WM'00 Conference, February 27-March 2, 2000, Tucson, AZ

THE OFFICE OF RIVER PROTECTION—MANAGING AND DISPOSING OF HANFORD SITE'S HIGH-LEVEL WASTE

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ABSTRACT

In late 1998, Congress directed the U.S. Department of Energy (DOE) to establish the Office of River Protection (ORP) at the Hanford Site to manage the largest and most complex of DOE's environmental cleanup projects. The ORP reports directly to the DOE Assistant Secretary for Environmental Management and is responsible for storing, treating, immobilizing, and disposing of the Hanford Site's 200,000 m^3 (53 Mgal) of highly radioactive waste in an environmentally sound, safe, and cost-effective manner. This waste, stored in deteriorating underground tanks, threatens the Columbia River and must be dealt with before more waste leaks to the soil and groundwater.

CH2M HILL Hanford Group, Inc. (CHG) and BNFL Inc. (BNFL), prime contractors to DOE, are conducting most of the work on this project. CHG is responsible for managing the waste within the tank farms, retrieving the waste, and then storing or disposing of the immobilized waste after it has been processed. BNFL Inc. is responsible for processing the waste in facilities that it designs, constructs, operates, and finances. Waste processing consists of dividing the waste into high-level and low-activity fractions, removing radionuclides from the low-activity fraction, vitrifying both fractions, and pouring the vitrified waste into steel containers. It is estimated that approximately 14,000 m^3 of vitrified high-level waste (HLW) and 185,000 m^3 of low-activity waste (LAW) will be produced. The HLW canisters will be stored on Site until shipped to a federal geologic repository, while the LAW containers will be disposed of on Site in near-surface vaults. After the waste has been removed, the tanks will be closed.

Since being formed in December 1998, the ORP has taken several actions to better manage the work. These include becoming a separate DOE office at the Hanford Site, changing the tank farm operations contractor to an ORP prime contractor, managing the effort as a single project, acquiring additional approval authority and budget control, and adding experienced staff with the skills to manage a large, fixed-price contract. The ORP Manager has challenged the project team with two goals:

1. Double productivity while still safely managing the stored tank waste
2. Start treating and immobilizing the waste by 2005.

This is a huge challenge, but the importance of this project to the people of the Northwest, the high cost, and the decades required to complete the project demand that the team do its very best.

INTRODUCTION

The Office of River Protection (ORP) has been established within the U.S. Department of Energy (DOE) to manage the DOE's largest and most complex environmental cleanup project. The ORP, located at the Hanford Site and reporting directly to the DOE Assistant Secretary for Environmental Management, is responsible for managing the Tank Waste Remediation System

(TWRS). The TWRS mission is to store, treat, immobilize, and dispose of the highly radioactive Hanford Site waste in an environmentally sound, safe, and cost-effective manner. Cleanup of other Hanford waste sites that also could affect the Columbia River is managed by the DOE Richland Operations Office (RL).

FORMATION OF OFFICE OF RIVER PROTECTION

In Section 3139 of the *Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (Public Law 105-261)* (1), Congress directed the Secretary of Energy to establish the ORP at the Hanford Site to manage the tank waste project. The Act imposed the following requirements:

1. The ORP be headed by a senior official of the DOE who shall report to the Assistant Secretary of Energy for Environmental Management.
2. The head of the ORP be responsible for managing all aspects of the TWRS, including those portions under privatization contracts.
3. The Secretary provide the manager of the ORP with the resources and personnel necessary to manage the tank waste privatization program in an efficient and streamlined manner.

The Act also required an integrated management plan within 90 days and a report at the end of two years on TWRS progress and any improvements in management as a result of the ORP.

The "Office of River Protection" name was chosen to emphasize the critical importance of the project to the nation; it was established at the Hanford Site in December 1998.

WASTE DESCRIPTION

The Hanford Site's highly radioactive waste, accumulated between 1943 and 1988, resulted from the production of plutonium for the nation's nuclear defense program. The waste volume and the size of the tanks can best be appreciated by comparison to the familiar (see Fig. 1 and Fig. 2).

