NEWCASTLE MUNICIPALITY

# IDENTIFICATION AND PERMITTING OF A NEW LANDFILL SITE FOR THE NEWCASTLE MUNICIPALITY

## PRELIMINARY DESIGN REPORT

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# NEWCASTLE MUNICIPALITY

## PRELIMINARY DESIGN REPORT

## 1. INTRODUCTION

Envitech Solutions (Pty) Ltd have been appointed by the Newcastle Municipality to conduct a site selection process, the necessary geotechnical and geohydrological investigations, environmental authorizations, permitting and design of a new regional landfill site for Newcastle in KwaZulu-Natal. This report covers the preliminary design aspects of the proposed facility.

The Newcastle Municipality needs to develop a new landfill site due to the existing landfill site rapidly reaching its end of design life. Infrastructure that will be constructed as part of the landfill site includes an access road, internal haul roads, perimeter fencing, security gates and guard houses, weighbridges, stormwater management infrastructure, leachate management infrastructure, site offices, staff ablutions, wheel wash bays and a workshop.

Municipalities are required in terms of the Municipal Systems Act, 2000 (Act 32 of 2000) to assess all alternatives for the provision of sustainable and affordable services (including waste management services) to develop a licensed sanitary landfill site in order to promote the healthy environment as prescribed in the constitution of the country.

## 2. SITE LOCALITY AND DESCRIPTION

The preferred site for the proposed Newcastle Landfill Site is the Greenwich Farm, located approximately 10km to the South of Newcastle in KwaZulu-Natal (see Figure 1). The farm has been purchased by the Newcastle Municipality after being identified as a possible suitable site for the new landfill.

The Greenwich farm is approximately 844 ha and the proposed landfill site occupies an area of about 180 ha and will comprise of the following infrastructure:

- Access Controlled Entrance;
- Access Roads;
- 2 No. 18m Weighbridges;
- Administration Offices;
- Recycling/Transfer Area;
- Leachate Management System;
- Wheel Wash/Workshop Area;
- Cover Material Stockpile Area;
- Landfill Cells (to be developed in phases);
- Future Leachate Treatment Plant and
- Future Landfill Gas Extraction and Utilization Plant

The site is relatively flat with an average slope of approximately 4% in the North-South and East-West directions.

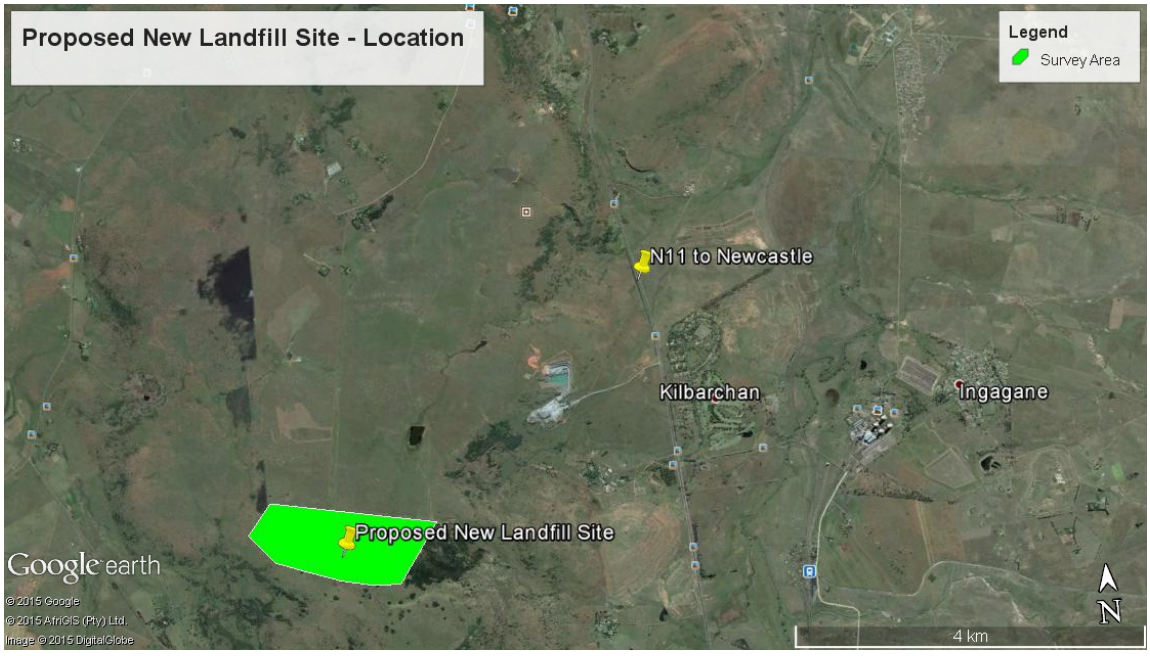


**Figure 1: Location of Proposed New Landfill Site**

## 3. GEOLOGY

The Newcastle area is underlain by consolidated sediments of the Ecca Group and Beaufort Group of the Karoo Group. The bedrock underlying the immediate vicinity of the town comprises shale and sandstone of the Vryheid Formation. To the west of the town, shale and mudrock of the Volkrust Formation and Adelaide Subgroup respectively outcrop as elevations begin to increase. These bedrock formations are relatively flat lying and present a stratigraphic succession with increasing elevation.

Karoo Igneous Province dolerite extensively intrudes the bedrock of the region in the form of both dolerite dykes and sills. The dolerite sills, as shown by the available geological maps, are fairly extensive, intruding large areas. Much of the Greenwich Farm is underlain by dolerite intrusions.

The soils in the study area are derived from weathering of the underlying geology, with the outcrops of Quaternary Sands along river beds. The residual soils are generally comprised of silty to occasionally sandy clays and clayey silts, however profiles are usually not extensive, with typical depths in the region of 0.45m to 0.75m, or perhaps slightly more, within a 15km radius of Newcastle. Weathering profiles in the sediments are generally shallow, except in the zones where seepage occurs, whilst dolerite sills are occasionally weathered to depths of over 5m.

