PRELIMINARY REPORT ON GEOTECHNICAL INVESTIGATION OF THE FRANKFORT LANDFILLS Free State PROVINCE

GEOTECHNICAL INVESTIGATION REPORT FOR THE LANDFILL

PREPARED FOR:	PREPARED BY:
DIPABALA CONSULTING ENGINEERS NO.9 UNIT D WESTDENE BLOEMFONTEIN 9301 Tel: 051-430-0248 Email: :om Dipabalace@gmail.com	LUANDE TECHNICAL GROUP 4 MODDERFONTEIN ROAD EDLEEN X5 KEMPTON PARK 1621 GAUTENG Tel: 082-7681-464 Email: Info.luande@lgce.co.za

	Website: www.lgce.co.za

COMPILED AND ORIGINATED BY LUANDE TECHNICAL GROUP

NAME	TITLE	SIGNATURE	DATE
NJ MHLOPHE	MATERIAL ENGINEER		

REPORT REVIEW

NAME	TITLE	SIGNATURE	DATE
K. Mnisi	Geologist		

ACCEPTED AND APPROVED BY: DIPABALA CONSULTING ENGINEERS

NAME	TITLE	SIGNATURE	DATE
T.MOTHEANE	SNR ENGINEER		

ACCEPTED BY CLIENT: MAFUBE LOCAL MUNICIPALITY

NAME	TITLE	SIGNATURE	DATE

Table of Contents

APPENDIX

APPENDIX A	:	SITEPLAN SHOWING GEOTECHNICAL ZONES/LOCALITY PLAN
APPENDIX B	:	TEST PIT PROFILE
APPENDIX C	:	SANAS LABORATORY TEST RESULTS
APPENDIX D	:	DCP FIELD RESULTS
APPENDIX E	:	TEST PIT PHOTOS
APPENDIX F	:	SITE PHOTOS/TEST PIT PHOTOS

TABLES

FIGURES

1. INTRODUCTION

1.1 TERMS OF REFERENCES

1.1.1 Dipabala Consulting Engineers appointed Luande Technical Group & Geotechnical Services to conduct a preliminary Soil Profiling Geotechnical Investigation and compile a Geotechnical Engineering Report for the proposed Waste Disposal facility in Frankfort..

1.1.2 The investigation was carried out as per the specification method outlined on Jennings and Brink. The test holes for the investigation were taken in accordance with *SAICE (South African Institute of Civil Engineers) Site Investigation Code of Practice*. We were also guided by the size of the landfill which is number 14ha topographical plan. The coordinates will differ from area to area. Within the vicinity of where sampling took place

1.1.3 The purpose of this investigation was to also characterize the subsurface condition and provide geotechnical comments and recommendation to assist the design and site development of the new Solid Waste Site to be developed.

1.1.4 Determine Excitability of the in-situ material on site.

1.1.5 Identify geotechnical constraints for the establishment of the Solid Waste Disposal site and associated infrastructure.

1.1.6 The purpose of this investigation was to also determine the appropriate Founding Bearing Pressure and potential Settlement over the area.

1.1.7 Recommendation are made with regards to founding conditions for proposed Landfill and other structures.

1.1.8 The site investigation work commenced on the 10th December 2018 and material was sent to the Laboratory on the 13th December 2018. Therefore DCP's was also carried out.

1.2 LOCATION

Frankfort is located approximately 30.5km North of Tweeling,32.4 Km West of Cornelia and it is 52.4 Km east of Heilbron, From the capital city of Free State Bloemfontein it is approximately 308 Km north East of Bloemfontein along the N1 and N5 route. Refer to Figure 1 and 2 below for Locality Plan and Aerial Photo showing the existing landfill site (Google earth images).

Coordinates: E: 28 29' 49'' S: 27 17' 43'

