

**HANFORD SITE
TANK WASTE REMEDIATION SYSTEM
PROGRAMMATIC ENVIRONMENTAL
REVIEW REPORT**



Prepared by
U.S. Department of Energy

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Programmatic Environmental Review Report

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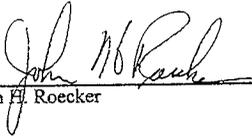
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ACRONYMS AND ABBREVIATIONS

BIO	Basis for Interim Operations
BNFL	BNFL, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FSAR	Final Safety Analysis Report
HLW	high-level waste
IHLW	immobilized high-level waste
ILAW	immobilized low-activity waste
LAW	low-activity waste
LMAES	Lockheed Martin Advanced Environmental Systems
PA	Performance Assessment
PNNL	Pacific Northwest National Laboratory
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SA	Supplement Analysis
SST	single-shell tank
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TWRS	Tank Waste Remediation System
WMA	waste management area

EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) committed in the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) Record of Decision (ROD) to perform future National Environmental Policy Act (NEPA) analysis at key points in the Program. Each review will address the potential impacts that new information may have on the environmental impacts presented in the TWRS EIS and support an assessment of whether DOE's plans for remediating the tank waste are still pursuing the appropriate plan for remediation or whether adjustments to the program are needed. In response to this commitment, DOE prepared a Supplement Analysis (SA) to support the first of these reevaluations. Subsequent to the completion of the SA, the Phase IB negotiations process with private contractors resulted in several changes to the planned approach. These changes along with other new information regarding the TWRS Program have potential implications for Phase I and Phase II of tank waste retrieval and waste storage and/or disposal that may influence the environmental impacts of the Phased Implementation alternative. This report focuses on identifying those potential environmental impacts that may require further NEPA analysis prior to authorization to begin facility construction and operations.

The SA and this report are one part of a comprehensive authorization-to-proceed process being conducted by DOE prior to proceeding with the next phase of the TWRS privatization project (Phase IB). The authorization-to-proceed process, including this report, was prepared to fulfill the ROD commitment to perform scientific, regulatory, and financial review of the TWRS Program at key points in the TWRS Program.

The TWRS Program mission is to store, treat, immobilize, and dispose of current and future Hanford Site tank waste in an environmentally sound, safe, and cost-effective manner. The Phased Implementation alternative selected in the TWRS ROD to support the TWRS Program tank waste disposal mission included a two-phased approach to tank waste retrieval, treatment, and storage or disposal. Phase I includes 1) continuing to safely manage the tank waste; 2) constructing and operating facilities to treat and immobilize 6 to 13 percent of the tank waste; 3) collecting additional information through tank waste and vadose zone characterization; and 4) demonstrating technologies that have the potential to reduce technical and financial uncertainties. Phase II includes constructing and operating larger production-scale facilities to retrieve, treat, immobilize, and store or dispose of the majority of the tank waste.

Changes in TWRS Program have occurred since the ROD and SA in 1) waste processing; 2) the schedule for Phase IB activities; and 3) other aspects of the TWRS Program (e.g., changes in the schedule for interim stabilization). Each of these categories of changes includes a variety of new information with differing potential environmental impacts. Many of the changes are interrelated. The major changes in the TWRS Program are as follows.

- The number of contractors authorized to proceed with Phase IB activities has been reduced from two to one. BNFL was chosen to proceed. This change has implications for compliance with the Tri-Party Agreement, the number of facilities and associated environmental impacts, and DST space management.

- Under the negotiated plan, Phase IB will consist of two parts: Part B-1 and Part B-2. Part B-1 will consist of a design phase of 24 months between 1998 and 2000. During Part B-1 BNFL will address technology scale-up; regulatory, financial, and permitting issues; and the safety basis for operations. At the end of Part B-1, DOE will make a decision whether to proceed with BNFL in Part B-2 and implement fixed-unit prices that will not exceed levels negotiated prior to the beginning of Part B-1. If DOE and BNFL cannot agree on fixed-unit prices at the end of Part B-1, DOE will have the rights to the design and intellectual property developed during Part B-1 and be able to proceed with a different contractor. If DOE proceeds with Phase B-2 using another contractor there is a risk of delaying the overall project.
- DOE will work with BNFL to carry out a number of activities including defining the most effective financing, technical, and programmatic approaches for the subsequent construction and operations period, Part B2.
- During Phase I/Part B-2, BNFL will initiate waste pretreatment in 2005, HLW vitrification in 2006, and LAW vitrification in 2007. Phase I will include immobilization operations from 2006 through 2016, when the facilities would be deactivated or used for Phase II waste processing.
- Because of the sequencing of hot operations startup, LAW liquids from the BNFL waste separations process (i.e., pretreatment) would be transferred to DSTs maintained by the Site management and integration contractor for storage for approximately 2 years. This change would impact DST space management during Phase IB and put additional constraints on available DST space to support SST waste retrieval. However, waste from two DSTs would be combined into one DST by removing cesium, strontium, technetium, and transuranics and concentrating liquids, and the number of tanks allocated to private contractors for waste receipt tanks has been reduced from two tanks to one tank. The extent of these constraints on DST space requires further evaluation during Phase I/Part B-1, which will determine whether further environmental reviews are necessary.
- Sludge washing will be conducted in the BNFL facility rather than in DSTs. This change will improve operational flexibility, reduce the volume of HLW for processing, and free up DST space allocated under the Site management and integration contractor's sludge washing approach.
- Specifications for removing technetium from the waste stream would result in much lower amounts of technetium in the ILAW. This would reduce potential environmental impacts from ILAW disposal to levels below those calculated in the Draft Performance Assessment (PA) for ILAW disposal. The PA will need to be recalculated to determine the extent of improvement in environmental impacts. The results could make alternative waste packaging and/or waste forms more viable depending on the waste performance and cost.

- Changes in the Phase IB schedule will require renegotiating the Tri-Party Agreement for milestones associated with start of hot operations of Phase I facilities and SST waste retrieval.
- No changes are proposed for implementation of Phase II at this time; however, changes in the schedule for implementing Phase I could influence decisions regarding how Phase II is implemented. Later startup of facilities in Phase I would compress the schedule for Phase II operations and require changes in Phase II facilities and/or operations required to meet Tri-Party Agreement milestones for completing SST waste retrieval and waste processing.

The proposed Phase IB changes would have implications for environmental impacts for a number of aspects of the TWRS Program. Several of the changes would tend to reduce potential environmental impacts compared to those calculated in the TWRS EIS or the SA. Potentially lower levels of environmental impacts include:

- Impacts to shrub-steppe habitat resulting from the decision to proceed with one rather than two contractors and the associated reduction in the number of facilities to be constructed
- Impacts to groundwater and long-term human health resulting from onsite disposal of ILAW containing lower levels of technetium.

Other proposed changes could either increase or decrease environmental impacts, depending on the outcome of evaluations performed during Phase I/Part B-1. These changes include the following.

- Resolving DST space management issues and the associated schedule for SST waste retrieval could have environmental impact depending on how the issue is resolved. Because the SSTs have exceeded their design life, continued use to store waste poses potential risks to the environment. Constructing new storage capacity would diminish the potential risks if the new space were to be used to accelerate SST retrieval. However, constructing new storage capacity also has environmental impacts, and the tradeoffs between the impacts of constructing new storage capacity would need to be compared to the impacts of continued SST storage.
- Resolving issues regarding using Phase IB facilities during Phase II waste processing will influence Phase II operations. In the TWRS EIS it was assumed that Phase I would extend from 2002 to 2012 and Phase II would last from 2011 to 2028. This schedule supports compliance with Tri-Party Agreement milestones for completing SST waste retrieval in 2018, LAW immobilization in 2024, and HLW vitrification in 2028. By changing the Phase IB production schedule from 2002 through 2012 to 2006 through 2016, less time is available in Phase II for processing the larger volume of TWRS waste. This compression of Phase II activities, if it can be practicably implemented, has potential environmental impacts because it may require completing activities in shorter time periods resulting in increases in the potential for accidents and increased concentrations of air emissions and construction and operation of larger facilities. If the

compression of Phase II activities cannot be practicably implemented, changes to the Tri-Party Agreement would need to be negotiated.

Based on this review, the new information supports proceeding with implementation of Phase I/Part B-1. The 24-month design phase will allow DOE to address issues important to implementation of treatment and immobilization (e.g., DST space management, ILAW packaging and waste form, and SST waste retrieval schedule). In addition to addressing issues directly related to waste processing during Phase IB, the design phase will support refinement of DOE's approach to the TWRS mission (i.e., Phase II) in light of changes to Phase IB.

Based on the results of the Phase I/Part B-1 project definition activities and prior to authorization of construction and operations for Phase I/Part B-2, DOE would need to complete an evaluation under NEPA of potential changes in environmental impacts associated with the following issues identified in this report:

- DST space management issues (i.e., impacts associated with SST retrieval) (Sections 3.2.1.1, 3.2.1.2, 3.3.2.1)
- ILAW packaging and waste form (i.e., impacts associated with ILAW disposal) (Section 3.1.2.3)
- Construction and operations schedules supporting Phase I and impacting Phase II (Sections 3.1.3, 3.3.1.1, 3.2.2)
- Treatment, immobilization, and other operations changes that may emerge during the design phase (Phase I/Part B-1) (Sections 3.1.1.2, 3.1.1.3).

Other new information developed subsequent to this review during Phase I/Part B-1 may require NEPA analysis prior to proceeding with Part B-2.

1.0 PURPOSE OF THE PROGRAMMATIC ENVIRONMENTAL REVIEW REPORT

1.1 PURPOSE

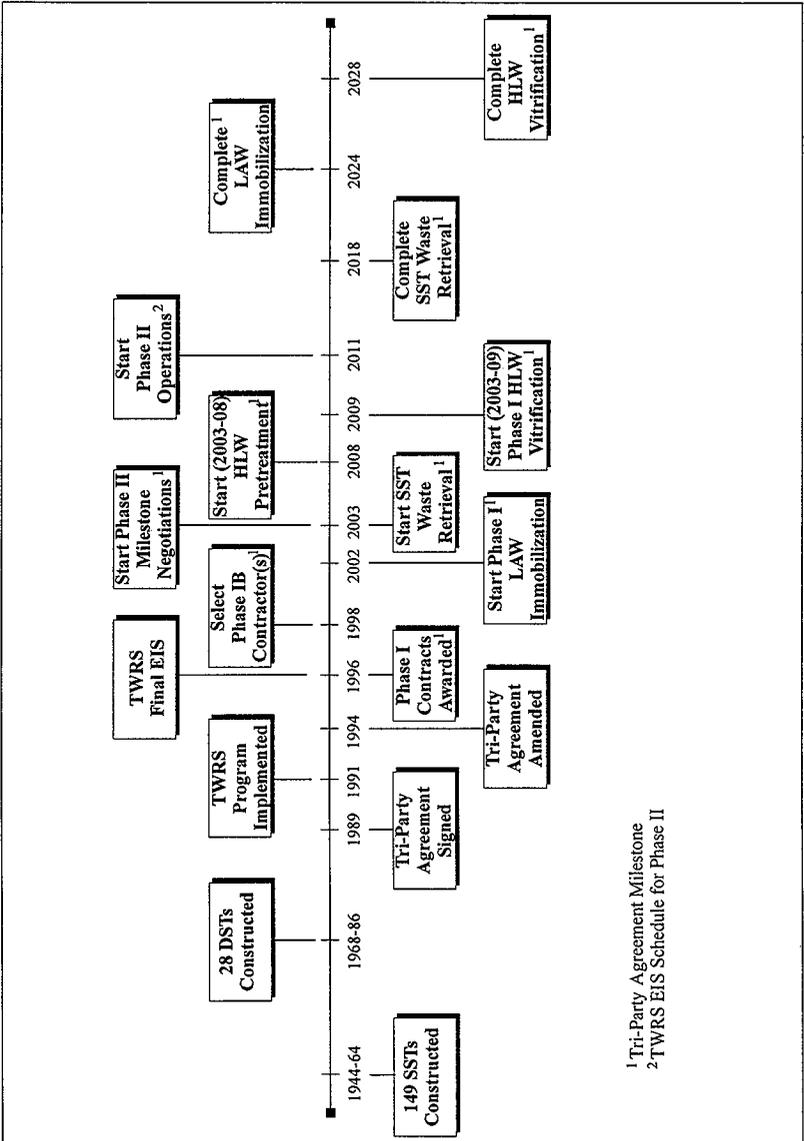
The U.S. Department of Energy (DOE) committed in the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) Record of Decision (ROD) to perform future National Environmental Policy Act (NEPA) analysis at key points in the remediation process to address the potential impacts that new information may have on the impacts presented in the EIS and to support an assessment of whether DOE's plans for remediating the tank waste are still pursuing the appropriate option for remediation or whether adjustments to the project need to be made (62 FR 8692). In response to this commitment DOE prepared a Supplement Analysis (SA) to support the first of these reevaluations (DOE 1998c). The SA and this report are one part of a comprehensive authorization-to-proceed process being conducted by DOE prior to proceeding with the next phase of the TWRS privatization project (Phase IB). The authorization-to-proceed process, including this report, was completed to fulfill the ROD commitment to perform scientific, regulatory, and financial review of the TWRS Program at key points in the TWRS Program.

The SA addressed whether the new information developed from the completion of the TWRS EIS through the September 1997 submission of the Lockheed Martin Advanced Environmental Systems (LMAES) (LMAES 1997a) and BNFL, Inc. (BNFL) Environmental Reports (BNFL 1997a) and modifications to the Environmental Reports submitted in January 1998 substantially changed the environmental impacts presented in the TWRS EIS and whether further NEPA analysis was necessary. The SA determined that a Supplemental EIS was not required at this time. Subsequent to the completion of the SA, the negotiation process with LMAES and BNFL resulted in changes to the planned approach to Phase IB (DOE 1998b). These changes have potential implications for Phase I and Phase II of tank waste retrieval, waste processing and immobilization, and waste storage and/or disposal that potentially influence the environmental impacts of the Phased Implementation alternative selected in the TWRS EIS ROD for implementation. This report addresses those potential programmatic changes and identifies if any of the new information developed since completion of the TWRS EIS ROD and the SA potentially changes environmental impacts and therefore may require additional NEPA analysis. The report does not analyze the changes in environmental impacts, rather, it identifies impacts that may require evaluation prior to proceeding with Phase I/Part B-2 construction and operations.

1.2 BACKGROUND

The Federal government established the Hanford Site near Richland, Washington in 1943 to produce plutonium for national defense purposes. This defense production mission ended in 1988, and the current Hanford Site mission is waste management and environmental restoration, including treatment and disposal of the 212 million liters (L) (54 million gallons [gal.]) of mixed waste (i.e., hazardous and radioactive waste) that is stored in 177 underground tanks (Figure 1.1).

Figure I.1 TWRS Current Program Timeline



¹ Tri-Party Agreement Milestone
² TWRS EIS Schedule for Phase II

The 177 tanks include 149 single-shell tanks (SSTs) constructed between 1944 and 1964 and 28 double-shell tanks (DSTs) constructed between 1968 and 1986 (Figure 1.2). Sixty-seven of the SSTs have leaked or are suspected to have leaked approximately one million gallons. None of the DSTs are known to have leaked. The caustic tank wastes include water, sodium nitrate/nitrite, sodium hydroxide, sodium aluminate, sodium phosphate, large amounts of organics, and approximately 195 million curies of radionuclides. The waste forms include liquids, slurries, saltcakes, and sludges. The tank farm system is located in the central portion of the Hanford Site and is designated in Site land-use planning documents as an exclusive waste management area (WMA). The tanks are located approximately 11 kilometers (km) (7 miles [mi]) south and 16 km (10 mi) west of the Columbia River.

In addition to the waste stored in the tanks, significant quantities of strontium-90 and cesium-137 were removed from the tank waste, converted to solid salts, doubly encapsulated in approximately 1,900 metal containers, and stored in water basins. There are also approximately 40 inactive and 8 active miscellaneous underground storage tanks located in the 200 Areas and pipes, pits, diversion boxes, support buildings, and other facilities that make up ancillary equipment associated with the tank farms.

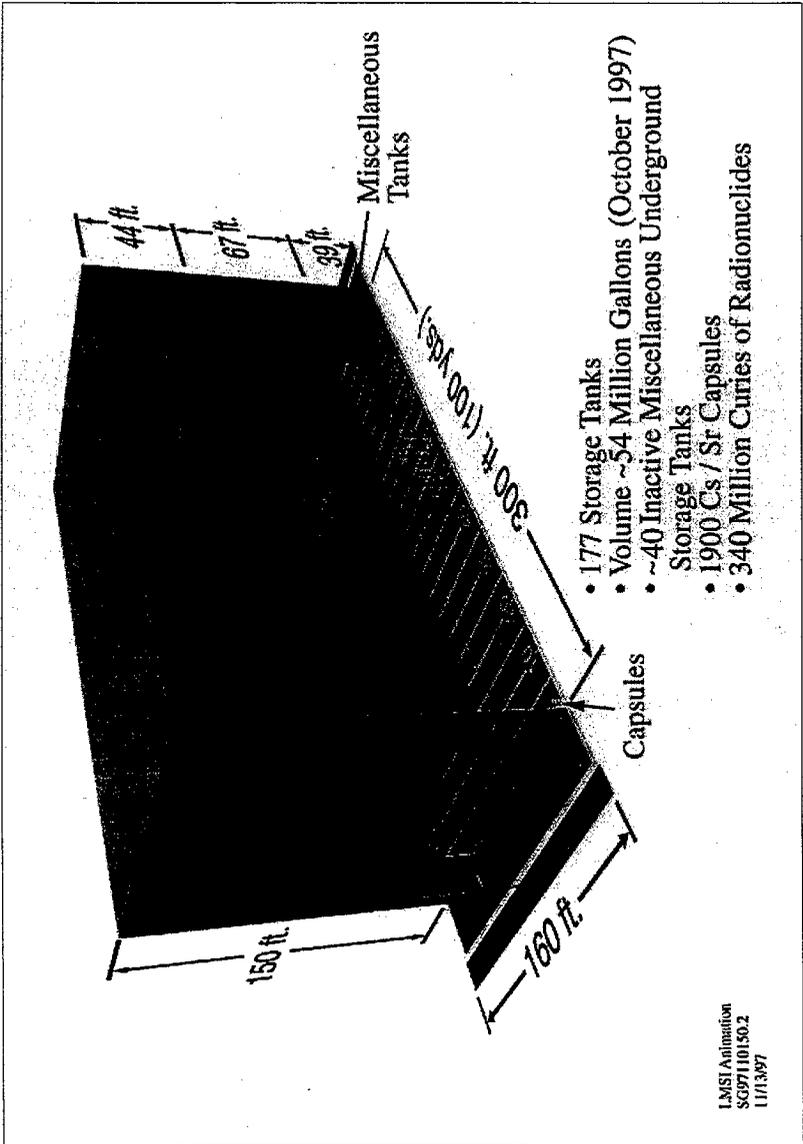
Beginning in 1986, regulators from U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and DOE's Richland Operations Office began examining how best to bring the Hanford Site into compliance with the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The regulators and DOE agreed to 1) develop one compliance agreement that set agreed-upon milestones for cleaning up past disposal sites under CERCLA; and 2) bring operating facilities into compliance with RCRA. Negotiations concluded in late 1988, and the Tri-Party Agreement was signed by the three agencies on January 15, 1989 (Ecology et al. 1989). The Tri-Party Agreement is the primary framework for CERCLA and RCRA regulation of the Hanford Site, including the tank farms. The Tri-Party Agreement was amended in 1994 (Ecology et al. 1994) to incorporate changes in the TWRS strategy.

In 1991 the TWRS Program was established to safely store, treat, and dispose of those wastes. An EIS was issued in 1996 (DOE 1996) and a ROD was issued in February 1997 (62 FR 8692). In the TWRS ROD, DOE decided to implement the Phased Implementation alternative (Section 2.1). The decision was based on the determination that the Phased Implementation alternative provided an appropriate balance among potential short- and long-term environmental impacts, stakeholder interests, regulatory requirements and agreements, costs, managing technical uncertainties, and the recommendations received from other interested parties.

The TWRS ROD committed to reviewing the TWRS Program at various stages as the project proceeds, including the following.

- Conducting periodic independent scientific and technical expert reviews

Figure I.2. Current Hanford Tank Waste Volume



- Conducting three formal evaluations of the entire TWRS Program at key decision points from 1997 to 2005 with review by independent technical and financial experts
These three formal evaluations are to occur:
 - Before proceeding into privatization Phase IB (this review)
 - Prior to the start of hot operations of privatization Phase IB (December 2002/December 2003)
 - Before deciding to proceed with privatization Phase II (December 2005).

In 1996, it was also decided to privatize waste treatment and immobilization in two phases. The Tri-Party Agreement was changed again in 1996 to accommodate privatization of waste treatment and immobilization. In 1996, contracts were awarded to BNFL and LMAES to proceed with Phase I (DOE 1996c, d). The initial effort, Phase I, includes Phase IA, a 20-month development period, and Phase IB, which includes the design, construction, operation, and decontamination period for treating and immobilizing 6 to 13 percent of the tank waste. DOE has completed its review of the Phase IA deliverables received in January 1998 and is now ready to authorize BNFL to proceed with Phase IB.

Since January 1998, a number of assessments have been made to support DOE's Phase IB authorization-to-proceed decision process, including:

- Assessing the Hanford Site management and integration contractor readiness-to-proceed including a review of the technical, planning, and management systems required to provide infrastructure to the Phase IB facilities, waste feed stream to the private contractor, storage/disposal of the waste products, and other areas of the program (e.g., waste characterization, retrieval technology implementation, safety)
- Assessing the DOE TWRS Office readiness-to-proceed including the technical, planning, and management systems required to provide contract and program management and oversight, ensure interfaces between the Hanford Site management and integration contractor and private contractors are appropriately managed (e.g., infrastructure for the vendors, waste feed stream to the vendors, permits and approvals, secondary waste from the vendors), and immobilized waste verification and acceptance
- Assessing the DOE Regulatory Unit readiness-to-proceed including the status of vendor proposals and plans relative to their ability to ensure regulatory compliance of the Phase IB privatization facilities
- Assessing NEPA compliance to determine 1) if new technical, scientific, or regulatory information have emerged that would change the understanding of environmental impacts and require additional NEPA analysis prior to proceeding with Phase IB; and 2) if any new data, information, or proposals (e.g., privatization contractor proposals for Phase IB and the negotiated path forward) or uncertainties with technical, scientific, or regulatory aspects of the program required DOE to change its programmatic path forward. An SA was completed for information available through the submittal of the privatization

contractors' Environmental Reports in September 1997 and amendments to the reports submitted in January 1998 (DOE 1998c). This environmental review report reviews the information developed since January 1998 to determine if the new information changes the planned approach to Phase IB in a manner that potentially influences the environmental impacts of the Phased Implementation alternative

- Evaluating the privatization contractors' Phase IA submittals to determine viability of one or both Phase IA contractors to proceed with Phase IB
- Determining the best value to the government
- Negotiating with the privatization contractors to achieve the best contract.

Each of these activities supports DOE's decision that it is technically, scientifically, financially, and regulatorily prepared to successfully implement privatization by authorizing BNFL to proceed with Phase IB. This authorization-to-proceed process is further described in the TWRS Report to Congress (DOE 1998b). These assessments and the negotiation process have resulted in proposed changes to the TWRS Program (Section 2.2 and Section 3.0) and new information with implications to environmental impacts (Section 3.0).

An independent panel of five individuals reviewed this report. Each panel member possesses expertise on the Hanford Site and/or other DOE remediation programs and the technical and programmatic issues associated with the TWRS Program. Their comments have been considered during the drafting and review of the report. They concur that areas identified as being potentially environmentally impacted require further evaluation prior to proceeding with Phase I/ Part B-2. The review panel charter and panel member resumes are included in Appendix A.

2.0 OVERVIEW OF THE CURRENT TWRS PROGRAM (JANUARY 1998) COMPARED TO THE PROPOSED TWRS PROGRAM (JUNE 1998)

The TWRS Program mission is to store, treat, immobilize, and dispose of current and future Hanford Site tank waste and provide for disposition of cesium and strontium capsules in an environmentally sound, safe, and cost-effective manner (Figure 2.1).

The Phased Implementation strategy selected in the TWRS ROD included a two-phased approach to tank waste retrieval, treatment, and storage or disposal. Phase I includes 1) continuing to safely manage the tank waste; 2) constructing and operating waste treatment and immobilization demonstration facilities; 3) collecting additional information through tank waste and vadose zone characterization; and 4) demonstrating technologies that have the potential to reduce technical and financial uncertainties. Phase II includes constructing and operating larger production facilities to retrieve, treat, and immobilize waste by a private contractor(s). It also includes storing or disposing of the remainder of the tank waste by the Site management and integration contractor.

Section 2.1 provides an overview of the currently approved TWRS Program baseline based on the TWRS EIS ROD and changes to the program through January 1998 based on new information addressed in the SA (DOE 1998c). Section 2.2 provides a discussion of proposed changes to the currently approved TWRS Program baseline based on negotiations for implementing Phase IB (Phase IB is described in Section 2.2).

2.1 OVERVIEW OF THE CURRENT TWRS PROGRAM (JANUARY 1998)

This section provides an overview of the currently approved TWRS Program baseline. Thus, the discussion addresses the TWRS Program as defined in the TWRS EIS ROD and changes in the TWRS Program through January 1998. Proposed changes in the TWRS Program resulting from negotiations for implementing Phase IB are addressed in Sections 2.2 and 3.0.

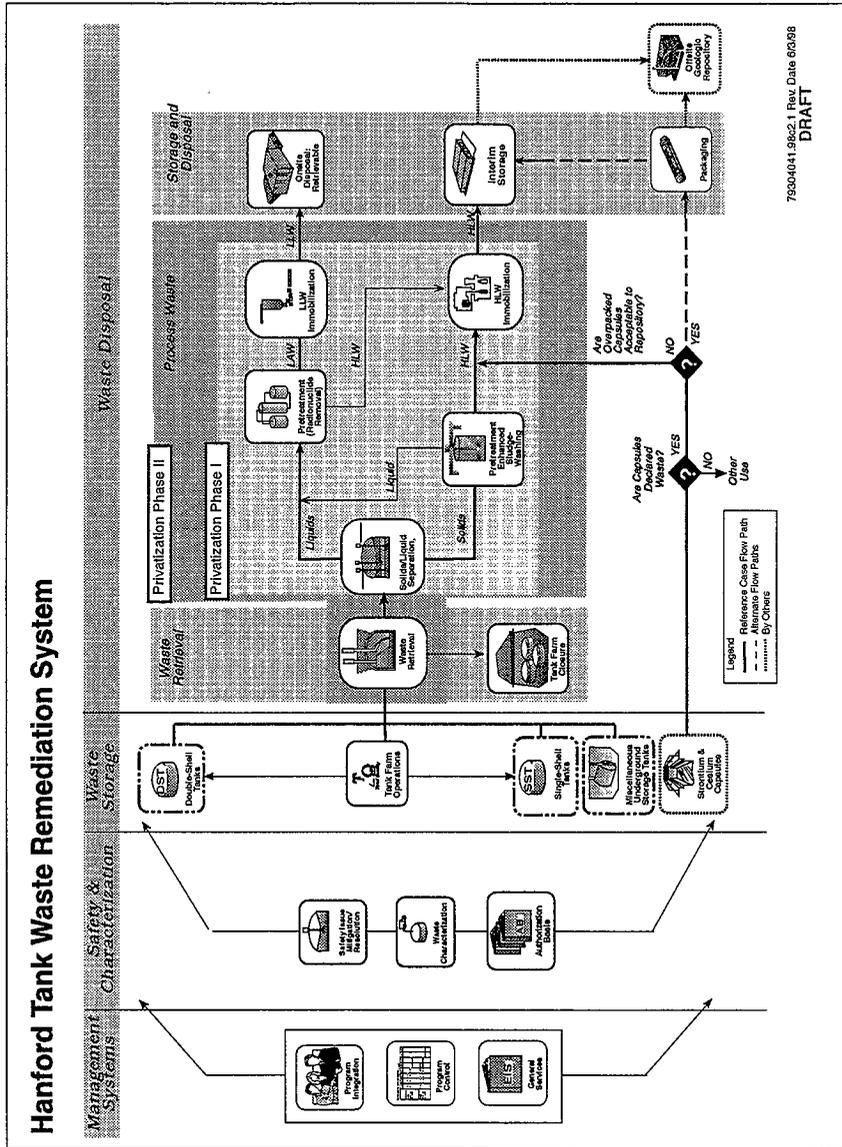
2.1.1 Management Systems

Management Systems includes activities such as program integration, budgeting, program control, National Environmental Policy Act (NEPA) evaluations and documentation, environmental permitting and compliance, and regulatory and external interface. Systems engineering methods have been used to develop TWRS logic diagrams that show the relationship and sequence of program activities. These logic diagrams have been developed from the top down and are used to develop work plans, schedules, and budgets. The top level logic diagram is shown in Figure 2.2.

