2.3 Hanford Cleanup Operations

J. P. Duncan

This section describes continuing Hanford Site environmental protection, enhancement, and regulatory activities with respect to cleanup of the Hanford Site. Included are discussions on solid waste management, liquid effluent treatment, environmental restoration, groundwater protection, waste tank research, and project regulatory compliance activities.

2.3.1 Pollution Prevention Program

J. G. Coenenberg

Pollution prevention is the DOE's preferred approach to environmental management. The Hanford Site Pollution Prevention Program is an organized and continuing effort to reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary waste. The program fosters the conservation of resources and energy, reduction of hazardous substance use, and prevention or minimization of pollutant releases to all environmental media from all operations and site cleanup activities.

The program is designed to satisfy DOE requirements, executive orders, and federal and state regulations and requirements. In accordance with sound environmental management, the first priority is to prevent pollution through source reduction. When source reduction is not possible or practical, waste treatment to reduce quantity, toxicity, or mobility is considered. The second priority is environmentally safe recycling, and the third priority is approved disposal to the environment at permitted sites.

The DOE Richland Operations Office is responsible for the Hanford Site Pollution Prevention Program. The office defines program requirements that each Hanford Site contractor must meet. The Hanford Site met the fiscal year 2003 Secretarial Goals (as defined in a DOE memorandum)[a] for low-level waste and mixed low-level routine waste generation and sanitary waste (including paper, plastic, cardboard, glass, etc.) recycling. In 2003, the program reported recycling of 2,339.79 tonnes (2,579.17 tons) of sanitary and hazardous waste. This recycled waste included 398.42 tonnes (439.18 tons) of office and mixed paper, 251.81 tonnes (277.58 tons) of iron/steel, 73.37 tonnes (80.87 tons) of non-ferrous metal, and 33.60 tonnes (37.04 tons) of computers and hardware.

However, the routine hazardous waste generation goal for the Hanford Site was not met. Routine hazardous waste generation was 17.78 cubic meters (23.2 cubic yards), which exceeded the fiscal year 2003 goal ceiling of 16.39 cubic meters (21.4 cubic yards) by 1.39 cubic meters (1.82 cubic yards). This was largely due to cleanup of a diesel oil spill at the Waste Treatment Project, which accounted for approximately 6.1 cubic meters (8 cubic yards).

Affirmative procurement (the purchase of environmentally preferable products containing recycled material) at the Hanford Site achieved 100% of the 2003 goal. The Hanford Site generated 20,454 cubic meters (26,754 cubic yards) of cleanup/stabilization waste (i.e., low-level waste, mixed low-level waste, and hazardous waste), which was 8,150 cubic meters (10,660 cubic yards) below the 2003 cleanup/stabilization goal ceiling of 28,604 cubic meters (37,414 cubic yards).

(a) Memorandum from B. Richardson (The Secretary of Energy) to Heads of Departmental Elements, *Pollution Prevention and Energy Efficiency Leadership Goals for Fiscal Year 2000 and Beyond*, dated November 12, 1999.

2.3.2 Spent Nuclear Fuel Project

M. S. Gerber

The Spent Nuclear Fuel Project was established in February 1994 to provide safe, economical, and environmentally sound management of Hanford Site spent (irradiated) nuclear fuel and to prepare the fuel for long-term storage leading to final disposal. Most of Hanford's spent nuclear fuel was stored in the K Basins attached to the now-defunct K-East and K-West defense production reactors. The K Basins contained 2,100 tonnes (2,300 tons) of N Reactor spent fuel and a small quantity of slightly irradiated single-pass reactor fuel when the Spent Nuclear Fuel Project began.

The Spent Nuclear Fuel Project's strategy is to remove spent fuel from underwater storage in the K Basins, dry it, and place it in dry interim storage in the 200-East Area. Fuel in the K-East Basin is transferred into the K-West Basin for processing. In the K-West Basin, the fuel is cleaned (washed) and packaged into containers called multi-canister overpacks. The multi-canister overpacks are then vacuum processed to remove any water and mechanically sealed at the Cold Vacuum Drying Facility located in the 100-K Area. The dried overpacks are then transported to the Canister Storage Building in the 200-East Area where they are placed in storage in below-ground steel tubes. After an observation period to detect any internal issues that might develop, each multi-canister overpack is brought back to the ground-level operating deck of the Canister Storage Building, and a permanent steel cap is welded over the mechanical seal. The multi-canister overpacks will be maintained in dry storage pending a federal decision on final disposition. If necessary, the re-packaged spent fuel could remain in dry storage for up to 40 years. This strategy supports completion of fuel removal from the K Basins by the Tri-Party Agreement (Ecology et al. 1989) date of July 2004.

During 2003, the Spent Nuclear Fuel Project made progress as follows:

- Transferred 200 shipments of fuel from the K-East Basin to the K-West Basin, completing 215 of 380 planned shipments (56% complete).
- Removed and dried 113 multi-canister overpacks of fuel from the K-West Basin, for a total of 293 multi-canister overpacks out of approximately 385 (75% complete). The 2003 progress brought the total amount of fuel removed and dried to approximately 1,600 tonnes (1,800 tons).
- Started welding operations in the Canister Storage Building (February 2003) and 120 multi-canister overpacks were permanently closed with "N-Stamped" welds (those meeting the highest nuclear quality standards of the American Society of Mechanical Engineers). The welding subproject remained consistently ahead of schedule.
- Installed scrap-processing equipment in the K-West Basin and began loading fuel scraps into multi-canister overpacks in autumn 2003.
- Continued the washing and loading of aged fuel canisters for disposal as low-level nuclear waste. By end of 2003, 3,700 cans (55% of the total) had been washed and disposed.

During 2003, the Spent Nuclear Fuel Project achieved 5 million safe work hours (a project record) in the summer and another 1 million safe hours by December 2003. The project also opened a Career Resource Information Center to help guide employees to new job opportunities when the project ends.

2.3.3 Sludge Retrieval and Disposition Project

M. S. Gerber

The corrosion of spent nuclear fuel stored underwater in Hanford's K Basins for many years, as well as fuel handling operations related to the Spent Nuclear Fuel Project, contributed to the accumulation of sludge in the basins. The sludge, defined as particulate debris that will pass through a strainer with 0.64-centimeter- (0.25-inch-) diameter holes, is a non-homogeneous collection of bits of degrading irradiated fuel and other components, natural accumulation of insects, and windblown sand and soil. The sludge contains fuel corrosion products (i.e., uranium oxides, hydrates, and hydride), pieces of corroded fuel cladding, racks and canisters, ion exchange resin beads, and polychlorinated biphenyls. Sludge can be found on the floor of the basins, in canisters stored underwater, and in basin pits (smaller areas connected to the basins at either end used during the defense production area to handle special materials or special use equipment). Approximately 60 cubic meters (80 cubic yards) of sludge exist in the K Basins, with about 80% found in the K-East Basin.

In its current condition, the sludge is commingled with spent fuel and not considered as waste. However, when the sludge is separated from the fuel and removed from the basins, it becomes waste and will be dispositioned as transuranic waste, as prescribed in a September 1999 record of decision (EPA/ROD/R10-99/059) developed under the CERCLA.

Throughout much of 2003, Fluor Hanford, Inc. managed the effort to retrieve sludge from K Basins as part of the larger Spent Nuclear Fuel Project. The plan called for collection of the sludge in large steel containers, and transport to T Plant in Hanford's 200-West Area for interim storage as remote-handled transuranic waste. This waste would then be included in a treatment and disposition path for other remote-handled transuranic waste at Hanford.

In late 2003, to bring more focus and dedicated resources to sludge issues, Fluor Hanford, Inc. separated the sludge work scope from the Spent Nuclear Fuel Project and created the new Sludge Retrieval and Disposition Project. T Plant had always been an interim storage site, and Fluor Hanford, Inc. and the DOE desired to establish a path leading more directly toward sludge disposal. Fluor Hanford, Inc. organized and staffed its new Sludge Retrieval and Disposition Project with experts who focused on the various types of sludge and sludge locations within the K Basins. K-East Basin contains a mixture of fuel canister sludge and sludge from the basin floor and pits, while K-West Basin sludge exists in four discrete streams. These streams include sludge in pits, sludge dispersed on the basin floor, and canister and fuel wash sludge that collects in the Integrated Water Treatment System equipment used for spent nuclear fuel processing. The Integrated Water Treatment System equipment captures sludge greater than 500 micrometers in knock out pots and/or strainers, and the balance in an arrangement of settling tanks. K-West Basin sludge also includes metallic uranium fuel fragments and fuel corrosion products from fuel of slightly higher enrichment levels than the K-East Basin fuel. Because composition of the sludge is complex, Fluor Hanford, Inc. obtained assistance from Pacific Northwest National Laboratory and others, to determine suitable methods to handle and treat the sludge.

At the end of 2003, the new Sludge Retrieval and Disposition Project had been in existence only 3 months. The project staff had begun to study potential sludge treatment methods and had initiated treatment of the approximately 6 cubic meters (7.85 cubic yards) of KE North Loadout Pit sludge in a pilot grouting program. The project obtained a sample of sludge from the KE North Loadout Pit for analysis and treatability testing, and initiated treatment studies and equipment design to disposition the balance of the K Basins sludge. In the pilot grouting program, North Loadout Pit sludge will be mixed in concrete to prepare it for disposal at the DOE's Waste Isolation Pilot Plant in New Mexico as contact-handled transuranic waste.

2.3.4 Central Plateau Remediation Project

The Hanford Site's Central Plateau Remediation Project's mission is to transition the Central Plateau (200-East and 200-West Areas) from its current post-operational state to a state where excess facilities and waste sites are cleaned up in an environmentally sound, safe, secure, and efficient manner. The activities discussed in the following sections were performed during 2003.

2.3.4.1 224-B Plutonium Concentration Facility Decommissioning Project

C. R. Haas and D. L. Klages

The 224-B Plutonium Concentration Facility (224-B Facility) is located in the 200-East Area, to the south and parallel to the 221-B Separations Facility. The 224-B Facility was used to purify and concentrate product plutonium nitrate solution from the 221-B Separations Facility bismuth-phosphate process. From the 224-B Facility, the concentrated solution was shipped to the 231-Z Isolation Building in the 200-West Area. Plutonium concentration operations were performed in conjunction with 221-B separations activities from 1944 to 1953. The 224-B Facility's process components were deactivated shortly thereafter.

Operational reports from 1953 indicate the process was shut down normally, and documentation specifically states that process equipment and lines were flushed and drained. However, radionuclide contamination and residual amounts of process chemicals may remain in the facility. The remaining inventory of radionuclides and process chemicals has not been quantified.

Following deactivation of the 224-B Facility, the load out area was converted to a regulated workshop, which is an area used to perform work on radiologically contaminated equipment. Office space was constructed on the gallery (non-contaminated) side of the facility during this time. Decontamination and decommissioning work was initiated in the early 1980s, and a number of tanks and other equipment were removed from the galleries.

The 224-B Facility is currently an inactive surplus facility and is administered under a surveillance and maintenance program while awaiting final disposition. The DOE has identified no further use for the 224-B Facility, making the facility a candidate for decontamination and decommissioning.

This decontamination and decommissioning project is a CERCLA non-time critical removal action defined in the 224-B Engineering Evaluation/Cost Analysis (DOE/RL-2000-06). The decontamination and decommissioning work will be performed per a Removal Action Work Plan subsequent to publication of an Action Memorandum. The purpose of the decontamination and decommissioning activities is to safely dismantle the facility and dispose of the demolition waste in a manner that is protective of human health and the environment, and is cost-effective. Development of documentation to support the CERCLA process is ongoing. No other work is anticipated to be performed in fiscal year 2004.

2.3.4.2 224-T Plutonium Concentration Facility Decommissioning Project

C. R. Haas and D. L. Klages

The 224-T Plutonium Concentration Facility (224-T Facility) is located in the 200-West Area, to the south and parallel to the T Plant Complex Canyon Building (221-T). Completed in 1944 and originally designated the 224-T Bulk Reduction Building, the purpose of the 224-T Facility was to concentrate the plutonium nitrate solution produced in the first major step in the plutonium recovery process conducted at the T Plant complex. It operated in this capacity from January 16, 1945 until early 1956, when the T Plant complex was retired from active service as a chemical processing facility.

The 224-T Facility was idle before being modified in 1975 to meet the requirements for storing plutonium-bearing waste. In 1985, the building became the 224-T Waste Storage and Assay Facility and operated in that capacity until the late 1990s.

These past operations resulted in contamination throughout the structure. The 224-T Facility is currently an inactive surplus facility and is administered under a surveillance and maintenance program while awaiting final disposition. The DOE has identified no further use for the 224-T Facility, making the facility a candidate for decontamination and decommissioning.

This decontamination and decommissioning project is a CERCLA non-time critical removal action defined in the 224-T Engineering Evaluation/Cost Analysis (DOE/RL-2003-62). The work will be performed per a Removal Action Work Plan subsequent to publication of an Action Memorandum. The purpose of the decontamination and decommissioning activities is to safely dismantle the facility and dispose of the demolition waste in a manner that is protective of human health and the environment, and is cost-effective. Development of documentation to support the CERCLA process is ongoing. Some work is anticipated to be performed during fiscal year 2004 including setting up structures and equipment necessary to support the Decontamination and Decommissioning Project and limited facility characterization of radiological and chemical conditions within the facility.

