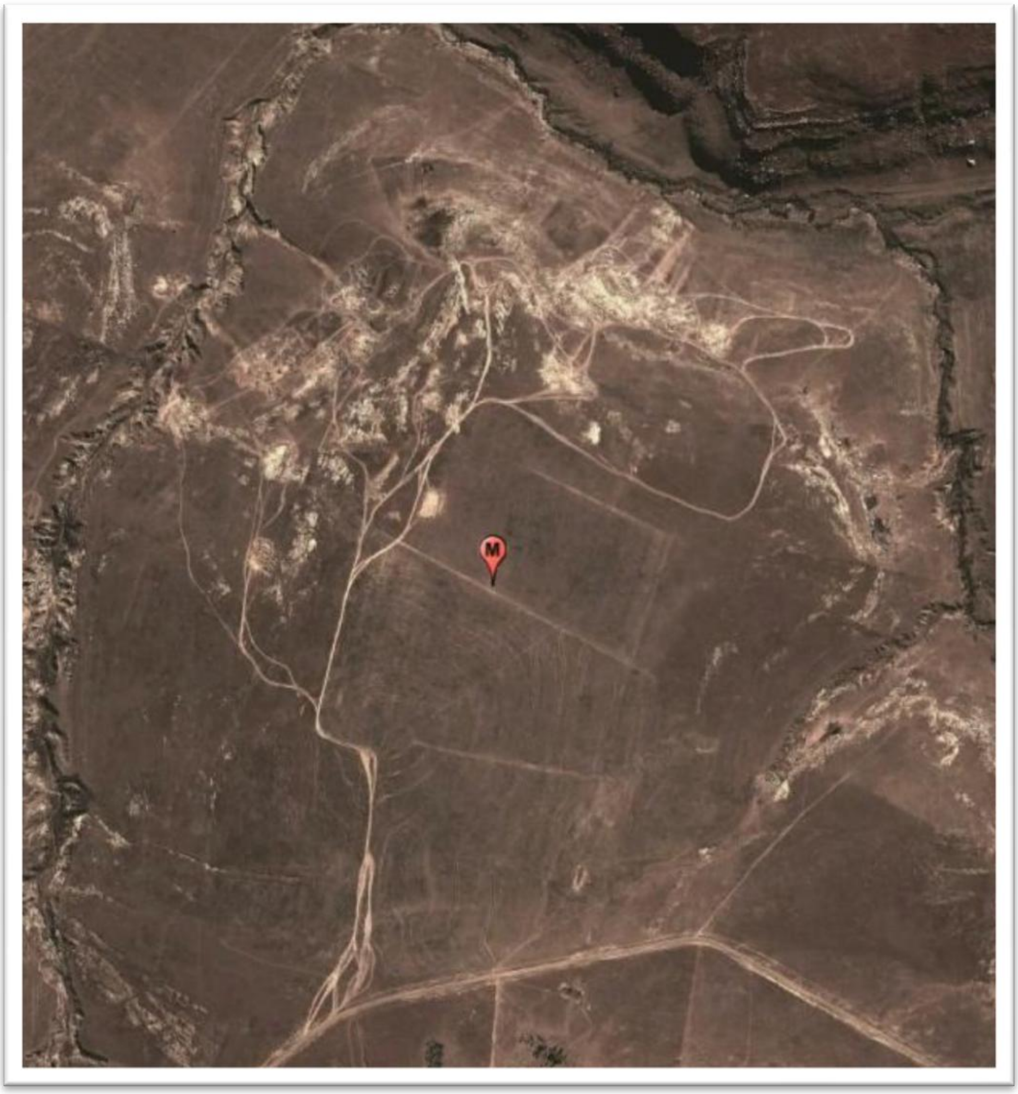
REPORT ON THE GEOTECHNICAL INVESTIGATION OF THE PROPOSED NEW LANDFILL SITE, MALUTI-A-PHOFONG



