ANNEXURE A – DWS CHECKLIST

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT REGULATIONS 2013: BASAL BARRIER SYSTEM CHECKLIST FOR THE LEAD AUTHORITY (NATIONAL OR PROVINCIAL GOVERNMENT) IN ADVANCE OF DOCUMENT SUBMISSION TO COMMENTING AUTHORITY

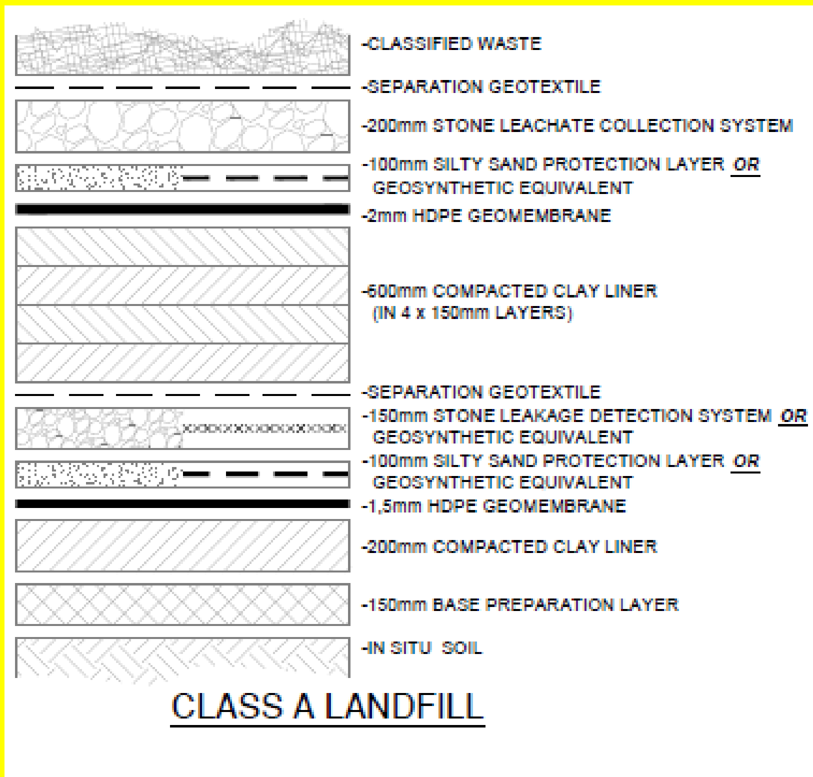
In order to consider a waste license application, it is worth reminding ourselves of the requirements for a pollution control barrier technical report as shown below (emphasis is added by a yellow highlight), over and above controlling legislation from which extracts are included as Appendix A.

1. Extract from NEMWA Regulations 2013 R636 regulation 3 (emphasis added)

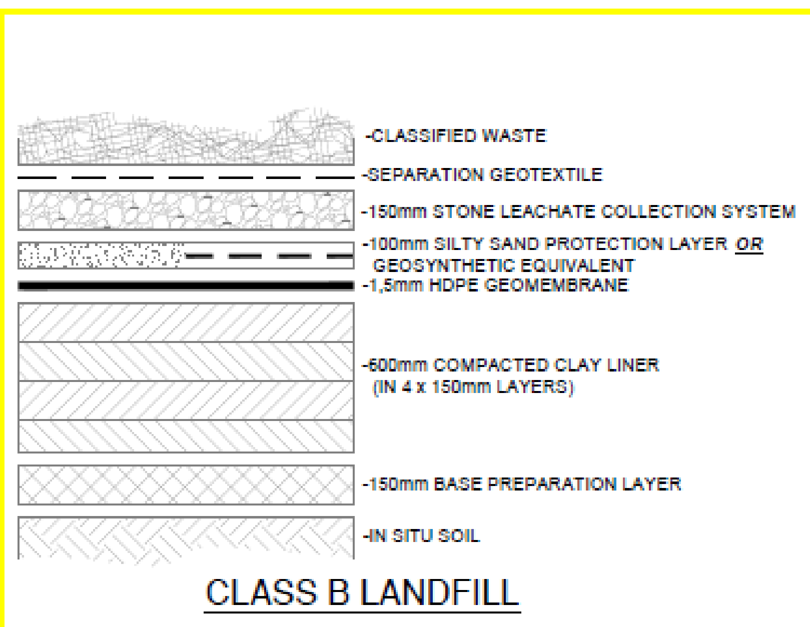
Regulation 3. Landfill Classification and Containment Barrier Design