2.1.2 Safety and Characterization

The three primary activities conducted in this function are safety issue resolution, waste characterization, and authorization basis development and maintenance.

Figure 2.1 Hanford Tank Waste Remediation System



Safety Issue Resolution

A number of waste tank safety concerns were identified in the late 1980's, resulting in Public Law 101-50, Section 313, Safety Measures for Waste Tanks at the Hanford Nuclear Reservation (also known as the Wyden Amendment), that placed special restrictions on 54 tanks with serious potential for the release of highly radioactive material in the event of uncontrolled increases in temperature or pressure. Without corrective action, these safety issues posed an unacceptable risk for continued operations. The four highest priority safety concerns included:

- **Flammable gas** - Nuclear waste stored within TWRS facilities is capable of generating flammable gas (i.e., principally hydrogen gas) through the radiolysis of water, radiolysis and thermolytic decomposition of organic components, and corrosion of a tank's carbon steel walls. Additional flammable gases (e.g., methane and an oxidizer, nitrous oxide) are generated by chemical reactions between various degradation products of organic chemicals present in the tanks. The gas can be trapped in some waste forms and released episodically, potentially causing flammable concentrations in the tank dome space where it could burn or explode if an ignition source was present. The tank of greatest concern, tank 101-SY, was mitigated in 1993 when a large mixer pump was installed. This pump stirs up the viscous region where the gas is trapped and causes the gas to be released routinely and not build up. No gas concentrations above the lower flammability limit have been measured in the tank dome space since the pump was installed in this tank. However, a slow rise in the tank waste surface has been observed over the past year and is under investigation as an Unreviewed Safety Question. Flammable gas controls have been placed on all other tanks and systems, and tank monitoring and sampling continue to determine if corrective action is needed in other tanks.
- **Ferrocyanide** - Ferrocyanide compounds were added to some of the waste in the 1950's to precipitate cesium from the liquid. As the liquids were being removed from the SSTs in more recent times, the concern was that the ferrocyanide and nitrates in the tanks might become heated by the combined chemical reaction and radioactive decay heat and that a runaway exothermic chemical reaction could occur and the tanks could explode. Following years of testing and sampling it was determined that the ferrocyanide had degraded into less reactive chemicals and was no longer a safety concern. This safety issue was closed in 1996.
- **Organics** - Like ferrocyanide, organic materials in the waste could react with the nitrates and, if heated high enough, could burn or explode. This issue has also been under study for several years, and the findings indicate that the organics have degraded into less reactive chemicals. It is anticipated that this safety issue will be closed this year.
- **High-heat waste** - One of the older SSTs, tank 106-C, contains high concentrations of strontium requiring periodic additions of water to cool the tank by evaporation. This cooling is effective, but the safety concern is that should the tank start to leak, the choice would be to continue adding water and accept the leakage, or stop adding cooling water and let the waste overheat. To avoid facing this choice, the plan is to remove this waste from tank 106-C and transfer it to a DST that is designed for higher heat waste.

Equipment has been installed, and removal and transfer of this waste to DST 102-AY is scheduled for later this year.

The number of tanks with special safety concerns associated with the organic nitrate and flammable gas safety issues has been reduced from the original 54 tanks to 38 tanks. There are also other lower priority safety concerns being addressed such as tank integrity.

Waste Characterization

The waste characterization activity gathers and provides information on the quantity, radiological, chemical, and physical characteristics of the tank waste as requested by other TWRS functions in their Data Quality Objectives. This information is used to safely receive, transfer, store, and evaporate waste; identify and resolve safety issues; and plan for retrieval, treatment, and immobilization of the waste. Information is obtained from process records and sampling and analytical methods and reports. To date, 131 of the 177 tanks have been sampled, and characterization reports on 112 tanks have been approved by the regulators in accordance with Tri-Party Agreement requirements.

To support waste treatment and immobilization; facility design, waste characterization, and process information were used to develop waste feed bounding conditions (envelopes) for selected analytes and radionuclides and physical properties. Four envelopes were defined to represent the waste for Phase I processing (Patello et al. 1996). For the waste that was to be delivered to the private contractors, waste feed limits were defined for the physical properties of the waste including sodium concentrations and other major chemical and radiological components. The insoluble solids fraction would not exceed 5 volume percent of the waste transferred (Patello et al. 1996). In 1996, a total of 11 DSTs and two SSTs were identified to provide waste feed for Phase IB. Seven of the 11 DSTs and one of the two SSTs have been recharacterized since 1996.

Inventory estimates based on historical records and process knowledge have been completed (Agnew 1997), and waste sampling and analysis efforts have been ongoing. In an effort to reduce inventory uncertainties, resolve differences among the reported inventory values, and provide a consistent and technically defensible inventory basis for all waste management and disposal activities, a task was initiated in FY 1996 to establish a revised inventory for chemicals and radionuclides in Hanford Site tank waste. In August 1997 the TWRS Program issued a revised inventory that provides a standardized inventory basis for the tank waste (Kupfer et al. 1997). There are two components of the revised inventory for the SSTs and DSTs. A revised inventory has been developed and represents an overall total inventory estimate for all tanks. Tank-by-tank inventory estimates also have been developed that provide an inventory for each of the 177 tanks (LMHC 1997). There are discrepancies for some constituents between the tank-by-tank inventory and the revised inventory. There is an effort underway to reconcile the two inventories in FY 1998, which could include some adjustment of both inventory estimates. The revised inventory represents the best available information; however, it is expected to change and will be updated as new information becomes available.

The SA assessed the environmental impacts associated with the revised inventory (DOE 1998c). It concluded that the revised inventory, when compared to the inventory used in the TWRS EIS

to calculate environmental impacts, would result in small increases in short- and long-term health impacts and small increases in impacts to groundwater quality.

Authorization Basis

To protect the workers and the public, activities conducted in nuclear facilities must be within the controls established in an authorization basis. These controls are determined by analyzing normal, abnormal, and potential accident conditions and establishing controls with an adequate margin of safety. Tank farm operations have been addressed in the TWRS Basis for Interim Operations (BIO) (LMHC 1997d). A Final Safety Analysis Report (FSAR) is in review and when implemented will further upgrade the authorization basis. This authorization basis is for current activities and does not address future activities such as tank waste retrieval, treatment, immobilization, and disposal. The authorization basis will be revised to include future activities (such as waste retrieval) before they are implemented. The activities conducted by the privatization contractor, BNFL, will be authorized separately by the DOE Regulatory Unit and other State regulators.

2.1.3 Waste Storage

The waste storage function includes a number of tank farm operations. Those of most importance are waste surveillance and maintenance, DST space management, interim stabilization, and tank farm upgrades.

Surveillance and Maintenance

To ensure that the waste is safely stored until it can be retrieved for disposal, a number of activities must be conducted. Surveillance activities include measuring waste liquid level, waste temperature, tank pressure, flammable gas concentration, and ventilation air flow, and monitoring for tank waste leakage and airborne and surface contamination. Both preventive and repair maintenance are needed to keep these systems operating.

The SA (DOE 1998a) assessed the data regarding past tank leaks, contaminant migration, and vadose zone and groundwater contamination that have emerged since the completion of the TWRS EIS (DOE 1996). It concluded that the new data emphasized the need to initiate tank waste retrieval and treatment.

DST Space Management

The 28 DSTs are the only tanks used for receiving new waste and waste pumped from the SSTs. The DSTs also will serve as the blending and feed tanks to supply waste to the privatized treatment and immobilization facilities. One DST for each contractor was identified for use as a waste receipt tank.

The tanks currently contain approximately 71.9 million L (19 million gal.) of waste and will receive an additional estimated 18.9 million L (5 million gal.) of liquid waste pumped from the SSTs as the interim stabilization activity is completed. In addition, a few hundred thousand gallons of new liquid waste are received each year from other Hanford Site facilities. A waste evaporator, which is used to remove water from the waste to minimize the waste volume, is a valuable tool in managing the waste space within the existing tank space.

In 1995, DOE completed an EIS addressing the need for constructing additional DSTs to support waste space management (DOE 1995). The EIS concluded that while it was not necessary to construct additional DSTs to carry out the TWRS mission, DOE should continually monitor waste volume projections because changes in the space management requirements (e.g., capacity needed to ensure safe operations) and waste transfers to the DSTs could result in a future need for additional DST space.

Interim Stabilization

An activity has been underway for several years to remove all the pumpable liquid from the SSTs and transfer it to the DSTs. This reduces the amount of waste available to leak should a leak develop. The waste is removed from the SSTs by installing a perforated well into the saltcake and sludge in the tank and then slowly pumping the liquid that drains into the well. This activity, called interim stabilization, has been completed on 119 of the 149 SSTs. It is estimated that an additional 18.9 million L (5 million gal.) can be pumped from the remaining 30 tanks. The TWRS EIS reflected the baseline plan, which includes completing interim stabilization by 2000.

Tank Farm Upgrades

While much of the tank farm instrumentation and equipment is old and obsolete, some dating back to the 1950's, the waste will remain in the tanks for another 20 to 30 years. To ensure safe storage, where feasible, the tank farms need to be upgraded. Projects have been authorized to replace ventilation systems, electrical systems, pipelines, and instrumentation. This work will continue for many years. The tank farm upgrades were addressed in the TWRS EIS and potential impacts resulting from changes to the tank farm upgrades program were addressed in a SA completed in 1997 (DOE 1997).

2.1.4 Waste Disposal

The plan for disposing the tank waste is to 1) retrieve the waste from all of the tanks; 2) separate it into low-activity waste (LAW) and high-level waste (HLW) fractions; 3) immobilize and dispose the LAW fraction containing the bulk of the chemicals and a small amount of the radionuclides in on-site near-surface vaults; and 4) immobilize and store the HLW fraction onsite until it can be shipped to an offsite geologic repository for disposal. The overall disposal effort is divided into two phases. Based on the current plan, Phase I will process approximately 6 to 13 percent of the waste and last 10 years (2002 to 2012), and Phase II will increase the processing capacity and complete immobilization of the remaining waste (2011 to 2028). The waste disposal function includes waste retrieval, treatment and immobilization (i.e., waste processing), and storage and disposal.

Waste Retrieval

Waste will be retrieved from the tanks during Phase IB by the Hanford Site management and integration contractor. The retrieved waste will be blended and pumped to the privatized waste treatment and immobilization facilities.

For Phase II waste retrieval activities may be contracted out (i.e., privatized). Under the current program baseline, which is compliant with the Tri-Party Agreement, DOE must attain at least

99 percent retrieval of the tank waste volume or provide the rationale to Ecology and EPA as to why this volume of retrieval cannot be obtained on a tank-by-tank basis. The current milestones are to begin SST waste retrieval in 2003 and complete SST waste retrieval in 2018. Waste retrieval from DSTs would begin in 2003 and continue through completion of immobilization in 2028. Waste retrieved from tank 106-C to address the high-heat safety issue would provide HLW feed for Phase IB. The retrieval, originally planned for 1997, is now scheduled to begin in September 1998.

Retrieving waste from DSTs for HLW feed will be accomplished by installing two or more large mixer pumps in a tank to mobilize the solids and then pumping out the resulting slurry. This technique has been successfully employed at the Savannah River Site and the West Valley Demonstration Project. Two large pumps have been installed in tank 101-AZ to demonstrate this application in the first quarter of FY 1999. Some additional methods (e.g., robotic arm, crawler based systems) may be required to clean out the tanks to an acceptable level for closure.

The baseline retrieval system for SST waste is sluicing. This technique was used at the Hanford Site in the 1950's to 1970's to remove the bulk of the solids from more than 50 tanks. Sluicing water is pumped through a large nozzle on an articulated arm. The nozzle is directed to different areas in the tank to slurry the waste toward a pump, which then pumps out the slurry. Because this technique is not expected to remove all waste and may not be acceptable for tanks that leak or have leaked, an initiative is underway to develop other retrieval methods. The TWRS Hanford Tanks Initiative Project, a follow on project to earlier retrieval technology development efforts of the DOE Tanks Focus Area, is working with private industry to modify and demonstrate commercial systems that will remove the residual waste, including the hard heel from tank 106-C after the bulk of the waste has been removed by sluicing and use much less water to retrieve the waste.

After retrieving the waste from the tanks, a tank closure plan must be prepared by DOE and approved by Ecology. This action is not scheduled for several years. The decision about whether to dispose of the tanks in situ has not been made.

Waste Treatment

Solid/liquids separation to separate the soluble waste from the sludge and sludge washing/enhanced sludge washing to remove as many soluble chemicals as practical from the sludge would be completed in DSTs by the Site management and integration contractor prior to transferring the waste to the private contractor for waste treatment and immobilization. Once transferred to the private contractor, the waste would be treated to separate it into two fractions – HLW and LAW. Treatment would consist of removing cesium, strontium, technetium, and transuranics from the waste, using one of a number of alternate processes (e.g., ion exchange and precipitation) and would be blended in the HLW stream. The remaining larger volume of waste, including as much of the chemicals in the waste stream as practical, the soluble waste, and chemicals removed from the waste in the DSTs, would make up the LAW stream. During Phase I/Part A, the privatization contractor identified and proposed the treatment processes to remove radionuclides from the waste.

Waste Immobilization

Both the HLW and LAW fractions must be immobilized for disposal. Under the current plan, waste immobilization of LAW would start in 2002 and be completed in 2024. HLW immobilization would start after 2002 and be completed in 2028. The Office of Civilian Radioactive Waste Management has established repository waste acceptance specifications for the immobilized HLW (DOE 1996). The HLW fraction will be vitrified as a borosilicate glass and poured into 0.7-meter (m) (2-foot [ft])-diameter by 4.5-m (15 ft)-long stainless steel canisters.

