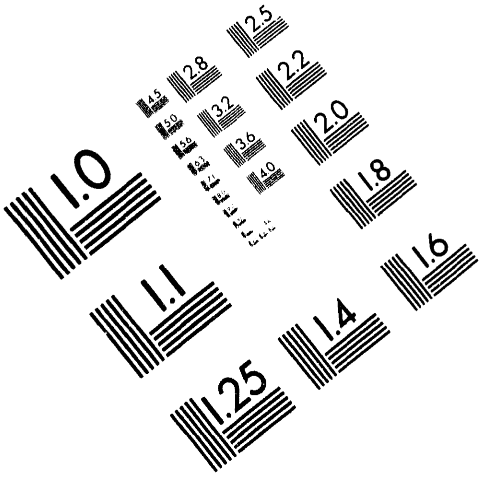

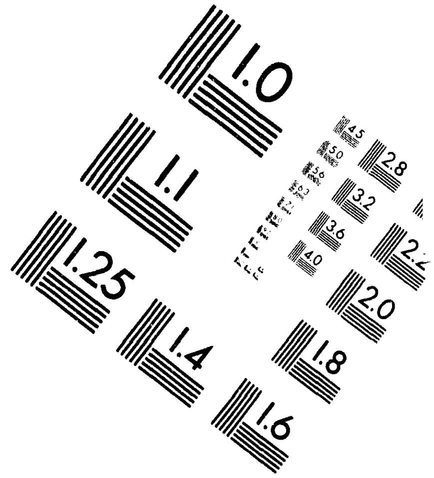

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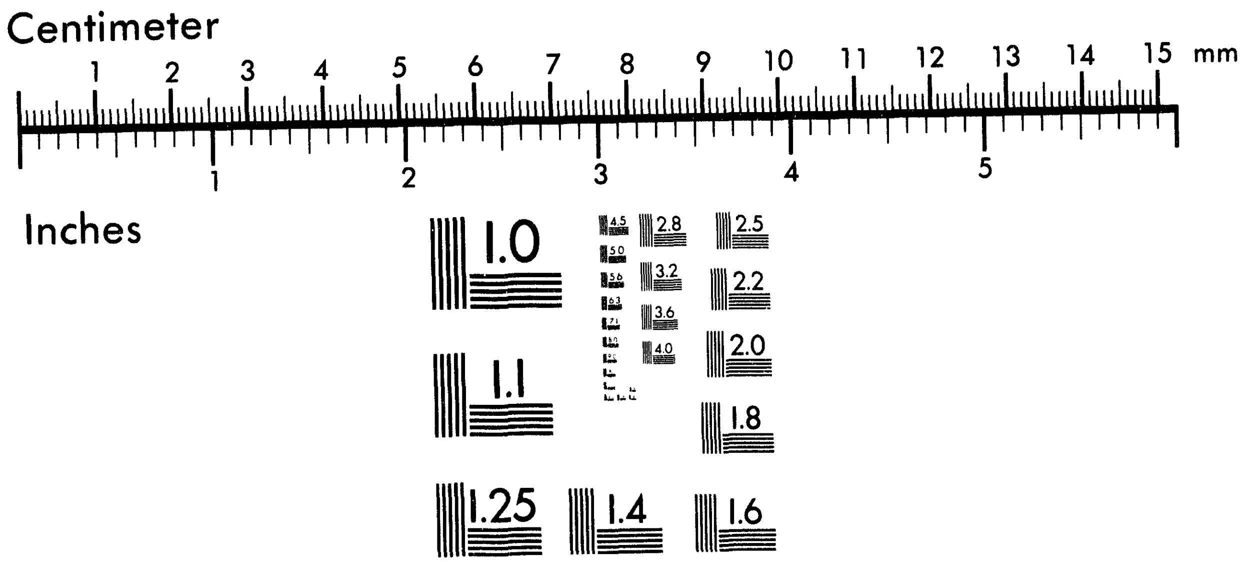

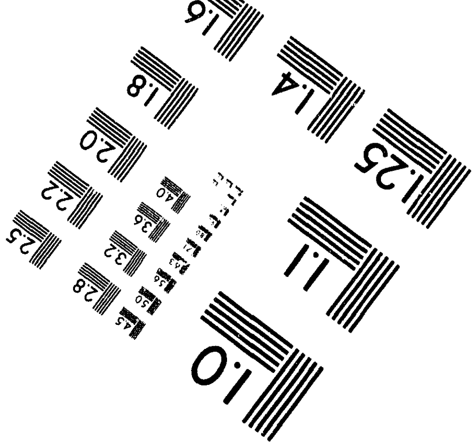

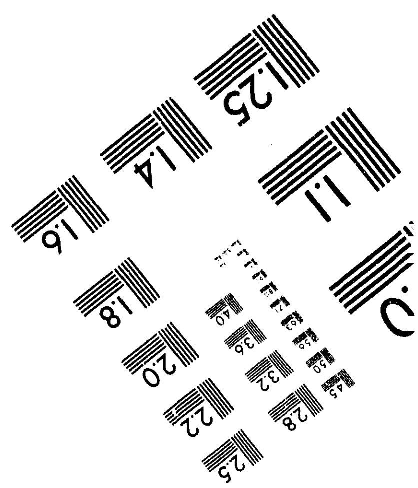

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7. Abstract

This document provides an analysis of the leakage mitigation mission applicable to past and potential future leakage from the Hanford Site's 149 single-shell high-level waste tanks. This mission is a part of the overall mission of the Westinghouse Hanford Company Tank Waste Remediation System division to remediate the tank waste in a safe and acceptable manner. Systems engineering principles are being applied to this effort. Mission analysis supports early decision making by clearly defining program objectives. This document identifies the initial conditions and acceptable final conditions, defines the programmatic and physical interfaces and constraints, estimates the resources to carry out the mission, and establishes measures of success. The results of the mission analysis provide a consistent basis for subsequent systems engineering work.

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Mission Analysis Report for Single-Shell Tank Leakage Mitigation

S. S. Lowe
J. M. Cruse

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ABSTRACT

This document provides an analysis of the leakage mitigation mission applicable to past and potential future leakage from the Hanford Site's 149 single-shell high-level waste tanks. This mission is a part of the overall mission of the Westinghouse Hanford Company Tank Waste Remediation System division to remediate the tank waste in a safe and acceptable manner. Systems engineering principles are being applied to this effort. Mission analysis supports early decision making by clearly defining program objectives. This document identifies the initial conditions and acceptable final conditions, defines the programmatic and physical interfaces and constraints, estimates the resources to carry out the mission, and establishes measures of success. The results of the mission analysis provide a consistent basis for subsequent systems engineering work.

EXECUTIVE SUMMARY

The Hanford Site's 149 single-shell tanks currently store approximately 140 million liters (37 million gallons) of high-level radioactive liquid waste. Historical data indicates 67 of the SSTs have leaked a portion of their contents into the surrounding soil. Objectives for environmental cleanup of the Hanford Site include retrieving, treating, and disposing of the SST waste in an acceptable manner. The Westinghouse Hanford Company's Tank Waste Remediation System division is responsible for achieving these objectives in accordance with the Tri-Party Agreement, applicable DOE orders, and applicable state and federal regulations. Hydraulic sluicing is the primary approach currently envisioned for retrieval of the single-shell tank waste. The sluicing operations typically will add some level of working liquid to the tank to mobilize the solidified saltcakes and sludges. The design life of the tanks has expired and the integrity of the tank containment boundaries is in question.

Tank wastes have leaked into the ground as a result of seepage from single-shell tanks and associated transfer lines, and other miscellaneous spills. Sixty-seven single-shell tanks are assumed to have leaked a total volume of approximately 2,271 to 3,407 m^3 (600,000 to 900,000 gal) (Hanlon 1993). There is concern regarding additional leakage that may result from the hydraulic head and fluid dynamic forces impacting the tank shells during retrieval. Future leakage may also result from the residual waste that remains in the tanks following retrieval; the residual may amount to one percent or more of the current waste inventory. If the residual cannot be removed it also eventually could leak into the soil. The soil contamination resulting from historical tank leakage and any future leakage because of the mechanisms noted above eventually will migrate downward through the vadose zone to the groundwater unless mitigative actions are taken.

TWRS is investigating a number of options to mitigate past and potential future leakage from the single-shell tanks. Systems engineering principles are being applied to this effort. Mission analysis supports early decision making by clearly defining the program objectives and evaluating the feasibility and risks of achieving those objectives. This report identifies

the initial conditions and acceptable final conditions, defines the programmatic and physical interfaces and constraints, estimates the resources to carry out the mission, and establishes measures of success. The results of the mission analysis provide a consistent basis for subsequent systems engineering work.

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CONTENTS

LIST OF TABLES

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ACRONYMS

ADS	Activity Data Sheet
DOE	U. S. Department Of Energy - Headquarters
DST	Double-Shell Tank
Ecology	Washington State Department Of Ecology
EPA	U. S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
FY	Fiscal Year
HDW-EIS	*Final Environmental Impact Statement, Disposal Of Hanford Defense High-level, Transuranic And Tank Wastes, Hanford site, Richland, Washington*
LLW	Low-Level Waste
MYPP	Multi-Year Program Plan
MSGW & EF	Manage System Generated Waste & Excess Facilities
RCRA	*Resource Conservation And Recovery Act Of 1976*
RL	U. S. Department Of Energy, Richland Field Office
SST	Single-Shell Tank
TBD	To Be Determined
TRAC	Track Radionuclide (Computer Program)
TRU	Transuranic Waste
TWRS	Tank Waste Remediation System
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
WAC	*Washington Administrative Code*
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION

This document provides an analysis of the leakage mitigation mission applicable to past and potential future leakage from the Hanford Site's 149 single-shell high-level waste tanks. This mission is a part of the overall mission of the Westinghouse Hanford Company (WHC) Tank Waste Remediation System (TWRS) division to remediate the tank waste in a safe and acceptable manner. The following is the mission of the Tank Waste Remediation System program.

