DOCUMENT RELEASE AND CHANGE FORM

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By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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The Technology and Innovation Roadmap is a comprehensive plan for technology development. It is required by the DOE ORP.

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RPP-PLAN-43988
Revision 7

Technology and Innovation Roadmap

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TECHNOLOGY and INNOVATION ROADMAP

CHIEF TECHNOLOGY OFFICE

Published:

A.L. Hede

D.J. Reid

T.A. Wooley

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Executive Summary

This Technology and Innovation Roadmap (Roadmap) presents a comprehensive and integrated assessment of the technology elements related to maintaining the River Protection Project (RPP) baseline, reducing risk, and providing opportunity for improvement. These elements contribute to achieving successful completion of the Hanford Site tank waste cleanup mission. Key near-term U.S. Department of Energy (DOE), Office of River Protection (ORP) RPP mission needs with respect to the next 5 years are identified and prioritized. This Roadmap is used to assist with planning near-term scope to address technology development priorities in fiscal year 2023 (FY23).

The Roadmap is updated annually with input from several key sources including DOE, Tank Operations Contractor (TOC) Washington River Protection Solutions LLC (WRPS) management, Waste Treatment and Immobilization Plant contractors, Plateau Remediation contractors, and other knowledgeable fieldwork specialists. All the known technology elements are identified by the appropriate fieldwork specialists and summarized via individual Technology Element Description Summary Sheets (TEDS).

There are over 100 technologies detailed in the Roadmap. The Chief Technology Office (CTO) assigned importance to TEDS based on the communicated focus of the ORP and the RPP mission support needs in the End-State Technology Maturation and Execution (TM&E) chart as well as the Near-Term TM&E Chart. Catalog sheets are then developed to summarize each technology element. The Roadmap is compiled and released for use within the DOE complex. The appropriate representatives then determine the utilization of resources to achieve needed technologies.

TM&E activities are identified to aid the integration of RPP mission programs and support achievement of RPP mission needs. Currently, those activities are categorized into eight mission programs divided into two areas:

1. Direct-Feed Low-Activity Waste Operations Support
   - Immobilized Low-Activity Waste Glass
   - Tank-Side Cesium Removal & Low-Activity Waste Pretreatment System
   - Cementitious Waste Forms
   - Supplemental Low-Activity Waste
2. RPP Mission Support
   - Alternate Retrieval Technology Identification and Development
   - Tank Integrity Technology Identification and Development
   - Sampling & Monitoring Technology Identification and Development
   - Worker Protection (Sampling & Monitoring, Personal Protective Equipment (PPE), Investigation, etc)

As the mission evolves, the programs detailed in the TM&E charts will evolve to address new and emerging needs. Technology elements that align best with the focus of ORP and support the mission needs per the TM&E chart are emphasized as potential solutions to the significant technical challenges facing the tank waste cleanup mission and enhance the safety of the workforce. The information presented in this Roadmap is used to guide investments to address the high priority technical needs supporting the RPP mission and to affect change as necessary.

Scheduling and mission impacts for technology elements in this Roadmap revision are mapped in the End State TM&E chart for the complete mission and the Near Term TM&E chart for the next 5 years. The charts also identify the benefits and risk mitigation potential for non-baseline technologies. Finally, the TM&E charts have the key mission decision points identified. In addition, a National Laboratory Technology Capabilities Matrix is included in APPENDIX F as Table F-1. Roadmap TEDS sheets that identify the need for National Laboratory support are cross walked to National Laboratory capabilities.

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List of Terms

AI	Artificial Intelligence
ALARA	As Low As Reasonably Achievable
ASCEM	Advanced Simulation Capability for Environmental Management
ASME	American Society of Mechanical Engineers
BBI	Best-Basis Inventory
CAM	Continuous Air Monitor
CCN	Cloud Condensation Nuclei
CD	Critical Decision
CEM	Continuous Emissions Monitor
CFD	Computational Fluid Dynamics
CH	Contact-Handled
COC	Compound Of Concern
COPC	Chemical Of Potential Concern
CP	Central Plateau Contractor
CPC	Central Plateau Cleanup Company
CST	Crystalline Silicotitanate
CTF	Cold Test Facility
CTO	Chief Technology Office
DFAS	Data Fusion and Advisory System
DFHLW	Direct-Feed High-Level Waste
DFLAW	Direct-Feed Low-Activity Waste
DOE	U.S. Department of Energy
DOT	Department of Transportation
DST	Double-Shell Tank
DTW	Dispose Tank Waste
Ecology	Washington State Department of Ecology
EM	U.S. Department of Energy, Office of Environmental Management
EMAT	Electromagnetic Acoustic Transducer
EMF	Effluent Management Facility
EOI	Expression of Interest
EPA	U.S. Environmental Protection Agency
EROMS	Enterprise Risk and Opportunity Management System
ERSS	Extended Reach Sluicing System
ESP	Electrical Safety Program
ETF	Effluent Treatment Facility
FFRDC	Federally Funded Research Development
FID	Flame Ionization Detection
FLTF	Field Lysimeter Test Facility
FT	Flash Thermography
FTIR	Fourier Transform Infrared
FWF	Federal Waste Facility
FY	Fiscal Year
GC	Grand Challenge
GC-FID	Gas Chromatography Flame Ionization Detection
GC-MS	Gas Chromatography Mass Spectrometry
GEIT	General Electric Inspection Technology
GPS	Global Positioning System
GWPA	Guided Wave Phased Array
HIHTL	Hose-In-Hose Transfer Line
HLW	High-Level Waste
HWEE	Hanford Waste End Effector
IDAV	Internal Data Access And Visualization
IDF	Integrated Disposal Facility
IEWO	Inter-Entity Work Order
IH	Industrial Hygiene

List of Terms

IHLW	Immobilized High-Level Waste
ILAW	Immobilized Low-Activity Waste
IX	Ion Exchange
LAW	Low-Activity Waste
LAWPS	Low-Activity Waste Pretreatment System
LCO	Limiting Condition of Operation
LDP	Leak Detection Pit
LERF	Liquid Effluent Retention Facility
LIBS	Laser-Induced Breakdown Spectroscopy
LIDAR	Light Detection And Ranging
LLW	Low-Level Waste
LOW	Liquid Observation Well
LSW	Liquid Secondary Waste
LTA	Less Than Adequate
MARS-V	Mobile Arm Retrieval System, Vacuum-mode
MTW	Manage Tank Waste
MW	Manage Waste
MWGS	Mechanical Waste Gathering System
N	No
N/A	Not Applicable
NDE	Non-Destructive Examination
NDMA	N-Nitrosodimethylamine
NEMA	National Electrical Manufacturers Association
NRT	Neutron Radiographic Testing
OEL	Occupational Exposure Limit
OP-FTIR	Open Path Fourier Transform Infrared
ORP	U.S. Department of Energy, Office of River Protection
ORSS	Off-Riser Sampler System
OTS	Operator Training Simulator
PA	Performance Assessment
PNNL	Pacific Northwest National Laboratory
PPE	Personal Protective Equipment
PTR-MS	Proton Transfer Reaction – Mass Spectrometer
PTW	Process Tank Waste
RCRA	Resource Conservation and Recovery Act of 1976
Risk Registry	Enterprise Risk and Opportunity Management Program
Roadmap	Technology and Innovation Roadmap
ROI	Return On Investment
RPP	River Protection Project
RTW	Retrieve Tank Waste
RVMS	Residual Volume Measuring System
SBS	Submerged Bed Scrubber
SCBA	Self-Contained Breathing Apparatus
SLAW	Supplemental Low-Activity Waste
SPP	Strategic Partnership Program
sRF	Spherical Resorcinol Formaldehyde
SRNL	Savannah River National Laboratory
SST	Single-Shell Tank
SSW	Secondary Solid Waste
SWITS	Solid Waste Information and Tracking System
TBD	To Be Determined
TBI	Test Bed Initiative
TEDS	Technology Element Description Summary
TEM	Transmission Electron Microscope
TFF	Tank Farm Fugitive

List of Terms

TM&E	Technology Maturation and Execution
TOC	Tank Operations Contractor
TRA	Technology Readiness Assessment
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989)
TRL	Technology Readiness Level
TRU	Transuranic
TSCR	Tank-Side Cesium Removal
TSR	Technical Safety Requirement
TWCS	Tank Waste Characterization and Staging
TWINS	Tank Waste Information Network System
UT	Ultrasonic Testing
UV	Ultraviolet
UV-DOAS	Ultraviolet Differential Optical Adsorption Spectroscopy
UV-FTIR	Ultraviolet Fourier Transform Infrared] Stack Monitor
VMC&R	Vapor, Monitoring, Characterization and Remediation
VMDS	Vapor Monitoring and Detection System
VOC	Volatile Organic Chemical
VWB	Virtual Workbench
WAC	Waste Acceptance Criteria
WBS	Work Breakdown Structure
WCS	Waste Control Specialists
WESP	Wet Electrostatic Precipitator
WFD	Waste Feed Delivery
WFE	Wiped Film Evaporator
WIPP	Waste Isolation Pilot Plant
WMA	Waste Management Area
WMIS	Waste Management Information System
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant
XRID	X-Ray Diffraction
Y	Yes

1.0 INTRODUCTION

On March 18, 2008, the U.S Department of Energy (DOE), Office of Environmental Management (EM) introduced the Engineering and Technology Roadmap to support the complex cleanup effort. The National Academy of Sciences reviewed the EM Engineering and Technology Roadmap and issued report *Advice on the Department of Energy's Cleanup Technology Roadmap: Gaps and Bridges* (NAS 2009) documenting their gap analysis on the current state of the DOE Hanford Site cleanup effort.

The initial TOC Technology and Innovation Roadmap (Roadmap) was released in 2010 in response to the 2009 National Academy of Sciences report and aligned with the desires and goals of the DOE EM at that time. The Roadmap has been updated and improved with each revision. See APPENDIX A for Tank Farm background information and APPENDIX B for a more complete description of the evolution of the Roadmap.

This edition of the Roadmap is focused on highlighting the technology needs of the Hanford mission for FY22 and FY23 as well as longer term future planning. These needs are identified in individual TEDS sheets and are concisely summarized in one or two pages, known as "Catalog Sheets," See Section 4.0 for more details on TEDS and Catalog Sheets.

There are 103 technology needs highlighted herein. The technologies are summarized by functional area in Table 1-1. The five functional areas are Manage Tank Waste (MTW), Retrieve Tank Waste (RTW), Process Tank Waste (PTW), Dispose Tank Waste (DTW), and Manage Waste (MW).

Table 1-1. Technologies by Functional Area.

Functional Area	Near-Term	Future Projects	Total
MTW	11	29	40
RTW	5	26	31
PTW	4	13	17
MW	1	4	5
DTW	4	6	10
Total	26	77	103

The reduction of the number of technology needs from those reported in the previous Roadmap revision was due to the retirement of several TEDS. Retirements are driven by development work completion and/or recognition of the lack of the technology need or viability and are discussed in APPENDIX E.

This document is compiled based on input from ORP, WRPS management, and knowledgeable fieldwork specialists. These specialists include TOC and ORP management, facility managers, operations leads, cognizant engineers, and design authorities, as well as other knowledgeable Hanford workers. All the known technology needs are identified by the appropriate specialists and summarized via individual TEDS sheets. The TEDS sheets document technology elements, which are components and/or systems requiring development that have been identified as a technology need. Section 3.6 describes how technology elements are aligned with mission initiatives. Individuals including the functional area fieldwork specialists, and ORP use the summaries to prioritize the technology elements.

2.0 ROADMAP TECHNOLOGY DEVELOPMENT SUMMARY

Near-term Technology Needs are identified by WRPS as necessary to begin, continue, or deploy in the next five years for the most efficient use of time and greatest return on investment. Near-term technology needs that have specific identified funding are shown in Table 2-1.

Table 2-1. Near-Term Technology Needs with Funding for FY22/FY23

TEDS ID	Title
DTW-02	Low Temperature Waste Form Process
DTW-03	Immobilized LAW Glass Testing for IDF PA Support
DTW-07	Solidification and Stabilization of Solid Secondary Waste
DTW-08	IDF Long-term Waste Form Durability Study (Lysimeter Data)
MTW-11	DST Primary Tank Bottom Volumetric Inspection
MTW-20	Improve Visual Inspection
MTW-37	Tank Waste Characterization and Identification
MTW-41	Analytical Method Development for Chemicals of Concern
MTW-77	Large Volume Supernatant Sampler and Transportation System
MTW-79	Reduce Entries into Tank Farms while Collecting Vapor Related Data
MTW-87	Real-Time Localized Corrosion Monitoring Probe
MTW-92	Tank Repair
MTW-94	Internal Data Access and Visualization (IDAV)
MTW-95	Predicting Tank Farm Vapor Conditions
MW-02	Ammonia Vapor Mitigation
PTW-23	Methods for Mitigating DFLAW Flowsheet Gaps
PTW-38	Radioactive Waste Test Platform
PTW-53	DFLAW Process Operational Troubleshooting
PTW-55	Chemical Process Modeling Software to Support DFLAW Operations
RTW-01	Retrieval and Closure Solid Waste Sampling Tools
RTW-02	Residual Volume Management System (RVMS)
RTW-08	Dry Sludge Retrieval System
RTW-12	Development of Tank Dome Core Cutter System
RTW-55	Low Volume Addition Retrieval

The Future Technology Needs are those needs that have been identified as profitable areas of focus but are not part of the current five-year vision for technology development and do not have specifically allocated funding. As time goes on and technology needs are fulfilled, retired, or become immediately necessary, needs may move between the Future and Near-term categories. Future Technology Needs are listed in Section 6.0.

3.0 MISSION INTEGRATION

The Roadmap maps technology needs that support accomplishment of ORP's mission. The "End-State Technology Maturation and Execution (TM&E) Chart", Figure 3-1, is a pictorial representation of the technology needs that support that mission. The End State is defined as the completion of technology development activities for equipment, system, and facilities. This Roadmap revision updates the End State TM&E chart and the Near-Term TM&E Chart.

The TM&E charts, Figure 3-1 and Figure 3-2, depict the integration of RPP mission programs and technology maturation activities supporting ORP priorities for thirty years and five years, respectively. In alignment with the current focus of DFLAW and the mission at large, the technology needs are reported in eight major mission programs divided into two areas:

1. Direct Feed Low-Activity Waste (DFLAW) Operations Support
    a. Immobilized Low-Activity Waste Glass
    b. Tank-Side Cesium Removal & Low-Activity Waste a Pretreatment System
    c. Cementitious Waste Forms
    d. Supplemental Low-Activity Waste
2. RPP Mission Support
    a. Alternate Retrieval Technology Identification and Development
    b. Tank Integrity Technology Identification and Development
    c. Sampling & Monitoring Technology Identification and Development
    d. Worker Protection

Major mission programs were identified from existing TEDS sheets, the National Laboratory Technology Capability Matrix (APPENDIX F), other Hanford Site contracts and the RPP Mission Plan, ORP-11242. Development activities were mapped to the major mission programs and the corresponding TEDS are identified. As waste is treated, technology pushes forward and the mission evolves, the programs depicted in the TM&E charts will also evolve.

The technology elements documented in this Roadmap should inform planning decisions. As potential funding becomes available, the elements representing potential technology ideas that can improve operational flexibility, increase processing rates, decrease costs, and/or increase safety should be considered. These charts are updated annually to reflect changing priorities, changing mission needs, and completed development activities.

3.1 DFLAW Operations Support

The near-term mission for the ORP is to treat tank waste using the Low Activity Waste (LAW) Vitrification Facility, which is part of the Waste Treatment and Immobilization Plant (WTP). The DOE has opted to use and prioritize the Direct Feed LAW approach to start treating tank waste. This approach uses the Tank Side Cesium Removal (TSCR) facility to remove Cesium-137 from supernatant and then feed this stream to the LAW Vitrification facility. This approach requires technologies that develop glass formulations, support TSCR, enable cementitious waste forms for secondary waste, and enable Supplemental LAW solidification in cementitious waste forms.

3.1.1 Immobilized Low-Activity Waste Glass

Immobilized LAW (ILAW) glass testing generates the required data for maintenance of the Integrated Disposal Facility (IDF) Performance Assessment (PA) and future revisions to the IDF PA to include Enhanced Waste Glass (EWG) compositions. This work has three primary decision points,

1) Determine how the range of EWG glasses should be represented within the IDF PA to assess against performance objectives
2) Whether sufficient data has been produced for EWG using alternative or traditional test methods to evaluate EWG in the IDF PA
3) Whether statistical correlations between EWG performance and glass composition are necessary and sufficient to assess EWG in the IDF PA

The threats as identified in the Enterprise Risk Opportunity Management System (EROMS) being addressed by Near-Term technology development for ILAW Glass are DFLAW-0363-T, WTP LAW Throughput is Less Than Adequate; DFLAW-0249-T, WIR Evaluation Approval is Delayed; and DFLAW-0149-T, IDF Permits to Operate Including Disposal Authorization Statement (DAS) Delayed. Details on the specific handling actions for each threat can be found in EROMS.

3.1.2 Tank-Side Cesium Removal & Low-Activity Waste Pretreatment System

The TSCR system is a technology that is utilized as a first feed solution supporting the production of ILAW. TSCR is a modular system that removes cesium (Cs) from tank waste supernate prior to feeding it from Tank Farms directly to the WTP LAW Facility. The TSCR system has been deployed as a two-phased demonstration project. The first phase will monitor system performance and demonstrate the ability to safely operate and maintain the TSCR system in support of feed production for WTP hot commissioning and early operations. The second phase will demonstrate the ability to reliably and efficiently treat tank waste for an extended operating period.

The completed TSCR has been deployed and is operating. In support of enhanced future operational efficiency, activities have been identified to support alternate feeds or response to off normal conditions. These activities include development of additional filtration approaches such as alternative media, enhanced cleaning methods, and use of filter pre-coats. Development of these efforts can help ensure operational throughput is maintained when new or unexpected operating conditions are encountered, preserving capability for providing LAW production.

The threats identified in EROMS being addressed by Near-Term technology development for the TSCR & LAW pretreatment system are DFLAW-0363-T, WTP LAW Throughput is Less Than Adequate; DFLAW-0232-T, WTP Radioactive Dangerous Liquid Effluent Composition is Less Than Adequate; DFLAW-0106-T, Staged Treated LAW Feed to WTP Does Not Meet Waste Acceptance Criteria for Cesium-137; DFLAW-0075-T, Secondary Liquid Waste Volumes are Higher Than Expected; DFLAW-1148-T, TSCR Solids Filtration Throughput is Less Than Adequate; and DFLAW-1095-T, TSCR and WFD Systems Unable to meet WTP Feed Demand during Operations. Details on the specific handling action can be found in EROMS.

3.1.3 Cementitious Waste Forms

Advanced grout technology development spans three key areas,

1) Improving contaminant retention and waste form stability for immobilized secondary waste

2) Development and implementation of waste formulations to treat unique process streams such as the high ammonia bearing Effluent Treatment Facility (ETF) effluent brine

3) Formulation development to enhance the retention of key Compounds of Concern (COCs) such as 129-I and 99-Tc to enable the opportunity to break the internal vitrification facility recycle by directly solidifying the bottoms from the Effluent Management Facility (EMF) evaporator.

In addition, the cross-cutting technology maturation needs associated with the long-term stability and durability of cementitious waste forms is addressed in this mission area.

The threats identified in EROMS being addressed by Near-Term technology development for Cementitious Waste Forms are DFLAW-0206-T, Secondary Solid Waste Management Less Than Adequate (Tank Farms and WTP); DFLAW-0232-T, Secondary Liquid Waste Management Less Than Adequate; and DFLAW-0401-O, Alternative Treat/Dispose Path for EMF Evaporator Concentrate. Details on the specific handling actions for each threat can be found in EROMS.

3.1.4 Supplemental Low-Activity Waste

Technology maturation efforts to enable solidifying Supplemental Low Activity Waste (SLAW) into a cementitious waste form include,

1) Quantifying and resolving issues associated with the possible presence of RCRA LDR organics in SLAW
2) Developing tailored waste formulations to enhance the ability of solid matrices to Capture-and-Hold the problematic constituents, 129-I, 99-Tc, and Nitrate
3) Evaluating modifications to the waste packages and IDF backfill to enhance retention of hazardous and radioactive constituents within the IDF footprint

Both onsite as well as offsite disposal options are considered in this work. Offsite disposal requirements are included to address opportunities for enhancing the waste treatment mission.

The threat identified in EROMS being addressed by Near-Term technology development by Near-Term technology development for SLAW is DFLAW-0363-T, WTP LAW Throughput is Less Than Adequate. Details on the specific handling action can be found in EROMS.

3.2 RPP Mission Support

Other mission needs fall under RPP Mission Support which is working toward the mission End-State. This includes identifying and developing technologies to address alternate retrieval methods, tank integrity verification and improvement, waste sampling and monitoring methods, and overall worker protection.

3.2.1 Alternate Retrieval Technology Identification and Development

Alternate retrieval addresses the technologies needed to identify, develop, and allow successful deployment of new or enhanced Alternative Retrieval Technologies (ART) for solids removal from waste tanks at the Hanford Site tank farms. The goal of this program is to develop the technology necessary to support retrieval of the remaining tank waste solids in a safe and efficient manner. Tank retrieval activities are governed by ORP-11242, *River Protection Project System Plan*, herein after referred to as the System Plan and by RPP-PLAN-40145, *Single-Shell Tank Waste Retrieval Plan*.

The threats identified in EROMS being addressed by Near-Term technology development for ART are

AAXRC-0012-T, Delays in A-104 and A-105 Retrieval Due to Technology Development; AAXRC-0016-T, Excessive Equipment Failures (other than pumps); AAXRC-0051-T, Damage to Tank/Equipment During Equipment Installation or Removal; and AAXRC-0043-T, Equipment in Risers is More Difficult to Remove than Anticipated (DOE). Details on the specific handling actions for each threat can be found in EROMS.

3.2.2 Tank Integrity Technology Identification and Development

The primary objectives of the Tank Integrity programs are to monitor the condition of the valuable Double Shell Tank (DST) assets over time, evaluate any unanticipated changes in condition and rectify them where feasible. The data obtained by these programs serves to inform future operational and inspection decisions. To date, discoveries of tank bottom corrosion in the primary tank of DST AY-102, material loss from the foundation side of the secondary liner of several DSTs, and liquid-to-air interface corrosion in tank AY-101 have served to spur additional action to prolong the life of the DSTs and mitigate damage mechanisms as they are discovered. Discovery of these challenges early on is a critical component of the integrity program mission.

The Non-Destructive Examination (NDE) technologies consist of surface and volumetric techniques. Surface NDE technologies to date have focused on improved visual inspection of the DSTs. Consideration is being given to other methods of examination. Volumetric NDE techniques target inspection of the material to characterize any degradation present, such as thinning, pitting, cracking and other surface defects. To date ultrasonic testing has been the primary method used; the program is investigating other methods such as guided wave and electromagnetic acoustic transducers.

Tank Integrity also includes Tank repair activities. The DSTs are expected to provide sufficient capacity for retrieving waste from SSTs for treatment and stabilization; remaining in operation for several decades beyond their originally planned operating life. The Hanford mission relies on the availability of DSTs to ensure that there is sufficient storage space in the tank farms during the life of the mission. Identifying and developing a toolbox of technologies that can affect a range of repair needs will improve potential storage space options and provide confidence in overall tank integrity.

