PNNL-14027

An Initial Assessment of Hanford Impact Performed with the System Assessment Capability

September 2002

Prepared for the U.S. Department of Energy
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Executive Summary

In 1999, the U.S. Department of Energy initiated the development of an assessment tool that will enable the users to model the movement of contaminants from all waste sites at Hanford through the vadose zone, groundwater and the Columbia River and estimate the impact of contaminants on human health, ecology and the local cultures and economy. This tool was named the System Assessment Capability (SAC). An assessment was recently completed with the SAC that demonstrates that it is a functional assessment capability. Future modifications to the tool will be driven by the requirements of specific assessments. Results will continue to improve as input data are refined through characterization and scientific research.

The results of the first runs performed with SAC were presented to the Integration Project Expert Panel in September 2001. Analysis performed on these early results identified a number of issues that needed to be addressed before the tool could be considered useful. The major issues were addressed by replacing a simple two-dimensional groundwater model in the capability with the three-dimensional sitewide Hanford Groundwater Model, correcting the quantity of contaminant assigned to several waste sites, and obtaining more efficient hardware for performing analyses. Following the implementation of those changes, the assessment was rerun. This document presents the results of that assessment.

A sitewide risk assessment is an essential part of the Hanford Site cleanup mission. This type of cumulative risk assessment has never been conducted at the site, and it is a complex and challenging undertaking. However, the results from the initial SAC assessment indicate this type of assessment is possible.

The assessment:

- Modeled the movement of contaminants from more than 500 locations throughout the Hanford Site representing 890 waste sites through the vadose zone, groundwater and the Columbia River.
- Incorporated data on 10 radioactive and chemical contaminants (carbon tetrachloride, cesium-137, chromium, iodine-129, plutonium-239/240, strontium-90, technetium-99, tritium, total uranium, and uranium-238).
- Focused on subsurface transport, the Columbia River, and risks to human and ecological health, and the economy and culture.

The Columbia River flows through the northern portion of the Hanford Site.

- Included the geographic region from Rattlesnake Mountain to the Columbia River and from the Vernita Bridge to McNary Dam on the Columbia River.
- Included the cleanup actions in Hanford's cleanup plans and agreements as of October 2000.
- Consisted of a stochastic simulation for the period 1944 to 3050 using 25 realizations, thus providing insight into the median response and an initial look at uncertainty.

What is SAC and what will it do?

The System Assessment Capability is an integrated system of computer models and databases used to assess the impact of waste remaining on the Hanford Site. This tool will help decision makers and the public evaluate the cumulative effects of contamination from Hanford. With this capability, DOE will be able to estimate contaminant effects under realistic exposure conditions. In addition, DOE will be able to address the primary impact to the health of individual organisms, as well as the secondary impact on the region's economy.

Central to the cleanup scenario represented in this assessment are the cleanup agreements that exist between the U.S. Department of Energy and the regulatory community. These agreements include that waste, debris, and contaminated soil will be removed from the 100 Areas leaving soil that meets residential occupancy standards. Similarly, waste, debris, and contaminated soil will be removed from the 300 Areas, but the remaining soil will meet industrial occupancy standards. In this scenario, post-1970 stored transuranic waste will be recovered, tested to determine waste content, repackaged, and sent offsite for disposal at the Waste Isolation Plant in New Mexico. The waste in the 618-10 and 618-11 burial grounds will be removed, and transuranic waste will be repackaged and removed from the Hanford Site while low-level waste will be disposed in solid waste burial grounds in the Central Plateau. In accordance with agreements, 99% of the tank waste volume will be recovered from the tanks and a 1% residual volume will remain. Losses to the subsurface during waste recovery are assumed to average 30,280 liters (8,000 gallons) per single-shell tank recovered. The recovered tank waste will be separated into low-activity and high-level fractions. Both will be immobilized in glass waste forms. Low-activity waste will be disposed onsite, while the high-level fraction will be disposed in the national repository. All spent fuel also will be stored in a stable configuration for shipment to and disposal in the national repository.

This assessment predicts that the risks to human health and the environment from the contaminants modeled is greater today than it will be in the next 1,000 years.

