2.3 Hanford Cleanup Operations

J. P. Duncan

This section describes continuing Hanford Site environmental and regulatory activities. Included are project compliance activities, solid waste management, liquid effluent treatment, revegetation and mitigation, environmental restoration, groundwater protection, and waste tank research. Activities, accomplishments, and relevant issues are presented and discussed openly with the regulators and with the public to assure resolution.

2.3.1 Pollution Prevention Program

J. G. Coenenberg

Pollution prevention is 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, the reduction of hazardous substance use, and the 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.

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.

Hanford Site pollution prevention efforts during 2002 helped to reduce disposal quantities through source reduction and recycling of an estimated 142,908 cubic meters (5 million cubic feet) of radioactive and mixed waste, 737 metric tons (812 tons) of RCRA hazardous/dangerous waste, and 3,936 metric tons (4,339 tons) of sanitary waste. Waste disposal cost savings during 2002 exceeded $37 million for these activities. During 2002, the Hanford Site recycled 547 metric tons (603 tons) of paper products and 559 metric tons (616 tons) of various metals.

2.3.2 Spent Nuclear Fuel Project

D. J. Watson

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 or final disposal. During 2002, the project continued to make progress on an accelerated strategy to move spent fuel stored in the K-West and K-East Basins (K Basins) in the 100-K Area, away from the Columbia River into the Canister Storage Building in the 200-East Area. The 40-year-old K Basins were used to temporarily store 2,100 metric tons (2,300 tons) of N Reactor spent fuel and a small quantity of slightly irradiated single-pass reactor fuel. The spent fuel is being removed from underwater storage in the K Basins and placed in dry interim storage in the 200-East Area. Prior to interim storage, the fuel is cleaned and packaged in containers called multi-canister overpacks. The overpacks are vacuum processed to remove any water and then mechanically sealed at the Cold Vacuum Drying Facility located in the 100-K Area. The dried overpacks are transported to the Canister Storage Building, a welded cap is attached over the mechanical

seal, and the overpack is put in dry storage. The multi-canister overpacks will be maintained in dry storage pending a decision by the Secretary of Energy 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. 1998) date of July 2004.

The corrosion of the fuel in the K Basins, as well as fuel handling operations, have led to the accumulation of sludge and debris in old fuel storage canisters and on the floors of the basins. The majority of the sludge is in the K-East Basin. The sludge, debris, and empty storage canisters will be removed at the same time the spent nuclear fuel is removed. Water remaining in the basins will also be removed, treated at the Effluent Treatment Facility and disposed of onsite. Debris and old fuel canisters will be transported to the Environmental Restoration Disposal Facility for disposal to the extent possible. Debris that does not meet acceptance criteria for the Environmental Restoration Disposal Facility will be transferred to the appropriate onsite waste management facility. The K Basins will then be prepared for interim stabilization pending final remediation.

The Spent Nuclear Fuel Project also includes in its mission, the gathering of other spent nuclear fuel stored elsewhere on the Hanford Site and the relocation of that spent nuclear fuel to the 200-East Area Interim Storage Area or to the Canister Storage Building. Other spent nuclear fuel and its storage locations include the following:

- Fuel from the Fast Flux Test Facility in the 400 Area.
- Fuel from the Training, Research, and Isotope Production General Atomics in the 400 Area.
- Fuel originally from the Shippingport reactor in Pennsylvania and now stored at T Plant in the 200-West Area.
- Fuel from research reactors and miscellaneous special case fuel in the 324, 325, and 327 Buildings in the 300 Area.

Major accomplishments of the Spent Nuclear Fuel Project in 2002 included the following items:

- A total of 730.5 metric tons (805 tons) of spent nuclear fuel were removed from the K-West Basin and transported to the Cold Vacuum Drying Facility for processing and then taken to the Canister Storage Building for storage.
- A total of 260 fuel canisters (or ~82 metric tons [90 tons]) of spent nuclear fuel were transferred from the K-East Basin to the K-West Basin for cleaning and re-packaging before transport to the Cold Vacuum Drying Facility for processing.
- A total of 1,133 fuel storage canisters and 917 fuel storage canister lids were cleaned for disposal at the Environmental Restoration Disposal Facility. A total of 1,172 canisters were shipped to Environmental Restoration Disposal Facility for disposal.
- Construction of the sludge removal system for the K-East Basin progressed to 95% completion.
- Three cask shipments containing non-defense spent nuclear fuel were received for storage at the 200 Areas Interim Storage Area near the Canister Storage Building facility.

2.3.3 Central Plateau Remediation Project

J. K. Perry

The Central Plateau Remediation Project's mission is to transition the Central Plateau from its current post-operational state to a state where excess facilities and waste sites are cleaned up, and waste characterization, retrieval, treatment, storage, and disposal operations are performed in an environmentally sound, safe, secure, and efficient manner.

On July 1, 2002, the Central Plateau Remediation Project began working on activities transferred from the environmental restoration contractor. The activities include the Groundwater Protection Program, the 200 Area Facility Surveillance Maintenance Program, and the Plutonium Concentration Facilities Demolition Project. The Central Plateau Remediation Project will continue to manage the 300 Area activities until the work is transferred to the new river corridor contractor. The activities discussed in the following sections were performed during 2002.

2.3.3.1 Accelerated Deactivation Project

C. R. Haas

The mission of the Accelerated Deactivation Project is to complete facility deactivation and closure activities 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 300 Area buildings and structures that date back to 1943. It includes fuel supply facilities that were used to support the manufacturing of nuclear fuel for the Hanford Site reactors. Significant accomplishments during 2002 included the following activities:

- Received certification of partial RCRA closure for the 300 Area Waste Acid Treatment System from the Washington State Department of Ecology.
- Performed surveillance and maintenance of 300 Area Accelerated Deactivation Project facilities.

2.3.3.2 327 and 324 Facilities Deactivation Project

C. R. Haas

Construction of the 327 and 324 Buildings was completed and operations began in 1953 and 1966, respectively. These buildings contain hot cells that were used for radiological research and development work. Both facilities were transferred to Fluor Hanford, Inc. during 1996 for deactivation. Facility disposition is to be completed by the new river corridor contractor, pending award of the contract.

Significant accomplishments achieved at the 327 Building during 2002 included the following:

- Continued collecting and packaging special case waste comprised of metallurgical specimens removed from the dry storage carousel and legacy waste buckets from hot cells in support of special case waste disposition activities relating to Tri-Party Agreement Milestone M-92-16.
- Shipped three of five remaining legacy waste containers to the Central Waste Complex from the 327 Building.

Significant accomplishments achieved at the 324 Building during 2002 include the following:

- Completed radiochemical engineering cells airlock pipe trench waste collection activities and subsequent shipment of waste to the Central Waste Complex.
- Completed transfer of five pressurized water reactor spent nuclear fuel assemblies to the 200 Areas for storage.
- Completed consolidation and removal of the remaining 324 Building spent nuclear fuel, including the boiling water reactor fuel assemblies stored in B-Cell and loose boiling water reactor and pressurized water reactor pins stored in B and D cells.
- Completed packaging and shipment of spent nuclear fuel segments and fragments in support of the Special Case Waste Project per Tri-Party Agreement Milestone M-92-16. Spent nuclear fuel removal and shipment activities were completed on budget and 4 months ahead of baseline schedule.

2.3.3.3 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 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.

During 2002, a radiologically contaminated crane measuring 162 cubic meters (5,721 cubic feet) was transferred to an offsite U.S. Nuclear Regulatory Commission-licensed company for equipment reuse. Four railroad flatcars (235.5 cubic meters [8,317 cubic feet]) and 0.52 cubic meter (18.4 cubic feet) of lead bearings from railcars were radiologically surveyed and released for unrestricted re-use offsite. The condenser (32.2 cubic meters [1,137 cubic feet]) was shipped to Duratek in Tennessee for recycling of the contaminated steel into shield blocks for DOE. One

of the skid-mounted concrete burial boxes (67.28 cubic meters [2,376 cubic feet]) was placed in onsite reuse as a burial grout form within the low-level burial grounds. Three tall fuel-cask railroad cars (480 cubic meters [16,951 cubic feet]) were shipped to Duratek in Tennessee. The steel was recycled into shield blocks for DOE, and the lead was used for lining containers. Also during 2002, 3 flatcars (176.6 cubic meters [6,237 cubic feet]), 12 railcar wheel assemblies (36 cubic meters [1,271 cubic feet]), and the 2 skid-mounted concrete burial boxes of grouted ion exchange columns (134.6 cubic meters [4,753 cubic feet]) were placed in the low-level burial grounds for disposal.

2.3.3.4 233-S Plutonium Concentration Facility Decommissioning Project

D. L. Klages

Decontamination and decommissioning activities continued in 2002 at the 233-S Plutonium Concentration Facility located in the 200-West Area adjacent to the Reduction-Oxidation Plant. This work is being performed as a non-time-critical removal action under CERCLA. The 233-S facility and associated process equipment were used to concentrate plutonium produced at the Reduction-Oxidation Plant from 1955 to 1967.

Equipment cleaning and waste disposal activities continued throughout 2002, 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. The facility is scheduled for demolition.

