Central Plateau Cleanup at DOE's Hanford Site – 12504

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The discussion of Hanford's Central Plateau includes significant work in and around the center of the Hanford Site – located about 7 miles from the Columbia River. The Central Plateau is the area to which operations will be shrunk in 2015 when River Corridor cleanup is complete. This work includes retrieval and disposal of buried waste from miles of trenches; the cleanup and closure of massive processing canyons; the cleanout and demolition to "slab on grade" of the high-hazard Plutonium Finishing Plant; installation of key groundwater treatment facilities to contain and shrink plumes of contaminated groundwater; demolition of all other unneeded facilities; and the completion of decisions about remaining Central Plateau waste sites.
A stated goal of EM has been to shrink the footprint of active cleanup to less than 10 square miles by 2020. By the end of FY2011, Hanford will have reduced the active footprint of cleanup by 64 percent exceeding the goal of 49 percent. By 2015, Hanford will reduce the active footprint of cleanup by more than 90 percent. The remaining footprint reduction will occur between 2015 and 2020.

The Central Plateau is a 75-square-mile region near the center of the Hanford Site including the area designated in the Hanford Comprehensive Land Use Plan Environmental Impact Statement (DOE 1999) and Record of Decision (64 FR 61615) as the Industrial-Exclusive Area, a rectangular area of about 20 square miles in the center of the Central Plateau. The Industrial-Exclusive Area contains the 200 East and 200 West Areas that have been used primarily for Hanford's nuclear fuel processing and waste management and disposal activities. The Central Plateau also encompasses the 200 Area CERCLA National Priorities List site. The Central Plateau has a large physical inventory of chemical processing and support facilities, tank systems, liquid and solid-waste disposal and storage facilities, utility systems, administrative facilities, and groundwater monitoring wells.

As a companion to the Hanford Site Cleanup Completion Framework document, DOE issued its draft Central Plateau Cleanup Completion Strategy (DOE 2009c) in September 2009 to provide an outline of DOE's vision for completion of cleanup activities across the Central Plateau. As major elements of the Hanford cleanup along the Columbia River Corridor near completion, DOE believed it appropriate to articulate the agency vision for the remainder of the cleanup mission. The Central Plateau Cleanup Completion Strategy and the Hanford Site Cleanup Completion Framework were provided to the regulatory community, the Tribal Nations, political leaders, the public, and Hanford stakeholders to promote dialogue on Hanford's future.

The Central Plateau Cleanup Completion Strategy (DOE 2009c) describes DOE's vision for completion of Central Plateau cleanup and outlines the decisions needed to achieve the vision. The Central Plateau strategy involves steps to: (1) contain and remediate contaminated groundwater, (2) implement a geographic cleanup approach that guides remedy selection from a plateau-wide perspective, (3) evaluate and deploy viable treatment methods for deep vadose contamination to provide long-term protection of the groundwater, and (4) conduct essential waste management operations in coordination with cleanup actions. The strategy will also help optimize Central Plateau readiness to use funding when it is available upon completion of River Corridor cleanup projects.

One aspect of the Central Plateau strategy is to put in place the process to identify the final footprint for permanent waste management and containment of residual contamination within the 20-square-mile Industrial-Exclusive Area. The final footprint identified for permanent waste management and containment of residual contamination should be as small as practical and remain under federal ownership and control for as long as a potential hazard exists. Outside the final footprint, the remainder of the Central Plateau will be available for other uses consistent with the Hanford Comprehensive Land-Use Plan (DOE 1999), while maintained under federal ownership and control.

Accordingly, the Central Plateau strategy is organized into the following three principal components:

Inner Area – defined as the final footprint area of the Hanford Site that will be dedicated to permanent waste management and containment of residual contamination. The boundary of the Inner Area is defined by waste disposal decisions already in place and the anticipated future decisions that will result in the requirement for continued waste management and control of residual contamination. The Inner Area is anticipated to be approximately 10 square miles, or less, in size and will remain under federal ownership and control for as long as potential hazards exist. If future waste management facilities are required to support mission completion, e.g., tank waste treatment, those facilities will be located within the Inner Area.

Outer Area – defined as all areas of the Central Plateau beyond the boundary of the Inner Area. It is DOE's intent to clean up the Outer Area to a level comparable to that achieved for the River Corridor. Contaminated soil and debris removed as part of Outer Area cleanup will be placed within the Inner Area for final disposal. Completion of cleanup for the approximately 65-square mile Outer Area will shrink the active footprint of cleanup for the Central Plateau to the Inner Area.