2.3.4.3 Accelerated Deactivation Project

D. E. Rasmussen

The mission of the Accelerated Deactivation Project is to complete deactivation and closure activities at facilities while maintaining the facilities in a safe and compliant status until they are turned over to the site contractor responsible for final disposition of the facilities.

300 Area Accelerated Deactivation Project. Accelerated deactivation in the 300 Area focuses on several buildings and structures that date back to 1943. It includes fuel fabrication facilities that were used to support the manufacturing of nuclear fuel for Hanford Site reactors. Significant accomplishments during 2003 included the following activities:

- Completed demolition of the 303-K Building in support of the RCRA closure plan.
- Performed surveillance and maintenance of 300 Area Accelerated Deactivation Project facilities.

2.3.4.4 327 and 324 Facilities Deactivation Project

D. E. Rasmussen

Construction of the 327 and 324 facilities was completed and operations began in 1953 and 1966, respectively. These facilities contain hot cells that were used for radiological research and development work. Deactivation of both facilities was assigned to Fluor Hanford, Inc. during 1996. Facility disposition is to be completed by the new River Corridor Closure contractor (contract award pending).

Significant accomplishments achieved at the 327 Building during 2003 included the following:

- Continuation of waste shipment activities for completion of the 327 Building portion of Tri-Party Agreement milestone M-92-16.
- Completion of initial hot cell deactivation activities enabling the facility to enter into a minimum safe mode (i.e., the minimum required preventive and corrective maintenance activities necessary to maintain compliance with regulatory requirements and facility safety basis requirements).

Significant accomplishments achieved at the 324 Building during 2003 include the following:

- Completion of packaging and shipment of special-case waste (i.e., radioactive waste for which there was no previously identified economic disposal or storage pathway) from the building. These activities resulted in completion of the 324 Building portion of Tri-Party Agreement milestone M-92-16.
- Continuation of facility deactivation activities in support of the *324 Building Radiochemical Engineering Cells, High-Level Vault, Low-Level Vault, and Associated Areas Closure Plan* (DOE/RL-96-73).
- Initiation of decommissioning and decontamination activities in the basement and Shielded Material Facility within the 324 Building.

2.3.4.5 Equipment Disposition Project

D. L. Klages

When the Hanford Site was dedicated to the defense production mission, rail and other heavy equipment was used to handle and transport radioactive or hazardous materials and/or to enter facilities where radioactive and hazardous materials were present. Through use, the equipment became radiologically and/or chemically contaminated to the point where it was either removed from service and buried onsite or managed for future use or disposition.

During 1995, the need to manage radiologically contaminated rail equipment became apparent, and the Equipment Disposition Project was established. The technical objective of the project is the disposition of 37 contaminated railcars, 5 pieces of heavy equipment, 1 condenser, 1 skid-mounted concrete burial box filled with K Basin materials, and 2 skid-mounted concrete burial boxes filled with ion exchange columns left over from past Hanford programs.

No funding was available to support the continuation of the Equipment Disposition Project during 2003. Therefore, only minimal surveillance and maintenance activities were conducted.

2.3.4.6 233-S Plutonium Concentration Facility Decommissioning Project

D. L. Klages

Decontamination and decommissioning activities continued in 2003 at the 233-S Plutonium Concentration Facility (233-S Facility) located in the 200-West Area adjacent to the Reduction-Oxidation (REDOX) Plant. This work is being performed as a CERCLA non-time-critical removal action. The 233-S Facility and associated process equipment were used to concentrate plutonium produced at the Reduction-Oxidation (REDOX) Plant from 1955 to 1967.

Equipment cleaning and waste disposal activities took place throughout 2003, along with decontamination efforts on the facility's interior surfaces. Contamination levels within the facility were significantly reduced and the majority of fissile material was removed. Demolition of the 233-S Facility began in 2003 and is scheduled for completion in 2004.

2.3.4.7 Central Plateau Surveillance and Maintenance Project

G. J. LeBaron

Disposition of 200 Areas facilities includes the surveillance, maintenance, and deactivation of buildings and waste sites in the 200-East, 200-West, and 200-North Areas, and on the Fitzner/Eberhardt Arid Lands Ecology Reserve.

Included in the facilities managed by the Central Plateau Surveillance and Maintenance Project are interim status RCRA treatment, storage, and disposal units awaiting closure. In July 2002, responsibility for additional facilities, including the "canyon" facilities (Plutonium-Uranium Extraction [PUREX] Plant, B Plant, Reduction-Oxidation [REDOX] Plant, and U Plant), was transferred from Bechtel Hanford, Inc. to the Central Plateau Surveillance and Maintenance Project managed by Fluor Hanford, Inc. Three operating major air emission units and three operating minor emission stacks as defined by 40 CFR 61 are now maintained by the project.

During 2003, facility work conducted under this project included closing one major emission unit (the B Plant filters vent), inspecting and cleaning the sample probe and line, and collecting data at the B Plant stack to show that it is a minor emission unit. This work was done in addition to the normal surveillances and maintenance that were conducted to ensure that the facilities are secure and maintained and do not pose a threat to human health or the environment.

The Radiation Area Remedial Action Program is part of the Central Plateau Surveillance and Maintenance Project. The project is responsible for the surveillance, maintenance, and decontamination or stabilization of over 500 waste sites including former cribs, ponds, ditches, trenches, unplanned release sites, and burial grounds. These sites are maintained by performing periodic surveillances, radiation surveys, and herbicide applications and by initiating timely responses to identified problems. The overall program objective is to maintain these sites in a safe and stable configuration and to prevent contaminants at these sites from spreading in the environment while final remediation strategies are identified and implemented.

2.3.4.8 Canyon Disposition Initiative

J. R. Robertson

The purpose of the Canyon Disposition Initiative is to investigate the potential for using the five canyon buildings at the Hanford Site as disposal facilities for Hanford Site remediation waste, rather than demolishing the structures. ("Canyon" is a vernacular term used at the Hanford Site for the chemical separations plants, inspired by their long, high, narrow structure.) While planning and sampling activities of the Canyon Disposition Initiative actually began in the mid-1990s, the bulk of the work to prepare the feasibility study (DOE/RL-2001-11) was completed in 2001 as the final phase of the CERCLA remedial investigation/feasibility study for disposition of the 221-U Chemical Processing Facility (U Plant). The U Plant was used as the pilot project for the Canyon Disposition Initiative. During 2002 and 2003, work was done to finalize the draft feasibility study (DOE/RL-2001-11) and to prepare the associated draft proposed plan for public review.

Following regulator and public review of the Phase I feasibility study for the Canyon Disposition Initiative (DOE/RL-97-11), five options were selected for final evaluation and screening: (1) no action (2) full removal and disposal, (3) entombment with internal waste disposal, (4) entombment with internal/external waste disposal, and (5) close in place – collapsed structure. The feasibility study (DOE/RL-2001-11) determined that options 2, 3, 4, and 5 meet the requirements to protect human health and the environment, and that options 3 and 4 are consistent with the *Performance Management Plan for the Accelerated Cleanup of the Hanford Site* (DOE/RL-2002-47). The final option for U Plant will be selected during the record of decision process. Selecting the final option for the five canyon buildings figures prominently in the DOE's plan to use the Central Plateau as an area for long-term treatment, storage, and disposal of waste to support Hanford cleanup operations.

2.3.5 Fast Flux Test Facility

D. A. Gantt

The Fast Flux Test Facility is a 400-megawatt thermal, liquid-metal-cooled reactor located in the 400 Area. It was built in the late 1970s to test equipment and fuel for the Liquid Metal Fast Breeder Reactor Program. The Fast Flux Test Facility operated from April 1982 to April 1992, during which time it successfully tested advanced nuclear fuels, materials, and safety designs and also produced a variety of isotopes for medical research. The reactor has been in a standby mode since December 1993. Fuel has been removed from the reactor vessel and stored in two sodium-filled vessels and in aboveground dry-storage casks. Twenty-three of the facility's 100 systems were deactivated during the previous deactivation period from 1993 to 1997.

The Fast Flux Test Facility continued with deactivation in April 2003. The repairs and upgrades to the fuel handling equipment were completed and successfully tested. Following the removal of a hold order imposed by U.S. District Court, the sodium was drained from the secondary heat transport system loops to the Sodium Storage Facility tanks, where it is stored pending future conversion to sodium hydroxide for use by the Waste Treatment Plant. Eighty-one fuel components were washed, packaged, and placed in approved interim storage. This included 32 un-irradiated mixed-oxide fuel assemblies, which are now in storage at the Plutonium Finishing Plant.

Fluor Hanford Inc. awarded a contract to TransNuclear, Inc. for fabrication of the remainder of the interim storage casks, and work to design a pump to drain the reactor vessel continued.

2.3.6 Advanced Reactors Transition Project

J. M. Bishop

The mission of the Advanced Reactors Transition Project is to convert the Plutonium Recycle Test Reactor facility, located inside the 309 Facility, into a structure that is suitable for low-cost surveillance and maintenance. During 2003, facility surveillance activities were conducted.

2.3.7 Plutonium Finishing Plant

M. S. Gerber

During 1949, the Plutonium Finishing Plant began processing plutonium nitrate solutions into metallic form for shipment to nuclear weapons production facilities. Operation of this plant continued into the late 1980s. During 1996, the DOE issued a shutdown order for the plant, authorizing deactivation and transition of the plutonium processing portions of the facility in preparation for decommissioning.

Workers at the Plutonium Finishing Plant complex embarked on a large and multifaceted effort to stabilize, immobilize, re-package, and/or properly dispose of nearly 18 tonnes (19.8 tons) of plutonium-bearing materials in the plant, and had nearly completed this mission by the end of 2003 (completion occurred in February 2004). The workers also began to deactivate and dismantle the processing facilities, while still providing for the safe and secure storage of nuclear materials until final disposition.

Significant accomplishments achieved at the Plutonium Finishing Plant during 2003 included the following:

- Completed stabilizing nearly 1,000 plutonium-bearing polycubes using a unique thermal stabilization method devised specifically for this project.
- Completed re-packaging the original 4 tonnes (4.4 tons) of plutonium-bearing residues identified for action by the Defense Nuclear Facilities Safety Board in 2000, and went on to package additional materials categorized as residues since 2000.
- Began shipment and disposal of re-packaged plutonium-bearing residues off of the Hanford Site to the Waste Isolation Pilot Plant in Carlsbad, New Mexico.
- Continued welding stabilized plutonium forms into sturdy, triple-layered cans meeting strict specifications of the DOE's "3013" safety standard.
- Began stabilizing a collection of plutonium-bearing oxides containing large amounts of chloride salts, using a unique process developed for this project.
- Stabilized approximately 90% of the total plutonium inventory by the end of 2003.
- Completed cleanout of plutonium held in an initial glove box known as HC-7C in the main Plutonium Finishing Plant Facility and began cleanout in a second large glove box known as HC-9B.
- Began equipment removal in the 232-Z Incinerator facility in the Plutonium Finishing Plant complex and completed key environmental documentation in preparation for additional deactivation work.
- Attained over 1 million safe work hours and became the first high-hazard nuclear facility in the DOE complex to achieve Star Status in DOE's Voluntary Protection Program.

2.3.8 Waste Encapsulation and Storage Facility Project

F. M. Simmons

The mission of the Waste Encapsulation and Storage Facility Project is to provide safe interim storage of encapsulated radioactive cesium and strontium. The facility was initially constructed as a portion of the B Plant complex and began service in 1974. There are currently strontium fluoride and cesium chloride capsules stored at the facility. The capsules will be stored at the Waste Encapsulation and Storage Facility until 2018 when they will either be treated at the Waste Treatment Plant or transported to the national repository.

Tri-Party Agreement milestone M-92-05 was revised in 2003 to assess the viability of directly disposing of the capsules at the national high-level waste repository as an alternative to vitrification. The completed assessment is due June 30, 2007, to Washington State Department of Ecology.

2.3.9 Office of River Protection

Congress established the Office of River Protection during 1998 as a DOE field office reporting directly to the DOE Assistant Secretary for Environmental Management. The Office of River Protection is responsible for managing the DOE's River Protection Project to store, retrieve, treat, and dispose of high-level tank waste and close the tank farm facilities at the Hanford Site. The main tasks of the Office of River Protection are discussed in the following sections.

2.3.9.1 Waste Tank Status

J. D. Doughty

The Hanford Federal Facility Agreement and Consent Order, or Tri-Party Agreement (Ecology et al. 1989), formally establishes a schedule for stabilization, retrieval, and closure of the Hanford 200 Areas waste tanks. Stabilization is achieved by removing all pumpable liquids from a tank; pumpable liquids are those that will, under the force of gravity, flow from the waste matrix to the pump intake. Retrieval is achieved by removing all waste that can be accessed, mobilized, and retrieved from a tank, to the limits of the selected retrieval technology. All waste removed from a single-shell tank during stabilization and retrieval activities is transferred to a double-shell tank.

A monthly waste tank summary report documents the status of waste tanks. The December 2003 report, HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2003*, provided the following information:

- The Hanford tank farms contain 177 high-level radioactive waste tanks, of which 149 are single-shell tanks and 28 are double-shell tanks.
- Of the 177 tanks, 67 single-shell tanks are assumed to have leaked at some time in the past.
- The volume of liquid waste that may have leaked from these tanks has been conservatively estimated to be between 3 and 4 million liters (750,000 and 1 million gallons).

