

## **DOE Oak Ridge Cleanup History – Setting the Stage for Future Success 16273**

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### **ABSTRACT**

The operation of the three DOE sites in Oak Ridge for 70+ years has produced a complex set of contaminated environmental media (water, soil, air) and facilities. In order to effectively plan for cleanup of the remaining contamination, understanding the causes of the contamination and the techniques that have proven effective in cleanup to date is essential. This paper summarizes the operations and resulting radioactive and chemical releases, the cleanup that has been accomplished to date, and the cleanup remaining to be completed.

### **INTRODUCTION**

Three primary facilities have been operated by DOE and its predecessors in Oak Ridge, TN: the K-25 site (now the East Tennessee Technology Park [ETTP]); the Oak Ridge National Laboratory (ORNL), and the Y-12 National Nuclear Security Site (Y-12).

As a result of operations at these plants surrounding water and sediment, soil, and facilities have become contaminated with a variety of radioactive and chemical materials. Site related contaminants above levels of concern on the Oak Ridge Reservation (ORR) include base neutral acids, inorganics, metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, pesticides, radioactive materials, and volatile organic compounds. Some contamination has migrated beyond the boundaries of the ORR, primarily in surface water and sediment pathways. Institutional controls are in place for these contaminated media located off the ORR and include fish consumption advisories, a permit review process for dredging sediments, and periodic surveys of land and resource use activities.

Efforts have been underway since the mid-1980s to reduce the release of contaminants from the facilities and to eliminate the sources of the releases.

### **Operational Practices That Resulted in the Need for Cleanup**

Discharges to the air from local ventilation and stacks resulted in exposure to workers and the surrounding public to gases, chemicals, and particulates but did not result in the creation of significant legacy contamination issues requiring remediation.

Numerous sources of process liquid discharges resulted from operations at the three plants. The two primary methods of discharge for these liquids were direct discharge to surface water and through seepage basins. Discharges from multiple sources on the sites were typically collected in pipes or ditches, combined with

storm water runoff and routed to a major discharge location, typically through an unlined holding or settling pond. The ponds provided flow equalization and hold up capacity that allowed for the settlement of suspended solids and, in the case of ORNL, holdup for radioactive decay. Discharges directly to nearby surface waters resulted in contaminated sediments, uptake by plants and animals, and eventual release of contaminants off-site to the Clinch River. In some cases process liquids were directed to an unlined pond or basin designed to discharge liquid to the surrounding soil and groundwater relying on the natural sorptive capabilities of the soil to trap chemical and radioactive contaminants and dilution to reduce the contaminant concentration. These practices continued until the late 1980s when environmental regulations required the treatment of liquids and the use of lined ponds and basins.

The disposal of contaminated solid materials resulting from operations at all three plants was primarily by shallow land burial in unlined trenches and landfills. Loose and containerized solid waste containing chemicals and radioactive material was typically dumped into an unlined excavated trench or landfill and then covered with soil. Over time water infiltrated the waste leaching contaminants that were then adsorbed on surrounding soil or released to nearby surface water or underlying groundwater. In addition to providing a continuing source of contaminant release to the environment, the remaining contaminated waste presents a threat to anyone who might inadvertently dig into the buried waste at some time in the future. Shallow land burial of waste continued until the late 1980s when an agreement with regulators was reached to limit the contaminant levels that were buried, use "greater confinement disposal" techniques, or store and then dispose of waste off-site.

As a result of the operations performed over the last 70+ years numerous buildings and associated infrastructure have become contaminated with chemicals and radioactive materials. Many of these buildings are in a shutdown condition, and some are currently the source of release of contaminants to the environment. Due to their age and condition most of these buildings have no potential for re-use and must eventually be demolished to protect workers, eliminate the ongoing or future potential for release of contaminants, and provide access for remediation of contaminated soil and groundwater located under the buildings.

### **Pre-Cursors to Cleanup – Regulations and Environmental Awareness**

Early operations in Oak Ridge were primarily regulated by the Atomic Energy Act of 1946 that officially created the U. S. Atomic Energy Commission (AEC) as a civilian agency with exclusive control over "fissionable" materials. The Act was established because of the government's keen interest in monitoring the national defense uses of atomic energy. The AEC inherited the facilities and personnel of the Manhattan Engineering District on January 1, 1947. Government concerns included radiation hazards and the disposal of radioactive waste. The Act established a general

regulatory structure for operation of nuclear weapons facilities and was amended in 1954 to support construction and use of nuclear power plants.

In the 1960s and 1970s national awareness of the importance of environmental issues resulted in the passage of a number of laws and regulations that were important precursors for the Oak Ridge operations and cleanup efforts to come. The following key laws led to the treatment and control of pollutants released from the Oak Ridge plant operations: NEPA -1970; Clean Air Act (CAA) - 1970; Clean Water Act (CWA) - 1972; Safe Drinking Water Act - 1974; RCRA -1976; Toxic Substances Control Act (TSCA) -1976.

The actual cleanup of the Oak Ridge sites was spurred with the passage of several other laws including: CERCLA - 1980; Emergency Planning and Community Right-to-Know Act - 1986; Superfund Amendments and Reauthorization Act of 1986; Federal Facilities Compliance Act (FFCA) - 1992.

The ORR was placed on the National Priorities List in 1989 identifying the Reservation as requiring clean up under CERCLA. The legislative actions summarized above provided the regulatory authority and framework for the cleanup of the Oak Ridge facilities, but the impetus to perform the cleanup was driven by events from 1982 to 1984.

In 1982, as a result of a study by ORNL researchers, the state of Tennessee - and later DOE - posted warnings against eating fish from Poplar Creek and East Fork Poplar Creek in Oak Ridge. The ORNL work showed that bluegill fish in East Fork Poplar Creek had higher-than-permitted levels of mercury and that the Y-12 facility was a continuous source of mercury to the creek. In response to a newspaper reporter's 1982 inquiry under the Freedom of Information Act, DOE disclosed on May 17, 1983, its large historic losses of mercury to the environment – approx. 333,000 kg (733,000 lbs). The discharges came from lithium separations work performed in support of thermonuclear bomb development and production using mercury.