Groundwater Remediation – as acknowledged in the Hanford Site Groundwater Strategy Protection, Monitoring, and Remediation (DOE 2004), the Hanford Integrated Groundwater and Vadose Zone Management Plan (DOE 2007), and then reaffirmed in the 200-ZP-1 record of decision (EPA 2008), DOE's goal is to restore Central Plateau groundwater to its beneficial uses, unless restoration is determined to be technically impracticable. This includes the groundwater underlying both the Inner and Outer Areas.

In 2009, the Tri-Parties agreed to negotiate changes to the Tri-Party Agreement that would address Central Plateau cleanup completion strategies and integration of facility disposition with remediation of geographically associated waste sites, among other topics. In March of 2010, the Tri-Parties signed a Tentative Agreement (Tentative Agreement on Hanford Facility Agreement and Consent Order Change Forms Implementing Changes to Central Plateau Cleanup, DOE 2010d) and proposed Tri-Party Agreement change packages to implement the new approach for Central Plateau cleanup. Among other changes, this agreement re-aligns the existing process-based operable units on the Central Plateau to be more geographical in nature and consolidates the decision making to support a more holistic approach to Central Plateau cleanup.

Current Situation

Liquid waste sites on the Central Plateau have discharged more than 450 billion gallons of liquid waste and cooling water to the ground. These past releases have created extensive plumes of groundwater contamination originating from the Central Plateau with a combined area of about 60 square miles above drinking water standards (DOE 2009d). A significant portion of the previously released contamination remains above the water table and poses a threat to groundwater. Interim groundwater treatment is in place for contaminant plumes in the 200 West Area. A record of decision for the large carbon tetrachloride plume (200-ZP-1 Operable Unit) has recently been signed (EPA 2008), and design and construction of the 200-ZP-1 groundwater plume containment and restoration system is underway. Active waste management facilities are operating to support the ongoing cleanup, and many of these facilities will be required to support cleanup until completion. These facilities include liquid effluent treatment, solid waste packaging and handling, solid waste disposal, spent fuel storage, analytical laboratories, and eventually the Waste Treatment and Immobilization Plant (WTP) for treatment of radioactive tank waste.

Key Challenges for Central Plateau Cleanup

The challenges for cleanup of the Central Plateau differ from those in the River Corridor. Most cleanup efforts along the River Corridor have focused on removal of contaminants to the Central Plateau. A portion of the plateau, however, will retain significant inventories of contamination and long-term waste management activities will be required to ensure protection of human health and the environment. The Inner Area will continue to be used until completion of all cleanup activities including tank waste treatment and closure.

Cleanup of the Central Plateau is a highly complex activity because of the large number of waste sites, surplus facilities, active treatment and disposal facilities, and areas of deep soil contamination. Past discharges of more than 450 billion gallons of liquid waste and cooling water to the soil have resulted in about 60 square miles of contaminated groundwater. Today, some plumes extend far beyond the plateau. Containing and remediating these plumes remains a high priority. Another priority has been removal of nuclear materials stored at the Plutonium Finishing Plant. Complete removal of the

Plutonium Finishing Plant complex is expected by 2015. Removing waste sites in the approximately 65 square mile Outer Area of the plateau is underway. In tandem with River Corridor cleanup, removal of these Outer Area waste sites will shrink the footprint of active cleanup to an area of approximately 10 square miles. The following paragraphs describe some of the significant challenges facing the cleanup of the Central Plateau:

Number, Variety, and Complexity of Cleanup Actions

What is the challenge? There are more than 800 waste sites on the Central Plateau and the cleanup of the plateau will involve a mix of containment, removal, and disposal (e.g., to ERDF), and in-place remediation (e.g., for groundwater). The number and variety of waste sites, surplus facilities (900+), active and inactive burial grounds, and active and inactive processing facilities means that many cleanup decisions must be coordinated. Also, the actions to implement cleanup decisions will need to be coordinated to make the efficient use of cleanup resources.

Where are we today? The Central Plateau Cleanup Completion Strategy (DOE 2009c) seeks to arrive at timely and integrated decisions to implement efficient cleanup actions. Approaching remedy selection in a holistic, rather than sequential, manner will assure the public and taxpayers that remediation dollars are focused on the highest priority actions.

Need for Remediation of Deep Vadose Zone Contamination

What is the challenge? A vast majority of Hanford‘s remaining in-ground contaminants reside in the vadose zone of the 200 Area Central Plateau, where reprocessing operations occurred. The vadose zone at this location is comprised of about 250 feet of water-unsaturated soil above groundwater that discharges to the Columbia River. Contaminants in this zone originated from intentional liquid discharges to cribs, retention basins, and trenches and from unintended tank waste releases in the tank farms. The deep vadose zone is defined as the region below the practical depth of surface remedy influence (e.g., excavation or surface barrier). Traditional remedies will have limited effectiveness to solve these problems because of contaminant depth, contaminant sorption, and the presence of a complex geologic, geochemical and microbial environment.