The threats identified in EROMS being addressed by Near-Term technology development for Tank Integrity are TFIRR-0045-T, DST Tank Failure in East Area; TFIRR-0046-T, DST Tank Failure in West Area; TFIRR-0047-T, SST Failure in East Area; TFIRR-0048-T, SST Failure in West Area; AAXRC-0012-T, Delays in A-104 and A-105 Retrieval Due to Technology Development; and AAXRC-0024-T, Waste Temperatures Exceed HIH Limits. Details on the specific handling actions for each threat can be found in EROMS.

3.2.3 Sampling & Monitoring Technology Identification and Development

The primary driver for all sampling technologies is successful support of the RPP tank waste cleanup mission needs. To help prevent the risk of mission delays, all future project and mission elements need to be assessed as soon as possible for any potential waste sampling technology gaps. Identifying gaps in advance will allow ample time to develop the needed technologies to meet mission goals.

The threats identified in EROMS being addressed by Near-Term technology development for Sampling and Monitoring are AAXRC-0011-T, Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved; AAXRC-0024-T, Waste Temperatures Exceed HIH Limits; and DFLAW-0232-T, WTP Radioactive Dangerous Liquid Effluent Composition Less Than Adequate. Details on the specific handling actions for each threat can be found in EROMS.

3.2.4 Worker Protection

The purpose of worker protection is to identify, develop, and deploy new or enhanced worker protection program technologies for protection of Hanford Site tank farm workers and associated Hanford workers (other DOE Site subcontractors) from potential hazards. The technology effort focus is to determine, with the Hanford work force (management, technical staff and field workers), what the potential hazards are, the extent of the hazard and what technologies can be developed and deployed to mitigate the hazards to acceptable and/or required safe conditions.

The threat identified in EROMS being addressed by Near-Term technology development for Worker Protection is WRPSC-0003-T, Tank Vapors Controls Impact Project Execution.

3.3 End-State Technology Maturation and Execution Chart

The End-State TM&E chart, Figure 3-1, includes an assessment of mission program impacts (i.e., return on investment) for key project technology development initiatives. Technology developments that present potential significant benefit to accomplishing the RPP mission are included. These are identified as key opportunities for each mission program. RPP mission programs also include those technology development activities that envelope all tank farm activities (e.g., worker protection).

Both TM&E charts employ a color/shape coding of activities. This enables a quick visual understanding of end-state support. The coding is as follows:

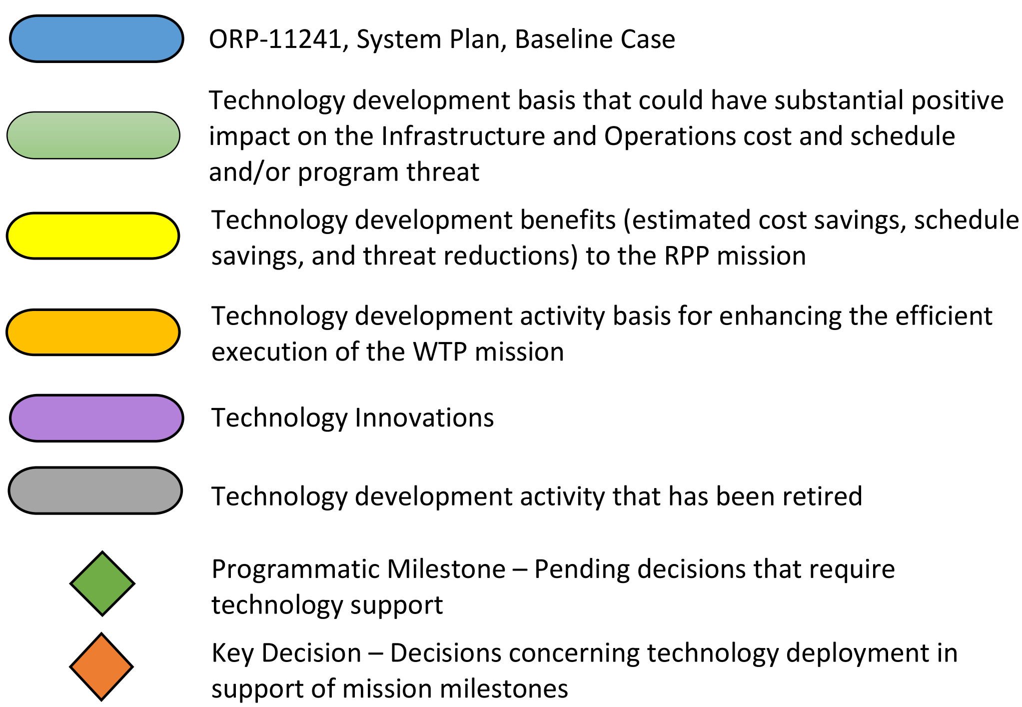
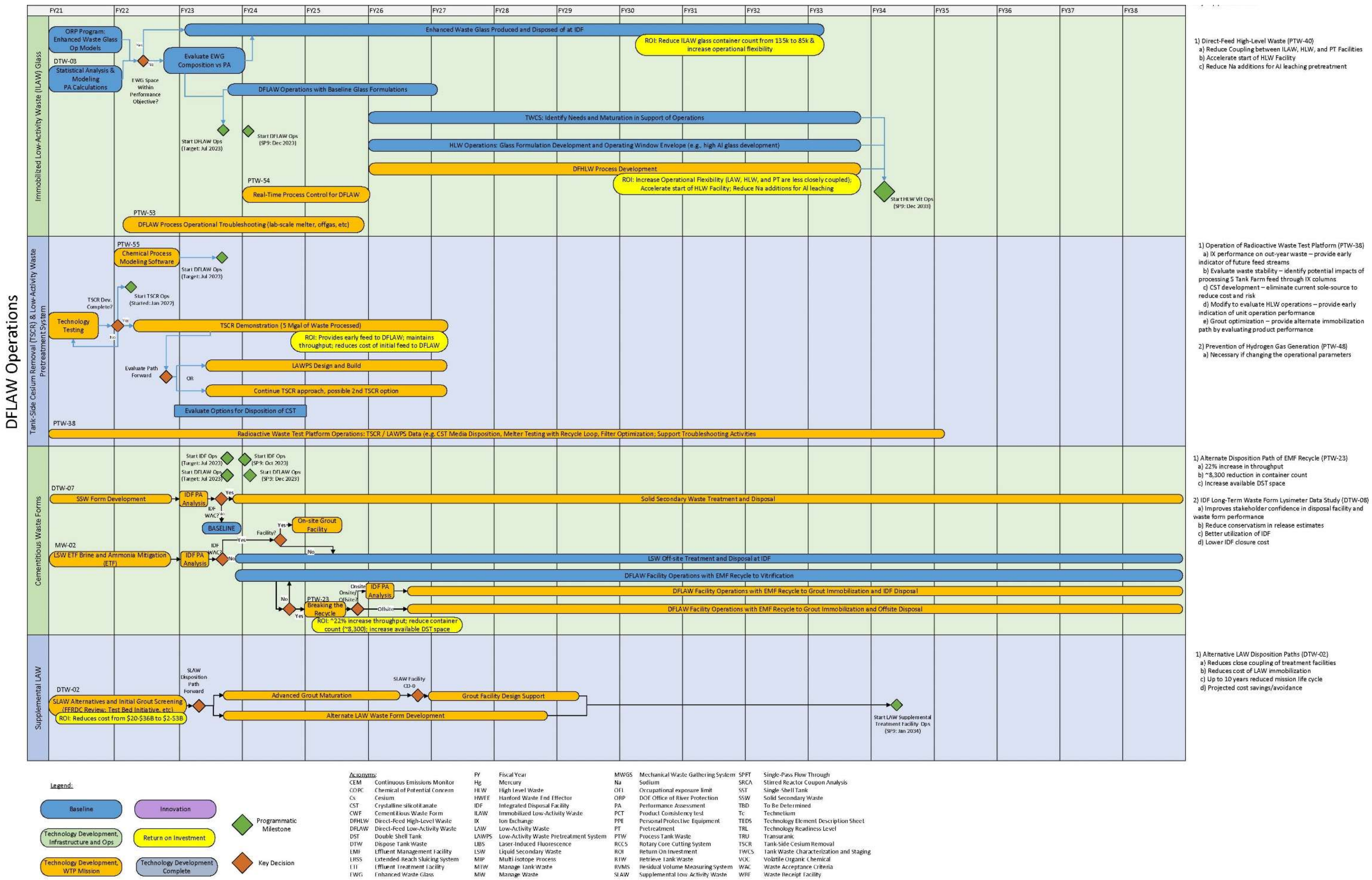
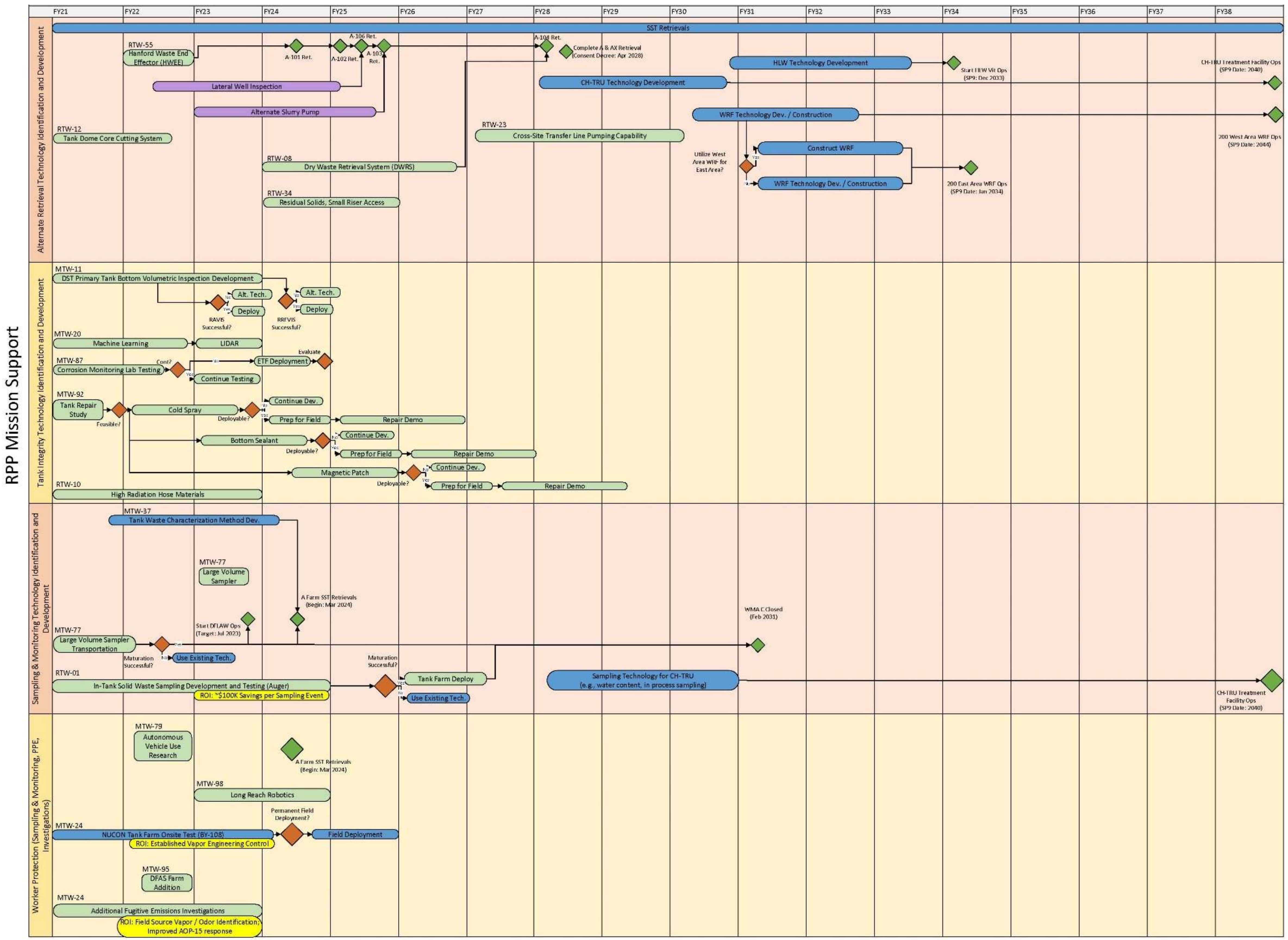


Figure 3-1. End-State Technology Maturation and Execution





Key Opportunities

1) ERSS Modifications (RTW-34)
   a) Improve Efficiency of waste removal by enhancing range of motion of ERSS (utilize less arms during retrieval and avoid obstructions)
   b) Increase pumping capability over greater range of solids rheological properties

2) High-Radiation Hose Material Testing (RTW-10)
   a) Increased lifecycle of hose-in-hose exposed to high-radiation environment and reduce cost

3) Development of an RCCS to Improve Access Inside the Tanks (RTW-12)
   a) Reduced worker exposure during core drilling activities
   b) Increases riser size, increasing range of retrieval technologies, including commercial off-the-shelf technologies

4) HWEE Development (RTW-55)
   a) 2-5X improvement in retrieval rate
   b) 10x improvement in dilution ratio

1) Automated DST Annulus Camera System (MTW-09)
   a) Reduce cost and exposure of annulus inspections
   b) Increase frequency and timeliness of event response

2) Radiation Tolerant Multi-Use Manipulator (MTW-81)
   a) Enhanced sensor deployment method, reducing cost and exposure

1) Tank Waste Characterization and Identification (MTW-37)
   a) Improved equipment reduces uncertainty with analytical results
   b) Improves exposure to technicians ALARA

2) Use of Sonar and Ultrasound to Quantify Solids in DSTs (RTW-44)
   a) Reduced uncertainty in solids measurements
   b) More accurate measurements reduce conservatism in tank waste evaluations
   c) Reduced schedule for volume determination
   d) Reduced dose to workers and simplifies measurement technique

3) Three-Dimensional Flash LIDAR to Map Waste Tanks (RTW-53)
   a) Reduced uncertainty in residual measurements
   b) Reduced schedule for tank waste mapping
   c) Reduced dose to workers and simplified measurement technique

4) Online Monitoring (e.g., Raman Spectroscopy) (MTW-76)
   a) Reduced sample operations cost
   b) Reduced analysis duration

1) Self-Diagnosing Continuous Air Monitoring (MTW-72)
   a) Minimize need for maintenance and personnel to service equipment during daily rounds

2) Autonomous Robotic Platform (MTW-79)
   a) Reduced worker exposure through reduced tank farm entries
   b) Collect tank and vapor data in remote farms prior to initiating waste-disturbing activities
   c) Enhance tank farm walk-down capabilities

3) Mobile Proton Transfer Reaction – Mass Spectrometer (MTW-68)
   a) allows for near real time detection (e.g., ultraviolet – differential optical spectrometer) of COPCs at OELs
   b) Improved temporal resolution, low part per trillion sensitivity and extremely high mass resolution

4) CEM (MTW-24)
   a) Stack, area, and headspace monitor
   b) Autonomous, programmable whole-air sampling capability

3.4 Near-Term Technology Development

The Roadmap provides a focused look at the next five years in addition to the longer-term mission integration. This focused look at the near-term mission is intended to provide clarifying information to aid in the planning of projects. For continuity, the near-term focus is depicted in a Near-Term TM&E chart, Figure 3-2, that is divided into the same areas and major mission programs as the End-State TM&E chart. The Near-Term TM&E chart lists TEDS's numbers that are on-going activities starting with the FY22. The chart also contains recommendations/expectations for subsequent fiscal years. These TEDS's numbers are as follows,

DFLAW Operations Support

Immobilized Low Activity Waste Glass

- DTW-03, Immobilized ILAW Glass Testing for IDF PA Support
- PTW-53, DFLAW Process Operational Troubleshooting
- PTW-54, Real-Time Process Control for DFLAW

Tank-Side Cesium Removal & Low-Activity Waste Pretreatment System

- PTW-38, Radioactive Waste Test Platform
- PTW-55, Chemical Process Modeling Software to Support DFLAW Operations

Cementitious Waste Forms

- DTW-07, Solidification and Stabilization of Solid Secondary Waste
- DTW-08, IDF Long-term Waste Form Durability Study (Lysimeter Data)
- MW-02, Ammonia Vapor Mitigation
- PTW-23, Methods for Mitigating DFLAW Flowsheet Gaps

Supplemental Low-Activity Waste

- DTW-02, Low Temperature Waste Form Process

RPP Mission Support

Alternate Retrieval Technology Identification and Development

- RTW-08, Dry Retrieval Systems
- RTW-12, Development of New Riser Installation System
- RTW-34, Remove Residual Solids in Non-Leaking Tanks
- RTW-55, Low Volume Addition Retrieval

Tank Integrity Technology Identification and Development

- MTW-11, DST Primary Tank Bottom Volumetric Inspection
- MTW-20, Improve Visual Inspection
- MTW-87, Real-Time Localized Corrosion Monitoring
- MTW-92, Tank Repair
- RTW-10, Evaluation of Hose-in-Hose Transfer Line (HIHTL) Material Properties

Sampling & Monitoring Technology Identification and Development

- RTW-01, Retrieval and Closure Solid Waste Sampling Tools
- MTW-77, Large Volume Supernatant Sampler and Transportation System

Worker Protection

- MTW-24, Vapor Monitoring, Characterizing & Remediation
- MTW-79, Reduce Entries into Tank Farms while Collecting Vapor Related Data
- MTW-95, Predicting Tank Farm Vapor Conditions

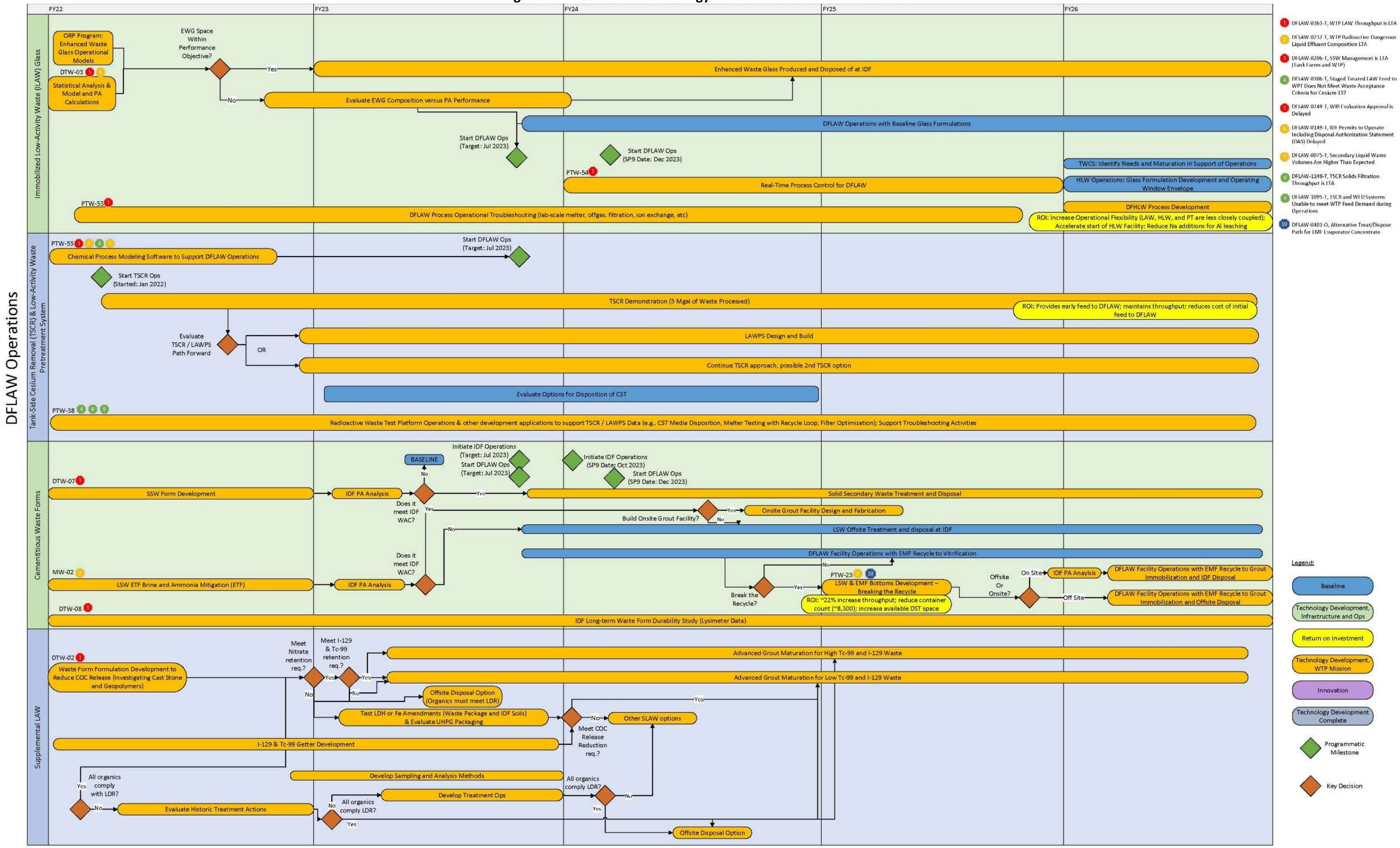
More information on each of these needs can be found in the corresponding Catalog Sheets Section 5.0.

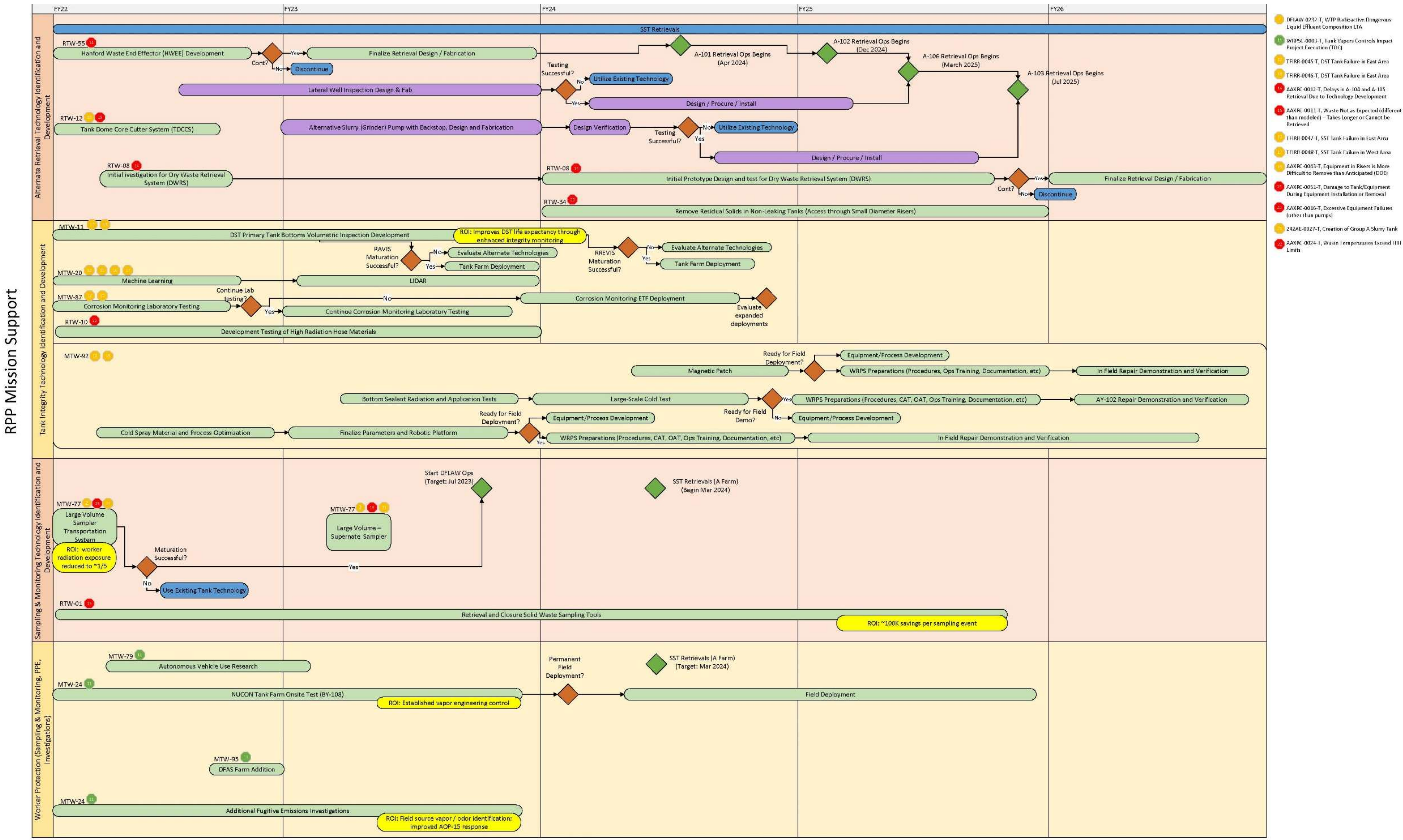
3.5 Near-Term Technology Maturation and Execution Chart

The Near-Term TM&E chart, Figure 3-2, gives a clearer, more detailed breakdown of tasks and task durations of projects. This chart is used to highlight and identify the projects that are both in progress and those that are needed in the near future. This chart includes the on-going activities from the fiscal year this revision of the Roadmap was published with recommendations/expectations for the following four fiscal years. Additionally, the Missions Risks as identified in the Enterprise Risk Opportunity Management System (EROMS) are called out by identification number and title to provide a clearer understanding of the need for the technology development. Each TEDS identification number on the chart is accompanied by a risk identifier that is the color of the risk level as identified in EROMS and corresponds to the EROMS Identification number indicated on the right hand side of the chart.