During 2003, ten single-shell tanks were declared stabilized: 241-U-107, 241-AX-101, 241-A-101, 241-S-107, 241-SX-102, 241-SX-101, 241-C-103, 241-U-111, 241-SX-103, and 241-BY-105. Two additional tanks, 241-BY-106 and 241-S-101, are believed to be stabilized, but are being further evaluated. As of December 31, 2003, only tank 241-U-108 remains to be stabilized. Calendar year 2003 stabilization activities transferred more than 1 million liters (300,000 gallons) of waste from single-shell tanks to double-shell tanks.

At the close of 2003, waste in 13 tanks was in some stage of retrieval. Four tanks were in retrieval status but were not yet being prepared for waste retrieval: 241-C-103, 241-C-105, 241-S-103 and 241-S-105. Seven tanks were in preparation for retrieval: 241-C-104, 241-S-102, 241-S-106, and four 241-C-200 series tanks. Waste retrieval from tank 241-S-112 was begun, with completion scheduled for 2004. Waste retrieval was declared complete for tank 241-C-106 in December 2003, and the tank is now in an evaluation mode to verify retrieved status. Retrieval activities removed approximately 4.9 million liters (1.3 million gallons) of waste from single-shell tanks.

To support safe waste storage and retrieval, the contents of 154 of the 177 (87%) tanks have been characterized. All of the double-shell tanks and most of the single-shell tanks have been sampled; however, a number of these tanks were analyzed for a limited number of analytes.

During 2003, CH2M HILL Hanford Group, Inc. retrieved waste from tank 241-C-106, dissolving and mobilizing the waste with an acid solution. Retrieval also began at tank 241-S-112, where water was used to dissolve and mobilize the waste. Evaluation of a third technology, the mobile retrieval system, continued. This third technology is intended for use on solid waste. It consists of a remote controlled in-tank waste vehicle (used to push tank waste to a central location) and an articulated mast (used to guide the vacuum pump intake to the waste positioned for retrieval by the in-tank vehicle). Workers plan to deploy the articulated mast in 2004 for waste retrieval in the C-200 series tanks. The entire mobile waste retrieval system, both the mast and the in-tank vehicle, is planned for deployment in 2005 to retrieve waste from the C-100 series tanks.

2.3.9.2 Waste Tank Closure Acceleration

J. D. Doughty

During 2003, the DOE revised the closure plan for the single-shell tank system based on comments received from Washington State Department of Ecology. The process and integration necessary to achieve accelerated closure of single-shell tanks and waste management areas and the first closure activities will be performed on tank 241-C-106 (RPP-13774).

CH2M HILL Hanford Group, Inc. selected a single supplemental treatment technology, bulk vitrification, for further evaluation of treatment of retrieved low-activity tank waste and is pursuing a field assessment of that technology. The project will address the feasibility of using vitrification (i.e., heating and melting inert materials to form a solid glass matrix) to immobilize low-activity waste in a form suitable for disposal. Vitrification will be achieved by mixing S-109 tank waste and matrix materials (glass formers) in a container and then applying electrical resistance heating through electrodes buried in the waste/glass forming mixture. The heat produced will melt the glass mixtures and encapsulate the low-activity waste. If selected for full-scale implementation, this technology will provide treatment capacity to supplement the treatment provided by the Waste Treatment Plant, facilitating accelerated tank waste retrieval and tank closure. Planning and design have begun for a 2005 demonstration, and the required environmental permit applications have been submitted.

In addition, CH2M HILL Hanford Group, Inc. continues its evaluation of a separate disposal path for select mixed transuranic tank waste. The approach will include onsite treatment and packaging for shipment and final disposal at the DOE Waste Isolation Pilot Plant in New Mexico. The *National Environmental Policy Act* documentation and environmental permit applications have been prepared, and a contract was awarded for design and fabrication of the waste treatment and packaging system.

2.3.9.3 Geophysical Data Logging for Vadose Zone Characterization and Monitoring

R. G. McCain and B. W. Mathis

Geophysical data logging at the Hanford Site is performed by S.M. Stoller Corporation under their contract with the DOE Grand Junction Office. This work draws upon capabilities and experience established for the National Uranium Resource Evaluation Program. The primary logging capability is high-resolution spectral gamma logging. The spectral gamma logging system uses cryogenically cooled high purity germanium detectors to collect in situ gamma energy spectra. Specific gamma-emitting radionuclides are identified and quantified from their characteristic energy levels, and the results are plotted as a function of depth. Other logging capabilities include neutron moisture and passive neutron. The neutron moisture log irradiates the formation with neutrons from an americium-beryllium source and measures neutron backscatter, which is primarily due to the presence of moisture in the vadose zone. For the neutron moisture log, the count rate is an indication of volumetric moisture content. The passive neutron log measures ambient neutron activity in the subsurface. The primary reaction contributing to neutron activity is the interaction between alpha particles and oxygen in the formation. Thus, the passive neutron log is a qualitative indicator of alpha-emitting radionuclides.

Log data are collected in new and existing boreholes to support ongoing remedial investigation activities conducted by other Hanford contractors. S.M. Stoller Corporation is also responsible for a baseline characterization program, where the objective is to log all existing boreholes associated with waste disposal sites on the Hanford Central Plateau and establish a baseline of vadose zone contamination conditions against which future measurements can be compared to assess contaminant mobility.

2.3.9.4 Monitoring Activities in the Single-Shell Tank Farms

R. G. McCain and B. W. Mathis

The tank farms geophysical logging baseline characterization effort was completed in 2000. This work delineated subsurface contaminant plumes in the vicinity of 12 single-shell tank farms. Cobalt-60, cesium-137, europium-152, europium-154, uranium-235, and uranium-238 were the dominant manmade gamma-emitting contaminants. Minor amounts of tin-126 and antimony-125 were also detected. Shorter-lived contaminants, such as ruthenium-106 (half life = 1.02 years) were found to have decayed below detectable levels.

Since specific contaminants have been identified and quantified by the baseline characterization program, it is only necessary to identify changes in contaminant levels over time. For this purpose, the radionuclide assessment system was deployed in 2000. This logging system uses scintillation detectors, which are more sensitive, in terms of photon interactions, but their energy resolution is relatively poor, and they may not be able to resolve specific energy lines associated with manmade radionuclides. Since specific radionuclides have been identified in the baseline characterization program, this is not critical for monitoring purposes. The overall result is a faster and simpler logging system capable of detecting changes in gamma activity levels over time.

Specific boreholes and depth intervals for routine monitoring are selected and prioritized on the basis of intersection with known contaminant plumes, proximity to tanks known or suspected of leaking, or proximity to tanks containing relatively large volumes of drainable liquid. Monitoring frequency is determined on the basis of overall priority. The goal is to log high-priority boreholes on at least a yearly basis and all boreholes at least once in a 5-year period.

Initiation of waste retrieval operations in selected tanks has created a demand for additional monitoring in boreholes associated with tanks undergoing retrieval. Dry well monitoring is an important component of the overall leak detection and mitigation activity for waste retrieval operations. Currently, boreholes around a tank are logged at least once immediately prior to waste retrieval operations, and at monthly intervals during waste retrieval. After retrieval operations are completed, monthly monitoring is specified for an additional 6 months. In addition to gamma activity, the neutron moisture log is also used for monitoring purposes. Monthly logging measurements are supplemented by more frequent measurement over limited depth intervals with hand-held moisture gauges operated by tank farms personnel.

See Section 6.0.6 for additional information on vadose zone monitoring in 2003.

2.3.9.5 Waste Immobilization

B. Curn

The Waste Treatment Plant is being built on 26 hectares (65 acres) located on the Central Plateau outside of the Hanford 200-East Area to treat radioactive and chemically hazardous waste currently stored in 177 underground tanks. Currently, three major facilities are being constructed: a pretreatment facility, a high-level waste vitrification facility, and a low-activity waste vitrification facility. Supporting facilities are being constructed also. The River Protection Project is currently upgrading tank farm facilities to deliver waste to the Waste Treatment Plant.

During 2003, the contractor continued construction for the Pretreatment Plant, High-Level Waste Vitrification Plant, and Low-Activity Waste Vitrification Plant. Walls and floors are being placed. Several tanks are being constructed, such as the Pretreatment Plant 4-pack tanks. In the Low-Activity Waste Vitrification Plant, the contamination zone number 3/5 drain sump collection vessel was placed in the north side of the facility. The Pretreatment Plant building is approximately 27% complete, the High-Level Waste Vitrification Plant building is approximately 10% complete, and the Low-Activity Waste Vitrification Plant building is approximately 13% complete. The balance of facilities, which includes support facilities and utilities not associated with the Pretreatment Plant, High-Level Waste Vitrification Plant, or Low-Level Waste Vitrification Plant, is approximately 25% complete.

2.3.10 Solid Waste Management

Solid waste management includes the treatment, storage, and/or disposal of solid waste produced as a result of Hanford Site operations or obtained from offsite sources that are authorized by the DOE to ship waste to the site. The following sections contain information regarding specific site locations.

2.3.10.1 Central Waste Complex

D. G. Saueressig

Waste is received at the Central Waste Complex in the 200-West Area from sources at the Hanford Site and any offsite sources that are authorized by the DOE to ship waste to the Hanford Site for treatment, storage, and disposal. Ongoing cleanup, research, and development activities on the Hanford Site, as well as remediation activities, generate most of the waste received at the Central Waste Complex. Offsite waste has been primarily from other DOE sites and U.S. Department of Defense facilities. The characteristics of the waste received vary greatly, including low-level, transuranic, or mixed waste, and radioactively contaminated polychlorinated biphenyls.

The Central Waste Complex can store as much as 20,800 cubic meters (735,000 cubic feet) of mixed low-level waste and transuranic waste. This capacity is adequate to store the projected volumes of transuranic, mixed waste, and radioactively contaminated polychlorinated biphenyls to be generated, assuming on-schedule receipts and transfer for treatment or disposal of the stored waste. The dangerous waste designation of each waste container is established at the point of origin based on process knowledge or sample analysis.

2.3.10.2 Waste Receiving and Processing Facility

H. C. Boynton

Waste destined for the Waste Receiving and Processing Facility includes stored waste as well as newly generated waste from current site cleanup activities. The waste consists primarily of contaminated cloth, paper, rubber, metal, and plastic. Processed waste that qualifies as low-level waste and meets disposal requirements is direct buried onsite. Low-level waste not meeting direct burial requirements is processed in the facility for onsite burial or prepared for future treatment at other onsite or offsite treatment, storage, and disposal facilities. Waste designated at the facility to be transuranic is certified and packaged for shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico, for permanent disposal. Other materials requiring further processing to meet disposal criteria are retained, pending treatment.

The Waste Receiving and Processing Facility began operating in 1997 and analyzes, characterizes, and prepares drums and boxes of waste for disposal. The 4,800-square-meter (52,000-square-foot) facility is located near the Central Waste Complex in the 200-West Area. The facility processed and shipped 1,881 drums and 112 boxes of waste during 2003.

2.3.10.3 Radioactive Mixed Waste Disposal Facility

R. R. Connolly

The Radioactive Mixed Waste Disposal Facility is located in the 218-W-5 low-level waste burial ground in the 200-West Area and is designated as trenches 31 and 34. Disposal to trench 34 began during September 1999. Currently, there are approximately 2,000 cubic meters (70,600 cubic feet) of waste disposed in about 1,150 waste packages in trench 34, and there are approximately 60 cubic meters (2,100 cubic feet) of waste stored in about 180 waste packages in trench 31. The trenches are rectangular landfills, with approximate base dimensions of 76 by 30 meters (250 by 100 feet). The bottom of the excavations slopes slightly, giving a variable depth of 9 to 12 meters (30 to 40 feet). These trenches comply with RCRA requirements because they have double liners and systems to collect and remove leachate. The bottom and sides of the facilities are covered with a layer of soil 1 meter (3.3 feet) deep to protect the liner system during fill operations. There is a recessed section at the end of each excavation that houses a sump for leachate collection. Access to the bottom of each trench is provided by ramps along the perimeter walls.

2.3.10.4 T Plant Complex

B. M. Barnes

The T Plant Complex in the 200-West Area provides waste treatment, storage, and decontamination services for the Hanford Site as well as for offsite facilities. The T Plant Complex currently operates under RCRA interim status. In 2003, the following activities occurred at the T Plant Complex:

- Head-space gas was sampled in hundreds of containers of transuranic waste to support the Waste Isolation Pilot Plant Project.
- Numerous containers and boxes of waste were re-packaged, treated, sampled, and characterized to meet waste acceptance criteria and land disposal restriction requirements.
- Approximately 40 Shippingport reactor fuel elements were shipped to the Canister Storage Building. Twenty-eight fuel elements remain in storage. The fuel elements are from the Shippingport Atomic Power Station, a nuclear generating station in western Pennsylvania that is being decommissioned.
- Approximately 25 containers of material were shipped to the 400 Area Consolidation Center.
- Equipment was decontaminated for re-use or disposal as waste.

