Tank Closure Contract Tour

(2440 Steven Center / Conference Room 1305A/B)

January 24, 2019

INTRODUCTION

Good morning and welcome to the Hanford Tank Closure Contract Tour. It is our privilege to provide for you a firsthand observation of the enormity of the Hanford Site cleanup progress and challenges. My name is Steve Pfaff and I am a project manager with the U.S. Department of Energy, Office of River Protection. I will be your tour guide for today.

Each of you should have received a tour packet this morning. If you have not received a tour packet, please stop by the sign-in table before boarding the bus. I will be reading from a tour script on the bus as we travel to the Hanford site, referring you to either side of the bus to point out facilities of interest. This tour script will be available to you on the Tank Closure Contract Acquisition website following the tour. There will be stops along the way where you can get off the bus, and we will provide a brief description of the facility/area at that time. The tour packet includes a general site map for your reference as we travel between the key facilities and features that fall within the scope of the Tank Closure Contract.

Also included in the tour packet are index cards. If you have any questions, please use the index cards to jot down questions. I have extra cards available upon request. The cards will be collected at the end of the tour. Your questions will be answered and placed on the Tank Closure Contract Acquisition website, or considered as feedback for industry input. Please provide your name/contact information on the first card and name on all subsequent cards you turn in so we can contact you if we have any questions regarding your requested information.

As a reminder, this is an industrial site and we ask that you stay together as a group and follow all verbal safety instructions given on the tour. Safety is a priority for *everyone on the Hanford Site. While on the tour, there will be no recording or picture taking allowed. Everyone should have a visitor badge and have it visible at all times.*

There will be employees at the areas we are visiting, and we ask that you not attempt to converse with them or otherwise distract them from their duties.

I would like to introduce Karen Sinclair as our tour coordinator. Karen would like to take a few moments to go over tour logistics and then we will begin boarding the bus.

FEDERAL OFFICES AND COMPANY DESCRIPTIONS

The Department of Energy operates the Hanford Site with two managing offices: The Office of River Protection, located at 2440 Stevens Center and the Richland Operations Office located at 2420 and 2430 Stevens Center.

Both of these offices oversee the day-to-day operations and cleanup work on the site, which is performed by several prime contractors. Each of these contractors or their subcontractors have an assigned scope of work to complete under the guidance of the Department of Energy.

- *The **Office of River Protection** is responsible for the retrieval, treatment and disposal of Hanford's 56 million gallons of radioactive tank waste, currently stored in 177 underground tanks in the central part of the site. In support of this mission, the Office of River Protection manages the Tank Operations Contract, the Laboratory Analysis and Testing Services contract, and the Waste Treatment and Immobilization Plant Project.*

    - ***Bechtel National, Inc.** is the Office of River Protection prime contractor for the design, construction, startup and commissioning of the Hanford Waste Treatment and Immobilization Plant (also called "WTP" or the "Vit" Plant). When complete, the Waste Treatment and Immobilization Plant will be the world's largest nuclear waste treatment facility and will immobilize substantial portions of the chemical and radioactive waste stored in Hanford's 177 underground tanks using a process called vitrification.*

    - ***Washington River Protection Solutions** is the Office of River Protection prime contractor for the storage, retrieval, and safe management of approximately 56 million gallons of chemical and radioactive waste stored* *in Hanford's 177 underground tanks. Its role also includes characterizing the waste and delivering it to the Waste Treatment and Immobilization Plant for vitrification when that plant begins operating.*

- ***Wastren Advantage, Inc, Hanford Laboratory** is the Office of River Protection prime contractor for analytical services under the Hanford 222-S Laboratory Analysis and Testing Services contract. In the past year, Wastren was purchased by Veolia Nuclear Solutions Federal Services. They perform routine analytical work at the 222-S Laboratory on tank waste and other samples in support of day to day operations in the tank farms as well as analyses for other Hanford contractors on a project by project basis.*

- *The **Richland Operations Office** oversees cleanup along the Columbia River and in Hanford's Central Plateau, including groundwater and waste site cleanup, management of solid waste and spent nuclear fuel and sludge; facility cleanout, deactivation and demolition; environmental restoration; and all site support services. This office oversees the prime contractors for HPM Corporation, Mission Support Alliance and CH2M Hill Plateau Remediation Company.*

    - ***HPM Corporation** is the current occupational medical contractor that provides services to approximately 9,000 employees working for Hanford site contractors, Department of Energy offices, or others working on site. Besides providing medical monitoring and qualification-for-work exams, services also include operating and maintaining two clinical facilities, conducting epidemiological studies of Hanford site workers, and maintenance of the medical records for Hanford workers.*

    - ***Mission Support Alliance** is Hanford's prime contractor for safely providing critical infrastructure services such as road maintenance, water systems and electrical power. MSA directs the site's emergency* *preparedness, communications, fire and rescue and site security services, as well as property and environmental stewardship. Other services include providing information management, document control, records management and multimedia services to the Hanford Site. MSA also is responsible for managing the B Reactor National Historical Landmark and ensuring the preservation of the site's cultural history and artifacts.*

  - ***CH2M HILL Plateau Remediation Company*** *is the prime contractor responsible for the safe environmental cleanup of the Central Plateau and for moving hazards away from the Columbia River. Their work includes reducing risks on the Hanford Site by removing some of the highest hazard waste streams and facilities, cleaning up contaminated groundwater plumes before they reach the Columbia River, removing highly radioactive "sludge," and demolishing the Plutonium Finishing Plant.*

A third DOE office is located near the Hanford Site as we approach the Horn Rapids Road to the right.

- ***The Pacific Northwest Site Office*** *provides stewardship of the Pacific Northwest National Laboratory by considering the appropriate balance of risk, investment and oversight for the Department of Energy's Office of Science.*

  - *The Pacific Northwest National Laboratory, managed by the Battelle Memorial Institute of Columbus, Ohio, delivers technological innovation to support the Department of Energy's critical missions, while devoting the majority of its capabilities to advance science for other government agencies, academia, and commercial enterprises. Drawing on world-leading capabilities in chemistry, earth sciences and data analytics, the Laboratory addresses some of the world's most challenging problems in energy, earth sciences and national security.*

PACIFIC NORTHWEST NATIONAL LABORATORY

We are now approaching the north end of the campus of the Pacific Northwest National Laboratory at Horn Rapids Road.

- *To the right of the bus, you will see the PNNL facilities to the east towards the Columbia River and then further north in the Hanford Site 300 Area.*

HANFORD SITE SOUTHERN BOUNDARY

This is Horn Rapids Road, which makes up part of the southern boundary of the Hanford Site.

FRAMATOME RICHLAND FACILITY

On your left, we are now approaching the Framatome Operational Center of Excellence – manufacturing fuel products and related components and services for commercial pressurized water reactors and boiling water reactors worldwide.

- *The fuel produced in Richland accounts for five percent of the electricity generated in the United States.*
- *Regulated by the Nuclear Regulatory Commission, the facility has been in operation for more than 40 years under several corporate entities, and received the industry's first 40-year license renewal in 2009.*

COLD TEST FACILITY

On your right, we are approaching the Cold Test Facility.

- *Operated by Washington River Protection Solutions, the Cold Test Facility has served since 2002 as a non-hazardous, non-radioactive test site for new and innovative technologies used to safely remove high-level radioactive and chemical waste from Hanford's underground waste storage tanks.*

- *The open-topped steel tank is constructed to replicate the interior dimensions (75' diameter) of the majority of the tanks found in the Tank Farms.*
- *The adjacent control trailer allows for complete system testing as well as operator training on new technologies prior to deployment in an actual waste tank.*
- *Other engineering and fabrication firms – some local, some not – have played important roles in developing and testing tank farm equipment as well.*

HANFORD TANK FARMS BACKGROUND INFORMATION

During World War II, the Hanford Site began its mission to supply plutonium for the nation's nuclear weapons arsenal.

- *December 1942 – President Roosevelt authorized the Manhattan Project*
- *January 1943 – The Hanford Site was selected to produce plutonium, initiating a massive construction project focused around three plutonium production reactors, three reprocessing "canyon" facilities, and numerous supporting facilities and infrastructure.*
- *September 1944 – B Reactor began operations, irradiating uranium fuel to produce plutonium through transmutation.*
- *December 1944 – T Plant began operations to separate plutonium from the irradiated fuel using the bismuth phosphate method.*
- *The first tank farms, B, C, T, and U Farms, were located approximately ½ mile from their respective reprocessing canyons (Exception: C Farm. There never was a "C Canyon"). Each of these farms consisted of twelve large underground reinforced concrete tanks (capacity of 530,000 gallons each) and four smaller reinforced concrete tanks (capacity 55,000 gallons) – all with a single carbon steel liner on the sides and bottom of each tank – known as "single-shell" tanks.*
- *An entire tank farm was constructed at a time, beginning with the large excavation that would allow construction of all the tanks before backfilling to bury*

the tanks. At the bottom of the excavation, the reinforced concrete base mat for each tank was placed. Then the bottom of the carbon steel tank liner was welded together, followed by welding of the carbon steel side liner. Reinforcing steel was assembled around the walls of the tank. Concrete formwork was erected on the sides, and scaffolding and formwork was assembled inside the tank as well to support the formwork for the concrete dome of the tanks. Concrete was placed around the sides of the tank and across the top or dome. After curing, the formwork was removed from around the sides, and extracted from inside the tank through two construction openings near where the dome met the sides. Notice on the completed tank in the picture that there are only a very few openings or "risers" into the tank. This was characteristic of the earliest tanks, when they were built in a hurry, and the concern was more about getting waste in rather than retrieving the waste at a later date.