Refer to Locality Plan (APPENDIX and Layout Plan (APPENDIX) for more details

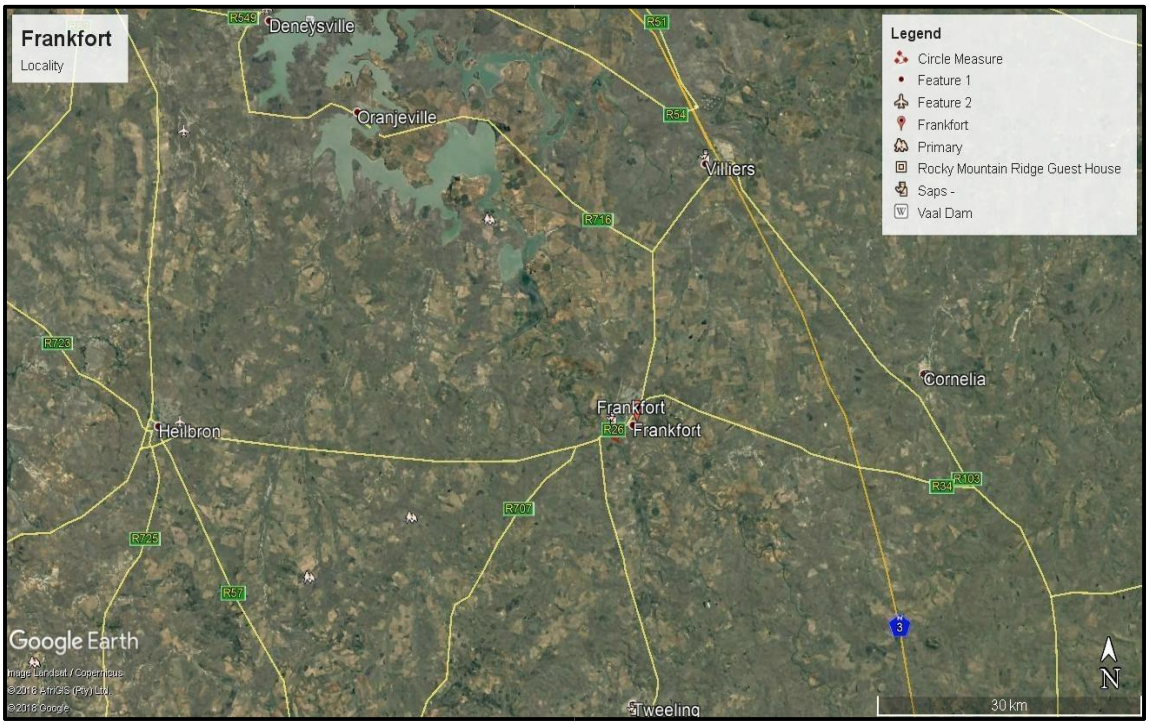

FIGURE 1: Frankfort Locality Plan

FIGURE 2: Site Location, of Landfill in Frankfort Free State (Google Earth Map)

1.3 DESK STUDY

The desk Study was also carried out on the day of the investigation from the Geological plan.

1.3.1 Information used in Study

- AGIS Geological Map

2.0 INFORMATION USED IN THE STUDY

CRI Clayton and M.C Matthews and N.E Simons. Site Investigation, 2nd Edition, Department of Civil Engineering
University of Surrey

JENNING JE, BRINK ABA, and Williams AAB.1973. Revised guide to soil profiling for civil engineering purposes in southern Africa, the Civil Engineer in South Africa, Jan 1973 Trans SAICE, Vol 150No 1

Geological Map of the South Africa and the Kingdoms of Lesotho and Swaziland (1997), Council for Geoscience.
(SCALE 1:50000)

An Empirical Preliminary Prediction of Heave, ISSN 1021-2019, Vol 59 No 4, GA Jones
Guideline for Profiling, Guideline for Soil and rock logging in South Africa, 2nd Impression by ABH Brink and
RMH Bruin

Minimum Requirements for Waste Disposal by Landfill", DWAF

Climate of Frankfort:
http://www.saexplorer.co.za/southafrica/climate/frankfort_climate.asp

Software: Google Earth

3.0 TEST METHODS

Sampling and Testing by Geotechnical Laboratory

Sampled according to the TMH5: 1981 and specification according to the Consulting Engineers.

Sampling was done by a BELL Backhoe Loader 4 x 2 75Kw

FIGURE 3: BELL TLB USED FOR INVESTIGATION

The test methods used include the following SANAS accredited Methods:

TMH1: 1986, A1 (a) – The wet preparation and sieve analysis of gravel, sand and soil samples.

TMH1: 1986, A2 – The determination of the liquid limit of soils by means of the flow curve method.

TMH1: 1986, A3 – The determination of the plastic limit and plasticity index of soils.

TMH1: 1986, A4 – The determination of the linear shrinkage of soils.

TMH1: 1986, A5 – The determination of the percentage of material passing a 0.075mm sieve in a soil sample.

*TMH1: 1986, A6 – The determination of the grain size distribution in soils by means of a hydrometer. (Particle Size Distribution of Samples)

TMH1: 1986, method A7 - The determination of the maximum dry density and optimum moisture content of gravel, soil and sand.

TMH1: 1986, method A8 -The determination of the California Bearing Ratio of untreated soils and gravels.

*TMH1: 1986, method A17 – The determination of the moisture content of soils.

*TMH1 1986: method A20 - The electrometric determination of the pH value of a soil suspension.

*TMH1 1896: methodA21T - Tentative method for the determination of the conductivity of a saturated soil paste and water

*Colto Classification of Material Properties.