Where are we today? DOE has initiated a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. These tests (DOE 2008b) focus on technologies for remediating deep technetium-99 and uranium. Initial field testing is underway for desiccation technology to reduce the mobility of technetium-99 in the vadose zone. Additional tests are planned for sequestration of uranium to immobilize subsurface uranium.

Long-Term Effectiveness of Engineered Surface Barriers

What is the challenge? Engineered surface barriers will be required for disposal sites on the Central Plateau including ERDF, the Integrated Disposal Facility, and the mixed-waste disposal trenches. There is growing recognition that surface and subsurface engineered barriers are an integral part of waste site remediation that is needed to

minimize further contamination spread, allow time for additional radionuclide decay, and lower worker and environmental risks. Nonetheless, DOE also recognizes concerns remain over the long-term effectiveness of barriers and their expected longevity. Long-term assurance of barrier performance will build upon near-term research, analysis, and field-testing of each barrier component and the integrated barrier system to ensure that it will work as designed.

Where are we today? The best example within the DOE complex of testing barrier performance is the 5-acre surface-engineered barrier built in 1994 atop a liquid waste site in the 200 East Area, called the Hanford Prototype Barrier. Barrier design was based on years of material and soil research that provided the foundation for barrier construction. Thus, the 1994 barrier was built from layers of natural sediments and human-made materials that control moisture and plant and animal entry while minimizing erosion. Barrier performance has now been monitored for 16 years—the longest period of any surface barrier in the DOE complex. Data confirm the barrier continues to achieve its performance goals. Results from such short-term (years to a few decades) research and tests are fed into models to continuously refine barrier performance predictions. In addition, post-remediation monitoring will be required to confirm and validate continued barrier performance. Performance monitoring and barrier maintenance would be carried out under the long-term site stewardship responsibilities (see Section 6.0).

Remediation of Legacy Solid Waste Burial Grounds

What is the challenge? Sixty percent of Hanford‘s solid waste volume was disposed before 1970, mostly on the Central Plateau in large landfills using common waste management practices of the day. A key challenge for remediating these landfills is to obtain a common understanding of the potential risk the waste poses to the environment and how to best minimize that risk. Burial grounds could have the waste removed and disposed elsewhere on the Hanford Site, they could have an engineered surface barrier installed, or a combination of the two actions could be taken. If decisions are made to remove waste from some or all of the burial grounds, then robotics and surface enclosures would be required to ensure worker and environmental protection while characterization, removal, treatment, and/or repacking takes place.

Where are we today? This remains one of Hanford‘s more challenging decisions. The decisions will involve comparing the risk of two options: (1) leaving waste where it is buried, with sufficient controls provided to contain contaminants from the accessible environment, or (2) incurring the risk and cost of exhuming more concentrated and dangerous materials and re-disposing of them elsewhere on the site or at an offsite location. Public workshops, sponsored by DOE, Ecology and EPA, will be held to have a public dialogue on the remediation of Central Plateau radioactive landfills.

Strategy for Inner Area Cleanup

Recognizing that past decisions have already established permanent waste management areas within the Central Plateau Inner Area, the senior executives of the Tri-Parties have acknowledged that there will be a portion of the Central Plateau that

will be required for continued waste management and containment of residual contamination. These existing commitments to continued waste management form the basis for defining the Inner Area. Reducing the area where this occurs to the smallest practical size is consistent with CERCLA and RCRA policy, DOE management goals, sound fiscal practices, and stakeholder input.
Figure 4-2 highlights DOE's initial proposed boundary for the Inner Area. In developing the proposed boundary, DOE considered:

Waste disposal decisions already in place, such as ERDF, the Integrated Disposal Facility, the Naval Reactor Compartment Disposal trench, Trench 31 and 34 Mixed Waste Landfills, the U Plant canyon decision, and the US Ecology Washington Low-Level Radioactive Waste facility.
Areas where post-closure and cleanup actions would likely result in engineered surface barriers even if some waste removal was performed, such as the remaining canyons, tank farms, portions of the Waste Treatment Plant, and existing low-level waste burial grounds. Areas where deep vadose zone contamination exists below the effective range of surface remedies will likely require long-term surface controls.

As cleanup decisions are made and implementation progresses, the boundary of the Inner Area will be refined as appropriate to reflect the final management/containment area.

