

Hydraulic Isolation of Waste Disposal Areas at Oak Ridge National Laboratory - 8452

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ABSTRACT

The Melton Valley watershed at Oak Ridge National Laboratory (ORNL) is the location of several large waste disposal areas that received waste from more than 50 years of operation, production, and research activities at ORNL and the U.S. Atomic Energy Commission's Southern Regional Burial Ground for wastes from more than 50 other facilities. The major burial grounds in the valley are Solid Waste Storage Areas (SWSAs) 4, 5, and 6, where wastes were buried in more than 850 unlined trenches and more than 1500 unlined auger holes. The area includes 3 seepage pits and 3 gravel-filled trenches used by ORNL for the disposal of liquid low level wastes. The burial grounds contained several hundred thousand cubic yards of waste, and the combined inventory of the burial grounds and liquid disposal sites was well over 1 million curies.

The Record of Decision for Interim Actions for the Melton Valley Watershed at ORNL selected hydraulic isolation of major waste sources as the primary mechanism for remediation of the watershed. Isolation was to be accomplished mainly through the construction of multi-layer caps over the burial grounds, seepage pits, and trenches. Groundwater diversion and collection systems were installed along the upgradient and downgradient edges, respectively, of selected caps to enhance the performance of the isolation system. The waste areas were covered with both Resource Conservation and Recovery Act (RCRA)-type and isolation multi-layer caps. A total of 13 multi-layer caps covering 58.7 hectares (ha) (plan view) were constructed in Melton Valley between 2003 and 2006.

The project encountered considerable challenges, not the least of which was its scale, involving simultaneous construction activities at widely scattered sites across the 430-ha watershed. Detailed planning and coordination enabled year-round fieldwork, an essential requirement necessary to retain a skilled, experienced workforce and meet the contract milestone for completion. Other factors key to the success of the project involved the use of an on-site borrow area and construction of a dedicated haul road for transfer of materials from the borrow area to the capping sites.

INTRODUCTION

The 13,970-hectare (ha) Oak Ridge Reservation (ORR) is located within and adjacent to the corporate city limits of Oak Ridge, Tennessee, in Roane and Anderson counties (Fig. 1).

