ORP-11242
Revision 2

RIVER PROTECTION PROJECT SYSTEM PLAN

RETRIEVE AND TREAT HANFORD'S TANK WASTE AND CLOSE THE TANK FARMS TO PROTECT THE COLUMBIA RIVER

Prepared for U.S. Department of Energy
Office of River Protection

ORP-11242
Revision 2

River Protection Project System Plan

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River Protection Project System Plan – Revision 2

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Approval of this System Plan indicates that the two scenarios evaluated and presented in this document are suitable for strategic planning purposes only. This document is not intended as a budget request, nor does it represent contractual commitments on behalf of any party.

Some of the activities describe herein may be subject to and/or undergoing the analysis required by the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321, et seq. They are included within this document for planning purposes only, not for decisional purposes which will be conducted following the NEPA process.

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History Sheet

Revision	Date	Reason for revision	Revised by
0	August 2002	Initial Issuance	K. R. Wells
1	April 2003	Reflect Proposed Changes and Additions to the Waste Treatment Proc++++- esses & Facilities to Accelerate Mission Completion	K. R. Wells
2	September 2003	Reflect a Target Case which depicts the mission based on how ORP expects the WTP to perform and a Stretch Case which depicts the mission if significant increases in both WTP and Non-WTP LAW treatment performance are realized.	P. J. Certa

EXECUTIVE SUMMARY

The U.S. Department of Energy, Office of River Protection (ORP) is responsible for the retrieval, treatment, and disposal of the radioactive wastes contained in the Hanford Site waste tanks, and closure of all the tanks and associated facilities. Currently, the ORP is committed to completing the treatment of all the tank wastes by 2028, and closure of all facilities by 2034.

The current strategy for completion of the mission uses a number of interrelated activities. The ORP will reduce risk to the environment posed by tank wastes by:

- Removing pumpable liquids remaining in single-shell tanks (SSTs) to the extent practical (will be completed in 2004);
- Retrieving wastes remaining in SSTs to double-shell tanks (DSTs) for staging to the Waste Treatment and Immobilization Plant (WTP), or directly to transuranic (TRU) packaging or supplemental treatment;
- Aggressively managing DST space so that the retrieval and closure of SSTs can be accelerated to maximize overall risk reduction;
- Constructing and operating the WTP which will pretreat and immobilize the most hazardous wastes contained in tank farms, and maximizing its capability and capacity;
- Deploying packaging capabilities for tank waste that is TRU for shipment and disposal in the Waste Isolation Pilot Plant (WIPP);
- Developing and deploying supplemental treatment capacity that can safely treat and immobilize a significant fraction of the low-activity waste (LAW) contained in tank farms;
- Disposing of immobilized low-activity waste (ILAW) in an integrated facility on site; and
- Closing SST and DST tank farms, ancillary facilities, and all waste management and treatment facilities.

The ORP has established contracts to implement this strategy to accelerate overall risk reduction and establish a basic capability to complete the overall mission. Major decisions regarding the supplemental treatment technology, the ultimate needed capacity, and its relationship to the WTP have not yet been made. A major programmatic decision point has been established in 2005 that will determine the ultimate deployment strategy for supplemental treatment versus additional capacity added to the WTP. This System Plan investigates the impacts of potential innovations associated with the WTP ILAW facility; and alternative configurations of supplemental treatment.

Purpose

To that end, the System Plan examines two related scenarios, the "Target Case" and the "Stretch Case." As the mission evolves, the ORP may incorporate selected features from either the Target Case or the Stretch Case into future baseline changes.

The Target Case demonstrates how ORP will use the WTP to meet the 2018 *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement or TPA) milestone M-62-00A for processing 10% of the waste by mass and 25% by activity and together with supplemental treatment and packaging to complete the treatment of the waste by 2028 (M-62-00). This case asserts that the WTP being constructed by Bechtel National, Inc. (BNI) will perform better than its minimum contractual performance requirements in conjunction with WTP Supplemental LAW Treatment and a nominal amount of Non-WTP Supplemental Treatment of LAW and packaging of transuranic/low-level waste (TRU/LLW).

The Target Case continues the alignment of the Tank Farm Contractor's plans for waste feed delivery, SST Retrieval, and supplemental treatment or packaging with the hot commissioning and ramp-up plans for the WTP. Refinements to this Target Case are being used as an input to a baseline change request for the Tank Farm Contractor that is being prepared in parallel with this System Plan.

The purpose of the Stretch Case is to show the ORP's vision of how the waste treatment mission might unfold if sufficient breakthroughs in the performance of the WTP are realized in conjunction with WTP and Non-WTP Supplemental LAW Treatment and Packaging of TRU/LLW. By identifying those areas in which breakthroughs are required, the ORP can set performance goals that selectively drive the contractors towards its vision.

Results

The key features of the Target and Stretch Cases are listed in Table ES-1 with the differences between the cases highlighted by shaded cells. The simplified mass balances in Figure ES-1 and Figure ES-2 summarize the key features and show the amounts of waste processed by each treatment or packaging facility. The main differences in the results of the two cases are the disposition of the LAW, which are compared in Table ES-2.

Both cases show that for the assumptions provided in Appendix C, the WTP, together with Supplemental Treatment and Packaging, can treat (or package) all tank waste by December 2028. In addition, both cases will treat at least 10% of the waste by mass and 25% of the waste by activity by 2018.

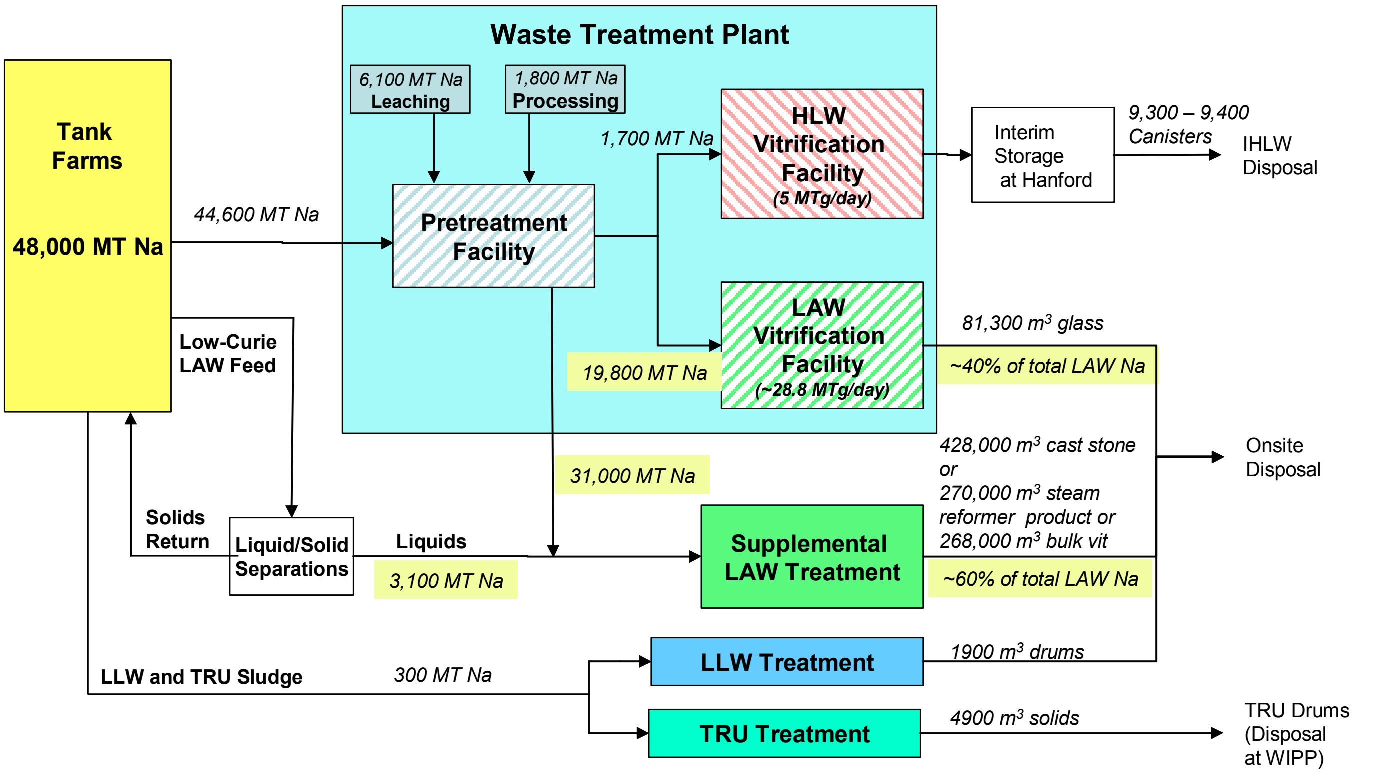
Table ES-1. Key Feature of Target and Stretch Case.

Key Feature	**Target Case**	**Stretch Case**
WTP Hot Commissioning – Full Operations	12/2009 – 2/2011	12/2009 – 2/2011
WTP Pretreatment Capacity	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr
WTP LAW Vitrification	28.8 MTG/d	34 MTG/d
WTP HLW Vitrification	5 MTG/d	5 MTG/d
WTP and Non-WTP Supplemental LAW Treatment	2011 – 2028	2011 – 2028
Non-WTP Supplemental LAW Treatment	3,100 MT Na	8,100 MT Na
WTP Supplemental LAW Treatment	31,000 MT Na	14,000 MT Na
Supplemental Sludge Treatment	12 TRU and 1 LLW	12 TRU and 1 LLW
WTP LAW Sodium Oxide Loading	Gimpel Rule (~14.6 wt%)	20 wt%
WTP HLW Glass Properties Model	Relaxed	Relaxed

Notes:

HLW = high-level waste
LAW = low-activity waste
LLW = low-level waste
MT Na = Metric tons sodium
MTG/d = Metric tons of glass per day
TRU = transuranic
yr = year
wt% = weight percent
WTP = Waste Treatment and Immobilization Plant

Figure ES-1. Simplified Mass Balance – Target Case.



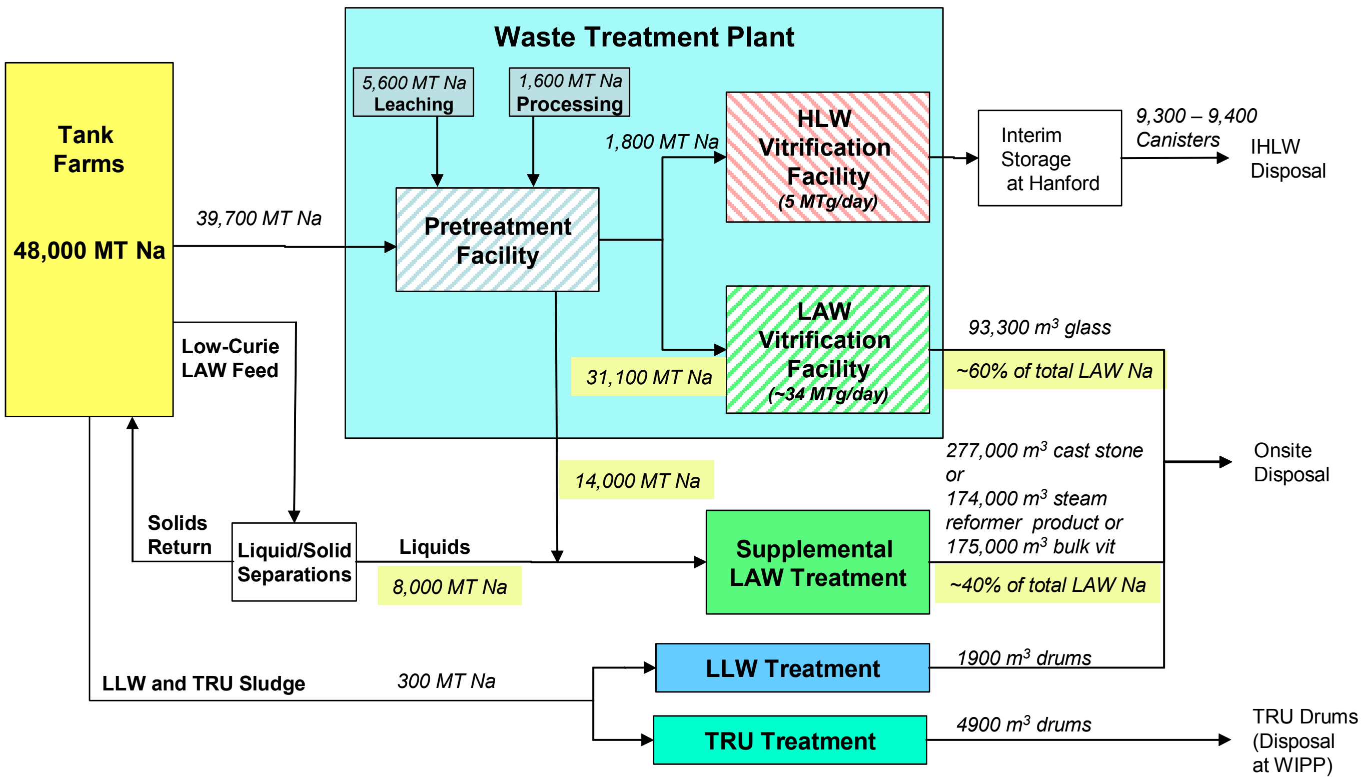
Target Case Features

- Hot Commissioning…. 12/2009 – 1/2011
- Waste Treatment ……. 1/2011 – 12/2028
- 3,100 MT Na low-Cs waste does not require Cs removal prior to treatment

Product volumes are external package volumes

- LAW Melter ………….. 36 MTg/day at 80% TOE = 28.8 MTg/day net.
- LAW Waste Loading … 14.6 wt% Na_2O average
- HLW Melter ………….. 6 MTg/day at 84% TOE = 5 MTg/day net.
- HLW Waste Loading … 33 – 35 wt% non-volatile waste oxides avg.

Figure ES-2. Simplified Mass Balance – Stretch Case.



Stretch Case Features

- Hot Commissioning…. 12/2009 – 1/2011
- Waste Treatment ……. 1/2011 – 12/2028
- 8,000 MT Na low-Cs waste does not require Cs removal prior to treatment

Product volumes are external package volumes

- LAW Melter ………….. 40 MTg/day at 85% TOE = 34 MTg/day net.
- LAW Waste Loading … 20 wt% Na_2O average
- HLW Melter ………….. 6 MTg/day at 84% TOE = 5 MTg/day net.
- HLW Waste Loading … 33 – 35 wt% non-volatile waste oxides avg.

Table ES-2. Disposition of LAW Waste.

Treatment Pathway	Percent of LAW (measured as sodium)	
	Target Case	Stretch Case
WTP LAW Vitrification	37 (~ 40%)	59 (~ 60%)
WTP Supplemental LAW Treatment	57	26
Non-WTP Supplemental LAW Treatment	6	15

Notes:
LAW = low-activity waste
WTP = Waste Treatment and Immobilization Plant

In both the Target and Stretch Cases, the pretreatment and vitrification of high-level waste (HLW) drive the duration of the treatment mission. Any changes that increase the amount of HLW glass produced or limit the production rate will increase the duration of the mission. Keep in mind that sufficient supplemental LAW treatment capacity was added to ensure that LAW processing would not be the bottleneck.

For the Target Case, approximately 8 MCi of total radioactivity[1], decayed to January 1, 2001, is estimated to be contained in the combined LAW products (LAW Glass from the WTP plus both WTP and Non-WTP Supplemental LAW product). This represents about 4% of the total tank inventory of 195 MCi. For the Stretch Case, about 7 MCi total activity representing 3.6% of the total inventory is estimated to be contained in the combined LAW products. This is consistent with one of the guidelines established by the U.S. Nuclear Regulatory Commission (NRC) in which it was acceptable to leave about 8.5 MCi of activity in the LAW (Paperiello 1997).

[1] Reported activities include metastable daughter products, unless stated otherwise.

Opportunities

In addition to meeting the regulatory commitment of 2028 for the completion of waste treatment, ORP has established a goal to complete the overall treatment mission by 2025. This acceleration would result in further lifecycle cost reduction, accelerated risk reduction, and would enable overall acceleration of the 200 Area sitewide closure. One of the useful outputs of this System Plan is to identify areas where additional improvements are necessary to achieve this further acceleration.

The LAW pretreatment rate averaged 2860 MT Na/yr in the Target Case and 2570 MT Na/yr for the Stretch Case, both lower than the assumed pretreatment capacity of 2950 MT Na/yr. The Stretch Case requires less of the available pretreatment capacity because an additional 5,000 MT of sodium from low-cesium tank waste is being treated by Non-WTP Supplemental Treatment. This underutilized capacity is an asset and suggests a scenario where the combined capacities of LAW Vitrification, Non-WTP Supplemental Treatment, and WTP Supplemental Treatment are in excess of that needed to treat all LAW by 2028. Excess LAW treatment capacity will provide a more robust system configuration that can tolerate changes in many of the LAW processing assumptions. For example, if one of the treatment pathways performs less well than desired, the other two may potentially make up the shortfall and, therefore, keep the mission on schedule. Alternatively, if the combined performance is more than that which is needed to treat the LAW by 2028, then there is potential to shorten the mission if commensurate changes are made on the HLW side.

Under current assumptions, the mission duration is being controlled by HLW processing – to shorten the mission, either the vitrification (and pretreatment) rates need to be increased or the total volume of HLW glass decreased. Key efforts to that end being pursued by ORP include:

- Increasing the effective HLW vitrification capacity by the addition of bubblers to HLW system and addition of a second HLW melter;
- Glass formulation work to decrease the total amount of HLW glass produced by improvements in chromium solubility;
- Implementation of oxidative leaching in the WTP to reduce the impacts of chromium inventory in Hanford Site tank wastes;
- Improvements in the expected Total Operating Efficiency (TOE) by improved maintenance and operational concepts incorporated into the HLW facility design;
- Reduction of the total amount of HLW glass to be produced by direct packaging and disposal of tank TRU waste to WIPP; and
- Consideration of direct immobilization of low curie wastes that meet the criteria for radionuclide removal established jointly by the U.S. Department of Energy (DOE) and the NRC.

Further enhancement to the HLW capacity will most likely come in the form of further enhancements to HLW glass formulations (or alternative glass systems), enhanced feed blending to reduce the total amount of HLW glass to be produced; and further integration of the WTP with tank farms, supplemental treatment, the 242-A Evaporator, and the Effluent Treatment Facility (ETF) facility to more effectively manage troublesome recycle streams within the plant.

Key Issues and Uncertainties

Some of the assumptions used for the Target Case and Stretch Case present issues and uncertainties that need to be successfully addressed to reach the desired performance for the mission. Most of these challenges are common to both cases and are discussed in more detail together with potential mitigating actions in Table 4-2. Two challenges specific to the Stretch Case are discussed in Table 4-3.

CONTENTS

APPENDICES

FIGURES

TABLES

TERMS

AABS	alkali-alumino-borosilicate
BBI	Best-Basis Inventory
BCR	Baseline Change Request
BNI	Bechtel National, Inc.
BOM	Balance of mission
CERCLA	*Comprehensive Environmental Response, Compensation and Liability Act of 1980*
CH	Contact-handled
CH2M HILL	CH2M HILL Hanford Group, Inc.
Ci/L	Curies per liter
CSB	Canister Storage Building
CWC	Central Waste Complex
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	State of Washington Department of Ecology
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FY	fiscal year
g/mL	grams per milliliter
gal	gallons
gpm	gallons per minute
HDW	Hanford Defined Waste (Model)
HLW	High-level waste
hp	horsepower
HTWOS	Hanford Tank Waste Operations Simulator
HVAC	Heating, ventilation, and air conditioning
IDF	Integrated Disposal Facility
IHLW	Immobilized high-level waste
ILAW	Immobilized low-activity waste
IMAP	*Integrated Mission Acceleration Plan*
LAW	Low-activity waste
LERF	Liquid Effluent Retention Facility
LLW	Low-level waste
m^3	cubic meters
MCi	million curies
Mgal	million gallons
MT	Metric tons
MT Na/yr	Metric tons sodium per year
MTG	Metric tons of glass
MTG/d	Metric tons of glass per day
NEPA	*National Environmental Policy Act of 1969*
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Amendments Act of 1987
ORP	U.S. Department of Energy, Office of River Protection

Pa·s	Pascal-seconds
PBI	Performance Based Incentive
PUREX	Plutonium Uranium Extraction
R&T	Research and Technology
RCRA	*Resource Conservation and Recovery Act*
RH	Remote-handled
RL	U.S. Department of Energy, Richland Operations Office
RPP	River Protection Project
SALDS	State-Approved Land Disposal Site
SBS	submerged bed scrubber
SpG	specific gravity
SST	Single-Shell tank
TBD	to be determined
TEDF	Treated Effluent Disposal Facility
TFC	Tank Farm Contractor
TFCO&UP	*Tank Farm Contractor Operation and Utilization Plan*
T_L	maximum spinel liquidus temperature
TOE	total operating efficiency (used interchangeably with "availability factor")
TPA	Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order*)
TRU	transuranic
TWINS	Tank Waste Information Network System
WESF	Waste Encapsulation and Storage Facility
WFD	Waste Feed Delivery
WIPP	Waste Isolation Pilot Plant (Carlsbad, New Mexico)
WIPP-WAC	Waste Isolation Pilot Plant – Waste Acceptance Criteria
WRF	Waste Retrieval Facility
WTC	Waste Treatment Complex
WTP	Waste Treatment and Immobilization Plant
wt%	Weight percent

1.0 INTRODUCTION

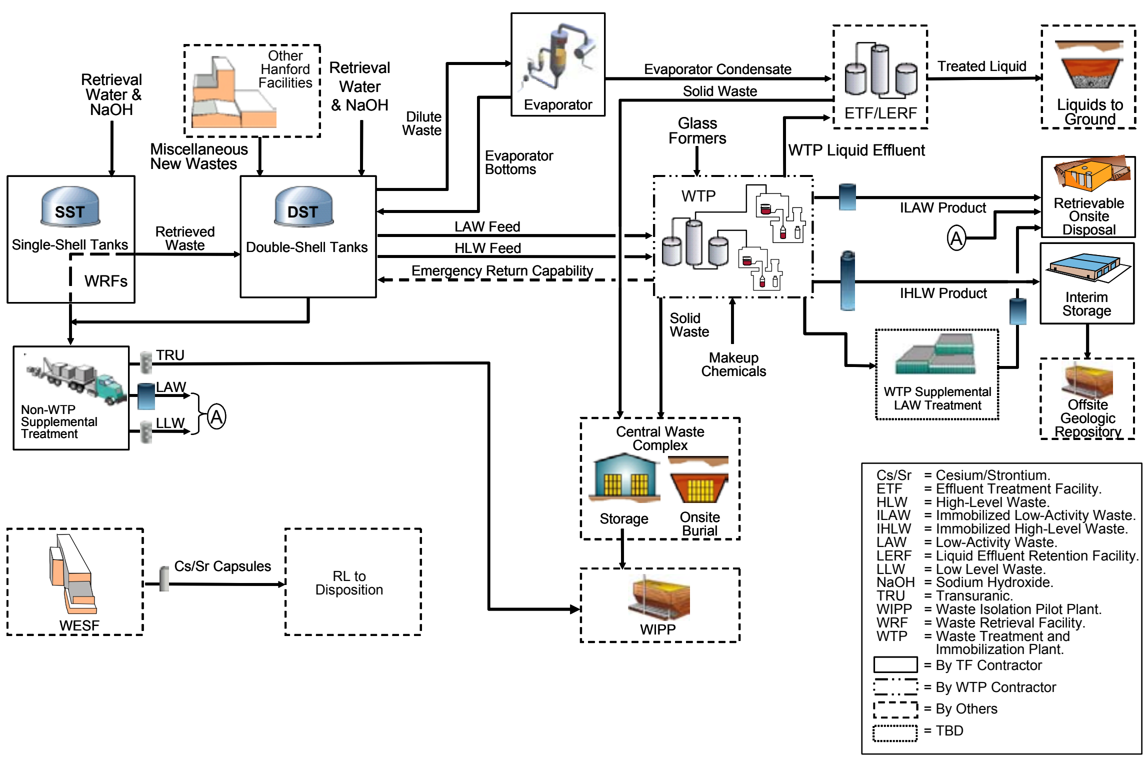
1.1 PURPOSE

This System Plan investigates the impacts of potential innovations associated with the Waste Treatment and Immobilization Plant (WTP) Immobilization Low-Activity Waste (ILAW) facility and alternative configurations of supplemental treatment. To that end, the Plan examines two related scenarios, the "Target Case" and the "Stretch Case." As the mission evolves, the U.S. Department of Energy, Office of River Protection (ORP) may incorporate selected features from either the Target Case or the Stretch Case into future baseline changes.

1.2 OVERVIEW OF THE WASTE TREATMENT COMPLEX

The proposed configuration of the River Protection Project (RPP) Systems and interfaces are described in this section and shown in Figure 1-1. Final decisions concerning the configuration will be made using the *National Environmental Policy Act of 1969* (NEPA) process.

Figure 1-1. RPP System-Simplified Flow Diagram.



1.2.1 Tank Farms

In the 200 East and 200 West Areas of the Hanford Site, waste storage tanks were built in 18 groups called tank farms. The farms contain from 2 to 18 tanks each and hold varying amounts of waste. Twelve of the farms contain single-shell tanks (SST) and six contain double-shell tanks (DST).

1.2.1.1 Single-Shell Tanks

The SSTs were built from 1943 to 1964 to hold radioactive waste created by the production and separation of plutonium and other radioactive isotopes. SSTs in the following numbers and capacities were built at the Hanford Site:

- 16 have 55,000-gal capacity,
- 60 have 530,000-gal capacity,
- 48 have 758,000-gal capacity, and
- 25 have 1,000,000-gal capacity.

The total holding capacity of the SSTs is 94 Mgal. The SSTs currently contain approximately 32 Mgal of mixed radioactive and hazardous waste and 103 MCi of radioactivity[1]. These tanks contain saltcake and sludge (moist soluble and insoluble solids). Most of their free liquids were evaporated or transferred to the newer DSTs to lessen the chance of leakage. The waste volume and activity inventories for the SSTs is slightly lower than reported in Revision 1 of this System Plan primarily due to transfer of liquid waste from SSTs to DSTs via saltwell pumping (Interim Stabilization), which is now nearly complete. The data are current as of the date of the inventory used in the model analysis (approximately June 30, 2002).

1.2.1.2 Double-Shell Tanks

The DSTs were built from 1968 to 1986. Their capacities vary:

- 4 have 1,000,000 gal capacity, and
- 24 have 1,120,000 gal to 1,160,000 gal capacity.

The DSTs have a total holding capacity of 31 Mgal. The DSTs contain approximately 22 Mgal of mixed radioactive and hazardous waste and 92 MCi of radioactivity. Generally, the tanks contain liquids and settled salts. Some tanks also contain a bottom layer of sludge. Activities are currently underway to increase the overall physical storage capacity of most of the DSTs by allowing greater fill heights. Other activities to better utilize the physical storage capacity are discussed in Sections 2.3.2 and 3.3.2. The data are current as of the date of the inventory used in the model analysis (approximately June 30, 2002).

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[1] Throughout this report, activity is reported with a January 1, 2001 decay date.

1.2.1.3 Waste Retrieval

Waste from the SSTs is retrieved to reduce the risk to the public and environment. The disposition of the waste depends on whether it satisfies criteria as low-activity waste (LAW) feed, low-curie LAW feed, low-level waste (LLW) sludge, transuranic (TRU) sludge, or high-level waste (HLW).

- LAW feed is material that will require pretreatment to remove some of the isotopes (primarily Cs-137) so that it can be treated and disposed as ILAW (by the WTP or Supplemental Treatment).

- Some of the waste stored in SSTs will meet criteria to be classified as low-curie LAW feed. It is not cost-effective to remove additional Cs-137 from this waste. Therefore, this waste is candidate material for direct processing in supplemental treatment processes without additional pretreatment. (See Issue 11, Table 4-2.)

- LLW sludge is insoluble solids that do not meet the criteria for HLW or TRU. This sludge is candidate material for retrieval, packaging, and onsite disposal without pretreatment in the WTP. (See Issue 18, Table 4-2.)

- Other sludge in SSTs meets criteria for definition as TRU waste. The TRU sludge is candidate material for dewatering, packaging, and disposal to the Waste Isolation Pilot Plant (WIPP) without pretreatment to remove isotopes and without processing through the WTP or Supplemental Treatment facilities. (See Issue 18, Table 4-2.)

- Most of the waste in SSTs is HLW, which will be transferred to the WTP for pretreatment and immobilization.

The relative amounts of SST waste distributed between pretreatment for WTP processing, pretreatment for supplemental treatment, and direct transfer to Supplemental Treatment are part of the assumptions used in evaluating the Target and Stretch Cases in this plan. The key features and results for each case are described in Sections 2.0 and 3.0.

SST waste can be retrieved using several techniques – modified sluicing, mobile retrieval system (using a crawler), or a vacuum retrieval system. The selection of retrieval techniques and the associated retrieval durations are part of the detailed Hanford Tank Waste Operations Simulator (HTWOS) model assumptions. SST waste retrieval will add varying amounts of water to the waste, depending on technique. Estimated waste volumes after retrieval are specifically assumed by tank for some SSTs, generally those early in the retrieval sequence. The remaining SSTs have an estimated volume after retrieval based on assuming that the waste is retrieved with sufficient water to make a 5-molar sodium solution or a 10-wt% solids slurry (after dissolution). The final volume uses the condition that requires the most water. Retrieval of SST waste is assumed to dissolve soluble salts in the waste to the extent defined by the water wash factors.

Retrieval of SSTs requires a pathway to staging vessels or processing facilities. Early SST retrievals will be accomplished by direct retrieval to DSTs using over ground transfers or by directly sending the tank waste to alternative processing/packaging systems. Some of the SST waste will be retrieved later into three planned Waste Retrieval Facilities (WRF). The need date for the WRFs is established from results of the modeling, starting from a preliminary assumption. WRFs will provide the necessary tanks and pumps to support retrieval and conditioning of the waste before transfer to the DST system. SSTs retrieved prior to October 1, 2009 are assumed to not require a WRF.

The Target and Stretch Cases require different assumptions for the sequence and timing of SST retrieval. The specific assumptions are addressed in Sections 2.0 and 3.0.

DST waste retrieval involves combinations of 300-hp mixer pumps (for sludge, settled salts, or staging tank use), fixed or variable inlet height transfer pumps, and the ability to add diluent to the waste. The transfer pumps allow the retrieved material to be pumped to another DST or be delivered to the WTP or Supplemental Treatment as feed.

1.2.1.4 Waste Transfer Lines

The tank farms contain underground piping so the waste can be pumped between tanks, between tank farms, from different facilities, and between the 200 East and 200 West Areas. These farms also contain equipment, such as diversion boxes and valve pits, which is used to route the waste. For safety, the pipelines generally have a double-wall design with sensors to monitor for leaks. Hose-in-hose transfer lines may also be used directly or in combination with existing transfer routes to permit more rapid deployment, reduce costs, and provide additional flexibility.

1.2.1.5 Tank Farm Waste Evaporator (242-A Evaporator)

The 242-A Evaporator is operated on a campaign basis to concentrate tank waste as required by the ORP through fiscal year (FY) 2018. Responsibility for the 242-A Evaporator has recently been transitioned to the Tank Farm Contractor (TFC).

1.2.2 Waste Treatment Plant

The WTP will pretreat and immobilize by vitrification to borosilicate glass some of the waste now stored in underground tanks at the Hanford Site. The WTP consists of three individual waste treatment facilities (Pretreatment, HLW Vitrification, and LAW Vitrification), a stand-alone analytical and radiochemical laboratory, and the Balance of Facilities. The waste treatment facilities are described in Sections 1.2.2.1 and 1.2.2.2, below.

1.2.2.1 Pretreatment

The WTP Pretreatment Facility (PT) separates waste feed from the Tank Farms into a HLW fraction and LAW fraction for subsequent treatment by either vitrification or a separate supplemental process. The WTP Pretreatment Facility consists of a series of process vessels located in process cells and a hot cell. The Pretreatment Facility includes systems to support the following activities:

- Receive and store waste feed from the tank farm DST system;

- Concentrate waste feed and recycle streams to minimize the water load on the LAW melter(s);
- Precipitate strontium (Sr) and TRU from selected waste for incorporation into HLW feed;
- Blend appropriate amounts of HLW feed with LAW feed for use as feed to the ultrafilters;
- Ultrafilter, wash, and leach solids, and store solids for HLW vitrification feed.
- After removal of Sr, TRU, and Cs, transfer the remaining process stream to the LAW Vitrification Facility and/or Supplemental Treatment process; and
- Blend pretreated HLW feed with separated Cs, Sr, and TRU material and then transfer it to the HLW Vitrification Facility.

1.2.2.2 High-Level Waste and Low-Activity Waste Vitrification

The HLW and LAW vitrification facilities provide the final treatment for a portion of the tank waste. In each facility, the waste is blended with various chemicals and glass-forming material and is fed into high-temperature joule-heated melters where the waste is processed into molten borosilicate glass. The glass is poured into large canisters (immobilized high-level waste [IHLW]) and packages (ILAW), cooled, sealed, decontaminated, and staged for interim storage or final disposal respectively.

Assumptions about the sodium loading in the ILAW glass differ for the Target Case and Stretch Cases, as described in Sections 2.3.5.2 and 3.3.5.2.

The method for estimating the HLW incorporation into IHLW is the same for both the Target and Stretch Cases. However, some of the constraints for HLW glass processing (liquidus temperature, viscosity, and acceptable chromium content) have been relaxed to increase estimated waste oxide loadings. This is discussed further in Sections 2.3.6.4 and 3.3.6.4.

The amount of waste incorporated by the WTP into ILAW and IHLW varies with the Target and Stretch Cases. The primary variation is how the ILAW is treated within each of the cases. However, assumptions about retrieval and resultant incidental blending for the two cases do affect the amount of IHLW produced so that the IHLW results are not identical

1.2.3 WTP Supplemental LAW Treatment

The technologies proposed for WTP Supplemental LAW Treatment are different from and complement the technology used for the WTP LAW Vitrification Process. The WTP Supplemental LAW Treatment process would probably be located on the site originally reserved for the second LAW Vitrification Facility and would process pretreated LAW from the WTP Pretreatment Facility. Three technologies have been proposed and are currently being evaluated for further development and deployment. These technologies are described below.

Cast Stone – The pretreated waste would be processed by an ambient temperature solidification step wherein the waste would be well mixed with grout formers such as Portland cement, fly ash, slag, and other getters/conditioners as required to meet Washington State Dangerous Waste Standards and Hanford Site radioactive material disposal requirements. The grout would be placed in containers for disposal, which will facilitate retrieval if ever deemed necessary. The model assumes the cast stone product is packaged in 4'x4'x8' boxes (3.6 m^3).

Bulk Vitrification – The vitrification of waste in large containers (35-m^3 roll-off boxes with 30 MT glass capacity). Each container serves as both the melter vessel and the waste disposal container. Because of higher temperatures used to form aluminosilicate glass, higher waste loadings may be achievable, which supports a reduced volume of ILAW glass product relative to the baseline WTP vitrification process. Both the Target and Stretch Cases assume 20-wt% waste sodium oxide loading in the bulk vitrification glass.

Steam Reforming – Steam reforming utilizes a high-temperature fluidized bed under a slight vacuum. Superheated steam and additives are injected into the bed creating both reducing and oxidizing zones. The process destroys nitrates and, with the help of additives, incorporates radioisotopes together with sodium, sulfate, chlorine, and fluorine into a mineral-like waste form. The granular waste product would be packaged in a high integrity container for disposal, which would support future retrieval if deemed necessary. It also has the apparent ability to treat high sulfate waste, which currently limits the treatment of LAW waste by the baseline WTP ILAW vitrification process. Modeling of the steam reforming process assumes a 19.8-wt% sodium oxide loading and use of 2.3-m^3 standard ILAW containers. The assumptions apply to both the Target Case and the Stretch Case.

1.2.4 Non-WTP Supplemental Treatment

Four Non-WTP Supplemental Treatment processes are identified. Three processes address immobilization of LAW waste and one addresses packaging and disposal of LLW/TRU sludge.

1.2.4.1 Low-Activity Waste

Cast Stone, Bulk Vitrification, and Steam Reforming are also the proposed Non-WTP Supplemental LAW Treatment technologies. These are the same processes and use the same packages as in Section 1.2.3, WTP Supplemental LAW Treatment. The differences are in the amounts and choices of feeds, the required capacity, and location of the process. The feed to Non-WTP Supplemental LAW Treatment is taken from a subset of the SSTs, which have low Cs-137 concentrations. The low concentration would potentially allow liquids from the selected tanks to be processed without pretreatment in the WTP (see Issue 11, Table 4-2). The amount of waste processed and the processing rate vary with the Target and Stretch Cases.

1.2.4.2 TRU/LLW Sludge

Supplemental TRU/LLW Sludge treatment is unique to the Non-WTP Treatment pathway. Candidate sludge stored in some SSTs and DSTs is packaged directly for disposal as TRU waste and LLW in both the Target and Stretch Cases, which use the same set of assumptions in this area.

Tanks containing candidate sludge are SSTs in the T-200 series and B-200 series, Tank T-110, and Tank T-111. The DSTs with candidate sludge are AW-103, AW-105, and SY-102. Sludge in the SSTs is retrieved with minimal or no water addition, and packaged as contact-handled waste. No liquid is assumed to be returned from the SSTs to the DST system. Waste from the SSTs, except Tank T-110, is assumed to be TRU to be dispositioned at WIPP. Tank T-110 sludge is modeled as LLW and disposed onsite (see Sections 2.3.7 or 3.3.7 and Issue 18, Table 4-2).

Sludge in the three DSTs is treated using wash and decant steps, with the washed solids assumed to be contact-handled TRU (see Sections 2.3.7 or 3.3.7 and Issue 9, Table 4-2). Liquids from the wash steps are returned to DST system as LAW feed.

1.2.5 Interfacing Facilities

The major interfacing facilities are described in this section. Other interfaces, such as with roads, water supplies, and electrical supplies are not addressed.

1.2.5.1 Effluent Treatment Facility/Liquid Effluent Retention Facility

The Effluent Treatment Facility (ETF) processes the 242-A Evaporator condensate and aqueous waste water containing low specific radioactivity. The Liquid Effluent Retention Facility (LERF) collects and stores wastewater from various Site locations. Wastewater collected in LERF is sent to the ETF for treatment and disposal. Treated effluent is discharged to a State-Approved Land Disposal Site (SALDS).

Future services for ETF/LERF include processing WTP radioactive liquid effluent and potentially Waste Encapsulation and Storage Facility (WESF) pool cell water. Liquid effluent from packaging of TRU/LLW sludge may also be sent to the ETF/LEFR.

Modifications to the ETF waste solidification system may be required based on the expected composition and volume of the WTP radioactive liquid waste stream. Also, a life extension upgrade is planned for the LERF in FY 2015, based on its 20-year design life.

This Plan assumes ETF/LERF will be available throughout the ORP mission. If the treatment mission requires that changes be made to the ETF or its operating plans, the ORP is assumed to successfully drive the change.

The holding capacity of LERF is assumed to be 7.8 Mgal, and the throughput capacity of ETF is assumed to be 24 Mgal per year (5 Mgal per year evaporator condensate) for both the Target and the Stretch Cases.

1.2.5.2 Central Waste Complex

The Central Waste Complex (CWC) in the 200 West Area provides compliant interim storage for containerized LLW, mixed LLW on the Hanford Site, and TRU waste awaiting treatment and final disposal at the WIPP. The CWC receives solid waste from the tank farms and WTP.

1.2.5.3 Canister Storage Building (Interim Storage of HLW Canisters)

The IHLW canisters will be stored in existing vaults 2 and 3 at the Canister Storage Building (CSB) until they can be shipped to an approved offsite geologic repository. These vaults, after retrofitting by Project W-464, will be able to store 880 canisters of IHLW. After the CSB is full, IHLW will need to be shipped directly to the geologic repository at Yucca Mountain. The CSB will be a *Resource Conservation and Recovery Act* (RCRA)-permitted facility.

This is a change from the previous version of this System Plan which assumed construction of four additional CSBs, each with the capacity to hold 2,640 IHLW canisters and assumed that shipping to Yucca Mountain would not start until after 2030.

1.2.5.4 Integrated Disposal Facility (Retrievable Onsite Storage)

The ILAW packages from WTP LAW Vitrification and both WTP and Non-WTP Supplemental LAW Treatment are assumed to be disposed of directly at the near-surface ILAW Integrated Disposal Facility (IDF). The IDF consists of a trench that can be expanded as needed to support both the U.S. Department of Energy, Richland Operations Office (RL) and ORP disposal needs. The IDF is expected to be a RCRA-permitted facility. Final decisions concerning the use and configuration of the IDF will be made using the NEPA process.

1.2.5.5 222-S Laboratory

The 222-S Laboratory provides key analytical support for the operation (primarily waste compatibility analysis, 242-A Evaporator campaign planning, and SST retrieval) of the Tank Farms. Approximately 10,000 gallons per year of liquid waste is returned to the Tank Farms. The responsibility for operation of the 222-S Laboratory is currently being transferred to the Tank Farm Contractor (RPP-15069).

1.2.5.6 Other Hanford Site Facilities

A small amount of liquid waste continues to be received into the tank farms. The majority of waste from sources other than RPP is from the following facilities:

- Plutonium Uranium Extraction (PUREX) Facility, approximately 5,000 gallon per year;
- T Plant, up to 17,000 gallon per year plus 22% flush water;
- 300 Area, up to 29,000 gallons per year plus 44% flush water; and

- Plutonium Finishing Plant (PFP) stabilization, 45,000 gal total between 2002 and 2005 plus 22% flush water.

