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Red Hill Landfill – design considerations for a hazardous waste cell

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ABSTRACT: The Eastern Metropolitan Regional Council (EMRC) of Perth, Western Australia, operates the Red Hill Waste Management Facility on behalf of six local governments and it also accepts waste directly from the private sector. In addition to putrescible waste (Class II waste) it also accepts contaminated soils (Class III waste) and is the only facility in Western Australia licensed to accept Class IV Hazardous Waste. The original Class IV cell was constructed in 1997 with a double HDPE liner and compacted clay system on the base and a single HDPE liner with compacted clay on the walls. EMRC has subsequently encountered a number of issues associated with operation and management of this lined facility, especially with regard to storm water and leachate management. It is now embarking on the design of another Class IV cell and it wishes to address these issues and produce a design that is extremely secure and practical from both a construction and operation perspective. The new cell is expected to be a double HDPE lined system throughout, with compacted clay and a GCL used in the base and a GCL alone on the slopes. Leachate and leakage collection systems are expected to be geosynthetic based in order to maximize hydraulic efficiency and enhance void space. The paper outlines the design and the testing processes and will discuss the impact of the design on practical construction and operational issues.

1 BACKGROUND

The Red Hill Waste Management Facility, situated near Perth in Western Australia serves six local governments and is operated by the Eastern Metropolitan Regional Council (EMRC) as a combined facility.

It has operated as a municipal and putrescible waste facility since 1983, with additional land and buffer zones being allocated from time to time.

In 1996 a need was identified for a Class IV disposal site for low level hazardous waste (essentially contaminated soils) and this resulted in the first hazardous waste cell (Stage 1) being built in 1997.

The Stage 1 cell has base dimensions of 110 m × 150 m and side slopes of 1:3 with a depth of 10 m. It is divided into two sections by a central bund 1.5 m high constructed on top of the liner system. It has a leachate collection system of HDPE pipes feeding into PVC sewer pipes with inspection manholes.

Stage 1 was awarded the Case Earth Award and has the following main features (bottom up):

- A compacted clay liner 500 mm thick on the base and side slopes with permeability less than 1×10^{-8} m/sec.
- A 1 mm thick HDPE liner underlain by a 180 g/m^2 geotextile.
- A leak detection layer based on a geonet with a sump in the south west corner of the cell.
- A 1 mm thick HDPE liner on the base extending 1 metre up the side slopes.
- A 300 mm thick layer of free draining sand.

Current operational issues are a substantial build up of leachate within the cell, a limited volume of storage within the Class IV leachate pond and leachate in the leak detection manhole.

Camera inspections have indicated that the leachate in the leak detection manhole is present due to a pipe blockage, and its presence is seen as an indication that the lining system remains intact.

Although the cell is closed in winter, and a temporary clay cap placed, it appears that in the earlier years the storm water was shed towards the sand layer over the HDPE liner and has been contained within the cell as leachate.

This excess of leachate is currently being cleared by evaporation from temporary evaporation ponds on top of the cell.

Class IV waste has largely been generated from clean-up of contaminated soils and deposits have been slower than anticipated. Several years capacity remained in 2004 when the possibility of a particularly large site clean-up gave impetus to development of a design for Stage 2.

2 STAGE 2 DESIGN

Stage 2 has taken into account the development of newer materials such as geosynthetic clay liners (GCLs) and high capacity geonets.

The cell is a rectangle similar to Stage 1, but with side slopes at 1:2 such that an additional 20,000 cubic metres of void space will be created. It is proposed that the lining of the side slopes will comprise (from bottom up):

- A needlepunched GCL liner.
- A textured HDPE liner 2 mm thick.
- A geocomposite leachate drainage layer.
- A 2 mm thick HDPE liner.
- A geonet or geocomposite leachate drain.
- A geotextile filter layer.

The base liner will be similar to the side slope lining system, with the addition of a 500 mm thick compacted clay liner beneath the GCL, using clay from the site.

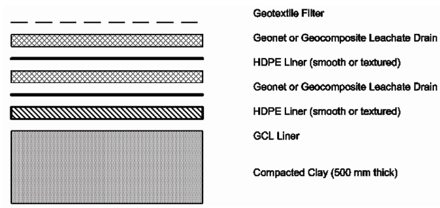

Figure 1. Proposed base liner system.

It is envisaged that the upper geonet would be installed incrementally as waste is received so that when the cell is closed an "HDPE apron" can be installed to prevent rain ingress to the base of the cell.

The use of a geonet in lieu of the free draining sand and the use of the GCL and the HDPE on the side slopes in lieu of the clay lining will increase the volume available for disposal.

The slope liner system will use high interface friction materials (textured liner and geocomposite drainage layers with geotextile against the geonet) for all except the upper interface which will use a smooth liner surface in direct contact with the geonet.

