Final Closure of the Maxey Flats Low-Level Radioactive Waste Disposal Site – 16088

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ABSTRACT

This paper describes the final closure remedy for the former Maxey Flats Low-Level Radioactive Waste Disposal Site (MFDS), the challenges presented at the site due to the condition of the disposal facility and waste, and their resolution through comprehensive geosynthetic design. The MFDS is an inactive landfill located in Kentucky on a ridge surrounded by a buffer zone. Historically, waste disposal occurred without reducing voids or without compacting the placed waste. Settlement and water management issues led to releases of radioactive contamination into surrounding waters, resulting in the closure of the facility in 1977.

The final closure remedy consists of 1) development and implementation oversight of a sump abandonment design to ensure no direct pathways for infiltrating water to contact the waste and 2) development and implementation oversight of the Final Closure Period (FCP) cap design. Challenges successfully addressed by the FCP scope included:

- Abandon sumps to minimize stormwater migrating into the waste
- Address potential existing groundwater waste interaction
- Maximum use of on-site cap construction materials
- Design cap to fit very restricted site footprint
- Assess and address potential isolated differential settlement
- Maximize passive stormwater management
- Provide alternative site access during construction

The FCP remedy and resultant design satisfies these challenges through use of layers of geogrid-reinforced soil and geosynthetic materials, contours and slopes that minimize the quantities of construction materials while maximizing the use of available material, probabilistic subsidence modeling, an integrated stormwater management system ensuring the slow release of stormwater into receiving streams, and a dedicated construction haul road system.

INTRODUCTION

This paper describes the layers of protection being constructed as the long-term solution for the final closure of the former Maxey Flats LLRW Disposal Site (MFDS). The paper details the design and construction challenges presented by the site due to the condition of the disposal facility and waste and the resolution of these conditions through a comprehensive geosynthetic design. Construction is ongoing and good practices and design adjustments will be shared.

SUMMARY OF THE PROBLEM

Historic disposal operations involved the practice of placing waste with very little attention to landfill stability or water infiltration into 40+ shallow surface trenches. During the 1960's and 1970's, waste disposal at MFDS occurred without reducing voids and without compacting the placed waste. Settlement and water management became two of the key issues at the Site and led to releases of radioactive contamination into groundwater and surface waters. This resulted in the premature closure of the MFDS and its eventual listing on the National Priorities List (NPL). After comprehensive assessments, a multi-phase remedy was approved which called for an Initial Remediation Phase (IRP), an Interim Maintenance Period (IMP), and the FCP. The IMP ended and the FCP started in November 2012. The FCP must transform the MFDS from an actively managed site to a closed facility providing long-term protection of the public and the environment while minimizing the need for and reliance on ongoing active maintenance of the site.

PROJECT BACKGROUND

The MFDS is a former commercial LLRW disposal facility owned by the Commonwealth of Kentucky (Commonwealth). The 1,000+ acre facility is located in Hillsboro, KY – about 90 miles east of Frankfort, Kentucky in the Appalachian plateau of the Knobs physiographic region. This area is characterized by hills and relatively flat-topped ridges. The 55-acre fenced disposal area is situated on a ridge bounded by steep slopes on the west, east, and south and is approximately 350 feet above the adjacent valleys (Fig. 1).

Fig. 1. Site Location.

In 1962, the Commonwealth was the first state to be granted Agreement State status by the US Atomic Energy Commission, allowing them to assume regulatory powers for managing low-level radioactive materials. In that same year, the Commonwealth issued a license to Nuclear Engineering Company (NECO) for disposing LLRW, making the MFDS the country's first such disposal facility.

The MFDS operated commercially from 1963 to 1977, disposing approximately 4.8 million cubic feet of solid LLRW from hundreds of publicly- and privately-owned facilities. The waste contained approximately 2.4 million curies of by-product material, 533,000 pounds (lbs.) of source material, and 950 lbs. of special nuclear material. Solid waste forms included clothing, paper, glassware, used equipment, shielding materials, and animal carcasses, all in containers constructed of various materials including cardboard, wooden boxes, and steel drums. Liquid waste was accepted from 1963–1972 under a license amendment requiring solidification and placement in special trenches designated for liquids.

During commercial operations, waste was disposed in 46 unlined trenches, except for waste designated as “high specific activity,” which was placed in “hot wells.” A typical disposal trench was 30 feet deep, with accumulated waste covered by 3 to 10 feet of soil. This method of waste placement created an unstable waste trench matrix that left the landfill susceptible to recurrent subsidence events and stormwater infiltration. Beginning in 1972, leachate was pumped from the trenches to prevent overflow. From 1973 to 1986, an evaporator facility was operated on site to reduce the volume of accumulated leachate. Over 6,000,000 gallons of leachate was treated, producing over 100,000 gallons of concentrates, which were solidified and disposed in six additional noncommercial trenches from 1979–1990.

In 1977, it was determined that trench leachate was migrating off site through subsurface geology. NECO was then ordered by the Commonwealth to cease the receipt and burial of radioactive waste. To ensure proper closure and long-term stewardship, NECO’s license and financial liability was transferred back to the Commonwealth, as required under Commonwealth administrative regulations.