### 3.1 Geotechnical Investigation

The field work for the detailed geotechnical investigation was carried out on 19 February 2014 by Geomeasure and comprised the excavation and profiling of sixteen (16) trial pits to a maximum depth of 2.53m below ground level across the investigate area of the proposed landfill site. The soil profiles exposed in these pits were logged and the trial pits were subsequently backfilled with a TLB (backacter). The test pits positions were recorded with a hand held GPS and are located on the site layout plan of the Geotechnical Report (Appendix 2) Figure.

Six (6) soil samples were sent to a geotechnical laboratory for full indicator tests as follows:

- Two (2) samples for natural MOD AASHTO analysis,
- Two (2) samples for constant head permeability tests,
- Two (2) samples for consolidated slow-drained shear tests.

Based on the laboratory test results, a 95% compacted modified AASHTO maximum dry density of 1650kg/m$^3$ and average optimum moisture content of 18.5% are recommended for the near surface soil cover material. The table below shows the results of the consolidated slow-drained shear test results.

| Test Parameters & Results | TP 12 – Silty Gravel | | | TP 15 –Silty Clay | | |
|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Test 1 | Test 2 | Test 2 |
| Normal Stress (kN/m$^2$) | 100 | 200 | 300 | 100 | 200 | 300 |
| Dry Density (kg/m$^3$) | 1653 | 1653 | 1653 | 1472 | 1472 | 1472 |
| Moisture Content (%) | 18.4 | 18.4 | 18.4 | | | |
| Shear Strain (%) | 4.6 | 7.7 | 11.8 | 3.9 | 7.1 | 9.9 |
| Shear Stress (kN/m$^2$) | 98.0 | 162.1 | 242.4 | 103.8 | 155.8 | 204.5 |
| **Shear Strength Parameters** | | | | | | |
| Angle of Internal Friction (φ) | 36 | | | 27 | | |
| Cohesion (kPa) | 23 | | | 54 | | |

**Table 1: Slow-Drained Shear Test Results**

### 3.2 Slope Stability

The consolidated slow-drained shear tests carried out during the Geotechnical Investigation returned an angle of friction of 27$^0$ and cohesion value of 54 kPa for the sampled silty clays underlying the majority of the proposed landfill footprint. The site is relatively level with a gentle slope and therefore slope stability issues are not anticipated within the existing soil profile. Nonetheless, it is recommended that excavation and fill slopes within the prevalent soil materials should not exceed 1 vertical: 1,5 horizontal (34%).

### 3.3 Soil Permeability

From the Geotechnical Investigation carried out by Geomeasure Group in 2014, permeability tests were carried out on the soil samples retrieved from the various test pits excavated on the site. The results of the permeability tests are shown in Table 2 below.

| Physical Properties | TP 12 Silty Gravel | TP 15 Silty Clay |
|---|---|---|
| Measured Permeability (cm/s) | $1.461 \times 10^{-6}$ | $3.659 \times 10^{-8}$ |
| Measured Permeability (cm/day) | $1.262 \times 10^{-1}$ | $3.161 \times 10^{-3}$ |
| Measured Permeability (cm/month) | 3.787 | $9.484 \times 10^{-2}$ |
| Measured Permeability (cm/year) | 45.443 | 1.138 |
| Empirical Leakage rates (cm/year) (0.6 m thick liner / 0.3 m head above the liner) | 23 | 1 |

**Table 2: Time-Calculated Permeability Results**

It can be seen that should any leachate breach the landfill liner, it would migrate at a rate of approximately 0.45m per year in the silty gravels, yet only approximately 1cm per year in the silty clays. As silty clays are more prevalent across the site, there is little perceived risk of groundwater contamination. Based on the assessment of the geohydrological data, should the lining system be breached the potential contaminants from the landfill would take approximately 1830 years to reach the nearest dam which is 1km from the proposed site.

## 4. GROUND WATER INVESTIGATION

### 4.1 Borehole Drilling

2 No. new monitoring boreholes were drilled on 7 April 2014 by Messrs. Duckworth Drilling to assess the existing ground water conditions. The details of the boreholes drilled are summarized in Table 3 below.

| BH No. | Latitude | Longitude | Depth (m bgl)* | Steel Casing (m) | Plain uPVC Casing (m) | Slotted uPVC Casing (m) | Water Strikes (m bgl) | Blow Yield (l/hr) |
|---|---|---|---|---|---|---|---|---|
| NL 1 (Up-gradient) KZN 140114 | $27^0$ 51' 20.01" S | $29^0$ 55' 12.85" E | 60.00 | 10.00 | 35 | 25 | 48 | 1 000 |
| NL 2 (Down-gradient) KZN 140115 | $27^0$ 50' 49.48" S | $29^0$ 55' 15.75" E | 60.00 | 3.00 | 37 | 23 | Seepage | Seepage |

** m bgl = meters below ground level*

**Table 3: Summarized borehole location and construction details**

The drilling exercise included the installation of 1 up-gradient (NL 1) and down-gradient (NL 2) borehole to assess the current ground water condition and also to monitor ground water after the commissioning of the proposed landfill site. A pump test was conducted on NL 1 on 7 May 2014 but NL 2 only intercepted seepage and therefore there was inadequate volume to conduct a pump test. Geomeasure Group returned to the

Greenwich Farm on 16 April 2015 to assess the static water levels in borehole NL 1 and NL 2. The results are shown in Table 4 below:

| Monitoring Borehole | SWL* (m bgl) | |
|---|---|---|
| | 07-May-14 | 16-Apr-15 |
| NL 1 (Up-gradient) | 16.00 | 24.07 |
| NL 2 (Down-gradient) | (dry) | 21.72 |

* SWL – static water level

**Table 4: Borehole Static Water Levels**

### 4.2 Pump Testing

The pump testing compromised a 12 hour calibration and monitored recovery pump test which comprised pumping the borehole at varying pump rates until the water level drawdown in the borehole starts to stabilize.