As a result of the media attention surrounding the mercury release report two environmental groups filed suit under the CWA and RCRA to enforce hazardous waste and water pollution control regulations at the DOE nuclear weapons facility in Oak Ridge, Tennessee. The Federal District Court in Knoxville found on April 13, 1984, that the DOE nuclear weapons facilities were not exempt from federal and state environmental regulations. DOE chose not to appeal the district court decision resulting in the eventual application of federal and state environmental regulations to all nuclear weapons facilities nationwide.

Environmental laws and the two events described above were critical in providing the impetus to implement waste treatment processes and modify Oak Ridge operations to meet environmental regulations resulting in a reduction in the actual release of contaminants to the environment and minimizing the creation and spread of contaminated areas that would require cleanup in the future.

## **1980s – Compliance and Cleanup Begins**

### Establishing New Directions

In 1982, Joe La Grone became Manager of the Oak Ridge Operations and began a new era of openness and attention to environmental issues in Oak Ridge. The decision in 1984 that determined that DOE was subject to RCRA and other environmental laws led to a series of regulatory actions by the Tennessee Department of Health and the Environment (TDHE) and responses by DOE that are summarized in the following paragraphs. This began the process of aligning the DOE operations with the environmental laws passed in the 1970's and early 1980's.

Numerous Orders of Correction were issued by the TDHE against DOE concerning the management of hazardous and mixed waste treatment, storage, and disposal facilities including: the K-1407-B and C Pond at the K-25 site; Solid Waste Storage Area 6 at the ORNL; the S-3 Ponds, New Hope Pond, Bear Creek Burial Grounds, and, the Oil Land Farm at the Y-12 site. The Y-12 Closure and Post-Closure Activities Program was conducted to close the Bear Creek Burial Grounds, Burial Ground A, and New Hope Pond by diverting Upper East Fork Poplar Creek into Lake Reality. Dewatering of the impoundments of the S-3 Ponds and placement of sediments from the upper portion of Bear Creek, known as Blue Lagoon, into the S-3 Ponds were completed and a multi-layer cap was constructed.

An FFCA was entered into between the EPA and DOE to assure compliance by the Y-12 facility with the CWA and a 'comprehensive' National Pollutant Discharge Elimination System Permit was issued to the Y-12 facility covering all known surface water discharges from the plant including New Hope Pond, Upper East Fork Poplar Creek, Bear Creek, Kerr Hollow Quarry, Rogers Quarry, etc. Remedial Action Programs were established at the Oak Ridge facilities, RCRA Facility Investigation plans and schedules were developed, and field activities were initiated. ETTP Solid Waste Management Units suspected of releasing contamination to the environment were identified in a report submitted by DOE to EPA in March 1987.

As a result of the issuance of the RCRA 3004(u) permit for the ORR, DOE accepted responsibility for evaluating off-site contamination in the Oak Ridge area and a preliminary survey indicated that contaminants had accumulated in the sediments of Watts Bar Reservoir.

Construction was completed on the ORNL Non-Radiological Wastewater Treatment Plant (Bldg. 3608) to meet CWA requirements and Central Ventilation System upgrades to meet CAA requirements. Treatment/disposal operations at Kerr Hollow Quarry were completed and disassembly of equipment and other facilities was started.

In 1989, the first DOE Five-Year Plan established 2019 as the goal for completing cleanup of weapons production facilities. DOE established the Office of

Environmental Management (EM) to oversee the cleanup of hazardous materials at DOE facilities throughout the United States, including the ORR. The ORR was placed on the National Priorities List, identifying it to be cleaned up under the provisions of CERCLA.

### **The 1990's – Clean up Framework and Stakeholder Involvement, Risk Reduction, and Re-Industrialization**

In the early 1990s efforts begun in the 1980s under RCRA began to shift toward cleanup under the provisions of the CERCLA. Key agreements were reached among the DOE, EPA, and the Tennessee Department of Environment and Conservation, the successor to TDHE, on the overall framework for cleanup on the ORR and the involvement of local stakeholders that is reflected in the Oak Ridge Federal Facility Agreement signed in 1992.

A cleanup approach was developed with many cleanup activities at the site grouped according to watersheds. ETTP is not a well-defined watershed and is treated as a single watershed for administrative purposes. The ORNL site is divided into the Bethel Valley Watershed and the Melton Valley Watershed, both of which are drained by White Oak Creek. The Y-12 site is divided into the Bear Creek Valley Watershed and the Upper East Fork Poplar Creek Watershed.

The ORR Local Oversight Committee was formed to give local government a collective voice in addressing concerns relating to DOE. A Citizens Working Group was formed to provide feedback to DOE on potential remedial alternatives for the cleanup of Lower East Fork Poplar Creek providing the catalyst for modifying cleanup levels, resulting in less cost and less environmental disruption from excavation. DOE established the Oak Ridge Site Specific Advisory Board (ORSSAB), a federally appointed citizen's panel that provides advice and recommendations to DOE EM, under the FFCA. The ORSSAB sponsored a public meeting that resulted in the formation of the End Use Working Group, a diverse group of stakeholders that developed recommendations for end use of contaminated Oak Ridge sites. A key outcome of this effort was the recommendation that cleanup in most operating areas of ORNL and Y-12 would target meeting controlled industrial land use requirements.

In parallel with the community involvement and regulatory framework efforts, cleanup efforts were prioritized to reduce risk and accomplish critical cleanup milestones.

Efforts to address off-site contaminant migration included developing and issuing the Records of Decision (RODs) for remediation of Lower East Fork Poplar Creek and Lower Watts Bar Reservoir and institutional controls were established to control access to and use of Watts Barr reservoir sediments. The Central Mercury Treatment System at the Y-12 site was brought online and excavation of mercury-contaminated soils in the East Fork Poplar Creek floodplain was performed. A time critical removal action to design and construct a sediment-retention structure

across the mouth of the White Oak Creek Embayment to prevent off-site migration of sediments contaminated by Cs-137 into the Clinch River was completed.

