ENVIROSERV WASTE MANAGEMENT

CHLOORKOP LANDFILL NORTHERN EXPANSION
BASIC ASSESSMENT ENGINEERING REPORT
CONCEPT DESIGN REPORT

Report No.: JW130/19/6007-21 - Rev 0

September 2019

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Engineering & Environmental Consultants

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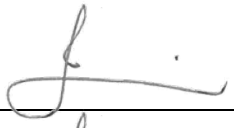
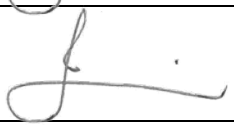
Reviewed	Project Director	Jabulile Msiza	30/08/2019	
Approved	Project Director	Jabulile Msiza	30/08/2019	

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SYNOPSIS

EnviroServ own the Chloorkop Landfill Site (CLS) and operate it in terms of a waste management licence (Ref: 16/2/7/A230/D17/Z1). General waste is received from the Midrand and Kempton Park area, including the City of Johannesburg and the City of Ekurhuleni Metropolitan Municipalities and private clients.

The waste body at the CLS has finite airspace, defined by the permitted footprint, height and design parameters. The CLS will not be able to receive waste once it reaches the above mentioned airspace capacity.

EnviroServ proposes to expand the CLS onto an adjacent property. The targeted property, north of the site, is Erf 335 of Chloorkop Extension 6, which is 3.1249 ha in extent as stated in the title deed.

Construction of the disposal cells will be implemented in phases with each waste cell being developed as the demand for waste disposal capacity requires. Construction of each disposal site will be undertaken in terms of the approved designs which will have considered the local site parameters and the Norms & Standards (GNR 636) as appropriate. This will require site preparation activities such as: vegetation clearance, soil stripping, bulk earth works and levelling to the required elevations.

The expansion will only permit the landfilling of general waste. Therefore, a Class B Barrier system has been detailed in accordance with GNR 636 of August 2013, the “National Norms and Standards for Disposal of Waste to Landfill” for the Phase 1A cells and Contaminated Storm Water Dam.

Clean storm water diversion trenches are maintained on the eastern and western sides of the CLS and will be extended to include the expansion. There is natural drainage north of the expansion footprint for these trenches to open end into. Energy dissipation will be installed at the outlets of the drainage trenches. New culverts below Anker Street on the eastern and western side of the expansion will be required. Contaminated storm water needs to be diverted to a new contaminated storm water dam. This will be managed through a network of storm water canals located at the footprint of each cell that lead to the new contaminated storm water dam.

It is envisaged that horizontal gas extraction wells will be installed in Phase 1A Cell 1, 2 and 3 at 10m intervals and be extracted at the same flare compound.

For rehabilitation of the expansion, the intention is to apply the same capping design that has been previously approved for the current facility.

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Drawing Number:	**Drawing Description:**
6007-12-001	General Arrangement
6007-12-002	Final Landfill of Phase1A
6007-12-003	Storm water management plan
6007-12-004	Sections
6007-12-005	Phase 1A Cell 1 Details
6007-12-006	CSWD Details
6007-26-002	Access road details

Abbreviations

CLS	:	Chloorkop Landfill Site
CSWD	:	Contaminated Storm Water Dam
EnviroServ	:	EnviroServ Waste Management (Pty) Ltd
GCL	:	Geosynthetic Clay Layer
GDARD	:	Gauteng Department of Agriculture and Rural Development
HDPE	:	High Density Polyethylene
VWP	:	Vibrating Wire Piezometer

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1. PROJECT DESCRIPTION

1.1 Introduction

1.1.1 General overview and objectives

EnviroServ Waste Management (Pty) Ltd own the Chloorkop Landfill Site (CLS) and operate it in terms of a waste management licence (Ref: 16/2/7/A230/D17/Z1). General waste is received from the Midrand and Kempton Park area, including the City of Johannesburg and the Ekurhuleni Metropolitan Municipalities and private clients.

The CLS has been developed over the past two decades with six engineered waste disposal cells that form the waste body. The waste body covers an area of approximately 23.2 ha. In 2016, the Gauteng Department Agricultural and Rural Development Department (GDARD) granted approval for the permitted height of the waste body to be a maximum of 25 m above ground level.

The waste body at the CLS has finite airspace, defined by the permitted footprint, height and design parameters. The CLS will not be able to receive waste once it reaches the above mentioned airspace capacity.

Given the current and future waste generation potential of the region, there is an ongoing need for waste disposal services, even with growing levels of waste diversion. Alternative airspace in the Midrand and Kempton Park region is limited. EnviroServ is therefore proposing to expand the CLS in order to provide additional airspace for ongoing disposal of municipal solid waste.

EnviroServ proposes to expand the CLS onto adjacent properties. The targeted properties, north of the site, are Erf 334 and 335 of Chloorkop Extension 6, which are approximately 10 ha in extent. Erf 335 is directly adjacent to the existing landfill and would provide space for the initial cells of the expansion. Erf 334 is separated from Erf 335 by a road (Anker Street) which increases the complexity of the design and approval process. Although Erf 334 would provide additional space for future cells, the design being submitted is only for the cells situated above Erf 335. EnviroServ is in engagements with the property owner.

In addition to the above discussed expansion, EnviroServ are in the process of applying for approval to construct a seventh cell within the permitted footprint.

The objective of this report is to document the main design aspects of the expansion such that the impacts on the site can be fully investigated.

See layout of existing Cells in **Figure 1.a**.

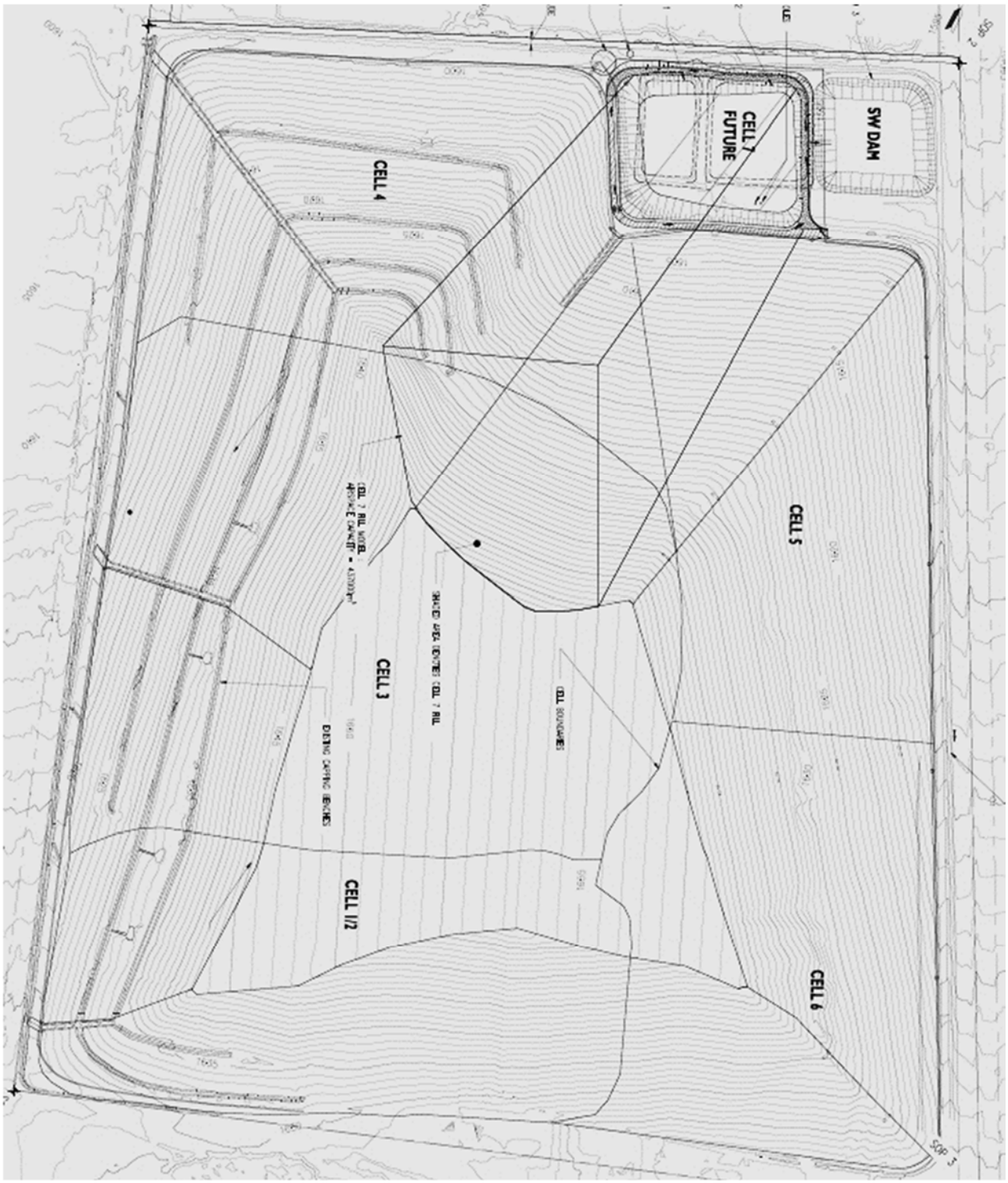

Figure 1.a: Layout of existing cells at Chloorkop Landfill Site

1.1.2 Location

The CLS is located in the Chloorkop Industrial area on Portion 63 of Klipfontein 12-IR in the City of Ekurhuleni Metropolitan Municipality, Gauteng Province and is accessed from Marsala Road. The proposed CLS Northern Expansion project area is situated adjacent and immediately to the north of the CLS on Erf 335. Please refer to **Figure 1.b.**

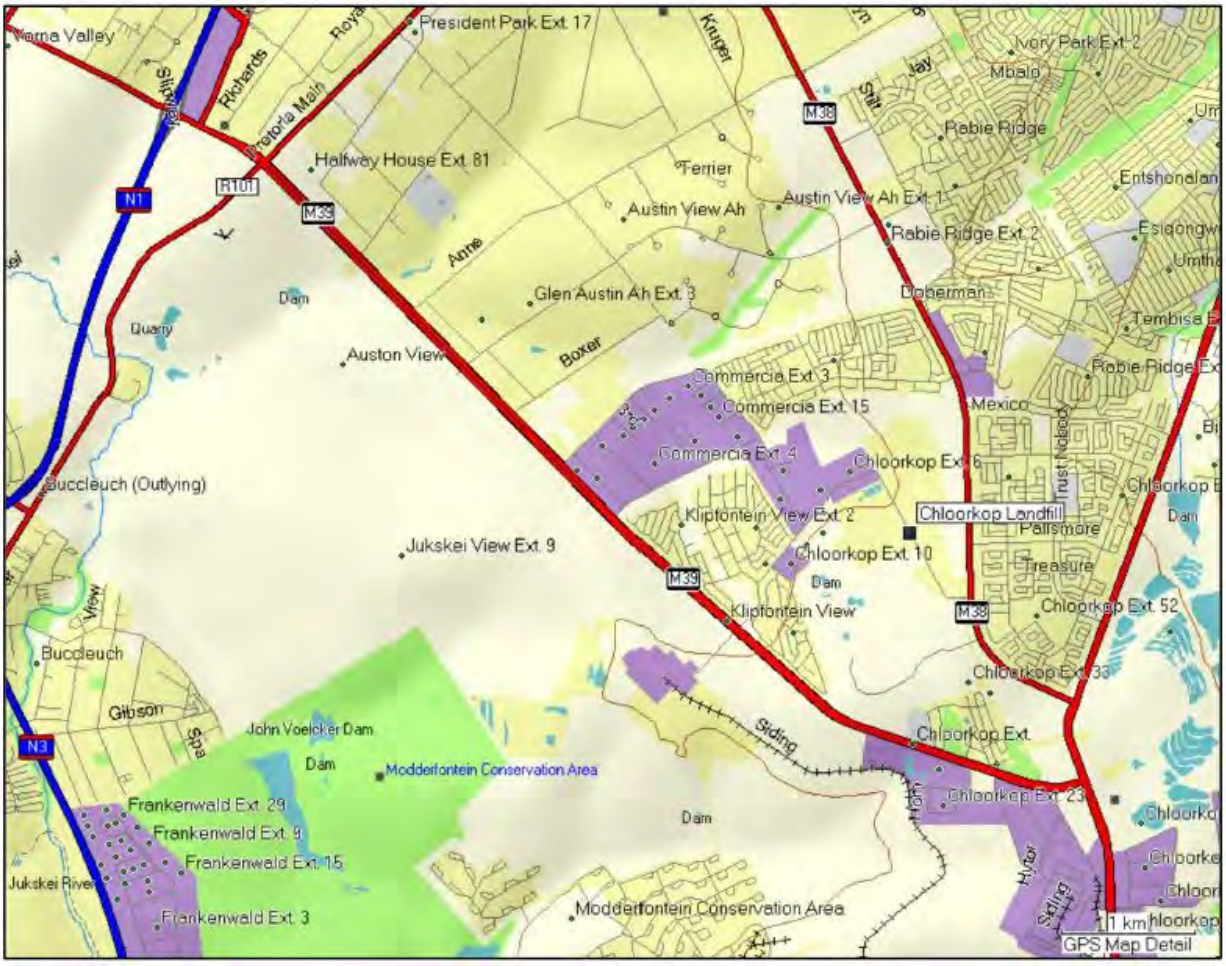

Figure 1.b: Locality of the Chloorkop Landfill Site

1.1.3 Regional Geology

The following is an extract from a geohydrological investigation report done at the Chloorkop Waste Disposal Facility in 2016 (Report No.: JW240/16/B197).

The Chloorkop Landfill Site is located on the Halfway House Granite Suite, also known as the Johannesburg Dome Basement Granites (**Figure 1.c)**. The granites are not homogenous or uniform and display gneissic banding with foliation that trend in a NW-SE direction and with steep dips. The surficial material consists mainly of residual material derived from the in-situ decomposition of granitic bedrock (Meyer and Tredoux, 1997).

The residual soil is typically fairly well graded, coarse silty sand with a significant gravel component and a minor amount of clay. Depth of weathering is variable and ranges from 5 m to some 42 m below surface based on previous investigation geological logs. Extensive localised weathering between shallow pinnacles of granite have been exploited for sand mining in the vicinity. The site has been located in such an old sand quarry. Leachate will tend to accumulate on the eastern and northern perimeter of the site. A deep weathering zone associated with the dyke which transects the site in an east west direction can also be observed. However, this is not always the case as in the instance of the dyke located to the North which is hardly weathered (Meyer and Tredoux, 1997). The granite is characterised by linear features such as dolerite, diabase and syenite dykes, quartz veins, shear zones and faults.

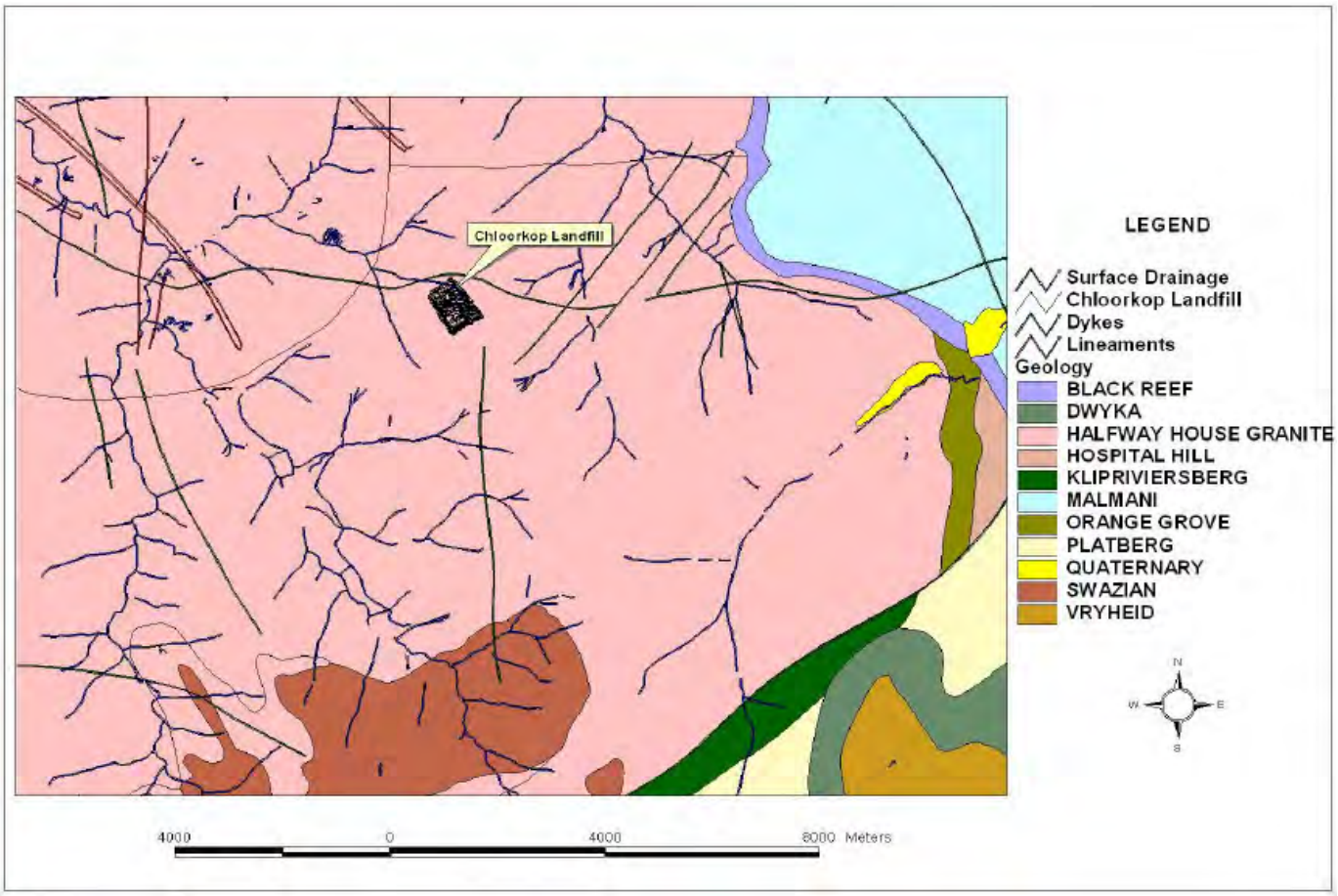

Figure 1.c: Regional geology of Chloorkop Landfill Site

1.1.4 Geohydrology

The following is an extract from a geohydrological investigation report done at the Chloorkop Waste Disposal Facility in 2016 (Report No.: JW240/16/B197).

The primary porosity of granite is negligible and as such is a poor aquifer. This is confirmed by the hydrocensus results that have been described in previous investigations which reflect poor yields and many unsuccessful boreholes in the vicinity. Water occurrences are therefore restricted to structural features such as the contact zones of dykes or localised pockets of deeper weathering. Two (2) aquifers may therefore be defined for the area namely a shallow weathered aquifer and a deeper fractured aquifer. The characteristics of these aquifers may be expected to vary significantly over short lateral distances. These aquifers are considered to be hydraulically connected and contamination migration is likely to occur between these two (2) units. The weathered aquifer is likely to range from about 12 m below surface in the vicinity of the watersheds to 5 m in the vicinity of the lower reaches of the rivers.

The groundwater levels within both aquifers range from 2 m to approximately 10 m below surface with shallower levels found closer to the rivers due to groundwater convergence and deeper levels found towards watershed boundaries as is to be expected. The groundwater gradients tend to broadly mimic the topography although rivers higher in the catchment have less influence on the piezometric surface due to the depth to groundwater (**Figure 1.d**).

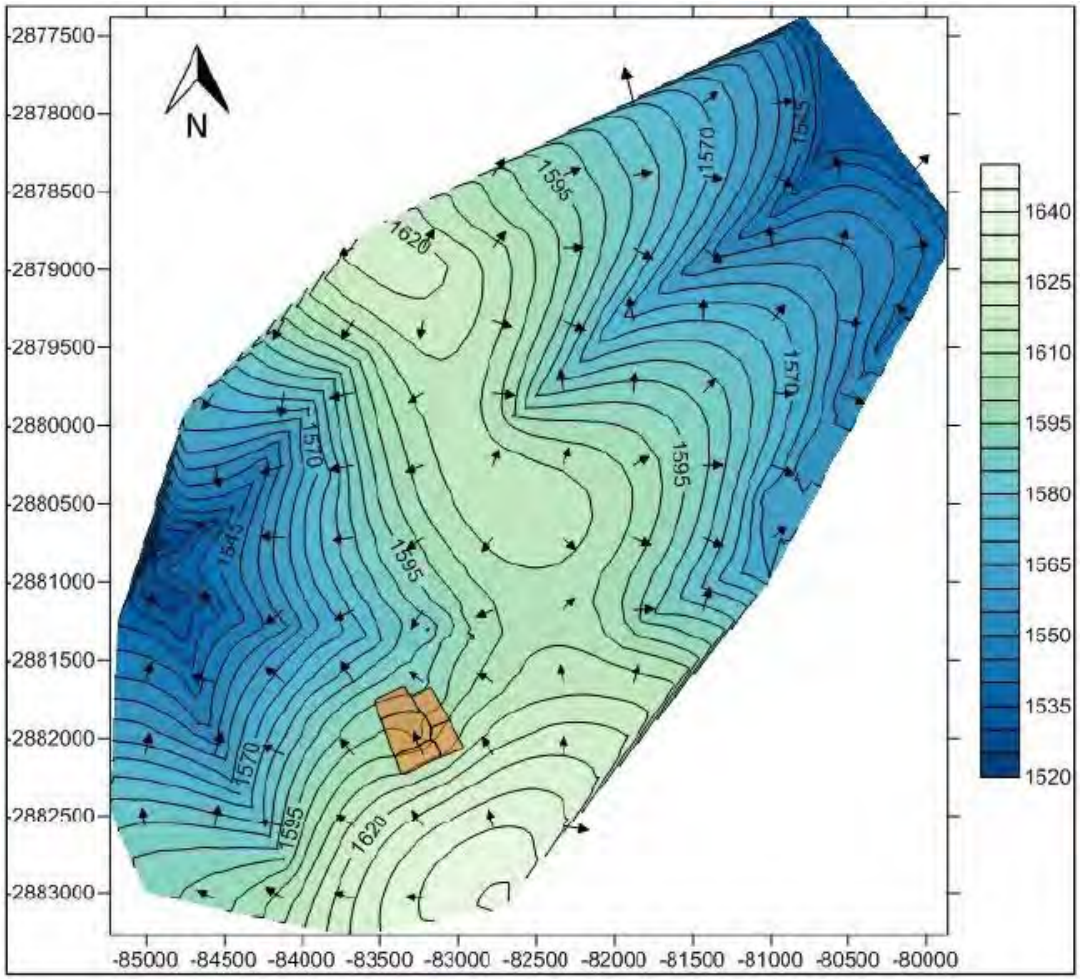

Figure 1.d: Predicted Groundwater Flow Directions

1.1.5 Design criteria

The disposal cells will be designed and operated in terms of the current National Norms and Standards for Disposal of Waste to Landfill (GN R 636) as well as the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1998).

1.2 Activity Description

1.2.1 General Layout

The proposed layout and phasing of the CLS expansion are shown in **Figure 1.e**. Two main phases of the expansion were investigated as part of the design: Phase 1A and Phase 1B. The reason for the phased approach is the location of Anker Street, a public road situated north of Erf 335 and south of Erf 334 of Chloorkop Extension 6. The road will need to be relocated around the north of Erf 334 if Phase 1B progressed and would require its own impact assessment and authorisation processes. This would have to run in parallel to the operations of Phase 1A. Due to the uncertainties of the options for relocating Anker Street, as well as the identification of wetlands in the Phase 1B footprint, Phase 1B will not be advanced. Therefore, the details involving the Phase 1B expansion are not detailed in this report other than at a high level for record purposes (such as showing the location on the general arrangement 6007-12-001).

Phase 1A is expected to extend directly from the northern face of the existing waste landfill (i.e. connecting to Cell 4, Cell 7 (if approved and developed) and Cell 5). After the relocation

of Anker Street, Phase 1B would have extended directly from the northern face of Phase 1A.

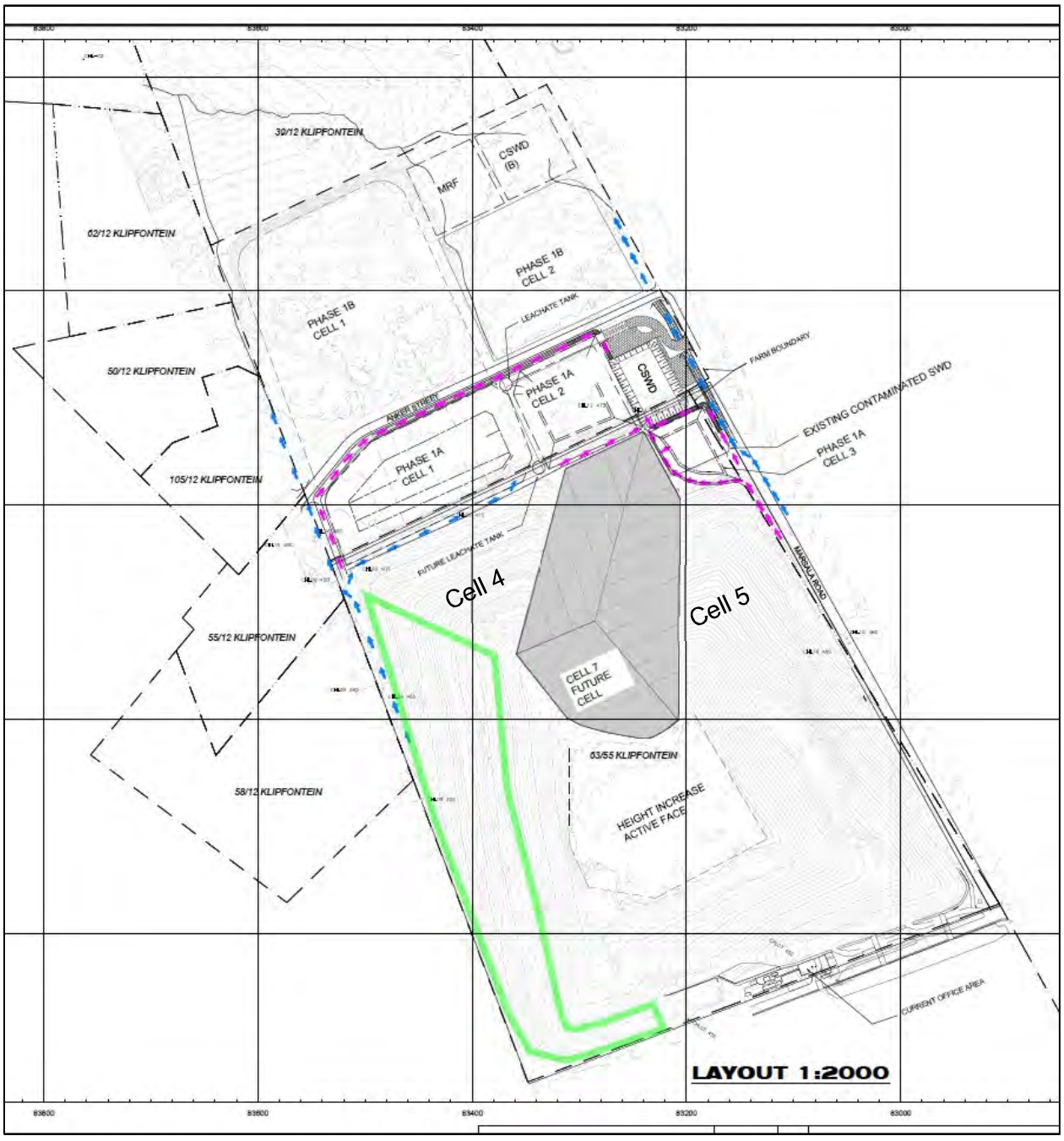

Figure 1.e: Layout of Northern Expansion (extract from drawing no. 6007-12-001)

The topography and geometry of the Phase 1A footprint has resulted in the splitting of the phase into two cells, designated Cell 1 on the west side and Cell 2 on the east side. As the expansion is lower down the catchment than the existing storm water dam, it is unfeasible to use the dam for the Phase 1A cells and a new Contaminated Storm Water Dam (CSWD) will be constructed.

The existing storm water dam becomes redundant once the Phase 1A (CSWD) is constructed. Therefore, the existing storm water dam will be developed into Cell 3 of Phase 1A.

1.2.2 Cell 7 design, construction and operations

The current landfill site consists of 6 cells. A seventh cell is planned and is currently in the design approval stage, with construction planned for the last quarter of 2019 and commencement of operations in early 2020. See **Figure 1.a.**

Cell 7 will cover the existing leachate pond as well as one of the two existing contaminated storm water dams. It will provide 413 000 m^3 additional airspace and prolong the facility life by 11.8 months (using a consumption rate of 35 000 m^3 per month).

If Cell 7 is approved and constructed, the Phase 1A expansion will extend northwards from the Cell 7 waste body, as well as Cell 4 and Cell 5 as shown on **Figure 1.e**. The proposed leachate tank will also be available for utilisation during the operations of Phase 1A Cell1. The tank will, however, be covered during the operations of Cell 2 and therefore a new tank between the cells will be required as shown on drawing 6007-12-005.

1.2.3 Waste classification

The expansion will only permit the landfilling of general waste, as permitted for the CLS. Therefore, a Class B Barrier system has been detailed in accordance with GNR 636 of August 2013, the "National Norms and Standards for Disposal of Waste to Landfill" for the Phase 1A cells and CSWD.

1.2.4 Liner System Design

The proposed lining system for Phase 1A is shown in **Figure 1.f** below and consists of:

- 150 mm base preparation layer with subsoil under drainage and monitoring system;
- 4 x 150 mm compacted clay layers;
- 1.5 mm HDPE geomembrane (mono-textured on the side slopes and double textured on the basin);
- Protection geotextile;
- 150 mm leachate collection layer (30 - 50 mm stone);
- Separation geotextile;
- Classified waste body.

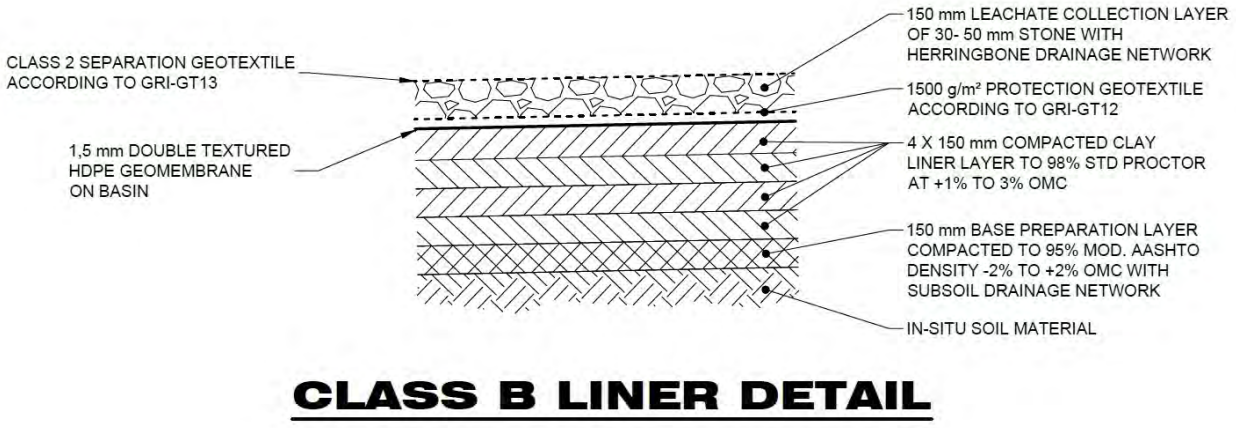

Figure 1.f: Phase 1A proposed liner system

The high density polyethylene (HDPE) geomembrane has been specified to be mono-textured on the side slopes (using with the textured side on the underside) and double textured on the basin. The texturing increases the angle of friction of the underside over the top which forces movement along the slopes, due to consolidation of waste placed on the barrier system, to

occur above the geomembrane thereby preventing tensile stresses developing within the geomembrane.

The maximum height of waste above the liner is 26m which results in a normal load of 260KPa (assuming a refuse unit weight of 10KN/m^3). Compaction ratio calculations show that the site density may be as high as 11.77KN/m^3, this would increase the total normal load to 306.3KPa.

Based on the above scenarios, a 1.5Kg/m^2 protection geotextile has been selected to provide acceptable protection against puncture of the geomembrane by the leachate drainage stone layer.

A similar liner system would be used in the CSWD except the leachate collection layer is replaced with a ballast layer consisting of a 150mm layer of cement stabilised sand and a 150mm layer of concrete filled geocells.

1.2.4.1 A note on geosynthetic service life

A paper by Professor Kerry Rowe, *Impact of landfill liner time–temperature history on the service life of HDPE geomembranes*, discussed the effects of temperature on a geomembrane's service life. In the manufacturing process of geomembranes, antioxidants are added to the material to act as the sacrificial component in terms of oxidation. This means that for a certain time period the antioxidants prevent the geomembrane from getting oxidised, which has the result of increasing the material's durability and service life. The time required to deplete the antioxidants in the geomembrane depended on its exposure rate. In Appendix D, a note has been included which details the three stages of degradation and the service life of 1,5 mm HDPE geomembrane that meets the GRI GM13 specification.

The results in **Table 1-1** show a clear indication of the effect of temperature on the service life of an HDPE geomembrane. The estimated service life of a geomembrane is 190 years at 35 °C and decreases to 20 years at a temperature of 60 °C.

Table 1-1: Estimated times for three stages of degradation and resulting service lives (Rowe, 2005)

(1) Temp: °C	(2) Stage 1: years Simulated,* t_{sim}	(3) Stage 2: years Base,† t_V	(4) Stage 2: years Adjusted,‡ t_{Va}	(5) Stage 3: years Base,§ t_B	(6) Stage 3: years Adjusted,¶ t_{Ba}	(7) Service life: years Unadjusted,** t_{SL}	(8) Service life: years Adjusted,†† t_{SLa}
10	280	50	30	2445	1380	2775	1690
20	115	15	10	765	440	900	565
30	50	6	4	260	150	315	205
35	35	4	2	155	90	190	130
40	25	2	1	95	55	120	80
50	10	1	0·6	35	20	50	35
60	6	0·4	0·3	15	9	20	15

*Based on simulated liner antioxidant depletion tests (Table 5).
†Calculated using data from Viebke *et al.* (1994) for 2·1 mm wall thickness pipe with water inside and air outside.
‡As per previous note, but adjusted for possible effect of leachate using equation (35) and data from Table 5.
§Calculated using activation energy from Viebke *et al.* (1994) for 2·1 mm wall thickness pipe with water inside and air outside and half-life of 90 days at 115°C from Bonaparte *et al.* (2002).
¶As per previous note, but adjusted for possible effect of leachate using equation (36) and data from Table 5.
**$t_{SL} = t_{sim} + t_V + t_B$.
††$t_{SLa} = t_{sim} + t_{Va} + t_{Ba}$.

The liner system of the cells at Phase 1A will be covered by general waste and therefore exposed to ambient temperatures for a limited period during construction and early operations. It is also not anticipated that elevated temperatures below the waste will occur due to the nature of the waste disposed. No records of temperature at the liner currently exist for the site. However, it is planned to install a temperature monitoring system on the liner of Cell7 to commence a temperature record. This system is planned to extend on the Phase 1A cells.

Therefore, until temperature records have commenced, it is assumed that the unadjusted service life predictions are relevant. It is important to note that the above antioxidant depletion times and service lives were calculated assuming a constant temperature throughout the entire life. However, temperature of the liner is likely to vary with time.

The temperature monitoring system will include the use of the vibrating wire piezometers (VWP). This instrument is more robust and measures temperature with higher accuracy than thermo couples which have traditionally been used for this application. An added benefit is the ability to measure pore water pressures with the VWPs.

It is suggested that four VWPs be installed and these should be placed on top of the liner in the leachate collection layer. These VWPs should also be equidistant from the main leachate collection pipe and the herringbone drains to ensure that the atmospheric temperature in the pipes do not influence the temperature reading on the liner. The VWP should be connected to a datalogger via a cable where the excitation supply cable is separate from the signal cable.

1.2.4.2 Subsoil drainage

The Phase 1A cells have a subsoil drainage system which corresponds to the leachate collection herringbone configuration. The system drains to a manhole next to the cells. The manhole will be equipped with a valve which will allow pumping to the Phase 1A CSWD or gravity outlet.

1.2.4.3 Leachate Collection

A leachate collection system is provided over the entire lined area of the Phase 1A Cells. The system is situated above the protection geotextile. It consists of a 150 mm thick (30 – 50mm) stone layer draining into a network of 160 mm and 250mm diameter HDPE pipes. The strength of the pipes have been specified at PE100 PN 20 to limit the deflection of the pipes to 4.6% (less than 5%). The pipes are installed on a 1.5 kg/m^2 protection geotextile which is in direct contact with the 1.5 mm thick HDPE geomembrane liner. The stone layer is covered by a Class 2 separation/filtration geotextile to prevent clogging of the system. The system exits the cells through liner penetrations through the side wall and discharges under gravity via a 250 mm diameter pipe, into the leachate tank. **Figure 1.g** shows the typical drainage detail at the basin of the liner.

