U.S. DEPARTMENT OF
ENERGY

Hanford Tank Waste Retrieval, Treatment, and Disposition Framework

September 24, 2013

U.S. Department of Energy
Washington, D.C. 20585

This page intentionally left blank.

CONTENTS

This page intentionally left blank.

TERMS

BOF	Balance of Facilities
CH-TRU	contact-handled transuranic waste
DFHLW	direct-feed high-level waste
DFLAW	direct-feed low-activity waste
DOE	U.S. Department of Energy
DST	double-shell tank
HLW	high–level waste; High-Level Waste Facility
IDF	Integrated Disposal Facility
LAB	Analytical Laboratory
LAW	low-activity waste; Low-Activity Waste Facility
LBL	Low-Activity Waste Facility, Balance of Facilities, and Analytical Laboratory
NEPA	*National Environmental Policy Act*
ORP	U.S. Department of Energy, Office of River Protection
PJM	pulse jet mixer
PT	Pretreatment (Facility)
RCRA	*Resource Conservation and Recovery Act*
SST	single-shell tank
TRU	transuranic waste
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WTP	Waste Treatment and Immobilization Plant

This page intentionally left blank.

Hanford Tank Waste Retrieval, Treatment, and Disposition Framework

1. Introduction

Immobilizing Radioactive Tank Waste at the Office of River Protection

Forty years of plutonium production at the Hanford Site has yielded a challenging nuclear waste legacy—approximately 56 million gallons of radioactive and chemical wastes stored in 177 underground tanks (tank farms) located on Hanford's Central Plateau. The mission of the U.S. Department of Energy (DOE) Office of River Protection (ORP) is to address the risks posed by this tank waste through immobilization of the waste, and the ultimate closure of the tanks and decommissioning of the treatment facilities. While there are no immediate risks to the Hanford workforce, the public, or the accessible environment from leaking tanks, DOE remains steadfastly focused on treating Hanford's tank waste as safely and expeditiously as possible.

The tank waste is currently stored in aging single-shell (SST) and double-shell tanks (DST). The liquid portion of the waste is the portion most likely to leak from the tanks. DOE took steps beginning in the 1980s to mitigate this risk by transferring all pumpable liquids from the older single-shell tanks to newer double-shell tanks. The next step is to immobilize this waste.

Immobilization will occur in the Waste Treatment and Immobilization Plant (WTP). The WTP is a highly complex nuclear and chemical processing facility with many first-of-a-kind technology applications. The tank waste at Hanford is also the most complex and heterogeneous radioactive tank waste in the United States. The complexity of both the waste itself as well as the WTP facilities has led to difficult, and to date, unresolved technical issues for the portions of the facility (primarily the Pretreatment [PT] Facility and to a lesser extent the High-Level Waste [HLW] Facility) that will process the solid portions of the waste. Because the current design of WTP anticipates that all waste will be processed through the PT Facility, immobilization of any waste could not occur per the current plan until the technical issues involving the PT Facility are resolved. Therefore, an alternative approach for immobilizing waste as soon as practicable, while simultaneously resolving the remaining technical challenges, has been identified.

The technical issues will take time to resolve, but DOE has assembled dedicated teams of DOE, contractor, national laboratory, and industry experts and is devoting significant resources to resolve these issues. At the same time, by adopting a DFLAW option in which the waste bypasses the PT Facility, waste immobilization can begin years earlier than if we wait until all technical issues are resolved and the Pretreatment Facility is completed.

This document describes a strategic framework for addressing the risks and challenges to completing the ORP mission as soon as practicable by implementing a multipronged, phased approach that is designed to accomplish the following objectives:

- Begin immobilization of the tank waste as soon as practicable through DFLAW.
- Process transuranic (TRU) tank wastes for disposal at the Waste Isolation Pilot Plant (WIPP), should those wastes be properly classified as TRU and be permitted for disposal at WIPP.

- Resolve technical issues for the PT and HLW Facilities, including determining how to adequately mix and sample the waste prior to processing, to enable design completion, and the safe completion of construction, startup and operations of these facilities.

This document is not a proposal, but rather a framework for discussion as DOE and the State of Washington seek to resolve concerns regarding completion of the waste treatment mission. Viewed as a whole, this Framework describes an approach that would allow for immobilization of tank waste to begin as early as practicable without waiting for completion of work to resolve the technical issues associated with the PT and HLW Facilities. For each of the waste streams described in more detail in the following sections, this Framework identifies potential waste treatment options, based on a combination of previous alternatives analyses, external reviews, testing, and ongoing analyses. Where possible, the document identifies a preferred alternative.

Current System Design

The WTP consists of five facilities/complexes: (1) the Analytical Laboratory (LAB), (2) Balance of Facilities (BOF), (3) LAW Facility, (4) HLW Facility, and (5) PT Facility. The WTP is being designed to process the tank farm waste during a roughly 40-year period. The current design requires waste to be processed through the PT Facility, where it will be separated into a low-activity waste stream to be vitrified in the LAW Facility and a high-level waste stream to be vitrified in the HLW Facility. The LAB and BOF support these vitrification activities.

The LAW Facility, BOF, and the LAB—collectively referred to as the LBL—are nearest to completion and do not have any significant remaining technical issues. As described in more detail in the following sections, technical issues associated largely with mixing in the vessels of primarily the PT Facility, and to a lesser extent the HLW Facility, have caused construction of the PT Facility to be suspended and construction of the HLW Facility to be slowed.

Addressing Technical Risks and Challenges

Hanford tanks contain a complex and diverse mix of radioactive and chemical waste in the form of sludge, salts, and liquids, necessitating a variety of unique waste retrieval and treatment methods. The uncertainty and diversity of the physical and chemical properties of the 56 million gallons of waste make the mission uniquely complex.

The underground tank farms at Hanford include 149 older SSTs that are decades past their design life. Some of these tanks are known or are assumed to have leaked, and some SSTs continue to slowly leak. Although there is no immediate health and safety risk posed by these leaks, addressing the long-term environmental concerns associated with the leaks requires a robust and sustainable strategy for waste retrieval, treatment, and disposal or long-term storage. This strategy, thus far, has involved transferring the pumpable liquid waste that posed the highest risk of leaking to the environment from the SSTs to 28 DSTs.

As the design and construction of the WTP has progressed, a number of technical issues have emerged involving the tank farms, the WTP, and the interfaces between the two. As previously noted, the issues in WTP are primarily associated with the PT Facility and, to a lesser degree, the HLW Facility. However, because in the current design all waste flows through the PT Facility, these technical issues impact ORP's overall ability to begin treating Hanford's tank waste.

The WTP technical issues are centered on the ability of the PT Facility to mix and transfer HLW slurries with high solids concentrations and the adequacy of the piping and vessel designs in inaccessible black cells to support the WTP's 40-year operational life. Some of these issues involve uncertainties associated with the erosion and corrosion of piping and vessels, criticality, and hydrogen generation in vessels. In the tank farms, the primary issue is lack of capability to ensure that the waste feed delivered from the tank farms to WTP meets the applicable waste acceptance criteria (WAC).