From 1983 to 1986, the Commonwealth pursued placing the MFDS on the NPL. In 1986, after comprehensive investigation, the EPA listed the site on the NPL under the Superfund Program. The EPA issued a Record of Decision (ROD)[1] in 1991, detailing remedial actions and prescribing the three components of the remedy: the IRP, the IMP, and the FCP. The remedy selected by EPA was natural stabilization during the IRP and IMP, to allow the wastes in the trenches to subside naturally to a stable condition prior to installation of a final engineered cap. Natural stabilization was anticipated to occur over a period of 30 to 100 years. The final Consent Decree [2] was signed and became effective in 1996.

The objectives of the IRP, which began in 1998, were met through two activities: 1) landfill dewatering of over 900,000 gallons of leachate, solidification, and on-site disposal and 2) construction of an interim cap.

To prevent water infiltration and to allow for monitoring of trench stabilization, a 52-acre exposed geomembrane interim cap was constructed. During the IRP the Commonwealth also acquired additional buffer zone properties and filed deed restrictions on the properties. This concluded the IRP and moved the MFDS into the IMP, a period of monitoring and maintenance.

During the IMP, which began in 2003, the Commonwealth continued environmental monitoring, cap maintenance, and evaluation of trench stabilization under established radiological controls. Primary focuses of the IMP were evaluation of 83 trench sump leachate levels and cap subsidence monitoring, both of which were key factors in evaluating trench stabilization. The Consent Decree [2] established Trench Stabilization Criteria to achieve prior to entering the FCP and construction of a final cap.

On November 16, 2012, the EPA approved the Trench Stabilization Criteria Evaluation for the MFDS submitted by the Commonwealth, which indicated that natural stabilization was substantially complete. This action signified entry of the MFDS into the FCP. The decision to move forward with the FCP recognized that the trenches may continue to settle fractionally over the next decades, but that it was more beneficial to proceed with the final closure than wait for complete settling. In accordance with the Consent Decree, the Commonwealth selected a supervising contractor (AECOM) to complete the FCP.

FINAL CLOSURE PERIOD CHALLENGES AND SOLUTIONS

Challenges successfully addressed by the FCP cap included:

- Abandon sumps to minimize stormwater migrating into the waste
- Address potential existing groundwater waste interaction
- Maximum use of on-site cap construction materials
- Design cap to fit very restricted site footprint
- Assess and address potential isolated differential settlement
- Maximize passive stormwater management
- Provide alternative site access during construction

The design of a sump abandonment process and configuration of the FCP cap solves the issues of surface stability and water infiltration through the innovative use of a range of geosynthetic materials, probabilistic modeling, and hybrid cap design. Once constructed, the compact FCP cap composed of soil reinforced with geosynthetics full addresses the goals of the remedy identified by EPA. Before the FCP cap could be installed, the trench sumps and other risers and protrusions through the interim liner had to be abandoned or improved as they were a direct conduit to the trenches, allowing water to infiltrate the waste and contaminated material to potentially escape to surface water on the sides of the ridge.

Sump Abandonment Phase

The Sump Abandonment Phase began in February 2014 and was completed in November 2014. The radiologically-restricted area of the site contained sumps, monitoring wells, and underground leachate tanks, many of which were already abandoned by the Commonwealth. Fig. 2 shows the general configuration of the site within which these features are located. The goal of the Sump Abandonment Phase was to close off the potential IRP liner surface contamination and exposure pathways represented by the sampling activities and liner penetrations at the trench sumps and monitoring well. To prevent the spread of surface contamination, any construction activity requiring direct contact with the IRP liner required implementation of contamination controls.

Exposure rate surveys were conducted to document the radiological condition of the restricted area, resulting in levels below the annual public exposure limit. Therefore, after completion of sump abandonment and installation of soil over the liner, further cap construction activities did not require implementation of radiological controls.

To accomplish this goal, AECOM developed the following designs and plans and provided oversight during their implementation.