Jaco Bloem Consulting

Title: ***REPORT ON THE GEOTECHNICAL INVESTIGATION OF THE NEW LANDFILL SITE, MALUTI-A-PHOFONG***

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REPORT ON THE GEOTECHNICAL INVESTIGATION OF THE NEW LANDFILL SITE, MALUTI-A-PHOFONG

1. INTRODUCTION

The author was requested by Landfill Consult, on behalf of their client, to determine the sub soil conditions of the proposed new Landfill Site close to Phuthadijhaba. The brief was simply to excavate test holes on the site and determine the geological layers and excavatebility of the material on site. This will also provide information to determine the viability of the establishment of the landfill.

2. PURPOSE OF THE INVESTIGATION

The purpose of the investigation was the following:

- Determine the geological and geotechnical characteristics of the different soils underlying the site;
- Determine excavatebility of the in-situ material on site;
- Identify geotechnical constraints for the establishment of a landfill facility for general waste;
- Comment on possible liner quality material on site; and
- Give recommendations as to any other special precaution to be taken, including shallow ground water seepage.

3. SITE LOCATION AND DESCRIPTION

This site is located east of Phuthaditjhaba on previously cultivated land. Access is via paved and gravel roads that goes via the Matsikeng suburb of Puthadijhaba. The location of the site is indicated on the following map, **Figure 1**.

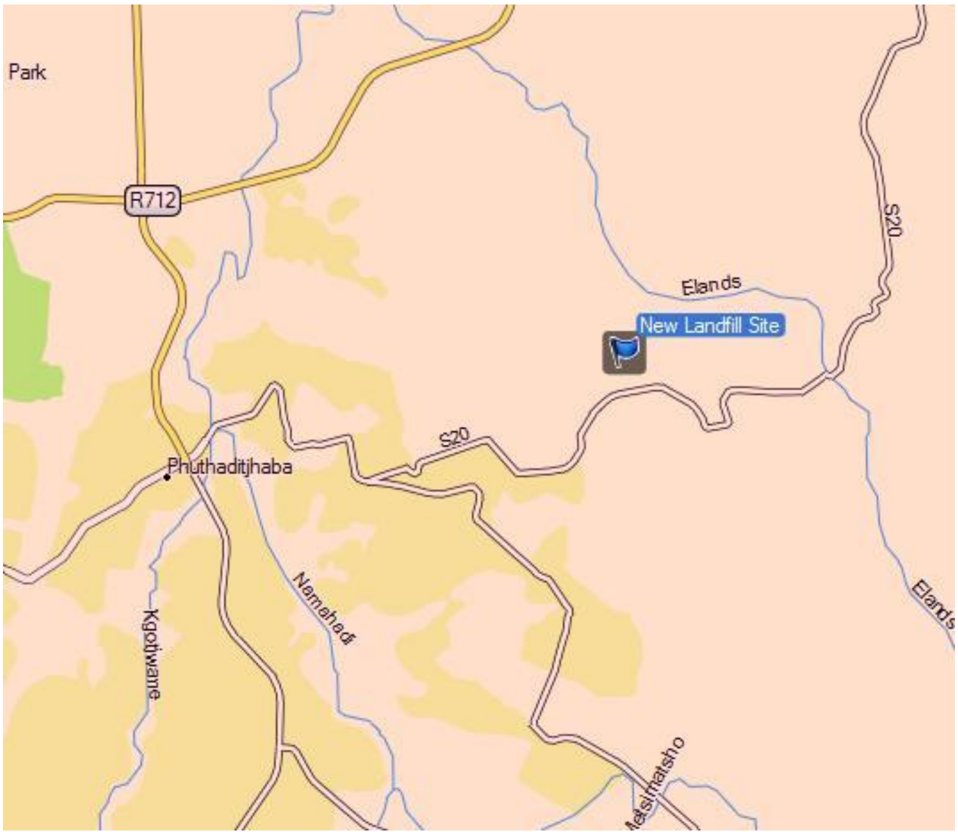

Figure 1: Site Locality

The area investigated has been cultivated previously with prominent contours constructed along the slopes of the ridge. There is also an old sand quarry on the northern edge of the property.