> *Store, treat, and immobilize highly radioactive Hanford Site waste (existing and future tank waste and the strontium and cesium capsules) in an environmentally-sound, safe, and cost-effective manner.*

The scope of the TWRS includes project and program activities for receiving, storing, retrieving, treating, and disposing onsite, or packaging for offsite disposal, all Hanford Site tank waste. Hanford Site tank waste includes the contents of 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs), plus any new waste added to these facilities, and all encapsulated cesium and strontium stored onsite and returned from offsite users. Within the TWRS function of "Manage Tank Waste," is the function entitled "Store Waste," which reads as follows.

> *Contain and monitor SST waste, waste in miscellaneous tanks, and cesium and strontium capsules. Receive, contain, and monitor DST waste and in-process waste. Define and initiate action for mitigation/resolution of safety issues.*
>
> *Waste is currently being received, contained, and monitored. This will continue until all waste is removed for final processing.*

Also within "Manage Tank Waste," is the following function entitled "Retrieve Waste."

> *Remove tank waste from SSTs, DSTs, and miscellaneous tanks, and remove the cesium and strontium capsules from storage for transfer to other facilities. Wastes to be removed from the tanks include liquids, saltcake, sludges, slurries and solids (e.g., failed equipment, concrete, rocks, lead bricks, samarium balls, and cobalt slugs). Solids will be removed only to the extent necessary to prevent interference with the retrieval of other wastes or as required to allow completion of closure activities.*
>
> *Waste retrieval has been initiated. Sufficient waste will be removed to allow closure without further removal of material.*

Historical data indicate 67 of the SSTs have leaked a portion of their contents into the surrounding soil. The primary approach currently envisioned for retrieval of the SST waste is hydraulic sluicing. The sluicing operations typically will add some level of working liquid to the tank to mobilize the solidified saltcakes and sludges. The design life of the tanks has expired and the integrity of the tank containment boundaries is in question. Concerns exist regarding additional leakage that may result from the driving head and fluid dynamic forces impacting the tank shells during retrieval. Future leakage may also result from the residual waste remaining in the tanks following retrieval; the residual may amount to 1 percent or more of the current waste inventory. If the residual cannot be removed, it also eventually could leak to the soil.

The soil contamination resulting from historical tank leakage and any future leakage due to the mechanisms noted above will eventually migrate through the vadose zone to the groundwater unless mitigative actions are taken. Upon completion of waste retrieval, the SSTs will transfer to the TWRS *Manage System Generated Waste & Excess Facilities (MSGW & EF)* function, which reads as follows.

> *Manage waste and excess facilities generated during the process of remediating TWRS tank waste. Activities to be managed include immobilization of the [low-level waste] LLW components, disposition of liquid and gaseous effluent, as well as solid waste and excess facilities, and the disposition of reusable materials.*
>
> *This effort includes management of miscellaneous wastes and processing to transfer failed equipment like pumps and melters to the organization responsible for ultimate disposal. This activity will terminate when all tank waste is remediated and all excess facilities have been turned over to the site-level Deactivate Facilities function (4.1) for final cleanup and closure.*

The function *Disposition Excess Facilities* within *MSGW & EF* includes preparing SSTs for final closure. One of the constraints in achieving "Closure-Ready SSTs" will be the tank system closure requirements of *Washington Administrative Code* (WAC) 173-303-640(8), which includes removal or decontamination of contaminated soils as best as can be achieved practicably. Also, closure activities must meet all requirements in WAC 173-303-610. It is important to note that the acceptance levels of removal of residual waste in the tank and soil contamination required to achieve "closure readiness" have not been established. Based on the lack of definitive acceptance levels, the assumed TWRS mission will be to take a best-as-practicable approach.

The TWRS program recently issued DOE/RL-92-60 Rev. 1, *Tank Waste Remediation System Functions and Requirements*. Mitigation requirements for SST leakage are invoked by three TWRS fourth level functions: (1) Store Waste, (2) Retrieve Waste, and (3) Disposition Excess Facilities. Accordingly, the TWRS has established the SST leakage mitigation mission. The mission analysis documented herein results in the following mission statement:

> *Confine past and any future tank leaks, and remove resultant soil contamination to a level allowing closure of the single-shell tank farms in a safe and cost-effective manner.*

The TWRS program has undertaken an effort to evaluate options to fulfill this mission. Options may include subsurface barriers, soil flushing, and excavation.

Systems engineering principles are being applied to this effort in accordance with the Department of Energy (DOE) Order 4700.1, *Project Management System*. The systems engineering process is a sequence of activities and decisions that transform an identified mission need into a set of performance parameters and a preferred system configuration. The purpose is to ensure that the product meets the program objectives, satisfies the functional requirements, operates effectively in the intended environment, and demonstrates a level of performance and reliability that justifies the investment. Systems engineering includes the engineering required to define the system performance parameters and the configuration to best satisfy the program objectives; planning and control of technical tasks; integration of engineering specialties; and management of the design effort to meet cost, schedule, and technical objectives.

1.1 PURPOSE

Mission analysis is the first step in the systems engineering process. Mission analysis supports early decision-making by clearly defining the program objectives and evaluating the feasibility and risks associated with achieving those objectives. The results provide a consistent basis for subsequent systems engineering work (e.g., functional analysis, requirements definition, parametric analysis).

1.2 SCOPE

The mission analysis has the following elements.

- Expand and refine the mission statement.
- Identify the mission goals or objectives.
- Identify the initial conditions and acceptable final output conditions.
- Define the boundaries (i.e., programmatic and physical interfaces) and constraints.
- Estimate the resources needed to carry out the mission.
- Establish criteria to determine the extent to which the problem will be solved (i.e., measures of success).
- Identify additional information needed.
- Assess the mission feasibility.

The mission analysis will be updated throughout the systems engineering process, as required.

1.3 BACKGROUND

The SSTs contain neutralized waste from fuel reprocessing in the form of sludge, saltcake, and liquid. The sludge consists of the solids (hydrous metal oxides) precipitated from the neutralization of acid waste before being transferred to the SSTs. The saltcake consists of the various salts formed from the concentration of alkaline waste by evaporation. The liquid waste exists as both supernatant and interstitial liquid. Saltcake is over 80 percent sodium nitrate. The liquid in the SSTs is called supernatant and is composed mainly of sodium nitrate and nitrite, sodium aluminate, and water. All of the waste is highly alkaline.

Many of the SSTs are assumed to have already leaked. Reasons for the leaks vary and many are unexplained. The carbon steel liners in the SSTs have sustained significant corrosion damage (Hauptmann and Carlos 1993, Leach and Stahl 1993b). Some tanks are suspected to have leaked because of nitrate-assisted, through-wall, stress-corrosion cracking of the liner. Pitting of the liner has occurred as a result of maintaining liquid levels static. High concentrations of dissolved carbon dioxide occur locally at the air-liquid interface resulting in a low pH condition. The effect is particularly severe in the meniscus. General corrosion resulting from the increasing chemical concentration (stabilization) of the waste has been equally damaging. Buckling of the liner on the tank bottom occurred in a number of SSTs in aging waste service. Seepage between the liner and concrete encasement was heated until the vapor pressure was greater than the hydrostatic head, lifting the bottom liner. Some tanks were known to leak right away because of rapid changes in operating temperature and the resultant stresses on the tank liner. There probably have been additional leaks that were undetected because of the nature of the SSTs' design and instrumentation.

Waste previously has been retrieved from the SSTs in two major campaigns from 1952 to 1957, and from 1962 to 1978. The purpose of these campaigns was to recover uranium from the sludge, free up tank space, and remove radioactive cesium and strontium. The sludge was dislodged and dissolved by sluicing it with large volumes of water, allowing it to be pumped to the surface. The retrieved sludge had only been stored a short period of time and was relatively soft and uncompacted. The campaigns were successful, given the equipment failures that occurred and process limitations. Sluicing was stopped on two occasions because of tank leaks.

Past-practice sluicing was identified in the TWRS National Technology Workshop (Anttonen 1992) held in June 1992 as one of the reference methods for retrieving the remaining SST waste. Using a long-reach manipulator arm with end effectors was the other alternative recommended. However, the waste form differs somewhat from that encountered during previous sluicing campaigns, and the effectiveness of future sluicing is uncertain. Two-thirds of the current SST inventory is saltcake that was not present in the earlier campaigns. Some SSTs are known to contain layers of hardened sludge. Alternate retrieval technologies that use less water are being evaluated for difficult to retrieve waste. Use of weak acids (e.g., oxalic acid) is being considered to soften hardened sludge.

The design life of the SSTs has expired and more leaks are anticipated. Contaminants in the leaked waste can migrate through the soil. Mass transport in the vadose zone occurs by advection, diffusion, and dispersion. Advection is movement in the direction of flow with the concentration being unchanged. Dispersion is mixing along the path of travel because of transverse velocity components and nonuniformity of the longitudinal velocity component. Diffusion is mixing resulting from random molecular motion and occurs independently of the velocity field. Advection is typically the dominant mode of transport near the surface because of the infiltration of moisture from precipitation.

The rate of transport depends on the soil moisture recharge rate and the waste chemistry, soil properties, and subsurface geology. Adsorption of contaminants onto the soil particles can occur. Adsorption is affected by a variety of chemical reactions or processes including (1) adsorption site density per unit area of adsorbent, (2) binding site strength or affinity, (3) total amount of dissolved adsorbate available for interaction with the adsorbent surface, (4) speciation of the adsorbent (oxidation state and complexation state), and (5) the concentrations of competitive adsorbates. Mass transport can also depend on solubility. Low solubility of a species will limit its dissolved concentration and reduce its mobility.