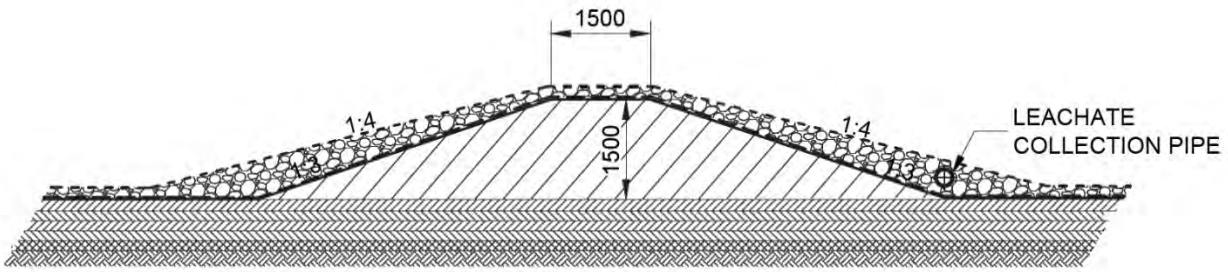

Figure 1.g: Typical drainage detail in the basin and stabilising berm

1.2.5 Site access, access roads and office platforms

1.2.5.1 Site access

Access to the Phase 1A extension is shown in **Figure 1.h**. Phase 1A will be accessed from Marsala Street at an existing gravel entrance road to ERF335. This location is approximately 35 m from the intersection of Marsala and Anker streets.

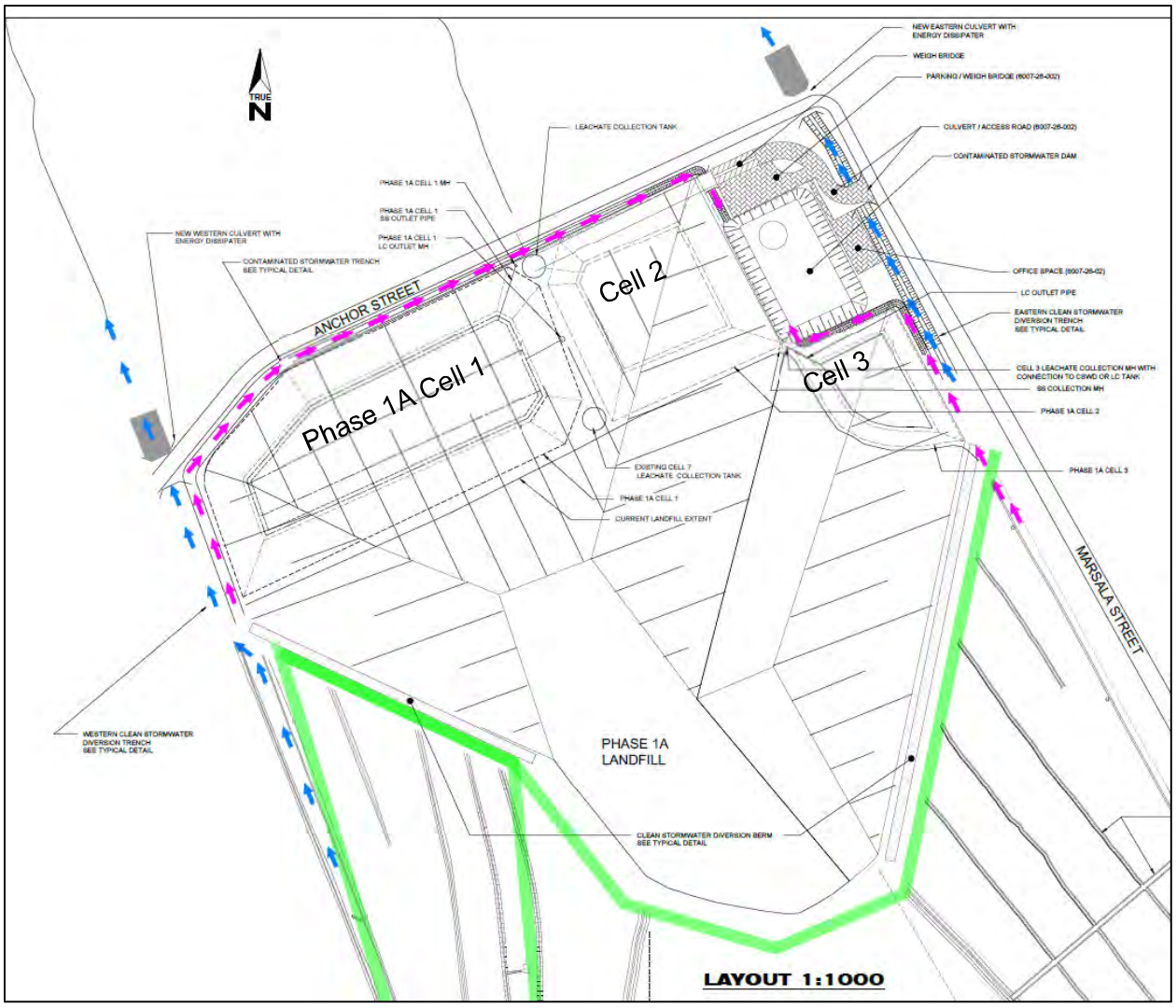

Figure 1.h: Phase 1A Landfill Development

1.2.5.2 Access control

The access control measures implemented under the current CLS operations will be maintained as follows:

- Access will be through a main gate at the site boundary;
- A manned security control point will be located at entrance gate where entrants will sign in and out of the facility;
- The vehicle will then proceed to the weigh bridge, if dumping waste, or the admin office, if meeting with operations staff.

The extension will have fencing or precast concrete walls installed on the entire perimeter to prevent unauthorised access. The contaminated storm water dam (CSWD) area will have a separate fence along the perimeter with a padlocked gate for access.

1.2.5.3 Access road design

The access road is approximately 200 m in length and is subdivided by the proposed weigh bridge at CH 110 with the first 100 m constructed from gravel wearing course while the

section after between the weigh bridge and the access shall comprise concrete block paving with kerbs.

The design traffic category for the access road is E1 ($0.2 – 0.8 \times 10^6$) which caters for filling of Phase 1A in cells 1, 2 and 3.

The concrete block paving is constructed on a 20 mm bedding sand layer and supported by two structural layers comprising a 150 mm C4 layer and 150 G6 layer. **Figure 1.i** shows the typical pavement layerworks.

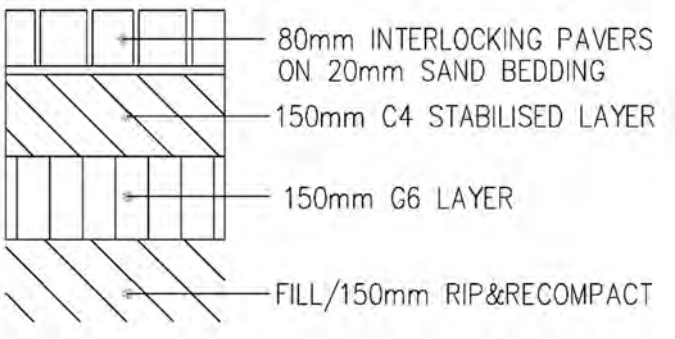

Figure 1.i: Access road pavement layerworks.

The layout of the access road and platforms is shown in drawing 6007-26-002 attached in the Appendices.

1.2.5.4 Parking and office platform

The parking terrace comprises a 30 x 18 m paved platform which is located between the proposed weighbridge and contaminated storm water dam. A 30 x 13 m platform is also provided for locating office containers. These platforms are finished with concrete block pavers.

1.2.5.5 Drainage of roads and platforms

The paved surfaces of the access road and platforms will be finished to a 2 % crossfall for drainage and stormwater will be diverted towards the clean water system.

Two additional culverts will be sized and located at CH 100 (for contaminated SW) and at CH190 (for the uncontaminated SW).

1.2.6 Waste cell design

Each of the two cells in the expansion (Phase1A) will consist of the following:

- Site Clearance including removal of fill, topsoil and vegetation;
- Excavation to lines and grades, incorporating 1[v]:3[h] side slopes and a graded basin to a low point for subsoil and leachate collection outlets;
- Construction of a Class B liner system – see **Figure 1.f** for intended liner system. Including pipe networks below and above the liner for subsoil and leachate collection respectively.
- Construction of storm water management infrastructure at the crest of the cell embankment.
- Construction of (or utilisation of existing) leachate storage infrastructure in the form of a leachate tank.

Cell 3 will be positioned over the existing contaminated storm water dam. It is envisaged that the existing liner system will be removed and that a new Class B liner system will be installed.

A number of stability cross walls have been included in the cell design to ensure that there is sufficient stability of the waste body above the liner system. These berms are approximately 1.5m high and 1.5m wide at the crest as shown in **Figure 1.g**

1.2.7 Stormwater Management

The management and separation of clean and contaminated storm water is illustrated in **Figure 1.l**

In general, clean storm water diversion trenches are maintained on the eastern and western sides of the CLS and expansion. There is natural drainage north of the expansion footprint for these trenches to open end into. Energy dissipation will be installed at the outlets of the drainage trenches. New culverts below Anker Street on the eastern and western side of the extension will be required.

Contaminated storm water needs to be diverted to the new contaminated storm water dam. This is managed through a network of storm water canals located at the footprint of each cell that lead to the new CSWD.

Discussions of how storm water is managed in each phase is further described in Section 1.3.2.1.

1.2.8 Contaminated Storm Water Dam (CSWD)

The full description of the contaminated storm water dam is included in Report No.: JW090/19/6007-24 - Rev 0.

The catchments reporting to the CSWD are shown in **Figure 1.j.** It is assumed that by the time the CSWD is required, the original landfill area (Cell 1 to 7) has been rehabilitated and only Phase 1A Cells have exposed areas requiring a dirty catchment.

A second assumption is that a permit to pump industrial effluent as well as contaminated storm water to municipal sewer from the CSWD is in place.

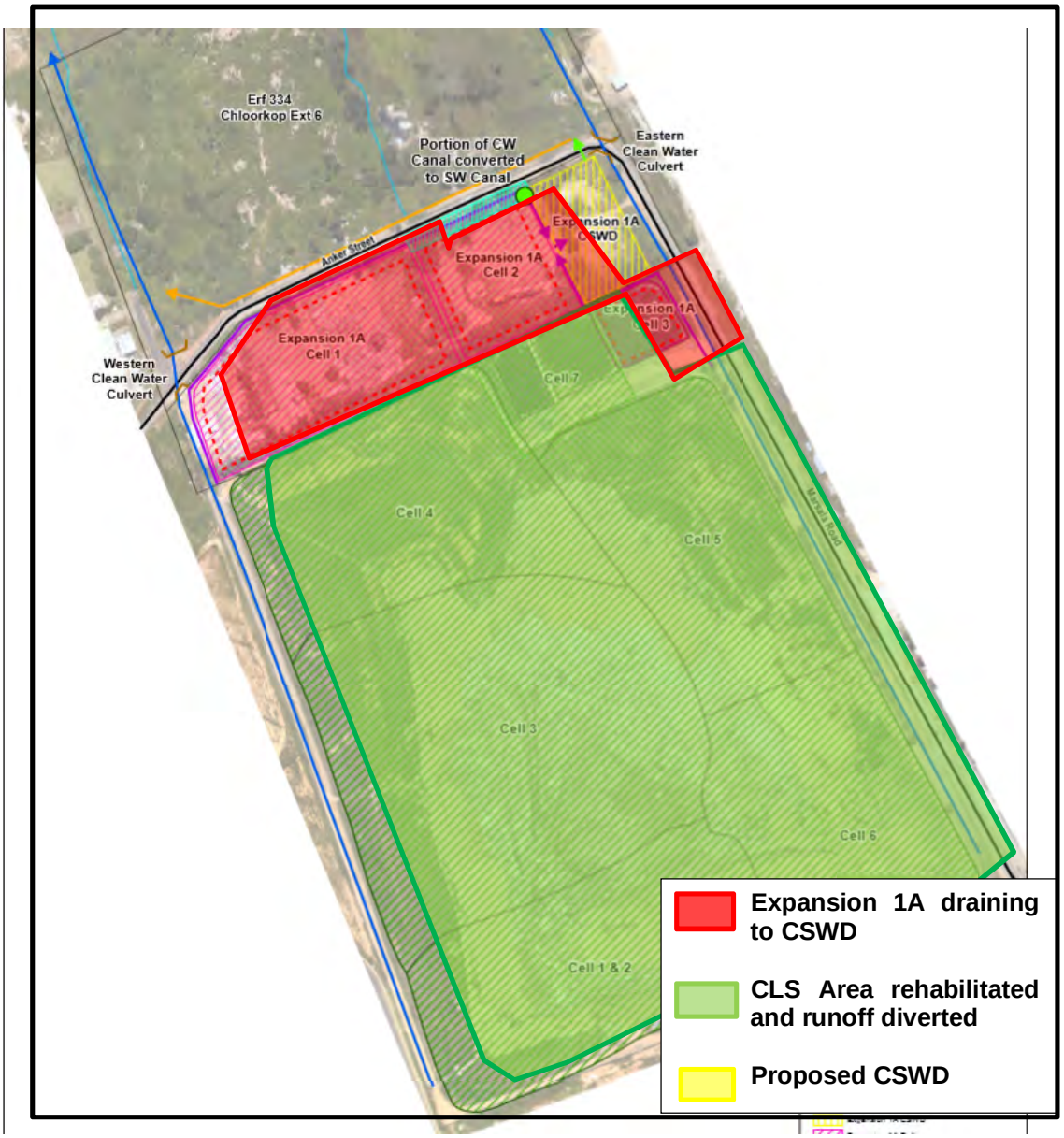

Figure 1.j Areas draining to CSWD for Expansion 1A

In summary the dam characteristics required are shown in **Table 1-1**:

Table 1-2: Contaminated storm water dam characteristics

Parameter	Value	Units
Capacity	14 300	m^3
Surface area	3 600	m^2
Assumed average depth	4.0	m
Volume in dam at start of period	-	m^3
Dead storage / operational requirement	5 713.00	% of capacity m^3

Pumping to sewer will be 300m^3/d and dust suppression will be 45m^3/d (which is as per current operations).

1.2.9 Leachate Management

A leachate tank is currently proposed at the CLS for the current operations (operations of Cell 7 – See Section 1.2.2). This tank would be located on the northern edge of the existing footprint and is sized to be 11.6m in diameter and 9.3m deep providing a storage capacity of 450m^3 below the lowest inlet pipe. Installation of the leachate collection tank will involve excavating a pit and installing a vertical retaining structure in the form of soil nails, reinforcing and gunnite. The tank will be premanufactured out of steel and lined with a PVC bladder.

Its use is planned for the operation of Phase 1A Cell 1. If feasible, the tank will be moved to cater for Phase 1A Cell 2. The new position will be located between Cell 1 and Cell 2 along the northern boundary of the site. If it is not feasible to move the tank, a new leachate tank, similar in size, is proposed. See Drawing 6007-12-002.

1.3 Project Phases

1.3.1 **Planning Phase**

1.3.1.1 Borehole monitoring network

The borehole monitoring network is shown in **Figure 1.k.** If Cell 7 is constructed, borehole pair CL07-42 S&D will be sealed. Similarly, if Phase1A is developed, Borehole CL06-41D will need to be sealed. Borehole pairs CL06-40 S&D and CL12-47 S&D will be very close to the Phase 1A cells as shown on the general arrangement (drawing no. 6007-12-001), however, will be built into the works to remain operational.

Figure 1.k: Borehole network at the Chloorkop landfill site

Additional borehole pairs shall be drilled downstream of Phase 1A as proposed in Report JW109/19/6007-22,with co-ordinates summarised in **Table 1-3.**

Table 1-3: Co-ordinates of proposed borehole pairs as stated in Geohydrology Investigation Report JW109-19-6007-22.

ID	Longitude (East)	Latitude (South)	Owner	Frequency
CL20-50D & S	-83 674.66	-2 881 526.90	CLS Northern Extension	Bi-Annual
CL20-51D & S	-83 598.17	-2 881 390.93	CLS Northern Extension	Bi-Annual
CL20-52D & S	-83 407.43	-2 881 306.89	CLS Northern Extension	Bi-Annual

1.3.2 Construction and Commissioning Phase

Construction of the disposal site will be implemented in phases with each waste cell being developed as the demand for waste disposal capacity requires. Construction of each waste cell will be undertaken in terms of the approved designs which will have considered the local site parameters and the Norms & Standards as appropriate. This will require site preparation activities such as: vegetation clearance, soil stripping, bulk earth works and levelling to the required elevations.

Construction activities for the liners will include: compaction of the base materials and berms, excavations for drains and anchor trenches, placement of the liner components, placement of pipes, aggregates and protection materials. Installation of the liner system is complex and accuracy and quality control is vital to ensure an effective barrier.

Phase 1A (schedule and life)

Table 1-4: Phase 1A airspace and footprint

Description	Area	Volume*	Operations Duration		Constr. Duration
	m^2	m^3	months	years	Months
Phase 1A Cell 1	18 210	362 700	10.36	0.86	9.11
Phase 1A Cell 2	9 011	435 700	12.45	1.04	4.51
Phase 1A Cell 3	4 126	143 300	4.09	0.34	2.06
Phase 1A Total	31 347	941 700	27	2.2	15.67

Note *: These volumes do not include the airspace of Cell 7 which is assumed to be part of current operations although is still in approval stage. Cell 7 volume = 413 000m^3

1.3.2.1 Storm water management

The management and separation of clean and contaminated storm water is illustrated in **Figure 1.l** and on drawing 6007-12-003. A description for each phase is given below:

Current management on site

On the existing CLS, the western face has been partially rehabilitated (below the additional height lift). Therefore, the storm water flowing along the western toe is considered clean and exits into the environment at the north east corner of Cell 4.

Clean storm water from the catchment upstream of the CLS is diverted around the existing site and flows along Marsala Road until it enters Erf334.

Contaminated flow currently starts at the access ramp on the southern face of the CLS and travels around the toe of the facility, anticlockwise, draining most of the southern, all of the eastern and part of the northern faces until it exits into the existing CSWD at the northern corner of the site. The dam has a municipal sewer connection in use.

Figure 1.l: Phase 1A Storm water management plan

The development of Cell 7 results in contaminated storm water flowing along the cell's northern and eastern boundary, draining directly into the existing CSWD.

A leachate tank is planned to store leachate created at the site. The tank will be located at the north western corner of Cell 7. An emergency overflow from the tank will connect to the existing CSWD to prevent spill to surrounding areas.

Phase 1A Cell1

With the development of Phase 1A Cell1, the clean storm water running along the western side of the CLS will need to continue to flow in a northern direction in formalised concrete (or alternative erosion protection) lined storm water trenches with a dedicated culvert below Anker Street and energy dissipation infrastructure at the outlet onto Erf 334 with the intention that it will eventually flow into the unnamed tributary of the Jukskei River. Similarly, on the eastern side of Erf 335 and the northern side of Phase 1A Cell 2 footprint, formalised storm water trenches will lead to a second dedicated culvert below Anker Street (including energy dissipation at outlet of culvert).

Due to the footprint of Phase 1A Cell 1 being approximately 6m below the existing CSWD, it will not be possible to use the existing dam and a new dam is required in the footprint of Phase 1A on Erf335. This CSWD will be positioned on the eastern side of Phase 1A. Contaminated storm water will then flow on the eastern, northern and western sides of Phase 1A Cell1, in dedicated concrete lined canals, towards the CSWD. Clean and dirty water separation will be required on the western side of Cell1. It is assumed that the new dam will have a municipal sewer connection.

It is assumed that the area south of the Cell 7 development has been fully rehabilitated and that the storm water runoff from these areas is diverted to the clean storm water systems on the eastern and western sides of the facility. Due to the eastern side of the existing CLS being assumed fully rehabilitated, there is no need for contaminated trenches, these will be converted into clean storm water trenches.

It is anticipated that the leachate tank used for Cell 7 will be suitable for use for Phase A Cell1. The overflow from the tank will be redirected to the Phase 1A CSWD.

Phase 1A Cell 2

The effect that Cell 2 will have on the storm water management is that the clean water trenches on the northern edge of Cell 2 will be converted to contaminated storm water and be transferred to the new Phase 1A CSWD instead of draining through the eastern clean water culvert.

The existing CSWD, made redundant by the Phase 1A CSWD, will be converted into a waste cell (Cell 3). All contaminated storm water will then report to the Phase 1A CSWD.

Due to the construction of Cell 2 allowing the landfill to extend northwards and cover the Cell 7 leachate tank, a new leachate tank will be required on Phase 1A between the two cells. All leachate generated on site will then report to the new tank which will have an overflow to the Phase 1A CWSD and a municipal sewer connection.

Final landform

Once the final landform has been developed it is assumed that the total catchment has been rehabilitated and is clean. Therefore, there is no more contaminated flow on site. The Phase 1A CSWD has been rehabilitated and only the leachate tank remains on site with an overflow connected to sewer.

1.3.2.2 Construction Quality Control Assurance and Project Specification

The project specification showing the materials specified is attached in Appendix C. The Construction Quality Control Plan is submitted in Appendix D.

1.3.2.3 Landfill Gas Operations

The CLS has had an operating landfill gas extraction system since January 2008. The system includes a number of vertical and horizontal wells that extract landfill gas from the existing cells to a double flare compound located on the northern side of the site (shortly to be relocated if Cell 7 as part of the Cell 7 works).

It is envisaged that horizontal wells will be installed in Phase 1A Cell 1, 2 and 3 at 10m intervals and be extracted at the same flare compound. The wells will serve to capture gas earlier during the cell lifetime compared to if vertical wells are installed later at final height.

It was also found by air quality specialists investigating the possibility of future extensions of the landfill that by extending the operations of the gas extraction system to Phase 1A that the impacts of the landfill in terms of odour risk can be reduced from high to medium risks.

The landfill gas extraction gas system has been sub-contracted to a specialist service provider who aim to relocate the flare compound. It is anticipated that the design of the landfill gas management system in Phase 1A will take place once the flare compound has been relocated and in association with the service provider.

1.3.3 **Operations Phase**

1.3.3.1 Waste Management and Disposal

Waste that requires disposal will be assessed in terms of the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GN R 635). Each disposal cell will be operated in terms of the conditions of the WML, the applicable Regulations and Norms and Standards. Wastes that are prohibited for disposal, as per Regulation 5(1) of the aforementioned Norms and Standards will not be disposed.

1.3.3.2 Decommissioning and Closure Activities

The life of the site is directly related to the rate of airspace utilisation which is outside of EnviroServ's control. Once the site is near to its final levels a closure plan will be developed. Closure of each of the disposal cells will require shaping and capping to achieve the final landform. The final end land use will be determined through a consultative process.

1.3.3.3 Capping system and rehabilitation

A provisional capping design for the CLS final landform was submitted and approved by the Gauteng Department of Agriculture and Rural Development (GDARD) in the permit amendment dated 24 June 2016. While Phase 1A would expand on the final landform shape that was used in the approval, it does not significantly impact the capping design philosophy. Therefore, the intention is to apply the same design that has been previously approved, for the Phase1A operations. These include details on the following approved drawings (refer DWS Review dated 30 June 2016):

- 6007-08-001 Chloorkop WDS Revised Final Landform General Arrangement;
- 6007-08-002 Chloorkop WDS Revised Final Landform Clean Dirty Storm Water Separation Berm Layout & Detail;
- 6007-08-003 Chloorkop WDS Revised Capping Details Layout;
- 6007-08-004 Chloorkop WDS Revised Final Landform Capping Details Typical Sections & Details;
- 6007-08-F01 Current Landform Plan & Sections;

- 6007-08-F02 Chloorkop WDS Longitudinal Section.

The attached drawings are shown in Appendix A.

1.4 Development Alternatives

1.4.1 Discussion

Other than considering a further expansion further northwards (Phase 1b discussed in Section 1.2.1), the only alternative to the Northern Expansion of the CLS would be to site a new landfill in a nearby location. EnviroServ regularly reviews opportunities for the siting of waste management facilities. No firm alternative sites have been identified. Due to the time that is required to develop an alternative site, which could take up to 3 years, the additional airspace provided by the expansion of the CLS would be required to allow operations to continue at the CLS until a new facility was ready.

A height increase of the current landfill (Cells1 to 6) has already been permitted and utilised in full, therefore, an alternative of further increasing the height of the dump is not technically feasible.

1.4.2 No-go Development Alternative

The no-go alternative would result in the CLS being closed after operations of Cell 7 (if approved) are completed and the site is rehabilitated. The air space of Cell 7 is expected to extend the life of the landfill until the end of 2020.

Due to the on-going waste generation in the region, the closing of the CLS would lead to a demand for local landfill sites. There are not many alternative landfill options and operators would need to travel to other landfill sites such as those positioned in the south of Johannesburg, Centurion or even Pretoria.

Therefore, the no-go alternative is considered less feasible than a CLS expansion.

1.4.3 Liner system alternative

One alternative that could be considered for the liner system is to replace the clay layers within the Class B liner system with a Geosynthetic Clay Layer (GCL). This layer is manufactured from two geotextiles with a thin layer of bentonite in between which are then needle-punched together. The benefits of using such a layer over conventional clay layers is ease of construction and control over the required quantities (i.e. if there is insufficient quantity of clay on site, the clay would need to be commercially sourced).

There are a few disadvantages to using a GCL:

- Slope stability: Once the bentonite in the GCL becomes hydrated, the internal shear strength of the layer is reliant on the needle punching of the geotextile. At high normal loads, these may break leading to an instability.
- Chemical compatibility with leachate: The chemical constituents of the leachate in the landfill may affect the bentonite's natural swelling capability due to cation exchange. This reduces the effectiveness of the GCL as a barrier.

The alternative layer system is shown in **Figure 1.m**. Additional soil layers are installed to either side of the GCL to ensure sufficient compression applied to the GCL which serves to decrease its permeability while ensuring that the bentonite within the GCL is continuously hydrated to prevent desiccation.

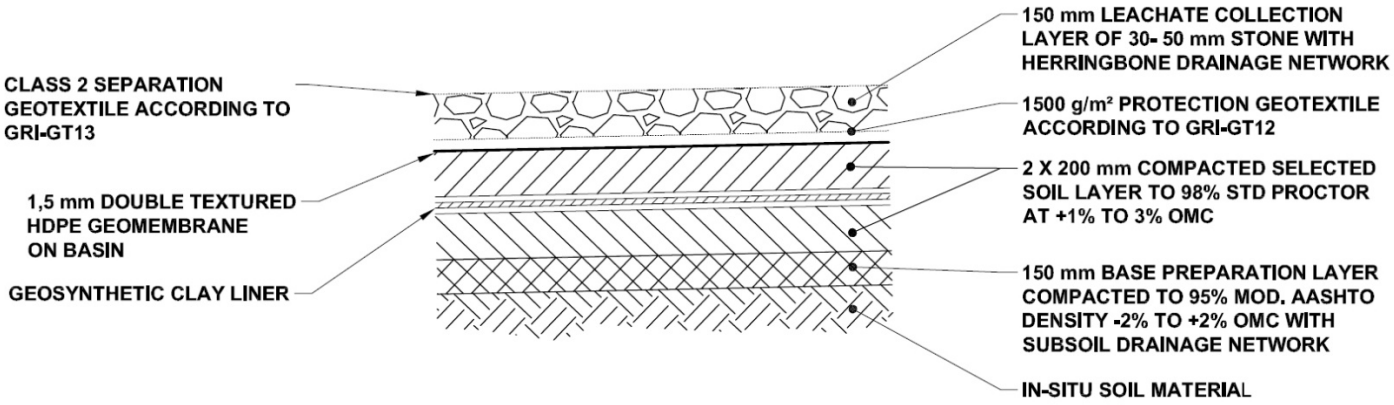

Figure 1.m: Alternative liner system incorporating a Geosynthetic Clay Layer

Due to the disadvantages discussed above, the liner system incorporating the conventional compacted clay layers is preferred and taken forward in the design – See the preferred liner system in **Figure 1.f**.

2. DESIGN SUMMARY

In this report all the design aspects of Phase 1A have been discussed. **Table 2-1** below summarises the main design aspects for the cell.

Table 2-1: Main design aspects

Design element	Measurement / description
Plan area Cell 1 Cell 2 Cell 3	 18 210m^2 9 011m^2 4 126m^2
Capacity / Airspace Cell 1 Cell 2 Cell 3	 362 700 m^3 435 700 m^3 143 300m^3
Maximum Waste Height	26m vertically above Phase 1A liner*
Embankment foundation	In situ material compacted to 95% MOD AASHTO at mc -2 to +2 of OMC
Embankment type	Homogenous earth fill embankment
Embankment Side slopes	1 in 3
Basal slope	1 in 50
Liner type	Class B

Note *: Maximum wall height is measured vertically between the crest of the cell and the highest point of the waste above the crest.

3. REFERENCES

The following documents were referenced in this report:

1. Jones & Wagener Report No.: JW090/19/6007-24 - Rev 0, Chloorkop Landfill Expansion Project, Surface Water Specialist Study, Final Report. Dated June 2019
2. Jones & Wagener Report No. JW240/16/B197: Geohydrological Investigation Report Chloorkop Waste Disposal Facility. Dated 2016
3. Jones & Wagener Report No. JW109/19/6007-22 – Rev C, EnviroServ Chloorkop Waste Disposal Site Expansion Site Selection, Hydrogeological Investigation Final Report. Dated June 2019.

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3 July 2019
Document source: https://joneswagener.sharepoint.com/JonesWagenerProjects/6007DTCHLOORSITECOSTS/Shared Documents/21_ConceptDesign/REP/NorthernExp/6007-21-19-JW130_r0_EWM_CLS_EXP_DesRep.docx
Document template: Normal.dotm

APPENDIX A

DESIGN DRAWINGS

Drawing Number:	Drawing Description:
Phase 1A	
6007-12-001	General Arrangement
6007-12-002	Final Landfill of Phase1A
6007-12-003	Storm water management plan
6007-12-004	Sections
6007-12-005	Phase 1A Cell 1 Details
6007-12-006	CSWD Details
6007-02-026	Access Road Layout
Approved Capping Drawings for Chloorkop Landfill Site	
6007-08-001	Chloorkop WDS Revised Final Landform General Arrangement;
6007-08-002	Chloorkop WDS Revised Final Landform Clean Dirty Storm Water Separation Berm Layout & Detail
6007-08-003	Chloorkop WDS Revised Capping Details Layout
6007-08-004	Chloorkop WDS Revised Final Landform Capping Details Typical Sections & Details
6007-08-F01	Current Landform Plan & Sections
6007-08-F02	Chloorkop WDS Longitudinal Section

LAYOUT 1:2000

NOTE:
PHASE 1B CELL 1 AND 2, MRF AND CSWD (B), SHOWN ONLY FOR INFORMATION TO RECORD ALTERNATIVE DESIGNS CONSIDERED

LEGEND

- CLEAN CATCHMENTS (REHAB) BOUNDARY
- FACE WATER FLOW FORMALISED TRENCHES
- UNNAMED TRIBUTARY OF THE JUSKEI RIVER
- CONTAMINATED SW
- CLEAN SW
- NEW CULVERT WITH EROSION PROTECTION DOWNSTREAM
- CSWD = CONTAMINATED STORM WATER DAM
- MRF = MATERIAL RECYCLING / RECOVERY FACILITY
- POSSIBLE FUTURE DEVELOPMENTS
- LEACHATE TANK POSITION

DRAWING LIST

6007-12-001 – GENERAL ARRANGEMENT (THIS DRAWING)
6007-12-002 – PHASE 1A LANDFORM
6007-12-003 – STORMWATER MANAGEMENT
6007-12-004 – LANDFILL DEVELOPMENT SECTIONS
6007-12-005 – PHASE 1A CELL 1 – LAYOUT AND TYPICAL SECTIONS
6007-12-006 – CONTAMINATED STORMWATER DAM
6007-26-002 – ACCESS ROAD PLAN, SECTIONS & DETAILS

Reference Drawings	Rev.	Revision	Name	Date	Approved
	B	DRAWING UPDATED AND RE-ISSUED FOR APPROVAL	MK	19.08.19	CC
	A	ISSUED FOR APPROVAL	MK	8.07.19	CC

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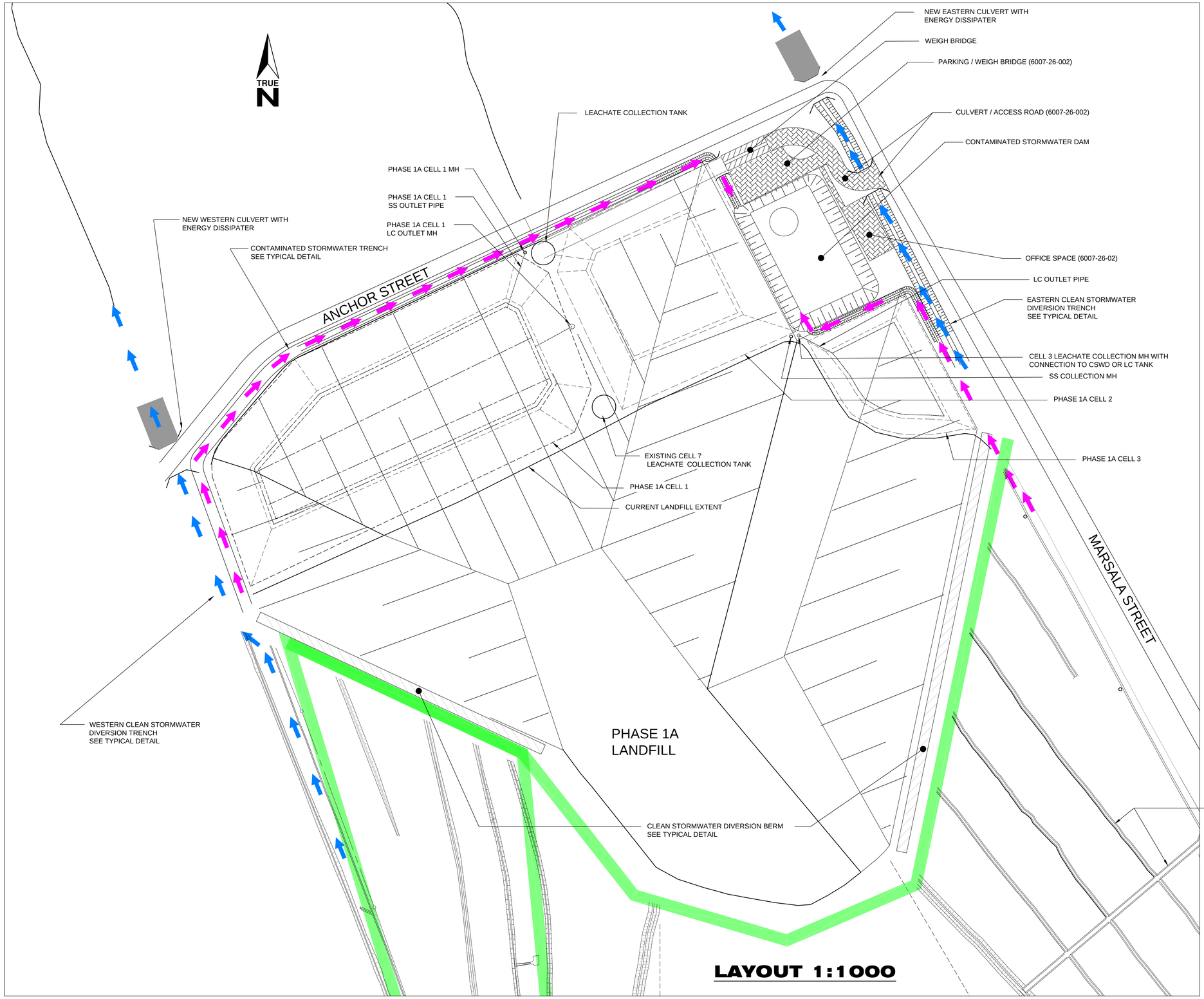
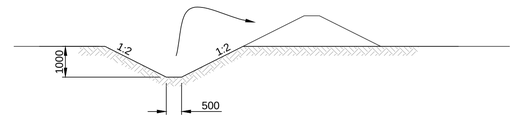
Drawn	MK	11.6.19
Designed	C CILLIERS	JUNE 19
Checked	C CILLIERS	JUNE 19
Pr. Eng. Approval	C CILLIERS	.
Signature		

Client **ENVIROSERV**
Project **CHLOORKOP LANDFILL SITE**
NORTHERN EXPANSION
FEASIBILITY
GENERAL ARRANGEMENT

Scale 1 : 2000 A1
Drawing No **6007 - 12 - 001**
Revision **B**



LAYOUT 1:1000



TYPICAL STROMWATER DIVERSION TRENCH& BERM

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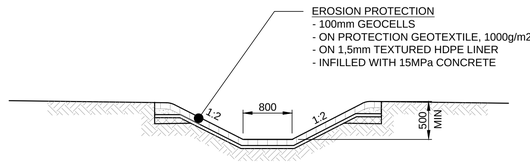

CONTAMINATED STROMWATER TRENCH 1:50

LEGEND

- CLEAN CATCHMENT (REHAB) BOUNDARY
- SURFACE WATER FLOW FORMALISED TRENCHES
- UNNAMED TRIBUTARY OF THE JUSKEI RIVER
- CONTAMINATED SW
- CLEAN SW
- NEW CULVERT WITH EROSION PROTECTION DOWNSTREAM
- CSWD = CONTAMINATED STORM WATER DAM
- MRF = MATERIAL RECYCLING / RECOVERY FACILITY
- LEACHATE TANK POSITION

NOTE :
THIS DRAWING ASSUMES THAT CELL 7 HAS BEEN CONSTRUCTED

Rev.	Revision	Name	Date	Approved
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C	DRAWING UPDATED AND RE-ISSUED FOR APPROVAL	MK	19.08.19	CC
B	CONTAMINATED STORM WATER DAM REVISED	LdW	8.07.19	CC
A	ISSUED FOR APPROVAL	MK	.	CC

Reference Drawings: . . .