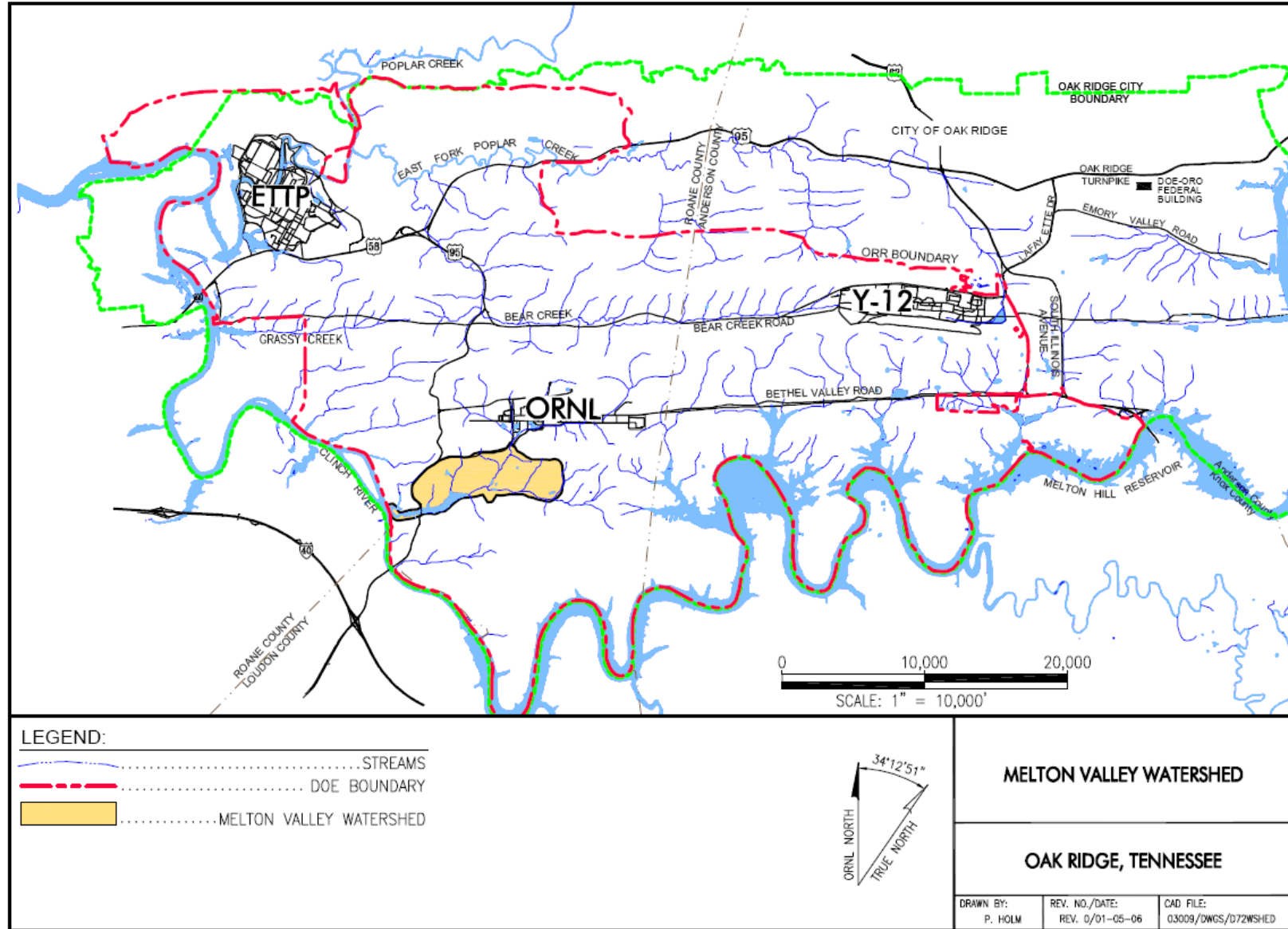


Fig. 1. DOE boundaries/Oak Ridge Reservation.

Oak Ridge is located approximately 20.1 kilometers (km) west-northwest of Knoxville, 19.3 km southwest of Clinton, and 16 km northeast of Kingston. ORR is bounded to the east, south, and west by the Clinch River (Melton Hill and Watts Bar) and on the north by the city of Oak Ridge. ORR hosts three major industrial research and production facilities originally constructed as part of the World War II (WWII)-era Manhattan Project: East Tennessee Technology Park (formerly the K-25 Site), Oak Ridge National Laboratory (ORNL), and the Oak Ridge Y-12 National Security Complex Plant.

The Melton Valley (MV) Watershed, situated just south of ORNL, encompasses approximately 430 ha. ORNL historic missions (i.e., plutonium production during WWII and nuclear technology development during the post-war era) produced a diverse legacy of contaminated inactive facilities, research areas, and waste disposal areas in MV. From 1955 to 1963, ORNL's solid waste areas were designated by the Atomic Energy Commission (AEC) as the Southern Regional Burial Ground. During this period, ORNL served as a major disposal site for wastes from more than 50 off-site government-sponsored installations, research institutions, and other isotope users. The principal contaminated areas in the MV Watershed included the following:

- buried wastes,
- landfills,
- tanks,
- impoundments,
- seepage pits and trenches,
- hydrofracture wells and associated grout sheets,
- buried liquid waste transfer pipelines,
- leak and spill sites,
- surface structures, and
- contaminated soil and sediment.

Contaminants present in MV include radionuclides (short- and long-lived), metals, and volatile organic compounds in waste, soil, groundwater, surface water, sediment, and biota. Migration from shallow groundwater to surface water is the principal exit pathway from contaminant source areas in MV.

The major burial grounds in the valley are Solid Waste Storage Areas (SWSAs) 4, 5, and 6, where wastes were buried in more than 850 unlined trenches and more than 1500 unlined auger holes. The area includes 3 seepage pits and 3 gravel-filled trenches used by ORNL for the disposal of liquid low level waste (LLLW) (Fig. 2). The burial grounds contained several hundred thousand cubic yards of waste, and the combined inventory of the burial grounds and liquid disposal sites was well over 1 million curies.

The Record of Decision for Interim Actions (ROD) for the MV Watershed at ORNL selected hydraulic isolation of major waste sources as the primary mechanism for remediation of the watershed. Isolation was to be accomplished mainly through the construction of multi-layer caps over the burial grounds, seepage pits, and trenches. The objective of the capping activity was to prevent infiltration through the buried wastes and lower the water table such that wastes were neither seasonally nor perennially inundated. Groundwater diversion and collection systems were installed along the upgradient and downgradient edges, respectively, of selected caps to enhance the performance of the isolation system.



Fig. 2. Melton Valley remedial action areas – hydraulic isolation.