Currently there are 200,000 m^3 (53 Mgal) of waste in 177 large underground tanks and 1,933 cesium and strontium capsules (Fig. 1). The 177 tanks include 149 single-shell tanks (SST) constructed between 1944 and 1964 and 28 double-shell tanks (DST) constructed between 1968 and 1986 (Fig. 2). The tank farm systems are located in the 200 Areas in the central portion of the Hanford Site, 11 km (7 mi) south and 16 km (10 mi) west of the Columbia River. The SSTs have exceeded their design lives, and 67 have leaked or are suspected to have leaked approximately 3,800 m^3 (1 Mgal) of radioactive and hazardous wastes, thereby contaminating the soil and groundwater. The tanks contain a mixture of chemicals and approximately 7 TBq (190 MCi) of radionuclides.

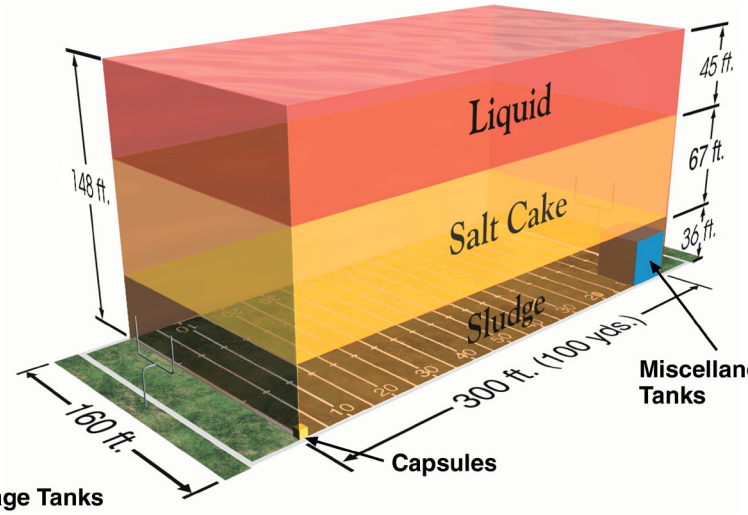

Fig. 1. Hanford Site Tank Waste Volume in Relationship to the Size of a Football Field.

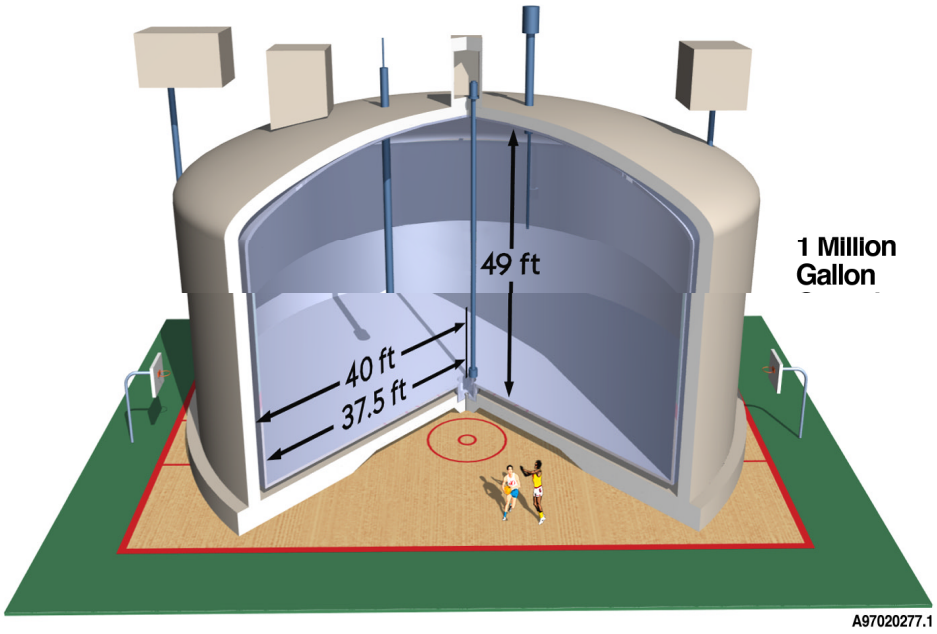

Fig. 2. The Size of a High-Level Radioactive Waste Underground Storage Tank as Compared to a Basketball Court.