The near-term TM&E chart is divided into the same eight major mission programs in two areas as the End State TM&E chart and includes a finer project timeline for the near-term projects. Technology development is ongoing in each of the major mission programs.

Figure 3-2. Near-Term Technology Maturation and Execution Chart

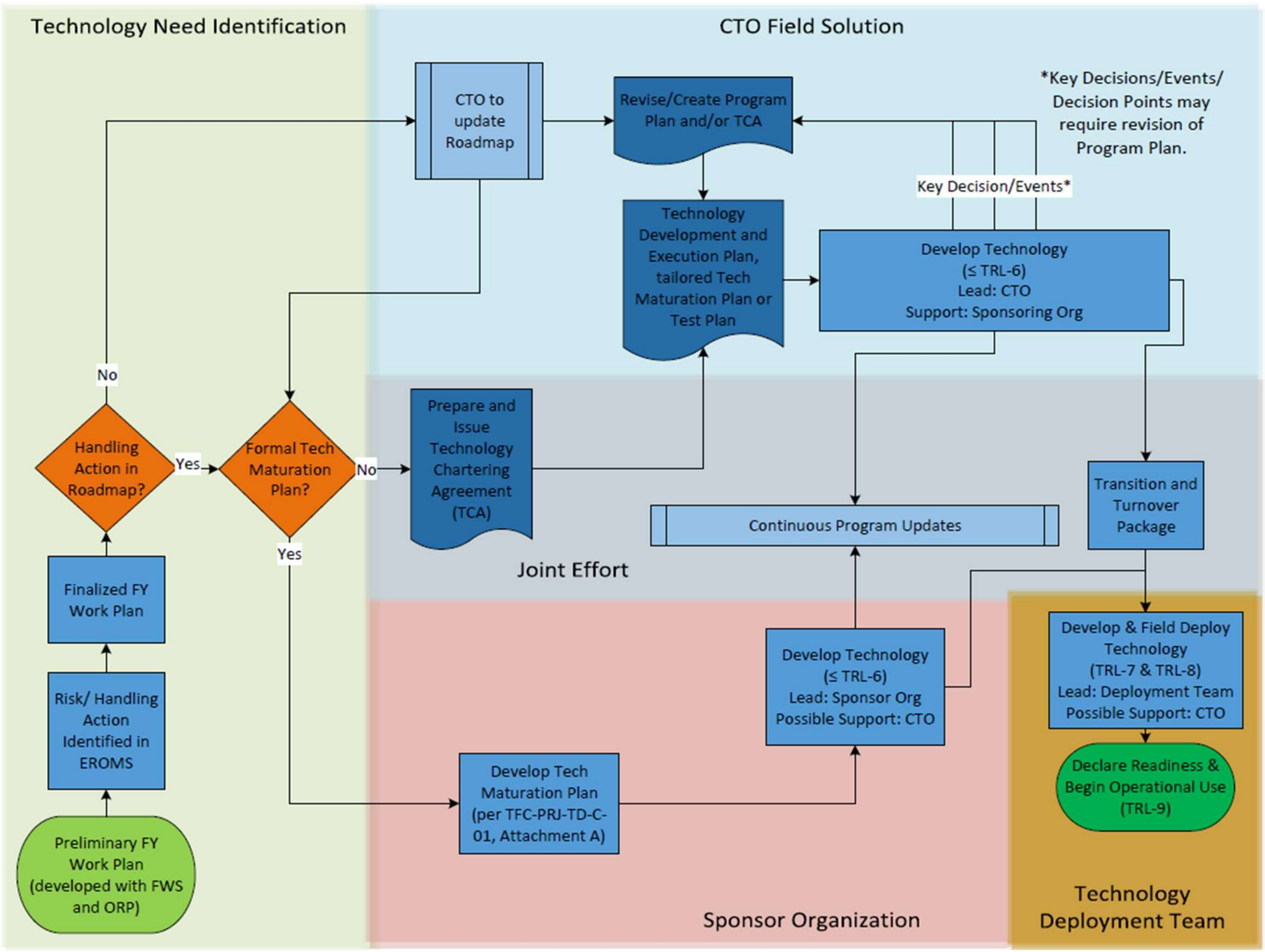



RPP Mission Support
FY22
FY23
FY24
FY25
FY26
Alternate Retrieval Technology Identification and Development
SST Retrievals
RTW-55
Hanford Waste End Effector (HWEE) Development
Cont?
Yes
No
Finalize Retrieval Design / Fabrication
Discontinue
A-101 Retrieval Ops Begins (Apr 2024)
A-102 Retrieval Ops Begins (Dec 2024)
A-106 Retrieval Ops Begins (March 2025)
A-103 Retrieval Ops Begins (Jul 2025)
Testing Successful?
Utilize Existing Technology
Lateral Well Inspection Design & Fab
Design / Procure / Install
RTW-12
Tank Dome Core Cutter System (TDCCS)
Alternative Slurry (Grinder) Pump with Backstop, Design and Fabrication
Design Verification
Testing Successful?
Utilize Existing Technology
Design / Procure / Install
RTW-08
Initial ivestigation for Dry Waste Retrieval System (DWRS)
RTW-08
Initial Prototype Design and test for Dry Waste Retrieval System (DWRS)
Cont?
Finalize Retrieval Design / Fabrication
Discontinue
RTW-34
Remove Residual Solids in Non-Leaking Tanks (Access through Small Diameter Risers)
Tank Integrity Technology Identification and Development
MTW-11
DST Primary Tank Bottoms Volumetric Inspection Development
ROI: Improves DST life expectancy through enhanced integrity monitoring
RAVIS Maturation Successful?
Evaluate Alternate Technologies
Tank Farm Deployment
RREVIS Maturation Successful?
Evaluate Alternate Technologies
Tank Farm Deployment
MTW-20
Machine Learning
LIDAR
MTW-87
Corrosion Monitoring Laboratory Testing
Continue Lab testing?
Continue Corrosion Monitoring Laboratory Testing
Corrosion Monitoring ETF Deployment
Evaluate expanded deployments
RTW-10
Development Testing of High Radiation Hose Materials
MTW-92
Ready for Field Deployment?
Equipment/Process Development
Magnetic Patch
WRPS Preparations (Procedures, Ops Training, Documentation, etc)
In Field Repair Demonstration and Verification
Bottom Sealant Radiation and Application Tests
Large-Scale Cold Test
Ready for Field Demo?
WRPS Preparations (Procedures, CAT, OAT, Ops Training, Documentation, etc)
AY-102 Repair Demonstration and Verification
Equipment/Process Development
Ready for Field Deployment?
Equipment/Process Development
Cold Spray Material and Process Optimization
Finalize Parameters and Robotic Platform
WRPS Preparations (Procedures, CAT, OAT, Ops Training, Documentation, etc)
In Field Repair Demonstration and Verification
Sampling & Monitoring Technology Identification and Development
Start DFLAW Ops (Target: Jul 2023)
SST Retrievals (A Farm) (Begin Mar 2024)
MTW-77
Large Volume Sampler Transportation System
ROI: worker radiation exposure reduced to ~1/5
Maturation Successful?
MTW-77
Large Volume – Supernate Sampler
Use Existing Tank Technology
RTW-01
Retrieval and Closure Solid Waste Sampling Tools
ROI: ~100K savings per sampling event
Worker Protection (Sampling & Monitoring, PPE, Investigations)
MTW-79
Autonomous Vehicle Use Research
Permanent Field Deployment?
SST Retrievals (A Farm) (Target: Mar 2024)
MTW-24
NUCON Tank Farm Onsite Test (BY-108)
ROI: Established vapor engineering control
Field Deployment
MTW-95
DFAS Farm Addition
MTW-24
Additional Fugitive Emissions Investigations
ROI: Field source vapor / odor identification: improved AOP-15 response
DFLAW-0232-T, WTP Radioactive Dangerous Liquid Effluent Composition LTA
WRPSC-0003-T, Tank Vapors Controls Impact Project Execution (TOC)
TFIRR-0045-T, DST Tank Failure in East Area
TFIRR-0046-T, DST Tank Failure in East Area
AAXRC-0012-T, Delays in A-104 and A-105 Retrieval Due to Technology Development
AAXRC-0011-T, Waste Not as Expected (different than modeled) – Takes Longer or Cannot be Retrieved
TFIRR-0047-T, SST Tank Failure in East Area
TFIRR-0048-T, SST Tank Failure in West Area
AAXRC-0043-T, Equipment in Risers is More Difficult to Remove than Anticipated (DOE)
AAXRC-0051-T, Damage to Tank/Equipment During Equipment Installation or Removal
AAXRC-0016-T, Excessive Equipment Failures (other than pumps)
242AE-0027-T, Creation of Group A Slurry Tank
AAXRC-0024-T, Waste Temperatures Exceed HIH Limits

3.6 Transition to Operations

Transitioning equipment, systems, and facilities from start-up and commissioning to field operations may require the deployment of different technologies. Additional technology development and/or studies may be required to support commissioning and field operations. For this reason, CTO will work closely with the sponsoring organization to ensure continuity between technology development and deployment. See the figure below.

Figure 3-3. Technology Development Flow Chart

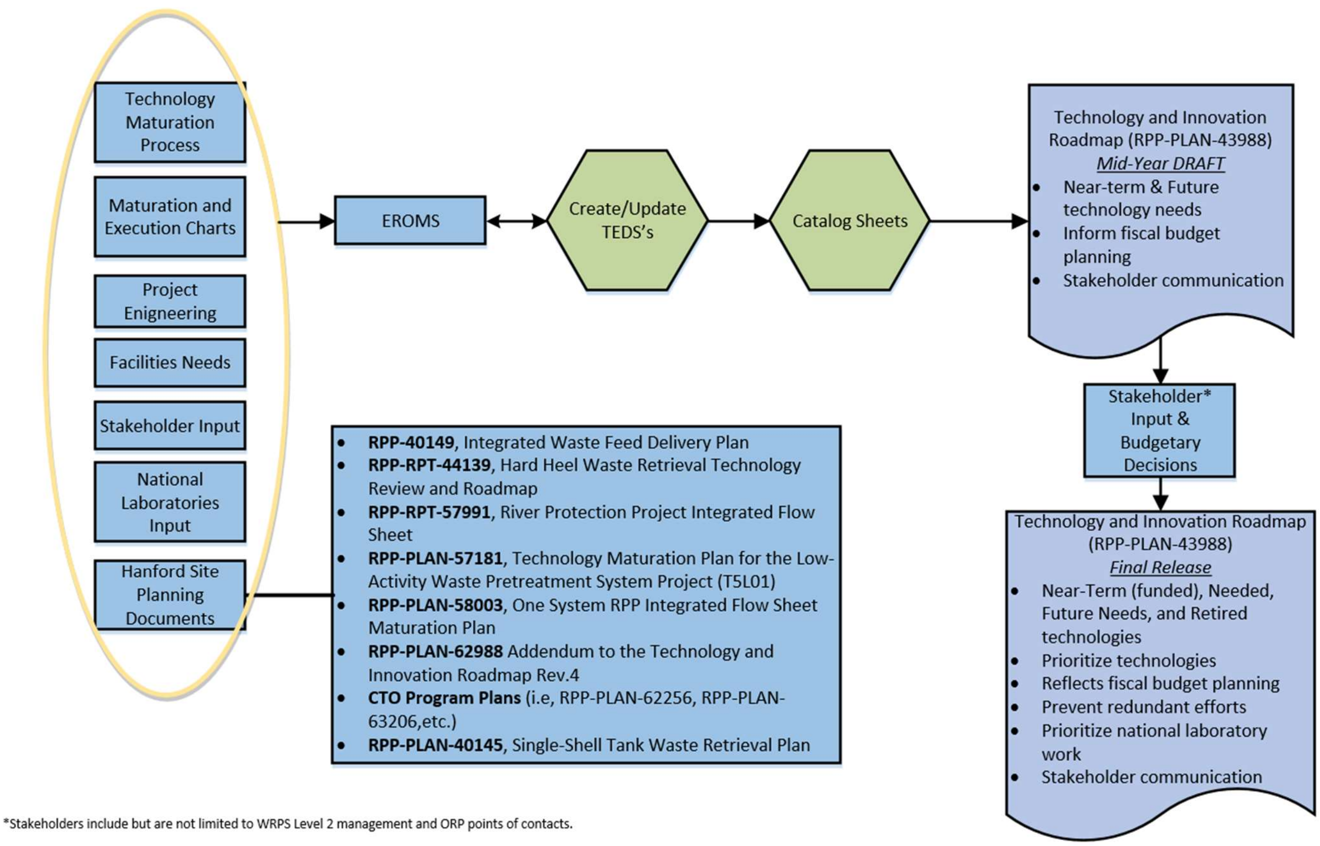


4.0 PROCESS SUMMARY

The technology maturation process as defined in TFC-PLN-90, *Technology Maturation Management Plan*, defines technology elements that are incorporated into TEDS sheets as necessary. After technology development needs are received from throughout the company, the DOE complex (contractors to DOE), and outside industries, Hanford Site planning documents are reviewed to identify any technology needs that were missed. Figure 4-1 highlights some of the planning documents that are reviewed. A TEDS sheet is generated for any additional technology needs.

This Roadmap is updated annually to incorporate the changing RPP technology needs. Figure 4-1 illustrates this process, which initiates with the solicitations of technology needs from a variety of sources.

Figure 4-1. Technology Roadmap Development Process



This process is used to ensure that the planning and strategic initiatives agree. These sources include: (1) previous year's Roadmap (Legacy Technology Outputs); (2) technologies derived through technology maturation; (3) TM&E chart (Figure 3-1); (4) stakeholder input; (5) facility needs; (6) EROMS; (7) ORP Grand Challenges (GC); and (8) programmatic planning documents. Most of these inputs are Hanford-centered, but the ORP GC obtained solicitations from industry, academia, and the DOE-wide complex. The GC program was discontinued, and no new GCs have been produced since 2018.

Ultimately, all technology elements will be mapped to programmatic and project threats and opportunities via EROMS. This is an ongoing process facilitated through interaction with risk engineers. EROMS is the web-based application that WRPS uses to identify and manage Threats (or Risks) and Opportunities (T&Os). The principal reasons for employing EROMS are to identify and manage those Threats and Opportunities (T&Os) that may have significant impact on achieving goals and objectives of the entire WRPS enterprise, and to provide a basis for prioritizing and allocating limited resources required to implement recommended handling strategies.

T&Os are addressed at multiple levels, from Line organizations (which includes all functional organizations), through Projects and Programs, and up to the Business, or top level. All of these T&Os are subject to potential interfaces with entities external to WRPS, such as other Hanford site contractors, the DOE, or other stakeholders (e.g., Washington State regulators, Defense Nuclear Facility Safety Board, Congress). It is important to note that T&Os are normally managed at the lowest possible level, and only those that have higher level impacts or that require resources beyond those available to the current organizational level would get elevated to the next level in the hierarchy. In addition, only those T&Os with significant potential impact to the overall organization would be elevated to the enterprise level where they would be managed as directed by the Senior Management Team (SMT).

4.1 Compiling Technology Element Description Summaries (TEDS)

All of the known technology needs are identified by the appropriate Fieldwork Specialists via individual TEDS sheets. In Revisions 0 through 3 of the Roadmap, TEDS sheets were referred to as pro forma work sheets. Beginning in Revision 4 existing ProFormas were updated to the TEDS format (see a sample TEDS form in APPENDIX A) and additional TEDS sheets were developed to address new technology needs. The TEDS sheets were used from Revision 4 through Revision 7. At Revision 7, the data from the TEDS was migrated into a database application for ease of management.

The TEDS is a standardized work sheet that enables direct comparison of provided input. The TEDS sheets primarily include the following information:

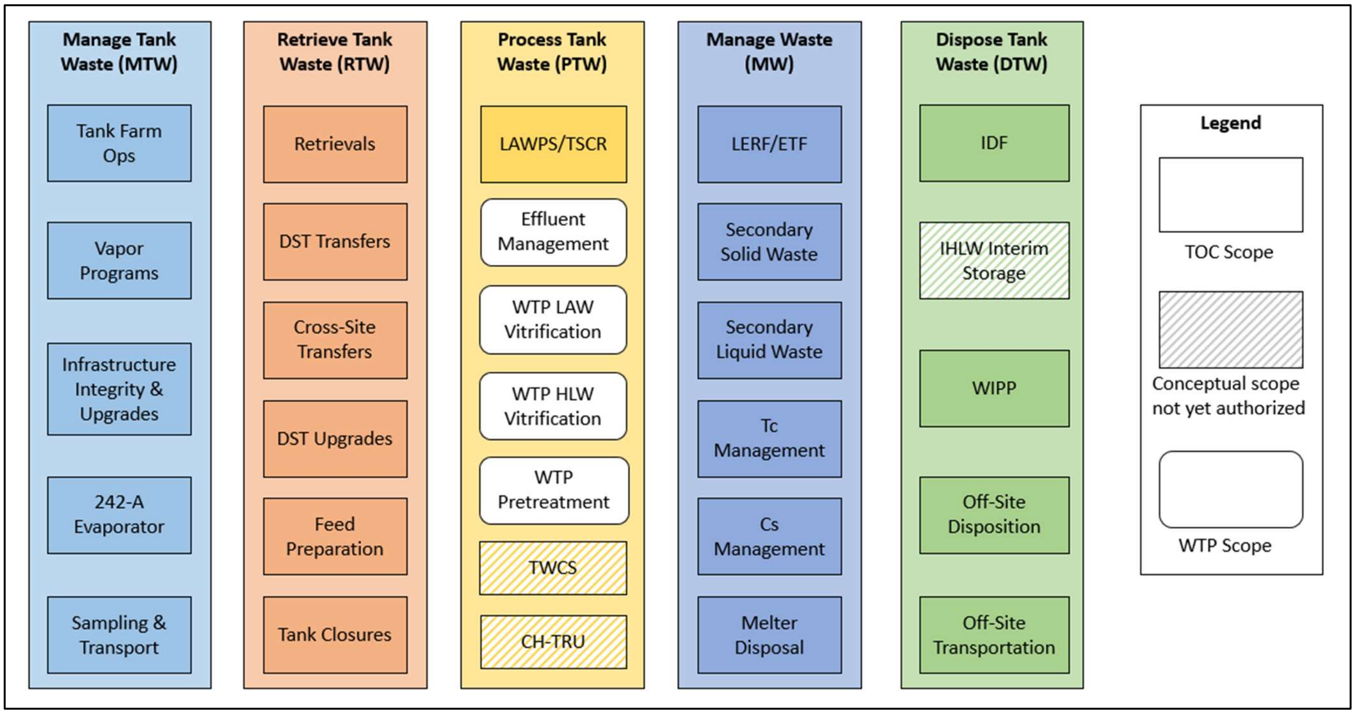
- Funding Status
- Technology Summary
- Priority Ranking
- Functional Area
- Cost and Schedule
- Points of Contact
- Technology Need
- Technology Solution
- Technology Maturation Level
- National Laboratory Involvement
- Grand Challenge Relationship
- Technology Impact and Threat Identification

To kick-off the request for TEDS sheets and ensure that the technology needs and gaps are comprehensively captured, the WRPS Chief Technology Office assembled a team with extensive experience in Hanford Site tank farms that spanned all mission functional areas.[1] This team included ORP and WRPS personnel, including managers and technical leads and individuals with field experience. Although WTP technology development is identified in the functional framework, this

[1] The RPP mission functional areas are in alignment with the DE-AC27-08RV14800 Tank Operations Contract work breakdown structure and are discussed further in RPP-51303, *River Protection Project Functions and Requirements*, and RPP-RPT-56516, *One System River Protection Project Mission Analysis Report*.

roadmap currently does not include WTP technology development activities. The five mission functional areas are depicted in Figure 4-2. Having experienced Hanford Site members for all five functional areas served as a way to ensure all of the RPP mission requirements have coverage in the Roadmap.

Figure 4-2. Functional Area Summary



For Revision 7, CTO reached out to the relevant WRPS, ORP, and other Fieldwork Specialists and requested any additional technology needs that were not addressed by the previous year's TEDS, and new TEDS sheets were created as necessary. The primary input into the technology needs was the TM&E chart (see Figure 3-1 in Section 2.0).

Technology development is primarily driven by the need to mitigate threat and realize opportunity; therefore, the risk registries are significant input into the technology needs. The threats and opportunities are identified, managed, and assessed via the EROMS which is also known as the Risk Registry. A key feature of the Risk Registry is handling actions. Handling actions propose what is or could be done about threats or opportunities to minimize or maximize the impacts to the work scope. A section of the TEDS form requests the threat and opportunity input. This input includes the handling actions that could be implemented by the proposed technology development. Additionally, opportunities identified in the Risk Registry are assessed for technology development application.

Previously, the ORP GC Workshop brought together members of DOE, National Laboratories, academia, contractors, and outside industries. ORP has not solicited GCs for FY 2022, but previous years' ideas that are related to technology development have previously been incorporated into TEDS sheets. The catalog sheets indicate GC participation from previous years only.

4.2 Catalog Sheets

The catalog sheets for projects that are planned for FY22 make up Section 5.0 of this Roadmap.

Information provided by the TEDS sheets is used to prepare the Roadmap catalog sheets highlighting each technology need. The catalog sheets are concise summaries of technology developments. They are shared with other DOE Sites, National Laboratories, and vendors as needed. Current activities are primarily those that are needed in the near (<5 years) or intermediate (5-10 years) time frame. Technology developments that are planned for FY22 are described on two pages identifying needs, solutions, threats, opportunities, activity duration, funding, interfacing contractor, and ORP contact information. The relationship between a TEDS and a catalog sheet is defined in APPENDIX D.