The natural gradient of the site is to the north and east with a 4 – 6 % gradient and surface run-off will drain to the north to the Eland River.

4. GEOLOGY

The geological map indicates that the site is underlain by alternating bands of mudstone, siltstone and sandstone, very typical of the Ecca Group of the Karoo Supergroup (Figure 2). Dolerite intrusions are also present in most of the Karoo sedimetery rock that intruded as sills. However there was no evidence of dolerite present on the site during the excavations of the test pits.

The Weinert N-value, which gives an indication of the predominant rock weathering process, is 2.4 for this region and therefore decomposition is the overriding process.

Figure 2: Site Geology

5. METHOD OF INVESTIGATION

A Bell TLB was used to open 12 test pits to determine the subsurface conditions. All the test pits were dug to their refusal or the maximum reach of the excavator. The test pits were placed in such a manner as to get maximum coverage of the proposed future development of the site.

The test pits were profiled by a qualified engineering geologist according to the method described by Jennings et al (1973).

The profiles are included in **Appendix A** with photos of each test hole included in **Appendix B.** Coordinates of all the test pits were taken and are included on the soil profiles and are indicated on **Figure 3**.

Selected soil horizons were sampled to confirm the soil description and these results are included in **Appendix C**

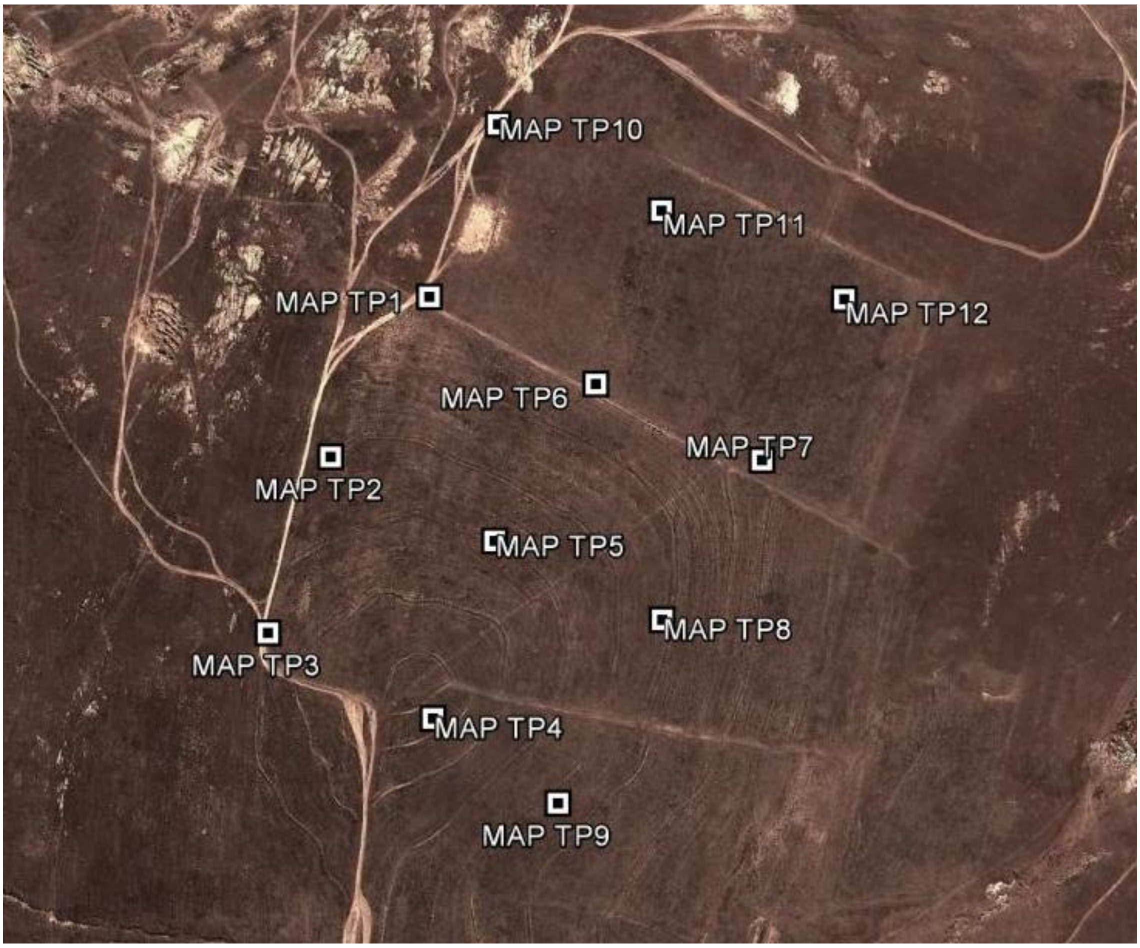

Figure 3: Test Pit Positions

6. RESULTS

6.1 SOIL PROFILES

The test pits were spaced in such a manner to determine the availability of liner material, if any, and to determine if there is a perched water level on site

Table 6.1: Test pit profile summary of the site showing depths of the different soil horizons

Test Pit No	Brown Silty Sand	Ferricrete Layer	Silty Sand	Sandy Silt	Test pit depth (m) (refusal)