- *Only the most radioactive waste was sent to these underground tanks during the production years. From the forty-three years of production, approximately 450 millions gallons of reprocessing and other waste streams were sent to the Tank Farms. More than 400 billion gallons of contaminated waste streams were sent to ground.*
- *Over the course of the Cold War, there were five "generations" of single-shell tanks, growing in size from the initial 530,000 gallon tanks through 758,000 gallons to one million gallons in capacity. Some leak detection capabilities were designed into the later tanks – A and AX Tank Farms. The last of the 149 single-shell tanks was constructed by 1965.*
- *More than 60 of the single-shell tanks were confirmed or suspected of having leaked to the ground. The Waste Tank Summary Report in your tour packet is a great source of information on the waste in the tanks, which tanks underwent retrieval and when, and which tanks are confirmed or assumed leakers. The number has dropped from a maximum of 67 tanks as we've been able to do more analysis on process history for some of the tanks, and concluded that certain specific tanks had not developed liner leaks. Some of those that are now*

considered to be "sound" tanks have however been overfilled, sending some waste to the vadose zone in the vicinity of the tanks.

- *By 1968, Hanford began constructing the first of 28 double-shell tanks – a carbon steel tank inside of another carbon steel tank that provided secondary containment and improved leak detection capabilities. Each of the double-shell tanks has a capacity of slightly more than one million gallons with some holding up to 1.2 million gallons in the final Hanford tank farm – AP Farm – which was constructed by 1986.*
- *The first and only leaking double-shell tank – Tank AY-102 – is also the first double-shell tank constructed. The leak of waste from the primary tank was confirmed in 2012 and was contained by the secondary tank. The primary tank has been pumped to other double-shell tanks.*
- *The leak was confirmed through visual inspection of the 2.5 foot wide annulus space between the primary tank and the secondary tank. The primary tank sits on an 8-inch thick refractory pad inside of the secondary tank. This refractory pad, supporting the entire bottom of the primary tank, has slots constructed into the pad to allow the flow of cooling air from the very center underneath the primary tank to the outer parts where the air can then be exhausted from the annulus space. In Tank AY-102, moist crystalline deposits were found oozing from some of these air slots and accumulating in two locations in the secondary tank. The very slow leaks did not result in any standing liquids in the annulus space initially. When most of the contents of AY-102 had been transferred to other tanks however, then the sluicing retrieval method forced liquid through multiple leak sites on the bottom of the primary tank and a few inches of liquid temporarily rested in the annulus space around the entire primary tank.*
- *The 56 million gallons of waste in the Tank Farms consist of:*
    - *21 million gallons of supernate – chemically-saturated liquids at a pH greater than 12 – residing mostly in the double-shell tanks.*
    - *23 million gallons of saltcake – mostly soluble solids created through evaporation of tank liquids to save tank space.*
    - *12 million gallons of insoluble sludges.*

- *28.6 million gallons of waste – a little more than half of the total waste volume – reside in the single-shell tanks with approximately 90% of the waste consisting of saltcake and sludges.*
- *All production of plutonium at the Hanford Site concluded by 1997 with the shutdown of N Reactor.*
- *In 1989, the U.S. Department of Energy, along with the U.S. Environmental Protection Agency, and the Washington State Department of Ecology, signed the Hanford Federal Facilities Agreement and Consent Order, commonly called the "Tri-Party Agreement", dictating Site cleanup strategies and milestones. Nearly all Tank Farm-related cleanup efforts are subject to regulation by the Washington State Department of Ecology – with delegated Resource Conservation and Recovery Act or "RCRA" authority from the U.S. Environmental Protection Agency.*
- *The multi-decade single-shell tank stabilization effort, which concluded by 2005, transferred most of the pumpable liquids from the single-shell tanks into the safer double-shell tanks to reduce environmental risks from leaking tanks. There are still approximately three million gallons of interstitial liquids remaining in the single-shell tanks.*
- *Since that time, Tank Farm operators have found evidence of water intrusion into some of the single-shell tanks – with 22 tanks having confirmed water intrusion and 7 additional tanks with evidence of recent water intrusion.*
- *A portable tank ventilation exhauster fan was installed at single-shell tank T-111 after operators confirmed evidence of both water intrusion and recent waste leakage into the ground under the tank. The exhauster did remove some of the water in the tank through evaporation. Although discussions with the Washington State Department of Ecology are ongoing about potential options to remove water in other single-shell tanks, there are no current efforts in progress.*
- *Beginning in 1998, operators retrieved sludge wastes from the 16 tanks in C Farm to three double-shell tanks. C Farm closure negotiations are ongoing with the Washington State Department of Ecology. Retrieval of the saltcake waste in single-shell tank S-112 was completed several years ago.*

- *The primary method of retrieving the sludges in C Farm was "modified sluicing". Double-shell tank supernate (saturated liquids) was pumped from a double-shell tank in AN Farm through hose-in-hose transfer lines to the particular C Farm tank and sprayed through two sluicing nozzles – resembling fire hose nozzles that could be remotely directed to mobilize the sludge waste toward a pump suspended from the center of the tank. This pump in the single-shell tank transferred the slurry through hose-in-hose transfer lines back to the same double-shell tank in AN Farm that had supplied the supernate.*
- *This method could reliably retrieve 80 to 85% of the waste solids in a sludge tank, but the hard heel materials at the bottom of the tank were more difficult. Caustic dissolution was often used. The retrieval goal was to leave no more than 360 cubic feet (2,693 gallons) of residual material in the tank, an amount equating to a one-inch layer spread uniformly over the bottom of the tank.*
- *These retrieval efforts have led to the development of effective retrieval tools that will be used next in the AX and A Tank Farms. The timing of retrieval activities in these next two single-shell tank farms are governed by a court-ordered Consent Decree.*
- *We will discuss retrieval and closure plans in more detail out on the site.*
- *The complex waste in the Hanford Tank Farms varies greatly tank to tank – the result of three generations of fuel reprocessing, uranium recovery from tank waste, cesium/strontium recovery from tank waste, and numerous miscellaneous waste streams from other Site processes during the production years and early cleanup efforts.*
- *The Tank Farms as a whole are a Hazard Category 2 nuclear facility with an up-to-date Documented Safety Analysis and Technical Safety Requirements. The single-shell tanks and the double-shell tanks are considered to be in "interim status" from an environmental permitting standpoint. A "Revision 9" to the sitewide RCRA permit – that would describe the permit requirements for the double-shell tank system – has been in review and negotiation with the Washington State Department of Ecology for a few years.*

We will now don hard hats and safety glasses and walk down to the Cold Test Facility "tank". Please watch your step as we walk over gravel and uneven surfaces.

- *The trailer located next to this mock-up tank allows full system testing of the technologies developed and has been used to train operators on new equipment.*
- *This tank measures 75 feet in diameter, just like most of the Tank Farm underground tanks. The tank itself could hold approximately 660,000 gallons if filled with water (and it has never been filled like that), but bulk retrieval of liquids has never been the problem so this tank has been partitioned off and loaded with challenging simulants of the solids we encounter near the tank bottoms.*
- *Tank Risers, or pipes extending from grade-level to various depths in the tanks vary in size from 4 inches in diameter to 42 inches in diameter. The oldest tanks have the fewest risers, and in C Farm, all risers were 12 inches or smaller.*
- *Retrieval of sludge wastes in the C Tank Farm began with the use of sluicer nozzles – resembling fire hose nozzles – that could be pivoted to reach all parts of the tank. Two sluicers were deployed per tank using the 12 inch risers. A long multi-stage centrifugal pump suspended through a 12 inch riser in the center of the tank would pump the slurry to a double-shell tank. This method would generally retrieve roughly 80-85% of the single-shell tank contents.*
- *The Tri-Party Agreement retrieval goal however was to retrieve all wastes so that no more than 360 cubic feet (or 2,693 gallons) remained. That would look like a one-inch layer uniformly coating the bottom of the tank.*
- *Additional work was required to retrieve the "hard heel" waste at the bottom of the tanks. Most often, caustic dissolution (adding 19M NaOH) was used effectively to dissolve hard heels and retrieve more of the waste.*
- *To deploy new large retrieval technologies, a 55 inch diameter hole was cut in the domes of Tanks C-105 (using a hole-saw type of technology) and in C-107 (using a very high pressure water/garnet abrasive mix). New 52 inch risers were installed in the center of each of these tanks.*