SITE BACKGROUND

Shallow land burial was used routinely at ORNL for disposal of solid low level waste (LLW) from 1943 to 1986, when improved disposal technologies were implemented. The principal waste burial sites in MV are SWSAs 4, 5, and 6. Early burial procedures used unlined trenches and auger holes covered by either soil from the trench excavation or a combination of concrete caps and soil. The concrete caps were used for disposal of high-activity wastes (> 200 mrem/hour at the container surface) or wastes with transuranic constituents. The burial of LLW in unlined trenches and auger holes ceased in 1986 when ORNL began placing solid LLW in below-grade, concrete-lined silos in SWSA 6. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) wastes generated from previous actions were disposed in silos or underground vaults in SWSA 6.

Department of Energy (DOE) Order 5820.2A was issued in September of 1988. It required that all LLW disposed after the issuance date meets performance objectives for LLW disposal. Since 1988, DOE has used wells, silos, trenches, and the highly engineered aboveground tumuli technology for disposal. Specific to above-grade disposal and located in the SWSA 6 area, Tumulus I operated from 1988 to 1990. Tumulus II operated from 1990 to 1992. The Interim Waste Management Facility (IWMF) located in the SWSA 6 area has operated since 1992.

In the fall of 1999, DOE-Oak Ridge Operations (ORO) requested and received an approval to exempt all post-1988 disposals, except for Tumulus I and II and the IWMF, from the requirements of DOE Order 435.1 (successor to DOE Order 5820.2A). This request was justified since the post-1988 wells and silos are collocated with pre-1988 wells and silos; the post-1988 wells and silos were evaluated as part of the ongoing CERCLA analysis of MV; and the radiological inventory of the post-1988 wells and silos is less than 2% of the total inventory of SWSA 6 and much less than the total inventory analyzed in the MV CERCLA assessment.

In MV during the early 1950s, chemically treated LLLW was disposed of in large seepage pits and trenches excavated in low-permeability soil. As intended, LLLW seeped into the surrounding clay soil. This clay soil acted as a sorption agent for some radionuclides contained within the waste. Seven seepage pits and trenches were used from 1951 to 1966.

The Intermediate Holding Pond (IHP) was located immediately east of SWSA 4 and encompassed an area of approximately 7 acres within the White Oak Creek (WOC) Floodplain. It was one of the most highly contaminated floodplain soil areas in MV. This impoundment was created in the spring of 1944 through the construction of an earthen dam across WOC. That fall, the dam failed, but an intermediate pond remained until sometime after 1951. This area acted as a settling pond for sediments and collected radionuclide-contaminated sediments. Principal contaminants in the pond were Sr-90 and Cs-137, with Sr-90 concentrations ranging from 8 to 3000 pCi/g.

An emergency waste basin located in the SWSA 6 area was constructed in 1961-1962 as an emergency holding pond for LLLW or process wastes. It was never used for this purpose.

REMEDIAL ACTIONS

The ROD for the MV Watershed at ORNL selected hydraulic isolation of major waste sources as the primary mechanism for remediation of the watershed. Isolation was to be accomplished mainly through the construction of multi-layer caps over the burial grounds, seepage pits, and trenches. The objective of the capping activity was to prevent infiltration through the buried wastes and lower the water table such that wastes were neither seasonally nor perennially inundated. Groundwater diversion and collection

systems were installed along the upgradient and downgradient edges, respectively, of selected caps to enhance the performance of the isolation system.

The remedial action selected for many of the waste areas in MV was hydrologic isolation, which involved placing Resource Conservation and Recovery Act (RCRA)-type multi-layered caps over the buried waste. The areas selected for hydrologic isolation included areas in the Pits and Trenches area, SWSA 4, SWSA 5, and SWSA 6.

Hydrologic isolation was achieved by covering the waste areas with both RCRA-type and isolation caps. These provide hydrologic isolation by reducing infiltration through the waste disposal areas. A detail of a cap showing a typical layer of the multi-layer RCRA-type and isolation cap sections is shown in Fig. 3. The RCRA-type cap contains, in ascending order, a geotextile subsidence geogrid over waste trench areas (not shown), a gas vent layer/working surface, contouring fill, a geosynthetic clay liner (GCL), a geomembrane, a geocomposite drainage layer, 30.5 cm of frost protection soil, and a 15.2-cm vegetative layer. The isolation cap does not contain a GCL. By using the isolation cap on the out slopes, the maximum slope of the cap was increased from 5:1 to 3:1.