The pump data and management recommendation sheet can be found in Appendix 3 of this report.

## 5. SITE CLASSIFICATION

The proposed new landfill site in the Newcastle Municipality area, will only accept general waste and therefore have a "G" classification based on the Minimum Requirements for Waste Disposal by Landfill, Second Edition 1998. This waste will comprise mostly domestic waste, garden waste, commercial and building waste as well as non-hazardous industrial waste and will therefore only accept Type 2 waste as per R636.

The proposed site is estimated to have sufficient capacity for approximately 42 years using the following parameters:

- An estimated initial rate of deposition of approximately 375 tonnes/day
- An annual growth rate of 3.0%
- Land-filling operations of 260 days / year
- Compacted waste density of 1000kg/m$^3$
- An average vertical waste body height of 40m

- A final waste volume of approximately 17.772 million $m^3$
- A landfill footprint area of approximately 55 ha.

It is anticipated that the landfill will have a maximum deposition rate (MRD) of approximately 1234 tons/day and will therefore be classified as a large (L) site according to the Minimum Requirements.

The water balance for the region, based on the seasonal rainfall and evaporation as transcribed by the Minimum Requirements of DWA, indicates a rainfall surplus for the region, such that leachate will be produced. The data shows that the average precipitation for the wettest six months for the area is approximately 600mm/annum to 800mm/annum and the average evaporation 490mm/annum based on 10 years of data. In terms of the above information, the site would have a rainfall surplus and should be designed and permitted as a General (G), Large (L) site with a positive water balance ($B^+$), or $G:L:B^+$ facility. While according to the DEA National Environmental Management: Waste Act (2008) National Norms and Standards for Disposal of Waste to Landfill, this equates to a Class B landfill.

## 6. SITE DEVELOPMENT PLAN

A site development plan has been compiled and consists of the following prepared infrastructure:

- Access road, perimeter service road and on-site roads;
- Perimeter fencing and entrance gate and control;
- Stormwater drainage measures;
- Office, ablutions and stores building;
- Weighbridges;
- Recycling yard and transfer area;
- Future Composting yard;
- Landfill cells;
- Pollution Control Dam;
- Future Leachate Treatment Plant;
- Future Landfill Gas Extraction and Utilization Plant and
- Workshop and Wheel Wash Bays

### 6.1 Site Layout and Design Drawings

A3 copies of drawings referred to in the design report and included in Appendix 1 include the following:

207-2008-1-Rev1 : Site Layout Plan Showing Greenwich Farm Boundary Coordinates
207-2008-2-Rev1 : Site Layout Plan
207-2008-3-Rev1 : Aerial Image Showing Proposed Landfill Development & Existing Fenceline
207-2008-4-Rev1 : Site Plan Showing Buffer Zone
207-2008-5-Rev1 : Landfill Cells Layout Plan Showing Leachate Collection Systems
207-2008-6-Rev1 : Typical Section of Cell 1 Showing Liner Detail
207-2008-7-Rev1 : Typical Details of Cell 1
207-2008-8-Rev1 : Typical Section and Details of the Pollution Control Dam
207-2008-9-Rev1 : Typical Details
207-2008-10-Rev1 : Proposed Landfill Gas Recovery and Utilization Plant
207-2008-11-Rev1 : Proposed Leachate Treatment Plant
207-2008-12-Rev1 : Proposed Access Road from the N11
207-2008-13-Rev1 : Cell 1 Rehabilitation and Closure Plan Showing Details and Typical Section

### 6.2 Landfill Site Life Calculation

A summary of the landfill site life calculation is presented below. This is based on a maximum disposal rate of 445 000 tonnes/annum.

| Cell No. | Gross Airspace Capacity ($m^3$) | Cover Material Requirement ($m^3$) | Nett Airspace Available ($m^3$) | Life of Cell (years) |
|---|---|---|---|---|
| 1 | 1 244 000 | 311 000 | 1 555 000 | 6.0 |
| 2 | 1 453 000 | 363 000 | 1 816 000 | 6.0 |
| 3 | 1 819 000 | 455 000 | 2 274 000 | 6.0 |
| 4 | 2 186 000 | 546 000 | 2 732 000 | 6.0 |
| 5 | 2 423 000 | 606 000 | 3 029 000 | 6.0 |
| 6 | 2 957 000 | 740 000 | 3 697 000 | 6.0 |
| 7 | 3 568 000 | 892 000 | 4 460 000 | 6.0 |
| **Totals:** | **15,650,000 $m^3$** | **3,913,000 $m^3$** | **19,563,000 $m^3$** | **42 years** |

**Table 5: Summary of airspace / site life calculation**

The estimated airspace required is 19, 563, 000 $m^3$ using the initial rate of deposition of 375tonnes/day and an annual growth rate of 3.0%. The density of the landfilled waste was assumed to be 1000kg/$m^3$.

### 6.3 Phased Landfill Development

A Digital Terrain Model (DTM) has been used to obtain the maximum airspace volume for the proposed landfill. The height of landfill has been limited to a proposed height of 40 m above natural ground level.

The area to be developed for landfilling is subdivided into seven (7) cells as shown in Drawing No. 207-2008-5-Rev 1. The construction of these cells will be in seven (7) distinct phases with each cell being constructed, landfilled and covered separately, starting with the construction and operation of Cell No. 1. Each cell has been sized to have airspace for approximately 6 years taking into consideration the annual growth rate.

