INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

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RPP-22607-FP
Revision 0

Hanford Tank Waste Treatment System

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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Hanford Group, Inc.

P.O. Box 1500
Richland, Washington

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Revision 0

Hanford Tank Waste Treatment System

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Department of Energy - Office of River Protection

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Hanford Tank Waste Treatment System

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ABSTRACT

The U.S. Department of Energy (DOE) is constructing the Hanford Waste Treatment Plant which is the largest waste pretreatment and vitrification facility in the world. This massive facility will begin commissioning operations in 2009, with full scale production beginning in 2011. While this facility will provide a much needed waste treatment capability to meet the department accelerated cleanup goals for closure of the Hanford waste tank systems, it alone will not provide enough capacity to complete the waste treatment mission by the 2028 regulatory milestone.

The 53 million gallons of radioactive waste remaining in Hanford's 177 single-shell tanks (SST) and double-shell tanks (DST) present a broad range of radiochemical and chemical contents. The U.S. Department of Energy, Office of River Protection (ORP) has established a strategy for waste retrieval and waste treatment that recognizes that all tank waste is not identical, and that other processes can be utilized to safely and economically treat tank waste for ultimate disposal.

The ORP is pursuing a 3-tiered strategy to define, develop, and deploy treatment capability that will meet the 2028 waste treatment milestone.

Ultimately, by tailoring the treatment process to the actual waste being processed, economies and efficiencies can be exploited to improve the overall treatment approach. In the end, DOE expects that each of the three elements will process waste as follows:

- Transuranic (TRU) waste packaging and disposal will treat about 2 percent of the total waste sodium
- Supplemental treatment will account for about 47 percent of the low-activity waste (LAW) waste sodium
- The Waste Treatment Plant will process about 53 percent of the LAW waste sodium and 100 per cent of the high-level waste (HLW).

INTRODUCTION

The DOE is constructing the Hanford Waste Treatment Plant (WTP) which is the largest waste pretreatment and vitrification facility in the world. This massive facility will begin commissioning operations in 2009, with full scale production beginning in 2011. While this

facility will provide a much needed waste treatment capability to meet the department accelerated cleanup goals for closure of the Hanford waste tank systems, it alone will not provide enough capacity to complete the waste treatment mission by the 2028 regulatory milestone.

THE WASTE

The 53 million gallons of radioactive waste remaining in Hanford's 177 single- and double-shell tanks present a broad range of radiochemical and chemical contents. This material came from a wide variety of nuclear fuel processing, uranium and radioisotope recovery, and plutonium purification and metal production activities. While much of the waste has been transferred repeatedly to support these various processing and recovery campaigns, along with tank waste concentration efforts, there are number of tanks that have not been mixed with other processing wastes. The DOE believes that current Hanford tanks contain remote and contact handled TRU wastes, wastes previously treated to remove cesium and are feed candidates for supplemental treatment, and wastes that should be processed by the WTP to be treated and immobilized as either immobilized low-activity waste (ILAW) or HLW.

One hundred and seventy-six tanks remain to be retrieved (Tank C-106 has been retrieved) at the Hanford Site and are currently categorized as:

- 11 contain contact handled TRU waste resulting from plutonium purification and recovery operations
- 9 contain remote handled TRU waste resulting from plutonium purification and recovery operations
- 27 contain soluble wastes with cesium levels low enough to meet the 1997 established Nuclear Regulatory Commission (NRC) agreement on extent of radionuclide removal with solid liquid separation and perhaps, selective dissolution to control the cesium concentration, and
- 129 single- and double-shell tanks contain wastes that will be treated by the WTP and supporting facilities, including a portion of the supplemental treatment plant.

The ORP has established a strategy for waste retrieval and waste treatment that recognizes that all tank waste is not identical, and that other processes can be utilized to safely and economically treat tank waste for ultimate disposal.

THE TREATMENT STRATEGY

The ORP is pursuing a 3-tiered strategy to develop and deploy treatment capability that will meet the 2028 waste treatment milestone. Currently underway are:

- Completion and startup of the WTP, with subsequent enhancement of the LAW melters during normal maintenance replacement of the melters (expected to occur by 2015), along with other productivity improvements in pretreatment and high level waste melter systems.
- Waste retrieval and packaging of TRU wastes contained in the tanks for geologic disposal in Waste Isolation Pilot Plant (WIPP) [Remote Handled Transuranic Waste (RH-TRU) will require washing in the DST system prior to drying and packaging].