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Drawn	MK	11.6.19
Designed	C CILLIERS	JUNE 19
Checked	C CILLIERS	JUNE 19
Pr. Eng. Approval	C CILLIERS	.
Signature		

Client: **ENVIROSERV**

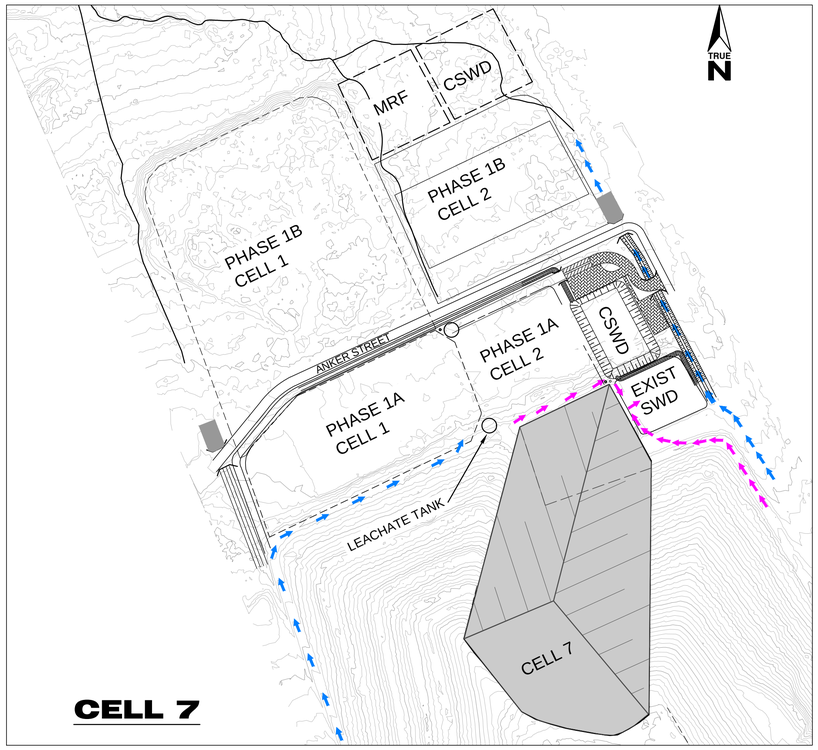
Project: **CHLOORKOP LANDFILL SITE**
NORTHERN EXPANSION
FEASIBILITY

PHASE 1A LANDFORM

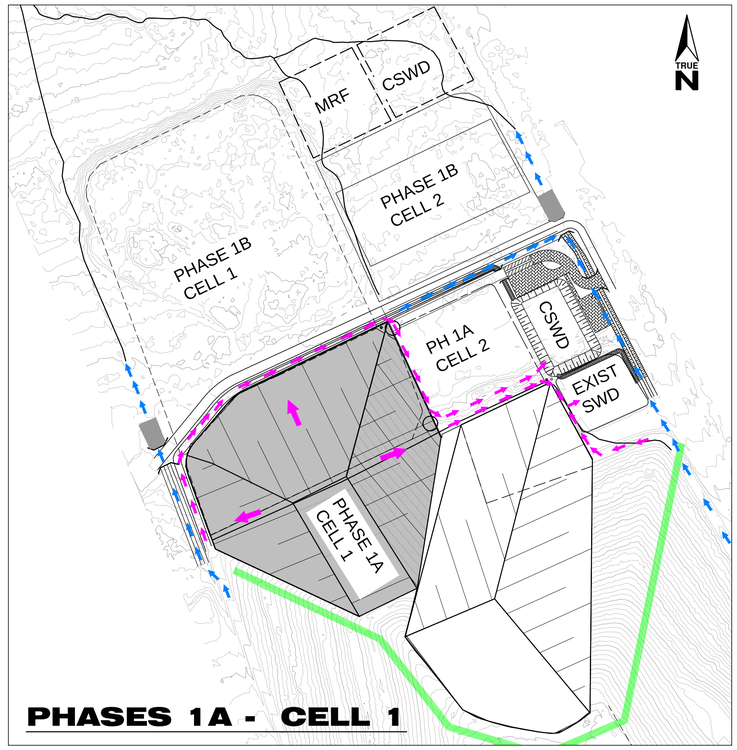
Scale: 1 : 1000 A1

Drawing No: **6007 - 12 - 002**

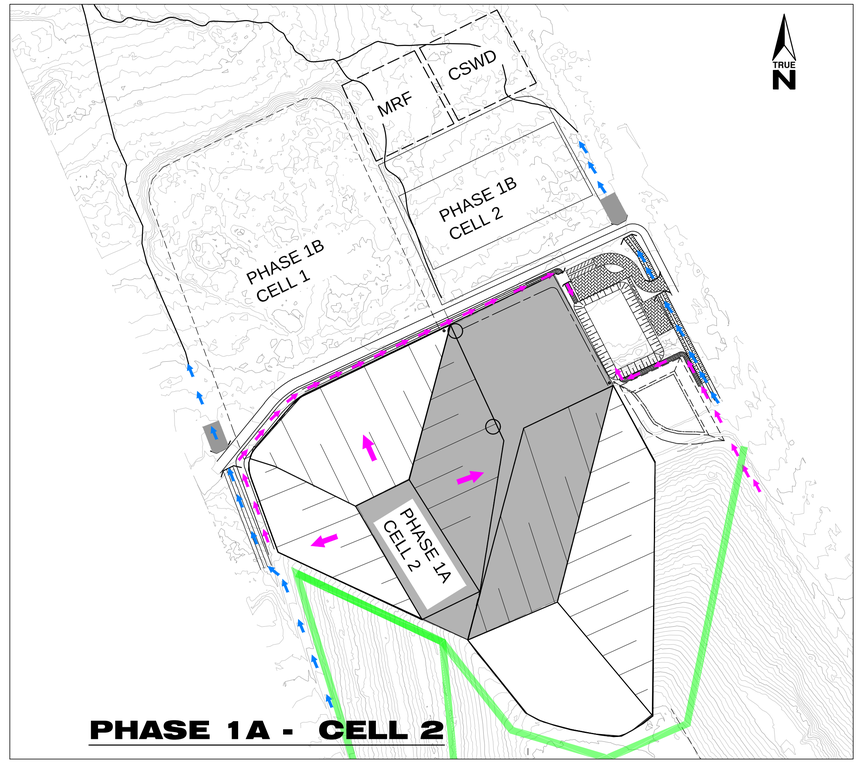
Revision: **C**



CELL 7



PHASES 1A - CELL 1



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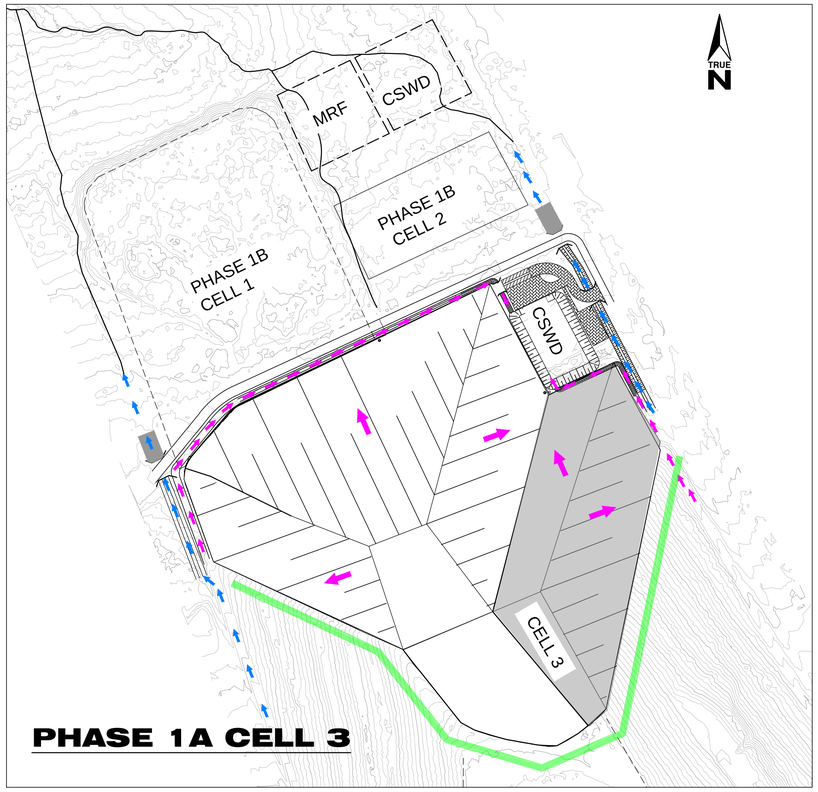

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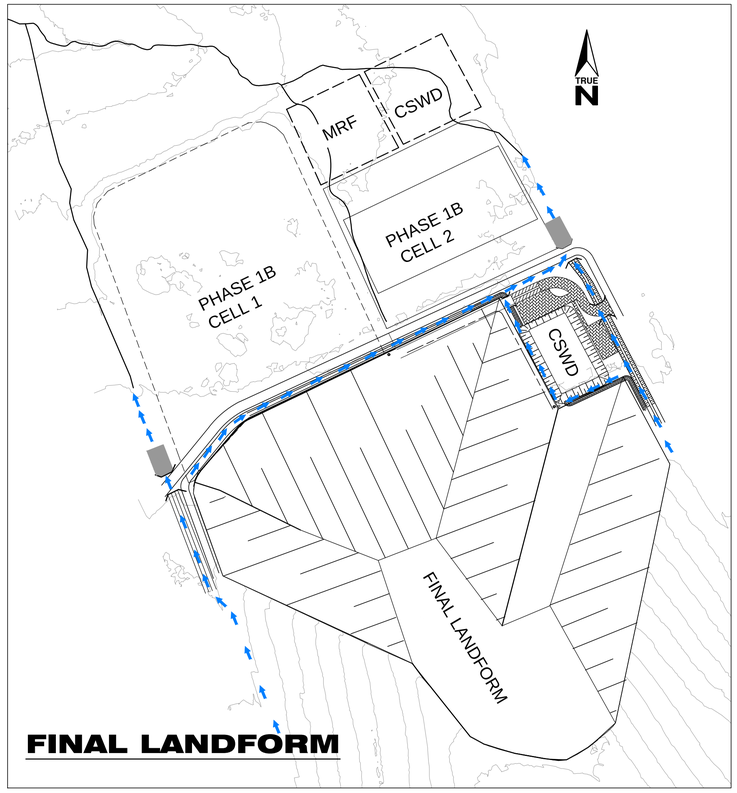
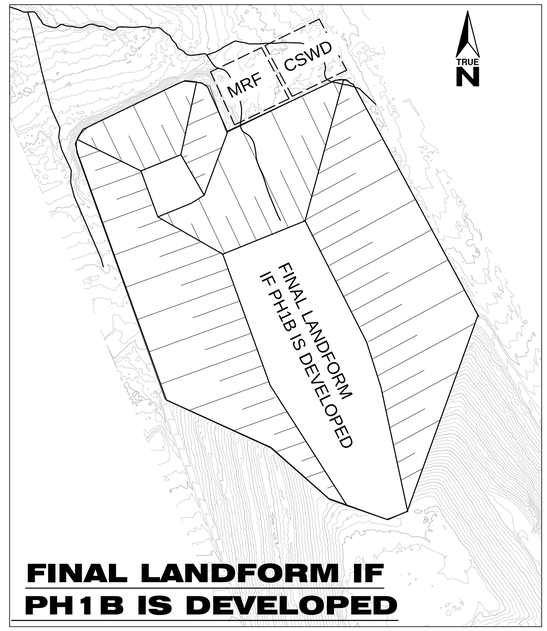


FINAL LANDFORM



FINAL LANDFORM IF PH1B IS DEVELOPED

LEGEND

- CLEAN CATCHMENT (REHAB) BOUNDARY
- FACE WATER FLOW FORMALISED TRENCHES
- UNNAMED TRIBUTARY OF THE JUSKEI RIVER
- CONTAMINATED SW
- CLEAN SW
- NEW CULVERT WITH EROSION PROTECTION DOWNSTREAM
- CSWD = CONTAMINATED STORM WATER DAM
- MRF = MATERIAL RECYCLING / RECOVERY FACILITY
- POSSIBLE FUTURE DEVELOPMENTS
- LEACHATE TANK POSITION

Reference Drawings		Rev.	Revision	Name	Date	Approved
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.	.	A	ISSUED FOR APPROVAL	MK	8.07.19	CC

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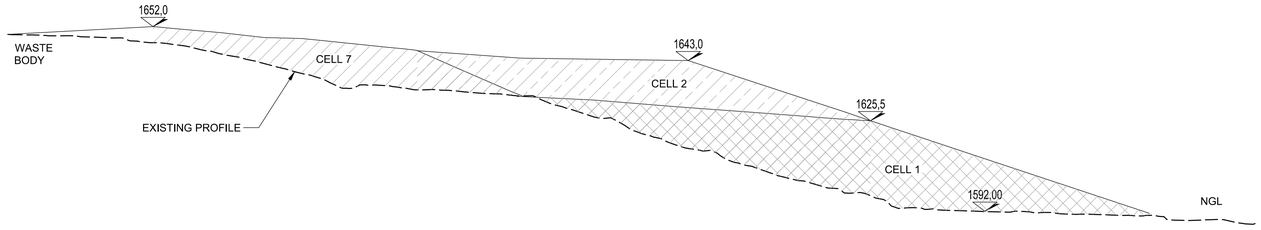
Drawn	MK	MAY 19	
Designed	C CILLIERS	25.04.19	
Checked	C CILLIERS	30.05.19	
Pr. Eng. Approval	C CILLIERS	-	
Signature			

Client: ENVIROSERV
Scale: 1 : 2500 A1
Project: CHLOORKOP LANDFILL SITE
NORTHERN EXPANSION
FEASIBILITY
STORM WATER MANAGEMENT
Drawing No: 6007 - 12 - 003
Revision: B



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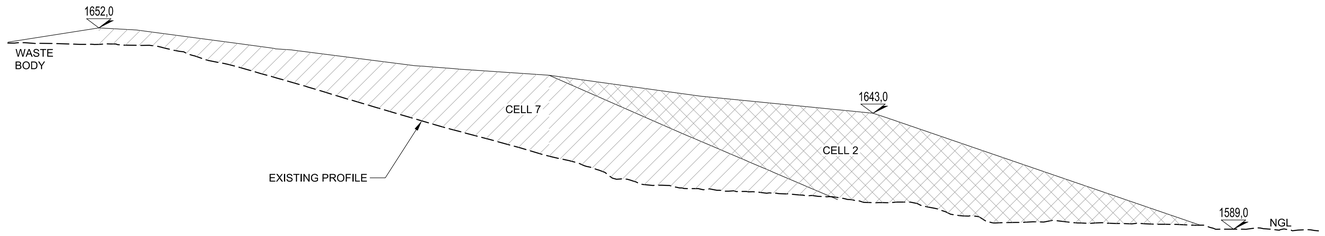

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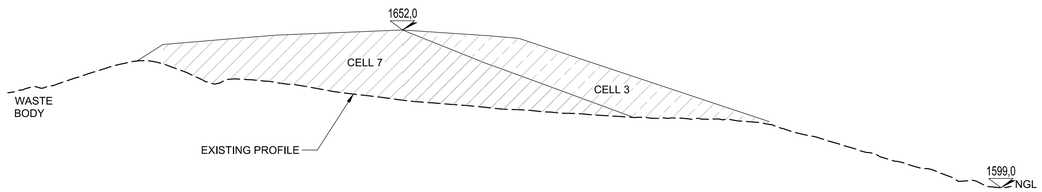

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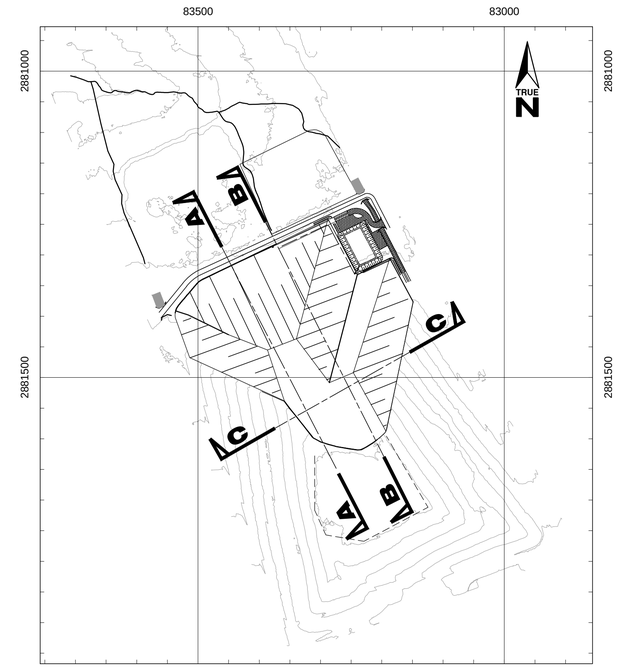

KEY PLAN - FINAL LAND FORM
1 : 5000

NOTE:
CELL 1, 2 AND 3 REFER TO PHASE 1A CELLS.
CELL 7 REFER TO EXISTING CLS CELLS

Reference Drawings		Rev.	Revision	Name	Date	Approved
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.	.	B	DRAWING UPDATED AND RE-ISSUED FOR APPROVAL	MK	19.08.19	CC
.	.	A	ISSUED FOR APPROVAL	MK	8.07.19	CC

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Drawn	MK	MAY 19
Designed	C CILLIERS	25.04.19
Checked	C CILLIERS	30.05.19
Pr. Eng. Approval	C CILLIERS	.
Signature		

Client: **ENVIROSERV**

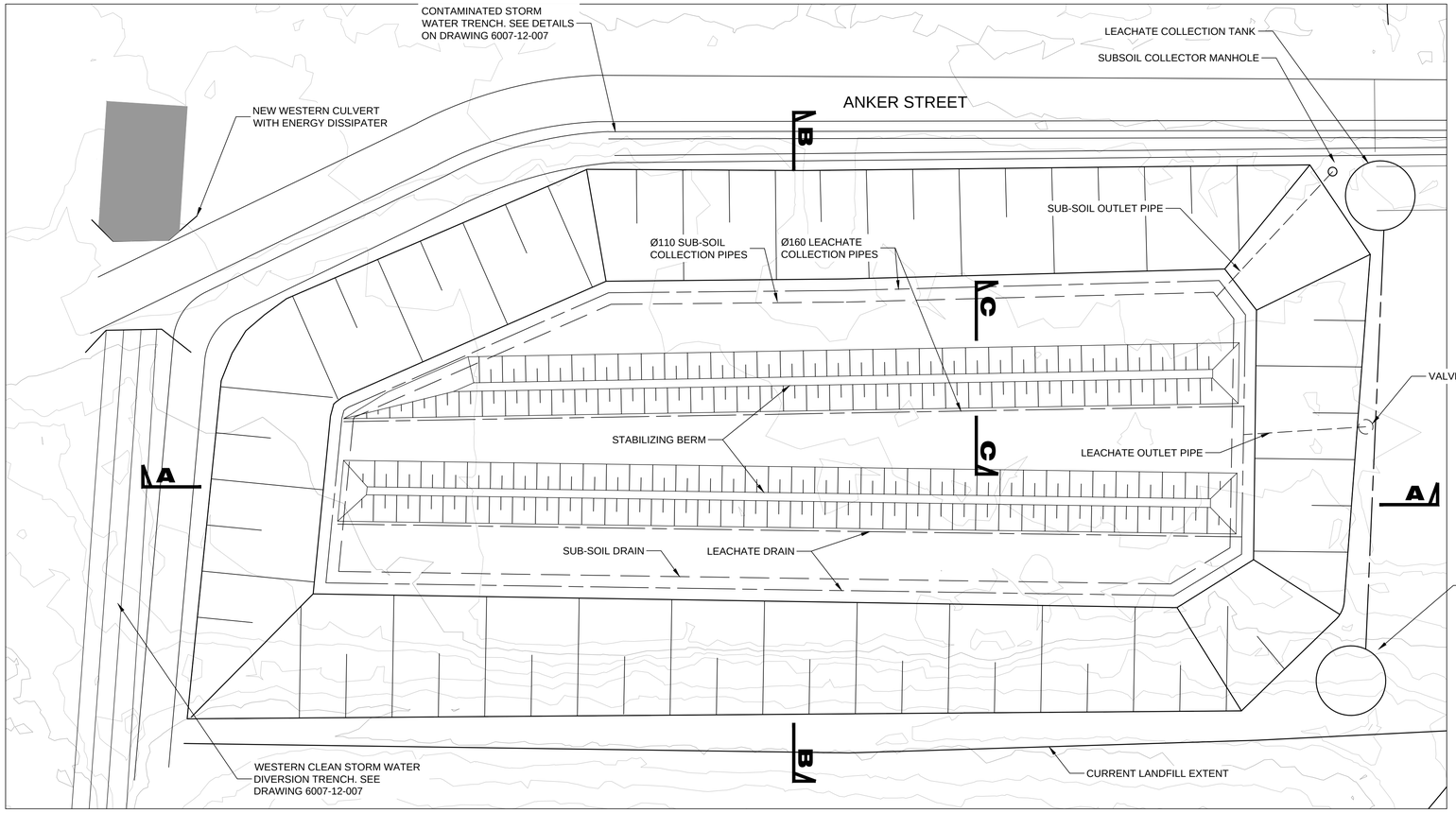
Project: **CHLOORKOP LANDFILL SITE**
NORTHERN EXPANSION
FEASIBILITY

LANDFILL DEVELOPMENT SECTIONS

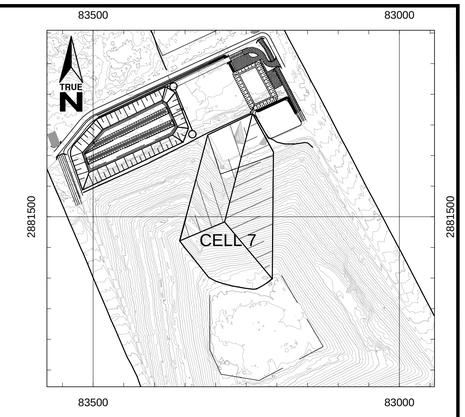
Scale: 1 : 1000 | A1

Drawing No: **6007 - 12 - 004**

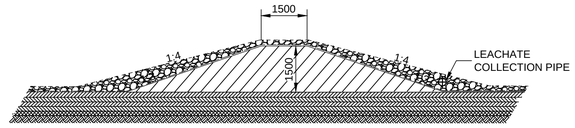
Revision: **B**



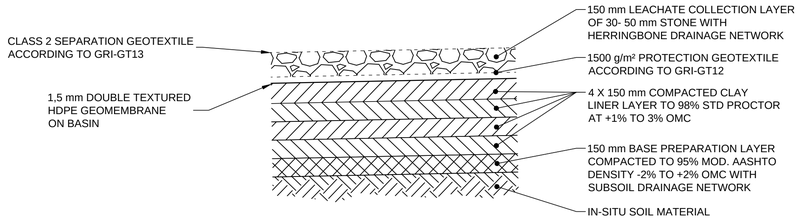
LAYOUT OF PHASE 1A CELL 1
1 : 500



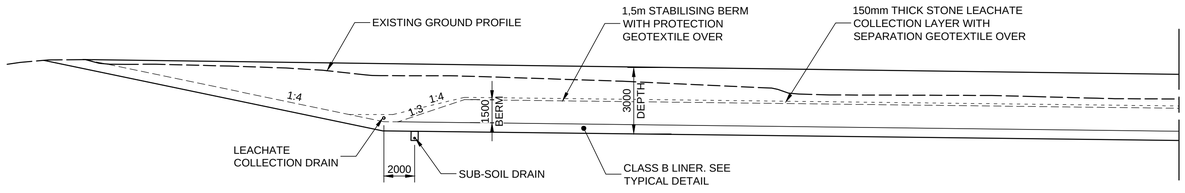
KEY PLAN
1 : 5000



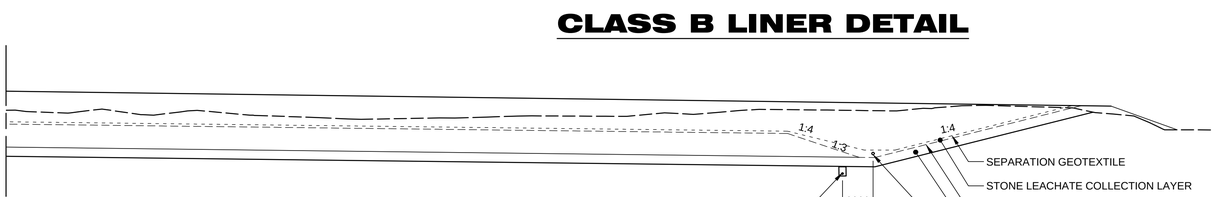
SECTION C
1 : 100

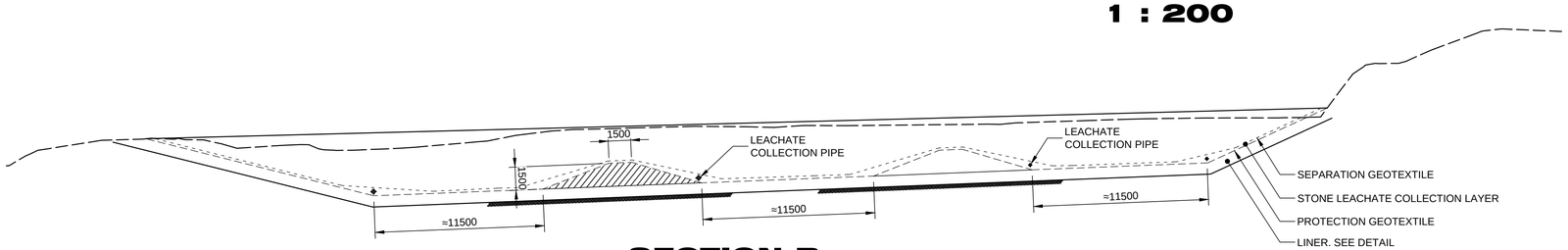


CLASS B LINER DETAIL



SECTION A
1 : 200





SECTION B
1 : 200

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.	.	B	DRAWING UPDATED AND RE-ISSUED FOR APPROVAL	MK	19.08.19	CC
.	.	A	ISSUED FOR APPROVAL	MK	8.07.19	CC
Reference Drawings		Rev.	Revision	Name	Date	Approved

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Drawn	MK	11.6.19
Designed	C CILLIERS	JUNE 19
Checked	C CILLIERS	JUNE 19
Pr. Eng. Approval	C CILLIERS	-
Signature		

Client: **ENVIROSERV**

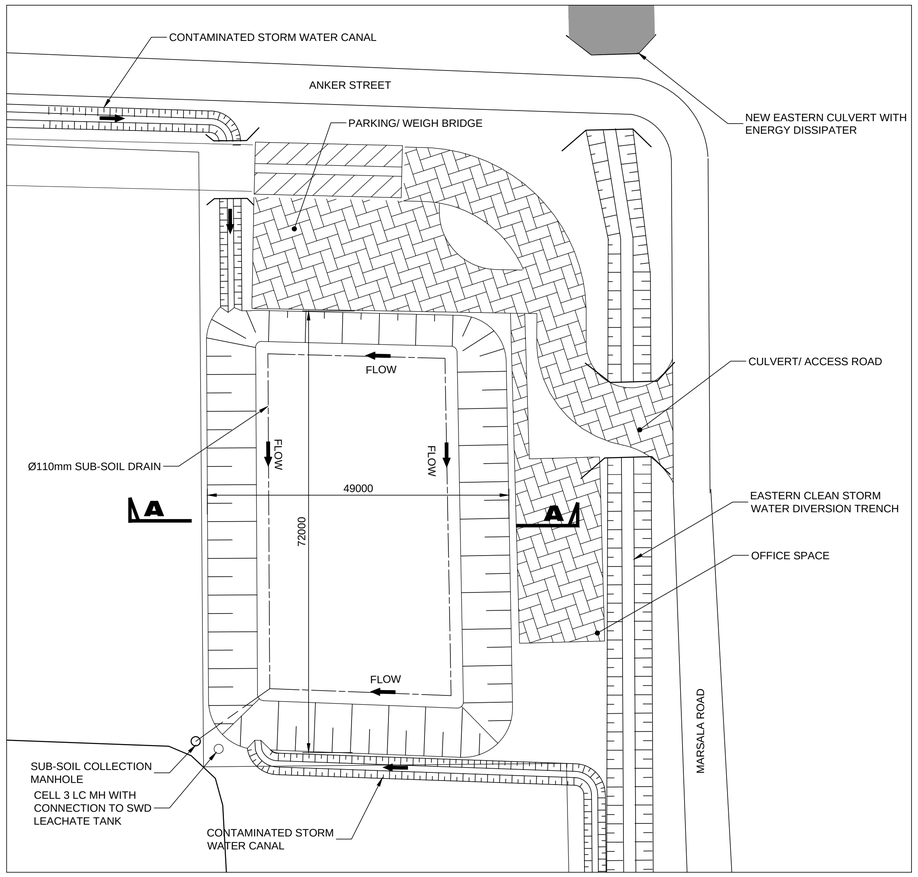
Project: **CHLOORKOP LANDFILL SITE**
NORTHERN EXPANSION
FEASIBILITY

PHASE 1A CELL 1

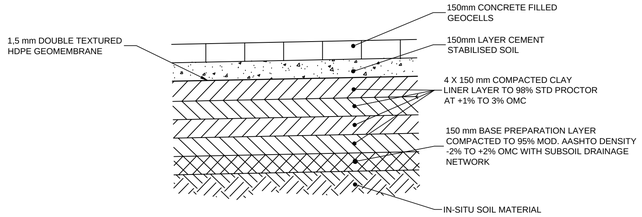
Scale: 1 : 2000 | A1

Drawing No: **6007 - 12 - 005**

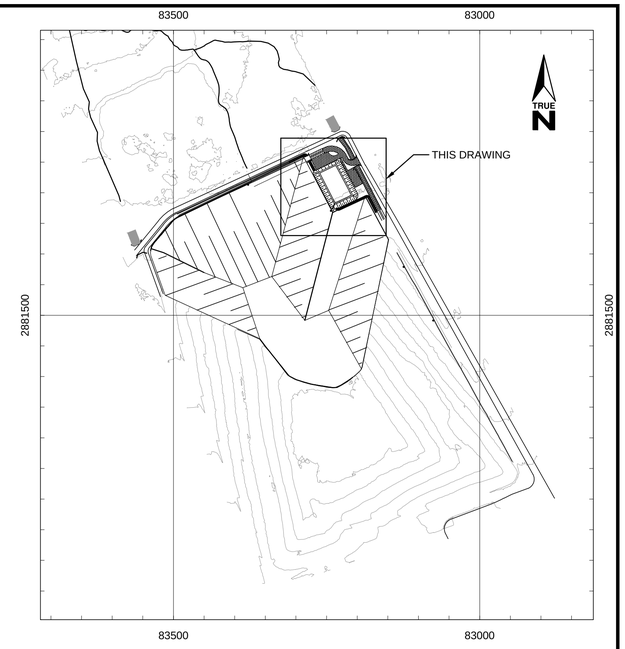
Revision: **B**



LAYOUT 1:500

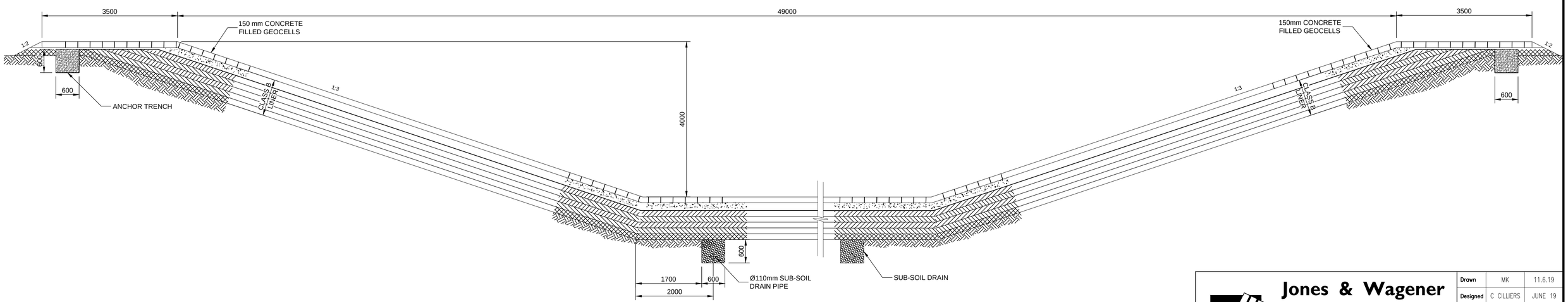


CLASS B LINER DETAIL



KEY PLAN
1 : 5000

VOLUME	14300m³
SURFACE AREA	3528m²
DEPTH	4m



SECTION A
1 : 50

Reference Drawings		Rev.	Revision	Name	Date	Approved
.	.	.	.	.	.	.
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.	.	B	DRAWING UPDATED AND RE-ISSUED FOR APPROVAL	MK	19.08.19	CC
.	.	A	ISSUED FOR APPROVAL	LdW	08.07.2019	CC

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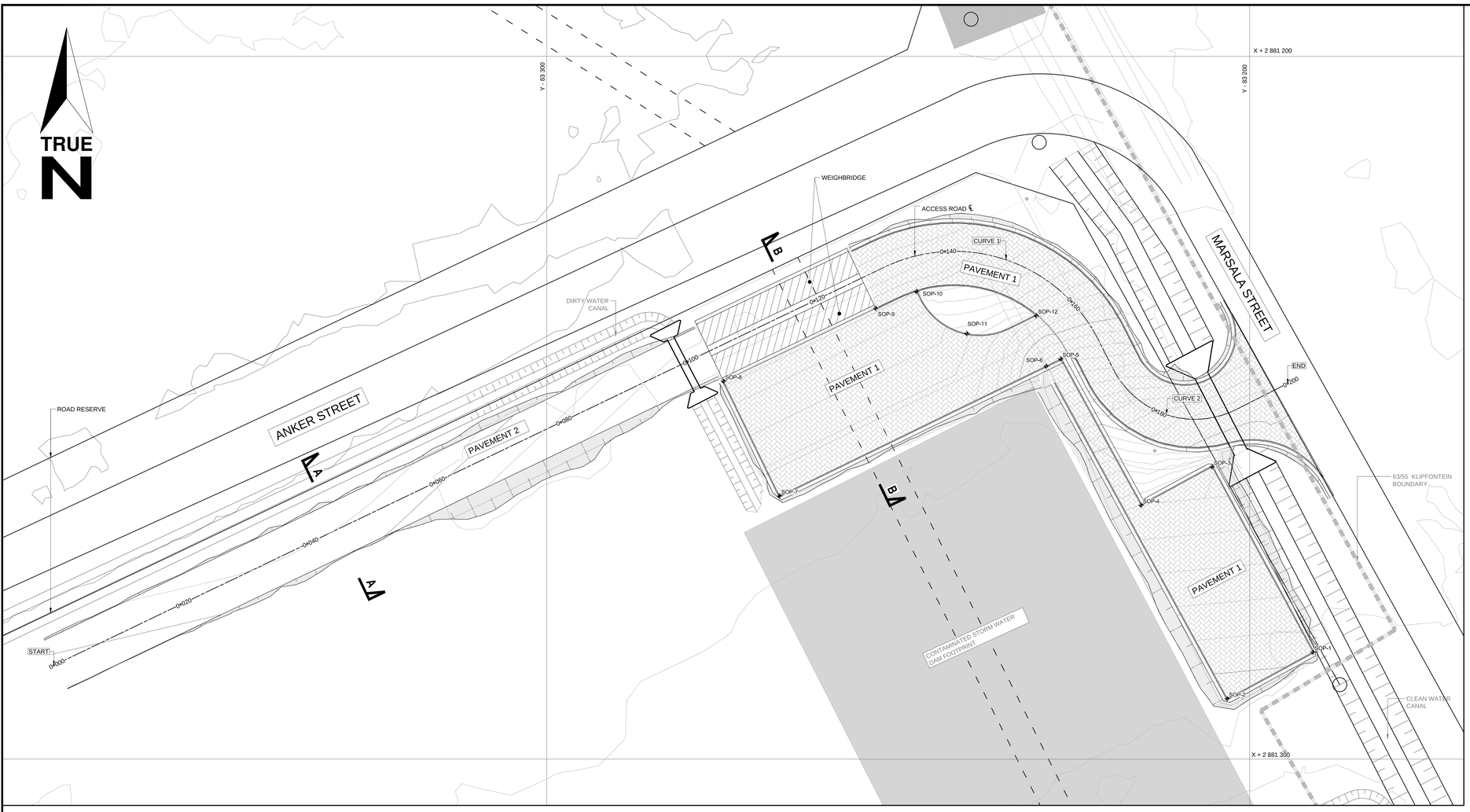
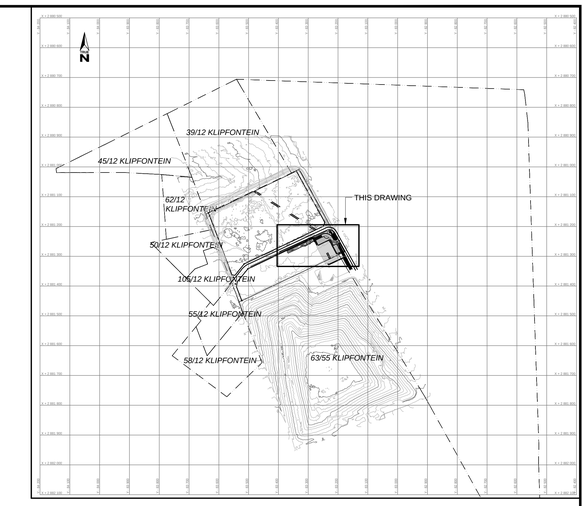
Drawn	MK	11.6.19
Designed	C CILLIERS	JUNE 19
Checked	C CILLIERS	JUNE 19
Pr. Eng. Approval	C CILLIERS	.
Signature		

Client: **ENVIROSERV**
Project: **CHLOORKOP LANDFILL SITE**
NORTHERN EXPANSION
FEASIBILITY
CONTAMINATED STORM WATER DAM

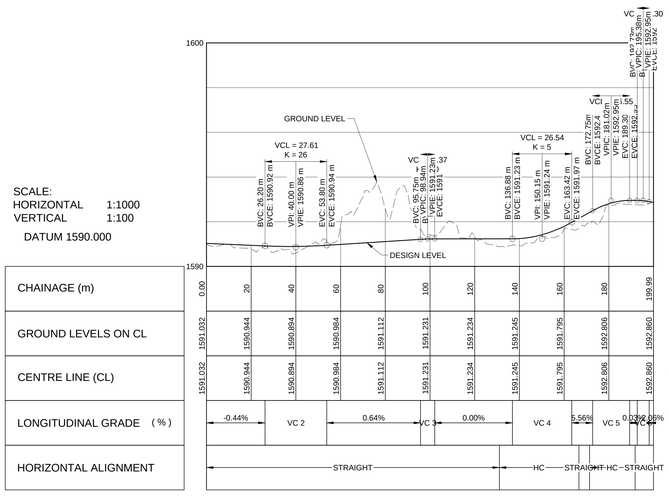
Scale: 1 : 2000 | A1
Drawing No: **6007 - 12 - 006**
Revision: **B**



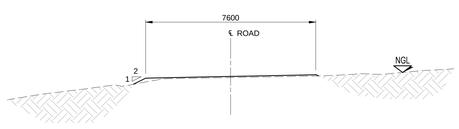
PLAN
1 : 250



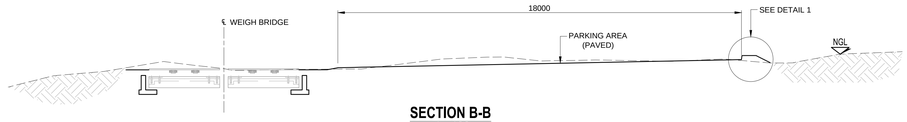
KEY PLAN
1 : 7 500



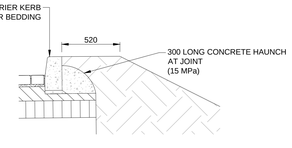
LONGSECTION- CHLOORKOP ACCESS ROAD



SECTION A-A
1 : 100

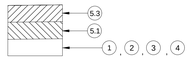


SECTION B-B
1 : 100



DETAIL 1
1 : 20

PAVEMENT 1
(PAVED AREA)



PAVEMENT 2
(GRAVEL ROAD)

CONSTRUCTION NOTES

1. REMOVE TOPSOIL/VEGETATION TO DEPTH 150mm WHERE REQUIRED.
2. EXCAVATE IN SITU MATERIAL TO BELOW FINISHED LAYERWORKS LEVEL AND PLACE IN FILL FOR ROAD OR SPOIL.
3. RIP 150mm, CORRECT MOISTURE CONTENT AND COMPACT AT 90% MOD AASHTO DENSITY.
4. FILL AS REQUIRED IN 150mm LAYERS USING SELECTED FILL MATERIAL COMPACTED TO 93% MOD AASHTO.
5. CONSTRUCT LAYERWORKS:

PAVEMENT 1:

5.1 150mm SELECTED LAYER USING GRANULAR MATERIAL (G6) COMPACTED TO 93% MOD. AASHTO DENSITY AT OMC ±2%.