In response to the emergence of these technical issues, DOE assembled a Design Completion Team and five associated technical teams to resolve these issues. The majority of ongoing work associated with the HLW Facility is focused on resolving the technical issues and completing the facility design. In addition, DOE suspended all of the construction work on the PT Facility to focus resources on resolving the open PT Facility technical issues. The timing of resolution of these issues will determine when construction can begin again on the HLW and PT Facilities. Given the more narrow scope of the technical challenges and the HLW vessel testing program currently underway, DOE expects to be able to restart full construction for the HLW Facility prior to restarting PT construction.

Hanford's Three Waste Streams

The 56 million gallons of tank waste can be roughly binned into three major categories for treatment: (1) low-activity waste; (2) potential contact-handled transuranic waste (CH-TRU); and (3) high-level waste, which is further subdivided into waste not requiring special handling (easier to process) and waste requiring special handling (harder to process).

1. **Low-activity waste**. Consisting primarily of the supernate (liquid) portion of the tank waste with most of the solids and radioactivity removed before vitrification, low-activity waste will be the largest tank waste stream by volume (approximately 90% of the volume), but the lowest in radioactivity content (approximately 10% of the curies).
2. **Potential contact-handled transuranic waste**. There are approximately 1.4 million gallons of waste in 11 SSTs that could potentially be classified as CH-TRU and transferred to the WIPP for disposal. The waste in these 11 tanks is undergoing review to determine whether or not it can be classified as CH-TRU.
3. **High-level waste**. High-level waste is primarily sludge and saltcake, with the sludge fraction of the waste consisting of metal oxides and hydroxides, and the saltcake fraction consisting of the product of numerous acid-base reactions. The high-level waste in the tanks accounts for the bulk of the radioactivity. However, once the liquid is removed from the tanks, this waste form is not very mobile. The high-level waste feed stream can be further divided into two subcategories, depending on the need for some form of special handling in order to meet the plant's WAC.
    a. **High-level waste not requiring special handling (easier to process)**. This subcategory of waste is expected to meet the PT WAC and be processed through the PT Facility and vitrified in the HLW Facility. The majority of the high-level tank waste is not expected to require special handling.
    b. **High-level waste requiring special handling (harder to process)**. This high-level waste stream contains high concentrations of fast-settling particles, plutonium dioxide, or metal particles. Options for treating the waste include directly feeding the waste to the HLW Facility (bypassing the PT Facility) or preconditioning the waste prior to treatment in PT Facility or the HLW Facility.

Strategy for Completing the Hanford Tank Waste Mission: Phased Construction and Startup of the Waste Treatment and Immobilization Plant

To maximize near-term risk reduction and to leverage the experience gained as the WTP facilities are completed, DOE is considering a three-phased approach to the tank waste mission. The Framework describes what options could be taken for the three waste streams. The phases describe how the options could be implemented. Although some work will proceed in all three phases in parallel, the phases sequence the completion of the WTP facilities in a manner that lets DOE apply resources to address the most mobile tank waste, supernate, in the near term while resolving the technical issues associated with the HLW and PT Facilities. As the technical issues are resolved, construction resources will move to the HLW Facility followed by the PT Facility. This approach will allow WTP vitrification operations to begin as soon as practicable while continuing to resolve the remaining the technical issues in PT and HLW. The scope and pace of work associated with each of these phases is dependent on a number of variables, including technical issue resolution and available appropriations.

The Department is currently focused on completing the design, procurement, and construction of the LBL facilities. Most of the BOF are expected to be completed in the near future, followed by the LAB, and then the LAW Facility. Startup and commissioning activities for LBL will follow completion of construction.

Because these facilities will be completed before the HLW and PT Facilities, DOE could begin WTP operations and waste vitrification in Phase 1 by establishing DFLAW, bypassing the PT Facility.

Phase 1 key activities include:

- Current Activities
  - Completion, commissioning, and startup of BOF and the LAB
  - Completion of the ongoing C Farm retrievals
- DFLAW Activities
  - Completion of the tank farm infrastructure and an interim pretreatment capability (for removal of cesium and miscellaneous solids) needed to directly feed the LAW Facility
  - Completion, commissioning, and startup of the LAW Facility
  - Final permitting of the onsite Integrated Disposal Facility (IDF) for low-activity waste
- CH-TRU Activities
  - Retrieval and shipment of any CH-TRU waste from the SSTs to WIPP, pending the proper and legal classification of the waste as TRU and obtaining the necessary permits
- DFHLW Activities
  - Initiation of a tank waste characterization and staging capability in the tank farms to support HLW
- Technical Issue Resolution
  - Completion of full-scale vessel testing and resolution of technical issues in the PT and HLW Facilities.

Phase 2 key activities include:

- DFHLW Activities

  - Completion of HLW
  - Completion of a tank waste characterization and staging capability
  - Completion and commissioning of the Interim Hanford Storage Facility.
- PT Facility
  - Continue construction of the PT Facility

Phase 3 key activities include.

- Full WTP Completion
  - Pretreatment Facility commissioning
  - Initiating integrated WTP operations
  - Possible additional preconditioning capability for the harder to process waste

This phased approach—with individual but integrated paths for each of the three primary waste streams—is intended to provide optionality, flexibility, and redundancy for completing the tank waste cleanup mission. This approach would enable DOE to mitigate the impact of the outstanding technical issues at the PT and HLW Facilities by beginning immobilization of the most mobile tank waste at Hanford without awaiting resolution of those technical issues. Because a phased approach allows for LAW operations to begin before PT and HLW Facility construction is complete, and because the volume of low-activity waste is much higher than the volume of high-activity waste in Hanford's tank farms, this approach has the potential shorten the overall duration of the tank waste mission.

2. Low-Activity Waste Stream

Key Near-Term Recommendation:	*Make design and operational changes to the WTP and Tank Farms to allow for directly feeding the Low-Activity Waste Facility*

The low-activity waste will make up approximately 90% of the total volume of waste to be treated, and has the greatest influence on the total duration of the Hanford tank waste mission. The liquid form of this waste makes it susceptible to leakage. The low activity waste is also the tank waste most easily processed through the WTP. In particular, there are no significant technical risks associated with vitrifying this waste in the LAW Facility.

With the LAW Facility scheduled to be completed before the PT and HLW Facilities, there is an opportunity to begin treating this waste stream before overall completion of the WTP by pursuing a DFLAW approach. If the decision is made not to pursue DFLAW, the treatment of low-activity waste would await the resolution of the remaining technical issues involving the PT Facility.

DFLAW could provide a range of significant operational and environmental benefits, including:

- Begin treating the most mobile tank waste at the earliest practicable time
- Provide flexibility and redundancy to the tank waste treatment system by providing an avenue to continue operations in the event of a future outage in the PT Facility
- Create opportunity to optimize radioactive operations for WTP filtration and ion exchange technology and further validate LAW glass performance models in a full production environment
- Reduce the commissioning and startup risk of the remainder of WTP's production facilities (e.g., HLW and PT Facilities) as a result of lessons learned from the commissioning and startup of the LAW Facility.