In addition to the waste stored in the large underground tanks, approximately 5.3 TBq (143 MCi) of ^{90}Sr and ^{137}Cs were removed from the tank waste, converted to solid salts, doubly encapsulated in 1,933 metal capsules, and stored in water basins. The Facility Transition Project at RL is responsible for safely storing these capsules until they are transferred to the ORP for disposal.

There are also 47 active and inactive smaller miscellaneous underground storage tanks containing hazardous and radioactive waste of a largely undetermined nature. Additional equipment associated with the tank farms includes transfer pipes, pits, diversion boxes, support buildings, and other facilities.

PROJECT DESCRIPTION

A TWRS Environmental Impact Statement was issued in 1996 and a Record of Decision in 1997. The DOE decided to proceed with tank waste retrieval, treatment, immobilization, and disposal in two phases. Phase I would be a demonstration phase processing a small portion of the waste, and Phase II would be a production phase processing the remaining waste. The DOE decided to defer action on the cesium and strontium capsules until further information was available.

The TWRS Project is regulated under the *Hanford Federal Facility Agreement and Consent Order* (2), known as the Tri-Party Agreement, because the wastes contain hazardous components that fall within the *Resource Conservation and Recovery Act of 1976* (3). The Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the DOE signed the Tri-Party Agreement.

Objectives

While the ORP mission is to safely store, treat, immobilize, and dispose of the highly radioactive waste, its goal is to protect the Columbia River from future tank waste leaks by accomplishing the following objectives:

- Store the waste in a safe and environmentally sound manner until it can be retrieved for processing and disposal.
- Characterize the waste to provide the data necessary to store, retrieve, treat, immobilize, and dispose of the waste safely.
- Retrieve waste from the SSTs, DSTs, and miscellaneous underground storage tanks to the extent needed for closure of these tanks.
- Separate the retrieved waste into HLW and LAW fractions, so that most of the radionuclides and only a small part of the other waste materials are in the HLW fraction, with the remainder in the LAW fraction.
- Immobilize and dispose of the LAW fraction on Site.

- Immobilize and store the HLW on Site until it can be shipped to a federal offsite geologic repository for disposal.

- Close the tank farms and dispose of any residual waste, in-tank equipment, ancillary equipment, and underlying or adjacent contaminated soils.

- Dispose of the cesium and strontium capsules following evaluation of alternatives and issuance of a Record of Decision.

- Meet all Tri-Party Agreement commitments.

- Minimize total TWRS Project cost and reduce budget peaks.

Technical Approach

The technical approach for the TWRS Project is shown in Fig. 3 and includes the following five functions:

- Management systems
- Waste storage
- Waste retrieval
- Waste processing
- Immobilized waste storage and disposal.

Management systems include strategic planning and system integration, budgeting, developing and controlling the project schedule and cost baselines, coordinating environmental permitting and compliance, and stakeholder/public involvement.

The primary functions in waste storage are safety issue mitigation and resolution, waste characterization, authorization basis development and maintenance, waste surveillance and maintenance, DST space management, SST interim stabilization, tank farm upgrades, and vadose zone/groundwater investigation.

Waste retrieval involves retrieving the liquid and solid waste from the tanks and transferring it to the waste processing facilities. The tank farms will also be closed after the waste has been retrieved.

Waste processing includes treatment and immobilization of the waste. Treatment consists of separating the waste into two fractions, removing radionuclides from the LAW fraction, and blending the removed radionuclides with the HLW fraction. Both the LAW and HLW will be immobilized by vitrification and packaged in steel containers. It is estimated that approximately 185,000 m^3 (6.5 million ft^3) of LAW glass and 14,000 m^3 (494,000 ft^3) of HLW glass will be produced.