A measure of the mobility of a particular contaminant is its distribution coefficient, K_d. Distribution coefficients vary with the soil properties and the general chemical environment (i.e., alkaline, acidic, or organic). Values determined under a given set of chemical conditions are only applicable to systems with similar conditions. The rate of transport can change significantly if the conditions are altered, unless the changes do not affect adsorption. Hanford-Site-specific adsorption data for different chemical environments is reported in Ames and Serne (1991), and Cantrell and Serne (1992). Highly mobile species (e.g., ^{3}H, ^{99}Tc, and NO_3) have distribution coefficients on the order of 0 - 1 mL/g and essentially move with the groundwater. Less mobile contaminants (e.g., ^{137}Cs and ^{239}Pu) have distribution coefficients that are greater than 100 mL/g, indicating they are readily sorbed onto the soil particles. Computer modeling can be used to predict the movement of contaminants from tank leaks. However, the accuracy of the results is affected by the uncertainty in the input parameters.

Some components of the SST waste are hazardous waste as defined in the *Resource Conservation and Recovery Act of 1976* (RCRA) and/or the *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations." The SSTs are classified under RCRA as treatment, storage, and disposal units that must meet certain operating and closure requirements. The SSTs lack secondary containment and do not meet current interim status standards. Leaking or unfit-for-service tanks must be removed from service, and sufficient waste be removed within 24 hours to prevent further release, or at the earliest practicable time. An interim stabilization program is ongoing to reduce the waste volumes and remove all the SSTs from liquid storage service. Free liquid is pumped out to the extent possible to minimize the potential environmental impact in the event of a tank leak. The *Hanford*

Federal Facility Agreement and Consent Order (known as the Tri-Party Agreement) (Ecology et al. 1992) establishes a schedule of interim stabilization for the SSTs that constitutes an agreement as to the "earliest practicable time." The Tri-Party Agreement also requires that the SSTs be closed in accordance with the closure and post-closure requirements of WAC 173-303-610. The Tri-Party Agreement also requires 99 percent waste retrieval, subject to cost and radiation exposure considerations.

Waste will continue to be stored in the SSTs until it is retrieved. Partial retrieval of the waste in tank 241-C-106 is planned for October 1997 to resolve the high-heat safety issue (milestone M-45-03A). The waste in the remaining SSTs will be retrieved beginning in December 2003 (milestone M-45-05-T01) and continuing until September 2018 (milestone M-45-05). Closure of all the SSTs will be completed by September 2024 (milestone M-45-06). Waste from the SSTs will be separated into low-level, and high-level and/or transuranic fractions. The low-level waste will be immobilized by vitrification and disposed of on the Hanford Site. The high-level/transuranic waste will be vitrified, placed in interim storage, and later shipped offsite for disposal in a geologic repository. Custody of the empty SSTs will then be transferred to the Environmental Restoration Contractor (ERC), which has responsibility for closure.

2.0 MISSION ANALYSIS RESULTS

Following are the results of the mission analysis. A problem statement or mission need was first developed, and mission objectives identified. The mission analysis was then conducted to a level of detail appropriate to the mission objectives.

2.1 MISSION STATEMENT

The Hanford Site SST farms are being operated and will be closed as interim status treatment, storage, and disposal units in accordance with WAC 173-303, which also invokes RCRA as promulgated in 40 CFR 265 Subparts F through R. Further, the closure standards of WAC 173-303-610 will also apply according to Section 5.3 of the Tri-Party Agreement. The general closure requirements are in accordance with WAC 173-303-610, Item (2)(a), which states:

> *(2) Closure performance standard. The owner or operator must close the facility in a manner that: (a)(i) Minimizes the need for further maintenance; (ii) Controls, minimizes or eliminates to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, ground water, or the atmosphere; and (iii) Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity.*

A closure plan is scheduled to be submitted to the Washington State Department of Ecology (Ecology) by November 2004 as specified in milestone M-45-06-T01 of the Tri-Party Agreement.

Tank wastes have been released to the ground from leaks from SSTs and associated transfer lines, and other miscellaneous spills. Sixty-seven SSTs are assumed to have leaked a total volume of approximately 2,271 to 3,407 m^3 (600,000 to 900,000 gal) (Hanlon 1993). In addition to the 67 assumed leaking tanks, at least 378 m^3 (100,000 gal) of liquid wastes are estimated to have been released to the ground as a result of unplanned releases and spills. The information available for these releases and spills indicates generally low levels of radioactivity. Several studies (Lowe 1993, Schmittroth 1993) have indicated that the contaminants present in this volume of leakage could cause violation of groundwater quality standards, once the contaminants migrate down through the vadose zone to the groundwater.

The Hanford SST tank farms were constructed during the period from 1943 to 1964. Retrieval of waste from the SSTs currently is scheduled for a fifteen-year campaign beginning in 2003 and ending in 2018, except tank C-106, which is planned for retrieval in

1997 to provide a demonstration of retrieval technology. Accordingly, the SSTs will be as old as 60 to 75 years at the initiation of retrieval, depending on the sequence for individual tanks.

The primary approach currently envisioned for retrieval of the SST waste is hydraulic sluicing. The sluicing operations typically will add some level of working liquid to the tank to mobilize the solidified saltcakes and sludges. The design life of the tanks has expired and the integrity of the tank containment boundaries is in question. Concerns exist regarding additional leakage that may result as a result of the hydraulic head and fluid dynamic forces impacting the tank shells during retrieval. The robotic arm-based confined sluicing method for retrieval probably would reduce the chances of leakage; however, leakage during retrieval may still occur in areas where the tank containment structure has deteriorated significantly.

The concerns of environmental impact because of migration of the contaminants that have already leaked from the tanks and the potential for additional leakage during retrieval have led to establishing the leakage mitigation mission. The concerns are summarized by the following problem statement.

Minimize soil contamination and prevent contamination of the groundwater due to leaks from SSTs.

The TWRS functions and requirements document requires waste retrieval from the SSTs and preparation for final closure. The level of removal of residual waste in the tanks and removal of soil contamination in order to achieve "closure-ready" SSTs has not been defined. Regulatory requirements indicate that residual waste and soil contamination will need to be removed to the extent practicable (i.e., a best available technology approach). The TWRS program is continuing to evaluate options and technologies to achieve the most effective cleanup levels. The mission statement for tank leakage mitigation program is

Confine past and any future tank leaks, and remove resultant soil contamination to a level allowing closure of the single-shell tank farms in a safe and cost-effective manner.

2.2 MISSION OBJECTIVES

The mission objectives of tank leakage mitigation, based on the aforementioned, are the following.

1. *Minimize the spread of soil contamination that has resulted from past tank leakage and prevent contamination of groundwater.*

Several basic options may be useable to mitigate this environmental threat: (1) installation of subsurface barriers in conjunction with soil flushing, (2) soil flushing alone, and (3) soil excavation. The TWRS program is evaluating these options.

2. *Minimize soil contamination that may occur during tank waste retrieval by implementing confinement around tanks that may leak during retrieval operations.*

Prevention of new leakage during retrieval is considered to be one of the most effective methods of supporting the overall leakage mitigation mission. This is primarily because of the high cost of removing contamination from soil and the risk and worker exposure that would result from these operations. Close-coupled subsurface barriers are under evaluation to serve this need. Also, a stand-off barrier system may be applicable for tank farms in which a number of tanks have already leaked or are suspected of leaking during retrieval.

3. *Remove soil contamination resulting from tank leakage to a level that will allow final closure.*

Soil contamination caused by past and future leakage will need to be removed to a level supporting final closure of the tank sites. Ecology (Anderson, 1993) has stated the following position regarding soil cleanup following retrieval of tank waste if subsurface barriers are installed.

> *A tank farm can be closed as a landfill provided that it is cleaned up down to the waste barrier. The site will be required to be cleaned up whether or not there is any evidence of leakage during retrieval operations.*

The position taken by Ecology on this question indicates strong regulatory resolve to remove as much contamination as possible from the soil surrounding the tanks following retrieval. The ultimate level of removal probably will be a point of negotiation with Ecology and the U.S. Environmental Protection Agency (EPA) as part of the closure plan approval process. Soil flushing and excavation are two potential options to decontaminate the SST sites as required, and are under evaluation.

The TWRS program is continuing a number of activities to develop capability to meet the mission objectives. This is reflected in the recent revision to the Tri-Party Agreement, which incorporates Milestone M-45-07, "Complete Evaluation and Demonstration Testing of Sub-scale Barriers" (September 1997). Near term activities to evaluate subsurface barriers and other alternatives for SST leakage mitigation are established by Tri-Party Agreement Milestone M-45-07A (September 1994), which follows:

> *Complete a feasibility study of barriers to accomplish the following:*
>
> *(1) Estimate the potential environmental impact of waste storage and retrieval activities without the application of barriers.*
>
> *(2) Establish functional requirements of barriers to minimize the impact associated with the waste storage and retrieval activities.*

(3) *Evaluate the application of existing subsurface barrier technologies to meet functional requirements of barriers and the potential reduction in environmental impacts from the application of barriers to SST waste storage and retrieval activities.*

The approach will be to evaluate subsurface barriers along with other mitigation options in terms of reduction in environmental impact and cost. The evaluation will be used to support an initial decision regarding further development of the necessary technologies. Those concepts showing promise will be further developed to support possible subsequent implementation. A final decision on implementation will be made on a tank or tank-farm specific basis, i.e., one or more different technologies may be used in a given tank farm depending on a number of parameters.

2.3 INITIAL CONDITIONS

Initial conditions for the tank leakage mitigation mission are shown in Table 1. These establish the current programmatic and physical state of the system on which the mission is to be performed. The initial state is described in terms of the system's major topics, or significant system attributes or variables to be considered for treatment by the mission. References to sources that contribute further details are provided. Additional information needed to further define the initial conditions is listed.

2.4 FINAL CONDITIONS

Final conditions for tank leakage mitigation mission are shown in Table 2. These establish the programmatic and physical end state to be achieved by execution of the mission. The final conditions are described in terms of the end-state system's major topics. The end-state major topics identify the desired status of significant system attributes or variables that were treated by the mission. Stakeholder values were considered in selecting the end-state major topics. Discussion is included that relates the final conditions to the mission objectives. References to sources that contribute further details are provided. Information needed to further define the final conditions is listed.