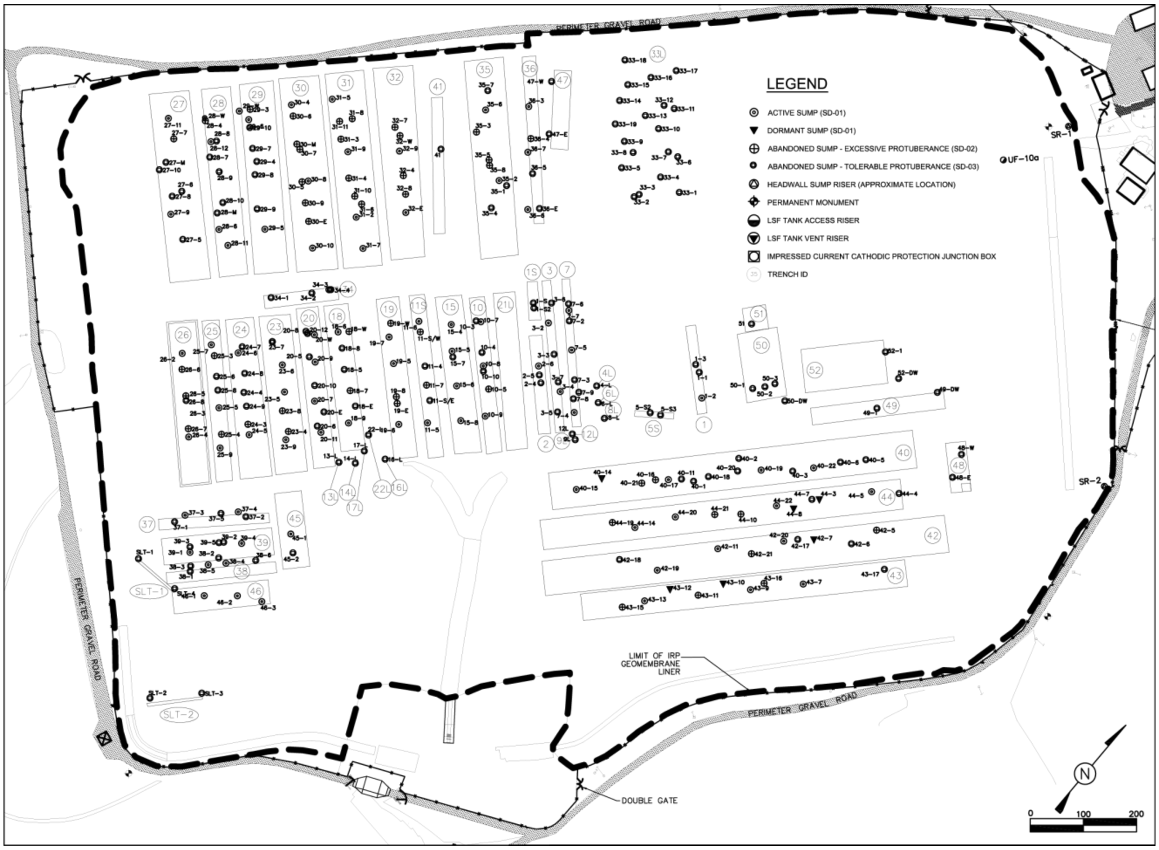

Fig. 2. MFDS General Site Layout.

First, the well and all active sumps were abandoned and improvements made, where necessary, to previously abandoned sumps. Following these abandonment or improvement activities, a protective liner cover was installed over each of the 274 sumps.

A total of 89 existing, functional trench sumps and two headwall sumps were abandoned. The liquid level transducer and cable in each sump was disconnected at the flange and dropped immediately in the sump along with any caps, appurtenances, and other debris. The sumps varied in their total depth, depth of water in the bottom, pipe diameter, and height of the casing above ground. These items were measured to calculate the estimated quantity of bentonite needed to solidify the leachate in the sump and the estimated quantity of grout needed to fill the remaining space. Once each sump was backfilled with bentonite and grout, the liner around the above-ground casing was cut and the casing was removed 3 inches below grade. The sump casings, headwall risers, and debris that were too large to put in the sumps were disposed of in Leachate Storage Facility (LSF) Tank #1 (described below). The area was then backfilled to existing grade.

There were 185 previously abandoned sumps previously grouted with their casings removed. Forty-nine of these sumps had excessive protuberances, that is, the ground surrounding the sump had settled to the point where the casing was protruding from the ground and in danger of penetrating the IRP temporary liner. In these cases, the liner was cut and sufficient soil was added to bring the immediate grade around the abandoned sump flush with the surrounding grade such that the tenting of the liner was eliminated. No improvements were needed to prepare the 136 previously abandoned sumps with tolerable protuberances for the addition of the sump abandonment protective liner.

A monitoring well within the disposal area was abandoned per the Commonwealth's Well Abandonment Regulations. The well was backfilled with bentonite pellets to within 2 feet of the top of the borehole, with the last 2 feet filled with soil. The liner around the monitoring well's above-ground casing was cut and the casing was removed 3 inches below grade. The casing, caps, and appurtenances were disposed of in LSF Tank #1. The area was then backfilled to existing grade and the liner repaired.

After necessary improvements were made, any scrap liner that was previously removed was flattened and placed directly above the backfilled area. Half-inch, beveled-edge high-density polyethylene (HDPE) flat stock was then placed and centered directly over the sump pipe with the beveled edge facing up. Steel shear studs, 1-inch diameter x 12-inch-long hex bolts were installed flush in the counter-bored holes and embedded down into the fill material. The only exception to the requirement for the HDPE flat stock for abandonment activities is in the LSF tank area. No flat stock was required in this area for the tank risers or repair to the liner over LSF Tank #1.

Next, new 16 oz. geotextile cushion was placed over the HDPE flat stock while providing a 3-inch minimum overlap beyond the edge of the flat stock. The geotextile also provided a 3-inch minimum overlap with the existing polypropylene liner. A new section of 45-mil polypropylene liner (patch) was placed over the geotextile while providing a 3-inch minimum overlap beyond the edge of the geotextile. The edges of the new liner patch were adhered to the existing liner with 6-inch wide butyl tape, with a minimum of 2 inches of tape contacting the new and old liner. The butyl tape did not perform as expected, and several months after placing it, the tape began to fail down the center along the edges of the new liner patch. Therefore, the tape was cut away from the patches and the patches were leistered to the IRP liner. Fig. 3 shows a sump after abandonment is complete.