- Supplemental treatment for previously separated wastes and waste pretreated in the WTP pretreatment facility to immobilize LAW in accordance with agreements previously reached with the NRC.

This treatment capability will be integrated into the overall River Protection Project system depicted in Figure 1. Wastes are retrieved from single shell tanks either for transfer to the DST system or treatment by either the TRU waste system or the Supplemental Treatment Plant (STP) (some wastes retrieved in DST's will be treated via STP as well). Wastes contained in the DST's are staged to the WTP for pretreatment, and immobilization of the HLW and ILAW fractions. About half of the pretreated ILAW feed is immobilized by the WTP ILAW immobilization system, while the remainder is immobilized by the STP, once pretreatment removed radionuclides to meet levels that conform to the agreement previously reached with the NRC.

THE WASTE TREATMENT PLANT

The Waste Treatment Plant is under construction and on schedule for a December 2009 hot startup. DOE has continued to conduct research and technical work that shows promise of additional improvements in LAW glass formulations and melter throughputs. DOE is planning to enhance the capability of the LAW facility in a series of natural evolutions, as plant equipment is replaced over the life of the facility. In similar fashion, enhancements to the pretreatment and HLW facilities are expected.

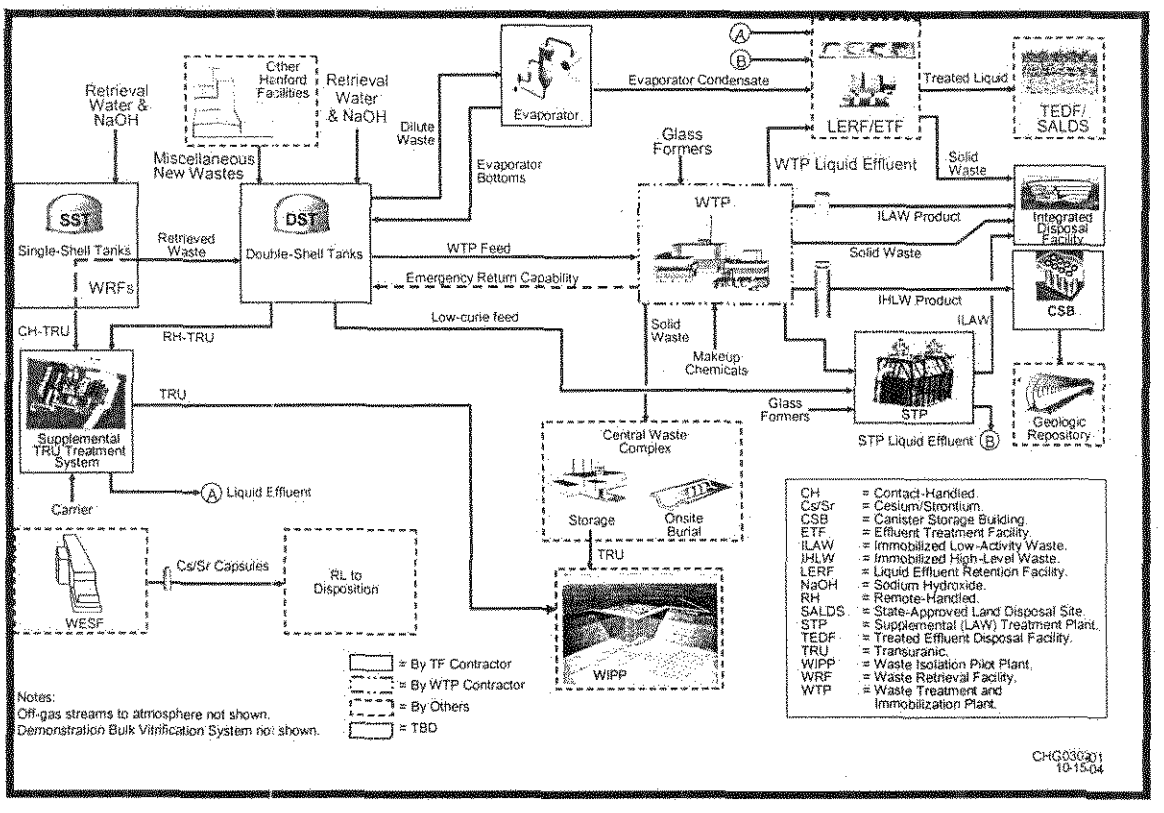

Figure 1 River Protection Project System

The expected WTP capacity enhancements include:

- Pretreatment facility enhancements to ion-exchange systems, evaporation systems and solid liquid separations systems that provide for additional pretreatment capacity. This pretreatment capacity is used to generate feed for the WTP ILAW immobilization system and the STP.

- LAW facility enhancements incorporating second generation melter technology that allows higher glass production rate and higher waste loading in the glass, along with expected improvements in glass formulations to improve waste loading

- HLW facility enhancements incorporating second generation melter technology that allows higher glass production rate and higher waste loading in the glass

It is planned that these enhancements should be in place to support higher WTP productivity by 2015.

TRU WASTE TREATMENT SYSTEM

The contact-handled TRU Waste Packaging System is currently under procurement. The DOE has projects underway to design, permit, and install TRU waste packaging systems at Hanford, and is working with state and federal regulators to determine the conditions under which this option can be successfully implemented.

An overall schematic of the initial contact handled TRU system is illustrated in Figure 2. Suitable TRU waste is retrieved from SST storage and transferred for packaging. The resulting packages are inspected and certified, and interim stored at the Hanford TRU storage facilities.

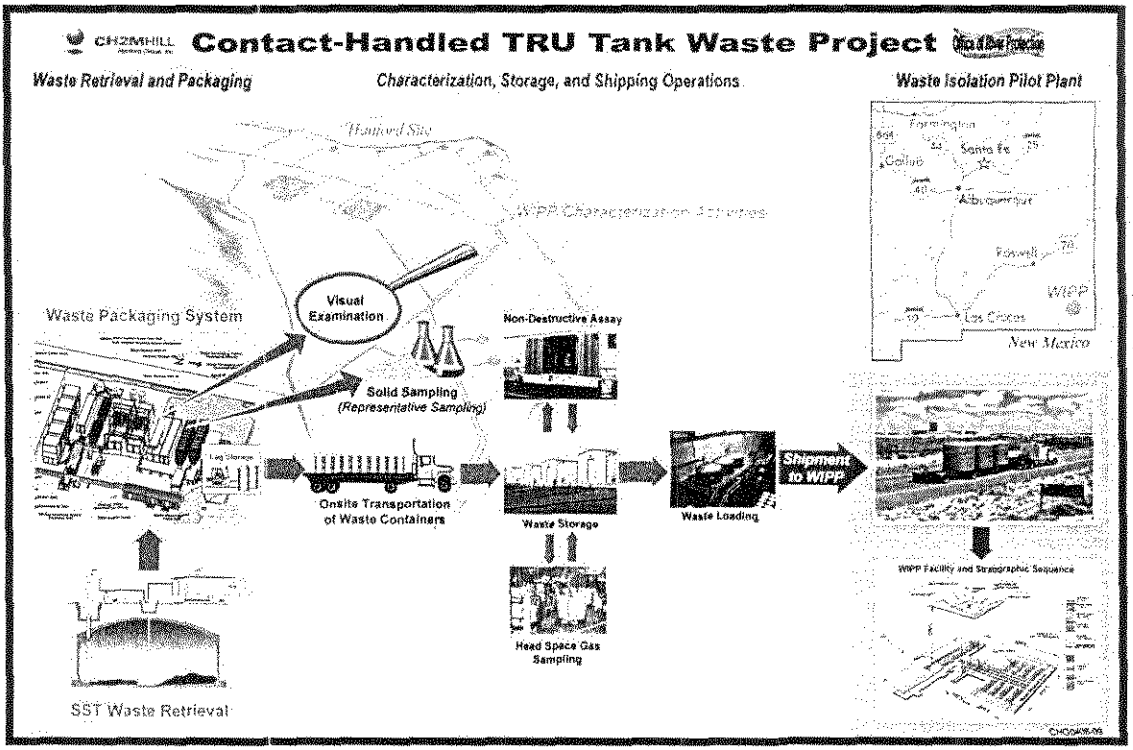

Figure 2. TRU Tank Waste Project

Once certification is complete, the waste containers are loaded into TRUPAC containers and transported to the WIPP for disposal. A similar approach would be established for the RH-TRU waste once requirements become finalized. It is possible that water washing to remove soluble radionuclides might be required to meet RH-TRU transportation requirements. It is expected that the TRU system will be moved from tank area to tank area to efficiently utilize the overall packaging system, with additional shielding added to package the washed RH-TRU tank waste material.

SUPPLEMENTAL TREATMENT PLANT

