DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RIV14800
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Integrated Waste Feed Delivery Plan, Volume 1 - Process Approach

T. D. Woo, Washington River Protection Solutions, LLC
R. N. Wagner, AEM Consulting LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

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Abstract: The Integrated Waste Feed Delivery Plan (IWFDP) describes how waste feed will be delivered to the Hanford Tank Waste Treatment and Immobilization Plant (WTP) to safely and efficiently accomplish the River Protection Project (RPP) mission. This revision of the IWFDP provides an overview of the phased-approach and focuses on the start-up, commissioning, and initial operating phase of the WTP Low-Activity Waste (LAW) Vitrification Facility.

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Integrated Waste Feed Delivery Plan

Volume 1 – Process Approach

T. D. Woo
Washington River Protection Solutions, LLC

R. N. Wagner
AEM Consulting, LLC

Date Published
October 2015

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Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800

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Richland, Washington
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- Editorial changes throughout to accommodate updated operating scenario and planning inputs.

| RS 3A | Removal of OUO designation | B. M. Tardiff | S. T. Arm |
EXECUTIVE SUMMARY

The U.S. Department of Energy, Office of River Protection manages the River Protection Project at the Hanford Site. The River Protection Project mission is to safeguard the nuclear waste stored in Hanford’s 177 underground tanks, and to manage the waste safely and responsibly until it can be treated in the Hanford Tank Waste Treatment and Immobilization Plant for final disposition. Specifically, the mission is to manage, prepare, and deliver the tank waste to the Hanford Tank Waste Treatment and Immobilization Plant, wherein the waste feed will be immobilized as low-activity waste and high-level waste borosilicate glass wasteforms.

This Integrated Waste Feed Delivery Plan describes the commissioning, near-term, and long-term waste transfer/pre-process operations necessary to provide Hanford tank waste feed to the Hanford Tank Waste Treatment and Immobilization Plant. The Plan is based on a phased-approach, overarching concept for performing the River Protection Project mission, in accordance with guidance provided by the Office of River Protection. The Plan focuses on the start-up, commissioning, and initial operating phase of the Hanford Tank Waste Treatment and Immobilization Plant Low-Activity Waste Vitrification Facility as projected by a Tank Operations Contract life-cycle planning tool.

Hanford Tank Waste Treatment and Immobilization Plant low-activity waste vitrification will be performed in the direct-feed mode prior to the commencement of high-level waste vitrification. The direct-feed low-activity waste process involves the delivery of tank farm supernatant to the Low-Activity Waste Pretreatment System where it is treated to remove solids and cesium via filtration and ion-exchange. Low-Activity Waste Pretreatment System delivers the pre-treated feed to the Hanford Tank Waste Treatment and Immobilization Plant Low-Activity Waste Vitrification Facility for conversion to glass and final disposition. Secondary liquid waste streams are generated during the vitrification process with a fraction being returned to the tank farms and managed as tank waste. This waste will be processed in subsequent waste feed delivery campaigns.

Figure ES-1 provides an introductory overview representation of the key waste feed functions and facilities performing the direct-feed low-activity waste portion of the River Protection Project mission. Tank waste is stored in underground single-shell tanks until retrieval, conditioning (predominately via evaporation), and accumulation in double-shell tanks. The double-shell tank system is the focal point for waste feed preparation and delivery to the Low-Activity Waste Pretreatment System. Sampling, characterization, waste acceptance, and feed preparation activities supporting waste feed delivery are performed within the double-shell tank system, specifically the 200-East Area double-shell tanks geographically closest to the Low-Activity Waste Pretreatment System. These streams include solids rejected by the filtration system and cesium eluted from the ion-exchange columns. These streams will be managed within tank farms and ultimately blended with fresh tank waste as feed to either Low-Activity Waste Pretreatment System or the Hanford Tank Waste Treatment and Immobilization Plant Pretreatment Facility (when Hanford Tank Waste Treatment and Immobilization Plant high-level waste hot operation...
Secondary liquid waste returned from the Hanford Tank Waste Treatment and Immobilization Plant Low-Activity Waste Vitrification Facility (Effluent Management Facility concentrate) will likewise be collected in double-shell tanks, managed, blended, and returned as waste feed. The total projected volumetric flow requires the waste feed delivery planning process to coordinate across the entire double-shell tank system and with 200-East and 200-West Area single-shell tank retrievals during the direct-feed low-activity waste period, which is scheduled to commence hot operations in December 2021.

Figure ES-1. Direct-Feed LAW Mission Functions (Impacting Waste Feed Delivery)

The purpose of the Integrated Waste Feed Delivery Plan is to meet contractual requirements (Hader, 2015).

The Plan is divided into three volumes:

- Volume 1 – Process Approach (this volume),
- Volume 2 – Campaign Sequence (RPP-40149-VOL2), and
- Volume 3 – Project Plan (RPP-40149-VOL3).

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1 The life-cycle process model describes the totality of the tank waste treatment within the River Protection Project mission. This includes direct-feed low-activity waste, the start-up and operations of the Hanford Tank Waste Treatment and Immobilization Plant Pretreatment and High-Level Waste Vitrification Facility, and the start-up and operations of the Supplemental Low-Activity Waste Vitrification Facility through treatment mission completion.

2 The previous version of the Integrated Waste Feed Delivery Plan was consistent with ORP-11242, River Protection Project System Plan (System Plan).
The Integrated Waste Feed Delivery Plan draws from Office of River Protection direction, technical and programmatic assumptions, and requirements that relate to waste feed delivery and the interface between the tank farms and Hanford Tank Waste Treatment and Immobilization Plant. Volume 1 establishes the overall process approach required to meet the waste feed delivery goals and describes a baseline tank usage strategy (i.e., how the double-shell tanks will be used to prepare and deliver feed) as per life-cycle process modeling. The life-cycle process modeling output is used to define the sequence of projected feed campaigns; thus forming the basis for Volume 2 describing all projected individual feed campaigns with feed trends defined in 24590-WTP-ICD-MG-01-030, ICD-30 – Interface Control Document for Direct LAW Feed. Volume 3 identifies the required waste feed delivery system architecture (double-shell tanks, waste transfer routing systems, and supporting infrastructure and utilities).

The waste feed delivery planning process links long-term (system) planning with operational planning and control. The process includes multiple feedback opportunities that support successive refinements through multiple iterations. Feedback specifically supports River Protection Project Integrated Flowsheet (RPP-RPT-57991, One System River Protection Project Integrated Flowsheet); mission modeling; risk management; various processes identified in the Interface Management Plan; Integrated Project Teams; general decision making processes; tradeoff studies; and the various cross-cutting Baseline Management Processes.

A simplified graphic of the waste feed delivery planning process is depicted in Figure ES-2. The waste feed delivery strategy will continue to evolve as key issues and uncertainties are identified and addressed, and in response to changes in the overall mission (technology, timing, and configuration of treatment capacity). This will be reflected in subsequent revisions of the Integrated Waste Feed Delivery Plan. The One System organization, which leads programs that coordinate and integrate across multiple Hanford Site prime contractor workscopes and has responsibility for maintaining the Plan.
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TERMS

Abbreviations and Acronyms

BDGRE buoyant displacement gas release event
DFLAW direct-feed low-activity waste
DOE U.S. Department of Energy
DST double-shell tank
EMF Effluent Management Facility
ETF Effluent Treatment Facility
FY fiscal year
HLW high-level waste
HTWOS Hanford Tank Waste Operations Simulator
ICD interface control document
IMP Interface Management Plan
IWFDP Integrated Waste Feed Delivery Plan
LAW low-activity waste
LAWPS Low-Activity Waste Pretreatment System
ORP Office of River Protection
PT Pretreatment
RPP River Protection Project
SST single-shell tank
TOC Tank Operations Contract
TWCS Tank Waste Characterization and Staging
WAC Waste Acceptance Criteria
WFD waste feed delivery
WTP Hanford Tank Waste Treatment and Immobilization Plant
WVR waste volume reduction

Units

°C degrees Celsius
°F degrees Fahrenheit
gal gallon
in. inch
kg kilogram
kgal thousand gallons
M molar
Mgal million gallons
mL milliliter
min minute
MT metric ton
sec second
wt% weight percent
1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) manages the River Protection Project (RPP) at the Hanford Site. The RPP mission is to safeguard the nuclear waste stored in Hanford’s 177 underground tanks, and to manage the waste safely and responsibly until it can be treated in the Hanford Tank Waste Treatment and Immobilization Plant (WTP) for final disposition. Specifically, the mission is to manage, prepare, and deliver the tank waste to the WTP, wherein the waste feed will be converted into low-activity waste (LAW) and high-level waste (HLW) borosilicate glass wasteforms.

This Integrated Waste Feed Delivery Plan (IWFDP or the Plan) describes the commissioning, near-term, and long-term waste transfer/pre-process operations necessary to provide Hanford tank waste feed to the WTP. The Plan is based on a phased-approach, overarching concept for performing the RPP mission, in accordance with guidance provided by the ORP. The Plan focuses on the start-up, commissioning, and initial operating phase of WTP LAW Vitrification Facility as projected by a Tank Operations Contract life-cycle planning tool.

WTP LAW vitrification will be performed in the direct-feed mode for nominally 10 years prior to commencement of HLW vitrification. The direct-feed low-activity waste (DFLAW) approach involves the delivery of tank farm supernatant to the Low-Activity Waste Pretreatment System (LAWPS) where it is treated to remove solids and cesium via filtration and ion-exchange, respectively, which are returned to Tank Farms. LAWPS delivers the pre-treated feed to WTP LAW Vitrification Facility for conversion to glass, followed by onsite disposal at the Integrated Disposal Facility. Secondary liquid waste streams are generated during the vitrification process with a small fraction being returned to the tank farms and managed as tank waste. This waste will be processed in subsequent waste feed delivery (WFD) campaigns. The total projected volumetric flow requires the waste feed delivery planning process to coordinate across the entire double-shell tank (DST) system and with 200-East and 200-West Area single-shell tank (SST) retrievals during the DFLAW period, which is scheduled to commence hot operations in December 2021.

DFLAW will be implemented through programs that coordinate and integrate across multiple Hanford Site prime contractor workscopes. The One System organization, which leads and performs planning, analysis, and integration activities, developed and will update this Plan, as required, and has responsibility for maintaining the Plan.

This Plan consists of three volumes. Volume 1 is organized into seven sections.

- Section 1.0, “Introduction,” describes the purpose, objectives, evolution, and context of the Plan.
- Section 2.0, “Waste Feed Delivery Process Approach,” describes the waste feed delivery approach and DST system waste volume management approach as projected by the life-cycle process model.
- Section 3.0, “Waste Feed Delivery System Utilization,” addresses the configuration and functions of the DST system for waste feed delivery and waste volume management.
• Section 4.0, “Special Topics,” describes off-normal conditions, including out-of-spec feed, contingency feeds, emergency returns from the WTP and the controls or mitigations by which they will be addressed.

• Section 5.0, “Issues and Uncertainties,” addresses the process for the management of current and future challenges to successful waste feed delivery.

• Section 6.0, “Path Forward: Future Refinements,” discusses the waste feed delivery path forward with respect to near-term and long-term planning.

• Section 7.0, “References.”

1.1 PURPOSE

The purpose of the Plan is to meet contractual requirements (Hader, 2015).

With regard to the Plan as a whole:

“The Contractor shall prepare, submit for DOE-ORP approval, and implement an Integrated Waste Feed Delivery Plan (IWFDP) (Deliverable C.2.3.1-2) to provide optimum and reliable pretreatment (if needed), blending/mixing, retrieval and delivery of feed to DOE-ORP treatment facilities. This Plan shall include the needs of commissioning, near-term, and long-term operations and projected waste transfer/pretreatment operations. It should provide adequate information so that infrastructure requirements and upgrades can be identified.”

The Plan is divided into three volumes:

• Volume 1 – Process Approach (RPP-40149-VOL1),
• Volume 2 – Campaign Sequence (RPP-40149-VOL2), and
• Volume 3 – Project Plan (RPP-40149-VOL3).

Specific to the Plan, Volume 1 – Process Approach (this volume):

IWFDP – Process Approach. This product will document the Tank Operations Contractor approach on how to prepare and deliver appropriate feed to each treatment facility, with emphasis on those activities that support the current focus of the Campaign Plan (IWFDP Volume 2); other activities may be addressed in less detail. The IWFDP should be revised as needed to align with current planning.

This revision of the Plan documents the Tank Operations Contract (TOC) approach to preparing and delivering appropriate feed to LAWPS, with emphasis on activities that support the startup and operations of the WTP LAW Vitrification Facility in the DFLAW mode. The Plan draws from ORP direction, technical and programmatic assumptions, and requirements that relate to waste feed delivery and the interface between the tank farms and WTP. Volume 1 describes the process approach. Volume 2 describes the initial campaigns (∼20 DFLAW campaigns) based on the process approach per the life-cycle process model and consistent with ORP mission guidance. Volume 3 identifies the scope and timing of the tank farm upgrade projects necessary to execute the process approach. Issues, potential mitigating actions, and future refinements regarding waste feed delivery are identified within each volume.
of the Plan. The purpose and scope of each volume, and the primary inputs to and outputs from the Plan as a whole, are likewise described in Figure 1-1.

Figure 1-1. Scope and Purpose of the Integrated Waste Feed Delivery Plan

1.2 OBJECTIVES

This plan develops the overall scheme for delivering compliant waste feed in a timely manner to the following facilities to safely and efficiently accomplish the RPP mission:

- LAWPS and WTP LAW Facility for DFLAW treatment;
- WTP Pretreatment (PT) Facility, WTP HLW Facility, and Tank Waste Characterization and Staging (TWCS) Facility, which come on line subsequent to DFLAW; and
- A supplemental LAW facility if/when such a facility comes on line subsequent to WTP PT and WTP HLW.

“Timely,” within the context of the Plan, refers to the ability of the tank farms to supply acceptable waste feed to the facilities and processes listed above at sufficient rate as to meet production goals. Likewise, tank farms will maintain adequate space so as to receive eluent and effluent returns from LAWPS and WTP LAW, respectively, thus supporting efficient operations throughout the treatment mission. Modifications to existing systems and installations of new systems will be coordinated in Volume 3 to meet startup, commissioning, and processing needs.
for these facilities and processes. Supporting objectives that aid in accomplishing the primary waste feed delivery objective include:

- Providing an integrated systems approach to waste retrieval, pre-treatment, and delivery, which includes establishing the hardware baseline wherein existing DST farm conditions are evaluated to document the status of site infrastructure and storage/retrieval systems;
- Managing the dynamic between supporting near-term SST retrievals and waste feed delivery activities;
- Integrating DST system upgrades with other tank farms workscope;
- Relying on mature/proven technologies;
- Placing a high priority on operability and maintainability of systems;
- Assessing technical and programmatic risks and opportunities on a continuous basis;
- Providing flexibility to adapt to evolving requirements and process improvement opportunities;
- Assessing and responding to project performance risks; and
- Optimizing cost efficiency.

1.3 EVOLUTION OF THE INTEGRATED WASTE FEED DELIVERY PLAN

The Plan evolves and matures through an ongoing iterative process of successive refinements. This iterative approach builds from existing waste feed delivery infrastructure (tankage, evaporative capacity, etc.) configuration, upgrade plans and projects, and waste feed delivery process modeling requirements and assumptions.

Volume 1 of the Plan establishes the overall process approach required to meet the waste feed delivery goals. Volume 1 describes a baseline tank usage strategy (i.e., how the DSTs will be used to prepare and deliver feed) as per the life-cycle process model. The life-cycle process model output is also used to define the sequence of projected feed campaigns; thus forming the basis for Volume 2. Volume 2 describes all projected individual feed campaigns and trends. Volume 3 establishes the basis for the waste feed delivery system architecture - DSTs, waste transfer routing systems, and supporting infrastructure and utilities.

Issues will be managed and risks identified during this process are gathered and managed using the TOC risk management process (TFC-PLN-39, PBS-ORP-0014 Enterprise Risk & Opportunity Management Plan) and the processes defined in 24590-WTP-PL-MG-01-001, Interface Management Plan. Risks and opportunities associated with successful execution of the Plan will be captured and addressed in accordance with the WRPS Enterprise Risk and Opportunity Management (EROM) Framework (WRPS-57232, Rev. 1).

The process for managing the risk associated with open items and issues is addressed by the TOC risk management program, as summarized in Section 5.0, “Issues and Uncertainties.”
1.4 CONTEXT

The RPP mission is to safeguard the tank waste and manage the waste safely and responsibly until it can be treated in the WTP. The tank farms must be able to reliably retrieve, accumulate, prepare, and transfer waste feed to the WTP and/or other potential treatment facilities to execute the RPP mission. Figure 1-2 provides an overview of the tank waste retrieval and treatment mission functions. Those covered in the main body of this document revision include liquid (supernatant) cross-site transfers, evaporator operation, LAW feed staging, LAWPS, and DFLAW vitrification feed receipt at the WTP.

Figure 1-2. River Protection Project Mission Functions

Topics dealing with HLW are outside the scope of this revision, however, a brief discussion of WTP PT and WTP HLW operations is included in Appendix B. As discussed previously, this revision of the Plan focuses on supernatant processing through DFLAW. Figure 1-3 provides an introductory overview representation of the key waste feed functions and facilities performing the DFLAW portion of the RPP mission.
Tank waste is stored in underground SSTs until retrieval, conditioning (predominately via evaporation), and accumulation in DSTs. The DST system is the focal point for waste feed preparation and delivery to LAWPS. The LAWPS will provide pretreated supernatant for WTP LAW Vitrification Facility. LAWPS processes include solids filtration and cesium removal by ion-exchange via elutable spherical resorcinol formaldehyde resin (or similar). Sampling, characterization, waste acceptance, and feed preparation activities supporting waste feed delivery are performed within the DST system, specifically the 200-East Area DSTs (AP and AW tank farms) closest to the LAWPS and WTP. The DST system is also used to collect return streams from the LAWPS, i.e., solids rejected by the filtration system and cesium eluted from the ion-exchange columns. These streams will be managed within tank farms and ultimately blended with tank waste and transferred to the WTP Facility (preferably when WTP HLW hot operation commences and not to LAWPS during DFLAW). Secondary liquid waste returned from the WTP LAW Vitrification Facility (Effluent Management Facility (EMF) concentrate) will likewise be collected in DSTs, managed, blended, and returned as waste feed.