1.2.5.7 Waste Encapsulation and Storage Facility

Approximately one third of the cesium and strontium contained in the tank waste was previously removed and incorporated into capsules, which are stored in water pools located in WESF pending final disposition. WESF provides safe storage and monitoring of the capsules, which contain radioactive cesium chloride salt and strontium fluoride powder. The current inventory consists of 1,312 cesium capsules, 23 over-packed cesium capsules, and 601 strontium capsules. The capsules contain some 133 MCi of radioactivity. The disposition of the capsules is RL scope and is, therefore, not a part of this plan.

1.2.5.8 200 Area Liquid Waste Processing Facilities (Liquid to Ground)

The 200 Area Liquid Waste Processing Facilities dispose of clean/treated liquid effluents to the following liquid storage/disposal facilities:

- The SALDS receives discharge from ETF.

- The Treated Effluent Disposal Facility (TEDF) collects and routes non-hazardous, non-radioactive waste streams for disposal.

1.2.5.9 Yucca Mountain (Offsite Geologic Repository)

Geologic disposal is designed to isolate the IHLW canisters from the environment for tens or hundreds of thousands of years. The *Nuclear Waste Policy Amendments Act of 1987* (NWPA) lists Yucca Mountain, Nevada, as the only site to be studied as a candidate for a deep geologic repository. Based on the study results, Yucca Mountain, Nevada was recommended by the U.S. Department of Energy (DOE) to Congress in 2002 for selection as the geologic repository. However, until the site for a deep geologic repository is ready for receipt of the IHLW canisters, they will have to be stored and monitored on an interim basis at the CSB, and if necessary, additional storage facilities of similar design. Yucca Mountain will not be permitted for waste storage under RCRA.

1.2.5.10 Waste Isolation Pilot Plant

The WIPP, located in New Mexico, is the world's first underground repository that is licensed to safely and permanently dispose of TRU radioactive waste left from the research and production of nuclear weapons. The WIPP is designated to receive TRU waste from the DOE complex, including the Hanford Site. Candidate TRU sludge from the tank farms is assumed be retrieved, packaged to meet Waste Isolation Pilot Plant – Waste Acceptance Criteria (WIPP-WAC), and sent as contact handled- (CH-)TRU waste to the WIPP, according to this System Plan.

1.3 ORGANIZATION OF DOCUMENT

This System Plan addresses two sets of assumptions (cases) regarding the disposition of tank waste and the methods and timing for its retrieval, treatment, storage, and disposal. The cases include a Target Case and a Stretch Case. These cases are intended for strategic planning purposes and, therefore, were not constrained to match current contracts and requirements. Background information about the Waste Treatment Complex (WTC) common to both cases was presented in Section 1.2. Section 1.2 also provides general indications about where the two cases use different assumptions about WTC operations.

The Target Case is defined and its key features and results are discussed in Section 2.0; the Stretch Case in Section 3.0. These two sections intentionally contain common material so that they can be read apart from each other.

Section 4.0 provides summary results from both cases and a discussion of associated key issues and uncertainties.

References are located in Section 5.0.

This document also includes four appendices containing additional detailed information. A glossary of terms is provided in Appendix A. Appendix B summarizes the assumptions used in modeling the two cases. Appendix C defines the success criteria and key enabling assumptions used to develop the modeling inputs and mission planning bases for the two cases. Each case must meet the success criteria while conforming to the enabling assumptions.

Appendix D contains the mission summary diagram for the Target Case. The mission summary diagram provides the schedule of TFC projects and the major activities associated with this case.

This System Plan is one of a group of three related documents that all address planning cases for the WTC. The other two documents are *Single-Shell Tank Retrieval Sequence and Double-Shell Tank Space Evaluation* (RPP-8554) and the *Tank Farm Contractor Operation and Utilization Plan*, (TFCO&UP), (HNF-SD-WM-SP-012). The former comprises a detailed evaluation of tank retrieval and space planning. The TFCO&UP uses some of the results developed for RPP-8554 and includes additional modeling to estimate the composition of waste that will be transferred to the WTP. The TFCO&UP is aimed at implementing the tank farm contract. This System Plan uses related, but not identical, case information in order to evaluate potential improvements in the overall mission.

For traceability purposes, the detailed HTWOS modeling assumptions are maintained in the model archives and filed under “STC 7-21-2003a” for the Target Case and “SSC 8-12-2003 new-SST” for the Stretch Case.

2.0 TARGET CASE

2.1 PURPOSE

The purpose of the Target Case is to show how the ORP expects the waste treatment mission to proceed. This case asserts that the WTP being constructed by Bechtel National, Inc. (BNI) will perform better than the minimum contractual performance requirements in conjunction with WTP Supplemental LAW Treatment and a nominal amount of Non-WTP Supplemental Treatment of LAW and packaging of TRU/LLW.

The Target Case continues the alignment of the TFC's plans for Waste Feed Delivery (WFD), SST Retrieval, and Supplemental Treatment or Packaging with the hot commissioning and ramp-up plans for the WTP. Refinements to this Target Case are being used as an input to a baseline change request (RPP-03-009) for the TFC that is being prepared in parallel with this System Plan.

2.2 KEY FEATURES AND RESULTS

The key features of the Target Case from a strategic planning viewpoint are shown in Table 2-1. Those features that distinguish the Target Case from the Stretch Case are highlighted for easy comparison. A more detailed discussion of assumptions and results is presented in Section 2.3.

The Target Case met both of the success criteria that were established for the System Plan as shown in Table 2-2. The first criteria supports a literal interpretation of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement or TPA) Milestone M-62-00A, meaning that credit is only taken for waste that is "pretreated and vitrified" by the WTP. If credit is taken for both WTP and Non-WTP Supplemental LAW Treatment, then the criteria would be met approximately four years sooner.

Figure 2-1 presents a summary mass balance[1] for the Target Case. The figure tracks sodium, waste oxides[2] less sodium, sulfate, and activity. From this figure, two important metrics can be estimated:

- The total LAW product comprising WTP LAW glass, WTP Supplemental LAW product, and Non-WTP Supplemental LAW product is estimated to contain approximately 8 MCi of activity which is about 4% of the total activity in the waste.
- Approximately 37% of the LAW (measured as MT of sodium) is incorporated into the glass produced by the WTP LAW Vitrification Facility; the remaining 63% of the LAW is incorporated into either the WTP or Non-WTP Supplemental products.

[1] For simplicity, Stream 3 reflects the net removal of low-cesium feed from the tank farms after return of separated solids and Stream 12 reflects the net removal of TRU/LLW sludge from the Tank Farms after return of the carrier liquid used to deliver the TRU from the three DSTs.

[2] By convention, this coverts all nonvolatile waste components (less sodium) into their oxide forms, regardless of phase.

Table 2-1. Key Features of Target Case.

Key Feature	Target Case	Stretch Case
WTP Hot Commissioning – Full Operations	12/2009 – 2/2011	12/2009 – 2/2011
WTP Pretreatment Capacity	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr
WTP LAW Vitrification	28.8 MTG/d	34 MTG/d
WTP HLW Vitrification	5 MTG/d	5 MTG/d
WTP and Non-WTP Supplemental LAW Treatment	2011 – 2028	2011 – 2028
Non-WTP Supplemental LAW Treatment	3,100 MT Na	8,100 MT Na
WTP Supplemental LAW Treatment	31,000 MT Na	14,000 MT Na
Supplemental Sludge Treatment	12 TRU and 1 LLW	12 TRU and 1 LLW
WTP LAW Sodium Oxide Loading	Gimpel (~ 14.6 wt%)	20 wt%
WTP HLW Glass Properties Model	Relaxed	Relaxed

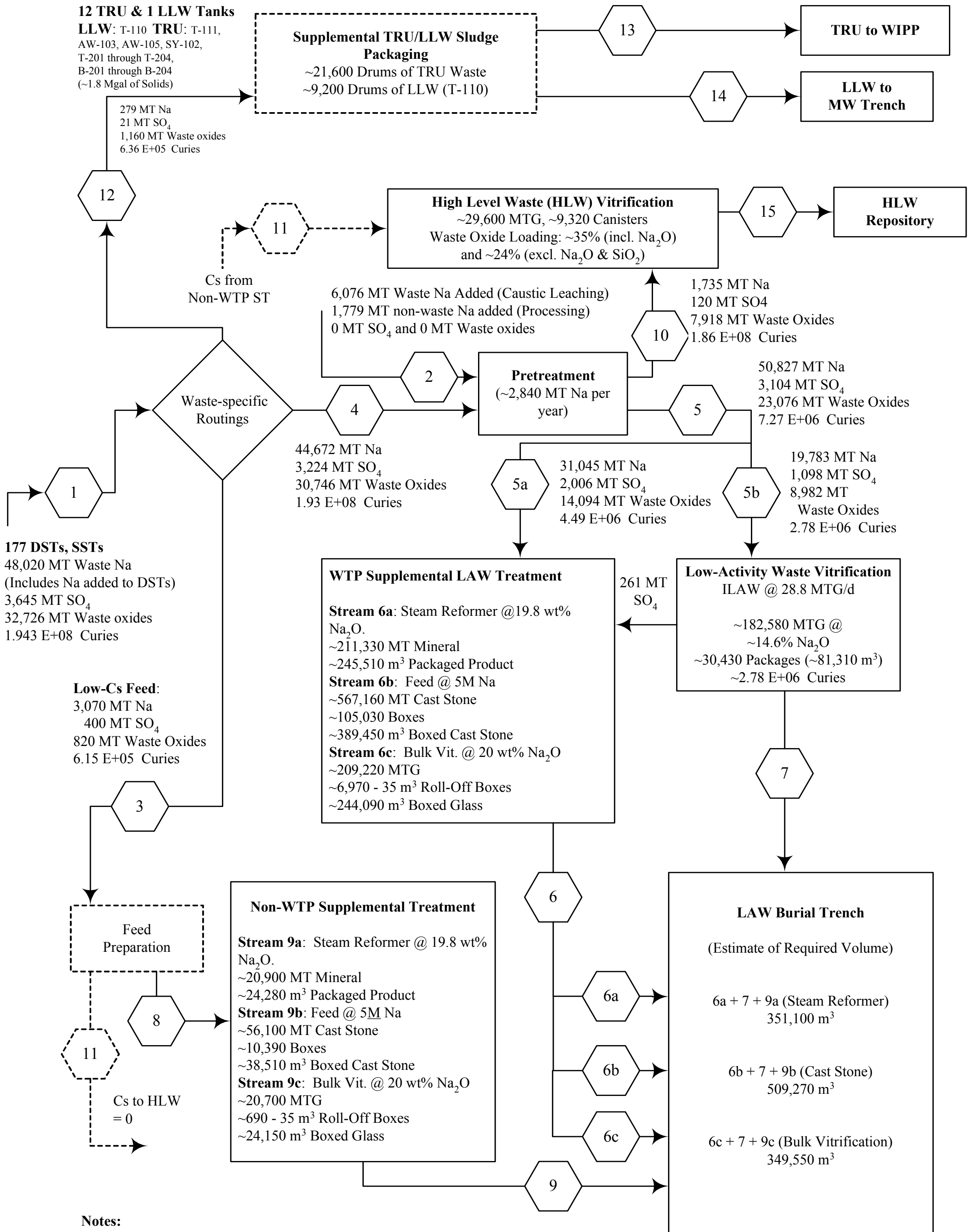
Notes:

HLW = High-level waste
LAW = Low-activity waste
LLW = Low-level waste
MT Na = Metric tons sodium
MTG/d = Metric tons of glass per day
WTP = Waste Treatment and Immobilization Plant

Table 2-2. Success Criteria for Target Case.

Success Criteria	Status
Pretreat and vitrify no less than 10 percent of the Hanford Site's tank waste by mass and 25 percent by activity by February 28, 2018. The 10 percent by mass is further defined to mean at least 6,000 MT of sodium from LAW feed and at least 800 MT of waste oxides from HLW feed.	These criteria were projected to be met in 1/2017. On 2/28/2018, the following amounts have been pretreated and vitrified by the WTP: • 7,200 MT Na • 3,800 MT waste oxides • 53% of the activity If credit is taken for the waste treated by both WTP and Non-WTP Supplemental LAW Treatment, then the criteria would be met in 3/2013.
The WTC *could* treat or package all Hanford Site tank waste by the 12/31/2028 TPA Milestone if all supplemental facilities are provided and the enhanced throughput rates achieved.	Treatment or packaging of all Hanford Site tank waste was projected to complete in 12/2028.

Figure 2-1. Summary Mass Balance – Target Case.



Notes:

1. All waste oxide values reported on the figure are excluding sodium oxide (Na_2O).

2. Na, SO_4, and waste oxide masses, Curies, and ILAW and IHLW quantity data are from HTWOS Model run "STC 7-31-2003a". All other product quantity data are calculated from HTWOS output data.

3. Activity values are indexed to January 1, 2001.

2.3 DISCUSSION

The results for the Target Case are generally organized along the lines of Figure 1-1, RPP System-Simplified Flow Diagram. Appendix D contains a Mission Summary Diagram for the Target Case. This diagram shows the timing of the various Tank Farm Contractor projects and the main feed delivery activities for the early portion of the mission. This covers the projects needed to support the initial LAW and HLW feed tanks, waste transfers, storage, disposal, shipping, and Non-WTP Supplemental Treatment activities.

2.3.1 Single-Shell Tank Retrieval

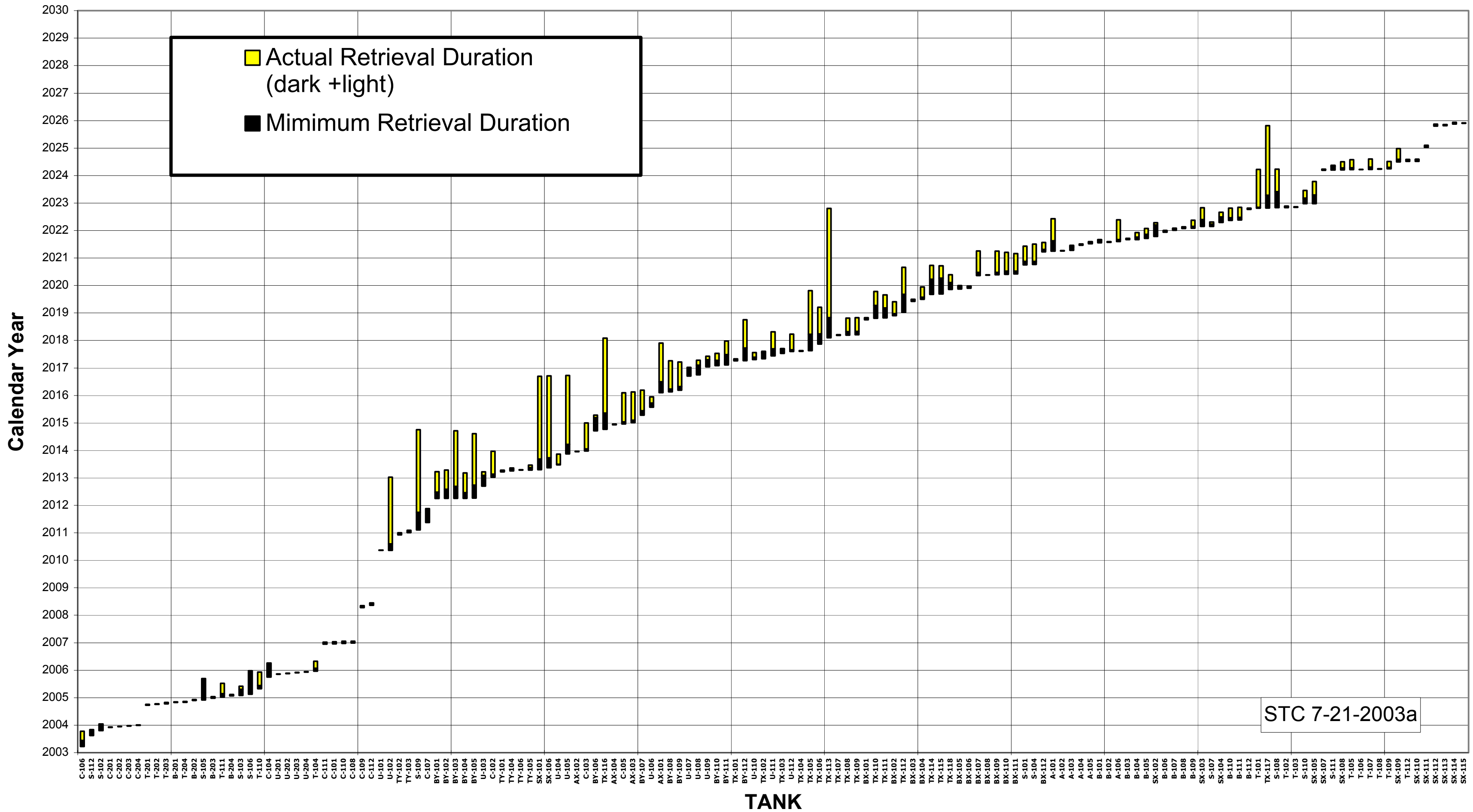
The transfer system and interface configuration to support retrieval of the SSTs into the DST system has not yet been defined. For planning purposes, it is assumed that the necessary upgrades will be provided.

The sequence and timing of the SST retrievals were established by the HTWOS model using the following general priorities:

- Retrieve the 7 SSTs with TPA Milestones on or before their due date;
- Provide up to 3,100 MT low-Cs feed;
- Retrieve up to 26 SSTs before the end of FY 2006, DST tank-space permitting, following the order and timing from the Planning Alignment Case 5-28-2003;
- Retrieve the remaining tanks from C-Farm to provide HLW feed for the WTP and to get ready for closing the first tank farm; and
- Retrieve the remaining tanks, in general order of risk, while balancing the amount of LAW and HLW required for operation of the WTP.

The resulting SST retrieval sequence for the Target Case is shown in Figure 2-2. Single Shell Tank Retrieval – Target Case. This sequence does not represent the final sequence and as such should be considered a placeholder while the SST retrieval sequence is refined to better reflect the TFC's emerging plans. The actual selection of retrieval sequence, while based on risk reduction and supplying feed to the WTP, will be guided by several factors. DST tank space limitations and ORP's initiatives to retrieve 40 SSTs before the end of FY 2006 will impact choice of tanks. Retrieval logistics, including pipeline and infrastructure availability, will affect retrieval capabilities, particularly as longer term projects and their detailed schedules are more clearly defined. The desire to prepare complete farms for closure may also impact retrieval selection. Application of the retrieval selection criteria will continue to be informed by the risk-based selection method included in the case models.

Figure 2-2. Single Shell Tank Retrieval – Target Case.



The retrieval selection criteria and tank retrieval sequence are part of the upcoming TPA negotiations for interim milestone M-45-00C. This milestone requires that the negotiations for a second phase of SST waste retrieval activities (for the period September 30, 2006 through September 30, 2015) be completed by February 28, 2004. In addition to the selection of a SST retrieval sequence, these negotiations will also address several closely related topics, including waste retrieval technology development; Retrieval Performance Evaluations (RPE); leak detection monitoring and mitigation (LDMM); design, construction and operation of SST waste retrieval systems, and closure planning/Closure Plan developments.

The results of the SST retrieval analysis are sensitive to some of the input assumptions, as described below.

The volume of waste retrieved from each tank depends on the tank waste inventory (amount and type of waste) and the selected retrieval technology. The retrieval technology selection depends on the soundness of the tank and its waste type. The volume that SST waste will occupy in the DST system after retrieval but before any waste volume reduction through the 242-A Evaporator is called the "as-retrieved" volume. The as-retrieved volume includes added water and is important in understanding the management of DST tank space and the demand placed on the 242-A Evaporator. The ability to predict the as-retrieved volumes is limited, but will improve as the various retrieval technologies are demonstrated in the field. Since DST space is being aggressively utilized prior to the startup of the WTP, increases in the as-retrieved volume will increase the transient demand for DST tank space and may reduce the number of SSTs retrieved by the end of FY 2006 while decreases in the as-retrieved volume may allow additional SSTs to be retrieved.

The duration of retrieval is estimated for each SST depending on its inventory and the retrieval technology selected. These minimum durations form part of the modeling assumptions. They are the same for the Target and Stretch Cases. Results of modeling show that some of the actual durations are longer than the minimum specified. This situation indicates the presence of a constraint that delays the retrieval completion. Constraints include limitations on pipeline availability, DST space, and assumed limits on the number of simultaneous transfers allowed. Since some constraints (such as projects) may be fixed in time, the actual retrieval durations may differ between the Target and Stretch Cases, since the Target and Stretch Case retrieval sequences differ.

Another source of uncertainty is in the starting inventory and partitioning assumptions. The starting inventory is established by the Best-Basis Inventory (BBI) using sample data and the Hanford Defined Waste (HDW) model (LAUR-96-3860). The BBI is under configuration control. Partitioning assumptions determine for modeling purposes how much of the saltcake and sludge dissolves when retrieved with water. The partitioning assumptions arise from Best Basis Wash Factors, which were established in 1998 using limited sample data and predicted waste behavior where sample data were not available. Wash factors for aluminum and chromium are currently being revised, since these elements can affect the volume of HLW glass produced from a given amount of waste. Changes in the water wash factors could change the estimated amount of waste sent to each of the various treatment pathways (WTP HLW Vitrification, WTP LAW Vitrification, Non-WTP Supplemental Treatment, WTP Supplemental

Treatment). If the changes are large enough, the desired system configuration could change. Section 2.3.6.2 contains additional discussion on water wash and caustic leach factors.

Previously, four planned WRFs were used in modeling, each one supporting collection and conditioning of retrieved waste for a quadrant of SSTs. The WRFs would provide the infrastructure for supporting multiple retrievals from a given quadrant and help prepare the waste and transfer it to the DST system. The southeast (SE) quadrant WRF was determined not to be needed because waste in the SE quadrant and southwest (SW) quadrant (other than U-Farm) can be retrieved directly to DSTs. Current plans and assumptions for both the Target and Stretch Case call for one WRF for each northern quadrant, plus one for U-Farm (TFCO&UP, Rev. 4B, page A-68). WRFs are assumed not to be required for retrieving SSTs for Supplemental Sludge Treatment, and SSTs retrieved prior to October 1, 2009 are assumed to not require a WRF.

2.3.2 Double-Shell Tank Operation

The DSTs are used for a variety of purposes, which include:

- Storage of waste retrieved from SSTs,
- Staging of feed for the WTP,
- Staging of waste to and product from the 242-A Evaporator,
- Receipt of newly generated waste from legacy facilities,
- Staging of remote-handled TRU to Supplemental Sludge Packaging, and
- Possible staging of low-Cs waste to Supplemental LAW Treatment.

The HTWOS model tracks the volumes and composition of waste in all of the DSTs. Figure 2-3 shows the demand on DST tank space and the allocation of the "unused" space. The Target Case stays within the maximum DST system capacity. However, tank space is very tight between FY 2003 – FY 2011, limiting the number and volume of SSTs that can be retrieved into the DST system before FY 2011. After FY 2011, the WTP and Non-WTP supplemental LAW Treatment begin operation which frees up DST tank space allowing SST retrieval to proceed at an increased rate.

The actual volume of waste in the DST system is the sum of the volume of the waste originally in the DST system and the volume occupied by waste retrieved from the SSTs. A portion of the DST tank space is allocated for various purposes and, therefore, not available for other uses, such as retrieval of SST waste. These allocations include emergency tank space, evaporator operational space, restricted space for tanks containing TRU sludge, WTP feed staging tank headspace, and headspace above tanks into which additional waste may not be added for safety basis concerns.

The total allocated space slightly exceeds the total system capacity around FY 2014 and FY 2016. This is an artifact due to unnecessarily reserving the evaporator operational space during periods in which the evaporator is not used (both the feed and bottoms tank for the evaporator are empty when these peaks occurs). The fix is to either reallocate the evaporator operational space or use the space for evaporator campaigns.

Credit for some of the various tank space saving options described in the *Integrated Mission Acceleration Plan* (IMAP) (RPP-13678) have been taken by the Target Case. These include:

- Increase the DST fill height from 416 to 436 inches in 22 tanks.
- Reserve only the space equivalent to one DST as emergency space.
- Stage and concentrate dilute supernatant up to a 1.41 specific gravity (SpG).
- Retrieve TRU/LLW waste from the SSTs directly to a packaging system.
- Implement tank-by-tank evaluations to allow greater concentration of wastes beyond current 1.41 SpG limit. A 1.47-SpG limit is used as a placeholder for this action.
- Use a portion of the "restricted" space in tanks that contain staged feed for WTP. This activity may affect existing characterization of the WTP.

Figure 2-3. Double-Shell Tank Space Utilization – Target Case.

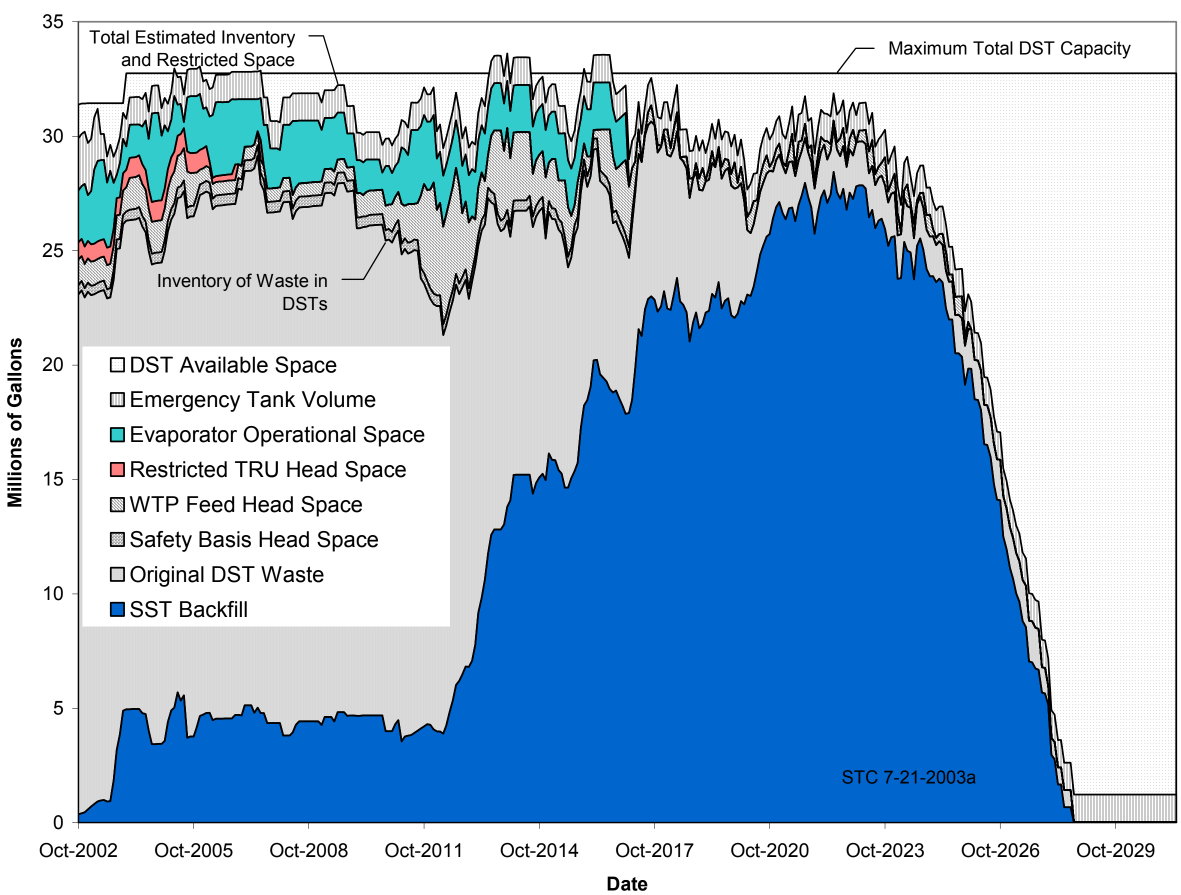


Figure 2-4 shows the delivery schedule for each feed batch to the WTP through 2018. The figure shows the destination of the feed (LAW or HLW feed receipt tanks), the source tank and the planned envelope (A, B, C, or D), and any staging tanks. For HLW feed, multiple batches of feed are delivered from the same batch group; the timing of these deliveries also is shown as small tic marks. Delivery schedules for feed batches after 2018 have been modeled to support this System Plan but are not shown because of the large number of transfers. Future revisions to this System Plan can show the post-2018 transfers as the transfers get closer to implementation.

The key enabling assumptions (see Appendix C) state that "the scenarios will not be constrained to match current contracts, performance based initiatives, funding, interface control documents, or other planning guidance except as captured by the key enabling assumptions." Therefore, a review of the compliance with existing feed specifications was not performed for this version of the System Plan.

Most of the initial feed batches for the WTP have been placed under configuration control (Boston 2000) and require ORP permission before the composition or quantity of feed can be materially changed. These tanks are shown on Figure 2-4 with a thick solid or dotted border. Those tanks with thick, *solid* borders remain static, except for those activities needed to deliver them as feed to the WTP. However, the composition or quantity of the feed in the four tanks with thick, *dotted* borders has been changed by the Target Case. These changes are similar to those in the baseline established by Baseline Change Request (BCR) RPP-03-007 and the WFD Project Implementation Plan (letter CH2M-0301858) and are summarized in Table 2-3. Additionally, a fifth tank (AW-103) which is under configuration control is not shown on Figure 2-4 since it is packaged as TRU instead of being delivered to the WTP for treatment as HLW.

A new process is being implemented to handle existing and emerging feed configuration control decisions. These decisions include changes to feed tanks currently under configuration control, insertion of new feed tanks (such as Tanks AP-103 and AP-105) in the sequence, and how to determine if an existing or proposed feed is suitable for delivery to the WTP (which may go beyond simple compliance with the contractual feed specifications). This process will consider the impacts that SST retrieval and 242-A Evaporator campaign decisions being made today will have on the feed being delivered to the WTP during its first years of commissioning and operation.

Figure 2-4. Time Phased Feed Delivery – Target Case.

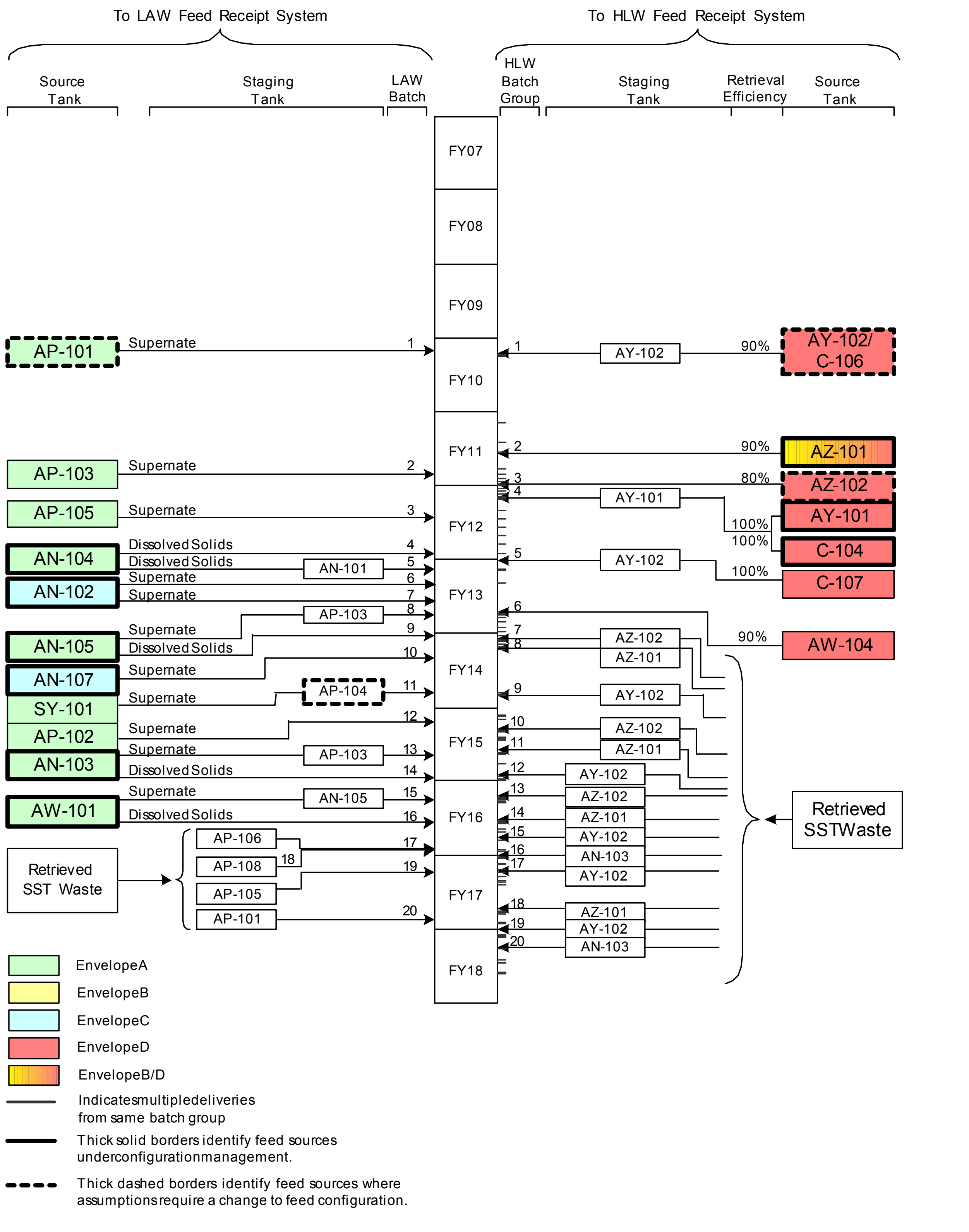


Table 2-3. Changes to Feed Configuration of Initial Feed Tanks – Target Case.

Tank	What Changes	Why
AP-101 LAW Feed Hot commissioning	The tank is emptied of dilute supernatant and refilled with more concentrated waste from the 242-A Evaporator.	Make more effective use of the space in AP-101 and thus retrieve more SST waste prior to 2011.
AZ-102 HLW Feed	The supernatant is decanted and blended with other dilute waste and concentrated with the 242-A Evaporator. The tank is refilled with concentrate from another evaporator campaign.	Reduce sulfate concentration in delivered feed to extend LAW melter lifespan and operability. Make more effective use of the space in AZ-102 and thus retrieve more SST waste prior to 2011.
AY-102 HLW Feed Hot commissioning	The supernatant is decanted and blended with other dilute waste and concentrated with the 242-A Evaporator. The tank is refilled with concentrate from another evaporator campaign.	Make more effective use of the space in AY-102 and thus retrieve more SST waste prior to 2011.
AP-104 LAW Feed	The tank is emptied of dilute supernatant and refilled with more concentrated waste from the 242-A Evaporator. This waste includes a portion of the waste originally in SY-101.	Make more effective use of the space in AP-104 and thus retrieve more SST waste prior to 2011.
AW-103	The sludge in this tank is consolidated, washed, and packaged as TRU waste.	Accelerate cleanup and reduce avoid treating TRU waste with more expensive HLW treatment technology.

One of the uncertainties with the delivery of the initial HLW feed batches is the amount of waste that will be mobilized by the mixer pumps in the DSTs and delivered as feed. Adjustments in retrieval system project timing may be required depending on actual retrieval system performance and WTP performance.

The Target Case uses several DSTs equipped with mixer-pumps and transfer pumps with dilution water capabilities to stage HLW feed for delivery to the WTP. The number of tanks used for HLW feed staging varies from three to five as new retrieval systems come on-line and as tanks are assigned new functions. Waste retrieved from the SSTs is transferred into an available staging tank through a WRF or from another DST. The waste is mixed and sampled and the sample provided to the WTP for use in feed acceptability determinations and for process control purposes. Two-hundred and seventy (270) days after a staging tank is full, the waste is assumed to be available for delivery to the WTP.

In a few cases, even with the use of five HLW staging tanks, the assumed 270-day waiting period limits, or nearly limits, the ability to provide a timely supply of HLW feed to the WTP. This is expected to be less of a concern in the future since the interface control documents

(ICD-19 and 20) have reduced this period to 180-days. The assumptions for future revisions to the System Plan should be brought into alignment with this reduced waiting period.

The Target Case used two different approaches for staging LAW feed depending on the physical condition of the feed. If the feed is primarily liquid, the supernatant is staged in a DST (which can be the same DST as the source DST) prior to sampling and delivery to the WTP. If necessary, dilution water can be added during the delivery transfer to ensure that the waste is below saturation in major sodium salts and meets the overall sodium concentration limits in the feed specification. If the feed is from one of the four saltcake-containing DSTs (AN-103, AN-104, AN-105, or AW-101), the supernatant is first decanted into another DST for staging as one batch of feed. The remaining salts are dissolved using water and mixer-pumps and delivered as a separate batch. For Tank AN-104 only, the dissolved solids and supernatant batches are blended together to reduce the peak sulfate concentration before delivery.

2.3.3 Tank Farm Waste Evaporator (242-A Evaporator) Operation

The 242-A Evaporator is operated on a campaign basis to concentrate tank waste as required by ORP through FY 2018. Responsibility for the 242-A Evaporator was transitioned to the TFC in May 2003. Demands on the evaporator differ between the Target and Stretch Cases because of differences in the waste retrieval schedule. Other evaporator assumptions are the same for both cases.

The 242-A Evaporator processing sequence in the simulation is designed to model the actual activities in the tank farms. After a dilute receiver tank is filled with waste, the contents are transferred to an available holding tank, sampled, and transferred to the 242-A Evaporator feed tank (Tank AW-102) for evaporation. Evaporator feed may be sampled and staged in one or more DSTs, including the evaporator feed tank during the three-month period prior to processing.

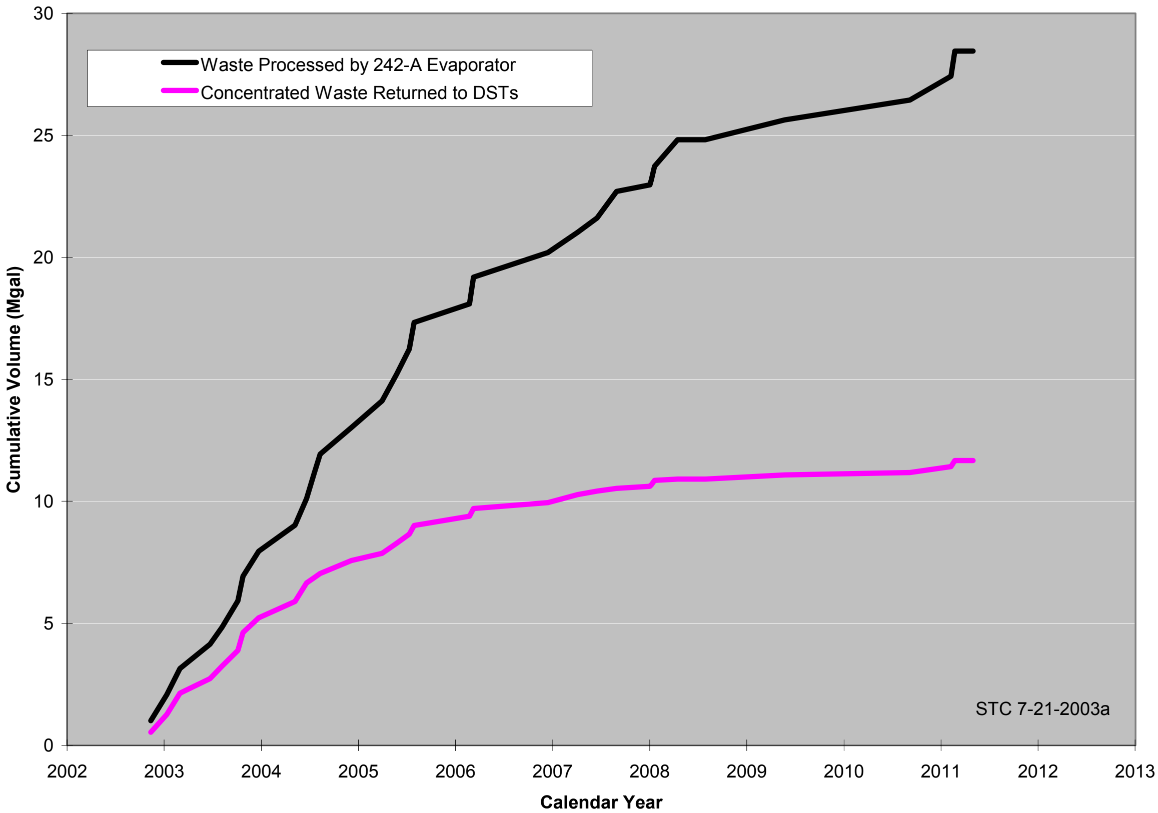
After dilute waste is concentrated in the 242-A Evaporator, it is sent to a slurry receiver tank (Tank AW-106) and then transferred to another DST for storage. The concentrated waste will eventually be treated for disposal through the LAW processing facilities.

Figure 2-5 shows the amount of waste processed by the 242-A Evaporator along with the volume of concentrated waste returned to the DST system. The difference between the two curves represents the reduction in waste volume achieved by operating the evaporator. Through 2011, approximately 28 Mgal of waste will be processed through the evaporator resulting in approximately 12 Mgal of concentrated waste with a corresponding waste volume reduction of about 16 Mgal. Although the 242-A Evaporator is assumed to be available until 2018, it was not used beyond 2011. Once the WTP and Supplemental Treatment facilities began full operations, the need for the evaporator to create DST space is diminished. Evaluation of the continued need of the 242-A Evaporator though 2018 is beyond the scope of this version of the System Plan.