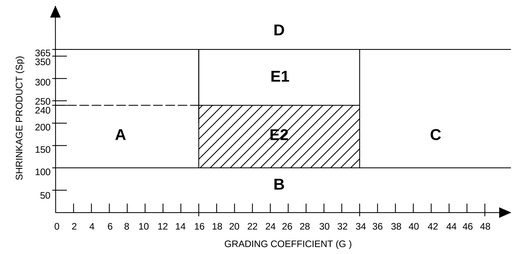
5.2 PLACE 150mm (C4) LAYER COMPACTED TO 97% MOD AASHTO DENSITY AT ±2% TO 0% OF OMC, 0.5 MPA < UCS < 1 MPA AT 97% MOD AASHTO DENSITY, ITS > 200 KPA AT STABILIZATION - G6. MATERIAL QUALITY BEFORE STABILISATION: G6.

6

PAVEMENT 2:

5.3 PLACE 150mm (G6) WEARING COURSE LAYER COMPACTED TO 95% MOD AASHTO DENSITY AT ±2% OF OMC.

- WEARING COURSE MATERIAL TO PLOT IN REGION E2 AS INDICATED BELOW.
- MAXIMUM PARTICLE SIZE = 37.5mm (WITH OVERSIZE INDEX (Io) = 0%).



$$Gc = \frac{(\%\ \text{PASSING 26.5mm SIEVE} - \%\ \text{PASSING 2.0mm SIEVE}) \times (\%\ \text{PASSING 4.75mm SIEVE})}{100}$$

Sp = LINEAR SHRINKAGE (LS) x % PASSING 0.425mm SIEVE.

Io = % RETAINED ON 37.5mm SIEVE.

HORIZONTAL ALIGNMENT
CHLOORKOP ACCESS ROAD

NAME	Y-COORD	X-COORD	LENGTH
START	83370.12 83251.97	2881286.66 2881230.00	131.03m
CURVE 1	83251.97 83221.53	2881230.00 2881240.32	35.59m
CURVE 2	83219.38 83201.91	2881244.55 2881250.25	20.40m
END	83201.91 83194.58	2881250.25 2881246.54	8.22m

SETTING OUT COORDINATES

POINT	Y COORD	X COORD	ELEVATION
SOP-1	83190.989	2881284.796	1594.14
SOP-2	83203.184	2881291.410	1594.25
SOP-3	83205.329	2881258.417	1593.59
SOP-4	83215.427	2881263.889	1593.68
SOP-5	83226.877	2881243.051	1592.27
SOP-6	83228.957	2881244.092	1592.42
SOP-7	83266.884	2881262.559	1591.87
SOP-8	83274.855	2881246.241	1591.51
SOP-9	83253.178	2881235.875	1591.23
SOP-10	83247.392	2881233.464	1591.51
SOP-11	83240.223	2881239.457	1591.76
SOP-12	83230.361	2881236.900	1591.78

Reference Drawings	Rev.	Revision	Name	Date	Approved
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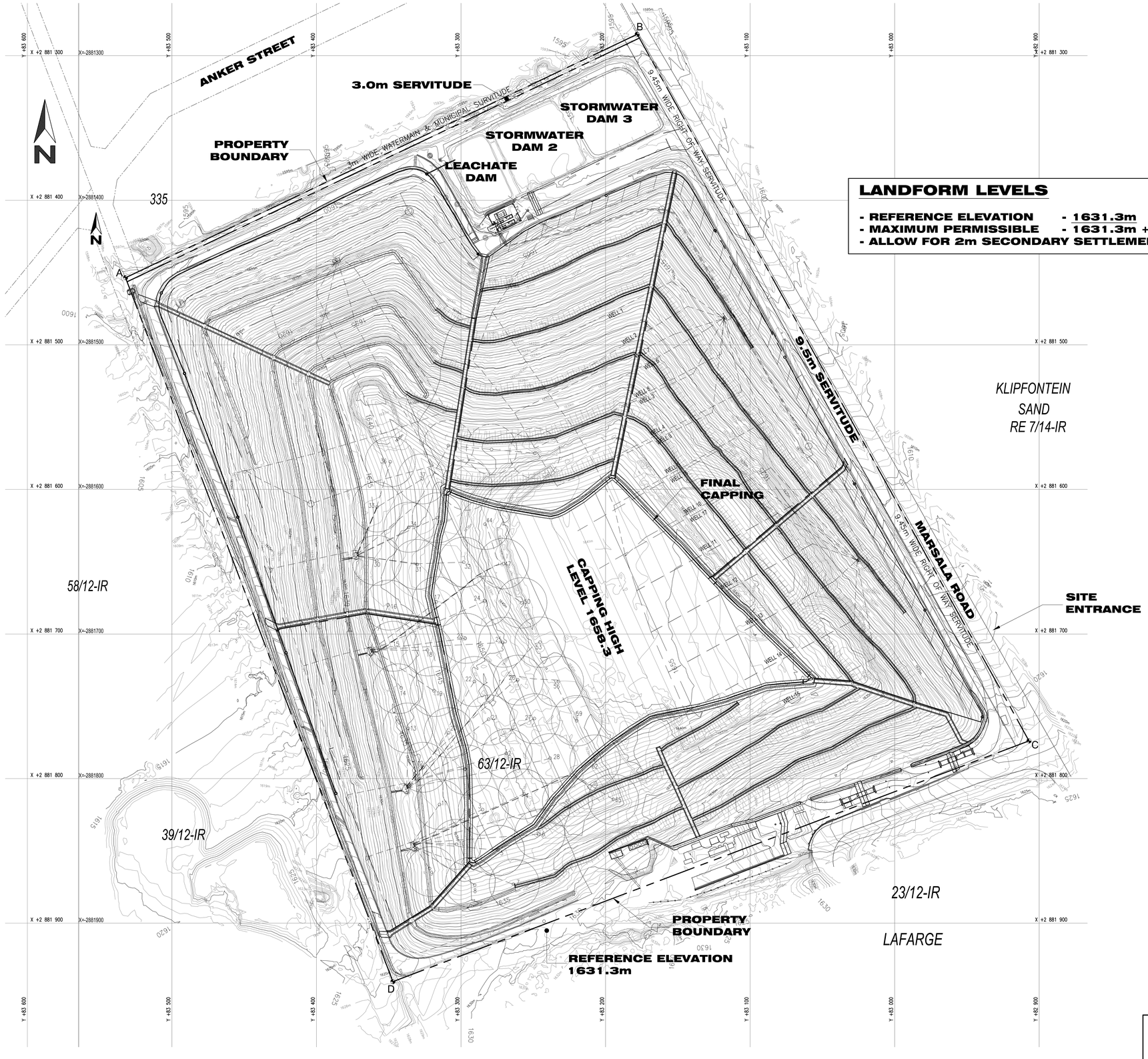
Drawn	MF	16.08.19
Designed	AsJ	16.08.19
Checked	WN	16.08.19
Pr. Eng. Approval	-	-
Signature		

Client: ENVIROSERV WASTE MANAGEMENT
Scale: AS SHOWN
Project: CHLOORKOP LANDFILL NORTHERN EXTENSION
PHASE 1A DEVELOPMENT
ACCESS ROAD
PLAN, SECTIONS & DETAILS
Drawing No: 6007 - 26 - 002
Revision: A



LANDFORM LEVELS

- REFERENCE ELEVATION - 1631.3m
- MAXIMUM PERMISSIBLE - 1631.3m + 10m + 15m = 1656.3m
- ALLOW FOR 2m SECONDARY SETTLEMENT - 1656.3m + 2m = 1658.3m

COORDINATE LIST

Point	+Y	+X
SITE BOUNDARY SETTING OUT POINTS		
A	83 532.090	2 881 453.540
B	83 178.125	2 881 285.165
C	82 907.064	2 881 773.913
D	83 347.125	2 881 940.450

Rev.	Revision	Name	Date	Approved
B	ADDED SITE BOUNDARY SETTING OUT TABLE	R.McL.	15.01.2015	J.S.
A	ISSUED FOR APPROVAL	LdW	28.11.2014	JS

Reference Drawings

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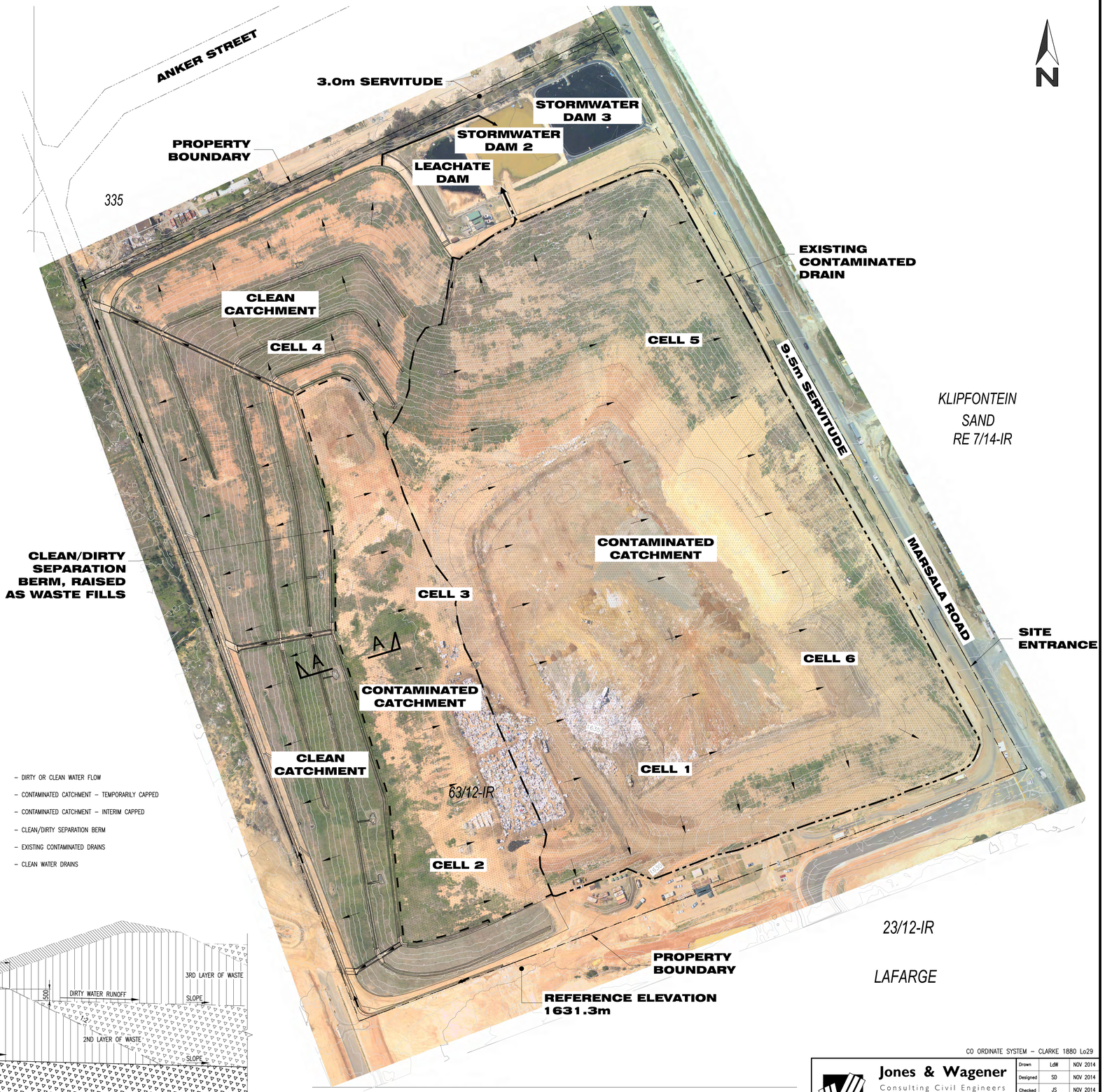
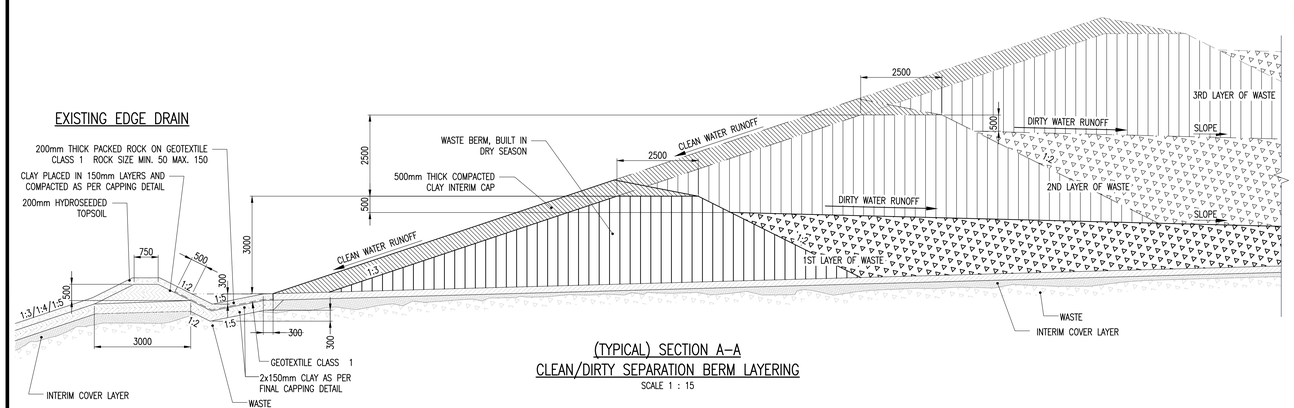
Drawn	LdW	NOV 2014
Designed	SD	NOV 2014
Checked	JS	NOV 2014
Pr. Eng. Approval	JS	.
Signature	J.Shamrock 20040309	

Client: ENVIROSERV
Scale: 1 : 1000 A0
Project: CHLOORKOP WASTE DISPOSAL SITE
REVISED LAND FORM
.
GENERAL ARRANGEMENT
Drawing No: 6007 - 08 - 001
Revision: B



KEY

- DIRTY OR CLEAN WATER FLOW
- CONTAMINATED CATCHMENT – TEMPORARILY CAPPED
- CONTAMINATED CATCHMENT – INTERIM CAPPED
- CLEAN/DIRTY SEPARATION BERM
- EXISTING CONTAMINATED DRAINS
- CLEAN WATER DRAINS



(TYPICAL) SECTION A–A
CLEAN/DIRTY SEPARATION BERM LAYERING
SCALE 1 : 15

[BASED ON CAPE 1880]

CO ORDINATE SYSTEM – CLARKE 1880 Lo29

0 10 20 30 40 60 80 100m
1:1000

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SETTING OUT DETAILS	6007-03-003	.	.	.	.	.	.
SECTIONS AND DETAILS	6007-03-002	.	.	.	.	.	.
GENERAL ARRANGEMENT	6007-03-001	A	ISSUED FOR APPROVAL	LdW	28.11.2014	JS	
Reference Drawings		Rev.	Revision	Name	Date	Approved	

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Designed	SD	NOV 2014
Checked	JS	NOV 2014
Pr. Eng. Approval	JS	26.2.09
Signature	J. Shamrock 20040309	

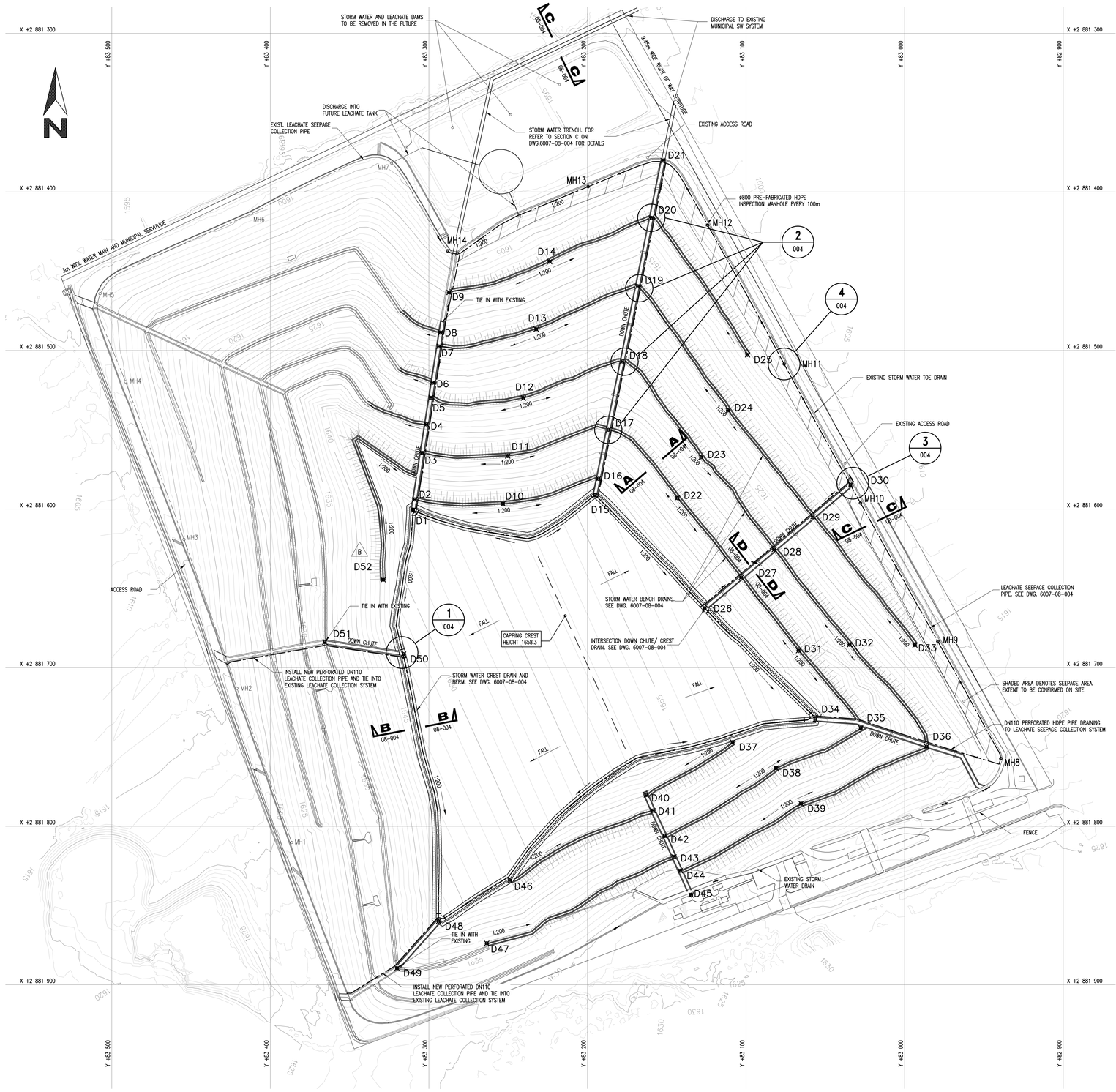
Client: ENVIROSERV

Project: CHLOORKOP WASTE DISPOSAL SITE
REVISED LAND FORM
CLEAN/ DIRTY STORM WATER SEPARATION BERM
LAYOUT AND DETAIL

Scale: AS SHOWN

Drawing No: 6007 - 08 - 002

Revision: A



COORDINATE LIST

CLARKE 1880 Lo29

POINT	Y-COORD	X-COORD	ELEVATION
SETTING OUT OF MANHOLES			
CONST:			
MH8	82939.37	2881757.36	
MH9	82979.14	2881683.47	
MH10	83027.89	2881596.08	
MH11	83076.03	2881508.55	
MH12	83124.20	2881420.98	
MH13	83199.56	2881396.74	
MH14	83288.20	2881437.15	
SETTING OUT OF STORM WATER DRAINS			
D1	83309.95	2881600.77	1652.30
D2	83308.88	2881593.96	1649.99
D3	83304.29	2881564.54	1640.06
D4	83301.61	2881546.56	1634.43
D5	83298.66	2881529.89	1630.09
D6	83297.47	2881520.27	1627.01
D7	83293.70	2881497.45	1620.05
D8	83292.73	2881488.75	1617.30
D9	83287.26	2881463.38	1609.93
D10	83253.24	2881596.66	1650.27
D11	83250.33	2881566.54	1640.30
D12	83240.40	2881530.05	1630.35
D13	83232.35	2881486.55	1630.35
D14	83223.87	2881443.94	1610.35
D15	83195.28	2881591.37	1629.02
D16	83193.15	2881580.90	1649.99
D17	83186.87	2881550.05	1640.03
D18	83178.09	2881506.90	1630.01
D19	83168.20	2881459.48	1619.96
D20	83159.67	2881416.39	1610.01
D21	83152.31	2881380.26	1613.00
D22	83143.36	2881593.05	1640.31
D23	83128.37	2881567.31	1630.37
D24	83111.35	2881537.74	1620.44
D25	83099.10	2881502.75	1610.55
D26	83126.10	2881662.59	1649.75
D27	83103.07	2881643.11	1639.99
D28	83082.26	2881625.50	1630.01
D29	83057.77	2881604.78	1620.00
D30	83034.16	2881584.80	1619.95
D31	83055.38	2881732.51	1646.71
D32	83027.64	2881738.13	1639.99
D33	82986.13	2881749.86	1630.66
D34	83066.91	2881689.31	1640.29
D35	83034.72	2881685.51	1630.38
D36	82993.51	2881685.78	1620.50
D37	83108.45	2881747.03	1650.29
D38	83081.11	2881763.29	1640.30
D39	83065.30	2881785.74	1631.07
D40	83162.91	2881780.33	1649.97
D41	83158.73	2881790.18	1646.51
D42	83151.24	2881806.13	1639.89
D43	83145.41	2881819.32	1635.47
D44	83141.47	2881828.09	1631.51
D45	83134.60	2881843.40	1627.84
D46	83248.89	2881834.25	1647.05
D47	83263.52	2881873.85	1635.80
D48	83293.89	2881859.98	1643.56
D49	83320.13	2881889.50	1634.10
D50	83315.93	2881691.46	1601.98
D51	83365.70	2881683.91	1602.61
B D52	83328.79	2881644.56	1645.72

NOTE:

NOTE POSITIONS OF GAS EXTRACTION INFRASTRUCTURE ON SITE AND EXERCISE CAUTION AND CARE WHEN WORKING IN THESE AREAS DUE TO RISK OF DAMAGE, FIRE OR EXPLOSION

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.	.	B	COORDINATE LIST AND DRAIN D52 ADDED	LdW	19.01.2015	JS
GENERAL ARRANGEMENT	6007-08-001	A	ISSUED FOR APPROVAL	LdW	28.11.2014	JS
Reference Drawings		Rev.	Revision	Name	Date	Approved

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Drawn	LdW	NOV 2014	
Designed	SD	NOV 2014	
Checked	JS	NOV 2014	
Pr. Eng. Approval	JS	.	
Signature	F.Shamrock 20040309		

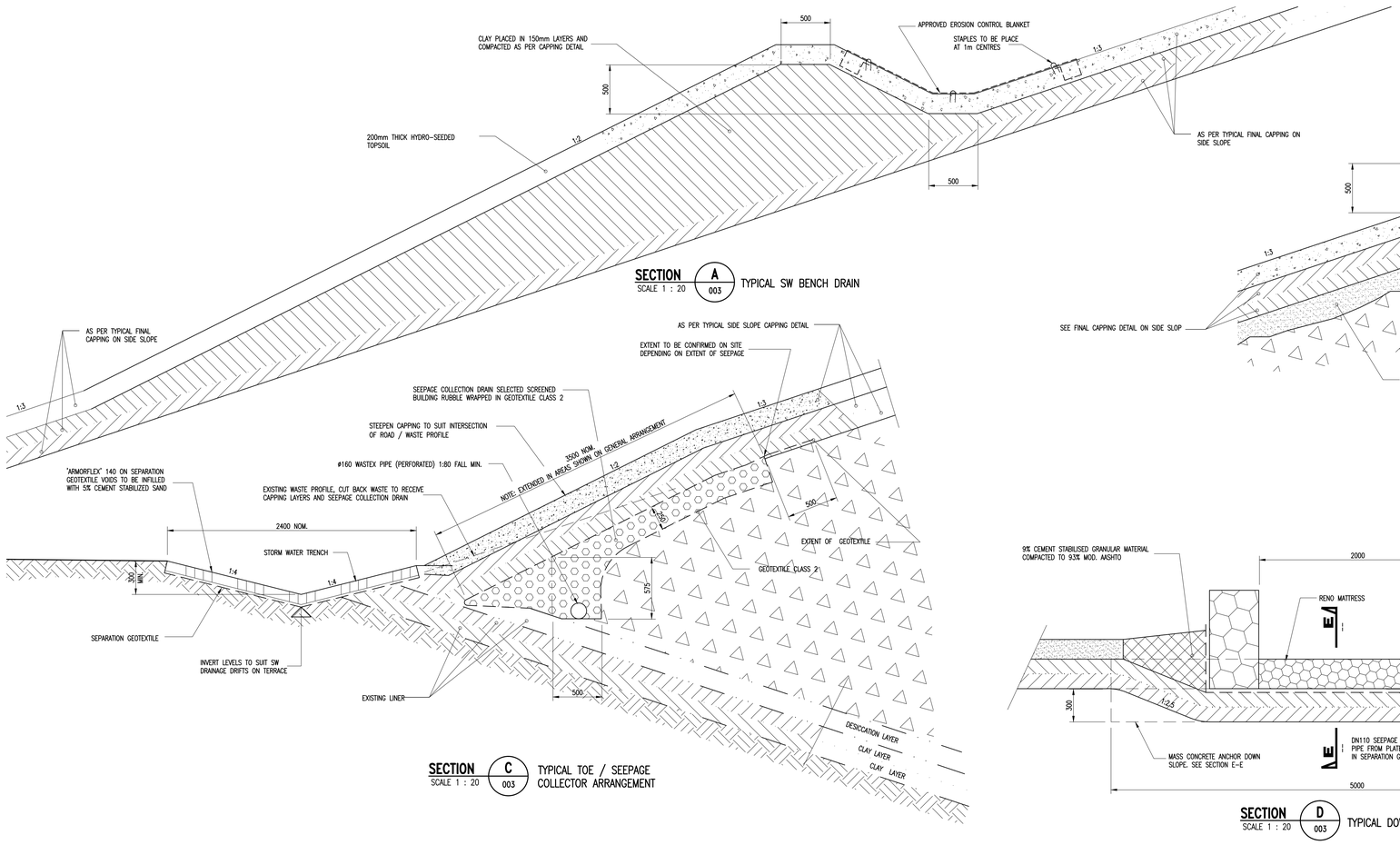
Client: ENVIROSERV

Project: CHLOORKOP WASTE DISPOSAL SITE
REVISED FINAL LAND FORM
CAPPING DETAILS
LAYOUT

Scale: AS SHOWN | A0

Drawing No: 6007 - 08 - 003

Revision: B



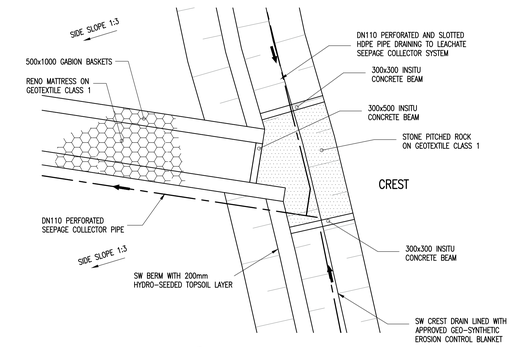
SECTION A / 003 — SCALE 1 : 20 — TYPICAL SW BENCH DRAIN

SECTION B / 003 — SCALE 1 : 20 — TYPICAL SW CREST DRAIN AND CAPPING DETAILS

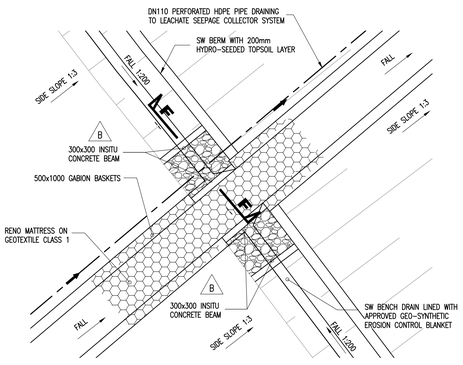
SECTION C / 003 — SCALE 1 : 20 — TYPICAL TOE / SEEPAGE COLLECTOR ARRANGEMENT

SECTION D / 003 — SCALE 1 : 20 — TYPICAL DOWN CHUTE

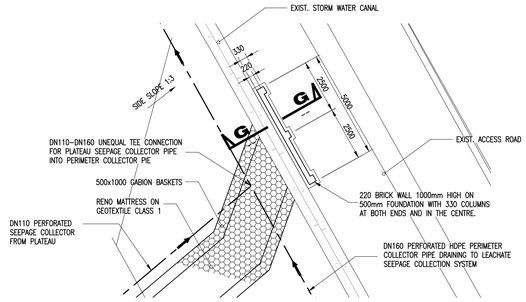
SECTION E / -- — SCALE 1 : 20 — TYPICAL ANCHOR DETAIL



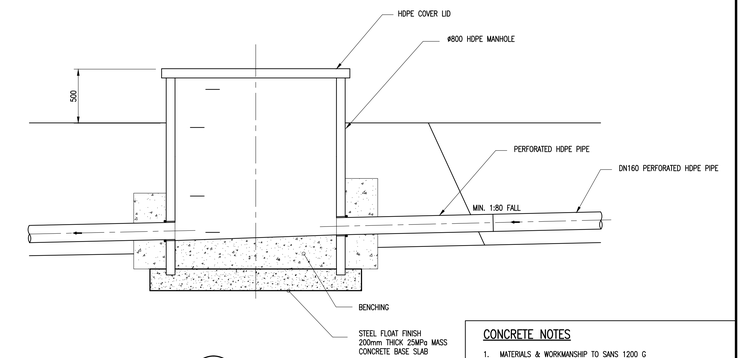
DETAIL 1 / 003 — SCALE 1 : 100 — TYPICAL INTERSECTION CREST DRAIN/ DOWN CHUTE



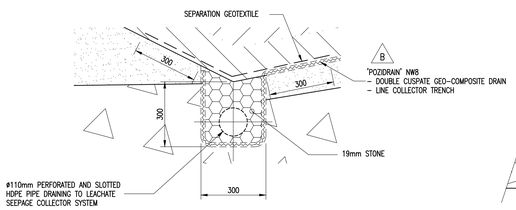
DETAIL 2 / 003 — SCALE 1 : 100 — TYPICAL INTERSECTION BENCH DRAIN/ DOWN CHUTE



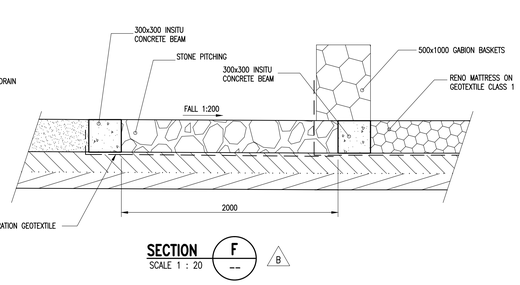
DETAIL 3 / 003 — SCALE 1 : 100 — DOWN CHUTE INTO EXISTING SW DRAIN



DETAIL 4 / -- — NTS — TYPICAL SEEPAGE COLLECTION INSPECTION MANHOLE



DETAIL 5 / -- — SCALE 1 : 10 — DRAINAGE LAYER OUTLET



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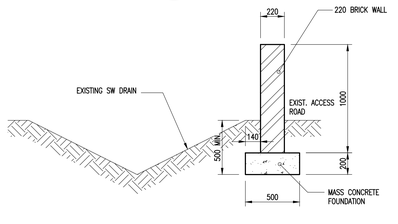

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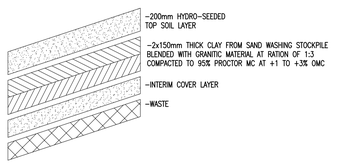
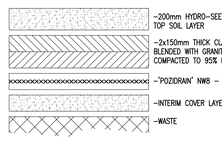


FINAL CAPPING DETAIL ON SIDE SLOPE



FINAL CAPPING DETAIL ON PLATEAU

CONCRETE NOTES

1. MATERIALS & WORKMANSHIP TO SANS 1200 G
2. STRENGTH CONCRETE : GRADE 25/19
3. PROVIDE 20x20 CHAMFER TO ALL EXPOSED CONCRETE CORNERS
4. EXCAVATION TO BE INSPECTED BY J&W PRIOR TO CONCRETING

GEOTEXTILE LEGEND

- GRI–GT13 CLASS 1, EQUIVALENT TO BIDIM A5
- GRI–GT13 CLASS 2, EQUIVALENT TO BIDIM A4
- GRI–GT13 CLASS 3, EQUIVALENT TO BIDIM A2
- ALL SEAMS TO BE STITCHED

PIPE NOTES B

–CREST LEACHATE DRAIN PIPE	–PERFORATED DN110 HDPE
–LEACHATE COLLECTOR PIPE DOWN SLOPE	–PERFORATED DN110 HDPE
–LEACHATE COLLECTOR PIPE AT TOE	–PERFORATED DN160 HDPE

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Drawn	LdW	NOV 2014
Designed	SD	NOV 2014
Checked	JS	NOV 2014
Pr. Eng. Approval	JS	.
Signature	J.Shamrock 20040309	

Client: **ENVIROSERV**

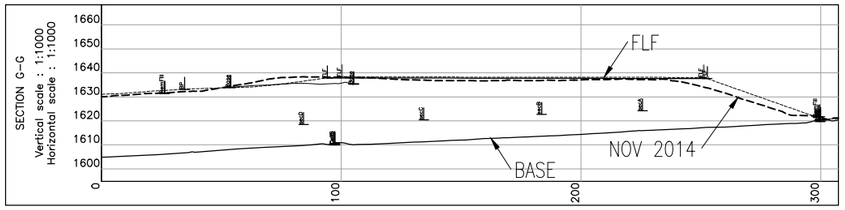
Project: **CHLOORKOP WASTE DISPOSAL SITE**
REVISED FINAL LAND FORM
CAPPING DETAILS
TYPICAL SECTIONS AND DETAILS