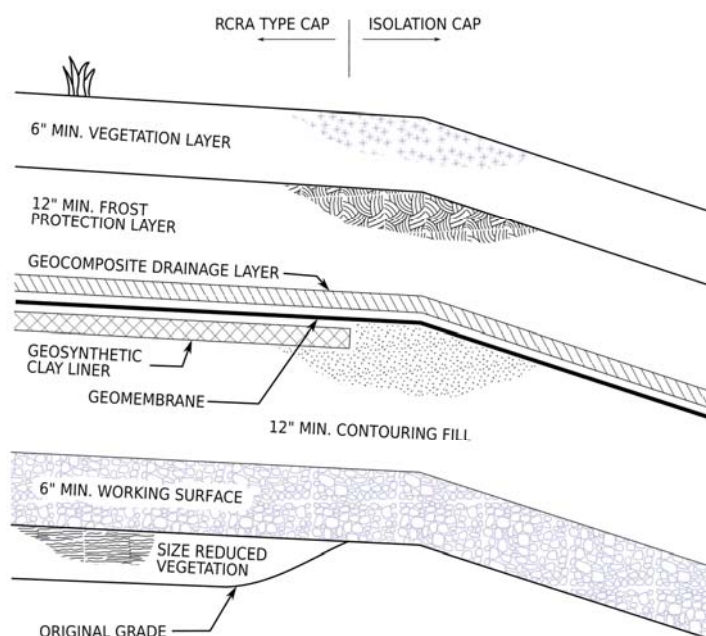


Fig. 3. Typical cross section of a hydrologic isolation cap.

A total of 13 multi-layer caps covering 58.7 ha (plan view) were constructed in MV between 2003 and 2006. Additional as-built quantities are summarized below.

Quantity of chipped vegetation and debris placed:	47,800 m ³
Quantity of working surface/gas vent layer placed:	149,200 m ³
Quantity of contour fill placed:	747,700 m ³
Quantity of graded rock (riprap) placed:	287,000 m ³
Area of geosynthetic clay liner installed:	44.6 ha
Area of geomembrane installed:	60.4 ha
Area of geocomposite drainage layer installed:	62 ha
Quantity of protective/topsoil layer placed:	347,600 m ³
Length of upgradient diversion trenches:	935 m

Length of low-permeability cut-off wall:	682 m
Length of downgradient interceptor trenches:	1645 m
Length of transfer lines to convey collected water:	4450 m

Major activities that supported cap construction involved the development and operation of a borrow area and the construction and maintenance of more than 4.8 km of haul road to connect the sites. The 10.5-ha Copper Ridge Borrow area was cleared, grubbed, and developed to provide fill material for the hydrologic isolation caps. More than 643,000 m³ of soil were removed from the borrow area. In addition, numerous minor facilities were demolished and disposed, a 131-kW power line was relocated, a 13.8-kV power line was also relocated, and more than 800 monitoring wells were abandoned in place. A centralized collection system was installed for the collection of the groundwater collected from the downgradient trenches. This collected groundwater is then pumped to the ORNL Process Waste Treatment System.

The capped areas are divided into four separate groups: Pits and Trenches, SWSA 4, SWSA 5, and SWSA 6. The following sections summarize the scope of activities and quantity of materials used in each area.

Pits and Trenches

The Pits and Trenches area includes 5 capped areas that are the Seepage Pits 2, 3, and 4 (6 ha), and Trenches 5 (0.4 ha), 6 (0.6 ha), and 7 (0.8 ha), and the 7A Leak Site (0.2 ha). The remedial actions performed in these areas include well plugging and abandonment (P&A), capping waste areas with a RCRA-type cap, and collection of up- and downgradient groundwater in the collection trenches.

A downgradient groundwater collection trench at Pits 2, 3, and 4 was installed along the western boundary of the cap to capture shallow groundwater that was potentially in contact with contamination associated with the Seepage Pits. The total length of the downgradient trench is 219 m. The trench was constructed by excavating to the top of bedrock and backfilling with gravel. Depth of the trench excavation ranged from 4.3 m to 7 m.

A sump was installed on the southeast corner of the Seepage Pits cap to collect water from an underdrain along the eastern edge of the Seepage Pits cap. Another sump was installed at the southeast corner of Trench 7 to collect water from an underdrain in the southeast portion of the cap that was installed to collect leachate from buried waste under the Trench 7 cap.

An upgradient trench was installed at the Trench 7A Leak Site to intercept uncontaminated upgradient storm flow and shallow groundwater prior to flowing underneath the cap. This is discharged beyond the limits of the cap and is monitored for potential contamination.