This assessment predicts that the risks to human health and the environment from the contaminants modeled is greater today than it will be in the next 1,000 years provided the baseline cleanup actions incorporated into the

model are successfully completed. A hypothetical farmer was used to calculate potential risk within the Hanford boundary. While farming is not anticipated on the Hanford Site in the foreseeable future, this scenario was used to provide a consistent measure for examining the cumulative impact from all contaminants included in the assessment. The greatest near-term risks to this farmer are from highly mobile contaminants (such as tritium) that resulted from large-volume long-term releases during the time nuclear material was produced. In the 1,000-year time frame of the assessment, mobile and slightly adsorbed contaminants with long half-lives (technetium-99, iodine-129 and isotopes of uranium) dominate risks midway between the sources and the Columbia River. While highly mobile contaminants, including chromium originating in the river corridor, have generally been flushed from the system in the 1,000-year period, highly mobile contaminants originating in the Central Plateau remain a water quality issue. Less mobile contaminants from the 200 Areas do not have an impact on the Columbia River during the period of this analysis. Assessments conducted beyond 1,000 years can be used to evaluate long-term releases and events.

The findings of the initial assessment for the Central Plateau sites and associated contaminant plumes parallel those of the composite analysis published in 1998 (Kincaid et al. 1998). The results also are consistent with concentrations in environmental media measured by the Environmental Surveillance Program (Poston et al. 2002) and the Hanford Groundwater Monitoring Project (Hartman et al. 2002). Both the monitoring results and the assessment reported here indicate that Hanford's effect on the Columbia River has peaked and is now declining if the cleanup actions currently planned are carried out.

The results of the assessment were considered in the development of a groundwater initiative within the Performance Management Plan for the Accelerated Cleanup of the Hanford Site.

The initial assessment also has identified some areas where an improvement to our understanding of the site and how it is represented in this capability could improve the quality of our decisions. While the capabilities of SAC are confirmed by its ability to simulate the tritium plume, further improvements are needed to better match groundwater plumes for other mobile contaminants including technetium-99, iodine-129 and total uranium. Completion of the initial assessment has provided information needed to design improvements to SAC, a revision that will be designed to meet the requirements for the composite analysis, an assessment required by DOE Order 435.1.

How Current Results Can Be Used

A cumulative impact assessment provides a sitewide context for cleanup decisions that must be made at individual waste sites.

While much of the emphasis on waste management at Hanford has been on isolating plutonium, strontium-90, and cesium 137 from the environment, this assessment identifies technetium-99 and uranium as the contaminants from the Central Plateau contributing most to potential impacts in the next 1,000 years through the groundwater pathway. The results of the assessment were considered in the development of a groundwater initiative within the *Performance Management Plan for the Accelerated Cleanup of the Hanford Site* (DOE/RL 2002). Locations containing large inventories of these mobile long-lived contaminants are being considered for accelerated action. The remediation of the BC cribs located just south of 200 East Area was identified as an important action for acceleration due to the large inventory of technetium in those facilities and its potential to adversely affect groundwater predicted by the assessment.

What do the results of the initial assessment mean? The results presented in this document should not be interpreted as definitive predictions of total radiation doses or other impacts. They are representative results based on the inventory, release, transport and risk/impact models. Definitive predictions must rely on further studies to confirm that additional contaminants do not contribute appreciably to the impacts. Other issues identified in this document must also be addressed before definitive predictions about the impact of Hanford contaminants can be made.

The SAC represents a holistic examination of the Hanford Site's radioactive and chemical waste legacy. For this reason, it can be used to examine the risk consequences of cleanup alternatives. To illustrate this, the assessment was rerun without infiltration reducing covers on waste sites. This action is not being considered for waste sites and was chosen only as a simple illustration of the capability. A 4-fold increase in the amount of technetium-99 released to groundwater was predicted for the no cover case. It also showed that covers have the greatest impact on mobile long-lived radionuclides that did not get released with large volume discharges. This clearly points out the importance of surface barriers and covers that protect groundwater from enhanced infiltration, and provides useful information for cost effective barrier design.

Used in this way, SAC provides a tool to quickly visualize the changes in impact associated with various remediation options. The model is not a black box where one inserts inventory and gets out risk. Rather, the model represents geologic features, disposal events, and hydrogeologic and transport processes, and can be examined in detail to understand the migration and fate of contaminants from inventory through risk/impact. It archives results of environmental consequence, i.e., contaminant concentration, for the vadose zone, groundwater, and Columbia River to provide a portrait of the cumulative impact from the Hanford Site. In analyzing cumulative impact, SAC presents risk/impact results for human health, ecology, economics, and culture. This kind of cumulative impact assessment provides a context for cleanup decisions that must be made at individual waste sites.