<u>Evaporator Bottoms Concentration</u> – The model assumes that the evaporator concentrates waste to a density of 1.41 g/mL until June 1, 2003, when the limit is raised to 1.47 g/mL as one of the tank space saving options. Operating the Evaporator to produce a denser waste increases the waste volume reduction and provides more DST space. The 1.47 g/mL limit is a placeholder

value that is broadly applied to all waste. In actual operations, the final density will vary according to the chemistry of the individual waste. The allowed extent of evaporation is sensitive to the need to prevent accumulation of trapped flammable gas, and the amount of recovered DST space is sensitive to the final waste density. If the waste cannot be concentrated as much as planned, the SST retrieval schedule may experience delays.

Figure 2-5. 242-A Evaporator Operation – Target Case.



Useful life and upgrades/outages – The evaporator is assumed to have a useful life through 2018, which is sufficient to support the proposed cases under the assumptions given. Both the Target and Stretch Cases assume three-, four-, and three-month facility maintenance and upgrades outages in 2003, 2004, and 2005, respectively. Planned outage activities include replacing the condensers and compressors. The evaporator is not operated for three to four weeks each summer to allow for the required inspection of its packaged boilers, which supply both process steam and building heat. Because of piping manifold design at the LERF, an outage is also required when wastewater collected in LERF Basin 42 is processed through the ETF (this restriction is being eliminated with a new manifold design). Increases in the duration of the outages or shifts in the timing of the outage can impact the evaporator's ability to generate free DST space when needed.

Sample time – Previous evaluations assumed baseline feed staging duration, which includes sampling and analysis of the feed, of four months. Both the Target and Stretch Cases now assume a three-month staging duration. This is based on efficiencies that occur because both the 242-A Evaporator and the 222-S Laboratory have been transitioned to the TFC.

Water Management – The amount of water added during waste retrieval directly impacts the demand on the evaporator. The capability to accurately predict how much water will be added during retrieval is not yet available, but will improve with operating experience. The model results are very sensitive to these assumptions. If more water is added during retrieval, it will take longer for the evaporator to generate free DST space, possibly impacting the SST retrieval schedule.

Liquid Effluent – Both the 242-A Evaporator and the WTP discharge wastewater to the LERF and ETF (see Section 2.3.4). While the volume capacities of LERF and ETF are included in the model assumptions, the acceptance criteria and process parameters for ETF are not modeled for this version of the system plan. Additionally, the WTP is expected to place a high dissolved solids demand on the ETF – outside its current processing capacity. If so, modifications to ETF may be required, impacting its availability.

2.3.4 Effluent Treatment Facility/Liquid Effluent Retention Facility

The ETF processes the 242-A Evaporator condensate and aqueous wastewater containing low specific radioactivity. The LERF can receive and store wastewater from various Site locations including the tank farms and WTP. The wastewater is sent to the ETF for treatment and disposal. Treated effluent is discharged to a State-Approved Land Disposal Site (SALDS). Assumptions and the discussion regarding ETF are the same for the Target and Stretch Cases.

The demand on the LERF and ETF has not been modeled since this version of the System Plan assumes that they will be able to support the mission. Volumetric capacities are assumed for each, but acceptance criteria have not been addressed, and projected contributions from WTP and other sources to LERF/ETF have not been compiled. As a result, no model reports for LERF/ETF as a result of case assumptions are available.

The ETF is designed to process condensate at up to 150 gpm with a 72% total operating efficiency (TOE) for an average processing capacity of 108 gpm (WHC-SD-C018H-FDC-001, Rev. 3). This value will be lower if the wastewater contains lots of organics or dissolved solids.

Unit operations in the ETF include a primary treatment train and a secondary treatment train. The primary treatment train includes filtration, ultraviolet oxidation, pH adjustment, degasification (dissolved gas removal for gasses such as CO_2), reverse osmosis, and ion exchange. The secondary treatment train includes an evaporator, thin film dryer, and drum fill and handling system. The process pathway through ETF can be adjusted for efficient processing according to waste composition. Products of ETF are treated wastewater and packaged solids containing material removed from the wastewater. The ETF feed flow rate capacity is sensitive to the composition of the wastewater it receives. Feed to the ETF must be filtered by generators to remove particulate, but dissolved chemicals that will be extracted by the dryer place a burden on the equipment, and are limited.

Large amounts of Na and SO_4 or other dissolved solids in the wastewater from the WTP pose an issue. Although not modeled in this revision of System Plan, Revision 1 of this System Plan reported 200 MT Na and 90 MT SO_4, primarily from WTP evaporator overheads, transferred to ETF. This is a known issue that is being addressed via WTP forecasts and evaluations by ETF staff in support of WTP Interface Control Document No. 6 (ICD-6). The forecasts are affected by changes in the WTP capacities and configuration.

If the wastewater produced by the 242-A Evaporator and WTP occupies the entire ETF processing capability, other users, such as groundwater remediation, may be impacted. Additionally, evolving plans for the Supplemental Sludge Packaging may add 1–2.5 Mgal of liquid for treatment at the ETF.

Another sensitivity is the lag storage capacity of the LERF basins. Three LERF basins provide feed to the ETF. One is used for the RCRA wastewater that is produced by the 242-A Evaporator and will be produced by WTP and Supplemental Treatment. The other two basins are used for specific types of *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) waste, including wastewater from groundwater remediation and leachate from the Environmental Restoration Disposal Facility (ERDF). (The CERCLA wastes are further subdivided between the two assigned basins by chemical composition to optimize ETF processing.)

RCRA and CERCLA wastewaters are segregated because the solid powder secondary waste produced from RCRA wastewater must be disposed as mixed waste. Powder from CERCLA wastewater can be disposed at ERDF, which is more economical. Each LERF basin has a capacity of 7.8 Mgal. If the WTP/242-A/Supplemental Treatment wastewater overwhelms the capacity of a single basin, continued segregation of RCRA and CERCLA wastewater to achieve cost efficiencies may be affected.

2.3.5 Waste Treatment Plant

2.3.5.1 Pretreatment

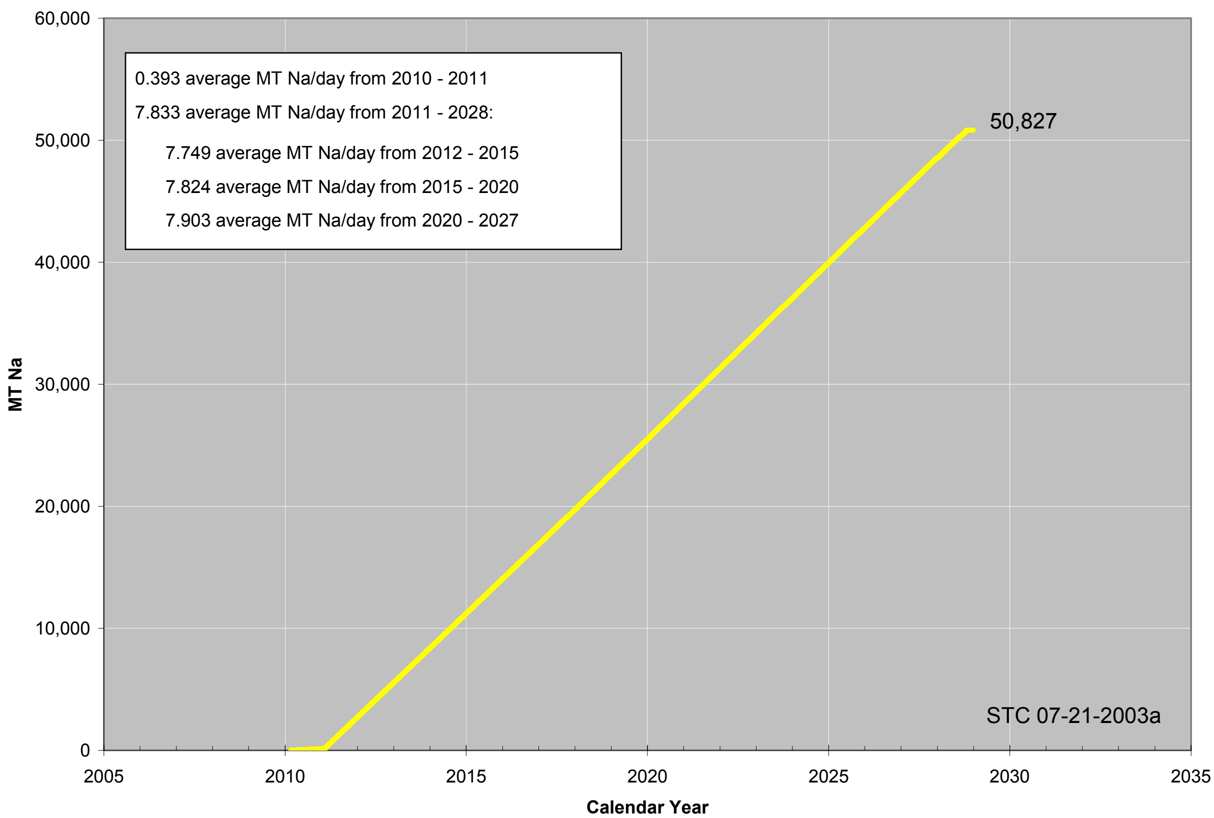
The Target Case assumes that the Pretreatment Facility can produce up to an average of 2,950 MT of sodium per year of pretreated LAW and sufficient pretreated HLW to produce up to 571 canisters of IHLW per year.

The LAW pretreatment capacity is based on a maximum capacity of 3400 MT Na/yr and 86% TOE. The basis for the TOE is *Assessment of Operations Research (OR) Model Run for the Technical Integration Baseline Development Team (TIBDT)*, (24590-PTF-RPT-PT-02-001, Rev. 0). The basis for the maximum capacity of 3,400 MT Na/yr is the “5-day” average goal of 90 MTG/d stated for PT L in Table C.6-5.1 of the BNI Contract, mod A029 and an average Na2O loading of 14 wt%.

The HLW pretreatment capacity is assumed to support a HLW Vitrification Facility producing an average rate of 5.0 MTG/d, 365.24 day/yr, and 3.2 MTG per canister. Since this capacity is given in terms of glass production and matches the HLW Vitrification assumptions (see Section 2.3.5.3, HLW Vitrification), a separate “process governor” for HLW pretreatment was not needed or modeled.

Figure 2-6 shows the estimated amount of pretreated LAW, reported as MT of sodium, produced by the WTP Pretreatment Facility. During modeling, the average LAW pretreatment capacity was adjusted slightly so that the proper amount of pretreated waste was directed to WTP Supplemental Treatment. During full operations, the LAW pretreatment rate varied from 2830 to 2890 MT Na/year with an average of 2860 MT Na/yr. This is consistent with the average maximum production capacity of 2950 MT Na/yr.

Figure 2-6. Pretreated LAW Production – Target Case.



The primary partitioning of waste into liquids and solids is described in Section 2.3.6.2, Water Wash and Caustic Leach Factors – the physical solid/liquid separation of the partitioned waste is accomplished using the Ultrafilter (UF) in the WTP. Additional partitioning takes place in the various unit operations (such as in the evaporators and the ion exchange systems) in the Pretreatment Facility.

The capacity of the Pretreatment Facility to produce pretreated liquids and solids is governed by a complex interaction between the feed delivered to the plant, the design of the various unit operations, and their planned operating modes including recycles. Nonetheless, the performance of three pretreatment systems is key to maintaining treatment capacity: the ultrafiltration system, the treated LAW evaporator, and the Cs Ion Exchange system.

The tank waste contains significant quantities of total organic carbon (TOC), much of which is oxalate. Although not modeled in the System Plan, oxalate may present process challenges if present at or near its solubility limits. On a case-by-case basis, the process will need to be evaluated to determine if the concentration of received TOC can be fed directly to either melter facility or if it will require special consideration.

2.3.5.2 LAW Vitrification

The Target Case assumes that the LAW Vitrification Facility can produce an average of 28.8 MTG/d at a sodium oxide loading determined by the Gimpel rule (24590-LAW-M4C-LFP-00002 and 24590-WTP-MCR-PT-02-002).

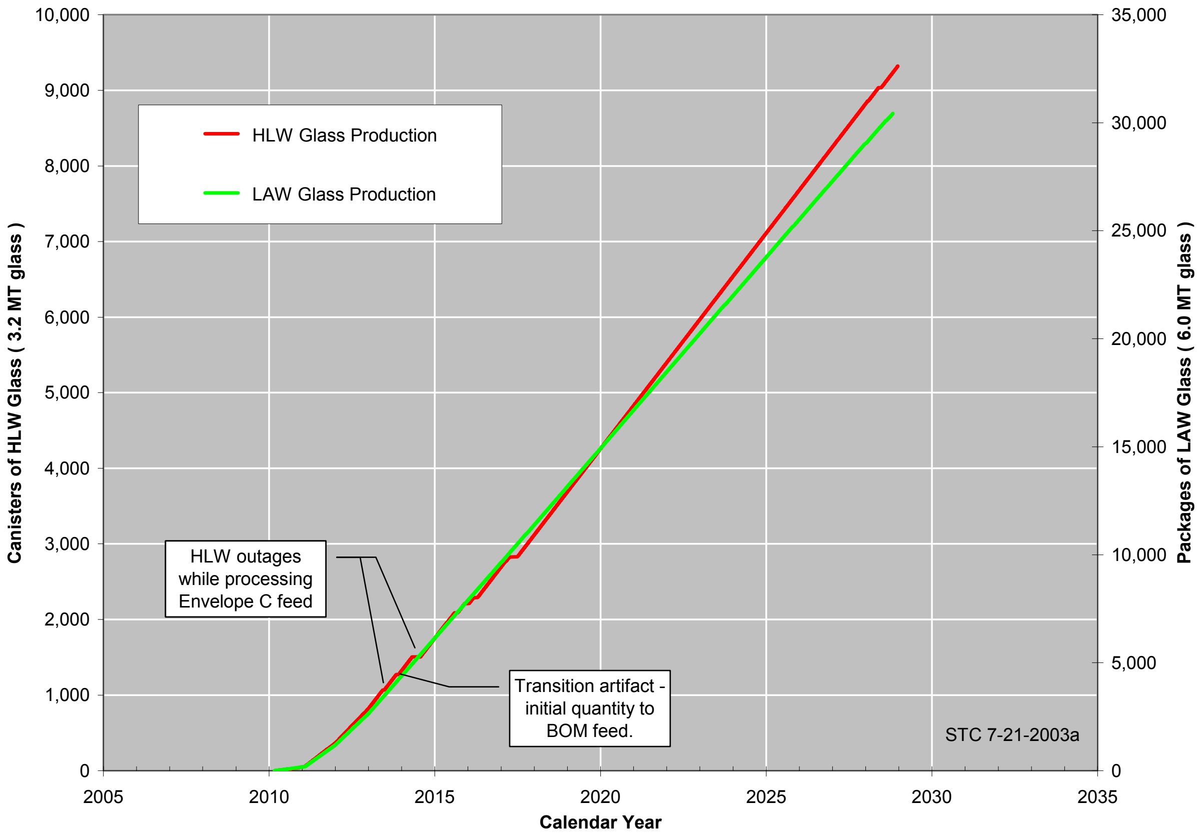
The average production is based on a nameplate capacity of 36 MTG/d and a 0.80 TOE. The basis for the TOE is *Low Activity Waste Facility Operations Research Availability Assessment* (24590-LAW-RPT-PO-03-001, Rev. 0) and is driven by the 16-week bubbler life. It is assumed that the TOE stated in the reference (0.774) can be increased to an average of 0.80 over the mission. The basis for the nameplate is the five-day average goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract for the LAW Facility.

During hot commissioning, the LAW Vitrification Facility was assumed to produce 188 packages of glass. This number is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. For modeling purposes, the corresponding average LAW vitrification rate (from March 1, 2010 through January 31, 2011) of about 3.36 MTG/d was selected so that the contract goals would be just met by the end date for hot commissioning. During full operations, the LAW glass production was assumed to ramp-up to 28.8 MTG/d over several years. The ramp-up is shown in Table 2-4, below. The green line in Figure 2-7 shows the resulting estimated production of LAW glass over time.

Table 2-4. LAW Vitrification Facility Ramp-Up – Target Case.

Date	Rate (MTG/d)
3/1/2010 – 1/31/2011	3.36 yielding 188 Packages
Starting on 2/1/2011	18.0
Starting on 1/1/2012	24.0
Starting on 1/1/203	28.8

Figure 2-7. Waste Treatment Plant Glass Production – Target Case.



The LAW glass production for the Target Case is based on the Gimpel rule (24590-LAW-M4C-LFP-00002 and 24590-WTP-MCR-PT-02-002). The Gimpel rule is an empirical relationship that estimates how much LAW glass will be made from a given amount of sodium and sulfate in the feed. The amount of pretreated waste that can be incorporated into the LAW glass (measured by the sodium oxide loading) is generally limited by the amount of sulfate in the feed. The average sodium oxide loading in the LAW glass is 14.6 wt% for the Target Case.

Approximately 1.4% of the total activity is expected to be incorporated into the LAW glass.

2.3.5.3 HLW Vitrification

The Target Case assumes that the HLW Vitrification Facility can produce an average of 5.0 MTG/d at a waste oxide loading determined by the relaxed glass properties model.

The average production is based on a nameplate capacity of 6 MTG/d and an 84% TOE. The basis for the TOE is *High Level Waste Facility Operations Research Availability Assessment*, (24590-HLW-RPT-PT-02-001, Rev. 0). The basis for the nameplate is the goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract.

During hot commissioning, the HLW Vitrification Facility was assumed to produce 56 canisters of glass. This number is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. For modeling purposes, the corresponding average HLW vitrification rate from May 17, 2010 through January 31, 2011 of about 0.69 MTG/d was selected so that the contract goals would be just met by the end date for hot commissioning. During full operations, the HLW glass production was assumed to ramp up to 5.0 MTG/d over several years. The ramp-up is shown in Table 2-5, below.

Table 2-5. HLW Vitrification Facility Ramp-Up – Target Case.

Date	Rate (MTG/d)
3/1/2010 – 1/31/2011	0.69 yielding 56 Packages
Starting on 2/1/2011	3.0
Starting on 1/1/2012	4.0
Starting on 1/1/203	5.0

The red line in Figure 2-7 shows the resulting estimated production of HLW glass over time. The first and third outages (seen as flat spots) result from the processing of Envelope C feed since HLW sludge cannot be caustic leached in the ultrafilters at the same time as the Sr and TRU are being precipitated from the Envelope C feed. During Envelope C processing, the HLW melters continue to run until the backlog of pretreated HLW sludge has been processed.

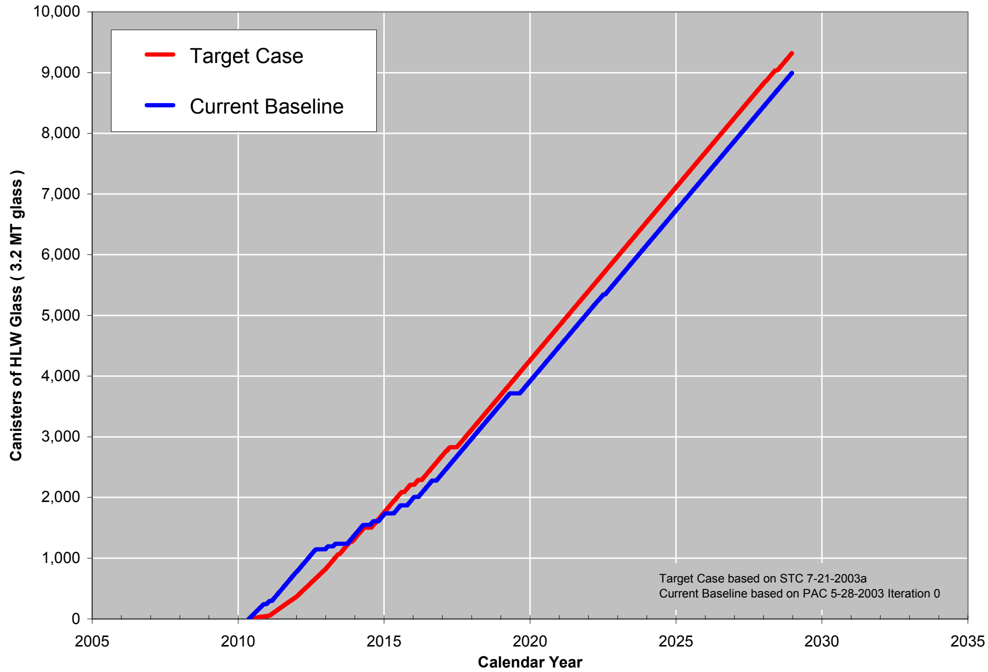
The second outage is a modeling artifact that was originally intended to allow for reporting on the initial order quantity feed separately from the feed for the balance of mission (BOM). This outage will disappear during future maintenance of the HTWOS model.

The other minor outages result from many intertwined factors such as the SST retrieval sequence and risk-based prioritization of retrievals, the relative balance of sludge and saltcake retrievals, the overall configuration (topography) of the retrieval and feed staging systems, constraints on simultaneous retrievals and transfers, the degree of incidental blending, the number and location of the HLW feed staging tanks, and the assumed 270-day waiting period.

As seen in Figure 2-8, the HLW glass production curve for this version of the System Plan is significantly better than the current Tank Farm Contractor Baseline established by BCR RPP-03-007 and the WFD Project Implementation Plan (letter CH2M-0301858). The early retrieval of sludge tanks from C-Farm after the initial 26 SSTs builds up a supply of HLW feed in the DST system that fills in most of the outages (the HLW outages in the baseline totaled about four to five years while in this version of the System Plan they total a little over one year). Another factor in reducing the HLW feed outages is that the gradual ramp-up of the HLW Vitrification Facility slightly delays the need for feed in the early years.

Using the assumptions established for the Target Case, the pretreatment and vitrification of HLW drives the duration of the treatment mission. Any changes that increase the amount of HLW glass produced or limit the production rate will increase the duration of the mission. Keep in mind that in the Target Case, sufficient Supplemental LAW Treatment capacity was added to ensure that LAW processing would not be the bottleneck.

Figure 2-8. Improvements in HLW Glass Production – Target Case vs. Current Baseline.



2.3.6 HLW Glass Volume

The quantity of HLW glass depends on the waste composition and quantity, water wash and caustic leach factors, post-leach wash effectivness, glass property model constraints, and the degree of blending. HLW glass volume is given its own section since these factors cross-cut both the Tank Farms and WTP.

2.3.6.1 Waste Composition and Quantity

The starting composition and quantity of waste for the Target Case is based on the BBI and represents the tanks contents on June 30, 2002. An assessment of the impacts of uncertainty in the BBI on HLW glass volume is beyond the scope of this version of the System Plan.

A portion of the insoluble solids (sludge) has been provisionally identified for packaging and disposal as TRU or LLW waste. However, if this waste is instead treated as HLW and pretreated and vitrified through the WTP, the estimated quantity of HLW glass will increase by about 15%, with a corresponding increase in mission duration.

2.3.6.2 Water Wash and Caustic Leach Factors

The water wash factors describe the solubility of the tank waste when contacted with large quantities of water. They define both how much saltcake dissolves during retrieval and how much slightly soluble material is removed from sludge when water-washed in the Pretreatment Facility. The caustic leach factors describe the solubility of the water-washed solids when contacted with a sodium hydroxide solution in the Pretreatment Facility.

The water wash and caustic leach factors are based on experimental data, solid-liquid equilibrium calculations, and extrapolations. Each tank contains one or more types of wastes, currently defined by the Hanford Defined Waste (HDW) model (LAUR-96-3860). Waste type templates (RPP-8847) are used to specify how much of each waste type is present in each tank. The wash and leach factors for a specific tank and analyte are determined using the following sources of information, in order of decreasing precedence:

- Experimental data specific to the tank and analyte,
- Calculated solid-liquid equilibrium conditions,
- Average values for waste template, and
- Global average values for all waste.

New estimates of the water wash and caustic leach factors for two components (Cr and Al) that currently drive HLW waste oxide loading have recently been documented (RPP-10222 and RPP-11079), but not yet included in the modeling assumptions. A future version of the System Plan will implement the new water wash and caustic leach factors along with oxidative leaching (RPP-15552). Oxidative leaching, if feasible, will roughly offset the 2 to 3 times increase in HLW glass volume expected from the change in these wash and leach factors.

The water wash and caustic leach factors in this revision of the System Plan are based on a conglomeration of three sources, documented in the Tank Waste Information Network System (TWINS):

- Initial order quantity tanks use water wash and caustic leach factors from Hendrickson in HNF-3157, except for caustic leach values for Al, Cr, and Fe provided by the WTP for tanks AZ-102, C-104, C-106, and C-107.

- Tanks AZ-102, C-104, C-106, and C-107 use caustic leach values for Al, Cr, and Fe provided by the WTP in Table C-2 of Appendix C.

- Balance of mission tanks use the global water wash and caustic leach factors from Colton in PNNL-11646.

The optimistic global water wash and caustic leach factors from Colton (PNNL-11646) were intentionally used for the balance of mission tanks to approximate the HLW glass canister count expected from the future use of oxidative leaching.

Work is underway at the WTP to develop and evaluate an oxidative leaching process for possible inclusion in WTP flowsheet (24590-WTP-PL-PO-03-020, Rev. 0). This work will include an evaluation of potential criticality issues in the Cesium Nitric Acid Recovery Process System (CNP) evaporator, degradation of the cesium ion exchange resin, possible re-precipitation of dissolved Cr in the CNP resulting in the incorporation of the Cr along with separated cesium in HLW glass, possible increases in the TRU concentration in the LAW glass, and oxidative leach cycle time impacts on overall system throughput.

Additional uncertainties with the saltcake partitioning assumptions and associated water wash factors are discussed in Section 3.3.8, Non-WTP Supplemental LAW Treatment (for the Stretch Case).

2.3.6.3 Post-Leach Wash Effectiveness

The post-leach wash effectiveness depends primarily on the operating modes and parameters selected for the operation of the ultrafilter. The purpose of the post-leach wash is to separate the material that has been dissolved by caustic leaching solids from the remaining insoluble solids.

2.3.6.4 Glass Property Model Constraints

In both the Target and Stretch Cases, the effects of potential improvements in HLW waste oxide loading were incorporated by relaxing three glass property model constraints. These are glass viscosity, chromium oxide (Cr_2O_3) glass solubility, and spinel liquidus temperature. Glass loading to these limits may not be achievable and will require more Research and Technology (R&T). However, they provide an indication of the reduction in the number of HLW glass canisters that can be potentially achieved and the positive effect on the RPP Program. Together, these glass property model limit changes reduce the estimated amount of HLW glass by about 20% from the baseline model.

Both cases assumed that the maximum allowable viscosity was increased from 5.5 Pascal-seconds (Pa·s) to 10 Pa·s. Ten to fifteen Pa·s has historically been the maximum operating viscosity recommended for glass development (PNNL-14060). The upper limit is set by the need to effectively transfer the glass from the melter and ensure glass will flow to the canister walls and minimize the potential for voids. In melters without bubblers or other mixing processes, glasses with 10 Pa·s also provide adequate natural convection mixing to facilitate acceptable processing rates. However, this is not a factor in the WTP melter design.

Both cases assumed that the maximum allowable chrome oxide loading was increased from 0.5 wt% to 1.0 wt%. The review of available alkali-alumino-borosilicate (AABS) glass literature, (PNNL-14060) described that the solubility of chromium in an AABS glass is a function of both composition and temperature.

Since the effect of composition on liquidus temperature in the eskolaite primary phase field is unknown, PNNL-14060 estimated the solubility of Cr_2O_3 at 1 mass percent. The solubility of Cr_2O_3 was measured in at least four simulated waste glasses. The first two were LLW glasses, L6-5412 (0.5 wt%) and L4-9012 (1.0 wt%); the second set of glasses fabricated with a simulated Hanford Site HLW and 1.0 wt% and 0.8 wt% Cr_2O_3; these glasses had liquidus temperature values of 1036 ºC and 974 ºC, respectively, with eskolaite as the primary phase. These data suggest that glass compositions optimized for Cr_2O_3 solubility should be capable of achieving

1 wt% for glasses in the eskolaite primary phase field (glasses in this primary phase field are comprised of relatively low concentrations of Fe_2O_3, NiO, ZnO, and MnO).

It should be noted that the melter glass contact refractories are high in Cr, so changes in glass composition to allow for high Cr solubility will likely increase corrosion rates of glass contact materials.

Both Cases assumed that the maximum spinel liquidus temperature (T_L) was increased from 1050 ºC to 1100 ºC. Current T_L models can predict liquidus temperatures to within only ~100 ºC. This uncertainty requires that a 100 ºC or greater buffer be added to T_L constraints (PNNL-14060). Additional R&T investments on T_L model accuracy would allow this buffer to be reduced or eliminated. It is also expected that the WTP melter will tolerate a small volume fraction of crystals without shortening the melter operating life (e.g., ~ 1 vol %).

For the model run for this case, approximately 75% of the HLW glass batches had their waste oxide loading limited by maximum spinel liquidus temperature limit while only 10% were limited by the Cr_2O_3 solubility constraint. Only 15% of the batches exceeded 0.8 wt% Cr_2O_3 in the glass.

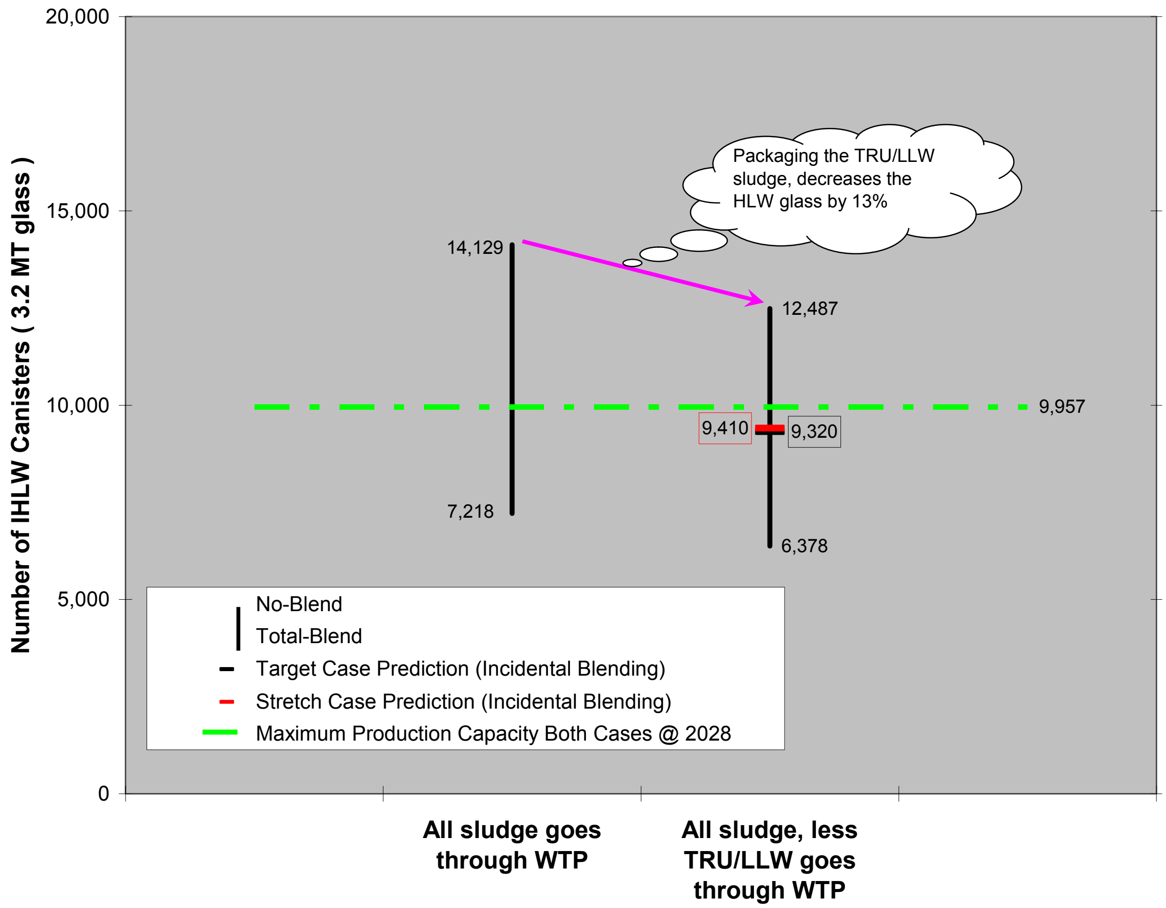
Refinements to the glass property models are available (PNNL-14060); however, these models have not yet been reviewed for suitability or impact on mission planning.

2.3.6.5 Blending

As waste is retrieved from the tanks and moved though the system, a significant amount of blending occurs. This blending is called “incidental” blending since it is incidental to the retrieval, staging, and feed delivery activities. The degree of incidental blending that occurs is very sensitive to the SST retrieval sequence and timing, and the overall topography of the system. Once the other factors influencing HLW glass volume have been established, a range that bounds the resulting glass volumes can be established. The minimum glass volume is reached for a hypothetical “Total-Blend” where all of the HLW is blended into a single uniform batch before vitrification. The maximum glass volume is reached for a hypothetical “No-Blend” where each tank of HLW is pretreated and vitrified by itself.

For the Target Case assumptions, the Total-Blend results in 6,400 canisters of HLW glass; the No-Blend results in 12,500 canisters. The degree of incidental blending provided by the Target Case results in an estimated HLW glass canister count of 9,320, which falls roughly halfway between the two extremes. This is shown on the right-hand side of Figure 2-9, below:

Figure 2-9. HLW Glass Volume Ranges.



The logistics of intentionally (not incidentally) blending the HLW waste is complicated since most of the HLW is limited by Cr (most often indirectly via the spinel liquidus temperature contraint). The new water wash and caustic leach factors, together with oxidative leaching, will reduce the impact of Cr on the waste oxide loading. This may make targeted, intentional blending feasible, or at the very least change the components that drive the waste oxide loading. Therefore, the overall blending strategy for HLW should be revisited once the new factors and oxidative leaching are adopted.

2.3.7 Non-WTP Supplemental TRU/LLW Sludge Packaging

The specific tanks selected to undergo Supplemental Sludge Treatment (LLW or TRU) and the general processing periods were all key enabling assumptions input to this plan, so no further evaluation of the viability of this treatment process was performed. The strategic initiatives for Supplemental Sludge Treatment processing (SSTP) are described in the IMAP (RPP-13678). Process assumptions are the same for both the Target and Stretch Cases.

The packaging of TRU/LLW sludge reduces the demand on the WTP HLW Vitrification Facility. Figure 2-9, above, shows that with current assumptions, the supplemental packaging of TRU/LLW sludge reduces the amount of HLW glass by about 13%.

The pathway for Supplemental Sludge Packaging is dry retrieval without dewatering for Tanks T-201 to T-204, B-201 to B-204, and T-110 and T-111. Waste from all of these tanks except T-110 is assumed to be contact-handled TRU destined for WIPP. Waste from Tank T-110 is assumed to be LLW destined for onsite disposal.

Waste from three DSTs is also expected to be TRU, but these tanks (AW-103, AW-105, and SY-102) will require washes with a dilute sodium hydroxide solution. The supernatant is decanted and the wet sludge packaged for disposal to WIPP as contact-handled TRU waste. The separated supernatant is not shown explicitly on Figure 2-1, Summary Mass Balance – Target Case – instead it is subtracted so that Stream 12 shows the net result.

The consolidation of TRU sludge from Tank AW-105 into Tank AW-103 and the washing of the TRU sludge in Tank SY-102 and the consolidated sludge in Tank AW-103 is modeled and accounted for in the tank space evaluation in Section 2.3.2.

Table 2-6 shows the amount of tank waste packaged as TRU or LLW by Supplemental Sludge Packaging in the Tank Farms. The values and schedule in this table will evolve as more detailed retrieval and packaging plans are developed.

Although not broken out on Figure 2-1, the packaged TRU being sent to WIPP (Stream 13) contains about 0.4 MCi of radioactivity and the LLW (Stream 14) contains about 0.2 MCi.

Table 2-6. Supplemental Sludge Processing – Target Case.

Tank	Bulk Sludge Volume (gal)	Staging Tank	Number of Drums	Retrieval Start	Retrieval Complete	Processing Schedule
T-201	28,000[a]	T-111	700 [a]	9/25/04	10/5/04	—
T-202	21,000 [a]	T-111	525 [a]	10/6/04	10/13/04	
T-203[b]	28,455 [a]	T-111	711 [a]	10/13/04	10/23/04	
T-203[c]	6,545	—	164	10/28/04	10/30/04	10/2004 to 1/2006
B-201	28,000	—	700	10/28/04	11/7/04	
T-204	38,000	—	950	11/1/04	11/13/04	
B-202	27,000	—	675	11/27/04	12/7/04	
B-203	50,000	—	1,250	12/27/04	1/14/05	
T-111[d]	523,455	—	13,086	1/9/05	7/12/05	
B-204	49,000	—	1,225	1/26/05	2/12/05	
T-110[e]	368,000	—	9,200	5/1/05	12/7/05	
AW-103/5[f]	124,000	—	3,100	6/26/07	7/2/07	6/2007 to 12/2009
SY-102	29,700	—	743	9/23/09	9/26/09	

Notes:

[a]The values in the shaded cells are already included in the row for Tank T-111.

[b]This row shows the portion of Tank T-203 waste retrieved and staged into Tank T-111 before it is filled.

[c]This row shows the portion of Tank T-203 waste processed directly upon retrieval, bypassing Tank T-111, since Tank T-111 is full at that time.

[d]The Bulk Sludge Volume and Number of Drums processed from Tank T-111 includes the original T-111 waste and the waste from Tanks T-201, T-202, and T-203 staged in Tank T-111.

[e]T-110 is handled as LLW sludge.

[f]After washing with dilute caustic.

Items of interest from this process are described below.

WIPP Criteria – The WIPP has acceptance criteria that limit free liquid, and restrict the Pu-239 fissile gram equivalents and plutonium equivalent curies. Dose rates are limited for contact-handled waste. The sludge packaging process will need to demonstrate compliance with the WIPP criteria. The comparison is not provided in the model results. These items will be addressed as process development continues.

Water Management – The key enabling assumptions include "dry" retrieval of the SSTs – however, emerging plans may result in adding ~ 1 Mgal to the retrieved waste to help transport it to the packaging facility. The disposition of this water has not been determined. If the waste is dried, condensate could be transferred to ETF (see Section 2.3.4). If supernatant is decanted, the liquid may require return to the DST system. Addition of sorbent sufficient to absorb the added liquid would increase the number of waste packages and potentially reduce the packaged waste below the definition of TRU. This issue will be addressed as process options are evaluated.

LLW Designation of Tank T-110 sludge – For purposes of this System Plan, the sludge in Tank T-110 is considered to be LLW. After comparison of the packaged sludge against land disposal restrictions, the packaged sludge would be disposed onsite in the Integrated Disposal Facility (IDF). The Tank T-110 waste identification is not final, and is being re-evaluated as new data become available. If shown to be TRU, the packaged waste would be transferred to WIPP with the other TRU sludge; if shown to be HLW, it would be retrieved and treated with other HLW. (See Table 4-2. Key Issues and Uncertainties for the Target Case, Item 18.)

Additional TRU tanks – If additional TRU tanks are identified, more waste could be disposed to WIPP, reducing the burden on the WTP and the other Supplemental Treatment processes.

Staging in Tank T-111 – The assumed process for retrieving waste from the T-200 tanks is to stage the waste in Tank T-111 (a placeholder until a specific SST is selected – Tank T-100 is being considered as an alternative). However, Tank T-111 does not have the capacity to accept all of the T-200 series waste. As a result, after Tank T-111 is filled, the model transfers the remainder of the T-200 series waste directly to the packaging facility. Tank T-111 is also a poor choice for use as a staging tank because it is assumed to be leaker (HNF-EP-0182). More generally, regulatory negotiations with the State of Washington Department of Ecology (Ecology) may be needed before using any SST for staging waste. Initial discussions indicate that Ecology may agree in principle, assuming that the SST is sound and that waste remains in the SST no longer than one year.

Contact-Handled SST TRU – The determination that SST TRU sludge will be contact-handled impacts the container and transport system required. Some of the inventory data for the tank waste is based on estimates developed from similar waste types in other tanks. Detailed tank history evaluations followed by additional sample data will confirm whether the proposed dose rates from packaged sludge will be acceptable for contact-handling.

TRU Sludge From DSTs – Sludge from Tanks AW-103, AW-105, and SY-102 is assumed to be packaged as contact-handled TRU after washing and decant steps. The model relies on water wash factors from 1998. Since 1998, however, these DSTs have had changes to inventory estimates and contents, while the wash factors remained fixed and based on earlier data. For example, the estimated aluminum inventory in Tank SY-102 is more than four times the inventory in effect when the wash factor was established. The current Tank AW-103 chromium inventory is more than two times the 1998 value. Answers about the waste composition and distribution after washing are sensitive to the wash factors. Additional work may be needed to confirm whether the washed solids will be TRU, and whether the packaged solids can be contact-handled. If this sludge is not TRU, it will be sent to the WTP for processing into HLW glass (rather than packaged for disposal to WIPP). The HLW glass canister count would increase, extending the mission end date.

DST Tank Space – Solids from Tank AW-105 are assumed to be consolidated in Tank AW-103, with the combined sludge washed in Tank AW-103. Solids in Tank SY-102 are washed separately. Washing increases the volume of supernatant. The volume increase plus the need to segregate the sludge segregation and consolidate it impact DST tank space.

2.3.8 Non-WTP Supplemental LAW Treatment

Starting in 2011, the Target Case treats approximately 3,100 MT Na from low-Cs waste by one of three candidate technologies and disposes of the waste at the IDF (Retrievable Onsite Disposal). The three candidate technologies are Bulk Vitrification, Steam Reforming, and Cast Stone.

For modeling purposes, the low-Cs waste was retrieved from SSTs located in 200 W Area and staged through a DST (SY-101) before being delivered to the Supplemental Treatment Process. Any insoluble solids were assumed to be separated from the waste and left behind in Tank SY-101 or separated by the treatment process and returned to the DST system. The estimates of the amounts of these insoluble solids are subject to change due to uncertainty in the saltcake partitioning (dissolution) assumptions. This is discussed in greater detail in Section 3.3.8, Non-WTP Supplemental LAW Treatment (for the Stretch Case).