The plan also is to vitrify the LAW fraction; however, the private contractors were given the option of recommending an alternate immobilization technology that would produce a product with a long-term performance at least as good as a vitrified waste form. Under the baseline plan, the vitrified waste will be poured into stainless-steel boxes (e.g., 1.2 by 1.2 by 1.8 m [4 by 4 by 6 ft]), which would then be placed in disposal vaults. Grout and other waste forms also were considered for LAW. However, vitrification was selected based on 1) stakeholder concerns with the performance of grout compared to glass; 2) the fact that glass would result in only one-fifth as much LAW volume as grout; 3) the fact that glass was considered to be retrievable; and 4) the estimated life-cycle cost for glass was no more than the life-cycle cost estimate for grout (Boomer et al. 1993). LAW and HLW immobilization will be carried out in a privatized treatment facility.

Waste Storage and Disposal

The immobilized HLW will be stored onsite until a national geologic repository is ready to accept it for disposal. Approximately 600 canisters of HLW will be produced in Phase I, and they will be stored in the Canister Storage Building currently under construction in the 200 East Area. This facility also will store the 2,100 metric tons of uranium from N Reactor spent fuel now located near the Columbia River in the K Reactor fuel basins. The Canister Storage Building consists of three cells. One cell will be used for spent fuel storage, and two cells will be outfitted for HLW storage. Additional storage vaults will be required for Phase II. Because current plans specify initiating the HLW shipments to the national geologic repository after all Hanford Site HLW has been vitrified, additional modular storage will be built as needed.

The immobilized LAW will be disposed in near-surface vaults in the 200 East Area and maintained such that it could be retrieved for up to 50 years. The initial Phase I LAW will be placed in the existing four vaults constructed for the now terminated grout disposal program. These vaults will be modified to accept the vitrified waste boxes. Additional disposal vaults will be required for Phase I and Phase II. Larger vaults are planned for another part of the 200 East Area.

2.2 PROPOSED CHANGES TO THE CURRENT TWRS PROGRAM BASELINE RESULTING FROM PHASE IB NEGOTIATIONS (JUNE 1998)

In January 1998, DOE entered into negotiations with BNFL and LMAES regarding each contractor's proposal to implement Phase IB. Based on the evaluation of the proposals and negotiations with each contractor, DOE determined that the LMAES proposal was not viable because the technical approach had significant risk and the business and finance approach was

not consistent with the goals of privatization (DOE 1998b). BNFL was judged viable, and DOE continued negotiations with BNFL. The path forward for Phase IB includes a number of changes to the current TWRS Program baseline based on the plan for Phase IB negotiated between DOE and BNFL and new information developed since completion of the TWRS EIS ROD and SA. These changes are focused in the waste disposal activities, as described in Section 2.1, and are summarized in the following subsections. Section 3.0 reviews these changes and other new information developed since January 1998 and identifies the potential changes in environmental impacts.

Under the negotiated plan for Phase IB there would be a design phase of 24 months to achieve an improved basis for setting fixed prices by reducing risks associated with facility design and regulatory requirements and providing time needed to obtain private financing and contractor equity commitments. Based on this change, Phase IB will consist of two parts: Part B-1 and Part B-2.

Part B-1 will consist of a design phase of 24 months between 1998 and 2000. During this design phase technology scale-up, regulatory, permitting, and financing issues, and the safety basis for operations will be addressed. At the end of Part B-1, DOE will make a decision whether to proceed with BNFL in Part B-2 and implement fixed-unit prices to be negotiated prior to the beginning of Part B-2. Incentives have been built into the contract to attain costs lower than the Phase IB/Part B-2 contract ceiling (DOE 1998b). BNFL will be paid a base fee upon successful financial disclosure and an incentive fee based on the fixed price. If DOE and BNFL cannot agree on fixed-unit prices at the end of Part B-1, DOE will pay BNFL for design phase costs and have the rights to the design and intellectual property developed during Part B-1 and be able to proceed with a different contractor. However, transferring this information to another contractor and the procurement process for selecting a new contractor could cause a delay in the overall project.

During Part B-1 of the project BNFL will complete (DOE 1998b):

- Process verification testing and product qualification work products
 - Characterization of LAW/HLW feeds
 - Laboratory-scale testing of waste separations, sludge washing, vitrifying ILAW and IHLW, removing sulfur from LAW, and optimizing ILAW and IHLW glass
 - Pilot-scale testing of solids-liquid separations, ion exchange system, LAW/HLW vitrification feed preparations, LAW vitrification melter, and IHLW/ILAW package qualification
 - Equipment verification analysis and testing
 - Process verification and testing, planning, and reporting
 - Laboratory and pilot-scale testing at the Savannah River Site and at Pacific Northwest National Laboratory (PNNL)

- Design studies and documentation
 - Process and facility design completed to approximately 30 percent (level of design necessary to support proceeding with construction, permitting facilities, and establishing firm fixed prices)
 - Process design products including control systems, process flow diagrams and material balances, and process and instrumentation diagrams
 - Facility design products including ventilation systems; civil, structural, and architectural design, seismic analysis, and mechanical flow diagrams
 - Site and facility arrangement drawings
- Estimate and facility cost development based on a “bottoms-up” estimate using material quantities from process and facility design products
- Permits and safety analysis required to support proceeding with construction and operations
- Construction authorization work products
 - Engineering execution plan
 - Construction strategy
 - Construction mobilization plan
 - Construction work packages
 - Facility acceptance strategy
 - Procurement work packages.
- Value engineering studies to optimize the facility throughput and cost (e.g., facility impacts of producing and packaging alternative ILAW forms), capsule processing, and using existing DSTs compared to tanks constructed by BNFL.

In parallel with BNFL’s activities in Part B-1, DOE will carry out a number of activities to ensure that the BNFL contract to be updated at the end of Part B-1 is the best attainable and to refine its management and regulatory approaches. The optimization activities will include defining the most effective financing, technical, and programmatic approaches for the subsequent construction and operations period, Part B-2. Programmatic alternatives will be explored in Part B-1 to ensure that proceeding with BNFL in Part B-2 is the best overall path forward for the TWRS Program. Lastly, DOE will be finalizing its management plan and team in Part B-1 to support Phase IB/Part B-2 activities including managing feed delivery, performing waste processing, and storing immobilized waste.

During Phase I/Part B-2, BNFL will initiate waste pretreatment in 2005, HLW vitrification in 2006, and LAW vitrification in 2007. These dates represent estimated start dates based on a 50 percent confidence that the date can be met. Final start of hot operations with a 90 percent confidence would occur during the same year or, in some cases, 1 year later. Because of this sequencing of hot operations startup, LAW liquids resulting from the BNFL waste separations process (i.e., pretreatment) would be transferred to DSTs maintained by the Hanford Site management and integration contractor for approximately 2 years. Phase I will include immobilization operations from 2006 through 2016 when the facilities would be decontaminated and decommissioned or used for Phase II waste processing.

2.2.1 Waste Retrieval and Feed

DOE will provide tank waste to BNFL that includes three LAW feed envelopes (i.e., Envelopes A, B, and C). A fourth waste envelope (D) would consist of the DST sludges, radionuclides separated from supernate, and solids separated from Envelopes A, B, and C. DOE will order a minimum quantity of waste treatment services and additional treatment services if feed is available and BNFL has the processing capability. During Phase I/Part B-2, approximately 6 to 13 percent of the mass of Hanford Site tank waste will be processed. A total of 9 DSTs and two SSTs have been identified as potential waste sources for Phase I. The HLW feed is currently stored in two DSTs and two SSTs. BNFL will operate DST 241-AP-106 as a waste feed receipt tank. From this tank, waste would be transferred by BNFL to the facility for treatment. A second tank, which had been identified for use by a second contractor, would now be used by DOE for space management.

2.2.2 Waste Treatment

Under the negotiated approach for Phase IB, sludge washing would be completed by BNFL in the treatment facility rather than in existing DSTs by the Site management and integration contractor. The treatment facility is scheduled to begin operations in 2005. Solids in the waste feed would be batch washed in large tanks with solids separated using cross-flow filters. The washed solids will be combined with cesium, strontium, transuranics, technetium, and glass-forming chemicals to make the HLW feed. The wash liquids would be routed to the LAW process once the LAW facility becomes operational in 2007. Until then the liquids would be returned to DOE for storage in DSTs. This would reduce LAW waste volume produced by in-tank sludge washing, eliminate the need for dedicated DSTs for sludge washing, reduce the risk of not meeting feed specifications for certain waste streams, provide sludge washing capability for additional waste beyond the current contract, enhance separations, and thereby reduce HLW volume. Waste treatment would continue to include removal of cesium, strontium, transuranics, and technetium.

2.2.3 Waste Immobilization

BNFL's waste immobilization approach centers on using a liquid-fed ceramic melter based on technologies used for HLW vitrification at West Valley and Savannah River. The facility configuration would include one pretreatment/HLW vitrification facility and one LAW vitrification facility. The LAW vitrification facility would have a design capacity of 30 metric tons per day of glass production (18 metric tons per day of average production assuming a 60 percent total operating efficiency), and the HLW facility would have a design production capacity of 1 metric ton per day of glass production (0.6 metric tons per average day of

production assuming a 60 percent total operations efficiency). Immobilized LAW would be poured into product containers and transferred to a storage area pending final transfer to DOE for disposal. BNFL would immobilize the separated cesium, strontium, technetium, and transuranics and have the option to vitrify the entrained solids or return the entrained solids to DOE. If entrained solids are immobilized, DST space planned for storage of the solids would be available for storing waste retrieved from SSTs or other waste management activities. The immobilized HLW would be poured into canisters and transferred to a storage area. The waste then would be transferred to DOE for onsite storage pending shipment to a geologic repository for disposal.

2.2.4 Facility Expansion/Extension

Facilities constructed to support Part B-2 operations (i.e., pretreatment and LAW and HLW vitrification) are planned to have the capability for capacity expansion/extension features to be built into the design. The facilities would have a minimum design life of 30 years. The pretreatment equipment will be sized to accommodate a 100 percent increase in capacity. The HLW facility is designed with space for two melters. Only one is required to meet the maximum Phase IB immobilization requirements. The LAW facility is designed with the flexibility to add a second LAW facility with a capacity similar to the first facility.

The capacity to expand/extend Phase IB facilities will present options for implementing a Phase II that includes continued operation of Phase IB facilities during Phase II with expanded ILAW treatment design capacity to 60 metric tons (36 metric tons per day of production with a 60 percent total operating efficiency), and immobilized HLW peak capacity expansion to 5.6 metric tons per day (3.4 metric tons per day of production with a 60 percent total operating efficiency). To meet the Tri-Party Agreement milestone to complete waste processing by 2028, Phase II would also need to include new facility construction and operations with a peak treatment capacity of approximately 5 metric tons per day (total operating efficiency) of immobilized HLW and 40 metric tons per day (total operating efficiency) of ILAW.

Many of these negotiated changes have potential implications on other TWRS Program elements identified in Section 2.1. For example, changes in the schedule for waste processing has implications for DST space management, which in turn has potential environmental impacts that may influence TWRS Program decisions. The implications of the changes in the waste treatment and immobilization elements of the TWRS Program is discussed in Section 3.0 along with the related potential environmental and human health impacts. Additionally, Section 3.0 identifies other new information that has emerged since completion of the SA (DOE 1998c) and discusses the potential environmental impacts of the new data.

3.0 IMPLICATIONS OF CHANGES TO THE TWRS PROGRAM

Changes in TWRS Program Phase IB approach have been proposed based on negotiations with BNFL. These changes are summarized in Section 2.2. This section provides additional information, where necessary, regarding those changes and other new information developed since the completion of the TWRS EIS and SA (DOE 1998c). It includes an assessment of the implications of the new information relative to potential environmental impacts. Changes have occurred in 1) waste processing; 2) the schedule for Phase IB activities; and 3) other aspects of the TWRS Program. Each of these categories of changes includes a variety of new information with differing implications for potential impacts to the environment. Many of the changes are interrelated. Therefore, sections include references to other sections when the change or new information impacts multiple aspects of the TWRS Program.

3.1 CHANGES IN WASTE PROCESSING

New information has been developed regarding waste processing. This new information relates to characterizing and sampling waste, sludge washing, waste separations, waste immobilization (LAW and HLW), and waste disposal.

3.1.1 Treatment

3.1.1.1 Characterization

New Information

Four waste feed envelopes (three for LAW and one for HLW) were identified in 1996 based on process history and characterization data. The Phase I LAW and HLW feed is proposed to come from up to nine DSTs and two SSTs (this assumes completion of waste retrieval from tank C-106 prior to DST retrieval to support Phase I and therefore C-106 waste would be located in a DST). One additional DST and one additional SST are identified as contingency feed for LAW and HLW. Of the nine DSTs and two SSTs identified as potential source tanks, waste in one SST and five of the DSTs have been recharacterized based on waste sampling data since the envelopes were defined in 1996 (DOE 1998b). Based on the recharacterization the contents all six tanks are within one of the four waste envelopes specifications (Esch 1997a, b, c, Herting 1997, Jensen et al. 1998). The waste in the remaining source tanks will be fully characterized during Part B-1. In addition to completing waste recharacterization of the remaining tanks, during Phase I/Part B-1 samples of waste will be retrieved from the tanks to support treatment and immobilization tests described in Section 2.2.

Implications of New Information

The new characterization information developed since the completion of the TWRS SA:

- Does not change the understanding of potential environmental impacts as calculated in the TWRS EIS or addressed in the SA
- Supports proceeding with Phase IB because it confirms that the waste composition to be provided to BNFL are within the compositional limits established in the contract

- Requires DOE to secure additional waste samples from Phase IB tanks beyond those anticipated earlier in the program to support Part B-1 tests. This change would not have environmental impacts because waste sampling was an activity considered in the TWRS EIS. However, the level of characterization required during Phase I/Part B-1 and B-2 will require implementing additional tank sampling activities to accommodate the volume of sample collection required.