Solid Waste Storage Area 4

The remediation activities associated with SWSA 4 include removing soil from the IHP, excavating contaminated soils, P&A of unneeded wells, capping of the SWSA 4 area, and collecting both up- and downgradient groundwater flow. A RCRA-type cap was installed over waste areas at SWSA 4 (13.4 ha) to provide hydrologic isolation for the below-ground waste by reducing infiltration of precipitation.

The IHP area was excavated to achieve a cleanup level of < 2500 μ R/hour. The cleanup level was achieved at an excavation depth in the range of approximately 30.5 to 61 cm for most areas. After the initial excavation of an area, a walkover survey was performed to verify the ROD requirement of < 2500 μ R/hour was achieved.

Both an up- and downgradient trench were installed along the perimeter of the SWSA 4 cap. The upgradient trench is installed a total length of 750 m along the northern edge between the cap and the new Lagoon Road. The trench is designed to intercept upgradient shallow subsurface groundwater flow.

The downgradient trench was constructed for collection of shallow groundwater (above bedrock). The trench collects groundwater contaminated by leachate from the SWSA 4 waste sites, preventing contaminants from discharging to White Oak Creek. The trench runs 355 m along the eastern edge of the cap. It was installed to a nominal depth of 3.4 to 4.3 m below grade to the top of bedrock.

Solid Waste Storage Area 5

The hydrologic isolation at SWSA 5 South (22 ha) and SWSA 5 North (0.2 ha) included the activities of demolishing structures within the footprint of the cap, relocating sections of two streams that encroached upon the toe of the cap, well P&A, constructing a RCRA-type cap, and a groundwater collection system.

Minor buildings were demolished and the debris placed under the SWSA 5 South Cap in the central ravine area. The central ravine area, called drainage area D-2, was located in a low area in the middle of the SWSA 5 South capped area. Waste placed in the D-2 area included demolished buildings, various materials from several old dump sites in the woods along the edge of SWSA 5, material stored at SWSA 6, and contaminated soils from other MV CERCLA actions. Using this area for collection of minor contaminated CERCLA wastes resulted in a cost saving both for disposal and for contour fill involved in the capping of SWSA 5 South.

A 335-m reach in the Melton Branch and two reaches totaling 76 m in the minor tributaries had to be relocated to facilitate construction of the SWSA 5 South cap. The stream reaches were relocated and restored using natural stream restoration methods so that the new sections replicated the original sections.

Two RCRA-type caps were installed in SWSA 5 to hydrologically isolate buried waste. The SWSA 5 North cap covers the Four-Trench area in the northeast corner of SWSA 5, and the SWSA 5 South cap covers more than 220 unlined waste trenches and nearly 1000 unlined auger holes.

A downgradient collection trench at the cap boundary along the southern side and portions of the eastern and western sides of SWSA 5 South collects leachate from the capped area. The length of the trench is 1071 m. Sumps are installed in the trench to extract the collected groundwater for transfer to Bethel Valley for treatment prior to being discharged into White Oak Creek.

A soil-bentonite slurry cutoff wall 681 m in length was constructed between the downgradient trench and Melton Branch stream to increase the collection of upgradient-contaminated leachate in the trench and to reduce infiltration of water from the Melton Branch floodplain. A trench was excavated to the top of bedrock and backfilled with a soil-bentonite slurry.

Solid Waste Storage Area 6

Five RCRA-type caps were constructed over waste areas in SWSA 6. To support the construction of the caps, other activities such as building demolition, well P&A, and creation of wetlands were also performed.

A total of 11 buildings were demolished in SWSA 6 in preparation for cap construction. Of the 11, 6 were placed under SWSA 6 Cap A, and the remaining 5 were placed in the D-2 area under the SWSA 5 South cap.

Five RCRA-type multi-layer caps (A, B, C, D, and E) were placed over waste disposal areas in SWSA 6 to hydrologically isolate below-ground waste by reducing infiltration of precipitation. Caps A (9.3 ha), B (2.8 ha), and C (1.2 ha) cover more than 400 unlined waste disposal trenches with additional waste disposal auger holes and silos. Cap D (0.4 ha) covers the Tumulus I and II facilities that are comprised of two concrete pads holding concrete vaults containing grouted LLW. Cap E (0.6 ha) covers the IWMF that contains vaults and pads similar to Tumulus I and II; however, the IWMF had a more sophisticated leachate collection and monitoring system than the Tumulus.