The implications of maintaining segregated low-Cs feed or avoiding staging through the DST system have not been evaluated. A decision on the need to use a DST for staging the low-Cs feed before treatment will be made based on process control considerations for the selected technology, how much decoupling (lag-storage) is needed between the retrieval and treatment of the waste, the logistics of deployment, and overall cost.

The tanks selected to supply low-Cs waste were based on a simple screening of the tank inventory for those tanks reported to contain less than 0.05 Ci/L Cs-137 when the sodium concentration is adjusted to 7 molar. For modeling purposes, only low-Cs tanks from the 200 West Area were used to simplify feed staging logistics.

The volume of treated product depends upon the waste loading, product density, and package fill achieved for the selected technology. Bulk Vitrification is expected to produce 21,000 MT product occupying 24,000 m^3 of external package volume; Steam Reforming is expected to produce 21,000 MT product occupying 25,000 m^3 of external package volume; and Cast Stone is expected to produce 56,000 MT product occupying 39,000 m^3 of external package volume. Approximately 0.3% of the total activity is expected to be incorporated into the treated product.

WHC-SD-WM-TI-699, *Technical Basis for Classification of Low-Activity Waste Fraction from Hanford Site Tanks* established the technical basis for classification of the LAW fraction of tank waste at the Hanford Site as waste not subject to the HLW disposal licensing authority of the U.S. Nuclear Regulatory Commission (NRC) after removal of additional radionuclides and immobilization, thus permitting disposal of the waste in shallow land disposal facilities. The report further concludes that "an evaluation of the cost to remove cesium from all of the retrieved waste shows that for dilute feeds (cesium concentration < 0.05 Ci/L), the cost of further curie removal increases dramatically making further removal not economically practical." The NRC reviewed TI-699 and concluded that a residual of 8.5 MCi activity remaining in the LAW "represents the maximum amount of separation currently technically and economically practical…" (Paperiello 1997). One of the key premises behind Non-WTP Supplemental Treatment is that this dilute low-Cs waste is indeed acceptable for immobilization and disposal as LAW without further radionuclide removal.

The ORP has provided incentives for the TFC to accelerate the retrieval, treatment, and disposal of tank waste using Non-WTP Supplemental Treatment techniques (Performance Based Incentive [PBI]-4), Supplemental Waste Treatment and Disposal). This will accelerate the production of ILAW requiring disposal at the IDF from 2011 as assumed in the Target Case to FY 2004 – 2006 per the incentives.

2.3.9 WTP Supplemental LAW Treatment

Starting in 2011, the Target Case treats approximately 31,000 MT Na from pretreated LAW waste by one of three candidate technologies and disposes of the waste at the IDF (Retrievable Onsite Disposal). The three candidate technologies are Bulk Vitrification, Steam Reforming, and Cast Stone. The facility housing the WTP Supplemental LAW Treatment process could be located on the site originally reserved for the second LAW Vitrification Facility.

For modeling purposes, the feed to the WTP Supplemental LAW Treatment includes the portion of the pretreated LAW that is not treated by the WTP LAW Vitrification Facility along with the submerged bed scrubber (SBS) recycle stream from the LAW Vitrification Facility. The SBS recycle stream is relatively dilute and normally is concentrated and blended with other LAW feed in the Pretreatment Facility. Its volumetric flow rate represents about 30% of the feed to Pretreatment Facility.

The SBS recycle stream also bleeds off about 20% of the sulfate normally destined for incorporation into the LAW glass. This allows for a slightly higher sodium oxide loading of 14.6 wt% instead of 13.1 wt% as was estimated in Revision 0 of this System Plan for a WTC configuration that did not include any supplemental treatment. The SBS recycle stream is also expected to include a portion of the more volatile radionuclides such as Tc-99. The HTWOS model does not currently model partitioning of components other than sulfate in the LAW melter or keep track of the volume of the recycle, so the Target Case model results cannot be used to predict the impacts of diverting the SBS recycle stream to Supplemental Treatment. In a future System Plan, additional partitioning assumptions can be added to the HTWOS model or the

WTP Dynamic Flowsheet model could be used in conjunction with the HTWOS model to account for the partitioning in the LAW melter facility[1]

The amount of treated product depends on the waste loading, product density, and package fill achieved for the selected technology. Bulk Vitrification is expected to produce 210,000 MT product occupying 240,000 m^3 of external package volume; Steam Reforming is expected to produce 210,000 MT product occupying 250,000 m^3 of external package volume; and Cast Stone is expected to produce 570,000 MT product occupying 390,000 m^3 of external package volume. Approximately 2.3% of the total activity is expected to be incorporated into the treated product.

An interface control document has not yet been established to define the location, amount, and composition of the feed to be provided by the WTP to the WTP Supplemental LAW Treatment Process. Key process decisions have not yet been made concerning the location and amount of evaporator capacity, if any, needed to concentrate either the SBS recycle stream or the combined feed to WTP Supplemental LAW Treatment; the size and location of lag-storage needed to decouple the supplemental treatment process from the WTP; and the suitability of a given supplemental technology to treat this stream.

The size of the WTP Supplemental Treatment Facility depends upon the difference between the ability of the WTP to produce pretreated LAW and the amount of pretreated LAW consumed by the LAW Vitrification Facility. The Supplemental Treatment decision point in FY 2005 will need to size this facility based on the predicted performance of the WTP, since the WTP performance will not have been demonstrated at that time. Another consideration would be to size the WTP Supplemental Treatment Facility to handle all of the Non-WTP Supplemental Treatment capacity needed after it goes online in 2011.

2.3.10 Retrievable Onsite Disposal

LAW products will be transferred to retrievable onsite disposal. Figure 2-10 shows the estimated total external volume vs. time for LAW packages from ILAW produced in the WTP and produced by each supplemental treatment process. The volumes from supplemental treatment are the sum of the WTP and Non-WTP pathways for each technology. The Supplemental Treatment volumes are alternatives. Each is based on processing the same amount of waste feed. The volume of packaged LLW sludge from Tank T-110 is small in comparison to the total LAW volume and, therefore, is not shown on the figure.

Total external package volumes for the Target Case are:

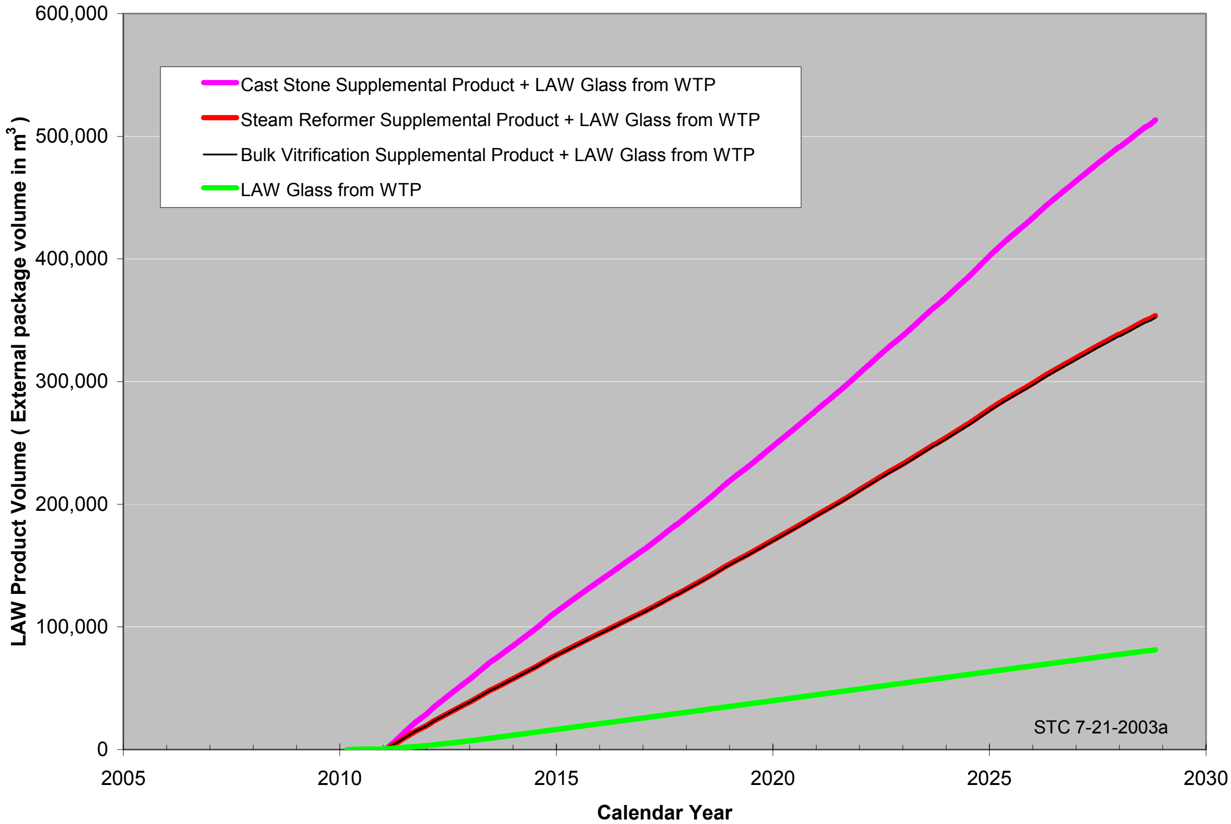
- WTP ILAW: 81,000 m^3;
- Bulk Vitrification: 271,000 m^3;
- Steam Reforming product: 272,000 m^3, and

[1] Decontamination Factors are documented in Table 3.2-5 "LAW Melter Decontamination Factors" and Table 3.3-1, "LAW Vitrification Material Flow Decontamination Factors by Component" in *Flowsheet Basis, Assumptions, and Requirements*, 24590-WTP-RPT-PT-02-005, Rev. 1

- Cast Stone: 432,000 m^3.

As shown in Figure 2-1, approximately 7.9 MCi of total activity, decayed to January 1, 2001, is estimated to be contained in the combined LAW products (LAW glass from the WTP plus both WTP and Non-WTP Supplemental LAW product). This represents about 4% of the total tank inventory of 195 MCi.

Figure 2-10. Immobilized LAW Production – Target Case.



Topics of interest regarding retrievable onsite disposal include the following:

<u>Volume demands on the disposal site are uncertain</u>. The waste loading into the WTP ILAW and Supplemental Treatment products directly affect the volume of waste packages produced. The Target Case assumes waste is incorporated into WTP ILAW glass according to the Gimpel rule, which results in an incorporation of sodium oxide in glass of 13 to 15 wt%. The Stretch Case uses a more optimistic assumption for WTP ILAW glass composition. Similarly, the ability of Supplemental Treatment products to efficiently incorporate waste affects the final package volumes. The Target and Stretch Cases made identical assumptions regarding the ability of supplemental treatments to incorporate waste.

<u>The LAW packages source term and performance assessment may impact acceptance at the disposal facility</u>. Disposal of waste onsite is subject to behavior within a performance assessment, which evaluates the impact of the disposed waste form on human health and the environment over a long period of time. Supplemental waste treatment products must be shown

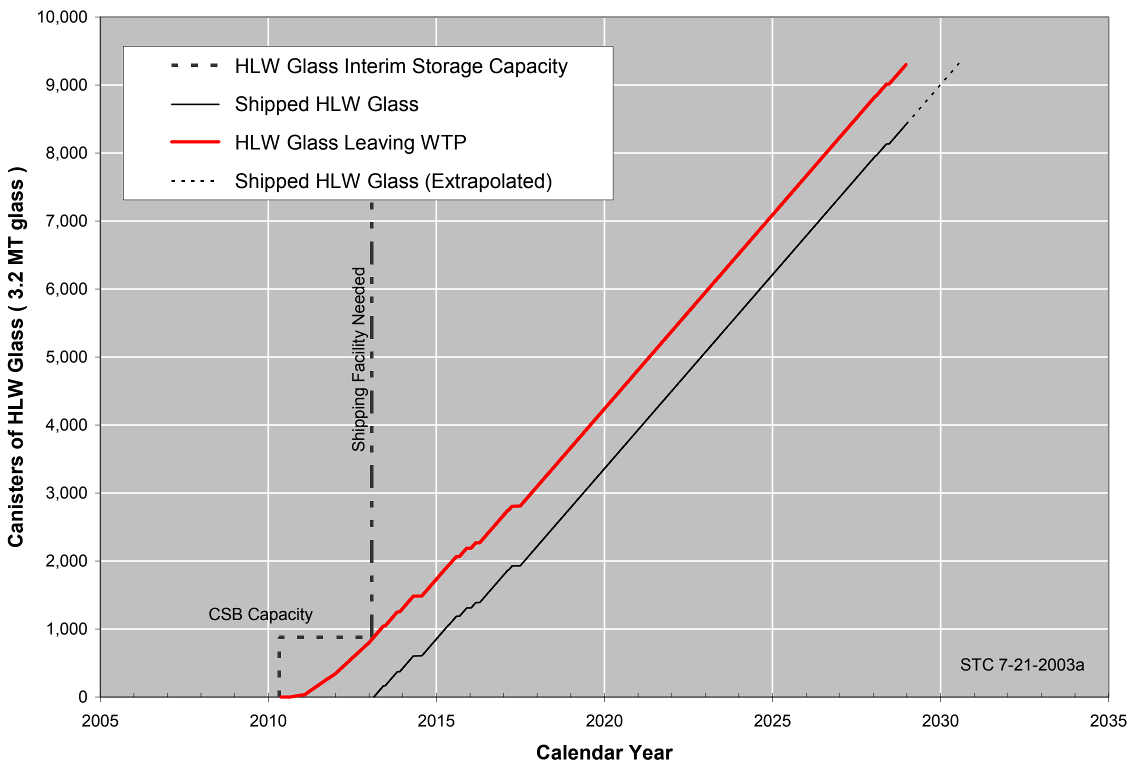
to perform acceptably, given the proposed waste incorporation (source term) and package configuration at the disposal site. Waste form performance is not part of the model used to generate this plan.

The IDF may require acceleration. Incentives to accelerate deployment of Supplemental Treatment may require accelerating the IDF (if constructed) so that it can provide temporary storage.

2.3.11 Interim Storage

Interim storage of IHLW will be provided by the Canister Storage Building (CSB), which shares space with stored spent nuclear fuel (SNF) currently being received from the Hanford Site's K-Basins. The Target Case assumes that the IHLW interim storage facility is needed on May 17, 2010, the date on which the first radioactive HLW canister is produced. Shipping to Yucca Mountain begins when the CSB is full (880 canisters + 22 canisters in WTP-provided lag storage), but no earlier than January 1, 2012. Figure 2-11 is a plot of HLW glass production vs. time with an overlay for storage capacity, shipping date, and quantity shipped. The figure shows that the CSB is available by May 2010 and that shipping to Yucca needs to begin in February 2013.

Figure 2-11. HLW Glass Interim Storage and Shipping Requirements – Target Case.



Topics of interest regarding interim storage are addressed below.

IHLW shares facilities with spent nuclear fuel retrieval. If completion of spent nuclear fuel retrieval is delayed, the schedule for preparing for receipt of IHLW canisters may also be delayed.

The WTP is seeking to replace the IHLW canister design. The current design uses thick wall canisters, but thin wall canisters are being pursued in order to minimize the number of canisters required to package the treated waste. Evaluation of the new canisters for acceptance at the CSB is underway. This System Plan assumes the use of the thin-wall canisters, each holding an average of 3.2 MT of HLW glass.

Shipping need date. When the CSB is full, shipments are assumed to begin to the repository at Yucca Mountain. If the repository is not ready at that time, additional storage capacity will be needed.

Yucca mountain receipt rate. Once the CSB is full, the rate at which the repository can accept packages must be at least as rapid as the production of IHLW canisters, or additional lag storage capacity will need to be developed. This System Plan does not address the number of shipping casks needed to support the required shipping rates nor the turn-around time needed to prepare and return a cask for reuse.

Treated HLW will require delisting. Waste stored in the tank farms is designated as listed dangerous waste under RCRA. A delisting petition must be prepared and accepted in order to ship and dispose of the immobilized HLW at Yucca Mountain, which will not be permitted under RCRA.

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3.0 STRETCH CASE

3.1 PURPOSE

The purpose of the Stretch Case is to show the ORP's vision of how the waste treatment mission might unfold if sufficient breakthroughs in the performance of the WTP are realized in conjunction with WTP and Non-WTP Supplemental LAW Treatment and Packaging of TRU/LLW.

By identifying those areas in which breakthroughs are required, ORP can selectively drive the mission towards its vision.

3.2 KEY FEATURES AND RESULTS

The key features of the Stretch Case from a strategic planning viewpoint are shown in Table 3-1. Those features that distinguish the Stretch Case from the Target Case are highlighted for easy comparison. A more detailed discussion of assumptions and results is presented in Section 3.3.

The Stretch Case met both of the success criteria that were established for the System Plan as shown in Table 3-2. The first criteria supports a literal interpretation of TPA Milestone M-62-00A, meaning that credit is only taken for waste that is "pretreated and vitrified" by the WTP. If credit is taken for both WTP and Non-WTP Supplemental LAW Treatment, then the criteria would be met approximately two years sooner.

Figure 3-1 presents a summary mass balance[1] for the Stretch Case. The figure tracks sodium, waste oxides[2] less sodium, sulfate, and activity. From this figure, two important metrics can be estimated:

- The total LAW product comprising WTP LAW glass, WTP Supplemental LAW product, and Non-WTP Supplemental LAW product is estimated to contain approximately 7 MCi of activity which is about 3.6% of the total activity in the waste.
- Approximately 58% of the LAW (measured as MT of sodium) is incorporated into the glass produced by the WTP LAW Vitrification Facility; the remaining 42% of the LAW is incorporated into either the WTP or Non-WTP Supplemental products.

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[1] For simplicity, Stream 3 reflects the net removal of low-cesium feed from the tank farms after return of separated solids and Stream 12 reflects the net removal of TRU/LLW sludge from the tank farms after return of the carrier liquid used to deliver the TRU from the three DSTs.

[2] By convention, this coverts all nonvolatile waste components (less sodium) into their oxide forms, regardless of phase.

Table 3-1. Key Features of Stretch Case.

Key Feature	Target Case	Stretch Case
WTP Hot Commissioning – Full Operations	12/2009 – 2/2011	12/2009 – 2/2011
WTP Pretreatment Capacity	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr	Up to 2,950 MT LAW Na/yr Up to 571 HLW Canisters/yr
WTP LAW Vitrification	28.8 MTG/d	34 MTG/d
WTP HLW Vitrification	5 MTG/d	5 MTG/d
WTP and Non-WTP Supplemental LAW Treatment	2011 – 2028	2011 – 2028
Non-WTP Supplemental LAW Treatment	3,100 MT Na	8,100 MT Na
WTP Supplemental LAW Treatment	31,000 MT Na	14,000 MT Na
Supplemental Sludge Treatment	12 TRU and 1 LLW	12 TRU and 1 LLW
WTP LAW Sodium Oxide Loading	Gimpel (~ 14.6 wt%)	20 wt%
WTP HLW Glass Properties Model	Relaxed	Relaxed

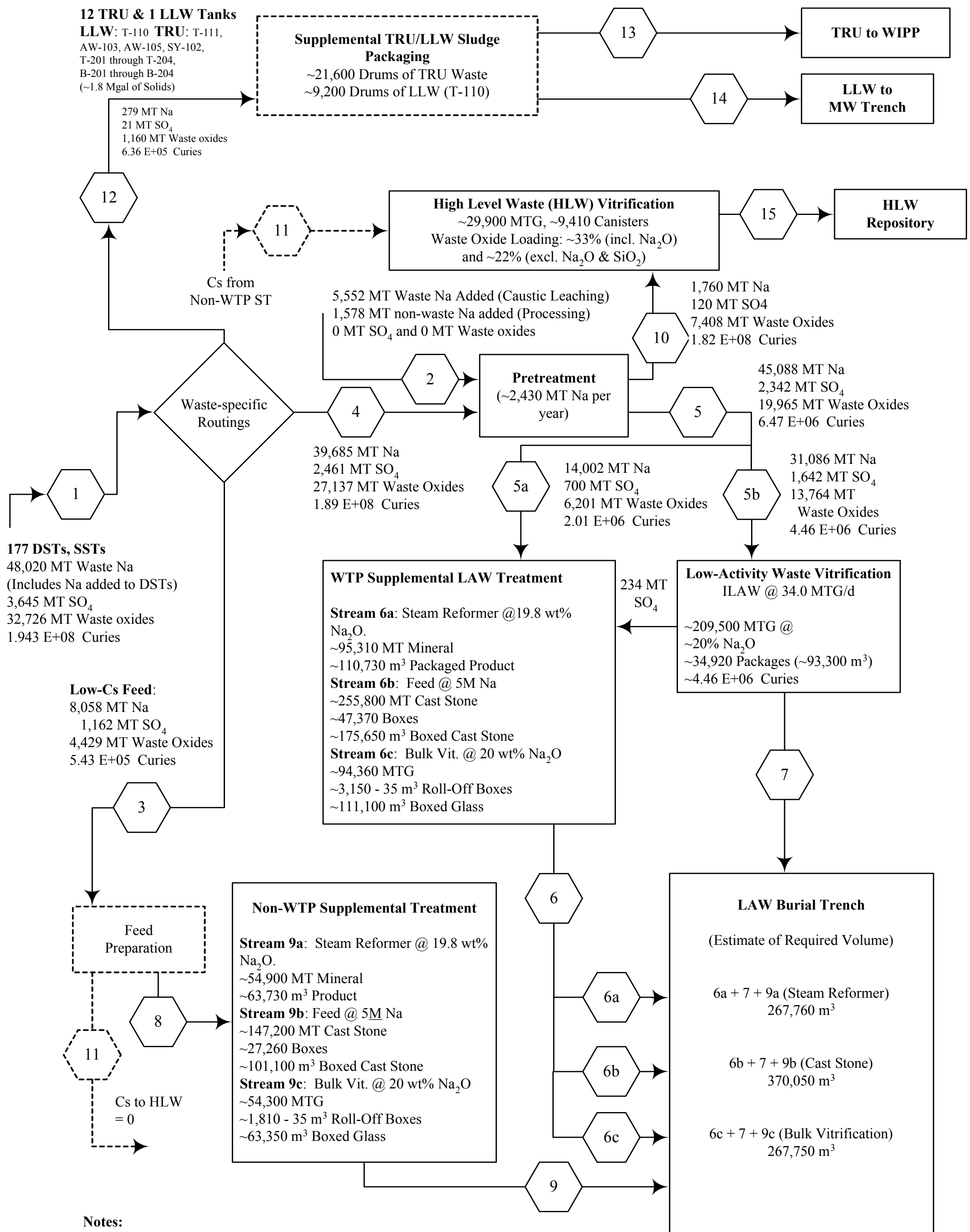
Notes:

HLW = High-level waste
LAW = Low-activity waste
LLW = Low-level waste
MT Na = Metric tons sodium
MTG/d = Metric tons of glass per day
WTP = Waste Treatment and Immobilization Plant

Table 3-2. Success Criteria for Stretch Case.

Success Criteria	Status
Pretreat and vitrify no less than 10 percent of Hanford's tank waste by mass and 25 percent by activity by February 28, 2018. The 10 percent by mass is further defined to mean at least 6,000 MT of sodium from LAW feed and at least 800 MT of waste oxides from HLW feed.	These criteria were projected to be met in 5/2015. On 2/28/2018, the following amounts have been pretreated and vitrified by the WTP: • 10,200 MT Na, • 3,600 MT waste oxides, and • 54% of the activity. If credit is taken for the waste treated by both WTP and Non-WTP Supplemental LAW Treatment, then the criteria would be met in 4/2013.
The WTC *could* treat or package all Hanford Site tank waste by the 12/31/2028 TPA Milestone if all supplemental facilities are provided and the enhanced throughput rates achieved.	Treatment or packaging of all Hanford Site tank waste was projected to complete in 12/2028.

Figure 3-1. Summary Mass Balance – Stretch Case.



Notes:

1. All waste oxide values reported on the figure are excluding sodium oxide (Na_2O).

2. Na, SO_4, and waste oxide masses, Curies, and ILAW and IHLW quantity data are from HTWOS Model run "SSC 8-12-2003". All other product quantity data are calculated from HTWOS output data.

3. Activity values are indexed to January 1, 2001.

3.3 DISCUSSION

The results for the Stretch Case are generally organized along the lines of Figure 1-1, RPP System-Simplified Flow Diagram.

3.3.1 Single-Shell Tank Retrieval

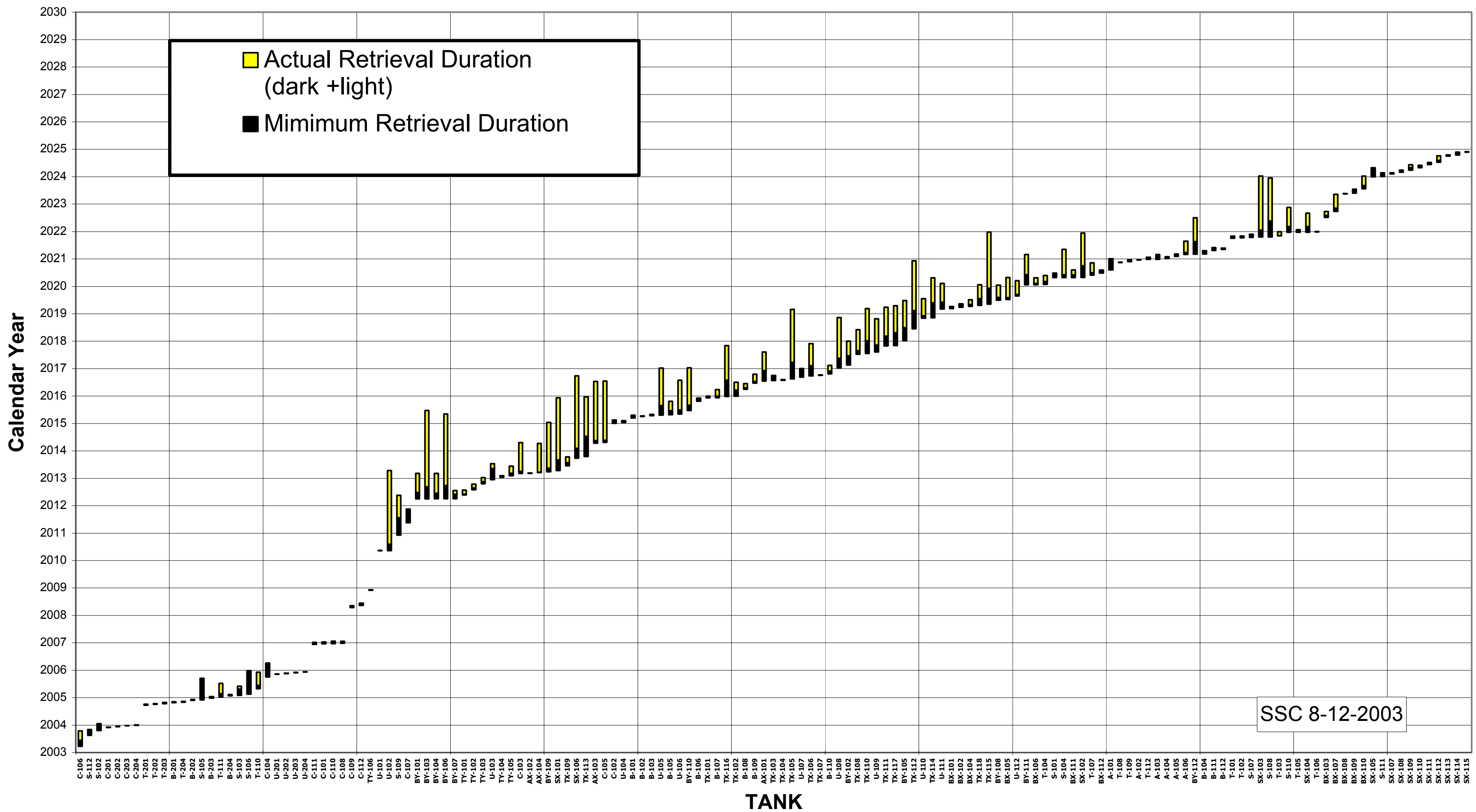
The methods for SST retrieval are the same for the Stretch Case as given in the Target Case. However, the order and timing of individual tank retrievals differs because the cases use different assumptions regarding the distribution of feed. The transfer system and interface configuration to support retrieval of the SSTs into the DST system has not yet been defined. For planning purposes, it is assumed that the necessary upgrades will be provided.

The sequence and timing of the SST retrievals were established by the HTWOS model using the following general priorities:

- Retrieve the 7 SSTs with TPA Milestones on or before their due date.
- Provide up to 10,000 MT low-Cs feed.
- Retrieve up to 26 SSTs before the end of FY 2006, DST tank-space permitting, following the order and timing from the Planning Alignment Case 5-28-2003, and allowing modifications if needed to reserve low-Cs tanks.
- Retrieve the remaining tanks from C-Farm to provide HLW feed for the WTP and to get ready for closing the first tank farm.
- Retrieve the remaining tanks, in general order of risk, while balancing the amount of LAW and HLW required for operation of the WTP.

The resulting SST retrieval sequence for the Stretch Case is shown in Figure 3-2. Single-Shell Tank Retrieval – Stretch Case. This sequence does not represent the final sequence and as such should be considered a placeholder while the SST retrieval sequence is refined to better reflect the TFC's emerging plans. The actual selection of retrieval sequence, while based on risk reduction and supplying feed to the WTP, will be guided by several factors. DST tank space limitations and ORP's initiatives to retrieve 40 SSTs before the end of FY 2006 will impact choice of tanks. Retrieval logistics, including pipeline and infrastructure availability, will affect retrieval capabilities, particularly as longer term projects and their detailed schedules are more clearly defined. The desire to prepare complete farms for closure may also impact retrieval selection. Application of the retrieval selection criteria will continue to be informed by the risk-based selection method included in the case models.

Figure 3-2. Single-Shell Tank Retrieval – Stretch Case.



The retrieval selection criteria and tank retrieval sequence are part of the upcoming TPA negotiations for interim milestone M-45-00C. This milestone requires that the negotiations for a second phase of SST waste retrieval activities (for the period September 30, 2006 through September 30, 2015) be completed by February 28, 2004. In addition to the selection of a SST retrieval sequence, these negotiations will also address several closely related topics, including waste retrieval technology development; Retrieval Performance Evaluations (RPE); leak detection monitoring and mitigation (LDMM); design, construction and operation of SST waste retrieval systems, and closure planning/Closure Plan developments.

The results of the SST retrieval analysis are sensitive to some of the input assumptions, as described below.

The volume of waste retrieved from each tank depends on the tank waste inventory (amount and type of waste) and the selected retrieval technology. The retrieval technology selection depends on the soundness of the tank and its waste type. The volume that SST waste will occupy in the DST system after retrieval but before any waste volume reduction through the 242-A Evaporator is called the "as-retrieved" volume. The as-retrieved volume includes added water and is important in understanding the management of DST tank space and the demand placed on the 242-A Evaporator. The ability to predict the as-retrieved volumes is limited, but will improve as the various retrieval technologies are demonstrated in the field. Since DST space is being aggressively utilized prior to the startup of the WTP, increases in the as-retrieved volume will increase the transient demand for DST tank space and may reduce the number of SSTs retrieved by the end of FY 2006, while decreases in the as-retrieved volume may allow additional SSTs to be retrieved.

The duration of retrieval is estimated for each SST depending on its inventory and the retrieval technology selected. These minimum durations form part of the modeling assumptions. They are the same for the Target and Stretch Cases. Results of modeling show that some of the actual durations are longer than the minimum specified. This situation indicates the presence of a constraint that delays the retrieval completion. Constraints include limitations on pipeline availability, DST space, and assumed limits on the number of simultaneous transfers allowed. Since some constraints (such as projects) may be fixed in time, the actual retrieval durations may differ between the Target and Stretch Cases, since the Target and Stretch Case retrieval sequences differ.

Another source of uncertainty is in the starting inventory and partitioning assumptions. The starting inventory is established by the Best-Basis Inventory (BBI) using sample data and the Hanford Defined Waste (HDW) model (LAUR-96-3860). The BBI is under configuration control. Partitioning assumptions determine for modeling purposes how much of the saltcake and sludge dissolves when retrieved with water. The partitioning assumptions arise from Best Basis Wash Factors, which were established in 1998 using limited sample data and predicted waste behavior where sample data were not available. Wash factors for aluminum and chromium are currently being revised, since these elements can affect the volume of HLW glass produced from a given amount of waste. Changes in the water wash factors could change the estimated amount of waste sent to each of the various treatment pathways (WTP HLW Vitrification, WTP LAW Vitrification, Non-WTP Supplemental Treatment, WTP Supplemental

Treatment). If the changes are large enough, the desired system configuration could change. Section 3.3.6.2 contains additional discussion on water wash and caustic leach factors.

Previously, four planned Waste Retrieval Facilities (WRFs) were used in modeling, each one supporting collection and conditioning of retrieved waste for a quadrant of SSTs. WRFs would provide the infrastructure for supporting multiple retrievals from a given quadrant and help prepare the waste and transfer it to the DST system. The southeast (SE) quadrant WRF was determined not to be needed because waste in the SE quadrant and southwest (SW) quadrant (other than U-Farm) can be retrieved directly to DSTs. Current plans and assumptions for both the Target and Stretch Case call for one WRF for each northern quadrant, plus one for U-Farm (TFCO&UP, Rev. 4B, page A-68). WRFs are assumed not to be required for retrieving SSTs for Supplemental Sludge Treatment, and SSTs retrieved prior to October 1, 2009 are assumed to not require a WRF.

3.3.2 Double-Shell Tank Operation

The DSTs are used for a variety of purposes, which include:

- Storage of waste retrieved from SSTs,
- Staging of feed for the WTP,
- Staging of waste to and product from the 242-A Evaporator,
- Receipt of newly generated waste from legacy facilities,
- Staging of remote-handled TRU to Supplemental Sludge Packaging, and
- Possible staging of low-Cs waste to Supplemental LAW Treatment.

The HTWOS model tracks the volumes and composition of waste in all of the DSTs. Figure 3-3 shows the demand on DST tank space and the allocation of the "unused" space. The Stretch Case stays within the maximum DST system capacity. However, tank space is very tight between FY 2003 – FY 2011, limiting the number and volume of SSTs that can be retrieved into the DST system before FY 2011. After FY 2011, the WTP and Non-WTP Supplemental LAW Treatment begin operation which frees up DST tank space allowing SST retrieval to proceed at an increased rate.

The actual volume of waste in the DST system is the sum of the volume of the waste originally in the DST system and the volume occupied by waste retrieved from the SSTs. A portion of the DST tank space is allocated for various purposes and, therefore, not available for other uses, such as retrieval of SST waste. These allocations include emergency tank space, evaporator operational space, restricted space about tanks containing TRU sludge, WTP feed staging tank headspace, and headspace above tanks into which additional waste may not be added for safety basis concerns.

The total allocated space slightly exceeds the total system capacity around FY 2013. This is an artifact due to unnecessarily reserving the evaporator operational space during periods in which the evaporator is not being used (both the feed and bottoms tanks for the evaporator are empty when this peak occurs). The fix is to either de-allocate the evaporator operational space or use the space for evaporator campaigns.

Credit for some of the various tank space saving options described in the IMAP (RPP-13678) have been taken by the Target Case. These include

- Increase the DST fill height from 416 to 436 inches in 22 tanks.
- Reserve only the space equivalent to one DST as emergency space.
- Stage and concentrate dilute supernatant up to a 1.41 specific gravity (SpG).
- Retrieve TRU/LLW waste from the SSTs directly to a packaging system.
- Implement tank-by-tank evaluations to allow greater concentration of wastes beyond current 1.41-SpG limit. A 1.47-SpG limit is used as a placeholder for this action.
- Use a portion of the "restricted" space in tanks that contain staged feed for WTP. This activity may affect existing characterization of the WTP.

Figure 3-3. Double-Shell Tank Space Utilization – Stretch Case.

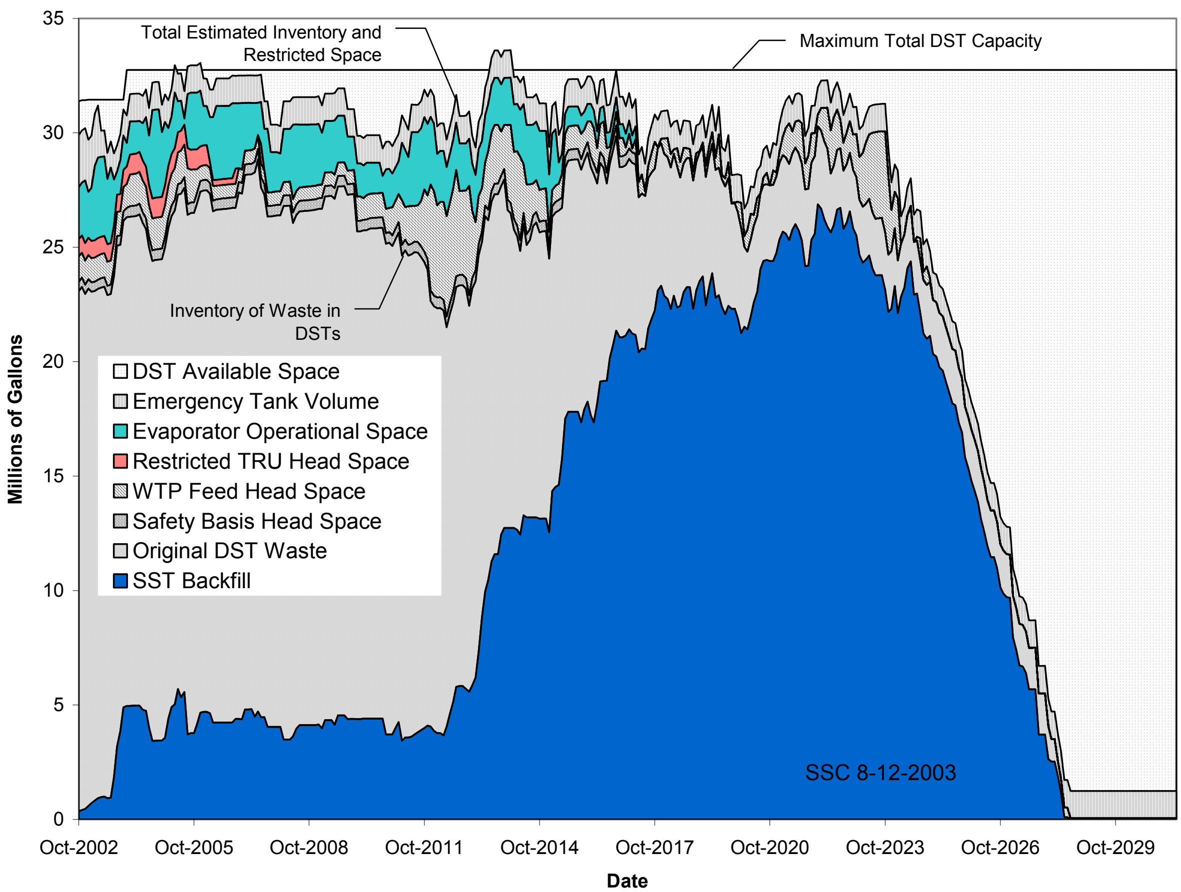
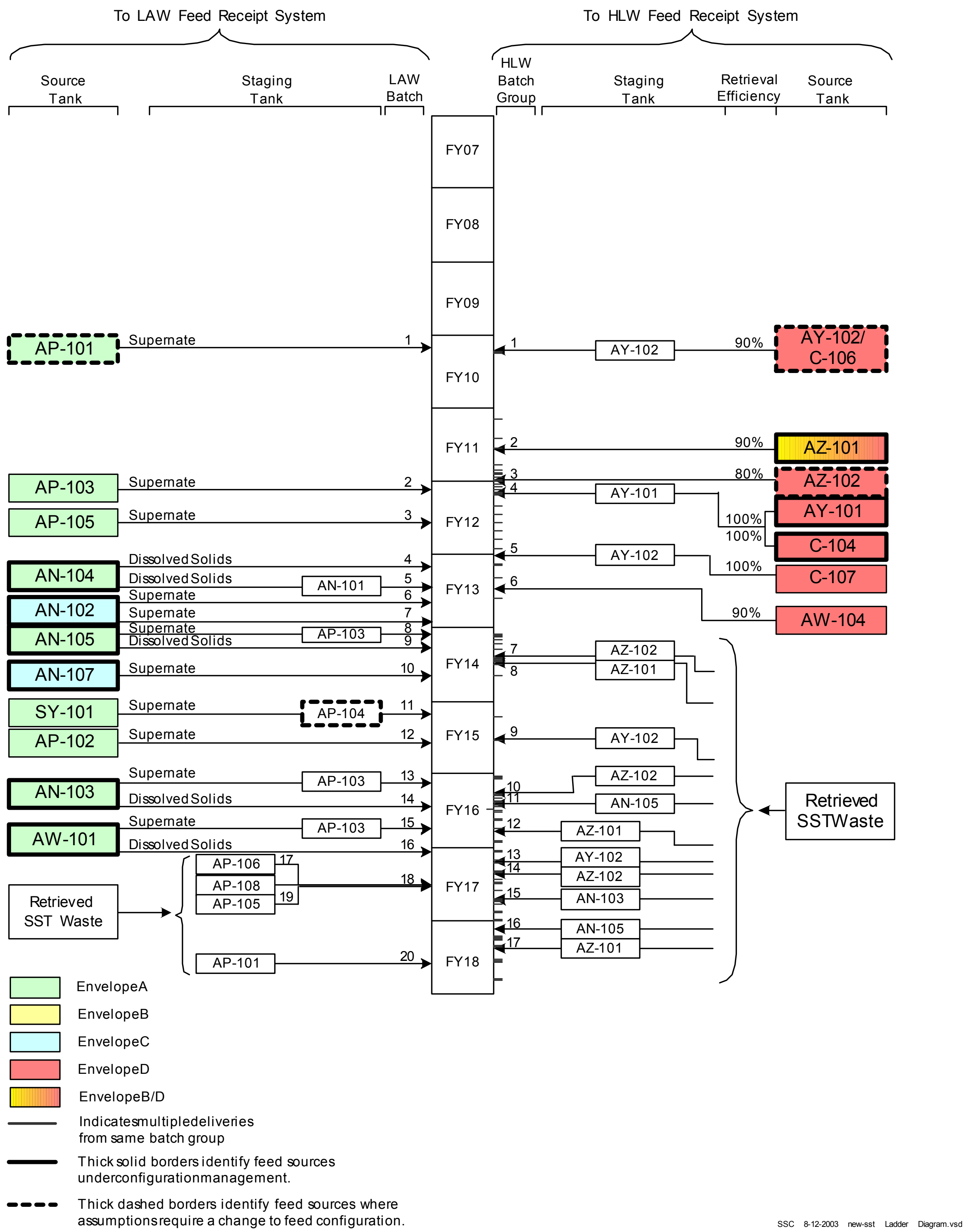


Figure 3-4 shows the delivery schedule for each feed batch to the WTP through 2018. The figure shows the destination of the feed (LAW or HLW feed receipt tanks), the source tank and the planned envelope (A, B, C or D), and any staging tanks. For HLW feed, multiple batches of feed are delivered from the same batch group; the timing of these deliveries also is shown as small tic marks. Delivery schedules for feed batches after 2018 have been modeled to support this plan but are not shown because of the large number of transfers. Future revisions to this System Plan can show the post-2018 transfers as the transfers get closer to implementation.