Projects focused on addressing high risk areas at the three plants on the ORR were also pursued. The K-1407 B&C pond sludge removal and remediation was completed. RODs were issued and the ORNL Gunitite Tank remediation was begun and the Old Hydrofracture tanks remediation was completed. RODs were issued and remediation was completed for the ORNL Surface Impoundments, Clinch River/Poplar Creek, and Union Valley Groundwater Plume.

Two treatment plants that would be critical to future cleanup actions were pursued. The TSCA Incinerator, the only incinerator in the nation capable of incinerating wastes containing polychlorinated biphenyls and radioactive constituents, began operation at the K-25 site. DOE entered into a fixed-price privatization contract with Foster Wheeler Environmental Corporation to construct, operate, decontaminate, and decommission a waste processing facility, which is now referred to as the Transuranic Waste Processing Center (TWPC).

Under Jim Hall's leadership a major new thrust was created to further the cleanup in Oak Ridge – Reindustrialization. In 1996, the Reindustrialization program was launched by DOE and the Oak Ridge community that focused on the reuse of the Department's former research and development facilities while DOE continued its decontamination and decommissioning (D&D) program.

The first lease of a K-25 Site facility was signed in 1995 between the Community Reuse Organization of East Tennessee (CROET) and a private company with the goal to eventually convert the site into a self-sustaining private industrial park. DOE renamed the K-25 site the East Tennessee Technology Park to reflect efforts to reindustrialize the site with private industry.

### **2000 to 2012 - Accelerated Cleanup, Integrated Facilities Disposition Project, American Recovery and Reinvestment Act, and Other Cleanup Initiatives**

Since 2000, major cleanup work has been accomplished and the groundwork has been laid for completing the cleanup of the ORR. The following paragraphs provide highlights of these cleanup activities.

A new Accelerated Cleanup Contract was negotiated in 2003 between DOE and its environmental cleanup contractor, Bechtel Jacobs Company, LLC (BJC), that focused on four major projects. In 2005, DOE and BJC accomplished the first major milestone on schedule with the safe disposition of a large amount of legacy waste that consisted of a variety of materials, including radioactive scrap metal, contaminated soil, construction debris, organic liquids, waste water, and sludge residues. The legacy waste included about 34,000 m<sup>3</sup> (1.2 M ft<sup>3</sup>) of low-level radioactive waste and 1,000 m<sup>3</sup> (36,000 ft<sup>3</sup>) of mixed low-level radioactive waste that resided in more than 27,000 containers, including concrete casks, drums, and large metal boxes.

The Melton Valley Remediation Project met the second major milestone on schedule with closure of three large shallow land burial waste disposal sites at ORNL that contained over 2 M Ci of radioactivity. The project included placing 59-ha (145-acres) of multi-layer, low permeability caps; constructing up-slope interceptor and down-slope collection systems; demolishing and disposing of 560 m<sup>2</sup> (6,000 ft<sup>2</sup>) of various buildings; excavating 1400 m<sup>3</sup> (50,000 yd<sup>3</sup>) of soil; grouting and stabilizing 9150-m (30,000-ft) of pipelines; performing in-situ grouting of 2 trenches; retrieving 204 casks, 8 boxes, and 42 m<sup>3</sup> (1,500 ft<sup>3</sup>) of loose waste; plugging and abandoning approx. 1,000 unneeded, shallow wells; developing and closing a 13-ha (33-acre) soil borrow area; construction of haul roads; and rerouting of several power lines.

Cleanup of ETTP was to be completed by 2008 to satisfy the third milestone. All buildings at the Park were scheduled for demolition except for approx. 26 facilities. These facilities were targeted for potential title transfer to private sector organizations under the reindustrialization program.

In 2006, an iron worker accidentally fell through a degraded concrete floor panel while working in the K-25 Building and was seriously injured. The ensuing investigations and response actions resulted in significant project re-planning and schedule delays. A new approach for demolishing the K-25 and K-27 buildings was developed that would better protect workers from deteriorated conditions in the buildings by reducing the number of workers and hours in the buildings. The new plan involved removing high-risk components, unbolting and removing motors and compressors, and then demolishing the building from the outside using heavy equipment.

As of the end of 2012, ETTP accomplishments included: 374 facilities demolished; 1.3 m<sup>3</sup> (1.77 M yd<sup>3</sup>) of waste removed; over 6,000 depleted uranium fluoride cylinders removed; 570-ha (1,400-acres) cleared for unrestricted use, 19 properties (~ 283-ha [700 acres]) and 31,000 m<sup>2</sup> (332,000 ft<sup>2</sup>) of building space transferred for re-use; 120-ha (300 acres) of DOE-owned property and 17,000 m<sup>2</sup> (180,000 ft<sup>2</sup>) of building space leased; and, more than 18 km (11 mi) of railroad and related equipment transferred to CROET, rehabilitated, and sold to the private sector. Based on projections at the time the cleanup of the ETTP was expected to be complete in approx. 2024.

The fourth milestone for cleanup of the Balance of the Reservation by 2015 was deferred and is now scheduled for 2046.

Another important initiative undertaken at the time of the Accelerated Closure was establishing an on-site disposal capability for low-level radioactive and hazardous wastes generated in the cleanup of the ORR. The Environmental Management Waste Management Facility (EMWMF) was developed in accordance with CERCLA to provide this capability. The EMWMF allows for the safe, compliant, and secure disposal of materials that otherwise would have to be shipped and disposed at facilities located off the ORR at far greater risk and expense. The above-ground

disposal facility opened in 2002 and the phased construction was completed in 2011. The EMWMF is located just west of Y-12 and contains six contiguous disposal areas, or cells, and has a total capacity of 1.7 M m<sup>3</sup> (2.2 M yd<sup>3</sup>). In addition to the disposal cells, the facility includes a leachate collection and transfer system, support facilities, access roads, storm water retention basins, and monitoring and security systems. Waste disposed in the facility primarily consists of soil, sediment, building demolition debris, personal protection equipment, and scrap equipment. To further enhance the safety and efficiency of the disposal facility, a dedicated 11-km (7-mi) long haul road was built between ETTP and the EMWMF keeping waste shipments off public roads.