3.1.1.2 Sludge Washing and Solids/Liquids Separation

New Information

Under the negotiated approach for Phase IB, sludge washing would be completed by BNFL in the pretreatment facility scheduled to begin operations in 2005 rather than in DSTs by the Site management and integration contractor. During Phase I/B-1, BNFL will complete laboratory-scale and pilot-scale testing of solids/liquids separations and sludge washing.

Solids in the HLW feed would be transported by pipeline to the BNFL facility and batch washed in large tanks with solids separated using cross-flow filters. The washed solids will be combined with cesium, strontium, transuranics, technetium, and glass-forming chemicals to make the HLW feed. The wash liquids would be sent to pretreatment for separations then returned to DOE for storage. Once the LAW facility is operational the wash liquids, following separations, would be routed to the LAW treatment facility for processing.

LAW would be transferred to a feed receipt tank managed by BNFL and then transferred to smaller lag feed storage tanks in the treatment facility where the LAW feed would be evaporated or diluted as required for further processing. The feed then will be pumped through a cross-flow filter to remove entrained solids. The entrained solids will be washed and characterized by BNFL and at DOE's option either returned to DOE for storage, incorporated into the LAW stream for immobilization, or included in the HLW stream for immobilization. BNFL would use a cross-flow filtration system to separate suspended solids from LAW feed streams.

Implications of New Information

Changing from sludge washing in DSTs to sludge washing in treatment facilities reduces the technical uncertainties associated with the processing step. However, this change would not alter the environmental impacts as presented in the TWRS EIS, except to the extent that it reduces the volume of waste to be processed in DSTs freeing space for waste volume management and eventual transfer of waste from SSTs to DSTs. This change would tend to decrease the potential of releases from SSTs during continued storage, and by accelerating the retrieval of SST waste it would reduce the potential for retrieval losses associated with tank failures related to aging of the SSTs.

Sludge washing in treatment facilities allows for greater process flexibility and control compared to sludge washing in DSTs. DOE estimates that the change will result in not needing approximately 3.5 million L (924,000 gal.) of tank space to support in-tank sludge washing over the TWRS Program life cycle, reduce the cost of the Site management and integration contractor performing sludge washing, reduce risk of not meeting feed specification for certain waste streams, and provide sludge washing capacity that would extend beyond the current contract term (DOE 1998b).

3.1.1.3 Radionuclide Separations

New Information

During Phase I/Part B-1, BNFL will complete laboratory-scale and pilot-scale testing of waste separations and ion exchange systems. Under the negotiated approach, during Phase IB BNFL would treat the liquid waste feed stream (Envelopes A, B, or C) to separate cesium, strontium, technetium, and transuranics (Figure 3.1 provides a representation of the Phase IB LAW and HLW treatment and immobilization services). Following solids/liquids separations (Section 3.1.1.2) to remove entrained solids, the liquids (for Envelope C waste only) would have strontium nitrate and ferric floc added to cause the strontium and transuranics to precipitate. The mixture would be filtered again, and the strontium and transuranic solids would be included in the HLW stream for immobilization. Following the second filtration step, the resulting liquids would be pumped through an ion exchange module to remove cesium. After cesium removal the liquid would be pumped to another ion exchange module to remove technetium.

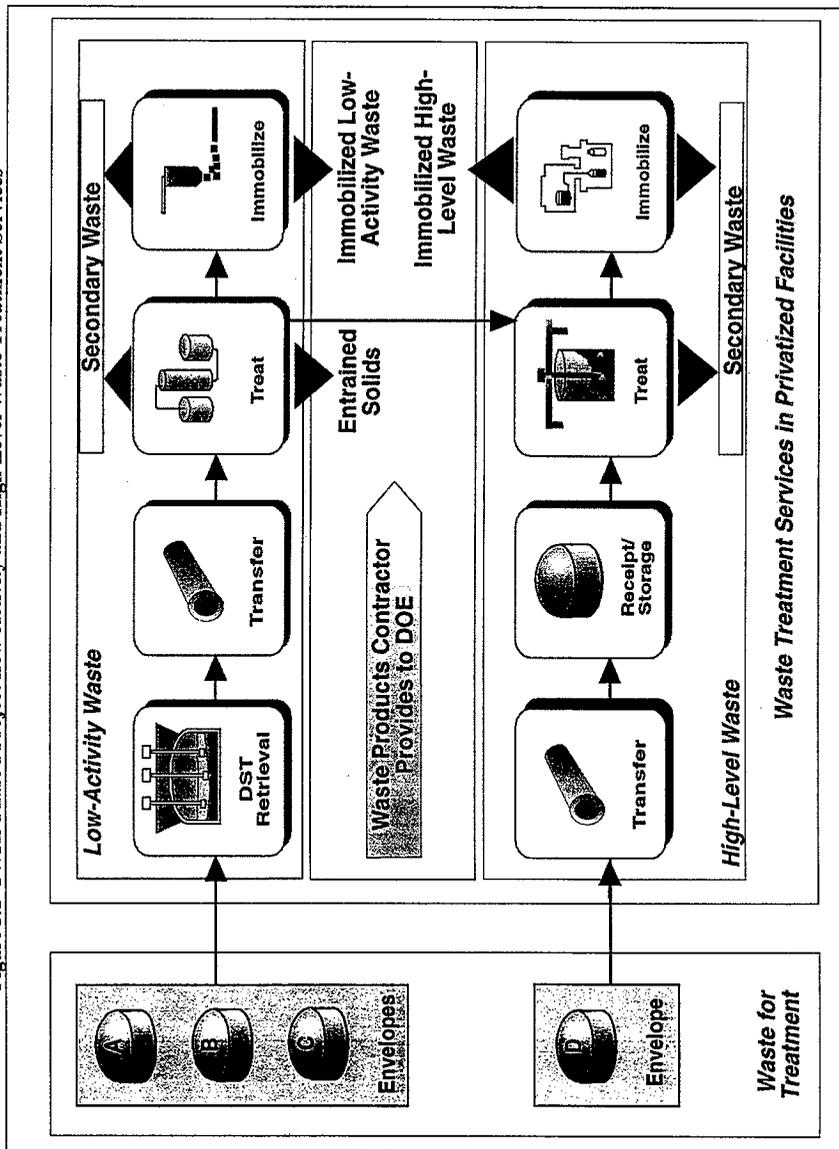
Supernate pretreated during the first 2 years of facility operations, prior to startup of LAW vitrification, would be concentrated in an evaporator and returned to DOE as pretreated LAW for storage. The cesium, strontium, transuranics, and technetium removed from the waste feed would be blended into the HLW stream for vitrification. These separations technologies have been used previously to separate waste including 1) elutable ion exchange to remove cesium; 2) isotopic dilution to remove strontium; 3) iron-nitrate precipitation to remove transuranics; and 4) elutable ion exchange to remove technetium. The waste separations process would remove technetium at levels better than used to calculate environmental impacts in the draft Performance Assessment (PA) (DOE 1998a) and TWRS EIS (DOE 1996). Separations would remove 80 percent of the technetium from the waste stream. This would result in a maximum of approximately 6,000 Ci in the ILAW based on the technetium inventory reported in the best-basis tank waste inventory. The 1998 draft PA estimated 22,300 Ci of technetium in the ILAW. At this level the ILAW disposal system met performance requirements (DOE 1998a). In the TWRS EIS ILAW was assumed to contain 23,700 Ci (DOE 1996). Because of the lower levels of technetium in the ILAW, value engineering studies will be completed during Phase I/Part B-1 to evaluate alternate ILAW packaging and waste forms.

Implications of the New Information

The improved technetium removal would result in a ILAW with lower concentrations of technetium than previously estimated in the draft PA and TWRS EIS. This change will improve the long-term human health risk performance of the ILAW following disposal compared to the environmental impacts calculated in the TWRS EIS (DOE 1996), the revised impacts calculated in the SA (DOE 1998c), and the impacts calculated in the PA for ILAW disposal (DOE 1998a). Technetium is the major contributor to human health risk for ILAW. Improved technetium removal during separations will divert more technetium to the HLW, resulting in lesser long-term impacts to groundwater and the Columbia River and related long-term impacts to human health and ecological and biological resources. See Section 3.1.2.3 for additional implications associated with ILAW disposal resulting from the reduction in technetium in the ILAW form.

The option for BNFL to immobilize entrained solids, if exercised, would reduce the need for DOE to store the solids pending future treatment.

Figure 3.1 TWRS Phase I Project Low-Activity and High-Level Waste Treatment Services



While each of the separations process has been used previously they will require additional development. For Part B-1 BNFL has identified a development program to address the technical uncertainties identified for each technology (Section 2.2). To support the development process, additional waste samples will be required during Phase I/Part B-1 (Section 2.2). This change would not alter potential environmental impacts compared to those presented in the TWRS EIS because the collection of waste samples was analyzed and included in the calculation of potential impacts.

3.1.2 Immobilization

3.1.2.1 LAW

New Information

Under the negotiated approach to Phase IB, LAW vitrification technologies that have been used previously to immobilize HLW would be implemented. HLW and LAW vitrification will use a liquid-fed ceramic melter similar to technology used for DOE waste at West Valley and Savannah River.

The proposed contract includes ILAW specifications that would enable the waste form and package to meet the waste disposal requirements. BNFL conducted treatment and vitrification tests on actual waste samples during Phase IA and indicated that it can meet the specification for ILAW provided for in the Phase IA contract.

The vitrification process will require additional development, and BNFL has identified a development program for Part B-1 to address the technical uncertainties identified with the vitrification technology (Section 2.2). The development process will include processing six additional waste samples, completing one continuous bench-scale melter test using actual Hanford Site tank waste, and performing cold testing of a LAW melter to address scale-up issues associated with the proposed LAW vitrification melter. The laboratory and pilot testing would be completed at authorized facilities (e.g., Savannah River Technical Center and/or PNNL).

Under the path forward for Phase IB, BNFL would begin hot operations of the ILAW facility in 2007, two years after the start of hot operations of the pretreatment facility. During this period, pretreated LAW would be returned to the Hanford Site management and integration contractor for storage in DSTs.

The Phase IB immobilization capacity includes a LAW facility with a design capacity of 30 metric tons per day and an average of 18 metric tons per day of glass production (assuming 60 percent total operating efficiency). This will support immobilizing approximately 6 to 13 percent of the total tank waste mass with 25 percent of the total tank waste radioactivity (totals for LAW and HLW) during Phase I (production from 2006 through 2016). The proposed plan calls for deactivation of the Phase IB facilities beginning in 2016.

The Phase IB facilities would have a 40-year design life, and a facility would be designed and constructed to accommodate an expansion of immobilization capacity by approximately 100 percent. However, continued production at the facility without expanding or adding facilities would not support the Tri-Party Agreement goal of completing immobilization of at least 99 percent of the tank waste volume by 2028.

Implications of New Information

The new information does not directly change potential environmental impacts as presented in the TWRS EIS or the SA. The implications of the delay in start of hot operations of the LAW facility compared to the pretreatment facility is discussed in Section 3.2.1.1. Additionally, the implications of the ability to extend or expand LAW immobilization are discussed in Section 3.1.3.

3.1.2.2 HLW

New Information

Under the negotiated path forward for Phase IB, HLW immobilization capacity includes a facility with a capacity of 1 metric tons per day production with an average of 0.6 metric ton of glass production per day (assuming 60 percent total operating efficiency). Hot operations would begin in 2006 and extend to 2016. The HLW immobilization facility would have a minimum 30-year design life and be designed to support capacity expansion up to a design capacity of 5.6 metric tons per day; however, the current plan calls for deactivation beginning in 2016. Continued operation of these facilities without expanding or adding facilities would not support the Tri-Party Agreement goal of completing immobilization of at least 99 percent of the tank waste volume by 2028.

Under the negotiated approach to Phase IB HLW vitrification technologies that have been used previously to immobilize HLW using a liquid-fed ceramic melter would be implemented. BNFL conducted treatment and vitrification tests on actual waste samples during Phase IA and indicated that it can meet the specification for IHLW provided for in the Phase IA contract. The vitrification process will require additional development, and BNFL has identified a development program for Part B-1 to address the technical uncertainties identified with the vitrification technology (Section 2.2). The development process will include completing laboratory and pilot-scale melter testing using actual Hanford Site tank waste. The laboratory and pilot testing would be completed at authorized facilities (e.g., Savannah River Site and/or PNNL).

Implication of New Information

The new information does not directly change potential environmental impacts as presented in the TWRS EIS or the SA. The implications of the ability to extend or expand HLW immobilization are discussed in Section 3.1.3.

3.1.2.3 Storage and Disposal

New Information

There is no new information that would change the environmental impacts associated with IHLW storage and disposal compared to the impacts presented in the TWRS EIS or the SA. The increase in technetium in the IHLW, compared to the TWRS baseline, is within the bounds of the EIS analysis of environmental and human health impacts from HLW immobilization and IHLW storage because the EIS evaluated alternatives that included no separations and the storage and disposal of all tank waste as IHLW.

Waste separations of technetium (Section 3.1.1.3) would reduce the quantity of technetium in the LAW stream and the ILAW to be disposed of at the Hanford Site compared to impacts previously calculated. Technetium is the major contributor to environmental impacts (i.e., impacts to groundwater quality and long-term human health) from disposal of ILAW. In the TWRS EIS the Phased Implementation alternative calculated impacts from ILAW disposal assuming 23,700 Ci of the technetium in the ILAW (DOE 1995). In 1998, DOE published a draft PA for ILAW disposal (DOE 1998a). The PA assumed that 1) 82 percent of the technetium inventory would be disposed of in the ILAW (22,300 Ci of technetium) based on a total inventory of 27,200 Ci of technetium; and 2) ILAW would be packaged to support retrievability for up to 50 years in by pouring the vitrified waste into stainless-steel boxes (1.4 by 1.4 by 1.4 m [4.6 by 4.6 by 4.6 ft]), which would then be placed in concrete vaults. The size of the box would change from the current program size of 1.2 by 1.2 by 1.8 m (4 by 4 by 6 ft). The PA concluded that ILAW disposal would comply with all disposal requirements. However, at 10,000 years groundwater concentrations of technetium would exceed the drinking water standard of 900 pCi/L resulting in contamination peaking at 1,560 pCi/L at 10,000 years. As this groundwater quality standard only applies for 1,000 years following disposal, the calculated exceedance provides a reference point and does not influence the ability to comply with existing regulations.