Technology developments that are identified but not planned for the next fiscal year are described on single page catalog sheets. These catalog sheets contain rough-order-of-magnitude cost and duration information.

The basis of estimate provided for out-years is the best estimate for the work scope. The best estimate values may not reflect baseline funding, in which case the duration of performance could change.

Included in the two-page Catalog sheets is a Measurable Organizational Value (MOV). An MOV is a measure of the overall goal and defines the measure of success. A MOV must be measurable, verifiable, and provide organization value. In assembling the MOV for each TEDS the project leads follow a set of steps. The project lead identifies the desired area of impact and desired value of eliminating the threat or realizing the opportunity. Using this information, an appropriate metric is developed, this includes assigning a time frame for achieving the MOV. The financial models that can be incorporated to showcase the tangible metric values of impact(s) include payback, breakeven, return on investment, net present value, or scoring. This in turn is then used to develop a clear and concise statement or table for the TEDS. The final step in this process is verifying MOV and documenting agreement from project sponsors, end users, and other key stakeholders. Since no single solution generally exists for most threat or opportunities, it is acceptable to identify several TEDS; these alternatives, or options, identified in the threat or opportunity assessment can be used as a strategy for achieving a single MOV.

4.3 Technology Roadmap Document

After catalog sheets are finalized, the Roadmap is compiled and released for use within the DOE complex. The Roadmap is a living document that is updated annually to accommodate changing needs of the RPP mission. As such, it will be a key resource for preparing program plans, transition plans, and out-year Roadmaps.

The extensive input to the Roadmap results in a multi-faceted output. The Roadmap is to be used as a planning tool for making informed budgetary decisions and to track the progress of ongoing technology development efforts, including completed tasks or abandoned efforts which are identified as “retired”. Ideally, the Roadmap will identify redundant efforts and gaps in technology development to optimize the approach taken to bring key technologies onto the Hanford Site. APPENDIX E describes CTO technology development achievements.

5.0 NEAR-TERM TECHNOLOGY DESCRIPTIONS

This section presents catalog sheets for technologies that are planned for FY22. These catalog sheets are two pages and are organized by the five basic functional areas:

- Manage Tank Waste (MTW)
- Retrieve Tank Waste (RTW)
- Process Tank Waste (PTW)
- Manage Waste (MW)
- Dispose Tank Waste (DTW)

Technology needs that are identified but not planned for FY22 are listed in Section 6.0. These catalog sheets are one page and can be found in APPENDIX C.

5.1 Manage Tank Waste

The MTW functional area includes technologies to ensure that the radioactive waste liquids, salts, and sludges are maintained in a safe, regulatory-compliant manner. This includes safeguarding the overall integrity of the tanks and tank infrastructure and safely managing the waste contents. Tank farms management involves monitoring the tank contents and surrounding soil, upgrading aging infrastructure and equipment as required, providing contingency storage in the event of a tank failure, and remediating vadose zones where waste has historically leaked to the environment.

The tank farms infrastructure must also be upgraded to support the DFLAW initiative. WRPS plans to upgrade utilities, transfer lines, and support facilities to deliver LAW feed directly to the WTP LAW Vitrification Facility. Actions are being taken to support an effort that promotes modernizing and automating tank farms equipment and infrastructure to further protect tank farms workers from potential exposure to tank vapors and transition the equipment to Operations. Continued analytical support services from the 222-S Laboratory and operational support services from the 242-A Evaporator are required to achieve continued safe operations of the tank farms.

This functional area includes the following focus areas:

1. Tank Farm Operations – Improve technology related to everyday operations.
2. Vapor Programs – Modernize and automate infrastructure to further protect workers from potential exposure to vapors and general worker protection.
3. Infrastructure Integrity and Upgrades – Improve inspection techniques and upgrade utilities, transfer lines, and support facilities to deliver feed to the WTP.
4. 242-A Evaporator – Upgrade the facility as necessary to support the RPP mission and increase DST space.
5. Sampling and Transport – Confirm tank waste is within chemistry control and prepare to feed to the WTP.

This section includes the catalog sheets for near-term projects that fall under the MTW functional area.

CHIEF TECHNOLOGY OFFICE

washington river protection solutions

DST Primary Tank Bottom Volumetric Inspection

HANFORD SITE
US DEPT OF ENERGY

NEAR TERM

Implement advanced ultrasonic testing (UT) techniques at the tank bottom to obtain quantitative data to validate the structural integrity in the bottom region of double-shell tanks (DSTs).

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

Yes

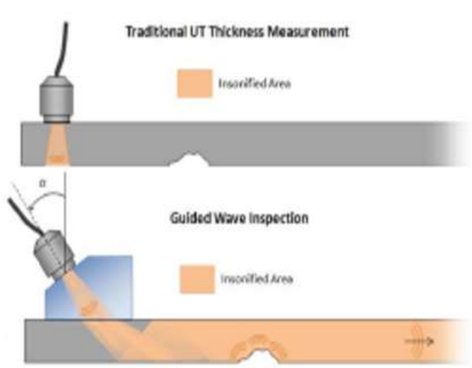
TEDS ID: MTW-11 **Timetable: ≤ 5 Years**

TECHNOLOGY NEED

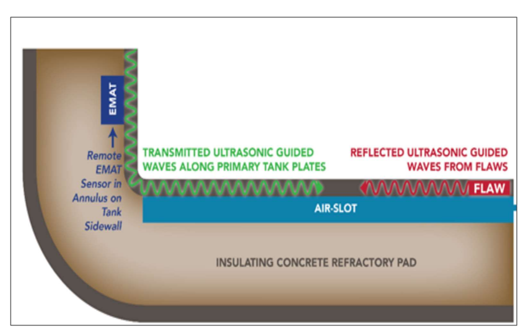
Currently, no technology is employed to quantitatively interrogate the integrity of the primary tank floor plates of the DSTs, which are physically inaccessible from the exterior of the tank and represent 90% of the tank floor. Development and deployment of such a technology would provide data to validate tank integrity through inspection of a suspect region where degradation understanding is limited.

TECHNOLOGY SOLUTION

The volumetric Ultrasonic Technology(UT) being proposed for this WRPS application falls under two categories: piezoelectric UT (shear wave, guided wave, and phased array) and electromagnetic acoustic transducers (EMAT) UT. Both methods propagate waves through the material being inspected giving data on the state of the plate as a whole rather than a single data point. The piezoelectric transducers are generally smaller and function at high frequencies. The challenge is that they require a couplant, which is often difficult for remote applications. EMAT requires no couplant because sound is generated in the part that is inspected and does not require a completely clean test surface. The challenge for EMAT is large size transducers and necessary additional signal processing.
Access to primary tank bottoms is extremely limited. Remote volumetric inspection devices, such as the EMAT, can take measurements from the annulus space by applying the EMAT to the lower portion of the primary tank wall and sending waves through the material to the bottom plates of the tank. Limitations to this inspection method are the size and location of risers as well as the impeding structures, such as pipes, in the annulus space. Inspection devices that cannot send saves through the curved knuckle of the primary tank, such as guidedwave phased array (GWPA) sensors, must couple directly to the primary tank bottom from the air-slots in the concrete refractory pad, on which the tank sits.



Piezoelectric Ultrasonic Guidedwave



EMAT Wave Propagation

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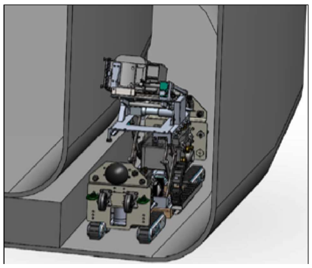
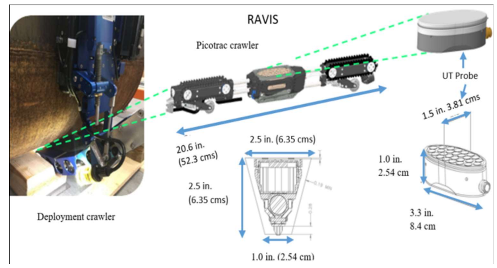
DST Primary Tank Bottom Volumetric Inspection

TEDS ID: MTW-11 Continued

ADDITIONAL TECH INFO



Remote Robotic EMAT Volumetric Inspection System (RREVIS)



Air-Slot Crawler of the Robotic Air-slot Volumetric Inspection System (RAVIS)

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $2.9M
- Insert corrosion flaws in qualification test plate for continued testing
- Order long-lead steel to extend the qualification test plate
- RAVIS GWPA sensor, Stage 2 part 2 qualification testing
- RREVIS, perform additional verification testing
- Develop Machine Learning algorithms for sensor output interpretation

FY23: $3.3M
- Fabricate Extended qualification test plate
- RAVIS GWPA sensor, Stage 3 qualification testing and verify integration between sensor and robotics
- Continue Developing Machine Learning algorithms

THREATS AND OPPORTUNITIES

TFIRR-0046-T: DST Tank Failure in East Area

TFIRR-0045-T: DST Tank Failure in West Area

MEASURABLE ORGANIZATIONAL VALUE

Improves DST life expectancy through enhanced integrity monitoring.

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CHIEF TECHNOLOGY OFFICE

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Improve Visual Inspection

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: MTW-20 **Timetable: ≤ 5 Years**

NEAR TERM

Hanford Tank inspectons are currently performed manually by reviewing hours of video footage. Improved cameras, lighting, and automated inspection software would save time and improve accuracy of tank defect detection.

TECHNOLOGY NEED

Current video camera and lighting cannot provide the level of detail required for tank integrity inspection examination of spontaneous chemical processes and other changes that may be occurring. The current visual inspection approach involves using a time consuming manual inspection process. An improved evaluation/inspection of the recordings could reveal areas of interest for prioritizing future inspections.

TECHNOLOGY SOLUTION

Identify and test an improved video camera and lighting system, a still photography system, a data acquisition system, and a data storage system for tank integrity inspections. The video and still camera systems should, at a minimum, provide:

- Sufficient resolution and lighting to identify down to 1/16-in. cracks in the tank concrete dome using existing risers.
- A reproducible indexing system and ability to be deployed by two people (maximum) without a crane.
- Ability to take high-resolution screenshots or pictures.
- Camera lenses and other components that will survive in high temperatures and radiation

A solution to process past video records more efficiently is proposed through the use of machine learning technology which will seek to minimize the subjectivity of video analysis, decrease processing time, and improve detection of defects.

Detecting Road Pavement Deteriorization with Finite Mixture Models

Ahlberg Hi-Rod XS Camera

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

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Improve Visual Inspection

TEDS ID: MTW-20 Continued

ADDITIONAL TECH INFO

Storage in the Cloud

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $568K

- Test model for recognition and qualification of flaws and develop comparative trending capability

FY23: $568K

- Test quantification capability and develop library

THREATS AND OPPORTUNITIES

TFIRR-0046-T: DST Tank Failure in West Area

TFIRR-0048-T: SST Failure in West Area

TFIRR-0045-T: DST Tank Failure in East Area;

TFIRR-0047-T: SST Failure in East Area

MEASURABLE ORGANIZATIONAL VALUE

Cost savings of up to $420k/year (assuming 21 tank inspections at 200 hours per inspection); savings increase and program risk decreases as the entire process is automated and more tanks can be inspected annually.

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NEAR TERM

This technology area supports the development of tank farm vapor monitoring, detection, and remediation system technologies (equipment and software).

Technology Maturation Level

Prototype

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

Vapor Monitoring, Characterizing & Remediation

TEDS ID: MTW-24 **Timetable: > 5 Years**

TECHNOLOGY NEED

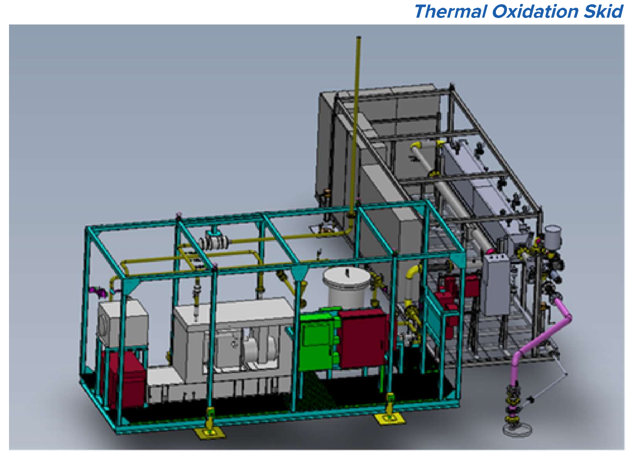
During work activities, it is desirable to quantify all known vapor sources and fugitive emissions sources and evaluate/investigate observed vapor situations, associated conditions, and provide a basis for resolution. The data/information gathered by various equipment in conjunction with dispersion modeling results supports three functional needs, namely providing: (1) a performance-based gas detection system designed to reduce risk by notifying/warning operations staff and workers during a potentially hazardous release event, (2) predictive tools for trending data analysis with dispersion modeling and forecasting events to assist work planning activities, and (3) characterization tools to describe tank farm vapor condition. In addition, there is a need to mitigate vapors via destruction and filtration.

TECHNOLOGY SOLUTION

Provide technology development to support the implementation of the recommended tank farm VMDS equipment/software. VMDS technologies include GPS (worker/equipment location); improved chemical and direct reading sensors (fixed/portable); spectroscopy monitors (ultraviolet Fourier transform infrared [UV-FTIR] stack monitor; open path Fourier transform infrared [OP-FTIR] and ultraviolet differential optical adsorption spectroscopy [UV-DOAS] area/fence line monitors); NDMA treatment; and whole-air samplers.

Fugitive Emissions Mapping Tool

Thermal Oxidation Skid



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Vapor Monitoring, Characterizing & Remediation

TEDS ID: MTW-24 Continued

ADDITIONAL TECH INFO

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY24, $2,300K
- Complete permitting, $10K
- Prepare test planning documentation, $396K
- Control System software development, testing, & documentation, $324K
- Procure materials and initiate fabrication of TOS system, $780K
- Materials and initiate fabrication of RPMS and DRE system cabinets, $376K
- Procurement documentation and work packages, $164K
- Project Management and Technical Support, $250K

FY25, $2,187K
- Complete fabrication of TOS system, FAT and NEC, $888K
- Complete fabrication of RPMS and DRE cabinets, FAT and NEC, $320K
- Package and ship TOS skids to Tank Farms. $64K
- Write/finalize work packages and lift plans, $12K

THREATS AND OPPORTUNITIES

WRPS-0003-T: Tank Vapors Controls Impact Project Execution

MEASURABLE ORGANIZATIONAL VALUE

TBD

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CHIEF TECHNOLOGY OFFICE

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Tank Waste Characterization and Identification

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: MTW-37 **Timetable: ≤ 5 Years**

NEAR TERM

The 222-S Laboratory employs XRD, scanning electron microscopy, polarized light microscopy and sequential leaching to identify solid phases in tank wastes. Improved instrument capabilities and sample preparation methods are needed to better identify solid and liquid phases in tank wastes and to improve ALARA considerations.

PNNL provides some additional capabilities

TECHNOLOGY NEED

Updated and new instrumentation is expected to improve routine analyses of tank wastes, infrastructure (piping, tanks, pumps), vadose zone sediments, as well as analysis of unique samples, to better support the Tank Operations Contractor (TOC) mission. Improved technologies enhance the detection and identification of liquid and solid phases and organics in tank wastes including those with short range order (e.g., nanoparticles). Instrument improvements may also aid waste processing (filtration, pumping, mixing, transfers) and support technology developments for direct-feed low-activity waste and the Low- Activity Waste Pretreatment System.

TECHNOLOGY SOLUTION

The existing x-ray diffraction (XRD) instrument includes minimal measurement and calibration capability. The desired XRD instrument incorporates dual detector technologies, point and area detectors, and multi-mode optical components and associated measurement geometries. The unique combination of these components allows for the unambiguous distinction between trace phases (currently unidentified peaks). The new XRD can also extend solid phase characterization capabilities to identify nanoparticle phases. This instrument will yield data of substantially higher resolution and statistical quality enabling the use of more advanced data analysis methods such as Rietveld refinement.
A complementary Raman micro-spectroscopy is needed to aid the identification of molecular constituents, based on vibrational frequencies of the chemical bonds and bond energies. A method of deployment is needed to use the microscopy method being developed.

The instrumentation was procured and installed at the 222-S laboratory under WRPS management. Method development for the instrument was transferred to HLMI along with 222-S laboratory management in FY21.

Infrared Microscopy

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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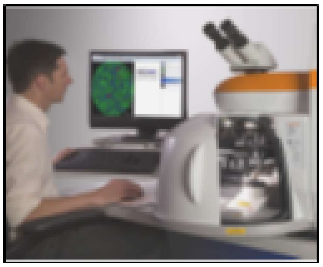
Tank Waste Characterization and Identification

TEDS ID: MTW-37 Continued

ADDITIONAL TECH INFO



Raman Microscopy

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $70K

- Method Development

FY23: $70K

- Method Development

THREATS AND OPPORTUNITIES

AAXRC-0011-T: Tank Waste Not as Expected (Different than Modeled) - Takes Longer or Cannot Be Retrieved

MEASURABLE ORGANIZATIONAL VALUE

TBD

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NEAR TERM

Analytical methods need to be developed, standard reference materials are needed and new instrumentation is needed to facilitate addition of COCs to the list of calibrated compounds

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

Analytical Method Development for Chemicals of Concern

TEDS ID: MTW-41 **Timetable: ≤ 5 Years**

TECHNOLOGY NEED

Develop methods or improve detection limits for dozens of analytes for the direct-feed low-activity waste feed qualification. The list of chemicals of concern (COCs) contains many chemicals for which there are no qualified (calibrated) analytical detection procedures. Developing new analytical methods is very time consuming and resources must be balanced against ongoing industrial hygiene analytical needs. Some compounds are never developed into calibrated procedures due to failing quality criteria too frequently or failing to pass method validation studies. Current analytical capabilities do not meet COC reporting limit needs for several compounds. Further investigation is needed to identify and adopt method improvements. Analytical conditions need to be determined for compounds where significant new separations are needed, new sampling or trapping media, or new instrumentation is needed.

TECHNOLOGY SOLUTION

Analytical method development requires more funding:

1. For staff to identify alternative sources of standard reference materials.
2. To purchase new sampling or trapping media.
3. For staff time to develop new analytical methods.
4. To test and evaluate alternative analytical methods when more appropriate than gas chromatography-mass spectrometry (GC- MS).
5. To coordinate supportive National Laboratory efforts.
6. To purchase additional instrumentation.

Method development began in FY21 on an existing HPLC system for detection of Chemicals of Concern. Continued development is expected with the procurement of new instrumentation.

High Pressure Liquid Chromotograply Instrument

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Analytical Method Development for Chemicals of Concern

TEDS ID: MTW-41 Continued

ADDITIONAL TECH INFO

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $70K

- Instrument Evaluation and Feasibility Study

FY23: $TBD

- Next steps to be determined by the results of the Evaluation and Study

THREATS AND OPPORTUNITIES

222SL-0009-T: 222-S Laboratory Analytical Capabilities are Exceeded

MEASURABLE ORGANIZATIONAL VALUE

TBD

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CHIEF TECHNOLOGY OFFICE

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Large Volume Supernatant Sampler and Transportation System

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: MTW-77 **Timetable: ≤ 5 Years**

NEAR TERM

A large-volume shielded sampler is needed to take 1 L samples of supernatant to support the direct-feed low-activity waste Radioactive Waste Test Platform. An improved transportation system is also needed to transport the larger samples to the laboratory

TECHNOLOGY NEED

The current tank farms approach to obtaining supernatant samples is to lower a weighted sample bottle on a wire to a required depth and collect a grab sample of 500 mL maximum (typically 250 mL). A large-volume sampler (1 L) is needed to support the River Protection Project mission, while providing improved shielding to reduce worker radiation exposure. An improved transportation system (Hedgehog III) is needed to transport the larger samples to the laboratory for analysis.

TECHNOLOGY SOLUTION

The solution proposed in this TEDS is based upon results determined by the RPP-RPT-60607 Sampling and Transportation Study. This development effort has been ongoing since 2018. Most recent efforts have focused on advancing the shielded sampler development through applying laboratory interface requirements (222-S and RPL), finalizing design and fabrication in preparation for FY21 proof of concept testing. In addition, the Hedgehog III is planned to be fully designed, fabricated and DOT7A certified by FY 22.

Hedgehog III DOT7A Sample Transport System

Technology Maturation Level

Research and Concept

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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Large Volume Supernatant Sampler and Transportation System

TEDS ID: MTW-77 Continued

ADDITIONAL TECH INFO

Shielded Sampler

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $219K

- Large Volume Sampler System: Complete documentation of test results
- HedgeHog III Transport Container: Complete documentation of test results

FY23

- No identified scope

THREATS AND OPPORTUNITIES

242AE-0027-T: Creation of Group A slurry Tank

AAXRC-0011-T: Waste Not as Expected (different than modeled) - Takes Longer or Cannot be Retrieived

DFLAW-0232-T: WTP Radioactive Dangerous Effluent Composition LTA

MEASURABLE ORGANIZATIONAL VALUE

Using the Large Volume Shielded Sampler technology saves about $1.145 million per sampling event, reduces collective worker radiation exposure by about 104 Rem per sampling event, and allows workers to collect up to 4 times the amount of supernatant waste in one sampling event as compared to the current baseline sampler bottle on a string. The Hedgehog III is a Department of Transportation (DOT) Specification 7A compliant transportation system that was developed specifically for transporting the larger liquid supernatant samples but could be used to transport smaller samples (both liquid and solid depending on source term) as well.

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CHIEF TECHNOLOGY OFFICE

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Reduce Entries into Tank Farms while Collecting Vapor Related Data

HANFORD SITE
US DEPT OF ENERGY

NEAR TERM

Use robotically driven systems to autonomously deploy data collecting and monitoring detection equipment into the tank farms and demonstrate the ability to download collected information to a central docking station to communicate with the central control room.

TEDS ID: MTW-79 **Timetable: ≤ 5 Years**

TECHNOLOGY NEED

Use autonomous instrumented vehicles to reduce entries into the tank farms while collecting vapor-related data in the worker breathing zone, reducing potential exposure to the workers.

TECHNOLOGY SOLUTION

Procure an autonomously driven device already on the market and configure the instrument deployment with select vapor-related sensors. Demonstrate operation of autonomous instrumented vehicle, monitoring and collecting of data, and wireless transmission of data to a central computing system in order to scale up capabilities. Future phases will build on Phase I to further enhance worker safety and productivity by integrating additional mission needs of the company.

Husky Autonomous Instrumented Vehicle by Clearpath

WR Vector Autonomous Robotic Platform by Waypoint Robotics

Technology Maturation Level

Prototype

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

CHIEF TECHNOLOGY OFFICE

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Reduce Entries into Tank Farms while Collecting Vapor Related Data

TEDS ID: MTW-79 Continued

ADDITIONAL TECH INFO

Onscreen Image of Positioning Data from the Autonomous Instrumented Vehicle

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

TBD

THREATS AND OPPORTUNITIES

WRPSC-0003: Tank Vapors Controls Impact Project Execution

MEASURABLE ORGANIZATIONAL VALUE

TBD

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CHIEF TECHNOLOGY OFFICE

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HANFORD SITE
US DEPT OF ENERGY

Real-Time Localized Corrosion Monitoring

TEDS ID: MTW-87 **Timetable: ≤ 5 Years**

NEAR TERM

NanoCorrTM analyzers were developed on the basis of the coupled multi-electrode array sensor technology patented by a major international research organization and backed by several other U.S. and international pending patents. They are highly sensitive and reliable for all types of non-uniform corrosions including localized corrosions. They are also the only type of corrosion instruments in the world that have ever been claimed to be quantitative for monitoring localized corrosion below mill-per-year or micron-per-year levels.