3 (1) The containment barriers of landfills for the disposal of waste in terms of section 4 of these Norms and Standards must comply with the following minimum engineering design requirements-

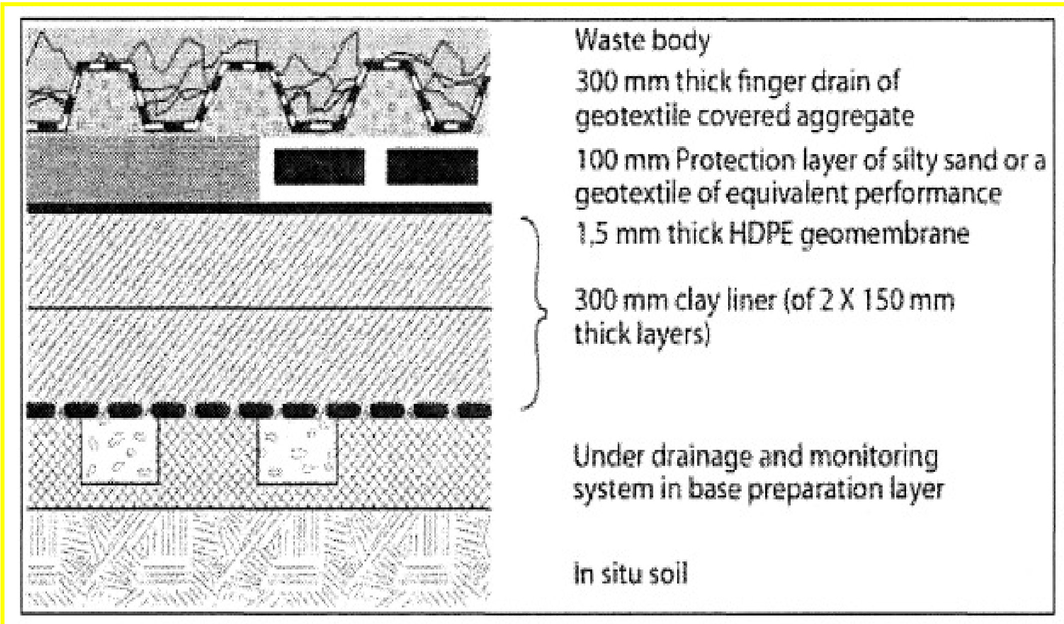
(a) Class A Landfill:



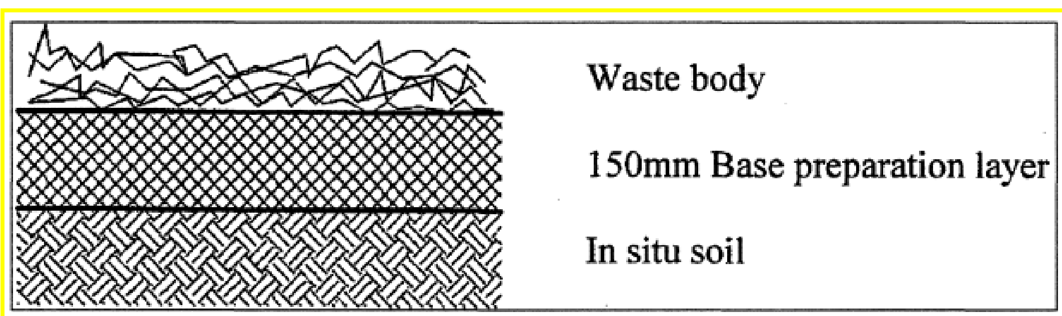
(b) Class B Landfill:



(c) Class C Landfill:



(d) Class D Landfill:



3(2) The following containment barrier requirements must be included in an application for waste management licence approval of a landfill site or cell –

(a) design reports and drawings that must be certified by a registered, professional civil engineer prior to submission to the competent authority;

(b) service life considerations that must be quantified taking into account temperature effects on containment barriers;

(c) total solute seepage (inorganic and organic) that must be calculated in determining acceptable leakage rates and action leakage rates;

(d) alternative elements of proven equivalent performance which has been

considered, such as the replacement of -
(i) granular filters or drains with geosynthetic filters or drains;
(ii) protective soil layers with geotextiles; or
(iii) clay components with geomembranes or geosynthetic clay liners;

(e) All drainage layers must contain drainage pipes of adequate size, spacing and strength to ensure atmospheric pressure within the drainage application for the service life of the landfill;

(f) Alternative design layouts for slopes exceeding 1:4 (vertical: horizontal) may be considered provided equivalent performance is demonstrated;

(g) Construction Quality Assurance during construction;

(h) Geosynthetic materials must comply with relevant South African National Standard specifications, or any prescribed management practice or standards which ensure equivalent performance; and

(i) Consideration of the compatibility of liner material with the waste stream, in particular noting the compatibility of natural and modified clay soils exposed to waste containing salts.