The T Plant Complex Part B Permit was submitted to Washington State Department of Ecology in September 2002 for inclusion in the Hanford Facility RCRA Permit (Ecology 1994). Washington State Department of Ecology has requested an update to this permit for their review. This review is in support of the Washington State Department of Ecology eventually incorporating this permit into the Hanford Facility RCRA Permit (Ecology 1994).

The T Plant Complex has completed all necessary activities to receive K Basin sludge for storage.

The T Plant Complex continued with upgrades to the 291-T-1 stack. Upgrades included removal of fans #1 and #2 from service, installation of a new fan (fan #4), removal of ducting, and installation of new ducting. Upgrades also included installation of a new stack cabinet monitoring system containing continuous air monitors for alpha and beta gamma.

2.3.10.5 Mixed Low-Level Waste Treatment Contracts

R. R. Connolly

During 2003, Fluor Hanford, Inc. continued to ship mixed low-level waste offsite to commercial treatment units. Fluor Hanford, Inc. had contracts with Pacific EcoSolutions to non-thermally treat mixed low-level waste debris and radioactive lead solids. Under these contracts, 873 cubic meters (30,826 cubic feet) of mixed low-level waste were treated and disposed of at Hanford.

Additionally during 2003, Fluor Hanford, Inc. contracted with PermaFix to thermally treat mixed low-level waste labpacks and solids contaminated with RCRA organic constituents. Under this contract, 15.4 cubic meters (544 cubic feet) of mixed low-level waste were treated and disposed of at Hanford.

2.3.10.6 Mixed Low-Level Waste Treatment and Disposal

R. R. Connolly

During 2003, 2,250 cubic meters (79,450 cubic feet) of mixed low-level waste were treated and/or direct disposed:

- 873 cubic meters (1,142 cubic yards) of waste, or approximately 4,195 drum equivalents (based on a standard 208-liter [55-gallon] drum), were non-thermally treated to RCRA land disposal restriction standards at the Pacific EcoSolutions facility located in Richland, Washington. The treated waste was returned to Hanford and disposed of in trench 34 of the Radioactive Mixed Waste Disposal Facility.
- 50 cubic meters (65 cubic yards), or approximately 240 drum equivalents of waste, were removed from inventory at the Central Waste Complex after it was determined that they met disposal standards. This waste was direct disposed in the Hanford Site low-level burial grounds.
- 104 cubic meters (136 cubic yards), or approximately 500 drum equivalents of waste, were directly disposed into the Radioactive Mixed Waste Disposal Facility. This waste came from various Hanford Site operations and either met land disposal restriction standards in the "as generated" state, or was treated according to treatment-by-generator provisions in WAC 173-303-170(3)(b) to meet RCRA and state land disposal restrictions.
- 1,512 cubic meters (1,978 cubic yards), or approximately 7,270 drum equivalents of waste, were removed from inventory at the Central Waste Complex and directly disposed into the Environmental Restoration Disposal Facility. The waste disposed was all originally from the 183-H basins and had been stored in the Central Waste Complex since the late 1980s. Approval to dispose of this waste in the Environmental Restoration Disposal Facility was obtained through an engineering evaluation/cost analysis determination, which was approved in July 2003. There remains in the Central Waste Complex approximately 2,200 cubic meters (2,877 cubic yards) of this waste, which is scheduled to be shipped to the Environmental Restoration Disposal Facility during calendar years 2004 and 2005.
- 15.4 cubic meters (20 cubic yards), or approximately 73 drum equivalents of waste, were thermally treated to RCRA land disposal restriction standards at PermaFix, in Oak Ridge, Tennessee. The treated waste was returned to Hanford and disposed of in trench 34 of the Radioactive Mixed Waste Disposal Facility.

2.3.10.7 Navy Reactor Compartments

S. G. Arnold

Two disposal packages containing defueled U.S. Navy reactor compartments were received and placed in trench 94 in the 200-East Area during 2003. This brings the total number of reactor compartments received to

112. All Navy reactor compartments shipped to the Hanford Site for disposal have originated from decommissioned nuclear-powered submarines or cruisers. Decommissioned submarine reactor compartments are approximately 10 meters (33 feet) in diameter and 14.3 meters (47 feet) long. They weigh between 908 and 1,362 tonnes (1,000 and 1,500 tons). Decommissioned cruiser reactor compartments are approximately 10 meters (33 feet) in diameter and 12.8 meters (42 feet) high. They weigh approximately 1,362 tonnes (1,500 tons).

2.3.11 Liquid Effluent Treatment

S. S. Lowe

Facilities are operated on the Hanford Site to store, treat, and dispose of various types of liquid effluent generated by site cleanup activities. These facilities are operated and maintained in accordance with state and federal regulations and facility permits.

2.3.11.1 242-A Evaporator

S. S. Lowe

The 242-A evaporator in the 200-East Area concentrates dilute liquid tank waste by evaporation. This reduces the volume of liquid waste sent to double-shell tanks for storage and reduces the potential need for additional double-shell tanks. The 242-A evaporator completed four campaigns during 2003. The volume of waste treated was 14.53 million liters (3.84 million gallons). The waste volume reduction was 4.28 million liters (1.13 million gallons), or approximately 29%, and the volume of process condensate transferred to the Liquid Effluent Retention Facility for subsequent treatment in the Effluent Treatment Facility was 5.68 million liters (1.50 million gallons).

Effluent treatment and disposal capabilities are available to support the continued operation of the 242-A evaporator. The Effluent Treatment Facility in the 200-East Area (Section 2.3.11.3) was constructed to treat the process condensate from the evaporator and other radioactive liquid waste. The process condensate is sent to the Liquid Effluent Retention Facility for interim storage while awaiting treatment in the Effluent Treatment Facility. Cooling water and non-radioactive steam condensate from the 242-A evaporator are discharged to the 200 Area Treated Effluent Disposal Facility.

2.3.11.2 Liquid Effluent Retention Facility

S. S. Lowe

The Liquid Effluent Retention Facility in the 200-East Area consists of three RCRA-compliant surface basins to temporarily store process condensate from the 242-A evaporator and other aqueous waste. The Liquid Effluent Retention Facility provides equalization of the flow and pH of the feed to the Effluent Treatment Facility. Each basin has a maximum capacity of 29.5 million liters (7.8 million gallons). Generally, spare capacity is maintained in the event a leak should develop in an operational basin. Each basin is constructed of two flexible high-density polyethylene membrane liners. A system is provided to detect, collect, and remove leachate from between the primary and secondary liners. Beneath the secondary liner is a soil/bentonite clay barrier should the primary and secondary liners fail. Each basin has a floating membrane cover constructed of very low-density polyethylene to keep out windblown soil and weeds and to minimize evaporation of small amounts of organic compounds and tritium that may be present in the basin contents. The facility began operating in April 1994 and receives liquid waste from both RCRA- and CERCLA-regulated cleanup activities.

The volume of wastewater received for interim storage during 2003 was approximately 98 million liters (26 million gallons). The wastewater received for interim storage during 2003 included approximately 7 million liters (2 million gallons) of RCRA-regulated wastewater (primarily 242-A evaporator process condensate), and approximately 91 million liters (24 million gallons) of CERCLA-regulated wastewater (primarily Environmental Restoration Disposal Facility leachate and contaminated groundwater from the 200-UP-1 Operable Unit in the 200-West Area). The majority of the wastewater was received via pipeline direct from the generators. Approximately 2.26 million liters (598,000 gallons) of wastewater was received from various generators by tanker trucks.

The volume of wastewater transferred to the Effluent Treatment Facility for treatment and disposal during 2003 was 98 million liters (26 million gallons).

The volume of wastewater being stored in the Liquid Effluent Retention Facility at the end of 2003 was 46.56 million liters (12.3 million gallons). This included 2.89 million liters (763,000 gallons) of RCRA-regulated wastewater and 43.67 million liters (11.54 million gallons) of CERCLA-regulated wastewater.

2.3.11.3 Effluent Treatment Facility

S. S. Lowe

Liquid effluent is treated in the Effluent Treatment Facility (200-East Area) to remove toxic metals, radionuclides, and ammonia, and destroy organic compounds. The treated effluent is stored in tanks, sampled and analyzed, and discharged to the State-Approved Land Disposal Site (also known as the 616-A crib). The treatment process constitutes best available technology and includes pH adjustment, filtration, ultraviolet light/peroxide destruction of organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. The facility began operating in December 1995. Treatment capacity of the facility is a maximum of 570 liters (150 gallons) per minute.

The volume of wastewater treated and disposed of in 2003 was approximately 98 million liters (26 million gallons), which included approximately 11 million liters (3 million gallons) of RCRA-regulated wastewater (primarily 242-A evaporator process condensate), and 87 million liters (23 million gallons) of CERCLA-regulated wastewater (primarily groundwater from the 200-UP-1 Operable Unit in the 200-West Area).

2.3.11.4 200 Area Treated Effluent Disposal Facility

S. S. Lowe

The 200 Area Treated Effluent Disposal Facility is a collection and disposal system for non-RCRA-permitted waste streams. The individual waste streams must be treated or otherwise comply with best available technology/all known available and reasonable treatment in accordance with WAC 173-240, which is the responsibility of the generating facilities. The 200 Area Treated Effluent Disposal Facility consists of approximately 18 kilometers (11 miles) of buried pipeline connecting three pumping stations, one disposal sample station (the 6653 Building) and two 2-hectare (5-acre) disposal ponds located east of the 200-East Area. The facility began operating in April 1995 and has a capacity of 12,900 liters (3,400 gallons) per minute. The volume of unregulated effluent disposed of in 2003 was 1,269 million liters (335.4 million gallons). The major source of this effluent was uncontaminated cooling water and steam condensate from the 242-A evaporator, with a variety of other uncontaminated waste streams received from other Hanford facilities.

2.3.11.5 300 Area Treated Effluent Disposal Facility

S. S. Lowe

Industrial wastewater generated throughout the Hanford Site is collected and treated in the 300 Area Treated Effluent Disposal Facility. Laboratories, research facilities, office buildings, and former fuel fabrication facilities in the 300 Area are the primary sources of the wastewater. The wastewater consists of once-through cooling water, steam condensate, and other industrial wastewater. The facility began operation in December 1994. Wastewater that is potentially contaminated is collected in the nearby 307 retention basins where it is monitored and released to the 300 Area process sewer for treatment by the 300 Area Treated Effluent Disposal Facility.

This facility is designed to continuously receive wastewater, with a storage capacity of up to 5 days at the design flow rate of 1,100 liters (300 gallons) per minute. The treatment process includes iron co-precipitation to remove heavy metals, ion exchange to remove mercury, and ultraviolet light/hydrogen peroxide oxidation to destroy organics and cyanide. Sludge from the iron co-precipitation process is dewatered and used for backfill in the low-level waste burial grounds. The treated liquid effluent is monitored and discharged through an outfall to the Columbia River under a National Pollutant Discharge Elimination System permit (No. WA 002591-7 [Section 2.2.8]). The volume of industrial wastewater treated and disposed of during 2003 was 145.5 million liters (38.43 million gallons). The volume of wastewater monitored and released to the 300 Area Treated Effluent Disposal Facility for treatment and disposal from the 307 Retention Basins in 2003 was 6.21 million liters (1.64 million gallons).

2.3.12 Environmental Restoration Project

The DOE selected an environmental restoration contractor in 1994 to perform environmental restoration projects at the Hanford Site. The Environmental Restoration Project includes characterization and remediation of contaminated soil, decontamination and decommissioning of facilities, surveillance and maintenance of inactive waste sites, and the transition of facilities into the surveillance and maintenance program.

2.3.12.1 Environmental Restoration Disposal Facility

M. A. Casbon

The Environmental Restoration Disposal Facility is located near the 200-West Area. The facility began operations during July 1996 and serves as the central disposal site for contaminated waste removed during CERCLA cleanup operations on the Hanford Site. To provide a barrier to contaminant migration from the disposal facility, the facility was constructed to RCRA Subtitle C Minimum Technology Requirements, which included a double liner on the bottom of the disposal cell and a leachate collection system to remove fluids that accumulate in the cell. Remediation waste disposed in the facility includes soil, rubble, or other solid waste materials contaminated with hazardous, low-level radioactive, or mixed (combined hazardous and radioactive) waste.

During 2000, waste was first placed into the first of two new cells (cells 3 and 4) that were constructed in 1999. Later in 2000, an interim cover was placed over portions of cells 1 and 2 that had been filled to their final configuration. Waste placement in the lower levels of cells 3 and 4 was completed during 2002 and is proceeding in the upper levels of those two cells. The construction of two new cells (cells 5 and 6) was initiated in 2003 with completion expected in 2004. As of the end of 2003, the facility had received over 4.2 million tonnes (4.6 million tons) of contaminated soil and other waste.

2.3.12.2 Waste Site Remediation

J. G. April, J. W. Donnelly, A. K. Smet, R. D. Belden, J. A. Lerch, J. D. Fancher, and M. A. Buckmaster

Full-scale remediation of waste sites began in the 100 Areas in 1996. Remediation activities in 2003 were performed in the 100-B/C, 100-K, 100-N, and 100-F Areas. Additionally, backfill activities were completed in the 100-F Area and began in the 100-B/C Area. Various records of decision issued by the DOE, EPA, and Washington State Department of Ecology authorize the remediation activities. At the 100-N Area, remediation of the treatment, storage, and disposal units is also performed in accordance with the Hanford Facility RCRA Permit. Figure 1.0.1 shows the former reactor areas (100 Areas) along the Columbia River.