A full scale demonstration Supplemental ILAW Treatment System is undergoing research, development, testing, and evaluation (RDT&E). After completion of a technology review and contract negotiation process, ORP is proceeding with demonstration of In-Container Vitrification (ICV) technology. A Hanford full-scale bulk demonstration system has been contracted for, and is expected to produce a full scale waste package from waste retrieved from SST S-109; ready for disposal by the end of fiscal year 2006. Similar demonstration activities are underway for steam reforming operations on radioactive wastes at other DOE sites. It is expected that these demonstrations will be successful in showing that lower capital cost waste treatment options are feasible for certain Hanford tank wastes.

An overall flow diagram for this Supplemental Treatment demonstration is provided in Figure 3. First waste is retrieved directly from a S-109 and transferred to the Design Basis Vitrification System (DBVS). The ICV process converts LAW into a glass form by mixing the waste with soil and applying an electrical current.

The vitrification step occurs in a large, refractory-lined steel container which also serves as the disposal package. The process consists of feed preparation, container lining installation and electrode placement, container waste filling, in container vitrification, off-gas treatment, ventilation cooling, topping off the container, sealing the container, decontamination of the container, and passive cooling before transferring the entire container and its vitrified contents to the onsite Integrated Disposal Facility (IDF) for onsite disposal.

The full scale STP will be scaled up by constructing parallel modules, based on the DBVS demonstration facility. The STP is conservatively sized with eight parallel ICV lines operating simultaneously as a repeating batch sequence and will treat an average (continuous) of 6 gal/min of Hanford LAW. The current concept is that the STP will receive wastes low enough in cesium staged in the double shell tank system, along with pretreated wastes from the WTP pretreatment facility.

The DOE is planning to make final decisions regarding the supplemental treatment technology and its deployment in 2006, in concert with the TPA milestone commitment. ORP expects that the full scope modular supplemental treatment system will begin operations in 2011.