TECHNOLOGY NEED

Currently, no technology is employed to perform real time monitoring of tank waste for localized corrosion (i.e., pitting) in the DSTs or at Effluent Treatment Facility (ETF). Development and deployment of such a technology would provide valuable information on localized corrosion in the DSTs and the ETF. An added benefit of deploying such probes in DSTs would be the ability to monitor changes in corrosion rates due to various tank operations such as waste transfers and chemistry additions to meet the new corrosion control limits. Such a technology could identify potential corrosion at the ETF during processing and allow for operational changes to minimize degradation. Recommended by the Tank Integrity Expert Panel – Corrosion Subgroup.

TECHNOLOGY SOLUTION

Recommend testing the off the shelf technology, NanoCorr system, in a laboratory environment using different waste simulants similar to what the probe would be monitoring. This testing is on-going at DNV GL and includes a stainless-steel probe to be used at ETF and a carbon steel probe to be used in the DSTs. Different waste simulants are being evaluated to test the probe and determine whether these probes should be recommended for deployment. The feasibility of field deployment at the ETF is being evaluated in FY2022. Field deployment is not yet planned but will likely be FY 2023 at the earliest.

NanoCorr Tank Corrosion Probe

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

CHIEF TECHNOLOGY OFFICE

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Real-Time Localized Corrosion Monitoring

TEDS ID: MTW-87 Continued

ADDITIONAL TECH INFO

NanoCorr Analyzer

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22 $100K complete technology validation and produce a report

FY23 500K field deployment at the Effluent Treatment Facility

THREATS AND OPPORTUNITIES

TFIRR-0046-T: DST Failure in West Area

TFIRR-0045-T: DST Failure in East Area

MEASURABLE ORGANIZATIONAL VALUE

TBD

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HANFORD SITE
US DEPT OF ENERGY

NEAR TERM

A practical repair strategy and method is needed to restore wall thickness and mitigate leaks to extend DST life and ensure existing DSTs can support the River Protection Project timeline. Successful development and use of this technology could help avoid new tank construction. Several repair methodologies have recently been screened through an evaluation process as presented in RPP-RPT-62020 Tank Repair Feasibility Study. Repair technology categories considered by the study include; process coating, solid phase processing, fusion processing and low energy repairs.

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

Yes

Tank Refurbishment

TEDS ID: MTW-92 **Timetable: ≤ 5 Years**

TECHNOLOGY NEED

The underground storage tanks at the Hanford Site, specifically the DSTs, are required to remain in operation for several decades beyond their original planned operating life. The DSTs are expected to provide sufficient capacity for retrieving waste from single-shell tanks for treatment and stabilization. A practical repair strategy and method is needed to restore wall thickness and mitigate leaks to extend DST life and ensure existing DSTs can support the River Protection Project timeline. Successful development and use of this technology could help avoid new tank construction.

TECHNOLOGY SOLUTION

Based on the assessment provided in RPP-RPT-62020 a three-pronged technology development approach is recommended:

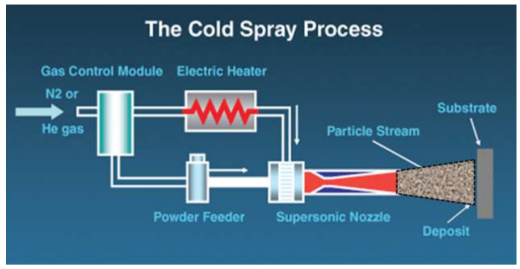
1. Mature promising, purpose-driven repair technologies (e.g., repairs applicable for very large, tank bottom flaw areas such as that observed in tank 241-AY-102).
2. Develop near-term, high-maturity technologies for expedited deployment in the event of a DST leak.
3. Initiate development of long-term, proactive endeavors that support Hanford mission sustainability, with a focus on the ability to rebuild DST surfaces prior to realizing through-wall penetrations.
4. Cold spray (solid state process coating) is currently being evaluated as a viable candidate for life extension and repair of U.S. Department of Energy (DOE) complex infrastructure (e.g., double-shell tanks) critical to the Office of Environmental Management cleanup mission. Applying cold spray to the DOE complex has the potential to reduce cost and schedule impacts associated with component failures and the need to procure and construct replacement infrastructure.

Technology development success will be determined through two stages:

1. At the microscopic level to determine level of bonding and thickness formation (porosity and density) capability and effects of surface preparation, which points to favorable mechanical properties.
2. Process parameter development to include NDE assessment of a repaired section.

TEDS ID: MTW-92 Continued

ADDITIONAL TECH INFO



PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $1,100K

- Cold Spray Process - Development of deployment method and demonstration

FY23: $1,100K

- Polymer Grout - Parameter Development and Phase 2 Demonstration
- Cold Spray Process - Continue development of deployment method and demostration

THREATS AND OPPORTUNITIES

TFIRR-0046-T: DST Tank Failure in West Area

TFIRR-0045-T: DST Tank Failure in East Area

MEASURABLE ORGANIZATIONAL VALUE

To simplify MOV it will use toolbox costs against a single case of AY-102 brought back into service for emergency storage of supernate. This calculation utilizes the total cost of the toolbox, which is expected to take $35M and completed over three to nine years. The total expected benefit is captured in not requiring the construction of a new tank, estimated at $200M based off project estimate in (WHC-SD-W236-CDR-001) divided into a single tank construction and adjusted for inflation. The ROI generated using these values is 471%.

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Internal Data Access & Visualization (IDAV)

TEDS ID: MTW-94 **Timetable: ≤ 5 Years**

HANFORD SITE
US DEPT OF ENERGY

NEAR TERM

Web-based application that provides IH users with access to historical and current vapor sampling and monitoring data. The application would provide intuitive tools for data analysis, exposure assessments, supporting development of hazard controls. The application also provides tools for visualizing and analyzing data from personal ammonia monitors and Gastronics fixed instrument skids.

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

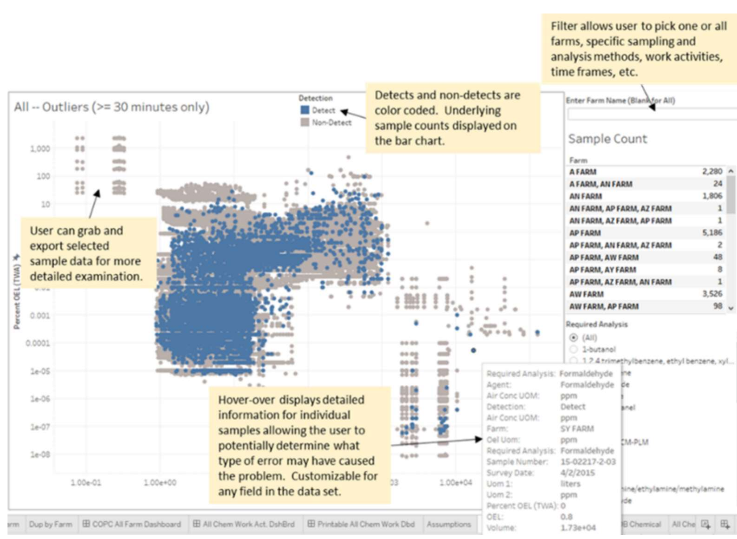
No

TECHNOLOGY NEED

Tank Operations Contractor Industrial Hygiene (IH) conducts tank farm worker hazard exposure assessments to identify, evaluate, and recommend controls, and other worker protection measures for tank farm chemical, physical, and biological hazards. The current IH database, involving tens of thousands of records, is a manual process. The IH vapor data varies widely in its scope and quality, containing errors from sampling and analysis issues, transcription, unit transposition, and inconsistent data collection. IH analysis and exposure assessments are time consuming and human resource intensive.

TECHNOLOGY SOLUTION

Model, build, and develop a web-based application that automates IH tank farm worker vapor, chemical, and biological exposure assessments, data collection, analysis, and visualization processes. The system would provide users with access to historical and current vapor sampling and monitoring results, intuitive tools for data analysis, exposure assessments, and IH evaluation supporting development of hazard controls. The system would be automated, providing scalable analysis process, defensible results, and improved quality.



Error Detection and Outlier Analysis (OEL Basis)

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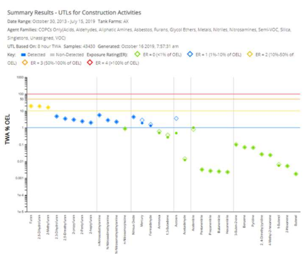
Internal Data Access & Visualization (IDAV)

TEDS ID: MTW-94 Continued

ADDITIONAL TECH INFO



Upper Tol Limit Summary Results by Work Activity (Const in AX Farm)

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22 $1652K
- IDAV and Tableau Tools Development and Testing

FY23 $1678K
- IDAV and Tableau Tools Development and Testing

THREATS AND OPPORTUNITIES

MEASURABLE ORGANIZATIONAL VALUE

TBD

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US DEPT OF ENERGY

Predicting Tank Farm Vapor Conditions

TEDS ID: MTW-95 **Timetable: ≤ 5 Years**

NEAR TERM

The DFAS, powered by the AECOM SmartSite software platform, compiles vast amounts of dynamic data and delivers it in an easily understandable dashboard monitor.

TECHNOLOGY NEED

Develop an integration of real-time vapor and meteorological data to predict tank farm vapor conditions (i.e., plume location or transient vapor concentrations) in the tank farm work areas. The Data Fusion and Advisory System (DFAS) is 1 of the 15 technologies identified during the Chemical Vapors Solutions Team (CVST) evaluations included the use of a chemical vapor release and response software system to gather and assimilate real-time data from detection/monitoring technologies (new and existing) to predict tank farm vapor-related conditions. A goal of this integrated system is to develop means to predict potential exposure scenarios and establish preemptive mitigating actions.

TECHNOLOGY SOLUTION

The DFAS will be able to correlate data from the multiple vapor sources and other vapor-related instruments, allowing users to study the factors present when the field conditions change in real time. The system will allow Hanford tank farms central shift office staff and field workers to track and trend vapor source data and to potentially predict future vapor source concentrations and weather conditions in work spaces and locations based on historical and real-time field-based data. Dashboard graphics will provide an at-a-glance indications of data to assess current conditions and potential risks.

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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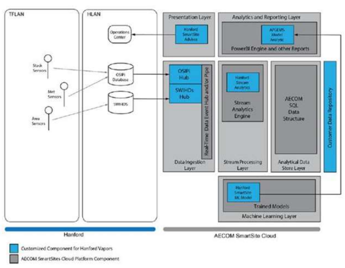
Predicting Tank Farm Vapor Conditions

TEDS ID: MTW-95 Continued

ADDITIONAL TECH INFO



SmartSite Solution Components

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $115K

- Expansion within Vapors program

FY23: $560K

- Supplemental Plume Modeling Development
- Predictive Modeling Development

THREATS AND OPPORTUNITIES

WRPSC-0003-T: Tank Vapors Controls Impact Project Execution

MEASURABLE ORGANIZATIONAL VALUE

The data fusion & advisory system will save ~ $950,000 over 5 years, save ~7,100 hours per year of daily work planning, and help workers avoid 3 days of hazardous vapor exposure annually.

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5.2 Retrieve Tank Waste

The waste retrieval functional area is required to remove most of the waste to close the tanks per regulatory requirements. Retrieval efficiency is based on knowledge of the tank contents for the extraction of the waste with effective tools, the transfers downstream, and the mixing and blending for delivery of feed to the WTP that meets waste form qualification requirements. Across all aspects of the waste retrieval process, there is a need-to-know overall waste composition, and chemical and physical characteristics. Remote in situ monitoring of these parameters would enhance and improve retrieval operations. The waste retrieval function can also include special processes such as those envisioned for contact-handled transuranic (CH-TRU) waste and mitigation of selected DSTs.

The various methods of waste retrieval are described in RPP-RPT-44139, *Nuclear Waste Tank Retrieval Technology Review and Roadmap* as well as RPP-PLAN-40145, *Single-Shell Tank Retrieval Plan*. Modified sluicing or salt cake dissolution is typically used to retrieve the majority of the waste volume from the SSTs; however, these methods are typically insufficient to reach the established residual waste volume goal of 360 ft^3 or less for 100-series SSTs, and 30 ft^3 or less for 200-series SSTs as mandated by the Tri-Party Agreement. This residual waste is typically characterized as a hard heel of insoluble material that requires more aggressive methods to mobilize and remove from the tank. The TOC also uses mechanical and chemical technologies for hard heel removal subsequent to waste retrieval operations using modified sluicing.

Implementing these technologies can require tank modifications in the form of new or larger tank penetrations to accommodate waste retrieval equipment. The RTW functional area includes the following focus areas:

1. Retrievals – Characterization of the SST waste is a first step in successful mobilization and retrieval of the tank waste. Multiple techniques are required to mobilize and retrieve the SST waste to the level needed for ultimate closure of tanks.
2. DST Transfers – The DST waste transfer system is a critical, interdependent system within the RPP that relies on the ability to continually retrieve, treat, and transfer tank waste to the LAW Pretreatment System (LAWPS), WTP, and various waste treatment facilities. The near-term DST waste transfer strategy focuses on startup, commissioning, and initial operation of LAWPS, waste volume management, and modeling of waste blending and staging strategies.
3. Cross-Site Transfers – Important technology considerations for cross-site transfer lines are leak detection, line plugging detection and clearing capability, and critical velocity measurement.
4. DST Upgrades – A primary objective of DST upgrades is to ensure that the Hanford Site tank farms are able to provide optimized, continuous, and reliable feed to the WTP or new supplemental treatment systems.
5. Feed Preparation – The primary goal of feed preparation is to ensure that qualified waste feed batches are readily available for WTP and secondary treatment system campaigns.
6. Tank Closures – The ultimate RPP mission goal is to close the waste tanks and associated waste management areas.

This section includes the catalog sheets for the near-term technologies that fall under the RTW functional area.

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US DEPT OF ENERGY

Retrieval and Closure Solid Waste Sampling Tools

TEDS ID: RTW-01 **Timetable: ≤ 5 Years**

NEAR TERM

Develop, design, build or modify solid waste sampling tools such as the existing ORSS and the extended finger trap.

TECHNOLOGY NEED

Improved tank waste sampling tools are necessary for the following:

1. Verification of tank closure standards.
2. Simulant development for testing new retrieval technologies.
3. Development of technologies targeted to specific tank waste retrievals.

Current sampling technologies do not fully address the aforementioned needs due to tank access limitations and inability to collect representative samples.

TECHNOLOGY SOLUTION

The first technology development effort involves modification of the existing off-riser sampling system (ORSS) to address inadequacies based on previous deployments. The second effort involves locating a replacement for the current ORSS. The first two efforts are currently unfunded. The third effort involves modification of an existing design to collect solids known as the finger trap sampler. Modification includes lengthening the sample chamber and improving the deployment to include off-riser capability.

Reference: RPP-18793, Performance Speciftcation for the Off-Riser Sampling System (ORSS}

Current ORSS - General Electric Inspection Technology (GEIT) V3020-6310 Crawler and V9500-4001 Sample

Technology Maturation Level

Prototype

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

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Retrieval and Closure Solid Waste Sampling Tools

TEDS ID: RTW-01 Continued

ADDITIONAL TECH INFO

Push Mode Core Sampling Device

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY23: $144K

- Investigate ORSS replacement system

FY24: $436K

- Procure identified replacement

THREATS AND OPPORTUNITIES

AAXRC-0011-T: Waste Not as Expected (different than modeled) - Takes Longer or Cannot be Retrieved

MEASURABLE ORGANIZATIONAL VALUE

~$100K savings per sampling event.

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Residual Volume Measurement System (RVMS)

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US DEPT OF ENERGY

TEDS ID: RTW-02 **Timetable: ≤ 5 Years**

NEAR TERM

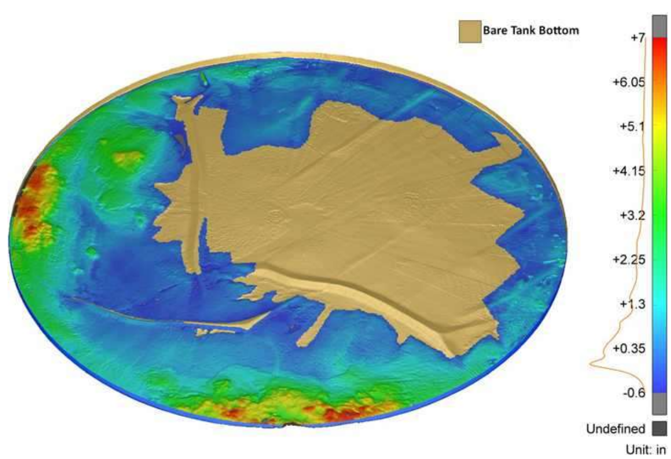
The previous RVMS that the Tank Operations Contractor used was limited by the size of the system (12-in. risers only}. The current system was recently deployed for deployment in a 6-in. riser. Smaller technology is needed to access the more available 4-in. risers on single-shell tanks.

TECHNOLOGY NEED

Accessibility to 12-in. and 6-in. risers is limited; therefore, a system deployable down 4-in. risers is needed as they are more accessible. The current limitation is the laser scanner itself, which cannot fit down a 4- in. riser. The ability to deploy down 4-in. risers provides flexibility in deployment locations ensuring ideal positioning for single or multiple location scans. This is essential when in-tank equipment would otherwise obstruct the scanner's view from a single riser. In addition, the existing RVMS, the sole tool used to determine residual waste volumes, was recently deployed to aide in tank dome condition inspections. This was a new use case not previously considered, further justifying the need.

TECHNOLOGY SOLUTION

A laser scanner small enough to fit down a 4-in. riser has been procured. Testing with the current RVMS deployment device still needs to be performed.



Depth of the waste remaining in AX-102 after 2nd retrieval technology was used

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

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Residual Volume Measurement System (RVMS)

TEDS ID: RTW-02 Continued

ADDITIONAL TECH INFO

4-in Capable Laser Scanner

6-in Capable Laser Scanner

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $166K

- Investigate 4in riser capable unit

FY23:-

- No identified scope

THREATS AND OPPORTUNITIES

AAXRC-051-T: Equipment in Risers is more difficult to remove than anticipated

MEASURABLE ORGANIZATIONAL VALUE

Free up 12 inch tank risers for Retrieval Operations

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Evaluation of Hose-in-Hose Transfer Line (HIHTL) Material Properties

TEDS ID: RTW-10 **Timetable: ≤ 5 Years**

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NEAR TERM

Improve the life expectancy of hose-in- hose transfer lines through testing that encompasses all the degradation mechanisms experienced in the fteld and uses the entire hose assembly. Completion of this scope will provide monetary savings and also reduces worker exposure to dose from the waste as replacement of the hoses becomes less frequent.

TECHNOLOGY NEED

All WRPS retrieval technologies use in tank pumps to transfer radioactive tank waste. Waste slurry is pumped from the single shell tanks through rubber hose in hose transfer lines (HIHTL) to valve boxes for re-routing the waste to the double-shell tanks. The effective service life of the HIHTLs is a function of the EPDM and the polyester reinforcement braiding resistance to the chemicals and radiological exposure form the tank waste in conjunction with the effects of operating degradation mechanism, such as temperature and pressure. The HIHTL lifetimes are set to ensure hose integrity during the forecasted operation time but the calculated life expectancies are only as good as the degradation testing inputs. Due to the complexity of degradation mechanisms for the radioactive waste these calculated life expectancies have been conservatively shortened since material testing using actual Hanford Site waste is difficult and typically published data does not combine both chemical and radiation exposure with the operating degradation mechanisms. Testing that combines the chemical and radiological degradation mechanisms along with the in field temperature and pressure exposure is needed to better predict the HIHTL service life.

TECHNOLOGY SOLUTION

The development approach includes preparation of specifications and a statement of work to award a contract with Florida International University {FIU} for the testing of the materials used in hoses and the hose assemblies themselves. The research includes testing to meet the physical requirements {e.g., pressure, flexibility, temperature} of the hoses and also determines the chemical and radiological degradation.

A current result of this work has been the successful implementation of testing performed at Savannah River National Laboratory {SRNL} and involved characterizing burst strength decay of hoses relative to radiation exposure. Although the hoses used in the SRNL study were similar to, but not identical to the hoses used at Hanford, the information gained was successfully applied to the hoses used on the Hanford Site increasing the maximum acceptable radiation exposure from 10 Mrad to 50 Mrad.

Current testing is focused on the chemical degradation from the waste{FIU} and the combined degradation

Technology Maturation Level

Research and Concept

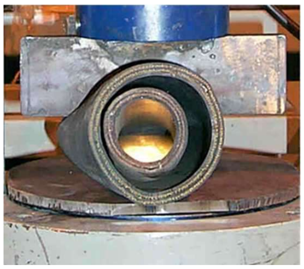
National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

ADDITIONAL TECH INFO



PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

TBD

THREATS AND OPPORTUNITIES

AAXRC-0024-T: Waste Temperatures Exceed HIH Limits

MEASURABLE ORGANIZATIONAL VALUE

TBD

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Development of New Riser Installation System

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: RTW-12 **Timetable: ≤ 5 Years**

NEAR TERM

Technology for drilling multiple enlarged holes in tank domes for risers up to 4 ft in diameter is in the design phase. Research, design, and development of the cutting system will ensure the dome cores are removed utilizing governing safety criteria. Factory and onsite acceptance testing will be performed prior to deployment of a ftnal system.

TECHNOLOGY NEED

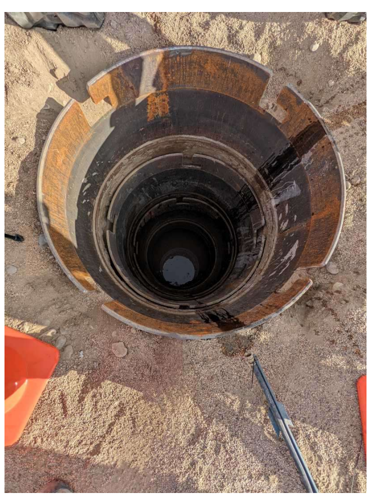
The goal of this work is to develop a method that is safer for tank farm personnel, is more efficient, and is more cost-effective to implement than previous core cutting efforts. In addition, hard to access risers and pits no longer need to be used for retrieval (e.g., tank C-105}. The rotary core cutting system will provide more efficient core cutting in the tank domes. Core cutting will support future work of installing new risers for tank waste retrieval, which will minimize the need to remove existing equipment and allow installation of and additional access for other new retrieval equipment.

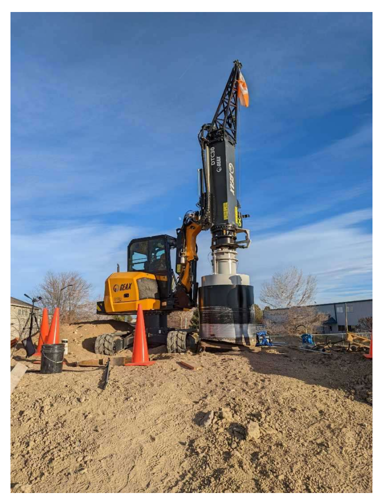
TECHNOLOGY SOLUTION

The development approach: Awarded contract with a commercial vendor for the development and testing of a mobile rotary core drilling system that is capable of core drilling (48 in.) holes in the dome of single-shell tanks in preparation of future riser installation. Based on successful development and testing, a prototype system was designed, fabricated, and will be delivered to the Hanford Site.