*Classification of Site – NHBRC Home Building Manual, Part 1, Section 2, Table: Residential Site Class Designations.

Tests marked - * “Not SANAS Accredited” in this report are not in the SANAS Schedule of Accreditation for this laboratory”

Opinions and interpretations expressed in the report are outside the scope of SANAS Accreditation of Roadlab (Pty) Limited – Geotechnical Services.

4.0 SITE CHARACTERIZATION

4.1 The site is currently being used as Waste Disposal Landfill for Frankfort General Waste. The access roads within the street next to the landfills is earth surfaced / gravel. The site has vegetation and there is no formal storm water provision on the current landfills. The site is relatively flat (around 1-2.5%) the Storm water runoff is normal however this can be investigated further..

4.2 The portion of the land is 14ha

4.3 The site is 14ha in total and the site slope from East to West. The waste disposal development falls on the South Western opposite of Frankfort Town and Township.

5.0 SCOPE OF WORK

Scope of Work was done by:

5.1 A 75Kw Bell Backhoe Loader (TLB) was used to excavate test pits at agreed Location

5.2 The site was selected adequately to cover the center point of the proposed Waste Disposal section to determine if there any characteristic in the site geology.

5.3 Machinery excavation was logged and to determine any variation of site geology and were profiled and were logged according to the standard method of Jennings, Brink and Williams (1973) Test photographs are included.

5.4 The Eight pits (TP01-TP09) were profiled by a Material Engineer to determine the strata layers and characteristics. Soil samples were retrieved as necessary for laboratory testing.

Test Pit	Test Pit Depth(m)	Refusal on	Coordinates		Material Description
			LATITUDE	LONGITUDE	
TP01	0- 0.75m 0.75-1.71m	Maximum Reach of TLB Machine	27°17'8,69" S	28°29'24,82" E	**Brownish Grey Black Firm sandy gravel/Light Brownish Sand gravel soil with a dense sand**
TP02	0.0-0.35m 0.35m-0.9m	Maximum Reach of TLB Machine	27°17'40,96" S	28°29'44,55" E	**Light Brownish Sand gravel soil with a dense sand/Brownish Sandy stone with**

					a very dense intact sandy soil
TP03	0.0-0.910m 0.91-2.7m	Maximum Reach of TLB Machine	27o17'36,61" S	28o29'45,41" E	**Brownish Firm sandy gravel/Brownish Black Sandy Material**
TP04	0.35-0.9m 0.9-1.76m	Maximum Reach of TLB Machine	27o17'25,53" S	28o29'14,31" E	**Brownish Firm sandy gravel/Brownish Black Sandy Material**
TP05	0.3-1.2m 1.2-1.51m	Maximum Reach of TLB Machine	27o17'5,94" S	28o29'43,45" E	**Brownish Firm sandy gravel/Greyish brown Sandy stone Material**
TP06	0.25-0.81m 0.81-1.56m	Maximum Reach of TLB Machine	27o17'37,03" S	28o29'53,04" E	**Light Greyish Sandy stone with slight moist/Brownish**
					Black,sand stone (mudstone) with slight gravel.
TP07	0.2-0.95m 0.95-1.92m	Maximum Reach of TLB Machine	25o17'36,60" S	28o29'50,98" E	**Light Greyish Sandstone with slight ease/Brownish black sandstone mudstone with slight grave**

TP08	0.25-0.8m 0.8-0.95m	Maximum Reach of TLB Machine	27o17'37,67" S	28o29'49,45" E	**Light Greyish Sandstone with slight ease/Brownish black sandstone mudstone with slight grave**
TP09-ROAD	0-1.10m 1.10-3.1m	Maximum Reach of TLB Machine	TBC		**Yellowish Brown sandy soil with firm consistency/Light Grey sandy soil mater with loose intact material**

Table 1: <u>Strata Layer Characteristic</u>

5.5 The soil sample were sent to a certified geotechnical Soils Laboratory (Roadlab) for testing and analysis which is SANAS Accredited.