2. Check List of Information Available in the Design Report for Confirming Performance of Containment Barrier Systems

2.1 The applicant and representative

Name of project:
(a) **LICHTENBURG LAFARGE CEMENT PLANT AND TSWANA QUARRY STORMWATER INFRASTRUCTURE AND POLLUTION CONTROL DAMS PRELIMINARY DESIGN REPORT**

(b) Name and contact details of the developers' representative e.g. CEO or area Manager:

<table>
<tr><th colspan="2">PARTY</th><th>Representative</th><th>Role</th><th>E-mail Address</th></tr>
<tr><td rowspan="5">FACILITY OWNER</td><td rowspan="5">LAFARGE INDUSTRIES SOUTH AFRICA (PTY) LTD

LICHTENBURG</td><td>Millicent Siwele</td><td>Project Manager</td><td>millicent.siwele@lafarge.com</td></tr>
<tr><td>Joggie Van Der Westhuizen</td><td>Project Leader</td><td>joggie.vanderwesthuizen@lafarge.com</td></tr>
<tr><td>Jan Norris</td><td>Engineer</td><td>NorrisJ@jgafrika.com</td></tr>
<tr><td>Uneysa Taljard</td><td>Environmental</td><td>uneysa.taljard@lafarge.com</td></tr>
<tr><td>Lefentse Makoko</td><td>Lichtenburg Area Manager</td><td>lefentse.makoko@lafarge.com</td></tr>
</table>

(c) Name, contact details and ECSA registration number of the professional engineer (civil) certifying the design report:

Name: Jan Norris
Pr Eng Registration: 980198

(d) Title of Design Report, reference number and date:

LICHTENBURG LAFARGE CEMENT PLANT AND TSWANA QUARRY STORMWATER INFRASTRUCTURE AND POLLUTION CONTROL DAMS PRELIMINARY DESIGN REPORT

Report Reference 5707

Date: 06/05/2022

(e) Confirmation of waste risk assessment (in accordance with R634 and R635):
An assessment of the waste stream for both the Additives area and the Coal Stockyard area was carried out by Environmental Pollution Laboratory (EPL) (Pty) LTD in accordance with R634 and R635. See Annexure E for waste classification test results for both PCDs. The test results indicate that the waste type for both PCDs is a Type 3 Waste.

A detailed Waste Classification report is being completed by JG Afrika and will be submitted to the DWS upon completion.

The preliminary design for both PCDs were carried out based a Type 3 Waste which requires Class C liner.

(f) Description of Waste stream:

- **Additives PCD**: The base flow entering the Additives PCD is from the contaminated runoff (dirty water) around the Additives area during storm events which will reach a flow rate of 2.29 m^3/s during the 1 in 50-year flood event.

- **Coal Stockyard PCD**: The base flow for the Coal Stockyard PCD originates from polluted (bad water) surrounding the Coal Stockyard region during storm events, reaching a maximum flow of 0.52 m^3/s during the 1 in 50-year flood event.

2.2 The engineers design report

(a) The design report and drawings signed-off and dated by a registered professional Civil engineer: Yes, see verification page of the Preliminary Design Report for both PCDs.

(b) Service life determination: For the design and construction quality assurance (CQA) for each infrastructure component, (cell or PCD etc.) -

(i) Polluting period of waste (years): The pollution period will only be during operation of the PCDs. Once the PCDs are decommissioned the source of contaminants will stop.

(ii) Operating period of PCD (years): until 2073 for both Additives and Coal Stockyard PCD.

(iii) Anticipated leachate temperature range (°C): N/A

(iv) Total tensile strain in geomembrane (percentage): 0.25%

(v) Service life of drainage system materials (years): At least 60+ years limited by HDPE pipe leachate collection system performance at 35-degree temperatures as per ISO 9080:2003. The system is however reliant on a submersible pump to remove seepage and/or leakage

(vi) Service life of other materials: Structures 50 years, for both Additives and Coal Stockyard PCD.