DOE's strategy for remediation of the Inner Area is to ensure that the configuration of the waste disposal facilities and residual contamination remaining after cleanup is protective of groundwater, human health, and ecological receptors.

- Apply the decision-making steps of the CERCLA process for the Inner Area's excess facilities, waste sites, burial grounds, and tank farm environmental media contaminated by radionuclides.

- Apply corrective action and closure requirements from RCRA and Washington state's Hazardous Waste Management Act (RCW 70.105), where applicable.

- Use sound technical cleanup principles as the basis for remedy selection to ensure that remedy selection criteria are applied consistently across the entire Inner Area.

- Use a comprehensive approach to evaluate remedial alternatives (1) to improve DOE's ability to evaluate each site in the context of the entire Inner Area cleanup, (2) to provide the best assurance that the full scope of potential risks and impacts are taken into account by decision-makers when selecting remedies for specific sites and (3) to appropriately balance other criteria such as long-term effectiveness and cost, and consider public acceptance across the entire Inner Area.

Integrate groundwater and soil remediation using a defense-in-depth approach that applies a combination of actions including infiltration barriers, vadose zone monitoring, groundwater monitoring, and readiness to implement groundwater treatment, when necessary.

Establish institutional controls that will complement engineered controls selected in decision documents. Continued federal ownership combined with institutional controls will ensure long-term protection of human health and the environment.

As part of the CERCLA five-year review process, monitor the Inner Area to ensure cleanup remedies remain protective and enable early action in the event of emerging contaminant plumes that could potentially impact groundwater.

To achieve consistent and protective cleanup decisions for the Inner Area, DOE intends to develop cleanup levels that (1) satisfy applicable or relevant and appropriate regulatory requirements and (2) ensure that the selected remedies are protective of groundwater, protective of ecological resources, and are protective of human health for future surface users consistent with the designated reasonably anticipated land use. For protection of future surface users, exposure scenarios will be developed that are consistent with the long-term waste management obligations, institutional controls, and surveillance activities required for the Inner Area.

Surplus Facilities

The Central Plateau includes more than 900 facilities and structures including offices, shops, and trailers, as well as large processing, storage, or handling facilities such as the Plutonium Finishing Plant. A combination of regulatory decision paths will be applied to structures depending on the extent of radioactive or hazardous chemical contamination present. DOE will manage the process to determine what cleanup remedy will be used for most uncontaminated structures. Contaminated structures will be dismantled in accordance with DOE decommissioning policies or as CERCLA removal actions if a threat of release of hazardous substances to the environment is present.

At the Plutonium Finishing Plant, the final steps in Hanford‘s plutonium production mission were performed. DOE shut down the facility in 1996, and most of the plutonium inventory has been shipped to other sites. In 2009, all special nuclear material was removed from the Plutonium Finishing Plant complex. This included slightly irradiated spent fuel that has been transferred to the Canister Storage Building for safe, interim storage and the Plutonium Finishing Plant complex will be reduced to slab on grade. The complex included numerous facilities and infrastructure including waste lines, ditches, and drain fields that are now identified as plutonium- and carbon-tetrachloride-contaminated waste sites.

Canyon Facilities

The Central Plateau contains five large defense production facilities, referred to as canyons (see Figure 4-1) that originally were designed for fuel reprocessing operations.

Four of the five canyons (i.e., U Plant, PUREX Plant, B Plant, and REDOX Plant) currently are in an inactive surveillance and maintenance mode. The fifth canyon, T Plant, is still part of active waste management operations. The canyon buildings range from approximately 500 feet long to approximately 1,000 feet long and are constructed of thick (5 to 9 feet) reinforced concrete. These facilities contain large amounts of residual radioactive material and pose a significant challenge for final disposition. Each canyon facility was supported by ancillary facilities and infrastructure including waste lines, ditches, and drain fields. Faced with this significant challenge, in the mid-1990s the Tri-Parties selected U Plant as a prototype for cleanup actions, and the CERCLA process was used to select its final configuration through a record of decision (EPA 2005).

The U Plant canyon completion approach includes the following steps:

- Remove material and equipment requiring disposal at a different location; place contaminated equipment and materials in cells, below-ground galleries, or other below ground portions of the building.
- Demolish the upper structure of the canyon leaving demolition debris in place.
- Place a protective barrier over the demolished building and adjacent waste sites and demolished structures.

DOE expects to also apply the CERCLA process to reach final completion decisions for the remaining four canyon facilities (PUREX, REDOX, B Plant, and T Plant) and that similar completion decisions will be selected. RCRA requirements will also be incorporated into the completion decisions.