Cell No.1 will be landfilled to a height of approximately 20m when construction and landfilling will need to commence in Cell No. 2 to allow for landfilling to the final height of 40m. This is needed to maintain the required side slopes of 1V:3H (see Drawing No. 207-2008-6-Rev1 for details).

### 6.4 Cell Construction

Cells will be constructed by excavating into the natural ground for achieving the design elevation of the basal area of the cells and filling to form berms and embankments and the outer perimeter of the cell side slopes where required. The cell embankment will be 2m high and the basal area will have a cross fall of approximately 2% to allow for leachate drainage into the leachate collection system. Excavation of the basal area of each cell will not exceed 2m below natural ground level at the lowest point as the geotechnical report showed that large boulders may be present.

### 6.5 Waste Deposition and Compaction

Waste deposition will be conducted in adherence with the proven sanitary landfill principles as per the DWA Minimum Requirements of spreading, compacting and daily covering of waste. In order to reduce the volume of exposed waste to rainfall and the environment and to afford the best compaction, operational cells will be as narrow as conditions permit. The incoming waste tonnage and number of vehicles accommodated during the operating day will determine the practical size of the day to day operating cell.

The waste deposited within a working cell shall be worked up a 1 in 3 slope and spread in a 300mm – 400mm thick layer and shall be compacted with a minimum of three passes with a 25 ton landfill compactor.

At the end of each working day all waste must be contained within the working cell. The entire waste surface shall then be enclosed by cover material having a minimum compacted thickness of 150mm and a maximum compacted thickness of 250mm above the mean surface of the waste. In areas not utilized for landfilling purposes for an extended period of time, intermediate cover with a thickness of 300mm must be placed over the waste body.

### 6.6 Cover Material

Daily cover material will be sourced from the adjacent future cell and the cover material stockpile from the excavation for the working cell. Cover material should be placed and compacted daily in a ratio of 1 part cover material to 4 parts waste.

The estimated quantity of cover material required over the expected life of the landfill is 3,913,000 $m^3$ based on a 1:4 cover ratio. Approximately 1,100,000 $m^3$ of cover material will be available from the excavation for the landfill cells and the remaining 2,813,000$m^3$ will be sourced from other areas within the Greenwich Farm boundary.

### 6.7 Buffer Zones and Mitigation Screens

The position of the landfill site allows for the following minimum buffer zones to the Greenwich Farm boundary from the proposed landfill footprint:

Northern Buffer – 300m
Southern Buffer – 1000m
Eastern Buffer – 900m
Western Buffer – 400m

Please refer to Drawing No. 207-2008-4-Rev1 highlighting the Buffer Zone.

Due to the topography of the site the landfill cells were positioned closer to the North Western side of Greenwich Farm. This resulted in a reduced buffer on the north and western sides of the landfill site. To mitigate any negative effects of the reduced buffer, mitigation screens by the form of vegetative and physical screens, are proposed on these boundaries. The details of these screens will be confirmed during the detail design phase.

## 7. SITE INFRASTRUCTURE

The selected site currently comprises entirely of vacant land with scattered vegetation and farming plots. There is no existing site infrastructure and no ongoing site operations currently taking place on the proposed site.

In addition to the landfill cells, the site infrastructure to be constructed will comprise the following:

Site Access and Internal Roads – It is proposed that these roads be constructed with an asphalt wearing surface. Details for the site access and internal roads will be confirmed during the detail design stage. The typical section and proposed alignment of the site access road can be found on Drawing No. 207-2008-12-Rev1.

Perimeter Fence and Access Control – The proposed perimeter fence will be a 2.4m high concrete palisade fence to prevent unauthorized entry to the site. The entrance to the site will be access controlled with a proposed security building.

Stormwater Management System – The stormwater drainage consists of a clean stormwater management system and contaminated stormwater management system. The contaminated stormwater management system will collect all runoff from uncapped side slopes of the landfill cells and will be directed to the pollution control dam by means of HDPE lined open drains and collection pipes. The clean stormwater will be directed by open earth/concrete drains and discharged downstream. Should there be a need for collection and storage of clean stormwater, for possible dust suppression, an allowance has been made for the future construction of a clean stormwater pond. The drains, dams and ponds will be designed for a 1 in 50 year return period with a minimum 500mm freeboard.

Administration Building – The site will comprise offices for the administrative staff, a laboratory, as well as ablution facilities, a boardroom, change rooms and a parking area.

Weighbridge – 2 No. 18m long weighbridge will be provided to capture the tonnages of all incoming waste streams. The waste data will be captured on a computer using software provided by the weighbridge supplier. The waste data will then be forwarded and captured on the SAWIS.

Recycling/ Transfer area – The recycling/ transfer area will comprise a hard stand/surface area for the stockpiling of recyclables and a steel portal frame roof structure for the sorting and storage of recyclable materials under all weather conditions.

Pollution Control Dam (PCD) – The pollution control dam will be constructed with the required lining system according to the minimum requirements. All storm water run-off from within the waste disposal facility, which may be potentially contaminated together with the leachate generated by the landfill will be discharged in the pollution control dam. The leak detection system will drain to 4 No. detection manholes located at the each corner of the PCD. During the initial stages of leachate generation from the waste body, the leachate quality and quantity will be assessed and an appropriate management option will be selected. The possible options include, sewer discharge, tankering to sea outfall and possible future leachate treatment.

Wheel Wash/ Workshop Area – The wheel wash/ workshop are will comprise of a steel portal frame roof structure on a concrete platform with 1 No. wheel washer to clean

disposal trucks and plant before they exit the landfill site. A workshop are will allow for the on-site maintenance of plant used in the operations of the landfill.

Preliminary Design / proposed construction details of the above infrastructure are given in the attached design drawings as listed in Section 6.1 above. It must be noted that these details may change during the detail design phase of this project.