2.3.3.5 200 Area Facilities Disposition Project

G. J. LeBaron

Disposition of 200 Areas facilities includes the surveillance, maintenance, and deactivation of buildings and waste sites in the 200-East Area, 200-West Area, and Fitzner/Eberhardt Arid Lands Ecology Reserve. A plan, including a cost estimate and schedule, was prepared for removing facilities and making other necessary changes to transfer the Fitzner/Eberhardt Arid Lands Ecology Reserve to the U.S. Fish and Wildlife Service.

Included in the facilities managed by the 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 Plant, B Plant, Reduction-Oxidation Plant, and U Plant), was transferred from Bechtel Hanford, Inc. to the 200 Area Facilities Disposition Project. Three major air emission units and three minor emission stacks as defined by 40 CFR 61 are now maintained by the project.

Facility work conducted under this program during 2002 included work in the 224-T facility in the 200-West Area. The cells at the 224-T facility were deactivated and closed during the 1960s. However, no documentation could be found concerning the flushing and final state of the cells and few entries had been made since its closure. During 2002, each cell was entered to perform detailed radiological surveys and to clean the cells to reduce the potential of personnel contamination or release to the environment. Preparations were made to remove the water that had accumulated in the deep portion of C-Cell. Plans are ongoing to inspect the cells and more fully characterize their contents.

During 2002, non-destructive analyses were conducted to characterize the radionuclides in the duct work at the former Plutonium Finishing Plant in the 200-West Area. Metal roofs were installed on the B Plant and Plutonium-Uranium Extraction Plant "canyon" facilities. The metal roofs are designed to last 50 years.

Outdoor tasks within the 200 Area Facilities Disposition Project include the Radiation Area Remedial Action Program, which 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.

2.3.3.6 Canyon Disposition Initiative

G. J. LeBaron

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 structuresl. (Note: "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 in 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, work was done to finalize the draft feasibility study and preparations were made to prepare the other CERCLA documentation for final disposition of the U Plant.

The Tri-Parties considered whether the pilot activities at U Plant could also apply to the remaining four canyon buildings. There were four options selected for final evaluation and screening: (1) full removal and disposal, (2) entombment with internal waste disposal, (3) entombment with internal/external waste disposal, and (4) close in place – collapsed structure. The feasibility study (DOE/RL-2001-11) determined that options 2 and 3 met the requirements to protect human health and the environment, as well as being consistent with the 2012 cleanup plan for the Central Plateau. The final option will be selected during the record of decision process. Selecting the final option for the five canyon buildings figures prominently in 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.

2.3.4 Fast Flux Test Facility

N. R. Dahl

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 plant 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 plant systems were deactivated during the previous deactivation period from 1993 to 1997.

During September 2002, deactivation and decommissioning activities were transferred from the DOE Office of Nuclear Energy to the DOE Office of Environmental Management, an indication of DOE's intention to permanently shut down the reactor. In November 2002, Benton County filed a motion in the U.S. District Court for the Eastern District of Washington to halt decommissioning work on the Fast Flux Test Facility. Subsequently, Benton County and federal attorneys agreed to a 120-day stoppage of the deactivation activities.

In an effort to reduce shutdown costs and accelerate the decommissioning schedule, upgrades aimed at increasing the efficiency and reliability of the refueling system were the primary focus of 2002 activities. The acceptance test procedure for the closed-loop ex-vessel machine was completed on August 1, 2002, following 10 months of testing. The closed-loop ex-vessel machine was used to install the immersion heaters and is ready to support the commencement of fuel wash activities. Acceptance testing for the sodium removal system was completed in September 2002. Major repairs and modifications to the solid waste cask are nearing completion. Upon completion of the cask assembly, acceptance testing will begin.

During 2002, one argon and three nitrogen storage tanks were removed during the facility closure process. In addition, parts of the Mobiltherm and Containment Margins systems were removed before closure activities were put on hold. The Mobiltherm System was a heat transfer system used in the sodium purification process. The Containment Margins System was designed to vent the containment dome after a gas buildup caused by an accident.

2.3.5 Advanced Reactors Transition Project

M. W. Benecke and W. F. Brehm

The mission of the Advanced Reactors Transition Project is to convert the Plutonium Recycle Test Reactor facility and the nuclear energy legacy facilities into structures that are suitable for re-use or low-cost surveillance and maintenance. Legacy facilities are those used for nuclear research projects conducted in the past at the Hanford Site. Although these legacy facilities existed in many areas of the Hanford Site, the only facilities remaining to be cleaned up are in the southeastern part of the 300 Area, the 337 Building high bay area, and the adjacent storage tank building, 3718-M. Deactivation of legacy facilities includes the disposition of non-radioactive sodium and sodium-potassium alloy originally used in the development and testing of components for use in liquid-metal-cooled reactors.

During 2001, roof repairs were completed on the support buildings attached to the dome at the Plutonium Recycle Test Reactor/309 Building, located in the 300 Area. Despite further deterioration of the weather coating on the dome, this facility is in a condition for low-cost surveillance and maintenance until deactivation, decontamination, and decommissioning are performed in accordance with the 300 Area Accelerated Closure Project Plan (HNF-6465).

In 2002, all remaining sodium-wetted piping was removed from the 337 Building, placed in shipping drums, and sent to an offsite treatment center. The remaining large cold trap (a device used in sodium systems to remove chemical impurities in the sodium) was stripped of insulation and heaters and moved to the main floor of the 337 Building high bay. Asbestos abatement techniques were required to remove all the insulation and heaters. The cold trap and associated heat exchanger piping were prepared for shipment to Argonne National Laboratory-West in Idaho, where the sodium will be drained and recycled and the trap cleaned. The total sodium volume is ~2,650 liters (~700 gallons).

A request for proposal to remove sodium residuals from the 3718-M and Composite Reactor Component Test Activity tanks was sent to 11 prospective bidders who attended an information meeting held at Hanford in October 2002.

2.3.6 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, DOE issued a shutdown order for the plant, authorizing deactivation and transition of the plutonium processing portions of the facility in preparation for decommissioning.

Today's mission is to stabilize, immobilize, re-package and/or properly dispose of plutonium-bearing materials in the plant; to deactivate and dismantle the processing facilities; and to provide for the safe and secure storage of nuclear materials until final disposition. Workers at the Plutonium Finishing Plant are making progress to stabilize plutonium and deactivate the facilities.

Significant accomplishments achieved at the Plutonium Finishing Plant during 2002 included the following:

- Completed re-packaging of ~547 items of plutonium-bearing ash from a historical Hanford incinerator (February 2002).
- Completed stabilization of 4,500 liters (1,189 gallons) of plutonium-bearing solutions ahead of a revised Tri-Party Agreement milestone and nearly $3 million under budget (July 2002).
- Began stabilizing over 860 plutonium-bearing polycubes using a unique thermal stabilization method devised specifically for this project. About 75% of polycubes, i.e., small cubes of polystyrene containing plutonium oxide, were stabilized by the end of 2002.
- Attained 1 million safe work hours and achieved safety Merit Status in DOE's Voluntary Protection Plan (November 2002).
- Continued welding stabilized plutonium forms into sturdy, triple-layered cans meeting strict specifications of DOE's "3013" safety standard (November 2002).
- Completed re-packaging the entire "sand, slag, and crucible" group of plutonium-bearing residues for permanent

disposal; began re-packaging another large group of residues known as "mixed oxides" (December 2002).

- Stabilized more than 55% of the total plutonium inventory by the end of 2002, and advanced the stabilization completion date for the Plutonium Finishing Plant Project to February 2004.
- Deployed four field teams to clean chemical residues and legacy plutonium held up in process equipment, as part of deactivation work; completed key environmental documentation in preparation for additional deactivation work and established an accelerated comprehensive deactivation schedule.

2.3.7 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 601 strontium fluoride capsules and 1,335 cesium chloride capsules stored at the facility. The capsules will be stored at the Waste Encapsulation and Storage Facility until 2018. The Waste Treatment Plant pretreatment facility will be designed to connect to a potential new facility to receive and treat the capsules. The final capsule shipment is scheduled for 2022.

The renewal of the U.S. Nuclear Regulatory Commission Certificate of Compliance number 9511, Revision 3 for the Beneficial Uses Shipping System (BUSS R-1) was issued on July 26, 2002, for a 5-year term that expires on July 31, 2007. A Beneficial Uses Shipping System cask is used at the Waste Encapsulation and Storage Facility for the onsite transportation of cesium and strontium capsules. The Beneficial Uses Shipping System cask is the only DOE licensed and certified Type B container for shipment of cesium chloride and strontium fluoride capsules.

2.3.8 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 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.

2.3.8.1 Waste Tank Status

P. A. Powell

A monthly summary report documents the status of waste tanks. The December 2002 report, HNF-EP-0182, *Waste Tank Summary Report for Month Ending December 31, 2002*, provides 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 are assumed to have leaked at some time in the past; all 67 are single-shell tanks.
- The volume of liquid waste that may have leaked from these tanks is estimated to be between 2.84 and 3.97 million liters (750,000 and 1,000,000 gallons).