The new Tank Dome Core Cutter is a mobile rotary core drilling system. It cuts through existing soil cover and SST concrete domes enabling installation of new SST risers (48 inch diameter).

The system is comprised of a DTC30 (limited access drill rig) base, stack caissons, core cutting drill bit and soil removal tool, core and pilot drill. The A and AX Tank Farm tanks are the next planned to be retrieved. Obstructions in these tanks make waste retrieval challenging. In addition to normal piping, pumps, other components, and materials left in the tank, the tanks were designed with air lift circulators (pipes extending from the dome to the bottom of the tanks} that present congestion for retrieval efforts, camera observation, and lighting.





Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

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Development of New Riser Installation System

TEDS ID: RTW-12 Continued

ADDITIONAL TECH INFO

Core retention in core bit. Left: start of cut. Right: end of cut

TDCCS with Soil Removal Attachment

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $936K
- Test Facility Construction
-Test driven improvements
- Delivery of Prototype
FY23
- Scope complete

THREATS AND OPPORTUNITIES

AAXRC-0043-T: Equipment in Risers is more Difficult to Remove than Anticpated

AAXRC-0051-T: Damage to Tank/Equipment Installation or Removal

MEASURABLE ORGANIZATIONAL VALUE

Using the New Riser Installation System about $853,000 will be saved per riser installation, meaning the New Riser Installation System will pay for itself in roughly 3 riser installations. By developing and implementing the New Riser Installation System, the amount of worker radiation exposure per installation is cut in half and risers can be installed 25 days faster than with the current technology.

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Low Volume Addition Retrieval

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: RTW-55 **Timetable: ≤ 5 Years**

NEAR TERM

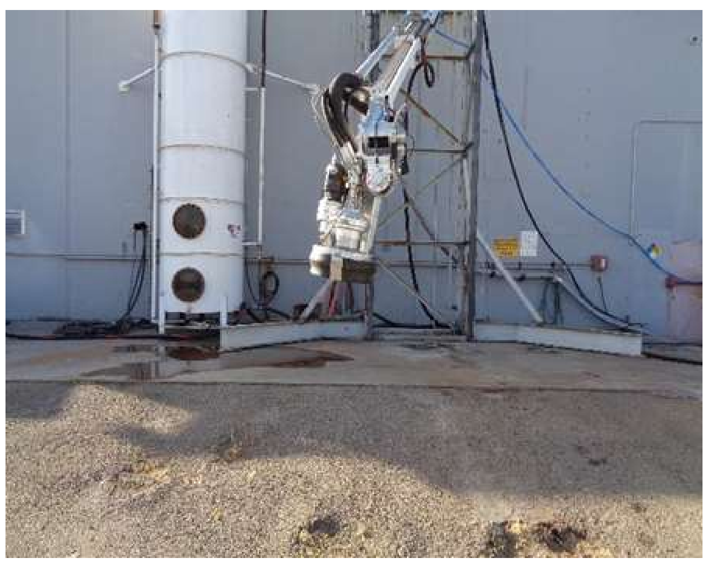
A modified version of previous a retrieval technology is being developed for unique Hanford Site retrieval scenarios. The previous version was deployed on a crawler; this version is being combined with an Extend Reach Sluicer to maximize resources. The Full implementation of this would result in a deployed Hanford Waste End Effector (HWEE) retrieval system.

TECHNOLOGY NEED

Existing sluicer technology requires excessive water consumption leading to increased waste volumes. The HWEE was proven to be more efficient (i.e. less water consumption) than the Extended Reach Sluicing System (ERSS) in simulated waste testing.

TECHNOLOGY SOLUTION

Phase I: HWEE End Effector Development – End Effector Down Select, identifying a confined sluicer to optimize water usage during retrieval. This was completed in fiscal year (FY) 2017. -Phase II: HWEE Advanced Functional Testing –End effector positioning, and effectiveness demonstration. Includes conveyance-testing, development of end effector positioning, including the ability to avoid expected obstructions in an SST; and demonstrate the effectiveness of the integrated HWEE system. This was completed in fiscal year FY 2018. -Phase III: HWEE adaptation to an ERSS articulated mast with functional test by vendor FY 2019. -Phase IV: Rebuild HWEE and perform functional cold test at HiLine with articulated mast using simulant with emphasis on conveyance capability FY 2022.



HWEE attached to ERSS Arm

Technology Maturation Level

Prototype

National Laboratory Involvment?

No

Submitted As Grand Challenge?

Yes

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Low Volume Addition Retrieval

TEDS ID: RTW-55 Continued

ADDITIONAL TECH INFO

FY19 Functional test

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22

Task 1 Disassemble HWEE-ERSS and perform HWEE repair, 2 months, $86,951.71

Task 2 Functional/Pressure Testing of the repaired HWEE and reattach to the ERSS 1 month, $42.355.64

Task 3 Perform functional integrated test with simulant of the repaired HWEE, 2 months, $279,820.24

THREATS AND OPPORTUNITIES

AAXRC-0012-T: Delays in A-104 and A-105 Retrieval Due to Technology Development

MEASURABLE ORGANIZATIONAL VALUE

It is possible the HWEE is up to 10 times faster and has a dilution ratio that is 20 times more efficient than traditional sluicing methods. The HWEE uses at least 6 times less water, which translates to upwards of $4 per gallon in the evaporator saved. The HWEE only requires about 1/4 of the time previous sluicing methods took, which translates to cost saved from labor.

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5.3 Process Tank Waste

The PTW functional area focuses on methods through which Hanford Site tank wastes must be retrieved from the tank farms and safely immobilized into stable waste forms for disposal. The baseline method for Hanford Site waste immobilization is vitrification. As part of the WTP design basis, the retrieved waste will be separated into LAW and high-level waste (HLW) fractions. The HLW fraction of the waste will be vitrified into borosilicate glass at the WTP HLW Vitrification Facility and some of the LAW will be vitrified into borosilicate glass at the WTP LAW Vitrification Facility. The LAW Vitrification Facility alone was never intended to treat the entire inventory of Hanford Site LAW in the same period as the HLW can be treated. Supplemental immobilization was proposed to treat part of the LAW (ORP-11242). The proposal was based on use of the minimum requirements in the WTP Contract assumed to be the basis of the full capability of the plant. Technologies that have been considered for immobilization include joule-heated melter vitrification (similar to WTP), grout (cast stone), fluidized bed steam reforming, and bulk vitrification. However, the scope of the supplemental immobilization and treatment projects have been deferred until a date yet to be determined and the final decision will require both programmatic and regulatory review. The scope of these projects will be made after the startup of DFLAW operations. The need for supplemental LAW capacity and its nature are indeterminate. Therefore, additional supplemental treatment technology elements will be added after that decision is made.

The TOC is committed to providing support for startup of the LAW Vitrification Facility by designing and deploying the DFLAW pretreatment facilities that will enable early facility startup.

As the RPP mission transitions from managing and retrieving tank farms to waste treatment operations, the need exists to understand the flowsheet interactions that may occur and to anticipate the implications this interconnectedness may cause with respect to chemical interactions, process flows, unit operations, and effluent management. The RPP mission is examined holistically to develop integrated process flowsheets from the individual process flowsheets that comprise each aspect of the RPP mission. The portions of RPP-RPT-57991, *One System River Protection Project Integrated Flowsheet*, that are of greatest importance for the scope of the Roadmap are those that directly impact the tank farms and future waste treatment support of DFLAW.

The PTW functional area includes the following focus areas:

1. DFLAW Pretreatment Operations – Uses filtration to remove suspended solids containing alpha-emitting TRU nuclides and highly radioactive strontium 90, and ion exchange (IX) using crystalline silicotitanate (CST) resin to remove cesium 137 from supernatant tank waste.
2. Effluent Management Facility (EMF) – During DFLAW operations, evaporation will be performed in the planned EMF. The volatile and corrosive halide and sulfate components are highly concentrated in this stream because they are volatile at melter operating temperatures.
3. WTP LAW – The LAW Vitrification Facility has been designed to vitrify LAW into borosilicate waste glass using a joule-heated, ceramic-lined melter system. That facility will generate a substantial volume (i.e., millions of gallons per year) of liquid secondary waste (LSW) from the off-gas treatment system.

4. WTP HLW – The HLW Vitrification Facility has been designed to vitrify HLW into borosilicate waste glass using a joule-heated, ceramic melter system.
5. Tank Waste Characterization and Staging – Provide a compatibility bridge between sludge wastes stored in the tank farms and the WTP receipt systems to ensure delivered waste is within the WTP waste acceptance criteria.
6. CH-TRU Tank Waste – Current assumptions are that 11 SSTs containing CH-TRU tank waste will be treated at a supplemental TRU treatment facility and then stored onsite at the Central Waste Complex until final disposition is determined.

This section includes the catalog sheets for the near-term technologies that fall under the PTW functional area.

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HANFORD SITE
US DEPT OF ENERGY

Methods for Mitigating DFLAW Flowsheet Gaps

TEDS ID: PTW-23 **Timetable: > 5 Years**

NEAR TERM

Laboratory and engineering-scale testing will be conducted to assess alternative processing technologies for various EMF feed and eff/uent streams. This work will address gaps in the baseline DFLAW flowsheet on partitioning and treatment of key COCs, determine if the WTP liquid eff/uent sent to the LERF/ETF will meet ETF WAC for delisting organics, evaluate the opportunity to purge the EMF bottoms and redirect to an alternate disposal path, and address recycle risks.

TECHNOLOGY NEED

Technology development and maturation activities are needed to address limitations in Waste Treatment and Immobilization Plant (WTP) operations caused by the Effluent Management Facility (EMF). This includes laboratory and pilot scale tests to:

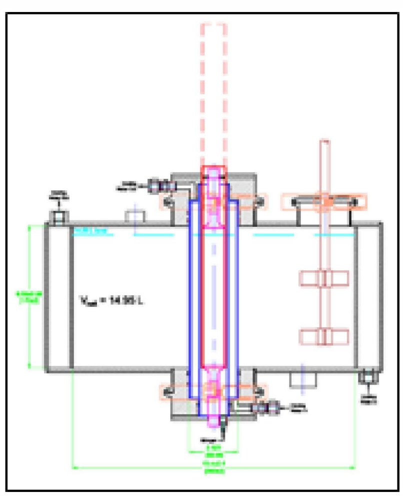
1. Address gaps in direct-feed low-activity waste (DFLAW) flowsheet on partitioning of key chemicals of concern (COCs) Tc-99, I-129, Hg, and organics within the melter and off-gas treatment system.
2. Determine if the liquid effluent from the WTP sent to the Liquid Effluent Treatment Facility (LERF)/ Effluent Treatment Facility (ETF) will meet ETF waste acceptance criteria (WAC).
3. Identify and develop solutions for COCs that exceed the LERF/ETF WAC or other regulatory requirements.
4. Demonstrate the efficacy of purging EMF bottoms to alternate disposal path to increase DFLAW throughput, reduce immobilized low-activity waste (ILAW) container count, and free space in double-shell tanks.
5. Address risk associated with high sulfate and high halide concentration in EMF bottoms recycle, fluctuations in the waste feed composition, reduction in waste loading/increased ILAW glass container count.

TECHNOLOGY SOLUTION

Laboratory and engineering scale testing will be completed to address project uncertainties associated with the partitioning and speciation of organics, 99-Tc, 129-I, and Hg in within the WTP melter and off-gas system to identify possible risks to meeting the LERF/ETF regulatory requirements. Mitigation strategies will subsequently be developed and test for these risk areas.

Key activities to support this include:

- Develop and test iodine removal media and reactor technologies capable of targeting the species of iodine observed in FY 2019 tests in the caustic scrubber liquids and EMF evaporator overheads.
- Evaluate extent of the natural potential for biological activity in the LERF basin to reduce the concentration of organics in WTP liquid effluent.



Laboratory-scale UV light reactor for organic destruction

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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Methods for Mitigating DFLAW Flowsheet Gaps

TEDS ID: PTW-23 Continued

ADDITIONAL TECH INFO

Packed columns to test removal of COCs from aqueous media

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $760K

- Aqueous Iodine Removal: address uncertainties in design basis
- Address Flowsheet gaps

FY23: $939K

- Aqueous Iodine Removal: Scale –up testing

THREATS AND OPPORTUNITIES

DFLAW-0401-O: Alternative Treat/Dispose Path for EMF Evaporator Concentrate

DFLAW-0232-T: WTP Radioactive Dangerous Liquid Effluent Composition LTA

MEASURABLE ORGANIZATIONAL VALUE

~22% increase throughput; reduce container count (~8,300); increase available DST space.

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US DEPT OF ENERGY

Radioactive Waste Test Platform

TEDS ID: PTW-38 **Timetable: ≤ 5 Years**

NEAR TERM

Develop and operate test Platform that will provide bench scale unit operations for DFLAW. Capability for troubleshooting, waste feed qualification data, check new unit operations, and close flowsheet gaps. Future capabilities include: -Understand specific tank chemistry with individual unit operations –HLW sludge and CST melts –Tank batch qualifications for CST usage –increase waste loadings for glass –opportunistic samples (after decontamination – any new unit operation validation and design input.

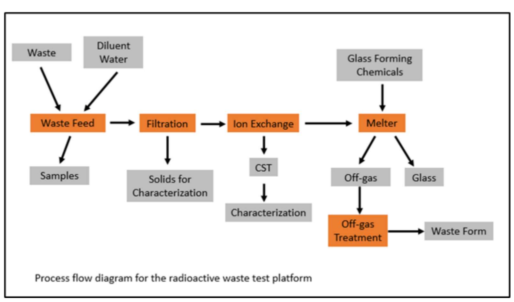
TECHNOLOGY NEED

Provide a test platform that supports unit operations trouble shooting, waste feed qualifications, flowsheet validation, and TSCR design input. Support waste form development and confirm design inputs for EMF bottoms. Provide unit operations trouble shooting. Support for waste feed qualifications and flowsheet validation.

TECHNOLOGY SOLUTION

A test platform is needed to address flowsheet gaps and inform future direct-feed LAW (DFLAW) operations. A scaled test platform will enable completion of the following tasks: waste feed preparation, filtration, ion exchange, solid waste form production and melter condensate recycle. The platform is intended to contribute to both LAW and HLW treatment.

Future applications include:
- Understand specific tank chemistry with individual unit operations
- Inform production operations-
- Process troubleshooting and evaluation-
- High-level waste sludge and crystalline silicotitanate (CST) melts
- Tank batch qualifications for CST usage
- Increase waste loadings for glass-
- Opportunistic samples (after decontamination)
- Any new operation validation and design input.



Process Flow Diagram for the Radioactive Waste Test Platform

Hot Cell

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

Radioactive Waste Test Platform

TEDS ID: PTW-38 Continued

ADDITIONAL TECH INFO

Cells Unit Filter

Melter

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22:$3,135K
- Filter waste at tank temperature
- Run waste through IX at safey basis temperature and tank temperature
- Run waste through Melter
- Continue storage studies of spent CST
- FY22 tasks to include AP 101 waste

FY23: $3,135K
- Filter waste at tank temperature
- Run waste through IX at safety basis temperature and tank temperature
- Run waste through Melter
- Continue storage studies of spent CST
- FY23 tasks to include AP 105 waste

THREATS AND OPPORTUNITIES

DFLAW-1148-T: TSCR Solids Filtration Throughput LTA

DFLAW-1095-T: TSCR and WFD Systems Unable to Meet WTP Feed Demand during Operations

DFLAW-0106-T: Staged Treated LAW Feed to WRTP Does Not Meet Waste Acceptance Criteria for Cesium-137

MEASURABLE ORGANIZATIONAL VALUE

TBD

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DFLAW Process Operational Troubleshooting

TEDS ID: PTW-53 **Timetable: ≤ 5 Years**

NEAR TERM

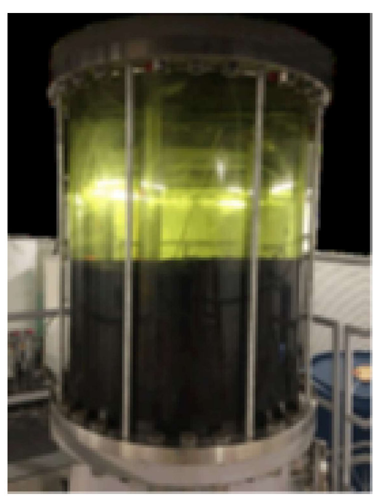
Technology solutions are needed to provide the resources and capabilities for rapidly resolving DFLAW operational issues

TECHNOLOGY NEED

Lessons learned from other DOE operations have shown significant delays that result from process upsets. And/or significant variations from flow sheet projections. To mitigate delays, technologies are needed to provide troubleshooting capabilities and reduce risks to commissioning, startup, and operations. Areas of operational uncertainty include, but are not limited to, waste feed pretreatment, glass former reliability, melter capability, foaming control, offgas treatment, and secondary waste management.

TECHNOLOGY SOLUTION

Technology development required to provide troubleshooting capabilities to mitigate uncertainty include the following:
Task 1: Maintain radioactive and nonradioactive test facilities (i.e., radioactive waste test platform) to support pretreatment filtration and ion exchange, which were developed as part of PTW-38.
Task 2: Provide and maintain melter/headspace and offgas treatment train (e.g., submerged bed scrubber, wet electrostatic precipitator, other elements) testing capability to gain operational assurance. This equipment should allow for rapid troubleshooting of startup and operational problems.
Task 3: Evaluate the need for and develop testing facilities to manage secondary waste formulation and handling.
Task 4: Identify and evaluate direct-feed low-activity waste (DFLAW) process issues and conduct testing to determine mitigation strategy (e.g., foam control).
Task 5: Identify and evaluate DFLAW mechanical issues and conduct testing to determine mitigation strategy (e.g., agitator).



Ion Exchange Test

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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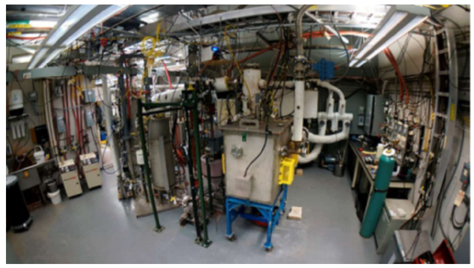
DFLAW Process Operational Troubleshooting

TEDS ID: PTW-53 Continued

ADDITIONAL TECH INFO



DM10 - Scale Melter at Vitreous State Laboratory

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FYTBD: $3,200K
Provide pilot-scale melter/off-gas system

FYTBD: $4,950K
Provide pilot-scale melter/off-gas system

THREATS AND OPPORTUNITIES

DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

MEASURABLE ORGANIZATIONAL VALUE

TBD

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US DEPT OF ENERGY

Chemical Process Modeling Software to Support DFLAW Operations

TEDS ID: PTW-55 **Timetable: ≤ 5 Years**

NEAR TERM

Design and develop dynamic chemical process modeling capabilities to aid in operational flow sheeting of Tank Side Cesium Removal (TSCR), Effluent Treatment Facility (ETF) and Waste Treatment and Immobilization Plant (WTP) operations.

TECHNOLOGY NEED

RPP-44491 identifies the need for operational flow sheeting software that is dynamic, uses a rigorous thermodynamic database, is supported commercially and contains an accurate representation of Waste Treatment and Immobilization Plant (WTP) operating logic so that transient behavior is predicted correctly. This has been expanded to include the need for a dynamic chemical process model of tank-side cesium removal (TSCR) and the Effluent Treatment Facility (ETF).

TECHNOLOGY SOLUTION

Development of the gPROMS WTP Model began in earnest after the release of the Operation Readiness Evaluation. A usable model exists today, including modifications to the facility for direct-feed low-activity waste (DFLAW) operations and the addition of the Effluent Management Facility (EMF). Model maintenance and updates to make the model more robust and to shift it from a planning tool to an operations tool will be needed each year, especially as the facility is started up and operational experience is gained.
Models of both the TSCR capability and the ETF have also been completed. The TSCR model will continue to be maintained and updated as operations strategies are developed and sample data is taken that can be used to verify the validity of the model. Additionally, updates are planned as more information is made available from laboratory experiments involving crystalline silicotitanate (CST). The ETF model will also be maintained and updated as changes to the facility design are chosen and implemented, new sample data is received, and operational experience with the new WTP effluent waste stream is gained.

Technology Maturation Level

Research and Concept

National Laboratory Involvment?

No

Submitted As Grand Challenge?

No

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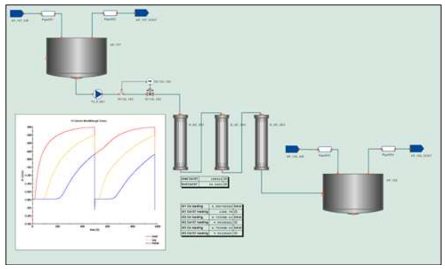
Chemical Process Modeling Software to Support DFLAW Operations

TEDS ID: PTW-55 Continued

ADDITIONAL TECH INFO



TSCR Process Schematic Example

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $300K

- gPROMS Model Updates

FY23: $300K

- gPROMS Model Updates

THREATS AND OPPORTUNITIES

DFLAW-0232-T: WTP Radioactive Dangerous Liquid Effluent Composition LTA

DFLAW-0106-T: Staged Treated LAW Feed to WTP Does Not Meet Waste Acceptance Criteria for Cesium-137

DFLAW-0075-T: Secondary Liquid Waste Volumes are Higher than Expected

DFLAW-0363-T: WTP LAW Throughput is Less Than Adequate

MEASURABLE ORGANIZATIONAL VALUE

TBD

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5.4 Manage Waste

Hanford Site waste immobilization processes will generate secondary waste byproducts in addition to canistered waste forms. Safe, effective disposal paths must be provided for the secondary waste byproducts. The appropriate disposal path will be determined based on the nature of the waste type (i.e., LSW or SSW).

Secondary Solid Waste (SSW) may be disposed using a variety of different methods, depending on the type, size, and level of contamination of the waste. SSWs (i.e., radioactive solid wastes) are non-liquid waste debris and byproducts of Hanford Site operations. The different SSW types include miscellaneous failed equipment, filters; debris; spent IX media; failed LAW melters; LAW melter consumables (e.g., bubblers, thermocouples); and glass residues, among others. Some SSW may be treated on or offsite and are planned to primarily be disposed of at the IDF.

The WTP HLW and LAW Facilities will convert radioactive wastes into glass. Vitrification is a high-temperature process. As a result of WTP vitrification, a portion of the volatile species in the waste (e.g., fluorides, chlorides, some radionuclides [technetium]) will partition to the off-gas system and become part of the LSW streams. In the DFLAW configuration, LAW vitrification will generate off-gas condensates that will be concentrated by evaporation at the EMF. The concentrate will be recycled to incorporate additional volatiles in the glass. EMF condensate must be processed through the Hanford Site ETF.

Technetium management is necessary to facilitate LSW disposal. Long-lived radionuclide technetium-99 is a fission product from nuclear reactors. Approximately 26,000 Ci of predominantly soluble technetium remains within the tank farms that will be processed as LAW. The primary chemical form of technetium-99 found in LAW is the pertechnetate anion (TcO_4^-), with a +7 oxidation state. Pertechnetate will not be removed from the aqueous waste during pretreatment. The compound will be immobilized in the LAW glass (though volatile at high temperatures), or in macro encapsulated SSW, all of which will be disposed of at the IDF. Due to a long half-life and high mobility, technetium-99 has the potential to be a major dose contributor at the IDF based on the PA. Sufficient risk to satisfying the performance standards may warrant a technetium management program.