- *The Mobile Arm Retrieval System or MARS was deployed in these larger risers – and the MARS consisted of a strong central mast and central pump, and a telescoping arm with a sluicing end effector (in Tank C-107) and a vacuum end effector (in Tank C-105), designed to reach all parts of the tank for more effective retrieval. While somewhat effective, technology development continued and led to the Enhanced Reach Sluicing System on display here – a lighter, less expensive telescoping sluicing tool that would fit down a 12 inch diameter riser. These have now been successfully deployed in a few C Farm tanks, and will be used as we transition to retrieving AX Farm wastes.*
- *The "bulldozer" device you see across the tank was an early prototype of a mechanical retrieval tool. It was never deployed in an actual tank, but it inspired other tools such as the FoldTrack – a "bulldozer" type of tool that could "unfold" to fit down a 12 inch riser, and then fold back together "transformer-style" to move waste residuals at the end of a tank retrieval campaign. The FoldTrack could move waste with a blade or the high pressure water jet. This device was deployed first in a C Farm tank, but the "tank tracks" fell off fairly quickly, reducing the effectiveness. Improvements were made and the second deployment in another C Farm tank worked better.*
- *The first superstructure level you see above simulates grade level over some of the older single shell tanks, while the upper superstructure level would simulate grade level over our higher capacity and deeper single-shell and double-shell tanks.*
- *Retrieval technology development continues with not-yet-deployed tools such as:*
    - *The Mechanical Waste Gathering System – a larger "bulldozer" style machine with cutting elements for difficult solids and a vacuum collection vessel for use in leaker tanks. It requires a 42 inch riser to access the tank.*
    - *The Hanford Waste End Effector uses a confined sluicing and waste conveyance approach that minimizes any standing liquids while retrieving solids in a potentially leaking tank. This end effector could be deployed on a telescoping arm.*

- *The dirt and debris you see in the bottom of this mock-up tank are leftover simulants from testing. Waste solids simulants varied from dirt and gravel-like materials, clays, and even low-strength grout.*

To the west of the Cold Test Facility lies the Volpentest HAMMER Federal Training Center. Originally, the HAMMER acronym was derived from Hazardous Material Management and Emergency Response.

- *This 88-acre multi-featured campus, dedicated in 1997, is operated by Mission Support Alliance for the Department of Energy. HAMMER represents a partnership of Federal, Tribal and State governments, Labor, the Tri-City Development Council, academia, and industry – and has served international clients as well.*
- *Staffed with a broad mix of the Hanford work force, HAMMER fulfills many vital training needs for tank farm operators and maintenance personnel using a combination of classroom and hands-on training with life-size, realistic props.*

As we travel north on Route 4 South towards the operating areas of the Hanford Site, we will point out features of the 586-square-mile of the Hanford Site that you may have heard about or seen for yourself.

The Hanford Site has operating areas, industrial sites that occupy about 6 percent of the site. About 4 percent of the Site is surface contaminated, and 30 percent of the Site overlays contaminated groundwater from the past production of defense nuclear materials.

300 AREA

On your right is what remains of the 300 Area operating area. It had three main functions:

- *Fabricating metal fuel for Hanford's nine nuclear reactors that operated in the north end of the Hanford Area along the river. Approximately 20 million fuel elements were produced and irradiated in the reactors.*
- *Performing chemical research to improve the entire plutonium production process.*
- *Conducting life-sciences research into the effects of radioactive hazardous materials on living organisms.*

Most of the 300 Area facilities and underlying waste sites have been cleaned up. Overall, 208 buildings have been demolished and 304 waste sites cleaned up, with the rubble and contaminated soils transported to a very large lined disposal trench called the Environmental Restoration Disposal Facility or ERDF.

RATTLESNAKE MOUNTAIN

On your left is Rattlesnake Mountain and the Arid Land Ecology Reserve (ALE), and on your right across the Columbia River is the Wahluke Slope and Saddle Mountains, forming the boundary of the site.

No nuclear activities were conducted on these areas. These areas have an abundance of wildlife. The Hanford Site is home to mule deer, elk, coyotes, badgers, rabbits, skunks, bald and golden eagles, herons, ducks, ground squirrels, several species of mice, lizards and three species of snakes.

Rattlesnake Mountain and the Wahluke Slope are part of the Hanford Reach National Monument, which is managed by the U.S. Fish and Wildlife Service (USFWS).

- *Rattlesnake Mountain is 3,600 feet high -- just a bit higher than the summit of Snoqualmie Pass in the Washington Cascades. The highest winds recorded on Rattlesnake by Hanford's meteorology equipment were about 150 mph.*

- *Old buildings on Rattlesnake Mountain have been demolished and removed as part of Hanford cleanup.*
- *On ALE, USFWS has maintenance facilities located at the 1200 foot level. Energy Northwest (ENW) operates a newer commercial communication facility at the top that supports Government and community communication services.*

618-10 BURIAL GROUND

On your left is the 618-10 Burial Ground

- *The entire 618-10 Burial Ground was cleaned, sampled, characterized and completed by September 2018.*
- *From 1954 through 1963, the 7.5-acre 618-10 Burial Ground received radioactive waste generated from Hanford's 300 Area laboratories and reactor fuel development facilities.*
- *Workers completed the retrieval of 2,201 drums from the trenches and 80 Vertical Pipe Units were removed. A Vertical Pipe Unit resembled five 55-gallon drums welded together to form a long disposal tube for highly radioactive waste*

ENERGY NORTHWEST

On your right is Energy Northwest's Columbia Generating Station.

- *DOE leases land to Energy Northwest (ENW) who owns and operates the Northwest's only operating commercial nuclear power plant, the Columbia Generating Station, which produces electricity for the Bonneville Power Administration. This boiling water reactor began commercial operations in 1984.*
- *Energy Northwest is not affiliated with Hanford cleanup.*
- *Columbia Generating Station produces slightly more than 1,200 megawatts of electricity --enough electricity to serve the needs of a city the size of Seattle.*
- *Construction of two pressurized water reactors began here as well in the 1970's, but stopped in the early 1980's due to economic and regulatory uncertainty. More than 20 reactor projects across the country were halted in this timeframe.*

400 AREA

On your left is the 400 Area.

- *The 400 Area is where the deactivated Fuels and Materials Examination Facility (FMEF), and Fast Flux Test Facility (FFTF) are located and managed by CH2M. Both the FMEF and FFTF facilities have been placed in long-term shut-down and surveillance.*

FAST FLUX TEST FACILITY (FFTF)

- *The FFTF is the domed facility which became fully operational in late 1982 and was designed to test fuel and materials for America's "breeder" reactor program, and to be a bridge to a newer, non-defense role for Hanford. The reactor used primary and secondary coolant loops filled with liquid sodium metal.*

- *This facility had successful operations for 10-years in performing a variety of research and testing programs on nuclear fuel, materials and equipment for nuclear systems. This breeder reactor program concept was terminated in 1993, and the reactor was defueled by 1995.*
- *DOE considered alternate operations of the FFTF reactor to produce tritium for national defense needs and medical isotopes for treating cancer and other ailments, but by the year 2000, DOE announced that FFTF would be closed permanently. Major deactivation work, such as draining the liquid sodium metal, was completed by 2009.*
- *The Fuels and Materials Examination Facility was never used for nuclear operations, but the Maintenance and Storage Facility has been used successfully to house mockup equipment for testing sludge retrieval and packaging equipment as part of the K Basins cleanup effort.*
- *Today the FFTF is kept in a safe configuration. The FFTF complex will be one of the last to be demolished at Hanford.*

WYE BARRICADE

We are approaching the Wye Barricade – our security entrance onto the Hanford Site. Even though Hanford no longer has a defense-production mission, there are still assets from valuable property to nuclear material that require protection.

- *The Wye Barricade is one of three perimeter access control points to the central portion of the Hanford Site. The other perimeter access control points are the Yakima Barricade – where Highway 24 and Highway 240 meet, and Rattlesnake Barricade, accessible further south from Highway 240. Access to the balance of the Hanford Site for the Arid Lands Ecology Reserve, the Wahluke Wildlife Area, and Saddle Mountain National Wildlife Refuge is controlled by the U.S. Fish and Wildlife Service, and DOE.*
- *The Wye and Yakima Barricades are staffed 24-hours a day, 7 days a week, 365 days a year.*
- *Beyond the Wye Barricade, the Central Plateau includes the 200 Areas, which includes activities associated with facility decontamination and demolition, waste site remediation, tank waste operations and construction of the Waste Treatment Plant. Further beyond the Central Plateau are the 100 Areas for the production reactors.*

200 AREAS

We are now approaching central Hanford, also known as the 200 Areas or the Central Plateau – where the groundwater is between 250-300 feet below grade.