(vii) Service life of barrier system (years): 106 years for both Additives and Coal Stockyard PCD, see Design Report Pg. 25.

(c) Total solute transport/seepage through the barrier system calculations:

(i) Footprint area (ha) 1.36 ha for Additives PCD, 0.22 ha for Coal Stockyard PCD.

(ii) Maximum wrinkle height in geomembrane (cm) 1 x 5cm (per 5m wide panel) similar for both PCDs.

(iii) Maximum wrinkle width (cm): 1 x 15cm (per 5m wide panel) similar for both PCDs.

(iv) Maximum interconnected wrinkle length (m) 30m, similar for both PCDs.

(v) Maximum percentage area of wrinkles 5%, similar for both PCDs.

(vi) Leachate head above liner: No leachate for both PCDs, but water head of 3.2 m with for the Additives PCD at full capacity and a water head of 3.08 m with for the Coal Stockyard PCD at full capacity

(vii) Leakage rate assessed for during operational period (l/ha/d): 59.7 l/ha/d for the Additives PCD and 41.8 l/ha/d

(viii) Leakage rate post closure (i.e. end of operational phase) (l/ha/d):0 l/ha/d Once both PCDs are decommissioned they will not leak as long as contaminated liquids are prevented from entering the basin.

(ix) Total leakage for component (l/d) 81.2 l/d for the Additives PCD and 9.2 l/d for the Coal Stockyard PCD.

(x) Quaternary catchment: N/A (Catchment is isolated within the cement plant area)

(xi) Has the site specific surface topography, geotechnics, geology and geohydrology been reported: Yes, see Preliminary Design Report section 3.6 & Annexure E for Geohydrological Report.

(d) Alternative elements of proven equivalent performance:

(i) What alternative elements have been used e.g. geotextile cushion in lieu of soil protection layer above geomembrane; geosynthetic drains in lieu of granular drains; waste material in lieu of natural material for protection and/or drains:

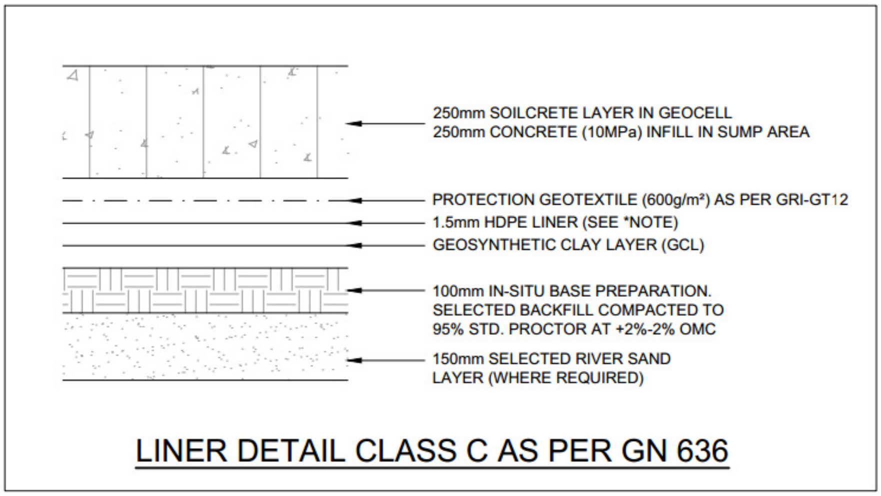
The following alternatives have been proposed to a standard Class C Liner as per GN R636 for both Additives and Coal Stockyard PCDs:

1) Geosynthetic Clay Liner (GCL) preferred over 2 x 150mm Compacted Clay Liner (CCL),

2) 100mm Silty Sand Protection Layer replaced with a 600g/m^2 non-woven geotextile protection layer (on the base of the PCDs only), which is overlain by 250 mm geocell layer with a 10MPa soilcrete infill layer. The

geocell/soilcrete layer also acts as a confining layer (imparting 5kPa of confining pressure) over the GCL.

The proposed liner system is detailed *Figure 1*;



*NOTE:
1. 1.5mm HDPE LINER IS TO BE SMOOTH-SMOOTH ON BASIN.
2. 1.5mm HDPE LINER IS TO BE SMOOTH-TEXTURED, WITH TEXTURED SIDE PLACED DOWN, ON SIDE SLOPES.

Figure 1: *Details of Proposed Liner*

See Appendix B for calculations and total strain, see Appendix E for laboratory test (Swell test) results confirming material performance specifications.

(ii) Has equivalent performance been demonstrated:

A: GCL to replace CCL for both PCDs.