Figure 3-4. Time Phased Feed Delivery – Stretch Case.



The key enabling assumptions (see Appendix C) state that "the scenarios will not be constrained to match current contracts, performance based initiatives, funding, interface control documents, or other planning guidance except as captured by the key enabling assumptions." Therefore, a review of the compliance with existing feed specifications was not performed for this version of the system plan.

Most of the initial feed batches for the WTP have been placed under configuration control (Boston 2000) and require ORP permission before the composition or quantity of feed can be materially changed. These tanks are shown on Figure 3-4 with a thick solid or dotted border. Those tanks with thick, *solid* borders remain static, except for those activities needed to deliver them as feed to the WTP. However, the composition or quantity of the feed in the four tanks with thick, *dotted* borders has been changed by the Target Case. These changes are similar to those in the baseline established by Baseline Change Request (BCR) RPP-03-007 and the Waste Feed Delivery (WFD) Project Implementation Plan (letter CH2M-0301858) and are summarized in A new process is being implemented to handle existing and emerging feed configuration control decisions. These decisions include changes to feed tanks currently under configuration control, insertion of new feed tanks (such as Tanks AP-103 and AP-105) in the sequence, and how to determine if an existing or proposed feed is suitable for delivery to the WTP (which may go beyond simple compliance with the contractual feed specifications). This process will consider the impacts that SST retrieval and 242-A Evaporator campaign decisions being made today will have on the feed being delivered to the WTP during its first years of commissioning and operation.

Table 3-3. Additionally, a fifth tank (AW-103) which is under configuration control is not shown on Figure 3-4 since it is packaged as TRU instead of being delivered to the WTP for treatment as HLW.

A new process is being implemented to handle existing and emerging feed configuration control decisions. These decisions include changes to feed tanks currently under configuration control, insertion of new feed tanks (such as Tanks AP-103 and AP-105) in the sequence, and how to determine if an existing or proposed feed is suitable for delivery to the WTP (which may go beyond simple compliance with the contractual feed specifications). This process will consider the impacts that SST retrieval and 242-A Evaporator campaign decisions being made today will have on the feed being delivered to the WTP during its first years of commissioning and operation.

Table 3-3. Changes to Feed Configuration of Initial Feed Tanks – Stretch Case.

Tank	What Changes	Why
AP-101 LAW Feed Hot commissioning	The tank is emptied of dilute supernatant and refilled with more concentrated waste from the 242-A Evaporator.	Make more effective use of the space in AP-101 and thus retrieve more SST waste prior to 2011.
AZ-102 HLW Feed	The supernatant is decanted and blended with other dilute waste and concentrated with the 242-A Evaporator. The tank is refilled with concentrate from another evaporator campaign.	Reduce sulfate concentration in delivered feed to extend LAW melter lifespan and operability. Make more effective use of the space in AZ-102 and thus retrieve more SST waste prior to 2011.
AY-102 HLW Feed Hot commissioning	The supernatant is decanted and blended with other dilute waste and concentrated with the 242-A Evaporator. The tank is refilled with concentrate from another evaporator campaign.	Make more effective use of the space in AY-102 and thus retrieve more SST waste prior to 2011.
AP-104 LAW Feed	The tank is emptied of dilute supernatant and refilled with more concentrated waste from the 242-A Evaporator. This waste includes a portion of the waste originally in SY-101.	Make more effective use of the space in AP-104 and thus retrieve more SST waste prior to 2011.
AW-103	The sludge in this tank is consolidated, washed, and packaged as TRU waste.	Accelerate cleanup and reduce avoid treating TRU waste with more expensive HLW treatment technology.

One of the uncertainties with the delivery of the initial HLW feed batches is the amount of waste that will be mobilized by the mixer pumps in the DSTs and delivered as feed. Adjustments in retrieval system project timing may be required depending upon actual retrieval system performance and WTP performance.

The Stretch Case uses several DSTs equipped with mixer-pumps and transfer pumps with dilution water capabilities to stage HLW feed for delivery to the WTP. The number of tanks used for HLW feed staging varies from three to five as new retrieval systems come on-line and as tanks are assigned new functions. Waste retrieved from the SSTs is transferred into an available staging tank through a WRF or from another DST. The waste is mixed and sampled and the sample provided to the WTP for use in feed acceptability determinations and for process control purposes. Two-hundred and seventy (270) days after a staging tank is full, the waste is assumed to be available for delivery to the WTP.

In a few cases, even with the use of five HLW staging tanks, the assumed 270-day waiting period limits, or nearly limits, the ability to provide a timely supply of HLW feed to the WTP. This is expected to be less of a concern in the future since the interface control documents (ICD-19 and 20) have reduced this period to 180-days. The assumptions for future revisions to the System Plan should be brought into alignment with this reduced waiting period.

The Stretch Case used two different approaches for staging LAW feed depending on the physical condition of the feed. If the feed is primarily liquid, the supernatant is staged in a DST (which can be the same DST as the source DST) prior to sampling and delivery to the WTP. If necessary, dilution water can be added during the delivery transfer to insure that the waste is below saturation in major sodium salts and meets the overall sodium concentration limits in the feed specification. If the feed is from one of the four saltcake-containing DSTs (AN-103, AN-104, AN-105, or AW-101), the supernatant is first decanted into another DST for staging as one batch of feed. The remaining salts are dissolved using water and mixer-pumps and delivered as a separate batch. For Tank AN-104 only, the dissolved solids and supernatant batches are blended together to reduce the peak sulfate concentration before delivery.

3.3.3 242-A Evaporator Operation

The 242-A Evaporator is operated on a campaign basis to concentrate tank waste as required by ORP through FY 2018. Responsibility for the 242-A Evaporator was transitioned to the TFC in May 2003. Demands on the evaporator differ between the Stretch and Target Cases because of differences in the waste retrieval schedule. Other evaporator assumptions are the same for both cases.

The 242-A Evaporator processing sequence in the simulation is designed to model the actual activities in the tank farms. After a dilute receiver tank is filled with waste, the contents are transferred to an available holding tank, sampled, and transferred to the 242-A Evaporator feed tank (AW-102) for evaporation. Evaporator feed may be sampled and staged in one or more DSTs, including the evaporator feed tank during the three-month period prior to processing.

After dilute waste is concentrated in the 242-A Evaporator, it is sent to a slurry receiver tank (AW-106) and then transferred to another DST for storage. The concentrated waste will eventually be treated for disposal through the LAW processing facilities.

Figure 3-5 shows the amount of waste processed by the 242-A Evaporator along with the volume of concentrated waste returned to the DST system. The difference between the two curves represents the reduction in waste volume achieved by operating the evaporator. Through 2011, approximately 29 Mgal of waste will be processed through the evaporator resulting in approximately 12 Mgal of concentrated waste with a corresponding waste volume reduction of about 17 Mgal. Although the 242-A Evaporator is assumed to be available until 2018, it was not used beyond 2014. Once the WTP and Supplemental Treatment facilities began full operations, the need for the evaporator to create DST space is diminished. Evaluation of the continued need of the 242-A Evaporator though 2018 is beyond the scope of this version of the system plan.

<u>Evaporator Bottoms Concentration</u> – The model assumes that the evaporator concentrates waste to a density of 1.41 g/mL until June 1, 2003, when the limit is raised to 1.47 g/mL as one of the tank space savings options. Operating the Evaporator to produce a denser waste increases the waste volume reduction and provides more DST space. The 1.47 g/mL limit is a placeholder value that is broadly applied to all waste. In actual operations, the final density will vary according to the chemistry of the individual waste. The allowed extent of evaporation is sensitive to the need to prevent accumulation of trapped flammable gas, and the amount of

recovered DST space is sensitive to the final waste density. If the waste cannot be concentrated as much as planned, the SST retrieval schedule may experience delays.

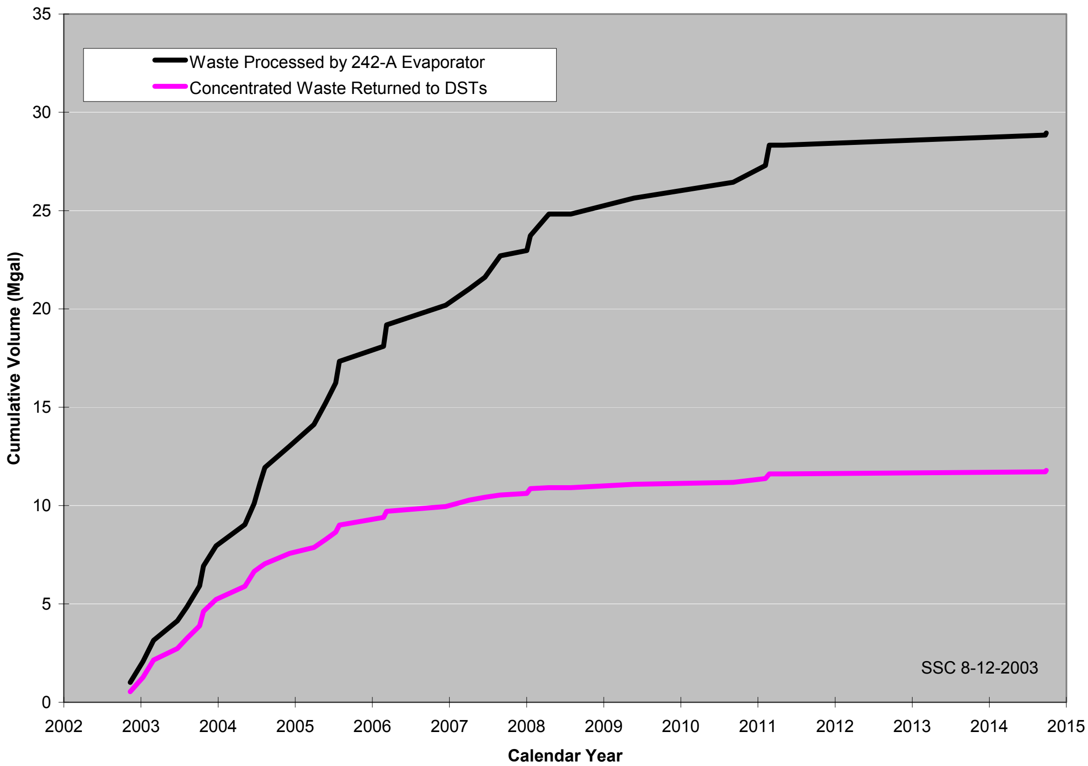
Useful life and upgrades/outages – The evaporator is assumed to have a useful life through 2018, which is sufficient to support the proposed cases under the assumptions given. Both the Target and Stretch Cases assume three-, four-, and three-month facility maintenance and upgrades outages in 2003, 2004, and 2005, respectively. Planned outage activities include replacing the condensers and compressors. The evaporator is not operated for three to four weeks each summer to allow for the required inspection of its packaged boilers, which supply both process steam and building heat. Because of piping manifold design at the Liquid Effluent Retention Facility (LERF), an outage is also required when wastewater collected in LERF Basin 42 is processed through the Effluent Treatment Facility (ETF) (this restriction is being eliminated with a new manifold design). Increases in the duration of the outages or shifts in the timing of the outage can impact the evaporator's ability to generate free DST space when needed.

Sample time – Previous evaluations assumed baseline feed staging duration, which includes sampling and analysis of the feed, of four months. Both the Target and Stretch Cases now assume a three-month staging duration. This is based on efficiencies that occur because both the 242-A Evaporator and the 222-S Laboratory have been transitioned to the TFC.

Water management – The amount water of added during waste retrieval directly impacts the demand on the evaporator. The capability to accurately predict how much water will be added during retrieval is not yet available, but will improve with operating experience. The model results are very sensitive to these assumptions. If more water is added during retrieval, it will take longer for the evaporator to generate free DST space, possibly impacting the SST retrieval schedule.

Liquid Effluent – Both the 242-A Evaporator and the WTP discharge wastewater to the LERF and ETF (see Section 3.3.4). While the volume capacities of LERF and ETF are included in the model assumptions, the acceptance criteria and process parameters for ETF are not modeled for this version of the system plan. Additionally, the WTP is expected to place a high dissolved solids demand on the ETF – outside its current processing capacity. If so, modifications to ETF may be required, impacting its availability.

Figure 3-5. 242-A Evaporator Operation – Stretch Case.



3.3.4 Effluent Treatment Facility/Liquid Effluent Retention Facility

The ETF processes the 242-A Evaporator condensate and aqueous wastewater containing low specific radioactivity. The LERF can receive and store wastewater from various site locations including the tank farms and WTP. The wastewater is sent to the ETF for treatment and disposal. Treated effluent is discharged to a State-Approved Land Disposal Site (SALDS). Assumptions and the discussion regarding ETF are the same for the Stretch and Target Cases.

The demand on the LERF and ETF has not been modeled since this version of the System Plan assumes that they will be able to support the mission. Volumetric capacities are assumed for each, but acceptance criteria have not been addressed, and projected contributions from WTP and other sources to LERF/ETF have not been compiled. As a result, no model reports for LERF/ETF as a result of case assumptions are available.

The ETF is designed to process condensate at up to 150 gpm with a 72% total operating efficiency (TOE) for an average processing capacity of 108 gpm (WHC-SD-C018H-FDC-001, Rev. 3). This value will be lower if the wastewater contains lots of organics or dissolved solids.

Unit operations in the ETF include a primary treatment train and a secondary treatment train. The primary treatment train includes filtration, ultraviolet oxidation, pH adjustment, degasification (dissolved gas removal for gasses such as CO_2), reverse osmosis, and ion exchange. The secondary treatment train includes an evaporator, thin film dryer, and drum fill and handling system. The process pathway through ETF can be adjusted for efficient processing according to waste composition. Products of ETF are treated wastewater and packaged solids containing material removed from the wastewater. The ETF feed flow rate capacity is sensitive to the composition of the wastewater it receives. Feed to ETF must be filtered by generators to remove particulate, but dissolved chemicals that will be extracted by the dryer place a burden on the equipment, and are limited.

Large amounts of Na and SO_4 or other dissolved solids in the wastewater from the WTP pose an issue. Although not modeled in this revision of System Plan, Revision 1 of this System Plan reported 200 MT Na and 90 MT SO_4, primarily from WTP evaporator overheads, transferred to ETF. This is a known issue that is being addressed via WTP forecasts and evaluations by ETF staff in support of WTP Interface Control Document No. 6 (ICD-6). The forecasts are affected by changes in the WTP capacities and configuration.

If the wastewater produced by the 242-A Evaporator and WTP occupies the entire ETF processing capability, other users, such as groundwater remediation, may be impacted. Additionally, evolving plans for the Supplemental Sludge Packaging may add 1–2.5 Mgal of liquid for treatment at the ETF.

Another sensitivity is the lag storage capacity of the LERF basins. Three LERF basins provide feed to ETF. One is used for the RCRA wastewater that is produced by the 242-A Evaporator and will be produced by WTP and Supplemental Treatment. The other two basins are used for specific types of CERCLA waste, including wastewater from groundwater remediation and leachate from the Environmental Restoration Disposal Facility (ERDF). (The CERCLA wastes are further subdivided between the two assigned basins by chemical composition to optimize ETF processing.)

RCRA and CERCLA wastewaters are segregated because the solid powder secondary waste produced from RCRA wastewater must be disposed as mixed waste. Powder from CERCLA wastewater can be disposed at ERDF, which is more economical. Each LERF basin has a capacity of 7.8 Mgal. If the WTP/242-A/Supplemental Treatment wastewater overwhelms the capacity of a single basin, continued segregation of RCRA and CRCLA wastewater to achieve cost efficiencies may be affected.

3.3.5 Waste Treatment Plant

3.3.5.1 Pretreatment

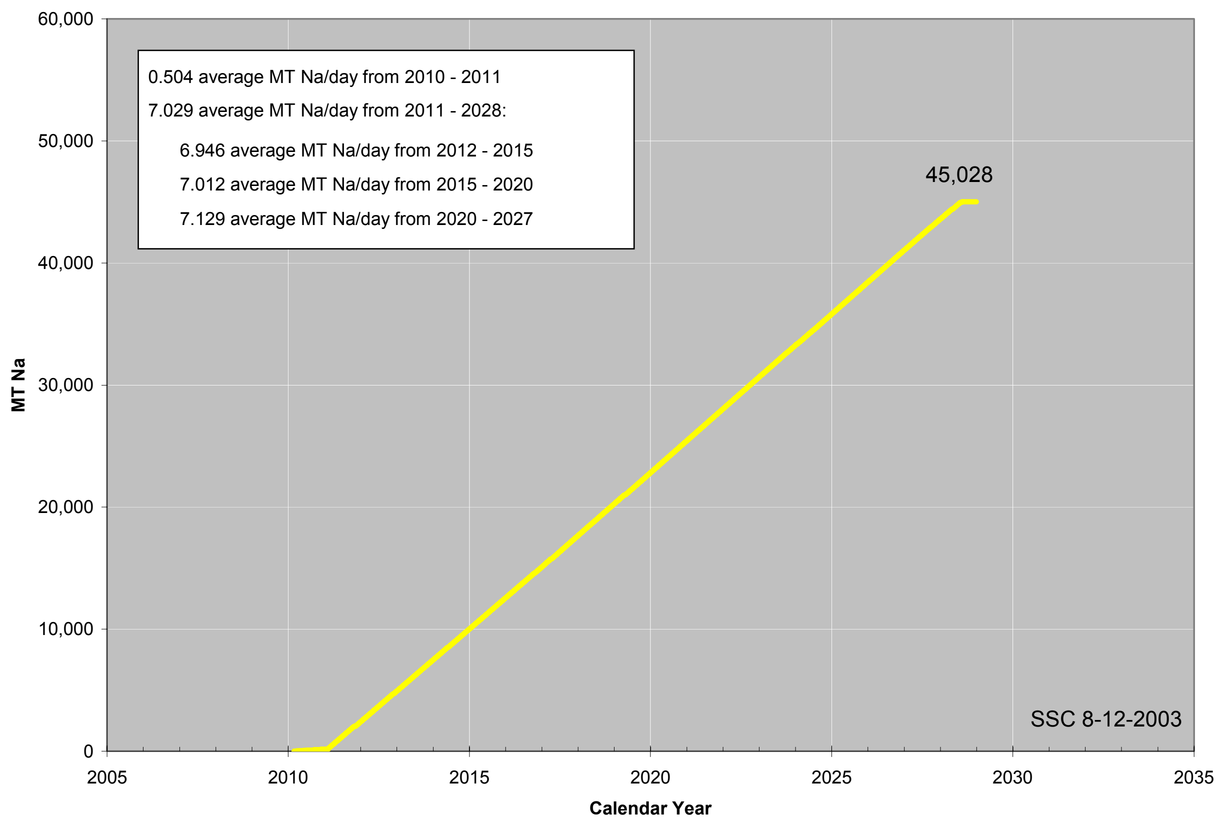
The Stretch Case assumes that the Pretreatment Facility can produce up to an average of 2,950 MT of sodium per year of pretreated LAW and sufficient pretreated HLW to produce up to 571 canisters of IHLW per year.

The LAW pretreatment capacity is based on a maximum capacity of 3400 MT Na/yr and 86% TOE. The basis for the TOE is *Assessment of Operations Research (OR) Model Run for the Technical Integration Baseline Development Team (TIBDT)* (24590-PTF-RPT-PT-02-001, Rev. 0). The basis for the maximum capacity of 3,400 MT Na/yr is the "5-day" average goal of 90 MTG/d stated for PT L in Table C.6-5.1 of the Bechtel National, Inc. (BNI) Contract, mod A029 and an average Na_2O loading of 14 wt%.

The HLW pretreatment capacity is assumed to support a HLW Vitrification Facility producing an average rate of 5.0 MTG/d, 365.24 day/yr, and 3.2 MTG/canister. Since this capacity is given in terms of glass production and matches the HLW Vitrification assumptions (see Section 3.3.5.3, HLW Vitrification), a separate "process governor" for HLW pretreatment was not needed or modeled.

Figure 3-6 shows the estimated amount of pretreated LAW, reported as MT of Sodium, produced by the WTP Pretreatment Facility. During modeling, the average LAW pretreatment capacity was adjusted slightly so that the proper amount of pretreated waste was directed to WTP Supplemental Treatment. During full operations, the LAW pretreatment rate varied from 2540 to 2600 MT Na/year with an average of 2570 MT Na/yr. This is consistent with the average maximum production capacity of 2950 MT Na/yr.

Figure 3-6. Pretreated LAW Production – Stretch Case.



The primary partitioning of waste into liquids and solids is described in Section3.3.6.2, Water Wash and Caustic Leach Factors – the physical solid/liquid separation of the partitioned waste is accomplished using the Ultrafilter (UF) in the WTP. Additional partitioning takes place in the various unit operations (such as in the evaporators and the ion exchange systems) in the Pretreatment Facility.

The capacity of the Pretreatment Facility to produce pretreated liquids and solids is governed by a complex interaction between the feed delivered to the plant, the design of the various unit operations, and their planned operating modes including recycles. Nonetheless, the performance of three pretreatment systems is key to maintaining treatment capacity: the Ultrafiltration system, the treated LAW evaporator, and the Cs Ion Exchange system.

The tank waste contains significant quantities of total organic carbon (TOC), much of which is oxalate. Although not modeled in the System Plan, oxalate may present process challenges if present at or near its solubility limits. On a case-by-case basis, the process will need to be evaluated to determine if the concentration of received TOC can be fed directly to either melter facility or if it will require special consideration.

3.3.5.2 LAW Vitrification

The Stretch Case assumes that the LAW Vitrification Facility can produce an average of 34 MTG/d at a 20 wt% sodium oxide loading.

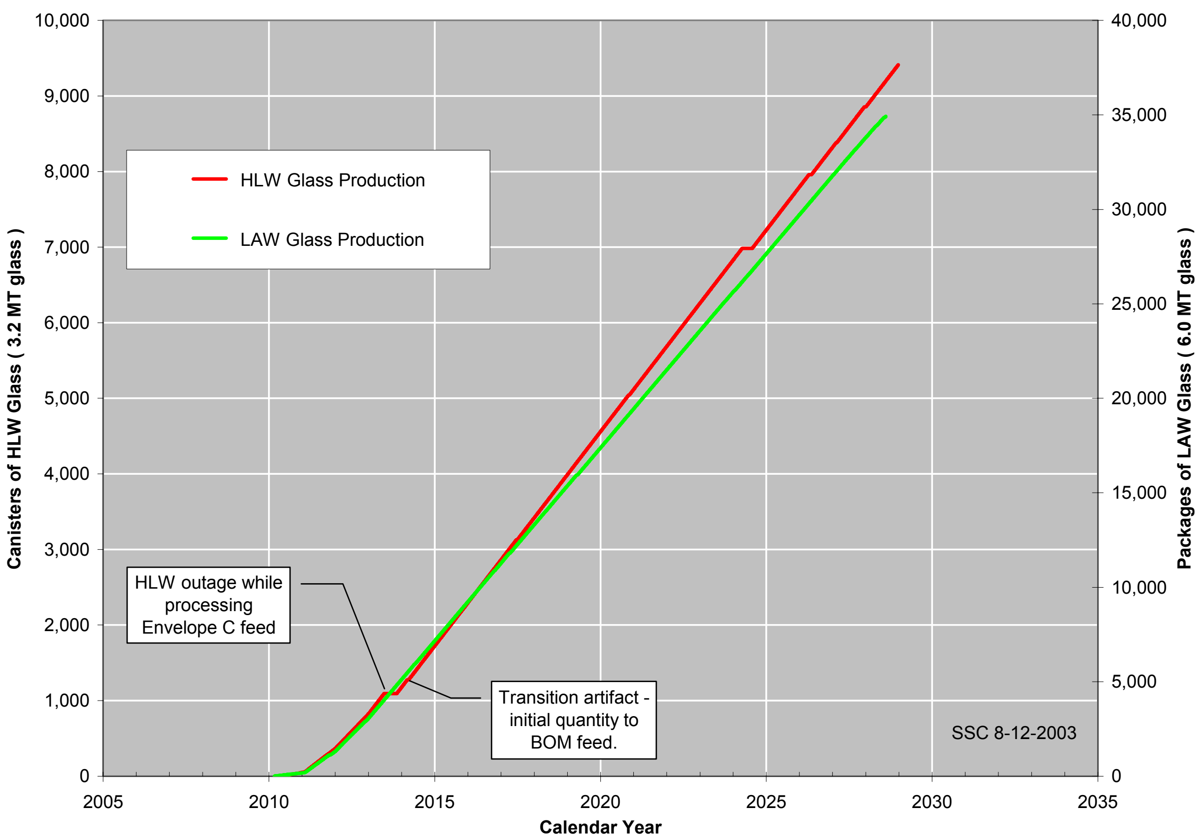
The average production is based on a nameplate capacity of 40 MTG/d and a 0.85 TOE. The basis for the TOE is *Low Activity Waste Facility Operations Research Availability Assessment*, (24590-LAW-RPT-PO-03-001, Rev. 0) and is driven by the 16 week bubbler life. It is assumed that the TOE stated in the reference (0.774) can be increased to an average of 0.85 over the mission. The basis for the nameplate is the 5-day average goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract for the LAW Facility. It is assumed that the nameplate derived from the reference (36 MTG/d) can be increased to 40 MTG/d prior to start of full operations.

During hot commissioning, the LAW Vitrification Facility was assumed to produce 188 packages of glass. This number is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. For modeling purposes, the corresponding average LAW vitrification rate (from March 1, 2010 through January 31, 2011) of about 3.36 MTG/d was selected so that the contract goals would be just met by the end date for hot commissioning. During full operations, the LAW glass production was assumed to ramp-up to 34 MTG/day over several years. The ramp-up is shown in Table 3-4, below. The green line in Figure 3-7 shows the resulting estimated production of LAW glass over time.

Table 3-4. LAW Vitrification Facility Ramp-Up – Stretch Case.

Date	Rate (MTG/d
3/1/2010 – 1/31/2011	3.36 yielding 188 Packages
Starting on 2/1/2011	21.0
Starting on 1/1/2012	29.0
Starting on 1/1/203	34.0

Figure 3-7. Waste Treatment Plant Glass Production – Stretch Case.



The LAW glass production for the Stretch Case assumes that a 20 wt% sodium oxide loading can be achieved. Using existing empirical relationships (24590-LAW-M4C-LFP-00002 and 24590-WTP-MCR-PT-02-002), the amount of pretreated waste that can be incorporated into the LAW glass (measured by the sodium oxide loading) is generally limited by the amount of sulfate in the feed to around 13 to 15 wt%. The path forward to reaching at 20 wt% sodium oxide loading is not clear – some areas of speculation include sulfate removal technologies, modifications to existing glass chemistry to be more tolerant of sulfate or to drive more sulfate into the offgas, retrofit with an alternative melter design, or use of a different glass formulation that tolerates high sulfate levels.

Approximately 2.3% of the total activity is expected to be incorporated into the LAW glass.

3.3.5.3 HLW Vitrification

The Stretch Case assumes that the HLW Vitrification Facility can produce an average of 5.0 MTG/d at a waste oxide loading determined by the relaxed glass properties model.

The average production is based on a nameplate capacity of 6 MTG/d and an 84% TOE. The basis for the TOE is *High Level Waste Facility Operations Research Availability Assessment*, (24590-HLW-RPT-PT-02-001, Rev. 0). The basis for the nameplate is the goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract.

During hot commissioning, the HLW Vitrification Facility was assumed to produce 56 canisters of glass. This number is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. For modeling purposes, the corresponding average HLW vitrification rate from May 17, 2010 through January 31, 2011 of about 0.69 MTG/d was selected so that the contract goals would be just met by the end date for hot commissioning. During full operations, the HLW glass production was assumed to ramp up to 5.0 MTG/d over several years. The ramp-up is shown in Table 3-5, below.

Table 3-5. HLW Vitrification Facility Ramp-Up – Stretch Case.

Date	Rate (MTG/d)
3/1/2010 – 1/31/2011	0.69 yielding 56 Packages
Starting on 2/1/2011	3.0
Starting on 1/1/2012	4.0
Starting on 1/1/2013	5.0

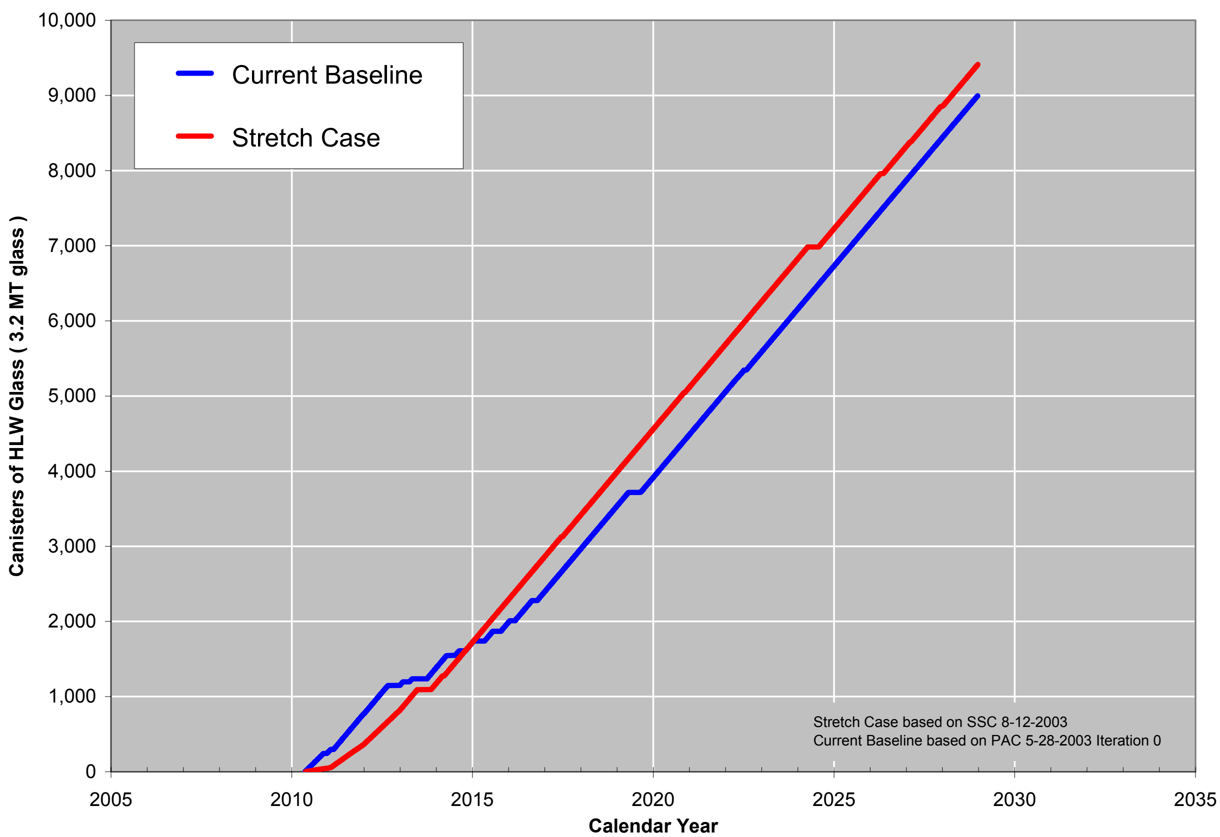
The red line in Figure 3-7 shows the resulting estimated production of HLW glass over time. The first outage (seen as a flat spot) result from the processing of Envelope C feed since HLW sludge cannot be caustic leached in the ultrafilters at the same time as the Sr and TRU are being precipitated from the Envelope C feed. During Envelope C processing, the HLW melters continue to run until the backlog of pretreated HLW sludge has been processed.

The second outage is a modeling artifact that was originally intended to allow for reporting on the initial order quantity feed separately from the feed for the balance of mission. This outage will disappear during future maintenance of the HTWOS model.

The other minor outages result from many intertwined factors such as the SST retrieval sequence and risk-based prioritization of retrievals, the relative balance of sludge and saltcake retrievals, the overall configuration (topography) of the retrieval and feed staging systems, constraints on simultaneous retrievals and transfers, the degree of incidental blending, the number and location of the HLW feed staging tanks, and the assumed 270-day waiting period.

As seen in Figure 3-8, the HLW glass production curve for this version of the System Plan is significantly better than the current TFC Baseline established by BCR RPP-03-007 and the WFD Project Implementation Plan. The early retrieval of sludge tanks from C-Farm after the initial 26 SSTs builds up a supply of HLW feed in the DST system that fills in most of the outages (the HLW outages in the baseline totaled about four to five years while in this version of the System Plan they total a little over one year).

Figure 3-8. Improvements in HLW Glass Production – Stretch Case vs. Current Baseline.



Another factor in reducing the HLW feed outages is that the gradual ramp-up of the HLW Vitrification Facility slightly delays the need for feed in the early years.

Using the assumptions established for the Stretch Case, the pretreatment and vitrification of HLW drives the duration of the treatment mission. Any changes that increase the amount of HLW glass produced or limit the production rate will increase the duration of the mission. Keep in mind that in the Stretch Case, sufficient Supplemental LAW Treatment capacity was added to ensure that LAW processing would not be the bottleneck.

3.3.6 HLW Glass Volume

The quantity of HLW glass depends on the waste composition and quantity, water wash and caustic leach factors, post-leach wash effectivness, glass property model constraints, and the degree of blending. HLW glass volume is given its own section since these factors cross-cut both the Tank Farms and WTP.

3.3.6.1 Waste Composition and Quantity

The starting composition and quantity of waste for the Stretch Case is based on the BBI and represents the tanks contents on June 30, 2002. An assessment of the impacts of uncertainty in the BBI on HLW glass volume is beyond the scope of this version of the System Plan.

A portion of the insoluble solids (sludge) has been provisionally identified for packaging and disposal as TRU or LLW waste. However, if this waste is instead treated as HLW and pretreated and vitrified through the WTP, the estimated quantity of HLW glass will increase by about 15%, with a corresponding increase in mission duration.

3.3.6.2 Water Wash and Caustic Leach Factors

The water wash factors describe the solubility of the tank waste when contacted with large quantities of water. They define both how much saltcake dissolves during retrieval and how much slightly soluble material is removed from sludge when water-washed in the Pretreatment Facility. The caustic leach factors describe the solubility of the water-washed solids when contacted with a sodium hydroxide solution in the Pretreatment Facility.

The water wash and caustic leach factors are based on experimental data, solid-liquid equilibrium calculations, and extrapolations. Each tank contains one or more types of wastes, currently defined by the Hanford Defined Waste (HDW) model (LAUR-96-3860). Waste type templates (RPP-8847) are used to specify how much of each waste type is present in each tank. The wash and leach factors for a specific tank and analyte are determined using the following sources of information, in order of decreasing precedence:

- Experimental data specific to the tank and analyte,
- Calculated solid-liquid equilibrium conditions,
- Average values for waste template, and
- Global average values for all waste.

New estimates of the water wash and caustic leach factors for two components (Cr and Al) that currently drive HLW waste oxide loading, have recently been documented (RPP-10222 and RPP-11079), but not yet included in the modeling assumptions. A future version of the System Plan will implement the new water wash and caustic leach factors along with oxidative leaching (RPP-15552). Oxidative leaching, if feasible, will roughly offset the 2 to 3 times increase in HLW glass volume expected from the change in these wash and leach factors.

The water wash and caustic leach factors in this revision of the System Plan are based on a conglomeration of three sources, documented in TWINS:

- Initial order quantity tanks use water wash and caustic leach factors from Hendrickson in HNF-3157, except for caustic leach values for Al, Cr, and Fe provided by the WTP for tanks AZ-102, C-104, C-106, and C-107.

- Tanks AZ-102, C-104, C-106, and C-107 use caustic leach values for Al, Cr, and Fe provided by the WTP in Table C-2 of Appendix C.

- Balance of mission tanks use the global water wash and caustic leach factors from Colton in PNNL-11646.

The optimistic global water wash and caustic leach factors from Colton (PNNL-11646) were intentionally used for the balance of mission tanks to approximate the HLW glass canister count expected from the future use of oxidative leaching.

Work is underway at the WTP to develop and evaluate an oxidative leaching process for possible inclusion in WTP flowsheet (24590-WTP-PL-PO-03-020, Rev 0). This work will include an evaluation of potential criticality issues in the Cesium Nitric Acid Recovery Process System (CNP) evaporator, degradation of the cesium ion exchange resin, possible re-precipitation of dissolved Cr in the CNP resulting in the incorporation of the Cr along with separated cesium in HLW glass, possible increases in the TRU concentration in the LAW glass, and oxidative leach cycle time impacts on overall system throughput.

Additional uncertainties with the saltcake partitioning assumptions and associated water wash factors are discussed in Section 3.3.8, Non-WTP Supplemental LAW Treatment.

3.3.6.3 Post-leach Wash Effectiveness

The post-leach wash effectiveness depends primarily on the operating modes and parameters selected for the operation of the ultrafilter. The purpose of the post-leach wash is to separate the material that has been dissolved by caustic leaching solids from the remaining insoluble solids.

3.3.6.4 Glass Property Model Constraints

In both the Stretch and Target Cases, the effects of potential improvements in HLW waste oxide loading were incorporated by relaxing three glass property model constraints. These are glass viscosity, chromium oxide (Cr_2O_3) glass solubility, and spinel liquidus temperature. Glass loading to these limits may not be achievable and will require more Research and Technology

(R&T). However, they provide an indication of the reduction in the number of HLW glass canisters that can be potentially achieved and the positive effect on the RPP Program. Together, these glass property model limit changes reduce the estimated amount of HLW glass by about 20% from the baseline model.

Both cases assumed that the maximum allowable viscosity was increased from 5.5 Pascal-seconds (Pa·s) to 10 Pa·s. Ten to fifteen Pa·s has historically been the maximum operating viscosity recommended for glass development (PNNL-14060). The upper limit is set by the need to effectively transfer the glass from the melter and ensure glass will flow to the canister walls and minimize the potential for voids. In melters without bubblers or other mixing processes, glasses with 10 Pa·s also provides adequate natural convection mixing to facilitate acceptable processing rates. However, this is not a factor in the WTP melter design.

Both cases assumed that the maximum allowable chrome oxide loading was increased from 0.5 wt% to 1.0 wt%. The review of available alkali-alumino-borosilicate (AABS) glass literature (PNNL-14060) described that the solubility of chromium in an AABS glass is a function of both composition and temperature.

Since the effect of composition on liquidus temperature in the eskolaite primary phase field is unknown, PNNL-14060 estimated the solubility of Cr_2O_3 at 1 mass percent. The solubility of Cr_2O_3 was measured in at least four simulated waste glasses. The first two were LLW glasses, L6-5412 (0.5 wt%) and L4-9012 (1.0 wt%); the second set of glasses fabricated with a simulated Hanford Site HLW and 1.0 wt% and 0.8 wt% Cr_2O_3; these glasses had liquidus temperature values of 1036 ºC and 974 ºC, respectively, with eskolaite as the primary phase. These data suggest that glass compositions optimized for Cr_2O_3 solubility should be capable of achieving 1 wt% for glasses in the eskolaite primary phase field (glasses in this primary phase field are comprised of relatively low concentrations of Fe_2O_3, NiO, ZnO, and MnO).

It should be noted that the melter glass contact refractories are high in Cr, so changes in glass composition to allow for high Cr solubility will likely increase corrosion rates of glass contact materials.

Both cases assumed that the maximum spinel liquidus temperature (T_L) was increased from 1050 ºC to 1100 ºC. Current T_L models can predict liquidus temperatures to within only ~100 ºC. This uncertainty requires that a 100 ºC or greater buffer be added to T_L constraints (PNNL-14060). Additional R&T investments on T_L model accuracy would allow this buffer to be reduced or eliminated. It is also expected that the WTP melter will tolerate a small volume fraction of crystals without shortening the melter operating life (e.g. ~ 1 vol %).

For the model run for this case, approximately 75% of the HLW glass batches had their waste oxide loading limited by maximum spinel liquidus temperature limit while only 7% were limited by the Cr_2O_3 solubility constraint. Only 24% of the batches exceeded 0.8 wt% Cr_2O_3 in the glass.