A total of 506,275 tonnes (558,073 tons) of contaminated soil was removed and disposed of at the Environmental Restoration Disposal Facility from the 100 Areas remediation activities in 2003. The breakdown of volumes for each area is stated below:

- 108,808 tonnes (119,940 tons) from the 100-B/C Area
- 2,954 tonnes (3,257 tons) from the 100-K Area
- 323,535 tonnes (356,636 tons) from the 100-N Area
- 70,978 tonnes (78,240 tons) from the 100-F Area.

Since cleanup activities began in 1996, the primary focus has been on liquid effluent waste sites. After nearly 7 years of work, the number of liquid effluent waste sites requiring remediation is significantly reduced. Cleanup activities are now phasing into remediation of burial ground waste sites, while still maintaining progress on completing the liquid effluent waste sites. The volume of contaminated soil in burial grounds is less than in liquid effluent waste sites. However, the burial grounds may contain unknown materials, and additional time may be necessary to characterize and properly dispose of the waste.

Remedial actions were completed at the 618-4 and 618-5 burial grounds in 2003. Between 1998 and 2003, more than 46,200 tonnes (51,000 tons) of contaminated soil and debris were transported from the 618-4 burial ground to the Environmental Restoration Disposal Facility. More than 45,800 tonnes (50,500 tons) of contaminated soil and debris were transported to the Environmental Restoration Disposal Facility from excavation and loadout operations at the 618-5 burial ground, which began in 2002.

Remediation work at the 300-FF-1 Operable Unit began in the 300 Area in 1997 (Figure 1.0.1), and was completed in 2003. Backfill and re-grading operations at the remediated 300 Area waste sites began in November 2003 and were completed in February 2004. Remediation activities in the 300-FF-1 Operable Unit are authorized by the 300-FF-1 record of decision (ROD 1996), which was approved by the DOE and the EPA. No additional remediation is necessary in the 300-FF-1 Operable Unit. The 300-FF-2 record of decision (ROD 2001) authorizes remediation activities for the 300-FF-2 Operable Unit. Remediation for the 300-FF-2 Operable Unit is scheduled to continue in 2004.

In 2003, more than 52,590 tonnes (57,970 tons) of contaminated soil were removed and disposed of at the Environmental Restoration Disposal Facility from the 300 Area remediation activities. The breakdown of quantities for each operable unit is stated below:

- More than 15,040 tonnes (16,579 tons) for the 300-FF-1 Operable Unit
- More than 37,550 tonnes (41,391 tons) for the 300-FF-2 Operable Unit.

2.3.12.3 Facility Decommissioning Project

J. W. Golden

Decontamination and decommissioning activities continued during 2003 in the 100-D/DR, 100-H, and 100-F Areas. These activities are conducted to support the interim safe storage of the four reactor buildings (D, DR, F, and H) for up to 75 years. Interim safe storage minimizes potential risks to the environment, workers, and public and reduces surveillance and maintenance costs. These activities are conducted as non-time-critical removal actions under CERCLA.

During 2003, interim safe storage of the F Reactor was completed. Demolition of the 117-DR Exhaust Filter Building and associated tunnels was also completed. This facility was part of the Large Sodium Fire Facility, a permitted treatment, storage, and disposal facility undergoing RCRA closure. The D Reactor Safe Storage Enclosure design was completed, and the subcontractor initiated construction activities. The demolition and closure of the 1720-HA Arsenal in the 100-H Area was completed, and demolition of the H Reactor basin was initiated and is nearing completion. Demolition and closure of the 118-C-4 Horizontal Control Rod Storage Cave in the 100-B/C Area was also completed in 2003.

Decontamination and decommissioning activities were also initiated in the 100-N Area with the demolition of the 1304-N Emergency Dump Tank, which is in progress.

2.3.12.4 Surveillance/Maintenance and Transition Project

J. W. Golden

The activities of the Surveillance/Maintenance and Transition Project maintain and watch over inactive facilities and waste sites prior to and following final disposition. Currently, the project performs surveillance and maintenance of the N, B, C, KE, and KW Reactors (excluding the basins) and the 308 Building in the 300 Area.

2.3.12.5 Revegetation and Mitigation Planning

A. L. Johnson and H. Newsome

To compensate for damage to the environment by the original construction of cells 1 and 2 at the Environmental Restoration Disposal Facility, a compensation plan was approved by the DOE Richland Operations Office and U.S. Fish and Wildlife Service to revegetate portions of the Fitzner/Eberhardt Arid Lands Ecology Reserve.

The Environmental Restoration Disposal Facility mitigation project included three separate planting elements: a native grass seeding, shrub seedling planting, and native grass plug planting. The native grass seeding and a majority of the shrub seedling planting was completed in December

2002 and monitored for initial survival in the spring of 2003 with results documented in the annual environmental restoration contractor monitoring report (e.g., BHI-01694). The final Environmental Restoration Disposal Facility mitigation planting element, planting native grass plugs and remaining shrub seedlings, was completed in November 2003. Approximately 21,000 65.6-cubic-centimeter (4-cubic-inch) grass plugs were planted on the Fitzner/Eberhardt Arid Lands Ecology Reserve. The grass plugs included 10,000 thickspike wheatgrass (*Agropyron dasystachyum*), 3,500 Indian ricegrass (*Oryzopsis hymenoides*), and 7,500 needle-and-thread grass (*Stipa comata*). Approximately 20,000 164-cubic-centimeter (10-cubic-inch) shrub seedlings were planted, which included 14,000 bitterbrush (*Purshia tridentata*), 1,920 sagebrush (*Artemesia tridentata*), and 4,000 rabbitbrush (*Chrysothamnus sp.*).

All Environmental Restoration Disposal Facility mitigation planting efforts will be monitored for survival. The 120-N-1 and 120-N-2 sites were remediated by Bechtel Hanford, Inc., the environmental restoration contractor, in accordance with the Hanford RCRA documentation (closure plan) (DOE/RL-96-39). Once remediation was completed, the sites were backfilled to grade using material from a nearby borrow pit. In preparation for revegetation, the top 15.24 centimeters (6 inches) of the area to be seeded was ripped with a spring tooth drawn implement. In mid-January, the 1.6-hectare (3.95-acre) area was broadcast seeded with 11.2 kilograms per hectare (10 pounds per acre) Sandberg's bluegrass (*Poa Sandbergii*), 2.8 kilograms per hectare (2.5 pounds per acre) Indian ricegrass, 2.8 kilograms per hectare (2.5 pounds per acre) thickspike wheatgrass, 2.8 kilograms per hectare (2.5 pounds per acre) bluebunch wheatgrass, 1.12 kilograms per hectare (1 pound per acre) needle-and-thread grass, 0.56 kilograms per hectare (0.5 pound per acre) sagebrush, 0.14 kilograms per hectare (0.125 pound per acre) yarrow, and small amounts of cushion fleabane, false yarrow, phlox, wall flower, and rabbitbrush. One half of the 1.6-hectare (3.95-acre) area received 112 kilograms per hectare (100 pounds per acre) of fertilizer co-applied during seeding, while the remaining area was treated with Biosol, an organic, slow release fertilizer, at a rate of approximately 1,120 kilograms per hectare (1,000 pounds per acre).

Upon completion of seeding and fertilizer application, the entire seeded area was irrigated with 0.62 centimeter (0.24 inch) of water. One-half of the fertilized area and one-half of the Biosol-treated area were each hydromulched with the industry standard mulch fiber. The remaining fertilizer- and Biosol-treated areas were mulched with grass straw at approximately 4.5 tonnes (4.96 tons) per hectare and crimped into the soil surface. Initial vegetation surveys were conducted on May 13, 2003; 21 species were recorded on the entire site including all 12 of the seeded species. Total cover was greatest on the fertilizer/straw mulch area with 18 species and 68% cover, followed by the Biosol/straw mulch area with 13 species and 44.1% cover. The fertilizer/hydromulch area yielded 13 species and 29.1% cover followed by the Biosol/hydromulch area with 12 species and 18.5% cover. This revegetation project will be incorporated into the environmental restoration contractor annual revegetation monitoring project report (e.g., BHI-01694).

In anticipation of future environmental restoration projects, a possible need for additional borrow material, and the need to protect ecological resources, an environmental assessment (*Environmental Assessment for Reactivation and Use of Three Former Borrow Sites in the 100-F, 100-H, and 100-N Areas* [DOE/EA-1454]) was completed in March 2003. These sites were not included in the 2001 *Draft Industrial Mineral Resources Management Plan* (DOE-RL-2000-61). As described in the environmental assessment, the borrow pit at the 100-F Area was developed in the summer of 2003 to supply material for the restoration of a 100-F Area liquid waste site. Prior to the excavation of fill materials, the top 30.5 centimeters (12 inches) of topsoil was salvaged and stockpiled for redistribution across the borrow pit upon completion of project activities. Following borrow pit re-contouring and topsoil redistribution, the entire 61.75-hectare (152.59-acre) pit area was broadcast seeded with 11.2 kilograms per hectare (10 pounds per acre) Sandberg's bluegrass; 2.8 kilograms per hectare (2.5 pounds per acre) Indian ricegrass, 2.8 kilograms per hectare (2.5 pounds per acre) thickspike wheatgrass, and 2.8 kilograms per hectare (2.5 pounds per acre) bluebunch wheatgrass and fertilized with 112 kilograms per hectare (100 pounds per acre) of fertilizer co-applied during seeding. The entire seeded area was irrigated with 0.62 centimeter (0.244 inch) of water per hectare and mulched with approximately 4.5 tonnes (4.96 tons) per hectare that was crimped into the soil surface. Revegetation efforts at the borrow pit will be monitored for success with results documented in the environmental restoration contractor revegetation monitoring report (BHI-01694).

2.3.13 Groundwater Remediation Project

B. H. Ford

The DOE established the Groundwater/Vadose Zone Integration Project (Integration Project) in 1997. On July 1, 2002, the project was transferred from the environmental restoration contractor (Bechtel Hanford, Inc.) to Fluor Hanford, Inc. and designated the Groundwater Remediation Project. The purpose of the Groundwater Remediation Project is to coordinate all projects at the Hanford Site involved in characterization, monitoring, and remediation of groundwater and vadose zone contamination, with the overall objective of protecting the Columbia River.

The Groundwater Remediation Project team includes staff from Fluor Hanford Inc., CH2M HILL Hanford Group, Inc., and Pacific Northwest National Laboratory, as well as support from other national laboratories and universities. The Hanford Groundwater Performance Assessment Project is under the umbrella of the Groundwater Remediation Project.

During 2003, the Groundwater Remediation Project team compiled an array of accomplishments that span its key focus areas – groundwater remediation, soil zone remediation, waste site investigations, assessment of Hanford Site impacts, science and technology, and integration management. The efforts within these focus areas directly support the DOE's plan for the Hanford Site.

2.3.13.1 Groundwater Remediation

G. G. Kelty and D. B. Erb

The overall objectives of groundwater remediation at sites adjacent to the Hanford Reach are to protect aquatic receptors in the river bottom substrate from contaminants in the groundwater entering the Columbia River, reduce levels of contamination in the areas of highest concentration, prevent further movement of contamination, and protect human health and the environment. Summary descriptions of groundwater remediation activities are discussed in the following paragraphs.

Chromium. Groundwater contaminated with chromium underlies portions of the 100-D, 100-H, and 100-K Areas (the 100-HR-3 and 100-KR-4 Operable Units). Chromium is of concern because of its potential to affect the Columbia River ecosystem. Low levels of chromium are toxic to aquatic organisms, particularly those that use the riverbed sediment as habitat (DOE/RL-94-102; DOE/RL-94-113). The relevant standard for protection of freshwater aquatic life is 10 µg/L (0.01 part per million) of chromium (WAC 173-201A). Chromium concentrations exceeding 600 µg/L (0.6 part per million) have been measured in the porewater of riverbed sediment adjacent to the 100-D Area (BHI-00778). Background chromium concentrations are usually less than 1 µg/L (1 part per billion) in the river.

During 1994, a pilot-scale groundwater extraction system was installed in the 100-D Area to test chromium removal from groundwater using ion exchange technology. Following the issuance of a record of decision in 1996 (EPA 1996), full scale pump-and-treat systems were constructed in the 100-D, 100-H, and 100-K Areas. The objective of these systems is to remove hexavalent chromium contamination from the groundwater and, thus, prevent or reduce the movement of chromium to the Columbia River.

During 2003, the total amount of groundwater treated by pump-and-treat systems in the 100-D and 100-H Areas was 416.6 million liters (110 million gallons), with the removal of approximately 43 kilograms (94.7 pounds) of hexavalent chromium. Since 1997, more than 1.95 billion liters (514.8 million gallons) of groundwater have been treated, with 204.3 kilograms (450.4 pounds) of chromium removed. Treated groundwater is re-injected into the aquifer upgradient from the 100-H Area extraction wells. Groundwater from both the 100-D and 100-H Areas is treated in the 100-H Area using separate treatment systems.