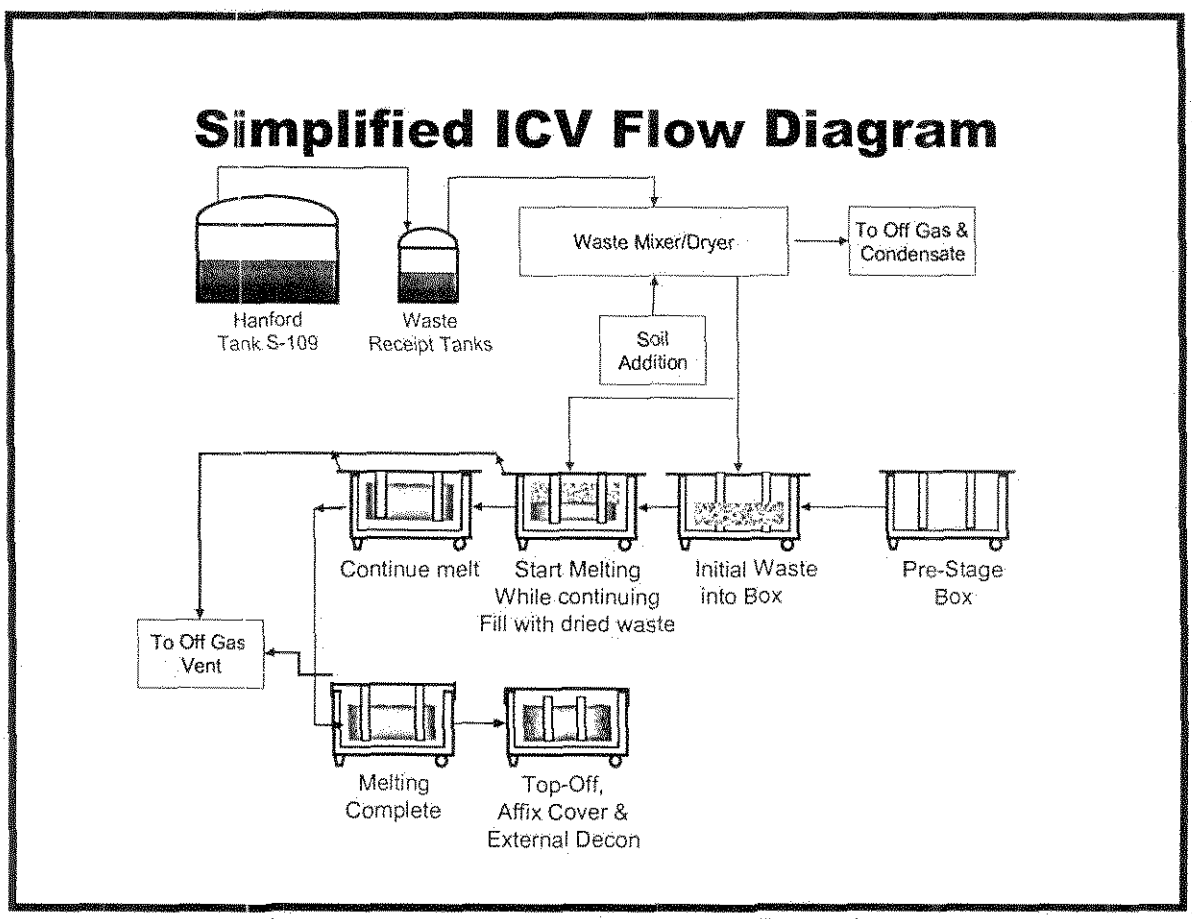

Figure 3 In-Container Vitrification Flow Diagram

THE OVERALL MATERIAL BALANCE

The needed production capacities and facility production schedules are provided in Table I.

Given these capabilities deployed according to the overall schedule will complete the overall waste treatment mission by December, 2028 which is the current Tri-Party Agreement milestone for the completion of all Hanford tank waste treatment.

Table I RPP Waste Treatment Capacities and Production Schedule

Waste Treatment System	Production Capacity	Production Schedule
Waste Treatment Plant	34 MT ILAW glass/day 5 MT HLW glass/ day	Waste Treatment Operations 2/2011 – 12/2028
TRU Waste Treatment	900 MT of sodium (equivalent)	1/2006 – 1/2011
Supplemental Treatment Plant	31 MT LAW glass/day with 8 process lines	1/2011 – 12/2028

The overall material balance for this overall strategy is depicted in Figure 4. The 53 million gallons of waste present today contains about 48,000 metric tons (MT) of sodium. At present, the quantity of sodium contained in the waste is the overall schedule limiting factor. Sodium content in general flows to the LAW side and is the limiting chemical constituent in the LAW waste treatment system. One of the principal objectives of the overall strategy is to enhance the ability of the LAW system to treat sodium, which in turn pulls the waste treatment end date in. The strategy depicted in Figure 4 represents the maximum acceleration that can be achieved by increases in the LAW treatment capacity. The entire system is close coupled, and delicately balanced. Further acceleration can only be achieved by further capacity enhancements of pretreatment, LAW treatment, and HLW treatment systems simultaneously.

The tank waste represented by the 48,000 MT of sodium is treated via one of the three primary pathways previously discussed:

- 43,300 MT of waste sodium is routed to the Waste Treatment Plant for pretreatment, LAW vitrification, and HLW vitrification
    - A little over One-half of the pretreated waste (22,700 MT of waste sodium) is routed to the STP for LAW immobilization
- A total of 3,760 MT of waste sodium contained in waste previously treated waste undergoes simple solid liquid separation (and potentially selective dissolution to reduce radionuclide concentration for As Low As Reasonably Achievable (ALARA) considerations and is treated by the Demonstration Bulk Vitrification System or the full scale STP.