Based on GNR 636 as well as Min. Requirements for the Disposal of Waste to Landfill (DWAF, 1998), the max. permeability for a CCL in a Class C Barrier System is 1 x 10^{-6} cm/s (1 x 10^{-8} m/s).

The rated capacity of the readily available GCL's in the market such as EnviroFix, BentoFix, BentoBarrier, etc provide manufacturer's specifications in the range of 1.9 to 5.0 x 10^{-11} m/s using de-aired and deionized water under a head of 0.15m.

The GCL (under ideal conditions) is 500 times less permeable than the CCL requirement for a Class C Barrier.

The key considerations in ensuring the GCL can at least produce equivalent performance to the CCL <u>include the following:</u>

1) Pre-hydration of the GCL is not considered necessary during construction, as the swell properties with the leachate are adequate.
   The GCL requires far less water to maintain hydration (and therefore the required permeability) than the CCL which needs to be much thicker (and therefore requires more water to remain hydrated) to ensure the required barrier effect.

   The GCL will therefore not rely on leakage to maintain its hydration.

2) **Leachate Compatibility with GCL for both**
   Even though the GCL will not rely on leakage from the PCD for hydration, compatibility tests with the waste water and bentonite from the GCL have been carried out. The tests comprise a modified Free Swell Test – as per ASTM D5890 except conducting the test with both deionized and with a site specific waste water sample.

   The Free Swell Test for both PCDs were carried out by SoilTecnix (PTY) LTD (Civil & Geotechnical Laboratory). See Annexure E for the Swell Test results. *Figure 2* and *Figure 3* below show the swell index.

SWELL INDEX TEST - ASTM D5890					
Sample No.:	GCL Sample Reference:	Wetting Agent	Wetting Agent Reference	Swell Index 16 Hours (mL/2g)	Swell Index 20 Hours (mL/2g)
STS1743	220126004	De-ionised Water	-	32	32
		Coal Stock	-	29	29

***Figure 2**: Swell test results for the Coal Stockyard PCD.*

SWELL INDEX TEST - ASTM D5890					
Sample No.:	GCL Sample Reference:	Wetting Agent	Wetting Agent Reference	Swell Index 16 Hours (mL/2g)	Swell Index 20 Hours (mL/2g)
STS1744	220126004	De-ionised Water	-	34	34
		Additive Runoff	-	34	34

***Figure 3:** Swell test results for the Additives PCD.*

The following charts provided by Leet et al. (2005) and Kolstad et al. (2004); presented in Figure 4 and ***Figure 5*** respectively, show that the GCLs hydraulic conductivity are lower than 1x10-10 m/s when free swell index is larger than 15ml/2g. The minimum swell index obtained from the swell test results is 29 ml/2g which has a hydraulic conductivity of roughly 1x10-11 m/s as seen in

Figure 5. These results imply that the GCL with the leachate is at least 1 000 times less permeable than the CCL for Class C liner.

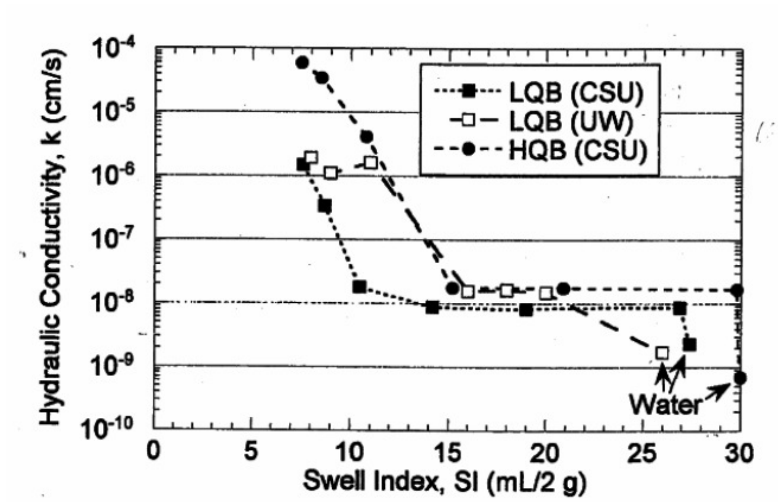


Figure 4: *Hydraulic Conductivity of GCL as a function of free swell of bentonite based on Lee et al. (2005)*