2.5 INTERFACES

There are both programmatic and physical interfaces. Programmatic interfaces originate from agencies that have authority to impose constraints on the mission development process and the end products. Programmatic interfaces are described in Table 3 and the sources of constraints are shown. Physical interfaces are those entities through which the mission receives or transfers information, materials, or energy outside the mission. Physical interfaces for tank leakage mitigation are described in Table 4.

2.6 MISSION RESOURCES

Determination of mission resources is based on the mission initial conditions, final conditions, and programmatic and physical interfaces described earlier.

Key WHC Organizations

- Barrier Demonstration & Retrieval Systems Engineering
- SST Retrieval Engineering
- SST Retrieval Projects
- Retrieval Program Office
- TWRS Technology Integration & External Interface
- Environmental Technology & Assessment
- Geosciences
- Groundwater Well Services
- Regulatory Analysis
- Waste Characterization
- Waste Tank Upgrades Support
- Tank Farms Operations & Maintenance
- Solid Waste Disposal
- Liquid Waste Disposal
- Operations Site Services
- Site Planning
- Procurement
- Transportation
- Packaging & Shipping

- Health Protection
- TWRS Safety Analysis
- Waste Tank Safety Assurance
- Environmental Protection
- Quality Assurance

Other Key Organizations

- Bechtel Hanford
- Kaiser Engineers Hanford
- Pacific Northwest Laboratory
- DOE(includes the Office of Waste Management and the Office of Technology Development)
- U.S. Department of Energy, Richland Field Office (RL)
- Ecology
- EPA

Skill Mix

- Program management
- Systems engineering
- Project engineering (includes change control)
- Mechanical engineering (includes remote systems/robotics and heating, ventilating, and air conditioning)
- Instrumentation and controls systems
- Electrical engineering
- Civil/structural/architectural
- Well drilling

- Geology
- Chemistry
- Radiological engineering
- Waste handling, packaging, and shipping
- Regulatory analysis
- Permitting
- Health protection
- Safety analysis
- Quality assurance
- Procurement
- Construction
- Operations (includes readiness review and startup)

Required Technologies

- Construction methods for installing barriers around and underneath SSTs
- Systems to verify barrier emplacement and integrity
- Leak detection capability to monitor barrier performance
- Vadose zone and/or groundwater monitoring to demonstrate compliance

Technology Development Tools

- Small-scale barrier or barrier feature testing
- Barrier scale-up by mathematical modeling, parametric studies, and sensitivity analysis
- Tank leak modeling
- Program support by offsite laboratories and engineering service contracts

Program Funding

Waste Retrieval Program-specific detailed planning is performed annually and documented in the multi-year program plan (MYPP) and fiscal year (FY) work plan. The MYPP develops the plans, schedules, and estimated costs of achieving the goals and objectives for the programs in each mission area. This development expands on the top-level technical logic to produce programmatic logic diagrams that support the current year planning basis. Descriptions of the technical requirements, interrelationships with other programs and activities, and the actions required to accomplish the program's workscope are included. The MYPP defines the technical basis for the program. Activity data sheets (ADSs) with supporting information are developed as attachments and provide the definition of the program cost and schedule. The fiscal year work plan details the workscope to be accomplished for the current year based on planning guidance or funding authorized by the Department of Energy, Richland Field Office (RL).

The current FY 1994 budget for the tank leakage mitigation program is to be determined. The overall funding required to complete this activity and satisfy the Tri-Party Agreement milestone M-45-07 is estimated to be determined.

2.7 MEASURES OF SUCCESS

Stakeholder values and expectations for interim storage of tank wastes and waste retrieval were assessed. Top-level categories of performance measures were identified. Measures of success within these categories were developed relative to the program mission and its objectives. The measures of success are listed in Table 5. When prioritized and further quantified, the measures of success provide a basis for evaluating and comparing alternatives.

2.8 ADDITIONAL INFORMATION NEEDED

Additional information that is needed to execute the mission and satisfy the goals and objectives has been identified. This missing information generally is related to (1) availability of resources, (2) completeness or correctness of source documents, (3) applicability of constraints or requirements, and (4) consistency of stakeholder values. A summary of the information needed is provided in Table 6.

2.9 MISSION FEASIBILITY

A large number of uncertainties exist with regard to tank leakage mitigation in the overall cleanup of the Hanford Site. Many of these can be resolved through continued dialogue with Ecology and further study of the SSTs and characterization of the waste therein. Questions about specific technologies can be addressed by carefully examining the engineering fundamentals. The decision to proceed with technology development will be determined by a feasibility study to be completed in September 1994. Testing of specific technologies will be based on the results of the feasibility study. The cost of demonstration testing alone will be significant. The high cost of barriers in general may preclude their use altogether. Waste retrieval alternatives and site cleanup options, including the use of barriers to protect the environment, need to be evaluated.

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
SSTs/Tank Farms	Tank Design - The SSTs are constructed of reinforced concrete with welded carbon steel liners on the bottom and sides to contain the liquid waste. There are 133 SSTs classified as 100-series tanks. Tanks in this series are 22.9 m (75 ft) in diameter with dome tops and located on 30.5-m (100-ft) centers. Tank volumes are either 1.9, 2.8, or 3.8 million L (500,000, 750,000, or 1 million gal). These tanks have a minimum of 1.8 m (6 ft) of soil cover on the dome and a below grade invert elevation of 11.3 to 15.5 m (37 to 51 ft). The other 16 SSTs are classified as 200-series tanks. These tanks are vertical cylinders 6.1 m (20 ft) in diameter with flat tops and located on 15.2-m (50-ft) centers. Tank capacities are all 3.7 million L (55,000 gal). The tanks have a minimum of 3.7 m (12 ft) of soil cover and a below grade invert elevation of 9.8 m (32 ft). Design of the SSTs is described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001.	Leach and Stahl, 1993b	None
	Tank Arrangement - The 149 SSTs are grouped in 12 tank farms of 4 to 18 tanks each, located in the 200 East and West Areas. The 1.9 million- and 2.8 million-L (500,000- and 750,000-gal) tanks originally were arranged in cascades of three, four, or six tanks so that when the first tank in a cascade filled it overflowed to the next tank, and so on. Much of the overflow piping between tanks later was removed because of frequent plugging. Tank farms with this arrangement include 241-B, 241-BX, 241-BY, 241-C, 241-S, 241-T, 241-TX, 241-TY, and 241-U. The 3.8 million-L (1 million-gal) tanks are in the 241-A, 241-AX, and 241-SX tank farms. The 208,000-L (55,000-gal) tanks are arranged in groups of four in the 241-B, 241-C, 241-T, and 241-U tank farms. Arrangement of the SSTs is described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001.	Leach and Stahl 1993b	None
	Tank Farm Facilities - Ancillary equipment associated with the tank farms was used for transferring waste between the tanks. The equipment consists of transfer lines, diversion boxes, valve pits, jumper pits, double-container receiver tanks, and catch tanks. Most of the transfer lines are now unusable. Active use of the SSTs ceased in November 1980. Only stabilization and isolation activities have occurred since. Each tank farm is isolated from active facilities as a unit, along with its associated diversion boxes. The tanks themselves remain undisturbed. Transfer lines are isolated at the nearest diversion box, and utilities are disconnected near the main supply. In-tank equipment in the risers is abandoned in place where possible, but certain equipment that obstructs surveillance or cannot be sealed is removed. The tanks contain instrumentation to monitor liquid level, specific gravity, and temperature. The tanks are either actively or passively ventilated.	Leach and Stahl 1993b	• Verify the accuracy of drawings showing the locations of potential interferences with barrier installation.

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
SSTs/Tank Farms (cont'd)	Air samplers, airflow measuring devices, and radiation monitors are installed on the ventilation systems to monitor releases to the environment. Ventilation equipment and associated instrument controls filter the supply and exhaust, and maintain the tank under a negative pressure. Ongoing stabilization, isolation, and surveillance require routine personnel access to the tank farms on a limited scale. Dry wells located within the tank farms monitor the soil for radioactivity and serve as a leak detection system. The dry wells extend below the bottoms of the tanks to a depth of 12. to 45.7 m (40 to 150 ft). Some tank farms also have horizontal dry wells that run approximately 3.0 m (10 ft) beneath the tanks. The tank configurations and locations of support equipment and facilities for each of the tank farms is shown in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001.		
	<u>Tank Leaks</u> - Sixty-seven of the SSTs have leaked a total of 2.3 million to 3.4 million L (600,000 to 900,000 gal) of waste. Miscellaneous spills and unplanned releases account for an additional 38,000 L (10,000 gal) of leaked waste. The SSTs that have leaked and the leak volumes are listed in *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68. Criteria limits used to determine whether a tank is possibly leaking are provided in *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-357. Drywells are provided to quantify contamination from tank leaks. The basis for the dry well monitoring frequency is described in *A Scientific Basis for Establishing Dry Well-Monitoring Frequencies*, RHO-ST-34. If a leak is suspected, additional dry wells may be installed and the monitoring frequency increased to better characterize the leak and follow its movement. The exact geometry of a leak plume is not predictable. The general absence of finer-grained sediment in the 200 East Area results in greater downward migration because of gravitational effects. The presence of finer sediment layers in the 200 West Area tends to spread liquids horizontally because of capillary action. Volumes of contaminated soil resulting from past SST leaks are estimated in Table J1-2 of *Tank Waste Technical Options Report*, WHC-EP-0616. These are based on characterizing the spread of radioactivity in the leak from tank 241-T-106.	Boomer et al. 1993 Hanlon 1993 Isaacson and Gasper 1981 WHC 1993a	• Re-evaluate the volume of past leaks and better identify the leak mechanism. • Determine the extent to which the soil column has been contaminated by past leaks. • Develop the leak source term as seen by barriers.
	<u>Structural Integrity</u> - Surface live, static and dynamic soil, dead, and hydrostatic and hydrodynamic loads are carried by the reinforced-concrete tank dome and encasement. Limits on tank dome loading and temperature of the concrete encasement are provided in *Operating Specifications for Single-Shell Waste Storage Tanks*, OSD-T-151-00013. The SSTs were all designed and constructed before the development of plant standardized seismic design criteria and were built to the codes and standards in effect at the time. Only tanks in the 241-A and -AX tank farms have been seismically evaluated to a 0.25-*g* peak horizontal ground motion. Remedial activities may introduce tank modifications and impose loadings on the SSTs beyond the original design envelope.	Boyles 1992 Leach and Stahl 1993b	• Develop in-depth, state-of-the-art structural acceptance criteria for the SSTs, and perform rigorous analysis for both past and anticipated loadings.

