Global Waste Management Symposium 2014 Extended Abstract

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Abstract Title: Design and Construction of a Leachate Conveyance Trench underneath a Landfill Cell Liner

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**Design and Construction of a Leachate Conveyance Trench underneath a Landfill Cell Liner**

**Extended Abstract**

The Indian River County Landfill (IRCL) facility is located in southern Indian River County, in Vero Beach, Florida. Municipal solid waste (MSW) and construction and demolition (C&D) debris are commingled and disposed of in its Class I landfill. The active Class I landfill includes Segments 1 and 2, and an Infill Area located between Segment 1 and Segment 2. In addition, an area with a footprint of approximately 76 acres, located immediately east and southeast of Segment 2 and designated as Segment 3 expansion, was designed and permitted by the Florida Department of Environmental Protection (FDEP) for construction and operation as a lateral and vertical expansion of the existing landfill. The first cell of the Segment 3 expansion was constructed from summer of 2012 to spring of 2013.

The lateral expansion consisted of connecting the existing Segment 2 single liner system, constructed in 1987, or the Segment 2 partial cover geomembrane, constructed in 1998, with the double liner system of the new Segment 3 expansion thereby providing continuous containment of waste and leachate. To maximize the available waste capacity (i.e., airspace) at the landfill, an innovative approach was adopted to connect the existing single liner to the double liner of the new cell. A leachate conveyance trench (LCT) was designed and constructed underneath the double liner system of the first cell (Cell 1 of the Segment 3 expansion) to collect and convey leachate from the existing Segment 2 single liner system at the IRCL. Figure 1 shows a cross section of the landfill with Cell 1 of the Segment 3 expansion and the location of the LCT. This extended abstract discusses the design and construction challenges for the LCT.

![Figure 1. Landfill Cross Section (Geosyntec Consultants, 2012)](image_url)
Design Challenges

The existing leachate collection system (LCS) of the single lined Segment 2 consisted of twelve 6-in. diameter polyvinyl chloride (PVC) leachate collection pipes. The 12 PVC pipes were constructed to collect leachate via gravity flow from the mid-point of Segment 2 and ran in the east-west direction. Three PVC pipes converged at one location. Manholes 1 through 4 (MH-1 through MH-4) were constructed to act as sumps at each of these four convergence locations along the east boundary of the Segment 2 landfill. A header pipe running in the north-south direction then conveyed the leachate to MH-9 and further to the lift station. Figure 2 depicts the layout of the existing Segment 2 LCS with the 12 PVC pipes and the four manholes.

Figure 2. Existing Segment 2 LCS and Piping Layout (Geosyntec Consultants, 2012)
As part of the Segment 3 expansion, the LCT was designed to run underneath the new Cell 1 double liner system in order to:

(i) provide containment of waste and leachate within Segment 2 of the existing landfill;

(ii) effectively convey the collected leachate from Segment 2 to the lift station; and

(iii) facilitate piggy-backing the waste from Segment 3 onto the slopes of Segment 2 and thereby avoid losing airspace.

Analyses for Slope Instability

A 1000-ft long and 15-ft deep LCT was designed to run underneath the Cell 1 liner system. The LCT was located at the toe of the slope of Segment 2 which consisted of approximately 100-ft high waste at an average slope of 4 horizontal to 1 vertical (4H:1V). In addition, due to space constraints at the toe of Segment 2, the design of the LCT required fairly steep side slopes of 1H:1V. Pursuant to Chapter 62-701.400(2) of the Florida Administrative Code (FAC) a minimum factor of safety (FS) of 1.50 was required against slope instability. Slope stability analyses were performed using Spencer’s limit equilibrium method (Spencer, 1973) as implemented in the computer program SLIDE®, version 5.043 (Rocscience, 2009). Based on the analyses performed and in order to achieve the target minimum FS of 1.50, a segmental construction technique was required to be adopted for the LCT, wherein 200-ft segments of the trench were permitted to be excavated, lined and backfilled at a time. The calculated FSs using the segmental construction technique were greater than the target minimum FS of 1.50.

Segment 2 LCS

Leachate collected from the Segment 2 LCS was conveyed to MH-9 by a header pipe and further conveyed to the lift station. Although the total volume of leachate collected from entire Segment 2 was recorded, the individual quantities of leachate collected at each of the four manhole locations, where the three LCS pipes converged, were unknown. This posed a design challenge for the new header pipe to be laid within the LCT. A conservative approach was adopted wherein the pipe diameter of the new high density polyethylene (HDPE) header pipe was incrementally increased from 8 in. at the southern end to 10 in. at the northern end. Further, in order to match the invert elevations of the gravity-flow LCT to the outlet inverts of the Segment 2 LCS pipes, an extensive modification of the piping system was adopted as shown in Figure 3. The existing manholes were demolished and the Segment 2 LCS PVC pipes were connected to the new HDPE header pipe using electro-fusion couplers. This piping modification ensured efficient conveyance of the Segment 2 leachate.
Construction Challenges

The LCT was lined to act as a dual containment to the new HDPE header pipe and was sloped from south to north for removal of any leaked leachate. The LCT was constructed on a 6-in. thick prepared subbase and was lined with a composite liner consisting of a geosynthetic clay liner (GCL) overlain by a 60-mil thick textured HDPE geomembrane. The LCT geomembrane liner was welded to the Segment 2 liner system geomembrane or the partial cover geomembrane along the length of the trench to provide continuous containment. A new HDPE leachate
collection header pipe was installed within the LCT after removal of existing manholes and connections were made to the existing 12 LCS pipes of Segment 2. The new HDPE header pipe, pipe embedment fill, and general fill within the LCT were wrapped in a geotextile burrito wrap. The double liner of Cell 1 was then laid on top of the LCT to isolate the LCS of Cell 1 from the LCT. A cross section of the LCT is shown in Figure 4.