Similar to the decision structure anticipated for the waste sites above, each of the five canyons will be assigned to its own geographic zone for decision making and remedy implementation purposes. Nearby waste sites will also be included with the final canyon cleanup decisions. Each canyon-oriented zone will include associated facilities, infrastructure, pipelines, and waste sites.

Strategy for Outer Area Cleanup

The Outer Area covers approximately 65 square miles and contains more than 100 waste sites and structures scattered throughout largely undisturbed sagebrush steppe habitat (see Figure 4-2). Most of the waste sites in the Outer Area are small near-surface sites that will be removed for treatment as needed for onsite disposal or sampled to confirm that no additional action is required, except for implementation of appropriate institutional controls. The largest components of the Outer Area remediation are the ponds where cooling water and chemical sewer effluents were discharged and the BC Control Area where surface contamination was spread because of animal intrusion into a waste site.

Most of the Outer Area of the Central Plateau will be remediated to unrestricted surface levels comparable to the adjacent River Corridor to support the future reasonably

anticipated land use of conservation/mining. Most of this area is reserved for the management and protection of archeological, cultural, ecological, and natural resources and related uses which require protection of human health and ecological pathways. Limited and managed mining (e.g., quarrying for sand, gravel, basalt, and topsoil for governmental purposes only) could also occur. Approximately 10 square miles of the Outer Area lies within the Industrial-Exclusive Area previously designated by the Hanford Comprehensive Land-Use Plan (DOE 1999) and the record of decision (64 FR 61615), and, following cleanup, would be available for uses consistent with that designation.

Outer Area remediation up to a depth of 15 feet is planned, to be consistent with the River Corridor and to enable authorized surface uses. Institutional controls will be required in limited areas as there may be restrictions on sub-surface use in portions of the Outer Area. Similar to cleanup of the River Corridor, cleanup of the Outer Area primarily involves removal of contaminated soil and surplus facilities with disposal in ERDF or other approved disposal locations. Monitoring and continued institutional control will likely be required at the large ponds in the Outer Area to allow radioactive contaminants to decay to levels suitable for unrestricted surface use, consistent with reasonably anticipated future land use of conservation/mining. A small area in the southeastern portion of the Outer Area containing two inactive landfills will be closed under Washington state landfill closure regulations (that is, placement of a cap and continued monitoring/institutional control). These lands are expected to remain under continued federal ownership and control.

DOE and the regulatory agencies have reached a tentative agreement (DOE 2010d) on the decision structure that will be used to make the CERCLA and RCRA decisions for the Outer Area. This agreement and associated Tri-Party Agreement change packages define the Outer Area decision structure and timing for completing remediation decisions.

Funding provided by the American Recovery and Reinvestment Act is supporting accelerated cleanup in the Outer Area. A variety of interim actions is underway to —shrink the active cleanup footprint‖ and support final cleanup decisions planned in an Outer Area record of decision as part of the new Central Plateau Cleanup Completion Strategy (DOE 2009c). Key activities include the demolition of the 212-N, 212-P and 212-R facilities (complete) and remediation of associated waste sites, and remediation of the large BC Control area (17 acres complete and greater than 65,000 tons of soil disposed at ERDF) based on recently completed aerial-based radiological survey. In addition, actions on dozens of small miscellaneous waste sites in the 200-MG-1 Operable Unit have been accelerated with American Recovery and Reinvestment Act funding. Characterization of Outer Area ponds and pipelines is also underway to support preparation of an Outer Area remedial investigation/feasibility study CERCLA documentation.

Strategy for Central Plateau Groundwater Cleanup

A key element of the Central Plateau cleanup strategy is groundwater remediation and protection. Protection of the groundwater and ultimately the Columbia River is essential. The groundwater beneath the Central Plateau is currently divided into four operable units for purposes of remedial investigation:

- The 200-PO-1 Operable Unit is located in the southern half of the 200 East Area and includes extensive plumes of tritium, iodine-129, and nitrate.
- The 200-BP-5 Operable Unit is located in the northern half of the 200 East Area and includes contaminant plumes of uranium and technetium-99.
- The 200-UP-1 Operable Unit is located in the southern half of the 200 West Area and includes contaminant plumes of technetium-99 and uranium.
- The 200-ZP-1 Operable Unit is located in the northern half of the 200 West Area and includes a large plume of carbon tetrachloride and smaller plumes of technetium-99, chromium, trichloroethylene, and iodine-129.