The immobilized waste storage and disposal functions include receiving the immobilized waste in steel containers; disposing of the LAW containers in near-surface trenches in a manner that would permit their retrieval for up to 50 years; and storing the HLW canisters on Site until they can be shipped to a geologic repository for disposal.

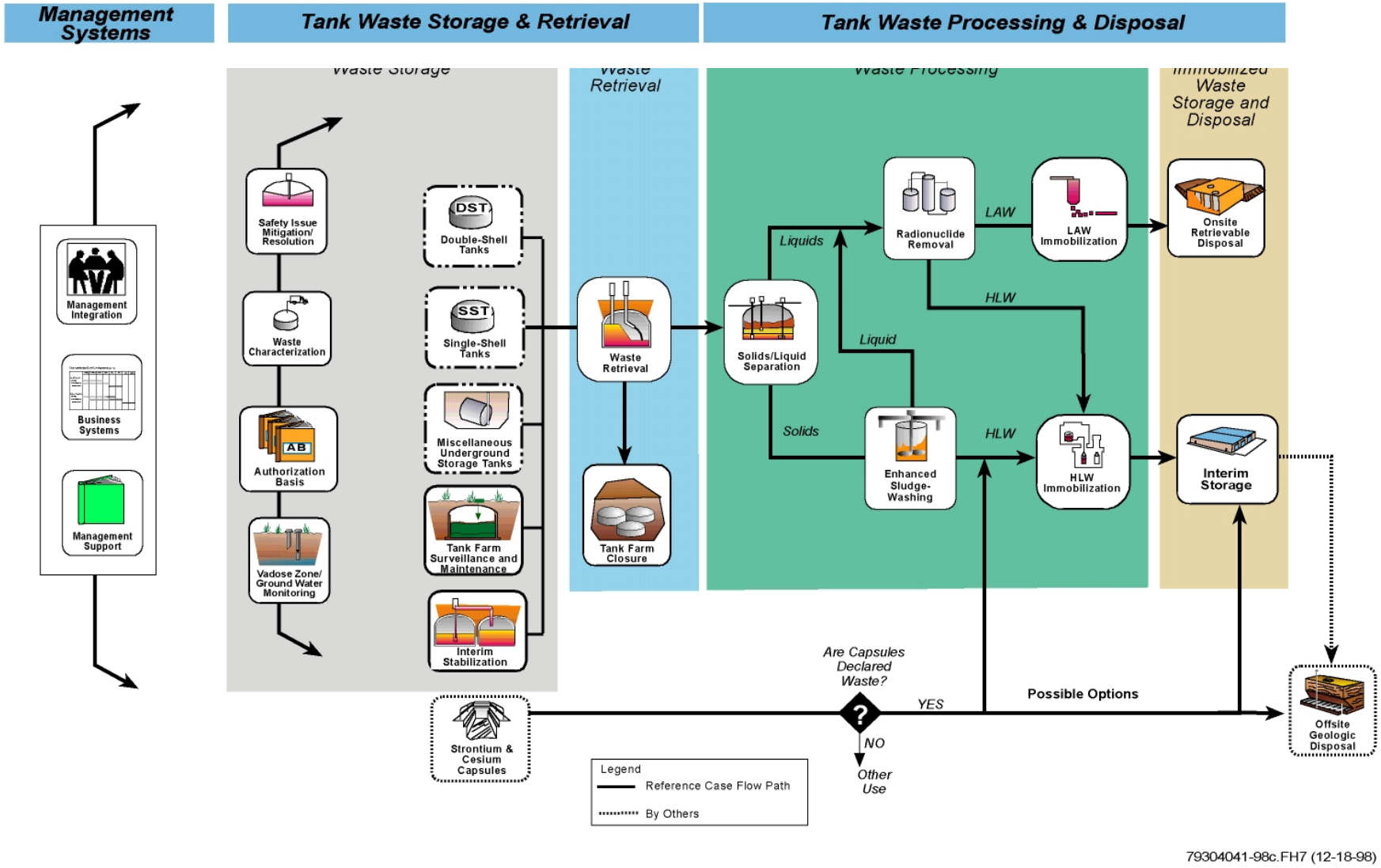

Fig. 3. Project Functional Diagram.