LSF Tank #1, constructed in 1997, was used to dispose all waste materials generated during sump abandonment and surface improvement activities. The tank was accessed by removing 4 to 5 feet of overburden. The quantity of waste expected to be generated from personal protective equipment; the sumps, well and risers to be abandoned; plus the owner-derived waste was estimated to be 12,000 to 15,000 gallons. Near the end of the Sump Abandonment Phase, when all debris was placed in LSF Tank #1, including its own risers, fittings and appurtenances, and cathodic protection system, the tank was abandoned. Any liquid in the tank was solidified with bentonite pellets and allowed to cure for 24 hours. The tank was then filled with grout and allowed to cure for another 24 hours. Finally, soil was then placed to fill the hole created by removal of the overburden.

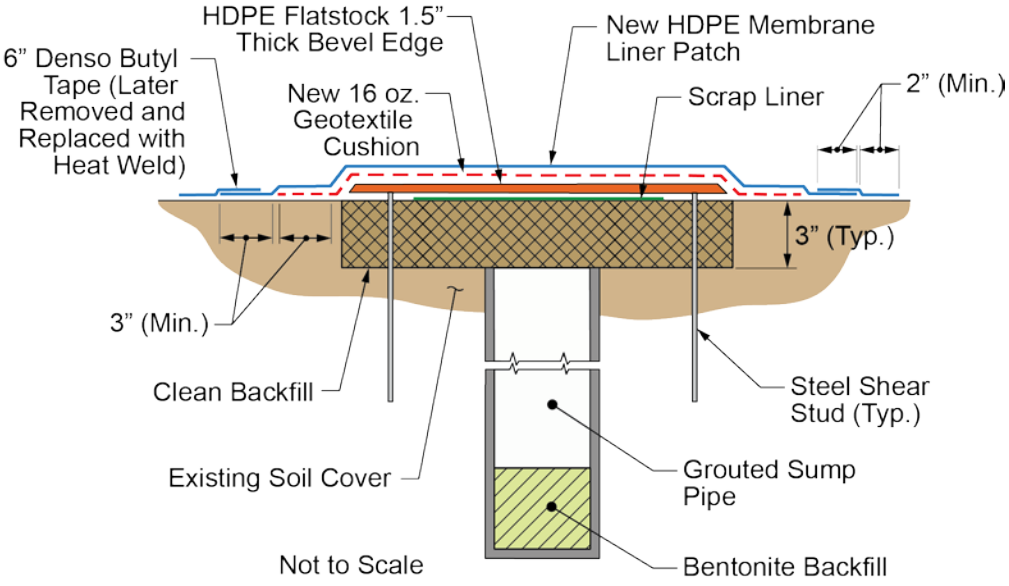

Fig. 3. Sump Abandonment Detail.

Geotechnical

To supplement the historic regional and site-specific geology data, AECOM performed a geotechnical site investigation across the Site in 2013. The geotechnical investigation focused on assessing the subsurface conditions immediately adjacent to and surrounding the restricted area (the area where the waste is present and where the FCP cap is being constructed), and exploring four potential borrow areas across the Maxey Flats property.

Site historic subsurface data was compiled and was supplemented by performing additional subsurface exploration at key locations throughout the Site, performing field reconnaissance to investigate possible haul road options, and collecting representative samples from exploration locations for laboratory testing to determine general soil properties and subsurface conditions across the Site. A combination of drilling methods was used in the geotechnical site investigation: hand auger, hollow stem auger, and Cone Penetrometer. Test pits were also excavated to expose subsurface soil. The investigation identified several borrow areas that had adequate amounts of soil for use in the FCP cap and haul road construction projects at the Site and identified the existing site conditions that are the foundation of the FCP cap design [3].

Groundwater

As part of the FCP Scope of Work, AECOM was asked to provide a technical position on whether the groundwater recharge from areas outside of the IRP-covered area is contributing to the water in the disposal trench sumps [4]. AECOM reviewed project records relevant to site geology and hydrogeology to evaluate the necessity of 1) constructing a horizontal flow barrier to prevent groundwater from re-entering the disposal trench sumps and 2) the need to extend the FCP cap to cover the groundwater recharge area north of the IRP cover.

The trenches were excavated to various depths. Some intercept the top of the Lower Marker Bed (LMB), the Nancy Member of the Borden Formation. Others intercept the top of the Farmers Member (FM) of the Borden. The presence of water in the disposal trenches was monitored by 89 sumps. Review of site records and previous analyses identified the following significant points.