MAP TP1	0 – 0.5	0.5 - 0.8	0.8 - 1.8		1.8 – Refusal on Sandstone
MAP TP2	0 – 0.25	0.25 - 0.45	0.45 – 0.9		0.9 - Refusal on Sandstone
MAP TP3	0 – 0.8	0.8 – 1.1	1.1 – 1.5		1.5 - Refusal on Sandstone
MAP TP4	0 – 0.1	0.1 - 0.5	0.5 – 1.3		1.3 - Refusal on Sandstone
MAP TP5	0 – 0.3	0.3 – 0.8	0.8 – 1.4		1.4 - Refusal on Siltstone
MAP TP6	0 – 0.3	0.3 – 0.9	0.9 – 1.1	1.1 – 2.3	2.3 – End of Hole - Siltstone
MAP TP7	0 – 0.1	0.1 – 0.7	0.7 – 1.8		1.8 - Refusal on Sandstone
MAP TP8	0 – 0.3	0.3 – 0.8	0.8 – 1.2	1.2 – 3.0	3.0 – End of hole - Siltstone
MAP TP9	0 – 0.3	0.3 – 0.6	0.6 – 1.2	1.2 – 1.4	1.4 - Refusal on Siltstone
MAP TP10	0 – 0.3	0.3 – 1.1	1.1 – 1.7		1.7 - Refusal on Sandstone
MAP TP11	0 – 0.3	0.3 – 0.7	0.7 – 1.0	1.0 – 1.8	1.8 - Refusal on Siltstone
MAP TP12	0 – 0.1	0.1 – 0.7			1.7 - Refusal on Hardpan Ferricrete

In most of the test pits the machine refused on either soft rock sandstone or siltstone with partial refusal in MAP TP 6 and 8 on soft rock Siltstone. Although only one test pit, MAP TP 12, refused on Hardpan Ferricrete, a poorly developed ferricrete layer is present in most of the test pits.

No groundwater seepage was encountered in the test pits during the investigation, however, perched water during the rainy season could occur above the Ferricrete layer.

The elevation of the site suggests it is situated below the African erosion surface. The African erosion surface represents a base level of erosion during which there was a prolonged exposure to weathering processes. The remnants of these areas are thus deeply weathered to the order of tens of meters.

The findings of this investigation are consistent with the notion that the site is below this African surface. The significance of this is that bedrock is shallower and ferricrete is well developed (McKnight, 1997).

6.2 LABORATORY TESTS

The *Plasticity Index* of the samples tested was between 4 and 18 with the *Linear Shrinkage* being between 2 and 10. The *Grading Modulus* is in general poor with values between 0.09 and 0.24.