Performance of Work

While DOE's ORP manages the TWRS Project, contractors do the work. The ORP has two prime contractors, CHG and BNFL. CHG has a cost-plus performance-fee contract and is responsible for the waste storage, waste retrieval, and immobilized waste storage and disposal functions. The waste processing function has been "privatized," and BNFL is expected to design, construct, finance, and operate waste treatment and immobilization facilities that will produce immobilized waste products meeting DOE specifications. The DOE then will pay fixed-unit prices for product delivered. The first phase of the project, Phase I, will process approximately 10% of the tank waste and 25% of the radioactivity. In August 1998, DOE authorized BNFL to proceed with a 24-mo design phase (Phase I-B1) that will result in sufficient engineering and financial maturity to establish these fixed-unit prices and financing terms. At the end of this 24-mo period, DOE will decide whether to authorize BNFL to construct and operate the facilities as proposed or to take an alternate path.

Battelle Memorial Institute, operator of the Pacific Northwest National Laboratory, provides science and technology to the project, and other Hanford Site contractors provide services and support.

PROJECT MANAGEMENT

The TWRS Project is being managed as a single, integrated project, i.e., the work to be done has been defined, end points have been established, and the work is being managed to a schedule and estimated cost. A management organization structure is in place, and roles and responsibilities have been defined.

Organization

The project organization shown in Fig. 4 is as follows:

- Assistant Secretary for Environmental Management – Has programmatic responsibility for the project and provides management oversight of the ORP. Chairs the ORP Executive Board and coordinates with Congress, other U.S. Department of Energy, Headquarters (DOE-HQ) Offices, and other federal agencies.

- Assistant Secretary for Environment, Safety, and Health – Provides technical support to regulate BNFL and provides DOE-HQ oversight of the ORP environment, safety and health functions.

- Manager, ORP – Responsible and accountable for managing all aspects of the TWRS Project and reports directly to the Assistant Secretary for Environmental Management.

- Manager, RL – DOE's signatory of the Tri-Party Agreement, helps ensure integration between ORP and other Hanford Site activities and provides administrative support to ORP.

- Office of Safety Regulation of TWRS-P (i.e., Privatization) Contractor – Responsible for regulating radiological, nuclear and process safety; and occupational safety and health in BNFL facilities and reports directly to the Manager, RL.

- CHG – The prime contractor responsible for waste storage, waste retrieval, and immobilized waste storage and disposal.

- Privatization Contractor – The prime contractor (BNFL) responsible for waste processing.