1. Water levels in some of the sumps had declined over time, some had risen, but most had remained relatively static. The hydraulic records indicate that the seeps/springs are drying up since installation of the IRP interim cap, but that the sumps are not. This suggests that the sump water levels are only poorly connected to the surrounding geologic material, namely the LMB and FM groundwater flow zones [5].
2. Both the LMB and FM are relatively resistant rock (siltstone and sandstone, respectively) and are zones through which groundwater flows and in which the contaminants of concern were detected [5]. Groundwater flow in the LMB and FM zones appears to be dominated by fracture flow as suggested by the presence of discrete seeps/springs on the hillsides where these units outcrop, and the response of these discharge features to rainfall events. Some of the seeps/springs have become less productive since the IRP cap was installed, and others have dried up altogether. The dominant fracture trend is northeast-southwest (along the ridge line) according to past site characterization, but the observed seeps are largely on the east and west sides of the ridge and not at its southwest end.
3. The IRP cap on the restricted area was relatively effective at reducing the potential for infiltration into the trenches.
4. The area north of the restricted area covered by Tilsit Silt Loam, a fine, silty, residual soil derived from weathering of siltstone and interbedded noncalcareous shale with a moderately low to moderately high saturated hydraulic conductivity. The area has two old farm ponds that are wet through the entire year but do not have any significant surface water catchment and a stone-lined cistern 6 feet in diameter and 16 feet deep with water up to approximately 2 feet below ground surface.

   The presence of farm ponds and the water-filled cistern in the area north of the restricted area suggest that some of the soils in the area have sufficiently low permeability to perch water near the surface and slow its downward infiltration. Water levels in the piezometers in this area are also perched relatively high, suggesting that there is relatively slow recharge to deeper groundwater.

The historical data and past analyses do not support the potential for water in the trenches to be significantly recharged by groundwater north of the restricted area. The potential for significant groundwater infiltration north of the restricted area is low and the potentiometric data do not allow for flow from the north into the restricted area.

Support for these conclusions was based solely on historical data. Based on the data reviewed and this analysis, AECOM concluded that neither a horizontal flow barrier or extending the FCP cap over the north area to prevent recharge to the trenches was warranted. AECOM recommended using post-remedial action characterization and monitoring results to verify the conclusions of this analysis.

Haul Roads

Construction vehicles were prohibited from using the highways and roads around the site, so it was necessary to construct a temporary ridge haul road (Fig. 4) to transport materials from the valley borrow areas to the ridge top for construction of the FCP cap.

Fig. 4. Ridge Haul Road.

The construction of the ridge haul road was a key element in the overall remedy at MFDS and significantly lowered the hauling cost of borrow materials. Its design and construction were extremely challenging due to the topographic conditions at the MFDS. Construction on the ridge haul road was completed in June 2015. Following construction of the FCP cap, the ridge haul road will be converted into a standard site road.

For construction of the haul road, an extremely large area had to be cleared and grubbed. This area was cleared and stumps removed with chainsaws, excavators, and dozers, and the felled trees and stumps were chipped using a wood chipper. These chips were used later for erosion control.

Multiple crews and equipment were required to construct the ridge haul road. Material was excavated or filled along the haul route. Excavated materials consisted of topsoil, clay, shale, durable rock, and so forth. Excavators were stationed in cut areas to excavate the material and either place it in an adjacent fill placement location or load the material into a dump truck to be transported to a fill placement location. When durable rock was encountered in the excavations, pneumatic hammers were used to break and remove the rock to design grade elevations. Dozers stationed in the excavation areas continuously graded the excavation areas during the loading operations, providing a smooth driving surface for the hauling trucks, assisting in gathering borrow soils for the excavator, and maintaining positive drainage of the borrow area of the haul road.

The upper road was 38 feet wide, which allows for two-way traffic. For safety purposes, the traffic pattern adopted put the full trucks on the uphill side of the two-way stretch. This is opposite to normal driving in the US, requiring drivers to keep in constant communication with other road users to ensure that no conflict occurred. The lower loop road was restricted to one-way traffic flow.

FCP Cap Subsidence

Differential subsidence (settlement) threatens the functionality of final cover systems at important waste disposal facilities ([6], [7], [8], [9]). The long-term reliability of the MFDS FCP cap depends on its ability to mitigate or resist the distortions imposed on the cap by differential subsidence. However, the evaluation of differential subsidence for the final closure system at MFDS is challenging because of the heterogeneity of the waste mass and buried structures.

The conventional “deterministic” approaches to subsidence analysis typically do not indicate any differential subsidence or resulting ponding in areas of the landfill with consistent waste fill height (i.e., subsidence/settlement will be uniform). These approaches are therefore poorly suited to treat a site like the MFDS, which has highly variable parameters due to past disposal practices and variable sizes, orientation, and spacing of the disposal units, particularly since it is impossible to fully characterize the mechanical parameters of waste in-place at every point.

To more rigorously evaluate the potential for differential subsidence at MFDS and to design an FCP cap that can resist/accommodate this potential subsidence, a state-of-the-practice design approach applying probabilistic models was used. This captured the spatial variability associated with imperfect information as well as non-uniform waste characteristics, placement, and backfill.

Because the model is probability-based, its predictions encompass several different possible simulated outcomes resulting from the highly variable conditions within the waste mass. For every single simulation, the resulting map of waste properties is used to calculate subsidence at all points above the settling waste. The effectiveness of the post-subsidence FCP cap in maintaining drainage across the site was then evaluated through the determination of the percent inundated area for each simulation. Fig. 5 shows an example of a single simulation (realization) showing a post-subsidence 1-ft inundated area (in blue) that is approximately 0.11% of the overall final closure area.