## 8. LANDFILL CELL CONSTRUCTION

### 8.1 Landfill liner system

The landfill will have engineered liners for the base as well as for the side slope. Proposed details for the landfill liner are as follows:

Proposed Landfill Basal Liner Detail (listed from waste surface to the in-situ base):

- 1m selected waste to ensure free drainage
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 200g/m²
- 300mm thick 53mm crushed rock aggregate to leachate drainage layer
- Needle punched nonwoven geotextile as protection layer, minimum nominal mass 1000g/m²
- 100mm sand as protection layer
- 2.0mm thick double sided textured HDPE liner (coarse texture down)
- Geosynthetic Clay Liner
- 200mm thick base preparation layer rip and re-compacted to 100% of Standard Proctor Density at OMC to OMC + 2% (In-situ clay layer) with subsoil drains

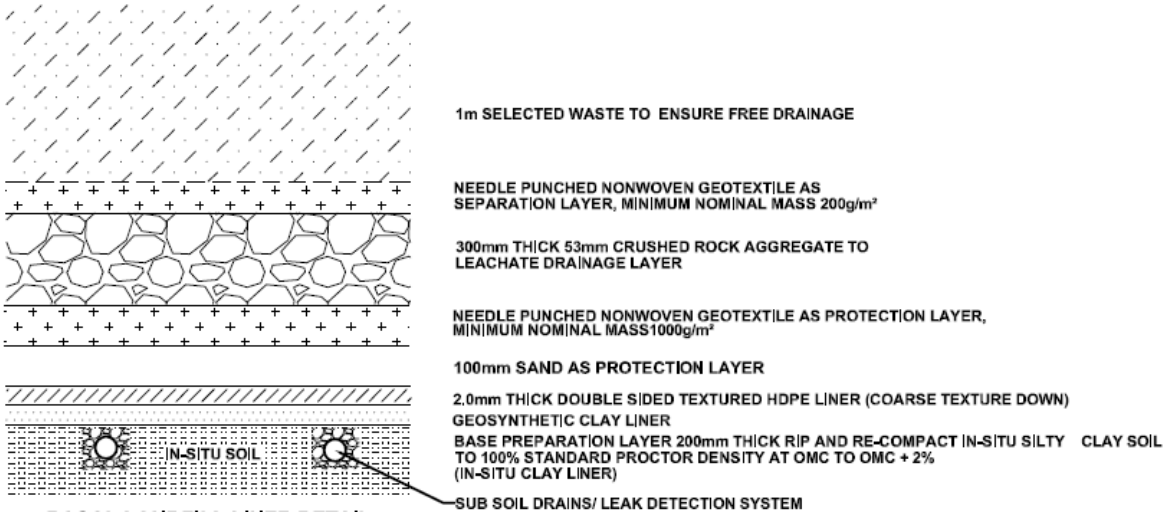


**Figure 2. Landfill Basal liner details**

Proposed Landfill Side Slope Liner Detail (listed from waste surface to the in-situ base):

- 1m selected waste to ensure free drainage
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 200g/m²
- 300mm thick 53mm crushed rock aggregate to leachate drainage layer
- Needle punched nonwoven geotextile as protection layer, minimum nominal mass 1000g/m²
- 2.0mm thick double sided textured HDPE liner (coarse texture down)
- Containment Berm constructed of Clayey soil

Based on the above liner configurations and the average cell slope lengths of 11m, the Factor of Safety is greater than 1.5. Please refer to Appendix D.

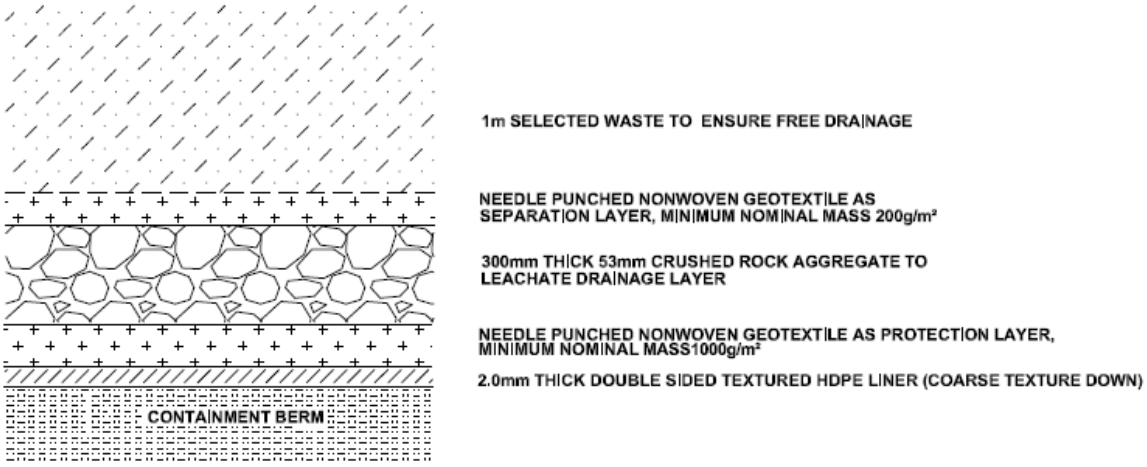


**Figure 3. Landfill Side Slope liner details**

### 8.1.1 Liner Quality Control and Assurance

Manufacturer's Qualifications:

The manufacturer of geomembrane of the type specified or similar product shall have at least five years' experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 1,000,000 $m^2$ of the specified type of geomembrane or similar product during the last five years. All products supplied must have quality assurance documentation as per the GRI GM13 specification for the test methods, test properties and test frequencies of the HDPE geomembrane.