- *During World War II, the 200 West and 200 East areas were constructed. During the production years, 200 West had three processing plants, initially T Plant (first generation reprocessing) and U Plant (excess capacity and never used for plutonium separation), followed a few years later by the REDOX plant (second generation reprocessing). 200 East began with B Plant (also first generation),* *and then by 1956, the PUREX plant (third generation – outperforming all the rest).*

- *In these reprocessing plants or "canyons" (due to their box canyon appearance inside) irradiated fuel from the 100 Area production reactors was chemically processed to separate and recover plutonium for use in nuclear weapons.*
- *The 222-S Laboratory originally began operations in 1951 as the process control laboratory for the REDOX plutonium separations plant. The laboratory is a 70,000 square foot full-service analytical facility that handles highly radioactive samples for the purpose of organic, inorganic, and radio-chemistry analyses.*
- *B Plant, U Plant, PUREX, and REDOX are shut down. The re-purposed T-Plant is still active as a waste management facility, and it is the oldest active nuclear facility in the United States.*
- *T Plant stores sludge removed from the K West Basin at Hanford. It has not conducted plutonium processing since 1956.*
- *We will see these facilities along with their related tank farms, and other Hanford facilities as we travel through the 200 Areas.*
- *Hanford has over 880 aging facilities that will require demolition as part of the overall Hanford cleanup strategy. Many of these are classified as nuclear facilities with associated documented safety analyses and controls specified in technical safety requirements. Funding limitations generally require prioritization of cleanup activities to those facilities that pose the greatest risk and return on investment. Therefore, lower priority excess facilities cleanup will be deferred and these must be monitored periodically to ensure they remain in a condition protective of the workers, the public, and the environment.*

WASTE TREATMENT AND IMMOBILIZATION PLANT

To the right of the bus you will see the construction site for the Hanford Waste Treatment and Immobilization Plant (also called WTP or the Vit Plant), which is DOE's largest construction project.

- *As stated earlier, the Vit Plant is being designed, built, and commissioned by Bechtel National, Inc. for DOE. Its purpose is to immobilize in glass much of the 56 million gallons of liquid radioactive waste stored in 177 aging underground tanks.*
- *Vitrification involves mixing radioactive wastes with glass-forming materials and heating them in a high-temperature melter. The process incorporates the waste into the glass itself. It is poured into canisters and allowed to cool and solidify – locking the radioactive material and other hazardous constituents in the glass to protect the environment.*
- *The low-activity waste containers (7.5 feet tall and 4.5 feet in diameter) will be transported for permanent disposal at the Integrated Disposal Facility (already constructed), which is an engineered trench complete with liners and leachate collection systems located southwest of the PUREX facility on the Hanford Site.*
- *Estimates from process modeling show that somewhere between 80,000 and 150,000 containers of immobilized LAW glass could be produced.*
- *The Integrated Disposal Facility is operated by the CH2M Hill Plateau Remediation Company.*
- *The high-level waste canisters (14.5 feet tall and 2.5 feet in diameter) will be stored at Hanford in a separate facility (not yet built) until a national repository is identified to receive Hanford's high-level waste. Production estimates for the immobilized HLW canisters produced range from 8,000 to 12,000.*
- *Three transfer lines currently extend from the Tank Farms to the west end of the large Pretreatment Facility to deliver tank waste to WTP for pretreatment followed by vitrification.*

PUREX PLANT

Notice the very large, concrete canyon facility approaching on your left. The PUREX Plant, which operated from 1956 until 1988, separated out 75% of the plutonium created in Hanford's production reactors. The canyon was deactivated by 1997.

During the production years, two tunnels were used to store highly-radioactive, failed equipment from the canyon. The equipment was remotely loaded on to rail cars and rolled into the tunnels.

In 2017, Tunnel #1 experienced a partial collapse, and the tunnel was filled with flowable grout to stabilize it and prevent further collapse. Evaluation of the much longer Tunnel #2 indicated substantial risk of collapse as well, and grouting activities for this tunnel began in 2018. An estimated 5,000 truck shipments of grout are required to fill Tunnel #2.

274 AW (Central Shift Office)

To your right is Building 274AW. It houses the Central Shift Office where the Shift Manager controls the release of work activities in the Tank Farms, and provides initial emergency response management for Tank Farm events. Across the hall from the Central Shift Office is a large Tank Farms Consolidated Control Room. Substantial upgrades within the past 10 years have led to this modern monitoring and control station with real time access to Tank Farm system lineups; waste transfer status; safety system operability; tank temperature, pressure, waste level, and alarm systems; and tank vapor release instrumentation.

AP FARM

The construction of the AP Tank Farm was completed in 1986. It's eight double-shell tanks have a maximum capacity of 1.2 million gallons each – up from the original capacity of 1.12 million gallons after seismic analysis supported holding more waste.

- *What you are observing across AP Tank Farm is removal of an obsolete long-length transfer pump from the AP-02D pit, above double-shell tank AP-102. One crane is used to extract the pump while simultaneously enclosing the pump in yellow plastic. The other crane will be used to attach a line to the middle of the* *pump and then carefully rotate the pump from vertical to horizontal, lowering the pump into a long transportation box.*

- *One of two primary tank exhaust fans is running at all times to maintain the tanks at a negative pressure with respect to atmosphere, and to evacuate the hydrogen produced by radiolysis. The primary tank headspace air is pulled through two stages of HEPA filtration, and the exhaust stack is monitored for radionuclides to ensure the effectiveness of the filtration system.*
- *The alarm you just heard comes from the pressurization alarm system. When the negative pressure that is normally maintained in the tanks approaches atmospheric pressure, this alarm notifies workers. It is not unusual for this alarm to sound when performing operations such as extracting a pump from a tank.*
- *One of two annulus tank exhaust fans is also running at all times, pulling air through the cooling slots in the eight-inch thick refractory pad running underneath the primary tank and up and out of the 2.5 foot wide annulus space between the side walls of the primary and annulus tanks. This air also passes through two stages of HEPA filtration and the exhaust stack is monitored.*
- *Level sensors in the normally dry annulus tank are online at all times to detect any substantial leakage from the primary tank to the annulus.*
- *Tank integrity testing using remotely controlled ultrasonic testing equipment has been performed for years, but only on the sidewalls of the primary tank. More recently, advances in technology led to a couple tethered tools with cameras and qualitative thickness testing equipment that have been able to traverse the air cooling slots in the refractory pad between the primary and annulus tank, providing a new level of tank examination that will aid in maintaining the operability of these tanks for many years.*

TANK FARM VAPORS

Beginning in 2014, Tank Farm workers expressed increased concern with their potential exposure to chemical vapors from the underground waste storage tanks. Efforts to *better characterize headspace vapors and re-evaluate protective measures were not new, but in the past few years, more has been accomplished than during prior efforts.*

- *DOE collaborated with contractor management and workers as well as outside entities such as the National Institute for Occupational Safety and Health (NIOSH), the Office of Inspector General, the DOE Office of Enterprise Assessments, a Vapor Management Expert Panel and others to develop new strategies and cutting-edge techniques for vapor monitoring and protection of workers, and to ultimately reach a settlement agreement with Washington State and the labor union.*
- *The immediate action was to have workers use Self-Contained Breathing Apparatus (SCBA) or supplied air for all tank farm entries, while characterization activities ramped up.*
- *AP Tank Farm became a test bed for deployment of infrared absorption vapor detection techniques (point to towers) as well as more sophisticated area monitors, vapor grab sampling technologies, and worker notification systems with new loudspeakers in all farms.*
- *Successful testing of air-purifying respirator cartridges has recently resulted in relaxing the previous 100% SCBA use requirement for some activities, but the longer term plan is for better use of engineered controls that prevent worker vapor exposure rather than reliance on personal protective equipment.*
- *The industrial hygiene program has increased staffing levels dramatically to produce a program on par with the radiological protection program for work in the Tank Farms.*

DIRECT FEED LOW ACTIVITY WASTE

Nearly since the beginning of construction of the Waste Treatment and Immobilization Plant, DOE has contemplated the potential startup of the Low Activity Waste vitrification facility in advance of the more complex Pretreatment facility and the High-Level Waste vitrification facility. By design however, the Low Activity Waste facility is intended to *receive liquid-only feed streams that are mostly decontaminated from the principal contributors to Tank Farm radioactivity – the fission products strontium and cesium. Prior efforts to provide this feed stream without using the huge Pretreatment facility never progressed beyond conceptual design until this most recent effort, commencing with the Direct Feed Low Activity Waste program in 2013.*