To date, 132 of the 149 (89%) single-shell tanks have been stabilized, and the stabilization program is on schedule to be completed by the end of September 2004. During 2002, three tanks (241-SX-105, 241-U-102, and 241-U-109) were declared stabilized. Waste was pumped from 17 single-shell tanks into the double-shell tank system. The following single-shell tanks were pumped during 2002: 241-A-101, 241-AX-101, 241-BY-105, 241-BY-106, 241-C-103, 241-C-106, 241-S-101, 241-S-102, 241-S-107, 241-S-111, 241-S-112, 241-SX-101, 241-SX-102, 241-SX-103, 241-U-107, 241-U-108, and 241-U-111. The pumping removed 5.3 million liters (1.4 million gallons) of waste. For the safe and timely removal of this waste, temporary transfer piping (above ground pipe in pipe which is shielded) was installed.

To assure safe storage and retrieval, 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 2002, CH2M HILL Hanford Group, Inc. began proof-of-concept testing on techniques to dissolve saltcake in waste tanks. Simply put, water was sprayed onto the saltcake to dissolve and mobilize the waste for retrieval through a centrally-located pump. Variations in the volume, pressure, and method of application were evaluated. Saltcake dissolution technology, intended for initial use in tank 241-S-112, was demonstrated in tank 241-U-107. A separate retrieval technology, involving use of a remote-controlled mobile retrieval system (tank crawler) was also evaluated during 2002. The tank crawler was designed to facilitate retrieval of insoluble waste, typically sludge; it was intended to function much like a small bulldozer, pushing solids to a central location in the tank for extraction. The system, planned for initial application in tank 241-C-104, was demonstrated at Hanford's Cold Test Facility.

2.3.8.2 Waste Tank Closure Acceleration

P. A. Powell

During 2002, DOE initiated plans to accelerate Hanford tank cleanup and closure. Early in 2002, DOE, the Washington State Department of Ecology, Hanford stakeholders, and CH2M HILL Hanford Group, Inc. began planning how to accelerate the cleanup and closure of the single-shell tanks. At the end of the year, an integrated plan for the cleanup was released in draft form. In addition, a closure plan for the single-shell tank system was submitted to Washington State Department of Ecology for review; the document (RPP-13774) defines the process and integration necessary to achieve accelerated closure of single-shell tanks and tank farms as well as defines the first closure activities to be performed on tank 241-C-106.

A key concept in the accelerated cleanup approach is the use of supplemental technologies to provide treatment capacity beyond that of the Waste Treatment Plant. During 2002, CH2M HILL Hanford Group, Inc. evaluated three supplemental waste treatment technologies (containerized grout, steam reforming, and bulk vitrification), all intended for use on retrieved tank waste. Containerized grout technology involves mixing waste with a very thick grout formula and allowing the mixture to solidify in a container. Both steam reforming and bulk vitrification would immobilize the waste in an aluminosilicate waste form. CH2M HILL Hanford Group, Inc. also began evaluating a separate disposal path for mixed transuranic tank waste that would include onsite treatment and packaging for shipment to the DOE Waste Isolation Pilot Plant in New Mexico.

2.3.8.3 Geophysical Logging for Vadose Zone Characterization and Monitoring

R. G. McCain, P. D. Henwood, S. M. Sobczyk, A. W. Pearson, and S. E. Kos

Geophysical logging at the Hanford Site is performed under the direction of the DOE Grand Junction Office, using capabilities and experience established for National Uranium Resource Evaluation program. Until 2002, this work was performed by MACTEC-ERS. On July 21, 2002, vadose zone logging and monitoring activities were transferred from MACTEC-ERS to the S. M. Stoller Corporation. Most MACTEC-ERS personnel were retained by the new contractor, and the work continued without interruption. Under the new contract, S. M. Stoller Corporation is responsible for all geophysical logging at the Hanford Site. Logging activities are now integrated across multiple organizations and projects, and consistent procedures and data quality objectives are in use. Logging equipment previously used by other organizations on the site is being transferred to S. M. Stoller Corporation. Plans and procedures are being updated to reflect the transition to the new contractor. In addition, responsibility for day-to-day program management was transferred from the DOE Grand Junction Office to the DOE Richland Operations Office.

S. M. Stoller Corporation performs geophysical logging for both the DOE Richland Operations Office and DOE Office of River Protection. The primary goal of logging activities performed for the DOE Richland Operations Office is characterization of waste sites on the Central

Plateau. For the DOE Office of River Protection, the logging effort involves vadose zone monitoring around the single-shell tanks.

2.3.8.4 Monitoring Activities in the Single-Shell Tank Farms

R. G. McCain, P. D. Henwood, S. M. Sobczyk, A. W. Pearson, and S. E. Kos

The tank farm baseline characterization effort identified subsurface contaminant plumes in the vicinity of the single-shell tank farms. Cobalt-60, cesium-137, europium-152, europium-154, uranium-235, and uranium-238 were the predominant gamma-emitting contaminants. Minor amounts of tin-126 and antimony-125 were also detected. Since specific contaminants have been identified and quantified by the baseline characterization, the primary focus of the monitoring program is to identify changes in contaminant levels between successive log runs.

Specific borehole and depth intervals for monitoring are selected on the basis of intersection with known contaminant plumes, proximity to tanks known to have leaked or to subsurface contaminant plumes, or proximity to tanks containing relatively large volumes of drainable liquid. The logging frequency is determined by the overall priority. Most boreholes of interest will be logged on at least a yearly basis. The goal of the monitoring program is to collect data from all boreholes at least once in a 5-year period.

During 2002, monitoring activities were performed in a total of 385 boreholes, representing ~6,706 meters (~22,000 feet) of logging. The high-priority boreholes in each tank farm were monitored at least once. In addition to routine activities, monitoring was also performed to support tank farm operations or to investigate potential anomalies. Monitoring of boreholes in the vicinity of tank U-107 was performed to support the planned tests for saltcake dissolution.

During 2002, the neutron moisture logging system was used to measure volumetric moisture content in the vadose zone around tank U-107. Experience with the neutron moisture log at Hanford has indicated that it is useful for identifying changes in soil moisture that may be related to ongoing contaminant migration and for delineating fine-grained beds for stratigraphic correlation.

2.3.8.5 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 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 2002, the contractor began pouring concrete for the Pretreatment Plant, High-Level Waste Vitrification Plant, and the Low-Activity Waste Vitrification Plant. The potable water services and the sewage system for the plant began operating.

2.3.9 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 from offsite sources that are authorized by DOE to ship waste to the site. The following sections contain information regarding specific site locations.

2.3.9.1 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 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 22,710 cubic meters (801,996 cubic feet) of low-level mixed waste and transuranic waste. This capacity is adequate to store the projected volumes of low-level, transuranic, mixed waste, and radioactively contaminated polychlorinated biphenyls to be generated from the sites identified above, assuming on-schedule treatment of the stored waste. Treatment will reduce the amount of waste in storage and make room for newly generated mixed waste. The dangerous waste designation of each container of waste is established at the point of origin based on process knowledge or sample analysis.

2.3.9.2 Waste Receiving and Processing Facility

H. C. Boynton

Waste destined for the Waste Receiving and Processing Facility includes legacy 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 operations 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 generated 967 drums and 144 boxes during 2002.

2.3.9.3 Radioactive Mixed Waste Disposal Facility

L. T. Blackford

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. Trench 34 began to be used for disposal during September 1999. Currently, there are ~1,450 cubic meters (~51,200 cubic feet) of waste contained in about 883 waste packages in trench 34. No waste is currently stored in trench 31. However, trench 31 will be used for storage, when needed, to accommodate large items awaiting disposal into trench 34. 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.

2.3.9.4 T Plant Complex

B. M. Barnes

The T Plant Complex in the 200-West Area provides waste treatment and storage and decontamination services for the Hanford Site. The T Plant Complex currently operates under RCRA interim status. In 2002, the following activities occurred at the T Plant complex:

- Head-space gas sampling was performed on ~70 containers of transuranic waste in support of 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.
- Eight process cells in the 221-T Building were cleaned to support the K Basin sludge storage mission. Four of the cleaned process cells were re-fitted with K Basin sludge storage equipment.
- The EC-1 condenser was shipped to Duratek's facility in Tennessee for recycling.

- Four pressurized Shippingport reactor fuel elements were shipped to the Canister Storage Building. The remaining 44 pressurized Shippingport reactor fuel elements are tentatively scheduled to be shipped to the Canister Storage Building during 2003.
- Approximately 30 containers of material were shipped to the 400 Area Consolidation Center for recycling.
- 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 Site RCRA Permit. It is presently under review.

The date for T Plant's Tri-Party Agreement Milestone M-91-20 (T Plant readiness to receive canisters of K Basin sludge) was December 31, 2003. The milestone was revised and now has a readiness date of May 28, 2003. Crane upgrades, purge system installation, and the receipt of a second transporter will occur as a result of this milestone change.