Installer's Qualifications:

- The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative/CQA Officer to install the geomembrane.
- The Installer shall have installed HDPE 2 mm geomembrane material for at least (3) completed landfill projects of comparable scope and complexity in the last (5) years having a total minimum area of 500,000 $m^2$. The installer must be certified / authorized by geomembrane manufacturer.
- The Installer shall have installed GCL material for at least (3) completed landfill projects of comparable scope and complexity in the last (5) years having a total

minimum area of 500,000m$^2$ of the proposed GCL. The installer must be certified / authorized by a GCL manufacturer.

- Installation shall be performed under the direction of a Field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs and all other activities of the Geomembrane Installer. The Installer shall appoint a certified site supervisor and a certified master seamer with a minimum experience of respectively 1,000,000 m² and 500,000 m² of GCL, geomembrane and protection geotextile installation. Both should read, speak and write English fluently. The Installer shall be approved by the Manufacturer.
- All seaming, patching, other welding operations and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

Delivery, Storage and Handling and Installation:

<u>Geotextile:</u>

The geotextile shall be delivered to site in rolls covered with an opaque plastic sheet to prevent damage from sunlight and should be stored as per the supplier's specification.
The geotextile shall be held in place with sandbags to prevent wind uplift. Care should be taken not to drag the geotextile on the leachate drainage layer, as this could damage the material.

Where the geotextile is being placed onto the geomembrane and underlying geosynthetics, it shall be deployed by hand so as not to damage the geomembrane and geosynthetics in any way. Special care shall be taken by the Installer to prevent damage of the geomembrane and underlying geosynthetics. The geotextile shall be held in place with sandbags to prevent wind uplift.

All rolls (placed alongside one another or end-on-end) shall overlap by a minimum of 300mm or be sewn with a polyester thread or shall be heat bonded along overlapping edges, or all three methods, as per the supplier's specification.

A minimum thickness of 300mm of cover shall be kept between heavy equipment and the geotextile at all times.

No construction traffic shall be allowed directly on any of the laid geotextile.

One properly identified 600 by 600 mm minimum size geotextile sample is to be submitted at the beginning of the Contract. The geotextile sample is intended for visual demonstration prior to product delivery.

Geocomposite Drain Layer:

The geocomposite drain layer shall be delivered to site covered with an opaque plastic sheet to prevent damage from sunlight and should be stored as per the supplier's specification.

The geocomposite drain layer is to be installed as per the supplier's specifications and shall be deployed by hand, however extreme care must be taken not to damage any subsoil drains below.

HDPE Geomembrane:

Material Delivery:

The engineer or his representative should be present, whenever possible, to observe the material delivery and unloading on site. The engineer or his representative is to note any material received in a damaged state and to remove any necessary conformance samples. Upon mobilisation on site, the contractor shall:

- Verify that the equipment used on site is adequate and does not present a risk of damage to the geomembrane or other materials,
- Mark rolls or portions of rolls which appear damaged,
- Verify that storage of materials ensures adequate protection against dirt, theft, vandalism, passage of vehicles and that the storage area is dry, ventilated and not exposed to direct sunlight,
- Ensure that rolls are properly labeled and that labeling corresponds with quality control documentation,
- Ensure that roll numbers, date, roll size and any damage are logged on the material delivery checklist.

Geomembrane Installation:

*Earthworks*

The contractor shall be responsible for preparing and maintaining the base preparation layer and GCL layers in a condition suitable for the installation of the geomembrane liner.

The base preparation layer shall be free of any sharp stones greater than 5mm and shall be finished to a level standard such that no step greater than 10mm, nor a gap greater than 20mm, can be measured beneath a 3m straightedge, particularly at construction joints as directed by the engineer on site.

.

*Surface Acceptance:*

Immediately prior to the placement of the geomembrane liner, the surface shall be moistened and swept clean by the contractor. The installer shall provide the contractor with a written acceptance of the surface to be lined. Subsequent changes or repairs to the subgrade and the surface shall remain the responsibility of the contractor.

*Anchor Trenches:*

The anchor trenches, if required, shall be excavated by the contractor to line and widths shown on the design drawings, prior to the geomembrane liner placement.

Anchor trenches excavated in clay soils susceptible to desiccation cracking should be excavated only for the length required for that day's geomembrane liner placement

Corners in the anchor trenches shall be slightly rounded where the geomembrane liner adjoins the trench in order to minimise sharp bends in the geomembrane liner.

*Field Panel Placement:*

Geomembrane liner deployment will not be carried out during any precipitation, in the presence of excessive moisture, in an area of standing water or during high winds.

The method and equipment used to deploy the panels must not damage the geomembrane liner or the supporting subgrade surface.

No personnel working on the geomembrane liner will wear shoes that can damage the geomembrane liner or engage in actions which could result in damage to the geomembrane liner.

When using welding/seaming equipment, a protection sheet shall be placed on the geomembrane liner and used as a working surface. All tools and equipment shall be placed on this sheet when not in use.
Adequate temporary loading and/or anchoring (i.e. sand bags, tyres), which will not damage the geomembrane liner, will be suitably placed to prevent wind lifting up the geomembrane liner.

The geomembrane liner will be deployed with enough slack to allow for typical thermal effects. Measures should be taken to prevent and / or accommodate wrinkling of the geomembrane liner resulting from its dimensional instability.

Any area of a panel seriously damaged (torn, twisted or crimped) will be marked and repaired in accordance with clauses elsewhere in of this specification.

The use of steel pegs driven through the geomembrane liner, as a means of securing it in anchor trenches, will not be permitted.

Irregular panels shall be cut so as to allow adequate overlaps for seaming.

*Geomembrane Field Seaming:*

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam as described in the specifications.

Factors such as the geomembrane temperature, humidity, wind, precipitation, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Test seams are required prior to daily production to determine if the weather conditions will affect the contractor's ability to produce quality

seams. Additional non-destructive and destructive testing of production seams will be carried out to substantiate the decision made by the contractor to seam on any given day.

### 8.2 Leachate Collection System

Provision have been made for the collection of leachate generated from the landfill cell operations using 2 No. perforated 160mm OD HDPE pipes in each cell. The pipes will be installed across the length of the cell and all leachate collected will drain into a leachate collection sump, positioned at the lowest point of the cells, from which it will flow via the leachate delivery pipes to the pollution control dam.

The pollution control dam will have engineered liners for the base as well as for the side slope. Proposed details for the pollution control dam liner are as follows:

Pollution Control Dam Basal Liner Detail (listed from surface to the in-situ base):

- Geocell or similar with 150mm stabilized sand as protection layer
- 2.0mm thick double sided textured HDPE liner (coarse texture down)
- Geosynthetic Clay Liner
- 100mm sand as cushion layer
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 200g/m²
- 150mm thick clean sand to leak detection layer
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 400g/m²
- 100mm sand as cushion layer
- 1.5mm thick mono-textured HDPE liner
- Geosynthetic Clay Liner
- 200mm thick base preparation layer rip and re-compacted to 100% of Standard Proctor Density at OMC to OMC + 2% (In-situ clay layer)

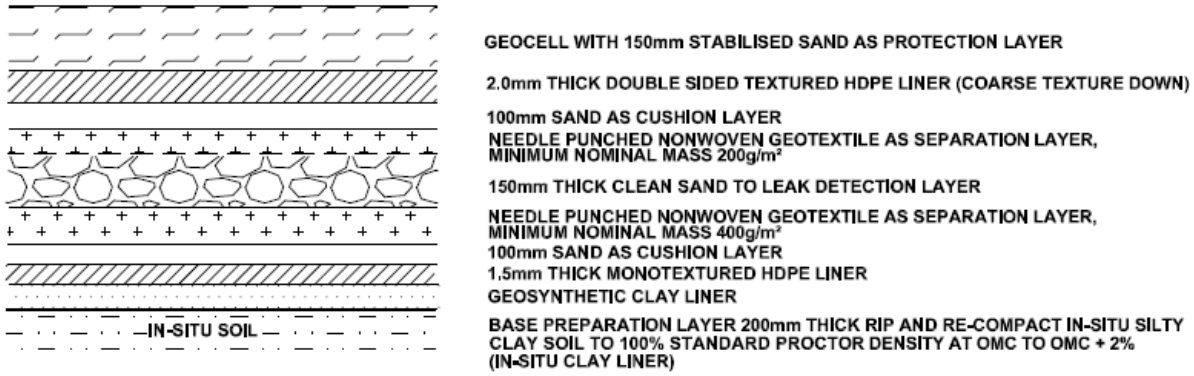


**Figure 4. Pollution Control Dam Basal Liner Detail**

Pollution Control Dam Side Slope Liner Detail (listed from surface to the in-situ base):

- Geocell with 150mm stabilized sand as protection layer
- 2.0mm thick double sided textured HDPE liner (coarse texture down)
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 200g/m²
- Geonet or similar to leak detection layer
- Needle punched nonwoven geotextile as separation layer, minimum nominal mass 200g/m²
- 1.5mm thick mono-textured HDPE liner
- Geosynthetic Clay Liner
- Dam Embankment Constructed of Clayey Soil


**Figure 5. Pollution Control Dam Side Slope Liner Detail**

### 8.3 Leachate Detection System

The leachate leak detection system located between the HDPE lining layers will consist of a Geonet or similar layer. If the upper barrier layers are breached then the potential contaminant will be collected in this layer and drained via a network of HDPE pipes to 4 No. leak detection manholes located at the corners of the pollution control dam. This manhole will be inspected on a regular basis.

### 8.4 Stormwater Management

DWA requires that stormwater runoff should be managed so that un-contaminated and contaminated stormwater flows are kept separate from each other. Un-contaminated stormwater must be diverted around the site whilst the contaminated stormwater runoff must be contained on site.

Contaminated stormwater runoff emanating from within the site will be collected and discharged into the leachate collection and evaporation dam while clean stormwater will be diverted around the waste body and discharged downstream.

## 9. SITE MONITORING

### 9.1 Groundwater Monitoring

Presently there are two groundwater monitoring boreholes on site which were drilled during May 2014 by Duckworth Drilling and supervised by Geomeasure Group as part of the geohydrological investigations for the site. The position of these boreholes can be seen on Drawing No. 207-2008-1-Rev1.

Initially, sampling and analyses of all the boreholes will be used to establish the background quality of the groundwater prior to construction of the waste disposal facility. In borehole NL 1 ground water was encountered at 48m below ground level and in borehole NL 2 only seepage was intercepted. The static water level in NL 1 then stabilized at 16m below natural ground level. Geomeasure Group then went back to the site in April 2015 to carry out sampling and analysis on the ground water in each borehole and found the static water level to be 24m and 22m in NL 1 and NL 2 respectively. The results of all the testing to determine the background quality of the

ground water can be found in the Geohydrolocial Investigation Report and the Follow-Up Groundwater Monitoring and Sampling Event Report compiled by Geomeasure Group in June 2014 and July 2015 respectively and referenced 2012/328.

For the environmental monitoring of the site, borehole NL 1 and NL 2 is proposed to be used to monitor the impact of the landfill on the groundwater quality. Groundwater monitoring will be carried out as per the permit requirements.

The monitoring borehole details are given in Table 6 below:

| Borehole No. | Depth (m) | Latitude | Longitude |
|---|---|---|---|
| NL 1 (up-gradient) | 60 | $27^0$ 51' 20.01"S | $29^0$ 55' 12.85"E |
| NL 2 (down-gradient) | 60 | $27^0$ 50' 49.48"S | $29^0$ 55' 15.75"E |

**Table 6: Groundwater Monitoring Boreholes**

### 9.2 Surface Water Monitoring

Surface water sources within a 2km radius of the site include 2 streams and 1 dam. During the geohydrological investigation the 2 streams were found to be dry. The dam is located approximately 1km from the proposed site and monitoring will be conducted as per the minimum requirements.