5.6 DCP results are included in the Appendix.

5.7 The Geotechnical Surveillance report was compiled.

6.0 REGIONAL GEOLOGY

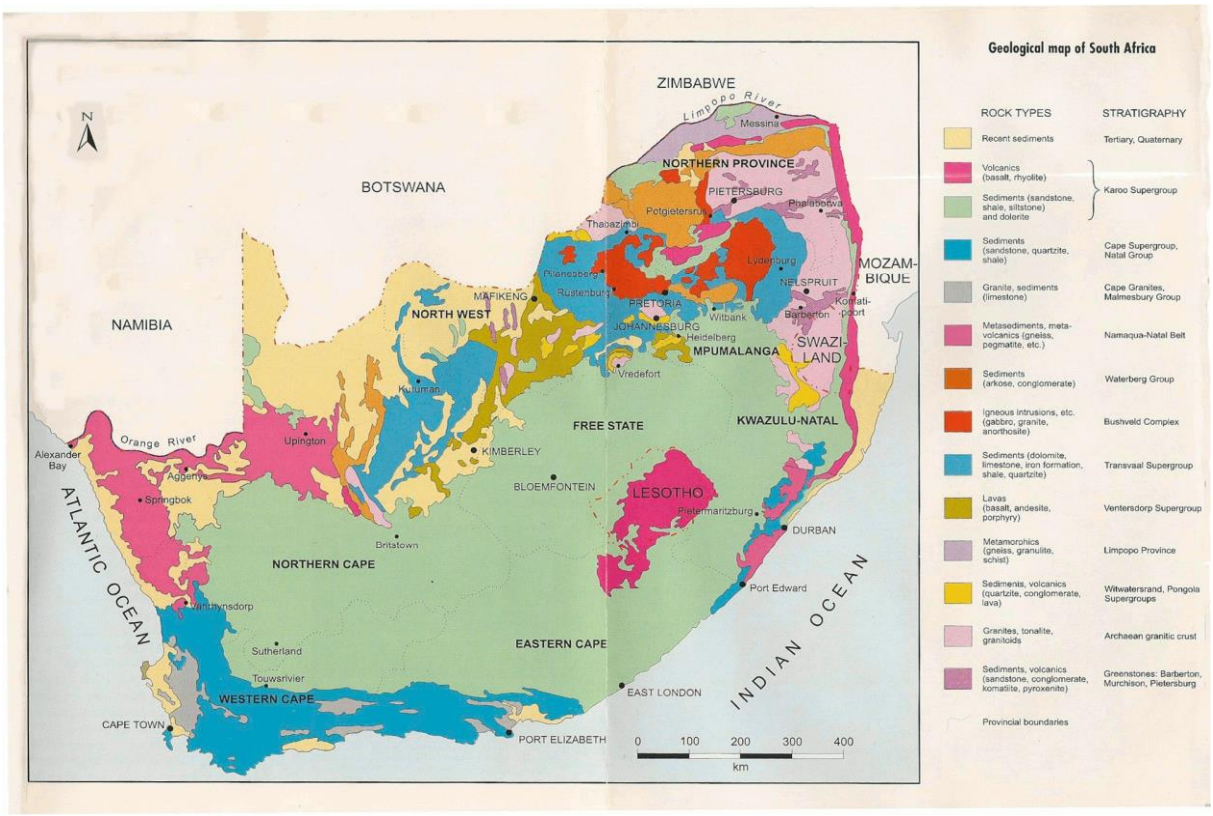

FIGURE 4: SOUTH AFRICAN GEOLOGICAL MAP

6.1 TOPOGRAPHY

The area of the proposed development is a relatively flat terrain that slopes from East to West.

The area is covered with short dense grass with thorn trees and bush.

At the position of test pit 2, to the North of the proposed development there is an existing Pond

6.2 GEOLOGY

The study area is typically located on Dolerite, Mudrock and sandstone at Beaufort Group. According to geological map, the site is also underlain by Phanerozoic. A map of the regional geology is attached to this Report.