### 1.4.1 Coordination with Single-Shell Tank Retrievals

In addition to providing all delivery and return functions for LAWPS and also accepting returns from WTP, the DSTs play a pivotal role in receiving waste from the aging SSTs in preparation for waste feed delivery. DFLAW waste feed supernatant is projected to include waste currently stored in East Area DSTs, saltcake waste to be retrieved from AX- and A-Farm (200-East) SSTs, and saltcake waste to be retrieved from S- and SX-Farm (200-West) SSTs. The retrieved SST saltcake waste also provides supernatant for recycle to support sluicing SSTs during sludge retrieval operations.
The life-cycle process modeling assumptions reflect the SST retrieval plan (RPP-PLAN-40145), planning assumptions for the SSTs (SVF-1647 and RPP-40545), and near-term SST operation planning. The SST retrieval sequence, in turn, provides the key input to the Hanford Tank Waste Operating Simulator (HTWOS) used to generate the life-cycle process modeling output.

1.5 WASTE FEED DELIVERY PLANNING PROCESS

The waste feed delivery planning process is depicted graphically in Figure 1-4. The following text briefly describes the process. Items included in Figure 1-4 are identified with italic font at their first mention in the textual discussion that follows.

The waste feed delivery *Inputs* are built on a wide range of requirements, guidance, technical inputs, and assumptions documentation. The requirements/regulatory documents are Hanford Federal Facility Agreement and Consent Order, as stipulated by the Tri-Party Agreement (TPA); Resource Conservation and Recovery Act of 1976; and National Environmental Policy Act of 1969. ORP inputs to the Plan include the Contract (TOC) and ORP direction, which is provided by multiple means, e.g., verbal direction, letter, contract changes. Inputs from the TOC are Best Basis Inventory of underground waste tank characteristics and Waste Compatibility Program. The WTP (Bechtel National, Inc.) inputs to the Plan include data quality objectives (DQOs) for WTP feed sampling and characterization and Interface Control Documents (ICDs) which includes waste acceptance criteria (WAC), and WTP design, flowsheet, operating modes, and availability.

The inputs are used to generate the *Integrated Waste Feed Delivery Plan, Volume 1, Process Approach*. The Process Approach and the *life-cycle process model* form a feedback loop, the output of which is the *WFD Campaign Sequence (IWFDP Volume 2)* and the *WFD Project Plan (IWFDP Volume 3)*. The WFD Project Plan (IWFDP Volume 3) feeds into waste feed delivery specific *Project Execution Plans* and *Upgrade Projects*.

The dashed box entitled “Implementation” at the bottom center of Figure 1-4 contains three documents, which are part of the current TOC Baseline Management Process and are directed by DOE orders and TOC requirements. These Implementation items are the *Individual Campaign Plan, Process Control Strategy, and Operating Procedures*.

The waste feed delivery planning process includes multiple feedback opportunities that support successive refinements via iteration. Feedback specifically supports the One System River Protection Project Integrated Flowsheet; mission modeling; risk management; various processes identified in the Interface Management Plan (IMP); Integrated Project Teams; general decision making processes; and tradeoff studies.
Figure 1-4. Integrated Waste Feed Delivery Planning Process

Note: Documents are denoted by page-shaped objects with a wavy lower boundary, while processes and activities are shown as simple rectangular objects.
2.0 WASTE FEED DELIVERY PROCESS APPROACH

This section describes how the DST system will be utilized to implement the DFLAW waste feed delivery process in accordance with the tank waste retrieval and management missions. First discussed (Section 2.1) is the relationship between LAWPS and the WTP LAW Vitrification Facility WAC and interface requirements with regard to feed delivery. Section 2.1.1 addresses LAWPS feed qualification, staging and receipt. This is followed by a discussion of WTP feed receipt (Section 2.1.2) for DFLAW. Returns to tank farms from LAWPS are addressed in Section 2.1.3; returns to tank farms from WTP LAW are addressed in Section 2.1.4. Section 2.2 covers waste volume management, as well as the 242-A Evaporator, dedicated DST emergency space, and the recovery of waste from tank AY-102. Lastly, Section 2.3 discusses the waste compatibility program requirements for any and all activity in the tank farms.

2.1 LOW-ACTIVITY WASTE FEED DELIVERY

The delivery and volume management of tank waste during DFLAW operations will require close coordination between the DST system, LAWPS, and WTP operations. Figure 2-1 depicts the primary DFLAW liquid stream flows to and from the DSTs, LAWPS, and WTP LAW Vitrification Facility. The DST system, via tank AP-107, delivers supernatant feed to the LAWPS on a semi-continuous, campaign (≈1 Mgal) basis; pre-treatment starts with the removal of suspended solids via filtration (see Section 2.1.1). Solids rejected by the filter in LAWPS are returned to tank AP-107 (see Section 2.1.3).
The filtered supernatant is then transferred to an ion-exchange column for the removal of cesium. Cesium captured on the ion-exchange media will periodically be eluted to the tank AW-106 (see Section 2.1.3) and subsequently blended with other tank waste.

LAWPS feed is conditioned to adjust sodium molarity sampled/characterized in LAWPS feed staging tanks AP-103 and AP-108 prior to transfer to tank AP-107. Looking further upstream, tanks AP-103 and AP-108 receive supernatant from 242-A Evaporator slurry receiver DSTs.

Treated LAW from LAWPS is directly fed to the WTP LAW Vitrification Facility (see Section 2.1.2). Melter condensate and other incidental waste streams from WTP LAW are received and treated by the WTP EMF. The low-radioactivity secondary liquid waste output stream (evaporator overheads) from the EMF is transferred to the Liquid Effluent Retention Facility, for treatment at the Effluent Treatment Facility (ETF). A majority of the concentrated liquid waste output (evaporator bottoms) from the EMF is recycled through WTP LAW vitrification with a smaller fraction returned to tank AP-105.

The primary prerequisites to preparation and delivery of waste feed are 1) that the waste selected as the first feed for LAWPS is transferred from its present location in tank AP-105 to the LAWPS feed tank, AP-107, 2) that tank waste within limits described in the WAC for LAWPS and WTP LAW is available, and 3) that tank-specific upgrades and any associated transfer system and tank farm infrastructure upgrades have been completed.
2.1.1 Feed to Low-Activity Waste Pretreatment System

As shown in Figure 2-1, LAWPS receives waste from tank AP-107. Tanks AP-103 and AP-108 receive supernatant from other DSTs and function as feed staging and characterization tanks prior to transfer to tank AP-107. Thus, supernatant in tanks AP-103 and AP-108 must be well-mixed and sampled sufficiently in advance of transfers to tank AP-107 to allow time for LAWPS feed characterization. Qualified supernatant from either tank AP-103 or AP-108 is transferred to tank AP-107 while the other tank of the pair undergoes sampling and analysis/qualification. Tanks AP-103 and AP-108 receive supernatant primarily from 242-A Evaporator slurry receiver DSTs. The Evaporator is fed from tank AW-102, which receives waste transfers from dilute receiver DSTs.

LAWPS is being designed to a rated capacity throughput of 1600 metric tons (MT) sodium annually. The sodium throughput is a function of waste feed sodium molarity and flow rate. For reference, the nominal LAWPS design target is 5.6M sodium concentration with a 10 gallon per minute flow rate (when operating). The majority of supernatants projected for DFLAW processing will require chemical adjustment (dilution) in AP-103/108 (the nominal 1.4 target specific gravity for 242-A evaporator results in 9'M sodium concentration for AP Farm supernatant which is greater than acceptable to LAWPS). These are all average values used to project sufficient feed for the nominal 21MT per day Immobilized LAW target glass production. In actual production operations, sodium molarity, and required LAWPS throughput will be campaign specific.

The general strategy for delivering feed to LAWPS is expected to proceed as follows. Concentrated supernatant from a slurry receiver or other DST is received by either tank AP-103 or AP-108 where it is sampled and characterized for LAWPS and LAW vitrification feed compatibility and process control (WAC analysis and evaluation) suitability. Upon certification of acceptability for LAWPS and LAW vitrification, the supernatant in either tank AP-103 or AP-108 is declared ready to deliver and is then transferred to tank AP-107 after a campaign has been delivered from AP-107 to LAWPS. This logic is to be employed for all campaigns except for the initial, start-up feed. The initial campaign feed will be prepared solely in AP-107 prior to delivery to LAWPS. The waste feed delivery logic is illustrated in Figure 2-2.

LAWPS feed requirements are defined the RPP-RPT-58649, Waste Acceptance Criteria for the Low-Activity Waste Pretreatment System. Simply, LAWPS feed must be a supernatant stream that will meet the WAC for DFLAW vitrification upon filtration and cesium ion-exchange. As shown in Figure 2-2, feed chemistry projections will be managed within the Feed Control List (HNF-SD-WM-OCD-015, Table A-1) to identify, isolate, and sequence supernatants prior to transfer to AP-103 or AP-108. Additional discussion of the Feed Control List is provided in Section 2.3, Waste Compatibility.
2.1.2 Feed to Waste Treatment and Immobilization Plant

The LAWPS product (pretreated LAW) is retained in three 60,000-gallon\(^3\) lag storage tanks until a call for feed is issued by LAW vitrification. At that point, the treated LAW feed is delivered to the WTP LAW facility.

At any given time, one of the three treated LAW lag storage tanks receives treated LAWPS product while a second filled tank is undergoing final confirmatory WTP WAC sampling/analysis. The third lag storage tank, having been previously characterized, provides batch transfers to WTP LAW vitrification. The three treated LAW lag storage tanks will rotate roles during LAWPS operation.

Once a LAWPS batch has been delivered to the WTP, the transfer line will be flushed with inhibited water to clear it of any residual waste. This process is then repeated for each LAWPS campaign with the goal of ensuring that the steps required for the next LAWPS campaign to be transferred are completed prior to WTP requesting the next LAW feed transfer.

The feed requirements and primary WAC for waste transfers from LAWPS to the WTP LAW are defined in ICD-30.

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\(^3\) 60,000 gallon working volume is consistent with conceptual LAWPS process design (modeled by the life-cycle process tool) per the LAWPS Conceptual Design Report (RPP-RPT-57120). Subsequently, lag storage working volume has increased to 75,000 gallons – as described in LAWPS CD-1 and will be reflected in updated life-cycle process (2016 on) modeling.
NOTE: The first campaign for DFLAW is prepared and qualified in AP-107, the feed tank. Subsequent campaigns are prepared and qualified in either AP-103 or AP-108, then transferred to the feed tank, AP-107.

Figure 2-2. Feed Delivery Logic for DFLAW Campaign 1 and Subsequent Campaigns
2.1.3 Low-Activity Waste Pretreatment System Returns to Tank Farms

As supernatant waste is transferred to LAWPS, solids rejected by the LAWPS cross flow filter are returned to tank AP-107. The solids level in tank AP-107 is sufficiently low to support both purposes (LAWPS feeding and solids stream receipt) for an extended period. This approach also contributes to waste volume management efficiency by recycling the liquid that necessarily suspends the solids for transfer. The solids return stream to tank AP-107 leaves the LAWPS process ahead of cesium removal; hence, there is no loss of efficiency with regard to the LAWPS cesium removal step. The accumulated solids will be transferred out of tank AP-107 to a solids receiver DST as necessary.

Referring to Figure 2-1, the LAWPS cesium eluate stream is returned to an operational DST, specifically tank AW-106. 200-East Area DSTs are the most logical candidates to receive the LAWPS cesium eluate in order to minimize utilization of transfer system piping to handle highly radioactive tank waste. Within 200-East Area, AW tank farm was selected over AP tank farm so as to minimize the amount of previously eluted cesium returned as feed to LAWPS during DFLAW. This also allows dilute receiver DST (i.e. used for SST retrieval accumulation) waste to proceed through to the 242-Evaporator without the cesium eluate burden, which would reduce the overall process efficiency.

During 21 MTG (metric ton glass) per day DFLAW operations (nominal process modeling assumptions to account for 70% total operating efficiency), the cesium eluate stream will be on the order of 40,000 gallons per month. This equates to approximately 60,000 gallons per month at the 30 MTG per day WTP LAW Vitrification Facility rated capacity.

The life-cycle process modeling minimizes cesium eluate blending with dilute receiver DSTs, however due to DST space limitations, the volumetric flow rates and duration projected for DFLAW require blending with other wastes. Currently, the strategy calls for blending eluate returns with EMF concentrate returns in AP-105, process through the 242-A Evaporator, and then distribute throughout the DST system. When this is not feasible, AW-106 waste will be transferred to other DSTs (preferentially AY-101 or AZ-102) to minimize impacts to DFLAW operations.

2.1.4 Waste Treatment and Immobilization Plant Returns to Tank Farms

The WTP generates two main liquid effluent streams that require treatment and disposition. These are melter off-gas condensates and contaminated plant wash liquids. Both are sent to the EMF for treatment. One additional WTP effluent stream, caustic scrubber waste, contains sufficiently low radionuclide concentrations that it can be sent directly to the LERF without further treatment.

Overheads from the EMF evaporator, which are very dilute in radionuclides, are sent to the LERF. The EMF evaporator bottoms are preferentially recycled to the WTP LAW receipt vessel and processed with a new batch of waste from LAWPS. However, nominally 15% of the evaporator bottoms over the DFLAW mission, consisting primarily of concentrated melter offgas condensate, are returned to tank AP-105 as shown in Figure 2-1.

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4 See IWFPD Volume 2 for more detail as to accumulation and dispersion of cesium eluate during DF LAW.
Prior to return to tank farms, chemicals (sodium nitrite and sodium hydroxide) are added to melter offgas condensate to meet the corrosion control requirements for the DSTs. During 21 MTG per day DFLAW operations with 15% of the EMF concentrate adjusted for corrosion control, the returns to tank farms are projected to be on the order of 30,000 gallons per month. This equates to 43,000 gallons per month at the 30 MTG per day WTP LAW rated capacity.

2.2 WASTE VOLUME MANAGEMENT

Effective and efficient management of DST space is essential to mission success during the DFLAW timeframe. The majority of DST space is used for waste storage or as operable space for waste transfers, SST retrievals, or 242-A evaporator support. The total capacity of the 27 DSTs is 31.2 Mgal (following AY-102 recovery), however some headspace must be set aside to accommodate operating constraints:


- **DST emergency space**, in accordance with DOE M 435.1-1, Radioactive Waste Management Manual, represents 1.265 Mgal of available space that could be used to receive waste from another DST in the event that a DST would leak. See Section 2.2.2 for more detail.

To achieve the DFLAW mission, the near-term goal of tank waste volume management is focused on tanks in the AP and AW Farms – which are instrumental during the DFLAW mission for preparing and delivering feed, as well as receiving cesium eluate returns from LAWPS and secondary liquid effluent returns from the EMF evaporator. The mission strategy is based on using the 242-A Evaporator to manage waste volume.

2.2.1 242-A Evaporator

The 242-A Evaporator is used for volume reduction of dilute waste. Two primary programmatic goals of the 242-A Evaporator are:

- Evaporate retrieved SST waste and DFLAW returns as needed to minimize storage space requirements.
- Evaporate dilute waste as needed to concentrate to WTP LAW WAC.

The evaporator is a conventional forced-circulation, vacuum evaporation system. The evaporator targets campaigns under the following conditions (HNF-14755, HNF-15279):

- Feed that would have at least 15 percent waste volume reduction (WVR) at a maximum target specific gravity of 1.5

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5 See IWFPD Volume 2 for more detail as to accumulation and dispersion of EMF returns during DF LAW.
• Feed that would have at least a 15 percent WVR at 80 percent of the maximum concentration of key radionuclides in the product.

Figure 2-3 depicts the operating window for the 242-A Evaporator. The flow rate of the slurry, or bottoms, stream from the evaporator ranges from 30 to 70 gal/min. The lower limit is based on the gravity-driven flow rate from the boiler and the upper limit is driven by safety limitations placed on the evaporator. The maximum boil-off rate of the evaporator is 40 gal/min. Based on the maximum slurry rate and the maximum boil-off rate, the effective maximum feed rate to the evaporator is approximately 110 gal/min.

![Operating Window for the 242-A Evaporator](image)

Figure 2-3. Operating Window for the 242-A Evaporator

The resulting bottoms sodium concentration is controlled by using a setpoint for the specific gravity and result in sodium concentration at or below 9.5 M sodium. Concentration of some waste types may result in solids precipitation. Accumulation of salts could result in retention of flammable gases and potentially result in an uncontrolled release.\(^6\)

Evaporator availability is essential to continue SST waste retrievals from AX, A, S, and SX tank farms prior to and during the DFLAW mission phase. Other strategies for DST space management include refining SST retrieval technology (e.g., modified sluicing, which uses DST supernatant rather than water for mobilizing SST waste), intentionally creating deep sludge tanks.

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\(^6\) RPP-17152 (Rev. 11) provides a detailed description of how 242-A Evaporator operations are modeled in HTWOS for planning purposes.
by using modified buoyant displacement gas release event (BDGRE) controls, and increasing the maximum liquid level limit of certain DSTs to hold more waste.\textsuperscript{7}

Waste retrieved from the SSTs, following evaporation, is projected to be diluted for delivery to LAWPS in order to meet the WAC for LAWPS. Initial analysis indicates pinch points in the DST storage volume as a results of the new functions in the AP Farm required to support LAWPS/DFLAW, as well as the recovery of tank AY-102 waste. This will be described in Volume 2 of the Plan.

\textbf{2.2.2 Dedicated Emergency Space}

The current strategy is to allocate 1.265 Mgal\textsuperscript{8} of DST space for tank farms emergencies. The emergency space is distributed tank space that is available at all times. It is not practical to keep one entire tank empty for emergency space because that would inhibit DST utilization and waste feed delivery staging efforts. Currently, tank AW-105 is the candidate for the bulk of the emergency space. After tank AW-105 receives the supernatant during AY-102 recovery (See Section 2.2.3), the available emergency space will be balanced among the available DSTs. As needed, any additional space would be distributed among one or more DSTs with available space. Additionally, tank AW-102 has been identified as the receiver tank in the event a leak is detected in tank AW-105 (HNF-3484, Double-Shell Tank Emergency Pumping Guide).

For process modeling in HTWOS, available space in the 200-West Area is included in the calculated Dedicated Emergency Space, however, the cross-site transfer line servicing the 200-West Area is not currently usable. Volume 2 of the Integrated Waste Feed Delivery Plan should ensure that the Emergency Space requirement is not challenged in the near-term and that at least 1.265 Mgal of Emergency Space are available in the 200-East Area prior to the cross-site transfer line becoming serviceable. The use of Emergency Space in the 200-West Area should be carried as a risk in the One System Direct Feed Low Activity Waste Program Risk and Opportunity Management Plan (RPP-PLAN-60093).

\textbf{2.2.3 Leaking Tank AY-102 Recovery}

Tank AY-102 was declared a confirmed leaking tank in October 2012. As documented in RPP-RPT-57042, Decision Report for the Disposition of Sludge from Tank 241-AY-102 and the 241-A/241-AX Farm Tanks, sludge in tank AY-102 will be retrieved into tank AP-102. Tank AW-105 will receive the tank AY-102 supernatant.

Tank AP-102 then becomes the potential WTP HLW hot commissioning feed tank, while tank AY-102 is permanently removed from service at the end of calendar year 2016. Detailed discussion of HLW hot commissioning is outside the scope of this revision of the Plan.

\textbf{2.3 WASTE COMPATIBILITY & ACCEPTANCE}

Waste feed delivery concerns are addressed in the Feed Control List (HNF-SD-WM-OCD-015, Table A-1). The objective of these controls include protecting the integrity of WTP hot

\textsuperscript{7} The basis for increasing the maximum limit of specific DSTs is documented in OSD-T-151-00007.

\textsuperscript{8} The value for the emergency space allocation is based on the maximum volume of waste that can be stored in an AP Farm DST (OSD-T-151-00007).
commissioning feed; maintaining or improving overall compliance with waste feed envelope specifications; and addressing processability of waste through the WTP. With respect to DFLAW, the primary goal is to endure a DST accumulation and transfer sequence leading to feed staging tanks AP-103 and AP-108.

ICD-30 and RPP-SPEC-56967 (*Project T5L01 Low-Activity Waste Pretreatment System Specification*) addresses the waste acceptance requirements for preparing and delivering feed to LAWPS for DFLAW. Feed for LAWPS is selected and prepared to meet the target compositions and key constituent concentrations identified in ICD-30. LAWPS feed requirements are defined the RPP-RPT-58649, *Waste Acceptance Criteria for the Low-Activity Waste Pretreatment System*.

As depicted in Figure 2-1, return streams include cesium eluate from LAWPS and melter offgas condensate from the EMF. ICD-31 (24590-WTP-ICD-MG-01-031, *ICD-31 – Interface Control Document for DFLAW Effluent Returns to Double-Shell Tanks*) addresses melter offgas condensate returns to Tank Farms due to DFLAW. HNF-SD-WM-OCD-015 may be updated to address the cesium eluate return stream from LAWPS. Note that due to the rigorous characterization of both untreated LAW (prior to LAWPS) and treated LAW (in the three treated LAW lag storage tanks), receipt of off-spec feed at the WTP LAW Vitrification Facility is not anticipated.
3.0 WASTE FEED DELIVERY SYSTEM UTILIZATION

This section discusses how the DST and associated waste transfer systems are projected to be used to prepare and deliver feed for DFLAW operations. Each DST utilized for waste feed delivery will have capabilities to perform various functions based on its equipment configuration. The DST equipment configuration consists of existing equipment associated with the tank that will not be removed and the planned equipment additions to support the waste feed delivery mission.

3.1 DOUBLE-SHELL TANK CAPABILITY (FUNCTIONS)

The following subsections discuss the use of the DST system for LAW feed delivery, LAW feed staging, dilute feed (retrieval) receipt, 242-A Evaporator feed staging, 242-A Evaporator slurry (bottoms) receipt, and 200-West Area liquid cross-site transfer functions. For reference, Figure 3-1, a pictorial representation of the current 200-East DST system configuration with emphasis on supernatant handling, is provided. The delivery system for the transfer of LAW from LAWPS to WTP is being designed separately and is not discussed in this section.

3.1.1 Low-Activity Waste Pretreatment System Feed Delivery

Tank AP-107 is currently projected as the singular LAWPS feed delivery tank. AP-107 will also receive the solids recycle stream from LAWPS cross flow filters during LAWPS campaigns. A campaign volume will be on the order of 1Mgal and will proceed from a full AP-107 volume to a designated process control limit (currently estimated at 3.3 weight percent solids). For life-cycle process modeling, this limit was assumed to equate to 100,000 gallons residual volume (heel).

DFLAW will consist of nominally 20 such campaigns, effectively a projected flow of ≈2Mgal per year. This is consistent with the previously stated LAWPS throughput – 2Mgal of 5.6M Na feed equates to ≈1000MT of sodium throughput (or 60% of the instantaneous LAWPS design capacity).

3.1.2 Low-Activity Waste Pretreatment System Feed Staging

Two LAWPS feed staging tanks have been identified; AP-103 and AP-108. The primary functions within feed staging are waste accumulation, blending, and dilution (with inhibited water). To ensure LAWPS WAC (RPP-RPT-58649) and WTP LAW vitrification WAC for DFLAW (24590-WTP-ICD-MG-01-030) are met, rigorous sampling will be performed in these two staging tanks before transferring any waste to LAWPS feed tank AP-107. A 14-day window is allotted for tank sampling, followed by a 180-day window for WTP LAW WAC analysis and evaluation for vitrification feed qualification and process control planning.9

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9 The tank sampling and characterization duration of 194 days is per the life-cycle process modeling. At the time of publication, a RPP Integrated Flowsheet Rapid Improvement Event (RIE) is being managed to reduce this time requirement (Flowsheet Integration Field Execution Schedule activity WFQ-0240, “Refine Final Process/Process Demo”). For this revision and the RIE, 222-S Laboratory is assumed to be the qualification laboratory.
Figure 3-1. Representation of 200-East Area DSTs and Supernatant Transfer Lines
### 3.1.3 Dilute Receipt

Dilute receiver DSTs stage dilute supernatant primarily from SST retrievals. Waste is accumulated and then transferred to the 242-A Evaporator feed tank, AW-102. Prior to DFLAW start-up, waste will be staged in either the dilute receivers or tank AW-102 for a minimum duration of 90 days to allow for sampling and analysis of the dilute waste prior to concentration (see Section 3.1.2 for discussion of the analysis). Upon DFLAW start-up, it is assumed the staging time can be reduced to 60 days.

If a dilute receiver tank is left with less than 250 kgal of pumpable liquid remaining after transferring into tank AW-102, it can be utilized for alternate functions, such as supernatant handling or evaporator slurry receiver.

### 3.1.4 242-A Evaporator Feed

Waste from dilute receiver tanks will be transferred to the evaporator feed tank, AW-102, and staged for an evaporator campaign. Tank AW-102 can also receive waste from evaporator slurry receiver tanks. As a guideline, the minimum evaporator campaign size is 500 kgal of feed. Waste will be accumulated and staged in tank AW-102 until at least 500 kgal are available. Waste in tank AW-102 will be sampled and evaluated to determine the appropriate specific gravity setpoint for evaporator operations, if the sampling and analysis were not performed in the dilute receiver tank. Samples are used to perform boil-down tests and determine the setpoint for each evaporator feed (HNF-14755, *Documented Safety Analysis for the 242-A Evaporator*; HNF-15279, *Technical Safety Requirements for the 242 A Evaporator*; and RPP-17152, *Hanford Tank Waste Operations Simulator (HTWOS) Version 7.9 Model Design Document*).

### 3.1.5 Evaporator Slurry Receipt

Evaporator slurry receiver tanks receive evaporator bottoms from the 242-A Evaporator as concentrated slurry. AW and AP Farm tanks can serve as evaporator slurry receiver tanks. The AW and AP Farms were selected as 242-A Evaporator slurry receiver tanks for the following reasons: (1) the transfer lines from the 242-A Evaporator to AW and AP Farms are 2-in. lines, (2) the AW and AP Farms are close to the evaporator, and (3) pressure rating of the transfer lines. The proximity minimizes temperature drop and helps reduce the potential to precipitate solids. The 2-in. diameter of the transfer lines allows for higher velocity to keep any solids in suspension.