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
Tank Waste	<u>Waste Volumes</u> - The volume of sludge, saltcake, and supernate in each of the SSTs is reported monthly in *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68. The total volume of drainable liquid in each tank is also given; drainable liquid is the volume of supernate plus the volume of drainable interstitial liquid in the sludge and/or saltcake. A total of about 140 million L (37 million gal) of waste are stored in the SSTs; about 54 million L (12 million gal) are sludge, 91 million L (24 million gal) are saltcake, and 2.3 million L (600,000 gal) are supernate. An estimated 23 million L (6 million gal) of drainable interstitial liquid is present in the SST sludge and saltcake.	Hanlon 1993	None
	<u>Chemical Composition</u> - The SSTs contain primarily inorganic waste. Sludge consists of the solids (hydrous metal oxides) precipitated from the neutralization of acid waste before being transferred to the SSTs. Saltcake consists of the various salts formed from the evaporation of alkaline waste. Saltcake is primarily (~93 wt%) sodium nitrate ($NaNO_3$) and sodium nitrite ($NaNO_2$). On transfer of the evaporator slurry into the SSTs, some of the salt precipitated with the sludge. Roughly 50 percent of the reported sludge volume is saltcake. Liquid waste exists as supernate or interstitial liquid in the tanks. Small amounts of plant solvents were entrained during fuel reprocessing. Waste-soluble complexing agents and carboxylic acids added in the B Plant fractionation process are in some SST wastes. A listing of all nonradioactive chemicals known to have been used at production plants and support facilities that transferred waste to SSTs has been documented in *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944-1980)*, WHC-EP-0172. Specific chemicals that may have been transferred to the SSTs and that appear on the "Dangerous Waste Sources List," WAC 173-303-9904, include carbon tetrachloride, methylene chloride, hexone, acetone, and ethyl ether.		

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
Tank Waste (cont'd)	The Track Radionuclide (TRAC) data are the most comprehensive set of radionuclide and chemical data available. The TRAC code was designed to provide stable chemical data to predict the radionuclide inventory. The TRAC chemical data have been adjusted (normalized) so that the total chemical inventories agree with inventories for SST wastes described in *Final Environmental Impact Statement, Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington* (HDW-EIS), DOE/EIS-0113. The HDW-EIS chemical compositions of different tank wastes were derived from records of fuel elements processed, chemicals used, and from a limited number of waste sample analyses. The HDW-EIS lists estimated average composition of SST wastes after the completion of jet pumping. This was broken into individual tank inventories using the TRAC code assumptions. The normalized chemical composition of the SST wastes on a tank-by-tank basis is provided in Table D-4 of *Tank Waste Technical Options Report*, WHC-EP-0616. Chemical reactions (e.g., oxidation-reduction, neutralization, precipitation) and radiolysis may have converted many of the chemicals in the waste into other compounds with different physical and chemical properties. Analyses of recent core samples are being used to update the waste compositions. Only 33 of the SSTs have been core sampled to date.	Boomer et al. 1993 DOE 1987 Jungfleisch 1984 Klem 1990	• Characterize the SST waste.
	Radionuclide Inventory - The estimated radionuclide inventory of the SSTs is based on computer modeling of the spent fuel. The TRAC code distributed the radionuclides among various tank farms and tanks based on waste transfers from process facilities and chemical solubilities. The radionuclide values, with the exception of ^{90}Sr and ^{137}Cs, are consistent with those of *Hanford Defense Waste Disposal Alternatives: Engineering Support Data for the Hanford Defense Waste Environmental Impact Statement*, RHO-RE-ST-30P. The ^{90}Sr and ^{137}Cs inventories are consistent with information in the *Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, DOE/RQ-0006. The radionuclide inventory of the SSTs is provided in Table D-6 of *Tank Waste Technical Options Report*, WHC-EP-0616.	Boomer et al. 1993 DOE 1991 RHO 1985	• Characterize the SST waste.
	Interim Stabilization - Interim stabilization is the process of removing as much liquid waste from an SST as practical to minimize the environmental impact in case the tank begins to leak. The liquid waste is pumped to a double-contained receiver tank, and from there to a DST that contains compatible waste. Following interim stabilization, an SST will contain less than 11,000 L (5,000 gal) supernate and less than 110,000 L (50,000 gal) total drainable liquid. One hundred six SSTs have been interim stabilized to date. Tanks that have been interim stabilized are listed in *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68. The schedule for interim stabilization of the remaining SSTs (except for tank 241-C-106) is set forth in the Tri-Party Agreement and shall be completed by September 2000 (milestone M-41-00).	Ecology et al. 1992 Hanlon 1993	• Monitor the progress of interim stabilization.

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
Tank Waste (cont'd)	Watch List Tanks - Forty-five SSTs have been identified as watch list tanks. Conditions in these tanks could lead to worker (onsite) or offsite radiation exposure through an uncontrolled release of fission products. There are four categories of safety issues: • Tanks containing more than 1000 g-mol of ferrocyanide (20 SSTs), • Tanks with potential for hydrogen or flammable gas accumulation above the flammability limit (17 SSTs), • Tanks containing concentrations of organic salts more than 3 wt% total organic carbon (9 SSTs), • Tanks with high heat loads (more than 40,000 Btu/hr) (10 SSTs). Tanks with safety issues are listed in *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68. Some SSTs have more than one safety issue. Methods to mitigate or resolve the safety issues are being developed.	Hanlon 1993 Public Law 101-510, Section 3137	• Characterize the waste in the watch list tanks. • Evaluate the safety of barrier installation and operation.
Waste Retrieval	Waste Retrieval Program - The scope of the Waste Retrieval Program and its integration with other elements of the TWRS Program is described in *Integrated Retrieval Program Plan*, WHC-SD-WM-PLN-067. The strategy and plans to satisfy the schedular, technical, fiscal, quality, and regulatory requirements and objectives of the program are described. Means to implement the strategy are discussed, as well as how functional activities such as technology development, engineering, and procurement fit into the Waste Retrieval Program.	WHC 1993b	None
	Retrieval Method - Sluicing and using a long-reach manipulator arm with end effectors are the two reference methods for retrieving the SST waste.	Anttonen 1992	• Determine the effectiveness of sluicing for retrieving the SST waste. • Estimate the amount of leakage that may occur with sluicing.
	Retrieval Sequence - The retrieval sequence is defined in *DST/SST Retrieval Sequence*, WHC-SD-WM-ER-193. First priority is retrieving waste from tanks on the safety watch list. Retrieval then proceeds farm-by-farm, based on available funding and completion of necessary infrastructure upgrades, to provide feed for waste treatment and disposal. A retrieval sequence document shall be issued and updated annually per Tri-Party Agreement milestone M-45-02.	Ecology et al. 1992 Williams 1993	• Update the retrieval sequence to address changes negotiated to the Tri-Party Agreement. • Develop flowsheets for waste treatment and disposal. • Assess the impact on the retrieval sequence of using subsurface barriers, because barriers may need to be constructed on a farm-by-farm basis.
	Retrieval Schedule - The retrieval schedule is driven by the Tri-Party Agreement milestone M-45-03A to initiate sluicing of the waste in tank 241-C-106 (October 1997), and interim milestones under M-45-05 to initiate retrieval of waste from the remaining SSTs [December 2003 (M-45-05-T01) to September 2017 (M-45-05-T15)].	Ecology et al. 1992	None

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
Waste Retrieval (cont'd)	Tank Farm Closure - The SST system comprises six operable units that include the SSTs, transfer lines, diversion boxes, valve pits, jumper pits, double-contained receiver tanks, catch tanks, cribs, and contaminated soil from spills and leaks. Following waste retrieval, these operable units will be remediated in accordance with approved closure plans. All units located within the boundary of each tank farm will be closed in accordance with WAC 173-303-610. Ancillary equipment associated with the SSTs and previously classified as RCRA past-practice units is now included with the treatment, storage, and disposal facilities for the purpose of ensuring a consistent closure approach. Closure plans for the SST operable units are to be submitted to Ecology starting November 2004 under milestone M-45-06 of the Tri-Party Agreement. Closure is to be completed by September 2024.	Ecology et al. 1992	• Develop closure plans for the SST operable units.
Hanford Site	Hydrogeologic Setting - Average annual precipitation on the Hanford Site is only 16 cm (6.3 in). Moisture infiltration is negligible where the root zone is undisturbed. Where the surface vegetation has been removed (as in and around the single-shell tank farms), moisture may penetrate to considerable depths. Moisture content of the soil generally ranges from 2 to 4 wt% based on samples collected during the installation of groundwater monitoring wells. Estimates of the hydraulic conductivity of the vadose zone beneath the tank farms vary from 10^{2} to 10 cm/sec. Porosity is estimated at 10 to 30 percent. Because of the arid environment and prevailing winds, the Hanford Site is blanketed by a thin veneer of wind-blown (eolian) sediments. Underlying much of the Hanford Site is the Hanford formation, which consists of coarse-grained sediments deposited by	Delaney et al. 1991 Lindsey et al. 1992a Lindsey et al. 1992b Reidel et al. 1992	• Obtain geologic and hydrologic data for the 200 East Area and 200 West Area, particularly in and around the single-shell tank farms.
	cataclysmic glacial flood waters during the Pleistocene epoch. The Hanford formation is thickest in the vicinity of the 200 Area, where it can be up to 107 m (350 ft) thick. The Hanford formation is divided into three facies (gravel-, sand-, and silt-dominated), all of which are gradational with each other. Interbedded sands and silts with only a few gravel layers predominate in the 200 East Area. Gravels of cobbles and boulders with layers of silt occur in the 200 West Area. Variations in the soil column beneath the tank farms exist even within individual tank farms. Clastic dikes are common in the vadose zone and can act as barriers or pathways for contaminant transport. Excavated material from construction was used for backfill around the tanks; typically this is medium- to coarse-grained sand and gravel. The most current description and interpretation of the Hanford Site geology is provided in *Geology and Hydrology of the Hanford Site: A standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-003; *Geologic Setting of the 200 East Area: An Update*, WHC-SD-EN-TI-012; *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008; and *Field Trip Guide to the Hanford Site*, WHC-MR-0391.		