### **Integrated Facilities Disposition Project**

In 2005, DOE performed a complex wide review of the environmental vulnerabilities that were not included in current budget plans. This resulted in the development of the Oak Ridge Integrated Facilities Disposition Project (IFDP). The IFDP was planned to support multiple DOE missions: completing environmental cleanup on the ORR as required by CERCLA; advancing the economic, defense, and energy security of the United States; and promoting scientific and technological innovation. Consistent with the 2002 Comprehensive Closure Plan for the ORR, the IFDP addressed the balance of the cleanup work and supported the modernization and reindustrialization plans for ORNL and Y-12 by including D&D of 439 facilities comprising more than 490,000 m<sup>2</sup> (5.3 M ft<sup>2</sup>) and remediation of contaminated soil and groundwater.

The IFDP Critical Decision – 1 “Approve Alternative Selection and Cost Range” was approved by the Assistant Secretary for Environmental Management on November 17, 2008. The IFDP was intended to integrate and re-sequence current EM baseline scope at ORNL and Y-12 with the new cleanup scope resulting in enhanced risk reduction, larger cost savings, and more rapid and efficient performance of the work. The IFDP would not affect completion of EM scope at ETTP. The approved cost range for the IFDP was \$9.4 to \$14.5 B with a schedule range of 26 to 29 years.

Following approval of the Critical Decision - 1, efforts were initiated to begin preparation of the Critical Decision - 2 “Approve Performance Baseline” documents for the project. These efforts were impacted by the U.S. financial crisis and the passage of the American Recovery and Reinvestment Act (ARRA) in 2009.

### **American Recovery and Reinvestment Act Cleanup**

In 2009, the ARRA legislation provided about \$755 M for environmental cleanup projects across the ORR. Fortunately, the IFDP provided a ready road map for cleanup opportunities and 24 “shovel ready” projects were initiated at ETTP, ORNL, and Y-12.



As the Oak Ridge EM program's ARRA work progressed, projects were performed under original cost estimates, resulting in savings of more than \$90 M. Those savings were used to fund 12 additional projects. Most of the additional projects were completed in 2012, with the remaining projects completed in 2013. Following is a summary of the major cleanup work accomplished with the ARRA funds.

Roughly \$105 M in ARRA funding was allocated to work at ETTP and was used for several projects to prepare former enrichment facilities for D&D and demolish the K-33 gaseous diffusion building.

Roughly \$250 M in ARRA funding was allocated to work at ORNL and was used for several projects to prepare former research facilities for D&D, demolish old buildings, characterize and remediate contaminated soils, excavate and remove the last ORNL underground storage tank, close the remaining ORNL burial grounds, and disconnect facilities from the Central Stack.

Roughly \$250 M in ARRA funding was allocated to work at Y-12 and was used for several projects to prepare former processing facilities for demolition, cleanup the Old Salvage Yard, demolish old buildings, characterize and remediate contaminated soils, and reduce mercury migration.

Roughly \$150 M in ARRA funding was allocated to waste management on the ORR and was used for several projects to expand capacity and extend operating hours for existing waste facilities.

### **Remaining Oak Ridge Cleanup**

The approach for completing the remaining cleanup work in Oak Ridge is captured in the Oak Ridge Environmental Management Strategic Plan developed in 2013. The Strategic Plan reflects three "Portfolio Plans" - one for each site.

The remaining ETTP cleanup includes building demolition and remediation of soil, buried waste, and groundwater. The major focus of cleanup activities will be to complete demolition of remaining buildings and complete soils and sediment remediation.

The challenges to completing the ETTP cleanup include: facility contamination with highly mobile technetium; facility deterioration resulting in worker safety issues and increased cost due to the need for structural stabilization; challenging budgets that make maintaining momentum and the skilled work force difficult; high annual costs to maintain and secure the infrastructure; and, integrating cleanup, historical preservation, and privatization on the same site.

There are several on-going projects including: the K-25 Building demolition was completed in 2014; the K-27 Building pre-demolition work is underway with characterization ongoing and removal of Sodium Fluoride traps underway; the K-31 gaseous diffusion building demolition was completed in 2015. Historical Preservation activities, surveillance and maintenance, waste operations, security,

infrastructure, and landlord activities are ongoing. The ETPP Portfolio Plan Schedule is shown in Figure 1 that indicates work will be complete in approx. 2024, although latest estimates indicate all K-25 work will be complete in 2020.