### 3.1.6 West Area Liquid Cross-Site Transfer

The current plan is to use tank SY-101 as the 200-West liquid cross-site tank. Tank SY-101 will be equipped with a typical transfer pump, allowing liquid transfers to be made. Tank SY-101 receives decanted supernatant from the two other 200-West Area DSTs, SY-102 and SY-103, as these tanks build up solids. Tank SY-101 also receives liquid waste from the 222-S Laboratory as needed. Collected supernatant in tank SY-101 is transferred through the supernatant cross-site transfer line to a LAW feed staging tank in the 200-East Area, followed by a 24-kgal flush.

Figure 3-2 provides the current and projected functionality of all DSTs through 2023 (post DFLAW start-up).
### Figure 3-2. Current DST Functions and Utilization for DFLAW Start-up and Operations

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<sup>1</sup>Complexed Concentrate – Tanks that currently store waste that includes high concentrations of complexed Sr-90 and TRU in supernatant.

<sup>2</sup>Group A Tank – A tank, that because of its waste composition and quantities, has the potential for a spontaneous BDGRE and is conservatively estimated to contain enough flammable gas within the waste that if all were released into the tank headspace, the concentration of the flammable gas would be a flammable mixture.

<sup>3</sup>Group B Tank – Tanks, that due to their waste composition and quantities, are conservatively estimated to contain enough flammable gas within the waste that if all were released into the tank headspace, the concentration of the flammable gas would be a flammable mixture, but would not have the potential for a spontaneous BDGRE.
3.2 DOUBLE-SHELL TANK UTILIZATION

This revision of the Plan relies on existing and upgraded tank farm capability with the pre-conceptual capacity and functionality of LAWPS, the rated WTP LAW Vitrification Facility capability and pre-conceptual functionality of EMF. The DST system will be used to accumulate, prepare, stage, and deliver supernatant to LAWPS and accept the necessary process returns while simultaneously supporting SST retrievals and DST volume management. This revision is consistent with the life-cycle process modeling and based on the HTWOS modeling used to support the life-cycle process modeling. As such, this description of utilization is intended to define the functionality necessary to accomplish the DFLAW mission but is not specific input to system design.

3.2.1 Double-Shell Tank System Configuration

The DST system configuration for DFLAW as per the life-cycle process modeling is shown in Figure 3-3. This figure is an amalgam of the configuration shown in Figure 2-1 with the existing DST system as represented in Figure 3-1.

As mentioned previously, the DST system configuration for DFLAW is focused on tanks in the AP and AW Farms as they are instrumental during the DFLAW mission for preparing and delivering feed, as well as receiving cesium eluate and rejected solids returns from LAWPS and secondary liquid effluent returns from the EMF evaporator at WTP LAW. The 242-A Evaporator is projected to perform approximately 40 campaigns during the DFLAW mission phase, further amplifying the focus on AP and especially, AW Farm.

A number of DST configuration changes will be needed to support LAWPS and DFLAW, as well as recovery of waste from leaking tank AY-102. New transfer lines are proposed to support the direct transfer of supernatant from AP-107 to LAWPS as well as the return of solids to AP-107. EMF returns from WTP LAW to tank farms are projected to be delivered directly to AP-105.

Cesium eluate from LAWPS will require additional transfer infrastructure, but is projected to route through the AP valve pit to AW Farm. Likewise, when cesium eluate (AW-106) is combined with EMF returns in AP-105 (to meet the source term requirements for 242-A evaporator and also to improve the WVR) and then transferred to the 242-A Evaporator, this is projected to route through AW and AP valve pits. It is also assumed existing transfer infrastructure can be upgraded to allow dispersion of the resulting evaporator bottoms concentrate to AY and AZ Farms. These transfer routes may utilize existing valve pits and jumper connections into the tank farms unless it is determined that the use of the existing valve pits and jumper connections conflicts with other ongoing tank farms activities (i.e., SST retrievals, tank space management, etc.).

As stated above, this configuration is an initial attempt to describe the process flow and initial DST system volume handling estimates projected for DFLAW. It is not prescriptive; alternative configurations may indeed be shown superior. As such, it is anticipated that operational and engineering reviews will utilize this as input (and the following utilization matrix description) for formal infrastructure upgrade and design activity.
Figure 3-3. Schematic of Lower 200-East Area DST System Configuration for DFLAW
3.2.2 Double-Shell Tank Utilization Matrix

A DST utilization matrix is presented in Table 3-1. This matrix lists the DSTs with their planned equipment configuration according as per the functionality required by the life-cycle process model.\textsuperscript{10} The DST utilization matrix shows which DSTs can perform the various specific functions based on their equipment, availability date, and location. The different DST functions (as assigned in HTWOS) are listed along the left edge of the figure, and are preceded by the section numbers of this document in which the functions are discussed. Functions that are not specific to DFLAW are outside the scope of this revision. One function, “Designated Emergency Space” is something of a “catch-all” function and is discussed in Section 2.2 (discussion of “Designated Emergency Space” for the balance of mission operations is outside the scope of this revision).

Following a specific DST function from left to right in the matrix will reveal the transfer and sample equipment required for the function, followed by the DSTs that will be able to perform that function. Eighteen of the 28 DSTs are listed along the top of the figure; these are the DSTs that are utilized in the near-term to support retrievals and DFLAW operations.

Following a specific DST from top to bottom shows the period the DST will be unavailable for normal operation (transfers into and out of the tank), and a listing of equipment that will be installed during the time the tank is unavailable. (Infrastructure upgrades required to support DFLAW operations have not yet been defined or scheduled. More detailed information will be included in Volume 3 of the Plan.) Continuing down the column reveals which functions the DST is capable of performing. DSTs that may perform a specific function are indicated in the matrix wherever the intersection of the DST and function is not shaded with a gray cross-hatch pattern. The gray pattern indicates excluded use for a tank with regard to a specific function.

DSTs that will perform a specific function early in the mission (DFLAW) have their intersection shaded in green. Similarly, tanks that will likely be tasked with functions during the balance of the mission have their intersections shaded in yellow.

Intersections between DSTs and functions that are not shaded or cross-hatched indicate where a DST may perform a function based on installed equipment, timing of equipment installation, and physical location, thus offering a degree of flexibility for the overall RPP mission. However, the DST is not expected to be needed for that function in the current planning approach.

Note that several new function rows have been added per this revision of the Plan. These include three functions for tank AY-102 Recovery and three for LAWPS. Finally, note that tank AY-102 is permanently unavailable (removed from service) after December 31, 2016, at which time its contents will have been retrieved to other DSTs (supernatant to tank AW-105, sludge to tank AP-102).

\textsuperscript{10} TOC Projects and Engineering have initiated work to formally define the functions and requirements and associated infrastructure upgrades necessary to support DFLAW.
Table 3-1. Double-Shell Tank Utilization Matrix

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**Color Key for Section & Function Columns:**
- Addressed in Main Text Body
- Addressed in Appendix B for HLW

**Color Key for Tank Matrix Area of Figure:**
- **Initial Use Only**
- **Full / Balance of Mission Use Only**
- **Excluded Use**
- **Available for Use**

Note: - white cells in the main table without "X" indicate tanks that could be used for the stated function, but are tentatively being avoided to simplify mission operations.

- **"X"** implies a logical "OR" - that at least one of these configuration items are needed to support the function.

**Legend:**
- **Available for Use**
- **Excluded Use**

**Schedule for planned upgrades will be determined in Volume 3 of the Plan.**

- **Although Tank AW-104 is not classified as a Group A tank, it is planned/projected to be processed in the same manner due to its similar waste type.**

- **Tank AY-102 is a leaking DST and will be removed from service following completion of sludge retrieval.**

Additional Notes:
- The start of a 26-month construction period for upgrading Tank AW-102 will be timed to coincide with a planned 242-A Evaporator outage.
- Basic Transfer Pumps will be located with their inlets located sufficiently above any solid in the tank to provide decant capability.
- Inlet elevation of Transfer Pumps for Slurry may be occasionally adjusted, if needed, to provide decant capability.
4.0 SPECIAL TOPICS

The following subsections present special topics primarily related to storage of waste in the DSTs and delivery of DST supernatant to LAWPS and pretreated LAW to WTP in support of DFLAW. Discussion of special topics specific to HLW storage and delivery to WTP is outside the scope of this revision.

4.1 SOLID/LIQUID PARTITIONING AND THE INTEGRATED SOLUBILITY MODEL

Accurate solubility modeling is important to managing solids during DFLAW. Unwanted precipitation of solids that could plug transfer lines and/or hamper tank mixing and waste characterization efforts is to be avoided. Note that preventing precipitation of large quantities of solids is also served by limiting the maximum specific gravity of 242-A Evaporator product.