For areas of groundwater contamination in the Central Plateau, the goal is remediation of the aquifer to achieve drinking water standards, unless determined to be technically impracticable. In those instances where remediation goals are not achievable in a reasonable time frame, programs will be implemented to contain the plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction opportunities as new technologies become available. Near-term actions will be taken when appropriate to control plume migration until remediation goals are achieved. This goal is consistent with the Hanford Site Groundwater Strategy (DOE 2004).

Currently, the 200 West Area groundwater operable units, 200-UP-1 Operable Unit (EPA 1997) and 200-ZP-1 Operable Unit (EPA 1995b), have interim pump-and-treat systems that attack the highest concentration portions of the plumes. DOE‘s strategy to enhance the existing interim pump-and-treat systems reflects the need to improve containment of contamination and to return the aquifer to drinking water standards. DOE is implementing this strategy through a remedy decision (200-ZP-1 Operable Unit, DOE 2008d and EPA 2008). DOE is currently designing and building the treatment system for the 200-ZP-1 Operable Unit and intends to include sufficient capacity to also treat the uranium and technetium-99 plumes that are part of the 200-UP-1 Operable Unit. This treatment system is anticipated to be used for 25 years with the intent of removing 95% of the mass of carbon tetrachloride currently in the aquifer.

Analyses supporting the record of decision for 200-ZP-1 indicate that an additional 100 year period of monitored natural attenuation will be needed for contaminant levels to reach cleanup levels. As part of the Central Plateau Cleanup Completion Strategy (DOE 2009c), the Tri-Party Agencies have agreed to address the future 200-UP-1 Operable Unit remedy decision as a future record of decision amendment to the 2008 200-ZP-1 Operable Unit record of decision, resulting in a consolidated remedy decision for the 200 West Area groundwater plumes. It is anticipated that the new combined remedial investigation/feasibility study and proposed plan for the 200 West Area groundwater plumes will be issued by September 30, 2010, with a record of decision in early 2011.

DOE is scheduled to continue investigations and make remedy decisions for the 200 East Area groundwater plumes through a consolidated remedial investigation/feasibility study and proposed plan, anticipated to be issued by December 31, 2012. The consolidated remedial investigation/feasibility study and proposed plan will result in a combined record of decision for the East Area 200-BP-5 and 200-PO-1 Operable Units in 2013. For the 200-PO-1 Operable Unit, the likely response will be to monitor the existing iodine, tritium, and nitrate plumes to ensure that these plumes decay or attenuate to levels below drinking water standards within a reasonable timeframe. For the 200-BP-5 Operable Unit plumes of uranium and technetium-99, treatment options will be investigated to contain these plumes within the plateau and return the groundwater to drinking water standards.

DOE expects that groundwater plumes will be successfully contained within the Central Plateau and eventually returned to drinking water standards. Treatment systems have been installed and are being expanded to support this intent. DOE expects to simplify and streamline the regulatory decision process for final groundwater remedy selection by amending the existing 200-ZP-1 record of decision (EPA 2008) to encompass remedy decisions for the 200-UP-1 operable unit in the 200 West Area. Subsequently, DOE expects to issue one additional record of decision to encompass both 200-BP-5 and 200-PO-1 operable units in the 200 East Area.

Deep Vadose Zone Strategy

On the Central Plateau, the deep vadose zone is defined as the region below the practical depth of surface remedy influence (e.g., excavation or barrier). Deep vadose zone contamination presents unique characterization and remediation challenges. This type of contamination is not considered to pose environmental or health risks through direct exposure or uptake by biota. However, it is a primary concern as a conduit and ongoing source of groundwater contamination and exposure to human or ecological receptors through the groundwater pathway.

This subsurface environment consists of complex stratified and sometimes discontinuous layers of unconsolidated to semi-consolidated and water-unsaturated sediments that are in many places contaminated with radionuclides, metals, organics, and, in some cases, complex mixtures. Contamination originated from intentional liquid disposal to ground surface waste disposal facilities and from unintended tank waste releases. A number of the released contaminants (e.g., strontium,-90, cesium-137, and plutonium) have limited mobility in the vadose zone and groundwater. Other contaminants (e.g., technetium-99, uranium, and carbon tetrachloride) have the ability to migrate to regions deep within the vadose zone, reaching the groundwater in some locations and posing a long-term threat in others. A lack of understanding of key processes (e.g., biogeochemical and hydrologic) affecting contaminant migration makes it difficult to predict the location, transport, and fate of these contaminants in the subsurface. These factors also make it difficult to design and deploy sustainable remedial approaches and monitor long-term contaminant behavior and the performance of remedial actions. These and other issues make the deep vadose zone contamination one of the most challenging remediation problems at the Hanford Site.