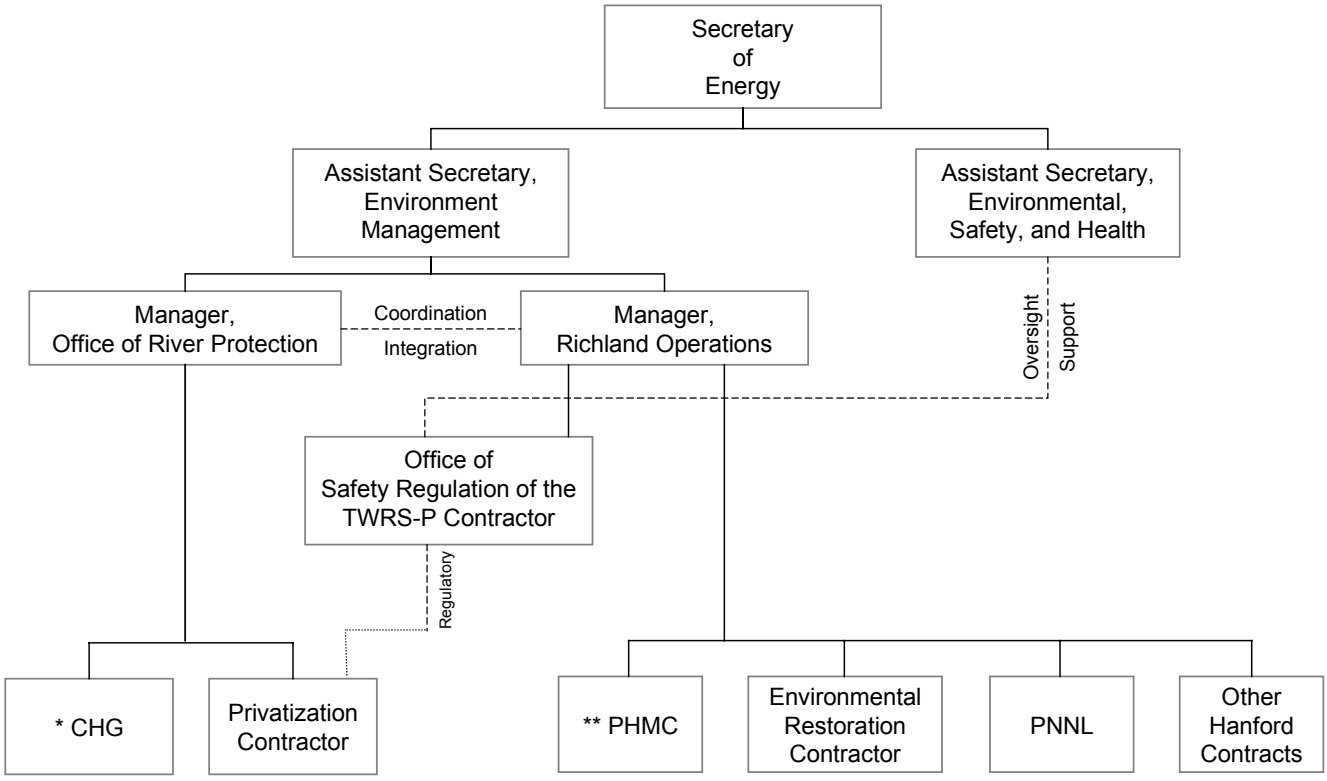

Fig. 4. Office of River Protection Organization Structure.

Management Approach

The TWRS Project will use proven project management systems to plan, execute, and control the work. An integrated baseline is being established as the primary management tool. The integrated baseline will describe the work scope to be accomplished, the schedule to which the work will be done, and the cost to do it. Baseline management includes maintaining the baseline; executing work in accordance with the baseline; monitoring, evaluating and reporting work progress against the baseline; controlling baseline changes; and taking corrective actions

when problems develop. A Project Integration Office has been established within the ORP to provide focus and integration of this effort.

Schedule and Cost

The Tri-Party Agreement includes a number of enforceable milestones for the project. The schedule for several important activities is as follows:

- Issue authorization to proceed with design and construction of Phase I waste treatment facilities: August 2000
- Start construction of Phase I waste treatment complex: July 2001
- Mitigate/resolve all high-priority tank safety issues: September 2001
- Complete removal of pumpable liquid from all 149 SSTs: September 2004
- Start hot commissioning of Phase I waste treatment complex: December 2007
- Start commercial operation of Phase I waste treatment complex: December 2009
- Complete Phase I waste treatment: December 2018
- Complete treatment of all waste: December 2028.

The cost of this project is estimated to be $30 to 50 billion in today's dollars. A more definitive cost estimate is being prepared as part of baseline development and will be available by August 2000.

ACCOMPLISHMENTS

The TWRS Project continues to safely store the waste and can boast of a number of recent technical and management accomplishments:

- Waste tank safety issue resolution – One of the old SSTs contained sufficient radionuclides that water had to be added to the tank to remove the decay heat by evaporation. Ninety-five percent of the sludge was sluiced from this tank (241-106-C) and transferred to a DST that is designed to accommodate the higher heat load. This action has resolved the high-heat safety issue.