Upland wetlands were constructed at the former Emergency Waste Basin near SWSA 6 to provide mitigation of impact on small wetlands in the vicinity of SWSAs 5 and 6 along the haul road.

CHALLENGES

The project encountered considerable challenges, not the least of which was its scale, involving simultaneous construction activities at widely scattered sites across the 430-ha watershed. Detailed planning and coordination enabled year-round fieldwork, an essential requirement necessary to retain a skilled, experienced workforce and meet the contract milestone for completion. Other factors key to the success of the project involved the use of an on-site borrow area and construction of a dedicated haul road for transfer of materials from the borrow area to the capping sites. Successful completion of the cap construction activities in August 2006 was a critical factor in meeting the September 30, 2006 milestone for overall completion of the MV remedial action project.

Design Packages and Regulatory Approval

The first challenge the project faced was the completion of the design packages and approval from the regulatory agencies to begin work. The design for the MV caps was started in mid-March 2003. The design packages were grouped into three areas, being SWSA 5, Pits and Trenches, and SWSA 6. The SWSA 4 package and work had already been started. The intent was to start work on the SWSA 5 area and stream relocation in late August of 2003 and continue through the winter with both SWSA 5 and Pits and Trenches areas. The required approval of the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) for SWSA 5 was September 15, 2003, and Pits and Trenches on September 30, 2003.

To accomplish this aggressive goal, a teaming partnership was established with DOE, the Environmental Protection Agency (EPA) Region IV, Tennessee Department of Environmental Conservation (TDEC), and Bechtel Jacobs Company LLC. Review meetings were held to status the 30%, 60%, and 90% packages. The formal submittal to the agencies for approval occurred at the 90% package, which represented a design effort of 100%.

Material Delivery

With 13 caps to be built, and more than 747,000 m³ of contour fill to place, the design of the haul road and use of a variety of dump trucks were critical. The haul road was constructed to be 40 feet wide with a minimum visual distance for the drivers of 107 m. This allowed for a speed limit of 48 kph. At the peak of the project activities, there were 22 tri-axle dump trucks and 12 off-road dump trucks or Moxy trucks. More than 225 loads of dirt or rock were placed each day. Total distance traveled without a single event or accident was in excess of 19,000,000 km.

Rock Slopes

While the caps being constructed in MV generally were 5:1 over the waste areas and 3:1 on the out slopes for the isolation caps, there were three areas where rock buttresses had to be constructed to allow for a 2:1 slope. One of the locations at SWSA 5 was used to cover an old debris dump area discovered during clearing operations. This slope used graded rock to construct a stable 2:1 slope, then using choke stone (2 cm or less) a geotextile and geomembrane were placed to create an isolation cap. More than 9200 m³ of rock were placed on this slope. Figure 4 is an example of the placing of the stone for the rock buttresses.

EFFECTIVENESS OF HYDRAULIC ISOLATION

During 2006, a multi-year project was completed to conduct remedial actions specified by the MV ROD. Remedial actions conducted as part of the MV Interim Actions included hydrologic isolation of approximately 140 acres of shallow land burial areas, plugging and abandonment of 111 deep wells associated with the hydrofracture disposal of radioactive liquids and sludges, demolition and disposal of small facilities, remediation of 6 surface wastewater impoundments, remediation of contaminated soils throughout approximately 800 acres of MV, grouting of thousands of feet of abandoned liquid waste transfer pipelines, and plugging and abandonment (P&A) of hundreds of unneeded shallow wells and piezometers.

Although the post-remediation effectiveness metrics and monitoring locations were developed in large part during the remedial design, environmental monitoring of those metrics was initiated during 2006 while construction was ongoing in most of MV. Continuation of monitoring during 2007 demonstrates the shift in the environmental response to the remedial actions.

The MV ROD specified surface water quality, surface water risk targets, and groundwater controls to be achieved within specified periods after completion of the remedial actions. The ROD also included specific performance objectives that would be used as the metrics to evaluate effectiveness of the remediation. These goals and metrics are presented below.

Surface Water Quality Goals and Monitoring Requirements

Surface water goals include protection of the Clinch River to meet its stream use classification (e.g. as a domestic water supply), and to achieve ambient water quality criteria (AWQC) in on-site waters of the state. The ROD included specific surface water remediation levels (RLs).