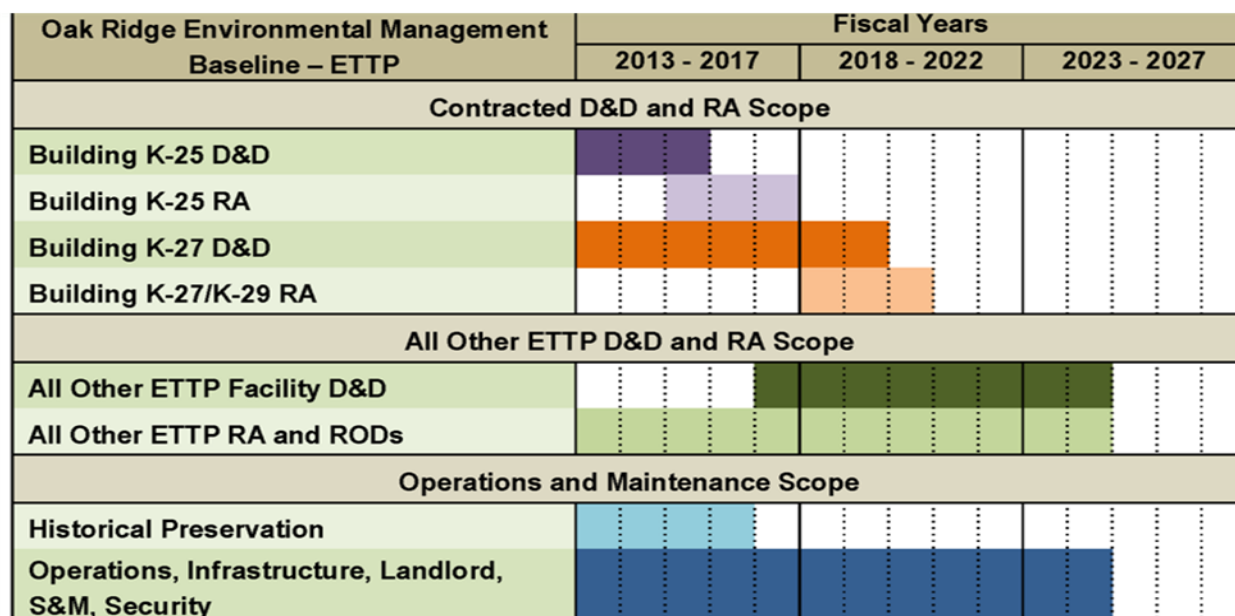


Fig. 1 ETPP Portfolio Plan Forecasted Schedule

As indicated in Fig. 2 annual funding levels vary from approx. \$ 230 to \$ 175 M/yr from FY 2014 to FY 2022, then decline rapidly until project completion in 2024.

Completion of the ETPP cleanup will result in the demolition of all excess, contaminated facilities; removal and disposition of existing legacy material and waste; completing remedial actions, including finalizing records of decision for groundwater; and, release of the site for industrial reuse.

## 8.2 Oak Ridge National Laboratory

The ORNL cleanup strategy has two components. The first is to continue operations and maintenance of critical systems for waste treatment and environmental monitoring activities and complete removal and disposition of existing legacy waste and material from FY 2013 – FY 2024. The second is to complete demolition of excess facilities in the Central Campus and Melton Valley, complete remediation of media, and release strategic acreage for ORNL redevelopment from FY 2024 to FY 2045.

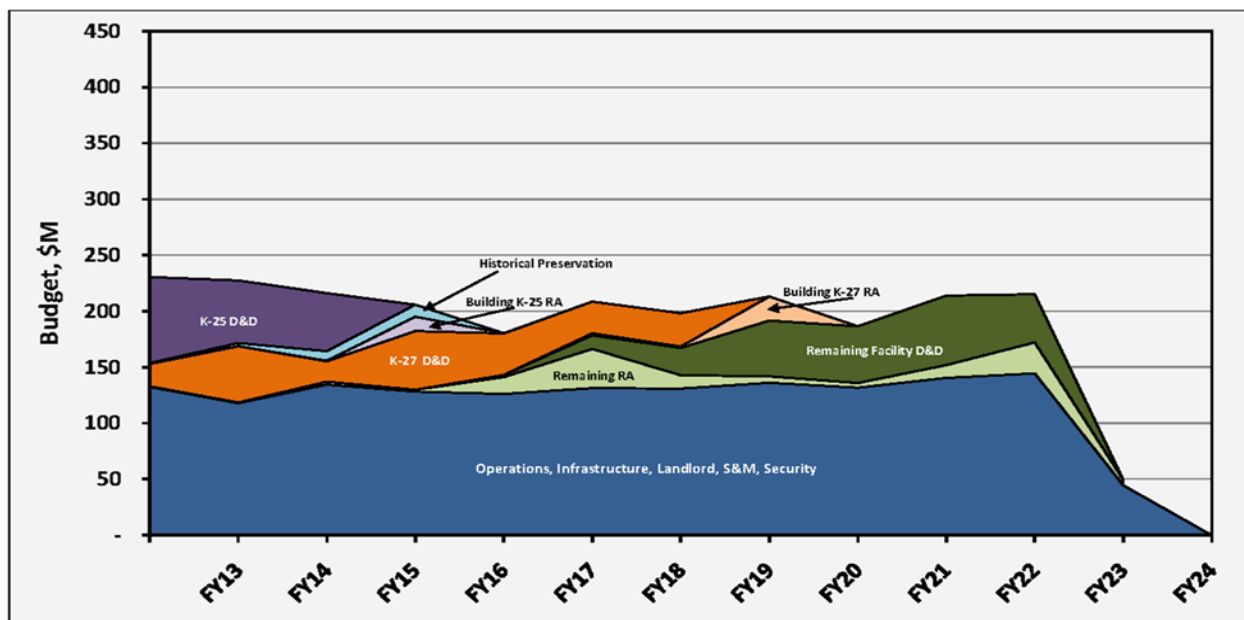


Fig. 2 East Tennessee Technology Portfolio Plan Forecasted Budget

The challenges in executing this work include: performing the work in close proximity to ongoing missions; the presence of deteriorating facilities; and, the specialized handling and packaging required for the radioactive materials present.

There are two on-going projects to process and/or remove radioactive waste and materials from the ORNL. Transuranic waste disposition will involve processing and/or repackaging solid transuranic waste on-site at the TWPC, then shipping the waste off-site for disposal in Nevada or New Mexico. Future construction is planned to provide a facility for processing approx. 1900 m<sup>3</sup> (500,000 gal) of tank sludge for off-site disposal in Nevada.

U-233 Disposition will involve processing and disposing of 1,098 canisters of U-233 material. To date, approx. 10% of the U-233 canisters have been removed from the site (sent for reuse). Another approx. 40% will be sent off-site for reuse or disposal by 2016. The remaining 50% of the inventory will be processed by down-blending and disposed off-site.