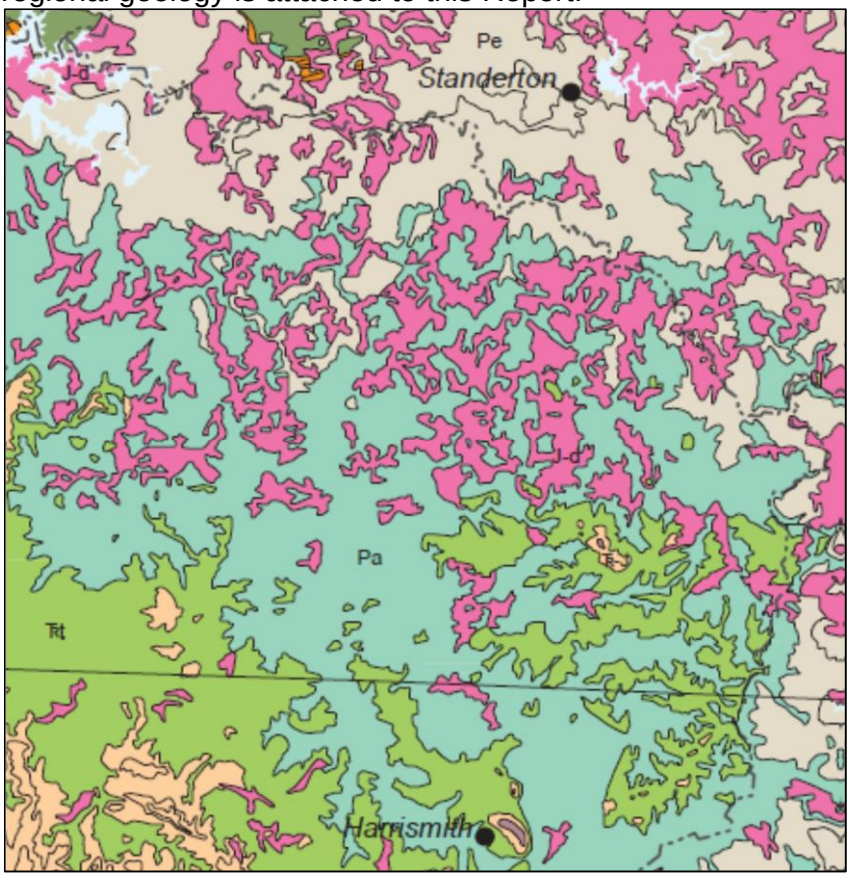

FIGURE 5: REGIONAL GEOLOGICAL MAP

6.2.1 Undermined Ground

No indication of the presence of undermined ground was found during the investigation. It is certain that the site is not shallow undermined and there is no risk of surface settlements that maybe caused by mining activities. However the site Engineer may verify this with the department of mineral resources to find out there is any undermined ground in the area. According to the information explored at Geoscience the site is not Dolomitic.

6.3 VEGETATION

The site is generally approximately 60-65% covered by grass vegetation around and there is also a scattered waste in the excavated area (former quarry), which is currently used as a solid waste site.

6.4 CLIMATE

Frankfort (EC) normally receives about 700mm of rain per year, with most rainfall occurring mainly during Summer.

It receives the lowest rainfall (8mm) in July and the highest (90mm) in March. The monthly distribution of average daily maximum temperatures shows that the average midday temperatures for Frankfort (ec) range from 18.9°C in July to 26°C in February.

The region is the coldest during July when the mercury drops to 5.5°C on average during the night.

7.0 FIELD WORK & SITE INVESTIGATION

Eight (9) test pits were investigated by means of a BELL 75kw TLB.

The test pits were profiled in accordance with Brink, Jennings and Williams guidelines for geotechnical profiling.

Profiles are given in Appendix B. Typical samples from selected test pits were taken to conduct the required tests.

A total of Eighteen (18) Dynamic Cone Penetrometer were carried out on the test pit Position or the approved location.

The aim of the DCP testing was to establish the consistency of the sub soil underlying the site at shallow to moderate depth to the bedrock if occurring at shallow to moderate depths.

The results are recorded graphically in the appendix for ease of evaluation, Table 3 gives a quality to the indication of none and cohesive, and soils based on the DCP results. It should be noted that results are specific to DCP's testing equipment and should be used with caution as it is only provided as a guide.

Table 2: Subsoil consistency inferred from DCP test results

Non-Cohesive Soils		Cohesive Soils	
No of blows/300mm Penetration	Subsoil Consistency	No of blows/300mm Penetration	Subsoil Consistency
<8	Very Loose	<4	Very Soft
8-18	Loose	4-8	Soft
19-54	Medium Dense	9-15	Firm
55-90	Dense	16-24	Stiff
>90	Very Dense	25-54	Very Stiff
		>54	Hard

8.0 GEOTECHNICAL ANALYSIS

The Test pit in general indicated a shallow weathered, residual Sandy gravel Clay Content with Ferricrete with a collapsible Fabric.

8.1 Potential Collapsible Soils

It is suggested that the design engineer to conduct a one-dimensional Oedometer test to be carried out to determine the collapsible potential per specific structure and site.

8.2 Potential Expansive Clays.

The potential expansiveness of the soil profiles investigated, vary from low to medium based on van der Merwe's method for predicting potential heave.

8.3 Potential Compressible Soil

Further investigation will be required to ensure that the material around this area is compressible to a degree by means of the Consolidation Process or test.

8.4 Groundwater

TP6 encountered groundwater however.

- Proper Linning measures will be required. Service trenches may also have to be dewatered during construction.

TP1-TP5, 7-9 no groundwater encountered.

8.5 Slope Stability & Erodibility

No natural instability is anticipated to occur on the gently sloping ground across the site.There is no evidence on site that significant water erosion has occurred in the past. Wind erosion of the upper drier Silty sandy soils is possible when the vegetation is removed.

8.6 Excavatability

The Eight (9) test pit profiles have been used to determine the general depths of the excavation classes across the site. The excavation procedures are in accordance with SANS 1200D/DA/DB.