The final disposition of spent LAW and HLW melters has not yet been determined (ORP-11242). The alternatives evaluated (DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*) assume that the spent HLW melters will be packaged in an overpack and stored at the interim Hanford storage area until they can be removed for disposition and final disposal. For planning purposes, the final disposition of the LAW melters is assumed to be at the IDF to maintain consistency with the current performance measurement baseline.

The MW functional area includes the following focus areas:

1. Liquid Effluent Retention Facility (LERF) / ETF – The low radioactivity LSW output stream (evaporator overheads) will be transferred to the LERF for treatment at ETF. However, the ETF currently treats wastes from a number of sources on the Hanford Site. LSW feed streams will include the following:

    - Mixed Waste disposal trench leachates

- IDF leachates
- 242-A Evaporator condensates
- Laboratory wastewaters and other miscellaneous minor aqueous streams
- EMF overheads and other miscellaneous LSW

2. SSW – These wastes (i.e., radioactive solid wastes) are non-liquid waste debris and byproducts of Hanford Site operations.
3. LSW – As a result of WTP vitrification, a portion of the volatile species in the waste (e.g., fluorides, chlorides, some radionuclides [technetium]) will partition to the off-gas system and the concentrated condensate (via EMF) will become incorporated into the waste glass via recycle through the melters.
4. Technetium Management – The technetium management effort evaluates and guides the options for reducing the amount of secondary waste technetium-99 disposed at the IDF.
5. Cesium Management – The treatment of LAW must provide for the removal of cesium.
6. Melter Disposal – It is assumed that spent HLW melters will be packaged in an overpack and stored at the interim Hanford storage area until they can be removed for disposition and final disposal. For planning purposes, the final disposition of the LAW melters is assumed to be at the IDF to maintain consistency with the current performance measurement baseline.

This section includes the catalog sheets for the near-term technologies that fall under the MW functional area.

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Ammonia Vapor Mitigation

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: MW-02 **Timetable: ≤ 5 Years**

NEAR TERM

Investigate potential solutions to mitigate ammonia vapor release from Liquid Secondary Waste.

TECHNOLOGY NEED

Solidification of Effluent Treatment Facility (ETF) liquid secondary waste is being pursued in conjunction with the planning for Direct-Feed Low-Activity Waste (DFLAW). Prior testing with simulants identified that ammonia vapor release during grouting is substantial for streams with high dissolved ammonia content. The Notice of Construction permit for the prior ETF solidification project had an allowable ammonia release of 2 lbs/hr. Mass balance projections indicate that actual releases could greatly exceed this level. Work in FY18 through FY21 has developed and demonstrated up to the engineering scale, a solidification process that binds soluble ammonia as the mineral struvite prior to solidifying the liquid waste. FY21 work also demonstrated the ability to grout the rinse water solution generated from cleaning an ETF grout facility mixer. Experiments to demonstrate the ability of the grout to solidify a range of expected brine feed compositions were met with process repeatability challenges by a different laboratory. Additional work is needed to address processing and storage issues that arise during the design, construction, and start-up of a full-scale grout facility.

TECHNOLOGY SOLUTION

Work was completed in FY21 at laboratory and engineering scales with simulant waste and simulant mixer rinse water. Tests showed reasonable set times, high compressive strength, and low ammonia flow rate during and after curing for up to 6 days. Experiments are planned for FY22 to support facility design, construction, and start-up. Tasks include resolving issues with process repeatability by different laboratories and personnel and evaluating the effects of thermal cycling and EDTA addition to the ETF brine.

Laboratory Set Up

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

Yes

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Ammonia Vapor Mitigation

TEDS ID: MW-02 Continued

ADDITIONAL TECH INFO

Grout Samples Curing

Engineering Scale Demo

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $500K

-Complete Formulation Development for Process Wastewater

- Develop Process Procedures
- Start-up Support

FY23: $450K

- Start-up Support

THREATS AND OPPORTUNITIES

DFLAW-0232-T: Secondary Liquid Waste Management LTA

MEASURABLE ORGANIZATIONAL VALUE

Successful testing will satisfy commitments made in the settlement agreement to complete the tech- nology demonstration.

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5.5 Dispose Tank Waste

Disposal is the ultimate goal for Hanford Site tank waste. The method of treatment, final waste form characteristics, and type of waste form will determine how and where the waste can be disposed. LSW effluents will be treated at the ETF and disposed at a permitted land disposal site. ETF SSW will be disposed of at the IDF. ILAW and potentially supplemental LAW will likely be disposed of at the IDF, with some offsite options being explored. Immobilized HLW (IHLW) will be interim-stored onsite and ultimately disposed of at an as-yet undetermined geologic repository. CH-TRU waste is planned to be disposed of at the Waste Isolation Pilot Plant (WIPP). There are other relatively benign wastes (e.g., submerged bed scrubber condensates) that may be treated offsite and disposed of at commercial waste disposal facilities.

The DTW functional area includes the following focus areas to assess potential methods of disposal for the waste:

1. IDF – The IDF is located on the Hanford Site in the 200 East Area and is the designated disposal location for ILAW. The facility consists of a single landfill with two expandable cells for extra capacity. The cells use a double lined system with leachate collection, detection, and removal capability.
2. IHLW Interim Storage – The path forward for IHLW interim storage entails sequential construction of potentially several modular facilities. One or more facilities will be provided as necessary to furnish IHLW interim storage capacity.
3. WIPP – The WIPP is the nation's underground disposal facility for DOE TRU solid waste. Hanford Site ships legacy TRU waste to WIPP as part of the Central Plateau Cleanup Company program to disposition solid waste landfills.
4. Offsite Disposition – Offsite disposition refers to both offsite treatment and disposal of Hanford tank liquid and/or related solid waste.
5. Offsite Transportation – Offsite transportation refers to future transportation systems needed for shipping Hanford waste (liquid and/or solid) to offsite treatment and/or disposal facilities. This effort supports offsite disposition by developing shipping transportation systems for material transport.

This section includes the catalog sheets for the near-term technologies that fall under the DTW functional area.

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Low Temperature Waste Form Process

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: DTW-02 **Timetable: > 5 Years**

NEAR TERM

Develop and qualify a low-temperature waste form for supplemental immobilization of Hanford LAW. A low temperature immobilization process for Hanford LAW would be significantly less complex to design, construct and operate than a high-temperature vitrification process. Estimates indicate capital costs will be approximately seven times lower and operating costs three times lower for a low temperature process. A further benefit could be realized if a single grout facility is used to immobilize both LAW and Secondary Wastes.

TECHNOLOGY NEED

The Waste Treatment and Immobilization Plant (WTP) Project is designing and building a vitrification facility for immobilizing Hanford Site low-activity waste (LAW) in a glass waste form. However, the LAW Vitrification Facility has limited capacity and will only be able to treat about one-third of the total LAW within the mission duration timeframe (bounded for high-level waste [HLW] treatment). Additional LAW immobilization capacity is needed for timely completion of the waste treatment mission and to avoid protracted interruptions of the HLW Vitrification Facility operations. Low temperature supplemental LAW treatment (i.e., grout) could provide the needed capacity. However, waste form performance data for grouted LAW are needed for both a supplement analysis to the Tank Closure and Waste Management Environmental Impact Statement to construct and operate the facility and process, and for the Integrated Disposal Facility Performance Assessment, to allow ultimate disposal of the waste form. Technology maturation activities are also needed to support a future U.S. Department of Energy (DOE) Record of Decision on what process to use for supplemental immobilization of Hanford LAW.

TECHNOLOGY SOLUTION

The development approach is described in a Technology Maturation Plan that is patterned after the DOE/EM 413.1-4 technology maturation process and embodies a phased approach to mature the technology over multiple fiscal years. The logical progression of the technology development work includes formulation development, testing to support long-term performance projections for the performance assessment, engineering-scale integrated testing, and waste form qualification testing. Work to integrate a low temperature solidification process into the full WTP mission is also planned. This includes the development of sampling and analysis methods necessary to ensure RCRA LDR compliance in the final waste form.

Test Cylinders

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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Low Temperature Waste Form Process

TEDS ID: DTW-02 Continued

ADDITIONAL TECH INFO

Testing with Actual Waste

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22 - $1,569K
- Formulation Development
- Capture and Hold Method Improvements
- LDR Organic Sample and Send Method Development
- Long Term Performance - PA Support

FY23: $1,456K
- Complete Capture and Hold Method Improvement
- Complete LDR Organic Sample and Method Development
- Bulk Waste Form Improvement
- Actual Waste Testing

THREATS AND OPPORTUNITIES

DFLAW-0363-T: WTP LAW Throughput is Less than Adequate

MEASURABLE ORGANIZATIONAL VALUE

The total savings from constructing and using a grout facility rather than a vitrification facility are estimated to be about $31 billion (un-escalated) and $95 billion (escalated). Using a grout facility in lieu of a vitrification facility would also save about 11 years' time treating all tank waste and about 13 years' time completing all SST retrievals.

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Immobilized LAW Glass Testing for IDF PA Support

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: DTW-03 **Timetable: ≤ 5 Years**

NEAR TERM

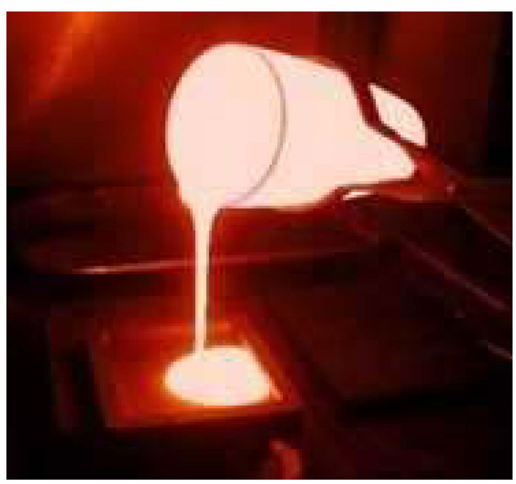
Perform engineering and laboratory tests to characterize Immobilized Low Activity Waste (LAW) glass to support the Integrated Disposal Facility (IDF) Performance Assessment (PA) update and future maintenance.

TECHNOLOGY NEED

The Waste Treatment and Immobilization Plant (WTP) Project is designing and building a vitrification facility for immobilizing Hanford Site LAW in a glass waste form. Immobilized waste from the LAW vitrification facility, starting with direct-feed LAW processing, will be disposed of onsite in the Integrated Disposal Facility (IDF). Waste form performance data is needed to support the IDF Performance Assessment (PA) and PA maintenance to permit and operate the IDF. Work performed in FY 2017 through FY 2021 supported improvements in waste loading/processing. Additional work is needed to prepare the data packages used to update the IDF PA modeling platforms. Additional work is also necessary to verify long-term glass dissolution rates for enhanced glasses. The near-term risk associated with not performing this work is the necessity to restrict WTP operations to lower waste loading baseline glasses rather than expanding operations to include enhanced glasses. Long-term risks include the potential for higher operating costs for LAW immobilization and IDF disposal caused by the need for lower throughput to maintain lower waste loading in the glass and the subsequent generation of a greater volume of waste for disposal.

TECHNOLOGY SOLUTION

The 2017 IDF PA performed analysis using baseline glasses. However, recent work is being completed to develop new LAW glasses that can achieve higher waste loadings. The hope is to integrate the new glass formulations into DFLAW as soon as practical after DFLAW System hot commissioning. To implement enhanced glass formulation, testing data on the short- and long-term dissolution rate of the new glasses is needed. This information will be needed to support PA analysis of the fate of the enhanced glasses in the IDF and their potential impact on the environment. It is likely the PA analysis will be performed right before startup of DFLAW.



ILAW Glass Sample Formulation

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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Immobilized LAW Glass Testing for IDF PA Support

TEDS ID: DTW-03 Continued

ADDITIONAL TECH INFO

Ground Glass Samples used in Dissolution Rate Tests

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $2,475K
- Define Secondary Mineral Phases Reaction Network
- Prepare Data Packages for the IDF PA
- Monitor Long-Term Dissolution Test
- On-going IDF PA Maintenance Support

FY23: $2,630K
- Prepare Data Packages for the IDF PA
- Monitor Long-Term Dissolution Tests
- On-going IDF PA Maintenance Support

THREATS AND OPPORTUNITIES

DFLAW-0249-T: WIR Evaluation Approval is Delayed

DFLAW-0149-T: IDF Permits to Operate Including Disposal Authorization Statement (DAS) Delayed

MEASURABLE ORGANIZATIONAL VALUE

Production of enhanced glass as opposed to baseline glass will reduce total mission glass canister count by up to 50K, provide a potential savings of up to $1.86 Billion, and aid in keeping the mission completion target of 2065.

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Solidification and Stabilization of Solid Secondary Waste

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: DTW-07 **Timetable: ≤ 5 Years**

NEAR TERM

Development and maturation of a technology for the solidification and stabilization of solid secondary waste (SSW) by macro or micro-encapsulation in grout waste forms.

TECHNOLOGY NEED

During DFLAW operations, radioactive SSW will be generated at the waste processing facilities. Such wastes are expected to include used process equipment, contaminated tools and instruments, decontamination wastes, high-efficiency particulate air filters, carbon absorption beds, iodine sorbent beds, and spent ion exchange resins. SSW treatment processes and waste forms will be needed in time to support DFLAW operations. Accordingly, these waste forms have been included and analyzed as part of the 2017 IDF PA. In FY16, information available from published literature was reviewed, surveyed and compiled in a data package for the 2017 IDF PA. Development and testing activities to collect data on Hanford SSW was started in FY17. Results in FY20 for ultra high performance grout (UHPG) indicate orders-of-magnitude improvement for contaminant retention over baseline formulations. Additional data using specific SSW materials is needed to confirm these results and provide data for upcoming PA maintenance activities. These results will also provide insight on the ability of UHPG to be used as a diffusion barrier for other waste forms.

TECHNOLOGY SOLUTION

Work scope priorities are based on the results of the 2017 IDF PA analysis, which indicated that there are 4 major SSW that have significant inventories of contaminants of concern for the IDF. Those 4 major SSWs, are sRF resin, HEPA filters, carbon bed adsorbers, and silver mordenite. Since then, a fifth SSW, A-532E resin, has been identified for iodine removal from ETF feed. This work will employ a variety of standard laboratory-scale tests to measure physical and chemical properties of grout/waste form formulations. The findings will then be assessed with anticipated IDF disposal requirements to identify waste forms and processing methods for producing SSW disposal packages. These results will also provide insight on the ability of UHPG to be used as a diffusion barrier for other waste forms. Work will be accomplished in four phases: 1) Formulation development; 2) Waste form fabrication and Qualification/Characterization; 3) Waste Form Performance Testing; and 4) Scale-up or Engineering Scale Testing.

Grout Flow Testing of Encapsulation Grout

Technology Maturation Level

Laboratory Testing

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

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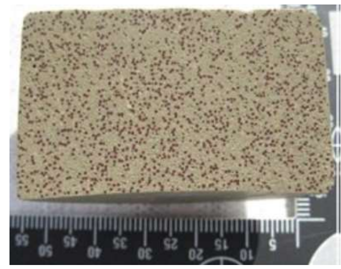
Solidification and Stabilization of Solid Secondary Waste

TEDS ID: DTW-07 Continued

ADDITIONAL TECH INFO

Samples During Formulation Development



sRF Resin in Grout

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $900K
- Waste Form Durability
- Leach Test of UHPG

FY23: $1,500K
- Leach Test of UHPG
- Development and testing of waste Form 5 (A-532E Resin)
- Waste Form Durability
- Development and testing of Waste Form 4 (Carbon Bed Adsorber)
- Waste Form Testing for scale-up

FY24: $1,800K
- Waste Form Durability
- Development and testing of Waste Form 4 (Carbon Bed Adsorber)
- Waste Form Testing for scale-up
- Testing with Real Waste

THREATS AND OPPORTUNITIES

DFLAW-0206-T: Secondary Sold Waste Management LTA (Tank Farms and WTP)

MEASURABLE ORGANIZATIONAL VALUE

Verify that SSW generated during DFLAW operations will meet DOE 435.1 requirements for disposal in the IDF. UHPCC has the potential for reducing the impact to groundwater in the IDF PA.

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IDF Long-Term Waste Form Durability Study (Lysimeter Data)

HANFORD SITE
US DEPT OF ENERGY

TEDS ID: DTW-08 **Timetable: ≤ 5 Years**

NEAR TERM

Validation of Performance Assessment (PA) (RPP-RPT-59958) models using field results from monitored and well understood/documented lysimeter tests are needed to improve stakeholder confidence in disposal facility and waste form performance. Increased understanding of model performance can allow modelers to better understand how well the model predicts Integrated Disposal Facility (IDF) conditions and could allow a reduction in conservatism in release estimates, resulting in better utilization of the IDF and lower IDF closure requirements and costs.

Technology Maturation Level

Modify Existing Technology

National Laboratory Involvment?

Yes

Submitted As Grand Challenge?

No

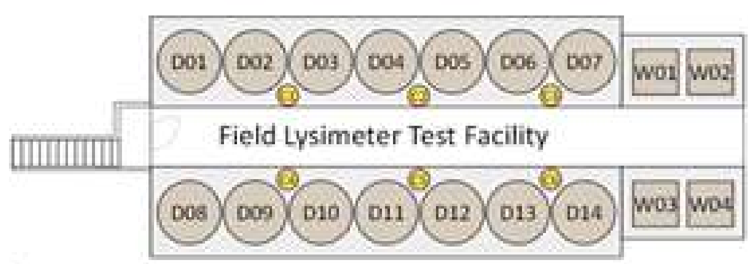
TECHNOLOGY NEED

A long-term study of LAW waste form degradation using the Field Lysimeter Test Facility (FLTF) on the Hanford Site will: 1) provide field experimental data on degradation of various waste forms; 2) be used to refine process model descriptions of contaminant (source term) release from the waste forms; 3) reduce uncertainties about the representativeness of laboratory testing results for determining long-term waste form performance under field conditions; 4) improve confidence in the IDF PA by providing data that verify parameters and assumptions used in the PA modeling, 5) determine potentially important impacts from co-disposal of the glass and cementitious waste forms; 6) determine changes in the physical (e.g., structural properties) and chemical (e.g., secondary phase formation, reducing capacity, leach rate) properties of the glass and cementitious waste forms during interaction with surrounding materials to improve long-term predictions of waste form performance; and 7) identify relevant secondary phases that are formed during waste form alteration in the lysimeter to improve long-term predictions of waste form performance.

TECHNOLOGY SOLUTION

Develop a test plan covering waste forms, surface to volume ratios, precipitation, and other parameters which influence waste form durability and are key inputs to performance assessment models such as STOMP and GoldSim. Focus will be on cementitious waste forms but glass will be included. Laboratory and field work will include:

1) Loading the lysimeters and monitor parameters needed as input and to validate models
2) Systematically retrieving samples, analyze them, and compare results to models ran to simulate sample/lysimeter history; including analysis for secondary phases.



Schematic of the Facility

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IDF Long-Term Waste Form Durability Study (Lysimeter Data)

TEDS ID: DTW-08 Continued

ADDITIONAL TECH INFO

Aerial view of Lysimeter Location

PRELIMINARY COST ESTIMATE AND SCOPE SUMMARY

FY22: $990K

- Ongoing Monitoring

FY23: $1,947K

- Ongoing Monitoring
- Loading Additional Cells

THREATS AND OPPORTUNITIES

DFLAW-0206-T: Secondary Solid Waste Management LTA (Tank Farms and WTP)

MEASURABLE ORGANIZATIONAL VALUE

Facilitates DFLAW operations by reducing uncertainty associated with the IDF PA fate-and-transport modeling predictions for grout waste forms, specifically. Provides long-term data on containment release, at actual IDF conditions, that can be used to validate the numerical models. Reduces conservatism used for the IDF PA analyses.

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5.6 Technology Development Funding

WRPS collaborates with the DOE National Laboratory network, academia, and industry experts to develop innovative approaches to enhance our ability to meet the mission needs. This section details technology development funding.

WRPS prioritizes technology development tasks annually. Tasks that are selected for funding seek to increase safety, improve efficiency, and minimize life cycle costs associated with completing the TOC mission. This section details the following:

- Technology development program funding
- National Laboratory support to funded programs
- National Laboratory, academia, and supplier/contractor support distribution

Development activities with their budgets for FY2022 are shown in Figure 5-1. The figure shows the total funding along with individual program funding levels expressed in dollars and depicted in a pie chart as percentages. During FY 2022, technology development funding will be invested in the Non-Destructive Examination (14%), ILAW Glass Testing (14%), and Radioactive Waste Test Platform (11%) projects, among other projects.

Efforts are made to evaluate all work scope and utilize the appropriate laboratory to support the project based on the laboratory capabilities and past experience. For FY 2022, National Laboratory support is being provided by Pacific Northwest National Laboratory (PNNL) and Savannah River National Laboratory (SRNL). Investments in technology were also made with the academic institution Vitreous State Laboratory (VSL). Development activities in FY 2021, supported by the National Laboratories are shown in Figure 5-2. National Laboratories expertise was and will be utilized in these development programs. National Laboratory support funding distribution for these technology development programs is shown in Figure 5-2. The figure shows the total funding and individual program funding levels expressed in dollars and depicted in a sunburst chart. For FY 21 the majority of the funding (75%) went to PNNL.

In addition to National Laboratory and academia institution support, WRPS also teams with commercial suppliers/contractors, such as Atkins. However, PNNL received 55.5% of the support as the dominant supplier. A complete list of teaming suppliers is shown in Figure 5-3. The figure shows the funding percentage distribution.

Technology development funding is provided primarily by the CTO. When available, some funding may be provided by other tank farm organizations such as Tank & Pipe Integrity, Project Office, and Closure & Interim Measures. Funding provided by other tank farm organizations is distributed similarly to CTO distributed funds, however it is not included herein.