DOE has initiated a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. These tests (DOE 2008b) are focused on technologies to remediate deep technetium-99 and uranium. Initial test plans have been developed for field testing of desiccation technology to reduce the mobility of technetium-99 in the vadose zone. Additional tests have been planned for sequestration of uranium to immobilize subsurface uranium.

At the completion of all Central Plateau remediation activities, there are some waste sites where soil contamination will remain, e.g., under caps or very deep contaminants. Inclusion of an integrated monitoring approach that is designed to provide early warning of significant contaminant movement or impact to groundwater is a necessary part of the long-term institutional controls identified in source and groundwater records of decision. A comprehensive, defense-in-depth approach could include monitoring of the applied remedy (such as monitoring installed into barriers to detect elevated soil moisture beneath selected areas of the remedy), monitoring in the vadose zone beneath the remaining contamination, and monitoring in the groundwater.

This defense-in-depth approach includes the following elements:

- Implementation of appropriate surface remedies (e.g., excavation or infiltration barriers) to mitigate the potential impacts of deep vadose zone contamination.
- Inclusion of an integrated groundwater and vadose zone monitoring system that is designed to provide early warning of significant contaminant movement or impact to groundwater.
- Implementation of groundwater treatment systems that can expand to handle emerging plumes, when necessary.
- Continued investment in treatability tests to evaluate potential approaches to remediate deep vadose zone contamination.
- Sustained investment in advanced science and technology solutions to tackle deep vadose zone challenges including characterization, prediction, remediation, and monitoring.
- Periodically revisit the effectiveness of remedies and possible changes in environmental conditions through the CERCLA five-year review process.

This effort is necessary to improve understanding of the deep vadose zone problem, to develop cost effective characterization and monitoring methods, and to develop effective remediation approaches that do not rely solely on extraction of contaminated groundwater.

An important additional activity that is related to the defense-in-depth monitoring approach is DOE‘s commitment to initiate a series of treatability tests to identify and evaluate potential approaches to deep vadose zone contamination. If viable technologies are developed here or elsewhere, then remedies could be selected and implemented across broad regions of the Central Plateau in a manner analogous to groundwater remedy selection. If viable technologies are not available, then long-term institutional controls focused on groundwater monitoring would provide early warning of new contamination entering the groundwater below the Central Plateau and would

provide time to implement existing remedies such as groundwater pump-and-treat systems. To complement these treatability tests, a new research and technology development approach is needed. Given the large number and depth of vadose zone plumes in the 200 Area, it is clear that a holistic understanding of water, gas, and chemical exchange within this complex region is needed to improve long-term predictions of contaminant movement and flux into the groundwater. Through improved understanding of the deep vadose zone region, DOE intends to devise and demonstrate effective remedial actions that control the migration of deep subsurface contaminants so as to protect groundwater.

The Tri-Parties have agreed to realign operable units within the Inner Area of the Central Plateau to be generally more geographic in nature rather than based on process history (DOE 2010d). In addition, a deep vadose zone operable unit will be created to support investigation and remedy selection for this challenging type of waste site. These investigations and remedy selection actions will be coordinated with similar actions for past releases to the soil from single-shell tank farms. Many deep vadose zone sites are in close proximity to tank farm waste management areas, and commingled tank farm and non-tank farm vadose zone plumes exist. A common approach will be applied to ensure that consistent and protective remedies are developed. For waste sites that are part of the geographic operable units (e.g., 200 West Inner Area and 200 East Inner Area), it is anticipated that deep vadose zone sites will be identified for which remedies protective of groundwater cannot be assured and for which further technology development and treatability testing will be needed. In this situation, these sites will be evaluated first for the need to apply interim actions (e.g., soil removal or interim barriers) and then these sites will be assigned to the deep vadose zone operable unit for final remedy selection. These final remedies will be supported by the ongoing treatability testing and science and technology development efforts that DOE has initiated for the deep vadose portion of the Central Plateau. It is expected that some of these final remedies will not be implemented until adjacent tank farms are ready for final closure, which could be two or more decades in the future.

Ongoing Waste Management

The Central Plateau contains the primary waste management facilities that support cleanup. These treatment, storage, and disposal facilities will continue to be used and, in some cases, expanded from current capabilities, e.g., disposal of immobilized low-activity waste from tank waste processing or systems for treatment of contaminated groundwater. It is DOE‘s intent to consolidate these services within the central portion of the plateau compliant with the Hanford Comprehensive Land-Use Plan EIS (DOE 1999). As a pre-scoping document to the Hanford Comprehensive Land-Use Plan, in 1992, the Hanford Future Site Uses Working Group (Hanford Future Site Uses Working Group 1992) recommended use of the Central Plateau Widely for Waste Management.