Potential Technology Alternatives for Implementing Direct Feed of the Low-Activity Waste Facility

Beginning LAW Facility operations before the PT Facility is operational would require a capability to remove the cesium and miscellaneous solids from the waste stream so that low-activity waste could be directly fed to the LAW Facility.

Preconditioning Alternative A (Preferred): Construct an Interim Pretreatment System Facility

Initial analyses indicate that a standalone Interim Pretreatment System Facility would best address this need. It would be located between the tank farms and the LAW Facility and would remove the solids and cesium and possibly other radioactive elements from the liquid waste stream. This facility would provide the processing capability to support a DFLAW operation prior to the completion of PT. As this option uses mature technologies, the technical risks associated with this alternative are low.

Figure 1 depicts the location of a potential Interim Pretreatment System Facility within the tank waste system.

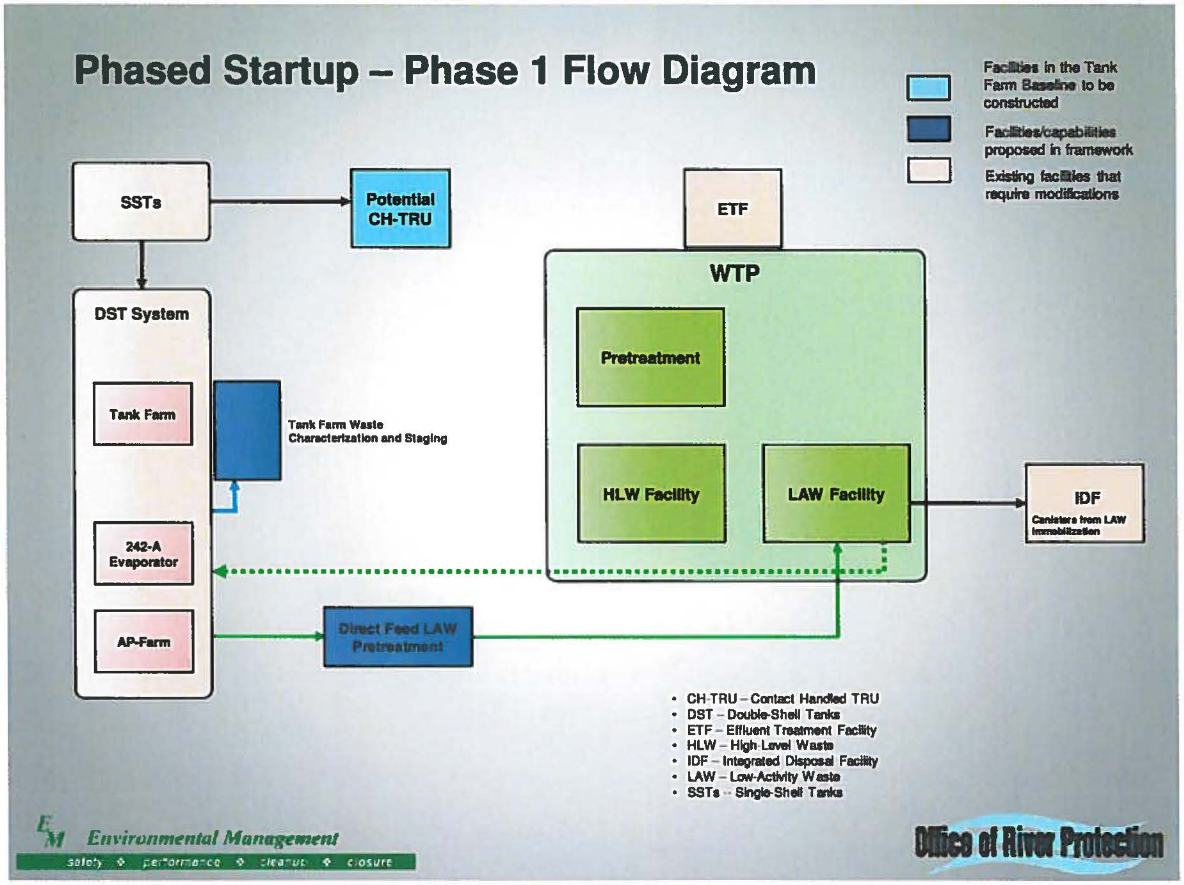

Figure 1. Direct-Feed Low-Activity Waste—Interim Pretreatment System Facility Flow Diagram.

Preconditioning Alternative B: Install In-Tank Interim Pretreatment Capability

As the critical decision process proceeds, other alternatives will be reviewed in order to achieve an optimum solution. For example, technology exists to potentially perform this interim pretreatment capability within the tanks or tankside. Skid-mounted, portable ion exchange columns and solids filtration systems could be installed either in the tank or on skids near the outside of the tanks to process the supernate stream and leave the cesium and solids in the tank. However, current technology does not appear to be able to supply LAW feed at a high enough rate to support operating the LAW Facility at full capacity. Additional investigation and possible technology development would be needed for this alternative. Also, additional analysis of options for transporting waste to the LAW Facility, including permanent piping, hose-in-hose temporary lines, or tanker trucks, would need to be completed to determine whether or not to pursue this alternative.

Additional Requirements to Treat the Low-Activity Waste Stream

Proceeding with DFLAW will require the supernate stream to be transferred to the LAW Facility for vitrification following interim pretreatment. Secondary liquid wastes generated from the LAW Facility offgas system would then be transferred back to the tank farms and likely volume-reduced through evaporation activities using the existing 242-A Evaporator in the tank farms.

Implementation of either of the above alternatives also depends on additional variables, including the completion and availability of the LBL and the completion of a *National Environmental Policy Act* (NEPA) analysis and issuance of a record of decision, as appropriate.

Regardless of the alternative chosen, the IDF—the disposal facility for the vitrified low-activity waste—must be available once LAW vitrification activities begin because there is no storage space for vitrified waste in the WTP. The IDF, shown in Figure 2, is a multiphased landfill similar in concept to the Hanford Environmental Restoration Disposal Facility with a planned capacity of up to 1 million cubic meters. Currently, the IDF is about 1,500 feet wide, 765 feet long, and 42 feet deep with a capacity of nearly 165,000 cubic meters.

To operate IDF, ORP must complete the remaining regulatory steps, including a performance assessment; a waste incidental to reprocessing determination as required by DOE M 435.1, *Radioactive Waste Management*; and a permit modification pursuant to the *Resource Conservation and Recovery Act* (RCRA).

Figure 2. Integrated Disposal Facility.

Near-Term Workscope

In FY14, BOF and LAB construction is scheduled to be completed with LAW construction continuing. However, in order to feed waste to the LAW Facility, significant upgrades as described above are required. If the DFLAW approach is pursued, and subject to appropriations, in FY14, completion of conceptual and preliminary design is expected for the tank farms Direct Feed System, which will transfer the waste to the LAW Facility and possibly perform separation activities.. In addition, the associated permitting and safety basis design work is expected to begin, as is the performance assessment development for the IDF. Figure 3 shows a high-level logic diagram for select activities associated with implementation of a DFLAW alternative.