The ORNL cleanup will be conducted within two valleys. A total of 268 facilities covering about 120,000 m<sup>2</sup> (1.3 M ft<sup>2</sup>) are to be demolished. In Bethel Valley (includes Central Campus), 160 facilities covering 74,000 m<sup>2</sup> (799,441 ft<sup>2</sup>) will be demolished and 2,900 m<sup>2</sup> (31,138 ft<sup>2</sup>) of facility area is to be decontaminated and preserved for historical purposes. In Melton Valley, 108 facilities covering 42,300 m<sup>2</sup> (455,855 ft<sup>2</sup>) will be demolished and 1,000 m<sup>2</sup> (10,240 ft<sup>2</sup>) of facility area will be decontaminated and preserved for reuse. Soils and sediment in Bethel Valley will require remediation (Melton Valley soils and sediments remediation was completed in 2006).

As indicated in Fig. 3 the ORNL cleanup is projected to be completed in FY 2045.

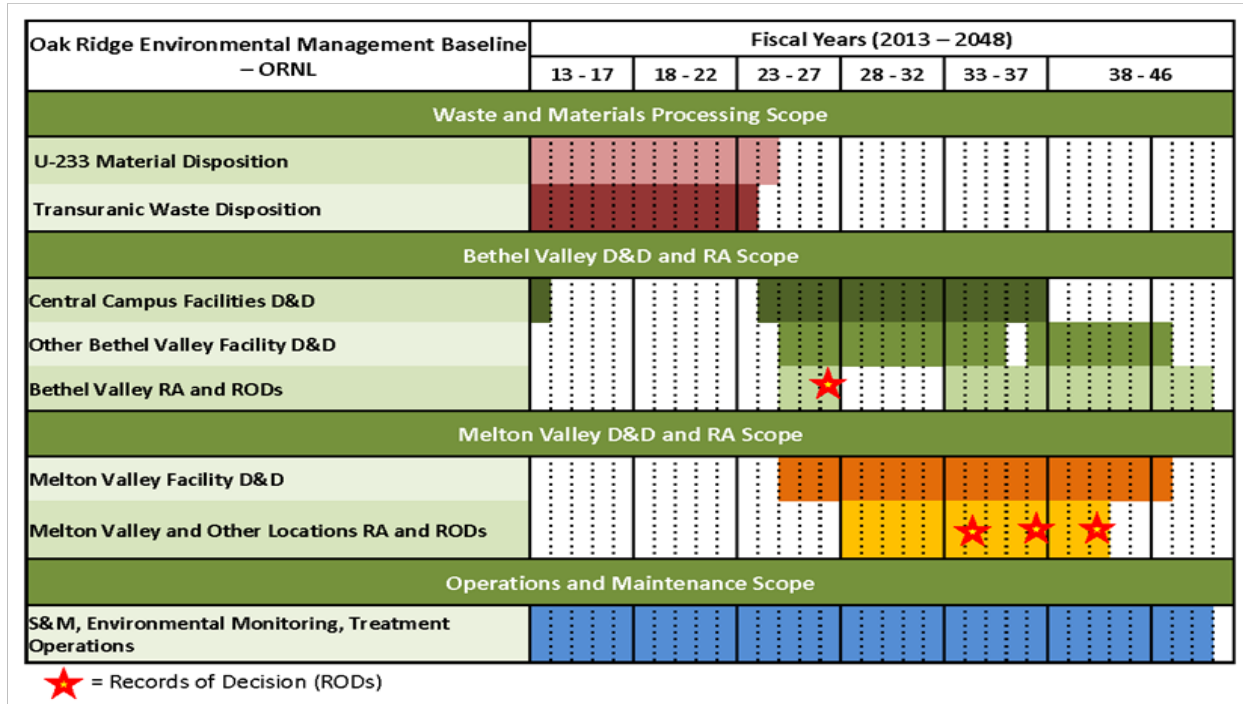


Fig. 3 ORNL Portfolio Plan Schedule

As seen in Fig. 4 annual funding levels average ~\$ 150 M/yr through FY 2022, then peak at ~\$ 470 M in FY 2038, then decline steadily until project completion in