2.3.9.5 Radioactive Mixed Waste Treatment and Disposal

L. T. Blackford

During 2002, 656 cubic meters (23,163 cubic feet) of mixed low-level waste were treated, recycled, and/or direct disposed:

- 356 cubic meters (12,570 cubic feet) of waste, or ~1,395 drum equivalents (based on a standard 55-gallon drum), were non-thermally treated to RCRA land disposal restriction standards at the Allied Technology Group Corporation Richland, Washington, facility and returned for disposal at the Hanford Radioactive Mixed Waste Disposal Facility.
- 101 cubic meters (3,566 cubic feet), or about 395 drum equivalents of waste, were removed from inventory at the Central Waste Complex after it was determined that it met disposal standards. This waste was direct disposed in the Hanford Site low-level burial grounds.
- 167 cubic meters (5,896 cubic feet) of mixed low-level waste were disposed directly into the Radioactive Mixed Low-Level Waste Facility. This waste came from various Hanford Site operations and either met land disposal restriction standards in the "as generated" state, or were treated according to Treatment-By-Generator provisions in WAC 173-303-170(3)(b) to treat the waste to meet RCRA and state land disposal restrictions.
- 32 cubic meters (1,130 cubic feet) of waste, specifically a legacy evaporator condenser, was recycled through Duratek's facility in Tennessee. The condenser was shipped to the facility, cut up, and melted; the metal was used to construct shield blocks for other DOE facilities.

2.3.9.6 Radioactive Mixed Waste Treatment Contracts

L. T. Blackford

In December 2001, Allied Technology Group Corporation, Fluor Hanford, Inc.'s primary contractor for treating mixed low-level waste, filed for Chapter 11 bankruptcy protection. During 2002, Fluor Hanford, Inc. worked with Allied Technology Group Corporation during bankruptcy proceedings to maintain a viable treatment capacity to support Hanford Site needs and assure that this capacity was used to the maximum extent possible.

Fluor Hanford, Inc. was able to work with Allied Technology Group Corporation to complete processing of waste removed from the Central Waste Complex and stored at Allied Technology Group Corporation for non-thermal waste treatment. Additional negotiations were concluded with the trustee, for management of the Allied Technology Group Corporation bankruptcy, and non-thermal waste treatment processing was continued. During 2002, 356 cubic meters (12,570 cubic feet) of waste were treated at the Allied Technology Group Corporation facility and returned for disposal at the Hanford Radioactive Mixed Waste Disposal Facility. Due to bankruptcy proceedings and financial viability, the thermal treatment processing line at the Allied Technology Group Corporation facility did not operate during 2002. Approximately 115 cubic meters (~4,060 cubic feet) of thermally treatable waste removed from the Central Waste Complex during 2001 remain in compliant storage at the Allied Technology Group Corporation facility waiting processing.

Additional thermal treatment options were explored during 2002 using other commercial capabilities. A potential for treating a minor portion of the Hanford waste streams was identified by the PERMA-FIX company and their Thermal Desorption process. A proposal was prepared,

and funding was secured through the DOE Technology Development Program. Contract negotiations with PERMA-FIX were begun during December 2002, with a target date to commence shipment of ~15 cubic meters (~530 cubic feet) of waste during March 2003.

2.3.9.7 Navy Reactor Compartments

S. G. Arnold

Eight disposal packages containing defueled United States Navy reactor compartments were received and placed in trench 94 in the 200-East Area during 2002. Six were submarine reactor compartments, and two were cruiser reactor compartments. This brings the total number of reactor compartments received to 110. 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 ~10 meters (33 feet) in diameter and 14.3 meters (47 feet) long. They weigh between 908 and 1,362 metric tons (1,000 and 1,500 tons) and are transported on their side. Decommissioned cruiser reactor compartments are ~10 meters (33 feet) in diameter and 12.8 meters (42 feet) high. They weigh ~1,362 metric tons (1,500 tons) and are transported on their end.

2.3.10 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.

2.3.10.1 242-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 tank waste and eliminates the need to construct additional double-shell tanks. The concentrated tank waste is returned to the double-shell tanks for storage. The 242-A evaporator completed one campaign during 2002. The volume of waste treated was ~3.9 million liters (~1 million gallons) and the waste volume reduction was ~1.6 million liters (~413,500 gallons) or 41%.

One cold run was completed at the 242-A evaporator during 2002. Cold runs are performed for training purposes to maintain operator proficiency. Water rather than actual tank waste was added to the process vessels and processed.

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 2.3.10.3) 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.

2.3.10.2 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 unwanted material and to minimize evaporation of 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 2002 was 100 million liters (26.4 million gallons).

The wastewater received for interim storage during 2002 included 2.9 million liters (766,000 gallons) of RCRA-regulated wastewater (primarily 242-A evaporator process condensate), and 97 million liters (25.7 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 volume of wastewater transferred to the Effluent Treatment Facility for treatment and disposal during 2002 was 83 million liters (22 million gallons).

The volume of wastewater being stored in the Liquid Effluent Retention Facility at the end of 2002 was 44 million liters (11.6 million gallons). This included 2.9 million liters (762,000 gallons) of RCRA-regulated wastewater and 41 million liters (10.9 million gallons) of CERCLA-regulated wastewater.

2.3.10.3 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 verification 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 2002 was 83.5 million liters (22 million gallons), which included 5.6 million liters (1.5 million gallons) of RCRA-regulated wastewater (primarily 242-A evaporator process condensate), and 78 million liters (20.6 million gallons) of CERCLA-regulated wastewater (primarily groundwater from the 200-UP-1 Operable Unit in the 200-West Area).

2.3.10.4 200 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 ~18 kilometers (~11 miles) of buried pipeline connecting three pumping stations, one disposal sample station (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 2002 was 863 million liters (227.9 million gallons). The major source of this effluent is uncontaminated cooling water and steam condensate from the 242-A evaporator, with a variety of other uncontaminated waste streams received from other Hanford facilities.

2.3.10.5 300 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 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 for continuous receipt of 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 2002 was 163.7 million liters (43.2 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 2002 was 5.5 million liters (1.5 million gallons).

2.3.10.6 Miscellaneous Streams

J. C. Sonnichsen

In February 1995, the Washington State Department of Ecology approved a *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams* (DOE/RL-93-94). This plan and schedule required that all miscellaneous streams be permitted under WAC 173-216. Categorical permits were used to permit miscellaneous streams with similar characteristics. The permitting process was completed in 1999. All milestones identified in the plan and schedule (DOE/RL-93-94) have been fulfilled, and the annual submittal of the Hanford Site miscellaneous streams inventory report is no longer required.

In January 2000, DOE issued the *Pollution Prevention and Best Management Practices Plan for State Waste Discharge Permits ST 4508, ST 4509, and ST 4510* (DOE/RL-97-67). Preparation of this plan was a requirement of the three waste discharge permits. This plan summarized the compliance requirements in all the categorical permits and set conditions for the individual streams. The plan provides details of remediation activities to prevent further contamination of groundwater. Table 2.3.1 provides a summary of the waste streams addressed in the categorical permits.

In addition to WAC 173-216, the *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams* (DOE/RL-93-94) required registration of the underground injection control wells operated on the Hanford Site (WAC 173-218). To comply, a significant and ongoing effort to verify the location and status of all Class V underground injection control wells on the

Table 2.3.1. Permits for Miscellaneous Waste Streams on the Hanford Site

Permit Number	Date Issued	What it Covers	2002 Activities	Status
Permit ST 4508	May 1997	Hydrotesting, maintenance, and construction discharges.	Permit renewal application submitted to Washington State Department of Ecology in 2002 and approved on April 29, 2002.	Existing permit remains in effect until a replacement permit is issued.
Permit ST 4509	May 1998	Cooling water discharges and uncontaminated streams condensate.	Permit renewal application submitted to Washington State Department of Ecology in 2002 and approved on April 29, 2002.	Existing permit remains in effect until a replacement permit is issued.
Permit ST 4510	April 1999	Industrial stormwater discharge	Permit renewal application submitted to Washington State Department of Ecology in 2002 and approved on April 29, 2002.	Existing permit remains in effect until a replacement permit is issued.

Hanford Site began in February 2000. On the Hanford Site, Class V injection wells include the injection of stormwater and other small quantities of uncontaminated wastewater (i.e., condenser condensate). Investigators determined a large number of underground injection control wells were inactive, and they were removed from the list of active wells. In most cases, these injection wells amount to locations where small quantities of non-contaminated wastewater percolate into the soil (i.e., small percolation drains).

Registration of Hanford Site Class V Underground Injection Wells (DOE/RL-88-11) was submitted to the Washington State Department of Ecology in March 2001. During 2002, a request was received from the Washington State Department of Ecology to incorporate this information into their underground injection control database. This request was completed on September 23, 2002. Two additional underground injection control wells were added to this database on October 23, 2002.

2.3.11 Revegetation and Mitigation Planning

A. L. Johnson, J. Meisel, H. Newsome, and M. R. Sackschewsky

The DOE Richland Operations Office and U.S. Fish and Wildlife Service cooperatively worked on a plan to re-vegetate land on the Fitzner/Eberhardt Arid Lands Ecology Reserve to compensate for damage to the environment caused by the original construction of cells 1 and 2 at the Environmental Restoration Disposal Facility.

The Environmental Restoration Disposal Facility mitigation project includes three separate planting elements: a native grass seeding, shrub seedling planting, and native grass plug planting. The native grass seed used in the seeding project was purchased from a local seed producer and derived from local sources. In preparation for planting ~65 hectares (~160 acres) with native grass seed, an application of Roundup™ was aerial applied to the project area in mid-November 2002. Following the herbicide application, in mid-December, 9 kilograms (20 pounds) per acre of a native grass seed mix including Sandberg's bluegrass (*Poa sandbergii*), thickspike wheatgrass (*Agropyron dasystachyum*), bottlebrush squirreltail (*Sitanion hystrix*), Indian ricegrass (*Oryzopsis hymenoides*), and needle-and-thread grass (*Stipa comata*) were planted. The grass seed was aerial broadcast then harrowed with a tractor drawn implement to increase seed to soil contact. An additional Roundup™ application was applied in mid-February to reduce cheatgrass (*Bromus tectorum*) competition to seeded species.