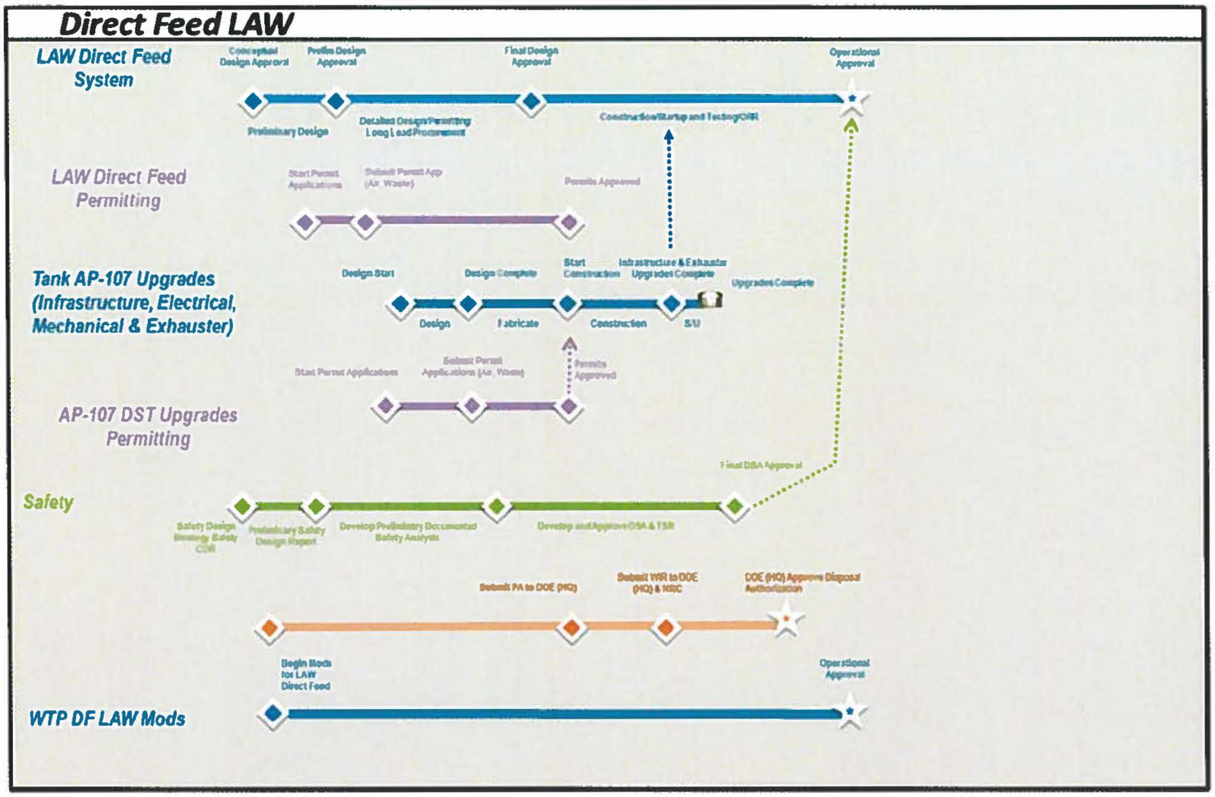

Figure 3. Direct-Feed of the Low-Activity Waste Facility Logic Diagram.

3. Potential Contact-Handled Transuranic Waste Stream

Key Near-Term Recommendation:	*Install infrastructure to retrieve and dispose at WIPP properly and legally classified mixed transuranic waste from up to 11 tanks of potential contact-handled TRU*

The Hanford tank farms contain approximately 1.4 million gallons of tank waste in 11 SSTs that are currently undergoing a classification analysis to determine whether the waste may be properly and legally classified as CH-TRU. This waste is currently stored in eight small 200-series tanks in the B and T Tank Farms and in three larger tanks located in the T Farm. Figure 4 shows the location of the B and T Tank Farms.

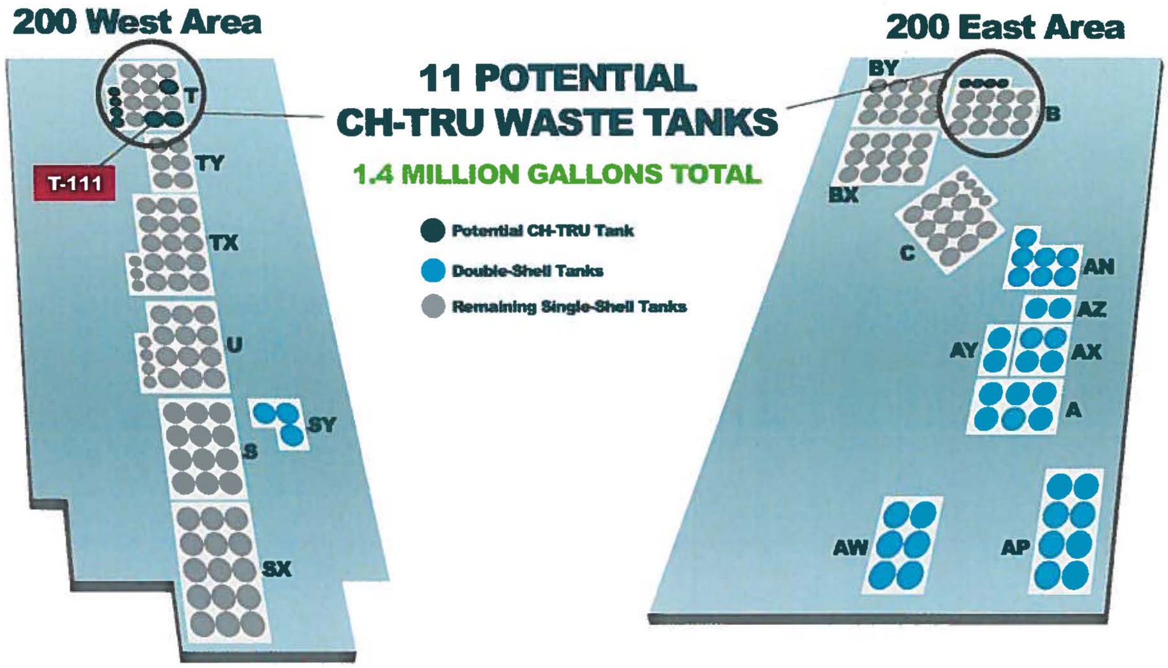

Figure 4. Location of Potential Transuranic Tanks in the 200 East and 200 West Area Tank Farms.

Four of the 11 potential CH-TRU tanks have been classified as assumed leakers. Recent ongoing integrity assessments have confirmed leakage from one of the large 200-series tanks, T-111. Retrieval and disposal of the CH-TRU waste at WIPP is the fastest way to reduce this risk.DOE completed and issued DOE/EIS-0391, *Tank Closure and Waste Management Environmental Impact Statement*, which evaluated the current DOE life-cycle baseline approach for retrieval and at-tank treatment and packaging. As part of the ongoing NEPA process, on March 11, 2013, DOE announced its preferred alternative to retrieve, treat, package, characterize, and certify tank waste that may be properly and legally classified as TRU for disposal at WIPP, assuming that applicable permits are approved and regulatory requirements can be met. In 2013, DOE also submitted to the New Mexico Department of Environment a modification to the WIPP Part B permit.