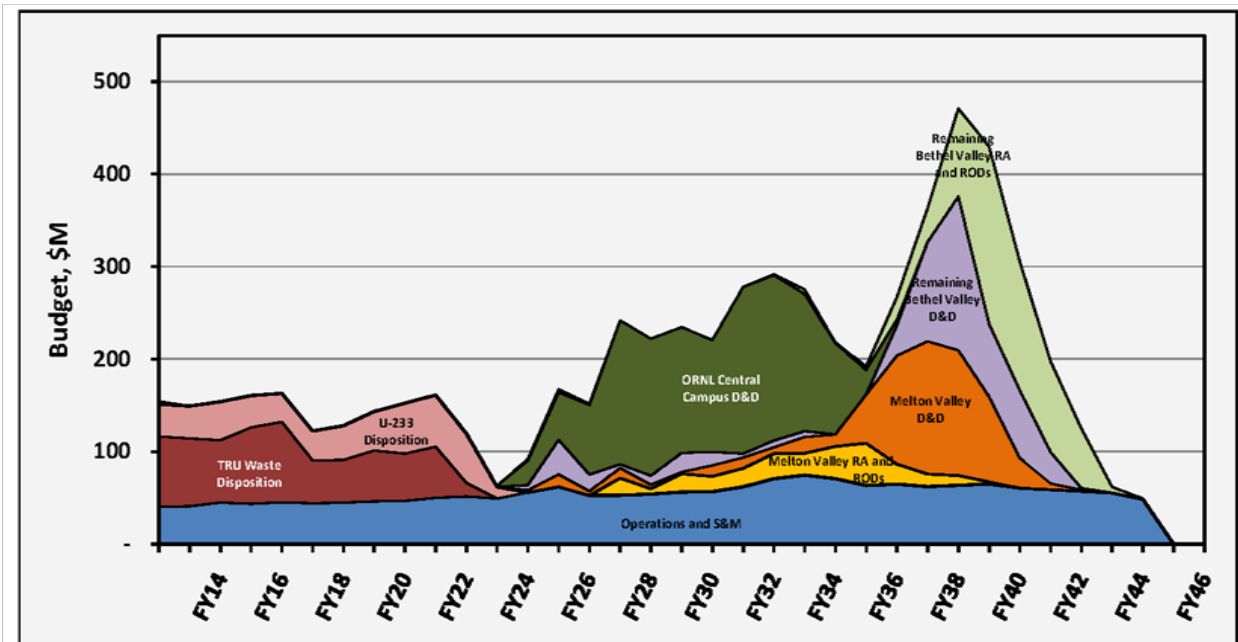


Fig. 4 ORNL Portfolio Plan Forecasted Budget

FY 2045. Completion of the ORNL Portfolio Plan will result in the removal and disposition of existing legacy waste and material, demolition of all excess,

contaminated facilities, completed remedial actions, including finalized RODs for groundwater and surface water, and release of acreage for future re-development in critical areas.

The Y-12 Portfolio strategy has three components. The first is to reduce mercury flux and expand on-site disposal capacity in the near-term. The second is to begin D&D of former mercury use buildings and soil remediation in the mid-term. The third is to begin D&D of the balance of contaminated excess facilities, remediate soil/sediment, finalize final surface water and ground water decisions; and implement the decisions. Y-12 cleanup challenges include: more than 9 M kg (20 M lbs) of mercury were used in early processing of lithium with approx. 33,000 kg (733,000 lbs) suspected to have been released to the environment; four large former mercury-use facilities to be demolished; possibly large volumes of mercury contaminated soil to be treated; mercury flux leaving the site needs to be reduced; and, cleanup has to occur alongside ongoing missions and within a high security footprint.

As part of the Y-12 cleanup 99 facilities covering 316,000 m<sup>2</sup> (3,398,980 ft<sup>2</sup>) will be demolished and 27,000 m<sup>2</sup> (292,815 ft<sup>2</sup>) of facility area will be decontaminated and preserved for historical purposes. Soil and other remediation work will be conducted in three areas. In the Upper East Fork Poplar Creek Area (main plant), soil around buildings and sediment in creeks are contaminated with mercury and will be excavated and may require treatment prior to disposal. In Bear Creek Valley (west of the main plant area), several waste disposal areas will require remediation. The last area includes remediation of soils on Chestnut Ridge (area to the south of main plant area).

Two near-term projects are included in the Y-12 Portfolio Plan. The first is the proposed Outfall 200 Mercury Treatment Facility that is planned to provide future mercury reduction capabilities for wastewater projected to be generated during large-scale demolition. The facility conceptual design was recently completed. Design and construction of the project is proposed to begin in FY 2015. The second is the proposed On-Site Disposal Facility for CERCLA waste to provide capacity for demolition debris and soil waste after the existing disposal site, the EMWMF, is filled. The disposal capacity expansion is projected to be needed in approx. FY 2020.

As indicated in Fig. 5 the Y-12 cleanup is projected to be complete in 2046. As shown in Fig. 6 average annual funding levels are less than \$100 M/yr through FY 2022, then increase to \$300 to \$400 M/yr until FY 2032, then peak at approx. \$510 M in FY 2035, then decline to an average of \$250 M/yr from FY2038 to FY 2044, then decline steadily until project completion in FY 2046.