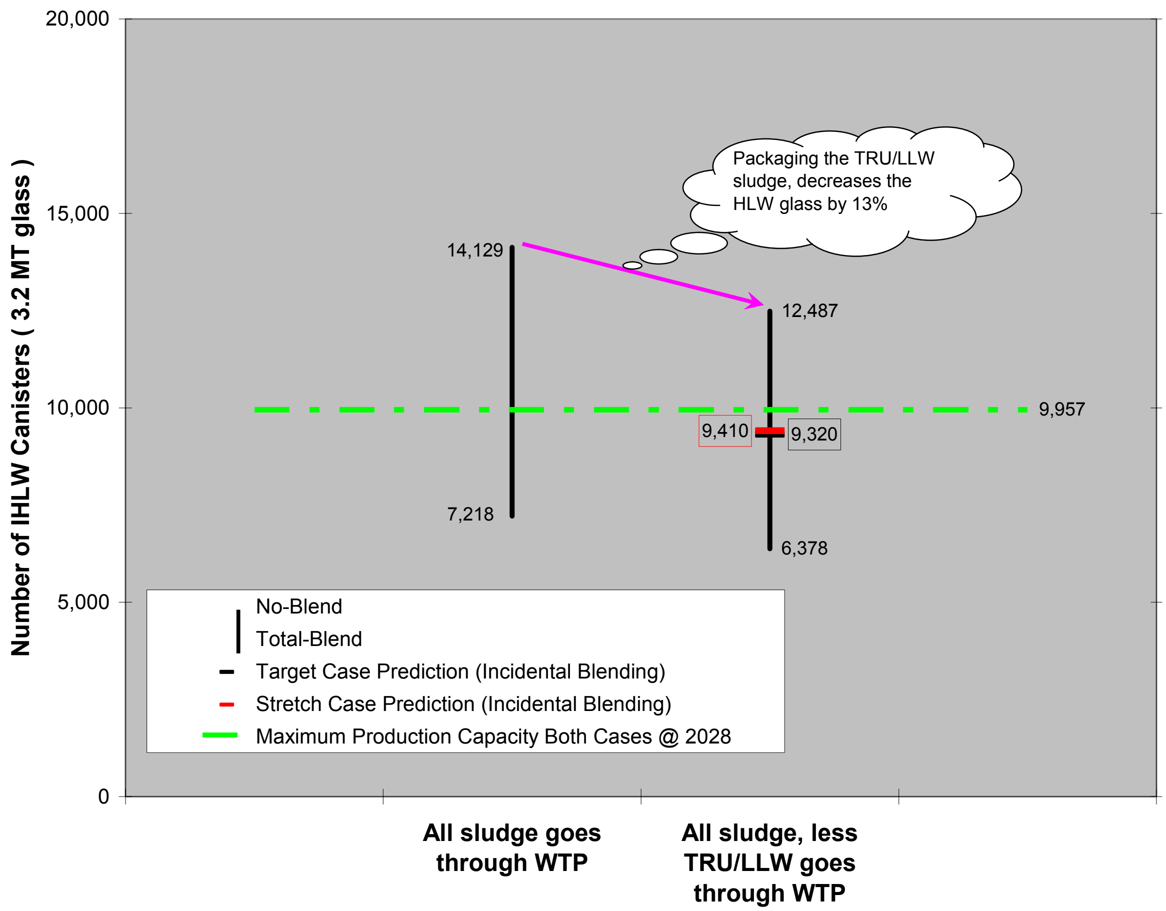
Refinements to the glass property models are available (PNNL-14060); however, these models have not yet been reviewed for suitability or impact on mission planning.

3.3.6.5 Blending

As waste is retrieved from the tanks and moved though the system, a significant amount of blending occurs. This blending is called "incidental" blending since it is incidental to the retrieval, staging and feed delivery activities. The degree of incidental blending that occurs is very sensitive to the SST retrieval sequence and timing, and the overall topography of the system. Once the other factors influencing HLW glass volume have been established, a range that bounds the resulting glass volumes can be established. The minimum glass volume is reached for a hypothetical "Total-Blend" where all of the HLW is blended into a single uniform batch before vitrification. The maximum glass volume is reached for a hypothetical "No-Blend" where each tank of HLW is pretreated and vitrified by itself.

For the Stretch Case assumptions, the Total-Blend results in 6,400 canisters of HLW glass; the No-Blend results in 12,500 canisters. The degree of incidental blending provided by the Stretch Case results in an estimated HLW glass canister count of 9,410 which falls roughly half-way between the two extremes. This is shown on the right-hand side of Figure 3-9, below:

Figure 3-9. HLW Glass Volume Ranges.



The logistics of intentionally (not incidentally) blending the HLW waste is complicated since most of the HLW is limited by Cr (most often indirectly via the spinel liquidus temperature contraint). The new water wash and caustic leach factors, together with oxidative leaching, will reduce the impact of Cr on the waste oxide loading. This may make targeted, intentional blending feasible, or at the very least change the components that drive the waste oxide loading. Therefore, the overall blending strategy for HLW should be revisited once the new factors and oxidative leaching are adopted.

3.3.7 Non-WTP Supplemental TRU/LLW Sludge Packaging

The specific tanks selected to undergo Supplemental Sludge Treatment (LLW or TRU) and the general processing periods were all key enabling assumptions input to this plan, so no further evaluation of the viability of this treatment process was performed. The strategic initiatives for Supplemental Sludge Treatment processing (SSTP) are described in the IMAP (RPP-13678). Process assumptions (and the discussion below) are the same for both the Target and Stretch Cases.

The packaging of TRU/LLW sludge reduces the demand on the WTP HLW Vitrification Facility. Figure 3-9, above, shows that with current assumptions, the supplemental packaging of TRU/LLW sludge reduces the amount of HLW glass by about 13%. The pathway for Supplemental Sludge Packaging is dry retrieval without dewatering for Tanks T-201 to T-204, B-201 to B-204, and T-110 and T-111. Waste from all of these tanks except T-110 is assumed to be contact-handled TRU destined for WIPP. Waste from Tank T-110 is assumed to be LLW destined for onsite disposal.

Waste from three DSTs is also expected to be TRU, but these tanks (AW-103, AW-105, and SY-102) will require washes with a dilute sodium hydroxide solution. The supernatant is decanted and the wet sludge packaged for disposal to WIPP as contact-handled TRU waste. The separated supernatant is not shown explicitly on Figure 3-1, Summary Mass Balance – Stretch Case – instead it is subtracted so that Stream 12 shows the net result.

The consolidation of TRU sludge from Tank AW-105 into Tank AW-103 and the washing of the TRU sludge in Tank SY-102 and the consolidated sludge in Tank AW-103 is modeled and accounted for in the tank space evaluation in Section 3.3.2.

Table 3-6 shows the amount of tank waste packaged as TRU or LLW by Supplemental Sludge Packaging in the Tank Farms. The values and schedule in this table will evolve as more detailed retrieval and packaging plans are developed.

Although not broken out on Figure 3-1, the packaged TRU being sent to WIPP (Stream 13) contains about 0.4 MCi of radioactivity and the LLW (Stream 14) contains about 0.2 MCi.

Table 3-6. Supplemental Sludge Processing – Stretch Case.

Tank	Bulk Sludge Volume (gal)	Staging Tank	Number of Drums	Retrieval Start	Retrieval Complete	Processing Schedule
T-201	28,000[a]	T-111	700 [a]	9/25/04	10/5/04	—
T-202	21,000 [a]	T-111	525 [a]	10/6/04	10/13/04	
T-203[b]	28,455 [a]	T-111	711 [a]	10/13/04	10/23/04	
T-203[c]	6,545	—	164	10/28/04	10/30/04	10/2004 to 1/2006
B-201	28,000	—	700	10/28/04	11/7/04	
T-204	38,000	—	950	11/1/04	11/13/04	
B-202	27,000	—	675	11/27/04	12/7/04	
B-203	50,000	—	1,250	12/27/04	1/14/05	
T-111[d]	523,455	—	13,086	1/9/05	7/12/05	
B-204	49,000	—	1,225	1/26/05	2/12/05	
T-110[e]	368,000	—	9,200	5/1/05	12/7/05	
AW-103/5[f]	124,000	—	3,100	6/26/07	7/2/07	6/2007 to 12/2009
SY-102	29,700	—	743	9/23/09	9/26/09	

Notes:

[a]The values in the shaded cells are already included in the row for Tank T-111.

[b]This row shows the portion of Tank T-203 waste retrieved and staged into Tank T-111 before it is filled.

[c]This row shows the portion of Tank T-203 waste processed directly upon retrieval, bypassing Tank T-111, since Tank T-111 is full at that time.

[d]The Bulk Sludge Volume and Number of Drums processed from Tank T-111 includes the original T-111 waste and the waste from Tanks T-201, T-202, and T-203 staged in Tank T-111.

[e]T-110 is handled as LLW sludge.

[f]After washing with dilute caustic.

Items of interest from this process are described below.

WIPP Criteria – The WIPP has acceptance criteria that limit free liquid, and restrict the Pu-239 fissile gram equivalents and plutonium equivalent curies. Dose rates are limited for contact-handled waste. The sludge packaging process will need to demonstrate compliance with the WIPP criteria. The comparison is not provided in the model results. These items will be addressed as process development continues.

Water Management – The key enabling assumptions include "dry" retrieval of the SSTs – however, emerging plans may result in adding ~ 1 Mgal to the retrieved waste to help transport it to the packaging facility. The disposition of this water has not been determined. If the waste is dried, condensate could be transferred to ETF (see Section 3.3.4). If supernatant is decanted, the liquid may require return to the DST system. Addition of sorbent sufficient to absorb the added liquid would increase the number of waste packages and potentially reduce the packaged waste below the definition of TRU. This issue will be addressed as process options are evaluated.

LLW Designation of Tank T-110 sludge – For purposes of this System Plan, the sludge in Tank T-110 is considered to be LLW. After comparison of the packaged sludge against land disposal restrictions, the packaged sludge would be disposed onsite in the Integrated Disposal Facility (IDF). The Tank T-110 waste identification is not final, and is being re-evaluated as new data become available. If shown to be TRU, the packaged waste would be transferred to WIPP with the other TRU sludge; if shown to be HLW, it would be retrieved and treated with other HLW. See Table 4-2. Key Issues and Uncertainties for the Target Case, Item 18.

Additional TRU tanks – If additional TRU tanks are identified, more waste could be disposed to WIPP, reducing the burden on the WTP and the other Supplemental Treatment processes.

Staging in Tank T-111 – The assumed process for retrieving waste from the T-200 tanks is to stage the waste in Tank T-111 (a placeholder until a specific SST is selected – Tank T-110 is being considered as an alternative). However, Tank T-111 does not have the capacity to accept all of the T-200 series waste. As a result, after Tank T-111 is filled, the model transfers the remainder of the T-200 series waste directly to the packaging facility. Tank T-111 is also a poor choice for use as a staging tank because it is assumed to be leaker (HNF-EP-0182). More generally, regulatory negotiations with the State of Washington Department of Ecology (Ecology) may be needed before using any SST for staging waste. Initial discussions indicate that Ecology may agree in principle, assuming that the SST is sound and that waste remains in the SST no longer than one year.

Contact-Handled SST TRU – The determination that SST TRU sludge will be contact-handled impacts the container and transport system required. Some of the inventory data for the tank waste is based on estimates developed from similar waste types in other tanks. Detailed tank history evaluations followed by additional sample data and will confirm whether the proposed dose rates from packaged sludge will be acceptable for contact-handling.

TRU Sludge From DSTs – Sludge from Tanks AW-103, AW-105, and SY-102 is assumed to be packaged as contact-handled TRU after washing and decant steps. The model relies on water wash factors from 1998. Since 1998, however, these DSTs have had changes to inventory estimates and contents, while the wash factors remained fixed and based on earlier data. For example, the estimated aluminum inventory in Tank SY-102 is more than four times the inventory in effect when the wash factor was established. The current Tank AW-103 chromium inventory is more than two times the 1998 value. Answers about the waste composition and distribution after washing are sensitive to the wash factors. Additional work may be needed to confirm whether the washed solids will be TRU, and whether the packaged solids can be contact-handled. If this sludge is not TRU, it will be sent to WTP for processing into HLW glass (rather than packaged for disposal to WIPP). The HLW glass canister count would increase, extending the mission end date.

DST Tank Space – Solids from Tank AW-105 are assumed to be consolidated in Tank AW-103, with the combined sludge washed in Tank AW-103. Solids in Tank SY-102 are washed separately. Washing increases the volume of supernatant. The volume increase plus the need to segregate the sludge segregation and consolidate it impact DST tank space.

3.3.8 Non-WTP Supplemental LAW Treatment

Starting in 2011, the Target Case treats approximately 8,000 MT Na from low-Cs waste by one of three candidate technologies and disposes of the waste at the IDF (Retrievable Onsite Disposal). The three candidate technologies are Bulk Vitrification, Steam Reforming, and Cast Stone.

For modeling purposes, the low-Cs waste was retrieved from SSTs located in 200 W Area and staged through a DST (SY-101) before being delivered to the Supplemental Treatment process. Likewise, low-Cs waste retrieved from SSTs located in 200 E Area was staged though Tank AN-107 before being delivered to the Supplemental Treatment process. About 30% of the insoluble solids associated with this feed were assumed to be incorporated into the LAW product by virtue of being soluble or if not soluble, of being LAW. The remaining solids were separated from the waste and left behind in the staging tanks (SY-101 or AN-107) or separated by the treatment process and returned to the DST system.

The estimates of the amount these insoluble solids associated with the low-Cs waste are subject to change due to uncertainty in the saltcake partitioning (dissolution) assumptions. During a preliminary run of the Stretch Case, it was noticed that the amount of HLW glass increased by about 5% due to less favorable incidental blending from the returned insoluble solids to the DST system. Tank-by-tank, these solids account for about 35% of the total HLW glass and a proportional amount of the total waste oxides and the glass created from these solids was limited by the maximum SO_3 constraint. This unexpected result suggests that the saltcake partitioning assumptions require refinement. Since the Stretch Case assumptions were not intended to change the HLW glass production, it was assumed that about 30% of these “insoluble” solids are either soluble or can be considered as low-activity waste.

The implications of maintaining segregated low-Cs feed or avoiding staging through the DST system have not been evaluated. A decision on the need to use DSTs for staging the low-Cs feed before treatment will be made based on process control considerations for the selected technology, how much decoupling (lag-storage) is needed between the retrieval and treatment of the waste, the logistics of deployment, and overall cost.

The tanks selected to supply low-Cs waste were based on a simple screening of the tank inventory for those tanks reported to contain less than 0.05 Ci/L Cs-137 when the sodium concentration is adjusted to 7 molar. Using this criterion, the low-Cs SSTs contain about 10,100 MT Na. Two of these SSTs, S-105 and S-112, are scheduled for early retrieval to meet TPA milestones M-45-05G-T01 and M-45-03C, respectively. These tanks contain about 1,600 MT Na which will be commingled with high-cesium waste during retrieval, evaporation, and storage, and thus will not be available for use as low-Cs feed. Essentially all of the remaining 8,500 MT Na was used as feed for Non-WTP Supplemental Treatment.

The two Non-WTP Supplemental Treatment facilities (one in 200 East, the other in 200 West) were staggered in their operation. The 200 West facility was operated from February 2011 through September 2021 while the 200 East facility was operated from February 2015 through October 2024 (see Figure 3-10 for this timing). The 200 West facility could not be started until its staging tank was emptied of other waste and cleaned out.

The volume of treated product depends on the waste loading, product density, and package fill achieved for the selected technology. Bulk Vitrification is expected to produce 21,000-MT product occupying 24,000 m^3 of external package volume; Steam Reforming is expected to produce 21,000-MT product occupying 25,000 m^3 of external package volume; and Cast Stone is expected to produce 56,000-MT product occupying 39,000 m^3 of external package volume. Approximately 0.3% of the total activity is expected to be incorporated into the treated product.

WHC-SD-WM-TI-699, *Technical Basis for Classification of Low-Activity Waste Fraction from Hanford Site Tanks* established the technical basis for classification of the LAW fraction of tank waste at the Hanford Site as waste not subject to the HLW disposal licensing authority of the NRC after removal of additional radionuclides and immobilization, thus permitting disposal of the waste in shallow land disposal facilities. The report further concludes that "an evaluation of the cost to remove cesium from all of the retrieved waste shows that for dilute feeds (cesium concentration < 0.05 Ci/L), the cost of further curie removal increases dramatically making further removal not economically practical." The NRC reviewed TI-699 and concluded that a residual of 8.5 MCi activity remaining in the LAW "represents the maximum amount of separation currently technically and economically practical…" (Paperiello 1997). One of the key premises behind Non-WTP Supplemental Treatment is that this dilute low-Cs waste is indeed acceptable for immobilization and disposal as LAW without further radionuclide removal.

The ORP has provided incentives for the Tank Farm Contractors to accelerate the retrieval, treatment, and disposal of tank waste using Non-WTP Supplemental Treatment techniques (Performance Based Incentive [PBI]-4), Supplemental Waste Treatment and Disposal). This will accelerate the production of immobilized low-activity waste requiring disposal at the IDF from 2011 as assumed in the Target Case to FY 2004 – 2006 per the incentives.

3.3.9 WTP Supplemental LAW Treatment

Starting in 2011, the Stretch Case treats approximately 14,000 MT Na from pretreated LAW waste by one of three candidate technologies and disposes of the waste at the IDF (Retrievable Onsite Disposal). The three candidate technologies are Bulk Vitrification, Steam Reforming, and Cast Stone. The facility housing the WTP Supplemental LAW Treatment process could be located on the site originally reserved for the second LAW Vitrification Facility.

For modeling purposes, the feed to the WTP Supplemental LAW Treatment includes the portion of the pretreated LAW that is not treated by the WTP LAW Vitrification Facility along with the submerged bed scrubber (SBS) recycle stream from the LAW Vitrification Facility. The SBS recycle stream is relatively dilute and normally is concentrated and blended with other LAW feed in the Pretreatment Facility. Its volumetric flow rate represents about 30% of the feed to Pretreatment.

The SBS recycle stream also bleeds off about 20% of the sulfate normally destined for incorporation into the LAW glass; however, this is not sufficient to reach a 20 wt% sodium oxide loading. The SBS recycle stream is also expected to include a portion of the more volatile radionuclides such as Tc-99. The HTWOS model does not currently model partitioning of components other than sulfate in the LAW melter or keep track of the volume of the recycle, so the Stretch Case model results cannot be used to predict the impacts of diverting the SBS recycle stream to Supplemental Treatment. In a future System Plan, additional partitioning assumptions can be added to the HTWOS model or the WTP Dynamic Flowsheet model could be used in conjunction with the HTWOS model to account for the partitioning in the LAW melter facility[1].

The amount of treated product depends on the waste loading, product density, and package fill achieved for the selected technology. Bulk Vitrification is expected to produce 54,000 MT product occupying 63,000 m^3 of external package volume; Steam Reforming is expected to produce 55,000-MT product occupying 64,000 m^3 of external package volume; and Cast Stone is expected to produce 147,000-MT product occupying 101,000 m^3 of external package volume. Approximately 1% of the total activity is expected to be incorporated into the treated product.

An interface control document has not yet been established to define the location, amount, and composition of the feed to be provided by the WTP to the WTP Supplemental LAW Treatment Process. Key process decisions have not yet been made concerning the location and amount of evaporator capacity, if any, needed to concentrate either the SBS recycle stream or the combined feed to WTP Supplemental LAW Treatment; the size and location of lag-storage needed to decouple the Supplemental Treatment process from the WTP; and the suitability of a given supplemental technology to treat this stream.

The size of the WTP Supplemental Treatment Facility depends on the difference between the ability of the WTP to produce pretreated LAW and the amount of pretreated LAW consumed by the LAW Vitrification Facility. The Supplemental Treatment decision point in FY 2005 will need to size this facility based on the predicted performance of the WTP, since the WTP performance will not have been demonstrated at that time. Another consideration would be to size the WTP Supplemental Treatment Facility to handle all of the Non-WTP Supplemental Treatment Capacity needed after it goes online in 2011.

[1] Decontamination Factors are documented in Table 3.2-5 "LAW Melter Decontamination Factors" and Table 3.3-1, "LAW Vitrification Material Flow Decontamination Factors by Component" in *Flowsheet Basis, Assumptions, and Requirements*, 24590-WTP-RPT-PT-02-005, Rev 1.

3.3.10 Retrievable Onsite Disposal

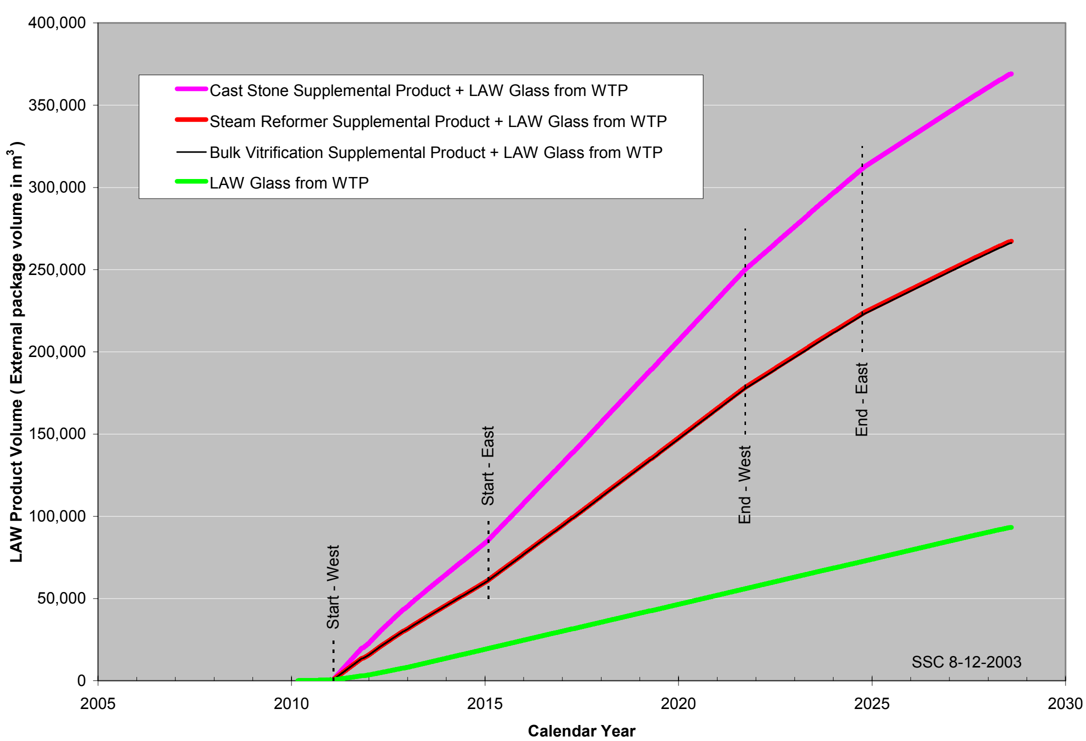
LAW products will be transferred to retrievable onsite disposal. Figure 3-10 shows the estimated total external volume vs. time for LAW packages from ILAW produced in the WTP and produced by each supplemental treatment process. The volumes from Supplemental Treatment are the sum of the WTP and Non-WTP pathways for each technology. The Supplemental Treatment volumes are alternatives. Each is based on processing the same amount of waste feed. The volume of packaged LLW sludge from Tank T-110 is small in comparison to the total LAW volume and, therefore, is not shown on the figure.

Total external package volumes for the Stretch Case are:

- WTP ILAW: 93,000 m^3;
- Bulk Vitrification: 173,000 m^3;
- Steam reforming product: 174,000 m^3, and
- Cast Stone: 276,000 m^3.

As shown in Figure 3-1, approximately 7 MCi of total activity, decayed to January 1, 2001, is estimated to be contained in the combined LAW products (LAW Glass from the WTP plus both WTP and Non-WTP Supplemental LAW product). This represents about 3.6% of the total tank inventory of 195 MCi.

Figure 3-10. Immobilized LAW Production – Stretch Case.



Topics of interest regarding retrievable onsite disposal include the following:

Volume demands on the disposal site are uncertain. The waste loading into the WTP ILAW and Supplemental Treatment products directly affects the volume of waste packages produced. The Stretch Case assumes waste is incorporated into WTP ILAW glass to reach a limit of 20-wt% sodium oxide. The Stretch Case uses a more optimistic assumption for WTP ILAW glass composition than the Target Case. Similarly, the ability of Supplemental Treatment products to efficiently incorporate waste affects the final package volumes. The Target and Stretch Cases made identical assumptions regarding the ability of supplemental treatments to incorporate waste.

The LAW packages source term and performance assessment may impact acceptance at the disposal facility. Disposal of waste onsite is subject to behavior within a performance assessment, which evaluates the impact of the disposed waste form on human health and the environment over a long period of time. Supplemental waste treatment products must be shown to perform acceptably, given the proposed waste incorporation (source term) and package configuration at the disposal site. Waste form performance is not part of the model used to generate this plan.

The IDF may require acceleration. Incentives to accelerate deployment of Supplemental Treatment may require accelerating the IDF (if constructed) so that it can provide temporary storage.

Treated LAW will require delisting. Waste stored in the tank farms is designated as listed dangerous waste (State of Washington and RCRA designation). A delisting petition must be prepared and accepted in order to dispose of the immobilized LAW onsite.

3.3.11 Interim Storage

Interim storage of IHLW will be provided by the Canister Storage Building (CSB), which shares space with stored spent nuclear fuel (SNF) currently being received from the Hanford Site's K-Basins. The Stretch Case assumes that the IHLW interim storage facility is needed on May 17, 2010, the date on which the first radioactive HLW canister is produced. Shipping to Yucca Mountain begins when the CSB is full (880 canisters + 22 canisters in WTP-provided lag storage), but no earlier than January 1, 2012. Figure 3-11 is a plot of HLW glass production vs. time with an overlay for storage capacity, shipping date and quantity shipped. The figure shows that the CSB is available by May 2010 and that shipping to Yucca needs to begin in February 2013.

Topics of interest regarding interim storage are addressed below and are the same for the Stretch and Target Cases:

IHLW shares facilities with spent nuclear fuel retrieval. If completion of spent nuclear fuel retrieval is delayed, the schedule for preparing for receipt of IHLW canisters may also be delayed.

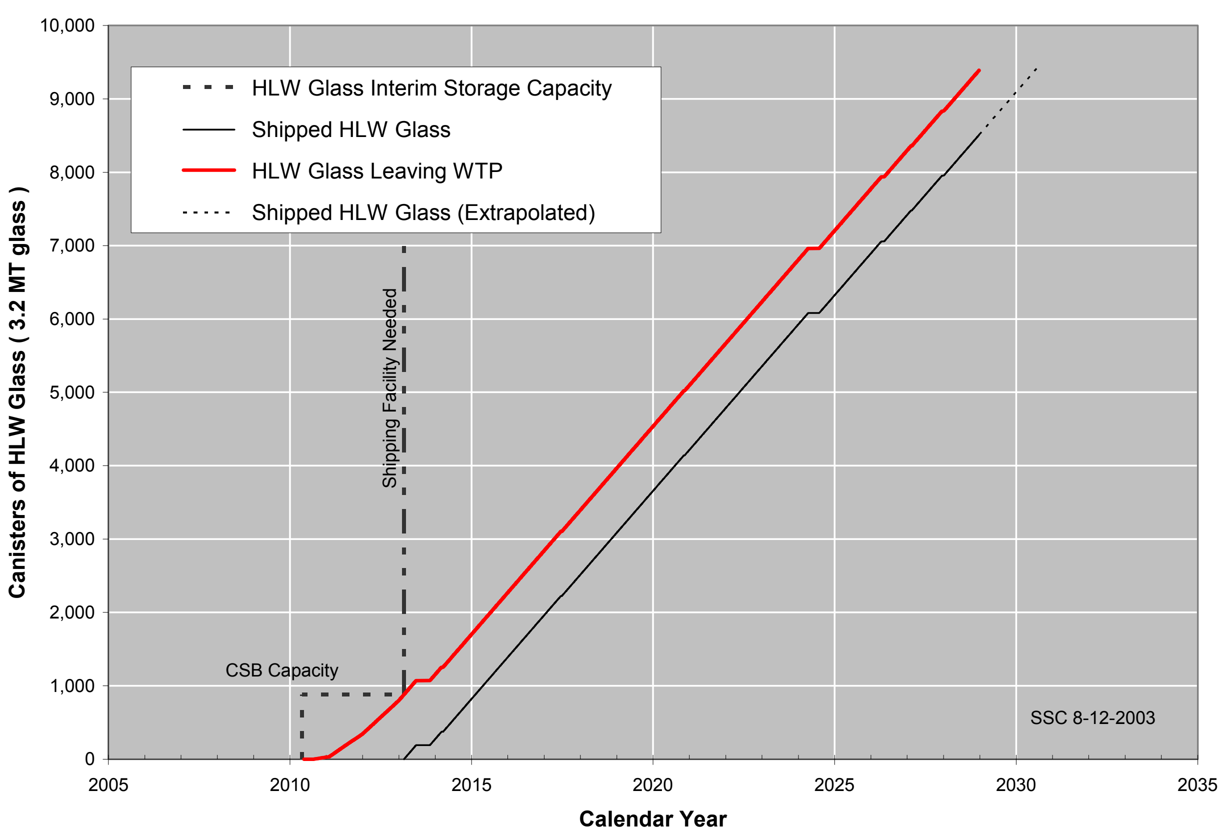
<u>The WTP is seeking to replace the IHLW canister design</u>. The current design uses thick wall canisters, but thin wall canisters are being pursued in order to minimize the number of canisters required to package the treated waste. Evaluation of the new canisters for acceptance at the CSB is underway. This System Plan assumes the use of the thin-wall canisters, each holding an average of 3.2 MT of HLW glass.

<u>Shipping need date</u>. When the CSB is full, shipments are assumed to begin to the repository at Yucca Mountain. If the repository is not ready at that time, additional storage capacity will be needed.

<u>Yucca mountain receipt rate</u>. Once the CSB is full, the rate at which the repository can accept packages must be at least as rapid as the production of IHLW canisters, or additional lag storage capacity will need to be developed. This System Plan does not address the number of shipping casks needed to support the required shipping rates nor the turn-around time needed to prepare and return a cask for reuse.

<u>Treated HLW will require delisting</u>. Waste stored in the tank farms is designated as listed dangerous waste under RCRA. A delisting petition must be prepared and accepted in order to ship and dispose of the immobilized HLW at Yucca Mountain, which will not be permitted under RCRA.

Figure 3-11. HLW Glass Interim Storage and Shipping Requirements – Stretch Case.



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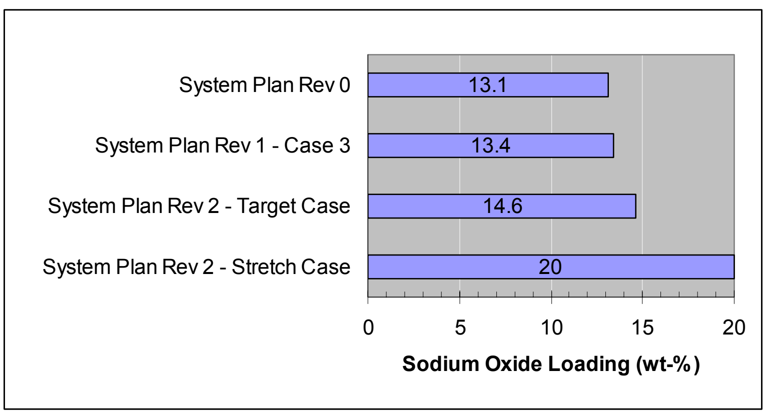
4.0 CONCLUSIONS

4.1 SUMMARY RESULTS

Both cases satisfy the success criteria by treating more than the required amount of waste[1] by February 28, 2018 (TPA milestone M-62-00A)and by completing treatment of all tank waste by December 31, 2028 (TPA Milestone M-62-00). The Stretch Case does treat more waste sooner; however, the mission end date of both cases is driven by the HLW glass volume and processing assumptions. The Target Case is projected to meet the M-62-00A milestone in January 2017; the Stretch Case in May 2015. If credit can taken for supplemental treatment and packaging in addition to the waste pretreated and vitrified by the WTP, then both cases would meet this milestone in 2013.

As can be seen from Figure 4-1, the average sodium oxide loading for the LAW glass is 14.6 wt-% for the Target Case. The improvements over System Plan Rev 0 are due primarily to routing the submerged bed scrubber recycle stream from the LAW Vitrification Facility to WTP Supplemental Treatment facility, which bleeds off about 20% of the sulfate (see Section 2.3.9). The improvements over System Plan Rev. 1 are because the low-Cs SSTs selected for Non-WTP Supplemental Treatment happened to contain a disproportionate amount of sulfate – the average SO_4/Na ratio for all waste is about 0.08 while the selected low-Cs SSTs are about 0.13 MT SO_4/MT Na for the Target Case and 0.14 for the Stretch Case. An informal sensitivity study showed that the Na_2O loading would only approach 14.9 wt% if the all of the low-Cs waste were sent to Non-WTP Supplemental Treatment.

Figure 4-1. Sodium Oxide Loading.



Another informal sensitivity study (Figure 4-2) was performed to show three different levels for the management of sulfate. The figure reports the estimated sodium oxide loading that would result for varying combinations of the amount sulfate incorporation in the LAW glass and the amount of sulfate removed from the system by not recycling the SBS stream. In this figure, the

[1] 10% by mass and 25% by activity.

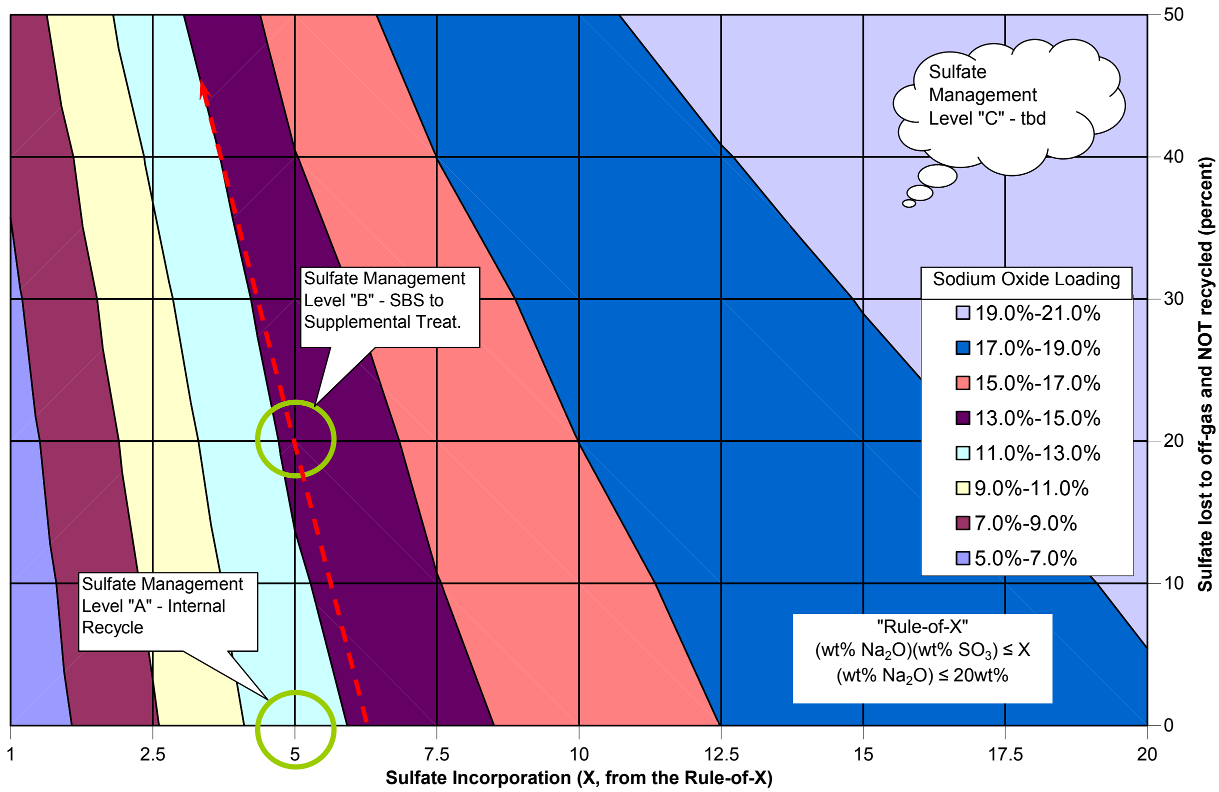
reported sodium oxide loadings will be about one or two percentage points less than the model runs since the study does not account for the sodium added to the waste during pretreatment and processing. Nonetheless, the figure is a useful depiction of the general behavior.

Sulfate management level "A" corresponds to the operating the WTP as designed with the SBS stream being recycled back into the pretreated LAW feed. It reflects the degree of sulfate incorporation expected using the "Rule-of-Five," which approximates the Gimpel Rule.

Sulfate management level "B" corresponds to the Target Case assumptions, where the SBS stream is sent to the WTP Supplemental LAW Treatment, slightly increasing the resulting sodium oxide loading in the LAW glass. The dotted red line shows that the amount of sulfate driven into the offgas can be increased, but at the expense of reductions in sulfate incorporation in the glass.

Sulfate management level "C" corresponds to the Stretch Case assumption of a 20wt% sodium oxide loading in the LAW glass. As previously discussed, the challenge is to find a way to move the process in this direction.

Figure 4-2. Sulfate Management Strategy.



Caveats: The reported sodium oxide loading is the average that results from applying the Rule-Of-X on a tank-by-tank basis to the 123 high-Cs tanks remaining after the 54 low-Cs and TRU/LLW tanks have been removed. Wash and leach factors are neglected - all sodium and sulfate is assumed to report to the liquid phase. Sodium added for caustic leaching of HLW and other processing is not included. The X in Rule-of-X and the amount of sulfate lost to offgas and not recycled are not independent and not all combinations are viable. Deviations from the base case (sulfate management Level A) may require changes to glass formulation, plant design or operating modes.

The LAW pretreatment rate averaged 2860 MT Na/yr in the Target Case and 2570 MT Na/yr for the Stretch Case, both lower than the assumed pretreatment capacity of 2950 MT Na/yr. The Stretch Case requires less of the available pretreatment capacity because an additional 5,000 MT of sodium from low-cesium tank waste is being treated by non-WTP supplemental treatment. This underutilized capacity is an asset and suggests a scenario where the combined capacities of LAW Vitrification, non-WTP supplemental treatment and WTP supplemental treatment are in excess of that needed to treat all LAW by 2028. Excess LAW treatment capacity will provide a more robust system configuration that can tolerate changes in many of the LAW processing assumptions. For example, if one of the treatment pathways performs less well than desired, the other two may make up the shortfall and, therefore, keep the mission on schedule. Alternatively, if the combined performance is more than that which is needed to treat the LAW by 2028, then there is potential to shorten the mission if commensurate changes are made on the HLW side.

Under current assumptions, the mission duration is being controlled by HLW processing – to shorten the mission either the vitrification (and pretreatment) rates need to be increased or the total volume of HLW glass decreased. It is not clear if significant increases in HLW production rates can be achieved since the HLW Vitrification system has little or no margin at its current nameplate capacity of 6 MTG/day. Small increases in production rates might be achieved by exploring improvements in HLW melter maintenance and bubbler life. In order to decrease the total volume of HLW glass, the factors that drive waste oxide loading would need to be explored (wash and leach factors, oxidative leaching, blending, glass properties model) as would avoiding any unnecessary treatment of TRU or LLW sludge as HLW.

Table 4-1 compares summary level results of the Target and Stretch cases to the previous revision of the system plan.

Table 4-1. Summary Results

Parameter		Target Case	Stretch Case	Rev 1 SP (Case 3)
Initial LAW feed delivery		12/2009	12/2009	7/2007
Initial HLW feed delivery		12/2009	12/2009	8/2007
Initial LAW glass produced		3/2010	3/2010	7/2007
Initial HLW glass produced		5/2010	5/2010	11/2007
WTP Start of Hot Commissioning milestone met		12/2009	12/2009	7/2007
WTP End of Hot Commissioning milestone met		1/2011	1/2011	11/2008
Start of WTP Supplemental Treatment		1/2011	1/2011	1/2010
First shipment of IHLW to Yucca Mountain		2/2013	2/2013	2030
Treatment (vitrification[1]) of 10% mass and 25% curies satisfied. Shaded items represent all treatment methods.		1/2017 3/2013[2]	5/2015 4/2013[2]	10/2016 7/2011[2]
Activity (7.1E+7 Ci) treated by 2/28/2018		53%	54%	57%
MT of waste oxide treated by 2/28/2018		3,800	3.600	5,175
MT of sodium in feed treated (vitrified[1]) by 2/28/2018. Shaded items represent all treatment methods.		7,200 18,700	10,200 19,500	6,831 22,050
IHLW Canisters produced by 2/28/2018		3,200	3,100	4,100
ILAW Containers[3] produced by 2/28/2018		11,700	13.600	13,600
Total IHLW Canisters		9,320	9,410	9,200
Total ILAW Containers[3]		30,400	34,900	27,400
Total Supplemental LAW product volume for candidate technologies, m^3	Cast Stone	428,000	277,000	440,000
	Steam Reformer	270,000	174,000	280,000
	Bulk Vitrification	268,000	175,000	270,000
Total Supplemental LLW Containers (55-gallon drums)		9,200	9.200	9,200
Total Supplemental TRU Containers (55-gallon drums)		21,600	21,600	21,900
SST Retrieval End Date		12/2025	12/2024	4/2024
Tank Waste Treatment End Date		12/2028	12/2028	2/2029
Total activity in all LAW waste forms, decayed to 1/1/2001. (% of total activity in waste)		8 MCi (4 %)	7 MCi (3.6 %)	Not reported

[1] The unshaded items represent literal interpretation of current TPA Milestones which specifies that waste must be pretreated and vitrified. Credit is taken only for waste pretreated and vitrified by the WTP.