2.1 *Leachate collection and drainage layer*

The major elements to be involved here will be:

(a) a select sandy waste material to provide the initial cover over the geosynthetic materials
(b) a geotextile filter

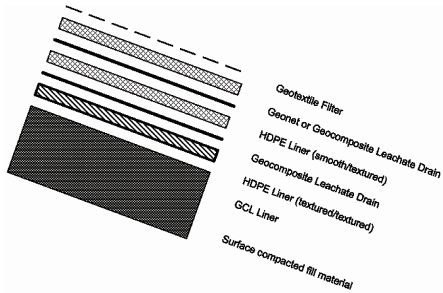

Figure 2. Proposed slope liner system.

(c) a geonet or geocomposite drain

These elements have been evaluated based on conservative estimates of leachate flow rates derived from local climate data, using the method and formulae in Giroud et al, 2000(b).

This method uses reduction factors, which enable an assessment to be made for each potential influence. These reduction factors are then multiplied together to form a combined reduction factor.

In this case the reduction factors were selected for a geonet for which there is a body of compressive creep test data. They are set out in the table below:

RFimco	Immediate compression	1.0
RFimin	Immediate intrusion	1.0
RFcr	compressive creep	1.2
RFin	Intrusion	1.1
RFcd	chemical deterioration	1.1
RFcc	chemical clogging	1.8
RFbc	biological clogging	1.3
RFpc	Particulate clogging	1.05

The required leachate drainage layer hydraulic flow rate capacity was determined to be 1.9×10^{-3} m^2/sec under a load of 150 kN/m^2 and a hydraulic gradient of 1. The specification for the geonet will include requirements for creep and other testing to justify the use of the reduction factors set out in the calculations.

The collection sumps are to be placed in the south west corner of the cell and the direction of the geonet main flow capacity will be directly along the 2% base slope towards the sumps. This is reflective of the testing data being derived from manufacturing machine direction flows rather than bias direction flows.

2.2 *Leak detection and drainage layer*

The methods set out and summarised by Fluet (2002) have been used to develop an estimate of the volume of leachate which may be expected to leak through defects in the primary liner. This provided a basis for the design of the leakage detection and drainage layer to be calculated in three steps as follows:

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(a) evaluate the potential leachate head in the notional area of the defects
(b) evaluate the leakage through the defects
(c) evaluate the necessary leachate drainage layer capacity for this leakage.

The required leakage drainage layer capacity was determined to be 2×10^{-4} m^2/sec under a load of 150 kN/m^2 and a hydraulic gradient of 1.

As expected, this requirement is less than the requirement for the leachate drainage layer.

2.3 *Filter design and testing*

The intention is to use a select sandy waste material as the cover material. The combined sand/geotextile filtration system will be required to achieve a minimum flow capacity, after the flow stabilises, which will be evaluated using a filtration performance test such as the gradient ratio test.

The required stable flow capacity was determined using reduction factors as follows:

RFimco	immediate compression	1.00
RFimin	immediate intrusion	1.00
RFcr	Creep	1.50
RFin	Intrusion	1.00
RFcd	chemical deterioration	1.10
RFcc	chemical clogging	5.00
RFbc	biological clogging	5.00
RFpc	particulate clogging	1.00

This is to be confirmed by hydraulic conductivity ratio testing using the actual soil, geosynthetics and leachate. The required hydraulic conductivity ratio test stable flow capacity of the combined sand/geotextile filtration system is 1.8×10^{-6} m^2/sec.

2.4 *Side slopes*

The conceptual design of the side slopes is to use high interface friction materials for all the internal interfaces and to create a low interface friction interface over the primary (upper) liner. This means that any waste mass instability does not result in loads on the liner system.

Using textured geomembrane for all except the upper surface we would expect interface friction angles as follows:

- Compacted slope soil to GCL – 20-25 deg
- GCL to textured HDPE – 20-25 deg
- Textured HDPE to geotextile face of geocomposite – 20-25 deg
- Geotextile face of geocomposite to textured HDPE – 20-25 deg
- Smooth HDPE to geonet – 8-10 deg

All layers except the upper geonet will be anchored by anchor trench, and with this friction relationship very little effective shear loading is expected in the slope liner system.

These relationships between layers are to be confirmed by interface shear box testing, which will be made a specification requirement.

In recent times there has been some concern over shrinkage separation of panels of GCL liner when left under an exposed HDPE liner.

This has been identified as related to the following factors:

- Use of GCLs with non-woven geotextiles without a base woven geotextile to provide dimensional stability
- Inadequate overlap between panels
- Lack of moisture control when installing the GCL.

If these factors can not be controlled, then early soil cover is a recommended action to control this. Since the intention is to leave these side slopes uncovered for some time, there is a need for the specification and supervision of the work to pay close attention to these requirements.

3 SUMMARY

This paper presents a preliminary technical evaluation of the key geosynthetic design aspects for the proposed Red Hill Stage 2 hazardous waste cell. It includes an assessment of the performance requirements of the following components:

(a) Leachate collection and drainage layer
(b) Leak detection and drainage layer
(c) Soil/geotextile filter
(d) Side slope stability.

The assessment is based on assumed data for the waste, leachate flows and characteristics, and is set out with calculations on spreadsheets that will allow rapid re-assessment when better data is available.

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