Table 1. Initial Conditions for Tank Leakage Mitigation.

Topic	Initial Conditions	Reference	Additional Information Needed
Hanford Site (cont'd)	<u>Infrastructure</u> - Site-wide support systems are described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001. These include ancillary equipment for transferring waste between the tanks and between the 200 East Area and the 200 West Area; electrical power distribution; instrumentation and surveillance monitoring [computer-automated surveillance system, area radiation monitoring, liquid level and sludge level measurement, leak detection and monitoring, and waste sampling]; cathodic protection; pump and ventilation system interlocks; water; steam; compressed air; and fire protection. Drawings H-2-34761 and H-2-34762 are area maps of the 200 East Area and 200 West Area, respectively. These show the locations of buildings, roads, railroads, tank farms, cribs, trenches, burial grounds, and retrievable storage areas.	Leach and Stahl 1993b	None
	<u>Conduct of Operations</u> - Tank farm operating procedures are listed in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001. Included are procedures for operation, maintenance, and surveillance of specific facilities and systems, as well as general procedures for various type activities.	Leach and Stahl 1993b	None

Table 2. Final Conditions for Tank Leakage Mitigation.

Topic	Final Conditions	Reference	Additional Information Needed
Tank Leaks	Soil Contamination - Migration of leaks to soils or surface waters is prevented. Further spread of contamination from past leaks is prevented.	40 CFR 265 DOE Order 5400.5	• Determine the extent to which the soil column has been contaminated by past leaks.
	Groundwater Quality - Primary and secondary contaminants and radionuclides in the groundwater below a discharge site do not exceed the limits in WHC-CM-7-5, *Environmental Compliance*, Table 8.1. [These criteria are established in the *Code of Federal Regulations* at 40 CFR 141, "National Primary Drinking Water Regulations," and WAC 173-200, "Water Quality Standards for Ground Waters of the State of Washington."]	WHC-CM-7-5	• Perform modeling for new discharges to ensure the groundwater meets the criteria in WHC-CM-7-5, Table 8.1.
Waste Disposal	Waste Retrieval - At least 99 vol% of the waste in each of the SSTs is retrieved, or as much as is technically practicable.	Ecology et al. 1992	• Determine what amount of waste retrieval is technically practicable. • Define the role of subsurface barriers in achieving the retrieval goal.
Site Cleanup	Tank Farm Closure - Tank waste is retrieved and contaminated soil is cleaned up sufficient to allow custody of the SSTs to be transferred to the (ERC) for closure.	RL 1993a	• Develop acceptance criteria and the operational interface with the ER mission area. • Determine the extent of soil cleanup needed following waste retrieval. • Define the role of subsurface barriers, soil flushing, and excavation in soil cleanup.
Technology	Performance of Subsurface Barriers, In-Situ Soil Flushing and Excavation - Installation and operation of tank leakage mitigation options is demonstrated and their performance under Hanford Site conditions is measured. The feasibility of implementing these options in the SST farms is determined.	WHC 1993b	• Identify specific applications for subsurface barriers, in-situ soil flushing and excavation.
	Availability of Subsurface Barriers, In-Situ Soil Flushing, and Excavation Systems - Capabilities of vendors to supply complete tank leakage mitigation systems is assessed.	WHC 1993b	• Specify technical and administrative requirements for tank leakage mitigation.
	Cost-Effectiveness of Subsurface Barriers, In-Situ Soil Flushing, and Excavation Systems - A cost-risk-benefits analysis of tank leakage mitigation options is completed and alternatives are considered.	WHC 1993b	• Obtain cost data for tank leakage mitigation options.

Table 3. Programmatic Interfaces for Tank Leakage Mitigation.

Interface	Source of Constraint	Constraint on Mission	Working Position
U.S. Department of Energy (DOE)	<u>DOE Orders</u> • DOE Order 4700.1, *Project Management System* • DOE Order 5400.5, *Radiation Protection of the Public and the Environment* • DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards* • DOE Order 5480.11, *Radiation Protection for Occupational Workers* • DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities* • DOE Order 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities* • DOE Order 5700.6C, *Quality Assurance* • DOE Order 5820.2A, *Radioactive Waste Management* • DOE Order 6430.1A, *General Design Criteria*	Establish policies, organizations, methods, standards, or procedures; guide, instruct, and inform contractors in their work; and require action or performance of certain work.	New systems or facilities will be designed, constructed, and operated in accordance with current regulations, codes, standards, and directives. A graded approach to compliance will be developed for existing facilities, based on risk and importance to safety and protection of the environment. Exemptions may be sought to reduce costs and/or expedite cleanup of the Hanford Site.
	Budget	Total budget and funding profile limit scope and scale of testing.	Prioritize test objectives. Develop test strategy for maximum benefit. Focus on most-promising barrier technologies with greatest application.
	<u>Schedule</u> • Tri-Party Agreement milestone M-45-07: "Complete evaluation and demonstration testing of small scale subsurface barriers" by September 1997 (Ecology et al. 1992).	Schedule constraints limit duration of testing and time available for technology development.	Work to schedule as possible. Assure protection of public health, worker safety, and the environment. Submit change requests to adjust Tri-Party Agreement milestones affected by changes in budget or workscope.

Table 3. Programmatic Interfaces for Tank Leakage Mitigation.

Interface	Source of Constraint	Constraint on Mission	Working Position
U.S. Department of Energy, Richland Field Office (RL)	<u>RL Orders</u> • RL Order 5480.4C, *Environmental Protection, Safety, and Health Protection Standards for RL* • RL Order 6430.1C, *Hanford Plant Standards (HPS) Program*	Establish policies, organizations, methods, standards, or procedures; guide, instruct, and inform contractors in their work; and require action or performance of certain work.	New systems or facilities will be designed, constructed, and operated in accordance with current regulations, codes, standards, and directives. A graded approach to compliance will be developed for existing facilities, based on risk and importance to safety and protection of the environment. Exemptions may be sought to reduce costs and/or expedite cleanup of the Hanford Site.
U.S. Environmental Protection Agency (EPA)	<u>Statutes</u> • *Clean Air Act* • *National Environmental Policy Act* • *Resource Conservation and Recovery Act* (RCRA) • *Safe Drinking Water Act* *<u>Code of Federal Regulations</u>* • 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants" • 40 CFR 141, "National Primary Drinking Water Regulations" • 40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" • 40 CFR 261, "Identification and Listing of Hazardous Waste" • 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities"	Define cleanup goals and set timetable; prescribe requirements for remediation technology, site characterization, and monitoring; specify design and construction standards; limit liquid and gaseous effluents; identify permitting, documentation, and reporting needs.	Comply where possible. Negotiate alternate compliance strategy or obtain exemptions as needed.

Table 3. Programmatic Interfaces for Tank Leakage Mitigation.

Interface	Source of Constraint	Constraint on Mission	Working Position
Washington State Department of Ecology (Ecology)	<u>*Washington Administrative Code*</u> • WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells" • WAC 173-200, "Water Quality Standards for Ground Waters of the State of Washington" • WAC 173-303, "Dangerous Waste Regulations" • WAC 173-400, "General Regulations for Air Pollution Sources" • WAC 173-460, "Controls for New Sources of Toxic Air Pollutants" • WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides" • WAC 246-247, "Radiation Protection - Air Emissions	Define cleanup goals and set timetable; prescribe requirements for remediation technology, site characterization, and monitoring; specify design and construction standards; limit liquid and gaseous effluents; identify permitting, documentation, and reporting needs.	Comply where possible. Negotiate alternate compliance strategy or obtain exemptions as needed.
<u>Other state regulatory agencies</u> • Washington State Department of Health • Washington State Department of Labor and Industries	To be determined (TBD)	TBD	Comply where possible. Negotiate alternate compliance strategy or obtain exemptions as needed.
<u>Local regulatory agencies</u> • Benton-Franklin-Walla Walla Counties Air Pollution Control Authority	<u>Regulations</u> • General Regulation 80-7, *General Regulation of the Benton-Franklin-Walla Walla Counties Air Pollution Control Authority*	Applies where state regulations do not. Establishes standards for maximum permissible air emissions, requires registration of new sources, and provides for monitoring and reporting.	Comply where possible. Negotiate alternate compliance strategy or obtain exemptions as needed.

Table 3. Programmatic Interfaces for Tank Leakage Mitigation.

Interface	Source of Constraint	Constraint on Mission	Working Position
<u>Advisory and oversight committees</u> • Defense Nuclear Facility Safety Board • General Accounting Office • Hanford Advisory Board • National Academy of Sciences • Office of Management and Budget • Safety and Environmental Advisory Council • Technical Advisory Panel • TWRS Leadership Council • Internal and external audits	Influence and advice	Affect technical solutions, schedules, and program execution.	Consider guidance. Provide justification if alternate position taken.
Native Americans	Stakeholders	Affect technical solutions, schedules, and program execution.	Involve affected Native Americans in planning and decision-making.
Public	Stakeholders	Affect technical solutions, schedules, and program execution.	Involve public in planning and decision-making.

Table 3. Programmatic Interfaces for Tank Leakage Mitigation.

Interface	Source of Constraint	Constraint on Mission	Working Position
Westinghouse Hanford Company	WHC-CM- (controlled manuals) • WHC-CM-1-3, *Management Requirements and Procedures* • WHC-CM-1-5, *Standard Operating Practices* • WHC-CM-1-6, *Radiological Control Manual* • WHC-CM-4-2, *Quality Assurance Manual* • WHC-CM-4-3, *Industrial Safety Manual* • WHC-CM-4-9, *Radiological Design* • WHC-CM-4-11, *ALARA Program Manual* • WHC-CM-4-40, *Industrial Hygiene Manual* • WHC-CM-5-16, *Solid Waste Management* • WHC-CM-6-1, *Standard Engineering Practices* • WHC-CM-6-2, *Project Management* • WHC-CM-7-5, *Environmental Compliance*	Include administrative procedures, policies, and requirements for design, construction, operations, maintenance, decommissioning, project control, procurement, environmental protection, public health and worker safety, and quality assurance.	Comply where possible. Exemptions shall be in accordance with WHC-CM-1-3, MRP 2.21, "Controlled Manual Waiver Process."
Westinghouse Hanford Company (cont'd)	Interim Safety Basis • *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume I* (Section 2, "Acceptance Criteria") establishes safety objectives for onsite and offsite radiation exposure, toxic chemical exposure, property and mission protection, industrial safety, and environmental compliance (Leach and Stahl 1993a).	Provides basis for safety analysis and evaluation of unreviewed safety questions (USQs). Applies to all present and future tank farm operations.	Comply where possible. Perform hazards assessment and safety analyses for changes.

Table 4. Physical Interfaces for Tank Leakage Mitigation.

Interface	Interface Control	Constraint on Mission	Working Position
SSTs	<u>Interim Safety Basis</u> • The safety envelope that constitutes the technical basis for safe operation and maintenance of tank farm facilities, equipment, and processes is described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 1*, WHC-SD-WM-ISB-001 (Leach and Stahl 1993a). • Design and configuration of tank farm facilities and equipment is described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001 (Leach and Stahl 1993b).	Limits selection of available barrier technologies. Affects barrier design, construction, and operation.	Characterize local conditions and identify applicable barrier technologies. Analyze effects of barriers on SSTs. Develop design inputs for barriers. Document interfaces and adhere to established change control process.
Waste retrieval system	Retrieval project technical baseline documentation	Limits selection of available barrier technologies. Affects barrier design, construction, and operation. Restricts schedule to implement barriers. Confinement for waste retrieval may impede access for barrier installation.	Integrate retrieval planning to achieve program objectives. Document interfaces and adhere to established change control process.
Empty tanks [Includes SSTs from which waste has been retrieved, ancillary equipment, contaminated soil, and barriers (if present). Transfer to (ERC) for closure.]	<u>Surplus Facility Acceptance Criteria and Turnover Policy</u> • TBD [Specific requirements and responsibility for closure has not been established. Closure plans for the SST operable units are to be submitted to Ecology starting November 2004. Acceptance criteria will be negotiated with the ERC.]	Requires that barrier planning and design incorporate features and procedures that simplify and facilitate decommissioning. Determines the extent of follow-on remediation, including removal of tanks and/or barriers. Provides for monitoring and characterization of soil and groundwater to determine the nature and extent of residual contamination. Specifies that all structures be in a safe secure final condition. Surplus facilities must generally be in compliance with federal and state environmental regulations at turnover.	Identify need to develop acceptance criteria and turnover policy. Comply with acceptance criteria.

Table 4. Physical Interfaces for Tank Leakage Mitigation.

Interface	Interface Control	Constraint on Mission	Working Position
Solid waste [Includes failed equipment, soil, and debris with radioactive and/or hazardous chemical contamination. Transfer to Solid Waste Disposal (in Solid and Liquid Waste mission area).]	<u>Acceptance Criteria</u> • *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-3 (Willis and Triner 1991), includes general requirements for storage of radioactive solid waste; specifies acceptance criteria for storage of contact-handled transuranic (TRU) waste, low-level waste (LLW), and radioactive mixed waste; and provides handling requirements and disposal instructions for nonradioactive hazardous waste. • Criteria for acceptance and certification of remote-handled TRU waste are provided on a case-by-case basis by Solid Waste Engineering Analysis.	Affects waste form, waste container, waste package, labeling and marking, and documentation.	Comply with acceptance criteria.
Liquid waste [Includes dilute liquid waste with low levels of radioactive and/or hazardous chemical contamination. Transfer to the 200 Area Effluent Treatment Facility (in Solid and Liquid Waste mission area).]	<u>Acceptance Criteria</u> • TBD (Preliminary acceptance criteria are being developed.)	Limits composition and discharge rate. May require pretreatment.	Monitor development of acceptance criteria for impacts to barriers. Comply with acceptance criteria.
Liquid effluents [Includes nonradioactive and nonhazardous liquid effluents suitable for disposal to the environment. Transfer to the 200 Area Treated Effluent Disposal Facility (in Solid and Liquid Waste mission area).]	<u>Acceptance Criteria</u> • TBD	Limits composition and discharge rate.	Identify need to develop acceptance criteria. Comply with acceptance criteria.

Table 4. Physical Interfaces for Tank Leakage Mitigation.

Interface	Interface Control	Constraint on Mission	Working Position
Tank Leakage Mitigation Technology	Technology Development • Technology development activities including technology selection and prioritization at the program element level, technology integration and prioritization at the program level, and management of data development are described in *Tank Waste Remediation System Integrated Technology Plan*, DOE/RL-92-61 (RL 1993b).	Limits selection of available technologies. Restricts schedule to implement mitigation options. Impacts program cost.	Determine Waste Retrieval Program functional needs. Identify and prioritize technology development activities. ADSs (for EM-30) and/or technical task plans (for EM-50). Coordinate with the TWRS program.
Site infrastructure	Interim Safety Basis • Support systems, services, and utilities in the vicinity of the single-shell tank farms are described in *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001 (Leach and Stahl 1993b).	Limits selection of available technologies. Affects design, construction, and operation. Impacts program cost.	Characterize local conditions and identify additional support needed. Develop design inputs for barriers. Document interfaces and adhere to established change control process.

Table 5. Measures of Success for Tank Leakage Mitigation.

Category	Measures of Success
Environmental Protection	• Confine tank leaks and prevent further spread of past leaks. • Minimize the waste disposed of on-site. • Maximize unrestricted land use.
Public Health	• Protect the groundwater. • Minimize public exposure to radioactive and hazardous materials.
Worker Safety	• Minimize industrial hazards. • Minimize worker exposure to radioactive and hazardous materials.
Regulatory Compliance	• Support tank farm closure. • Minimize the volume of system generated waste. • Avoid regulatory uncertainty.
Technology	• Demonstrate effectiveness of approach. • Assure system reliability. • Safeguard tank integrity. • Continue essential tank farm operations.
Cost	• Minimize the cost of waste retrieval and follow-on site remediation. • Minimize life-cycle cost.
Schedule	• Support waste retrieval. • Minimize the time to resolve safety concerns and cleanup the Hanford Site.

Table 6. Additional Information Needed.

Information Needed	Purpose	Potential Impact
Verify the accuracy of drawings showing the locations of potential interferences with mitigation system installation.	Buried transfer lines and tank farm services and utilities, equipment, and facilities can interfere with mitigation system installation.	• Mitigation system integrity may be adversely affected (i.e., barrier may leak). • Cost increases and schedule delays for installing mitigation systems and initiating retrieval may result from accommodating unplanned interferences.
Re-evaluate the volume of past leaks and better identify the leak mechanism.	Use to determine the likelihood of future leaks, and estimate the leak volume and leak rate.	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation systems may be over-designed.
Determine the extent to which the soil column has been contaminated by past leaks.	Existing contamination will affect mitigation system selection (i.e., close-coupled or stand-off) and installation. Also a consideration in determining the need for follow-on remediation.	• Mitigation system installation may require remote equipment. • Added cost for spoils handling and disposal. • Personnel exposure to radiation and toxic chemicals.
Develop the leak source term as seen by mitigation systems.	Leak source term is a consideration in mitigation system design.	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation system materials may be incompatible with leaked waste. • Mitigation systems may be over-designed.
Develop in-depth, state-of-the-art structural acceptance criteria for the SSTs, and perform rigorous analysis for both past and anticipated loadings.	Tank structural limits constrain mitigation system selection, design, installation, and operation.	• Tank integrity may be adversely affected if structural limits are exceeded.
Characterize the SST waste, including that in the watch list tanks.	Waste composition is an input to the leak source term.	• Mitigation system materials may be incompatible with leaked waste. • Mitigation systems may be over-designed.
Monitor the progress of interim stabilization.	Waste volume is an input to the leak source term.	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation systems may be over-designed.
Evaluate the safety of mitigation system installation and operation.	Using mitigation systems to confine tank leaks is a new application for existing barrier technologies. Some new mitigation system technologies have not been demonstrated.	• Unsafe conditions may exist. • Regulations that protect public health and worker safety may be violated.
Determine the effectiveness of sluicing for retrieving the SST waste.	Duration of sluicing will affect the amount of leakage that may occur.	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation systems may be over-designed.

Table 6. Additional Information Needed.

Information Needed	Purpose	Potential Impact
Estimate the amount of leakage that may occur with sluicing.	Amount of leakage is an input to the leak source term.	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation systems may be over-designed.
Update the retrieval sequence to address changes negotiated to the Tri-Party Agreement.	Retrieval sequence is the basis for the schedule to install mitigation systems. Also a consideration in mitigation system selection (i.e., single tank, multi-tank, or entire tank farm).	• Retrieval may be delayed if mitigation systems are not available.
Develop flowsheets for waste treatment and disposal.	Providing feed to waste treatment and disposal is an input to the retrieval sequence.	• Retrieval may be delayed if mitigation systems are not available.
Assess the impact on the retrieval sequence of using subsurface mitigation systems, since mitigation systems may need to be constructed on a farm-by-farm basis.	Mitigation systems must be in place before retrieval.	• Retrieval may be delayed if mitigation systems are not available.
Develop closure plans for the SST operable units.	Mitigation systems must support any follow-on remediation and meet acceptance criteria of the ERC.	• Cost increases and schedule delays for tank farm closure may result. • Mitigation systems may be over-designed.
Obtain geologic and hydrologic data for the 200 East Area and 200 West Area, particularly in and around the SST farms.	Soil properties will affect mitigation system selection and installation.	• Mitigation system type may not be suitable for Hanford-Site soils. • Mitigation system integrity may be adversely affected (i.e., mitigation system may leak).
Perform modeling for new discharges to ensure the groundwater meets the criteria in WHC-CM-7-5, Table 8.1.	Modeling will establish the need for mitigation systems and is the basis for mitigation system design (i.e., thickness and permeability).	• Regulations that protect public health and the environment may be violated.
Determine what amount of waste retrieval is technically practicable.	Duration of sluicing will affect the amount of leakage that may occur. Alternative retrieval methods may be used that affect mitigation systems (e.g., weak acids to soften sludge).	• Mitigation system capacity may be inadequate to contain largest leak. • Mitigation system materials may be incompatible with leaked waste.
Define the role of mitigation systems in achieving the retrieval goal.	Retrieval operating conditions is a consideration in mitigation system design.	• Excessive residual waste may remain if retrieval is curtailed.
Develop acceptance criteria and the operational interface with the Environmental Restoration Contractor (ERC).	Disposition of mitigation systems (i.e., leave in place or remove) is a consideration in mitigation system selection and design. Need to support tank closure will affect mitigation system design life.	• Cost increases and schedule delays for tank closure may result.
Determine the extent of soil cleanup needed following waste retrieval.	Mitigation systems must support any follow-on remediation.	• Cost increases and schedule delays for tank closure may result. • Mitigation systems may be over-designed.

Table 6. Additional Information Needed.

Information Needed	Purpose	Potential Impact
Define the role of mitigation systems in soil cleanup.	Mitigation systems must support any follow-on remediation.	• Cost increases and schedule delays for tank closure may result. • Mitigation systems may be over-designed.
Identify specific applications for mitigation systems.	Tri-Party Agreement milestones and funding limits constrain mitigation system development.	• Mitigation system type may not be suitable for Hanford-Site applications. • Retrieval may be delayed if mitigation systems are not available.
Specify technical and administrative requirements for mitigation systems.	Specifications are needed to solicit and/or evaluate vendor proposals to install mitigation systems.	• Mitigation system systems may be incomplete. • Retrieval may be delayed if mitigation systems are not available.
Obtain mitigation system cost data.	Waste retrieval and remediation of the Hanford Site must be cost-effective. Lower cost alternatives to mitigation systems may be available.	• Unnecessary costs may be incurred. • Funding limits may delay cleanup schedule.

3.0 REFERENCES

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," *Code of Federal Regulations*, as amended.

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

40 CFR 191, "Environmental Radiation Protecton Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes," *Code of Federal Regulations*, as amended.

40 CFR 261, "Identification and Listing of Hazardous Waste," *Code of Federal Regulations*, as amended.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

Ames, L. L. and R. J. Serne, 1991, *Compilation of Data to Estimate Groundwater Migration Potential for Constituents in Active Liquid Discharges at the Hanford Site*, PNL-7660, Pacific Northwest Laboratory, Richland, Washington.

Anttonen, J. H., 1992, *TWRS National Technology Workshop, June 29, 30 and July 1, 1992* (letter 92-TRB-123 to addressees, August 17, 1992), U.S. Department of Energy, Richland Field Office, Richland, Washington.

Baynes, P. A., T. W. Woods, and J. L. Collings, 1993, *Tank Waste Remediation System Mission Analysis*, WHC-EP-0627, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Benton-Franklin-Walla Walla Counties Air Pollution Control Authority, 1980, General Regulation 80-7, Richland, Washington.

Boomer, K.D., et al., 1993, *Tank Waste Technical Options Report*, WHC-EP-0616, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Boyles, V. C., 1992, *Operating Specifications for Single-Shell Waste Storage Tanks*, OSD-T-151-00013, Revision D-1, Westinghouse Hanford Company, Richland, Washington.

Cantrell, K. J. and R. J. Serne, 1992, *Literature Search for 200-BP-1 Sorption*, PNL-8069, Pacific Northwest Laboratory, Richland, Washington.

Clean Air Act of 1977, as amended, 42 USC 7401, et seq.

Defense Authorization Act, Public Law 101-510, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation," Section 3137 (also known as the Wyden Amendment).

Delaney, C. D., K. A. Lindsey, and S. P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1987, *Final Environmental Impact Statement, Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes, Hanford Site, Richland, Washington*, 5 vols., DOE/EIS-0113, U.S. Department of Energy, Washington, D.C.

DOE, 1991, *Integrated Data Base for 1991: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, DOE/RQ-0006, Revision 7, U.S. Department of Energy, Washington, D.C.

DOE Order 4700.1, *Project Management System*, U.S. Department of Energy, Washington, D.C.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.11, *Radiation Protection for Occupational Workers*, U.S. Department of Energy, Washington, D.C.

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*, U.S. Department of Energy, Washington, D.C.

DOE Order 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities*, U.S. Department of Energy, Washington, D.C.

DOE Order 5700.6C, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

DOE Order 5820.2A, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

DOE Order 6430.1A, *General Design Criteria*, U.S. Department of Energy, Washington, D.C.

Ecology, EPA, and DOE, 1992, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Hanlon, B. M., 1993, *Tank Farm Surveillance and Waste Status Summary Report for November 1993*, WHC-EP-0182-68, November 1993, Westinghouse Hanford Company, Richland, Washington.

Hauptmann, J. P. and W. C. Carlos, 1993, *Comparison of Design, Materials, Fabrication, and Waste Environments of the Hanford Site and Savannah River Plant Single-Shell Steel Waste Tanks*, WHC-SD-WM-SMSL-015, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Isaacson, R. E. and K. A. Gasper, 1981, *A Scientific Basis for Establishing Dry Well-Monitoring Frequencies*, RHO-ST-34, Revision 0, Rockwell Hanford Operations, Richland, Washington.

Jungfleisch, F. M., 1984, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-EP-0172, Revision 1, Westinghouse Hanford Company, Richland, Washington.

KEH, 1993, *Engineering Study, Subsurface Barriers, Work Order ER3547*, ER3547ES, June 1993, Kaiser Engineers Hanford, Richland, Washington.

Klem, M. J., 1990, *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944-1980)*, WHC-EP-172, Revision 1, Westinghouse Hanford Company, Richland, Washington.

Leach, C. E. and S. M. Stahl, 1993a, *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 1*, WHC-SD-WM-ISB-001, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Leach, C. E. and S. M. Stahl, 1993b, *Hanford Site Tank Farm Facilities Interim Safety Basis, Volume 2: Design Description*, WHC-SD-WM-ISB-001, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A., B. N. Bjornstad, J. W. Lindberg, and K. M. Hoffman, 1992a, *Geologic Setting of the 200 East Area: An Update*, WHC-SD-EN-TI-012, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A., M. P. Connelly, and B. N. Bjornstad, 1992b, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Lowe, 1993, *Engineering Study of Tank Leaks Related to Hydraulic Retrieval of Sludge From Tank 241-C-106*, WHC-SD-WM-ES-218, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

National Environmental Policy Act of 1969, as amended, 42 USC 4321, et seq.

Reidel, S. P., K. A. Lindsey, and K. R. Fecht, 1992, *Field Trip Guide to the Hanford Site*, WHC-MR-0391, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Resource Conservation and Recovery Act of 1976, as amended, 42 USC 9601, et seq.

RHO, 1985, *Hanford Defense Waste Disposal Alternatives: Engineering Support Data for the Hanford Defense Waste Environmental Impact Statement*, RHO-RE-ST-30P, Rockwell Hanford Operations, Richland, Washington.

RL, 1993a, *Hanford Mission Plan*, DOE/RL-93-08, August 1993, U.S. Department of Energy, Richland Field Office, Richland, Washington.

RL, 1993b, *Tank Waste Remediation System Integrated Technology Plan*, DOE/RL-92-61, U.S. Department of Energy, Richland Field Office, Richland, Washington.

RL Order 5480.4C, *Environmental Protection, Safety, and Health Protection Standards for RL*, U.S. Department of Energy, Richland Field Office, Richland, Washington.

RL Order 6430.1C, *Hanford Plant Standards*, U.S. Department of Energy, Richland Field Office, Richland, Washington.

Safe Drinking Water Act, as amended, 42 USC 300, et seq.

Schmittroth, 1993, *Risk-Based Preliminary Assessment Supporting Closure of the Hanford Site Single-Shell Tanks as Land Fills*, WHC-EP-0692, DRAFT, Westinghouse Hanford Company, Richland, Washington.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, as amended.

WAC 173-200, "Water Quality Standards for Ground Waters of the State of Washington," *Washington Administrative Code*, as amended.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WAC 173-400, "General Regulations for Air Pollution Sources," *Washington Administrative Code*, as amended.

WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," *Washington Administrative Code*, as amended.

WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, as amended.

WAC 246-247, "Radiation Protection - Air Emissions," *Washington Administrative Code*, as amended.

WHC, 1993a, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-357, Revision 1K, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993b, *Integrated Retrieval Program Plan*, WHC-SD-WM-PLN-067, Revision 0, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-3, *Management Requirements and Procedures*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-5, *Standard Operating Practices*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-6, *Radiological Control Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, *Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-3, *Industrial Safety Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-9, *Radiological Design*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-11, *ALARA Program Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-40, *Industrial Hygiene Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-5-16, *Solid Waste Management*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-1, *Standard Engineering Practices*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-2, *Project Management*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, *Environmental Compliance*, Westinghouse Hanford Company, Richland, Washington.

Williams, L. S., 1993, *DST/SST Retrieval Sequence*, WHC-SD-WM-ER-193, Revision 0, Westinghouse Hanford Company, Richland, Washington.

Willis, N. P. and G. C. Triner, 1991, *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-3, Westinghouse Hanford Company, Richland, Washington.

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