In addition to the ROD surface water quality remediation goals, the MV ROD included specific performance objectives and performance measures that form the basis of remediation effectiveness monitoring. These performance objectives provide a quantitative basis to evaluate the effectiveness of hydrologic isolation at limiting contaminant releases from buried waste by monitoring groundwater fluctuation within hydrologic isolation areas. Additionally, the performance measure for surface water quality is to achieve the AWQC numeric and narrative goals related to contaminant discharges originating from MV areas within 2 years after completion of remedial actions.

Groundwater Quality Goals and Monitoring Requirements

Minimization of surface water infiltration and groundwater inflows into buried waste to reduce contaminant releases is key to the concept of hydrologic isolation. The MV remedy utilizes multi-layer caps to prevent vertical infiltration of rainwater into buried waste or other hydrologic isolation units as



Fig. 4. – Placing of rock buttresses.

well as upgradient storm flow interceptor trenches, where necessary, to prevent shallow subsurface seepage from entering the areas laterally. The MV ROD included the performance goal of reducing groundwater level fluctuations within hydrologically isolated areas by >75% from pre-construction fluctuation ranges. Prior to remediation, groundwater levels were observed to rise into waste burial trenches in many areas of Melton Valley. In some areas waste trenches were known to fill with water completely during winter months. Contact of this water with buried waste materials was the source of contaminated leachate that subsequently seeped downward and laterally to adjacent seeps, springs, and streams. The performance goal of attaining a >75% reduction in groundwater level fluctuations created a design requirement to minimize, as much as possible, the contact of groundwater with buried waste to reduce the contaminated leachate formation process. As such, the fluctuation range is most relevant in cases where groundwater levels rise into the waste burial elevation ranges. Groundwater level fluctuations at elevations below the contaminant sources have less importance to the overall remedy effectiveness. During the remedial design of each hydrologic isolation area wells were selected for monitoring post-remediation groundwater level fluctuations, baseline fluctuation ranges were evaluated, and target post-remediation groundwater elevations were determined to indicate that groundwater levels had dropped to below the 75% fluctuation range elevation. Target groundwater elevations and fluctuation ranges for wells within hydrologically isolated areas are presented in Table 1 along with a summary of the 2007 monitoring results.

Surface Water Contaminant Flux

Evaluation of trends in the radiological contaminant flux from MV areas is based on the long term data available at the key surface water integration points which include White Oak Dam, Melton Branch Weir, White Oak Creek Weir, and the 7500 Bridge Weir. Table 4 includes the annual flux of 90Sr, 3H, and 137Cs measured at the key surface water integration points from 1993 through 2007. This relationship exists because increased rainfall causes increased surface water runoff and because, prior to hydrologic isolation of contaminant sources, increased rainfall caused increased leachate formation and release to streams. The observed decreases in 90Sr and 3H between 2003 and 2007 are attributed to the combined effects of remedial action and lower rainfall in 2005 and 2006 that progressed to the extreme drought conditions of 2007. Continued monitoring through years with average and above-average rainfall patterns is necessary to fully evaluate the effectiveness of the remedy and to demonstrate sustained remedy performance.

Performance Summary

Remedy effectiveness data obtained during 2007 for the Melton Valley ROD actions collectively indicate that the remedy is generally operating and functioning as planned. Contaminant releases of the principal contaminants of concern in Melton Valley have decreased significantly during and since remediation of the contaminant source areas. Hydrologic isolation systems at the burial grounds functioned as intended as demonstrated by attainment of groundwater level goals in most areas.

