Prof. Randy L. Bassett (Geochemistry)
- Dr. John G. Conaway (Geophysics)
- Prof. James R. Karr (Fish and Wildlife Biology)
- Dr. Michael C. Kavanaugh (Civil, Chemical and Environmental Engineering)
- Dr. John Matuszek (Geochemistry)
- Mr. Ralph O. Patt (Hydrology)
- Dr. Peter J. Wierenga (Vadose Zone Hydrology)

The IPEP continues to emphasize that the broad benefits from integration at the Hanford Site can be considerable, but will require management and technical perseverance to achieve.

The DOE has requested that independent, external peer reviews be conducted by the NAS on a periodic basis. These reviews will be coordinated with IPEP work. In accordance with NAS standards, the NAS review will be conducted by nationally recognized technical experts. During FY00, the NAS review will focus on S&T.

The Hanford Site core projects use various technical and peer review methods to ensure quality and technically sound products. For example, vadose zone characterization data to be used in support of the Immobilized Low-Activity Tank Waste Performance Assessment will be reviewed by external peer reviewers in FY2000.

SUMMARY

The Groundwater/Vadose Zone Integration Project represents a strategic initiative on the part of the Department of Energy to meld engineering, technology and science to solve complex environmental cleanup problems. Ultimately, the Integration Project must work to ensure the protection of all of the Hanford Site's water resources (vadose zone/soils and groundwater), and all of the users of the Columbia River. To be successful, the Integration Project must:

- Adopt a site-wide approach to project planning and funding.
- Ensure that management attention is maintained on the subsurface and river resources.
- Be recognized for technical and scientific excellence in all products.
- Establish and ensure effective two-way communications with diverse project participants.