- *Technical issues with the Pretreatment facility, and to a lesser extent with the HLW facility, stalled design and construction on these facilities, leading to the Secretary of Energy decision to begin a phased startup of WTP facilities, beginning with the LAW facility.*
- *The Low-Activity Waste Pretreatment System capital project began with crossflow filtration and elutable ion exchange – essentially identical technologies to what would be used in the large Pretreatment facility. This project, which included substantial tank farm and transfer line upgrades, has been managed by Washington River Protection Solutions.*
- *At 75% design however, the cost of this 40-year design life permanent facility and supporting systems was on pace to double the original upper range for Total Project Cost set in 2015.*
- *A smaller modular approach using non-elutable ion exchange (crystalline silico-titanate or CST) was adopted at the beginning of fiscal year 2018 to obtain Low Activity Waste feed sooner and at much lower cost.*
- *This effort builds on the Tank Closure Cesium Removal module constructed in Richland, Washington for the Savannah River Site. The TCCR module is just now beginning operations on Tank 10H.*
- *This effort is now called Sub-project 1 of the Low-Activity Waste Pretreatment System project. The Tank Side Cesium Removal system module has a five year life. Temporary hose-in-hose transfer lines will connect the TSCR module to selected AP Farm tanks – AP-107 to feed tank waste to the TSCR module, AP-106 to receive and store the pretreated feed from the TSCR module, and AP-108 to receive system flushes.*

- *Pretreated feed will be sent in 9,000 gallon batches from tank AP-106 to the WTP LAW facility once or twice a day, and the waste will be immobilized in glass, and the glass containers will be disposed of in the Integrated Disposal Facility.*
- *Similar to Japan's experience with the Fukushima cleanup efforts, ion exchange columns with spent ion exchange media will be dried, removed from the module, and stored on a concrete pad for future disposition. The ion exchange media could be mixed into the WTP HLW feed stream but no efforts have begun on that front.*
- *Besides completing construction and startup of the WTP LAW and Laboratory facilities and approximately 20 supporting systems and facilities, Bechtel National, Inc. is constructing the Effluent Management Facility to process melter off-gas streams from the LAW vitrification facility that would have been otherwise processed in the large Pretreatment facility if it was available.*
- *Beginning in 2021, after the TSCR module begins operation, a new alternatives analysis of longer term LAW feed options will commence to determine the path forward for Sub-project 2 of the LAWPS project.*

HIGH LEVEL WASTE VITRIFICATION FACILITY PLANS

Under the court-ordered Consent Decree, the WTP High Level Waste vitrification facility must start up by 2033. Discussions are ongoing with Washington State Department of Ecology to determine potential strategies to start the HLW facility without the availability of the large WTP Pretreatment facility.

AX and A FARM RETRIEVAL INFRASTRUCTURE

Single-shell tank farms do not have active ventilation systems. Each tank has a HEPA filter attached to a tank riser to allow diffusion of any generated gases, and to allow equalization of tank pressure with atmospheric pressure – hence, these filters are referred to as "breather" filters.

For single-shell tank retrieval efforts however, active ventilation is required for the specific tank undergoing construction in preparation for waste retrieval or for active retrieval – for contamination control and for visibility in the subject tank while sluicing is in operation.

Notice the two "portable" exhausters on your left at the top of the sloped surface that surrounds AX farm. These are part of the extensive infrastructure upgrades necessary to support the retrieval of single-shell tank wastes to the double-shell tanks.

These infrastructure upgrades in the AX Farm, and also in the A Farm, require many construction workers. The older, smaller change trailers, such as the one you saw outside of AP Farm are inadequate to process workers into and out of the tank farms in a timely manner, so large "change tent" structures have been tucked into available spaces along the fence-line of this relatively congested area. Most of this work entails workers using SCBA, so bottle-changing stations use part of the space in the large tent, too.

242-A EVAPORATOR

The 242-A Evaporator is the only operating Tank Farms evaporator, and it is critical to the safe management of Hanford's double-shell tank inventory while making room for single-shell tank retrievals into the double-shell tanks.

- *It began operating in 1977 to reduce the volume of waste stored in Hanford's underground tanks. As such, it has reduced the total volume of waste in Hanford's tanks by more than 87 million gallons.*
- *The 242-A Evaporator is a Hazard Category 2 nuclear facility with its own Documented Safety Analysis and Technical Safety Requirements. It is permitted under the current revision of the sitewide RCRA permit.*

- *Waste is stage in double-shell tank AW-102 (across the street from 242-A). During an evaporator campaign, waste is pumped from AW-102 into the evaporator recirculation loop.*
- *The loop is heated by steam from the adjacent package boiler – operated by Johnson Controls under an Energy Savings Performance Contract until 2021 after which Tank Farms will take possession of the package boiler and operate it.*
- *The evaporator vessel, commonly called the "pot" is kept under vacuum so the waste boils at approximately 125ºF. Evaporator "overheads" are condensed and pumped to the Liquid Effluent Retention Facilities for later treatment in the Effluent Treatment Facility. Evaporator slurry "bottoms" are periodically sampled during campaigns, and when the specific gravity reaches a pre-determined point, the slurry is pumped to another double-shell tank, typically AW-106.*
- *The Evaporator has undergone extensive upgrades and repairs, and will continue to need further life-extension upgrades to maintain its availability for many more years.*
- *Currently, the 242-A Evaporator is out of service pending repair/replacement of the PB-1 and PB-2 pumps. Those pumps are expected to return to service in 2019. Additionally, the slurry transfer lines from 242-A back to the AW Tank Farm recently failed their encasement pressure checks, rendering the lines out of service due to lack of verifiable secondary containment. Efforts to design replacement slurry lines have begun with replacement potentially requiring two years.*

A TANK FARM – RETRIEVAL PREPARATIONS

The A Tank Farm was the second-to-last single-shell tank farm constructed. Designed to handle high-heat first cycle reprocessing waste from the PUREX Plant, the tanks had four air-lift circulators to mix the waste in hopes of preventing high heat sludges from accumulating at the bottoms of the tanks and compromising tank integrity. An airlift circulator is a 24-inch diameter pipe suspended from the top of the tank and anchored at the bottom. It's completely submerged in the waste and open at the top and bottom.

Air lines running inside this airlift circulator tube emit air bubbles at the bottom of the tube, and as the air bubbles rise, they entrain waste solids and liquids and provide a way to keep the tank contents circulating from the bottom, up through the circulators and out the top of the circulators.

- *In the case of Tank A-105, that strategy did not work. In January 1965, Tank A-105 underwent a pressurization event between the steel liner and the concrete bottom of the tank due to excessive waste temperatures at the bottom of the tank that bulged the bottom liner of the tank, ripping it from the sidewalls for approximately ¾ of the circumference. Very little waste remains above the bottom liner, and no technology has been identified to retrieve any waste solids under the bulged bottom liner.*
- *Following retrieval of AX Farm tanks, A Farm tanks are next, and infrastructure preparations such as installation of new portable exhausters is already in progress.*
- *One of the challenges experienced in the AX Farm tanks has been the removal of obsolete items such as thermocouple trees from risers. After decades of exposure to extreme conditions, these old pieces of equipment are often very difficult to remove – hampering installation plans for the new retrieval equipment. These difficulties are expected in A Farm as well.*

AX FARM – RETRIEVAL PREPARATIONS

DOE is pursuing retrieval of waste from the four AX Farm tanks and from 5 of the 6 A Farm tanks to meet the requirements of the court-ordered Consent Decree.

- *Tank AX-102 is scheduled to begin retrieval operations by the end of fiscal year 2019, with Tank AX-104 to follow. Both of these tanks have relatively low quantities of waste in them prior to any retrieval efforts (AX-102 has 31,000 gallons, and AX-104 has 5,000 gallons.)*

- *Lessons learned from C Farm retrievals are being applied to AX Farm preparations in that all the necessary infrastructure to efficiently move from one tank retrieval to the next is being installed up front. The most effective technologies used in C Farm, such as the Enhanced Reach Sluicer System will be used in AX Farm.*
- *Complicating retrieval efforts somewhat are the 22 air-lift circulators installed in each of the AX Farm tanks. If necessary, these obstructions are expected to be overcome by using more than just two sluicers per tank as was deployed in C Farm, where there were no air-lift circulators.*

AY FARM and AZ FARM

AY Farm, with its two tanks, was the first double-shell tank farm. AZ Farm, also with only two tanks, was the second double-shell tank farm in the 200 East Area (200 West Area SY Farm with three double-shell tanks was constructed during the same time as AZ Farm). Each tank has a one-million gallon capacity.