Figure 5-1. CTO-Managed Technology Development and Maturation Scope, Budget for FY22

CTO Program Management		
CTO Program Management	$	4708.502
Total	$	4,708.5
DFLAW Maturation		
Radioactive Waste Test Platform	$	2376.77
ILAW Glass Testing	$	2870.332
Lysimeter	$	1092.557
Secondary Waste Form Dev	$	838.173
SLAW Treatment Alternatives	$	1729.95
Flowsheet GAPs	$	857.064
Solid Secondary Waste Mgmt	$	521.112
Total	$	10,286.0
Vapors		
DFAS (SmartSites)	$	135.906
Total	$	135.9
Operational Support		
Non-Destructive Examination	$	2988.843
Tank Repair	$	1294.783
Hanford Waste End Effector	$	317.627
Off-Riser Sampler System	$	144.213
Machine Learning	$	280.694
Total	$	5,026.2
Retrievals		
Sludge Retrieval	$	835.888
Total	$	835.9

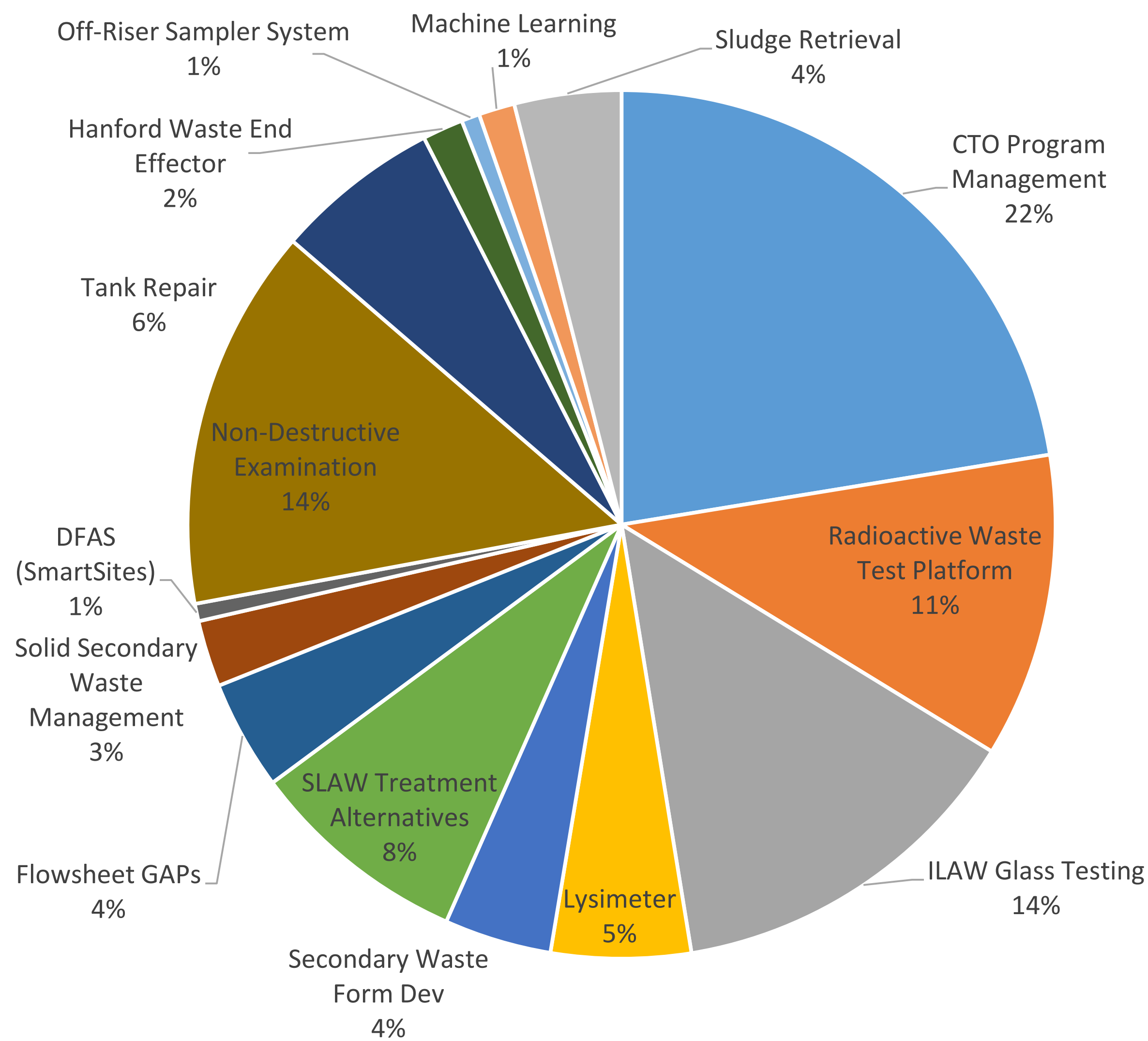


Figure 5-2. National Laboratory Support, Actual from FY21

National Laboratory Support ($K)		
PNNL		
DFLAW Maturation	$	6,463
Vapors Mgmt	$	224
LAWPS/TSCR	$	393.8
Operational Support	$	2,562
Total	$	9,644
SRNL		
DFLAW Maturation	$	574
LAWPS/TSCR	$	83
CTO Program Mgmt.	$	372
Total	$	1,029
VSL		
DFLAW Maturation	$	2,254
Total	$	2,254

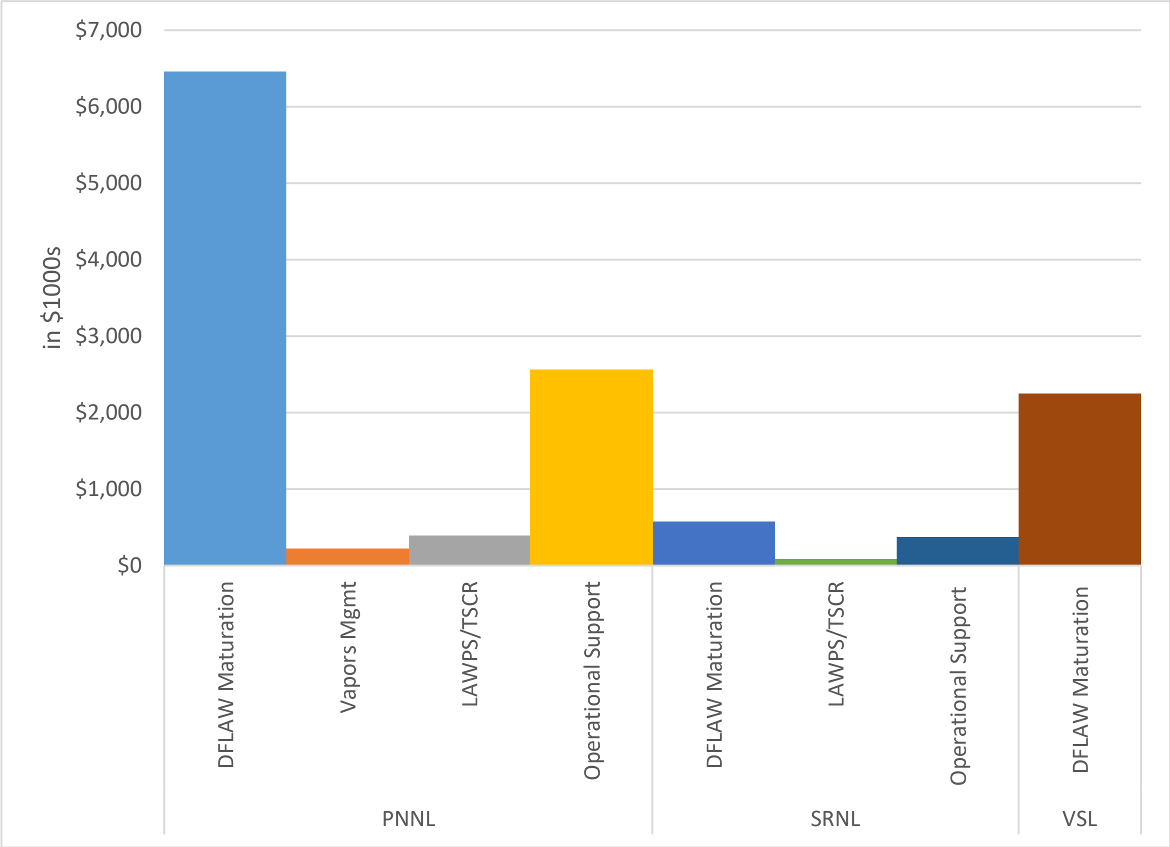
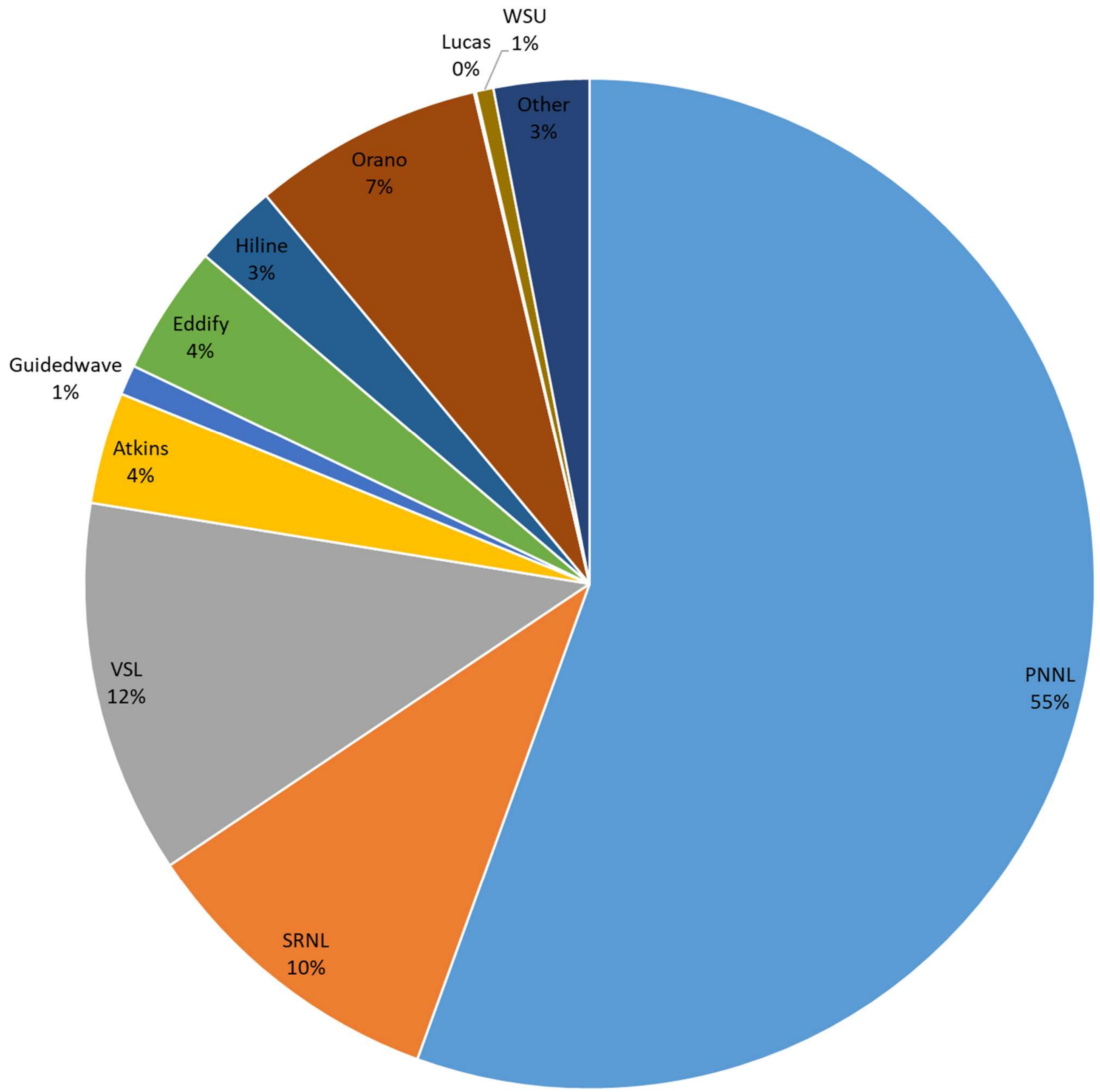


Figure 5-3. Technology Development Funding Distribution, Actual from FY22

TD Funding Distribution		
National Laboratory Support		
PNNL	55.5	%
SRNL	10.1	%
Academia		
VSL	12.0	%
WSU	0.6	%
Suppliers		
Atkins	3.6	%
Guidedwave	1.0	%
Eddify	4.1	%
Hiline	2.7	%
Orano	7.4	%
Lucas	0.1	%
Other	3.1	%



6.0 FUTURE TECHNOLOGY NEED DESCRIPTIONS

This section lists those proposed technology needs that are not currently targeted as near-term needs. This means the technology need is still recognized as a need; however, it is not currently being pursued for development. A technology need may be unpursued for a variety of reasons, the most common reasons being the technology is not needed in the next 5 years. These technology needs are listed in table format for each of the five basic functional areas. Catalog sheets for these technology needs are one page each and can be found in APPENDIX C.

Technology needs that have been overcome by events, developed and implemented, or otherwise deemed no longer in need of development, are considered Retired. A list of Retired TEDS along with retirement criteria can be found in APPENDIX E.

6.1 Manage Tank Waste

Table 6-1 lists technologies related to MTW that are not currently being pursued. Catalog sheets for each technology can be found in APPENDIX C.

Table 6-1. Future MTW Technologies

TEDS #	Title
MTW-10	Improved Inspection Methods for DST Primary Tank Walls
MTW-13	Improve Liquid Observation Well Data Acquisition
MTW-40	Improve Sampling Methods of Head Space
MTW-50	Additional Tank Space
MTW-57	Predicting Behavior of Mercury in EMF
MTW-59	Nitrosamine Monitoring and Reduction
MTW-70	Plutonium Particulate Criticality Safety Issue Resolution
MTW-71	Improve Best-Basis Inventory with TWINS Database
MTW-72	Continuous Air Monitor Remote Observation
MTW-74	Measure Liquid Loss from Evaporation
MTW-75	Reduce or Eliminate Equipment Contamination
MTW-76	Online Monitoring
MTW-78	In-Tank Volumetric Nondestructive Examination
MTW-80	Automated Visual Recognition Wireless Remote Video Monitoring
MTW-81	Radiation Tolerance Multi-Use Manipulator System
MTW-83	Secondary Liner Bottom Damage Mitigation Technologies
MTW-84	Pipeline Forensic Inspection Technology
MTW-85	Remote for Surface Examination
MTW-86	Protective Measures for Waste Transfer System Lines
MTW-88	Liquid Air Interface Sampler
MTW-89	Remote Concrete Surface Cleaning Apparatus
MTW-90	Water/Waste Volume Measurement for 242-A C-A-1 Vessel
MTW-91	Tank-Side Waste Evaporation
MTW-93	Cs Online Monitoring for TSCR
MTW-96	Enhanced Worker Capabilities
MTW-97	Continued Need for Improving Tools for Tank Farm Projects
MTW-98	Long-Reach Robotic Tool for Waste Storage Tank Pits
MTW-99	Tank Farm Smart Operating Procedures
MTW-100	Increased NDE Volumetric Inspection

6.2 Retrieve Tank Waste

Table 6-2 lists technologies related to RTW that are not currently being pursued. Catalog sheets for each technology can be found in APPENDIX C.

Table 6-2. Future RTW Technologies

TEDS #	Title
RTW-03	Remote Tank Farm Above Ground Inspections
RTW-04	Near Tank Soil Sampling
RTW-07	Post Waste Retrieval Updates to WMA CPA and Long-Term Maintenance
RTW-08	Dry Retrieval Systems
RTW-15	Evaluate Back-Up Options for HLW Delivery from the Tank Farms
RTW-16	Develop Integrated HLW Feed Qualification Plan
RTW-17	Assess Deep Sludge Pump Reliability for DST Mixer & Transfer Pumps
RTW-18	Improved Heat Removal for AW & AN Tanks TSR Heat Limits
RTW-19	Removal of SR-90 and TRU
RTW-21	Improve ESP – A Thermodynamic Modeling Program
RTW-23	Waste Transfer Pipe Unplugging
RTW-25	Void Filling to Prevent Collapse
RTW-27	Improved Solubility Modeling
RTW-31	In-Tank Sampling Technologies for Plutonium Particles
RTW-32	Criticality Safety Control Strategy for Particulate Plutonium
RTW-34	Remove Residual Solids in Non-Leaking Tanks
RTW-39	Risk-Informed Tank Retrieval Modeling Optimization
RTW-43	Computer Simulator to Measure Retrieval Operator Skills
RTW-44	Quantification of Solids in DSTs
RTW-52	Barrier Technology
RTW-53	Improved Configuration Documentation
RTW-54	Modular Tank Waste Treatment
RTW-56	Technology to Support Risk-Based Retrieval & Closure
RTW-57	Plutonium/Absorber Mass Ratios Measurement
RTW-58	Tank Crust Sampler
RTW-59	Retrieval of Sludge from Miscellaneous Underground Storage Tanks

6.3 Process Tank Waste

Table 6-3 lists technologies related to PTW that are not currently being pursued. Catalog sheets for each technology can be found in APPENDIX C.

Table 6-3. Future PTW Technologies

TEDS #	Title
PTW-26	High- to Mid- Fidelity Consolidated Operations Training Simulator
PTW-40	Simplified DFHLW Flowsheet
PTW-42	High-Level Waste Direct Vitrification – Condensate Treatment
PTW-45	Operations Productivity & Analysis Tools
PTW-46	Advance CH-TRU Tank Waste Treatment Technologies
PTW-48	Prevention of Hydrogen Gas Buildup
PTW-49	Feasibility of Removing Nitrates from the LAW Feed
PTW-50	High-Level Waste Solids Segregation
PTW-51	Nitrite-Hydroxide Solubility to Determine Aluminum Solubility in DFLAW
PTW-54	Real-Time Process Control for DFLAW
PTW-56	Treated Waste Concentration/Evaporation
PTW-57	In-Tank Solids Suspension
PTW-58	Solids Settling Rate Determination/Solids Washing Techniques

6.4 Manage Waste

Table 6-4 lists technologies related to MW that are not currently being pursued. Catalog sheets for each technology can be found in APPENDIX C.

Table 6-4. Future MW Technologies

TEDS #	Title
MW-10	Remotely Operated or Automated ETF Internal Tank Cleaning Device
MW-12	Upgraded Solid Waste Information & Tracking System
MW-13	Transportation Requirements for New Equipment Disposal
MW-15	At-tank Technetium and Iodine Removal & Disposition

6.5 Dispose Tank Waste

Table 6-5 lists technologies related to DTW that are not currently being pursued. Catalog sheets for each technology can be found in APPENDIX C.

Table 6-5. Future DTW Technologies

TEDS #	Title
DTW-06	Advance Liquid Waste Transportation Capability
DTW-10	Evaluation of Commercial Treatment and Offsite Disposal
DTW-11	Integrated Disposal Facility Risk Budget Tool Monitoring
DTW-12	Evaluation of Natural Analogues to Support Tailored Grouts
DTW-13	Long-Term Durability of Cementitious Waste Forms
DTW-14	Complex-Wide Database for Cementitious Waste Form Properties

7.0 INNOVATIONS

In addition to the technology development activities, WRPS regularly supports the Hanford operations by producing many unique tool designs designated here as Innovations. These Innovations are projects undertaken by various project engineering groups that do not require prolonged development activities. Many of the Innovations are commercially available items that are modified in some way for use in the unique Hanford environment. Innovations range from modified manual extended reach tools to more advanced robotic systems. Table 7-1 is a list of innovative projects undertaken by WRPS in FY21.

Table 7-1. Innovations

Name	Description
Core Catcher	Collects core drilling waste and prevents workers from needing to enter highly contaminated 242-A Evaporator Pump Room
Core Drill Guide Assembly	Allows accurate placement of the core drill and associated concrete anchors while maximizing worker safety
Core Drill Wall Clamp	Alleviates legacy problems associated with spalling during pit wall coring and subsequent pit repair
Hydraulic Pipe Bender	Allows safe bending of jumpers for disposal while preventing size reduction via higher risk cutting methods
Integrated Pressure Washer System	Complete, high=pressure water delivery system for decontamination of Long-Length Equipment
Long-Length Internal Pipe Grinder	Rapidly-executed tool for removing internal pipe interferences for Evaporator Feed Pump installation
Mini Conveyor System for Excavation	Increase worker safety during excavation with a simultaneous significant increase in productivity
Modula Extended-Reach Hacksaw	Adaptable solution for remote material cutting without pit entry
Nozzle Mounting Plate Assembly	Allows precise placement of the new wall nozzle assembly on the first attempt
Pipe Cap Sizing and Installation Tools	Simple, reliable tools for measuring and installing pipe caps without pit entry
Pump Room Core Drilling and Wall Nozzle Installation	Tool suite which prevents workers from needing to enter highly contaminated 242-A Evaporator Pump Room
RD8200 Cable Locator Implementation	Reliable approach to identification of energized electrical obstructions
Solid Sampler Retrieval System & Enhancements	New solid sample retrieval system speeds up work evolution and reduces worker strain and dose
Solid Sampling Support Equipment	Low-cist, reliable remote handling and shielding equipment makes sampling extreme-dose waste possible

Summaries of these Innovations are included in APPENDIX G.

8.0 EMERGING ISSUES

As day to day operations continue, there is the potential for unexpected issues to arise. This section describes those emergent issues and the technology development activities planned to address them.

8.1 Transfer Line Corrosion

The Hanford Tank Farms employ Pipe-in-Pipe transfer lines to move waste between tanks and treatment facilities. A borescope inspection of the AW farm transfer line SN-265, standing water was found between the primary pipe and the secondary pipe. A second borescope inspection of the encasement was conducted and confirmed that the accumulation of the water was due to a localized low point and the likely source is condensation. There was also evidence of increased corrosion on the safety significant primary piping, which resulted in Operations requesting Engineering assess the condition.

The appropriate Operations and Engineering groups are conducting an extend of condition of SN-265 and similar pipe-in-pipe installations to determine root cause and fit for use status. Additionally, an effort was kicked off to develop a method of in-situ transferline monitoring. Existing vendors for similar applications were contacted and application requirements were discussed.

A demonstration of a permanent in-situ guidedwave UT monitoring system is being planned for late FY22. The results of the demonstration will be used to determine next steps. Development of a transfer line monitoring system could address the needs detailed in MTW-84 and MTW-86.

8.2 AY-101 Solids Mobilization

According to RPP-ASMT-6128, AY-101 has been identified as the DST most at risk of failure due to multiple factors, including chemical composition. The potential exists for increased corrosion at the tank bottom due to non-conforming interstitial liquid within the solids. Testing data from 2019 shows that the waste currently presents a low corrosion risk, however the twin to AY-101, AY-102, had a similar technical basis prior to being removed from service due to integrity issues with the primary tank bottom.

Multiple approaches are being evaluated to address potentially corrosive conditions inside AY-101 including mechanically preventing localized concentration of any one substance and possible chemical alterations to discourage material degradation. These approaches could address the need identified in RTW-17.

9.0 SUMMARY AND CONCLUSIONS

ORP is responsible for managing and completing the RPP mission, which is comprised of both the Hanford Site tank farms operations and the WTP. The RPP mission is to accomplish the following:

- Safeguard and safe management of over 54 Mgal of nuclear waste stored in Hanford tanks
- Retrieve and Treat the waste
- Achieve safe waste disposition to protect the Columbia River and the environment

To reduce the risk and cost associated with these objectives, new technologies are regularly implemented. The identification of these technologies comes from a variety of sources, collected and prioritized in this Roadmap.

9.1 Summary

The Roadmap catalogs ideas for evaluation for each of the TOC process or functional areas. These ideas capture specific issues and potential approaches involving the development of new technology or innovative application of existing technology to accelerate threat reduction and lower life cycle costs. This information is intended to support the FY planning and National Laboratory contracting processes to ensure that RPP mission technology needs are supported as necessary. In addition, the Roadmap provides a basis for strategic planning by identifying opportunities to use technology solutions to enhance mission efficiency.

9.2 Conclusions

A revision of this Roadmap occurs annually. The revision is developed in a systematic manner to facilitate sound strategic, programmatic, and fiscal planning regarding existing technology gaps in the RPP mission. Each year expert personnel are solicited for input from each of the five functional areas of the RPP flowsheet. Input is provided in standardized TEDS format to ensure consistent reporting.

Based on TEDS input, the technology needs may be tied to projects or require development. As the RPP mission consists of many interwoven, interdependent unit operations, a technology gap or need in an upstream unit operation can cause impacts throughout many functional areas. The Roadmap reconciles individual technology development activities and combine efforts where possible. This process has been enabled in large part due to efforts of National Laboratory testing and development to meet the growing needs of Hanford to safely dispose of the stored waste.

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