During 2003, the 100-KR-4 pump-and-treat system treated 517.6 million liters (136.7 million gallons) of groundwater and removed 36.7 kilograms (80.9 pounds) of chromium. Total chromium removed since operations began in 1997 is 221.9 kilograms (489.2 pounds) through treatment of

2.20 billion liters (581.1 million gallons) of water. Treated groundwater is re-injected into the aquifer upgradient from the 100-KR-4 extraction wells.

In addition to pump-and-treat remediation, use of in situ redox manipulation technology continued in the southwest portion of the 100-D Area to treat hexavalent chromium contamination in groundwater. This technology immobilizes hexavalent chromium by reducing the soluble, more toxic, chromate ion to highly insoluble, less toxic, chromic hydroxide or a chromic-ferric hydroxide complex. This is accomplished by injecting a chemical-reducing agent into closely spaced wells to form a permeable reactive barrier. Following reduction, the reagent and reaction products are pumped out of the wells. Chromium is immobilized as groundwater naturally flows through the barrier. This groundwater cleanup technique was tested during 1997 through 1999 in five injection wells and then expanded to include additional injection wells in 2000, 2001, and 2002. During 2003, the treatment zone was expanded by injecting the chemical reducing agent into five wells.

Chromium concentrations in wells along the barrier axis are generally less than 20 µg/L (0.02 part per million), except in 14 barrier wells where concentrations are as high as 980 µg/L (0.98 part per million). Compliance wells to the west of the barrier still have high concentrations ranging from 11 to 1,200 µg/L (0.011 to 1.2 parts per million).

Barrier construction continued during 2003. By the end of 2003, five additional wells had been treated, increasing the barrier length to 680 meters (2,230 feet). The barrier is approximately 15 meters (48 feet) wide.

Strontium-90. The 100-NR-2 (N Springs) pump-and-treat system began operating in September 1995 north of N Reactor and was designed to reduce the flux of strontium-90 to the Columbia River. Groundwater is pumped into a treatment system to remove the strontium-90 contamination, and treated water is re-injected upgradient into the aquifer. The system was upgraded during 1996 and has continued to operate through 2003. Approximately 114.1 million liters (30.1 million gallons) of water were processed during 2003. During that period, 0.20 curies (7.4 gigabecquerels) of strontium-90 were removed from the groundwater. More than 900.8 million liters (237.9 million gallons) of groundwater have been processed since the system began operation, removing 1.5 curies (55.5 gigabecquerels) of strontium-90.

Carbon Tetrachloride. The carbon tetrachloride plume in the 200-West Area (originating in the 200-ZP-1 Operable Unit) covers over 11 square kilometers (4.2 square miles). The 200-ZP-1 pump-and-treat system operated as a pilot-scale treatability test from 1994 to 1996, with full-scale operation beginning in 1996. During 2003, 255 million liters (67.3 million gallons) of groundwater were treated, removing 799 kilograms (1,761 pounds) of carbon tetrachloride. A total of 2.21 billion liters (584 million gallons) of groundwater have been processed since startup, removing 7,848 kilograms (17,302 pounds) of carbon tetrachloride.

Uranium, Technetium-99, Carbon Tetrachloride, and Nitrate. Treatment of the groundwater plume underlying the 200-UP-1 Operable Unit in the 200-West Area continued throughout 2003. The contaminant plume contains uranium, technetium-99, carbon tetrachloride, and nitrate. A pump-and-treat system has operated since 1994 to contain the high concentration area of the uranium and technetium-99 plume. During early operations, groundwater was treated using ion-exchange resin to remove the uranium and technetium-99, and granular activated carbon was used to remove carbon tetrachloride. Since 1997, contaminated groundwater has been transferred by pipeline to basin 43 at the 200 Area Effluent Treatment Facility. Sophisticated treatment technology at the Effluent Treatment Facility removes all four contaminants. Treated groundwater is then discharged north of the 200-West Area at the State-Approved Land Disposal Site.

The pump-and-treat system operated continually during 2003. Three extraction wells were used during the year. The primary extraction well, 299-W19-39, ran continuously and was supplemented with smaller amounts of water from two upgradient wells, 299-W19-36 and 299-W19-43, in the high concentration part of the plume. Combined, the three extraction wells pumped 93.9 million liters (24.8 million gallons) of groundwater. The Effluent Treatment Facility treated 86.4 million liters (22.8 million gallons) of groundwater. Treatment of groundwater removed 10.1 grams (0.0222 pound) of technetium-99, 18.2 kilograms (40.1 pounds) of uranium, 2.7 kilograms (6.0 pounds) of carbon tetrachloride, and 3,191 kilograms (7,035 pounds) of nitrate. To date, the system has treated 714 million liters (189 million gallons) of water, removing 103.3 grams (0.2316 pound) of technetium and 181 kilograms (399 pounds) of uranium. The pump-and-treat operation made progress toward reducing technetium-99 to below required cleanup concentration levels as concentrations in all monitoring and extraction wells were below the remedial action objective of 9,000 pCi/L. Similar progress was made with uranium (DOE/RL-2003-58) as concentrations at all but one well, 299-W19-43, were below the remedial action objective of 480 µg/L. For well 299-W19-43, the reported concentration of uranium was exactly at the remedial action objective level.

During 2003, technetium-99 concentrations peaked at 188,000 pCi/L (6,956 Bq/L) at S-SX Tank Farm in well 299-W23-19. Concentrations declined to an average of 43,000 pCi/L (1,591 Bq/L) by the end of 2003. After completing a field evaluation and facility modification, it was decided that this well should be extensively purged prior to sampling. Purging (greater than 3,785 liters [1,000 gallons]) during quarterly sampling events was implemented starting in March 2003 (RPP-10757). The purgewater is disposed of at the Effluent Treatment Facility in the 200-East Area. Further actions will depend on how concentrations change in the future.

2.3.13.2 Soil Zone Remediation

V. J. Rohay

Soil-vapor extraction systems designed to remove carbon tetrachloride vapor from the vadose zone beneath the 200-West Area began operating during 1992 and continued through 2003. Soil-vapor extraction has been conducted in the vicinity of three historical carbon tetrachloride disposal sites: the 216-Z-1A tile field, the 216-Z-9 trench, and the 216-Z-18 crib. Extracted soil vapor is pumped through granular activated carbon, which absorbs carbon tetrachloride. The granular activated carbon is then shipped offsite for treatment. Three soil-vapor extraction systems have operated at three different flow rates: 14.2 cubic meters (500 cubic feet) per minute, 28.3 cubic meters (1,000 cubic feet) per minute, and 42.5 cubic meters (1,500 cubic feet) per minute. However, only the 14.2 cubic meters (500 cubic feet) per minute system operated during 2003; the other two systems are no longer operational. Passive soil-vapor extraction systems, which use atmospheric pressure fluctuations to pump carbon tetrachloride vapor from the vadose zone, were installed at wells near the 216-Z-1A tile field and 216-Z-18 crib during 1999. These passive systems operated throughout 2003. In 2003, 294 kilograms (658 pounds) of carbon tetrachloride were removed. Since operations began, soil-vapor extraction has removed 78,092 kilograms (172,163 pounds) of carbon tetrachloride from the vadose zone.

2.3.13.3 Waste Site Investigations – Operable Units

L. C. Hulstrom

Remedial investigation/feasibility study activities continued during 2003 at soil waste sites in the 200 Areas. Work was performed within the characterization and regulatory framework defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan* (DOE/RL-98-28). Work was performed at several operable units, which were at various stages of the CERCLA remedial investigation/feasibility study process. The following summary provides descriptions of activities that were performed during 2003.

200-CW-1 Operable Unit. The 200-CW-1 Operable Unit consists of former ponds and ditches located within the 200-East Area and north and east of the 200-East Area. These sites received mostly cooling water from facilities such as the Plutonium-Uranium Extraction and B Plants. Preparation of a feasibility study for the operable unit continued in 2003. The feasibility study refines remedial action objectives and remedial technologies originally identified in DOE/RL-98-28 and develops and evaluates remedial alternatives for the representative sites in the 200-CW-1 Operable Unit. The results of the remedial alternative evaluations of the representative sites are applied to the analogous sites in the operable unit as defined in DOE/RL-98-28. The feasibility study includes ecological screening level and baseline risk assessments. In addition to the 200-CW-1 Operable Unit waste sites, the 200-CW-3 Operable Unit and several other 200-North Area waste sites are included in the feasibility study based on negotiations with state and federal regulators on the Central Plateau Tri-Party Agreement milestones. Under Tri-Party Agreement milestone M-015-38A, the feasibility study and proposed plan were submitted to the state and federal regulators on March 31, 2003. Comments from the regulators are being incorporated. In addition, ecological sampling was conducted on two of the 200-CW-1 waste sites in the fall of 2003. Additional ecological sampling is planned for the spring of 2004. The feasibility study will be revised to incorporate the data from these sampling events and to support the public review of the proposed plan, anticipated for early 2005.

200-CS-1 Operable Unit. The 200-CS-1 Operable Unit consists of waste sites that received chemical sewer wastewater from major plant facilities in both the 200-West and 200-East Areas. A remedial investigation/ feasibility study work plan was approved during 2000 that defines planned remedial investigation activities at four representative waste sites: 216-S-10 pond, 216-S-10 ditch, 216-B-63 trench, and 216-A-29 ditch (DOE/RL-99-44). The final remedial investigation activities were performed in 2003 and included test pit characterization work at the 216-B-63 trench, 216-S-10 pond, and 216-S-10 ditch. In addition, three boreholes (one at each waste site) were installed at the 216-A-29 ditch, 216-B-63 trench and 216-S-10 ditch. The borehole at the 216-S-10 ditch was completed as a RCRA groundwater monitoring well. Previous test pit characterization work was completed in 2002 at the 216-A-29 ditch and partially completed at the 216-B-63 trench. The borehole at the 216-S-10 pond was installed during 1999 and completed as a RCRA groundwater monitoring well.

200-CW-2, 200-CW-4, 200-CW-5, and 200-SC-1 Operable Units. This consolidated operable unit grouping consists of waste sites that received cooling water, steam condensate, and chemical sewer waste from facilities in the 200-West Area, including U Plant, powerhouse and laundry facilities, the 242-S evaporator, the Plutonium Finishing Plant and associated facilities, the Reduction-Oxidation Plant, T Plant, the Plutonium-Uranium Extraction Plant, and the Waste Encapsulation and Storage Facility. The 200-CW-5 remedial investigation/feasibility study work plan (DOE/RL-99-66) was approved in 2000 and defined planned remedial investigation activities at one representative waste site (216-Z-11 ditch). This work plan directed field characterization using driven soil probes and geophysical logging to locate the area with the highest levels of transuranic contamination for subsequent borehole sampling. Data from the field work were compiled into a remedial investigation report (DOE/RL-2003-11), which was provided to the regulators for review during May 2003 in fulfillment of Tri-Party Agreement milestone M-015-40B. Comments are being incorporated into this document and an update to the work plan was also initiated. In the fall of 2003, a feasibility study was initiated to evaluate the remedial alternatives that could be applied to the waste sites in these operable units.

200-LW-1 and 200-LW-2 Operable Units. The waste sites in these operable units received two types of waste: liquid waste resulting from 300 Area process laboratory operations that supported radiochemistry metallurgical experiments and liquid waste resulting mainly from laboratory operations in the 200 Areas that supported the major chemical processing facilities and equipment decontamination at T Plant. A work plan (DOE/RL-2001-66) was approved in 2002 that requires remedial investigation activities at four representative waste sites (216-T-28 crib, 216-B-58 trench, 216-S-20 crib, and 216-Z-7 crib) and includes borehole drilling, soil sampling, and geophysical logging. During late 2003, two 30.4-meter- (100-foot-) deep boreholes were drilled in the 216-B-58 trench in anticipation of the transfer of four 200-LW-1 waste sites in the BC cribs and trenches area into the 200-TW-1 Operable Unit. Remaining field activities will be conducted in 2004.

200-MW-1 Operable Unit. The waste sites in this operable unit consist mainly of cribs, French drains, and trenches that received moderate- to low-volume equipment decontamination waste and ventilation system waste, plus small-volume waste streams commonly disposed to French drains. A work plan (DOE/RL-2001-65) was approved during 2002. The work plan requires remedial investigation activities at five representative waste sites (216-A-4 crib, 216-T-33 crib, 216-T-13 trench, 216-U-3 French drain, and 200-E-4 French drain). The investigative work includes installing vadose zone boreholes and test pits to collect soil samples and geophysical logging. These activities are scheduled to be conducted in 2004.

200-PW-2 and 200-PW-4 Operable Units. Waste sites in the 200-PW-2 Operable Unit received uranium-rich condensate/process waste, primarily from waste streams generated at U Plant, the Reduction-Oxidation Plant, and the Plutonium-Uranium Extraction Plant, as well as the B Plant and semi-works facilities. Waste sites in the 200-PW-4 Operable Unit received mostly process drainage, process distillate discharge, and miscellaneous condensates from the same facilities, including condensates from S and A Tank Farms and the 242-A evaporator. The original draft work plan (DOE/RL-2000-60) for 200-PW-2 was prepared and submitted for regulator review in December 2000. The revised work plan, which received regulator approval in February 2003 to proceed with field work, proposed remedial investigation activities at six representative waste sites (216-A-19 trench, 216-B-12 crib, 216-A-10 crib, 216-A-36B crib, 216-A-37-1 crib, and 207-A south retention basin). Field work was completed in October 2003 and included installing vadose zone boreholes to collect soil samples and conduct geophysical logging. In addition, five drive casings were installed and geophysically logged at the 216-A-10 crib to determine the optimum location for the characterization borehole that was installed. Evaluation of the data was initiated in conjunction with preparation of the remedial investigation report for these operable units. This report is scheduled to be provided to the regulators in June 2004.