- *Both of these farms were designed to handle high heat first cycle reprocessing waste from the PUREX Plant. Each tank has 22 air-lift circulators to mix tank solids and help prevent tank overheating from the self-boiling waste.*
- *Tank AY-102, the first double-shell tank constructed, endured numerous construction difficulties requiring the reworking of many welds.*
- *In 2012, Tank AY-102 was confirmed to have leaked waste from the primary tank to the secondary tank, and waste crystals could be observed as having oozed from the cooling slots in the refractory pad under the primary tank. Per a Consent Order from the State, Tank AY-102 was pumped to two other double-shell tanks. Investigation of the primary tank bottom revealed several areas of general and pitting corrosion.*
- *The two AZ Farm tanks are the hottest radiologically and thermally in the Hanford Tank Farms.*

- *In the mid-1990’s, two 300-horsepower mixer pumps were installed in Tank AZ-101 to determine how well the approximately two feet of sludge in the bottom of the tank could be mobilized – in anticipation for having to transfer such slurries to the WTP. The testing was successful, but no additional mixer pumps have yet been added to any other double-shell tanks.*
- *The buildings we walked by to get to this viewpoint are a replacement ventilation system constructed in the mid-1990s for these hotter AY Farm and AZ Farm tanks. This ventilation system has higher heat removal capabilities than the ventilation systems in use at the other double-shell tank farms.*

AN FARM

AN Farm, with its seven tanks, was completed in 1981. Each tank has a capacity of 1.12 million gallons.

- *Tanks AN-101 and AN-106 were used as receiver tanks for most of C Farm single-shell tank retrievals, and now have more sludge than any other double-shell tanks.*
- *Tanks AN-102 and AN-107 have “complexed” waste with the result that significant quantities of strontium are dissolved in the supernate instead of residing in the solids in most other tanks. These tanks may require special treatment prior to sending to WTP. Consequently, no transfers into or out of these tanks has occurred for decades to avoid mixing and spreading the difficult waste further.*
- *Tanks AN-103, 104, and 105 all have the largest saltcake quantities of any double-shell tanks. These tanks tend to retain hydrogen and other gases generated through radiolysis and chemical decomposition, and could be prone to large episodic releases of hydrogen gas if disturbed. Therefore, no waste transfer activities have occurred in these tanks for a very long time (decades).*

C FARM

The C Farm location is somewhat unusual in that it was built during World War II, but unlike the other WWII farms (B, T, and U), there is no C Canyon facility (there had been one on paper but never constructed). However, with the Hot Semiworks – a pilot plant for the REDOX Plant and PUREX Plant – nearby, and then with PUREX starting up in 1956, the farm was used to store sludge wastes.

- *The first modern single-shell tank retrieval occurred in Tank C-106 beginning in 1998 after a few years of preparation to remove obsolete equipment and contaminated soils from the pump and valve pits above the tank so new equipment could be installed. Tank C-106 was a high priority because it contained six feet of high heat sludge, requiring the addition of 6,000 to 8,000 gallons of water monthly to keep the waste temperatures down (through evaporation). It was one of only two single-shell tanks under active ventilation (the other being C-105). Using a new ventilation system, high capacity 300 gpm sluicers, and permanent pipe-in-pipe transfer lines, most of the sludge was transferred to Tank AY-102. Later campaigns used oxalic acid to dissolve hard heel, but oxalates could pose potential difficulty for WTP so oxalic acid has not been used any further. All of the retrieval efforts combined exceeded $100 million in costs. Every retrieval since C-106 has used lower capacity 100 gpm sluicers and hose-in-hose transfer lines to reduce costs, with equal effectiveness.*
-
- *When retrieving the sludges in C Farm, supernate from the AN Farm receiver tanks was used as the motive force, creating a closed loop between the C Farm tank being retrieved and the AN Farm receiver tank (either AN-101 or AN-106). Because the sludges are insoluble, it doesn't matter that the supernates are already chemically saturated.*
- *The same does not apply for saltcake retrieval however. Saltcake must be dissolved with clean water to effectively move it. Therefore, although we typically use the "56 million gallon" figure to describe the approximate volume of all of our*

tank waste, the "retrieved volume" is over 150 million gallons, using current techniques, because of all the clean water that would need to be added to dissolve the saltcake. Many 242-A Evaporator campaigns will be required to remove the extra water and maintain the waste inventory with the double-shell tanks that are available.

- *When looking at the before-retrieval and retrieval-in-process photographs of C Farm, you can see the enormous amount of added equipment. Because we tried multiple technologies in C Farm and progressed from tank to tank not in consecutive order, the arrangement looks highly variable and cluttered. There's exhauster units, hose-in-hose transfer line shield blocks and cover plates, portable transfer pits, hydraulic power units, ventilation ducting, and more.*
- *We will use the effective technologies from C Farm to design and install all the need infrastructure up front in AX and A Farms, moving more efficiently from tank to tank to retrieve waste.*

WASTE MANAGEMENT AREA C CLOSURE ACTIVITIES

Washington State Department of Ecology has already approved the Corrective Measures Study and the RCRA Facility Investigation. Other closure-related assessments and Tier 1 ,2, and 3 closure plans have been reviewed by Ecology, and comment resolution is in progress. Document revisions are likely.

A Waste Management Area C performance assessment has been completed, feeding into the Draft Waste Incidental to Reprocessing Determination, which is under review by the Nuclear Regulatory Commission. Both documents will likely require revision.

The 2013 Record of Decision to our 2012 Tank Closure and Waste Management Environmental Impact Statement stated that DOE's preferred path is to perform landfill closure of the single-shell tank farms. This involves void-filling the empty tanks with grout and installing suitable barrier caps over the farms. The topic is controversial *among our stakeholders, some of whom want entire tank removal and vadose zone cleanup.*

To move ahead with closure field activities, DOE must issue a final WIR Determination and Ecology must issue a RCRA permit (through the Class 3 permit modification process, including public participation).

Take a look at these “before” and “after” pictures of C Farm. Single-shell tank retrievals require an enormous amount of added equipment that must be removed prior to waste management area closure.

TRENCH 94 – NAVY REACTOR COMPARTMENT TRENCH

Trench 94 on your left houses over 100 de-fueled reactor compartments removed from decommissioned ships and submarines. The horizontal shapes are from submarines, and you are looking at the actual outer hull of the submarine, with the front and back end of the sub removed and the ends capped. The vertical shapes are reactor compartments from Navy cruisers, and these had to be constructed around each reactor compartment for shipping. This work is done at the Puget Sound Naval Shipyard. The hulk is loaded onto a barge and towed down the coast and up the Columbia River to the north end of Richland where it is loaded on to a trailer and towed to this trench for placement – all at the Navy’s expense.

LIQUID EFFLUENT RETENTION FACILITY / EFFLUENT TREATMENT FACILITY

The Liquid Effluent Retention Facility, known as LERF, and the Effluent Treatment Facility (ETF) work in concert to stage and treat mixed low-level liquid wastes. Together LERF/ETF is a less than Hazard Category 3 facility.

- *The LERF is permitted by the State of Washington and has three 7.8 million gallon liquid storage basins (polyethylene bladders) designed to hold a total of* *about 23,400,000 gallons of material. This aqueous waste includes process condensate from the 242-A Evaporator and other aqueous waste generated from onsite remediation and waste management activities.*

- *The basins and treatment facility have been in operation since 1995. Looking forward, the Tank Farms and the WTP will use nearly all of the ETF capacity. Two of the three large LERF basins are currently full. A fourth surface impoundment is available next to Basin 42 and is under consideration for installation of the necessary liners and cover to expand the storage capability during ETF outages. This capability is very important. For the WTP to operate, there has to be a storage and treatment location for the millions of gallons (annually) of dilute liquids produced by the melter off-gas treatment systems.*
- *Due to the age of the facility, throughput rate has averaged approximately 4 million gallons per year, but needs to increase to 8-10 million gallons per year to support Direct Feed Low Activity Waste Operations. A number of equipment replacements and upgrades are under review as well as the best timing – meaning should there be a lengthy outage now to get several items done at once, or should there be periodic, briefer outages between routine treatment campaigns?*
- *To assure continuous availability at LERF, workers replaced the basin floating covers (after more than 20 years of service) with new floating covers on Basins 42 and 43. Basin 44 cover replacement is expected to be completed in 2019. The ETF's primary treatment train removes or destroys radioactive and dangerous waste components from the aqueous waste. The primary treatment train consists of the following processes:*
    - *Influent Receipt/Surge tank: inlet, surge capacity.*
    - *Filtration: for suspended solids removal.*
    - *UV/OX: organic destruction.*
    - *pH adjustment: waste neutralization.*
    - *Hydrogen peroxide decomposition: removal of excess hydrogen peroxide.*
    - *Degasification: removal of carbon dioxide.*

    - *Reverse Osmosis: removal of dissolved solids.*
    - *Ion Exchange: removal of dissolved solids.*
    - *Verification: holding tanks during verification*
- *In the secondary treatment train, the waste components are concentrated in an evaporator and dried into a powder. This powder is collected into waste drums, and disposed of in the Environmental Restoration Disposal Facility. DOE is interested in alternative disposition paths, using a commercial facility or capability to immobilize either the secondary train slurry or dried powder, for disposal in the Integrated Disposal Facility on the Hanford Site.*
- *Once the waste water has been treated through the ETF, it is stored until tests confirm that various radioactive and hazardous contaminants have been removed or lowered to acceptable levels for discharge. The treated effluent is then discharged to the State-Approved Land Disposal Site (SALDS) north of the 200 West Area. The Effluent Treatment Facility does not remove tritium but the SALDS is located such that any tritium that enters the groundwater has time to decay (with its 12.3 year half-life) prior to entering the Columbia River.*
- *Separate from these treatment processes is the Treated Effluent Disposal Facility (TEDF) – east of the Effluent Treatment Facility. The TEDF receives already treated, non-radioactive, and non-hazardous effluent, for example from cooling water systems, collected via pump stations located in the 200 East and West areas. This treated effluent is discharged to the two state-approved infiltration basins that comprise TEDF.*

B, BX, BY TANK FARMS

To your left is the B Tank Farm, constructed during World War II, with its 12 530,000 gallons tanks and four 55,000 gallons tanks.