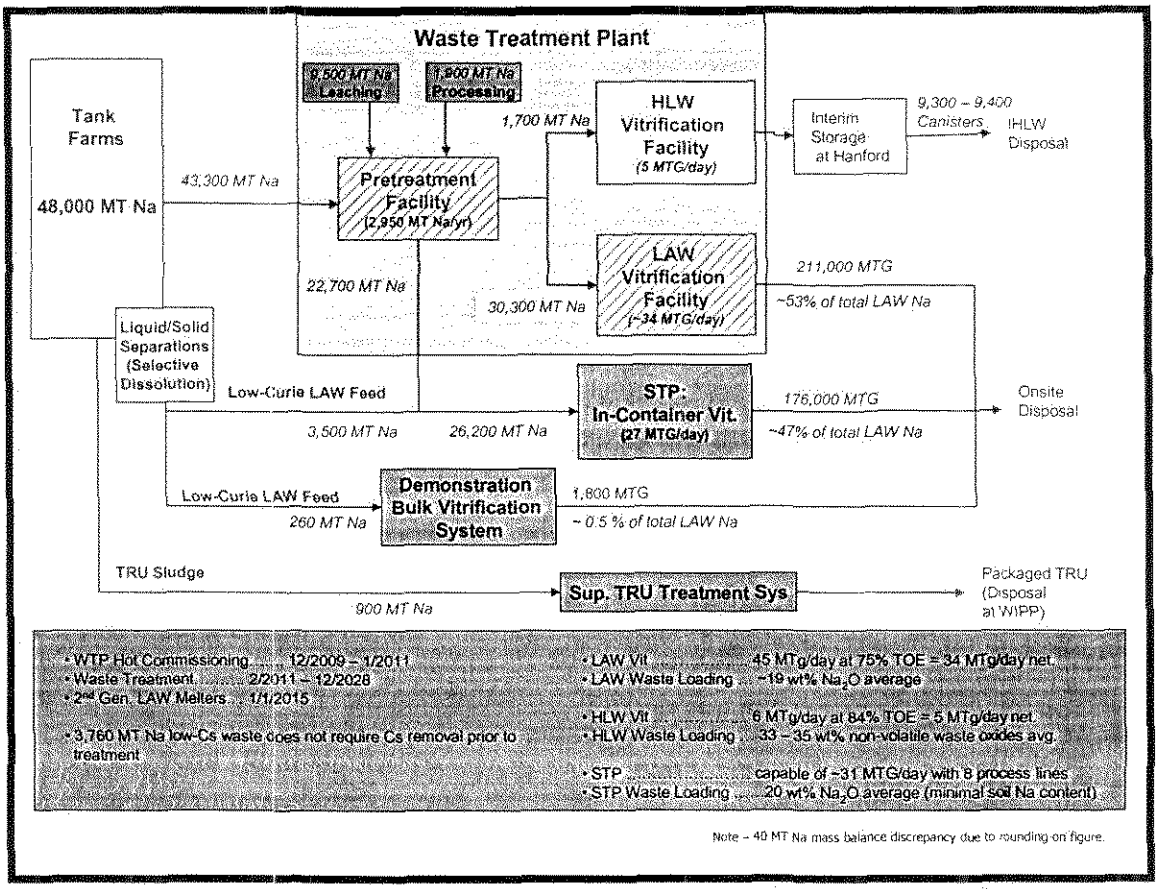

Figure 4 Material Balance for the RPP Waste Treatment System

- Approximately 900 MT of waste sodium is treated, packaged and shipped to WIPP for disposal

These treatment pathways result in the entire inventory of the Hanford tanks to be disposed as:

- ~9300 – 9400 immobilized HLW canisters that will ultimately be disposed at the nations HLW repository
- ~211,000 MT of LAW glass will be produced by the WTP ILAW facility and disposed onsite
- ~176,000 MT of LAW glass will be produced by the STP facility and disposed on site
- ~900 MT of waste sodium is packaged as either CH- or RH-TRU and is disposed in the WIPP.

Taken all together, this strategy will provide enough of the right capability, at the right time to complete the overall treatment mission in 2028. Ultimately, by tailoring the treatment process to the actual waste being processing, economies and efficiencies can result in improvements to the overall treatment approach.