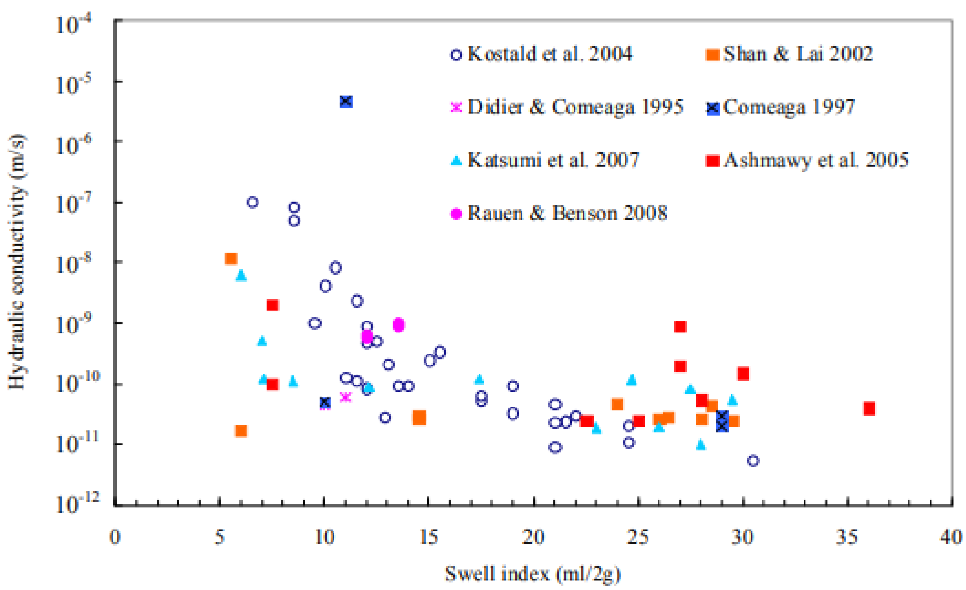


Figure 5: *Hydraulic Conductivity of GCL as a function of free swell of bentonite modified from Kolstad et al. (2004)*

For the above reasons, the GCL in combination with the rest of the lining system is expected to at very least perform equivalent to a CCL barrier specified as part of a Class C Lining System, if not better.

B) PROTECTION GEOTEXTILE/100mm SILTY SAND LAYER EQUIVALENCE

Based on GN R636 for a Class C facility, the 100mm Silty Sand Layer may be replaced with a protection geotextile of equivalent performance.

The intention of the silty sand layer is to provide protection to the geomembrane below from stone-gravel contact stresses, that may cause the liner to have localised strains, and reduce their ability to perform the barrier function. Given that the facility is to function as a pollution control dam and contain liquids, no leachate collection system has been included. The design does however have a 250 mm thick geocell, with a soilcrete infill protection layer included. The soilcrete is to comprise of a washed river sand with particles not exceeding 5 mm in size. As such no protection geotextile has been allowed for on the side slopes of the PCD. The base of the facility does however have a 600 g/m^2 non-woven protection geotextile included to facilitate light traffic (such as tracked skid steers) to clean the basin periodically.

A theoretical approach has been adopted, based on Koerner's (2012) theory for geotextile protection to assess the suitability of various geotextiles to perform the protection function. The design calculations for the site-specific loading conditions show that at least a 600 g/m2 geotextile would be required to protect the geomembrane.

Because this is very difficult to be proven ahead of construction, it is proposed that a trial pad is constructed on site, reproducing the layerworks design but with a 600g/m^2 geotextile protection layer in sections of the trial pad. The trial pad will then be loaded up to the design loading (52 kPa +) and the strain in the geomembrane assessed via a laser scanning process as offered by TANDM or similar service provider. Based on the results of the trial pad experiment, the appropriate protection geotextile will be used that limits strain in the geomembrane to less than 3%.

In summary, a 600 g/m^2 protection geotextile has been specified for the base of the PCDs in place of a 100mm thick silty sand cushion layer based on literature and experimental findings, however this will be subject to a construction trial pad experiment, after which the final grade of protection geotextile will be confirmed.

(e) Atmospheric pressure in drains:

List of drawings showing plan of drainage layout and long section elevation: Has the drainage rate over the operational period taken precipitate and organic clogging into consideration when confirming maximum liquid head above the liner:

Drawings 5707-JGA-P-LCP-CI-2002 & 5707-JGA-P-LCP-CI-2003 for the Additives PCD, and drawings 5707-JGA-P-LCP-CI-3001 & 5707-JGA-P-LCP-CI-3002 for the Coal Stockyard PCD.