Table I. Summary of 2007 groundwater elevation monitoring

Well	Area	No. of Meas.	Min. Elev.	Avg Elev.	Max. Elev.	Obs. Range	Target Elevation (TE) ¹	Target Range (TR) ¹	Avg. Meets TE	Max. meets TE	Meets Fluct. TR	Comment
0399	SWSA 6	12	771.86	775.8	776.57	4.71	782.90	1.36	Y	Y	N	WL below TE
0848	SWSA 6	12	778.44	778.85	779.11	0.67	779.2	0.27	Y	Y	N	Steadily declining
0850	SWSA 6	359	764.57	765.63	766.72	2.15	765.9	2.1	Y	Y	N	Declining trend
0055	PT-2,3,4	359	786.76	787.35	787.81	1.05	795	NA ³	Y	Y	—	
0057	PT-2,3,4	12	781.52	782.7375	783.48	1.96	795	NA ³	Y	Y	—	
1758	PT-Trench 6	12	825.26	827.26	828.32	3.06	836	4.42	Y	Y	Y	WL below waste
1760	PT-Trench 6	12	817.91	818.98	819.87	1.96	836	1.0	Y	Y	N	WL below waste
0949	SWSA 4	359	803.93	804.67	805.37	1.44	813.78	1.48	Y	Y	—	Stable @ <804 Jul - Sep
0956	SWSA 4	360	768.51	768.77	769.21	0.7	770.49	0.4	Y	Y	N	Steadily declining
4562	SWSA 4	12	783.32	784.08	784.48	1.16	NA ²	NA	—	—	—	Steadily declining
4563	SWSA 4	359	777.96	778.84	779.77	1.81	NA ²	NA	—	—	—	Steadily declining
2019	SWSA 5-N	12	803.04	806.93	809.93	6.89	824.3	1.67	Y	Y	N	WL below waste
2020	SWSA 5-N	12	817.89	821.57	821.95	4.06	828.2	0.78	Y	Y	N	WL below waste
0436	SWSA 5-S	3	770.68	770.82	770.99	0.31	773.90	2.35	Y	Y	Y	Steadily declining
0666	SWSA 5-S	12	818.52	820.16	821.3	2.78	836	1.35	Y	Y	N	Steadily declining
0710	SWSA 5-S	10	783.14	783.681	784.3	1.16	791.5	1.1	Y	Y	N	Steadily declining
4175	SWSA 5-S	12	769.29	769.84	770.5	1.21	775.8	4.1	Y	Y	Y	Steadily declining
4193	SWSA 5-S	12	768.28	769.23	770.13	1.85	775.4	1.32	Y	Y	N	Steadily declining
4204	SWSA 5-S	12	dry	dry	769.25	--	773.00	1.4	--	--	--	Dry after Oct 06@769.48

¹Target elevations and target fluctuation ranges. Target elevation is the groundwater elevation equivalent to 75% fluctuation reduction. Target range is the fluctuation range equivalent to 75% fluctuation reduction.

²Target range not specified.

Avg. = average

Elev. = elevation

Fluct. = fluctuation

Freq. = frequency

FY = fiscal year

Ground = ground

Meas. = measurement

Min. = minimum

M = monthly

NA = not applicable

Obs. = observed

Seg. = segment

SWSA = solid waste storage area

TE = target elevation

TR = target fluctuation range

W = weekly

Table II. Melton Valley surface water integration point radionuclide fluxes

Year	⁹⁰ Sr Flux (Ci)					³ H Flux (Ci)					¹³⁷ Cs Flux (Ci)			
	White Oak Dam	MBWeir	WCWeir	7500 Bridge		White Oak Dam	MBWeir	WCWeir	7500 Bridge		White Oak Dam	MBWeir	WCWeir	7500 Bridge
CY 1993	2.44	0.88	0.99	0.61		2141	1700	340	58		0.59	0.025	1.10	0.99
CY 1994	3.37	1.20	1.40	0.75		2783	2000	480	81		0.62	0.015	0.65	0.66
FY 1995	1.55	0.05	0.04	0.45		2340	1830	342	70		NA	NA	NA	NA
FY 1996	2.04	NA	NA	NA		2250	NA	NA	NA		NA	NA	NA	NA
FY 1997	1.99	NA	NA	NA		1860	NA	NA	NA		NA	NA	NA	NA
FY 1998	1.37	0.39	0.64	0.22		937	777	254	48		NA	NA	NA	NA
FY 1999	1.45	0.38	0.06	0.19 ^a		1080	732	160	31 ^a		NA	NA	NA	0.34 ^a
FY 2000	1.10	0.40	0.49	0.15 ^a		892	229	609	81 ^a		NA	NA	NA	0.98 ^a
FY 2001	1.20	0.47	0.45	0.22		795	568	210	27		0.63	0.002	0.27	1.40
FY 2002	1.49	0.52	0.55	0.25		956	700	237	61		0.96	0.003	0.63	0.74
FY 2003	1.88	0.78	0.65	0.41		1442	964	450	96		0.80	0.004	0.31	0.43
FY 2004	1.58	0.74	0.36	0.64		1267	1238	134	60		1.06	0.004	0.40	0.37
FY 2005	1.42	0.52	0.30	0.69		951	948	72	27		0.75	0.005	0.35	0.82
FY 2006	0.67	0.16	0.20	0.20		334	171	109	88		0.88	0.003	0.12	0.17
FY 2007	0.48	0.06	0.17	0.14		225	25.6	151	122		0.33	0.003	0.10	0.08

^aA 12-month flux was not available for 7500 Bridge. An 11-month flux was used for FY 2000, and an 8-month flux was used for FY 1999.

Ci = curie

CY = calendar year

FY = fiscal year