- *The sludges in the four small 200 series tanks (B-201 through B-204) have been characterized as containing transuranic waste instead of high-level waste. There has been consideration for years as to whether to retrieve, dry, and package the* *waste for shipment to the Waste Isolation Pilot Plant, or follow the WTP path like most of the rest of Hanford tank waste.*

- *BX Farm and BY Farm are expansion farms – each with 12 large tanks. BX Farm has the 530,000 gallon tanks while BY Farm tanks can hold up to 758,000 gallons.*
- *The pink object in the BY Farm is part of an old In Tank Solidification system. Tank waste was heated in the above-ground equipment to raise the tank temperatures closer to boiling. Water vapors from the underground tanks were condensed and discharged to the soil column. In this manner, excess water was removed from the tank waste, freeing up valuable tank space.*
- *The building to the east of B Farm is an earlier generation of tank waste evaporator that has not operated since the 1970's. It was later used by the PNNL for radioactive particle research, and now is under the custodial care of the CH2M Hill Plateau Remediation Company.*

WASTE ENCAPSULATON AND STORAGE FACILITY

B Plant stopped plutonium separations activities in 1952, but was modified in 1968 to support separation of radioactive cesium and strontium removal from tank waste. The purpose was to reduce the fairly extreme heat loads in the tank farms from PUREX waste at the time, and approximately 1/3 of the curies were removed from the tank waste. The Waste Encapsulation and Storage Facility was added on to B Plant, and the separated cesium and strontium salts were encapsulated in corrosion resistant capsules (1,936 in all) for storage in a temperature-controlled pool of water.

Long term plans involve placing the capsules into modified used reactor fuel casks for dry storage on a pad.

CANISTER STORAGE BUILDING

This green building has three underground vaults. Only the first vault has been used to date to hold the 2,300 tons of spent fuel from the K Basins.
Vaults 2 and 3 could be finished to hold the immobilized HLW canisters, but the building would only hold up to 880 canisters, and cannot be easily expanded. Without a permanent geological repository, DOE would need to have additional storage within a couple years of HLW facility startup. DOE intends to build a different HLW canister storage capability in later years closer to startup of the WTP HLW vitrification facility.

BUILDING 2704-HV

Used by Tank Farms workers and management for office space and training space. The laydown yard to the north is used to store tank farm-related equipment. The large number of office trailers have been added over recent years to accommodate the growing Tank Farms workforce.

CROSS-SITE TRANSFER LINE – 6241-V

The cross-site transfer line capital project was completed in 1998. Only the supernate line (one of the two lines) has ever been used, and there have been no transfers through this piping system for over 10 years.

- *Two RCRA-compliant stainless steel 3-inch diameter inner pipes surrounded by 6-inch outer pipes connect the SY-A pit in the SY Farm with a valve pit above double-shell tank AN-104 in the 200 East Area. From that pit and using piping jumpers, waste from the 200 West Area can be transferred to any of the double-shell tanks in the 200 East Area.*
- *One of the lines is for supernate transfers only. The other line – never used yet – is for slurry transfers and uses booster pumps in a separate building along the transfer route in the 200 West Area.*

- *This building to the right – 6241-V – is the high point for the transfer lines. After a transfer of tank waste from SY Farm to AN Farm, and after line flushes, valves in this building would be opened to allow air into the line and to allow the lines to flow back to their respective tank farms.*
- *The entire transfer route is over seven miles long.*
- *From here, you can also see the old vent station for the obsolete cross-site transfer lines. This older system had six transfer lines horizontally arranged in a buried concrete vault. At least four of the six lines had plugged or leaked into the encasement in the past.*
- *Restoring the newer cross-site transfer lines to service is necessary to move the waste from the 200 West Area to the double-shell tanks in the 200 East Area. This challenge also presents some opportunities. If alternate technologies to retrieve, treat, and immobilize tank waste in the 200 West Area could be developed, the waste may not need to be transferred for later treatment in the WTP.*

200 AREA FIRE STATION (STATION 92)

Coming up on the left is the 200 Area Fire Station (Station 92) – one of four fire stations on the Hanford Site.

- *The Hanford Fire Department is the primary response group for all types of fires on the Site. This includes emergency response to fires involving radiologically contaminated facilities to threatening wildfires.*
- *The mission of the Hanford Fire Department (HFD) is to support the activities of the Hanford Site by providing emergency incident management, fire suppression, fire prevention and fire safety education, emergency rescue, emergency medical service, hazardous materials response, respiratory protection equipment maintenance and service, and maintenance and testing of the site's fire detection and suppression systems.*

- *The Hanford Fire Department Emergency Medical Technicians (EMTs) and Paramedics respond to emergency medical incidents on the Hanford Site including the 200 West Clinic to transport patients needing medical care.*

BUILDING 616

This concrete building has been used by Tank Farms workers to manage low-level and mixed low-level solid waste streams until they are transported to their respective disposal locations.

WASTE SAMPLING & CHARACTERIZATION FACILITY (WSCF)

- *WSCF opened operations in 1994 as a site environmental laboratory. The majority of samples sent to WSCF were groundwater.*
- *WSCF was closed in 2014 as commercial capability and capacity became available to process samples at lower costs off site.*
- *Samples that could not be sent off site are routed to the 222-S Laboratory.*
- *Portions of the WSCF complex are still in use by the Hanford Radiological Site Services (RSS) and for cleaning and maintenance of field sampling equipment. RSS provides radiological survey equipment, internal and external dosimetry services, and management of radiological records for DOE and all of the Hanford Site contractors.*

200 WEST PUMP AND TREAT

Several pump and treat stations exist on the Hanford Site but this facility is by far the largest – treating groundwater at a sustained flowrate of up to 2,000 gallons per minute. It became operational in 2012 and captures radiological and hazardous constituents.

The facility draws a suction from the most contaminated parts of the groundwater – which covered up to 82 square miles in the past but has been reduced to under 65 square miles – and discharges the clean water at the outskirts of the contamination plumes to drive contaminants inward toward the suction points.

T PLANT

T Plant processed the nuclear material used in the world's first atomic explosion, the Trinity test in July 1945, and the nuclear material used in the Nagasaki weapon on August 9, 1945.

In 1957, T Plant was converted into a decontamination and repair facility. In the 1990's, it also became a waste packaging facility. As such it is the longest continuously operating nuclear facility in the world.

T FARM, TX FARM, TY FARM

T Farm is one of the original World War II tank farms. It contains the typical twelve 530,000 gallons tanks and the four 55,000 gallon tanks. These farms also employed a "cascading" arrangement of tanks to manage the large volumes of slurries coming from the first-generation bismuth-phosphate separations processes. Waste from the canyon would enter the first of three tanks in a cascade arrangement. Solids were allowed to settle, and at times, chemicals were added to the tanks to promote settling of as many radionuclides as possible. As the tank filled up and reached its limit, cascade lines would allow the somewhat less radioactive liquid to flow to the next tank in the series, and then on to a third tank. Beyond the third tank, the liquid tank waste flowed to a drainfield.

- *Similar to B Farm, the smaller tanks have been characterized as containing transuranic waste. Unlike B Farm, three of the larger tanks – T-104, T-110, and T-111 – also are considered to contain contact-handled transuranic waste. The* *waste in all eleven contact-handled TRU tanks amounts to about 1.4 million gallons – a substantial portion that may not need to be processed at the WTP.*

- *Tank T-106 was confirmed to have leaked more than any other single-shell tank (more than 100,000 gallons), so a polyuria barrier was placed over Tank T-106 and all or portions of five additional tanks in T Farm to minimize the recharge of leaked contaminants further down into the vadose zone. Moisture sensors under the barrier have confirmed its effectiveness.*
- *Across the street, an asphalt barrier was placed over all six of the 758,000 gallon capacity TY Farm tanks due to past leaks. Both of these barriers are sloped to allow any rainfall or snow melt to flow to a channel that then allows the liquid to infiltrate into clean soil outside of the tank farm.*
- *Further down the road to the left, TX Farm contains eighteen 758,000 single-shell tanks – the largest number of tanks in an individual tank farm at the Hanford Site.*
- *Retrieving waste from the T Farms or the B Farms presents extra challenges due to the substantial distances to the nearest double-shell tank farm. The construction of "waste receiver facilities" near the subject single-shell tank farms to aid in retrieval and ultimate transfer of the wastes to the 200 East Area double-shell tank farms has been reflected in lifecycle baseline scenarios, but no project actions have been initiated.*

BURIAL TRENCHES, WASTE RECEIVING AND PACKAGING FACILITY, CENTRAL WASTE COMPLEX

As we drive along 23rd Street and then along Dayton Avenue, we pass many burial trenches from the past. Some the transuranic waste in these trenches has been retrieved and repackaged in the Waste Receiving and Packaging Facility and in temporary tent structures at the excavation sites.