Wastes would be moving in the Central Plateau from across the site. Waste storage, treatment and disposal activities in the Central Plateau should be concentrated within this area as well, whenever feasible, to minimize the amount of land devoted to , or contaminated by, waste management activities.

One of the waste management operations provided within the Central Plateau is the management of used fuel and nuclear materials that will be removed to off-site locations. Some of these materials are yet to be generated, e.g., immobilized high-level waste from Hanford‘s tanks. Therefore, safe management of these materials will be required for decades. Any new waste management or disposal facilities that are needed to support mission completion (e.g., for completion of the tank waste mission) will be located within the Inner Area of the Central Plateau.

DOE has completed shipping special nuclear material (plutonium) from the Plutonium Finishing Plant to an off-site facility. Transuranic waste is being shipped to the Waste Isolation Pilot Plant in New Mexico. This waste results from the retrieval of stored waste and from transuranic contaminated materials that are newly generated as a result of cleanup operations. Funds provided by the American Recovery and Reinvestment Act are supporting increases in the effort to retrieve stored suspect transuranic waste. Activities are also underway to develop and implement new retrieval capabilities for difficult to handle items such as larger packages, failed containers, and highly radioactive wastes. Engineering work is also underway to identify processing and disposal capabilities needed to deal with waste streams that currently do not have a defined treatment or disposal pathway.

Nearly 2,000 cesium and strontium capsules are currently stored under water inside the Waste Encapsulation and Storage Facility adjoining the B Plant canyon facility. Current planning indicates that B Plant would be next in line after U Plant for completion of final disposition activities. The cesium and strontium capsules will need to be removed prior to starting those efforts. One option would be to pack the capsules in canisters and store them onsite and above ground on an interim basis pending final disposition.

The following operations are part of Hanford‘s waste management efforts:

- Package, certify, and ship transuranic waste to the Waste Isolation Pilot Plant in New Mexico.
- Operate solid low-level waste and mixed low-level waste disposal facilities including solid waste burial grounds, the Integrated Disposal Facility, and the ERDF.
- Operate liquid waste treatment and disposal facilities including the Effluent Treatment Facility and Liquid Effluent Retention Facility.
- Operate the Canister Storage Building to provide safe storage for spent fuel and immobilized high-level waste pending ultimate disposition.
- Operate other waste management facilities including the Waste Receiving and Processing Facility, Central Waste Complex, 222-S Laboratory, and the Waste Sampling and Characterization Facility.

As these facilities complete their missions, they will undergo final remediation through RCRA treatment, storage, and disposal unit closure or deactivation/decommissioning per DOE or CERCLA requirements.

Waste disposal decisions, both for low-level and mixed low-level waste, will be supported by performance assessments that meet DOE requirements (DOE Order 435.1), and in some cases, RCRA permit requirements (e.g., for an Integrated Disposal Facility).18 The disposal and closure conditions are intended to ensure that these sources do not pose a future threat to the groundwater. In addition to performance assessments for individual disposal facilities, DOE is required to maintain a composite analysis19 (per DOE Order 435.1) that is intended to ensure that the cumulative impact from Hanford Site disposal and closure actions comply with DOE performance criteria for radiological exposure. This analysis will draw upon the results of other remediation, closure and disposal decisions.

Central Plateau at Cleanup Completion

A significant amount of hazardous and radioactive material will remain on the Central Plateau after cleanup actions have been implemented. For example, current decisions that leave contamination on the Central Plateau include the ERDF record of decision (EPA 1995a) and the U Canyon record of decision (EPA 2005). Although many Central Plateau cleanup decisions remain to be made, DOE anticipates that additional decisions will also leave contamination in the Central Plateau, consistent with the Inner Area concept. Accordingly, institutional controls will be required after completion of cleanup for as long as potential hazards exist.

Cleanup of Hanford‘s Central Plateau will take decades to complete. The Central Plateau cleanup schedule is driven by the construction of the WTP and the subsequent retrieval and treatment of tank waste. Current schedules show completion of cleanup for the Central Plateau by 2050 time frame. The CERCLA five-year review process will provide a continuing mechanism to ensure that remedial actions, including institutional controls, have been successfully implemented and are protective. In addition, RCRA post-closure care requirements will need to be met.

DOE anticipates seeking site completion status for the Central Plateau in accordance with CERCLA closeout procedures for NPL Sites (EPA 2000) when Central Plateau groundwater meets drinking water standards for key contaminants, all cleanup remedies are implemented, and institutional controls are in place. A final close-out report will be developed that describes how Central Plateau cleanup was accomplished and will provide overall technical justification for site completion.