Improved technetium separations compared to those previously assumed (Section 3.1.1.3) would reduce the amount of technetium curies in the ILAW to approximately 6,000 Ci. Because of the resulting implications for ILAW disposal, as well as the cost estimate for LAW treatment services which were more expensive than estimated previously (DOE 1998b) during Phase I/Part B-1, DOE and BNFL will address LAW container specifications and ILAW product specifications (i.e., waste form). LAW container specifications require ILAW to be placed in a metal box suitable for handling and storage. This specification supports handling and retrievability of ILAW, but it may be a significant factor in the overall LAW treatment cost (DOE 1998b), and it is not required by disposal regulations.

Implication of New Information

As discussed in Section 3.1.1.3, the improved performance specification for technetium removal would result in a ILAW with lower concentrations of technetium than previously estimated. This change will improve the long-term human health risk performance of the ILAW following disposal compared to the environmental impacts calculated in the TWRS EIS (DOE 1996), the revised impacts calculated in the SA (DOE 1998c), and the impacts calculated in the PA for ILAW disposal (DOE 1998a) because technetium is the major contributor to human health risk for ILAW. Improved technetium removal during separations will divert more technetium to the HLW, resulting in lesser long-term impacts to groundwater and the Columbia River and related long-term impacts to human health and ecological and biological resources at the Hanford Site. This improved performance indicates that alternative waste packaging and/or waste forms (e.g., non-glass) may be able to meet performance requirements for protecting groundwater quality and long-term human health.

Early in Phase I/Part B-1, DOE and BNFL plan to evaluate these issues to support a determination of whether the waste packaging and/or waste form should be changed from the proposed approach for Phase I and/or Phase II. If an alternate ILAW package and/or waste form

with lower concentrations of technetium meets comparable levels of environmental performance to current ILAW package/waste form design with higher concentrations of technetium then the impacts would be bounded by the TWRS EIS analysis and it could be implemented. A change in waste packaging and/or waste form would require a revision to the ILAW PA to ensure that the disposal system complies with applicable regulations. It also would require additional NEPA analysis during Phase I/Part B-1 prior to proceeding with Part B-2.

3.1.3 Phase II Schedule and Facility Configuration

New Information

No changes are proposed for implementing Phase II; however, changes in Phase I could influence decisions regarding how Phase II is implemented.

Implication of New Information

The proposed changes in Phase I would have implications for environmental impacts for a number of aspects (e.g., DST space management, SST retrieval) of the TWRS Program (Section 3.2) including decisions regarding implementation of Phase II. Under the path forward for Phase IB, the facilities would have a minimum 30-year design life. However, the current plan is to decontaminate and decommission the facilities beginning in 2016 (concurrent with or within a few years following the startup of hot operations of Phase II facilities). Operation of Phase I facilities could be extended for the life of the TWRS Program (through 2028), and the facilities have the capacity to be expanded (Sections 3.2.1 and 3.2.2). However, extended and expanded operation of Phase I facilities would not be sufficient to support the Tri-Party Agreement goal of completing immobilization of approximately 99 percent of the tank waste volume by 2028. Therefore, for Phase II DOE would have the option of 1) decommissioning the Phase I facilities and constructing new facilities that are sized to compete the TWRS mission; 2) continuing to operate the Phase I facilities throughout Phase II and constructing new facilities that would be sized proportionately smaller than those needed under Option 1; or 3) extending and expanding the operation of the Phase I facilities through 2028 and constructing new facilities that would be proportionately smaller than those required under Option 1 or 2.

These decisions will have potential environmental impacts because of the implications associated with

- Constructing new facilities (e.g., construction injuries and illnesses and land use and related biological and ecological impacts).
- Operating the facilities (e.g., air emissions associated with the number and location of facilities and worker health and safety) and the schedule for operating and completing components of the program (e.g., SST waste retrieval and waste processing).

This issue would require additional NEPA analysis during Phase I/Part B-1 prior to proceeding with Part B-2.

3.2 CHANGES IN PHASE I SCHEDULE

3.2.1 Start of Waste Retrieval and Processing

Based on the negotiations, Phase IB will include additional design and testing of immobilization technologies. At completion of Phase I/Part B-1, DOE will make a decision regarding proceeding with BNFL for the remaining design, construction, and operations phases of Phase IB or implementing an alternative approach to waste treatment and immobilization (Section 2.2). This decision point will require a comparable review process to the one completed to support the decision to proceed with Phase IB. Additionally, there would be changes in the schedule for startup of hot operations of Phase IB facilities (i.e., pretreatment and LAW and HLW immobilization), and the duration of Phase IB waste processing would change to extend from 2006 to 2016. No changes are proposed for implementation of Phase II; however, changes in Phase IB could influence decisions regarding how Phase II is implemented. The proposed changes in Phase IB would have implications for environmental impacts for a number of aspects of the TWRS Program (e.g., DST space management, SST waste retrieval).

3.2.1.1 DST Space Management

New Information

The change in the TWRS Program resulting from the negotiations for proceeding with Phase IB limits the availability of DST space to support SST waste retrieval and storage during early portions of Phase IB. Under the current approach to Phase IB, waste separations would have begun in 2002 concurrent with the startup of hot operations for LAW vitrification. The separated HLW fraction would have been stored until the HLW treatment facilities initiated operations sometime between 2002 and 2009. However, under the negotiated approach, waste separations would begin in 2005 and HLW vitrification will begin in 2006. The LAW waste stream, consisting of the liquid waste fraction along with the liquid waste stream from sludge washing, would be returned to DSTs until the LAW facilities initiated operations beginning in 2007 (Section 3.1.2.1).

This change would result in limiting available DST storage space for supporting SST waste retrieval. The impacts of this change are offset by:

- Decreasing the number of tanks to be provided to private contractors as waste receipt tanks from two tanks to one tank (Section 3.3.1.2); however, during the Part B-1 design phase BNFL will evaluate operation of a second tank during Part B-2
- Transferring sludge washing from in DSTs to in the treatment facility (Section 3.1.1.2)
- Combining the waste from two DSTs into one DST.

The Site management and integration contractor performed a preliminary evaluation (a two-week effort) of the impacts that this TWRS Program change would have on DST space management (LMHC 1998). The analysis concluded that adequate tank space exists to store and deliver waste feed to BNFL and to store the entrained solids and pretreated LAW return streams. However, it also indicated that there is significant program risk that the tank space obligated to support the demands of the TWRS Program could exceed the DST space available and that retrieval of SST

waste beyond those required for Phase IB processing could be delayed until sufficient DST space is available. Sufficient space would not be available to support SST waste retrieval until early in FY 2008, assuming the following.

- BNFL processes waste feed at the maximum delivery rates.
- There are no changes in the functions assigned to the DSTs to support other TWRS missions (e.g., waste retrieval to mitigate safety issues, delays in saltwell pumping beyond 2004, 242-A Evaporator does not operate as planned, waste volumes entering the DST system are larger than planned).

This analysis was based on a limited review of the DST space issue. During the initial stages of Phase I/Part B-1 the Site management and integration contractor will evaluate DST space management issues in light of the negotiated changes in Phase IB.

Implications of New Information

DST space constraints have implications for environmental impacts and regulatory compliance of the Phased Implementation alternative. The implications for environmental impacts would include the increased potential for losses of waste from SSTs during continued storage pending transfer to DSTs and increased potential for retrieval losses due to failure of aging tanks during retrieval actions using liquids (Section 3.2.1.2). While each of these potential changes in the environmental impacts would result in potentially increased impacts to groundwater quality and ultimately long-term human health risk, the TWRS EIS considered alternatives that included long-term management of the SST waste and the resulting impacts of eventual release of the waste to the environment from all or portions of the SSTs (e.g., the TWRS EIS Long-Term Management and Ex Situ/In Situ Partial Retrieval alternatives). Thus the TWRS EIS bounds the environmental impacts of the delay in SST waste retrieval. However, the impacts of delaying retrieval of SST waste would fall between those of the Phased Implementation alternative and other long-term management alternatives and would tend to have substantially fewer impacts because all of the waste ultimately would be retrieved by 2018. The increased impacts would represent only the impacts from delays associated with not retrieving waste from a portion of the tanks beginning in 2003 through when they are retrieved prior to 2018. Moreover, methods are available to mitigate the potential impact of the delay including constructing additional DST space to accommodate SST waste transfers and implementing non-liquid based retrieval technologies. Each of these measures would require NEPA analysis during Phase I/Part B-1.

DST space constraints during Phase I could affect DOE's ability to comply with the Tri-Party Agreement.

- Under the Tri-Party Agreement based SST waste retrieval schedule, waste retrieval from SSTs would begin in 2003 and all SST waste would be retrieved by 2018.
- During Phase I (2002 to 2012), the schedule would require waste retrieval from approximately 35 SSTs with the remaining tanks retrieved between 2013 and 2018.

During Phase IB DOE will need to address the implications of delaying SST retrieval early in Phase I including:

- Evaluating the impacts resulting from the compressed schedule for SST waste retrieval during Phase II. This issue will have implications on how Phase II is implemented and the ability of DOE to comply with the requirements in the Tri-Party Agreement to complete SST waste retrieval by 2018.
- Reevaluating SST waste retrieval sequencing to address the delays in the schedule and meeting revised waste feed requirements.
- Renegotiations of the Tri-Party Agreement SST waste retrieval milestones.

Delays in SST waste retrieval also increase the need for:

- Completing the saltwell pumping of SSTs to remove drainable liquids. These tanks have already exceeded their design life, and additional delays in SST waste retrieval for treatment will increase the risk of tank leaks to the environment
- Evaluating the potential for sound yet aging tanks to leak during liquid-based retrieval actions (Section 3.2.1.2).
- Completing the planned tank farm upgrades to support safe and regulatorily compliant SST management.
- Evaluating the need for additional DSTs or other regulatorily compliant waste storage capacity.

3.2.1.2 Tank Design Life/Integrity

New Information

All of the SSTs presently exceed their design life by more than 20 years and some by more than 30 years. By the time SST waste retrieval is completed in 2018 the design life for the SSTs will have been exceeded by more than four decades for all of the SSTs. Due to past waste management practices and aging of the tanks, 67 SSTs are suspected or known to have leaked in the past. As the SSTs continue to age the potential for tank failures increase. A similar situation exists for the DSTs. Presently none of the DSTs have exceed their design life. However, when the DST waste retrieval is completed in 2028, DSTs constructed in the 1970's will have exceed their design life. The negotiated Phase IB approach includes changes to the waste processing schedule that impact SST waste retrieval during early portions Phase IB (Section 3.2.1.1). However, during latter stages of Phase IB or during Phase II waste retrieval from SSTs would need to be compressed to accommodate delays in the start of retrieval while complying with the

completion date of 2018 for all SST waste to be transferred to DSTs. At this time, no changes are proposed for Phase II that would impact the completion dates for SST or DST waste retrieval.

Implications of the New Information

The aging of SSTs and the compression of the schedule for SST waste retrieval would have implications for potential environmental impacts similar to those discussed in Section 3.2.1.1.

3.2.2 Start of Hot Operations

3.2.2.1 Startup Sequencing for Pretreatment, LAW Immobilization, and HLW Vitrification

New Information

As discussed previously the negotiated approach for Phase IB would change the sequence for start of hot operations for treatment and LAW and HLW immobilization facilities (Section 2.2). The changes include 1) start of hot operations of the treatment facility in 2005 rather than 2002 (TWRS EIS and Tri-Party Agreement primary path schedule) or 2003 (Tri-Party Agreement alternate path schedule); 2) start of hot operations of the LAW immobilization facility in 2007 rather than 2002 (TWRS EIS and Tri-Party Agreement primary path schedule) or 2003 (Tri-Party Agreement alternate path schedule); and 3) start of hot operations of the HLW vitrification facility in 2006 rather than sometime between 2002 and 2009 (TWRS EIS and Tri-Party Agreement primary path schedule). The dates for start of hot operations are based on a 50 percent confidence estimate. Startup dates later in the same year or the next year are projected under a 90 percent confidence estimate. Because of the timing of hot operations of the LAW facility (2007) compared to the pretreatment facility (2005), decontaminated LAW from the process facility will be returned to DOE for storage in DSTs. When the LAW facility is operational the LAW liquid waste stream will be fed to the melter. Also, Phase IB operations would extend to 2016 compared to an assumed end of Phase IB operations in 2012 in the TWRS EIS.

Implication of New Information

As a result of negotiations, the change in startup of hot operations Phase IB facilities has implications for:

- DST space management (Section 3.2.1.1)
- Compliance with the Tri-Party Agreement (Section 3.2.2.2)
- Tank design life/integrity (Section 3.2.1.2)
- SST waste retrieval (Section 3.3.2.)
- A revised end date for completing Phase IB (Section 3.1.3).

These changes would require additional NEPA analysis during Phase I/Part B-1 prior to proceeding with Part B-2.

3.2.2.2 Tri-Party Agreement Milestone Compliance

New Information

Changes resulting from the negotiations of Phase IB implementation would result in 1) a reduction in the number of Phase IB contractors; and 2) revised schedules for start of hot operations of Phase IB facilities (Section 3.2.2.1). These revisions would directly impact compliance with the Tri-Party Agreement. They also would indirectly impact compliance with the Tri-Party Agreement milestones for SST waste retrieval (Section 3.3.2.2) and potentially could impact Phase II implementation and completion of SST waste retrieval and completion of waste processing in accordance with the Tri-Party Agreement (Section 3.2.1.3).

Implication of New Information

Each of the Tri-Party Agreement milestones directly impacted by changes negotiated for Phase IB and other new information regarding the TWRS Program will require negotiation with Ecology and EPA to develop new milestones that ensure compliance with the Agreement. The Tri-Party Agreement includes a process for negotiating changes that provides for public input on any proposed changes. Some milestones require renegotiations early in Phase I/Part B-1 (e.g., those related to start of hot operations of facilities), while others may require renegotiations as information from Phase I/Part-B-1 studies becomes available, decisions are made at the end of Phase I/Part B-1 regarding proceeding with Phase I/Part B-2, or prior to contracting for Phase II.

3.3 OTHER CHANGES IMPACTING THE TWRS PROGRAM

3.3.1 Number of Contractors

DOE has decided to proceed with one contractor in Phase IB and construct one facility that would include waste treatment and HLW and LAW immobilization.