Approximately 139,000 shrubs were planted across ~125 hectares (~310 acres) during early December 2002. The shrubs planted included 10,300 ~164-cubic-centimeter (~10-cubic-inch) plants, 28,100 65.5-cubic-centimeter (4-cubic-inch) plants, and 93,000 bare root sagebrush (*Artemisia tridentata*) plants; 6,000 green rabbitbrush (*Chrysothamnus viscidiflorus*) plants; and 2,000 gray rabbitbrush (*Chrysothamnus nauseosus*) plants. The bare root plants were dipped in mycorrhizal root gel just prior to planting to provide the plant nutrients required for plant establishment. The shrubs were planted in three separate areas and will be monitored for survival.

Additional Environmental Restoration Disposal Facility mitigation planting is planned for 2003 and 2004. In 2002, grass and shrub seeds were collected from Indian rice grass, needle-and-thread grass, thickspike wheatgrass, antelope bitterbrush (*Purshia tridentata*), and gray and green rabbitbrush and sent to a native plant nursery for propagation into 65.5-cubic-centimeter (4-cubic-inch) plugs that will be planted over an area of ~8.1 hectares (~20 acres) during fall and winter 2003 and 2004.

All of the Environmental Restoration Disposal Facility mitigation planting efforts will be monitored by the river corridor contractor to document the planting success, plant establishment, and shrub survival with the data collections provided in an annual revegetation monitoring report such as BHI-01659.

Monitoring of the new transmission line that was installed to provide electrical power to the vitrification plant revealed that sagebrush and Sandberg's bluegrass were becoming established on nearly all of the tower pads. Both of these species were broadcast seeded in February 2001. Monitoring will continue through 2004.

Monitoring of survival and growth continued for ~90,000 sagebrush seedlings that were planted on about

90 hectares (222 acres) at nine locations on the Fitzner/Eberhardt Arid Lands Ecology Reserve during December 2000. Survival averaged about 55%, with values along individual transects ranging from a low of 3% to a high of 91%. This effort was the last phase of sagebrush transplanting as compensatory mitigation for the disturbance of sagebrush habitat resulting from the development of the site and infrastructure for the planned waste vitrification facility. Monitoring of these plants will continue through 2004.

2.3.12 Environmental Restoration Project

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 cleanup operations conducted under CERCLA on the Hanford Site. To provide a barrier to contaminant migration from the facility, the Environmental Restoration Disposal Facility was constructed to RCRA Subtitle C Minimum Technology Requirements including a double liner and leachate collection system. Remediation waste disposed in the facility include 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 lower levels of cells 3 and 4 was completed during 2002. Waste disposal operations then moved to the partially completed upper level of cell 2. As of the end of 2002, the facility had received over 3.62 million metric tons (3.98 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, and D. F. Obenauer

Full-scale remediation of waste sites began in the 100 Areas in 1996. Remediation and backfill activities continued through 2002 at several liquid waste disposal sites in the 100-B/C and 100-F Areas. Remediation of the treatment, storage, and disposal units at 100-N Area continued through 2002, and remediation activities were initiated in the 100-K Area. Figure 1.0.1 shows the former reactor areas along the Columbia River.

There were no soil excavation activities at the 100-H Area in 2002. However, from 1996 through 2001, 413,000 metric tons (455,000 tons) of contaminated soil were removed and shipped to the Environmental Restoration Disposal Facility.

Remediation activities were initiated in the 100-K Area during 2002. A total of 4,842 metric tons (5,321 tons) of contaminated soil was removed and disposed of at the Environmental Restoration Disposal Facility.

In 2002, over 137,000 metric tons (151,000 tons) of contaminated soil and 3,100 linear meters (11,800 linear feet) of pipeline in the 100-B/C Area were removed and shipped to the Environmental Restoration Disposal Facility. The cumulative amount of contaminated soil removed and shipped to the facility through December 2002 was 870,000 metric tons (957,000 tons) and 5,200 linear meters (17,100 linear feet) of pipeline.

Remediation in the 100-F Area continued with the removal of 279,000 metric tons (307,000 tons) of contaminated soil in 2002. A total of 749,000 metric tons (824,000 tons) of contaminated soil has been removed from the 100-F Area and disposed of at the Environmental Restoration Disposal Facility.

Remediation continued at the 116-N-3 and the 116-N-1 treatment, storage, and disposal facilities, which are both located within the 100-NR-1 Operable Unit in the 100-N Area. Remediation of these facilities is being completed as required by the Hanford Sitewide RCRA Permit. In 2002, 6,338 metric tons (6,965 tons) of contaminated soil were removed from 116-N-3 and 116,267 metric tons (127,766 tons) of contaminated soil were removed from 116-N-1. The total amount of contaminated soil removed through 2002 from the 100-NR-1 Operable Unit is 259,855 metric tons (285,853 tons), all of which was disposed of at the Environmental Restoration Disposal Facility.

The interim record of decision for the 100 Areas burial grounds, issued September 16, 2000, specified a cleanup remedy to remove/treat/dispose contaminated soil, structures, and debris from the 100 Areas burial ground sites. A 90% design package for the 100-B/C Area burial grounds was completed in 2002 and issued for review.

Remediation work at the 300-FF-1 Operable Unit began in the 300 Area in 1997 (Figure 1.0.1). Historically, both chemical and radiological materials were disposed of at the 300-FF-1 waste sites. During 2002, excavation operations were completed at the 618-4 burial ground. Between excavation operations performed at the site in 1998 and 2002, 510,000 metric tons (560,000 tons) of contaminated material and debris have been transported to Environmental Restoration Disposal Facility. Closure of the 618-4 burial ground is scheduled to be complete in 2003.

An interim action record of decision for the 300-FF-2 Operable Unit (EPA 2001) was issued in 2001. Implementation of the remedy prescribed by the record of decision consists of removal of contaminated soil and debris, treatment as necessary, and disposal at the Environmental Restoration Disposal Facility or other approved facility. Excavation of the 618-5 burial ground began in 2002, with 10,349 metric tons (11,373 tons) of contaminated soil removed and disposed of at the Environmental Restoration Disposal Facility. Excavation operations and site closeout of the 618-5 burial ground are scheduled to be completed in 2003.

2.3.12.3 Facility Decommissioning Project

R. R. Nielson

Decontamination and decommissioning activities continued during 2002 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 the public and reduces surveillance and maintenance costs. These activities are conducted as non-time-critical removal actions under CERCLA.

During 2002, interim safe storage of the DR Reactor was completed. Characterization sampling of the associated 117-DR Exhaust Filter Building was completed in preparation for demolition. This facility is part of the large sodium fire facility, a permitted treatment, storage, and disposal facility undergoing RCRA closure. Demolition activities at the F and D Reactors were completed, and activities to backfill the fuel storage basin areas are in progress.

Demolition work at the H Reactor was initiated during 2002 and progressed through two areas (control room/lunchroom and fuel storage basin areas). A system was installed in the fuel storage basin to remove the remaining water. Wastewater is being shipped to the Effluent Treatment Facility for treatment and disposal. A remote-controlled excavator is being deployed in the fuel storage basin to assist in sample collection and removal of high contamination areas within the remaining 1 meter (3.3 feet) of fill. A small number of spent nuclear fuel elements are expected to be located and will be removed and shipped to the 100-K Area fuel storage basins.

Preparations are also being made to initiate demolition activities at the 118-C-4 horizontal control rod storage cave in the 100-B/C Area and at the 100-N Area ancillary facilities. Engineering documents (e.g., work plan, air monitoring plan, sampling plans, etc.) are being developed in preparation for this work.

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 fuel storage basins) and the 308 Building.

2.3.13 Groundwater Protection Program

R. T. Wilde

DOE established the Groundwater/Vadose Zone Integration Project (Integration Project) in 1997 as its centerpiece for water resources protection for the Hanford Site. On July 1, 2002, the project was transferred from the environmental restoration contractor to Fluor Hanford, Inc. and re-designated the Groundwater Protection Program. Specifically, the Groundwater Protection Program coordinates all projects at Hanford involved in characterizing, monitoring, and remediating groundwater and the vadose zone, with the objective of protecting the Columbia River.

The Groundwater Protection Program 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 Monitoring Project is under the umbrella of the Groundwater Protection Program.

During 2002, the Groundwater Protection Program team compiled an array of accomplishments that span its key focus areas – groundwater remediation, soil zone remediation, waste site investigations, assessment of Hanford impact, science and technology, and integration management. The efforts within these focus areas directly supports DOE's plan for the Hanford Site.

2.3.13.1 Groundwater Remediation

L. C. Swanson

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 the 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 ppm) of chromium (WAC 173-201A). Chromium concentrations exceeding 600 µg/L (0.6 ppm) have been measured in the porewater of riverbed sediment adjacent to the 100-D Area (BHI-00778). Background chromium concentrations are usually <1 µg/L (0.001 ppm) in the river.