200-TW-1, 200-TW-2, and 200-PW-5 Operable Units. The 200-TW-1 Operable Unit consists of waste sites, mostly cribs and trenches, which received waste associated with uranium recovery activities at U Plant. The 200-TW-2 Operable Unit consists of waste sites, mostly cribs and trenches, which received waste from the decontamination processes at B Plant and T Plant. The 200-PW-5 Operable Unit consists of cribs, French drains, and unplanned releases that received similar types of wastes and quantities of effluents as the 200-TW-2 Operable Unit. The work plan (DOE/RL-2000-38) prescribed remedial investigation at three representative waste sites (216-T-26 crib in the 200-TW-1 Operable Unit, and the 216-B-7A crib and 216-B-38 trench in the 200-TW-2 Operable Unit). The field efforts for these operable units were completed in 2001 and consisted of installing three vadose zone boreholes (one each at the 216-T-26 crib, the 216-B-38 trench, and the 216-B-7A crib), collecting soil samples, and geophysical logging. Data from the laboratory analyses were compiled into a remedial investigation report (DOE/RL-2002-42), which was submitted to state and federal regulators in 2003 under Tri-Party Agreement milestone M-015-41B. The remedial investigation report includes a human health risk assessment and a screening of ecological impacts. In late 2003, following preparation and approval of a sampling and analysis plan, a borehole was drilled in the 216-B-26 trench. Data will be incorporated into a feasibility study and proposed plan that were initiated in 2003 to evaluate remedial alternatives to address the contamination at the waste sites in the combined 200-TW-1, 200-TW-2, and 200-PW-5 Operable Units.

200-PW-1, 200-PW-3, and 200-PW-6 Operable Units. The 200-PW-1 Operable Unit contains waste sites that received significant quantities of carbon tetrachloride and plutonium, as well as other contaminants associated with process waste from the Plutonium Finishing Plant. This operable unit also includes the carbon tetrachloride plume in the vadose zone that has migrated beyond the boundaries of the waste sites. A remedial investigation/feasibility study work plan for this operable unit was submitted for review during 2001 (DOE/RL-2001-01). The work plan includes a strategy to reach final decisions for remediation of carbon tetrachloride in the 200-West Area. The work plan is being revised to include the 200-PW-3 and 200-PW-6 Operable Units. The 200-PW-3 Operable Unit waste sites received organic-rich process waste from separation facilities such as S Plant (reduction-oxidation or redox process), A Plant (plutonium-uranium extraction or PUREX process), U Plant (uranium recovery process), and the C Plant (201-C Building or hot semi-works process). The 200-PW-6 Operable Unit waste sites received plutonium-rich process waste from the Plutonium Finishing Plant. The revised work plan is expected to be approved during 2004.

The remedial investigation at the 200-PW-1 Operable Unit is expected to focus on one representative waste site, the 216-Z-9 trench, and on other potential sources of carbon tetrachloride contamination. The first step in the carbon tetrachloride vadose zone investigation began during 2002 and was completed in 2003 (CP-13514). Soil-vapor sampling and analysis were used to explore the shallow vadose zone in the vicinity of the Plutonium

Finishing Plant. The sampling was conducted at engineered structures that had the potential to release carbon tetrachloride to the vadose zone. The engineered structures included liquid waste discharge sites, pipelines that conveyed liquid waste to those discharge sites, and solid waste burial ground trenches. The second step in the carbon tetrachloride vadose zone investigation will extend deeper in the vadose zone and to locations beyond the study area investigated during the first step. The representative waste site investigation includes soil sampling, soil vapor sampling, and geophysical logging during drilling of a slant borehole beneath the 216-Z-9 trench. The representative waste site investigation and initiation of the second step in the carbon tetrachloride vadose zone investigation are scheduled for 2004.

The remedial investigation at the 200-PW-3 Operable Unit is expected to focus on one representative waste site, the 216-A-8 crib. The representative waste site investigation, which includes soil sampling and geophysical logging, is scheduled for 2004.

200-UR-1 Waste Group Operable Unit. The 200-UR-1 Waste Group Operable Unit includes unplanned releases that generally consisted of small volume spills to the ground surface or subsurface; or windblown radioactive particulates, plant materials, and/or animal feces. Many of the unplanned release sites in the 200 Areas resulted from loss of control of radioactive materials during waste transfer or containment in areas with process facilities, roads, railroad lines, or tank farms. A small number of unplanned release sites were associated with burial grounds, trenches, and cribs. Causes for the releases were attributed to administrative failures, equipment failures, and operator error as well as to vegetation and animal intrusion. In the fall of 2003, a work plan and data quality objectives process were initiated. The data quality objectives process grouped the 147 unplanned release sites to allow consistent and streamlined remedial decision making.

200-BP-1 Prototype Barrier. The 200-BP-1 prototype barrier is a surface barrier to reduce the infiltration of water that drives contaminants through the soil to groundwater. Monitoring the performance of the 200-BP-1 prototype barrier continued during 2003. Activities included water balance monitoring, stability surveys, and biotic surveys. A draft report to document the monitoring results was prepared during 2003.

U Plant Closure Area. The U Plant Closure Area project is a prototype for area closures that will focus on addressing high risk sites and associated contiguous areas in a cost-effective and integrated manner. Key components of this strategy include cleanup of waste sites, facilities, and pipelines within a defined geographic area. For this area closure, it is anticipated that a separate record of decision will be needed for the high risk sites and 221-U facility, separate engineering evaluation/cost analyses and action memoranda will be needed for ancillary facilities and pipelines, and a separate record of decision will be needed for the 200-UP-1 Groundwater Operable Unit. These components are being executed separately because they require distinct alternatives and specific responses. A *Focused Feasibility Study for the U Plant Closure Area Waste Sites* (DOE/RL-2003-23) and the *Proposed Plan for the U Plant Closure Area Waste Sites* (DOE/RL-2003-24) was submitted to the EPA and Washington State Department of Ecology on June 27, 2003, which satisfied Tri-Party Agreement milestone M-015-47. The focused feasibility study and proposed plan continue to undergo regulator review and comment resolution. The most recent version of the proposed plan recommends that four high-risk cribs (216-U-1, 216-U-2, 216-U-8, and 216-U-12) be modified with barriers or caps; a remove and dispose alternative be implemented at 14 waste sites (e.g., trenches, unplanned release sites, French drains, one pipeline); institutional controls, monitoring of natural attenuation, and maintenance of existing soil cover be implemented at 8 sites (e.g., cribs, reverse wells, septic systems); and no action be taken at 4 sites (e.g., dump sites and septic tank). The record of decision is expected to be issued in 2004 and remedial action initiated in 2005. A remedial design report/remedial action work plan for these waste sites is expected to be completed in 2004. To support confirmation of the proposed actions and collect needed remedial design data, a *Data Quality Objectives Summary Report for the U Plant Closure Area Waste Sites* (CP-16244) was completed in 2003.

Regulators are currently reviewing a sampling and analysis plan (DOE/RL-2003-51) based on the data quality objectives. The document is expected to be issued in 2004. Characterization activities planned for 2004 include surface geophysical surveys, surface radiation surveys of selected waste sites, and installation of drive casings to facilitate spectral gamma logging at the 216-U-1, 216-U-2, 216-U-8, and 216-U-12 cribs.

BC Cribs and Trenches Area. The BC cribs and trenches area was identified for accelerated closure during 2003. Two trenches were identified for further characterization to facilitate an eventual decision regarding remedial action(s). The 216-B-58 trench, previously selected as a representative site for the 200-LW-1 Operable Unit, was the focus of two boreholes in 2003. The first borehole was located at the point of apparent highest concentration. The second borehole was drilled following the discovery of cobalt-60 at the west end of the trench during geophysical logging of drive casings that were placed to determine the point in the trench having highest contamination. The 216-B-26 trench, in the 200-TW-1 Operable Unit, was also sampled following approval of a sampling and analysis plan (DOE/RL-2003-44).

Specific data from waste sites within the BC cribs and trenches area were deemed essential to adequately characterize waste sites in this area. Efforts were also initiated to transfer four 200-LW-1 Operable Unit waste sites in the BC cribs and trenches area to the 200-TW-1 Operable Unit. This assembly of waste sites will be included in a feasibility study and proposed plan that will be submitted for regulator review at the end of March 2004. At this point, it is uncertain whether a partial record of decision for the BC cribs and trenches area will be sought.

618-10 and 618-11 Burial Grounds. In July 2002, the DOE assigned responsibility for the remedial design, planning, and execution of remedial actions for the 618-10 and 618-11 burial grounds in the 300-FF-2 Operable Unit to the Groundwater Protection Program (now the Groundwater Remediation Project). In June 2003, a remedial design technical workshop was held to gather technical experts from several DOE sites, academia, and industry who have experience in dealing with buried waste containing transuranic elements. The workshop was designed to share lessons learned and identify issues and potential solutions for a wide range of topics that affect the remedial design for these burial grounds. Results of the workshop are documented in WMP-17684.

In parallel with the workshop, a safety analysis was conducted of these burial grounds to systematically identify and analyze the hazards associated with surveillance, characterization, and groundwater monitoring activities. The basis for interim operations (CP-14592) was issued in August 2003. In parallel with this document, an unreviewed safety question program was developed and implemented, preliminary remedial design activities were initiated, and an update to a portion of the *Remedial Design Report/Remedial Action Work Plan for the 300 Area* (DOE/RL-2001-47) was generated. With funding support from DOE Headquarters, a program was also initiated to demonstrate technologies for the in situ delineation and excavation of transuranic waste using innovative technologies. This program is scheduled to continue through fiscal year 2006.

2.3.13.4 Assessment of Hanford Impact

R. W. Bryce and C. T. Kincaid

During 1999, the DOE initiated development of an assessment tool that will enable 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 local cultures and economy. This tool was named the System Assessment Capability. An assessment was completed during 2002 with the System Assessment Capability that demonstrated it is a functional assessment capability. The results of that assessment were presented in *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability* (PNNL-14027).

During 2003, preparations were initiated to support an update to the Hanford Site's composite analysis. A composite analysis was first performed for Hanford in 1998 (PNNL-11800). This analysis assessed the future impact on human health from all radioactive waste sources that will remain at Hanford and was based on model simulations of the movement of contaminants from these sources through the environment. The analysis was required by DOE Order 435.1 as a condition of the disposal authorization for low-level radioactive waste at the Hanford Site. Modifications were made to the capability and to the database supporting the simulations.

The major changes to the capability included the addition of a model to simulate contaminant transport through the air pathway. This was required because the composite analysis is an all pathways analysis, while the System Assessment Capability was initially assembled to examine the vadose zone/groundwater/river pathway. A soil model was also added so that the accumulation of contamination in the soil as a result of air transport of contaminants and irrigation with contaminated groundwater could be simulated. The results from this model will be used to assess uptake by plants and exposure to humans and ecological species.

Improvements to the database supporting the assessment include primarily improvements to the inventory database. Inventory has been estimated for additional waste sites through the use of the Soil Inventory Model developed by the Science and Technology Project (BHI-01496). This model uses information from historic facility operation records along with chemical reaction models to estimate the amount and form of various contaminants in waste streams discharged or disposed to the waste sites at Hanford. Results of field characterization efforts at waste sites are also used to validate the results of the Soil Inventory Model and have led to an improvement in the estimates.

Not only have the estimates of inventory at these waste sites been improved, but the inventory, transport, and impact of additional radionuclides will be considered in the update to the composite analysis. Table 2.3.1 lists the contaminants to be examined in this assessment of the impact of radioactive wastes. Data are being assembled to simulate chromium, carbon tetrachloride, and nitrate contaminant sources in future assessments.

Table 2.3.1. Radioactive Contaminants Evaluated in the Composite Analysis and Hazardous Chemical Contaminants Planned for Future Analyses

Radioactive Contaminants	
Tritium	Europium-152
Carbon-14	Radium-226
Chlorine-36	Protactinium-231
Selenium-79	Uranium-233
Strontium-90	Uranium-234
Technetium-99	Uranium-235
Iodine-129	Neptunium-237
Cesium-137	Uranium-238
Hazardous Chemical Contaminants	
Chromium	Nitrate
Carbon Tetrachloride	

Prior use of aggregated waste sites has been dropped during preparation for the composite analysis. Where groups of similar waste sites were aggregated in past analyses, the current effort is incorporating waste site specific data enabling the simulation of each waste site as an individual source to the vadose zone and groundwater.

Site-wide assessment results were used in several planning efforts at Hanford during 2003. The results were used by Fluor Hanford, Inc. to prioritize work in Hanford's strategy for groundwater protection, remediation, and monitoring (DOE/RL-2002-68). Assessments performed with the System Assessment Capability identified the BC cribs and trenches as one waste site where groundwater protection could be enhanced through acceleration of remedial actions. Characterization in support of the record of decision for the BC cribs and trenches area was initiated in 2004 rather than waiting until 2020 with the expectation that through earlier action the potential release of technetium-99 from the BC cribs and trenches area can be delayed and the concentration in groundwater will be reduced when the release occurs. The capability was also used to support a draft optimization strategy for Central Plateau closure. A site-wide cumulative assessment was also included in the Hanford Solid Waste Environmental Impact Statement (DOE/EIS-0286F).