Excavations during the investigation showed that the soil found in the area down to bedrock level can be excavated with medium ease by means of pick and shovel or TLB excavator. The soil can in general be excavated at a rate of approximately 0.15m^3/min by means of a TLB.

The depths of the anticipated excavation classes within each of the geotechnical zones/site classes are presented in Table 6.

TABLE 3: **Depth of Anticipated Excavation Classes for each Geotechnical Zones**

SITE CLASSIFICATION/GEOTECHNICAL ZONES	GENERAL DEPTH RANGES OF EXCAVATION CLASSIFICATION SANS 1200D/DA/DB	
	SOFT & INTERMEDIATE (m)	HARD EXCAVATION (m)
S	3.0+ (No refusal in test pit)	Not Encountered*
S(TP2)	(0.35-0.9)	>0.5 Hard Ripping possible.
S1	1.5-3.0m(No Refusal in test Pit)	Not Encountered*
TP09	0-3.1m	Not encountered

*Hard excavation was encountered with test Pit excavation depth in the Landifills. This point information could possibly vary across the proposed sites. Bedrock can therefore be present at any depth below stated depth E.g.: 3.0m + stated in the bedrock was encountered at a depth of 1.5m and above. depth was not determined in the test pit and may be present deeper than 3.0m level in terms of SABS 1200D the transported layer, pedogenic layer (nodular Ferricrete) and residuals soils can be classified as “Medium Excavation” and hardpan Ferricrete can be classified as “Hard Excavation”

The exposed cut faces should be battered back to suitable safe slope angles. In this regard, the soils should be battered at an angle of (1 vertical to 2 horizontal). Rock slopes greater than 1.5m in height should be battered to l vertical to 0.5 horizontal unless very closely jointed zones are encountered, which may require flattening. During the construction phase a geotechnical engineer should inspect cut faces as they are being formed so as to recommend whether the batter angles given above should be flattened in any instances, especially if groundwater is encountered.

8.7 Soil Analysis & Profile

The test pits were spaced in such a manner to determine the availability of the linear material, if any ad to determine if there is a perched water levels.

In general most of the test pits went to a maximum of (2.0m+) of the machine with refusal on weathered dolerite.70% percent of test pit refused this indicates that there is a either Ferricrete ,Hardpan Ferricrete boulders were present in some of the test pits. However TLB could not breakthrough the layer.

8.10 Seismicity

According to seismic hazard map of South Africa, peak ground acceleration with a 10% probability of being exceeded in a 50 year period is between 0.05g and 0.2g. This includes both natural and mining-induced seismicity (SANS 10160-4:2011, Edition 1.1). Figure below shows seismic hazard map of South Africa.

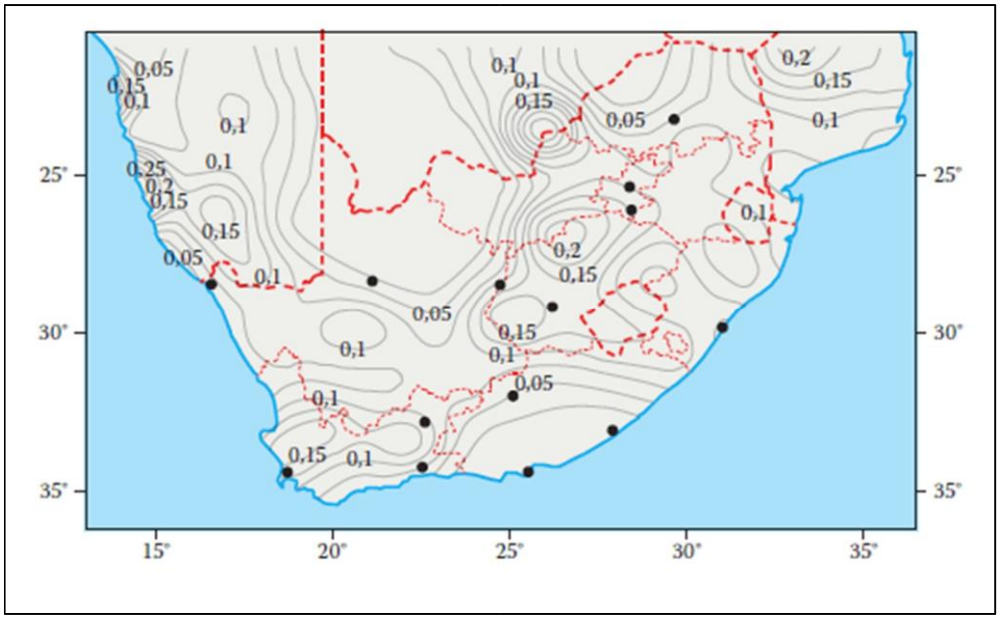

FIGURE 6: SEISMIC HAZARD MAP COUNCIL OF GEOSCIENCE

8.11 Dolomitic Land

Information obtained from Council of Geoscience shows that the site is not underlain by dolomite rock at surface or at depth (<100m). The site is therefore not classified as dolomitic land and is not at risk in terms of dolomite related surface subsidence. Generally, soluble rock, such as limestone or dolomite was not found on the site and no instability associated with this rock type anticipated