The HTWOS model, which is used to generate the life-cycle process model, is discussed in RPP-17152, Hanford Tank Waste Operations Simulator (HTWOS) Version 7.9 Model Design Document, Rev. 11. The HTWOS model incorporates an integrated solubility model that predicts the solubility for chemical components. Components are grouped based on relative solubility and magnitude of impact on the RPP mission. Each solubility group is comprised of sub-models of varying complexity that range from simplified empirical correlations to thermodynamic equilibria approaches.

4.2 WASTE GROUP A

Waste Group A tanks are DSTs with a potential spontaneous BDGRE flammable gas hazard in addition to a potential induced gas release event flammable gas hazard. These tanks are conservatively estimated to achieve a flammable gas concentration of 100 percent of the lower flammability limit (LFL) in the tank headspace, if all of the retained gas is released from a spontaneous BDGRE.

There are five tanks identified as Waste Group A tanks: AN-103, AN-104, AN-105, AW-101, and SY-103. These tanks are restricted from having waste transferred into or out of them until they are mitigated. None of these tanks are sources of feed to LAWPS/DFLAW; the life-cycle process model projects those feeds to be processed when WTP PT Facility is available. The strategy for processing waste from Group A tanks is outside the scope of this revision, but is identified as a potential option for optimizing DST space.

4.3 OUT-OF-SPECIFICATION FEED

Tank waste must meet waste acceptance feed criteria established by WTP contractual and interface requirements prior to delivery to WTP LAW feed receipt vessels. ICD-30 stipulates:

“If the treated LAW feed (prior to transfer to WTP) does not meet the feed acceptance criteria, alternative actions as described in the DFLAW DQO shall be taken. No transfers may take place until the WTP Contractor has reviewed the analytical results.”

1. “If the treated LAW feed does not comply with the feed acceptance criteria, the TOC, with support from the WTP Contractor, prepares an assessment and recommendation for the preferred method(s), of possible and practical, to
correct any feed composition or property deficiencies for ORP review and approval.

2. If a batch of treated LAW feed is found to be non-compliant after transfer to LAW CRV, the WTP Contractor, with support from the TOC, prepares an assessment and recommendation to disposition the transferred feed and submits the assessment and recommendation to ORP for review and approval.”

The waste feed delivery strategy involves a proactive approach to ensure that waste will meet contractual and interface requirements prior to WAC samples being taken. This includes taking process control samples throughout the preparation steps to ready a batch for delivery, identifying any waste that may be out-of-specification, and taking action to adjust the waste to conform to requirements for waste acceptance.

4.4 CONTINGENCY FEED

Contingency feed for DFLAW consists of reverting to the opposite feed staging tank (AP-103/AP-108) if the contents of the planned staging tank are discovered to be out of specification. This will also be the case if a transfer system hardware failure occurs that prevents feed delivery to tank AP-107 from the planned staging tank. Hence, sampling and characterization of LAWPS staging tanks AP-103 and AP-108 should be performed as soon as they have received supernatant from upstream DSTs so that contingency feed is available in the shortest possible time frame. This minimizes any potential impact to LAWPS or WTP LAW operations from any delay caused by the qualification time required.
5.0 ISSUES AND UNCERTAINTIES

Risks and opportunities associated with successful execution of the Plan will be captured and addressed in accordance with the WRPS Enterprise Risk and Opportunity Management (EROM) Framework (WRPS-57232 Rev. 1). The Direct-Feed LAW program addresses specific risks and opportunities associated with the execution of the overall program through a standalone One System Direct Feed Low Activity Waste Program Risk and Opportunity Management Plan (RPP-PLAN-60093). The Plan is critical to mitigation of risks associated with the DFLAW Program, specifically those related to the availability of DST space and qualified feed.
6.0 PATH FORWARD: FUTURE REFINEMENTS

This document revision represents a significant change from the previous waste feed delivery approach. Most notably, it introduces DFLAW as the key near-term RPP mission activity. Two facilities, LAWPS and EMF, with functionality specifically required for DFLAW are also introduced. These facilities are projected to return significant volumetric flow of secondary liquid waste to the DST system. These return streams impact/limit DST system waste accumulation, preparation, and feed delivery operations. This revision also addresses recovery of waste from leaking tank AY-102.

Future revisions of the Plan will include updates to planning assumptions for waste feed delivery for DFLAW, tasks completed to resolve existing issues and uncertainties, and emerging issues that arise during ongoing waste feed delivery planning activities. Long-term planning for the full-mission will also be included in future revisions of the Plan.

Refinements to the process approach to resolve issues and uncertainties associated with the Plan presented herein include (but are not limited to) the following.

1. Finalize waste feed requirements for waste acceptance (ICD-30).
2. Align and maintain waste feed delivery planning with ongoing DFLAW startup and commissioning planning.
3. Identify the feed qualification laboratory (assumed herein as 222-S) for DFLAW.
4. Develop plans to sample and characterize the intended first feed (currently stored in AP-105).
5. Restrict AP-105 activity, placing it on the Feed Control List, only allowing transfer to AP-107.
6. Transfer waste from AP-105 to AP-107 and use to prepare first feed.
7. Improve waste feed delivery approach to minimize impact of DFLAW returns on operations.
8. Incorporate changes (flush water requirements, internal recycle and/or alternate disposition of EMF bottoms, etc.) into process modeling captured through the issuance of ICD-30.
9. Update process modeling specifications for LAWPS and EMF as design matures.
10. Explore alternative SST retrieval and feed source strategies for potential improvements in meeting overall mission metrics.
11. Continue evaluation and implementation of DST tank waste management initiatives to increase useable operational space.
12. Complete the rationale and bases for specific DST equipment configuration and capabilities.
13. Complete upgrades to tanks, transfer systems, and tank farm infrastructure.
14. Update waste compatibility program (HNF-SD-WM-OCD-015) to address cesium eluate returns from LAWPS.