The subsurface drainage system sand is specified to be compatible with the 100 mm levelling layer is to be placed which is anticipated to be constructed of cohesive material available on site. The sand selected shall be finalized once the levelling layer material has been assessed during construction to ensure compatibility using Filters for Embankment Dams (FEMA) method. The stone aggregates below the sand will also be finalised once the sand has been selected to ensure internal stability.

(f) Alternative barrier systems on slopes steeper than 1v:4h (>14°):

(i) Does the facility have an alternative barrier on side slopes: The side slopes have been designed to be 1 in 3 (18.4º). Prior project experience has shown that drum driven compactors can safely work on such slopes when operating perpendicular to the slope and can achieve the required compaction.

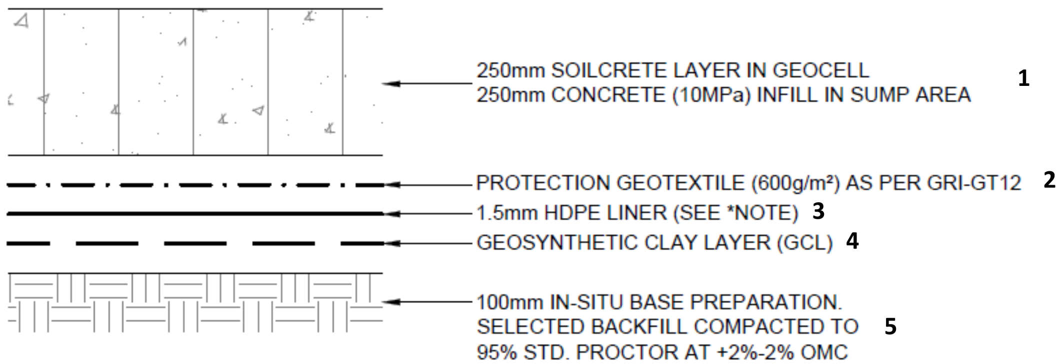
JG Afrika have recently obtained various samples of non-woven geotextiles, smooth-smooth, smooth-textured and textured-textured geomembranes, geotextiles and geosynthetic clay liners from suppliers and tested in a large shear box. Testing was conducted in 2 laboratories, namely UCT Geotechnical Lab in Cape Town, as well as SAGEOS in Canada.

The minimum interface properties obtained are indicated in ***Table 1*** below.

***Table 1:** Interface shear strength parameters*

			PEAK		RESIDUAL		
LAYER	LAYER	DESCRIPTION	Φ (º)	c' (kPa)	Φ (º)	c' (kPa)	Comment
1	2	Geocell - Pro GTX	42	20	28	0	Assumed Properties
2	3	Pro. GTX -- 1.5mm HDPE **Smooth**-Textured	19	5	11	5	Testing
3	4	1.5mm HDPE Smooth-**Textured** - GCL	35	4	16	10	Testing
4	5	GCL - Base Prep	25	15	18	5	Assumed Properties

CLASS C LINER DESIGN



LINER DETAIL CLASS C
AS PER GN 636

The results of the slope stability analysis for each liner component is presented in Table 2.

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Table 2: Factors of Safety for Interface stability

SCENARIO 1 - NO LOADING ON SLOPE			
Layer Interface		FOS	FOS (with seismic loading)
Geocell	1.5mm HDPE	1.62	1.4
1.5mm HDPE	GCL	1.71	1.4
GCL	Base Prep	3.66	3.08
Base Prep	In-situ Ground	1.57	1.35
Deep seated failure		2.3	2
SCENARIO 2 - LOADING ON SLOPE WATER (70 kN/m^2)			
Layer Interface		FOS (70 kN/m^2 only on slope)	FOS (with seismic)
Geocell	1.5mm HDPE	1.77	1.73
1.5mm HDPE	GCL	1.63	1.6
GCL	Base Prep	1.5	1.47
Base Prep	In-situ Ground	1.76	1.71
Deep seated failure		1.76	1.71

The Coal Stockyard PCD has retaining walls which are protected from leaking by means of water stops through the joints and the base of the wall. At the back face of the wall there are drainage strips and drainage pipe to drain groundwater that may be in contact with the wall. See drawing 5707-JGA-P-LCP-CI-3003.

(ii) Has equivalent performance to the base barrier system been demonstrated:

The attached design calculations, Annexure B demonstrate that alternative liner has equivalence performance to the base barrier system for both PCDs.