During 1994, a groundwater extraction system was installed in the 100-D Area to test chromium removal from groundwater using ion exchange technology. Following the record of decision during 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 2002, the total amount of groundwater treated by pump-and-treat systems in the 100-D and 100-H Areas was 350.5 million liters (92.6 million gallons), with the removal of ~32 kilograms (~70.6 pounds) of hexavalent chromium. Since 1997, more than 1.53 billion liters (404.1 million gallons) of groundwater have been treated, with 161 kilograms (354.9 pounds) of chromium removed (DOE/RL-2003-09). 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 2002, the 100-KR pump-and-treat system treated 445.7 million liters (117.7 million gallons) of groundwater and removed 35.3 kilograms (77.8 pounds) of chromium. Total chromium removed since operations began in 1997 is 184.1 kilograms (405.9 pounds) through treatment of 1.69 billion liters (446.4 million gallons) of water (DOE/RL-2003-09). Treated groundwater is re-injected into the aquifer upgradient from the 100-KR-4 extraction wells.

In addition to pump-and-treat remediation, in situ redox manipulation technology continues to be demonstrated in the southwestern 100-D Area to address 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 2002, the treatment zone was expanded by injecting the chemical reducing agent into 17 new wells.

The loss of reducing conditions in the aquifer at six wells was identified in early 2001. Five of the six wells were originally treated during 1997 or 1998, while the sixth well was originally treated during 2000. The wells were all re-treated in late 2002 to re-establish the reactive barrier.

Chromium concentrations in wells along the barrier axis and west of the northern and southern ends of the barrier are generally low (<20 µg/L [0.02 ppm]), except in three barrier wells where concentrations are as high as 230 µg/L (0.23 ppm). A few wells to the west of the central part of the barrier still have high concentrations ranging from 99 to 542 µg/L (0.099 to 0.542 ppm).

Barrier construction continued during 2002 and is expected be completed during 2003. By the end of 2002, 17 additional wells had been constructed and treated, increasing the barrier length to 630 meters (2,067 feet) (DOE/RL-2003-05). The barrier is ~15 meters (~48 feet) wide. The final barrier should be over 680 meters (2,230 feet) long. The barrier will intercept and neutralize chromium-contaminated groundwater moving from the aquifer to the Columbia River. The current pump-and-treat systems will also continue to operate.

Strontium-90. The 100-NR-2 (N Springs) pump-and-treat system began operating during September 1995 north of N Reactor and was designed to reduce the flux of strontium-90 to the Columbia River. The pump-and-treat system operates extraction wells to maintain hydraulic capture. 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 2002. About 121.7 million liters (32.2 million gallons) were processed during 2002. During that period, 0.20 curies (7.4 gigabecquerels) of strontium were removed from the groundwater. Over 788.2 million liters (208.2 million gallons) of groundwater have been processed since the system began operation, removing 1.3 curies (48 gigabecquerels) of strontium (DOE/RL-2003-09).

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 operation beginning in 1996. During 2002, 281 million liters (74.3 million gallons) of groundwater were treated, removing over 965.8 kilograms (2,125 pounds) of carbon tetrachloride. A total of 1.95 billion liters (516 million gallons) have been processed since startup, removing 7,049 kilograms (15,540 pounds) of carbon tetrachloride.

Uranium, Technetium-99, Carbon Tetrachloride, and Nitrates. Treatment of the groundwater plume underlying the 200-UP-1 Operable Unit in the 200-West Area continued throughout 2002. 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 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 2002, with the two extraction wells pumping 79.1 million liters (20.9 million gallons) of groundwater. Treatment of groundwater removed 14.9 grams (0.0329 pound) of technetium-99, 27.6 kilograms (60.8 pounds) of uranium, 2.7 kilograms (6.0 pounds) of carbon tetrachloride, and 3,665 kilograms (8,080 pounds) of nitrate. The pump-and-treat operation made significant progress toward reducing technetium-99 concentrations to below required cleanup concentration levels, but less progress was made with uranium (DOE/RL-2002-67).

During 2002, technetium-99 concentrations as high as 99,700 pCi/L (3,687 Bq/L) were observed at S-SX Tank Farm well 299-W23-19. In response to this situation and after completing a field evaluation, a technical approach of extensively purging this well (~11,300 liters [3,000 gallons]) during quarterly sampling events was implemented (RPP-10757). Purgewater from sampling 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 2002. 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 2002; the other two systems were maintained in standby mode. 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 2002. Since operations began, soil-vapor extraction has removed 77,798 kilograms (171,515 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 2002 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. During 2002, a series of negotiations were completed with DOE and state and federal regulators that resulted in the consolidation of a number of operable units and generation of a number of new milestones for these operable units. The revised investigation approach allows for evaluation of one or more operable units in a single remedial investigation/feasibility study. This consolidation is reflected in the following summary descriptions of activities that were performed during 2002.

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. 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 evaluation 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. Tri-Party Agreement Milestone M-015-38A requires the feasibility study to be submitted to the state and federal regulators by March 31, 2003. The results of the feasibility study have been summarized in a proposed plan that identifies the preferred remedial alternatives for the waste sites in these operable units. The proposed plan has the same milestone as the feasibility study. The proposed plan will undergo public review.

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 work conducted in 2002 included test pit characterization activities at the 216-B-63 trench and the 216-S-10 pond/ditch. The test pit characterization at the 216-A-29 ditch was completed during 2001.

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, 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 (http://www2.hanford.gov/ARPIR/common/findpage.cfm?AKey=D8434463). During 2002, a review was conducted to determine if any additional characterization was required to account for the consolidated operable unit waste sites being added to the work plan. It was concluded that the additional operable unit waste sites aligned with the 200-CW-5 Operable Unit conceptual models, or with conceptual models from other 200 Areas work plans, and that no additional characterization was needed to support the remedial investigation/feasibility study process.

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 from T Plant. A work plan (DOE/RL-2001-66) was approved in 2002. The work plan 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.

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 work includes installing vadose zone boreholes and test pits to collect soil samples and conducting geophysical logging at the boreholes.

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, Reduction-Oxidation Plant, and Plutonium-Uranium Extraction Plant, as well as 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 now proposes 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). The work includes installing vadose zone boreholes to collect soil samples and conduct geophysical logging. In addition, up to six drive casings will be installed and geophysically logged at the 216-A-10 crib. The geophysical log data will be used to determine the optimum location for the characterization borehole at the 216-A-10 crib.

200-TW-1 and 200-TW-2 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 work plan (DOE/RL-2000-38) was prepared and approved. The work plan proposes 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 two operable units were completed in 2001 and consisted of installing, soil sampling, and geophysical logging of three vadose zone boreholes (one each at the 216-T-26 crib, the 216-B-38 trench, and the 216-B-7A crib). In addition, five drive casings were installed for geophysically logging at the 216-B-38 trench. The drive casing data were used to determine the optimum location for the borehole at that waste site. Data from the laboratory analyses were compiled into a draft remedial investigation report during 2002, which was provided to reviewers in October. The remedial investigation report (DOE/RL-2002-42) includes a human health risk assessment and screening of ecological impacts. The document will be revised during 2003, following receipt of review comments.

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 for this operable unit was submitted for review during 2001 (DOE/RL-2001-01). The study includes a strategy to reach final decisions for remediation of carbon tetrachloride in the 200-West Area. The study 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 the Reduction-Oxidation Plant, the Plutonium-Uranium Extraction Plant, U Plant, and the C Plant. The 200-PW-6 Operable Unit waste sites received plutonium-rich process waste from the Plutonium Finishing Plant. The revised study is expected to be approved during 2003.

The remedial investigation at the 200-PW-1 Operable Unit is expected to focus on two representative waste sites, the 216-Z-1A tile field and 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. 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, the pipelines that conveyed liquid waste to those discharge sites, and solid waste burial ground trenches.

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 2002. Activities included water balance monitoring, stability surveys, and biotic surveys. A draft report to document the monitoring results was prepared during 2002.

2.3.13.4 Waste Site Investigations — Vadose Zone Characterization

R. G. McCain, P. D. Henwood, S. M. Sobczyk, A. W. Pearson, and S. E. Kos

Beginning in 2001, the method developed for the vadose zone baseline characterization around the single-shell tanks was extended to liquid waste disposal sites and burial grounds in the 200 Areas. The logging systems previously developed for detection and identification of manmade gamma-emitting radionuclides in the vadose zone are being used to support the work. The Spectral Gamma Logging System uses a detector that is capable of quantifying gamma-emitting radionuclides from background levels to several thousand picocuries per gram. A second system, the high-rate logging system, was specifically developed to measure radionuclide levels up to several hundred million picocuries per gram (cesium-137). These logging systems are collecting data in existing boreholes within and adjacent to waste disposal sites in the 200 Areas.

Approximately 860 existing boreholes have been identified in the Hanford 200 Areas Vadose Zone Characterization Plan (MAC-HGLP 1.7.1). In 2002, the characterization program completed the following:

- Spectral Gamma Logging System logs for 70 existing boreholes.
- Spectral Gamma Logging System logs for nine new boreholes drilled for ongoing remedial investigation projects.
- Spectral Gamma Logging System logs for five RCRA groundwater monitoring wells.
- Spectral Gamma Logging System logs for three boreholes at an intermediate and low-activity waste site.
- High-rate logging system logs for 23 boreholes.