The permeability test results on remoulded disturbed samples from test pits MAP TP 8, compacted to 95% Standard Proctor density, give permeability values of between 2.0×10^{-7} and 3.0×10^{-7} cm/s, which indicates that the material will be suitable for use in liner construction.

The disturbed sample taken and tested in MAP TP 1 showed a **CBR** values of 16.2 at 95% MOD AASHTO that classify the material as a G7. Therefore this material can only be used as a fill.

TABLE 1: SUMMARY OF FOUNDATION INDICATOR TEST RESULTS

SAMPLE No	TEST PIT No	SAMPLE Depth (m)	ORIGIN	DESCRIPTION	MAX DIAM (mm)	% <0,075	% CLAY	[1]GM	[2]LL	[3]PI	[4]LS %	HRB	[5]USCS
55199	MAP TP1	0.0-0.5	Transported	Silty sand	4.75	29	2	0.98	20	4	2	A-2-4(0)	SM
55200	MAP TP1	0.5-0.8	Pedogenic	Silty sandy gravel	13.2	25	7	1.74	26	11	5	A-2-6(0)	SC
55201	MAP TP1	0.8-1.8	Residual	Silty sand	13.2	28	10	1.17	30	14	6.5	A-2-6(1)	SC
55202	MAP TP6	1.1-2.3	Residual	Clayey silt	0.425	94	27	0.06	42	18	10	A-7-6(12)	CL

TABLE 1 (cont.) SUMMARY OF MOD AASHTO AND CBR TEST RESULTS

Test Pit NO.	SAMPLE Depth (m)	DESCRIPTION	MAX DIAMETER (mm)	% <0,075	[1]GM	[2]LL	[3]PI	[4]LS %	[8]MOD MDD kg/m^3	[9]OMC %	CBR					[7]TRH14	MATERIAL USAGE
											90	93	95	98	100		
MAP TP 1	0.8-1.8	Silty Sand	13.2	28	1.17	30	14	6.5	2054	8.5	9.0	12.8	16.2	25.9	36	G7	Fill

TABLE 1 (cont.) FALLING HEAD PERMIABILITY TEST RESULTS

SAMPLE No	TEST PIT No	SAMPLE Depth (m)	DESCRIPTION	Moisture Content		Dry Density kg/m^3	Coefficient of Permeability (**m/s**)			**Average (cm/s)**
							Range		Average (**m/s**)	
				Before Test (%)	After Test (%)		Minimum	Maximum		
2579-1	MAP TP 8	1.2 – 3.0	Clayey silt	18.3	21.4	1678	2.0×10^{-9}	3.0×10^{-9}	2.5×10^{-9}	**2.5×10^{-7}**

7. DISCUSSION OF RESULTS

During the Test Pit investigation the generalized soil profiles can be summarised as follows:

Typical profile:

0 – 0.3m	Brown, medium dense, silty sand. Topsoil.
0.4 – 1.0m	Brown, medium dense, silty sandy reworked Sandstone/Siltstone. Ferricrete Layer.
1.0- 1.8m	Yellow/red, very dense silty sand. Residual Sandstone.
1.8- 3.0m	Olive Brown and purple, firm clayey silt. Residual Siltstone.

7.1 PERCHED WATER LEVEL

A perched water level is usually associated with the presence of Ferricrete in the soil profile. However during the test pit excavation a poorly developed Ferricrete layer was evident in all the holes. However there was no groundwater seepage present in any of the test pit.

7.2 ROAD CONSTRUCTION

Samples that were taken during the investigation show that the material on site cannot be used as road building material in the construction of internal roads. All the construction material for road building will have to imported to the site

7.3 EXCAVATEBILITY

The excavator that was used on site was the Bell TLB. In most of the test pits the excavator refused on soft rock.

The excavatebility of the material on site was in the ***Intermediate*** to ***Hard*** range.