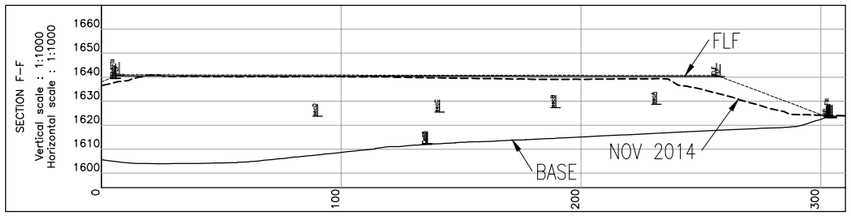
Scale: AS SHOWN — A0

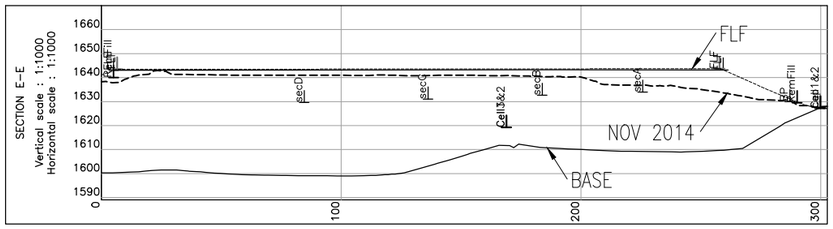
Drawing No: **6007 - 08 - 004**

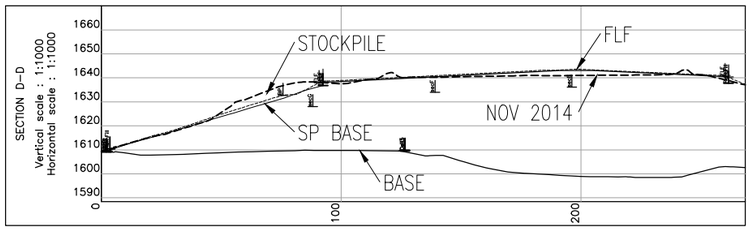
Revision: **B**

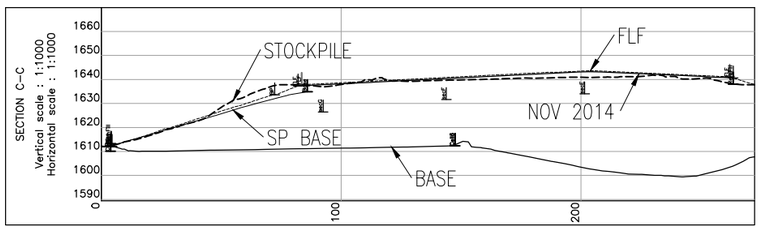
Reference Drawings		Rev.	Revision	Name	Date	Approved
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	B	PIPE NOTES AMMENDED, GENERAL NOTES AND SECTION F MODIFIED	LdW	19.01.2015	JS
GENERAL ARRANGEMENT	6007–08–003	A	ISSUED FOR INFORMATION	LdW	28.11.2014	JS

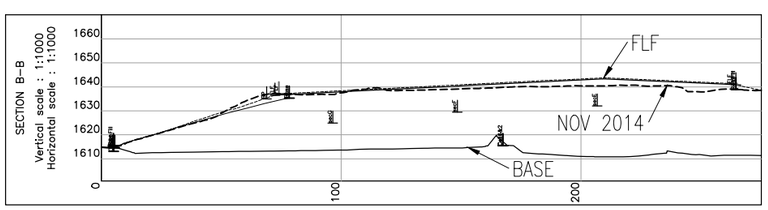


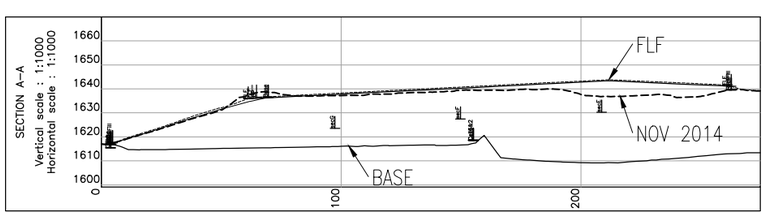


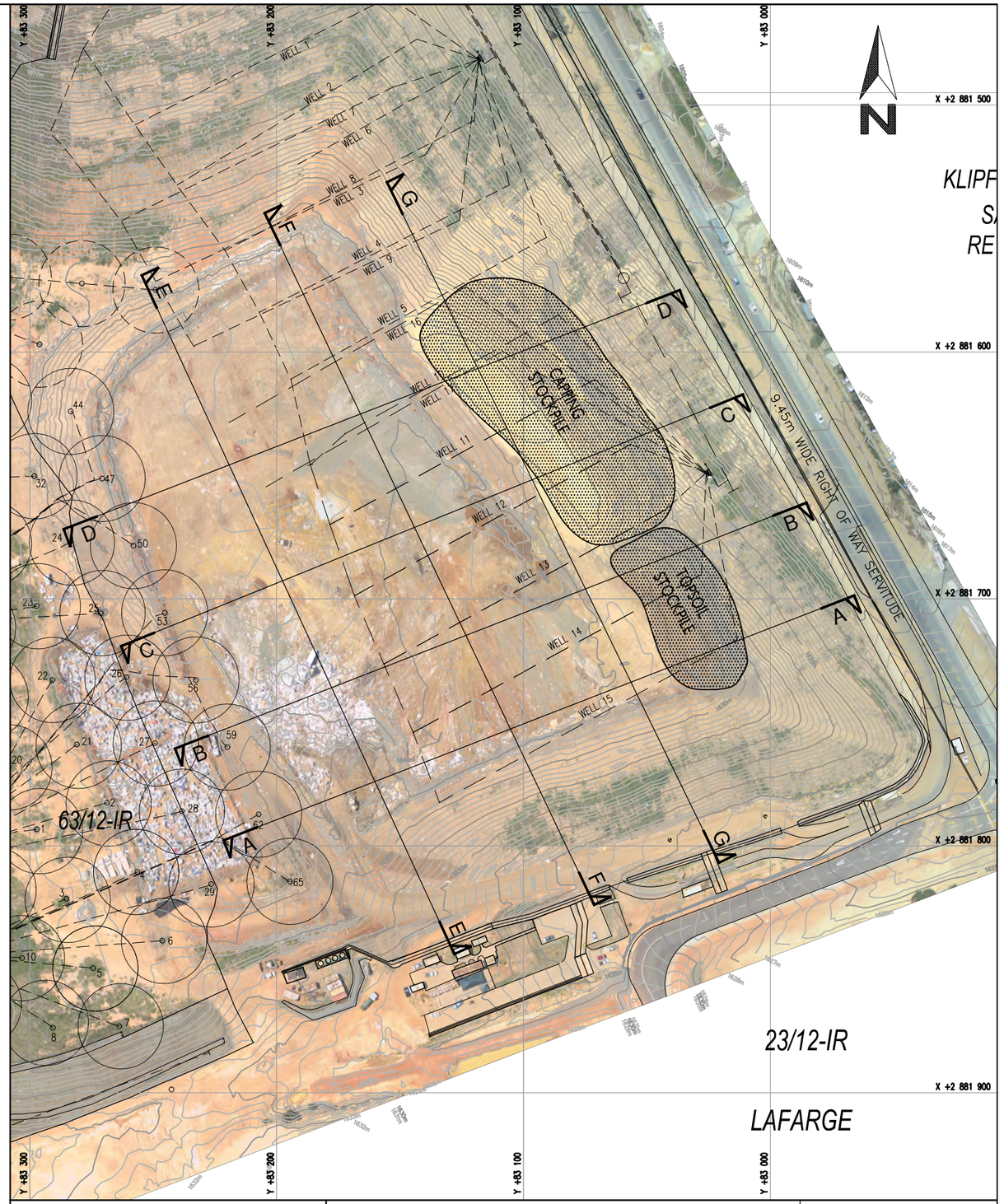




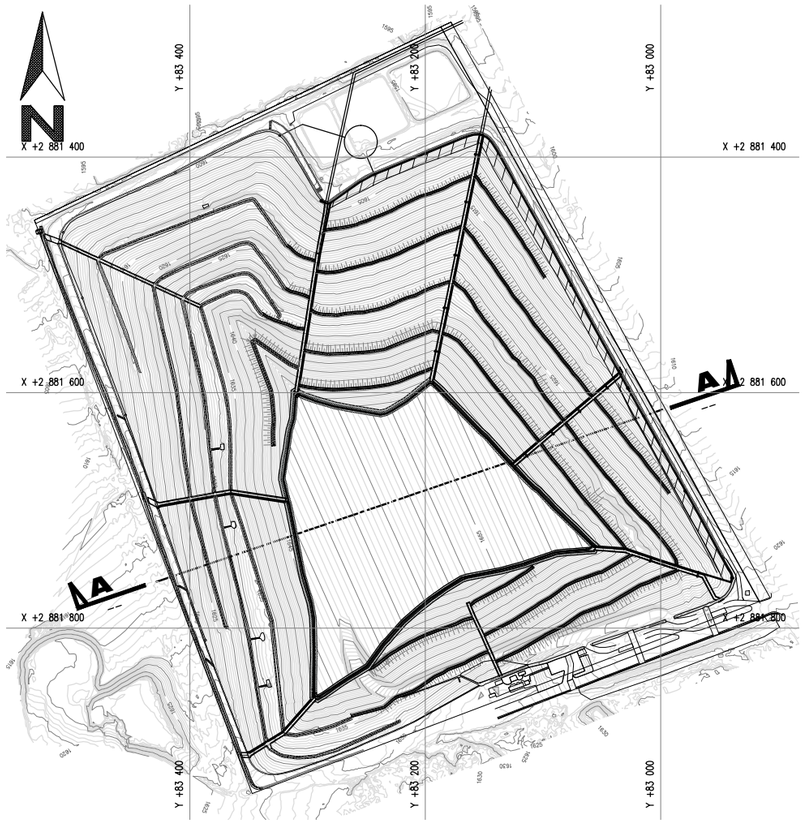








Client	ENVIROSERV WASTE MANAGEMENT	**Jones & Wagener** Engineering & Environmental Consultants P.O. Box 1434 Rivonia 2128 South Africa Tel. +27 (0)11 519-0200 Fax. +27 (0)11 519-0201	Drawing No. **6007 - 08 - F01**
Project	CHLOORKOP WASTE DISPOSAL SITE		
	CURRENT LAND FORM PLAN AND SECTIONS	Pr. Eng. Name –	Pr. Eng. Number –
SCALE	NOT TO SCALE A3	Signed	Date



LAYOUT

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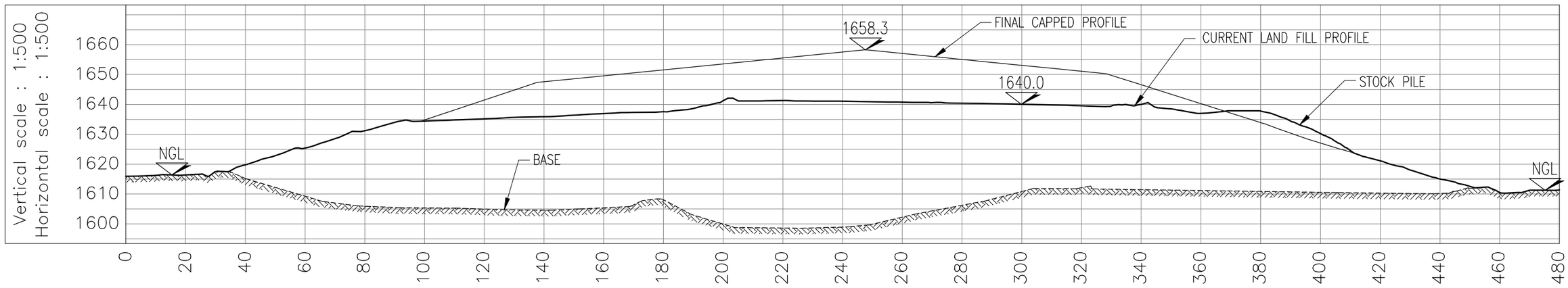

SECTION A–A

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ENVIROSERV WASTE MANAGEMENT
CHLOORKOP WASTE DISPOSAL SITE
LONGITUDINAL SECTION

J & W JOB No. 6007

6007-08-F02

APPENDIX B

GEOSYNTHETIC SERVICE LIFE NOTE

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tel: 00 27 11 519 0200 www.jaws.co.za email: post@jaws.co.za

NOTE

DESCRIPTION	Service life of 1.5mm HDPE geomembrane that meets the GRI-GM 13 specification	JOB NO.	6007/21
FILE NAME	001_LinerServiceLife_Phase1A.docx	DATE	22 August , 2019

Estimated service life of a 1.5mm HDPE geomembrane that meets the GRI-GM 13 specification

The service life of a geomembrane as defined by Rowe (2005) is "the period of time for which an engineered component of a barrier system performs in accordance with the design". Failure of the component is defined as the stage when specific properties of the component reduce to 50% of their original value or half-life. It is related to the durability of the component which in turn is related to the change of critical properties, such as tensile strength, over time.

The durability of a geomembrane is affected by external factors such as exterior chemical effects (e.g. leachate), mechanical loading, heat, moisture change & frost and internal factors such as material or chemical aging.

When geomembranes are effectively protected from external factors it is the internal factors (i.e. chemical aging) that are of most concern in terms of failure.

There are three stages to chemical aging:

1. Depletion time of antioxidants;
2. Induction time to the onset of polymer degradation;
3. Degradation of the polymer to decrease some properties to an arbitrary level (say 50% of original value).

Rowe (2005) stated the following:

> *It is not feasible to measure the length of these stages for actual field conditions because of the long time required to obtain useful results. Consequently, tests are conducted at elevated temperatures to accelerate ageing and the results are extrapolated to temperatures expected at the base of a landfill.*

Although this type of simulation provides answers to researchers in the short term, it requires extensive modelling and laboratory testing in order to provide an estimate on service life. Therefore in order to provide a service life estimate for the geomembrane on site, the values published in literature give the best available information to base the estimate on. These tests are carried out on specific lining systems and in specific conditions and care is required to ensure that the estimate includes a level of conservatism.

Phase 1: Depletion time of antioxidants

Antioxidants are additives that are mixed in with the resin material when the geomembrane is manufactured. The antioxidants are chemical compounds that prevent the oxidation of the geomembrane for a certain length of time thereby increasing the durability and service life of the geomembrane.

The ability of the antioxidant package to resist oxidation is measured by the Oxidation Induction Time (OIT) test (ASTM D3895). GRI-GM13 calls for an OIT of 100min.

The latest simulated geomembrane aging tests to estimate the first stage of chemical aging were carried out by Sangam and Rowe (2002). The results of these tests are summarised by Rowe (2005) and are used in this note for the service life estimate. Their simulation is based on the following:

Liner Setup (from the bottom):

- Unsaturated sand subgrade;
- Geosynthetic Clay Liner;
- 1.5mm HDPE geomembrane liner;
    - Initial OIT of 135 minutes
    - Crystallinity 49%
- Geotextile protection layer;
- Gravel saturated with leachate.

Process

- Samples are placed in baths and maintained at temperatures of 26, 55, 70 and 85°C;
- Test cells are periodically terminated and tested for a decrease in critical properties;
- Leachate is repeatedly replaced.

The simulation is conservative because:

- The simulation assumes that the geomembrane is consistently exposed to leachate;
- The leachate strength remains consistent as the leachate is repeatedly replaced;

Phase 2 and 3: Induction time to the onset of polymer degradation and degradation of the polymer to decrease some properties to an arbitrary level (50%)

At present there is very limited data for the other stages of aging (Rowe 2005). Some studies have been carried out on HDPE pipes and others on exhumed milk bottles from landfill. From the results of these studies Rowe (2005) has provided results of service life for these phases versus different temperatures.

The final result of the estimation of the average service life (all three phases) of the 1.5mm HDPE geomembrane (smooth or textured), as stated by Rowe (2005), is **160 years** for liner temperatures of 35°C.

The average ambient temperature for Chloorkop during December / January is 26°C and 19°C during June / July. The lower temperatures during the year, other than the December/January period, will prolong the service life of the geomembrane in excess of the estimate above.

Effect of temperature on geomembrane service life

High temperatures have a negative effect on the service life of a geomembrane. This was illustrated by Rowe (2005) who stated that the average service life of 1.5mm HDPE geomembrane can reduce from **160 years to 15 years** if the temperature at the liner is increased from 35° to 60°C.

The liner system of the Phase 1A cells will be covered by general waste and therefore exposed to ambient temperatures for a limited period during construction and early operations. It is also not anticipated that elevated temperatures below the waste will occur due to the nature of the waste disposed. No records of temperature at the liner currently exist for the site. Therefore, it is planned to install a temperature monitoring system on the liner of the Phase 1A cells to commence a temperature record.

Until records are available, the conservative estimate of 160 years based on 35°C should be used for the estimate of service life of a 1.5mm HDPE GRI GM13 geomembrane.

References:

Rowe, R. K. (2005*). Long-term performance of contaminant barrier systems.* 45th Rankine Lecture. Geotechnique 55, No. 9, 631–678

Sangam, H. P. & Rowe, R. K. (2002). *Effects of exposure conditions on the depletion of antioxidants from high-density polyethylene (HDPE) geomembranes*. Can. Geotech. J. 39, No. 6, 1221–1230.

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APPENDIX C

PROJECT SPECIFICATION

C3.3: PROJECT SPECIFICATIONS

STATUS

A: GENERAL

PS-1 PROJECT DESCRIPTION
PS-2 DESCRIPTION OF SITE AND ACCESS
PS-3 NATURE OF GROUND AND SUBSOIL CONDITIONS
PS-4 DETAILS OF CONTRACT
PS-5 CONSTRUCTION AND MANAGEMENT REQUIREMENTS
PS-6 DRAWINGS
PS-7 CONSTRUCTION PROGRAMME
PS-8 SITE FACILITIES AVAILABLE
PS-9 SITE FACILITIES REQUIRED
PS-10 FEATURES REQUIRING SPECIAL ATTENTION
PS-11 OCCUPATIONAL HEALTH AND SAFETY
PS-12 ADVERSE WEATHER CONDITIONS
PS-13 SITE INSTRUCTION BOOK AND SITE DIARY
PS-14 DEALING WITH WATER
PS-15 DUST SUPPRESSION
PS-16 SURVEY INFORMATION
PS-17 PROJECT SUPERVISION
PS-18 SUBCONTRACTING

B: AMENDMENTS TO THE STANDARD AND PARTICULAR SPECIFICATIONS

PSA: GENERAL
PSC: SITE CLEARANCE
PSD: EARTHWORKS
PSG: CONCRETE (STRUCTURAL)
PSH: STRUCTURAL STEEL
PASA: GEOSYNTHETIC MATERIALS
PASB: GEOMEMBRANE
PASC: HDPE PIPES

C3.3: PROJECT SPECIFICATIONS

STATUS

The Project Specification, consisting of two parts, forms an integral part of the contract and supplements the Standard Specifications.

Part A contains a short general description of the project works, the site and the requirements to be met.

Part B contains variations, amendments and additions to the Standardized Specifications and, if applicable, the Particular Specifications.

In the event of any discrepancy between a part or parts of the Standardized or Particular Specifications and the Project Specification, the Project Specification shall take precedence. In the event of a discrepancy between the Specifications, (including the Project Specifications) and the drawings and / or the Bill of Quantities, the discrepancy shall be resolved by the Employer's Agent before the execution of the work under the relevant item.

A GENERAL

PS-1 PROJECT DESCRIPTION

EnviroServ Waste Management (Pty) Ltd is in the process of extending the capacity of the Chloorkop landfill site by constructing a northern expansion (Phase 1A) split into three cells.

PS-2 DESCRIPTION OF SITE AND ACCESS

Site description

The landfill was developed in and around a disused quarry that was excavated for weathered granite. The site was first used for the disposal of general waste in 1997.

Site location and access

The Chloorkop Landfill Site is located on Portion 63 of the farm Klipfontein 12IR, District of Kempton Park, Gauteng Province. The northern expansion will be located on Erf 335.

To reach the site, the main access route is along Allendale Road (M18) which ends in a T-junction on Zuurfontein Street (M39). The road going left from this point eventually becomes Andrew Mapheto Street (M38) which heads to Thembisa, going right from the T-junction, Zuurfontein Street heads towards Isando.

Before Zuurfontein street becomes Andre Mapheto Street, there is a left turn onto Modderfontein Road and then a left turn again onto Marsala Road. The current Chloorkop Landfill Site is located on the left of Marsala Road, the entrance is approximately 750m along the road.
Marsala Road ends in a left turn into Anker Street. The Chloorkop Landfill site is positioned on the left of Anker Street.

PS-3 NATURE OF GROUND AND SUBSOIL CONDITIONS

The Chloorkop Landfill Site is located on the Halfway House Granite Suite, also known as the Johannesburg Dome Basement Granites. The granites are not homogenous or uniform and display gneissic banding with foliation that trend in a NW-SE direction and with steep dips. The surficial material consists mainly of residual material derived from the in-situ decomposition of granitic bedrock.

From previous investigations it is evident that medium hard rock granite occurs as shallow as 1.25 to 3m around the site.

PS-4 DETAILS OF CONTRACT

Commercially the Contract will be bound by the General Conditions of Contract for Construction Works, Third Edition, 2015 together with all special Conditions issued at tender stage. Specific details regarding technical issues are given in the project specifications and tender drawings, and as specified in the bill of quantities.

PS-5 CONSTRUCTION AND MANAGEMENT REQUIREMENTS

The Employer's operations will be on-going during construction.

PS-6 DRAWINGS

The reduced scale drawings that form part of the tender documents shall be used only for tender purposes. Only drawings marked "Approved for construction" may be used for the execution of the Contract. It must be noted that certain specifications which may appear on the drawings are not necessarily repeated in the Project Specifications. Where applicable certain items in the Bill of Quantities refer to the drawings.

A list of drawings issued at tender stage is given below:

Drawing number	Drawing title
6007-12-001	General Arrangement
6007-12-002	Phase 1A Landform
6007-12-003	Storm Water Management
6007-12-004	Landfill Development Sections
6007-12-005	Phase 1A Cell 1 – Layout and typical sections
6007-12-006	Contaminated Storm Water Dam
6007-26-002	Access Road Plan, Sections & Details

PS-7 CONSTRUCTION PROGRAMME

The contractor shall include with his tender a preliminary construction programme. The programme shall be in the form of a simplified bar chart with sufficient details (minimum Level 2) to show clearly how the works will be performed within the time for completion as submitted by the contractor in the Schedule of Quantities or covering letter. All tenders shall be based on a best-time best-price basis, bearing in mind the target completion dates as well as any interim target dates communicated at the site inspection meeting.

A detailed construction programme shall be submitted within 14 days after the award of the tender. This construction programme shall conform in all respects to the requirements as stipulated in the General Terms.

When drawing up his programme, the contractor shall, inter alia, take into consideration and make allowance for:

(i) All special non-working days, shut-down periods and breaks defined in the contract data.
(ii) Normal weather conditions and their effects, e.g. repairs/rework, mist delays, etc. Refer to PS-12 for details on adverse weather.
(iii) Known physical conditions and artificial obstructions.
(iv) The accommodation and safeguarding of public traffic.
(v) Dealing with, altering and installing services.
(vi) All other actions required in terms of this contract.

The program shall be submitted in the software stated above and includes the following supporting documentation:

(vii) The number of working hours per day, working days per week, assumed holiday or shut down periods on which the programme is based.

(viii) The overall labour and major plant resource histogram on which the program is based.

(ix) A schedule basis document indicating any other assumptions on which the program is based.

(x) The contractor shall furnish Method Statements for the works and such other details and information as the Employer's Agent may reasonably require to accept the program.

The contractor shall base his initial programme of work on the scope of the work as described in the project specification and the schedule of quantities. This programme shall be reviewed on a regular basis by the contractor in accordance with changing circumstances, delays and amendments to the work ordered by the Employer's Agent as a result of further examinations made by him.

It should be noted that it is in the contractor's best interest to provide a comprehensive programme giving as much information as possible about the times allowed for the various activities as well as resource or other limitations affecting the programme, since the approved programme may be used to evaluate any claims in terms of the general conditions of contract for extensions of time.

PS-7.1 Program update and reporting of progress

The contractor shall submit to the Employer's Agent biweekly progress updates in electronic and hard copies. One of the progress updates will be synchronous with the progress meetings and the submission shall be one working day (i.e. 24 hours) before the meeting. The update shall include and present the following:

(i) The contract program with progress charts and program graphs updated to reflect the actual progress based on the Earned Value measurements to date and a summary of progress on site over the period since the previous site meeting.

(ii) Details of activities running late, indicating what steps have been or will be taken to ensure that the work is completed within the specified time.

(iii) Actual progress shall be recorded by means of actual start and actual finish dates for activities, together with remaining duration of currently incomplete activities. The remaining duration shall be based taking account of anticipated conditions on site, actually achieved productions, availability of recourse and other relevant impacts. Periods of suspension of an activity must be noted in the updated programme.

(iv) Besides the detailed updated program, the contractor shall present a milestone/activity summary which at least includes the following:

a. Milestone/activity name
b. Latest contractual completion date
c. Current and previously reported completion dates
d. Planned and actual percentage completion

Should the contractor fail to submit a program for acceptance as the contractual program, or not regularly update the program, the Employer's Agent shall be entitled to reduce by one quarter the amount due to the contractor in the interim payment certificates until the contractor has complied with its obligations in respect of the program.

PS-8 SITE FACILITIES AVAILABLE

PS-8.1 Contractor's camp site and depot

A position for the Contractor's site camp will be pointed out during the site inspection meeting. The Contractor will be responsible to provide all infrastructure and security required at the site camp.

Since the site camp will be located on the Employer's property the Contractor shall at all times adhere to the health and safety regulations instituted by the Employer as attached in Annexure 1.

PS-8.2 Accommodation of Employees

No employees will be allowed to sleep or be accommodated on the site.

No housing is available for the Contractor's employees and the Contractor shall make his own arrangements to house his employees and to transport them to site.

No informal housing or squatting will be allowed.

Chemical toilets only will be allowed where temporary facilities have to be provided.

PS-8.3 Power supply, water and other services (including ablution facilities)

Unless otherwise stated at the site inspection meeting, the Contractor shall make his own arrangements concerning the supply of electrical power, water and all other services. No direct payment will be made for the provision of electricity, water and other services. The cost thereof shall be deemed to be included in the rates and amounts tendered for the various items of work for which these services are required, or in the Contractor's preliminary and general items as the case may be.

Under no circumstances will pit latrines or septic tanks with soakaways be permitted.

PS-9 SITE FACILITIES REQUIRED

PS-9.1 Temporary offices

The contractor will be required to provide temporary site offices for the duration of the project

Office cleaning and maintenance:

The Contractor shall be responsible to ensure that offices and ablution facilities are kept in a clean and working order throughout the contract.

PS-9.2 Laboratory facilities

The Contractor shall make provision for carrying out of all quality control testing required in terms of the works involved. This shall include, but is not limited to, the following:

- Soil grading analysis from 0.075mm up to 100mm;
- Soil testing for Atterberg limits;
- Soil density testing (nuclear and sand replacement);
- Soil testing for moisture content;
- CBR and compaction testing;
- DCP testing.

The contractor shall either provide a laboratory on site or may make use of approved external laboratories and/or laboratories of other contractors on site subject to the approval of the Employer's Agent.

PS-9.3 Telephone facilities

The contractor shall arrange for his own telephone, fax and e-mail facilities.

PS-9.4 Parking facilities

Parking space must be available at the site office for the Employer and Employer's Agent on days when progress meetings will be held.

PS-9.5 Facilities for the Employer's Agent

One office, minimum 3m x 6m, with the following facilities shall be provided for the Employer's Agent's Representative:

- One main office desk with power point for IT connection;
- One secondary desk for drawings review;
- A minimum of three chairs;
- Air conditioning;
- Cabinet; and
- Drawing rack.

PS-10 FEATURES REQUIRING SPECIAL ATTENTION

PS-10.1 Quality control

PS-10.1.1 Quality Assurance (QA)

The Contractor will be solely responsible for the production of work that complies with the Drawings and Specifications to the satisfaction of the Employer's Agent. To this end it will be the full responsibility of the Contractor to institute an appropriate Quality Assurance (QA) system on site. The Employer's Agent will audit the Contractor's quality assurance (QA) system on a regular basis to verify that adequate independent checks and tests are being carried out and to ensure that the Contractor's own control is sufficient to identify any possible quality problems which could cause a delay or failure. The Contractor shall submit the QA system to the Employer's Agent for approval and the Employer's Agent has to approve the QA system. No construction work will be allowed to commence on site prior to the approval of the Contractor's QA system.

The Contractor shall ensure that efficient supervisory staff, the required transport, instruments, equipment and tools are available to control the quality of his own workmanship in accordance with his QA-system. His attention is drawn to the fact that it is not the duty of the Employer's Agent or the Employer's Agent's representative to act as foreman or surveyor.

PS-10.1.2 Process control

The Contractor shall arrange for all tests required for process control to be done by a laboratory acceptable to and approved by the Employer's Agent.

The Contractor may establish his own laboratory on site or he may employ the services of an independent commercial laboratory. Whatever method is used, the Contractor must submit the results of tests carried out on materials and workmanship when submitting work for acceptance by the Employer's Agent. The costs for these tests shall be deemed to be included in the relevant rates and no additional payment will be made for testing as required.

PS-10.1.3 Acceptance control

The process control test results submitted by the Contractor for approval of materials and workmanship may be used by the Employer's Agent for acceptance control. However, before accepting any work, the Employer's Agent may have further control tests carried out by a laboratory of his choice. The cost of such additional tests will be covered by a provisional sum provided in the bill of quantities, but tests that failed to confirm compliance with the specifications, will be for the account of the Contractor.

PS-10.2 Existing Services

The Contractor shall make himself acquainted with the position of all existing services before any excavation or other work likely to affect the existing services is commenced.

The Contractor will be held responsible for any damage to known existing services caused by or arising out of his operations and any damage shall be made good at his own expense. Damage to unknown services shall be repaired as soon as possible and liability shall be determined on site when such damage should occur.

PS-10.3 Survey beacons

The Contractor shall take special precautions to protect all permanent survey beacons or pegs such as bench-marks, stand boundary pegs and trigonometrical beacons, regardless

whether such beacons or pegs were placed before or during the execution of the Contract. If any such beacons or pegs have been disturbed by the Contractor or his employees, the Contractor shall have them replaced by a registered land surveyor at his own cost. Where survey bench-marks falls within the works the Contractor will be required to replace these bench-marks with alternative bench-marks located outside of the affected works area prior to clearing of the site.

The Contractor shall verify the accuracy of the survey control points indicated and report any concerns, if applicable, to the Employer's Agent prior to commencing with construction.

PS-10.4 Disposal of spoil or surplus material

The Contractor shall dispose all surplus and unsuitable material at sites to be indicated by the Employer on site. Disposal of non-degradable or bio-hazardous waste shall be done at a legal disposal site to be determined by the Contractor and approved by the Employer's Agent. Disposal of general waste shall be in accordance with the Employer's environmental policies / requirements.

PS-10.5 Overhaul

No payment will be made for overhaul on this contract unless provision is made therefore in specific items. Unless otherwise stated the free haul distance shall be taken as 1.0 km measured from the point of loading to the point of disposal/placement along the shortest feasible haul route.

PS-10.6 Security

The Contractor shall provide security watchmen for the Contract as he deems fit at no separate payment item. The external security company used, must be the same company being used by the Employer. All costs for security must therefore be included under the applicable rates or P&G costs. The Contractor must ensure that all his employees, as well as the employees of his subcontractors are able to identify themselves as members of the construction team.

PS-10.7 Supply of diesel

The Contractor shall tender wet rates for all works based on the assumption that he will be responsible for his own supply and storage of diesel unless specifically otherwise indicated at the site inspection meeting.

PS-10.8 Medical Examinations

Medical certificates of fitness will be as required by the OHS Act and related regulations. The costs for these certificates shall be deemed to be included in the bill of quantities and no additional payment will be made for testing as required.

Onsite entry and exit medicals will be required. The Employer will carry the costs of these medicals.

PS-10.9 Electrical Installations

All installations must comply with the latest revision of SABS 0142 "Code of Practice for the Wiring of Premises". To comply with all the requirements of SABS 0142, both design and installation, only authorised electrical equipment and installation techniques are allowed to be used.

On completion of a new or modified installation, the contractor must supply a certificate of compliance duly signed by the relevant accredited person. The owner may require that these tests be witnessed by an Employer representative. Adequate notice of the proposed testing is required by the Employer in order to make the necessary arrangements.

All installations are to comply with the OHS Act.

- The Contractor shall supply the Employer with the name of the accredited person for the electrical installation prior to the commencement of the installation.
- The electrical contractor shall supply the Employer with a copy of the registration

certificate issued by the Electrical Contracting Board or proof of registration.

- The contractor shall submit the required commencement form to the supply Authority as required.

PS-10.10 Confidentiality

All plans, drawings, specifications and photographs and other information obtained by the contractor in connection with the contract or any activity on the site which comes to the knowledge of the contractor shall be held in confidence by the contractor and shall not be used by the contractor for any other purpose other than the performance of the work unless otherwise authorised in writing by the Employer.

The Contractor may not take photographs at the Site without prior written authorisation from the Employer.

The contractor shall be responsible for the observance of the provisions of this clause by its employees, agents, subcontractors and the employees of said subcontractors.

PS-10.11 Rules and Codes

Notwithstanding the other provisions of this contract, the Contractor must adhere to all of the Employers' rules, codes and policies applicable to the Site and the Employer's employees including but not limited to those relating to illegal drugs, alcohol, safety, security and the environment, and ensure that its employees as well as all subcontractors are conversant with and adhere to such rules, codes and policies.

PS-11 OCCUPATIONAL HEALTH AND SAFETY AND ENVIRONMENTAL

PS-11.1 General statement

It is a requirement of this contract that the Contractor shall provide a safe and healthy working environment and to direct all his activities in such a manner that his employees and any other persons, who may be directly affected by his activities, are not exposed to hazards to their health and safety, or that the construction works causes undue damage to the environment. To this end the Contractor shall, with regard to construction, assume full responsibility to conform to all the provisions of the Occupational Health and Safety Act (Act 85 and Amendment Act 181) of 1993, and the Construction Regulations 2014 issued on 07 February 2014 by the Department of Labour.

For the purpose of this contract the Contractor is required to confirm his status as mandatory and employer in his own right for the execution of the contract by entering into an agreement with the Employer in terms of health and safety legislation.

In addition to the requirements listed herewith the Contractor shall ensure that he is familiar with and complies in all respects to any Occupational Health and Safety Requirements, and Environmental Requirements of the Employer as attached in Annexure 1.

PS-11.2 Health and Safety Specifications and Plans to be submitted at tender stage

(a) Employer's Health and Safety Specification

...

...The Employer's Health and Safety Specification are included in Annexure 1 of the tender documents.

(b) Tenderer's Health and Safety Plan

The Tenderer shall submit with his tender his own documented Health and Safety Plan he proposes to implement for the execution of the work under the contract. His Health and Safety Plan must be based on at least the following principles:

(i) .a proper risk assessment of the works;

(ii) .pro-active identification of potential hazards and unsafe working conditions;

(iii)..provision of a safe working environment and equipment;

(iv) .health and safety of subcontractors, employees and visitors to the site, including safety training in hazards and risk areas;

(v) ..monitoring health and safety on the site of works on a regular basis, and keeping of records and registers as provided for in the Construction Regulations;

The Tenderer's Health and Safety Plan shall cover at least the following:

- Statement of methods to ensure the approval, implementation and maintenance of all health and safety aspects regarding subcontractors in terms of the Construction Regulations 2014;
- Details of the Construction Manager, Construction Supervisor, the Construction Safety Officers and other competent persons he intends to appoint for the construction works in terms of Regulation 8 and other applicable regulations;
- Details of risk assessment and risk items, work methods and procedures, and all requirements in terms of the Construction Regulations 2014; and
- Details of methods to ensure that his Health and Safety Plan is carried out effectively in accordance with the Construction Regulations 2014.

The Contractor's Health and Safety Plan will be subject to approval by the Employer before commencement of construction work. The Contractor will not be allowed to commence work, or his work will be suspended if he had already commenced work, before he has obtained the Employer's written approval of his Health and Safety Plan.

Time lost due to delayed commencement or suspension of the work, shall not be used as a reason to claim for extension of time or standing time and the related costs.

PS-11.3 Environmental requirements

The Tenderer shall familiarise himself with the Environmental Requirements of the Employer.

PS-11.4 Cost of compliance with all Statutory and Employer's health and Safety and Environmental Requirements

Separate items have been scheduled for the Contractor's Fixed and Time related costs of conforming to all Statutory and Employer's requirements. Should the Contractor not submit prices for the separate items, the rates and prices tendered by the Contractor shall be deemed to include all costs for conforming to the requirements of the Act, the Construction Regulations and the Employer's Health and Safety Specification and Environmental Requirements as applicable to this Contract. Should the Contractor fail to comply with the provisions of the Construction Regulations or other legal obligations, he will in addition to being instructed to comply, be liable for penalties that may be applicable.

PS-12 ADVERSE WEATHER CONDITIONS

No extension of time will be granted for delays arising out of normal unfavourable weather conditions. Where abnormal rainfall is experienced, an extension or reduction of contract period shall be granted, as agreed by the Employer's Agent. Extension of time arising from abnormal rainfall shall be calculated separately for each calendar month or part thereof in accordance with the formula below. Extensions of time for part of a month shall be calculated using pro-rata values of Nn and Rn. It shall be calculated for the whole period of completion of the contract including any extensions thereof, but excluding the annual builder's holiday.

$$V = (N_w - N_n) + \left(\frac{R_w - R_n}{20} \right)$$

If V is negative and its absolute value exceeds Nn then V shall be taken as equal to minus Nn.

The symbols shall have the following meanings:

V = Extension of time in calendar days in respect of the calendar month under consideration.

Nw = Actual number of days during the calendar month on which a rainfall of 10mm or more has been recorded.

Nn = Average number of days, as derived from existing rainfall records, on which a rainfall of 10mm or more has been recorded for the calendar month.

Rw = Actual rainfall in mm recorded for the calendar month under consideration.