[2] Based on waste treated by vitrification and supplemental LAW technologies and packaged as LLW or TRU sludge.

[3] Containers of LAW glass produced by the WTP Vitrification Facility – does not include any containers from supplemental treatment.

4.2 KEY ISSUES AND UNCERTAINTIES

For this revision of the System Plan, the risk discussion focuses on the key issues and uncertainties of the Target Case and Stretch Case. Since most of the key issues and uncertainties apply to both cases, the Stretch Case issues and uncertainties are incremental to the Target Case. The key issues and uncertainties risks were developed using a top-down qualitative approach. Since the cases are intended for planning evaluations, the key issues and uncertainties presented here may or may not be similar or the same as those critical risks related to the TFC and WTP contracts. Sources of issues and uncertainties included the ORP critical risk list, the mission acceleration risks from the IMAP (RPP-13678), the WTP risk list, and the key enabling technical assumptions for the System Plan and observations from the results of the model runs used to evaluate the technical assumptions of the Target and Stretch cases.

Table 4-2 lists those issues and uncertainties that are key for the Target Case, the corresponding assumption and possible mitigating actions. Table 4-3 addresses the incremental issues and uncertainties for the Stretch Case.

4.3 FUTURE MODELING AND ANALYSIS WORK

During evaluation of the Target and Stretch Cases, a number of programmatic and technical items related to the modeling effort were observed. These items are candidates for inclusion in future revisions to the System Plan and their priority and appropriateness should be considered when defining the purpose and scope of those revisions. Some of these items may also be amenable to parametric or sensitivity studies, rather than full mission modeling.

- Align the HTWOS model to match the 180-day period that staged and sampled feed must wait before delivery to the WTP.
- Include an evaluation of how well the delivered feed (feed vector) aligns with the WTP feed specifications.
- Include an evaluation of how well the HLW and LAW glass aligns with the WTP product specifications.
- Implement new water wash and caustic leach factors along with oxidative leaching.
- Review and refine the saltcake partitioning assumptions.
- Begin to track the total demand on the LERF and ETF by including them in the overall integrated flowsheet.
- Align the SST retrieval sequence with the outcome of the negotiations with Ecology.
- Adopt the most recent assumptions for supplemental treatment schedules, capacities, waste loading, and product forms.

- Assess the amount of “excess” LAW treatment capacity as a function of key mission parameters to help establish the desired system configuration.

- Evaluate the feasibility of additional blending (beyond that incidentally occurring during retrieval, staging, and delivery of feed) to reduce the HLW glass volume.

- Update the simple HTWOS model of the WTP to better match the key features of the current WTP process flowsheet to reduce the need to iterate with the detailed WTP dynamic flowsheet model.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
1	The demonstration of the Salt Cake Retrieval System, the Mobile Retrieval System, and/or the Vacuum Retrieval System will successfully remove sufficient SST waste to be acceptable for deployment.	SST Retrieval Effectiveness Successful SST retrieval system deployment will avoid cost increases and schedule delays associated with development of alternate technologies and/or backup waste feed sources to meet feed delivery requirements and accelerated SST closure projects.	1. Continue strategy to deploy technologies in actual waste removal activities so waste is removed, no matter how little. 2. Continue to evaluate performance of other lessons learned (e.g., West Valley waste removal, SRS waste retrieval, Oak Ridge National Laboratory (ORNL) Gunnite tanks, etc.). 3. Use cold test facility for demonstrating appropriate technologies. 4. Use the Riser and Equipment Inventory, which is maintained on SSTs, to affirm potential interferences with plans for retrieval activities. 5. Continue strategy to test multiple devices in same tank (e.g., C-104 planned strategy).
2	The "as retrieved" volume that SST waste will occupy in the DST system will be as predicted by the SST retrieval flowsheet for the assumed applied retrieval technology.	SST Retrieval Water Management The volume of waste retrieved from each SST depends on the tank waste inventory, and the selected retrieval technology. The ability to predict the as-retrieved volume is limited, but will improve as the three candidate SST retrieval technologies are deployed in the field. Since DST space is being aggressively utilized prior to WTP startup, increases in transient demand for DST space (i.e., increases in as-retrieved SST waste volumes) may reduce the number of tanks retrieved by the end of FY-2006 and may limit the amount of SST waste retrieval that is possible prior to the startup of the WTP.	1. Evaluate flowsheet and equipment performance at the Cold Test Facility. 2. Deploy the three candidate SST retrieval technologies and evaluate in-field retrieval system performance.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
3	The water wash factors in the Tank Waste Information Network System (TWINS) on September 30, 2001, will be used for partitioning waste into solid and liquid phases during retrieval and staging. The composition of waste in the feed vector will be reported on a fully water-washed basis.	<u>Water Wash Factors</u> Partitioning assumptions determine for modeling purposes how much salt cake and sludge dissolves when retrieved with water. Errors in water wash factors could change the amount of waste that is being sent to each of the various treatment pathways. Errors, if sufficiently large, could change the desired system configuration. Insoluble solids associated with low-Cs saltcake waste accounted for an unexpectedly large fraction of the HLW glass production.	1. Update the wash factors for aluminum and chromium since these elements can affect the volume of HLW glass produced from a given amount of waste. 2. Revisit saltcake partitioning assumptions
4	The caustic leach factors in the TWINS on September 30,2001, will be used as the basis for computing the caustic leach factors associated with each delivered batch of HLW solids, except for the caustic leach factors provided by the WTP (see Table C-2) will be used for AZ-102, C-104, C-106 and C-107. The TWINS values will be used for constituents for which no WTP value is provided.	<u>Caustic Leach Factors</u> The caustic leach factors describe the solubility of the water-washed solids when contacted with a sodium hydroxide solution in the Pretreatment Facility. New estimates of the water wash and caustic leach factors for two components (Cr and Al) that currently drive HLW waste oxide loading have recently been documented, but not yet included in the modeling assumptions. A future version of the System Plan will implement the new water wash and caustic leach factors along with oxidative leaching. Oxidative leaching or similar Cr removal technology, if feasible, will roughly offset the 2 to 3 times increase in HLW glass volume expected from the change in these wash and leach factors.	1. Update the caustic leach factors for aluminum and chromium since these elements can affect the volume of HLW glass produced from a given amount of waste. 2. Together with (1), implement oxidative leaching in the integrated flowsheet to offset the increase in HLW glass volume. 3. Develop and evaluate an oxidative leaching process for possible inclusion in WTP flowsheet.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
5	Existing DST space is sufficient to support the mission.	DST Space Availability Space initiatives are needed to provide sufficient storage space for SST retrievals and waste feed delivery to the WTP. DST integrity must be maintained and space saving initiatives must be successful to avoid re-planning of the TFC baseline strategy.	1. Request adjustments to contingency capacity requirements, 2. Evaluate retrieval technologies which avoid DST storage (e.g., dry retrieval and other supplemental processes, 3. Request adjustments to volume requirements, 4. Request adjustments to specific gravity requirements, 5. Optimize 242-A Evaporator operations to match as SST retrieval needs, 6. Either consolidate the TRU sludge in AW-103 and AW-105 or place concentrated waste on top of the TRU sludge, and 7. Continue to use the HTWOS modeling to optimize planned DST storage space requirements.
6	DSTs containing characterized feed to the WTP will maintain their characteristics until delivered to the WTP.	WTP Feed Configuration Control The initial feed batches for the WTP have been placed under configuration control and require ORP permission before composition or quantity of feed can be changed. The composition or quantity of feed has been changed by the Target Case in five DSTs: AY-102/C-106, AZ-101, AZ-102, AP-102, and AP-104. Retrieval and 242-A Evaporator campaign decisions need to be made today that DST space optimization will affect the feed being delivered to the WTP during its first years of commissioning and operation.	Implement a process that handles existing and emerging feed configuration control decisions, and optimizes DST space management and WTP operations.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
7	LERF/ETF will be capable of receiving and treating the effluents from the 242-A Evaporator, the WTP, and possibly Supplemental Sludge Packaging.	<u>LERF/ETF Capability</u> The 242-A Evaporator, the WTP, and possibly Supplemental Sludge Packaging will discharge liquid effluents to LERF/ETF. The WTP is expected to place a high solids demand on the ETF which may be outside its current processing capacity. If so, modifications to ETF may be required, impacting its availability.	1. Include LERF/ETF in the integrated flowsheet. 2. Evaluate the WTP effluent forecasts by ETF staff in support of ICD-6.
8	Improvements in HLW waste oxide loading can be accomplished by increasing the chromium oxide loading from 0.05 wt% to 1.0 wt%, increasing the viscosity from 5.5 Pa-s to 10 pa-s, and increasing the spinel liquidus temperature from 1050 degree C to 1100 degree C.	<u>Glass Property Model Limits</u> Together, these glass property model limit changes reduce the estimated amount of HLW glass by about 20% from the baseline model. The maximum operating viscosity for glass development has historically been 10 Pa-s. The Solubility of chromium in an alkali-alumino-borosilicate (AABS) glass is a function of both composition and temperature. Current T_L models can predict liquidus temperatures to within only ~100 ºC. This uncertainty requires that a 100 ºC to 200 ºC buffer be added to T_L constraints. It should be noted that the melter glass contact refractories are high in Cr, so changes in glass composition to allow for high Cr solubility will likely increase corrosion rates of glass contact materials. Glass loading to these limits may not be achievable.	Verify the validity of changing these constraints through additional research and technology.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
9	Sludge from AW-103, AW-105, and SY-102 is assumed to be packaged and disposed of as contact-handled TRU after washing and decant steps.	DST-TRU Waste Treatment and Packaging The model relies on water wash factors from 1998. Since 1998, however, these DSTs have had changes to inventory estimates and contents, while the wash factors remained fixed and based on earlier data. For example, the estimated aluminum inventory in Tank SY-102 is more than four times the inventory in effect when the wash factor was established. The current AW-103 chromium inventory is more than two times the 1998 value. Answers about the waste composition and distribution after washing are sensitive to the wash factors. Sludge washing may not adequately convert the remote-handled (RH)-TRU wastes stored in tanks AW-103, AW-105, and SY-102 to CH-TRU waste. Since WIPP is currently permitted to receive only CH-TRU waste, there is no off-site transportation, and disposition path for RH-TRU waste. WIPP is proceeding with acquiring the necessary regulatory permits for RH-TRU waste disposal, but the permits may not be available to meet the schedule. If, however, this sludge is not TRU it could be sent to WTP for processing into HLW glass rather than packaged for disposal to WIPP. The HLW glass canister count would increase, extending the mission end date.	1. Additional work may be needed to confirm whether the washed solids will be TRU, and whether the packaged solids can be contact-handled. 2. Continue discussions with WIPP and development of data in support of need and continue to monitor WIPP's progress on RH-TRU permitting.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
10	Solids from tank AW-105 are assumed to be consolidated in AW-103, with the combined sludge washed in tank AW-103.	DST-TRU Waste Consolidation Consolidation of the AW-105 with the AW-103 sludge provides necessary DST space for the retrieval of SST waste and further segregates the TRU sludge from potential cross contamination from other tank farm wastes that could prevent the sludge from being disposed of in WIPP. If this sludge is not TRU, it will be sent to WTP for processing into HLW glass. The HLW glass canister count would increase, extending the mission end date.	The space is not scheduled for use until 2/2006. Firm direction and approval is necessary from ORP prior to commitment of this space.
11	Dilute low-Cs waste (less than 0.05 Ci/L Cs-137 relative to 7M Sodium) is acceptable for immobilization and disposal as LAW without further radionuclide removal.	Non-HLW Waste Threshold A technical basis report (WHC-SD-WM-TI-699) on Hanford tank waste, made the case that waste containing less than 0.05 Ci/L Cs-137 relative to 7M Na to not be subject to NRC licensing authority. The NRC concurred with this position as long as certain criteria were met. The WTP separations and immobilized waste form processes were selected, in part, based on this product specification. If this threshold value decreases, or if the threshold value is not accepted by the regulators, then tanks that are considered low in Cs-137 may be required to undergo pretreatment at the WTP prior to immobilization and disposal.	Enter into a dialog with the regulators as to acceptability of this threshold value.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
12	For modeling purposes, the feed to the WTP Supplemental LAW Treatment includes the portion of the pretreated LAW that is not treated by the WTP LAW Vitrification Facility along with the submerged bed scrubber (SBS) recycle stream from the LAW Vitrification Facility.	Partitioning LAW Components The SBS recycle stream is also expected to include a portion of the more volatile radionuclides such as Tc-99. The HTWOS model does not currently model partitioning of components other than sulfate in the LAW melter or keep track of the volume of the recycle, so the Target Case model results cannot be used to predict the impacts of diverting the SBS recycle stream to supplemental treatment.	Add partitioning assumptions to the HTWOS model or the WTP Dynamic Flowsheet model could be used in conjunction with the HTWOS model to account for the partitioning in the LAW melter facility.
13	The WTP will provide pretreated feed to WTP Supplemental LAW Treatment.	LAW Supplemental Treatment Process Decisions The location, amount, and composition of the feed to be provided by the WTP to the WTP Supplemental LAW Treatment Process have yet to be defined. Key process decisions have not yet been made concerning the location and amount of evaporator capacity, if any, needed to concentrate either the SBS recycle steam or the combined feed to WTP supplemental LAW treatment; the size and location of lag-storage needed to decouple the supplemental treatment process from the WTP; and the suitability of a given supplemental technology to treat this stream.	Define the integrated flowsheet and the master production schedule between supplemental treatment and the WTP. Define the interface and establish an interface control document. Then, define and schedule the activities necessary to make the key process decisions concerning supplemental treatment of LAW and the WTP.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
14	The WTP will provide pretreated feed to WTP Supplemental LAW Treatment.	<u>WTP Supplemental Treatment Facility Size</u> The size of the WTP Supplemental Treatment Facility depends upon the difference between the ability of the WTP to produce pretreated LAW and the amount of pretreated LAW consumed by the LAW Vitrification Facility.	The supplemental treatment decision point in FY 2005 will need to size this facility based on the predicated performance of the WTP, since the WTP performance will not have been demonstrated at that time. Another consideration would be to size the WTP Supplemental Treatment Facility to handle all of the non-WTP Supplemental Treatment Capacity needed after it goes online in 2011.
15	Source term and performance assessment will allow disposal of LAW at the IDF.	<u>IDF Source Term and Performance Assessment</u> The LAW package, source term and performance assessment, may impact acceptance at the disposal facility. Disposal of waste onsite is subject to behavior within a performance assessment, which evaluates the impact of the disposed waste form on human health and the environment over a long period of time. Supplemental waste treatment products must be shown to perform acceptably, given the proposed waste incorporation (source term) and package configuration at the disposal site.	1. Perform risk assessment calculations as part of the down selection of potential supplemental waste forms. 2. Optimize waste form performance through waste formulation and testing. 3. Identify potential IDF design changes that could improve overall disposal system performance.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
16	When the CSB is full, shipments are assumed to begin to the repository at Yucca Mountain.	Yucca Mountain, NV Repository Availability If the Yucca Mountain repository is not ready at that time, additional storage capacity will be needed. Once the CSB is full, the rate at which the repository can accept packages must be at least as rapid as the production of IHLW canisters, or additional lag storage capacity will need to be developed.	Document an alternative IHLW shipping schedule that implements accelerated shipping into the national plan. ORP will then recommend to the DOE-Headquarters (HQ) HLW team that they include the accelerated shipping plan in a recommendations made to EM-1. By September 30, 2003, ORP is planning to receive the revised national shipping schedule from EM-1. This shipping schedule will be used to update the RPP baseline schedule and cost estimates associated with additional IHLW storage modules.
17	Supplemental LAW treatment capability will be available to support the mission.	Supplemental LAW Treatment Availability If supplemental LAW treatment capability is not available (development, NEPA documentation, design, regulatory permits, and construction) in time to begin LAW treatment in 2011 then the TPA Milestone for completing tank waste treatment in 2028 is in jeopardy, and additional costs and schedule impacts will occur. Development and implementation of supplemental LAW treatment capacity will allow the RPP to complete tank waste treatment in 2028 and support completion of the Hanford Site cleanup mission in 2033.	Pursue three alternative supplemental LAW treatment technologies to accelerate LAW processing. These are: steam reforming, containerized grout, and bulk vitrification. A decision on further development of one ore more of these technologies is scheduled for early FY 2004.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
18	Tank waste classified as non-HLW will have different treatment, packaging, and disposition pathways.	Tank Waste Classification Low-curie LAW feed (3100 MT Na) plus LLW and TRU Sludge (300 MT Na) by-pass the WTP Pretreatment Facility and go to TRU packaging or supplemental treatment. TRU waste is shipped off-site to WIPP for disposal. LAW and LLW are disposed on-site. If waste intended for TRU packaging or supplemental treatment cannot be classified as non-HLW in accordance with DOE O 435.1, then this waste may require processing through the WTP Pretreatment Facility and subsequent vitrification at the WTP prior to disposal as IHLW or ILAW. This may increase the WTP operating time beyond 2028.	WIR determination strategy is being developed.
19	The CSB will be used to store immobilized HLW (IHLW).	CSB Construction Conflicts Presently the Spent Nuclear Fuel Program is moving K-Basin spent fuel to the CSB for interim storage. There are additional spent fuel materials stored onsite that could be transferred to and stored at the CSB. If spent fuel movements extend beyond the current schedule, then these transfers could interfere with the construction and operation of the CSB's IHLW facilities.	Formalize ICD agreement to include late finish dates for spent nuclear fuel transfers so they will not interfere with construction and operating plans.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
20	Three Waste Retrieval Facilities (WRFs), one WRF for each northern quadrant, plus one for U-Farm, will provide the infrastructure for supporting multiple SST waste retrievals. WRFs are assumed not to be required for retrieving SSTs for supplemental sludge treatment and SSTs retrieved prior to 10/1/2009.	SST Waste Transfer to DST System Waste Retrieval Facilities (WRFs) provide the infrastructure that supports the collection and conditioning of retrieved SST waste, and retrieved SST waste transfers to the DST system. The specific infrastructure for the WRFs and the transfer system for retrievals prior to 10/1/2009 have not been determined. Temporary and relatively less expensive hose-in-hose transfer systems have been successfully used for shorter transfer distances. However, the distances from the outlying SST farms to the nearest DST system may be greater than can be accommodated with a hose-in-hose design. If this is the case, more robust and costly transfer systems may be required earlier than planned.	Perform value engineering analysis to determine the best, most cost effective approach for the near term and long term infrastructure support to SST waste retrieval.
21	Regulatory approvals will be timely and support the mission execution schedule	Timely Regulatory Approvals The mission execution schedule requires resolution of regulatory issues, permitting requirements, and NEPA scope before implementation of closure plans and supplemental technologies. If regulatory approvals are not obtained in a timely manner to support the mission, then deployment of alternative treatment technologies and tank closures could be impacted, resulting in increased costs, schedule delays, and extension of the RPP mission. Life-cycle costs and schedule savings reflected by the accelerated baseline may not be realized.	1. Permit requirements and associated regulatory issues, including performance requirements, waste acceptance criteria, will be evaluated during identification and selection of acceptable treatment technologies. 2. Align on scope required for the Environmental Impact Statement (EIS) and proceed with executing the approved EIS/Record of Decision (ROD) development schedule.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
22	The scenarios will not be constrained to match current contracts, performance based initiatives, funding, interface control documents, or other planning guidance except as captured by the key enabling assumptions.	WTP Feed Specifications A review of the compliance with existing feed specifications was not performed for this version of the system plan.	This activity is more appropriate once the main mission parameters are settled.
23	Source term and performance assessment will support disposal of secondary wastes generated by the WTP or by ETF on behalf of WTP that goes directly to the IDF.	Secondary Waste Disposal Secondary waste streams, such as solid wastes or solid wastes generated at ETF as a result of treating liquid effluents generated by the WTP, have not been considered by the IDF performance assessment. The source term and waste form of these secondary wastes may not be with in bounds of the IDF performance assessment and therefore may not be suitable for disposal at IDF.	1. Develop and document source term and waste form of secondary waste streams. 2. Use the resulting source terms and waste forms as input data to the IDF performance assessment.
24	The WTP LAW Vitrification Facility will achieve an average throughput rate of 28.8 MTG/d (36 MTG/d LAW design capacity with and 80% availability factor).	WTP LAW Vitrification Throughput (Target) The most recent Operations Research Assessment Report (OR) (24590-WTP-RPT-PT-02-015) indicates that an availability factor of approximately 74% for LAW could be expected if all failures are applied resulting in an average throughput rate of 20.2 MTG/d. Achieving the higher assumed average throughput rate of 28.8 MTG/d may require the upgrading of facilities and equipment (LAW Melter, LAW HVAC, support utilities, etc.).	Continue to refine OR assessments to track predicted throughput. Identify those features of the design and or/operating modes that limit throughput (both in terms of design capacity and influence on availability). Evaluate feasibility and desirability of changing the design and/or operating modes.

Table 4-2. Key Issues and Uncertainties for the Target Case.

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
25	The WTP HLW Vitrification Facility will achieve an average throughput rate of 5MTG/d (6 MTG/d design capacity with an 80% availability factor).	WTP HLW Vitrification Throughput The most recent Operations Research Assessment Report (OR) (24590-WTP-RPT-PT-02-015) indicates that an availability factor of approximately 76% for HLW could be expected if all failures are applied resulting in an average throughput rate of 4.4 MTG/d. Achieving the higher assumed average throughput rate of 5 MTG/d may require improvements in operating modes and design changes to improve equipment reliability.	Continue to refine OR assessments to track predicted throughput. Identify those features of the design and or/operating modes that limit throughput (both in terms of design capacity and influence on availability). Evaluate feasibility and desirability of changing the design and/or operating modes.
26	The Balance of Facilities (BOF) and utilities will support the increased throughput.	BOF Availability Factors Operational Research Assessment Reports have not analyzed the Balance of Facilities or utilities in determining overall system availability factors.	As development continues, assess the Balance of Facilities and utilities to determine their sensitivity to the overall availability factors.

Table 4-3. Key Issues and Uncertainties for the Stretch Case (Incremental).

Item	Assumption	Key Issue and Uncertainty	Potential Mitigation Actions
1	The WTP LAW Vitrification Facility will achieve an average throughput rate of 34 MTG/d (40 MTG/d LAW design capacity with an 85% availability factor).	WTP LAW Vitrification Throughput The most recent Operations Research Assessment Report (OR) (24590-WTP-RPT-PT-02-015) indicates that an availability factor of approximately 74% for LAW could be expected if all failures are applied resulting in an average throughput rate of 20.2 MTG/d. Achieving the higher assumed average throughput rate of 34 MTG/d may require the upgrading of facilities and equipment (LAW Melter, LAW HVAC, support utilities, etc.).	Continue to refine OR assessments to track predicted throughput. Identify those features of the design and or/operating modes that limit throughput (both in terms of design capacity and influence on availability). Evaluate feasibility and desirability of changing the design and/or operating modes.
2	The LAW Vitrification Facility can produce a glass with an average 20 wt% sodium oxide loading.	LAW Waste Oxide Loading Using empirical relationships, the amount of pretreated waste that can be incorporated into LAW glass (measured by sodium oxide loading,) is generally limited by the amount of sulfate in the feed to around 13-15 wt%.	The path forward to achieving a 20 wt% sodium oxide loading in LAW glass is not clear. Some areas of speculation include the application of sulfate removal technologies; modifying existing glass chemistry to be more tolerant of sulfate; or to drive more sulfate into the off-gas; retrofit with an alternate melter design, or use a different glass formulation that tolerates high sulfate levels.

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TFCO&UP, HNF-SD-WM-SP-012, 2003, *Tank Farm Contractor Operation and Utilization Plan*, Rev. 4B, CH2M HILL Hanford Group, Inc., Richland, Washington.

WHC-SD-C018H-FDC-001, 1995, *Project C-018H, 242-A Evaporator/PUREX Plant Condensate Treatment Facility, Functional Design Criteria,* Rev. 3, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-699, 1996, *Technical Basis for Classification of Low-Activity Waste Fraction from Hanford Site Tanks*, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

GLOSSARY

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APPENDIX A
GLOSSARY

Term or Abbreviation	Definition or Expansion
Date Vector	The "date vector" is produced by the Waste Treatment Plant (WTP) dynamic flowsheet model and lists the desired delivery date for every feed batch included in the feed vector.
Dynamic Flowsheet Model	A flowsheet model that describes the hardware and operating modes for that hardware and accounts for changes in hold-up and flow rates over time. Both Hanford Tank Waste Operation Simulator (HTWOS) and the WTP dynamic model are examples of dynamic flowsheets. The WTP dynamic model was not used in the production of this version of the System Plan.
Feed Vector	The feed vector is produced by the HTWOS model and lists every feed batch, the delivery date, type of feed (low-activity waste [LAW] or high-level waste [HLW]), composition and quantity of feed, and for HLW feed, the batch-specific leach factors.
Steady State Flowsheet Model	A flowsheet model that describes the hardware and operating modes for that hardware and accounts for process parameters such as stream compositions, intrinsic and extrinsic properties, hold-up, and flow rates do not change over time.
Gimpel Rule	An empirical relationship that allows estimation of the sodium oxide loading in LAW glass based on the amount of sulfate and sodium in the feed. The Gimpel rule predicts similar sodium oxide loading as the so-called "Rule-of-5."
G2	The software platform on which both HTWOS and the WTP dynamic model were built. It is a trademark of GENSYM Corporation.
Integrated Baseline	The integrated baseline comprises the integrated technical foundation, the project master baseline schedules, work scope definition, funding profiles, and risk registers.

Term or Abbreviation	Definition or Expansion
Integrated Flowsheet	In the context of this report, the integrated flowsheet is the result of employing the HTWOS dynamic model (with or without iteration with the WTP dynamic flowsheet model) and consists of • waste processing and treatment hardware and piping logic showing the flow of material through all the hardware • the operating modes of each unit operation and associated lag storage under normal and upset conditions (optional) • the sequencing, staging, quantity, and delivery dates of waste from the tank farms for delivery to the processing and treatment facility • material balances around the entire facility and within individual unit operations • results from the flowsheet that meet key facility enabling assumptions • a design that is acceptable to ORP
Integrated Technical Foundation	The Integrated Technical Foundation comprises the design and operating modes of the WTC, the integrated flowsheet, and the design underpinning that support key design parameters.
Operating Modes	The ways in which the hardware is operated, within its design limits, to achieve the desired material processing result.
Plan	River Protection Project System Plan
Target Case	The Target Case shows how ORP expects the waste treatment mission to proceed under the assertion that the WTP will perform better than the minimum contract requirements in conjunction with supplemental treatment.
Stretch Case	The Stretch Case shows ORP's vision of how the mission might unfold if sufficient breakthroughs in plant performance are realized in conjunction with supplemental treatment.
Case 3	Obsolete planning case from System Plan Revision 1 which determined that the WTC can complete the mission by 2028 assuming increased waste treatment capabilities and sufficient Pretreatment Facility capacity. Supported a WTP configuration using 2 HLW melters and 2 LAW melters.

Term or Abbreviation	**Definition or Expansion**
WTP	Waste Treatment Plant – the facility being constructed by BNI for the treatment of a portion of the Hanford Tank Waste, comprising a Pretreatment Facility, a LAW Vitrification Facility, a HLW Vitrification Facility, and numerous support buildings.
WTP Supplemental LAW Treatment	An additional process that treats the portion of pretreated LAW from the WTP that is not treated by the WTP LAW Vitrification Facility. Three technologies are under consideration for this treatment process – bulk vitrification, steam reforming, and cast stone.
Non-WTP Supplemental Sludge Packaging	An additional process that packages the portion of the tank waste that is designated as LLW or TRU in a form suitable for disposal onsite (LLW) or at WIPP (TRU).
Non-WTP Supplemental LAW Treatment	An additional process that treats the portion of LAW that is not treated by the WTP. Three technologies are under consideration for this treatment process – bulk vitrification, steam reforming, and cast stone.
Waste Treatment Complex	The WTC includes all facilities and equipment needed to safely store and treat the Hanford Site tank waste. It includes the WTP, the tank farms, waste transfer systems, Supplemental Treatment processes, immobilized high-level waste (IHLW) storage and immobilized low-activity waste (ILAW) disposal facilities, various laboratories, the 242-A Evaporator, and various effluent retention and treatment facilities.

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APPENDIX B

SUMMARY OF MODELING ASSUMPTIONS

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Item	TARGET Case	STRETCH Case	Comments
WTP Hot Commissioning			
Start	12/1/2009	12/1/2009	SAP4 Level 3 Schedule (11Mar03)
1st LAW Delivered	12/1/2009	12/1/2009	Hot Com. starts when 1st feed delivered.
1st HLW Delivered	12/15/2009	12/15/2009	Assume two week offset
1st ILAW	3/1/2010	3/1/2010	Start of Hot Com. for LAW Vit per SAP4 Level 3 Schedule (11Mar03)
1st IHLW	5/17/2010	5/17/2010	Start of Hot Com. for HLW Vit per SAP4 Level 3 Schedule (11Mar03)
End	1/31/2011	1/31/2011	Late date from SAP4 Level 3 Schedule (11Mar03)
Production Rates	HLW Vit – To make 56 Canisters LAW Vit – To make 188 Packages PT LAW – not limiting	HLW Vit – To make 56 Canisters LAW Vit – To make 188 Packages PT LAW – not limiting	LAW – To make 188 packages during hot commissioning. HLW – To make 56 canisters during hot commissioning. Ref: Table C.6-5.2

Item	TARGET Case	STRETCH Case	Comments
WTP Full Operations			
Start	2/1/2011	2/1/2011	Start after the late date for end of hot com
HLW Vit Production Rate	Ramp to 5.0 MTG/day: Starting On / Rate 2/1/2011 / 3.0 1/1/2012 / 4.0 1/1/2013 / 5.0	Ramp to 5.0 MTG/day: Starting On / Rate 2/1/2011 / 3.0 1/1/2012 / 4.0 1/1/2013 / 5.0	6 MTG/d @ 0.84 TOE Basis for TOE: High Level Waste Facility Operations Research Availability Assessment (24590-HLW-RPT-PT-02-001, Rev. 0) Basis for Nameplate: Table C.6-5.1 Goal
LAW Vit Production Rate	Ramp to 28.8 MTG/day: Starting On / Rate 2/1/2011 / 18.0 1/1/2012 / 24.0 1/1/2013 / 28.8	Ramp to 34.0 MTG/day: Starting On / Rate 2/1/2011 / 21.0 1/1/2012 / 29.0 1/1/2013 / 34.0	Target Case 36 MTG/d @ 0.80 TOE Basis for TOE: Low Activity Waste Facility Operations Research Availability Assessment (24590-LAW-RPT-PO-03-001, Rev. 0) provides a TOE of 0.774 – it is believed that improvements during the mission will allow a TOE of 0.80 to be reached. Driven by 16 week bubbler life. Basis for Nameplate: Table C.6-5.1 Goal Stretch Case 40 MTG/d @ 0.85 TOE
PT LAW Production Rate	Up to 2,950 MT Na/yr (all sources) ~2,840 Required	Up to 2,950 MT Na/yr (all sources) ~ 2,430 Required	3400 MT Na/yr @ 0.86 TOE Basis for TOE: Assessment of Operations Research (OR) Model Run for the Technical Integration Baseline Development Team (TIBDT) (24590-PTF-RPT-PT-02-001, Rev. 0). Basis for Nameplate: Table C.6-5.1 Goal (90 MTG/d = ~ 3400 MT Na/yr).

Item	TARGET Case	STRETCH Case	Comments
Supplemental Processing			
Supplemental LAW Treatment of WTP PT Supernatant	Online – 1/31/2011 Size to handle "excess" Na from PT.	Online – 1/31/2011 Size to handle "excess" Na from PT.	Modeled capacity of PT is reduced to direct the maximum amount of waste through WTP LAW Vit while ending by 12/31/2028.
Supplemental LAW Treatment of non-WTP Supernatant	Start Date – 1/31/2011 Size to handle 3,000 MT "excess" Na from TF.	Start Date – 1/31/2011 Size to handle 7,500 MT "excess" Na from TF.	Stretch Case requires changes in the SST Retrieval Sequence to help with segregation of low-Cs feed.
Supplemental LAW Treatment Waste Forms	Report on 3 waste forms: SR, Bulk Vit and Cast Stone	Report on 3 waste forms: SR, Bulk Vit and Cast Stone	Make similar product loading assumptions as BCR and System Plan.
Supplemental Sludge Packaging (TRU/LLW)	10 SSTs (FY 2005 – 2006) 3 Washed DSTs (FY 2007 – 2009)	10 SSTs (FY 2005 – 2006) 3 Washed DSTs (FY 2007 – 2009)	Make similar product loading assumptions as BCR and System Plan.
WTP Process Parameters			
Partitioning	Hendrickson / Colton wash and leach factors with BNI data when available	Hendrickson / Colton wash and leach (W&L) factors with BNI data when available	Updated W&L factors and oxidative leaching will be addressed in future runs.
HLW Loading	Relaxed gpm	Relaxed gpm	Model constraints relaxed to increase waste loading.
LAW Loading	Gimpel Rev 4 (~ 14 wt% Na_2O)	20 wt% Na_2O	Path-forward to reach 20-wt% not understood.
Tc IX	No	No	
"Non-Waste" Sodium	3.5%	3.5%	Na added by WTP, excluding caustic leach, as a % of pretreated LAW.
HLW Canister	Thin-Walled (3.2 MTG/can)	Thin-Walled (3.2 MTG/can)	
LAW Container	6.0 MTG/package	6.0 MTG/package	

Item	TARGET Case	STRETCH Case	Comments
Initial Feed Sequence to WTP			
LAW Feed Sequence to WTP	AP-101 AP-103 AP-105 AN-104 AN-102 AN-105 AN-107 SY-101 AN-103 AW-101	AP-101 AP-103 AP-105 AN-104 AN-102 AN-105 AN-107 SY-101 AN-103 AW-101	**Issue:** BNI is expecting the existing feed in AP-101 for hot commissioning. However, CH2M HILL plans to deliver a similar feed by utilizing available tank space in AP-101. **TIA Guidance:** Use the BCR Case feed sequence for planning purposes. This assumes that the "Feed Control Working Group" is successful in demonstrating that the impacts to the WTP cost, schedule and risk are acceptable.
HLW Feed Sequence to WTP	AY-102 AZ-101 AZ-102 C-104/AY-101 C-107 AW-104	AY-102 AZ-101 AZ-102 C-104/AY-101 C-107 AW-104	**Issue:** Shall the hot commissioning feed for HLW be AZ-101 or AY-102. Current TFC baseline is AZ-101; new BNI contract uses AY-102 as a benchmark. **TIA Guidance:** Use the waste in AY-102 as HLW hot commissioning feed. This assumes that impacts to the TFC cost, schedule and risk are acceptable. Supernatant in AZ-102 will be replaced with low-sulfate, high-sodium waste to mitigate sulfate damage to LAW melter and to improve DST space management.

Item	TARGET Case	STRETCH Case	Comments
IHLW Interim Storage and Shipping			
Shipping to Yucca Starts	No earlier than 1/1/2012	No earlier than 1/1/2012	
Interim HLW Storage	CSB	CSB	CSB provides storage for 880 canisters.
Interim HLW Storage Need Date	First IHLW produced	First IHLW produced	This is consistent with the WFD Project IP.
Shipping Facility	No lag storage modeled	No lag storage modeled	Future design consideration for shipping facility, not modeled at this time.
WTP HLW lag-storage (canisters)	45 – available 22 used	45 – available 22 used	Assume that ½ of WTP HLW lag-storage is kept full (use 22 of 45 storage positions).
Tank Farm Process Parameters			
Waste Inventory Basis	"FY 2003" Inventory	"FY 2003" Inventory	Routine update of inventory.
Nominal TFC Evaporator SpG	1.41 Raise to 1.47 on 6/1/03	1.41 Raise to 1.47 on 6/1/03	Concentrate existing supernatant when evaporator is available – placeholder limit.
Emergency Space	1.14 Mgal Raise to 1.20 Mgal on 1/1/2004	1.14 Mgal Raise to 1.20 Mgal on 1/1/2004	
DST Fill Height	Raise to 436 inches on 1/1/2004	Raise to 436 inches on 1/1/2004	2AW up to 426 inches; AY and AZ-Farms up to 364 inches.
SST Retrieval Sequence Priorities	7 SSTs w/TPA MS Up to 40 SSTs by 2006 Risk-based, balancing feed to WTP	7 SSTs w/TPA MS Up to 40 SSTs by 2006 Risk-based, balancing feed to WTP	Desired sequence and timing of 1st 26 tanks and sequence of next 14 tanks is based on refinements to Planning Alignment Case. Stretch Case sequence will need rework to accommodate 10,000 MT Na to non-WTP supplemental treatment.

B1.0 References

24590-HLW-RPT-PT-02-001, 2002, *High Level Waste Facility Operations Research Availability Assessment*, Rev. 0, Bechtel National, Inc., Richland, Washington.

24590-LAW-RPT-PO-03-001, 2003, *Low Activity Waste Facility Operations Research Availability Assessment*, Rev. 0, Bechtel National Inc., Richland, Washington.

24590-PTF-RPT-PT-02-001, 2002, *Assessment of Operations Research (OR) Model Run for the Technical Integration Baseline Development Team (TIBDT)*, Rev. 0, Bechtel National Inc., Richland, Washington.

APPENDIX C

SUCCESS CRITERIA AND KEY ENABLING ASSUMPTIONS

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C1.0 GENERAL INFORMATION

The success criteria and key enabling assumptions listed in this section document the initial input for modeling and mission planning purposes in June 2003. These were developed after reviewing existing assumptions from the previous RPP System Plan and the recent modifications to the WTP contract[1] and TFC baseline[2], the HTWOS model run[3] supporting the TFC baseline along with planning guidance and vision from ORP. They represent the major planning bases needed to develop an integrated flowsheet using the existing flowsheet and dynamic models[4] for each of the new System Plan cases. They are not intended to address design-basis decisions or detailed equipment operating plans.

The scenarios will not be constrained to match current contracts, performance based initiatives, funding, interface control documents, or other planning guidance except as captured by the key enabling assumptions. Changes in those areas may be required to implement scenarios built upon these modeling assumptions.

The cases to be evaluated are as follows:

Case 1 – "Target Case" – 2 HLW and 2 LAW Melter Configuration with Supplemental LAW Processing both upstream and downstream of WTP Pretreatment and TRU/LLW Waste Processing upstream of WTP to meet the 2028 TPA Milestone.

Case 2 – "Stretch Case" – Similar to the Target Case, except with enhanced LAW Vitrification production rates and sodium oxide loadings, and additional Supplemental LAW Processing upstream of the WTP of low-Cs waste.

Where success criteria and key assumptions are different depending on cases, additional information is provided.

ORP concurred with the Success Criteria and Key Enabling Assumptions on July 7, 2003. The assumptions were updated after ORP's review of preliminary model results in August and the final version is presented in this appendix.

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[1] DE-AC27-01RV14136, Modification Number A029, 2003, WTP Contract.

[2] RPP-03-004 R0, 2003, Baseline Change Request. This baseline was current when work began on establishing the success criteria and key enabling assumptions in June 2003.

[3] RPP-15588, Rev 0, 2003, *Hanford Tank Waste Operations Simulator (HTWOS) Model Run Results for the Proposed Baseline Change Request (BCR) Case*, CH2M Hill Hanford Group, Inc., Richland, Washington.

[4] Only the Hanford Tank Waste Operations Simulator (HTWOS) was used to model these cases. The WTP dynamic flowsheet model was not needed to evaluate the two cases in this version of the Plan.

C2.0 SUCCESS CRITERIA

C2.1 Pretreat and vitrify no less than 10 percent of Hanford's tank waste by mass and 25 percent by activity by February 28, 2018[1]. The 10 percent by mass is further defined to mean at least 6,000 MT of sodium from LAW feed and at least 800 MT of waste oxides from HLW feed.

C2.2 The Waste Treatment Complex *could* treat or package all Hanford Site tank waste by the 12/31/2028 TPA Milestone if all supplemental facilities are provided and the enhanced throughput rates achieved.

C3.0 KEY ENABLING ASSUMPTIONS

C3.1 General Assumptions

C3.1.1 The WTP will be operable for 40 years, from the start of hot commissioning through 2049.

C3.1.2 The supplemented Waste Treatment Complex will be available as follows:

- Supplemental TRU/LLW sludge packaging available on October 1, 2004.
- WTP Supplemental LAW facilities available on January 31, 2011.
- Non-WTP Supplemental LAW facilities available on January 31, 2011.

C3.1.3 The WTP pretreatment facility shall be enhanced to produce <u>up to</u> an average of 2,950 MT of sodium per year[2] of treated LAW and sufficient pretreated HLW to produce <u>up to</u> 571 canisters of IHLW per year[3].

C3.1.4 The Balance of Facilities, the Laboratory, and other support facilities are assumed to be capable of supporting the WTP.

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[1] A strict interpretation (only waste that is pretreated and vitrified by the WTP counts) of the M-62-00A milestone language will be used as the success criteria. We will, however, report on both the milestone as written and on modified language that includes all the waste treated for disposal and packaged in waste forms acceptable to the stakeholders.

[2] This is based on a maximum capacity of 3400 MT Na/yr and 0.86 TOE. The basis for the TOE is "Assessment of Operations Research (OR) Model Run for the Technical Integration Baseline Development Team (TIBDT)", (24590-PTF-RPT-PT-02-001, Rev 0). The basis for the maximum capacity of 3,400 MT Na/yr is the "5 day" average Goal of 90 MTG/d stated for PT L in Table C.6-5.1 of the BNI Contract, mod A029 and an average Na_2O loading of 14 wt%.