2.3.13.5 Remediation and Closure Science Project

M. D. Freshley

The Groundwater Remediation Project includes a science and technology effort to provide data, tools, and scientific understanding to fill information gaps to make remediation and site closure decisions. These activities are accomplished under the Remediation and Closure Science Project. The following is a description of 2003 accomplishments.

Soil Inventories. During 2003, the Soil Inventory Model was applied to estimate inventories for more than 300 past-practice soil waste disposal sites. This data will be used for the 2004 Composite Analysis, which will be performed with using the System Assessment Capability computer model. Work is continuing to estimate radionuclide inventories for the remaining waste sites to complete development of the Soil Inventory Model in 2004.

Tank Farm Investigations. The results of laboratory and modeling studies for the B-BX-BY Tank Farm were summarized in Appendix D of the Field Investigation Report (RPP-10098). The laboratory and modeling efforts included contributions from the Remediation and Closure Science Project and the Environmental Management Science Program. Activities were initiated to evaluate transport of uranium and technetium-99 in the T-TX-TY Tank Farm.

Vadose Zone Transport Field Study. Science and Technology Project staff completed the final field experiment, which evaluated reactive transport of non-radioactive strontium in the vadose zone at a clastic dike (a common sedimentary structure in the vadose zone at Hanford) located along Army Loop Road. The results of field experiments are being used to update conceptual and numerical models of water and contaminant transport in the vadose zone incorporating lateral spreading. This information is important for designing and implementing surface barriers over waste sites.

Biological Fate and Transport. During 2003, the Science and Technology team completed laboratory experiments to determine the uptake of strontium-90 by aquatic species. The goal of these experiments was to determine the rate at which radionuclide uptake occurred and the total uptake amount for determining exposures. The results are being incorporated into ecological risk assessment modules of the System Assessment Capability.

2.3.13.6 Integration Management: Strategic Planning, Public Involvement, and Databases

T. W. Fogwell and K. L. Nickola

During 2003, the Groundwater Protection Program's name was changed to the Groundwater Remediation Project to more closely align project work scope with similar site-wide DOE project work scopes and align the project with "end state" goals and remedial actions. Throughout the year, Groundwater Remediation Project personnel continued to work closely with the DOE and Hanford regulators to characterize, protect, remediate, and monitor Hanford Site groundwater. Project staff continued to coordinate and perform scientific research and development to support decision-making activities at Hanford and manage Hanford's modeling and assessment capabilities aimed at cleaning up groundwater.

Strategic Planning. The Groundwater Remediation Project team worked throughout 2003 to complete work found in the project's master plan of action, *Hanford's Groundwater Plan: Accelerated Cleanup and Protection* (DOE/RL-2002-68). Developed in 2002, the plan describes how and when accelerated cleanup work will be accomplished. Project personnel also worked to revise the *Optimization Strategy for Central Plateau Closure* (WMP-18061).

Public Involvement. During 2003, open meetings, held the first Monday of every month, gave the public, Tribal Nations, regulators, DOE, and other stakeholders an opportunity to discuss and resolve issues and identify upcoming events. Project staff also provided regular information to the Hanford Advisory Board and its subcommittees and held several information sessions and workshops concerning specific program events and activities. A new Internet website with information about the project's missions, a calendar of upcoming events, and links to a variety of valuable resources was launched in 2003 at http://www.hanford.gov/cp/gpp/. The Groundwater Remediation Project team also produced a 24-page, full-color 2002 progress report and a 4-page, full-color brochure, available in hard copy form or electronically on the Internet website under the Program Library link.

Databases. The Groundwater Remediation Project manages several Hanford Site environmental databases, available on its Internet and/or Intranet websites. These databases, collectively referred to as the Virtual Library, provide a web-based resource of Hanford environmental data to Hanford Site staff. Through the use of stand-alone modules, users can retrieve, graph, and generate reports with data contained in the electronic library. During 2003, several additions were made to the Virtual Library, including user-requested enhancements to the Environmental Monitoring module. The Environmental Monitoring module contains data for groundwater, soil, soil gas, air, surface water, and miscellaneous material samples captured in the Hanford Environmental Information System

(HEIS 1994) database. Over 50 new features were added, at user request. Data from the Hydrodat database maintained by Pacific Northwest National Laboratory were also added to the Environmental Monitoring module, giving scientists access to Hanford Site water-level data from groundwater monitoring wells. "Orphaned" modules housed in the Virtual Library are databases that are no longer maintained by Hanford Site contractors. They contain useful information that would be lost unless given a home. The "orphaned" database added during 2003 contained particle size and distribution data for Hanford Site soil.

In addition to the Virtual Library, the Groundwater Remediation Project manages the Hanford Environmental Information System, Hanford Well Information System, Hanford Geographic Information System, and Waste Information Data System databases. During 2003, the Hanford Geographic Information System was expanded to include data associated with more than 131 land survey jobs, and Waste Information Data System software was updated to include use of a map portal. The Groundwater Remediation Project also documented closure of 14 waste sites between July 2002 and June 2003 through the Waste Information Data System. Other databases supporting specific activities within the Groundwater Remediation Project were maintained during 2003, including pump-and-treat project-specific databases and the in situ redox manipulation project-specific database.

2.3.14 Hanford Tank Waste Science and Technology

J. P. Duncan

In 1994, the DOE's Office of Environmental Management created the Tanks Focus Area designed to integrate radioactive tank waste remediation efforts across the DOE complex. During September 2002, responsibility for the Tank Focus Area was transferred to the DOE Office of the Associate Manager for Science and Technology. Following this transition, CH2M HILL Hanford Group, Inc. and Pacific Northwest National Laboratory signed a memorandum of agreement (Memorandum of Understanding 2002) on science and technology integration in support of Hanford tank cleanup and closure. This partnership's 2003 contributions are discussed in the following sections.

2.3.14.1 Safe Tank Waste Storage

Remotely Operated Non-Destructive Evaluation System. The lower knuckle region of Hanford double-shell tanks (the 0.3-meter [1-foot] radius area where the vertical wall of the tank meets the tank bottom) is considered the area of greatest stress and carries the greatest potential for damage and leakage. This area of concern cannot be reached by conventional inspection techniques. To address the need for an inspection technology with the ability to provide structural integrity data from this critical region, the Remotely Operated Non-Destructive Evaluation System was developed in 2002. This system uses sound waves that are processed by a technique known as Synthetic Aperture Focusing, which is transformed with software developed by Pacific Northwest National Laboratory to produce high resolution images of the entire knuckle region. These images are used to detect and locate stress and corrosion cracks.

During 2003, Pacific Northwest National Laboratory developed a two-transducer Remotely Operated Non-Destructive Evaluation technique (Tandem Synthetic Aperture Focusing) that enables accurate measurements of the length and depth of a crack. In late August 2003, prototype testing of the technique was completed following successful performance demonstration testing. The system was successfully deployed in tank 241-AW-102.

2.3.14.2 Double-Shell Tank Thermal and Seismic Analysis

Under Tri-Party Agreement milestone M-48-14, an integrity assessment of the double-shell tank system is required. As a result, Pacific Northwest National Laboratory has initiated a 3-year effort under CH2M HILL Hanford Group, Inc.'s Double-Shell Tank Integrity Program to assess thermal and operation loads, seismic analyses, liquid level increases, minimum tank wall thicknesses, and tank bucklings.

During 2003, Pacific Northwest National Laboratory completed a finite element model of a representative double-shell tank and analysis of initial thermal and operating load cases. Analysis of soil elements beyond the tank boundaries and temperature distribution within the concrete forming the tanks and in the surrounding soil was completed, as was a 60-year thermal cycling and concrete creep test (deformation of the concrete over time due to constant stress). Other studies were initiated in 2003 to determine the adequacy of tank footings, evaluate the soil modulus under the tank (resistance to loads), and to develop calculations to demonstrate structural integrity.

2.3.14.3 Tank Waste Retrieval

During 2003, Pacific Northwest National Laboratory and CH2M HILL Hanford Group, Inc. conducted testing and provided technical support for the resolution of vapor and gas issues associated with the retrieval and transfer of tank waste. Non-radioactive simulants were used in conjunction with the C-200 vacuum retrieval system to estimate the amount of suspended materials in the C-200 series tanks (PNNL-14408).

Pacific Northwest National Laboratory and CH2M HILL Hanford Group, Inc. assessed the costs associated with waste mixing and mobilization. The assessment determined that one mixer pump, not two as was previously planned, would be sufficient for double-shell tank AN-101. This change resulted in savings of approximately $1 million.

2.3.14.4 Tank Waste Treatment Technologies

DOE continues to investigate systems to treat large quantities of mixed low-level waste. A treatment system is needed that can reduce the volume of waste for final disposal, isolate the radionuclides in a final waste form, and destroy the hazardous component in the waste. During 2003, three technologies were evaluated to supplement the processing of low-level tank waste: steam reforming, bulk vitrification, and containerized grout. These technologies are being evaluated as methods to accelerate waste cleanup and reduce costs.

One method that was tested is steam reforming. Steam is superheated and reacts with the organics in mixed low-level waste, generating a hydrogen-rich gas, and isolates radioactive and non-radioactive inorganics in a form that can then be encapsulated and/or vitrified. The small-scale tests performed during 2003 indicate that the mass and volume of waste is reduced using this method. Steam reforming would allow acceleration of the cleanup of tank waste by reducing the amount of waste requiring vitrification in the Waste Vitrification Plant

Bulk vitrification is the conversion of radioactive and mixed waste into radioactive glass within a container suitable for land disposal. Pacific Northwest National Laboratory conducted laboratory tests using crucible melts to develop a successful baseline aluminosilicate glass formula. This formulation was found to be less sensitive to sulfate concentrations compared to borosilicate glass formula, suggesting higher waste loading capability. Bulk vitrification would allow accelerated tank waste cleanup by reducing the mass of sodium requiring vitrification in the Waste Treatment Plant.

Containerized grout consists of solidifying waste with grout-forming additives to form immobilized waste suitable for land disposal. Containerized grout would allow acceleration of the tank waste cleanup by reducing the amount of sodium that the Waste Treatment Plant would need to process.

During 2003, Pacific Northwest National Laboratory completed waste form contaminant release calculations for steam reforming, bulk vitrification, and containerized grout technologies, as well as the baseline Waste Treatment Plant glass (PNNL-14414).

2.3.14.5 Accelerating Tank Closure

During 2003, Pacific Northwest National Laboratory characterized the sludge and drainable liquid from double-shell tank AY-102 to develop models for long-term risk assessments required to close underground radioactive waste tanks. Tests included physical characterization of the waste, quantitative analysis of waste composition, and water leachability and acid digestion. Results indicated technetium-99 was not completely water leachable as was previously assumed.

Sludge and drainable liquid samples from tank AY-102 were found to contain approximately 80% non-water leachable technetium-99, while technetium-99 from tank BX-101 was 100% water leachable, indicating that sludge and liquid samples are tank specific.

Characterization of solid phases within tank waste solutions was also initiated during 2003. Solubility of the solid and liquid components is necessary to prevent unwanted precipitation or gel formations that can affect remediation pretreatment.

2.3.14.6 Radiological Clearance for Release of Selected Hanford Reach National Monument Lands

Significant progress was made in 2003 toward the radiological release of selected Hanford Reach National Monument lands. The document, *Historical Site Assessment: Select Hanford Reach National Monument Lands – Fitzner/Eberhardt Arid Lands Ecology Reserve (ALE), McGee Ranch/Riverlands, and North Slope Units* (PNNL-13989), was completed and issued in July 2003. The objectives of this assessment were to determine locations where radioactive contamination may exist on these units, what activities could have resulted in radioactive contamination of these units, which radionuclides are most likely to exist at locations within these units based on existing environmental monitoring data, and an estimate of the current concentrations of radionuclides within these units.

Authorized limits, or radiological release criteria, that are required to release real property per DOE Order 5400.5 were developed and submitted to DOE Headquarters for approval in December 2003. The Authorized Limit Request was approved by DOE Headquarters in early March 2004, and issued as a Pacific Northwest National Laboratory document in April (PNNL-14622). This is the first such approved authorized limit for such a significant transfer of real property in the nation. The technical basis, which provides the radiation dose modeling analysis supporting the technical derivation of the authorized limit, was published as a Pacific Northwest National Laboratory document in March (PNNL-14531).

In addition, a soil sampling and analysis plan was prepared for the Fitzner/Eberhardt Arid Lands Ecology Reserve, *Fitzner-Eberhardt Arid Lands Ecology (ALE) Reserve Soil Sampling and Analysis Plan*, PNNL-14633, that is currently being carried out to confirm soil concentrations on the reserve are below the approved authorized limit. Fifty sample locations were identified; 31 randomly selected sites across the reserve based on a systematic grid pattern and a random starting location, 10 sites on two research lysimeter plots that are known to have used radionuclides in past years, and 9 sites located in alluvial fans at the base of Rattlesnake Mountain, in drainage washes, or from areas that appear to have collected windblown sand.