A total of 51 relations were generated to analyze the post-subsidence performance of the MFDS FCP cap. The mean percent inundated and mean 1-ft percent inundated areas calculated for these realizations were compared to an acceptance criteria that was developed using a standard, regulatorily-acceptable design to ensure that the proposed design satisfies the design criteria for post-subsidence drainage performance. Using the analytically simulated results, the cover soil thickness, types of geogrid reinforcements, and final slope to limit the occurrence of poor performing areas of the FCP cap to a prescribed design value (i.e., an acceptable performance criterion) were selected.

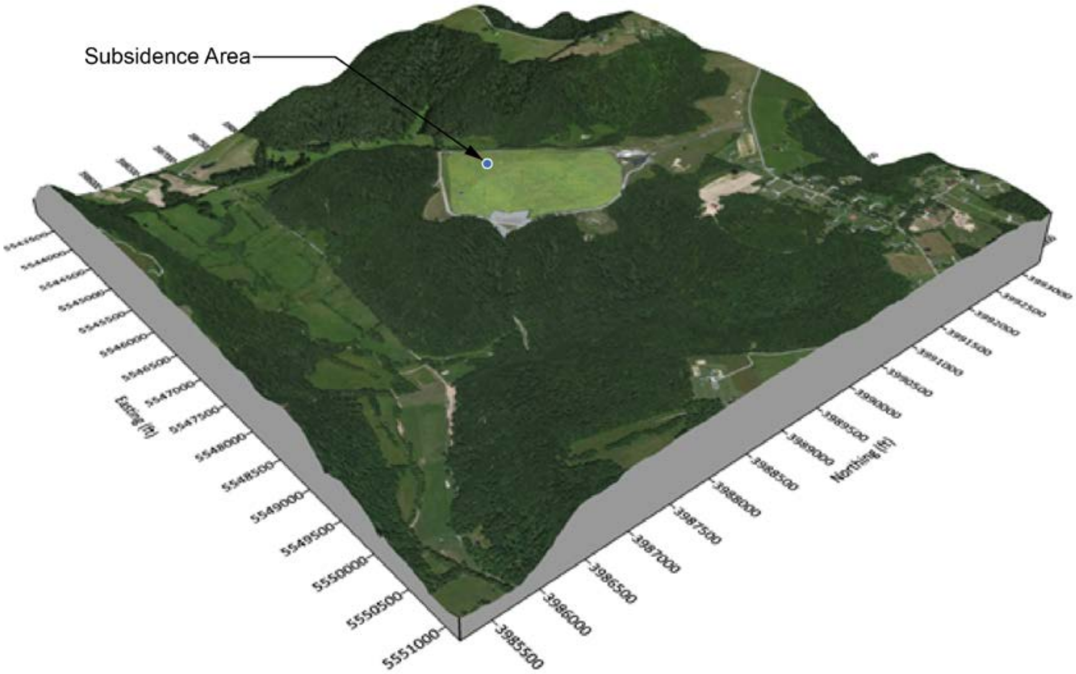

Fig. 5. Post-Settlement 1-ft Inundated Area.

Final Cap Design Elements

The FCP cap design provides surface stability and prevents water infiltration into the waste by using a composite (layered) cap consisting of geogrid-reinforced soil and several geosynthetic materials. Fig. 6 shows the layers of the final cap.

Stormwater is managed by a perimeter stormwater collection system and a series of detention ponds having the following characteristics:

Perimeter Stormwater Collection System: swales, catch basins, piping, and manholes, designed to carry the 100-year, 24-hour peak storm to the three stormwater management features (detention ponds).

Stormwater Management Features (one existing, two new): designed to store the 100-year, 24-hour peak storm and release the stormwater slowly into the receiving streams to diminish the possibility of erosion and contamination.