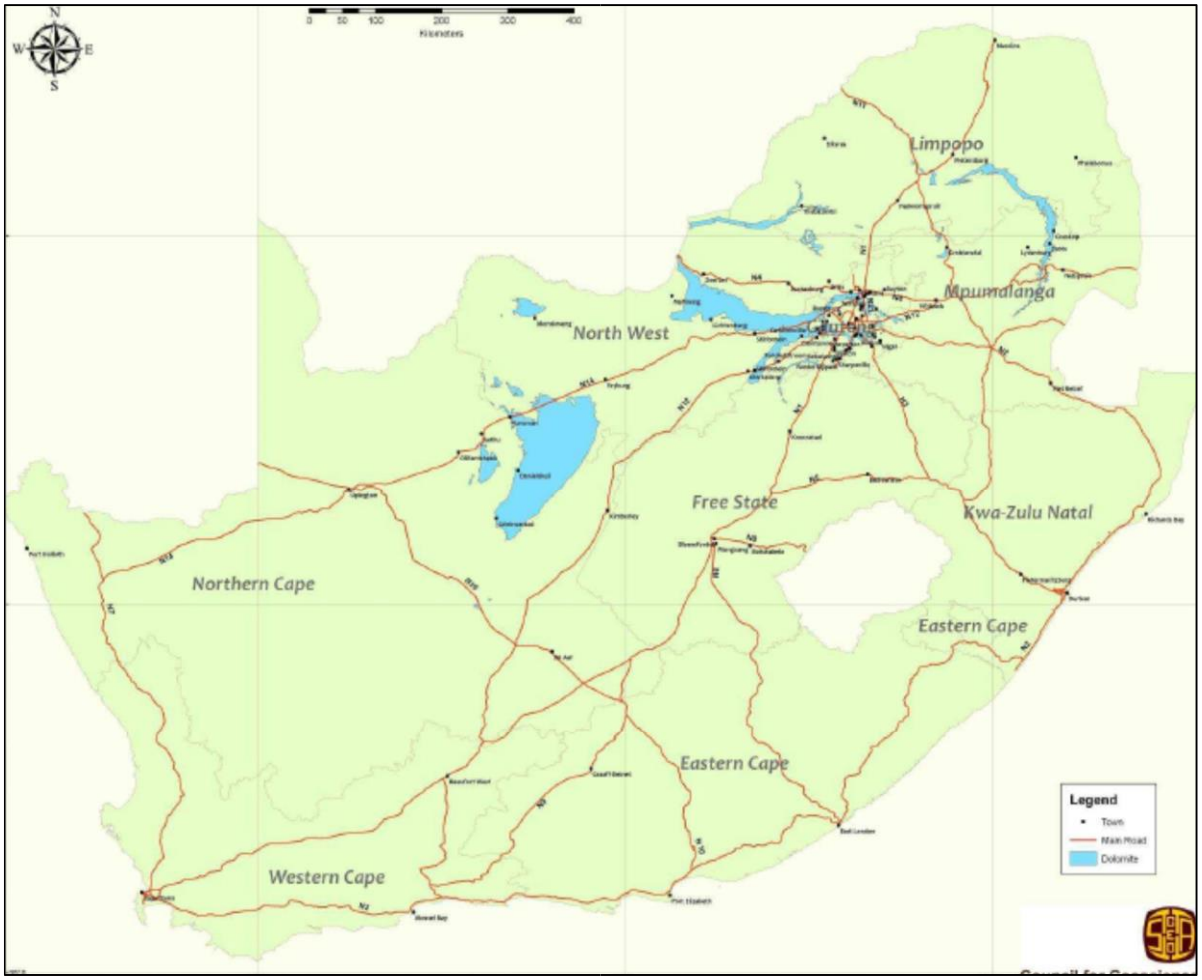

FIGURE 7: Distribution of Dolomite in Southern Africa

9. Site Classification

The site Classes/geotechnical zones have been categorized using Geotechnical Classification for Urban Development table contained in the GFSH-2 Document. For ease of reference, the Geotechnical Classification for Urban Development table is reproduced here as Table 6.The classification zones has been classified under the NHBRC manual (reference 2) and table 8 indicates the consequences of the type of pre-existing conditions that could affect development and this is catered for in the recommendations.