During 2002, Microsoft® Excel workbooks were used for log analysis. The primary advantage of Excel is that the calculations are easily traceable and greater flexibility is provided for dealing with variable borehole conditions. Also, Excel files represent a universal format by which log data can be transmitted to others. The log plots and the log data report are converted to Adobe® Acrobat® (*.PDF) files to facilitate electronic transmittal, allowing log data to be widely distributed via electronic media.

When all available boreholes in a specific area have been logged and evaluated, a waste site summary report is prepared. These reports consolidate information from individual baseline spectral gamma logs, other available borehole logs and drillers' reports, geologic data, sample data, and operational history to summarize vadose zone contamination conditions. Where appropriate, data from the tank farms baseline studies are incorporated, and subsurface visualizations are prepared. During 2002, waste site summary reports were issued for the 216-B-35 to 216-B-42 trenches (GJO-2002-322-TAR) and the 216-B-8 crib and adjacent areas (GJO-2002-343-TAR), and a waste site summary report for the 216-B-5 reverse well and adjacent sites was in progress. Waste site summary reports are issued in paper copy and on CD-ROM. All supporting data are included as appendices on the CD-ROM. All log data, log plots, and reports are accessible at http://www.gjo.doe.gov/programs/hanf/HTFVZ.html.

2.3.13.5 Assessment of Hanford Impact

R. W. Bryce and C. T. Kincaid

During 1999, DOE initiated the development of an assessment tool that will enable the users to model the movement of contaminants from all waste sites at Hanford through the vadose zone, groundwater, and the Columbia River and estimate the impact of contaminants on human health, ecology, and the local cultures and economy. This tool was named the System Assessment Capability. An assessment was completed during 2002 with the System Assessment Capability that demonstrates that it is a functional assessment capability.

The results of that assessment are presented in *An Initial Assessment of Hanford Impact Performed with the System Assessment Capability* (PNNL-14027). The assessment provided the following information:

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

- Focused on subsurface transport, the Columbia River, and risks to human and ecological health, the economy, and culture.
- Included the geographic region from Rattlesnake Mountain to the Columbia River and from the Vernita Bridge to McNary Dam on the Columbia River.
- Included the cleanup actions in Hanford's cleanup plans and agreements as of October 2000.
- Consisted of a stochastic simulation for the period 1944 to 3050 using 25 realizations, thus providing an initial look at uncertainty.

The findings of the initial assessment for the Central Plateau sites and associated contaminant plumes parallel those of the composite analysis published during 1998 (PNNL-11800). The results also are consistent with concentrations in environmental media measured by the Environmental Surveillance Program (PNNL-13910) and the Hanford Groundwater Monitoring Project (PNNL-13788). Both the monitoring results and the assessment indicate that Hanford's effect on the Columbia River has peaked and is now declining if the cleanup actions currently planned are carried out. The initial assessment also identified some areas where an improvement to our understanding of the Hanford Site and how it is represented in this capability could improve the quality of our decisions. While the capabilities of System Assessment Capability are confirmed by its ability to simulate the tritium plume, further improvements are needed to better match groundwater plumes for other mobile contaminants including technetium-99, iodine-129, and total uranium. Completion of the initial assessment has provided information needed to design improvements to System Assessment Capability, a revision that will be designed to meet the requirements for the composite analysis, an assessment required by DOE Order 435.1.

While much of the emphasis on waste management at Hanford has been on isolating plutonium, strontium-90, and cesium-137 from the environment, this assessment identifies technetium-99 and uranium as the contaminants from the Central Plateau that will contribute the most to potential impact in the next 1,000 years through the groundwater pathway. The results of the assessment were considered in the development of a groundwater initiative within the *Performance Management Plan for the Accelerated Cleanup of the Hanford Site* (DOE/RL-2002-47). Locations containing large inventories of these mobile long-lived contaminants are being considered for accelerated action. The remediation of the BC cribs located just south of 200-East Area was identified as an important action for acceleration due to the large inventory of technetium in those facilities and its potential to adversely affect groundwater predicted by the assessment.

The System Assessment Capability represents a holistic examination of the Hanford Site's radioactive and chemical waste legacy. For this reason, it can be used to examine the risk consequences of cleanup alternatives. To illustrate this, the assessment was re-run during 2002 without infiltration-reducing covers on waste sites. This action is not being considered for waste sites and was chosen only as a simple illustration of the capability. A four-fold increase in the amount of technetium-99 released to groundwater was predicted for the no cover case. It also showed that covers have the greatest impact on mobile long-lived radionuclides that did not get released with large volume discharges. This clearly points out the importance of surface barriers and covers that protect groundwater from enhanced infiltration, and provides useful information for cost-effective barrier design.

2.3.13.6 Science and Technology

M. D. Freshley

The Groundwater Protection Program's science and technology focus area provides data, tools, and scientific understanding to fill information gaps to make remediation and site closure decisions. The science and technology focus area also provides data to set the stage for long-term monitoring and site stewardship. The following is a description of 2002 accomplishments.

During 2002, the science and technology "roadmap" was updated to include activities for soil and groundwater remediation (PNNL-14092). The roadmap, which is a tool used to manage work, was revised during several workshops involving DOE, Hanford contractors, regulators, stakeholders, and Tribal Nations. This revision of the roadmap aligns work with the Groundwater Protection Program's initiatives to accelerate groundwater remediation and protection.

Soil Inventory. During 2002, the soil inventory model (BHI-01496) was modified and applied. The model was revised to estimate inventories of waste disposed to sites that operated over multiple years. The soil inventory model was used to estimate waste site inventories used in the site-wide assessment, i.e., the System Assessment Capability computer model.

B-BX-BY Tank Farm Investigation. Laboratory and modeling studies were completed for the B-BX-BY Tank Farm. These studies addressed a number of scientific issues associated with the composition of tank waste that has leaked to the vadose zone. The investigations resulted in new information about how strontium-90 and uranium move through the vadose zone and provided geochemical models to predict future behavior of contaminants. Information about the investigations is summarized in an appendix of the B-BX-BY Tank Farm field investigation report (RPP-10098).

Vadose Zone Transport Field Study. The Science and Technology Project completed a field experiment at a clastic dike (a common sedimentary structure in the vadose zone at Hanford) located along Army Loop Road. The clastic dike was used in an infiltration test to evaluate the effects of varying soil properties on water flow and contaminant transport in the vadose zone (PNNL-14109; PNNL-14150).

Biological Fate and Transport. During 2002, the Science and Technology team completed laboratory experiments to determine the uptake of technetium-99 by periphyton, the brown slime on rocks in the Columbia River. Experiments were initiated for strontium-90. The results demonstrate that uptake and elimination of the contaminants are concentration-dependent. The exposure concentrations did not cause a toxicological effect for either trout (completed in 2001) or periphyton.

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

T. W. Fogwell and K. L. Nickola

The Groundwater Protection Program team members have worked closely with DOE and Hanford regulators to characterize, protect, remediate, and monitor Hanford Site groundwater. Program staff also 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 Protection Program developed a master plan of action during 2002. In short, *Hanford's Groundwater Plan: Accelerated Cleanup and Protection* (DOE/RL-2002-68) describes how and when accelerated cleanup work will be accomplished.

Public Involvement. During 2002, 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. Program 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 website with information about the program's missions, a calendar of upcoming events, and links to a variety of valuable resources was developed during 2002. The website is scheduled to be launched in 2003 at http://www.hanford.gov/cp/gpp/.

Databases. The Groundwater Protection Program manages several Hanford environmental databases. The Virtual Library is a database that provides a web-based resource of Hanford environmental data to Hanford staff. Through the use of stand-alone modules, users can retrieve, graph, and generate reports with data contained in the electronic library. During 2002, several additions were made to the Virtual Library, including the addition of two new modules and two "orphaned" modules. One of the new modules contains data for groundwater, soil, soil gas, air, surface water, and miscellaneous material samples captured in the Hanford Environmental Information System (HEIS 1994) database. The other new module contains data from the System Assessment Capability Rev. 0 modeling run, which helps capability developers identify issues that must be addressed in future revisions. "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. Of the "orphaned" databases added during 2002, one contains data on the volume of

effluent discharged to the soil at disposal sites in the 200-East and 200-West Areas, while the other contains particle size and distribution data for soil on the Hanford Site.

In addition to the Virtual Library, the Groundwater Protection Program manages the Hanford Environmental Information System, the Hanford Well Information System, the Hanford Geographic Information System, and the Waste Information Data System. During 2002, the Hanford Environmental Information System was modified so users could more easily perform statistical analyses, the Hanford Well Information System was re-engineered to provide better quality traceable data, and the Hanford Geographic Information System was expanded to include data associated with more than 100 land survey jobs. During 2002, the Waste Information Data System documented closure of 23 waste sites, and a group of 71 individual releases in the tank farms were merged into 8 consolidated soil sites based on tank farm boundaries. Other databases supporting specific activities within the Groundwater Protection Program were also maintained during 2002, including pump-and-treat project-specific databases and the in situ redox manipulation project-specific database.