Rn = Average rainfall in mm for the calendar month as derived from existing rainfall records.

The total extension of time shall be the algebraic sum of all monthly totals for the period under consideration, but if that total is negative, the time for completion shall not be reduced due to abnormal rainfall.

This formula does not take account of flood damage, which could cause further or concurrent delays and should be treated separately as far as extension of time is concerned.

The factor (Nw - Nn) shall be considered to represent a fair allowance for variations from the average number of days during which rainfall exceeds 10mm. The factor (Rw–Rn)/20 shall be considered to represent a fair allowance for the variations from the average in number of days during which the rainfall did not exceed 10mm, but wet conditions prevented or disrupted work.

Where work is being carried out under cover or not affected by abnormal rainfall, or not on the critical path progress of construction, extension of time will not be granted in terms of this formula.

Information on the available rainfall records are given below. These are the most accurate measurements available and shall be regarded as the base data, unless other figures are agreed upon prior to the commencement of construction.

Source of information - Weather Bureau, Pretoria. Climate Statistics up to 1984, WB40, 1988.

Rainfall Measurement Station – OR Tambo International Airport.

MONTH	Nn	Rn (mm)
January	4.4	125
February	3.7	90
March	3.6	91
April	2.0	54
May	0.4	13
June	0.3	9
July	0.1	4
August	0.1	6
September	1.0	27
October	2.5	72
November	4.9	117
December	3.9	105
Annual Average	26.9	713

Accurate rainfall measurements shall be obtained from readings taken on site.

Should an extension of time be granted by the Employer's Agent, the Contractor shall be reimbursed for his relevant Time Related Preliminary and General items contained in the Schedule of Quantities. The amount of reimbursement shall be calculated as follows:"

$$\frac{No.of\ days Extension Of\ Time granted}{Total\ No.of\ calendar days in Contract\ period} \times Total Value of\ \text{Re}\ levant Time related P\ \&\ G Rates$$

Calculation of reimbursement shall be done in calendar days taking into account special non-working days, public holidays and the contractor's break over December/January.

All work that can continue on site is to be recorded in the daily site diary and will be used when assessing the percentage of the standing time that can be claimed for the specific day.

PS-13 SITE INSTRUCTION BOOK AND SITE DIARY

A triplicate book for site instructions, provided by the Employer's Agent, shall at all times be kept on site. All instructions to the Contractor will also be recorded in this site instruction book. All site instructions to be signed by the Employer's Agent or his representative and the Employer.

A site diary will be provided by the Contractor, which will be completed each day and shall be kept on site at all times.

PS-14 DEALING WITH WATER

The Contractor shall be responsible for handling all surface and sub-surface water in such a way that construction can proceed with minimum of cost and at no time shall normal drainage flows be blocked.

The Contractor shall also take particular care to ensure the safety of the works against damage by flooding.

An item has been included in the bill of quantities for dewatering of the works.

PS-15 DUST SUPPRESSION

All working surfaces and haul roads shall be wetted regularly so as to keep the creation of dust to a minimum. To this end the contractor shall have an operational water cart on site at all times.

PS 16 SURVEY INFORMATION

The Contractor is to provide the Employer's Agent with survey information of the Natural Ground Levels before any construction commences as well as as-built surveys at the end of construction. The survey information is to be according to the National LO co-ordinate grid system and is to be provided in digital format (either YXZ format or preferably in Model Maker file system ver. 7 or above).

The following survey information is required in order to approve construction works executed. This list is intended to give an indication of some of the survey work required, and is not intended to be an exhaustive list of all the surveys that will be required.

- Detailed pre-construction survey clearly showing natural ground level where applicable, and toe and crest lines of existing embankments and excavations for the bulk earthworks phase (for all works)
- Detailed bottom of excavation survey, before placement of any layerworks, clearly showing toe and crest lines of the basin excavation and embankment walls (for all works).
- Survey of invert level of subsoil and leachate collection collector and outlet pipes to verify falls and length of pipes installed.
- Survey of invert levels of existing pipes to be diverted.
- Detailed survey of final HDPE liner surface, clearly showing toe and crest lines of the final cell.

- As-built surveys of the bottom and top of Compacted Clay Liners to verify liner thickness, as well as of the final surface of the leachate collection layer is also required.
- Additional surveys to verify certificate quantities may be requested by the Employer's Agent.

Final As-Built survey information must be given to the Employer's Agent in the same format as what the setting out was given in the drawings. The final certificate will not be processed before this survey information has been evaluated and the final quantities within verified using a DTM package.

Cost of all required survey shall be included in the rates.

PS 17 PROJECT SUPERVISION

The Contractor must submit for evaluation, together with his tender, a site organogram showing the level of site supervision proposed. Such organogram shall show the number of contract managers, site agents and foreman, as well as their percentage of time on site for the duration of the project, 100% being full time.

The Contractor must allow for the MINIMUM level of site supervision in his establishment costs indicated below:

Site Agent – 100% on site for duration of the project.

The Contactor is to provide CV's of the proposed Contracts Manager and Site Agents. The site agents must remain at their allocated site for the duration of the project.

PS 18 SUBCONTRACTING

PS 18.1 Selection of sub-contractors in consultation with the Employer

The contractual relationship between the Contractor and the Sub-contractor selected by the Contractor, in consultation with the Employer, in accordance with the requirements of and a procedure set out in the Scope of Work, here-in after referred to as the Nominated Sub-Contractor, shall be the same as if the contractor had appointed the Nominated Sub-contractor.

PS 18.2 Nominated Sub-Contract work

The supply and installation of the geomembranes shall be carried out by a Nominated Sub-Contractor who shall sub-contract to the Contractor.

PS 18.3 Project responsibility

The project as a whole shall remain the responsibility of the Contractor until a certificate of completion has been issued by the Employer's Agent. At no time may the Contractor defer responsibility of the entire project to any of the Nominated Sub-contractors.

B: AMENDMENTS TO THE STANDARD AND PARTICULAR SPECIFICATIONS

INTRODUCTION

In certain clauses the standard, standardized and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in this part of the project specifications. It also contains additional specifications required for this particular contract.

The number of each clause and each payment item in this part of the project specifications consists of the prefix PS followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications. The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and which is included here, is also prefixed by PS, but followed by a new number which follows on the last clause or item number used in the relevant section of the standard specifications.

PSA: GENERAL (SANS 1200A)

PSA 1 APPLICATION (Clause 2.1)

The provisions of this specification are to be read in conjunction with the Special Conditions of Contract. Where the Special Conditions conflict with this specification, the Conditions of Contract shall prevail.

PSA 2 PLANT (Clause 4)

PSA 2.1 Add the following clause:

"4.3 Contractor's Construction Plant

If during the course of the Contract, the Employer's Agent or the Employer's Agent's Representative considers that any item or items of construction plant are in any way inefficient or inadequate to complete the works within the contract period, or do not meet the required safety standards, he shall have the right to call on the Contractor to either:

(a) put the construction plant in order, or

(b) remove such construction plant and replace it with other efficient and/or safe plant, or

(c) provide additional similar plant or plant of greater capacity.

The Employer shall have the right to stop all or part of the works where construction plant not complying with required safety standards is being used until such time as the plant has been made safe or replaced with approved plant.

No additional payment will be made to the Contractor for expenses incurred in complying with any or all of the above."

PSA 2.2 Laboratory Facilities (Clause 7.2)

The following sub-clause shall be added to this clause:

Should the contractor provide a laboratory on site the following shall apply:

The Contractor shall provide a laboratory with sufficient suitable equipment to carry out all routine tests required by the specifications and for carrying out any other tests which he may

deem necessary for the proper quality control of the works.

Where specialised equipment for carrying out the tests referred to above is required, the Contractor may make arrangements for carrying out the tests with a commercial laboratory approved by the Employer's Agent.

The Contractor's laboratory shall be staffed by experienced technicians conversant with the methods to be used for carrying out the routine tests.

If in the opinion of the Employer's Agent, the Contractor's laboratory is inadequately equipped or the standard of expertise of the technicians is unsatisfactory, then the Employer's Agent shall have the right to order the Contractor to cease work until such time as the Employer's Agent is satisfied that these deficiencies have been rectified. The cost resulting from such stoppage shall be to the Contractor's account.

The laboratory and equipment shall be made available to the Employer's Agent for the purpose of carrying out check tests on materials and construction. The costs attendant on making the laboratory facilities available to the Employer's Agent shall be included in the Contractor's tendered prices.

PSA 3 CONSTRUCTION

PSA 3.1 Watching, Barricading, Lighting and Traffic Crossings (Clause 5.2)

Further to the provisions of this clause, every excavation which is accessible to the public, including other contractor's or the Employer's personnel, or which is adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered shall be:

(a) protected by a barrier or fence consisting of not less than two ropes, or wires, stretched at heights of 600 mm and 1 200 mm between poles or standards, of strength adequate to safely contain pedestrians and as close to the excavation as practicable; and

(b) provided with red warning lights, or other boundary indicators, which are clearly visible at night, or when visibility is poor.

The Contractor shall so arrange his work that flow of the Employer's vehicular and pedestrian traffic can be maintained at all times. In this respect, it may be necessary that culverts and pipes be constructed in sections.

PSA 3.2 Protection of Overhead and Underground Services (Clause 5.4)

Further to the provisions of this sub-clause, the Contractor shall before commencing work, arrange with the Employer's Agent or the Employer to point out any underground or overhead services which may be affected by construction activities. Where necessary the Contractor shall excavate trenches by hand under direction of the Employer's Agent or Employer to establish the exact location of services. The Contractor shall be solely responsible throughout the contract period for the safety and protection of services. Repair of known services damaged by the Contractor shall be to his account. Any deviation of services affected by construction, whether carried out by the Contractor or other authority will be paid for by the Employer.

PSA 3.3 Pollution (Clause 5.6)

The Contractor shall provide adequate containers with lids for the disposal of refuse. Containers shall be provided at the accommodation site for employees and at the site office. Refuse and construction waste shall be collected and dumped by the Contractor at locations approved by the Employer's Agent. The Contractor shall ensure that his employees do not pollute any work areas with refuse.

PSC SITE CLEARANCE (SANS 1200C)

PSC 1 DISPOSAL OF MATERIAL (Clause 3.1)

Material resulting from clearing site and surplus excavated material shall be removed to a designated on-site spoil area. Under no circumstances will the burning of combustible material be permitted.

PSC 2 CONSERVATION OF TOPSOIL (Clause 5.6)

Where overburden or material resulting from site clearance is acceptable for use as topsoil, it shall be stockpiled adjacent to the site from which it is stripped for later use on embankment slopes and elsewhere where topsoil is specified or required.

PSD EARTHWORKS (SANS 1200D)

PSD 1 EMBANKMENTS AND FILL (Clause 5.3.2.1)

PSD 1.1 Construction

Cut and fill construction of embankments shall be to the lines and grades established on the drawings, or as modified in the field by the Employer's Agent. Fill embankments shall be constructed in layers not exceeding 150 mm after being compacted.

The fill shall be compacted to 95% Mod. AASHTO at a moisture content of between -2% and +2% of optimum moisture content. The compacted surface of any layer is to be scarified and wetted before any new layer is placed, if said layer is too dry or smooth to bond with the subsequent lift.

PSD 1.2 Sources

Soil material for the construction of embankment or berm fill is to be obtained from excavation or the stockpile area on site, within 1 km freehaul, in the area indicated by the Employer's Agent.

PSD 1.3 Spoil

Excess cut material to be spoiled in a designated stockpile area.

PSD 2 COMPACTED PRIMARY LINER

PSD 2.1 Material

The primary liner of the landfill shall consist of compacted clay sourced from the stockpile or from commercial source, and is to be constructed to the lines and the grades shown on the drawings. The clay shall have a maximum permeability of 1×10^{-6} cm/s when compacted to a density of 98% of maximum dry density according to the Standard Proctor density test (ASTM D698-07) with a moisture content of between +1% and +3% of optimum moisture content.

The clay used in the liners shall conform to the following physical properties:

PROPERTY	MAXIMUM	MINIMUM
Liquid Limit (LL)	100	20
Plasticity Index (PI)	50	7
% Fines (75 µm)	n/a	30
% Clay (2 µm)	40	15
Particle size (mm)	4.75	n/a
Activity (PI / % Clay)	n/a	0.35

The material shall be free from any stones or concretions larger than 5 mm. The Employer's Agent shall approve the material prior to construction of the Primary liner. The top layer of the

clay liners shall be graded and compacted using a smooth drum roller where it needs to be prepared for the placing of the geomembrane and shall be finished such that no gap greater than 30mm can be measured beneath a 3m straight edge. The finished surface must have no discontinuities on surface, no dry areas and no cracks present.

PSD 2.2 Sources

The material for the liners shall be selected material obtained from the stockpile on site within 1 km freehaul, or from commercial source. The Employer's Agent shall approve the material prior to it being used for construction.

PSD 3 COMPACTION TESTS

Specification on taking and testing of samples:

- Density control shall be either by the sand replacement method or by an approved nuclear density meter. The use of the nuclear density meter will be subject to the following provisions:
- The test will not be valid if performed within 1 m of concrete structures or in a confined space of width less than 2 m.
- For each 10 nuclear density meter tests carried out on the embankments, a minimum of 1 corresponding sand replacement test shall be performed.
- The accuracy of any nuclear density meter shall be proved by performing at least five comparative nuclear density and sand replacement tests on each type of soil used in the embankment before the results of the nuclear density meter will be accepted as valid. Thereafter the correlation between the nuclear density meter and sand replacement tests shall be reviewed on a fortnightly basis.
- Each nuclear density meter shall be required to have a certificate provided by the supplier of the machine stating that the machine is in good working order. Each density meter shall be re-calibrated by the supplier at least once a year. Certificates of proof of re-calibration will be required.

In the event of disagreement on the quality of compaction, results of sand replacement tests shall be accepted in preference to nuclear density meter test results.

PSD 3.1 Embankments, Fill and Compacted Primary Liner

The minimum testing frequency on field density and OMC that will be required from the Contractor shall be one test per 300 cubic meter or part thereof with a minimum of 4 tests per production lot.

A production lot shall be taken to mean a portion of fill in a particular zone of the embankment placed and compacted in one process, using material from a single zone in the excavation. If production continues uninterrupted, a production lot will usually be taken as the product of one day's work and shall not exceed two days production. A production lot of reduced quantity will be assumed, if:

- the fill material being used shows abnormal variation in quality,
- an area is obviously of lesser quality than the rest,
- a very high production rate is maintained.

Density tests shall be carried out within twenty four (24)hours of completion of compaction on the particular layer concerned. The results thereof shall be submitted to the Employer's Agent without delay, in any case not later than 24 hours after these become available.

The acceptance criteria for density test results for fill and in-situ compaction shall be as follows:

Specified Density	Minimum Average Density for Number of Tests	Minimum Value of any Single Test in a lot of:

% of STD	4	5	6	7	8	9+	4	5	6	7	8	9+
93	93.1	93.4	93.6	93.7	93.9	94.0	89.4	89.2	89.0	88.9	88.8	88.7
95	95.1	95.4	95.6	95.7	95.9	96.0	91.4	91.2	91.0	90.9	90.8	90.7
98	98.1	98.4	98.6	98.7	98.9	99.0	94.4	94.2	94.0	93.9	93.8	93.7

PSD-5.2 METHODS AND PROCEDURES

Add the following:

PSD 5.2.3.3 Compacted Clay Layers Construction

CCLs must be constructed in layers as specified on the drawings. The Contractor may not construct fewer, thicker layers than are specified, as this may increase seepage paths through the overall CCL. Clay liner layer thickness specified indicates the minimum compacted thickness of each layer.

The clay liner layers are to be compacted with a padfoot roller (minimum pad depth of 50mm) to allow adequate kneading and remoulding of the material.. Areas, such as haul truck tracks and smooth drum compacted surfaces, not on the final layer, shall be made rough by scarifying 25mm deep and wetted prior to placement of subsequent layers.

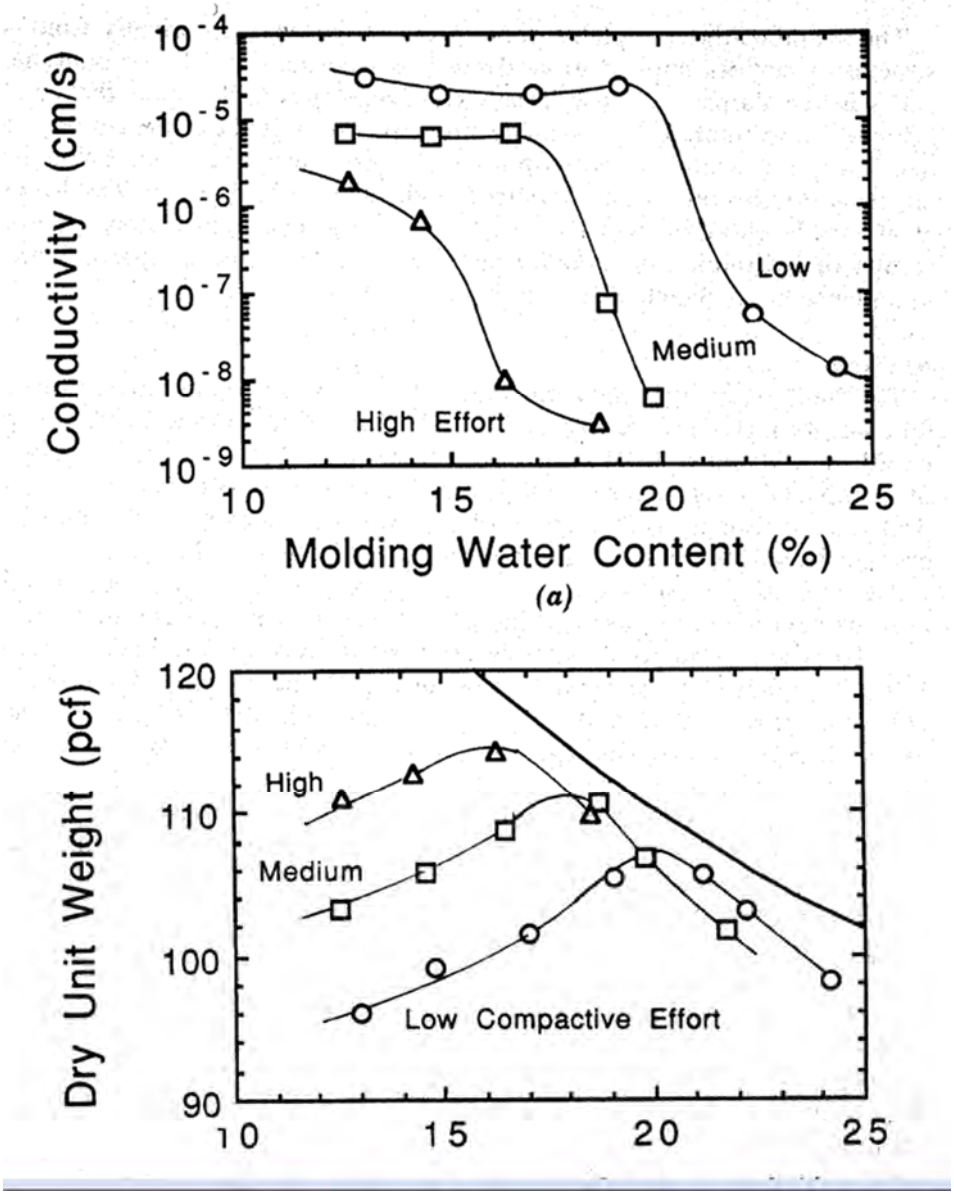
The top layer of the clay liners shall be scarified, wetted, graded and compacted using a smooth drum roller where it needs to be prepared for the placing of the geomembrane and shall be finished such that no gap greater than 30mm can be measured beneath a 3m straight edge. The finished surface must have no discontinuities on surface or abrupt changes in falls or alignments greater than 3mm and no dry areas. The final surface should provide direct and intimate contact with the HDPE liner.

No loose material or loose patches will be accepted on the final clay surface as this will prevent direct and intimate contact with the HDPE. If loose areas are to be repaired, it shall be done with similar or finer material at the moisture content as specified on the drawings and the material must be compacted, subsequent to scarifying and wetting the base material, such that is bonds with the surrounding soil and remains bonded if the surface starts to dry out.

No cracking of the clay is allowed that does not completely close-up and remains so when re-hydration takes place. These cracks should disappear after the geomembrane is placed and will be evaluated by the Employer's Agent as clay behaviour is site specific. Cracks that unravel and/or fill with debris or any other foreign matter that will not allow close-up after re-hydration is therefore not acceptable.

The permeability of layers is very dependent on compacting the material wet of optimum moisture content, typically +1 to +3 % of OMC. The layer must also not be allowed to desiccate subsequent to compaction and prior to covering with the next layer. Desiccation will result in a reduction of moisture content, and in extreme cases desiccation cracking and shrinkage, both of which have an adverse effect on the permeability. If the contractor cannot cover the layer within a suitable time, either with the subsequent layer, or for the final layer with the geomembrane, then allowance must be made in the rates for a sprinkler system used in combination with a thin movable plastic sheeting to maintain the design moisture content specification.

The contractor is to provide, along with his CQA plan, a detailed method statement of maintaining the liner moisture. Such a system must have an application rate that doesn't result in the formation of pools on the layer and doesn't result in the formation of erosion gulleys. The importance of compacting wet of optimum is illustrated in the graphs from Daniel and Benson (1990) ''Influence of clods on hydraulic conductivity of compacted clay.'' J. Geotech. Engrg., ASCE, 116(8), 1231–1248 below.



Illustrative photographs of acceptable CCL surface to accept geomembrane liner are included below. Large particles must be compacted into the surface so as not to protrude and should be removed if they break up during compaction. Large particles which could cause damage to the liner when the surrounding soil settles should also be removed. The Employer's Agent will identify the particle size of concern. The voids created in the layer by the removal of any large particles should be repaired by scarifying and wetting the clay surface and compacting material into the void ensuring the material bonds with the surrounding material.

PSG CONCRETE (Structural) (SANS 1200G)

PSG 1 SUB-CLAUSE 3.2.1

Cement shall be CEM 1 - 42.5 (Current SANS 1200 equivalent - Ordinary Portland Cement only). Blends may be submitted as alternatives, for the Employer's Agents' approval.

PSG 2 SUB-CLAUSE 3.2.3 STORAGE OF CEMENT (Add)

Cement shall not be kept in storage for longer than three months without the Employer's Agent's permission.

PSG 3 SUB-CLAUSE 3.4

The maximum size of the coarse aggregate shall be 20mm unless otherwise indicated on the drawings.

PSG 4 SUB-CLAUSE 3.5.1

Admixtures will not be permitted without written approval.

PSG 5 SUB-CLAUSE 3.5.2

An air entraining agent will not be permitted.

PSG 6 SUB-CLAUSE 3.6

Mild steel: Type A.
High tensile reinforcement shall be type C or D class 2, grade 1.

PSG 7 SUB-CLAUSE 3.9 SEALANTS (Additional Clause)

Polysulphide sealants shall be two part polysulphides complying with the requirements of SANS 110.

PSG 8 SUB-CLAUSE 5.1.2

Welding shall not be permitted.

PSG 9 SUB-CLAUSE 5.2.1

20mm x 20mm rebates or fillets are to be provided at all corners of concrete work unless stated otherwise on the drawings.

PSG 10 SUB-CLAUSE 5.2.5.6 CONSTRUCTION LOADS (Additional Sub-clause)

The Contractor shall not impose any construction loads which over stress the ground slabs, slabs or beams, allowing for the age of the concrete at the time of loading and the design loads as shown on the drawings. Where necessary, propping shall be carried through more than one floor with the props placed vertically above each other through the required floors.

PSG 11 SUB-CLAUSE 5.5.1.5

The minimum cement content and minimum cement/water ratio shall be:

- 300kg/m^3 and 1.5 for unreinforced concrete
- 340kg/m^3 and 1.7 for reinforced concrete
- 400kg/m^3 and 2.0 for pre-stressed concrete and for concrete of strength greater than or equal to Grade 40MPa.

PSG 12 STRENGTH CONCRETE (Additional)

The requirements for the various grades of concrete specified on the drawings are listed below:

Concrete Grade	Specified Concrete Strength MPa	Maximum Nominal Size Coarse Aggregate mm
10/19	10	19
25/19	25	19
30/19	30	19

PSG 13 APPROVAL OF STRENGTH MIXES (Additional Sub-clause)

Not less than two weeks before the start of any concrete work on the site, the Contractor shall submit to the Employer's Agent, for his information and subject to his approval, a statement of mix proportions. This statement shall provide the following information:

For each class of concrete:

- Mix proportions and types,
- Slump,
- Target strength.

For all concrete:
Method to be adopted for adjusting the amount of water added, to compensate for variation in moisture content of the aggregate.

The statement shall be accompanied by evidence in the form of either a statement from an approved laboratory of the results of trial mixes, or an authoritative report previous use and experience, establishing that concrete made with the materials in the proportions proposed will have the properties specified.

PSG 14 SUB-CLAUSE 5.5.3.2

PSG 14.1 Testing

Test results obtained by a ready mix production facility as part of its quality control system will not be acceptable for evaluation in terms of 7.3. All concrete shall be sampled at the point of placing and test cubes made in accordance with the relevant methods.

PSG 15 SUB-CLAUSE 5.5.5.1

Concrete may not be placed before the Employer's Agent's approval has been given in writing and a minimum written notice of 24 hours prior to pouring is required for each part of the structure.

PSG 16 SUB-CLAUSE 5.5.7

All kickers are to be cast monolithically with the base element. All joints are to be scabbled to remove laitance to expose stone aggregate.

PSG 17 SUB-CLAUSE 5.5.8

The method of curing and protection shall be to the Employer's Agent's approval.

PSG 18 SUB-CLAUSE 5.5.10

Unless otherwise noted all exposed unformed surfaces are to have a wood-float finish.

PSG 19 SUB-CLAUSE 5.5.13

Unless otherwise specified, the compressive strength of 50mm mortar cubes of grout shall not be less than 30 MPa at 7 days and 40 MPa at 28 days. Grout shall be completely free of calcium chloride. It shall be used in the semi-dry state, where the water/cement ratio does not exceed 0,4.

Where the space to be filled is inaccessible and/or where directed by the Employer's Agent non shrink liquid grout shall be used.

All approved proprietary grouts shall be used in accordance with the manufacturer's or Employer's Agent's instructions.

Unless specifically noted the grout shall not extend above the underside the base plate.

PSG 20 SUB-CLAUSE 7.3

Where more than three valid test results for a particular grade of concrete become available

the average strength of all the available results for the grade shall not be less than the required average strength given below. If the average strength is less than that given below the mix design shall be adjusted to ensure compliance with the required average strength.

(Refer to clause 14.3.3 of SANS 0100 - 2)

No. of Sets (of three test cubes)	Required Average Strength
4	Specified strength + 3,0 MPa
5	Specified strength + 4,5 MPa
6	Specified strength + 5,0 MPa
10	Specified strength + 6,0 MPa
20	Specified strength + 7,0 MPa
30 or more	Specified strength + 8,0 MPa

PSH STRUCTURAL STEEL (SANS 1200H)

PSH 1 SUB-CLAUSE 3.1

Unless noted otherwise, all steelwork shall be Grade 300WA.

PSH 2 SUB-CLAUSE 3.3

Cold-rolled hollow steel section profiles shall conform to the design requirements of SANS 0162. The manufacturer shall supply sufficient test certificates to establish that the minimum yield strength of cold formed sections after forming is greater than 230 MPa.

PSH 3 SUB-CLAUSE 5.1.2

The Contractor shall prepare all shop drawings including marking plans. He shall provide material lists for all the work indicating part number, detailed drawing number and arrangement drawing number. Two prints of all shop drawings (including marking plans) must be submitted for approval by the Employer's Agent. The design drawings will be issued to the contractor on commencement of the project.

PSH 4 SUB-CLAUSE 5.2.3

Where it is necessary to flame cut plates, edges of plates shall be ground smooth.

PSH 5 SUB-CLAUSE 5.2.4

Flame cutting of holes will in general not be permitted. Where permission is given in writing, the hole shall be burnt to a diameter at least 5mm smaller than the required diameter and then reamed to the correct size.

PSH 6 SUB-CLAUSE 5.2.6

All structural hollow sections shall be sealed against the ingress of moisture. All holes through structural hollow sections shall be fitted with spacer sleeves welded into position. The minimum wall thickness of the sleeve shall be 2mm.

PSH 7 SUB-CLAUSE 5.3

Shop connections shall be welded wherever possible.

PSH 8 SUB-CLAUSE 5.3.4

Welders must show evidence of having passed the appropriate tests in SANS 044.

PSH 9 SUB-CLAUSE 5.3.8

Steelwork shall be marked with the item number, general arrangement drawing number and order number by both hard stamping (10mm letter size) and by means of waterproof paint. The hard stamping shall be ringed with white paint.

PSH 10 SUB-CLAUSE 5.3.9

Protective treatment shall comply with the requirements of SANS 1200 HC and the relevant project specification clauses.

PSH 11 SUB-CLAUSE 5.5.1

Erection procedures are to be submitted for approval.

PSH 12 SUB-CLAUSE 5.5.6

Expansion bolts and chemical anchor bolts for fixing steelwork to concrete elements shall be installed in accordance with the manufacturer's recommendations for hole diameter, depth of embedment and tightening torque.

PSH 13 SUB-CLAUSE 7.2

The Contractor shall advise the Employer's Agent as soon as materials and fabricated parts are ready for inspection. The Employer's Agent may require that portions of the work be reassembled at the fabricator's works to check the accuracy of the work.

PSH 14 SUB-CLAUSE 7.3

The Contractor may be required to carry out non-destructive tests on the welds, including but not limited to the Dye Penetration test.

PSH 15 SUB-CLAUSE 8.3.1.2

The rate shall also cover the cost of supplying grade 4.6 and grade 8.8 bolts including nuts and flat and/or tapered washers, the mass of which will not be measured.

PSME CEMENT STABILISED MATERIAL

PSME 3.2.1 e) Replace 0.75 MPa with 1 MPa

Add the following item:

PSME 4.5 Only plant that will not risk damaging geomembrane layers below the cemented layer may be used if applicable.

PSME 5.4.4 Compaction requirements are defined on the drawings or nominal compaction is required.

PSME 5.5.1 The rate of application of cement is defined on the drawings or must be established in terms of 7.3.1.

Add the following after PSME 5.5.4.1

For cement stabilised material the soil, cement and water shall be mixed until an even colour is obtained without any visible streaks of cement or wet patches.

The size of the soil cement batches mixed will be such that all the material can be placed and compacted within two hours from time when the cement comes in contact with the soil. Compaction shall start 45-60min after the cement comes in contact with the soil.

Placement will be done early mornings and late afternoon when the membrane liners are smooth without any folds due to heat expansion as defined by the Employer's Agent's representative on site.

The final compacted depth of the soil cement shall be measured within 4 hours of compaction to prevent break out of soil cement already set.

Change PSME 5.5.6 To the following:

The compacted material will be covered immediately as placement progress and cured for at least seven days.

Change 7.2.1 To the following:

The following set of testing is required per daily production lot:

- One density test
- One indicator test (grading analysis and Atterberg limits)
- One UCS test
- One binder content test

Upon receiving test results that show consistently that the specification has been achieved, the Employer's Agent may reduce the frequency of testing to a minimum of one set of tests per 10 daily production lots.

PASA GEOSYNTHETIC MATERIALS

PASA 1 SCOPE

This specification covers the materials and workmanship of all the geosynthetic materials required for Cell7 at the Chloorkop Landfill Site.

PASA 2 INTERPRETATIONS

PASA 2.1 SUPPORTING SPECIFICATIONS

- GRI GTI 12(a) : Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials
- GRI GTI 13(a) : Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

PASA 2.2 DEFINITIONS

Refer supporting definitions, additional definitions are:

Geosynthetic: A planar, polymeric (synthetic or natural) material used in conjunction with soil/rock and/or any other geotechnical material in civil Employer's Agenting applications.

Geotextile: a permeable geosynthetic comprised solely of textiles.

PASA 3 SUBMITTALS

PASA 3.1 PRIOR TO CONSTRUCTION

The following documentation shall be submitted to the *Employer* and his Employer's Agenting Contractor before commencement of the geosynthetics installation:

a) Proposed layout drawings of the installation, showing panel location and location of seams and type thereof for each layer of synthetic material to be installed. The layouts should be drawn to scale with the design outlines in the background. The drawings could be made available electronically upon request.

b) Method Statement with accompanying Quality Control Plans (QCPs) [a.k.a. Inspection and Test Plans (ITPs)], detailing the Contractor's proposed construction procedure of the specific elements of the Works. No work related to such elements shall commence before the method statement and QCPs/ITPs has been submitted, reviewed, intervention points added and accepted for implementation by the *Employer* and his Employer's Agenting Contractor. All intervention points (Hold, Witness, Review, Monitor and Verify) designated in the Method Statement and QCPs to be observed and duly signed off by the relevant parties in accordance with the requirements of each intervention type.

c) Quality control documentation from the manufacturer of each geosynthetic supplied for this project to verify that it complies with the specification as detailed in this document. Submittal shall include:

    - Dates of manufacture
    - Batch numbers and roll numbers, length and width
    - Manufacturer's conformance certificates
    - Documentation of the manufacturer's quality control program, which shall test data indicating the actual test values, per roll or per batch, as may be applicable.

d) Conformance testing for the properties listed in the relevant sections undertaken at an approved testing facility(where applicable). The costs of this test work to be

included in the supply costs.

e) The ASTM specifications for GRI GT 12 and GT13 have been included as external conformance testing will be carried out at TRI in the USA. If supplier's data sheets are compiled in ISO format then the ISO versions of the GRI GT 12 and GT 13 specifications will be used to adjudicate initial compliance, however conformance testing and compliance to the specifications will be finalized on the ASTM values.

PASA 4 CONFORMANCE TESTING ON DELIVERY

The geosynthetic materials will be tested for conformance to the specifications on delivery to site. The testing requirements for the individual materials are described in each section for the relevant product. The costs for the testing will be included as an allowance in the BOQ.

PASA 5 PLANT

All plant shall be in good repair, adequate for its purpose and operated by persons experienced in the type of equipment used.

PASA 6 MATERIAL DELIVERY AND STORAGE

The products shall be packaged, transported, unloaded and stored in accordance with the manufacturer's instructions, subject to the *Employer* and his Employer's Agenting Contractor's approval, and generally in accordance with ASTM Standard D 4873, "Standard Guide for Identification, Storage and handling of Geosynthetic Rolls"

a) The area where the material is to be stored shall be free of any protrusions, rocks and other sharp objects, which could damage the material. The Earthworks Contractor will clear an area of sufficient size for the storage of materials within 1km of the construction site close to the Earthworks Contractor's campsite.

b) Materials delivered to site shall only be those as stated on the quality control sheets and lists previously disclosed to the *Employer* and his Employer's Agenting Contractor.

c) All material deliveries shall be logged and a summary of this log presented to the *Employer* and his Employer's Agenting Contractor no more than three (3) days after delivery to site for any particular material type.

The *Employer* and/or his Employer's Agenting Contractor or his representative should be present, whenever possible, to observe the material delivery and unloading on Site. The *Employer* and/or his Employer's Agenting Contractor or his representative will note any material received in damaged state.

PASA 7 GEOTEXTILES

The geotextiles as specified below shall be supplied and installed by the Earthworks *Contractor*. Installation is to take place in consultation with the Lining Sub-Contractor/*Contractor* (as applicable) where necessary.

PASA 7.1 MATERIAL

PASA 7.1.1 Geotextile for Separation

The separation geotextile shall be a non-woven, needle-punched, staple fibre or continuous filament, polypropylene, polyethylene or polyester, which complies with the specifications as set out in GRI-GT13 Class 2 (moderate survivability). The separation geotextile shall be supplied and installed by the Earthworks Contractor. The geotextile shall be placed with seams overlapping a minimum of 150mm.

Extract from GRI-GT13(a)
Table 2 (b) - Geotextile Properties Class 2 (Moderate Survivability)

Property	**Test Method**	**Unit**	**Value for Elongation ≥ 50%**
Grab Tensile Strength	ASTM D4632	N	700
Trapezoid Tear Strength	ASTM D4533	N	250
CBR Puncture Strength	ASTM D6241	N	1400
Permittivity	ASTM D4491	Sec^{-1}	0.02
Apparent Opening Size	ASTM D4751	Mm	0.60
Ultraviolet Stability	ASTM D4355	% Ret. @ 500 hrs	50

Please note that the above is only given as a guide and that it will still be the responsibility of the Contractor to make himself familiar with the full specification.

PASA 7.1.2 Geotextile for Protection

The protection geotextiles shall be a 1500g/m^2 non-woven, needle-punched, staple fibre or continuous filament, polypropylene, polyethylene or polyester, which complies with the specifications as set out in GRI-GT12(a). The geotextile for protection shall be supplied and installed by the Earthworks Contractor. The protection geotextile shall be placed with seams overlapping a minimum of 150mm.

Extract from GRI-GT12(a)
Adapted from Table 1(b) – Required Properties, Test methods and Values for Geotextiles used as geomembrane Protection (or cushioning) materials

Property	**Test Method**	**Unit**	**Value**
GRI-GT12(a)			
Mass per unit area	ASTM D5261	g/m^2	1500
Tensile Properties Grab Tensile Strength Grab Tensile Elongation	 ASTM D4632 ASTM D4632	 kN %	 2.52 50
Trapezoidal Tear Strength	ASTM D4533	kN	1.13
CBR Puncture	ASTM D624	kN	9.08
UV Resistance	ASTM D7238	%	70

PASA 7.2 TESTING

The *Contractor* is to ensure that the manufactured geotextile is tested in the factory for conformance to the specification prior to dispatching to site. The cost of this testing is to be included in the geotextile supply rates.