3.3.1.1 Facility Configuration and Siting

New Information

For purposes of environmental impact analysis the TWRS EIS and the SA assumed that two contractors would be selected resulting in the construction and operation of at least two facilities (one LAW and one LAW/HLW facility). In the SA, based on information provided by LMAES and BNFL, the environmental impacts to previously undisturbed shrub-steppe habitat associated with construction of the Phase I facilities increased from the impacts presented in the TWRS EIS (26 to 60 ha [64 to 150 ac]). The increase in impacts was, in part, the result of increases in the footprint of the facilities proposed by the contractors (an increase in impacts from 18 to 27 ha [45 to 67 ac]). The increased impacts were within the 200 East Area, which is a portion of the exclusive use WMA. However, it was determined that the overall impact to these components of the environment was comprised of small increases in impacts and the impacts were within the bounds of the TWRS EIS analysis (DOE 1998c).

Implications of New Information

The reduction in the number of Phase IB contractors and the associated decrease in facility footprints will decrease the impacts to shrubb-steppe habitat from facility construction and

operations. This reduction in impacts will mitigate the increase in shrubb-steppe habitat disturbance since the completion of the TWRS EIS, resulting in a minimum net increase in impacts of approximately 4 ha (10 ac) from Phase IB waste processing facilities depending on the final negotiated Phase IB facility footprints. The reduction would also reduce the number of waste treatment facilities operating, which would lower overall air emissions and related impacts on air quality and short-term public and worker health risks.

3.3.1.2 Contracting Strategies

New Information

As discussed previously, DOE has decided to proceed with implementing Phase IB with only one contractor. This contracting strategy differs from the strategy for implementing the Phased Implementation alternative. Previously it was assumed that Phase IB would proceed with two contractors.

Implications of the New Information

The decision to proceed with one rather than two contractors for Phase IB does not in itself change the understanding of potential environmental impacts from facility construction and operation during Phase IB. As indicated in the TWRS EIS, the contracting strategy (e.g., one or two contractors - privatization or Site management and integration contractor) does not influence environmental impacts. For the TWRS EIS calculations it was assumed that the contractor would be the Site management and integration contractor.

Reducing the number of contractors does change DST space management (Section 3.2.1.1) in that previously each of the two potential Phase IB contractors would have been allocated a DST to receive waste for processing. Under the negotiated approach only one contractor will occupy DST space, allowing the second DST to be used for waste management. However, during the design phase (Part B-1), BNFL will evaluate using a second DST to support Phase I/Part B-2 waste processing.

There are regulatory implications of the decision not to proceed with two contractors. Under Tri-Party Agreement Milestone M-60-10, by July 1998 DOE was to select two contractors and issue authorizations-to-proceed with Part B for work on LAW pretreatment and immobilization (Section 3.2.2.2). The Tri-Party Agreement provides an alternate path for implementing waste processing. Under the alternate path, Phase IB contracting would need to be completed to support start of pretreatment facility hot operations in December 2003, LAW immobilization would need to be completed by 2028 rather than 2024, and the milestone for hot operations of Phase I pretreatment would change from 2002 to 2003. The start of hot operations of LAW immobilization would remain at 2003. Under the negotiated Phase IB approach, attaining the alternate path Tri-Party Agreement milestones for start of hot operations would not be achievable (Section 3.2.1.1). This, along with other changes to the TWRS Program, would necessitate renegotiating the Tri-Party Agreement.

3.3.2 Waste Transfers and Retrieval

3.3.2.1 Waste Retrieval in Support of Phase IB

New Information

Since completion of the SA the only new information regarding waste retrieval to support Phase IB is the identification of the specific tanks (DSTs and SSTs) that will be retrieved to provide waste feed for Phase IB. While no new tanks have been identified, some tanks previously identified may no longer be retrieved in support of Phase IB waste processing.

Implication of New Information

The new information does not change the understanding of potential environmental impacts compared to those identified in the TWRS EIS or the SA.

3.3.2.2 SST Retrieval

New Information

As discussed in Section 3.2.1.1, proposed changes in the schedule for Phase IB waste processing would impact DST space availability during early portions of Phase IB (through at least 2008). These changes would prevent retrieving SSTs on the current Tri-Party Agreement schedule. Recently DOE and Ecology initiated revisions to the SST retrieval strategy based on changes to the TWRS Program embodied in the TWRS ROD and the 1996 revisions to the Tri-Party Agreement that addressed the Phased Implementation alternative. The Site management and integration contractor is revising the SST retrieval strategy and plans on developing revised retrieval sequences by September 1998. The revised strategy would address the factors identified earlier and the following considerations:

- Understanding feed delivery requirements and constraints
- Achieving risk reduction as an objective
- Implementing SST retrieval on a learn-as-we-go basis
- Addressing potential leakage losses during retrieval
- Reducing risk by transferring waste from SSTs to DSTs as space becomes available
- Minimizing SST retrieval costs prior to Phase II.

Implications of New Information

Proposed changes in the SST waste retrieval schedule have potential environmental implications. As SSTs continue to age the potential for leakage during retrieval increases from tanks currently assumed to be sound, as well as from known and assumed leakers according to the retrieval technology deployed. The TWRS EIS analysis of environmental impacts assumed that all 149 SSTs would leak an average of 15,200 L (4,000 gal.) during retrieval to bound potential SST retrieval losses. The TWRS EIS also indicated that alternate retrieval technologies could be deployed to minimize the potential losses (e.g., using non-liquid or low-liquid based retrieval

technologies). However, further delays in SST waste retrieval could increase the need to deploy such technologies.

Based on the new information, early during Phase I/Part B-1 DOE will need to:

- Reevaluate the SST waste retrieval strategy to the factors identified previously
- Assess the implications of the delay in retrieval of some SSTs relative to the integrity of the SSTs and DSTs during the life of the TWRS Program (Section 3.2.1.2)
- Assess DST space availability and the potential need for additional DST capacity to support SST waste retrieval.

3.3.3 Interim Stabilization

New Information

The TWRS EIS assumed that all saltwell pumping would be completed by FY 2000. Under the Tri-Party Agreement, liquid removal from an additional 17 tanks was to have been initiated in FY 1998 and all remaining saltwell pumping was to be completed by FY 2000 (Ecology et al. 1994). However, requirements for flammable gas safety controls and increased costs slowed saltwell pumping in FY 1998 to pumping a maximum of five tanks in FY 1998. DOE is currently investigating methods to decrease the tank-by-tank cost of the project. Based on current funding estimates and operational constraints, DOE estimates completion of saltwell pumping in FY 2004. In June 1998, Ecology notified DOE that it intended to file suit for failure to comply with Tri-Party Agreement milestones associated with saltwell pumping.

Implications of New Information

The delays in completing the saltwell pumping program coupled with the delays proposed for the retrieval of SST waste (Section 3.2.1.1) emphasize the need for completing interim stabilization as soon as practicable. The remaining tanks requiring saltwell pumping have in excess of 18.9 million L (5 million gal.) of pumpable liquids that, if released to the environment, could result in contaminant migration deep into the vadose zone and ultimately to the groundwater and the Columbia River. The impacts to the environment and cost of remediating the liquids once released to the environment are likely to far outweigh the near-term impacts and cost of removing the liquids from the tanks.

REFERENCES

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- DOE 1995.** Safe Interim Storage of Hanford's Tank Waste Final Environmental Impact Statement. DOE/EIS-0212. U.S. Department of Energy. Richland, Washington. October 1995.
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APPENDIX A
INDEPENDENT REVIEW PANEL

PROGRAMMATIC ENVIRONMENTAL REVIEW INDEPENDENT REVIEW PANEL CHARTER

In the Tank Waste Remediation System (TWRS) Environmental Impact Statement (EIS) Record of Decision (ROD) the U.S. Department of Energy (DOE) committed to performing a review of the TWRS Program at various stages as the project proceeds. DOE committed to the following.

- Conduct periodic independent scientific and technical expert reviews, which DOE believes are essential to the success of the TWRS program.
- Conduct formal evaluations of the entire TWRS program at the following stages before proceeding into Privatization Phase I Part B (scheduled for no later than July 1998) and at two other times prior to proceeding with key aspects of the TWRS program.
- Require selected offerers to submit further environmental information and analyses and will use the additional information to assist in the National Environmental Policy Act (NEPA) compliance process.

DOE considered proposals from BNFL Inc. and Lockheed Martin Advanced Environmental Systems for Phase IB. This included reviewing the technical, scientific, regulatory, and financial aspects of the proposals and an independent review of the DOE evaluation of the proposals. DOE is also reviewing Fluor Daniel Hanford documents related to readiness to proceed with support services required to provide infrastructure, waste feed stream, and immobilized waste storage or disposal. This includes a review of the technical, scientific, regulatory, and financial aspects of the contractor's readiness to proceed documents. DOE is also completing a review of DOE's readiness to proceed, the readiness to proceed of the Regulatory Unit, and a review under NEPA of new information that had developed since the completion of the TWRS EIS ROD. Each of these reviews will be subject to an independent review process.

To support a review of environmental implications of proposed changes to the TWRS Program based on negotiations with BNFL regarding Phase IB, DOE is preparing a Programmatic Environmental Review Report. LMAES was dropped from consideration for Phase IB services subsequent to submitting a proposal in January 1998. DOE will prepare the report to review the new information developed since the preparation of the TWRS EIS and the January 1998 Supplement Analysis. The review will identify potential areas of environmental and human health impacts that should be evaluated prior to proceeding with Phase IB facility construction and operation. The report will not address technical, financial, or scientific issues addressed in other DOE reviews (i.e., of the proposals or contractor readiness to proceed) except to the extent that the issues may influence changes in environmental and human health impacts that may require additional NEPA analysis. Instead the report will appropriately reference the source of the technical information for interested persons. The focus of the report will be on proposed changes resulting from the negotiations process. However, other new information that has emerged since completion of the Supplement Analysis will be addressed if the new information would potentially affect environmental impacts.

The report will be reviewed by an Independent Review Panel. The Panel will not provide a review of the technical, scientific, or financial issues being addressed by other components of the TWRS review process. Rather, the Panel will address issues that may result in changes in environmental impacts that should be evaluated prior to proceeding with construction and operation of TWRS facilities.

RESUME

KENNETH W. BRACKEN**QUALIFICATIONS SUMMARY**

I have 10 years of experience with program/policy formulation for both nuclear waste management and defense programs at the state and national levels. My experience as a program or project manager has included three and a half years of Major Systems Acquisition-level project management on the largest DOE Waste Management Project (Hanford's Tank Waste Remediation System) as the Deputy Assistant Manager responsible for Disposal. I have extensive experience with the public sector representing DOE on numerous technical, environmental and financial issues.

PROFESSIONAL EXPERIENCE

President, Bracken Inc.: Consulting firm focused on general management and waste management issues within the nuclear industry. Period of time: October 1995 to Present.

Deputy Chief Financial Officer, Richland Operations Office (RL), U.S. Department of Energy (DOE): Responsible for development and integration of the major site management systems for baseline management i.e., tracking work scope, cost and schedule; and the oversight and coordination of the Site budget planning and execution. Period of time: February 1995 to October 1995.

Deputy Assistant Mgr for Disposal, RL, DOE: Responsible for retrieval, treatment and disposal of current and future Hanford high-level tank wastes. The effort involved the retrieval of tank waste from underground storage tanks; the treatment of the tank waste to prepare acceptable feed streams for subsequent processing, and the processing of the high-level, transuranic and low-level waste to final waste for disposal. This was a major part of the Tank Waste Remediation System program (TWRS). Period of time: December 1991 to February 1995.

Director of Waste Management Division, RL, DOE: Responsible for the Hanford Defense Waste management programs for the treatment, storage, transportation and disposal of high-level, transuranic and low-level radioactive waste, mixed waste and hazardous waste and associated process and technology development work. Headed a major program redefinition study that led to the Secretary of Energy's decision to establish the TWRS program. Period of time: May 1990 to December 1991.

Deputy Assistant Manager for Operations, RL, DOE: Responsible for the management of production reactor operations, nuclear materials processing operations,

radioactive and hazardous waste management activities, and environmental restoration and compliance functions. Primary responsibility for performance evaluation of contractors, preparation of program planning and budget documents, and review of and compliance to environmental laws and regulations. Period of time: November 1986 to May 1990.

Director, Office of Plans and Budgets, RL, DOE: Responsible for development and preparation of Site strategic plan and the formulation and justification of the RL program budget requirements for manpower resources, materials, supplies, travel, capital equipment, and construction projects for all programs. Period of time: November 1985 to November 1986.

Detailed work histories available upon request

SPECIAL ASSIGNMENTS

Member, Source Evaluation Board to consolidate Hanford GOCO contracts (1987)

Detail assignment to the office of the Assistant Secretary for Defense Programs (1989)

Member, DOE HQ Nuclear Weapons Complex Reconfiguration Study (1990-1991)

Member, Source Evaluation Board to select Hanford AE/Construction contractor (1993-1994)

RL technical negotiator for TWRS environmental compliance agreement (1993-1994)

EDUCATION

B.A. Accounting, Central Washington State University

M.B.A. Financial Management, Washington State University

QUALIFICATIONS OF ALLEN G. CROFF RELATED TO THE HANFORD TANK WASTE REMEDIATION SYSTEM

Presently the Associate Director of the ORNL Chemical Technology Division.