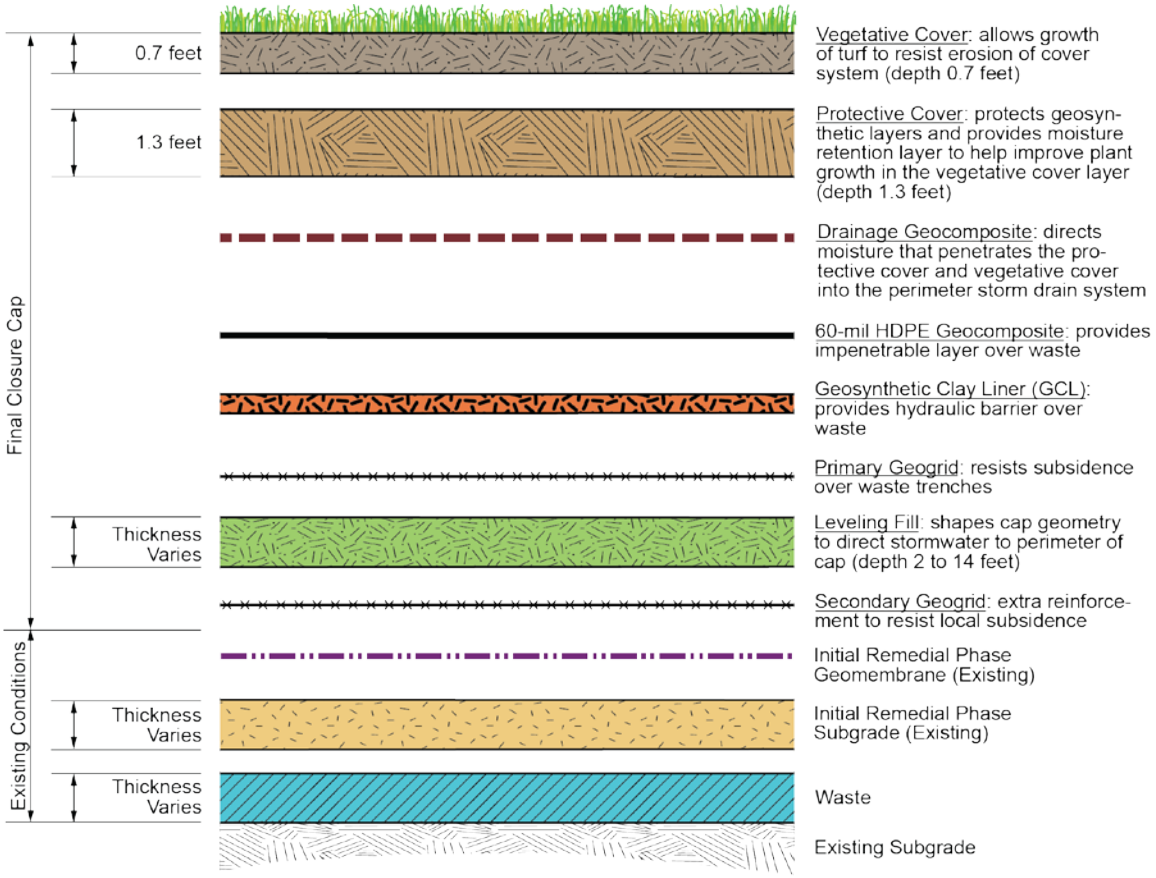

Fig. 6. FCP Cap Layers.

Cap Geometry

The Maxey Flats ROD mandates several required elements for the composite cover and was a principal input for determining the final design. Designers were bound by required thicknesses unless there were equivalent or better technologies.

The one technology which had the potential to significantly improve the cap design and reduce the cap profile was to replace the ROD-specified compacted clay layer portion with a geosynthetic clay liner. This change provided more controlled protection for the landfill and less thickness and weight in the FCP cap. When this change was made, an explanation of significant difference to the ROD was required and published by EPA Region 4.

For a stabilize-in-place remedy at the MFDS there is very little flexibility horizontally. Sharp drop-offs exist on three of the four sides of the ridge where the landfill is located, with very little room from the edge of the existing landfill to the edge of the drop-off. On the fourth northern side, the support facility and site infrastructure are established preventing expansion in that direction. Therefore, the footprint established by the existing interim cap defined the horizontal limits for the final cap.

Common geometric designs for caps over landfills include: a “gable” design with a “hip” slope at each end (Fig. 7[a]); a “mansard” design (Fig. 7[b]); and a “ridge and valley” design (Fig. 7[c]). The gable and mansard designs require massive amounts of soil fill, steep slopes, and typically large footprints extending beyond the disposal area, making the geometry of these two options difficult if not impossible to accomplish at the MFDS. The advantage of the gable and mansard designs is that stormwater sheet flows off of the cap and is collected at the perimeter of the landfill without creating any concentration of flows.

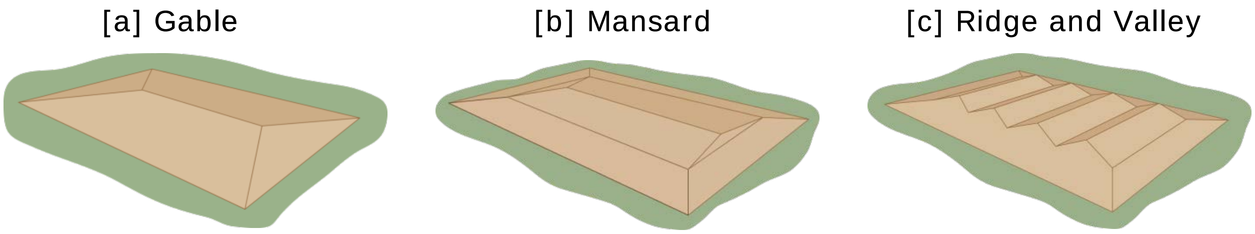
[a] Gable [b] Mansard [c] Ridge and Valley

Fig. 7. Common Landfill Cover Geometric Designs.

Generally, the Commonwealth prefers that landfill caps be designed without valleys. However, the ridge and valley design is not only the most economical design, but also provides a cap system that will function and apply the least weight to the landfill. One concern with the ridge and valley design is the creation of internal valleys over the landfill, which results in stormwater runoff flows being concentrated in valley channels over the waste footprint.