7.0 REFERENCES


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APPENDIX A

GLOSSARY
<table>
<thead>
<tr>
<th>Term (abbreviation)</th>
<th>Definition or expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buoyant-Displacement Gas Release Event (BDGRE)</td>
<td>Tank waste generates flammable gases through the radiolysis of water and organic compounds, thermolytic decomposition of organic compounds, and corrosion of the carbon steel tank walls. Under certain conditions, this gas may accumulate in a settled solids layer until the waste becomes hydrodynamically unstable (less dense waste near the bottom of the tank). A BDGRE is the rapid release of this gas, partially restoring hydrodynamic equilibrium. The release may result in the temporary creation of a flammable mixture in the headspace of the tank, depending on the size of the release relative to the capacity of the ventilation system.</td>
</tr>
<tr>
<td>Complexed Concentrate (CC)</td>
<td>The term used for wastes with organic chelating agents that were used during strontium recovery operations at B Plant in the 1960s and 1970s. Waste was considered to be complexed concentrate if the total organic carbon concentration exceeded 10 g/L after concentration. Complexed concentrate has the potential to maintain strontium and transuranic elements in solution, requiring additional pretreatment steps prior to treatment and disposal. Tanks AN-102 and AN-107 are identified as complexed concentrate waste.</td>
</tr>
<tr>
<td>Cross-Site Transfer</td>
<td>The Hanford waste tanks are located in two physically separated areas called the 200-East Area and 200-West Area, about seven miles apart. The cross-site transfer system includes transfer pipelines and ancillary equipment that is used to transfer supernatant and slurry from the 200-West Area to the 200-East Area.</td>
</tr>
<tr>
<td>Cs eluate</td>
<td>Stream containing the Cesium ions captured during the ion exchange in LAWPS that are removed from the ion exchange column via chemical means and returned to Tank Farms.</td>
</tr>
<tr>
<td>Disposal</td>
<td>Emplacement of waste in such a manner that ensures protection of the public, workers, and the environment with no intention of retrieval and that requires deliberate action to regain access to the waste (per DOE M 435.1-1).</td>
</tr>
<tr>
<td>Direct-feed LAW (DFLAW)</td>
<td>Direct transfer of Hanford Tank Farm treated low-activity waste (LAW) feed by the Tank Operations Contract (TOC) to the Hanford Tank Waste Treatment and Immobilization Plant (WTP) LAW Facility.</td>
</tr>
<tr>
<td>EMF Bottoms</td>
<td></td>
</tr>
<tr>
<td>Group A Tanks</td>
<td>Tanks that, due to their waste composition and quantities, have the potential for a spontaneous BDGRE and are conservatively estimated to contain enough flammable gas within the waste that if all were released into the tank headspace, the concentration of the flammable gas would be a flammable mixture.</td>
</tr>
<tr>
<td>Group B Tanks</td>
<td>Tanks, that due to their waste composition and quantities, are conservatively estimated to contain enough flammable gas within the waste that if all were released into the tank headspace, the concentration of the flammable gas would be a flammable mixture, but would not have the potential for a spontaneous BDGRE.</td>
</tr>
<tr>
<td>High-Level Waste (HLW)</td>
<td>The fraction of the tank waste containing most of the radioactivity that will be immobilized into glass and disposed at an off-site repository. HLW includes the solids remaining after pretreatment plus certain separated radionuclides.</td>
</tr>
<tr>
<td>High-Level Waste (HLW) Feed</td>
<td>The slurry stream (sludge plus supernatant) that is delivered to the WTP Pretreatment Facility. Any solids remaining after pretreatment are routed to the WTP HLW Vitrification Facility along with separated radionuclides.</td>
</tr>
<tr>
<td>Hanford Tank Waste Operations Simulator (HTWOS)</td>
<td>A dynamic event-simulation model that tracks waste as it moves through storage, retrieval, feed staging, and multiple treatment processes from the present day until the end of the River Protection Project (RPP) mission.</td>
</tr>
<tr>
<td>Hot Commissioning</td>
<td>The phase in which WTP does production runs using actual tank waste.</td>
</tr>
<tr>
<td>Term (abbreviation)</td>
<td>Definition or expansion</td>
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</tr>
<tr>
<td>Incidental Blending</td>
<td>Blending of HLW that naturally occurs during the retrieval, staging, storage, and delivery of feed without any special effort other than SST sequencing. It is sometimes called unavoidable blending.</td>
</tr>
<tr>
<td>Inhibited Water</td>
<td>Process water that contains at least 0.01 M sodium hydroxide and 0.01 M sodium nitrite.</td>
</tr>
<tr>
<td>Low-Activity Waste (LAW)</td>
<td>During DFLAW operations, supernatant waste that has been pretreated at LAWPS to remove entrained solids and cesium. This stream is transferred from LAWPS to the WTP LAW Vitrification Facility for treatment. For the balance of mission, waste that remains following the process of separating as much of the radioactivity as practicable from HLW. This stream is transferred from pretreatment to the WTP LAW Vitrification Facility for treatment.</td>
</tr>
<tr>
<td>Low-Activity Waste (LAW) Feed</td>
<td>During DFLAW operations, the liquid stream that is delivered to WTP LAW Vitrification Facility following pretreatment at LAWPS to remove entrained solids and cesium. For the balance of mission, the liquid stream (supernatant plus a small amount of entrained solids) that is delivered to the WTP Pretreatment Facility. LAW feed is managed as HLW until it has been pretreated.</td>
</tr>
<tr>
<td>LAW Pretreatment System (LAWPS)</td>
<td>The low-activity waste pretreatment system is part of the direct feed low-activity waste process for treating sodium-bearing waste in the Hanford Tank Farm. The LAWPS Facility has the main objective to remove undissolved solids and radioactive cesium from the liquid LAW waste stream.</td>
</tr>
<tr>
<td>Retrieval</td>
<td>The process of removing, to the maximum extent practical, all of the waste from a given underground storage tank. The retrieval process is selected specific to each tank and accounts for the waste type stored and the access and support systems available. In accordance with OSD-T-151-00031, a tank is officially in “retrieval status” if one of two conditions is met: (1) waste has been physically removed from the tank by retrieval operations, or (2) preparations for retrieval operations are directly responsible for rendering the leak or intrusion monitoring instrument out-of-service.</td>
</tr>
<tr>
<td>Saltcake</td>
<td>A mixture of crystalline sodium salts that originally precipitated when alkaline liquid waste from the various processing facilities was evaporated to reduce waste volume. Saltcakes are comprised primarily of the sodium salts of nitrate, nitrite, carbonate, phosphate, and sulfate. Concentrations of transition metals such as iron, manganese, and lanthanum and heavy metals (e.g., uranium and lead) are generally small. Saltcake typically contains a small amount of interstitial liquid. The bulk of the saltcake will dissolve if contacted with sufficient water.</td>
</tr>
<tr>
<td>Sludge</td>
<td>A mixture of metal hydroxides and oxyhydroxides that originally precipitated when acid liquid waste from the various reprocessing facilities was made alkaline with sodium hydroxide. Sludge is comprised primarily of the hydroxides and oxyhydroxides of aluminum, iron, chromium, silicon, zirconium, and uranium, plus the majority of the insoluble radionuclides such as $^{90}$Sr and the plutonium isotopes. Sludge typically contains a significant amount of interstitial liquid (up to nominal 40 wt% water). Sludge is mostly insoluble in water; however, a significant amount of aluminum and chromium will dissolve if leached with sufficient quantities of sodium hydroxide.</td>
</tr>
<tr>
<td>Term (abbreviation)</td>
<td>Definition or expansion</td>
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</tbody>
</table>
| Slurry              | The term slurry is used in several different contexts:  
|                     | • Slurry is a mixture of solids (e.g., sludge or undissolved saltcake) suspended in a liquid. For example, a slurry results when the sludge and supernatant in a tank is mixed together. Slurries can be used to transfer solids by pumping though a pipeline.  
|                     | • Slurry can refer to the bottoms stream from the 242-A Evaporator or other evaporator streams.  
|                     | • Slurry also refers to a specific waste produced at Hanford that results from evaporating supernatant originally removed from tanks containing saltcake so that aluminum salts begin to precipitate in addition to the sodium salts. This material, called “double-shell slurry” or “double-shell slurry feed” is present in the DSTs (specifically tanks AN-103, AN-104, AN-105, and AW-101). For simplicity, this document will use the term “settled salts” or “saltcake” instead of slurry in this context. |
| Solids              | The product of centrifuging the LAW feed, separating and drying the solids, and removing the dissolved solids contribution. |
| Supernatant         | Supernatant is technically the liquid floating above a settled solids layer. At Hanford, it is typically used to refer to any non-interstitial liquid in the tanks, even if no solids are present. Supernatant is similar to saltcake in composition and contains many of the soluble radionuclides such as $^{137}$Cs and $^{99}$Tc. |
| Tank Waste Characterization and Staging | Facility that will be designed to aid in the resolution of the technical issues associated with mixing and characterizing high-level tank waste. When constructed, the TWCS facility functions will include (but not limited to): adequate mixing, ability to sample, and ability to characterize high-level tank waste feed prior to delivery to WTP. |
| Waste Feed Delivery (WFD) | Hanford waste currently stored at the tank farms that will eventually be transferred from the DSTs to WTP. |
| Waste Feed Delivery (WFD) System | RPP-47172$^f$ defines the WFD system as being composed of the DST system and the waste retrieval facilities; however, for the purposes of the Plan, WFD system is used to refer to those portions of the WFD system directly supporting preparation and delivery of waste feed to the WTP. |

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APPENDIX B

WTP FULL OPERATIONS – PRETREATMENT, LOW-ACTIVITY WASTE, AND HIGH-LEVEL WASTE
Post DFLAW, the waste feed delivery mission will expand to provide complaint feed to:

- WTP PT Facility, WTP HLW Facility, and TWCS Facility, which come on line subsequent to DFLAW; and
- A supplemental LAW (SLAW) facility if/when such a facility comes on line subsequent to WTP PT and WTP HLW.

The operations necessary to provide tank waste feed to WTP for the balance of mission are described in memorandum, “Waste Feed Delivery: Balance of Mission Operations – Pretreatment, Low-Activity Waste, and High-Level Waste, and Technical Rationale,” WRPS-1503870-OS.

Figure B-1 provides an overview of the balance of mission tank waste retrieval and treatment mission functions, including liquid (supernatant) cross-site transfers, evaporator operation, feed staging, feed receipt at the WTP PT, and LAW and HLW vitrification – as per life-cycle process modeling. Topics specific to HLW processing include slurry cross-site transfers, HLW feed staging, and HLW feed delivery to WTP.

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**Figure B-1. River Protection Project Mission Flowsheet**
A full discussion of waste feed delivery during full WTP operations is not appropriate as redesign efforts are underway for the WTP PT facility and there is a lack of technical definition regarding TWCS. The TWCS capability will be designed to aid in the resolution of the technical issues associated with mixing and characterizing high-level tank waste. When constructed, the TWCS Facility will provide the ability to adequately mix, obtain samples from, and characterize high-level tank waste feed prior to delivery WTP. As additional design input is received, balance of mission operations will be redefined accordingly and incorporated within the main text of the Plan.

One key assumption common to WTP and TOC planning and operations is that the WTP PT Facility hot commissioning feed will be supplied from tank AP-102, which is planned to receive tank AY-102 sludge during recovery of that assumed leaking tank. The current contents of tank AY-102 (i.e., prior to recovery) are comprised primarily of solids consolidated from tank C-106 and supernatant from tank AP-101.

A process strategy for the hot commissioning feed was developed and documented in the waste feed delivery flowsheet completed in September 2010 for tank AY-102 (RPP-RPT-46020, Tank 241-AY-102 Waste Feed Delivery Flowsheet). Hot commissioning includes the delivery to the TWCS Facility and HLW batch transfers to the WTP. The high-level tank waste feed will be adequately mixed, sampled, and characterized in the TWCS Facility prior to delivery to WTP.

The most current flowsheet for the Tank AY-102 hot commissioning feed was completed prior to the development of the current operating scenario, as depicted in ORP-11242 (Rev. 6). The flowsheet will be matured alongside facility design; commissioning activities will then be integrated with mission planning and operations. A detailed schedule directing hot commissioning activities will be developed within the timeline established by IWFD P contract direction.