TABLE 4: SITE CLASSES INDICATION

Constraint		Most Favourable (1)	Intermediate (2)	Least Favourable (3)
A	Collapsible Soil	Any collapsible horizon or consecutive horizons totaling a depth of less than 750mm in thickness*	Any collapsible horizon or consecutive horizons with a depth of more than 750mm in thickness	A least favorable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1.5m below ground surface	Permanent or perched water table less than 1.5m below ground surface	Swamps and Marshes
C	Active	Soil Low-Heave potential anticipated	Moderate soil Heave potential anticipated	High Soil Heave Potential anticipated
D	Highly Compressible Soil	Low Soil Compressibility anticipated	Moderate soil Compressibility anticipated	High soil compressibility anticipated
E	Erodibility of Soil	Low	Intermediate	High
F	Difficulty of excavation to 1.5m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 4o% of the total volume

G	Undermined Ground	Undermining at a depth greater than 240m below surface (except where total extraction mining has not occurred	Old undermined areas to a depth of 90-240 m below surface where slope closure has ceased	Mining within less than 90- 240m old surface or where total extraction mining has taken place
H	Stability: (Dolomite & Limestone)	Possibly stable. Areas of dolomite overlain by Karoo Rocks or intruded by sills. Areas of Black Reef rocks. Anticipated inherent Risk Class I	Potentially characterized by Instability. Anticipated inherent Risk Classes 2 5.	Known sinkholes and Do lines. Anticipated inherent
J	Steep slopes	Between 2" and 6" (all regions)	Slopes between 6'and 18' and less than 2" (Natal and Western Cape) Slopes between 6' and 12" and less than 2" other regions)	More than 18' (Natal and Western Cape) More than 12' (all other regions)

K	Areas of unstable Natural slopes	Between 2" and 6" (all regions)	Slopes between 6'and 18' and less than 2" (Natal and Western Cape) Slopes between 6' and 12" and less than 2" other regions)	More than 18' (Natal and Western Cape) More than 12' (all other regions)
L	Areas subject to flooding	A "most favorable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas within a known drainage channel or floodplain

10.0 Liner Material

No liner quality material was encountered onsite. The material is sandy and lacks cohesion and this will result in a high permeable layer even if full compacted.

11.0 Foundation Conditions

Due to the highly expansive nature of the material according to South African Distribution of clay maps.it is recommended that certain precaution should be taken to prevent structural damage to newly constructed. According building to the NHBRC this site will classify as a C1 and all the prescribed conditions as specified should be adhered to.

11. Recommendation

The recommended Foundation Design, building Procedures and precautionary measures for Landfill development Structure on Compressible soil is summarized in below:

Please note the above and below is only recommendation and the design should be done by a professional Engineer.

11.0 General Recommendation and Conclusion

11.1 Building foundations must be reinforced or earth mattresses should be used due to the expansive and collapsible potential of the soils on site. Allowable bearing pressure should be no less than 150kPa

11.2 The upper 100mm of the in-situ soil with roots masking majority of the site topsoil, would be unsuitable for use of construction material. The soil with abundant roots should be stockpiled prior the commencement of construction for later reuse for possible vegetation.

11.3 The foundation should be protected from moisture ingress by constructing a concrete paved apron slab around the building.

11.4 Proper sub-soil drainage systems should be constructed due to the presence of perch water level onsite.

11.5 Excavatability on site is medium to intermediate

11.6 Site roads and infrastructure roads can be built by the material available onsite.

11.7 Proper surface drainage needs to be designed and constructed to prevent excessive erosion.

11.8 Fill material should be compacted in 150mm layers to 95% Mod AASHTO and the upper 300mm of fill
Should be compacted in two 150mm layers to 97% Mod AASHTO density;

11.9 All foundations should be inspected by a competent geotechnical engineer or engineering Geologist prior to placing of concrete to ensure that the correct founding material has been Obtained in the excavations. This is an important aspect because the investigation findings rely on point information (test pits) and localized variations may be revealed in the excavations. This is of particular significance with respect to identifying new loose test pit backfill;

11.10 The excavation of the material on site posed no problem as the material is classified as intermediate to hard in terms of the earthwork excavation

11.11 100 year flood line should also be calculated and investigated to check whether the area is suitable for conservation purpose.

11.12 The base of the excavation needs to be inspected and approved by the engineer before further work is done

11.13 The site appear to be suitable for the development of the proposed Landfills

APPENDIX A
LOCALITY PLAN

APPENDIX B
TEST PIT PROFILE

APPENDIX C
SANAS LABORATORY RESULTS

APPENDIX D

DCP FIELD RESULTS

APPENDIX E
TEST PIT PHOTOS

TP01

TP02

TP03

TP04

TP05

TP06

TP07

TP08

TP09