- Equipment was installed and more than 340 m^3 (90,000 gal) of waste was pumped from Tank 241-101-SY to Tank 241-102-SY. Removing this waste from Tank 241-101-SY and diluting the remaining waste with water mitigated the waste level increase caused by the buildup of gas in the crust. Over the past few years, much work has been done to resolve other tank safety issues, and tank safety is now of much less concern.

- Safety management – The final safety analysis report for the tank farms was implemented and the Integrated Environment, Safety and Health Management System (ISMS) received Phase II verification.

- Interim stabilization of the SSTs – More than 1,900 m^3 (500,000 gal) of liquid waste was removed from SSTs in 1999. Pumpable liquids now have been removed from 120 of the 149 SSTs, and pumping is in progress on several others. The liquids slowly drain from the waste solids to a salt well where they are pumped from the SST to a DST over a period of several months. When removed, the liquids are no longer available to leak from these old tanks.

- Waste characterization – Waste characterization in more than 130 tanks has been completed and more than 200 full-depth waste samples have been taken and analyzed.

- Waste transfers – More than 3,800 m^3 (1 Mgal) of waste have been transferred from the 200 West Area to the 200 East Area through the recently completed 10.0-km (6.2-mi) cross-site transfer system.

- Waste processing – BNFL has been authorized to proceed with a 24-mo design phase to develop sufficient engineering and financial maturity to establish fixed-unit prices and financing terms for providing tank waste treatment and immobilization services in privately owned and operated facilities.

- Established the ORP – The ORP has been established at the Hanford Site, separate from RL and in separate facilities.

- ORP roles and responsibilities – A memorandum of agreement was established among the Assistant Secretary for Environmental Management; Manager, ORP; and Manager, RL, on roles and responsibilities. The Manager, ORP, obtained direct control of the ORP budget and full contracting authority over ORP prime contractors.

- ORP staffing – Of the 27 additional federal positions for ORP, 21 have been filled. Several of the new staff with expertise critical to managing the privatization contract were recruited from outside DOE.

- Operating contractor assignment – The operating contractor was reassigned from its role as a subcontractor to Fluor Hanford to a role as prime contractor to ORP. CHG became the new operating contractor in December 1999.

CHALLENGES

The ORP faces many challenges in carrying out this large, complex project. Most of the tank farms are old and contain obsolete equipment, yet the waste must be stored safely until it can be retrieved and immobilized. The environment must be protected while waste is removed from the many old SSTs that have leaked or may leak. The amount and rate at which leaked waste will travel through the vadose zone and groundwater to the Columbia River are not well understood. The large volume of waste and its complex chemical mixture challenge the treatment and vitrification processes and require a significant increase in vitrification capacity.

Acquiring the large amount of funding required to carry out this project over the next three decades will require the continued support of a broad constituency. The high cost mandates that all project participants make cost reduction a primary goal. Bold, innovative ways need to be found to do more for less while conducting the work safely.

The Manager, ORP, has challenged the project participants:

1. To double productivity (do twice as much work for the same funding) while still storing the waste safely.
2. To start waste treatment and immobilization by 2005.

CONCLUSIONS

The ORP has a critical mission of great importance to the Northwest – protecting the Columbia River. To achieve this mission, it must safely store the highly radioactive tank waste and aggressively move forward with waste retrieval, treatment, immobilization, and disposal. Excellent progress has been made in resolving safety issues and preparing for waste retrieval and processing; however, the next critical step is to acquire the large capital facilities needed for waste processing. The year 2000 will be a defining time for the project as DOE will decide whether to authorize BNFL to proceed with construction and operation of its waste processing facilities, and Congress will be requested to make a large funding commitment. The project team needs to rise to this challenge and make it happen.

REFERENCES

1. *Strom Thurmond National Defense Authorization Act for Fiscal Year 1999*, Public Law 105-261.

2. Ecology, EPA, and DOE, 1996, *Hanford Federal Facility Agreement and Consent Order,* as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and the U.S. Department of Energy.

3. *Resource Conservation and Recovery Act of 1976*, as amended, 42 USC 6901 et seq.