7.4 LINER MATERIAL

The DWAF's "Minimum Requirements for Waste Disposal by Landfill" document gives the following requirements for a clayey soil to be used as a compacted clay liner:

- Plasticity Index (PI) of at least 10

- Maximum particle size of 25 mm
- Permeability not greater than 1 x 10^{-6} cm/s for General waste (G) landfills and not greater than 1 x 10^{-7} cm/s for Hazardous waste (H) landfills.

The clay sample taken has a PI value of 18, and maximum particle size less than 25 mm. The remoulded permeability values of 2.5 x 10^{-7} cm/s indicate that the clay is suitable for use in a General waste liner, and is marginally suitable for use in a Hazardous waste liner.

The clays underlying the site are therefore considered suitable for use in the compacted clay component of both general waste and hazardous waste geo-composite landfill liners.

7.5 CLAY VOLUMES

The volume of the clay has been calculated using a software program called Surfer, the program uses three methods to calculate the volume, namely: The Trapezoidal rule, Simpson's rule and the Simpson's 3/8 rule.

The difference in the volume calculations by the three different methods measures the accuracy of the volume calculations. If the three volumes are reasonably close together, the true volume is close to these values (Golden Software Inc).

The GPS data that were used for the calculations were the following:

- Coordinates, and
- The elevation of the test pits

The volume of the clay was calculated from top of first intersection of the clay to the maximum depth of the clay.

This volume could differ from the actual volume in the field due to a few factors i.e.

- Unconformities in the subsoil strata;
- Undulating weathering of the residual rock; and
- The maximum reach of the machine used (clay could extend deeper).

The volume of clay calculated in Area 1 comes to a total of **18 622 m^3**.

Although the test result indicates that the clay is suitable for the use as liner material the calculations indicate that there is not enough material for the construction of the site. Therefore either a clay source has to located or a GCL used for the liner construction of the site.

7.6 FOUNDATION CONDITIONS

Due to the medium activity indicated on the Van der Merwe Activity diagram, it is recommended that certain precautions should be taken to prevent structural damage to newly constructed buildings. According to the NHBRC this site will classify as an H – H1 and all the prescribed conditions as specified should be adhered to.

8. CONCLUSIONS

- The site is underlain by sandstone and siltstone that consist mainly of silty sands and clayey silts.
- During the fieldwork 12 test pits were excavated using a Bell TLB.
- This test pits varied in depth between 0.9 and 3.0m.
- No perched water was present in any of the test pits.
- A perched water level could be present on the drainage area during the rainy season.
- Excavation of the material on site will pose no problem as the material classify as *intermediate to hard.*
- The clay material found on site will be suitable for the use as liners material however the volumes are low.
- Due to the nature of the soil on site the only major concern will be perched water that could occur during the rainy season, however this can be overcome by proper design of a storm water and groundwater control system.
- Therefore the site is suitable for the use as a GENERAL LANDFILL SITE.

9. RECOMMENDATIONS

- The site will be suited to develop a GENERAL WASTE DISPOSAL site.
- Liner material for the construction of the landfill liners is present on site, however additional volumes must be imported due to the low site volumes or a GCL could be used.
- Proper sub-soil drainage systems should be constructed due to the presence of a perch water level on site.
- Building foundations must be reinforced or earth mattresses should be used due to the swell potential of the soils on site. Allowable bearing pressure will be approximately 150 kPa.
- The foundation should also be protected from moisture ingress by constructing a concrete or paved apron around the buildings.
- Material will have to be imported for the building of the site roads.

10. REFERENCES

Jennings, J.E., A.A.B. Brink and A.B.A. Williams. *Revised guide to soil profiling for civil engineering purposes in southern Africa.* The Civil Engineer in South Africa, 1973.

“Minimum Requirements for Waste Disposal by Landfill”, DWAF, Second Edition 1998.

Appendix A

Test Pit and Borehole profiles

Appendix B

Test Pit and Borehole Photo's

Appendix C

Laboratory Results