If the waste in these tanks can be properly and legally classified as CH-TRU, disposing of this waste at WIPP could reduce the potential environmental risk from some of the leaking SSTs, deliver important life-cycle cost savings, and result in the retrieval of the tanks significantly before commencement of waste processing operations in the PT and HLW Facilities. If the decision is made not to pursue disposal at WIPP, the waste would be processed through WTP as currently planned. Feeding this waste to the WTP would require infrastructure upgrades and the resolution of the technical issues at the PT and HLW Facilities; hence this waste would not be treated for a significant amount of time.

Potential Alternatives for Implementing Disposal of Potential Contact-Handled Transuranic Tank Waste

Initial analysis has identified a preferred alternative based on available equipment and anticipated processes. However, if the waste may be properly and legally classified as CH-TRU, as the critical decision process progresses, each of the following alternatives will be reviewed, considering various factors including cost, schedule, and programmatic impacts.

Alternative A (Preferred). Retrieve the waste and use skid-mounted processing equipment to process and package the waste for disposal at WIPP or at a mixed low-level waste disposal facility. WIPP certification could occur at an onsite or offsite facility.

Alternative B. Construct an appropriately sized CH-TRU processing and packaging facility for disposal of the waste at WIPP or at a mixed low-level waste disposal facility. A standalone facility could be built in the tank farms that could retrieve, process, and package CH-TRU waste (or the processing and packaging could occur in a modified Hanford Site facility). This facility also could be modified should a decision be made to retrieve potential remote-handled TRU in the future.

Alternative C. Retrieve the waste and ship offsite for processing and packaging for disposal at WIPP or at a mixed low-level waste disposal facility. Current retrieval technologies could be modified to transfer the waste to a tanker truck for shipment offsite for further processing.

Additional Requirements for Disposing of Potential Contact-Handled Transuranic Waste at the Waste Isolation Pilot Plant

For any of the CH-TRU disposal alternatives, a number of additional actions would be required, including the following:

- Completion of the waste classification process
- Completion of any additional NEPA analysis and the issuance of an appropriate record of decision
- Completion of the alternatives analysis for processing CH-TRU, including the examination of potential commercial capabilities through an expression of interest
- Approval of the modification to the WIPP Part B permit
- Issuance of a RCRA permit modification for the tank farms
- Completion of the design and construction process for the appropriate infrastructure through DOE's project management and critical decision process.

Subject to funding constraints, and based on current analyses, the first five actions could potentially take approximately 36 months to complete if performed in parallel as much as possible. Further, any CH-TRU waste to be disposed at WIPP would have to be certified for shipment and disposal in a Carlsbad Field Office-approved program. The Hanford Site historically has performed the certification at the Waste Receiving and Processing Facility. The Department also has the ability to certify and package waste through the Central Characterization Program. Both of these options would need to be explored in order to make a final determination concerning WIPP certification of the waste. In addition, depending on the packaging and treatment technology chosen, some portion of the retrieved waste may assay at radionuclide concentrations below the transuranic waste legal limit and would be designated as mixed low-level waste, requiring disposal at a facility other than WIPP.

Near-Term Workscope

In FY14, DOE expects to make a waste classification and to continue critical decision documentation development that will define the technology and infrastructure needed to retrieve, process, and package the waste for disposal. This will inform which alternative for processing CH-TRU is chosen.

Figure 5 shows a high-level logic diagram for select activities associated with implementation of a CH-TRU to WIPP alternative.

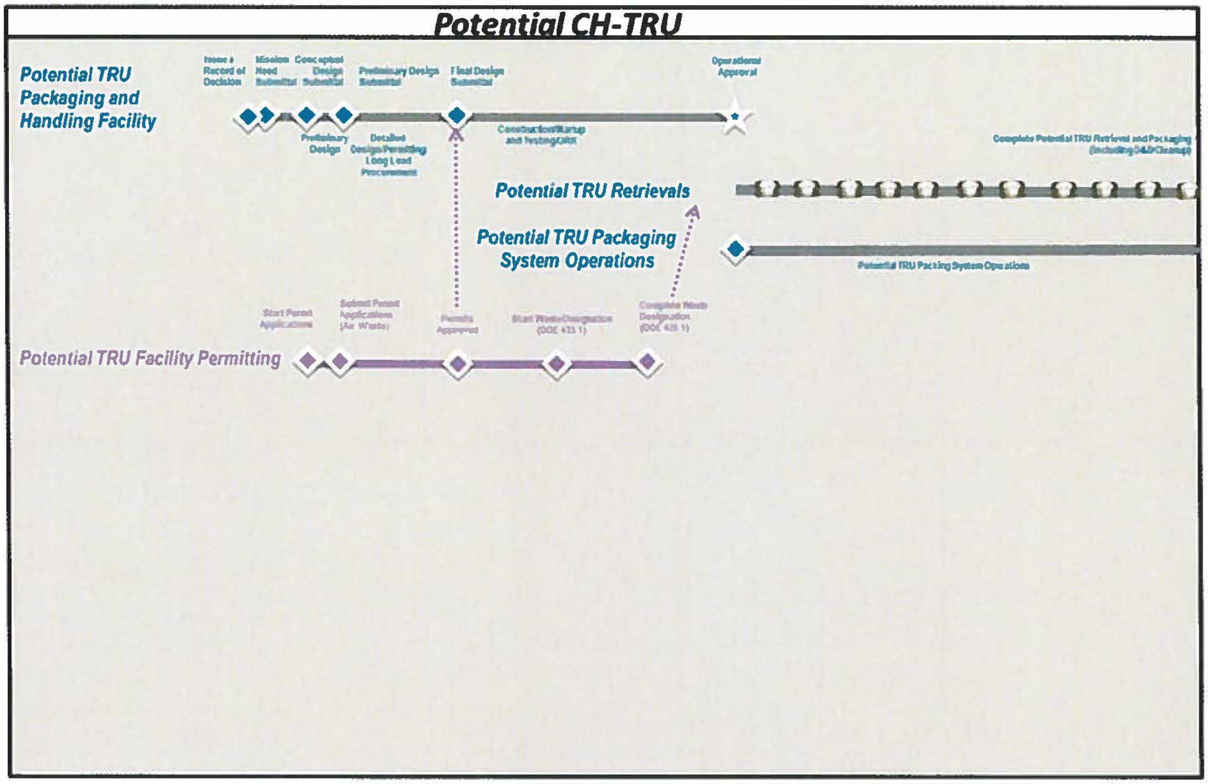

Figure 5. Contact-Handled Transuranic Waste Logic Diagram.