The geotextiles will also be tested after arrival on site. The procedure to be followed is:

I. Once material has been delivered to site the *Employer* and/or his Employer's Agenting Contractor will cut samples and arrange for shipping and testing. A sample will be cut from any roll at random, but not the same roll as that tested prior to shipping.
II. A 500mm wide strip is to be cut along the total width of the roll. This is then to be subdivided into 500mm wide samples. Ten (500mm × 500mm) samples as indicated by the *Employer* and/or his Employer's Agenting Contractor will be sent to the testing facility.

The geotextiles will be tested for the properties as listed below:

Separation

Property	Test Method
Mass per unit area	ASTM D 5261
Tensile Properties	ASTM D 4632
Permittivity	ASTM D4491
Apparent Opening Size	ASTM D4751
Trapezoidal Tear Strength	ASTM D 4533

Protection

Property	Test Method
Mass per unit area	ASTM D 5261
Tensile Properties	ASTM D 4632
Trapezoidal Tear Strength	ASTM D 4533
CBR Puncture	ASTM D 6241
UV resistance	ASTM D 7238

PASA 7.3 STORAGE AND HANDLING

All geotextiles shall be handled and stored as described in ASTM D 4873.

PASA 7.4 INSTALLATION

Geotextile fabric shall be placed as detailed on the drawings.

At the time of installation fabric shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation, or storage.

The area on which the fabric is to be placed shall be smooth and free of projections or depressions that may cause the fabric to be punctured.

Geotextile fabric shall be placed without stretching and shall lie smoothly in contact with the prepared surface. Fabric shall be placed with seams overlapping a minimum of 150mm with upstream geotextile always overlapping the downstream geotextile.

Edges of the material shall be sufficiently anchored during installation to prevent displacement by wind, heat tacking is allowable.

PASA 8 MEASUREMENT AND PAYMENT

PASA 8.1 GEOSYNTHETIC SUPPLY AND INSTALLATION UNIT: m^2

Items will be provided for each geosynthetic type required. The area measured will be the net (i.e. exclusive of all wastage, joints and overlaps) area shown on the drawings.

The quantities set out in the schedule of quantities have been determined from data available at the time. However the liability shall rest entirely and solely with the *Contractor* to determine before ordering, the required types and quantities of the various materials required for the completion of the Works in accordance with the specifications and the drawings issued. Any reliance placed by the *Contractor* on the estimated quantities stated in the Schedule of Quantities, or measurements made by the *Contractor* from the drawings shall be entirely at the *Contractor's* risk and the *Employer* accepts no liability whatever in respect of materials ordered by *Contractor* on this basis.

The supply rate shall include all costs involved in purchasing the geosynthetics local or international, Manufacturing Quality Control (MQC) testing, transport to site, off-loading and storage as per specification.

The installation rate shall include the cost of cutting, placing, overlapping, joining, repairing,

terminating, and fastening the geosynthetics in position during construction, any temporary protection works against flooding, upliftment, traffic and any other adverse conditions that may exist. The rate shall also include for all Construction Quality Control (CQC) testing as specified.

PASA 9 ALTERNATIVES

The original design and specified product is to be priced. Alternatives will be considered and must be fully detailed on a covering letter covering all aspects including, but not limited to, technical specifications, prices and delivery dates.

PASB GEOMEMBRANE

PASB 1 SCOPE

This specification covers the supply of materials and installation workmanship to provide impermeable flexible membrane liners, as detailed on the Chloorkop Landfill Site Cell7 design drawings.

PASB 2 INTERPRETATIONS

PASB 2.1 SUPPORTING SPECIFICATIONS

1. SANS 1526 : Thermoplastics sheeting for use as a geomembrane
2. SANS 10409 : Design, Selection and Installation of Geomembranes
3. GRI-GM13 :Test methods, test properties and testing frequency for High Density Polyethylene (HDPE) geomembranes
4. GRI-GM19 :Seam strength and related properties of thermally-bonded polyolefin geomembranes

PASB 2.2 DEFINITIONS

Refer supporting specifications. Additional definitions are:

Normal temperature: A temperature between 15°C and 32°C

Wrinkle, wave or fold: Undulation in the liner that is caused by installation methods, temperature fluctuations or activities like cover placement taking place on the liner.

Lining Contractor: The Contractor/Sub-Contractor (as applicable) appointed to perform the supply and the installation of the geomembrane liners required for the project

Earthworks Contractor: The principal/main Contractor appointed to undertake the excavation, backfilling, compaction and surface preparation required by the Lining Contractor to allow for the installation of the geomembrane liners.

PASB 3 MATERIAL

PASB 3.1 MATERIAL SPECIFICATIONS

Mono-textured and double textured geomembrane liner, 1.5 mm thick, shall be supplied and installed by the Lining Contractor as detailed on the drawings and that conform to the requirements stated in the latest edition of SABS 1526 and GRI GM13 published at the date of tender/bid closure.

PASB 3.2 RESIN TYPE

All HDPE geomembranes and welding rods shall be manufactured from a hexene or octene base polymer. During installation all welding rods shall have the same base polymer and additives as the lining material. The base polymer supplied, combined with the master batch additives that make up the eventual liner material and welding rods, must comply with GRI GM13.

PASB 3.3 MANUFACTURING PROCESS

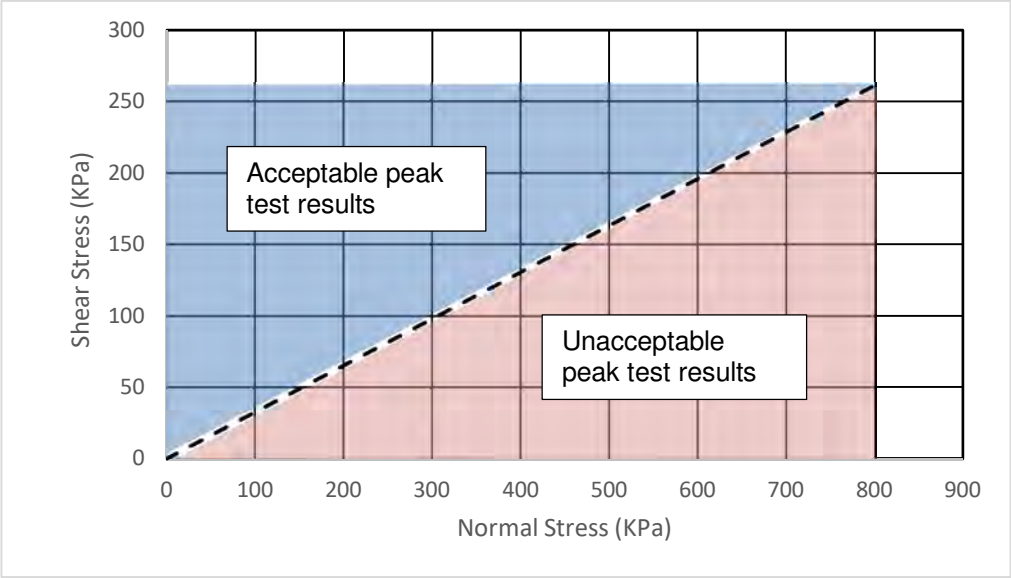
All liners will be manufactured using the flat-die extrusion process. Minimum panel widths for smooth material is 7.5m, and for textured material 5m.

PASB 3.4 DEVIATIONS FROM GRI GM13 FOR TEXTURED MATERIAL

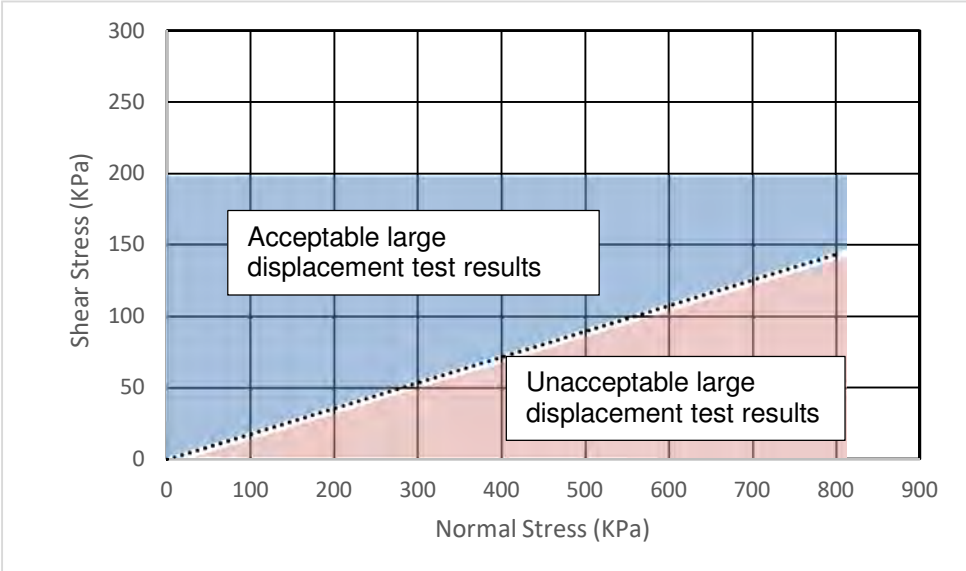
- Thickness: minimum average shall be ≥1.5 mm, and the lowest individual value for any of the 10 values is to be -10% as per ASTM D5994
- Texturing is to be embossed
- Break elongation to be minimum 250% as per ASTMD6693 Type IV
- Puncture resistance to be minimum 450 N for 1.5mm
- Rapid tensile strain test to be undertaken at a strain rate of 300 mm/minute to determine if the material exhibits any separation in plane behaviour.

PERFORMANCE SPECIFICATION FOR TEXTURED GEOMEMBRANE INTERFACE

From stability analyses carried out during the design stage, the following peak shear strength envelope indicates the minimum shear strength required between the textured side of the geomembrane and the clay material envisaged for use on site in order to have a Factor of Safety of 1.5.



The following minimum large displacement shear strength envelope is required.



The contractor is required to confirm that the geomembrane supplied will meet the interface shear strength required for the geomembrane clay interface.

Shear interface testing to verify conformance with this requirement will be carried out in parallel to geomembrane conformance testing (see Section PASB7) when the material

arrives on site.

Notes on Friction Interface Testing:

1. Tests are to be carried out to *ASTM D 5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method* as required in GRI GM 13
2. The interface should be the compacted clay at the density and moisture condition described on the drawings.
3. Standard Proctor Compaction as per ASTM D698-07. The D698 protocol shall be followed in terms of allowing the equilibrium/mellow time required.
4. Wetting condition of the interface: the interface should be flooded for a minimum of 24 hours before testing.
5. The tests will need to be carried out under at least three normal stress conditions including a minimum stress of 150KPa, a medium stress of 500KPa and a maximum stress of 700KPa
6. Peak and large displacement (>75mm) shear strengths are required.

PASB 4 PLANT

All plant shall be in good repair, adequate for its purpose and operated by persons experienced in the type of equipment used. Welding machines that cause any on-going damage to geomembranes will have to be removed from site and replaced with equivalent functional units.

PASB 5 CONSTRUCTION

The geomembrane liner will be installed and the quality control carried out in accordance with the latest edition of SANS 10409 and GRI GM19 published at the date of tender/bid closure. Below follows additional requirements.

PASB 5.1 SUBMITTALS PRIOR TO CONSTRUCTION

The following documentation shall be submitted to the *Employer* and his Employer's Agenting Contractor before commencement of the geomembrane installation:

a) Proposed layout drawings of the installation, showing panel location, seams and type thereof for each layer of synthetic material to be installed. All panels and seams must be numbered in sequence of intended installation. The layouts should be drawn to scale with the design outlines in the background. The drawings should be made available electronically upon request. Closure joints should also be shown. Offcuts shorter than 10m will not be permitted to be used in the installation unless shown in the original layout. The *Contractor* takes special note that any deviations from the initially Accepted panel layout drawing during construction, shall be subject to Acceptance by the *Employer* and his Employer's Agenting Contractor, prior to implementation of such changes.
b) Method Statement detailing the Lining Contractor's proposed construction procedure and Construction Quality Assurance (CQA) and Construction Quality Control (CQC) programme, compliant with SANS 10409, is to be submitted for the specific elements of the Works. No work related to such elements shall commence before the method statement has been submitted and approved. Particular mention must be made of the cover/protection layer placing procedure integrated with the geosynthetic deployment to ensure minimal fold/wrinkle development and propagation during such cover placement. Working hours must be specified and particular notice must be taken of the allowable folds in the liner to be placed as described under the tolerances section. Any and all costs (i.e. direct and indirect) resulting from the repairs on the folds not conforming to this specification, shall be for the *Contractor's* account.
c) Quality control documentation from the manufacturer to be submitted and approved prior to shipping of each type and gauge of geomembrane liner supplied for this project. Submittal shall include:
    - dates of manufacture.
    - resin supplier/type of resin.
    - batch numbers and roll numbers, length and width.
    - documentation of the manufacturer's quality control program, which shall test data

indicating the actual test values, per roll or per batch, as may be applicable.

d) Conformance testing - each type and gauge of geomembrane liner supplied are to be tested for conformance to the specifications and approved **prior to shipping**, by an external third party testing authority, see PASB 7 for list of required conformance tests. The *Contractor* is to include the time allowed for this testing in the material delivery schedule. This conformance testing will not supplant the conformance testing to be carried out when the material arrives at site as required in PASB 7.

PASB 5.2 TEMPORARY ANCHORING

The Lining Contractor shall supply and deploy double lined sandbags or other method Accepted by the *Employer* and his Employer's Agenting Contractor, to keep all material in place during the installation process. The bags are to be filled with sand of maximum particle size 5mm. The *Contractor* takes special note that, for environmental reasons, stabilised BP material may not be used for filling of sand-bags. A sufficient number of bags must be used to anchor the membrane on flat and sloped surfaces to prevent slippage and adequately restrain the geomembrane to prevent the formation of wrinkles, waves or folds and to secure the edges of the geomembrane liner to prevent wind uplift. The number and spacing of the bags is to be determined by the Lining Contractor.

PASB 5.3 MARKINGS ON GEOSYNTHETICS

All markings on the geosynthetics shall be made with a marker that will be clearly visible and that will not harm or impede the function of the geosynthetic. Only the Lining Contractor, 3rd Party Quality Controller and the Employer's Agent and/or *Employer* will be allowed to make any markings on the geosynthetics.

PASB 5.4 SURFACE PREPARATION

The Earthworks Contractor shall be responsible for preparing and maintaining the subgrade or supporting surface in a condition suitable for installation of the liner. The Lining Contractor is responsible to ensure that the area to be lined is free from all protrusions, stones, roots, vegetation, dry/loose soil, cracks and material and other objects that may be detrimental to the performance of the geomembrane prior to commencing installation.

In instances where the geomembrane is to be placed over a previously installed geosynthetic layer, care shall be taken that no wrinkles or folds are entrapped and that the placement of the geomembrane layer will be done such that the underlying geosynthetic is not damaged or disturbed.

A blinding layer consisting of sand and or fine gravel will only be used where specifically authorised by the *Employer* and his Employer's Agenting Contractor.

PASB 5.5 COVER PLACEMENT

The geomembrane will be installed in such a way that it lies flat on the substrate below without any tensile forces (i.e. trampolining) present during the coldest period of the working day. Subsequent cover layers will be placed by the Earthworks Contractor when the geomembrane is in the condition described above. Covering of the geomembrane should therefore take place early in the morning and should be stopped once folds start to appear. If covering of the liner is carried out after normal working hours to prevent folds it is taken that this cost is included in the installation rates.

Equipment shall not be driven directly on the geomembrane. Equipment will only be allowed to traffic in a straight line on the already installed protection layer. Equipment to have an allowable ground pressure of < 35 kPa.

The *Contractor* shall at all times, employ points-men from the Lining Contractor at the

interface where the cover layers are being deployed onto the geosynthetic materials. The purpose of these points-men being to monitor and ensure compliance to the Accepted method statement for cover layer placement, and to identify excessively coarse or angular particles in the cover material, for removal by these points-men, prior to incorporation into the cover layer.

PASB 5.6 ACCEPTABLE WEATHER CONDITIONS

Welding of the geomembrane may only occur within the limits set below:

Ambient air temperature:	>5 °C
Ambient air temperature above dew point:	>3 °C
Geomembrane surface temperature:	≤75 °C

In order to achieve this, an electronic weather station must be provided that records temperature and humidity continuously. If no allowance is made in the BoQ for this item it must be included in the installation rates. Measurement of geomembrane surface temperature must be carried out using suitable thermometers, such as an infrared thermometer or surface thermocouple. Adjacent panels may not be seamed until their temperatures have normalised to within 5 °C of each other. Measurements must be recorded in the CQC documentation.

PASB 6 TOLERANCES

Verification of Permissible Deviations (PDs) are described in the table below:

Dimensions will be verified at normal temperature, measurements being made with a tape at normal temperature.

For installation, at sunrise or at such time as when, in the opinion of the *Employer* and his Employer's Agenting Contractor, the effect of the sun is of no consequence.

All PDs will be rounded up to the next whole millimetre

1	2	3	4
ITEM	PERMISSIBLE DEVIATION DEGREE OF ACCURACY (mm)		
	III	II	I
Substrate			
Flatness of substrate		See Note 6.1 below	
Anchor trenches			
Anchor trench Position on plan	*	+-75	*
Anchor trench dimensions	*	-0	*
Anchor trench surface in contact with membrane	*	15	*
Membranes			
Refer SANS 1526 for MQC			
Waves & Folds		See Note 6.3 below	
Battens			
Flatness of concrete surface		See Note 6.2 below	
Width of flange		+-4	

Thickness of flange		-0	
Warpage of flange		Width/200	
Flatness of web		Width/120	
Location of holding down bolt centre point in plan		+-3	
Thickness of Gasket		-0 to +1	

PASB 6.1 SUBSTRATE FLATNESS

The top layer of the subgrade layer shall be graded and compacted using a smooth drum roller by the Earthworks Contractor where it needs to be prepared for the placing of the geomembrane and shall be finished such that no gap greater than 30mm can be measured beneath a 3m straight edge. No abrupt changes in falls or alignments will be allowed.

PASB 6.2 CONCRETE FLATNESS

The concrete layer shall be floated with a steel float where it needs to be prepared by the Earthworks Contractor for the fixing of the geomembrane and shall be finished such that no gap greater than 1mm can be measured beneath a 200mm straight edge. No abrupt changes in the surface will be allowed.

PASB 6.3 LINER FLATNESS

With cover: If the liner is placed with the intention of placing a cover layer over it one 20mm high x 100mm wide wave will be permitted every 10m per panel width. Propagation of waves by the placing of cover material will not be permitted.

Without cover: It the liner is placed with the intention of keeping it exposed the above requirement may be relaxed as agreed by the *Employer* and his Employer's Agenting Contractor.

Along weld: No folds or waves will be allowed along or across extrusion or wedge welds.

PASB 7 TESTING

All Manufacturing Quality Control (MQC) and Construction Quality Control (CQC) testing and reporting are described in the supporting specifications and must be adhered to strictly.

In addition to the above quality control testing the following independent 3rd party conformance testing will be performed.

One set of tests will be carried out for each membrane thickness, surface texturing or resin base change, per 100,000 m^2 or part thereof, by a 3rd party accredited laboratory prior to shipping as described in 5.1.d). The costs for this testing are to be included in the supply costs.

One set of ten 300mm x 300mm samples will be cut evenly spaced across the width of a selected roll in the presence of the *Employer* and his Employer's Agenting Contractor once the material is delivered to site. This will be done for each membrane thickness, surface texturing or resin base change, per 100,000 m2 or part thereof, delivered to the site. The samples will be cleaned and packaged and sent to TRI – Austin, Texas for testing. Information on the specific roll numbers from which the samples are cut will be recorded, these are to be different than the rolls sampled before shipping. The cost of this testing will be for the Employer and will be paid under the allowance made in the Schedule of Quantities.

Table of Conformance Test Properties

Property	Test method
Thickness (10 spaced across a roll width)	
Textured	ASTM D 5994
Asperity height	ASTM D 7466
Density	ASTM D 1505
Tensile Properties	ASTM D 6693 Type IV
Tensile Properties at 300 mm/min strain rate	ASTM D 6693 Type IV
Stress Crack Resistance	ASTM D 5397
Carbon Black Content	ASTM D 1603
Carbon Black Dispersion	ASTM D 5596
OIT – Standard Pressure OR OIT – High Pressure	ASTM D 3895 ASTM D 5885
Oven Aging at 85°C Standard OIT 55% retained after 90 days OR Oven Aging at 85°C High Pressure OIT 80% retained after 90 days	ASTM D 5721, ASTM D 3895 ASTM D 5721, ASTM D 5885
UV Resistance High Pressure OIT % retained after 1600 hrs	ASTM D 7238, ASTM D 5585

PASB 8 MEASUREMENT & PAYMENT

PASB 8.1 GM1: SUPPLY GEOMEMBRANE UNIT: m^2

Items will be provided for each membrane thickness, resin type and surface texture requirement. The area measured will be the net (i.e. exclusive of all wastage, joints and overlaps) area shown on the drawings, including area of geomembranes installed in anchor trenches. The rate shall include all costs involved in purchasing the geomembrane local or international, welding consumables from the same parent resin, MQC testing, pre shipping conformance testing, transport to site, off-loading and storage as per specification. The rate is also to allow for covering of the material while in stockpile in order to protect it from UV damage.

The quantities set out in the schedule of quantities have been determined from data available at the time of design. However the liability shall rest entirely and solely with the *Contractor* to verify, before ordering, the required types and quantities of the various materials required for the completion of the Works in accordance with the specifications and the drawings issued to the *Contractor* for construction purposes. Any reliance placed by the *Contractor* on the estimated quantities stated in the Schedule of Quantities, or measurements made by the *Contractor* from the drawings, shall be entirely at the *Contractor's* risk and the *Employer* accepts no liability whatever in respect of materials ordered by the *Contractor* on this basis.

90% of the billed quantity will be paid as Materials On Site when the liner is delivered to site, subject to conclusion of waiver of lien with the *Employer*.

The supply rate is subject to adjustment caused by foreign exchange variation and shall be fixed on the date of order by means of forward cover – see PASB 8.5.

The following information will be provided by the *Contractor* regarding the supply of geomembrane material, as part of the tender documentation:-

- The exchange rate on which the item rate is based, and
- The percentage of the rate that is subject to change in the event of changes to the exchange rate.
- The forward cover variation will be allowed for in the Schedule of Quantities as a variation in the supply rate.

PASB 8.2 GM2: INSTALL GEOMEMBRANE UNIT: m^2

Items will be provided for each membrane thickness, resin type and surface texture requirement. The area measured will be the net (i.e. exclusive of all joints and overlaps) shown on the drawings including area of geomembranes installed in anchor trenches. The rate shall include the cost of preparing panel layout drawings, in electronic format, transporting from stockpile, cutting, placing, overlapping, joining, temporary anchoring, repairing, terminating, fastening the membrane in position during construction, any temporary protection works against flooding, uplift, traffic and any other adverse conditions that may exist. The rate shall also include for all CQC as specified. All work carried out after normal working hours is included in the installation rates. All lighting that may be required for carrying out work when dark should be included in the installation rates. The rate is to include for all CQC as specified and payment for installed areas will only be made once the CQC documentation, according to SANS 10409, is fully submitted and approved.

PASB 8.3 GM3: ANCHOR TRENCH UNIT: m^3

Items will be provided for each anchor trench configuration. The rate shall include for excavation in all materials, shaping the trench to the lines shown on the drawings, temporarily stockpiling the material adjacent to the trench, backfilling in layers not exceeding 200mm and compacting the material as specified and spoiling the excess material. If no compaction is specified the material will be compacted by two passes with a 1 ton smooth drum roller or equivalent approved.

PASB 8.4 GM4: 3RD PARTY TESTING UNIT: Sum

Items will be provided for conformance testing of materials delivered to site for each membrane thickness, resin type and surface texture requirement. The costs shall include the material cost of the samples, marking, cutting, packaging, dispatching, testing the samples at the laboratory and reporting thereon as per PASB 7.

PASB 8.5 FORWARD COVER UNIT: UNIT: Sum

All tenderers to provide forward cover indications as a separate item to the supply and install rates provided in the BoQ for the supply of any imported items with their tenders based on:

- Contract award date: Refer tender document
- Quantities stated in the tender BoQ based on tender drawings.

The indications shall state the forward exchange rate, which is the sum of the spot rate plus the forward points (or interest differential between the two currencies concerned). The quotations should be based on a fixed forward cover contract.

Quantities shall be measured off the drawings issued for construction.

PASC HDPE PIPES

PASC 1 SCOPE

This specification covers the materials and components used, the fusion jointing procedure and equipment and the quality assessment of the completed joints for HDPE piping.

PASC 2 INTERPRETATIONS

PASC 2.1 SUPPORTING SPECIFICATIONS

- SANS/ISO 4427-1:2008: Plastics piping systems -- Polyethylene (PE) pipes and fittings for water supply -- Part 1: General
- SANS/ISO 4427-2:2008: Plastics piping systems -- Polyethylene (PE) pipes and fittings for water supply -- Part 2: Pipes
- SANS/ISO 4427-3:2008: Plastics piping systems -- Polyethylene (PE) pipes and fittings for water supply -- Part 3: Fittings
- SANS/ISO 4427-5:2008: Plastics piping systems -- Polyethylene (PE) pipes and fittings for water supply -- Part 5: Fitness for purpose of the system
- ISO 21307: Edition 2 (2011) : Butt fusion jointing procedures for PE pipes and fittings used in the construction of gas and water distribution systems
- SANS 10268-10:2009: Welding of thermoplastics - Welding processes Part 10: Weld defects
- SANS 2001 – DP2:2008: Construction works part 2: Medium pressure pipelines

PASC 2.2 DEFINITIONS

Refer supporting definitions.

PASC 3 SUBMITTALS

PASC 3.1 PRIOR TO CONSTRUCTION

The following documentation shall be submitted by the Contractor to the Employer's Agent for approval prior to construction.

1. Certificates of Compliance (COC) in terms of ISO 4427 part 1, 2 and 3 on raw materials used and extruded pipe to be supplied by the Manufacturer.
2. All piping and fabricated fittings shall be manufactured from a PE 100 granule compound complying with table 1 as specified in ISO 4427 part 1
3. No recycled material, even internal, is allowed to be used in the pipes manufacture. Manufacturers are to certify this as part of the COC.
4. The Manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances shall be furnished.
5. The pipe and fittings manufacturer shall have an established quality assurance program responsible for inspecting incoming and outgoing materials. The pipe manufacturer should preferably be a member of the South African Plastic Pipe Manufacturers Association (SAPPMA) or a similar international accreditation body.
6. As a minimum, incoming polyethylene raw materials shall have a Certificate of Analysis (COA) and be tested for density, melt flow index, oxidative induction time, carbon black content and carbon black dispersion as per the relevant test methods and values stated in **PASC 4.1.** All incoming polyethylene materials shall be certified by the supplier who must run internal testing to verify the raw material properties. Certification shall be verified by a Manufacturing Quality Assurance programme. Incoming materials shall be approved before processing into finished goods.
7. The pipe and fittings manufacturer shall have an established quality assurance program responsible for assuring the long term performance of materials and products. Representative samples of polyethylene materials shall be tested against the physical property requirements of this specification.

8. Each extrusion line and moulding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ISO 4427-2, Table 3.
9. Quality assurance test for representative pipe and fitting samples shall include:

Test	***Standard***	***Pipe***	***Fittings***
Slow crack growth	*ISO 13479*	*Yes*	*Not Applicable*
Hydrostatic strength at 80 °C	*ISO 1167-1&2*	*Yes*	*Yes*
Hydrostatic strength at 20 °C	ISO 1167-1&2	Yes	Yes

10. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Manufacturing Quality Control shall perform tests of melt flow index, oxidative induction time, carbon black content and carbon black dispersion as per the relevant test methods and values stated in **PASC 4.1** on the manufactured pipe. Moulded fittings shall be subject to x-ray inspection for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment. The pipe and fitting manufacturer shall maintain permanent QC and QA records.
11. The pipe and fitting manufacturer shall package products for shipment in a manner suitable for safe loading, transport and off-loading by a commercial carrier. When delivered, a receiving inspection shall be performed, and any shipping damage reported to the pipe and fittings manufacturer. Pipe and fittings shall be handled, installed, and tested in accordance with manufacturer's recommendation, and the requirements of this specification.
12. Once delivered to site the Employer's Agent will take a sample of the pipe and perform tests of melt flow index, oxidative induction time, carbon black content and carbon black dispersion as per the relevant test methods and values stated in PASC 4.1 on the delivered pipe. An allowance in the Schedule of Quantities will be made for these tests.

PASC 4 MATERIALS

PASC 4.1 CHARACTERISTICS/PHYSICAL PROPERTIES

The Materials used for the manufacturer of polyethylene pipe and fittings shall meet the following minimum characteristics for polyethylene compound in granule and pipe form, and shall comply to the physical property requirements for **PE100**:

Physical Properties - Granule	**Test Method**	**Values**	**Unit**
Density	ISO 1183-2	≥ 930	Kg/m^3
Carbon Black Content	ISO 6964	2.0 – 2.5	% by mass
Carbon Black Dispersion	ISO 18553	≤ Grade 3	
Volatile Content	EN 12099	≤ 350	mg/Kg
Water Content	ISO 15512	≤ 300	mg/Kg
Oxidative Induction Time	ISO 11357-6	≥ 50	minutes
Melt flow index (190°C/5Kg)	ISO 1133:2005	0.2 – 1.4	g/10 min
Note: Water content is only applicable if the measured volatile content is not in conformity with its specified measurement.			

Physical Properties Pipe	**Test Method**	**Mode**
Tensile strength for butt fusion	ISO 13953	Ductile-pass, brittle - fail
Slow crack growth	ISO 13479	No failure during test
Hydrostatic strength	According to ISO 4427-2 Table 3	
Elongation at break	According to ISO 4427-2 Table 5	

PASC 4.2 PIPE AND FITTINGS

a) Dimensions (PE100):
   1. Pipe diameter and Class to be used shown on drawings.
   2. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with ISO 4427-2 Part 2 Table 1 & 2. Standard laying lengths shall be 6 m or 12 m, as may be specified by the Employer's Agent.
   3. All piping shall be black with or without a blue identification stripe. No other colour identification stripe shall be accepted.
   4. Fitting Dimensions: Fittings such as coupling, wyes, tees, adaptors, etc. for use in laying pipe shall have standard dimensions that conform to ISO 4427-3 Part 3.

b) Where possible, pipe and fittings should be produced by the same manufacturer from identical materials meeting the requirements the ISO 4427 Part 3 specification.

c) Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by the Employer's Agent. Whether moulded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

d) Moulded fittings shall meet the requirements this specification. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. Upon request, the manufacturer shall provide an explanation of this production code.

e) Markings:
   1. All piping and fabricated fittings shall be clearly marked as per ISO 4427 Part 2 and 3 section 11, thus enabling full traceability at all times.
   2. Typically this must display as a minimum the: Standard to which this is produced, The Manufacturer ID, pipe dimensions, SDR, material spec, Pressure rating and unique identification mark.
   3. The info as per item 2 must be displayed once/ meter pipe and at least once on the fitting.

PASC 4.3 SOURCE QUALITY CONTROL

a) Inspection requirements:

   1. Notification - If inspection is specified by the purchaser, the manufacturer shall notify the purchaser in advance of the date, time and place of testing of the pipe in order that the purchaser may be represented at the test.
   2. Access - The Employer's representative shall have free access to the inspection area of the manufacturer's plant. The manufacturer shall make available to the Employer's representative, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this specification.
   3. Certification - As the basis of the acceptance of the material, the manufacturer will furnish a certificate of conformance of these specifications upon request. When prior agreement is being made in writing between the purchaser and the manufacturer, the manufacturer will furnish other conformance certification in the form of affidavit of conformance, test results, or copies of test reports

b) Physical Test Requirements

   1. Sampling - The selection of the sample of pipe shall be as agreed upon by the purchaser and the manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate
   2. Conditioning - Conditioning of samples prior to and during test shall be as per the specified national or international standard. In case of no applicable standard, conditioning shall be for a minimum time of 24 hrs at a temperature of 23 °C ± 2 °C.

PASC 5 EXECUTION

PASC 5.1 FIELD QUALITY CONTROL

a) Pipe may be rejected for failure to conform to specifications or following:

1. Fractures or cracks passing through the pipe wall.
2. Scratches, mechanical damage sufficient to impair strength, durability or serviceability of pipe.
3. Defects indicating improper proportioning, mixing, and moulding.
4. Damaged ends, where such damage prevents making satisfactory joint.
5. Pipe ends shall be cut cleanly and square to the axis of the pipe.
6. Pipe internal and external surface appearance shall be smooth, clean and free from scoring, cavities and other surface defects such as pinholes.

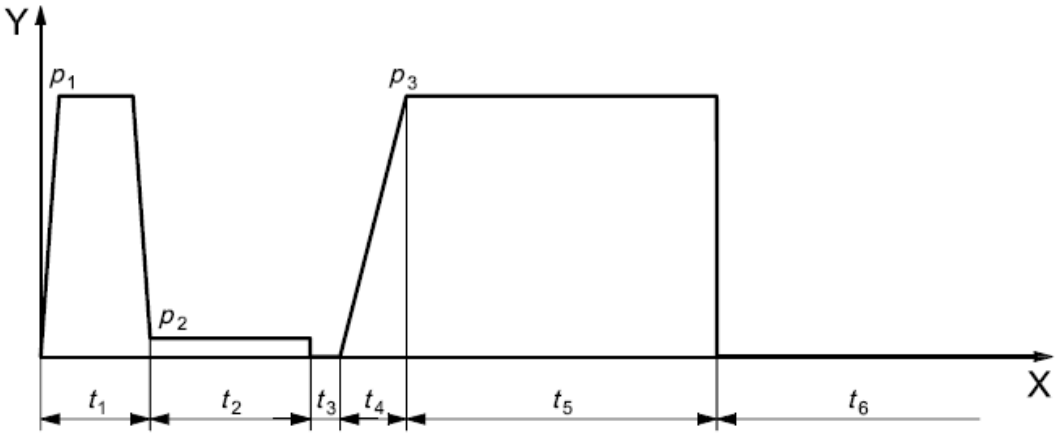
b) Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to these Specifications and ISO 4427 Part 3.

c) Notify Employer's Agent prior to backfilling trench. Contractor is to obtain as-built top of pipe coordinates and elevations at 20m intervals along the pipe prior to backfilling. **Also see PASC 6 Testing.**

PASC 5.2 INSTALLATION

a) Heat fusion of pipe to be single pressure with high fusion jointing pressure in accordance with ISO 21307 and SANS 10268 as specified in the table below:

Parameter	Unit	Value
Heater plate temperature	ºC	200 – 230
Initial bead-up fusion jointing pessure	MPa	0.52 +/- 0.1
Min heat soak time	sec	(11 +/- 1) x e_n
Min bead size after heating	mm	0.15 e_n + 1
Heat soak pressure	MPa	0 to drag pressure
Max heater plate removal time	s	0.1 e_n + 8
Fusion jointing pressure	MPa	0.52 +/- 0.1
Min cooling time in the machine under pressure	min	0.43 e_n
Min cooling time out the machine	min	[a]
[a] = A cooling time out of the machine and before rough handling may be recommended but in most cases is not necessary with these cooling times		



Key

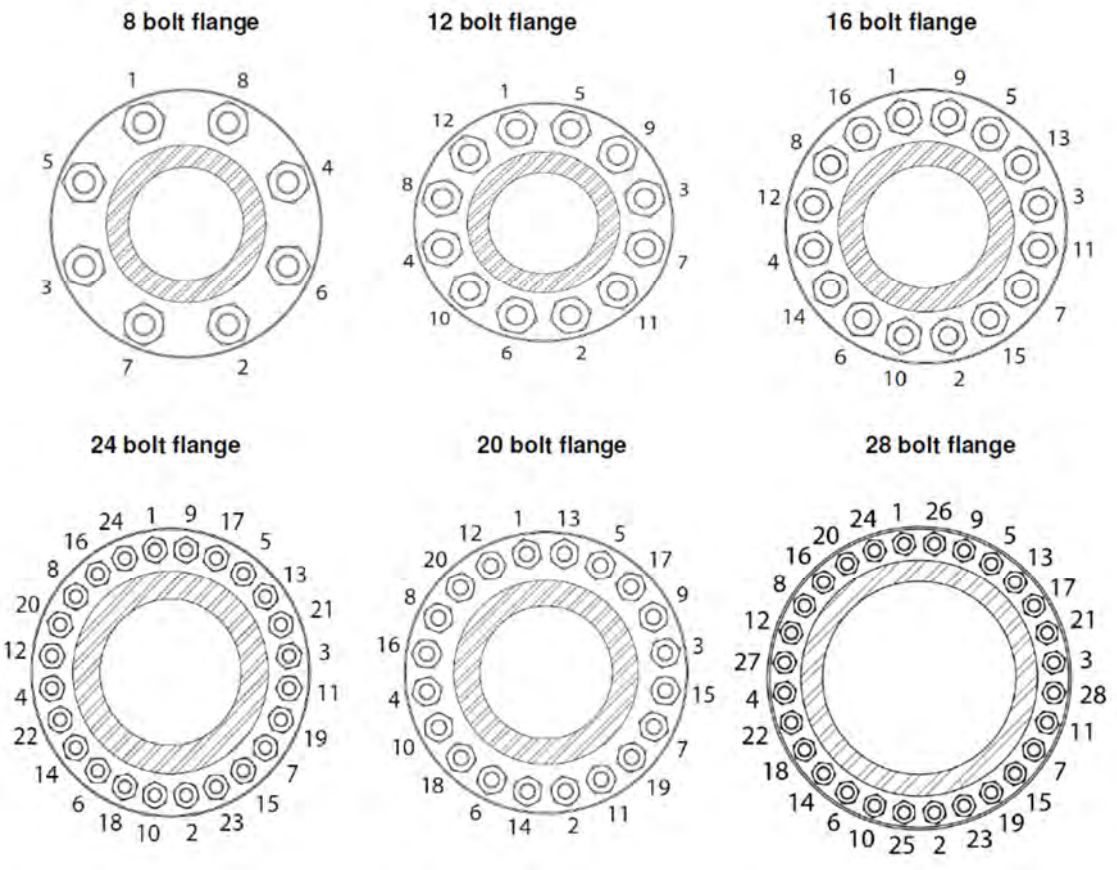
X time
Y pressure
t_1 initial bead-up time
t_2 heat soak time
t_3 heater plate removal time
t_4 time to achieve fusion jointing pressure
t_5 cooling time in the machine under pressure
t_6 cooling time out of the machine
p_1 initial bead-up pressure
p_2 heat soak pressure
p_3 fusion jointing pressure

1. Provide fusion operators certified by the pipe manufacturer.
2. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by ISO 21307 including, but not limited to, temperature requirements, alignment, and fusion pressures.
3. For cleaning pipe ends, planing unit and heater surfaces, a dry, clean, lint-free, non-synthetic cloth such as cotton is to be used every time. In extreme cases water can be used for cleaning followed by drying with a cloth as above. In the case of oil contamination Acetone or greater than 90% Isopropyl alcohol can be used.
4. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
5. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
6. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
7. Trial welds to be undertaken and externally tested prior to production welds being initiated.
8. Clamp the components in the butt fusion jointing machine and adjust as necessary to achieve proper alignment.
9. Plane the pipe or fitting ends to establish clean, parallel mating surfaces.
10. Remove any shavings from the pipe or fittings. Inspect the pipe for incomplete planning, voids or other imperfections and then bring them together to check for proper alignment.
11. Measure the gauge pressure required to overcome the frictional drag force of the machine and pipe. This pressure shall be added to the calculated bead-up and fusion jointing pressure.
12. Heater plate to be checked with hand held thermometer for even temperature distribution. The temperatures are to be taken at a minimum of four positions on the plate, and should not vary by more than 5 degrees. Readings to be recorded in the CQA data.
13. Install the heater plate in the machine and bring both pipe ends simultaneously into full contact with the heater plate to produce molten surfaces for fusion jointing. Pipe ends are not to be over pressurised during the soak time to prevent formation of pockets on the joint, maximum allowed pressure is to be 10% of the fusion pressure, soak pressure to be recorded in the CQA data.
14. At the completion of the heat soak time, pull the pipe from the heater plate then remove the heater plate and bring the pipes together in a controlled manner. The joint shall be held at the jointing pressure for the prescribed jointing time.
15. The molten joint shall be held immobile under pressure in the machine for the prescribed time.
16. An even double roll back bead all around the circumference of the pipe should be visible, both in width and height, with a smooth appearance. The pipes must be properly aligned, no mitered joints allowed, and there must be no visual evidence of any contamination in the bead.
17. Cover at end of each working day open ends of fused pipe. Cap to prevent entry by animals or debris.
18. Use compatible fusion techniques when polyethylenes of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.
19. Remove shavings inside pipe caused by perforation drilling prior to jointing.