(g) Construction quality assurance protocols:

(i) Does the design report include a CQA plan which addresses roles and responsibilities as well as document management for all materials used i.e. clay, granular filters, aggregate drainage, geotextiles, geomembranes, method of placement, method of construction and time constraints including records of defect rectification, and statistical analysis of CQC results: Yes, see Appendix C for the CQA plan.

(ii) Does the CQA include a requirement of a trial pad prior to construction: Yes, see CQA Section 5.2.1.1.

(iii) Does the CQA plan include confirmation of interface shear parameters as per SANS 1526 (2015): Yes, see Appendix C section 5.2.3.4.2 and Appendix E for Interface shear test results on site specific materials.

(iv) Does the CQA include independent electric leak location survey: No due to the influence of the soilcrete infilled geocell.

(h) Specification of relevant South African National Standards or prescribed management practices:

(i) Does the design report and CQA include a list of standard specifications: Yes, as reflected on the drawings in the CQA plan.

(ii) Are there any deviations from standard specifications: Yes

(iii) To what materials do the deviations apply: Geomembranes – Standard and HP OIT minimum values differ from SANS 1526 (2015) for HDPE geomembranes.

(i) Compatibility of liner materials with the waste stream:

Does the design report include confirmatory tests demonstrating chemical compatibility with liner materials: Yes, see Annexure E for Swell test results with the leachate for both PCDs, conducted by SoilTecnix (PTY) LTD.

(j) What is the Factor of Safety for stability for total stress and effective stress during the operational period and post operational period: The FoS during operation is 1,76 and post closure is 2.3.

(k) Has gas management been addressed: N/A

(l) Other aspects to be addressed in the Design Report:

(i) Waste classification and behaviour, including gas management and air quality. Waste classification test results for both PCDs are attached in Annexure E. The waste classification report will be shared with DWS once is available. No gas will be generated on site.

(ii) Locality map showing distance to the nearest water course, the 1:100 year flood line, and position of nearest dwellings, surface topography and drainage, subsurface geological features such as dolomites, undermining, dolerite intrusions and fault zones. See Preliminary Design Report pg. 8 for the locality map with the proposed PCDs. For the 1:100 year flood line see Annexure E, Figure 3-2 in Floodline Study Report.

(iii) Analysis of geotechnical and geohydrological investigation, detail design including depth of excavation and height above NGL of facility, side slopes, subsurface drainage and depth to groundwater, separation of clean and dirty water, design of drainage and liner systems including filter compatibility, and design of intermediate and final capping system. See Preliminary Design Report – Sections 3, 4 and 5.

(iv) **I**nstrumentation to test, measure and confirm the assumed parameters used in the design and construction performance assessments. The CQA report covers all testing during construction and installation of the liner. It is not planned to leave any long-term instruments in place for monitoring.

(v) If leachate or polluted water is disposed of offsite, has the receiving wastewater treatment works or similar facility's performance being assessed. N/A

(vi) Declaration of interests JG Afrika (Pty) Ltd does not have any interest, commercial or otherwise, in any of the manufacturers or installers of any of the geosynthetic products being proposed for this project.

(vii) Disclaimers do not override the Professional Engineers' accountability.

(m) Cost estimates and compliance with Treasury Regulations for organs of state:

(i) What is the estimated capital cost of the waste disposal facility, inclusive of all auxiliary works?

(ii)What is the capital cost of the solid waste disposal Cell including fees?

(iii) What is the cost per m^2 of the barrier system (R/m^2)?

(iv) What is the cost per m^3 of airspace (i.e. total cost of Cell/volume of disposal airspace created) (R/m^3)?

(v) Has any member of the developer, designer and/or CQA monitoring team declared a financial or conflicting interest in any material or service provider?

N/A the project is privately funded by Lafarge Industries South Africa (PTY) LTD.

(n) Peer Review:

Has the design been subjected to an internal peer review? The design has been checked in accordance with the firms ISO 9001 Quality Management System.

3. Confirmation of Readiness

I the undersigned certify that the above information is to the best of my knowledge true and accurate.

For the Applicant

Uneysa Taljard
14 December 2022

Signature, name, and date

For the Engineer

J C NORRIS Pr Eng. 980198
14/12/2022

Signature, name, date and Pr Eng no.

Confirmation of check list completeness by the Lead Authority (Provincial or National Department):

Signature, name and rank, contact details (mobile phone and email), date

Submit to the DWS Coordinator upon completion, Director: Resource Protection and Waste for attention Mr M Noe