4. High-Level Waste Stream

Key Decision:	*How and where should waste characterization and sampling be performed prior to transfer to the Pretreatment and/or High-Level Waste Facilities?*
Key Decision:	*Should design and operational changes be made to allow for direct feed of the High-Level Waste Facility prior to the completion of the Pretreatment Facility?*

The high-level waste stream constitutes a relatively small fraction of the total waste by volume in the tanks, but contains a large fraction of the total radioactivity. However, due to the characteristics of the high-level waste that limits mobility, this waste poses little risk to the accessible environment in the immediate future. The solids in the slurries have widely varying particle sizes, densities, and chemical characteristics, and limited data exists on what concentrations or types of solids are present in any specific tank. To account for the complexity of the high-level waste, it can be further categorized as follows:

- **Waste not requiring special handling.** This waste stream contains concentrations of high-level waste solids that are expected to fall within the PT Facility's solids handling and treatment capabilities and will be able to be processed through the PT Facility and on to the HLW Facility. The Department expects that the majority of the high-level waste onsite will not need special handling and could be fed to the PT Facility after sampling and characterization.
- **Waste requiring special handling.** In cases where the waste does not meet the solids-handling capabilities of the PT Facility as a result of, for example, the presence of large, fast-settling particles or sizeable plutonium dioxide and metal particles, the waste could potentially be directly fed to the HLW Facility for vitrification or would need to be preconditioned before it is fed through PT.

Treating the high-level waste feed stream will require the waste to be retrieved from the tanks; sampled, mixed, and characterized; combined with fluids to generate pumpable slurries; potentially pretreated or preconditioned; and fed through the HLW Facility for vitrification. To appropriately characterize the tank waste and ensure it meets the necessary WAC, ORP has begun examining how it will strengthen the site's capacity to effectively stage, mix, sample, and characterize the waste.

Technical Issues Impacting Pretreatment and High-Level Waste Facilities

Moving forward on any pathway for high-level waste requires the resolution of the technical issues at the HLW Facility and, in some cases, the PT Facility. The form and timing of resolving these technical issues will drive the return of the facilities to full construction, commissioning, and operation.

The following briefly describes the primary unresolved technical issues associated with the PT and/or HLW Facilities.

- **Hydrogen gas release from vessel solids.** High solids concentrations present in some of the PT Facility pulse jet mixer (PJM) vessels could form a sediment layer on the bottom of the vessel(s) that could retain hydrogen gas and lead to a sudden release of hydrogen into the top of the tank in unacceptably high concentrations.
- **Criticality.** Up to 16 of the 177 tanks at Hanford contain plutonium particles that may be so dense that they could settle on internal surfaces of the PJM vessels. If such settling were to occur and the PJMs could not resuspend the particles, in a very unlikely scenario, a sufficient quantity of

plutonium could form in a favorable geometry (e.g., a sphere) that could possibly initiate a criticality.

- **Pulse jet mixer control.** Accumulating solids in PJM vessels could interfere with vessel-level measurements, which could lead to overblow events (air discharged out of the PJMs into the vessel). The cumulative effect of overblows could exceed the vessel design limits and cause the material failure of the components within the vessels located in black cells.
- **Erosion.** The WTP vessel and piping design may not be sufficient to establish adequately conservative margins for erosive wear in the vessels and associated piping, particularly in light of the uncertainties in waste feed characteristics.
- **Potential line plugging**. Potential exists for large/dense particles to settle in pipelines and result in plugging.

Technical Issue Resolution and Design Completion Team

The WTP Design Completion Team, which was formed to address the outstanding WTP technical issues, includes members from ORP, Bechtel National, Inc., the national laboratories, and the Tank Operations Contractor. The role of the Design Completion Team is to provide leadership for resolution of the WTP technical issues in order to:

- Enable completion of the design of the HLW and PT Facilities
- Ensure the plant is designed and constructed to meet its 40-year operational life.

Work to resolve the WTP technical issues is being conducted by five technical teams. The Design Completion Team provides direction and oversight to the technical teams, approves their work products, and ultimately endorses the closure of the major technical issues. The five technical teams and near-term workscope are as follows:

- **Full-Scale Vessel Testing Technical Team.** This team will complete qualification testing of WTP PJM vessels and control systems to verify their designs will meet their mixing requirements using full-scale vessels and prototypic control system hardware. Up to six WTP vessels may be tested at full scale; alternatives and options for testing fewer vessels are being considered. Near-term workscope includes: (1) complete construction, assembly, and startup of the full-scale test facility for the first test of an HLW Facility vessel; (2) finalize test plans and complete initial testing of the prototypic PJM control system designs; (3) conduct PJM testing for one representative HLW Facility PJM mixed vessel; and (4) develop simulants and test plans and initiate planning for testing PT Facility vessels.
- **Erosion/Corrosion Technical Team.** This team will resolve outstanding issues associated with the WTP design basis for vessel and piping material selection and wear allowances for erosion and corrosion, and define the process operating limits to ensure that localized corrosion is prevented in vessels and piping. Near-term workscope includes: (1) establish test requirements, develop test specifications, and award subcontracts to perform a series of tests to more comprehensively define the design basis for preventing localized corrosion, and establishing conservative wear allowances for erosion and corrosion; (2) issue an engineering report documenting how particle properties change as waste feed moves through the various parts of the PT process; (3) conduct a comprehensive risk assessment and make recommended design changes (if necessary) for the HLW vessels and piping in advance of completion of erosion/corrosion testing by the end of 2013;

and (4) conduct a similar comprehensive erosion and corrosion risk assessment for the PT Facility by the end of 2014.

- **In-Service Inspection/Redundancy Technical Team.** This team will ensure that the vessels, components, and piping in HLW and PT black cells and hard-to-reach areas will support a 40-year operational life, and provide the technical basis to establish a Reliability Integrity Management Program for the HLW and PT Facilities. Near-term workscope includes: (1) conduct a series of failure modes and effects analyses to identify potential single-point failures in black cell and hard-to-reach areas; (2) prepare design reports for in-service inspection instrumentation and equipment for black cells and hard-to-reach areas; (3) issue engineering analysis and recommended control methods and equipment to prevent line plugging; and (4) define the requirements for a Reliability Integrity Management Program for the two facilities.
- **Black Cell Analysis Technical Team.** This team will complete structural designs for vessels, components, and piping in WTP black cells and hard-to-reach areas, and complete engineering studies to recommend any required design modifications to WTP vessels. Near-term workscope includes: (1) complete engineering studies to re-evaluate design load inputs for black cell vessels for HLW Facility vessels followed by PT Facility vessels; (2) conduct vessel analysis expert review panel evaluation of structural designs of WTP black cell vessels; and (3) complete a design verification report for all HLW Facility vessels.
- **Identification of Waste Preconditioning Requirements/Facilities Technical Team.** This team will determine the need for preconditioning of the Hanford tank waste prior to delivery of the waste to WTP. Near-term workscope includes: (1) prepare and approve an update to the Interface Control Document that provides the WAC for waste feed delivery to WTP; (2) prepare draft interface control documents for potential direct feed of tank waste to the LAW and HLW Facilities; and (3) update the WTP WAC data quality objectives document.

Tank Farm Issues

The following is a brief description of technical issues associated with tank farm systems.

- **Mixing and characterizing double-shell tank waste.** The ability to adequately mix, obtain samples from, and characterize tank waste in a million-gallon DST prior to delivery to the WTP continues to be a major concern. Past testing and analysis has not provided definitive assurance of the ability of the DSTs to adequately mix and characterize high-level waste feed for the WTP. Initial analysis indicates a tank waste characterization and staging facility may satisfy this need, but additional technical analyses and business cases will be prepared to consider alternatives to satisfy the tank waste characterization and staging requirements.
- **Waste transfer line pressures.** High-level waste feed from certain locations within tank farms (AW Farm and AN Farm) exceed the pressure rating of the standard PUREX connectors used throughout tank farms. Initial analysis indicates locating a staging facility between the tank farms and WTP may address this issue but additional analyses will be needed to determine the best way to transfer the waste.
- **Waste acceptance criteria evolution.** The WTP WAC describe the physical and chemical characteristics of the waste to be fed into the WTP facilities. The WAC have evolved significantly and are continuing to evolve based on ongoing technical issue resolution. Issues with respect to

the mixing ability of some tanks and concerns relating to erosion and pipeline plugging may combine to restrict the waste feed that meets these criteria. Current restrictions on allowable feed physical characteristics (e.g., particle size and density) further challenge DOE's ability to stage and adequately characterize high-level waste feed in million-gallon DSTs. The PT Facility receipt tank geometry and uncertainty regarding the capability of PJMs to maintain mobilization of heavy solids (e.g., large and dense particles) have led to concerns regarding criticality, flammable gas, and erosion in PT. Additionally, operating conditions and tank waste contents create corrosion concerns within certain WTP vessels. The characterization, sampling, and possible preconditioning of all waste entering the PT Facility will need to be performed and is the subject of the alternatives analysis for establishing a tank waste characterization and sampling capability.

- **Double-shell tank structural concerns**. The DSTs were not designed to support the extensive mixing and characterization sampling activities required by the WTP. Internal components, particularly in the AY and AZ Tank Farm (e.g., airlift circulators) DSTs are not sufficiently structurally robust to accommodate repeated stresses from high-shear mixer pumps without mitigating actions. Alternative locations (e.g., a new facility) for characterization and sampling will be analyzed as part of the alternatives analysis that will be performed for the tank waste characterization and sampling capability.

Potential Treatment Pathways for High-Level Waste

High-Level Waste Not Requiring Special Handling

For the majority of the high-level tank waste expected to meet the PT WAC, the PT Facility will provide the system's separation function and feed the HLW Facility, as intended under the current design and essential to the ultimate accomplishment of the waste retrieval and vitrification mission. Ongoing full-scale vessel testing for HLW and PT Facility vessels will inform the ultimate acceptance criteria and help define the characteristics of waste that can be fed without preconditioning.

High-Level Waste Requiring Special Handling

Direct Feed for High-Level Waste Facility

In cases where the waste requires special handling, or does not meet the WAC for the PT Facility but does meet the expected broader WAC for the HLW Facility, waste could be fed directly from the tank farms to the HLW Facility. This could mitigate technical uncertainties that result from the widely varying makeup of the tank waste. Specifically, this option has potential to mitigate criticality issues at PT by allowing the tank waste known to have the vast majority of plutonium and the larger plutonium particles to bypass PT and be fed directly to HLW. Because the HLW Facility does not concentrate solids like the PT Facility, the plutonium particles would present less of an issue for DFHLW than for the planned processing of this waste through PT.

A DFHLW capability would also provide additional system flexibility, serving as a backup to the PT Facility in the case of outages or maintenance. In addition, given that the HLW Facility technical concerns may be resolved before the technical issues involving the PT Facility are resolved, a DFHLW capability could enable the HLW Facility to begin operations before PT startup.

Establishing the capability to operate the HLW Facility independently from the PT Facility would require design modifications to both WTP and the tank farms, and would require an operational staging and characterization capability to stage, sample, mix, and characterize the waste before it is fed to the HLW Facility.

One of the challenges with the DFHLW approach is that it could result in the production of a higher quantity of high-level waste glass canisters because the high-level waste would be less concentrated than if processed first through PT. However, DOE has obtained promising results through its development of advanced glass formulations that may significantly reduce the number of high-level waste canisters, which would thereby reduce potential costs associated with disposal of additional high-level waste canisters.

Preconditioning Capability for High-Level Waste

A preconditioning capability may be needed in order for the harder-to-process HLW to meet the PT Facility WAC. This capability could include reducing the size of solids in the waste, dissolving or blending solids, segregating solids from the waste stream, or adding absorbers to address criticality concerns. A preconditioning capability could be established as a standalone facility or reside in a tank waste characterization and staging facility.

Tank Waste Characterization and Staging Capability

Tank farms operations will require waste staging, sampling, mixing, characterization, and possibly preconditioning in order to ensure it can deliver acceptable waste to the WTP. A tank waste characterization and staging capability (most likely in a new standalone facility) could also distinguish the waste requiring preconditioning or special handling from the waste not requiring it, and segregate the waste as necessary.

Initial analysis indicates a new facility may be needed for characterization and sampling of the waste. However, the Department is continuing to assess how much, if any, of the necessary characterization and sampling work can be performed in the existing DSTs. Before deciding to pursue the design of a facility, DOE would conduct an alternatives analysis.

Notional System Configuration for Direct Feed of the High-Level Waste Facility and Tank Waste Characterization and Staging

Figure 6 depicts a potential system configuration for DFHLW with a facility to perform tank waste characterization and staging. One possibility for this capability would be a facility located between the tank farms and HLW Facility that contains one or more tanks capable of providing staging, mixing, characterization and in an enhanced role, preconditioning of the waste.

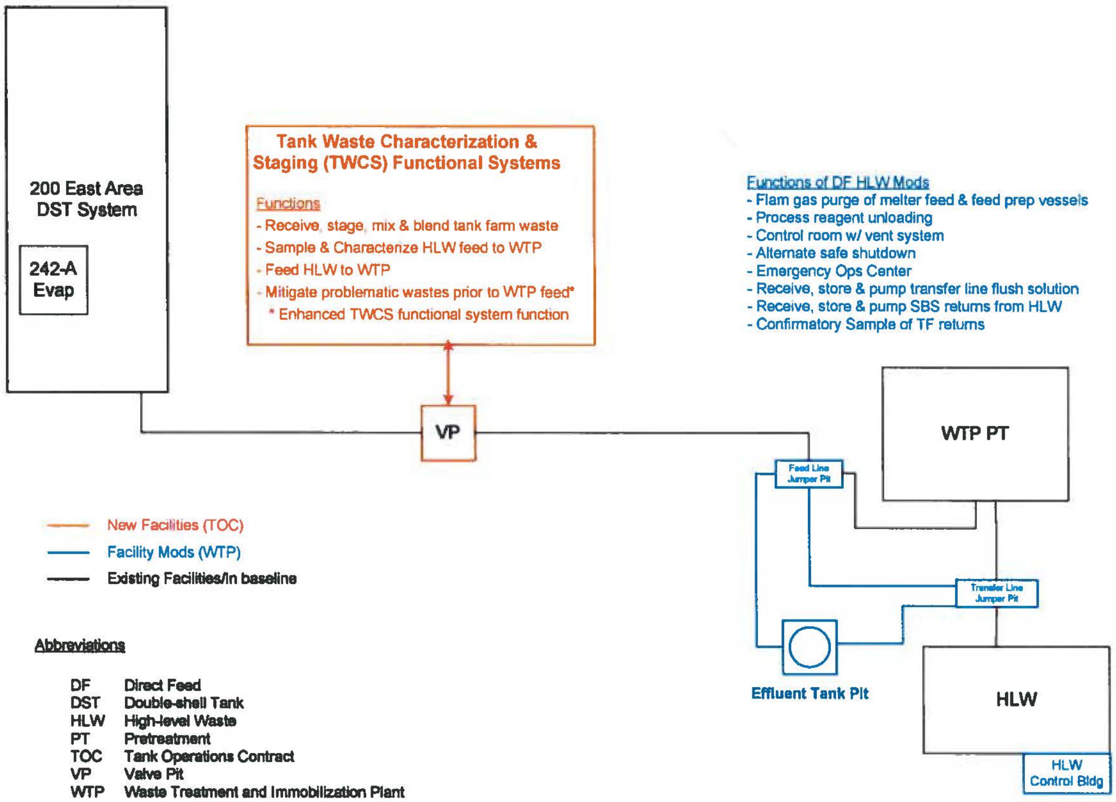

Figure 6. System Configuration Concept for Direct Feed of High-Level Waste

Additional Requirements to Treat the High-Level Waste Stream

Decision for implementation of any of the above alternatives also depends on additional variables, including the completion and availability of the HLW Facility and the PT Facility; installation of a staging, sampling, and characterization capability with an associated NEPA analysis and issuance of a record of decision, as appropriate; and the availability of the Interim Hanford Storage Facility, the onsite storage facility for the vitrified high-level waste needed until a permanent disposal repository is available.

Near-Term Workscope

In FY14, in addition to the technical team workscope described previously, DOE expects to begin developing the critical decision documents associated with the tank waste characterization and staging capability. DOE also expects to define a path for restarting full HLW construction and begin design and permitting work on the Interim Hanford Storage Facility. Figure 7 shows a logic diagram for the high level waste treatment option.

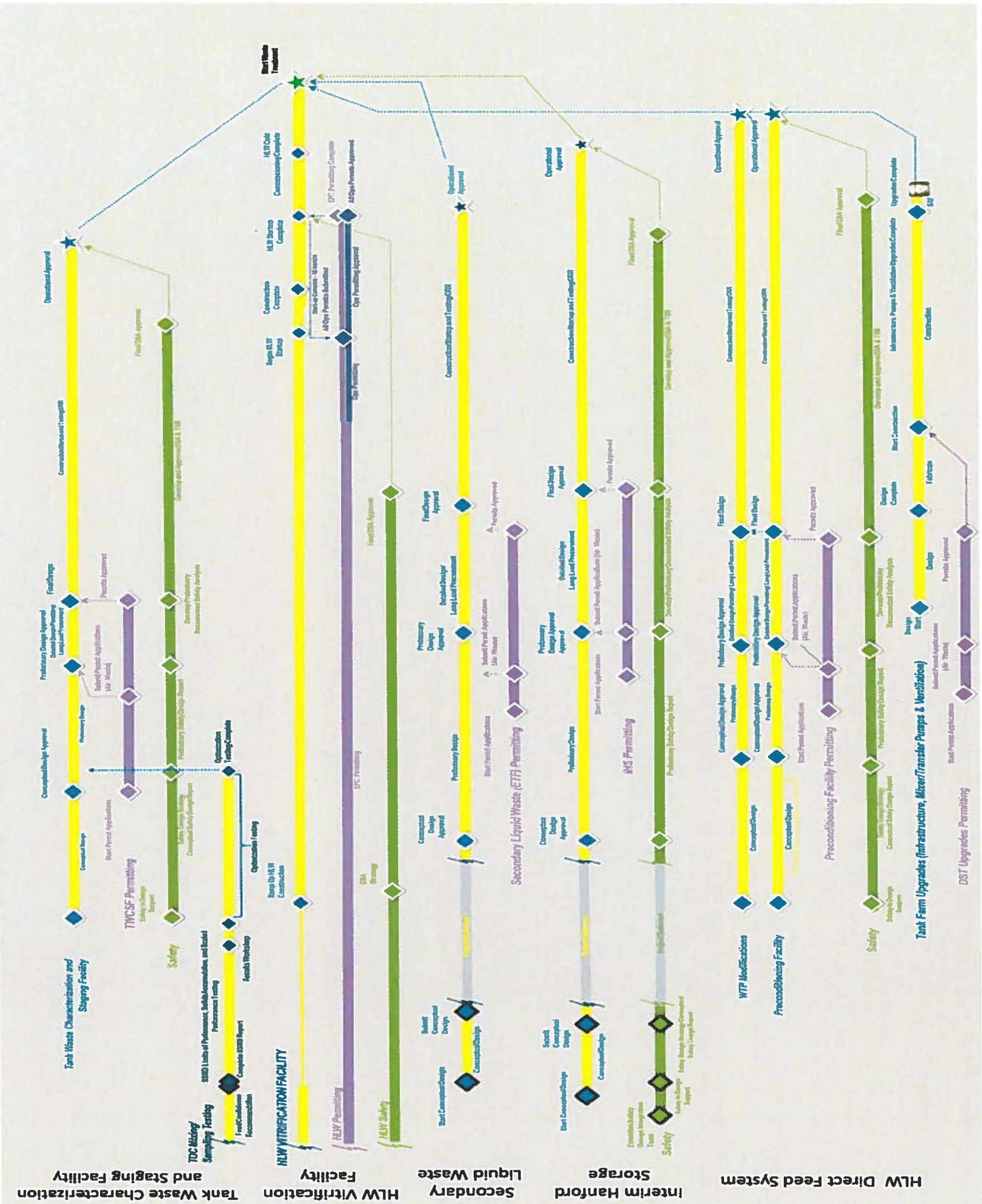

Figure 7. High-Level Waste Logic Diagram.

5. Conclusion

This multipronged, phased approach to the startup and completion of the tank waste mission is intended to facilitate the start of tank waste immobilization as soon as practicable while work continues to resolve the technical issues in the PT and HLW Facilities. This Framework recommends two waste treatment options, DFLAW and CH-TRU, and discusses a third, DFHLW. DOE will consider the views of the State of Washington in deciding on pursuing these options. Within the options, a number of implementing alternatives are presented. While preferred alternatives are identified in some cases based on current analyses, the alternatives analysis process continues for each and may result in different preferred alternatives or additional modifications.

The approach described in this Framework would provide additional flexibility and redundancy to the tank waste treatment system by establishing individual, and often independent, treatment pathways for the three distinct waste streams. Phasing WTP facility construction, completion, and commissioning—first the BOF, followed by the LAB, LAW Facility, HLW Facility, and finally the PT Facility—could also reduce the commissioning and startup risks of the later production facilities. By beginning waste vitrification sooner and developing alternative waste treatment pathways, this Framework describes a path forward that could complete the tank waste mission sooner, compared to waiting until all technical issues are resolved and the PT facility is completed.

The Department looks forward to engaging with the State of Washington, and ultimately Hanford's stakeholders, to discuss this approach to the tank waste mission and the alternatives for specific waste streams, and to create a sustainable path forward for addressing Hanford tank wastes.

This page intentionally left blank.