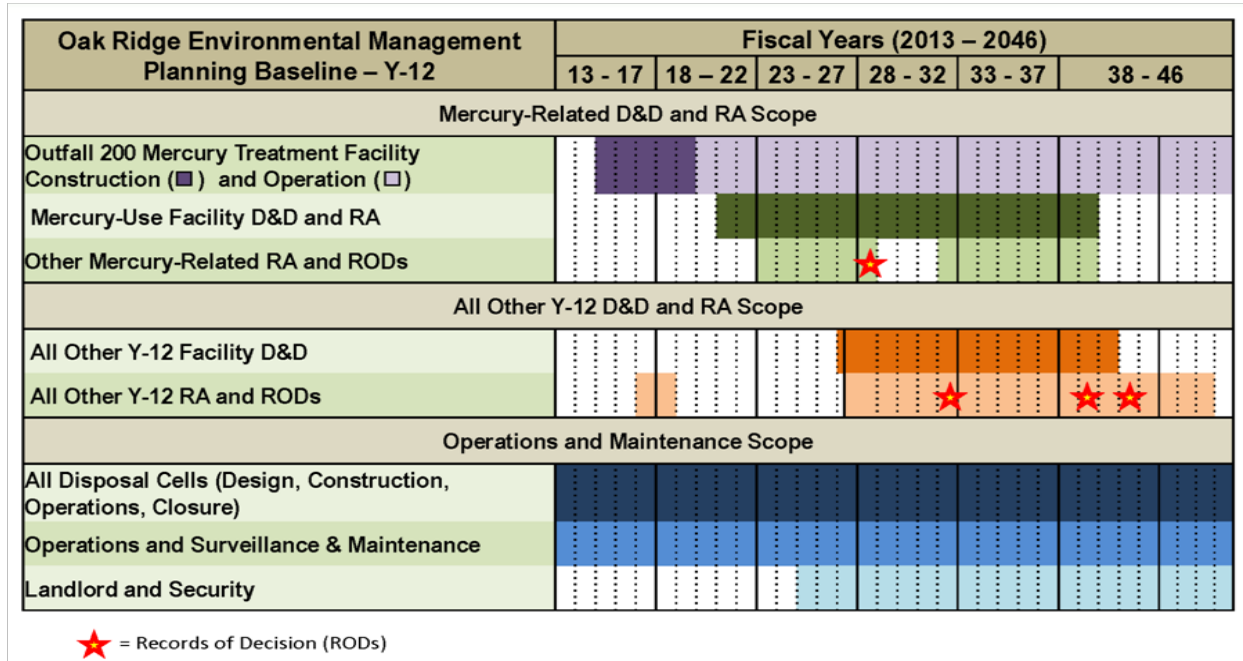


Fig. 5 Y-12 Portfolio Plan Schedule

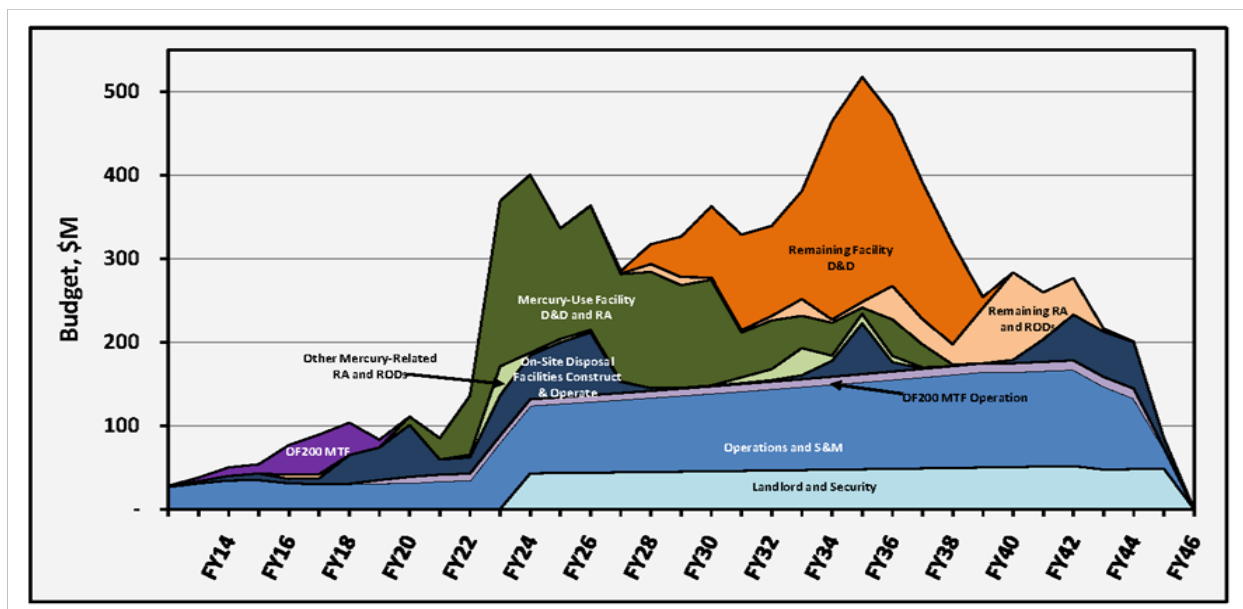


Fig. 6 Y-12 Portfolio Plan Forecasted Budget

## Conclusion

Several items are worthy of note for the future Oak Ridge cleanup.

First, the cleanup work completed to date clearly demonstrates that the capability (technology, disposal capability, people, and processes) exists to complete the remaining cleanup in Oak Ridge. Positive safety experience since the K-25 worker injury in 2006, including UCOR achievement of DOE Voluntary Protection Program

Star status in October, 2015, indicates that the cleanup work can be performed safely, but constant attention to safety is a must. Opportunities exist and should be pursued to apply new technologies that will result in reducing worker risks and driving down costs.

One area that experience to date indicates must be improved is providing adequate funding on a continuing basis. Recently, funding has been declining and budgets have been uncertain due to the lack of approved funding authorizations. The average annual funding levels for the Oak Ridge EM cleanup effort (the sum of the three Portfolio Plans) for FY 2014 through 2018 are in the \$ 420 M/yr range. Beginning in FY 2019, the proposed funding increases steadily to a peak of about \$760 M in FY 2037-38. Budgets decrease steadily to about \$600 M/year in FY 2040, then decline rapidly as remaining cleanup work at ORNL and Y-12 is completed in FY 2045 and FY 2046 respectively at a total cost in the range of \$16 B. It must be recognized that due to a variety of factors, it may be difficult to achieve these funding levels. Any reduction in funding would almost certainly result in a stretch out of the schedule, and/or a reduction in the scope of the cleanup effort.

It is important to note that a significant part of the Portfolio Plan work is associated with "infrastructure" type activities – operations, surveillance and maintenance, and security. The total is in the range of \$200 M/yr through FY 2022 comprised of ETTP at approx. \$130 M/yr, ORNL at approx. \$ 40 M/yr, and Y-12 at about \$ 30 M/yr. The total average cost remains fairly constant from FY 2023 to FY 2044 as the ETTP cost is eliminated, the ORNL cost increases to about \$50 M/yr, and the Y-12 cost increases to an average of about \$150 M/yr.

These two items result in the following critical conclusions regarding the financial challenges in to completing the Oak Ridge cleanup.

1. Given the "fixed" nature of the infrastructure type activities, any shortfall in projected funding levels would have a direct effect on reducing the actual amount of cleanup work that could be accomplished lengthening the overall Oak Ridge cleanup schedule and increasing the total cost.
2. Significant reduction in the total cleanup cost could be achieved if increased annual funding was available to shorten the cleanup duration thus reducing the amount of infrastructure maintenance costs. For each year the cleanup schedule is reduced about \$200 M/yr of infrastructure cost would be eliminated.

A great deal has been accomplished in reducing the environmental impact of ongoing operations and cleaning up the legacy contamination on the ORR – but there is still much to be completed. A precise estimate of the cost of cleanup accomplished to date is not available – but it likely exceeds \$10 B. The cost of work remaining to be completed as reflected in the Oak Ridge Environmental Management Strategic Plan is in the range of \$16 B. Based on the projected available annual funding the ORR cleanup is expected to be complete in FY 2046. One thing is certain, delaying the cleanup work will only increase the risk to

workers and nearby residents, jeopardize the critical ongoing DOE science and security missions, and increase the total cost to complete the ORR cleanup.