![Cross section of the LCT](image)

**Figure 4.** Leachate Conveyance Trench Detail (Geosyntec Consultants, 2012)

**Leachate Flow Control**

One of the major challenges during construction of the LCT was establishment of controlled leachate flow for the Segment 2 LCS. The Segment 2 LCS was required to be in continuous service collecting leachate and no disruption of the leachate collection was allowed. The Segment 2 LCS pipes were required to be kept active during the incremental demolition of MH-1 through MH-4, construction of the LCT and the piping modifications. As depicted in Figure 2 the existing header pipe conveyed leachate cumulatively from MH-1 through MH-4 and then to MH-9. The piping modification began at MH-4 location. Pneumatic pipe plugs were utilized by the contractor at MH-4 to prevent flow towards MH-9. Pipe plug was also installed at MH-9 to prevent backflow towards MH-4. Leachate from MH-1 through MH-3 was initially collected at a location just upstream of MH-4 and pumped directly to MH-9. Steady state leachate flow was established prior to initiating any piping modifications. It was estimated that plugging the LCS pipes for approximately 120 hours at one manhole location would correspond to the maximum allowable leachate head build-up within the sub-catchment of Segment 2 liner. Based on this, the three LCS pipes converging at the MH-4 location were plugged for a period of approximately 72 hours, but not exceeding 120 hours in any case. The contractor was required to make the necessary piping connections during the time the plugs were installed and demolish the manhole. Once the manhole was demolished and three LCS pipes were connected to the new HDPE header pipe, the plugs were removed. The plugs and the pumps were then moved to MH-3 location and leachate from MH-1 through MH-2 was directly pumped from a location just upstream of MH-3 to MH-9. Piping connections were then made at the MH-3 location and the three LCS pipes converging at MH-3 were connected to the new HDPE header pipe. This procedure was subsequently followed at the MH-2 and MH-1 locations to complete the piping modifications.
As assumed in the slope stability analyses, the excavation for LCT was carried out as segmental construction in 200-ft increments. Therefore, the piping modification was also carried out in tandem with the segmental construction.

Dewatering and Diversion Berms

As mentioned previously, the LCT was designed to act as a gravity-flow trench and sloped from south (MH-1) to north (MH-9). The composite liner of the LCT consisted of a GCL overlain by a 60-mil thick textured HDPE geomembrane. A picture depicting installation of the geomembrane component of the LCT is shown in Figure 5. At the downstream location of the LCT between MH-4 and MH-9, the bottom of the LCT was below the groundwater table elevation. Hence, during construction extensive dewatering was required in order to install the 6-in. thick prepared subbase layer and to achieve a relatively dry and compacted surface for deployment of the GCL. Sock drains and pumps were utilized for dewatering purposes.

In addition, due to the timing of the construction contract award, the LCT was constructed during peak rainy season (June through August 2012) in Florida making the construction even more challenging. Construction techniques such as construction of upstream diversion berms and tarping the LCT excavation and GCLs were implemented. Further, design changes and modifications, including replacement of MH-9 and jet cleaning of the LCS pipes, were adopted to enhance the existing leachate management system.
Performance of LCT Post-construction

Construction certification of the LCT and the Cell 1 liner system of the Segment 3 expansion was approved by the FDEP and Cell 1 started accepting waste in April 2013. The LCT appears to be functioning as designed, in that, the volume of leachate collected from Segment 2 has remained fairly constant pre- and post-LCT construction. **Figure 6** depicts the quantity of leachate generated and collected for the IRCL from January 2012 to date. Daily quantities of leachate collected pre-LCT construction (i.e., January to May 2012) are generally consistent with the quantities collected post-LCT construction (i.e., September 2012 to March 2013). The general increase in the leachate generation from August to October 2012 (also observed for 2013) corresponds to the time period of the wet season and immediately following the wet season when higher quantities of leachate are expected to be generated. Further, results of the semi-annual groundwater sampling at IRCL have not shown any increase in the concentration of leachate constituents within the groundwater downgradient of the LCT.

![Figure 6. Daily Leachate Quantities Collected at the IRCL](image)

Conclusions

Effective means and methods were successfully implemented to manage several design and construction challenges encountered during construction of the LCT at the IRCL. Quantities of leachate collected pre- and post-LCT construction and the results of groundwater monitoring indicate that the LCT is functioning satisfactorily as designed. Successful design and construction of the LCT enabled piggy-backing of waste from Segment 3 expansion and thereby providing additional airspace on the order of 1.2 million tons based on the permitted final waste design grades. This added airspace corresponds to an extension of the landfill life by approximately 11 years.
References:


