Shakaville Waste Landfill Site

Engineering Needs Assessment and Preliminary Closure Design Report

22 December 2017

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1 Introduction

1.1 Project Background

As a result of numerous complaints about the state of poorly operated municipal landfills and the associated impacts on the biophysical and social environment, the Department of Environmental Affairs (DEA) has embarked on an initiative to assist various Municipalities in South Africa with the licensing of the existing illegal waste disposal sites. The Shakaville landfill has been identified as one of the sites that will require a Waste Management Licence for decommissioning.

The site is no longer in use and the Local Municipality currently disposes of waste at the Dolphin Coast Landfill Management (DCLM) site, however pockets of illegal dumping of waste were evident within the site boundaries.

The Shakaville landfill occupies an area of approximately 80 000m² (8 Ha) and is located on Erf 3595 Stanger within the KwaDukuza Local Municipality. Direct access is available from Mbozambo Street which is located to the north west of the site. The site centre co-ordinates are 29°19'48.62"S; 31°18'171.19"E. The boundaries of the site are within the riparian area of a tributary of the Mbozamo River. Refer to **Figure 1** for the Locality Map of the site.

Figure 1: Location of Shakaville Landfill

1.2 Scope of Work

GA Environment Pty) Ltd were appointed by the DEA to undertake the Waste Management Licence Application process for the closure of the Shakaville landfill. RAPienaar Consulting (Pty) Ltd was in turn appointed by GA Environment to undertake Engineering investigations at the site to assist with the license application.

The scope of work for this report is to:

- assess the existing site against standard legislative requirements for landfill design and operations, and develop a suit of conceptual engineering recommendations, which must be considered as license conditions to ensure that the landfill site is designed and operated within legal compliance;
- assess and evaluate the requirements for the landfill containment barrier system (geomembrane lining) in accordance with the current legal framework and make key recommendations in relation to the above site investigations;
- provide preliminary engineering design for capping of facilities that will be licensed for closure;
- develop a suit of site-specific recommendations for consideration during the detail engineering design of the proposed landfill site and associated infrastructure;
- Provide the landfill engineering cost estimate;
- Provide recommendations to incorporate into the Closure/End Use Plan;

It is anticipated that should the Licence be granted, the Municipality will be able to source funding for the compilation of detailed engineering designs for the landfill and to allow for all activities related to the decommissioning of the landfill in line with NEM: WA, 2008, requirements. This report will thus aim to provide preliminary designs to aid the licensing process and a detailed engineering design would be required and approved prior to construction.

1.3 Details and CV of Author

This report was compiled by Mr Reon Pienaar (PrEng) who is the owner and director of RAPienaar Consulting (Pty) Ltd. Mr Pienaar holds a University degree in Civil Engineering, a BEng Honours degree and an MEng (Masters) degree in Environmental Engineering (specializing in Waste Management) from the University of Pretoria in South Africa. He has more than 12 years' experience in solid waste management, environmental management and dam engineering. The majority of his experience was spent in charge of projects and project teams.

He is registered as a Professional Engineer with the Engineering Council of South Africa (ECSA Reg. Nr. 20100281), he is a full member of the South African Institute of Civil Engineers (SAICE), a member of the Geosynthetic Interest Group (GIGSA), a member of the International Solid Waste Association, a member of MENSA and sits on the Central Branch Committee of the Institute of Waste Management of South Africa (IWMSA) as vice chairman.

1.4 Reference Report

In 2012/2013 the KwaDukuza Municipality appointed a Consultant to undertake the process of applying for a closure license of the Shakaville Waste Site. The Consultant in turn appointed Envitech Solutions (Pty) Ltd to undertake a Preliminary Engineering Design for the license application. A draft Preliminary Engineering Design Report was completed in March 2013 but for reasons unknown to the author of this report, the Preliminary Engineering Design Report was not officially finalised and the Waste management Licence process was never completed. The draft report entitled "KWADUKUZA MUNICIPALITY, SHAKAVILLE LANDFILL CLOSURE, PRELIMINARY CLOSURE DESIGN REPORT, March 2013" by Envitech Solutions (Pty) Ltd was thus used as a main reference for this report, and where applicable, the concepts and information contained in the reference report were transferred to this report with the permission of Envitech Solutions (Pty) Ltd.

1.5 Methodology

The methodology followed to compile this report was for the Engineer to study all available background information on the site in order to familiarize himself with the history and requirements of the facility. In order to gain a full perspective of the requirements for closure, the Engineer then undertook a site visit in the presence of the Geotechnical expert to assess the actual site conditions, and evaluate a concept of the ultimate preliminary design. The site visit was undertaken on 01 November 2017.

After visually assessing the site the Engineer then used all available information obtained, and applied his mind in order to best compile engineering recommendations for closure of the site in accordance with the technical, legal and legislative requirements for landfill closures in South Africa.

Non-technical base data used for report compilation was solely based on the Envitech Report, the site visit and discussions with municipal officials and the project EAP.

2 Site Assessment

2.1 Site Description

The landfill site is situated about two and a half (2.5) kilometers north east from the KwaDukuza CBD. Farming is the major activity in the general town area and the site is bound by a tributary of the Mbozamo River on the south east and south west of the site. The watercourses run adjacent to the toe of the landfill and there is a major concern of contamination. Further south west lies an industrial area There are currently informal settlements and animals within the boundaries of the landfill site that would need to be relocated prior to the rehabilitation of the site. The site is currently almost fully overgrown with weeds and natural vegetation that makes the presence of historic waste dumping difficult to observe. The only signs of waste on site is some scattered litter.

According to KwaDukuza Municipality the site served as a solid non-hazardous waste disposal facility for the municipality, thus only domestic and garden waste was dumped at the site. From previous reports, an average of 720 tonnes per month of waste was received on the site. The vehicle access is limited to a single vehicle entrance along Mbozambo Street. There is no security on the site to prevent unauthorized entry and illegal dumping of waste. A temporary concrete palisade fence and gate was erected to prevent vehicular access on to the site but this has been damaged in many places.

The Shakaville landfill site never had a weighbridge to weigh incoming waste. The waste volumes on site were determined by estimation. There is currently a water supply to the site by means of a single stand pipe. There also appears to be a sewer pipe running on the southern edge of the site.
The landfilling of waste was uncontrolled and therefore there appears to be no integration of various landfill cells. Formal waste dumping was reportedly ceased in 2007 and this is confirmed when looking at aerial imagery from 2006 when the site seemed to be an active waste dump.

Figure 2 shows a general layout of the site with elevations at key areas shown in **Table 1**. It seems as if historic waste disposal took place in a manner where waste was dumped on the plateau and pushed over the edge towards the river. This method of disposal has resulted in the slope of the disposed waste being more than 20m high in some places at a natural angle of repose in the order of 45^{o}.

Figure 2: Waste Site Layout

Table 1: Elevations at key points on site

Point	Elevation (m) above Sea Level	Description
1	49	Entrance Area
2	42	End of road access
3	44	Highest Point
4	36	Edge of Slope
5	30	Bottom of Slope (River Level)
6	26	Bottom of Slope (River Level)
7	22	Bottom of Slope (River Level)
8	19	Bottom of Slope (River Level)
9	17	Bottom of Slope (River Level)

In order to better understand the historic waste dumping on site it is worth observing the Google Earth® images from 2006 to present shown in **Figures 3 to 5**.

2006

Figure 3: Shakaville Landfill Aerial Image (2006)

Waste dumping was in actively taking place in 2006 with the working face focused to the east of the site.

2010

Figure 4: Shakaville Landfill Aerial Image (2010)

In 2010 it appears as if waste dumping has stopped although some exposed waste is still visible in the western portion of the site.

2013

Figure 5: Shakaville Landfill Aerial Image (2013)

The 2013 image indicates that no waste dumping had taken place for some time since the vegetation had already taken significant shape.

Figure 6 shows the rough cross section as would be expected at point 7 or 8 in **Figure 2**. Waste is typically end pushed from point B to point A and left to stand at the natrual angle of repose which is in the order of 45º or 1V:1H. The elevation between point A and B ranges from 6m to about 22m in places.

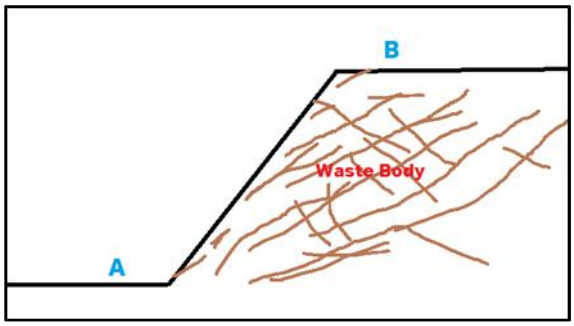


Figure 6: General Cross Section through Waste Body

The site received general municipal waste from the surrounding area and the Envitech report calculated a total waste volume in the order of 2.8 Million tons with an estimated maximum rate of deposition at the end of dumping of about 140 tons per day. This would classify the site as a Small (S) site in accordance with the Minimum Requirements for Waste Disposal by Landfill (DWAF, 1998).

It is assumed that the site has no base liner and that disposed waste had been placed in non-uniform layers over time with no direct purposeful compaction.

2.1.1 Climate

According to www.saexplorer.co.za the Stanger area normally receives about 866mm of rain per year, with most rainfall occurring during summer. It receives the lowest rainfall (16mm) in July and the highest (121mm) in January. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Stanger range from 22.4°C in July to 27.7°C in February. The region is the coldest during July when the mercury drops to 9.8°C on average during the night.

The site visit was undertaken for one day at the end of November 2017 which is in the summer season when temperatures and rainfall numbers are historically higher. It was a sunny and dry day on the day of the site visit with very little visual signs of leachate. With no leachate collection or detection system installed, it can be expected that leachate from rainwater falling on site will gradually make its way to the groundwater and/or the surface water bodies downstream. In winter it would be expected that the waste body would dry out slightly with higher risks of fires. The capping design measures proposed will be applicable for all seasons of the year since it works as a composite system.

2.2 Geotechnical Information

The 2017 Geotechnical Assessment by North Arrow Holdings contained the following information on the Geotechnical conditions at the site.

2.2.1 Geology

The Geological map of the Durban area shows the site to be underlain by quaternary alluvium, shale and post Karoo dolerite. A fault north-east to south-west striking fault is located approximately 1.5km north west of the landfill site. The fault is however not expected to play a crucial role in the local hydrogeology of the site.

Test pit excavations dug on the body of the landfill shows underlying competent khaki brown shale rock as geological map. Some test pits have exposed residual shale soils and in some cases residual dolerite soils. An in-situ exposure of khaki brown shale rock was observed on site. In this respect two samples each representing these two distinct soil types were collected. No groundwater or perched leachate tables were encountered within the test pits excavated. Laboratory results indicate that in general the soils tested comprise the following:

Weathered dolerite

The material is brownish in colour, containing Gravel (9%), sand (56%), silt (21%) and clay (14%). The soil is therefore described as clayey, silty sand. In terms of the Unified Soil Classification system the soil classifies mainly as a “SC” soil type, these being clayey sand. The Grading Modulus of 1.11 seems to reflect the soils as fairly fine coarseness nature, as corroborated with the sieving analysis results.

The plasticity indices (a measure of the plasticity of the clay) recorded show medium values (13) which are indicative of medium activity (lower medium expansiveness) for the soils. These should therefore be noted to constitute some slight problems under conditions of moisture migration.

Permeability (hydraulic conductivity) tests conducted in the laboratory using the flexible wall constant head permeability test, on disturbed samples, indicate permeability of $2.2x10^{-8}$m/s or $2.2x10^{-6}$cm/s. This soil is therefore deemed suitable to use as capping material subject to further consolidation at optimum density and moisture content.

Weathered khaki/light brown shale

The material is khaki light brown in colour, containing gravel (14%), sand (34%), silt (37%) and clay (14%). The soil is therefore described as a sandy silt. In terms of the Unified Soil Classification system the soil classifies mainly as a “CL” soil type, these being clayey sands or silty clays. The Grading Modulus of 0.79 seems to reflect the soils as fairly fine nature, as corroborated with the sieving analysis results.

The plasticity indices (a measure of the plasticity of the clay) recorded show low values (9) which are indicative of low activity (low expansiveness) for the soils. This should therefore not constitute any problems under conditions of moisture migration.

Permeability (hydraulic conductivity) tests conducted in the laboratory on disturbed samples indicate values of $4.8x10^{-10}$m/s or $4.8x10^{-8}$. This soil is therefore suitable to use as capping material subject to further consolidation at optimum density and moisture content.

2.2.2 Groundwater

The aquifer type of Shakaville is classified as minor aquifer class. Due to the nature of the alluvium expected below the site, the underlying aquifer is expected to be intergranular. However, the alluvial extent is limited and may not represent a significant aquifer. The National Ground Aquifer database does not have boreholes in very close proximity to the site but generally show an intergranular and fractured type aquifer. The water strikes are generally deeper than 30mbgl and are likely to be encountered between the two layers of rock. Recharge values range between 75 and 110 mm/annum and the groundwater levels are expected between 31 to 40 mbgl. Full details of groundwater and possible impacts are discussed in the Geotechnical report.

2.2.3 Geotechnical Conclusions

Based on laboratory test results, the in-situ materials are generally suitable for use as capping material. There is however not enough material on site to use for capping considering the geographic location of the site. However, during rehabilitation, some of this material will be exposed and re-used as part of the construction. Adequate material will need to be sourced from elsewhere.

Serious pollution into the proximal river system is currently taking place, sources being the local informal settlement poor sanitation conditions as well as possibly the leachate run-off from the landfill. The site does not reflect any risk for the formation of sinkholes or subsidence caused by the presence of water-soluble rocks (dolomite or limestone) and no evidence of mining activity beneath the site

3 Legislative Review

3.1 Minimum Requirements

The 1998 Department of Water Affairs and Forestry (now Department of Water and Sanitation) document called "*Minimum Requirements for Waste Disposal by Landfill*" (referred to as Minimum Requirements from her on) is still very widely used today to provide guidelines for waste management in South Africa. Most of it has been replaced by the regulations of the 2008 Waste Act (more about that in the following section) but in terms of landfill capping and closure, the Minimum Requirements are still used extensively. The minimum requirements document promotes environmental protection and provides guidelines for waste management best practice. In terms of capping requirements it is most important to note section 8.4.7 which inter alia provides the following information on capping.

1. The main purpose of the capping layer is to separate the waste body from the atmospheric environment. It is intended for protection and isolation of the waste from the long term effects of wind and water erosion, burrowing animals etc.
2. It limits and controls the amounts of precipitation that enters the waste and should also allow water to leave the landfill by evapo-transpiration and vent landfill gas in a responsible manner.
3. The cap is intended to work in conjunction with the base liner by limiting the long term generation of leachate.

3.2 Waste Act

The National Environmental Management: Waste Act (Act 59 of 2008) and the subsequent National Environmental Management: Waste Amendment Act (Act 26 of 2014) then built on the principles described in the Minimum Requirements to provide sustainable regulation of waste management practices in South Africa. Through regulations 634, 635 and 636 the waste act further provided information on the classification, management, assessment of waste for disposal to landfill and although these regulations do not cover the capping of waste facilities, there are still principles of design, monitoring etc. that holds true for both lining and capping of landfills.

3.3 Capping Notes

Due to fact that the regulations in the waste act focused more on waste disposal and lining, the guidelines for capping is still primarily derived from the 1998 minimum requirements document. For this reason the Institute of Waste Management of Southern Africa (IWMSA) recently approached the Department of Water and Sanitation (DWS) to provide updated guidelines on the capping of landfills. This has been workshopped at more than one occasion and a DWS Technical Advisory Practice Note on capping and closure of waste management facilities and pollution point sources is being prepared.

The DWS practice note had not yet been officially released upon compilation of this report but the principles discussed are that of groundwater and environmental protection when capping landfills by assessing each facility on its own merits.

4 Specifications for Closure Design

4.1 Required Closure Principle

When assessing the Shakaville landfill for closure and capping design, the information on site specific conditions and legislative requirements discussed in the preceding chapters were taken into full consideration. As mentioned the information contained in the Envitech Preliminary Design Report of 2013 was also considered. Since the facility has no basal liner, the minimum requirements capping design for Small (S) or Communal (C) landfills cannot be used.

For the capping design of this landfill it is proposed to use a restricted moisture cap (also called dry cap) in order to minimize the ingress of rain water and isolate the waste body form the atmospheric environment. The materials used in the design shall aim to reduce the percolation through the cap to less than 15 litres per hectare per day. The final closure design aims to ensure that any identified pollution risk is mitigated and managed. Pollution control is the primary function of the closure design.

4.2 Site Geometrics

During the 2013 investigations by Envitech the final elevation of the landfill cells was determined following a topographical survey and DTM modelling. The current elevation at the northern edge of the waste body (at the entrance) had been adopted as the final elevation of the final model. It is best practice to limit final height to that of the background topographical features; however in this scenario there are no significant features in close proximity to be considered. Their modelling consider a number of options and ultimately it was decided that the best option would be to use the top of the landfill centerline (generated from the highest point at the northern edge) with a gradient of three percent (3%) to the southern edge of the landfill. The landform was then further modelled with a slope of two percent (2%) from the centreline towards the eastern and western edges. This model resulted in a waste cut volume of 57 290m^3 and a waste fill volume of 58 340m^3. All side slopes were designed using a 1:3 slope. The rehabilitated landfill layout as per the Envitech Design is shown on Drawing SHAKA - 002 in **Annexure A**.

It was further decided that the plateau of the final landfill must be graded to a minimum of a two percent (2%) slope to encourage flow of water and discouraging ponding at the top of the landfill. Side slopes of a minimum of 1:3 have been adopted to ensure stability of the landfill. This slope also

encourages the growth of vegetation which will form part of the final, improving the aesthetics of the site in the post closure period. The growth of vegetation will also reduce erosion of the side slopes.
A small catchwater bank must be constructed at the top edge of the landfill to prevent water from flowing down the slope at undesignated locations. The catchwater bank should not be continuous around the landfill such that damming of water can occur. Downchutes, adequately protected, will be constructed. The downchutes will consist of a multicell with a concrete infill to allow for minor settlement of the waste body. Stormwater should be allowed to drain away from the landfill, without coming into contact with the waste.

A topographical survey was done before the Envitech report in 2013 but during the November 2107 site visit the Geotechnical specialist also took GPS coordinates and elevations to confirm the topography of the site as confirmed in the Geotechnical Report (**Figure 7**).

Figure 7: GPS Data Points taken during site visit

4.3 Capping Design

The design of the capping layers was done to maximize run off and minimize ingress of water into the waste body. Opportunity for water ingress on the top of the capped landfill is higher due to the flatter slopes. Long term ingress of water into the 1V:3H side slopes are less possible, but runoff needs to be encouraged, and thus capping designs for the top of the landfill and the side slopes differ slightly. The side slopes capping was designed without the HDPE Geomembrane contained in the top capping, but including a Geosynthetic Composite drainage layer as shown on Drawing EMA-002 in **Annexure A**. this was done to facilitate run-off of possible ingress on the slopes and limit ingress of water on the plateau.

4.3.1 Capping Layers Works

The description of the proposed design layers for the capping of the landfill plateau and side slopes is described here beginning from the waste body and ending at the final (top) layer. **Figure 8** shows the proposed capping layers on the plateau and side slopes of the landfill and results in a maximum layer works thickness of about 1,500mm depending on the final geosynthetic options chosen. Full descriptions are given for the layer works on the landfill top and also hold true for side slope layer works where applicable. It must be note that the Capping Layerworks differ from the design proposed by Envitech in 2013 and this is mostly due to industry related legislative and technological advances made since 2013. This capping design aims to adhere to the latest best practice.

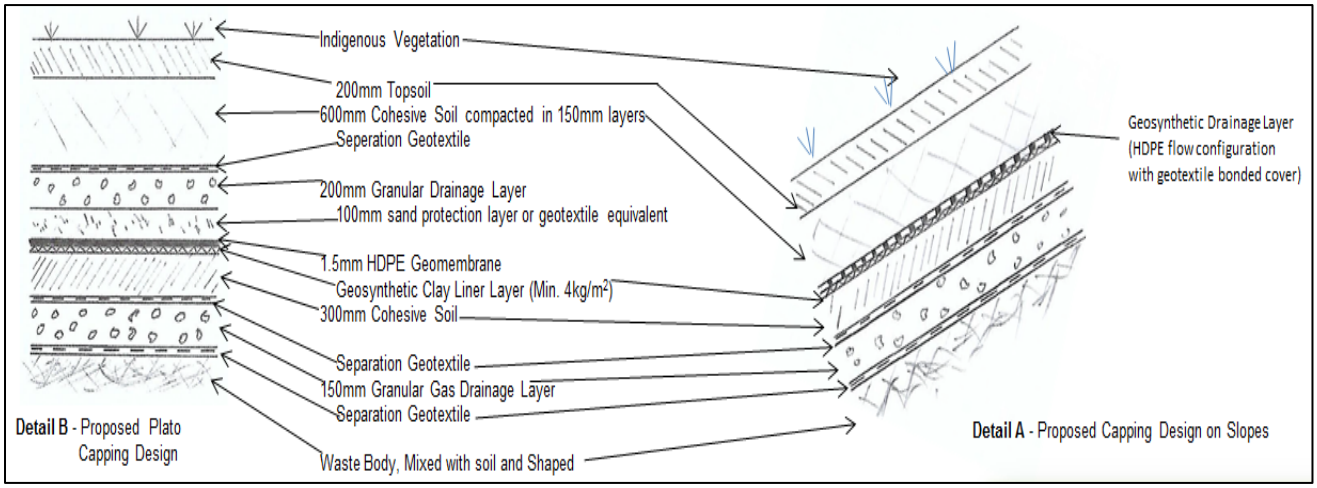


Figure 8: Proposed capping design

The various levels of the capping are described as follows:

- **Waste Body:** The final waste body is to be shaped as per the design drawings and compacted as well as possible with the equipment used during construction. It should be mixed with soil material where possible and shaped to a final profile that is as smooth as practically possible.

- **Separation Geotextile:** The separation geotextile separates the waste body from the capping layers and should be a non-woven geotextile with a typical thickness of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the waste body.

- **150mm Granular Gas Drainage Layer:** This is a landfill gas venting layer having a minimum thickness of 150mm and consisting of single sized stone or gravel of between 25mm and 50mm in size. This layer needs to be connected to a gas management system with gas vents being installed in key areas.

- **Separation Geotextile:** The separation geotextile separates the drainage layer from the capping layers and should be a non-woven geotextile with a typical thickness of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the drainage layer.

- **Cohesive Soil Layer:** This is a support layer to the below drainage system and should be 300mm thick consisting of in situ material compacted to a minimum density of 95% Standard Proctor maximum dry density at a water content of Proctor optimum to optimum +2%.

- **Geosynthetic Clay Liner (GCL):** A GCL is two geotextile layers with a layer of bentonite in the middle that acts as a containment barrier. The GCL should have minimum mass per unit area of 4kg/m2 and the permeability of the GCL must be such that an outflow rate of $1x10^{-6}$ cm/s will not be exceeded. These parameters are to be tested for the chosen material as per the construction Quality Assurance and Quality Control (QA/QC plan) that needs to form part of the detail design report before construction. The GCL and HDPE composite layer is considered to be the primary barrier layer.

- **HDPE Geomembrane Layer (Plateau only):** The High Density Polyethylene (HDPE) Geomembrane (GM) sheet needs to be in direct contact with the GCL and needs to be manufactured by a reputable company and installed according to the Engineer's specifications contained in the construction QA/QC plan. The thickness specified shall be minimum thickness, as measured with the SABS Specification 1526 test method. This layer is only considered for the top of the landfill cover and not the side slopes.

- **Sand Protection Layer (Plateau only):** The protection layer is placed directly above the GM to protect it from mechanical damage and can be in the form of a 100mm layer of fine to medium silty sand or a geotextile equivalent able to provide similar protection to the GM. If the geotextile options is chosen during detail design the total ballast layer above the GCL/GM composite should be carefully designed to still ensure full and proper contact between the GCL and GM. This layer is not required for the side slopes.

- **Granular Drainage Layer (Plateau only):** This system is provided to detect and remove any water leakage that has penetrated the layers above it. The granular drainage layer should consist of a 200mm thick layer of granular material (crushed stone) having a size of between 38mm and 50mm with perforated HDPE pipes installed at 20m intervals on the plateau of the landfill to direct leakage to the leachate collection system and sump.

- **Separation Geotextile (Plateau only):** The separation geotextile separates the drainage layer from the capping layers and should be a non-woven geotextile with a typical thickness

of about 2.5mm and unit weight of at least 1.5kg/m^2. This layer assists in preventing fine particles from the layer works entering the drainage layer.

- **Geocomposite Drainage Layer (Slopes only):** There are a number of products on the market that could potentially be used here. The final design should replicate the specifications of a geocomposite drainage system similar to the ABG Pozidrain® product which consists of a high strength flexible polyethylene cuspated drainage core (at least 4mm thick) with a non-woven geotextile filter fabric bonded onto one or either side. The geotextile filters a wide range of materials and is bonded to the core to ensure that it does not deform into the drainage channels under the load of the backfill material. The drainage composite allows fluids and gases to percolate into the core whilst supporting the backfill material. The collected fluids are then transported along the core to the leachate collection system at the landfill toe.

- **Cohesive Soil Layer:** This is a support layer to the below drainage system and should be 600mm thick consisting of in situ material compacted to a minimum density of 95% Standard Proctor maximum dry density at a water content of Proctor optimum to optimum +2%. The layers are to be placed and compacted in 150mm layers and also assist in providing the required pressure for the GCL/HDPE composite to function optimally. As indicated in the Geotechnical report the soils on site are weathered dolerites and shales with a clay content and fairly low permeability. This soil will work well in conjunction with the other layers of the capping system.

- **Topsoil Layer:** This needs to be a minimum of 200mm topsoil layer to assist in the establishment of vegetative cover as soon as possible. The layer needs to be optimally compacted to assist plant growth and can contain a mixture of hydro seeding if required.

- **Indigenous Vegetation:** The vegetation layer assists with stability and run off and needs to be established as soon after construction as possible. The vegetation needs to be indigenous to the area in order to ensure optimal sustainability of the capping system.

4.3.2 Properties of Capping Materials

The long term performance of the capping system will depend on the quality of the design and construction process. This preliminary design needs to be confirmed through a detail design process after award of the waste license and the detail design report should contain a full QA/QC plan to be followed during the construction process. Certain key material properties for the proposed capping layers are described here, to be confirmed during detail design.

In situ soil

The in situ-soil tested as part of the Geotechnical assessment is a clayey soil with very low permeability according to the results from the laboratory. This material, if well compacted, would be suited for use as capping for the facility. Due to the volume of material available however, legislative requirements and the nature of the site conditions, it is not recommended that this soil be used as a barrier layer for water ingress without combining it with geosynthetic layers as per the design.

GCL/GM

The stability of barriers composed of geomembranes and/or geosynthetic clay liners (GCLs) depends on the interface and/or internal shear resistances of the materials involved in the design materials. The internal resistance of stitch-bonded and needle-punched GCLs depends on the resistance of the core material (bentonite) and on the technique used to attach each geotextile layer of the GCL. When using a GCL in a slope, the evaluation of its internal shear strength is of fundamental importance for stability analysis, and for this reason it is recommended that a fully needlepunched GCL with nonwoven cover and either woven or nonwoven carrier geotextile be used on the slopes of the capping. The bentonite in the GCL should contain at least 75% Montmorillonite.

Although the stability of the rehabilitated waste body and specifically the slopes rely on many factors, the most important is proper moisture control and drainage. Capping failures tend to occur under saturated conditions and layer works thus need to be quality controlled and tested to ensure design parameters of drainage and permeability are adhered to.

4.4 Stormwater Management

Stormwater management is a critical component of sustainable capping and closure designs of landfills. The stormwater management infrastructure was designed to ensure clean and dirty water separation, to facilitate non critical flow and to prevent ponding. The main objectives of the proposed stormwater design are:

- Protection of the downstream water resources described in Chapter 1 by separating, collecting and discharging all stormwater runoff from the Shakaville landfill site before contamination;
- Ensuring that stormwater management infrastructure is designed to handle a storm event equal to the 1:50 year storm event;
- Preventing of standing water on site that could penetrate the capping layers and waste body creating leachate and possible failures of the capping layer works.

The final shaping and capping of the landfill as described, is aimed at preventing stormwater from coming into contact with the waste and any contamination. Any stormwater on the rehabilitated site

could thus be considered clean and runoff from the rehabilitated site will be discharged into the existing natural watercourse.

The proposed Shakaville stormwater management system shall at least include:

- Catchwater banks at the top edge of the landfill to prevent erosion and control the runoff down the side slopes
- Downchutes to direct the runoff down the side slopes
- A drainage bench midway down the side slope to reduce the flow velocity and further prevent erosion
- Reno mattresses at all discharge points to prevent scour
- Gabion baskets along the toe of the landfill to prevent erosion from the adjacent stream and the Mbuzana river

4.5 Leachate Management

The Envitech design report analyzed a number of leachate management options and the chosen option was to construct a shallow clay cut-off trench and a shallow leachate collection drain around the toe of the landfill that would gravity drain to a leachate collection manhole and will be pumped to sewer. It is, however, proposed as part of this design that the leachate be collected in a leachate sump so that it can be tested prior to release into the sewer system. If leachate is found to be unfit for release to sewer it would have to drained into a collection tank and disposed of at a licensed hazardous landfill. Alternatively the leachate can be treated until acceptable for release to sewer.

The leachate toe drain would also assist with draining any leachate seepage from the side slopes. The construction cost for this option was favorable when compared to some of the other options and minimum to no maintenance would be required. As landfilling operations on the site have stopped and the landfill will be shaped and capped to limit further infiltration of moisture, the leachate generation will be significantly reduced. However, should post closure monitoring of water quality show evidence of continuous contamination of the tributary of the Mbozamo River as a result of the landfill, a reassessment of the leachate management system will be required.

4.6 Gas Management

The degradation of the contents of municipal solid waste landfills produces a number of gases. For decomposing municipal solid waste landfills, methane and carbon dioxide are the principal gases. These gases may cause gas bubbles beneath the capping layer and cause uplift of the capping layer. It is therefore necessary to install gas vents. Gas monitoring probes could also be installed for use during post closure monitoring to trace gas releases. If the probes are considered too expensive

or deemed a target for theft, the monitoring team could use hand held gas monitoring devices during post closure gas monitoring.

5 Engineering Cost Estimate

5.1 Introduction

Capping designs that adhere to the legislative framework can be considered expensive and even with the best efforts of the design engineer and construction contractor, this could result in high budget allocations required from small municipalities. There are sources of funding that the municipality can use, other than its own funds and these have been widely used with great success. The reality is that most small municipal landfill sites have no base liner which is mostly due to the age of the facility (liners became a requirement from 1998) and /or the budgets of the municipality at the time. As described earlier in this report, the requirements of capping designs for landfills with no base liner is more strict than for facilities with operational base lining systems.

The costs given in this chapter is an estimate of construction costs for the establishment of the landfill cap and is not be considered a final value since it needs to be confirmed during the detail design stage prior to development of tender documentation for municipal procurement of construction contractors.

5.2 Engineering Estimate

Table 2 shows a summary of the construction estimate at the preliminary design stage, this would need to be confirmed during detail design. A full breakdown of the below amounts is given in **Annexure B**.

Table 2: Preliminary Engineering Construction Cost Estimate

SUMMARY OF BILL OF QUANTITIES		
PART	**DESCRIPTION**	**AMOUNT**
		R-c
PART 1	PRELIMINARY AND GENERAL	2 950 000.00
PART 2	EARTHWORKS: SHAKAVILLE LANDFILL	19 985 880.00
SUB-TOTAL A		**22 935 880.00**
PART 3	DAYWORKS	345 000.00
SUB-TOTAL B		**23 280 880.00**
CONTINGENCIES Add 10 % for Sub-total B (Provisional sum)		**2 328 088.00**
SUB-TOTAL C		**25 608 968.00**
VALUE ADDED TAX Add 14 % for Sub-total C (Provisional sum based on current rate of VAT)		3 585 255.52
ESTIMATE TOTAL AMOUNT (INCL VAT)		**29 194 223.52**

6 Closure and End Use Planning

6.1 Introduction

An integral part of the successful rehabilitation and closure of a landfill site is the closure and end use plan. Once capping and rehabilitation has been constructed, monitoring and maintenance of the site will be required to ensure that it remains effective. Rehabilitation cannot be regarded as completed until the vegetation has been suitably established across the site. Several years of management and maintenance may well be required,

Once the Shakaville landfill has been formally closed, additional monitoring activities will be necessary to assess water quality around the landfill, monitor the landfill gas collection system and inspect the landfill for signs of disrepair. The Closure and End Use Plan Report is a separate document to be developed by the Environmental Assessment Practitioner, and is intended to serve a guide for the formal closure and end use planning for the future closure of the Shakaville landfill site.

This section of the Preliminary Design Report will provide some key recommendations for future inclusion into closure and end use plan.

6.2 Recommendations for inclusion in Closure and End Use Plan

6.2.1 General

The following provides some general rehabilitation measures that may be implemented on the site.

- The site is cleaned up and all the residual waste remaining on and around the site is removed and stored in skips for final disposal at a licensed landfill site;
- The waste and cover material that has been placed on the site should be used to rehabilitate some of the areas, which have been damaged by soil erosion and loss of ground cover;
- A vegetative layer of approximately 200mm should be laid down in these scarred areas on the site and spread and lightly compacted;
- The site should then be grassed with the same type of indigenous grass mixtures as per specifications for the Shakaville area;

- The closure design needs to be prepared and supervised by a professional engineer working with an environmental scientist, and needs to be designed such that the site does not sharply contrast against the local geomorphology and background. The site shall have a slight cross-fall allowing easy drainage off the site away from any potential risk areas;
- The capping layer works provided in the engineering design should be conservatively constructed according to the specifications of the design and approved by the relevant authority to ensure compliance with the applicable legislation;

6.2.2 Cover Material

As reported in the engineering design of this report, the permeability of the in situ soil ranges from $2.2x10^{-6}$cm/s to $4.8x10^{-8}$cm/s which is a comparatively low permeability when compared to the minimum requirements for permeability of liner clay material of 1×10^{-6}cm/s. Thus, this material, even if used in a mixture of commercial material is well suited for cover material and the only additional material required over the capping would be a 200mm topsoil layer for facilitation of plant growth etc.

6.2.3 Erosion Control

Erosion is one of the major sources of damage to both natural and man-made slopes. Erosion on slopes can be caused by detachment and movement of soil particles due to raindrop impact and surface runoff. Some recommendations for protection of the site from erosion may include but not limited to the following:

- Cover the sloped edge of the waste body and the top of the waste body with the capping layers as per the engineering design;
- Cover the capping layer with the topsoil and compact;
- Seed all surfaces and banks with indigenous grass to allow vegetation growth and further protection and natural look;

Once the vegetation has established itself on the site possibilities of erosion are limited. Any signs of erosion should be reported and corrected immediately as part of the closure plan of the site.

6.2.4 Water Quality Monitoring

A Water Quality Monitoring Program should form part of the Closure Plan of the Shakaville landfill site. The water quality monitoring program is expected to continue for at least 10 years following closure due to the importance of water quality for the residents of the area. The program should

involve quarterly monitoring of surface water, groundwater and leachate at and surrounding the landfill. The water quality results will be compared to the accepted local and national standards and should be reviewed and reported yearly. The report will provide information on the effectiveness of the landfill cap and surface water drainage system, and address any identified water quality issues.

At the Shakaville landfill it is worth noting that leaking sewer lines and pollution from upstream industries and residents contribute to the pollution levels in the nearby stream and river. For the water quality monitoring plan, it would therefore be required to take background samples before the rehabilitation of the landfill starts and compare it to post closure samples to quantify the contributing polluting factors.

After ten years, it is anticipated that the water quality at the landfill should stabilize and the water quality monitoring frequency will be reduced to semi-annually. After 25 years, the results should again be reviewed and if there is sufficient evidence that shows that the landfill has not had significant impact on the surrounding environment, the water quality monitoring program can be concluded.

6.2.5 Gas Management

It is proposed in the preliminary engineering design that a landfill gas management system will be constructed prior to closure. The details of required operation, maintenance and monitoring of this system is to be include in the detail design phase and carried through tot eh closure plan. After closure, a remote monitoring system could be utilized and maintenance staff will be contacted for emergencies. A quarterly inspection and monitoring program will likely have to be established to evaluate landfill gas generation for a minimum of 25 years.

6.2.6 Inspections and Maintenance

After closure, a regular inspection and maintenance program must be initiated to maintain the integrity of the landfill. Allow for a maintenance period of one year following practical completion, (unless otherwise specified) and implement the following.

- Maintain the integrity of the fence around the site to ensure limited to no access for any pedestrians and livestock;
- Re-vegetation must match the vegetation type which previously existed so it blends in well with the natural environment;

- A minimum grass cover of 80% is required, and individual plants must be strong and healthy growers at the end of the Maintenance Period;
- In the case of sodding, acceptable cover entails that 100% cover is attained by the specified vegetation;
- Bare areas that show no specified vegetation growth after three months of the Rehabilitation Work are to be spread with additional topsoil, ripped to a depth of 100mm and re-planted, re-sodded, re-hand sown or re-hydro seeded.

Regular inspections are to be undertaken at the landfill and must include evaluation of the:

- landfill cap by noting any significant erosion, cracking, settlement or seepage;
- fence for structural integrity and performance;
- landfill cap for evidence of wildlife or rodent impacts; and,
- leachate collection system components for containment.

The inspection reports should identify if maintenance activities are required. Inspections are anticipated to be monthly for the first year and quarterly for the years following.

6.2.7 Stormwater and Leachate Management

Storm water management shall be by means of proper landscaping, allowing the surface run off to flow naturally away off the site in accordance with the design measures proposed. Once the site is properly vegetated the management of stormwater becomes less problematic. The site does not generate any significant amount of leachate at this stage but the proposed leachate management system of collection, trenching and storage should be monitored regularly and the leachate sump cleaned out at regular intervals.

6.2.8 Post Closure Monitoring

A post closure monitoring plan shall be developed to ensure that certain critical aspects are monitored continuously even after closure as may be required by the waste license for the site. These aspects may include but are not limited to the matters described above. Following each site inspection, a brief internal site audit report must be prepared with mitigation or recommended actions for mitigating any observed negative impacts on the site. Such measures may include but not be limited to the following:

- Any eroded material on site will have to be excavated;
- The eroded area must be filled with excavated material and re-compacted;
- Cover with capping impermeable material, compacted and top soiled as per specification;
- Seeded with indigenous grass and vegetation;
- Cover with netting and protected until vegetation blanked re-established

Generally the mitigation measures will depend on the nature, extent and significance of the impacts observed during the site audits.

7 Conclusion

As a result of numerous complaints about the state of poorly operated municipal landfills and the associated impacts on the biophysical and social environment, the Department of Environmental Affairs (DEA) has embarked on an initiative to assist various Municipalities in South Africa with the licensing of the existing illegal waste disposal sites. The existing Shakaville landfill has been identified as one of the sites that will require a Waste Management License for decommissioning.

The closure of the Shakaville Landfill site is subject to the requirements described in this report and the subsequent Closure and End Use Plan. The final shaping and capping of the landfill should be carried out as per the capping design and on-going monitoring of the groundwater and landfill gas should continue according to the requirements given. The site should be fenced off to prevent unauthorized access and further dumping.

For the capping design of this landfill it is proposed to use a restricted moisture cap to minimize the ingress of rain water and isolate the waste body form the atmospheric environment. The materials used in the design aimed to reduce the percolation through the cap to less than 15 litres per hectare per day. The final shape of the rehabilitated landfill needs to tie in the natural contours of the area.

It is recommended that this report be used as basis for the detail design phase of the landfill capping process once a waste license is issued for closure of the landfill.

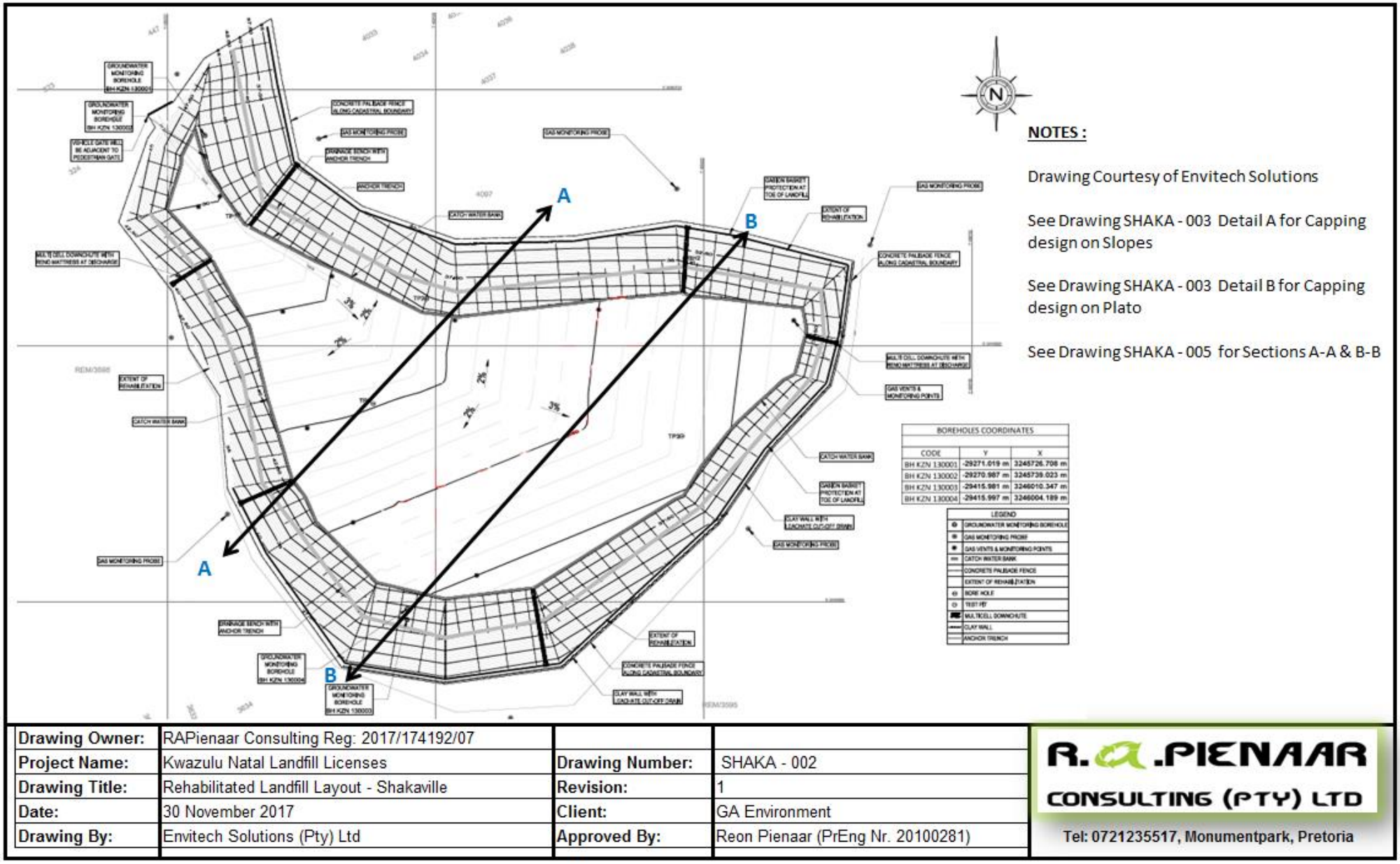
ANNEXURE A:

Preliminary Engineering Design Drawings

Point	Elevation (m)	Description
1	49	Entrance Area
2	42	End of road access
3	44	Highest Point
4	36	Edge of Slope
5	30	Bottom of Slope (River Level)
6	26	Bottom of Slope (River Level)
7	22	Bottom of Slope (River Level)
8	19	Bottom of Slope (River Level)
9	17	Bottom of Slope (River Level)

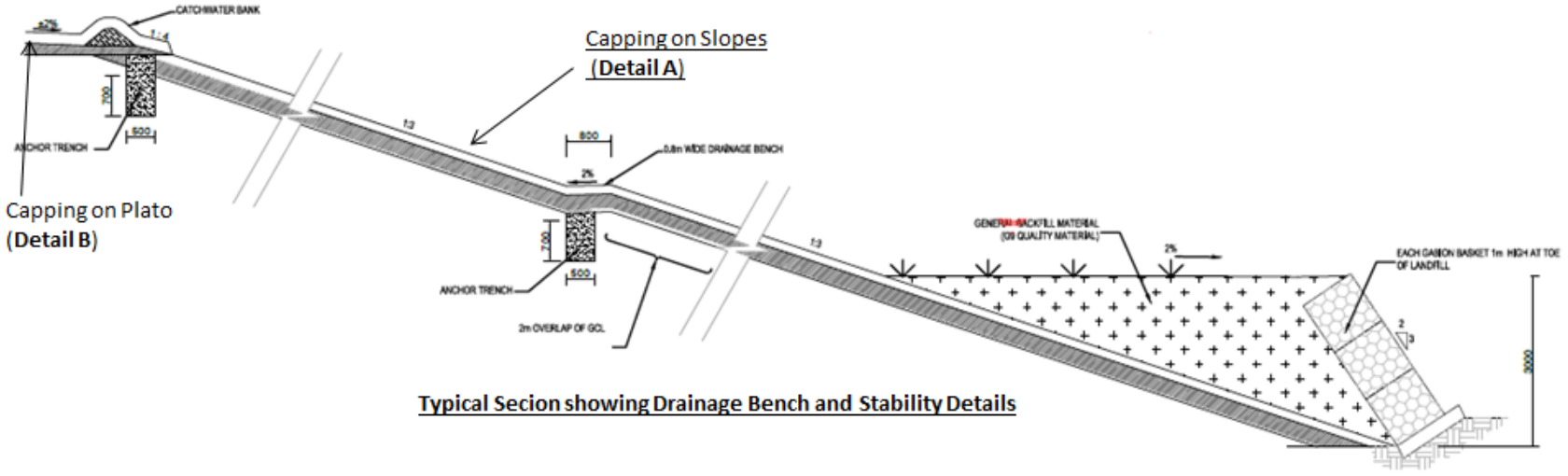
Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	SHAKA - 001
Drawing Title:	Shakaville - Existing Landfill Layout	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Reon Pienaar (PrEng Nr. 20100281)	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R.A.PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria

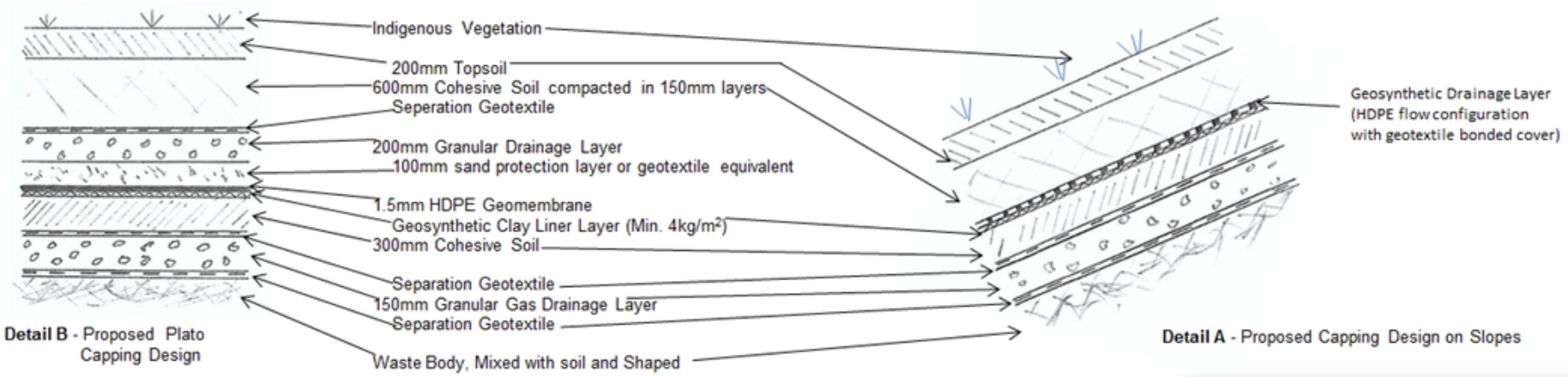


Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	SHAKA - 002
Drawing Title:	Rehabilitated Landfill Layout - Shakaville	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Envitech Solutions (Pty) Ltd	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R.A.PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria



Typical Secion showing Drainage Bench and Stability Details



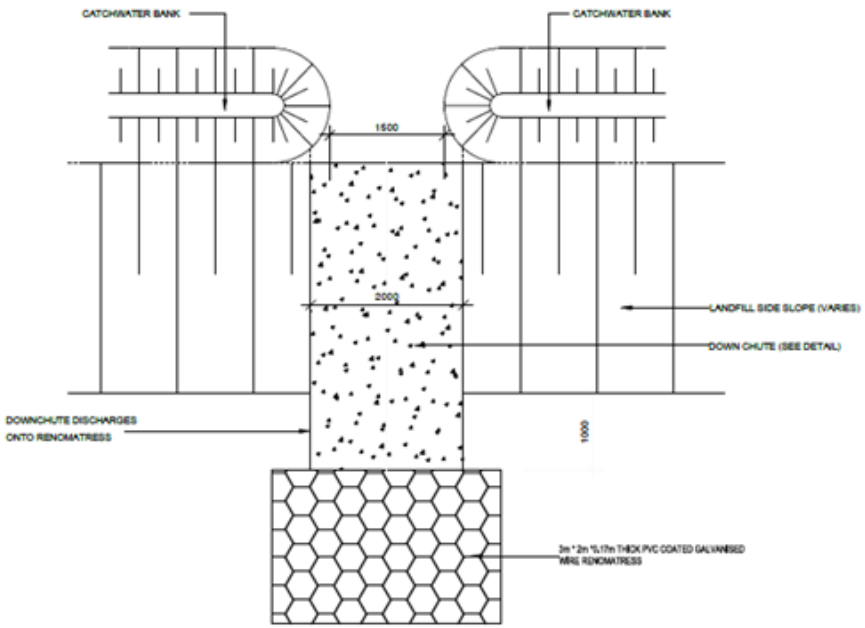
Detail B - Proposed Plato Capping Design

Detail A - Proposed Capping Design on Slopes

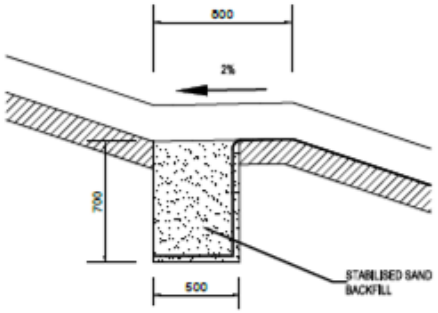
Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	SHAKA - 003
Drawing Title:	Shakaville Landfill - Sections and Capping Detail	**Revision:**	2
Date:	22 December 2017	**Client:**	GA Environment
Drawing By:	Reon Pienaar (PrEng Nr. 20100281)	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R.A. PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria

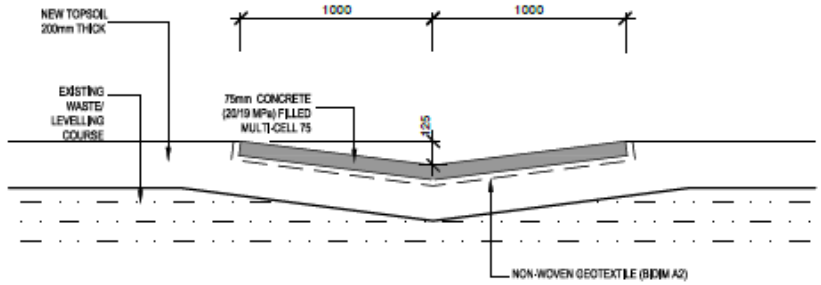
Drawing courtesy of Envitech Solutions (Pty) Ltd



PLAN OF MULTI-CELL DOWNCHUTE



TYPICAL ANCHOR TRENCH
DETAIL



SECTION THROUGH MULTI-CELL DOWNCHUTES
OVER LANDFILL CAPPING

Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	SHAKA - 004
Drawing Title:	Shakaville Landfill - Sections and Details	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Envitech Solutions (Pty) Ltd	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

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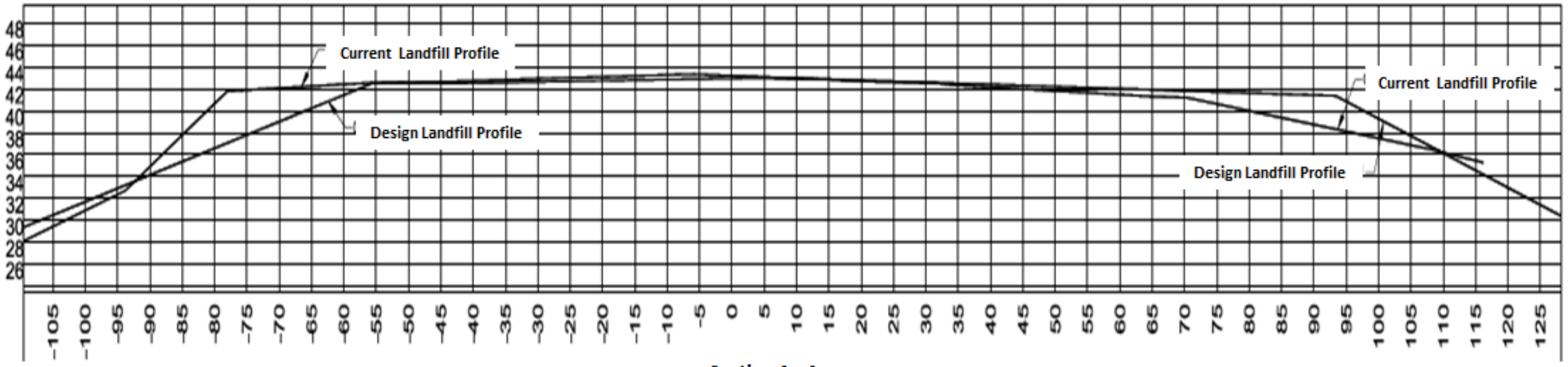
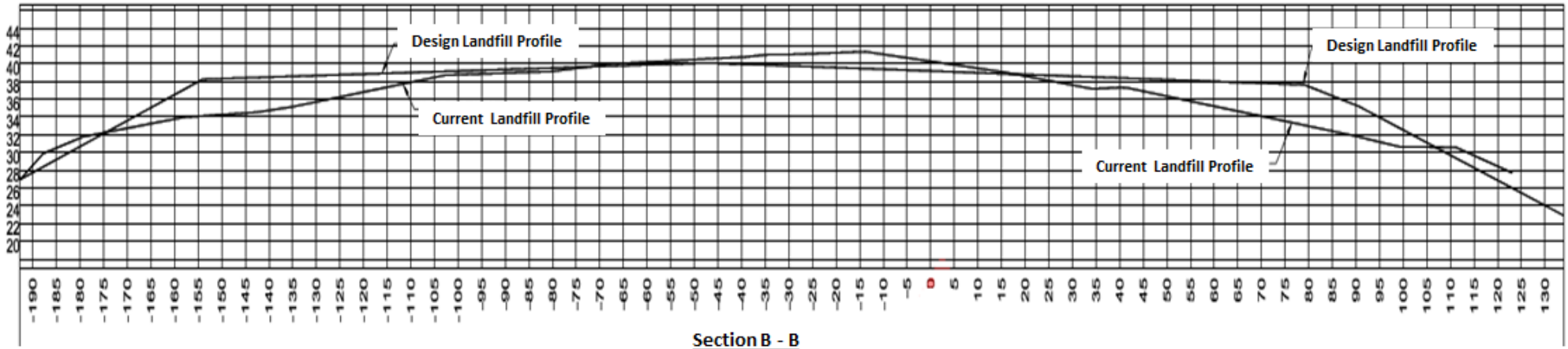


Section A - A



Section B - B

Drawing Owner:	RAPienaar Consulting Reg: 2017/174192/07		
Project Name:	Kwazulu Natal Landfill Licenses	**Drawing Number:**	SHAKA - 005
Drawing Title:	Shakaville Landfill - Cross Sections	**Revision:**	1
Date:	30 November 2017	**Client:**	GA Environment
Drawing By:	Envitech Solutions (Pty) Ltd	**Approved By:**	Reon Pienaar (PrEng Nr. 20100281)

R. PIENAAR CONSULTING (PTY) LTD
Tel: 0721235517, Monumentpark, Pretoria

ANNEXURE B:

Preliminary Engineering Design Cost Estimate

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.0		**PART 1: PRELIMINARY AND GENERAL**				
1.1	**SANS 1200A**	**GENERAL**				
	8.3	**Scheduled Fix-charge and Value-related Items**				
1.1.1	8.3.1	Contractual Requirements	Sum			2 000 000.00
	8.3.2	Establishment of Facilities on the Site				
1.1.2	PSA- 8.3.2.2	Facilities for Contractor	Sum			
1.1.3	8.3.3	Other Fixed-charge Obligations	Sum			
1.1.4	8.3.4	Removal of Site Establishment	Sum			
	8.4	**Scheduled Time-related Items**				
1.1.5	8.4.1	Contractual Requirements	Sum			900 000.00
	8.4.2	Operation and Maintenance of Facilities on Site, for Duration of Contruction, except where otherwise stated				
1.1.6	PSA- 8.4.2.2	Facilities for the Contractor	Sum			
1.1.7	8.4.3	Supervision for Duration of Construction	Sum			
1.1.8	8.4.4	Company and Head Office Overhead Costs for the Duration of the Contract	Sum			
1.1.9	8.4.5	Other Time-related Obligations	Sum			
	8.5	**Sums Stated Provisionally by Engineer**				
	(PSA)	(c) Additional Tests				
1.1.10		1) Additional tests ordered by the Engineer	Prov Sum	1		20 000.00
1.1.11		2) Handling cost and charges on (c)(1)	%	20 000		
		(d) Survey in terms of Land Survey Act				
1.1.12		1) Provisonal allowance for survey	Prov Sum	1		30 000.00
1.1.13		2) Handling cost and charges on (d)(1)	%	40 000		
TOTAL CARRIED FORWARD TO SUMMARY						**2 950 000.00**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
2.0		**PART 2: EARTHWORKS: SHAKAVILLE**				
2.1	**SANS 1200D**	**SECTION: EARTHWORKS**				
	8.3.1	Site Preparation				
2.1.1	8.3.1.1	Clear and Strip Site	m^2	56 000	7	392 000.00
	8.3.2	Bulk Excavation				
2.1.3	PSD 8.3.2	a) Excavate in all materials and use for embankment or backfill or dispose, as ordered	m^3	10 000	40	400 000.00
		b) Extra over for				
2.1.4		1) Intermediate Excavation	m^3	100	100	10 000.00
	PSD 8.3.4	Importing of Materials				
2.1.5		a) Extra over for importing materials from commercial sources or from Borrow pits for use in capping	m^3	10 000	80	800 000.00
2.1.6		b) Opening up and closing down designated borrow pits	Sum	1	50000	50 000.00
	8.3.6	Overhaul				
2.1.7		a) Limited Overhaul	m^3	200	100	20 000.00
2.1.8	PSD 8.3.14	Stormwater chutes as shown on drawings	m	200	1500	300 000.00
2.1.9	PSD 8.3.14	Gabion Basket as shown on Drawings, Full Construction	m^3	3 500	1200	4 200 000.00
2.2	**SANS 1200 DE**	**PART 2:** **SECTION : SMALL EARTH DAMS**				
	PSDE-8.3.5	Forming embankment				
		(i) Cut from excavation and/or stockpile				
2.2.1		(1) Suitable as fill material for stormwater berm	m^3	1 200	120.00	144 000.00
	PSDE- 8.3.11	Forming Site Capping				
2.2.2		(a) Shape and Compact In situ Waste Material	m^3	57 000	20.0	1 140 000.00
2.2.3		(b) Cut to fill from commercial sources a Drainage layer comprising of single sized crushed stone or gravel having a size of between 38 mm and 50 mm as shown on drawings	m^3	7 500	250.00	1 875 000.00

2.2.4		(c) Cut to fill from commercial sources silty sand material for use in protection layer as shown on drawings	m^3	2 000	300.00	600 000.00
2.2.5		(d) Cut to fill from commercial sources Topsoil layer as shown on drawings	m^3	10 000	120.00	1 200 000.00
2.2.6	PSDE- 8.3.12	160 mm dia perforated HDPE pipes placed inside gravel drainage layer on plato as shown on drawings including all bends, tees, corrections etc.	m	320	250.00	80 000.00
2.3	**PART SPEC PCI**	**PARTICULAR SPECIFICATION PCI: GEOTEXTILES**				
	PCI-5.1	Supply and install geotextile				
2.3.1		(a) Seperation Geotextiles in capping works as shown on drawings, 2.5mm thick, minimum 1.5kg/m^2	m^2	120 000	12.00	1 440 000.00
2.3.2		(b) Around drainage pipes	m^2	1 240	12.00	14 880.00
2.4	**PART SPEC PDI**	**PARTICULAR SPECIFICATION PDI : GEOSYNTHETIC MEMBRANES**				
	PDI-15.1	Supply and Installation of geosynthetic membranes				
2.4.1		(a) 1.5mm HDPE geomembrane for use in plato capping	m^2	20 000	55.00	1 100 000.00
2.4.2		(b) Geosynthetic Clay Liner (GCL) as per drawings	m^2	50 000	60.00	3 000 000.00
2.4.3		(c) Geocomposite Drainage Layer (ABG Pozidrain® or similar)	m^2	30 000	65.00	1 950 000.00
2.4.3	PDI-15.2	Geomembrane Guarantee	Sum	1	20 000.00	20 000.00
2.5	**PART SPEC PNE**	**SECTION: ESTABLISHMENT OF VEGETATION ON LANDFILL**				
2.5.1	PNE-7.1	The preparation, application and maintenance of vegetation	m^2	50 000	25	1 250 000.00
TOTAL CARRIED FORWARD TO SUMMARY						**19 985 880.00**

ITEM NO	PAYMENT	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3.0		**PART 3: DAYWORKS**				
3.1	DW-1	Labour				
3.1.1		(a) Net cost of labour	Prov Sum	1		100 000
3.1.2		(b) Contractor's charges and profit associated with administration of the above item 3.1.1	%	100 000	15	15 000
3.2	DW-2	Plant				
3.2.1		(a) Net cost of plant (including operator, assistance, fuel, oil, maintenance, etc)	Prov Sum	1		100 000
3.2.2		(b) Contractor's charges and profit associated with administration of the above item 3.2.1	%	100 000	15	15 000
3.3	DW-3	Material				
3.3.1		(a) Net cost of material	Prov Sum	1		100 000
3.2.2		(b) Contractor's charges and profit associated with administration of the above item 3.3.1	%	100 000	15	15 000
TOTAL CARRIED FORWARD TO SUMMARY						**345 000.00**

SUMMARY OF BILL OF QUANTITIES

PART	DESCRIPTION	AMOUNT R-c
PART 1	PRELIMINARY AND GENERAL	2 950 000.00
PART 2	EARTHWORKS: SHAKAVILLE LANDFILL	19 985 880.00
SUB-TOTAL A		**22 935 880.00**
PART 3	DAYWORKS	345 000.00
SUB-TOTAL B		**23 280 880.00**
CONTINGENCIES Add 10 % for Sub-total B (Provisional sum)		**2 328 088.00**
SUB-TOTAL C		**25 608 968.00**
VALUE ADDED TAX Add 14 % for Sub-total C (Provisional sum based on current rate of VAT)		3 585 255.52
ESTIMATE TOTAL AMOUNT (INCL VAT)		**29 194 223.52**

Professional Civil Engineer **Curriculum Vitae**

Reon Pienaar, PrEng

Education

- MEng (Environmental Engineering), University of Pretoria, 2015
- BEng Hons (Environmental Engineering), University of Pretoria, 2007
- BEng Civil, University of Pretoria, 2004
- Lichtenburg High School, 1999
- Mafikeng Primary School, 1994

Professional Registration

Professional Engineer with ECSA, Reg Nr. 20100281

Experience

With BKS / AECOM: 12 Years

With Other Firms: 5 months

Professional Memberships

- Registered as Member of SAICE, Nr 205479
- Vice Chair of Institute of Waste Management of South Africa (IWMSA) Central Branch, Member Nr 10114089
- Member of International Solid Waste Association (ISWA), Nr 14-1081
- Member of the Geosynthetics Interest Group of South Africa (GIGSA), Nr 9738

Date of Birth

10 March 1981 ID: 8103105137081

Nationality & HDI Status

South African

White male, no disabilities

Key Technical Qualifications

Reon Pienaar holds a University degree in Civil Engineering, a BEng Honours degree and an MEng (Masters) degree in Environmental Engineering (specializing in Waste Management) from the University of Pretoria in South Africa. He has more than 12 years' experience in solid waste management, environmental management and dam engineering. The majority of his experience was spent in charge of projects and project teams.

He has experience in project management, planning, design and procurement as well as construction supervision of projects related to all types of waste management as well as dams. He has experience with the feasibility and viability of alternative waste treatment technologies and has presented papers on the topic at waste management conferences. He has experience in working with the Public Finance Management Act and Treasury Regulations and has spent a great deal of his recent time on PPP projects. His work within the South African Institute of Waste Management as vice chair of the Central Branch committee, has also given him experience in the intricacies of the circular economy as well as waste minimization and beneficiation and ultimate resource efficiency.

Reon worked for AECOM SA until May 2017 on various projects in South Africa; and has experience working in Lesotho. He has travelled on business to the United Kingdom, Turkey, Canada, Austria, Hungary and the Czech Republic. He started his own company, RAPienaar Consulting (Pty) Ltd, in May 2017 focussing on waste management and environmental engineering consulting. He has a very good understanding of the work and policies of the South African Government through his liaison with government clients and projects over the years.

He is registered as a Professional Engineer with the Engineering Council of South Africa (ECSA Reg. Nr. 20100281), he is a full member of the South African Institute of Civil Engineers (SAICE), a member of the Geosynthetic Interest Group (GIGSA), a member of the International Solid Waste Association, a member of MENSA and sits on the Central Branch Committee of the Institute of Waste Management of South Africa (IWMSA) as vice chairman.

Key Non-Technical Qualifications

Reon is a person that gets along very well with his peers. He likes to have fun and work hard. In his role at AECOM he was responsible for managing staff and finances on a range of large projects. He is very well spoken and communicates well with his staff, peers and managers. He is very skilled in technical report writing and always looks for creative ways to solve problems. He is a team player who demonstrates an adaptability and willingness to seek and implement new solutions wherever possible. He is an emotionally intelligent person who cares for others and is aware of his own shortcomings and willing to work on them. He enjoys a challenge and is not afraid to work hard.

General

He is a very good home cook, a music lover and an average but passionate golf player. He also enjoys other outdoor activities and sports like cricket, rugby, camping, hiking etc. He lives in Monumentpark, Pretoria, with his family. He has been married to Su-Marie (Primary School Maths Teacher) since 8 December 2007 and they have three daughters. Karla (6), Jani (4) and Nina (2). He has a code B South African Driver's License and is willing to travel.

Work Experience

Employer	Post Held	From	To	Reason for Leaving
RAPienaar Consulting (Pty) Ltd	Director and Owner	May 2017	Present	N/A
AECOM SA (Pty) Ltd	Associate	Sep 2013	May 2017	Restructuring
AECOM SA (Pty) Ltd	Senior Manager/Engineer	Sep 2009	Sep 2013	Promotion
BKS (Pty) Ltd (later AECOM)	Engineer	March 2005	Sep 2009	Promotion
Jenkins & Potter Consulting (in the UK)	Engineer	Nov 2004	March 2005	Contract Ended

Professional Project Related Experience

RAPienaar Consulting (Pty) Ltd
May 2017 to Present

- **Project:** Engineering Investigation and Reporting for Sappi Enstra H:H Landfill in Springs
  Client: Sappi Enstra
  Approx. Project Value: R26,000
  Date: June 2017
  Position: Engineer responsible for site investigation and reporting on facility audit for Sappi Enstra Landfill in Springs.

- **Project:** Waste Company and Facility Audits on behalf of Betha Waste
  Client: Betha Waste
  Approx. Project Value: R25,000
  Date: July 2017
  Position: Engineer responsible for Audits on Betha Waste company and sub contract on behalf of Prominent Paints (PPG Group)

AECOM (Pty) Ltd (formerly BKS (Pty) Ltd)
October 2009 – May 2017

- **Project:** Feasibility Study on Development of Alternative Waste Treatment Technologies for the Ekurhuleni Metropolitan Municipality
  Client: Gauteng Infrastructure Financing Agency
  Approx. Project Value: ± R 5 Million
  Date: 2015 - present
  Position: Project Manager and Waste Engineer for lead transaction advisor team comprising technical, financial and legal specialists. Working with Treasury and PFMA.
- **Project:** Tshwane Regional Landfill Facility
  Client: Interwaste (Pty) Ltd
  Approx. Project Value: ± R 2.5 Million
  Date: 2014 - 2017
  Position: Project Manager and Lead Engineer. Responsible for client liaison and project management as well as designs required to obtain a waste license from authorities.
- **Project:** Landfill Master Planning
  Client: Ekurhuleni Metropolitan Municipality
  Approx. Project Value: ± R 2.5 Million
  Date: 2014 - 2016
  Position: Engineer and Project Manager responsible for updating the City's Landfill Master Planning and development of materials recovery facility master
  planning.

- **Project:** Franschhoek Waste Drop Off
  Client: Stellenbosch Municipality
  Approx. project value: ± R 2 Million
  DATE: 2015 - 2017

POSITION: Project Manager and Engineer responsible for site selection, design and construction monitoring of a major waste drop off facility in the Franschhoek area.

- **Project:** Stilfontein and Orkney Landfill Closures
  Client: City of Matlosana
  Approx. Project Value: ± R 3 Million
  Date: 2010 - 2014
  Position: Engineer responsible for Design, Tender Documentation and Construction Monitoring for the closure and rehabilitation of the Old Orkney and Stilfontein Landfill sites.

- **Project:** GIBELA Train Manufacturing Facility
  Client: GIBELA
  Approx. Project Value: ± R 100 Million
  Date: 2014 - 2017
  Position: Engineer responsible for planning and design of waste management requirements of the GIBELA train manufacturing facility in Gauteng, South Africa.

- **Project:** Mkuze Regional Landfill
  Client: Jozini Local Municipality
  Approx. Project Value: ± R 4 Million
  Date: 2013 - 2016
  Position: Engineer responsible for Design, Tender Documentation and Construction Monitoring for the upgrading of the Mkuze landfill site (project cancelled prior to construction).

- **Project**: Arnot Ash Water Return Dam
  Client: ESKOM
  Approx. Project Value: ± R 25 Million
  Date: 2013 - Present
  Position: Engineer responsible for Tender Documentation, Project Management and Construction Supervision of HDPE lined ash water return dam.

- **Project:** Municipal Landfill Audits
  Client: Masilonyana / Maquassi Hills Local Municipality
  Approx. Project Value: ± R 100 000
  Date: 2012 - 2014
  Position: Project Manager and engineer responsible for auditing and reporting on condition of landfill facilities in the Municipality.

- **Project:** De Beers (Mothusi) Dam Safety Inspections
  Client: Letseng Diamond Mine in Lesotho
  Approx. Project Value: ± R 500 000
  Date: 2011 - 2014
  Position: Responsible for the safety inspections at the De Beers (Mothusi) Dam at the Letseng Diamond Mine in Lesotho. Reon assisted Mr Danie Badenhorst (APP) with the initial inspection after which he was responsible to compile the report and undertake further inspections.

- **Project:** Western Cape Waste Licenses

  Client: Department of Environmental Affairs

  Approx. Project Value: ± R 10 Million

  Date: 2013 - 2015

  Position: Engineer responsible for Preliminary Design inputs into the closure or operations license applications for 50 waste disposal facilities in the Western Cape Province.

- **Project:** Construction Monitoring - North and South Dams
  Client: NCP Chlorchem
  Approx. Project Value: ± R 500 000
  Date: 2010 - present

Position: Engineer responsible to assist the APP with the Safety Inspection. Reon was then responsible for compilation of report and subsequently responsible or design and tender process to implement the recommended rehabilitation work. He was then also responsible for construction monitoring and project management at the Dams.

- **Project:** Rustenburg Waste Disposal Strategy and Transfer Stations
  Client: Rustenburg Local Municipality
  Approx. Project Value: ± R 40 million
  Date: 2010 – present
  Position: Responsible for planning and design of Solid Waste Transfer Stations as part of the municipality's plan to expand the waste services in the Rustenburg area.

- **Project:** Msukaligwa & Albert Luthuli Regional Landfill
  Client: Gert Sibande District Municipality
  Approx. Project Value: ± R 15 million
  Date: 2009 - 2010
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Ermelo in Mpumalanga. Waste license was successfully obtained. Study included Site Selection and conceptual design. Reon was also responsible for the detail design of the facility as well as the compilation of the Tender Document and the management of the tender process.
- **Project:** Govan Mbeki Regional Landfill
  Client: Mpumalanga Department of Environment, Economic Development and Toursim
  Approx. Project Value: ± R 15 million
  Date: 2009 - 2014
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Secunda in Mpumalanga (project stopped before completion).
- **Project:** Klinkerstene Regional Landfill
  Client: Interwaste (Pty) Ltd
  Approx. Project Value: ± R 5 million
  Date: 2009 - 2014
  Position: Project Manager for the Feasibility Study and Waste License Application for a regional landfill site near Delmas in Mpumalanga. Responsible for client liaison and project management as well as designs required to obtain a waste license from authorities.
- **Project:** Polihali Gauging Weir
  Client: Lesotho Highlands Development Authority
  Approx. Project Value: ± R 20 million
  Date: 2011 - 2014
  Position: Engineer responsible for the design, tender and construction monitoring of a gauging weir in the Senqu River in Lesotho as part of the second phase of the Lesotho Highlands Water Project to provide Water to South Africa.
- **Project:** Acid Mine Drainage (Witwatersrand)
  Client: TCTA (DWAF)
  Approx. Project Value: ± R 200 million
  Date: 2011 - 2013
  Position: Responsible for Waste Classification, wayleave Liaison and land acquisition in order to implement the Acid Mine Drainage project in the Witwatersrand area of Gauteng.
- **Project:** Exxaro Pollution Control Dams
  Client: EXXARO
  Approx. Project Value: ± R 70 000
  Date: 2012
  Position: Engineer responsible for Conceptual Design Report for the development of two pollution control dams at the Mooifontein Colliery.

BKS (Pty) Ltd
March 2005 – October 2009 (Candidate Engineer)

- **Project:** Rietfontein Weir

Client: Department of Water Affairs
Approx. Project Value: ± R 10 Million
Date: 2007 - 2008
Position: Engineer responsible for the preliminary design, final design, tender documentation and construction monitoring of the raising of the Rietfontein Weir near Kriel in Mpumalanga. Reon was also responsible for the design and tender process of a hazardous waste lagoon near the Rietfontein Weir that was never built due to budget constraints.

- **Project:** Orkney Solid Waste Transfer Station
  Client: Southern District Municipality
  Approx. Project Value: ± R 10 million
  Date: 2007
  Position: Design Engineer for the development of the Orkney Solid Waste Transfer Station.
- **Project:** Felophepha Waste Disposal Site
  Client: Potchefstroom Local Municipality
  Approx. Project Value: ± R 800 000
  Date: 2009
  Position: Engineer responsible for design, tender and (part time) construction monitoring of the second cell at the Felophepha landfill site near Potchefstroom.
- **Project:** Gert Sibande Integrated Waste Management Plan
  Client: Gert Sibande District Municipality
  Approx. Project Value: ± R 1 Million
  Date: 2004 - 2006
  Position: Engineer responsible for technical inputs and report writing to develop an integrated waste management plan for the Gert Sibande District Municipality.

Signed: ……. Date:12 September 2017

e-mail : reon@rapienaar.co.za

Cell: **072 123 5517**

edtea

Department :
Economic Development, Tourism and Environmental Affairs
PROVINCE OF KWAZULU-NATAL

Details of specialist and declaration of interest

in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), and the Environmental Impact Assessment Regulations, 2014

Reference number:	DC29/0025/2017
Project title:	*Basic Assessment for the proposed Decommissioning (Closure) of the Shakaville Landfill, KwaDukuza Local Municipality, KwaZulu Natal Province*

Specialist:	CIVIL ENGINEER		
Name of company:	RAPieser Consulting (Pty) Ltd		
Postal address:	635 Boesperwer Str Monumentpark		
Postal code:	0181	Cell:	0721236517
Telephone:	0721236517	Fax:	-
E-mail:	rene@rapieser.co.za		
Qualifications:	BEng; BEng(Hons); MEng		
Professional affiliations:	SAICE; ECSA (PrEng 20100281)		
Expertise:	13 years (waste Management)		

EAP:	Ntsebo Mkhize		
Name of company:	GA Environment (Pty) Ltd		
Postal address:	P.O Box 6723, Halfway House		
Postal code:	1685	Cell:	072 550 9669
Telephone:	011 312 2537	Fax:	27 11 805 1950
E-mail:	environment@gaenvironment.com /ntsebom@gaenvironment.com		

Declaration by the specialist

I, Rean Pieroor , declare that --

- I act as the independent specialist in this application;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the EIA Regulations, 2014;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Waste Act and NEMA, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Waste Act and NEMA, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of subregulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

RAPieroor Consulting (Pty) Ltd

Name of company

11/12/17

Date