20. Remove internal beads on leachate collection pump riser to allow for smooth entry and exit of the pump.
21. The details of the fusion joint procedure and conditions under which the fusion joint was executed must be fully logged. Electronic equipment, such as data loggers, are the preferred method. Data captured must comply with ASTM F3124 – Data capture requirements.

b) Flange Jointing:

1. Used on flanged pipe connection sections.
2. Connect slip-on carbon steel backup flanges with stainless steel nuts and bolts.
3. Butt fuse fabricated/ moulded flange adapters to the pipe.
4. Observe the following precautions in connection of flange joints:
   a. Align flanges or flange/valve connections to provide a tight seal. Gaskets are not required for HDPE/ HDPE and HDPE/ Carbon connections as specified by the Employer's Agent. Flange faces are undamaged and clean – rectify any surface damage prior to starting the bolt up process.
   b. Place round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated with grease in accordance with manufacturer's recommendations.
   c. Tighten flange bolts in a criss-cross sequence and accordance with manufacturer's recommendations. Hand tighten/ normal spanner tighten the bolts and nuts in the required sequence and recheck that there is no gap between the flange faces. The faces must be parallel.



   d. Allow the HDPE to "settle" for a minimum of 4 hrs before the final torque is applied. The correct range size torque wrench must be used and the torque wrench calibration certificate is to be available on site.
5. Pull bolt down by torque in accordance with manufacturer's recommendations, typical torque values shown in the table blow

Pipe OD (mm)	Bolt diameter (mm)	No. of bolts	Max lubed torque (N.m)
90	16	8	70
110	16	8	90
125	16	8	90
140	16	8	100
160	20	8	100
180	20	8	135
200	20	8	165
225	22	12	165
250	22	12	165
280	22	12	220
315	24	12	300
355	24	12	370
400	24	16	370
450	28	16	410
500	28	20	410
560	32	20	490
630	32	24	590
710	32	28	590
800	38	28	870
900	38	32	950
1000	38	36	950

Refer to Plastics Pipe Institute TN -38/ July 2011

6. Protect below ground bolts and flanges by covering with a 1.5mm thick polyethylene wrap. Denso tape wrap to the HDPE pipe.
7. Electrofusion couplers, where used, shall installed per MAB Generic Electrofusion Procedure for Field Joining of 12 Inch and Smaller Polyethylene (PE) Pipe and Installation Guidelines For Electrofusion Couplings 14" and Larger TN-34/2009 both available on the Plastics Pipe Institute Inc. (PPI) website http://plasticpipe.org

PASC 5.3 PIPE PLACEMENT

Pipe placement is to be conducted as follows:

1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion; but not to exceed 120m.
5. Cap pipe sections longer than single joining (usually 12m) on both ends during placement except during fusing operations.
6. Notify Employer's Agent prior to installation pipe into trench and allow time for Employer's Agent's inspection, correct irregularities found during inspection.
7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
11. Place in trench by allowing minimum 300mm/30m for thermal contraction and expansion.
12. Coordinate construction of pipes near access roads with Employer to limit impediment of site operations or operations of other Contractors.

PASC 5.4 PERFORATIONS

Perforated seepage collection pipes are to be perforated with 4 x 15 mm diameter holes drilled at 100 mm centre to centre, unless stated as solid.

PASC 5.5 CORRUGATED, SLOTTED AND PERFORATED PIPE

Specified subsoil pipes shall be slotted and perforated, double wall corrugated, 110 mm and 160 mm HDPE pipes.

The pipe shall comply with the following specifications:

		Value:	
Property:	**Unit:**	**110 mm**	**160 mm**
Outside diameter	mm	110	160
Inside diameter	mm	95	137
Infiltration area	mm^2/m	> 7000	> 7000
Nominal slot width	mm	1.3	1.8
Nominal hole diameter at 100mm centres	mm	15	15
Ring stiffness	kPa	> 450	> 450

PASC 6 TESTING FOR LANDFILL GAS EXTRACTION DELIVERY LINES

PASC 6.1 PREPARATION

a) Commence test procedures when the following conditions have been met.
   1. Pipe section to be tested is clean and free of dirt, sand or other foreign material.
   2. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts. Use concrete if necessary.
   3. Add compressed air slowly.
   4. Pressurizing equipment shall include regulator set to avoid over-pressurizing and damaging an otherwise acceptable section of pipe.

b) Provide necessary pipe connections between the section of line being tested and the compressed air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform the specified tests.

c) Furnish and install bulkheads, flanges, valves, bracing, blocking or other temporary sectionalising devices that may be required

d) Remove temporary sectionalising devices after tests have been completed

PASC 6.2 TESTING EQUIPMENT

a) Contractor shall provide all equipment required for this testing procedure.

b) Testing Equipment shall include, but may not be limited to:
   1. Polyethylene flange adapter with steel blind flange.
   2. Temperature gauge (0ºC to 100ºC) tapped and threaded into blind flange.
   3. Pressure gauge (0 to 1000 mb) ASME Standard B40.1 Grade 2A (accuracy of ±0.5% of full scale) with minor graduation marks no greater than 10 mb.
   4. Inlet valve to facilitate compressed air hose.
   5. Ball valve to release pipe pressure at test completion.
   6. Polyethylene reducers to be used to adapt test flange to size of pipe being tested.
   7. Air compressor shall provide adequate air supply for testing.
   8. Pressurizing equipment shall include a regulator set to avoid over-pressurizing and damaging otherwise acceptable pipe.

c) Provide verification and results of gauge calibration prior to (less than 60 days) and after Project completion.

PASC 6.3 TESTING

a) EMPLOYER and EMPLOYER'S AGENT shall be given 24-hr notification prior to test.

b) Appropriate Safety precautions must be in-place.

c) Pipe Test Segments:
   1. Butt-fusion weld pipe segments.
   2. Less than 610 meter in length.
   3. Blind flange with test apparatus on one end and fused cap or blind flange assembly on opposite end.

d) Environment:
   1. Place test segment in trench or lay test segment on ground surface and allow it to reach ambient temperature before test.
   2. Perform test during period when pipe segment will be out of direct sunlight to minimize pressure changes as a result of temperature fluctuations.

e) Test:
   1. Apply test pressure of 1000 mb to test segment.
   2. Observe test pressure for 1-hour.
   3. Mathematically correct pressure drop for temperature change.
   4. Temperature corrected pressure drop over 1-hour period should not exceed 1%.
   5. If retest is necessary, allow pressure to relax to 0 mb for a minimum of 8 hours prior to retest.

f) Test Failure:
   1. If retest is necessary, allow pressure to relax to 0 psig for at least 8 hours prior to retest.
   2. Perform the following when pipe segment fails test:
      i. Check entire length of pipe and fusion welds for cracks, pinholes, perforations or other possible leakage points.
      ii. Check blocked risers and capped ends for leakage and check gaskets at blind flanges.
      iii. Verify leaks by applying a soapy water solution and observe for bubble formation.
   3. Repair pipe and fused joint leaks by cutting out leak areas and refusing suitable segments.
   4. After the leaks are repaired, retest the pipe after the 8 hour relaxation period.

PASC 6.4 TEST REPORT

Each test shall be reported in writing, on the “HDPE PIPE PRESSURE TEST REPORT” included at the end of this section.

If failure occurs, the following information is to be included:
1. Location of failure segment.
2. Nature of leaks.
3. Details of repairs performed.
4. Retest

PASC 6.5 HYDRAULIC TESTING

Hydraulic testing in accordance with SANS 1200 L, Section 7.3, and SANS 2001:DP 2 Medium Pressure pipelines is also permissible.

HDPE PIPE PRESSURE TEST REPORT

Project Name/No.: _____ Date: _____
Contractor: _____ Time: _____
Person Performing Tests: _____
Description/Location of Test Segment: (Pipe Diameter, Length, and SDR's)

_____
_____

Location of Pipe Test Segment _____
Station From: _____ Station To: _____

Ti = Initial Temperature = _____ °C
Pi = Initial test pressure = _____ mb
Pc = Initial Pressure in mb corrected for temperature (Tt) at time "t"
t = Time in minutes from initiation of test
Tt = Temperature in °C at time 't'
Pt = Test pressure in mb at time 't'

$$Pc = \left[\frac{(P_i + 1013)(T_t + 273)}{T_i + 273}\right] - 1013$$

$$\text{Percent Pressure Drop} = \frac{Pc - Pt}{Pc} \times 100$$

Time (min)	Tt Temp Reading (°C)	Pt Gauge Pressure (mb)	Pc Corrected Pressure (mb)	Pressure Drop (%)
0				
20				
40				
60				

Pass/Fail: _____ Retest (yes/no) _____

Description/Nature of leaks repair of retest segment:

_____
_____
_____
_____
_____

ANNEXURE 1: ENVIROSERV Safety, Health and Environment (SHE) specifications

APPENDIX D

CONSTRUCTION QUALITY CONTROL PLAN

ENVIROSERV WASTE MANAGEMENT
CHLOORKOP LANDFILL SITE
PHASE 1A

EARTHWORKS AND LINING INSTALLATION CONSTRUCTION QUALITY CONTROL PLAN

AUGUST 2019

Jones & Wagener
Engineering & Environmental Consultants
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
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DOCUMENT APPROVAL RECORD

Designation	Name	Signature	Date
EnviroServ Waste Management (EWM)			
Group Operations Director	Nico Vermeulen		
Jones & Wagener			
Project Director	Jabulile Msiza		22/08/2019
Professional Engineer	Charl Cilliers		22/08/2019

RECORD OF REVISIONS AND ISSUES REGISTER

Date	Revision	Description	Issued to	Issue Format	No. Copies
2019-08-22	0	Final	EnviroServ Waste Management	PDF	1

ENVIROSERV WASTE MANAGEMENT
CHLOORKOP LANDFILL SITE
PHASE 1A
EARTHWORKS AND LINING INSTALLATION
CONSTRUCTION
QUALITY CONTROL PLAN

CONTENTS PAGE

APPENDIXES

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ENVIROSERV WASTE MANAGEMENT
CHLOORKOP LANDFILL SITE
PHASE 1A
EARTHWORKS AND LINING INSTALLATION
CONSTRUCTION
QUALITY CONTROL PLAN

1. INTRODUCTION

1.1 Background

EnviroServ Waste Management (EWM) propose to construct and operate a new landfill expansion, northwards, consisting of 3 cells, at the Chloorkop Landfill Site. The proposed expansion will extend the facility's capacity to receive general waste for approximately 27 months based on current tonnages.

As the position of the expansion will cover the existing contaminated storm water dam and leachate collection tank, a new leachate holding tank is included in the project.

The new cell will require a Class B lining system in terms of GNR. 636 (National Norms and Standards for the Assessment of Waste for Landfill Disposal).

Authorisations: Chloorkop Landfill Site

Authorisation	Date Received	Reference:
Waste Permit	30 October 1997	Permit No. 16/2/7/A230/D17/Z1/P280

1.2 Terms of Reference

Jones & Wagener Engineering and Environmental Consultants (J&W), was appointed to carry out the conceptual design of the Phase 1A northern expansion at the Chloorkop Landfill Site on 21 February 2019, by Mr Nico Vermeulen of EnviroServ Waste Management.

1.3 Purpose

This Quality Control Plan (QCP) has been developed by Jones & Wagener to specify the quality control procedures that will be implemented to ensure compliance with the project specifications.

This QCP must be developed further in conjunction with each specialist contractor that is appointed. These include:-

- Earthworks Contractor
- Lining Contractor
- Others to be specified

2. PROJECT TEAM

2.1 Designated Parties

(a) Construction Manager

Control and monitor the construction performance with respect to:

- Compliance with safety specifications;
- Compliance with environmental specifications;
- Compliance with quality specifications;
- Construction budget & procurement;
- Construction equipment, labour & plant;
- Day to day administration of the project;
- Jones & Wagener liaison;
- Co-develop and implementation of the Quality Control Plan, (QCP);
- Issuing of Request for Inspections to all parties concerned.

(b) Site Agent

Overall management responsibility of:

- Construction of the works;
- Construction equipment and vehicles on site;
- Timeous implementation of the construction programme;
- Specialised sub-contractors;
- On-site safety compliance and control;
- Maintaining the triplicate site instruction book;
- Maintaining the duplicate site diary.

(c) Client Project Manager

- Contract management from Client side;
- Payment of certificates;
- Overview of construction works;
- Jones & Wagener liaison.

(d) Client Construction Supervisor

- Review of contractor's quality control;
- Verify that the design is constructed as per the design and specification.

(e) Client Safety Officer

- Review of contractor's safety control;
- Review of contractor's environmental control.

(f) Jones & Wagener:

- Development of the Quality Control Plan;
- Verify the assumptions made during the design phase;
- Verify that the design is constructed as per the design, taking specific cognisance of the Construction Regulations 2014 and the Environmental Management Programme (EMPr);
- Full time construction monitoring by supervising team (if required);
- Carry out fortnightly routine inspections by head office staff;
- Inspect critical aspects of the construction works;
- Verify that materials used in the works meet the specification;
- Review implementation of the construction programme;
- Provide clarification on technical detail;
- Review of contractor's quality control;
- Review of contractor's environmental control;
- Review of contractor's safety control.

3. DRAWING CONTROL SYSTEM

All drawings will be checked upon receipt against the accompanying drawing receipt note.

Items to be checked on the drawings so received will be the following;

- Drawing number
- Revision number
- Date of revision
- Date drawings received
- Quantities of drawings
- Legibility of drawing especially the scale
- Purpose of drawing, marked such as "APPROVED FOR CONSTRUCTION"

If the above has all been noted and recorded the drawing receipt will be signed returned to J&W and filed in the Quality Assurance (QA) file.

A complete Master Set, containing the latest drawings, that have been issued by the Engineer will be held in the Contractor's site office.

The drawings that have been superseded will be removed from this set and stored in a separate file, marked "Issued Drawings".

A drawing register will be maintained and displayed in the Contractor's site office.

4. TEST AND INSPECTION PLAN

4.1 Definition

The test and inspection plan defines:-

- The components, the portion of components and grouping of components that need to be approved and signed off on the test & inspection plan once complete. This is carried out using the Bill of Quantities as a basis.
- Action points as follows:-
    - Hold Point (H)

      A hold point is a point beyond which no further construction work will proceed until the parties specified has performed an inspection and accepted the work carried out to that date and time.

    - Witness Point (W)

      This is a point requiring the presence of parties specified to witness or inspect a process or procedure during execution (i.e. not continuous).

    - Monitor (M)

      This requires the presence of parties specified to witness or inspect a process or procedure during execution (i.e. continuous).

    - Verify by Review (R)

      To verify is to review documents, reports or test results such as a survey, delivery notes which includes the specifications of the material and calibration certificates, to ensure that the items that are to be verified fully comply in all respects with the project specifications and requirements of the project.

4.2 Implementation

Each action point is invoked by the Quality Control Officer issuing an Approved For Inspection notice. The outcome of the inspection is either acceptance or non-conformance. The following forms are applicable:-

- JW1: Approved for inspection and its register.
- JW2: Non-conformance. This form will be issued for each inspection that does not conform to the project specifications and construction drawings.
- JW3: Acceptance report. This form will be issued for each request for inspection that is signed off.
- JW4: Level and Setting-Out Control Report.
- JW5: As-built Changes. This form will be completed for each component that is signed off under JW3 that deviates from the project specifications and the design drawings.

5. CONSTRUCTION PROCEDURES

5.1 Incoming Material & Manufactured Items

In the execution of a project, materials will be delivered to site. This material must comply with the necessary specifications and have a designated storage area. Each load, or batch must be marked to ensure that it can be traced and found in the storage area.

All incoming material and manufactured items checklists are to be completed upon receipt of incoming material and manufactured items to check the suitability of the equipment and its subsequent storage and identification.

Weekly photographs of the storage area will be taken to keep a visual record of material usage.

5.2 Laboratory Testing

All testing procedures required are specified in the Project Specifications and are not repeated here.

5.3 Site Instruction Book

A Site Instruction, (SI) consists of any communication to the Site Agent to confirm, change, influence or to vary the works or activities on site.

All site instructions given to the Site Agent will be recorded in the Site Instruction book. The following will be recorded on a single page:-

- The date the instruction was given.
- A short and concise description of the instruction so given.
- The reference to what specification and drawing the instruction given.
- An indication as to when the instruction should be executed.
- An indication if the SI will invoke a Variation Order.
- J&W, the Client Project Manager and the Site Agent must all sign the Site Instruction.

The original page of the Site Instruction so given will be filed in the QCP file and maintained on site.

Each and every site instruction will be written on a single page.

5.4 Variation Order Register

Each Variation Order (VO) will have a number and this will together with the variation order be recorded in the VO register.

Each VO will indicate the VO type which could be a result of:-

- Additional work
- Omitted work
- Provisional sum
- Design change
- Specification change

Each VO would give a short description of the VO and also indicate the reference to the specific relevant construction drawings, Project Specifications and Bill of Quantities.

Each VO would be Recommended/Instructed by Jones & Wagener and approved by the Client.

Each such VO would then be signed.

The date each VO is received will be recorded in the VO register.

Each VO will be priced and the resultant of the pricing of the VO will be recorded in the last column, plus or minus which will be arithmetically added to show the nett effect to the original contact amount. This result will be shown as the revised contract amount.

This VO register will be maintained and kept in the contractor's site office.

Each VO must be preceded by a Site Instruction.

5.5 Site Diary

The following will be recorded in the triplicate site diary, on a single page, on a daily basis:

- Any rainfall on the site, measured in an approved rainfall gauge device or weather station.
- The general weather on site, clear, cloudy and possible rain as well as wind conditions and dust.
- Number and type of machines on site as well as their availability.
- Number of staff on site.
- Number of staff on leave.
- Any injuries on site regarding staff.
- Any staff disruptions or complaints.
- Any accidents on site, mechanical or personnel.
- Any breakdown or servicing of machines.

Each daily page of the site diary will be signed by the Site Agent and the Contracts Manager on a daily basis.

The site diary will be maintained and available on site at all times.

The original page of the site diary will be filed in the QCP on a daily basis.

5.6 Project Data

The following information will be kept:

- JW6: Drawing register. The register will show the revision number and date of issue of all drawings and will be issued at each progress meeting.
- JW7: Site Instruction register. The register will record all instructions to the contractor that clarifies the works information and/or initiates a deviation to the scope of work. The register will be presented for discussion at each progress meeting.
- JW8: Rainfall record. The rainfall record will be kept and be presented for discussion at each progress meeting.
- JW9: Daily Diary. The daily diary records work started, works completed, works suspended, production rates, incidents on site, changes in the contractor's resources,

visitors to site. The Daily Diary must be kept on site and signed on a daily basis by the Site Agent & Contracts Manager.

5.7 Progress Meetings

The meeting will involve:-

- General health and safety discussion where the basic safety statistics are presented and any interventions that may be required to ensure compliance to the Employer's specifications and the associated legal requirements.
- A presentation by the contractor on progress to date followed by a discussion on any intervention that may be required to expedite or delay the works.
- A discussion of all technical issues and their cost impact that were identified during the formal site visit preceding the actual meeting and all issues that were identified and/or resolved during the previous two weeks.
- All claims that were identified during the past period will be tabled for discussion.

Jones & Wagener will produce a set of comprehensive minutes of these meetings as well as produce inspection reports.

5.8 Method Statements

The following method statements will be required from the contractor as a minimum (further method statements may be required and these will be added at a later stage):

- Construction of general earthworks including sub soil drainage system and general surface water management;
- Construction of clay layers;
- Installation of geosynthetic layers including the primary geomembrane;
- Installation of the leachate collection layers;
- Construction of the permanent access ramp;

A method statement structure showing minimum required information can be found in Appendix C.

6. PROJECT CLOSE-OUT

6.1 As-built Drawings

As-built information will be used to update the drawings to show:-

- Layout changes;
- Level changes; and
- Detail changes.

The drawings will be updated once construction is completed and submitted to J&W for issuing to the Authorities and the Employer for archiving.

6.2 Construction completion report

The report will document:

- All significant design changes that were carried out;
- A summary of the documented quality records;
- All significant events that occurred during construction including delays, incidents;
- Completed program indicating defects liability periods and aspects to be monitored during this period; and
- All progress meeting minutes & project data & registers will be appended.

Document source: https://joneswagener.sharepoint.com/JonesWagenerProjects/6007DTCHLOORSITECOSTS/Shared Documents/21_ConceptDesign/REP/NorthernExp/Appendixes/D/6007-21_QCP-01_rA_cc_PCD.docx
Document template: Normal.dotm

APPENDIX A

TEST & INSPECTION PLAN

APPENDIX A - Table of Contents

Test and Inspection Plan

Client	EnviroServ Waste Management
Project	**Chloorkop Landfill Site: Phase 1A**
Job no.	6007-21
Date	22-Aug-19
Revision	A

Jones & Wagener
Engineering & Environmental Consultants
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Tel 00 27 (0)11 519 0200 Fax 00 27 (0)11 519 0201 email post@jawsco.za

H = HOLD POINT
W = WITNESS
M = MONITOR
R = REVIEW

ITEM	*SPECIFICATION*	*DESCRIPTION*	*UNIT*	*QTY*	*Specification (SABS; SANS or Proj Spec)*	*Acceptance Criteria*	*Record*	*Tests*			*Jones & Wagener*		*AGA*		*Contractor*	
								Type	*No. of req'd*	*No. of done*	*1*	*Signature*	*2*	*Signature*	*3*	*Signature*
		The following description below is a basic schedule of the works. However, the ITP should be aligned with the final contract schedule of works at commencement.														
1		**CHLOORKOP LANDFILL SITE: PHASE 1A**														
		Bulk Earthworks														
	SABS 1200 C	*SITE CLEARANCE*														
2.1	*8.2.1*	Clear and grub	m^2													
	SABS 1200 D	*EARTHWORKS*														
2.2	*8.3.1*	Remove topsoil to nominal depth 300 mm , stockpile and maintain;	m^3													
	SABS 1200 D	*EARTHWORKS*														
	8.3.2	*BULK EXCAVATION*														
2.3		a) Excavate to cell profile below layerworks as indicated on drawings.	m^3													
		b) Fill in embankments.	m^3													
	SABS 1200 DM	*EARTHWORKS (ROADS, SUBGRADE)*														
2.5	8.3.3	Treatment of subgrade														
		Scarify 200mm deep in cell basin, adjust moisture content and compact insitu material to depth of 300mm to 95% MOD. AASHTO at moisture content -2% to 2% of OMC	m^2													
		Subsoil Drainage														
	SABS 1200 DB	*EARTHWORKS (PIPE TRENCHES)*														
	8.3.2	Bulk Excavation														
2.6		Excavate in all materials and use for embankment or backfill or stockpile or dispose, as ordered														
		a) Subsoil herringbone system, 300mm x 600mm and stockpile	m^3													
	SABS 1200 DE	*SMALL EARTH DAMS*														
2.7	*8.3.5*	Forming Embankment, berms etc.														
		a) Place 600mm layer 19mm stone from commercial source within subsoil drain	m^3													
	SABS 1200 DK	*GABIONS AND PITCHING*														
2.8		Supply and install separation geotextile as per specification	m^2													
	SABS 1200L	*MEDIUM-PRESSURE PIPELINES*														
2.9	*8.3.1*	Supply, lay and bed pipes including all welding														

Client	EnviroServ Waste Management
Project	**Chloorkop Landfill Site: Phase 1A**
Job no.	6007-21
Date	22-Aug-19
Revision	A

Jones & Wagener
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R = REVIEW

ITEM	*SPECIFICATION*	*DESCRIPTION*	*UNIT*	*QTY*	*Specification (SABS; SANS or Proj Spec)*	*Acceptance Criteria*	*Record*	*Tests*			*Jones & Wagener*		*AGA*		*Contractor*	
								Type	*No. of req'd*	*No. of done*	*1*	*Signature*	*2*	*Signature*	*3*	*Signature*
		The following description below is a basic schedule of the works. However, the ITP should be aligned with the final contract schedule of works at commencement.														
1		**CHLOORKOP LANDFILL SITE: PHASE 1A**														
		a) HDPE pipes														
		Install perforated DN160 drain pipe	m													
		Install solid DN250 PE 100 outlet pipe	m													
		Liner System														
	SABS 1200 DE	*SMALL EARTH DAMS*														
2.10	*8.3.5*	Forming Embankment, berms etc.														
		a) Transport clay material from borrowpit, place and compact in four x 150mm layers compacted to 98% Standard Proctor maximum dry density at MC of +1 to +3% of OMC	m^3													
	SABS 1200 DB	*EARTHWORKS (PIPE TRENCHES)*														
	8.3.2	Bulk Excavation														
2.11		Excavate in all materials and use for embankment or backfill or dispose, as ordered														
		a) Excavate 600mm x 600mm anchor trenches for liner	m^3													
	SABS 1200 DE	*SMALL EARTH DAMS*														
2.12	*8.3.5*	Forming Embankment, berms etc.														
		a) Selected fill material to backfill anchor trenches	m^3													
	SANS 10409	*LINING*														
2.13		Supply and Install 1.5mm mono textured HDPE geomembrane	m^2													
2.14		Extrusion Welding	m													
2.15		Supply and install stainless steel brackets as detailed at inlets and outlets to facility.	Psum													
		Leachate collection layer														
	SABS 1200 DE	*SMALL EARTH DAMS*														
2.16	*8.3.5*	Forming Embankment, berms etc.														
		a) Place protection geotextile above liner system as per specification	m^2													
		b) Place 53mm drainage stone in leachate collection layer	m^3													
		c) Place sepearation geotextlie above leachate collection layer as per specification.	m^2													

Client	EnviroServ Waste Management
Project	**Chloorkop Landfill Site: Phase 1A**
Job no.	6007-21
Date	22-Aug-19
Revision	A

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H = HOLD POINT
W = WITNESS
M = MONITOR
R = REVIEW

ITEM	*SPECIFICATION*	*DESCRIPTION*	*UNIT*	*QTY*	*Specification (SABS; SANS or Proj Spec)*	*Acceptance Criteria*	*Record*	*Tests*			*Jones & Wagener*		*AGA*		*Contractor*	
								Type	*No. of req'd*	*No. of done*	*1*	*Signature*	*2*	*Signature*	*3*	*Signature*
		The following description below is a basic schedule of the works. However, the ITP should be aligned with the final contract schedule of works at commencement.														
1		**CHLOORKOP LANDFILL SITE: PHASE 1A**														
	SABS 1200L	*MEDIUM-PRESSURE PIPELINES*														
2.17	*8.3.1*	Supply, lay and bed pipes including all welding														
		a) HDPE pipes														
		Install perforated DN160 drain pipe	m													
		Install solid DN250 PE 100 outlet pipe	m													
		Supply and install liner penetration as shown on drawings complete with concrete support anchor block and HDPE plate	Psum													
	SABS 1200 DK	*GABIONS AND PITCHING*														
2.18		e) Supply and construct cement stabilised backing berm for leachate collection drain using selected sand, stabilised with 8% cement by mass.	m^3													
		f) Supply of cement for "e" above	t													
		Subsoil outlet manhole														
	SABS 1200L	*MEDIUM-PRESSURE PIPELINES*														
2.19	*8.2.14*	*MANHOLES*														
		a) Supply and Install Manhole 1200mm diameter chamber sections with sealing and sealants as detailed.	m^3													
		b) Manhole penetrations	t													
		c) Supply and install valve	No.													
	SABS 1200 G	*CONCRETE*														
2.20	*8.4.4*	Provide 100mm thick screed 15MPa, mass concrete, steel float finish.	m^3													
2.21	8.4.3	Cast Strength 35/19 Concrete base for Manhole reinforced with 2 layers mesh ref.888 at top and bottom	m^3													
		General														
2.22		Supply & install complete leachate tank to design and specification	Psum													

APPENDIX B

TEMPLATES

APPENDIX B - Table of Contents

Templates

Job No:	6007/21
Date:	
S/N:	

APPROVED FOR INSPECTION REGISTER

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

REQ. NO	DETAIL OF REQUEST	DATE & TIME		SIGNATURE	ACTION TAKEN		
		SUBMITTED	READY		DATE & TIME	REMARKS	SIGNATURE
		Date	Date		Date		
		Time	Time		Time		
		Date	Date		Date		
		Time	Time		Time		
		Date	Date		Date		
		Time	Time		Time		
		Date	Date		Date		
		Time	Time		Time		

Job No:	6007/21
Date:	
S/N:	

FAILURE REPORT

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE – PHASE 1A**

FAILURE REPORT NO :	

_____ _____
SIGNATURE OF RESPONSIBLE PERSON DATE

_____ _____
RECEIVED BY CONTRACTOR (NAME AND SIGNATURE) DATE

SECTION OF WORK INSPECTED (DETAILS AND POSITION)

.....
.....
.....

DESCRIPTION OF FAILURE

.....
.....
.....

CORRECTIVE ACTION AGREED

.....
.....
.....

_____ _____
SIGNATURE OF CONTRACTOR DATE

DISPOSAL

The following information to be completed for record purposes (if applicable)

☐ **REPAIR / REWORK / REPLACE** (refer to Corrective Action)

Site Instruction no : ……..

☐ **APPLICATION FOR A CONCESSION**

☐ **ACCEPT WITH CONCESSION**

Reference no of letter : …….

☐ **REJECT CONCESSION**

☐ **FAILURE CLOSED-OFF**

Concession no : …….

_____ _____
SIGNATURE OF RESIDENT ENGINEER DATE

FILE NO :	DISTRIBUTION :

Job No:	6007/21
Date:	
S/N:	

ACCEPTANCE REPORT

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE – PHASE 1A**

TEST RESULTS	Test Results: Test No:
CONDITIONAL ACCEPTANCE	Conditional Acceptance: [ ] Yes [ ] No State Conditions: Signature: Date:
ACCEPTANCE	Acceptance: Signature: Date:

Job No:	6007/21
Date:	
S/N:	

LEVEL AND SETTING OUT CONTROL REPORT

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE – PHASE 1A**

Description of Item/Area Surveyed and Drawing No:

Position	Design Height	As-Built Height	Dif +/-	Design Thickness	As-Built Thickness	Dif +/-	Design Slope	As-Built Slope	Dif +/-	Design Distance	As-Built Distance	Dif +/-	Remarks

Job No:	6007/21
Date:	
S/N:	

AS-BUILT DRAWING CHANGES

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

CONTRACT :	**PERSON :**	**PAGE NO :**
DESCRIPTION OF ITEM/AREA AND DRAWING NO :		
SKETCH OF ITEM/AREA WORKED AND/OR DETAILS OF WORK DONE :		

Job No:	6007/21
Date:	
S/N:	

DRAWING REGISTER

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

DRAWING NUMBER	DRAWING TITLE	REVISION NUMBER AND DATE ISSUED					
		0	1	2	3	4	5

Job No:	6007/21
Date:	
S/N:	

SITE INSTRUCTION REGISTER

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

NUMBER	DATE ISSUED	DESCRIPTION	COST IMPLICATION
			Y/N

Job No:	6007/21
Date:	
S/N:	

RAINFALL RECORD

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

Month:		**Year:**
Date	**Rainfall (mm)**	**Remarks**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

Job No:	6007/21
Date:	
S/N:	

DAILY SITE DIARY

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

RAIN : …….. mm ……º C Max ……º C Min

VISITOR :

NAME : COMPANY :

…….. ……..

…….. ……..

…….. ……..

…….. ……..

…….. ……..

…….. ……..

…….. ……..

CHANGES TO :

	ITEM	+	-
PLANT			
PERSONNEL			
OTHER			
OTHER			

INCIDENTS/ SAFETY :

……

……

Is the Contractor working safely? ☐ Y ☐ N

WORK STARTED/ RESTARTED/ COMPLETED

……

……

……

……

……

……

……

WORK TEMPORARILY SUSPENDED/ DELAYS / DISRUPTIONS / POTENTIAL CLAIMS :

……

……

GENERAL

……

……

Job No:	6007/21
Date:	
S/N:	

QUANTITY CALCULATION SHEET

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE – PHASE 1A**

Contract No:	Unit:		
Contractor:	Rate:		
Payment Item No:	Scheduled Quantity:		
Payment Item Description:	Final Quantity:		
	Over/(under) quantity:		
	Over/(under) R/c:		
Calculations & Comments	Interim Qty	Agreed Final Qty	Agreed Eng Contractor

Job No:	6007/21
Date:	
S/N:	

VARIATION ORDER REGISTER

CLIENT	**ENVIROSERV WASTE MANAGEMENT**	**DESCRIPTION**	**CHLOORKOP LANDFILL SITE : PHASE 1A**

NUMBER	DATE ISSUED	DESCRIPTION	COST IMPLICATION

APPENDIX C

METHOD STATEMENT TEMPLATE

APPENDIX C - Table of Contents

Jones & Wagener
Engineering & Environmental Consultants
59 Bevan Road PO Box 1434 Rivonia 2128 South Africa
tel: 00 27 11 519 0200 www.jaws.co.za email: post@jaws.co.za

Method Statement

DESCRIPTION	Construction of the EnviroServ Waste Management Chloorkop Landfill Site Phase 1A	JOB NO.	6007/21
FOR	General Earthworks	DATE	

1. PRELIMINARIES

1.1 Purpose and scope

Scope of activity.

1.2 Project reference and requirements

Type:	Reference:	Title:
Project specification		
Project Drawings		
General specifications		
Legislation		

1.3 Contractor reference and requirements

Type:	Reference:	Title:
Contractor specifications		
Other		

1.4 Method Statement Responsibilities

Responsibilities of:

- Establishing and maintaining Method Statement
- Safety
- Environmental
- Quality

1.5 Definitions

Define all new and activity specific terms.

2. INTRODUCTION

2.1 General

What does the method statement cover?

2.2 Sequencing of work

Sequential order of sub-activities.

2.3 Major quantities

Major quantities – tie into Bill of Quantities.

3. METHOD

3.1 Safety

Requirements of the Construction Regulations 2014.

3.2 Environmental

Requirements of the Environmental Management Programme.

3.3 Quality

Requirements of the specification.

Tie-in to Inspection and test plan.

3.4 Methodology

Detailed methodology of the activity.

Include specific requirements of project specification.

4. MEANS

4.1 Materials

List materials to be used.

4.2 Plant and equipment

List plant to be used.

4.3 Services and Subcontractors

List sub-contractors.

5. RESPONSIBILITIES

List persons responsible for specific sub-activities stated in the methodology.

Document source: https://joneswagener.sharepoint.com/JonesWagenerProjects/6007DTCHLOORSITECOSTS/Shared Documents/21_ConceptDesign/REP/NorthernExp/Appendixes/D/6007-21_MS-01_GeneralEarthworks.docx
Document template: Normal.dotm