On the right, we pass the Central Waste Complex – several buildings serving as a storage and treatment unit, holding a variety of RCRA mixed waste, low-level waste, and transuranic waste for future disposal.

PLUTONIUM FINISHING PLANT DEMOLITION

During the production years, the Plutonium Finishing Plant was the final step in plutonium processing, producing metal and oxide forms for shipment offsite for further weapons production. Forty years of activity left the facility heavily contaminated.

Twenty years of decommissioning, decontamination, and equipment removal prepared the way for the start of demolition of the main facility in November 2016. Late in 2017, a contamination release during the demolition resulted in a lengthy work stoppage. Recovery actions are ongoing, but work has resumed to process some of the rubble and keep the remaining structure in a safe condition until full return to demolition activities.

U FARM and U CANYON

U Farm is one of the original tank farms, constructed during World War II to support the nearby U Canyon. It is mostly filled with saltcake waste.

U Canyon was excess capacity however, and was never used to separate plutonium. The facility was used to supply spare parts and provide training until it was put into service to recover the large quantities of uranium in the tank waste from the first generation bismuth phosphate separations method. This separation method only captured the plutonium, sending the uranium to the tanks. The uranium was far from being depleted of U-235, the useful isotope for fission in reactors. U Plant separated the *useful uranium from the tank waste, and converted it into UO_3 (yellow cake) for shipment offsite to Oak Ridge, Tennessee for recycling into reactor fuel.*

U Canyon will be the first canyon facility to undergo demolition. All 42 of the below grade process cells have been filled with grout to remove all voids. In the future, the above-grade walls will be collapsed onto the base and a barrier will be constructed over the entire mound, encapsulating the demolition site.

HOSE-IN-HOSE TRANSFER LINES

As we approach the SY Farm, take a look at the hose barns on your left. These were used to shield hose-in-hose temporary transfer lines to protect workers from radiation exposure during waste transfers. For shorter term efforts, such as removing pumpable liquids or solids from single-shell tanks, use of hose-in-hose transfer lines have been a cost effective tool – significantly less expensive than installing buried permanent pipe-in-pipe transfer lines. By our agreements with the Washington State Department of Ecology, the temporary lines can be used for three years, and up to seven years total with some evaluation after the first three years.

SY FARM AND TEST BED INITIATIVE

SY Farm contains three double-shell tanks and is the only double-shell tank farm in the 200 West Area. Each tank has a capacity of 1.12 million gallons.

Using the now-deactivated 242-S Evaporator, waste in double-shell tank SY-101 was over-concentrated, creating a thick salt layer that trapped flammable gases. Periodic – and predictable – releases caused the headspace concentration of hydrogen to exceed the lower flammable limit for short durations. A mixer pump was used for several years to mix the tank contents three times per week, releasing the trapped hydrogen regularly *in controlled amounts. Later, the tank was diluted and some of the contents transferred to a tank in the 200 East Area.*

Tank SY-101 is the candidate site for the Test Bed Initiative Phase 2. In 2017, Phase 1 was completed by assembling 3 gallons of archived tank waste samples from the 222-S Analytical Laboratory, pretreating the liquids using filtration and ion exchange, creating a low-activity waste stream, and then immobilizing the pretreated LAW feed in grout and transporting it to the Waste Control Specialists Federal Waste Facility in Andrews, Texas. DOE completed a WIR Determination for this waste.

Phase 2 will pretreat and immobilize up to 2,000 gallons of tank waste from Tank SY-101 using in-tank filtration and ion exchange. The pretreated LAW feed will be transported in totes to an off-site commercial facility for immobilization in grout. The same disposal facility in Texas will receive the grouted waste for disposal. Most activities are expected to be completed in fiscal year 2019 with the possible exception of removing the pump/filter/ion exchange assembly from Tank SY-101.

The National Academies of Science have been evaluating options to treat and immobilize some of the tank waste, and this process of pretreating it at the tank for immobilization in grout and shipping to Texas is expected to top the list.

S FARM AND SX FARM

S Farm contains twelve 758,000 gallon tanks. Only one – Tank S-112 – has been retrieved to meet the Tri-Party Agreement goal of less than 360 cubic feet remaining in the tank. The hundreds of gallons of saltcake that were retrieved from Tank S-112 were primarily dissolved using fresh water, but a mechanical retrieval tool called the Salt Mantis was also used to assist in breaking up the hard heel materials at the bottom of the tank.

SX Farm contains fifteen single-shell tanks, each with a capacity of one million gallons.

To reduce the risk of recharge driving contamination further into the vadose zone, 2/3 of SX Farm has been covered with an asphalt barrier. The remaining 1/3 of the Farm should also be covered with an asphalt barrier by the end of fiscal year 2019.

Barrier installation requires careful grading of the entire tank farm surface to create a uniformly-sloped surface to allow rainwater and snowmelt to drain off the tank farm.

222-S LABORATORY

We are now approaching the 222-S Laboratory

- *The 222-S Laboratory is the primary onsite lab for analysis of highly radioactive samples in support of all Hanford projects.*
- *The current contractor, WRPS, provides the Laboratory's support functions, maintenance, waste services and analytical methods development work.*
- *Another DOE contractor, Wastren Advantage, Inc (WAI) – now Veolia Nuclear Solutions Federal Services – performs analytical services at the Laboratory.*
- *These two contracts will soon be combined into one contract. Depending upon the timing of award and notice to proceed for the new 222-S contract, the facility maintenance and support services functions for the Laboratory could be within the scope of the Tank Closure Contract for a time.*
- *The Lab is a 70,000 square foot full-service analytical facility with 11 hot-cells, 100 pieces of analytical equipment, 156 fume hoods, and 46 manipulators to perform work on highly radioactive samples of tank waste while minimizing radiation dose to workers.*
- *The Laboratory is expected to operate through completion of the Hanford cleanup mission.*
- *Samples of tank waste are most often taken using a "grab sample" methodology to capture liquids at various depths in the tank. Core drilling of tank solids is another option, and the core drilling platform is currently located in the AP Tank Farm.*

REDOX

Behind the 222-S Laboratory, you see the REDOX Canyon.

- *The REDOX facility performed Plutonium and Neptunium separation processes between 1951 and 1967. The 222-S Laboratory was built as a support lab for REDOX operations. REDOX and all of the structures north of the alleyway are the responsibility of another Hanford Site contractor.*

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)

To the right is the Environmental Restoration Disposal Facility (ERDF)

- *ERDF is managed by CH2M Hill Plateau Remediation Company and is the largest engineered landfill in the Department of Energy's cleanup complex.*
- *It is a disposal facility for the mixed, low-level contaminated soil and materials at Hanford typically resulting from CERCLA cleanup activities, as well as building debris generated by demolition work at the Site.*
- *ERDF began receiving waste in 1996 and has received more than 18 million tons of contaminated debris and soil, most of it once located near the Columbia River.*
- *ERDF is designed to be expanded as needed.*
- *The long trench measures 1,000 feet across at grade level, is 70 feet deep, and measures 500 feet across at the bottom of the trench. Several of the disposal cells have already been filled and temporarily capped, but recent authorization to accumulate an additional 20 feet of waste on top of each cell will expand this disposal capability even further before trench expansion is needed.*
- *Once ERDF is filled with waste, an engineered barrier will be placed on top to prevent the release of waste and infiltration of moisture.*

6241-A DIVERSION BOX

The 6241-A diversion box is part of the cross-site transfer line system. Both the supernate and slurry lines pass through this enclosure, but for the slurry line, two 7-stage booster pumps are designed to add motive force to ensure waste slurries efficiently pass through the slurry line at appropriate velocities to minimize the risk of plugging the transfer line.

Arrive at 2440 Stevens Center

- *This concludes today's tour. As mentioned at the beginning of the tour, your tour packet included 3x5 cards to submit questions.*

- *Please remember to provide your name/contact information on the first card and name on all subsequent cards you turn in so we can contact you if we have any questions regarding your requested information.*

- *I would like to collect any completed cards as you exit the bus. In addition, Karen will be collecting your Hanford Site Visitor Badges as you leave the bus. Again, thank you for your time and we wish you safe travels as you return home.*