Given the constrained available cap footprint, the need to minimize concentrated stormwater flows, and the desire to minimize quantities of construction materials, a combination design was chosen applying elements from all three options (Fig. 8). The design includes a few valleys so the amount of imported fill can be optimized. The concerns regarding the erosion from concentration of flows in the valleys was addressed by using Turf Reinforcing Mat (TRM) in the bottom of each channel. TRM provides the needed resistance to the valley erosion and also provides a surface which can easily be maintained through scheduled mowing activity.

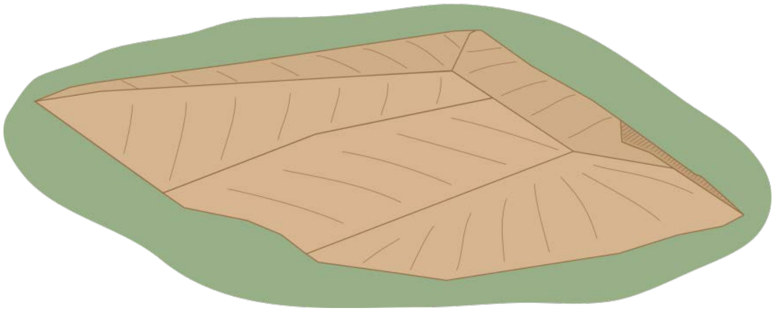

Fig. 8. Combination Design.

The geometry of the cap was optimized so the thickness of the fill provided was as thin as possible, reducing the weight over areas where potential future subsidence may occur.

The cap was designed with a slope of 3% to 5% over any waste deposits. This effectively allows for free draining of any rainwater from the cap without causing erosion when vegetation is established. Steeper slopes were necessary around the edge of the cap to maintain the cap footprint, but these slopes are not over waste trenches, and do not exceed 1’V:4’H. The design provides for the entire cap surface to be vegetated and the vegetation established prior to termination of the project.

Water Management Features

The FCP cap was designed to withstand the probable maximum 24-hour storm for this area, which equates to approximately 24 inches over a 24-hour period. However, if such a storm occurred, there would be erosive damage to the protective soil cover over the geosynthetic layers that would need to be re-graded or replaced. However, the geosynthetic portion of the cap is designed to remain in place without being affected by the maximum storm.

To prevent water from seeping into or discharging into the waste, two layers of geosynthetics were provided: a Geosynthetic Clay Liner (GCL), which uses a thin layer of bentonite clay between two layers of geotextile and an impervious 60-mil HDPE flexible membrane liner (FML) installed over the top of the GCL. The GCL is installed unhydrated. However, if the HDPE FML was damaged in an isolated location, any moisture penetrating it would immediately hydrate the GCL causing it to swell and become impervious, resisting discharge into the waste below. These two impervious layers are overlain by a layer of geocomposite drain that is constructed with a free draining heavy-gage geonet between two layers of non-woven, needle-punched geotextile. Any moisture that penetrates the soil cover of the cap will be captured by the geocomposite drain below the soil cover, and drain to the edges of the cap and daylight to the perimeter stormwater collection system.

The concentration of flow in the valleys could result in increased seepage through the protective cover soil and into the geocomposite drain. This was addressed in the design by placing a prefabricated drain, which is a sub-surface feature of geotextile, geonet, and sand. The prefabricated drain was placed below the soil layer along the bottom of all valleys and on top of the geocomposite drain layer. The prefabricated drain was sized to allow the free flow, without any resistance, of moisture penetrating the protective soil surface of the cap, to the perimeter of the cap and into the perimeter stormwater collection system.

The entire cap is surrounded at its perimeter by a stormwater collection system which effectively collects the stormwater from the cap and delivers it to one of the three Stormwater Management Features (SWMFs). The SWMFs release the collected stormwater over a 36-hour period, thereby providing manageable flows to the receiving streams. All of the stormwater collection features including swales, piping, catch basins, and SWMFs were designed to handle a 100-year, 24-hour storm, which is approximately 6 inches in 24 hours for the MFDS.

Because the limited space around the cap made it difficult to provide an open channel collection system and still maintain a perimeter access road, the design on a portion of the perimeter road included the roadway surface with an inverted crown as part of the collection system, with catch basins, and underlain by a piping system to collect the stormwater and deliver it to the SWMFs. On the portion of the roadway used in the stormwater collection system, the design requires a road surface of asphalt paving with an inverted crown cross section. In order to provide continuity and long-term ease of maintenance, the entire perimeter road was constructed with an asphalt surface.

CONCLUSIONS

Data gathered from sump leachate level monitoring and radioactivity analyses of groundwater and surface water at MFDS show that the temporary geosynthetic covers placed at the site during the IRP significantly decreased sump recharge and reduced releases of contamination to unrestricted areas. The FCP cap will provide a permanent solution to further reduce or eliminate contamination and protect human health and the environment. The overall geometry of the cap, combined with the geosynthetic layers and the vegetative cover, ensure that no water will be retained anywhere on the cap surface or in the protective soil cover, thereby eliminating the possibility of water seeping into or discharging into the waste.

AECOM is currently performing construction oversight for the FCP cap project. At this time, the construction of the entire FCP cap is approximately 70% complete and is expected to be completed in late summer, 2016.

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