### 9.3 Landfill Gas Monitoring

Landfill gas (LFG) will be generated from the biodegradation of the landfilled waste. LFG can result in an explosion hazard where methane gas reaches concentration of between 5% and 15% of atmospheric gas composition. Monitoring of the LFG should be conducted once the landfill has been operational for a period of time to determine the volume of gas produced on site to determine whether the methane concentration falls within the explosive limit range and to determine the migration characteristics of the gas from site.

Landfill gas monitoring should form part of the regular site auditing process in accordance with the DWA Minimum Requirements and the permit conditions. Provision has been made in the preliminary design for a landfill gas extraction and utilization plant

but the site conditions will have to be assessed once the site is operational to assess the feasibility of such an option.

Provision has also been made for the installation of landfill gas monitoring probes around the perimeter of the site and this will allow regular monitoring for landfill gas to assess if there is any migration and remedial action required.

### 9.4 Air Quality Monitoring

Hazardous pollutants may be dispersed from the landfill site as dust or as a gaseous substance and will have to be monitored during the operational period of the site. Regular sampling of areas where dust is created must be conducted and analyzed for all possible sources of hazardous substances as per the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

### 9.5 Technical and Environmental Audits

A responsible appointed official should carry out regular audits and inspections of the site. Quarterly external audits should also be carried out by an independent auditor who will identify deficiencies of the site operation and highlight the appropriate remediation action to be taken. The audit result should then be forwarded to the relevant regulatory authorities. The site operator must be aware that officials from the regulatory authorities can conduct unannounced inspections of the site at anytime.

All technical audits should take into consideration, the approved design of the facility, the approved operational plan and the permit conditions as issued by the regulatory authority.

### 9.6 Rehabilitated Areas

Rehabilitated areas require ongoing inspection and maintenance. This will include the filling of settlement depressions on the surface of the capped waste body as well as the filling of the erosion gulleys which may develop along the side slopes of the landfill. Portions of the rehabilitated areas may require re-grassing where the grass has not readily established itself or has died off.

## 10. CAPPING CLOSURE PLAN

In general the proposed capping design follows that of the Minimum Requirements for a G.L.B$^+$ facility. The finalization of the design will depend on the implementation of the future gas extraction and utilization plant. Should this be implemented the gas drainage layer may be excluded from the capping design.

The proposed capping detail can be found on Drawing No. 207-2008-13-Rev1 with the proposed end us of the site being recreational use by means of soccer fields and/or parks or gardens.

## 11. CONCLUSION

The proposed new Newcastle Regional Landfill site is classified as a G:L:B$^+$/Class B landfill site and will have a total airspace capacity of 19,563,000 m$^3$ and an estimated lifespan of 42 years using a waste density of 1000kg/m$^3$ after compaction. The site will be developed using a phased approach and will consist of 7 individual landfill cells each having an estimated lifespan of approximately 6 years.

The initial rate of deposition used for the design was 375tonnes/day with a growth rate of 3% per annum. The landfill cells are proposed to be excavated 2m below natural ground and the total proposed vertical height of the waste body is 40m.

Two groundwater monitoring boreholes have been drilled on site (BH NL 1 and BH NL 2). BH NL 1 will be used to monitor the ground water quality upstream of the site while BH NL 2 will be used for the downstream monitoring. The positions of these boreholes can be seen on Drawing No. 207-2008-1-Rev1. Water quality testing has been performed prior to construction of the landfill in order to establish the background water quality. From the borehole data it can be seen that the ground water is approximately 22m below natural ground level which provides a sufficient barrier between the landfill lining system and the ground water. The in-situ soil comprises a silty clay layer underlain by a sandstone rock.

All contaminated stormwater and leachate will be collected via a network of pipes and drains and contained and evaporated in the lined leachate dam located at the low point of the site. Clean stormwater will be directed around the waste body and will discharge

into the natural environment downstream. Should there be a requirement for storage of clean stormwater on site, provision has been made for a clean stormwater pond.

During the operational phase of the site, monitoring and testing of the leachate and landfill gas will be carried out to assess the viability and feasibility of implementing a gas extraction and utilization system and a leachate treatment plant.

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Date: 19 February 2016

# APPENDIX 1

**DRAWINGS**

| | |
|---|---|
| 207-2008-1-Rev1 | : Site Layout Plan Showing Greenwich Farm Boundary Coordinates |
| 207-2008-2-Rev1 | : Site Layout Plan |
| 207-2008-3-Rev1 | : Aerial Image Showing Proposed Landfill Development & Existing Fenceline |
| 207-2008-4-Rev1 | : Site Plan Showing Buffer Zone |
| 207-2008-5-Rev1 | : Landfill Cells Layout Plan Showing Leachate Collection Systems |
| 207-2008-6-Rev1 | : Typical Section of Cell 1 Showing Liner Detail |
| 207-2008-7-Rev1 | : Typical Details of Cell 1 |
| 207-2008-8-Rev1 | : Typical Section and Details of Pollution Control Dam |
| 207-2008-9-Rev1 | : Typical Details |
| 207-2008-10-Rev1 | : Proposed Landfill Gas Recovery and Utilization Plant |
| 207-2008-11-Rev1 | : Proposed Leachate Treatment Plant |
| 207-2008-12-Rev1 | : Proposed Access Road from the N11 |
| 207-2008-13-Rev1 | : Cell 1 Rehabilitation and Closure Plan Showing Details and Typical Section |

# APPENDIX 2

# APPENDIX 3

# APPENDIX 4