2.3.14 Hanford Waste Tanks Research and Technology Development

M. A. Showalter

Since 1994, the Tanks Focus Area, created by DOE's Office of Environmental Management, served to integrate radioactive tank waste remediation efforts across the DOE complex, including the development of technology. In September 2002, due to restructuring efforts at DOE, responsibility for the Tanks Focus Area was transferred to the Office of Environmental Management. However, before this transition, the Tanks Focus Area supported the DOE Office of River Protection during 2002 by addressing a number of high priority issues discussed in the following sections.

2.3.14.1 Safe Waste Storage

Remotely Operated Non-Destructive Examination 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 Examination System was developed in 2002. This system uses a slightly adapted off-the-shelf magnetic crawler to transport sound-emitting scanning equipment into the lower knuckle region. The scan data are then analyzed for indications of pitting, wall thinning, and corrosion.

During acceptance testing, the system was evaluated for (1) general system operability, (2) calibration and deployment, (3) flaw detection and sizing, (4) system failure modes and retrievability, and (5) system teardown and setup. The system also performed inspection of a variety of knuckle regions in a large carbon-steel simulated tank. Testing proved the system to be fully operational and paved the way for deployment of the system in tank AW-102 during January 2003.

2.3.14.2 Tank Waste Retrieval

During its 8 years of operation, the Tanks Focus Area assisted in developing methods to retrieve waste from the Hanford Site's single-shell tanks. During 2002, an independent panel of experts assessed the planning and development activities for retrieval technologies related to three single-shell tanks (tanks S-102, S-112, and C-104). The panel was also asked to review and discuss the rationale of the waste mobilization and transfer, and leak detection, monitoring, and mitigation aspects related to each tank and associated technology. The panel found that the technical and management approaches for each tank and associated technology were sound and likely to lead to successful completion. The panel recommended several technical and management enhancements that, if adopted, may further increase the probability of success regarding the

three tanks and associated technologies commissioned to retrieve waste from single-shell tanks.

Other retrieval technologies investigated by the Tanks Focus Area for the Hanford Site during 2002 are discussed in the following paragraphs.

Sonication. Large, underground storage tanks at the Hanford Site and across the DOE complex contain radioactive waste consisting of liquid and solidified materials (saltcake) that is difficult to mobilize. Conventional retrieval methods involve the use of large volumes of liquids to soften the saltcake; however, these methods may result in waste leaking into the soil. The Tanks Focus Area provided funding to Robotics Crosscutting Program staff from Pacific Northwest National Laboratory and Oak Ridge National Laboratory to identify methods for low-liquid-volume retrieval of waste from potentially leaking single-shell tanks. Sonication, a method using ultrasound, was selected for subsequent testing.

During 2002, Pacific Northwest National Laboratory staff conducted bench-scale testing on various saltcake simulants to evaluate the ability of sonication to fracture and dislodge waste simulants stored in potentially leaking single-shell tanks. Oak Ridge National Laboratory staff investigated the deployment of an array of sonicators using a small mechanical crawler.

Mobile Retrieval System. During 2002, the Tanks Focus Area, the Robotics Crosscutting Program, and CH2M HILL Hanford Group, Inc. began collaborations with industry to develop a mobile retrieval system (a technology that mixes and mobilizes sludge waste) for installation and deployment in tank C-104 (a tank that contains large quantities of high-level radioactive waste sludge). The Tanks Focus Area and Robotics Crosscutting Program organized an independent review of the planned cold testing of the retrieval system. During the review, participants discussed project status, system concept, risk analysis and mitigation, planned factory acceptance tests, future functional and operational cold testing, as well as lessons learned from Oak Ridge National Laboratory experiences. The independent review helped to determine the system's viability and provided recommendations to help reduce the risk of encountering significant field operational problems following deployment. Once the mobile retrieval system is deployed in tank C-104, it will be the first time that the proposed components will operate in a nuclear waste environment.

Fluidic Retrieval System. The Tanks Focus Area and CH2M HILL Hanford Group, Inc. collaborated with two international partners, AEA Technologies of the United Kingdom and the Mining Chemical Combine of Russia, to design, fabricate, and test somewhat similar fluidic retrieval systems for potential removal of sludge and salt waste from Hanford Site tanks. Following full-scale proof-of-concept testing of the two fluidic retrieval technologies during 2002, both systems are currently awaiting consideration for future use.

Tank S-112 Saltcake Retrieval. An alternative technology for sluicing and retrieving saltcake waste from tank S-112 was investigated in 2002. The system consists of three manual water distribution devices and a central water distribution device located on a riser near the center of the tank. From these devices, water is distributed to the surface of the saltcake. A previously installed pump is used to remove the liquid brine. Each water distribution device contains a solid stream nozzle and a spray nozzle. The solid stream nozzle can deliver a forceful, focused stream at a range of 9 meters (30 feet), and the spray nozzle can project a broader spray pattern at a similar range. The central water distribution device turns at an angle in the tank and also oscillates at a 360-degree rotation using its own water pressure to drive movement. The system was tested in 2002 at the newly constructed Hanford Cold Test Facility. The testing verified that the manual water distribution device and central water distribution device and nozzles performed as specified and in some instances exceeded expectations. However, the vertical plane range of motion of the central water distribution device is being re-evaluated.

2.3.14.3 Tank Waste Processing

Alternative Treatment for Low-Activity Waste. Plans were developed to demonstrate several alternative treatment options for low-activity liquid waste stored in tanks at Hanford. During a workshop held to identify criteria and quantitative measures to support decision(s) on supplemental treatment technologies to accelerate Hanford tank waste treatment, participants identified six

major goals: (1) provide environmental protection comparable to the current vitrified waste disposal plan, (2) maximize schedule acceleration, (3) maximize cost-effectiveness, (4) assure worker and public safety, (5) maximize operability, and (6) minimize impacts to the overall system. From these goals, the participants determined action items such as developing trial data for each measure and performing test scoring with the identified criteria and measures; using smaller group meetings to discuss the best approach for the operability measure; and determining what information feeds a performance assessment and how that information is used. To achieve the ultimate acceleration goal of immobilizing waste by 2028, immediate identification of criteria and measures was required to help define requirements for industrial procurements and the corresponding scope for technology testing during 2003. Ultimately, this effort was incorporated into the Hanford Performance Management Plan for accelerated cleanup.

Glass Property Models. The tank waste at Hanford will be separated into high-level waste and low-activity waste fractions, which will be separately vitrified in the Waste Treatment Plant. Technical issues related to vitrification of Hanford waste were evaluated in 2002, including the solubility of troublesome components, the influence of secondary phases on glass processing and acceptability of the waste form, and expansion of glass property models for glass volume projections. Hanford Site glass property models were evaluated and updated to reflect recent changes to information about sludge composition and blending strategies. These updates encompassed the revised composition for high-level waste glasses resulting from properties that may limit waste loading, including primarily troublesome component solubilities and liquid temperature. These models generated data that will allow staff to predict the production rate of generated glass based on various processing options. The updated glass property models replace previous glass property predictions for the Hanford Site, which were incomplete and led to large differences in the prediction of high-level waste glass volumes, waste feed delivery requirements, and melter sizing. As a result of this research, a new frit (the fused, or partially fused materials used in making glass) was developed during 2002 that will provide a melt rate 20% faster than previous frits in small-scale melter tests. This frit also has features that allow more waste to be incorporated into the glass and is expected to yield significantly higher melter throughput, which will help to significantly reduce vitrification costs.

Glass Formulations with Higher Waste Loading. Waste streams at the Hanford Site contain a variety of chemical compounds, many of which can affect waste loading during vitrification or cause operating difficulties with melt rate, offgas, or equipment corrosion. Previous research has shown that higher melt temperatures may permit higher waste loadings (more than 60%) in the glass for facilitating handling of waste containing high refractory oxides or waste solubility limiting components, such as aluminum, zirconium, chromium, and sulfate. However, before advanced melters can be implemented in DOE radioactive waste treatment facilities, some technical issues need to be addressed, including life of melter materials; the ability to accommodate electrically conductive noble metal fission products; power requirements and control stability; the ability to meet production rate goals with liquid feed; the ability to increase waste loading; offgas emissions treatment; and the ability of the vitrified product to meet disposal requirements.

During 2002, research on advanced melter technologies focused primarily on French and Russian melters using induction cold crucible melter technology (a smaller, less expensive melter that generates much less waste for ultimate disposal). This research was supplemented by evaluating increased waste loading for the standard Joule-heated melter (suitable for a wide range of low-temperature-melting glasses). A specific Hanford waste stream from tanks C-106 and AY-102 was used, representing a blend of tanks to be processed during high-level waste vitrification efforts. As a result, researchers developed glass containing up to 70% waste loading, which meets specific criteria for induction cold crucible melter processing which requires temperatures of ~1250°C to 1350°C (2282°F to 2462°F). In addition, researchers developed glass formulations at higher (50% to 60%) waste loading that can be potentially processed through the Joule-heated melter at 1150°C (2102°F). Based on these results, sites like Hanford and the Savannah River Site may benefit from immobilization using higher temperature glass formulations in advanced melters, enabling DOE to evaluate options for future high-level waste processing that may reduce waste volumes and costs.