[3] This is based on 5.0 MTG/d (see C3.2.7), 365.24 d/yr and 3.2 MTG/canister (thin-walled canisters).

C3.2 Production Schedule Assumptions

C3.2.1 Delivery of the first batch of LAW feed will begin on December 1, 2009.

C3.2.2 Delivery of the first batch of HLW feed will begin on December 15, 2009.

C3.2.3 Hot commissioning will begin on December 1, 2009 and end on January 31, 2011.[1]

C3.2.4 Vitrification at the WTP will begin on:[2]

	LAW Vitrification Start Date	HLW Vitrification Start Date
Cases 1 and 2	March 1, 2010	May 17, 2010

C3.2.5 Supplemental Sludge Packaging Process will available to receive first batch of TRU/LLW feed on October 1, 2004.

C3.2.6 Supplemental LAW Processing downstream of WTP Pretreatment (called WTP Supplemental LAW Treatment) is online January 31, 2011.

[1] The BNI Contract requires that 56 canisters of HLW glass and 188 packages of LAW glass be produced during hot commissioning. For modeling purposes, both cases adjust the average WTP glass production rates so that the contract goals are just met by the end date for hot commissioning.

[2] Dates are from the WTP SAP4 Level 3 Schedule dated March 11, 2003.

C3.2.7 The available modeled WTP treatment capacity, including WTP supplemental LAW treatment, is as follows:

			Net Capacity as Modeled		
Period	**From**	**To**	**LAW**	**HLW**	**Supplemental LAW Treatment**
Hot Commissioning	See C3.2.4	1/31/2011	188 Packages[1]	56 Canisters[2]	None
Full Operations	2/1/2011	TBD[3]	Case 1: Ramp to 28.8 MTG/d[4] Starting On — Rate[5] 2/1/2011 — 18.0 1/1/2012 — 24.0 1/1/2013 — 28.8 Case 2: Ramp to 34.0 MTG/d[6] Starting On — Rate[5] 2/1/2011 — 21.0 1/1/2012 — 29.0 1/1/2013 — 34.0	Ramp to 5.0 MTG/day:[7] Starting On — Rate[5] 2/1/2011 — 3.0 1/1/2012 — 4.0 1/1/2013 — 5.0	As-needed[8]

[1]This is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. The corresponding average LAW vitrification rate from 3/1/2010 through 1/31/2011 is about 3.36 MTG/d.

[2] This is the required production from Table C.6-5.2 of Standard 5 of the BNI Contract. The corresponding average HLW vitrification rate from 5/17/2010 through 1/31/2011 is about 0.69 MTG/d.

[3] The waste processing end date will be determined from the HTWOS model.

[4] This is based on a nameplate capacity of 36 MTG/d and a 0.80 TOE. The basis for the TOE is “Low Activity Waste Facility Operations Research Availability Assessment,” (24590-LAW-RPT-PO-03-001, Rev. 0) and is driven by the 16 week bubbler life. It is assumed that the TOE stated in the reference (0.774) can be increased to an average of 0.80 over the mission. The basis for the nameplate is the 5-day average goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract for the LAW Facility.

[5]The various ramp-up rates were provided by ORP.

[6]This is based on an enhanced nameplate capacity of 40 MTG/d and an enhanced TOE of 0.85.

[7] This is based on a nameplate capacity of 6 MTG/d and a 0.84 TOE. The basis for the TOE is “High Level Waste Facility Operations Research Availability Assessment,” (24590-HLW-RPT-PT-02-001, Rev. 0). The basis for the nameplate is the goal stated in Table C.6-5.1 of Standard 5 of the BNI Contract.

[8]The WTP Supplemental LAW Treatment capacity will be sized to handle the difference between the required LAW pretreatment capacity and the LAW vitrification melter capacity expressed in MT Na per year, and depends upon the glass formulation for specific LAW batches and the amount of sodium routed to non-WTP supplemental LAW treatment.

C3.2.8 The available modeled non-WTP supplemental LAW treatment capacity is as follows:

			Net Capacity as Modeled[1]
Period	**From**	**To**	**Non-WTP Supplemental LAW Treatment**
Hot Commissioning	n/a	n/a	None
Full Operations	2/1/2011	TBD[2]	Case 1: 170 MT Na/yr, yielding 3,000 MT Na total[3] Case 2: 420 MT Na/yr, yielding 7,500 MT Na total[4]

[1] The numbers in the table are rate and quantities (on a waste sodium basis) for the production of supplemental LAW product. Waste from tanks containing low-Cs waste (less than 0.05 Ci Cs-137/liter when normalized to 7 M Na) will be routed to non-WTP supplemental LAW treatment as feed and is assumed to not require additional Cs removal.

[2] The waste processing end dates will be determined from the HTWOS Model runs.

[3] The non-WTP Supplemental LAW Treatment capacity will be sized as needed so that sodium processing does not force the mission to finish after 2028. Quantities and rates may be adjusted if needed.

[4] The SST Retrieval Sequence and timing will need to be reworked to provide the requested amount of sodium and may disrupt existing plans for the first 40 tanks. Quantities and rates may need to be adjusted if needed depending upon the availability of the DST system to support segregated retrieval of low-Cs waste. The goal is to provide as much low-cesium feed as is possible, while continuing to meet the TPA milestones for early retrieval of seven SSTs.

C3.3 Technical Assumptions

C3.3.1 The total sodium loading of LAW glass from pretreated feed will be determined as follows:

Case 1	Estimate using the rules documented in 24590-WTP-MCR-PT-02-002, *LAW Glass Formulation for G2 Model*, Revision 4.
Case 2	Assume that a 20-wt% Na_2O loading will be achieved.

C3.3.2 The composition and waste oxide loading of HLW glass will be estimated using the Pacific Northwest National Laboratory Glass Properties Model, as documented in PNNL-11790, *Liquidus Temperature Data for DWPF Glass*; PNNL 0.2.1.5.4.03A, *Liquidus Temperature Study of High-Zirconia Hanford High-Level Waste in Borosilicate Glass*; and WHC-SD-WM-TI-768, *Tank Waste Remediation System Initial Quantity High-Level Waste Feed Processability Assessment Report;* except as indicated below:

- Increase Liquidus Temperature Spinel constraint from 1050°C to 1100°C.
- Increase Viscosity constraint from 5.5 Pa-s to 10 Pa-s.
- Increase Cr_2O_3 constraint from 0.5 wt% to 1 wt%.

C3.3.3 The quantity and composition of solids entrained in the delivered LAW feed will be estimated based on Assumptions A14.7 and A14.8 of the HNF-SD-WM-SP-012, *Tank Farm Contractor Operation and Utilization Plan*, Revision 4.

C3.3.4 The LAW (liquid) fraction of Envelope C waste from tanks AN-102 and AN-107 will be segregated from other waste until the strontium and transuranic components are removed.

C3.3.5 Starting tank inventories represents the contents of the tanks as of June 30, 2002. This will be referred to as the "FY 2003" inventory and is based on Best Basis Inventory (BBI) downloaded from TWINS circa 10/16/2002. Adjustments will be made in HTWOS model for historical transfers through October 31, 2002.

C3.3.6 The water wash factors[1] in the Tank Waste Information Network System (TWINS) on September 30, 2001[2], will be used for partitioning waste into solid and liquid phases during retrieval and staging. The composition of waste in the feed vector will be reported on a fully water-washed basis.

C3.3.7 The caustic leach factors[1] in the TWINS on September 30,2001[2], will be used as the basis for computing the caustic leach factors associated with each delivered batch of HLW

[1] There are uncertainties and biases in the wash and leach factors which can significantly influence the canister counts and end dates. Work is in progress to generate an improved set of wash and leach factors. These revised factors are to be included in future revision of the Plan.

[2] The set of water wash and caustic leach factors that are described in C3.3.6 and C3.3.7 is reflected in TWINS on May 14, 2003. The original language of these sections has been kept for continuity with System Plan, Revision 1.

solids, except for the caustic leach factors[2] provided by the WTP (see Table C-2) will be used for AZ-102, C-104, C-106 and C-107. The TWINS values will be used for constituents for which no WTP value is provided.

Table C-2. Caustic Leach Factors Provided by WTP.

Constituents	**AZ-102**	**C-104**	**C-106**	**C-107**
Al	0.667	0.971	0.31	0.82
Cr	0.583	0.521	0.49	0.70
Fe	0.0003	0.004	0.00	0.00

C3.4 Planning Assumptions

C3.4.1 The need date and demand for ILAW disposal capacity will be established assuming that the ILAW product goes directly to the disposal facility (i.e., none of the WTP ILAW storage capacity is used).

C3.4.2 The need date for IHLW interim storage facility (the Canister Storage Building) will be the date on which the first radioactive HLW canister is produced (May 17, 2010). The demand for interim storage space will be established assuming that 22 canisters of WTP-provided IHLW is used.

C3.4.3 The shipping date of IHLW to Yucca will be the date on which the Canister Storage Building is full (880 canisters + 22 canisters in WTP-provided lag storage), but no earlier than January 1, 2012. Assume shipping keeps up with production once shipping begins.

C3.4.4 When possible, 270 days will be allocated to sample the feed and verify compliance with permits and the safety authorization basis before delivery. This will apply to all HLW feed batches. This will also apply to those LAW batches delivered as part of the initial order quantity – after the initial order quantity, this activity is assumed to not delay feed delivery.

C3.4.5 Before January 31, 2011, when retrieval system construction schedules and waste transfer logic allow, the TFC will allocate 6 months of schedule float on each side of the 270-day window described in Section C3.4.4. After the date listed below, the retrieval systems will be ready no earlier than needed to support the sampling of feed per C3.4.4.

C3.4.6 The timing and capacities of ILAW disposal and the ETF[1] will be driven by the needs of the waste treatment mission and assumed to be available when needed.

C3.4.7 WTP sampling and analysis times will support production.

C3.4.8 The plant design, operating modes, and operating plans will drive the permits, and the permits will be modified as the design is modified.

C 3.4.9 Density of IHLW glass will be 2.7 Kg/liter.

C3.4.10 The density of ILAW glass will be 2.6 Kg/liter.

C3.4.11 Each thin-walled canister of IHLW will contain 3.2 MT of HLW glass on the average.

C3.4.12 Each package of ILAW will contain 6.0 MT of LAW glass on the average.

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[1] If the treatment mission requires that changes be made to the ETF or its operating plans, the ORP is assumed to successfully drive the changes.

C3.4.13 All HLW solids will be caustic leached, with the insoluble fraction incorporated into HLW glass.

C3.4.14 All solids entrained with the delivered LAW feed, except for those associated with the Envelope C waste from AN-102 and AN-107, will be caustic leached, with the insoluble fraction incorporated into the HLW glass.

C3.4.15 When the WTP requests delivery of HLW feed, the HLW feed receipt tanks will have sufficient space to receive 160,000 gal (600 m^3) of HLW feed without interruption.[1]

C3.4.16 When the WTP requests delivery of LAW feed, the LAW feed receipt tanks will have sufficient space to receive 1 Mgal of feed without interruption.[1]

C3.4.17 The initial LAW feed sequence (envelope) for delivery to the WTP for the cases will be as follows: AP-101[2] (A), 1-3 tanks from AP-Farm (A), AN-104 (A), AN-102 (C), AN-105 (A), AN-107 (C), SY-101 (A), AN-103 (A), AW-101 (A).

C3.4.18 The initial HLW feed sequence (the solid portions are all considered envelope D) for delivery to the WTP for the cases will be as follows: AY-102[3] (Including C-106 Retrieved Material), AZ-101, AZ-102, C-104/AY-101, C-107/AW-104.

C3.4.19 It is assumed that the delivered feed and internal WTP material flows and accumulations will be consistent with the WTP authorization basis.

C3.4.20 Cesium and strontium capsules are assumed to be dispositioned outside of the WTP and Tank Farm facilities. The WTP will retain the capability to incorporate the cesium and strontium from the capsules into the HLW glass.

C3.4.21 The WTP is assumed to not return any waste streams or wastewater back to the tank farms.

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[1] These are operational considerations.

[2] The identity and contents of the feed to be used for LAW hot commissioning needs to be established. The WTP is expecting the existing feed in AP-101 for hot commissioning. However, the TFC plans to deliver a similar feed by utilizing the available tank space in AP-101 to support accelerated SST Retrievals. This version of the System Plan assumes that the later will be demonstrated as being desirable.

[3] The selection of the feed to be used for HLW hot commissioning needs to be established. The WTP contract uses AY-102 as a performance benchmark. However, the TFC baseline is still AZ-101. This version of the System Plan assumes that AY-102 will be used for HLW hot commissioning and that the impacts the TFC's cost, schedule and risk are acceptable.

C3.4.22 The following SST Retrieval Assumptions, from the TFCO&UP (HNF-SD-WM-SP-012), are incorporated by reference (see table and footnotes for changes and explanations):

Cases 1–2	From HNF-SD-WM-SP-012, Rev 4B: A11.1, SST Tri-Party Agreement [*Hanford Federal Facility Agreement and Consent Order*] Milestones; A11.3, Waste Retrieval Facility Design; A11.6, Constraints on Simultaneous Retrievals; A11.7, Retrieval Rates[1]; A11.8, Retrieval System Reuse. The as-retrieved volumes of SSTs will be determined using the rules given in A11.9, Retrieved Waste Compositions, except a tank-specific estimate will be used when available. A11.2, Basis for SST Retrieval Sequence[2] will be modified by retrieving groups of tanks according to the following rules: **Sequence and timing of SSTs including tanks designated for supplemental sludge treatment as TRU or LLW**: ▪ The target sequence and timing of the first 26 tanks and sequence of the next 14 tanks is based upon refinements to the 3-3-2003 BCR Case Confirmatory Run that focus on early C-Farm retrieval. ▪ Selected low-Cs tanks will be used to provide up to 3,000 MT Na (Case 1) or 7,500 MT Na (Case 2) as feed to the non-WTP supplemental LAW treatment facility independent of the rest of the SST retrieval sequence. ▪ The timing of the remaining SSTs will be established using the existing risk-based selection method, while maintaining the proper balance of feed (sludge vs. sodium) for the WTP.

C3.4.23 Assume that the ORP will conduct an operational readiness review (ORR) only on the capital projects installing the first LAW (Tank AN-102), HLW (Tank AY-101) retrieval systems, the Supplemental Sludge Packaging Process, and both Supplemental LAW Treatment Processes. The ORR is assumed to take place during the existing 9-month startup/turnover duration in the TFC construction schedule. The remaining LAW and HLW retrieval projects will have readiness assessments that are also assumed to take place during the existing startup/turnover period.

C3.4.24 Minimum HLW Batch Volumes:[3]

Prior to 2018	No Minimum Volume
Following 2018	130 Kgal Minimum Volume.

[1] The technology-specific retrieval rates from Rev 4B of the TFCO&UP will be used even though the proposed technologies are changing.

[2] TFCO&UP Rev 4B uses a risk-based SST retrieval sequence; the comparative priority between the two risk measures was established to balance the relative amounts of LAW and HLW feed delivered to the WTP. The first eight SSTs are fixed in the sequence; no SSTs are specifically placed at the end of the sequence.

[3] These are operational considerations.

C3.4.25 Tank Farm Blending

- Continue to use incidental blending of both liquids and solids.
- The supernate (Env. B) in AZ-102 will be blended with other LAW feed to reduce sulfate concentration to the extent possible.

C3.4.26 WTP Supplemental LAW Processing Facility:

- Will receive LAW Vitrification Facility recycle stream.
- Will process excess LAW feed needed to complete mission by 2028.
- Will convert results into equivalent immobilized product volumes for disposal estimates.

C.3.4.27 LAW Process "Governor"[1]

- Case 1: The feed from the Pretreatment Facility to the LAW melter and/or supplemental LAW processing will be limited to not exceed an average of 2,840 MT Na / year as feed.
- Case 2: The feed from the Pretreatment Facility to the LAW melter and/or supplemental LAW processing will be limited on average to 2,430 MT Na / year as feed.

C.3.4.28 Supplemental LAW Treatment Product Assumptions

The product from both WTP and non-WTP supplemental treatment will be estimated using the following three sets of assumptions:

Process	Loading	Product Density	Package	Package Fill
Steam Reformer	19.8 wt% Na_2O	1.0 MT/m^3	ILAW Container	2.3 m^3/container
Cast Stone	1.4-times feed volume @ 5 M Na	1.5 MT/m^3	4'x4'x8' Box	3.6 m^3
Bulk Vitrification	20 wt% Na_2O	2.6 MT/m^3	35-m^3 roll-off box	30 MTG

[1] The modeled pretreatment capacity will be reduced from the assumed maximum of 2,950 MT Na/yr as needed to direct the maximum amount of waste possible through the WTP LAW Vitrification Facility. The stated values may be adjusted as needed.

C3.4.29 Supplemental Sludge Packaging:

- TRU waste from the T-200 and B-200 series SSTs and from T-111 and LLW from T-110 will be retrieved and packaged according to the schedule from the 3-3-2003 BCR Case Confirmatory Run without impact to DST tank space.
- Sludge from the SSTs (T-201 – T-204, B-201 – B-204, T111 and T-110) will not require washing or dewatering – there will be no return streams to the DST system or to the WTP.
- In FY 2006, the TRU sludge in AW-105 will be transferred to and consolidated with the TRU sludge in AW-103.
- Sludge from DSTs (AW-103/105 in FY 2007 and SY-102 in FY 2008) will be washed with 0.1M NaOH before delivery to the packaging system as a slurry. The wash will be assumed similar in efficacy to the post-leach wash used in the WTP.
- Supplemental packaging of the combined AW-105/AW-103 sludge and then the sludge in SY-102 will begin in FY 2007 finish in FY 2009. The supernate will be returned to the DST system for later delivery to WTP.
- Solidified LLW will be placed in 55 gal drums for onsite disposal.
- Solidified TRU sludge from the DSTs is assumed to not require remote handling and will be placed in 55 gal drums for shipment to WIPP.
- Solidified sludge from the SSTs is assumed to be contact handled and will be placed in 55 gal drums for disposal at WIP.

C4.0 References

24590-HLW-RPT-PT-02-001, 2002, *High Level Waste Facility Operations Research Availability Assessment*, Rev. 0, Bechtel National, Inc., Richland, Washington.

24590-WTP-MCR-PT-02-002, 2002, *LAW Glass Formulation for G2 Model*, Rev. 4, Bechtel National In., Richland, Washington.

HNF-SD-WM-SP-012, 2003, *Tank Farm Contractor Operation and Utilization Plan*, Rev. 4B, CH2M HILL Hanford Group, Inc., Richland, Washington.

PNNL 0.2.1.5.4.03A, 1996, *Liquidus Temperature Study of High-Zirconia Hanford High-Level Waste in Borosilicate Glass*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11790, 1999, *Liquidus Temperature Data for DWPF Glass*, Pacific Northwest National Laboratory, Richland, Washington.

WHC-SD-WM-TI-768, 1996, *Tank Waste Remediation System Initial Quantity High-Level Waste Feed Processability Assessment Report*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

APPENDIX D

MISSION SUMMARY DIAGRAM FOR TARGET CASE

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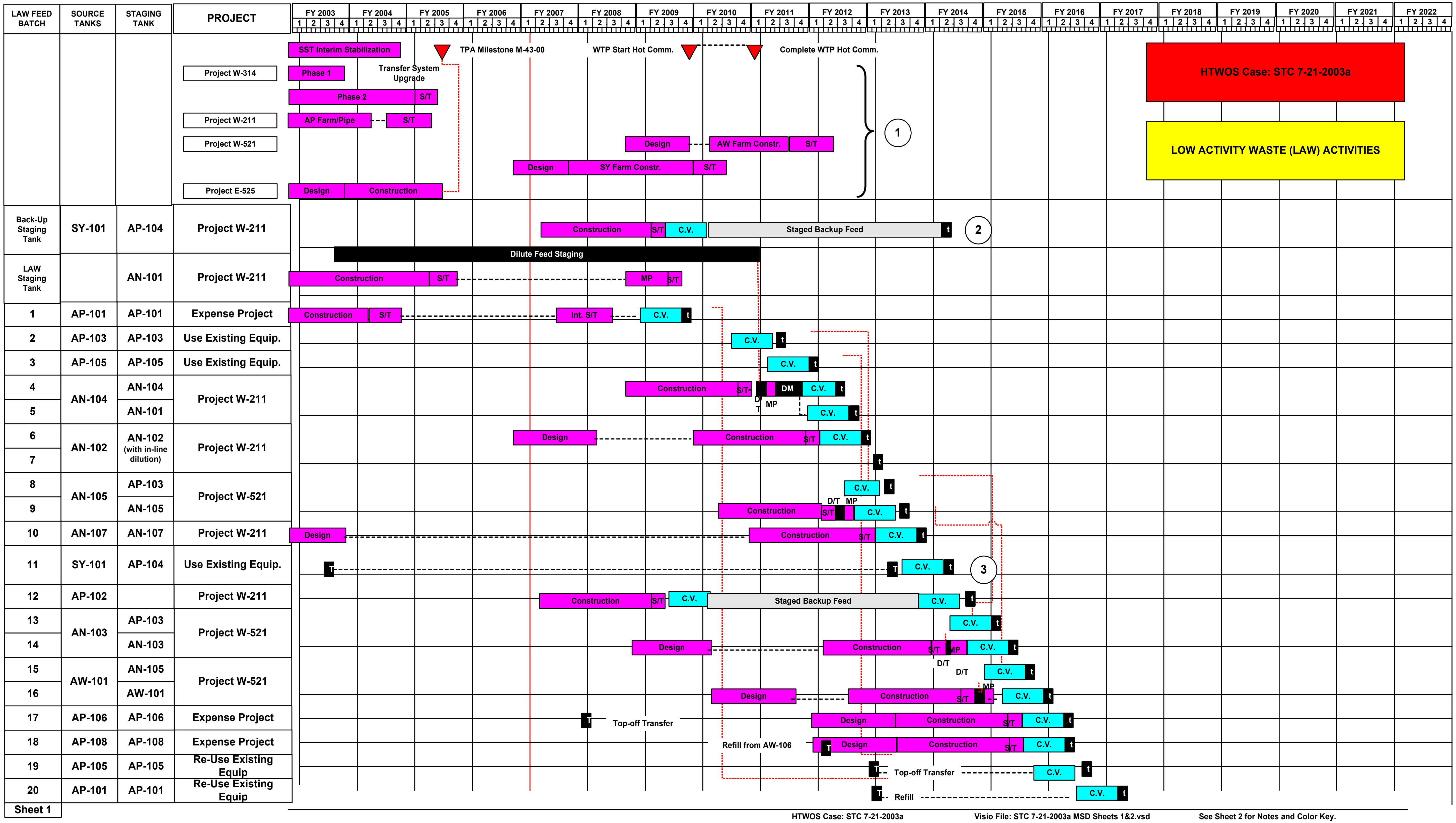
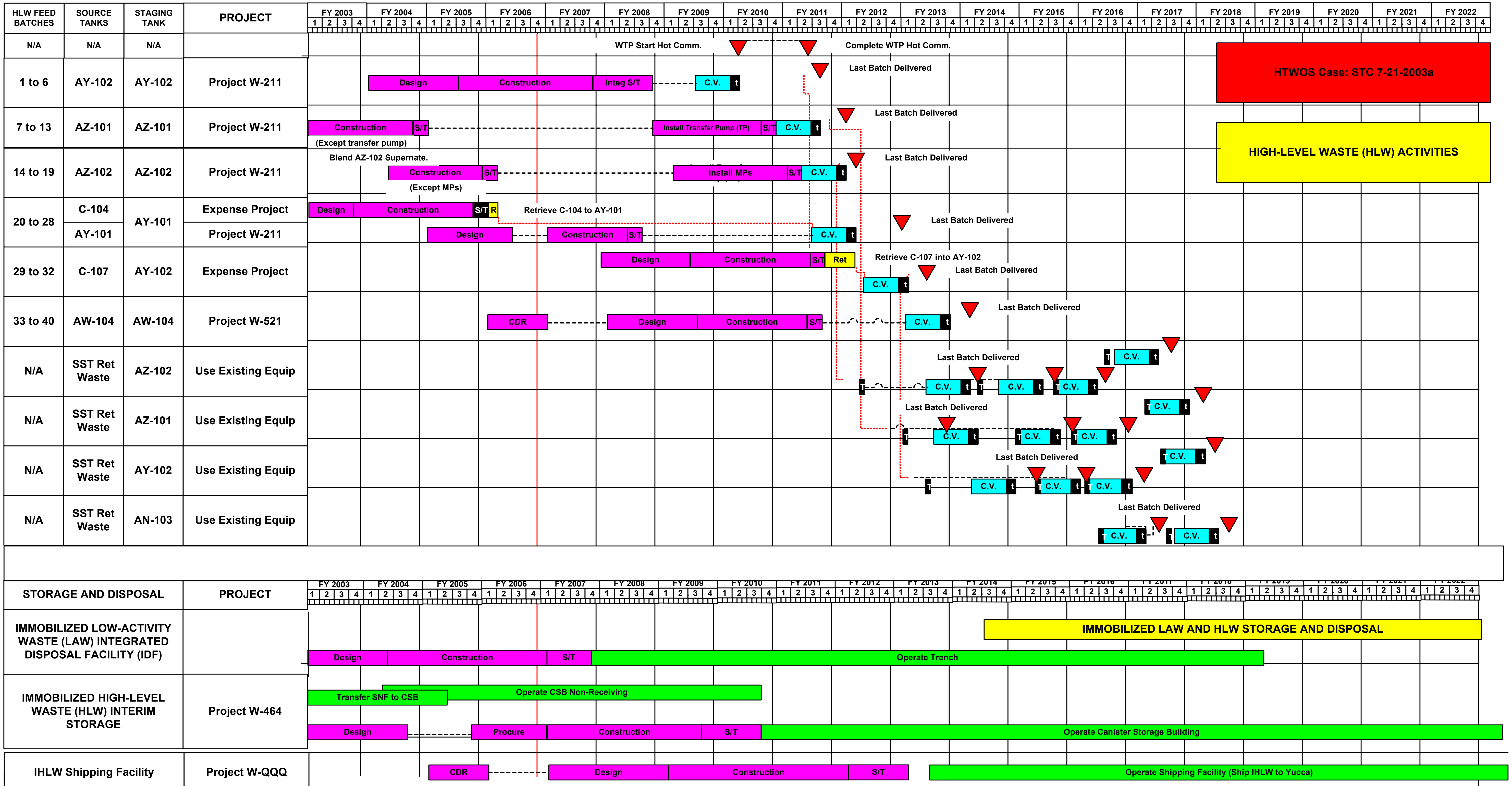


LAW FEED BATCH
SOURCE TANKS
STAGING TANK
PROJECT
FY 2003
FY 2004
FY 2005
FY 2006
FY 2007
FY 2008
FY 2009
FY 2010
FY 2011
FY 2012
FY 2013
FY 2014
FY 2015
FY 2016
FY 2017
FY 2018
FY 2019
FY 2020
FY 2021
FY 2022
SST Interim Stabilization
TPA Milestone M-43-00
WTP Start Hot Comm.
Complete WTP Hot Comm.
Project W-314
Phase 1
Transfer System Upgrade
Phase 2
S/T
Project W-211
AP Farm/Pipe
Project W-521
Design
AW Farm Constr.
SY Farm Constr.
Project E-525
Construction
HTWOS Case: STC 7-21-2003a
LOW ACTIVITY WASTE (LAW) ACTIVITIES
Back-Up Staging Tank
SY-101
AP-104
Project W-211
C.V.
Staged Backup Feed
Dilute Feed Staging
LAW Staging Tank
AN-101
MP
1
AP-101
Expense Project
Int. S/T
2
AP-103
Use Existing Equip.
3
AP-105
4
AN-104
5
DM
D/T
6
AN-102
AN-102 (with in-line dilution)
7
8
AN-105
Project W-521
9
10
AN-107
11
12
AP-102
13
AN-103
14
15
AW-101
16
17
AP-106
Top-off Transfer
18
AP-108
Refill from AW-106
19
Re-Use Existing Equip
20
Refill
Sheet 1
HTWOS Case: STC 7-21-2003a
Visio File: STC 7-21-2003a MSD Sheets 1&2.vsd
See Sheet 2 for Notes and Color Key.



① Near-Term Projects that affect Waste Feed Staging.

② Sampled and Analyzed to be used as backup LAW Feed.

③ Used Existing SY-101 Systems to Retrieve Early.

Note:

1. Transfer (t) windows account for 60 days before a "No Later Than" date.

2. DST space availability constraints shown as red-dotted lines.

COLOR KEY

Key Dates

Delivery of Feed Batch to WTP Feed Tank; t= Feed Delivery Transfer

Project Activities; MP=Mixer Pump Installation, S or S=Startup/Turnover, TP=Transfer Pump Installation

WTP Permit and Safety Authorization Basis Compliance Verification Sampling Activities; C.V.

Processing Activities; Vitrification = Vitrify, Vit, or V

Closure

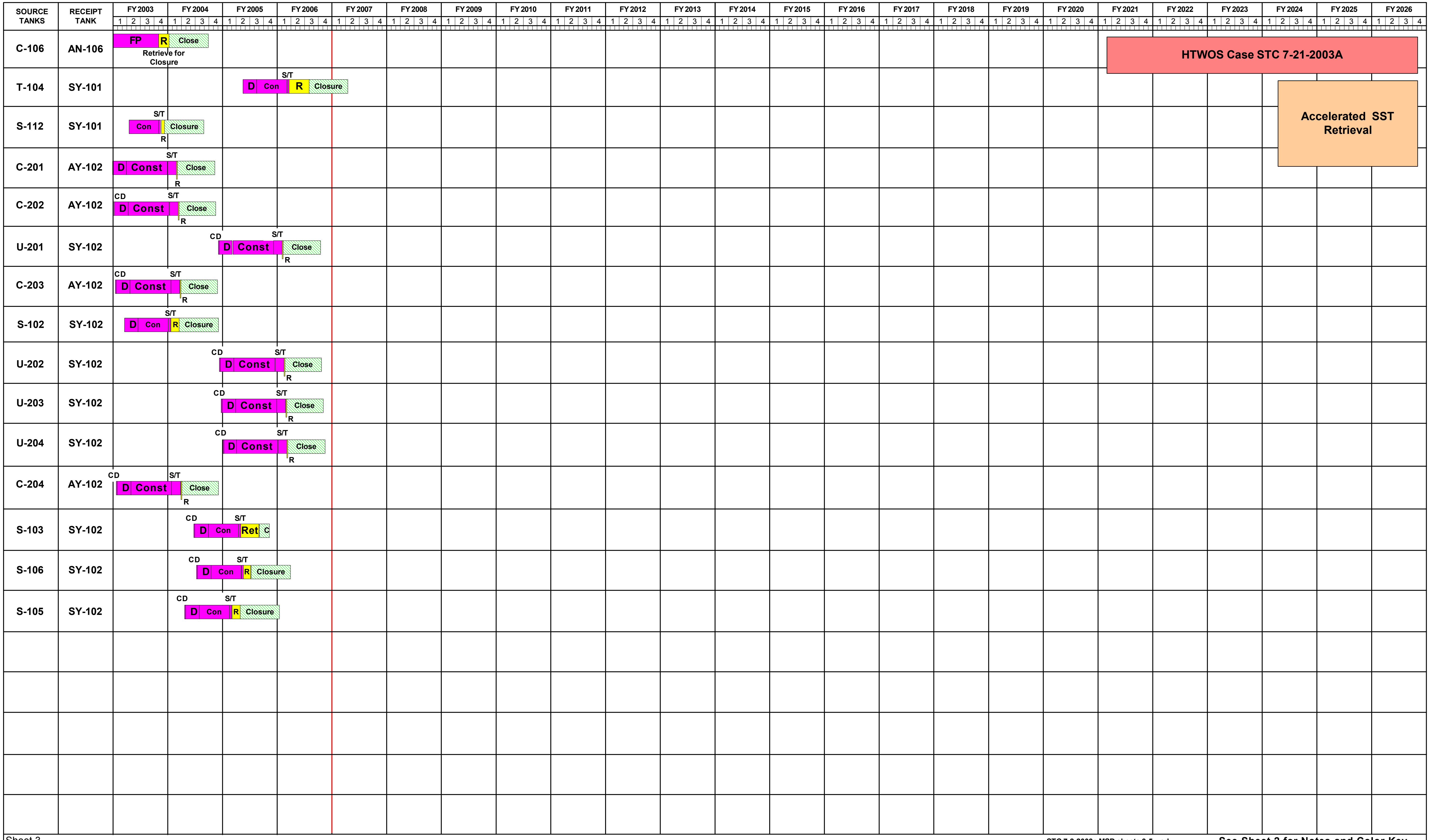
Staging Activities; M=Mix or Mobilize, T=Transfer, D/M=Dissolve/Mix, D/T=Decant/Transfer, M/T=Mix to Sample

SST Retrieval Activities

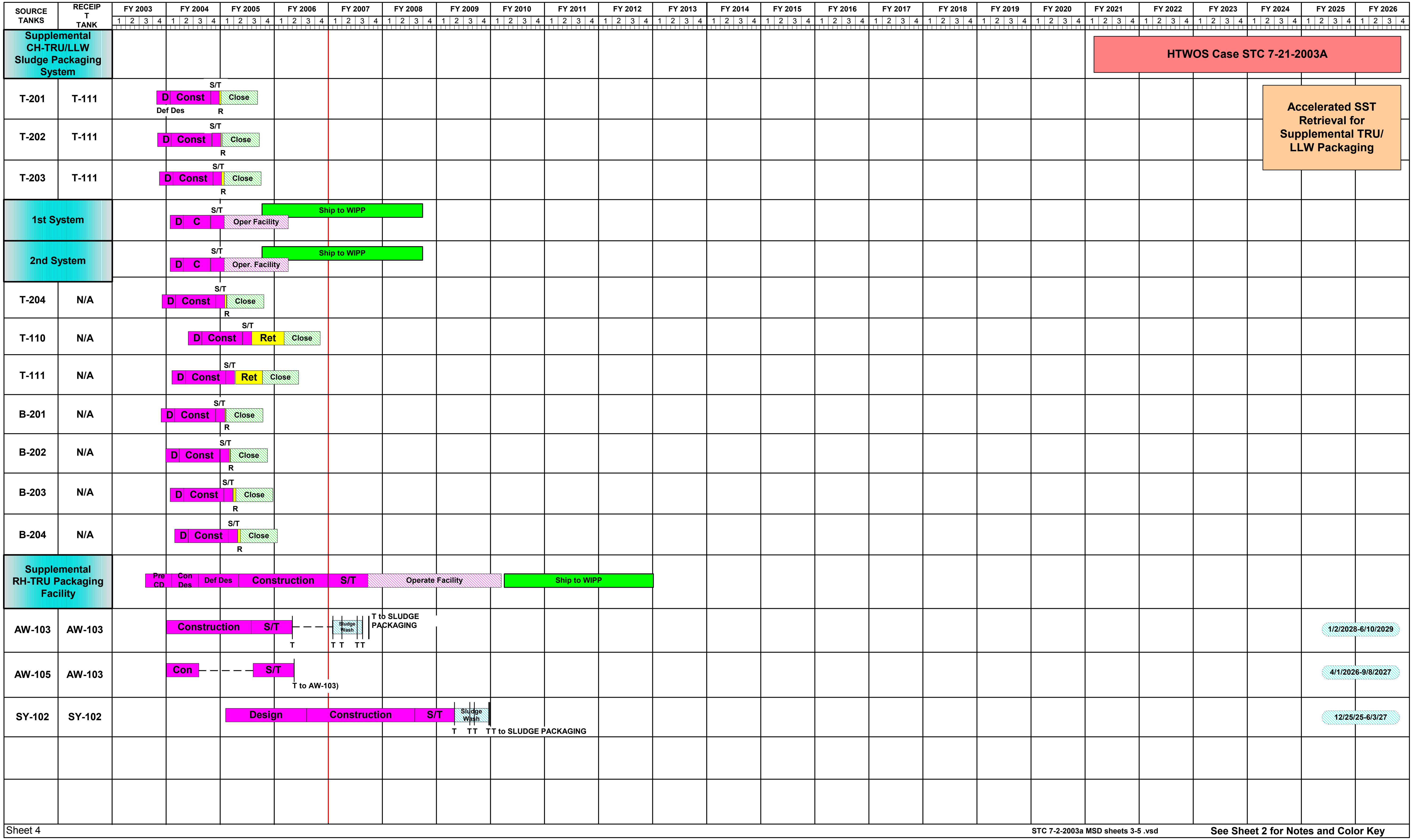
T.P Operations

ILAW Dispose and IHLW Storage Facility Operations

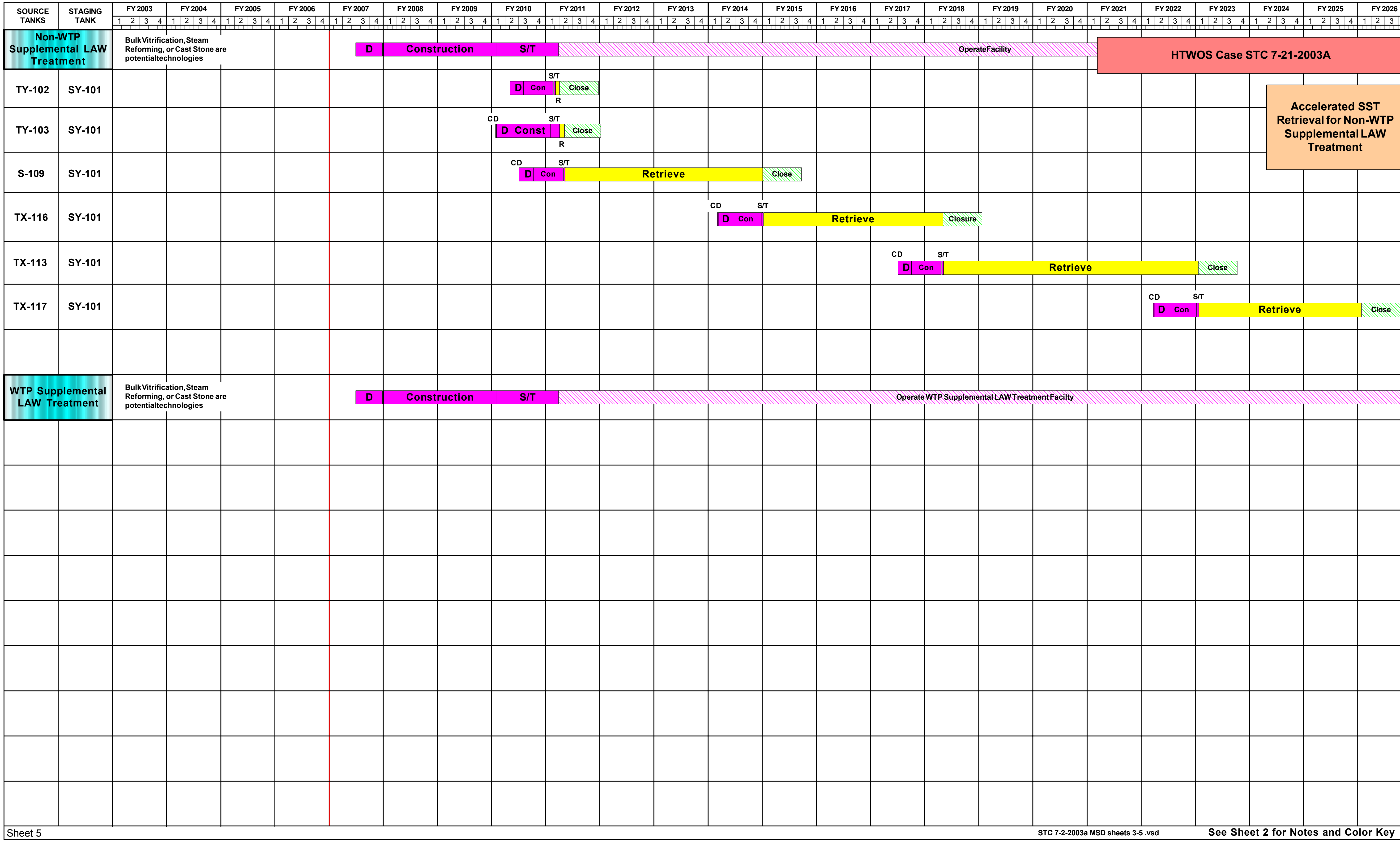
Sheet 2



Note: Cross-Site (T) are required to support SST Retrievals - S, SX, TY, and U Tank Farms



Note: Cross-Site (T) are required to support SST Retrievals - S, SX, TY, and U Tank Farms


SOURCE TANKS
STAGING TANK
FY 2003 FY 2004 FY 2005 FY 2006 FY 2007 FY 2008 FY 2009 FY 2010 FY 2011 FY 2012 FY 2013 FY 2014 FY 2015 FY 2016 FY 2017 FY 2018 FY 2019 FY 2020 FY 2021 FY 2022 FY 2023 FY 2024 FY 2025 FY 2026
Non-WTP Supplemental LAW Treatment
Bulk Vitrification, Steam Reforming, or Cast Stone are potential technologies
D
Construction
S/T
Operate Facility
HTWOS Case STC 7-21-2003A
Accelerated SST Retrieval for Non-WTP Supplemental LAW Treatment
TY-102 SY-101
S/T
D Con Close
R
TY-103 SY-101
CD S/T
D Const Close
R
S-109 SY-101
CD S/T
D Con Retrieve Close
TX-116 SY-101
CD S/T
D Con Retrieve Closure
TX-113 SY-101
CD S/T
D Con Retrieve Close
TX-117 SY-101
CD S/T
D Con Retrieve Close
WTP Supplemental LAW Treatment
Bulk Vitrification, Steam Reforming, or Cast Stone are potential technologies
D
Construction
S/T
Operate WTP Supplemental LAW Treatment Facility
Sheet 5
STC 7-2-2003a MSD sheets 3-5 .vsd
See Sheet 2 for Notes and Color Key