1. Technical
 - BS in chemical engineering, essentially a PhD (odd degree type) in nuclear engineering
 - 23 years experience in nuclear fuel cycles and waste management
 - Founding member of the Tank Focus Area and currently a member of the TFA User Steering Group
 - Member of the National Academy of Sciences' committee that reviewed the recent TWRS draft EIS (formal) and draft ROD (informal)
2. Affected Environment
 - Moderate experience with risk analysis and health effects
3. Regulatory Requirements
 - Familiar with the requirements of the Hanford TPA
 - Extensive knowledge of waste classification, including chairing the National Council on Radiation Protection committee on this subject
 - Extensive familiarity with regulations involving high-level and other repository wastes, and the repository per se
 - General knowledge of RCRA
4. Cost/Financial
 - Thesis on engineering economics and also have an MBA
 - Working experience on nuclear fuel cycle cost-risk-benefit evaluation
 - Long-term experience in DOE operating and capital cost regime from perspective of a technical division operating radiochemical facilities

J. LOUIS KOVACH

Education

Technical College, Szeged, Hungary, Diploma in Chemical Technology
 Technical University, Budapest, Hungary, D. Ch. E.
 MIT Nuclear Power Safety School
 MIT Fast Reactor Safety School

Professional Affiliations and Appointments

American Carbon Society, Member
 American Nuclear Society, Member
 American Society for Testing Materials Committee D.28, Member
 American National Standards Institute, NTAB Member
 ASME/ANSI Committee on Nuclear Air and Gas Treatment, Member
 American Waste Management Association, Member
 International Society of Nuclear Air Treatment, Member
 Consultant to USAEC, ERDA, DOE, Operational Safety Division, 1968-1982.
 re: Gaseous and liquid effluent control from production and reprocessing facilities.
 Consultant to Advisory Committee on Reactor Safety (ACRS), 1982-1987
 Member, Adjunct Faculty For Air Pollution Control Training USEPA, 1963-1976
 Lecturer on Nuclear Air Cleaning, Harvard U. School of Public Health, 1974-
 US Delegate & Chairman, OECD Group of Experts of Air Cleaning in Accident Situations
 at Nuclear Facilities, 1980-1988
 Member of Organizing & Editorial Board, DOE/NRC Air Cleaning Conferences, 1974-
 Chairman, IAEA Group of Experts on Air Cleaning in Severe Accidents, 1988-1990
 President, International Society of Nuclear Air Treatment, 1990-1992
 Member, USDOE High Level Waste Technical Advisory Panel (TAP), 1992-
 Member, USDOE HLW Chemical Reactions and Pretreatment Subpanels, 1993-
 Chairman, ASME Technology Subcommittee of Committee on Nuclear Air and Gas
 Treatment
 Chairman, USDOE Tank Waste Remediation System EIS Independent Technical Review
 Team
 Technical Lead for TWRS Privatization Business Group.

 Principal holder of 24 US and foreign patents.
 Author & coauthor of over 100 papers, book chapters, etc., relating to nuclear waste
 handling and gaseous and liquid phase pollution control

Employment

1956 - 1959 Chemcell Corporation (Celanese) Canada
 1959 - 1963 Barnebey Cheney Co. Columbus OH, Sr. Research Engineer
 1963 - 1968 Barnebey Cheney Co. Columbus OH, Director of Research
 1968 - 1972 North American Carbon Inc., Vice President & Director of R&D
 1972 - NUCON International, Inc. Columbus OH, President
 1992- Consultant on individual basis

Highlights of Specific Experience

The primary experience relates to the research, design, analysis, construction, and proof testing of both nuclear and non-nuclear gaseous and liquid phase pollution control systems. These involve the entire nuclear fuel cycle under both normal operating and accident conditions, nerve gas protection equipment for collective protection and for nerve gas destruction sites, air purification in enclosed spaces, and the collection and recovery of particulate, liquid and gaseous effluents.

Nuclear fuel manufacturing facility design, construction of gaseous control systems.

Design of original air cleaning system components for the Savannah River and Hanford production reactor sites.

Development and design of numerous air cleaning and liquid effluent control systems for nuclear facilities (fuel manufacturing, reactors, reprocessing plants).

Development and design of tritium recovery systems.

Participation in design and USEPA rule making process for nuclear fuel reprocessing sites.

R&D, design, and construction of organic contaminant recovery systems.

Development and design of radioactive noble gas control systems for LWRs, HWRs and reprocessing facilities .

Development and design of nuclear reactor primary coolant purification systems, utilizing inorganic ion exchange media.

Development and design of instrumentation for testing air cleaning systems and components.

Participation in development of source terms for both normal and accident conditions in relation to engineered safety features of nuclear facilities.

Design of refrigeration and separation systems utilizing the Brayton Cycle.

Research and development of the separation and solidification of mixed wastes.

Development of gaseous and liquid phase adsorbents for specific component separation and collection systems.

Design and operation of supercritical oxidation processes.

Development of inorganic ion exchange materials for control of radioactive isotopes in nuclear reactor coolants and nuclear waste management process streams.

Participation in the technical reviews of the design and operation of nuclear waste management sites of the USDOE.

Dr. J. Louis Kovach

Highlights: Member DOE High Level Waste Technical Advisory Panel 1992-current.
Member HLW Chemical Reactions and Pretreatment Subpanels 1993- current.
Chairman, DOE Tank Waste Remediation System EIS Independent Technical Review Team 1993.
Technical Lead for TWRS Privatization Business Group, 1994- current.

Education: D. Chemical Engineering, Technical University, Budapest, Hungary
MIT Nuclear Power Safety and Fast Reactor Safety Schools

Significant Accomplishments: Dr. Kovach has extensive experience in research, design, analysis, construction, proof testing of both nuclear and non-nuclear gaseous and liquid phase pollution control systems. These involve the entire nuclear fuel cycle under both normal and accident conditions, nerve gas protection equipment, and collection and recovery of particulate, liquid and gaseous effluents. He designed the original air cleaning system components for both Hanford and Savannah River production reactor sites. He has participated in a number of technical reviews of the design and operation of nuclear waste management facilities in the DOE complex. In particular, he is actively serving on the HLW Technical Advisory Panels and Subpanels and is thoroughly familiar with the Hanford waste tanks and their problems. He served as Chairman of the DOE TWRS EIS Independent Technical Review Team in 1993. He is currently President of NUCON International, Inc. Columbus, Ohio.

THOMAS E. LARSON

Lewis & Clark College, Portland, Oregon B.A. Chemistry

 Franck Scholarship

John Hopkins University, Baltimore, Maryland, 1950-1956

 M.A. Organic Chemistry 1951

 Ph.D. Physical Chemistry 1956

Los Alamos National Laboratory (LANL) 1956 – present

 1956-1974 Staff Member Explosives Technology Group

 1974-1975 Section Leader Explosives Technology Group

 1975-1984 Deputy Group Leader Explosives Technology Group

 1984-1991 Group Leader Explosives Technology Group

 1991 Program Manager Special Weapons Studies

 1991 Retired

 1991-Present LANL Laboratory Associate

Hanford Operations

 1990-Present Member of DOE High-Level Waste Technical Advisory Panel

 1993-Present Member of High-Level Waste Chemical Reactions Sub-Panel

Technical Areas:

 Kinetics of gaseous reactions of boron hydrides,

 Sensitivity of explosives to various stimuli,

 Explosives safety,

 New explosives development,

Explosives formulation & testing,

Development of non-explosive nuclear weapons materials,

Radioactive materials studies,

Nuclear weapon technology.

Awards:

Distinguished Performance Award for Terrazzo Invention 1982

Award of Excellence, Nuclear Weapons Program, Weaponization of Fogbank
1984

Award of Excellence, Nuclear Weapons Program, Development and
Weaponization of Terrazzo 1985

PROFESSIONAL PROFILE

JOHN H. ROECKER

CAREER OBJECTIVE

To make a significant contribution as a part-time technical staff member or consultant for an operating, engineering, program management, or consulting organization in nuclear waste technology and/or management.

SUMMARY OF QUALIFICATIONS

- Experienced and successful management of large engineering, operating, and program organizations for complex high technology operations.
- Broad technical background.
- Directed engineering development of process improvements leading to increased plant throughput and long-term waste disposal cost savings.
- Directed development of integrated systems engineering management for large, diverse organization.
- Experienced with development and management of customer and contractor interfaces.
- Recognized and respected as developer of young management and technical talent.

PROFESSIONAL CREDENTIALS

- Bachelor of Science Degree, Engineering Physics, University of Illinois
- Graduate Studies, Physics, University of Illinois - 1957
- Registered Professional Nuclear Engineer, (1975 - 1996)

COMMUNITY AND PROFESSIONAL INVOLVEMENT

1987)

Member - American Nuclear Society
 Member - Executive Board, ANS Power Division, (1984)
 Member - ANS National Planning Committee, (1984)
 Member - National Management Association, (1977 -

SECURITY CLEARANCE LEVEL

U.S. Department of Energy, Q-Clearance, (1958-1993)

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WORK EXPERIENCE

More than 39 years of experience in engineering, operations, and program management, including radioactive and hazardous waste management, nuclear chemical processing, space nuclear auxiliary power systems, breeder reactors, and commercial nuclear systems.

- Includes more than thirteen years of executive-level experience in complex nuclear and chemical engineering and management, and more than 21 years of project and program management experience.

As self-employed consultant participated in critical reviews of nuclear waste management and technology programs at Hanford and Savannah River Sites (11/93-Present).

- High Level Waste Committee, National Academy of Science
- TWRS Preliminary Safety Analysis Report, Lockheed Martin Co.
- TWRS Privatization Proposal, Lockheed Martin Co.
- Project Hanford Management Contract Proposal, Lockheed Martin Co.
- High Level Waste System Review, Westinghouse Savannah River Co.
- TWRS Alternative Configuration Study Review, Westinghouse Hanford Co.
- TWRS Systems Engineering Review, Westinghouse Hanford Co.
- TWRS Multi-year Program Plan Review, U.S. Department of Energy, Richland
- Systems Engineering Course, Systems Management and Development Co.

As manager of Tank Waste Remediation System (TWRS) Program Integration, Westinghouse Hanford Company was responsible for management of program planning and integration, systems engineering, integrated technology planning, and NEPA and regulatory permit planning and integration. Responsibilities included senior management level support to the interface with the Department of Energy. Managed a staff of approximately 35 professional personnel and an annual budget of approximately \$14 million (1/92-10/93).

- Prepared and maintained the TWRS Decision Plan.
- Introduced and initiated application of systems engineering principles within the TWRS program.
- Developed the TWRS New Technical Strategy (NTS).
- Provided lead technical support to the USDOE during Hanford Federal Facility Agreement and Consent Order negotiations.

John H. Roecker
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As deputy manager of Defense Waste Remediation, Westinghouse Hanford Company was responsible for providing management and technical support to the manager and other senior Westinghouse management (1/91-1/92).

- Provided management and technical leadership in the development of the Tank Waste Disposal Redefinition Study.
- Provided impetus to management for the integration of the Double Shell Tank Waster Disposal Program and the Tank Safety Program into a single integrated Tank Waste Remediation System program.

As Assistant to the Vice President, Environmental and Waste Management, Westinghouse Hanford Company was responsible for providing technical staff support (11/90-1/91).

As director of Plutonium Recovery Modification Project, Rocky Flats Plant, Rockwell International was responsible for project and technical management of the upgrading and modification of the plutonium recovery facility. Responsibilities included day-to-day management of the architect-engineer, identification and coordination of the supporting technology development needs, day-to-day management of the construction contractor. Managed a staff of approximately 60 professionals and an annual budget of approximately \$30 million (7/87 to 10/90).

As director of Defense Waste Management and Decontamination and Decommissioning Operations, Rockwell Hanford Operations, was responsible for executive-level management of programs and operations, including long-range waste disposal planning, near-term program budget and schedule planning and control, waste disposal technology, site-wide hazardous waste management, project management of new facilities construction and modifications to existing facilities, development of public information programs, and safe and economical operations of waste handling facilities. Responsibilities also included principal executive-level interface with Department of Energy as well as other on site contractors for defense waste and decontamination and decommissioning programs. Managed a staff of approximately 550 professional and craft personnel and an annual budget of approximately \$130 million (1986-1987).

- Organized Hanford Environmental Management Program Office for site-wide management of hazardous waste compliance program.
- Managed design of Hanford Waste Vitrification Facility. Capital expenditure approximately \$650 million.
- Operating facilities achieved record production and safety records.
- Initiated hazardous waste compliance actions meeting agency schedule commitments.

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As director, **Research and Engineering, Rockwell Hanford Operations**, was responsible for providing technical direction and engineering support for Rockwell Hanford Operations chemical processing and waste management programs and plant operations, including systems engineering; engineering analysis; equipment development and design; and process chemistry development and control. Responsibility also included providing engineering management of construction projects, as well as managing and implementing company-wide engineering policies and procedures. Managed a staff of approximately 675 with an annual budget of approximately \$80 million (1979-1986).

- Directed engineering of process changes resulting in an increase of PUREX headend throughput capability by more than 30 percent.
- Established a close, constructive working relationship with Kaiser Engineers Hanford Company on engineering and design activities for construction projects.
- Established a close, constructive working relationship with Pacific Northwest Laboratory on chemical processing and waste management technology development.
- Redesigned the engineering management system to incorporate a systems engineering approach to program/project management.
- Managed the development and preparation of the waste management and chemical processing technology and program plans.
- Introduced the Triad of Excellence Program to enhance pride, innovation, and quality

As program director, **Defense Waste Management Program, Rockwell Hanford Operations**, was responsible for the direction and control of all program management associated with the interim management of radioactive wastes, as well as planning and development of programs to enhance operational performance of facilities. Defense Waste Management had an annual budget of approximately \$40 million (1977-1979).

- Managed waste management program activities leading to the successful completion of the tank farm "currency" program in 1977, a Department of Energy Congressional commitment.
- Initiated development activities in cesium and strontium processing that led to significantly improved production rates. Six-month production run exceeded one half of prior four-year total production.
- Initiated development activities that resulted in significantly improved salt-well jet pump performance.

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As a project manager on the Prototype Large Breeder Reactor, Atomics International, was responsible for the management of the architect/engineer contractor, providing engineering support for the balance-of-plant and for the development of overall plant criteria and requirements, fuel handling system design, and plant cost estimates (1975-1977).

- Managed maintenance engineering studies for repair, removal, and replacement of large components for both loop and pool-type LMFBRs.

As a senior engineer at Southern California Edison Company, was responsible for systems and equipment engineering for the San Onofre Nuclear Generating Station and for providing technical direction on contract negotiations with the Nuclear Steam Supply System contractor (1973-1975).

As project manager of FFTF Closed Loop System, Atomics International, was responsible for the systems engineering analysis and design, component design and procurement, remote maintenance engineering studies, and module mockup fabrication (1969-1973).

As manager of Nuclear Test Engineering, Atomics International, was responsible for analysis and evaluation of test data from all nuclear testing (1966-1969).

As project engineer of SNAP Nuclear Test Operations, Atomics International, was responsible for nuclear ground testing of the SNAP 8 Reactor, including design, construction, and operation of test facilities (1960-1966).

Experienced and successful management of engineering, operations, and programs.