MUKONA
CONSULTING ENGINEERS

Mukona Consulting Engineers (Pty) Ltd

Postnet Suite 387
Private Bag X121
Halfway House
1685

International Business Gateway
Midridge Office Estate (North)
Midridge Park, New Road,
Midrand, 1685

Telephone: +27 11 443 8293 / 3536
Fax: +27 86 571 2958
Email: info@mukonagroup.com
Website: www.mukonagroup.com

BBBEE: Level 1

PI No. ENGSPS130453 (AON)

REPORT NO. MK 18/480/rev.01

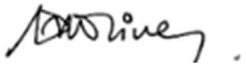
PHASE 1, INTERPRETIVE GEOTECHNICAL INVESTIGATION REPORT

PROPOSED TOWNSHIP DEVELOPMENT, AERORAND SOUTH, MIDDELBURG, MPUMALANGA

Rev	Date	Compiled by	Reviewed by	Approved by	Description	Status
01	04 June 2019	L Netshilindi	DM Oliver	TS Phalanndwa	Submitted for Design	SFD
00	December 2018	L Netshilindi	DM Oliver	TS Phalanndwa	Submitted for Information	SFI

☒ Professional Engineer (if required): TS Phalanndwa

Title	:	***PHASE 1, INTERPRETIVE GEOTECHNICAL INVESTIGATION FOR THE PROPOSED TOWNSHIP DEVELOPMENT AT AERORAND SOUTH, MIDDLEBURG, MPUMALANGA***
Prepared for	:	*Steve Tshwete Local Municipality* *P.O. Box 14* *Middelburg, Mpumalanga* *1050*
Contact Person	:	*Rhulani Mathebula* *Tel: 013 249 7789* *Email: rhulanim@stlm.gov.za*
Prepared by	:	*Mukona Consulting Engineers (Pty) Ltd,* *International Business Gateway,* *Midridge Office Estate (North),* *Midridge Park,* *New Road, Midrand, 1685,* *Tel: (011) 443 8293/3536 Fax: 086 571 2958*
Contact Person	:	*TS Phalanndwa* *Mobile: 083 785 0284*
Report No.	:	*MK18/480/rev.01*
Project team	:	*Mr TS Phalanndwa, Pr.Eng. Project Director* *Mr DM Oliver, Pr.Sci.Nat. Principal Engineering Geologist* *Miss L Netshilindi; Engineering Geologist* *Mr L Pfuluwani; Engineering Geologist*
Coordinates	:	*29°27'42.02"S, 25°48'17.83"E*
Location	:	*Aerorand South, Middelburg, Mpumalanga*
Date	:	*04 June 2019*

Compiled by:	***Reviewed by:***	***Approved by:***
		
L Netshilindi	***DM Oliver Pr.Sci.Nat.***	***TS Phalanndwa Pr.Eng.***
Engineering Geologist	*Principal Engineering Geologist*	*Project Director*

EXECUTIVE SUMMARY

Mukona Consulting Engineers (Pty) Ltd were appointed to carry out a near surface geotechnical investigation for the proposed township development at Aerorand South, Middelburg, situated in Mpumalanga.

The proposed township development is located within an area of approximately 101 hectares and comprises of a total of 624 stands earmarked for various uses such as: residential units, institutional use, municipal use and public open spaces. The proposed site is a “greenfield” site and is located within the Steve Tshwete Local Municipality, south of Middelburg in Mpumalanga.

The investigation was aimed at identifying geotechnical factors that could have an impact on the proposed development, evaluating the suitability of the site for the proposed engineering works and to enable an adequate and economical design to be prepared.

The geotechnical investigation comprised a site walkover, excavation of thirty-five (35) test pits and subsequent sampling of the in-situ soils for laboratory testing. In addition, nine (9) Dynamic Probe Light (DPL) tests and six (6) Dynamic Cone Penetrometer (DCP) tests were carried out at selected locations across the site, to provide an estimation of the consistency of the subsoil profile.

The investigation revealed that the site is underlain by transported soils (colluvium) and residual soils (sandstone, quartzitic sandstone and shale) derived from sedimentary bedrock. Pedogenic material, in the form of ferricrete, was also encountered below the site. No groundwater seepage was encountered within the test pits excavated on site.

It is anticipated that the site will classify as “soft excavation”, as per SANS 1200D, to depths of between 0.9m and 1.5m in areas where pedogenic material is encountered, and between 1.7m and 2.5m in areas where residual material is encountered.

The residual quartzitic sandstone and pedogenic material classify as **G6** (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

The residual sandstone classifies as **G7** (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

The site can be classified into three zones, namely; **Zone 1** - Site Class R/S, **Zone 2** - Site Class S1, and **Zone 3** - Site Class P (potential flood zone). Foundations for structures should be placed on either an engineered fill below individual strip footings, a reinforced concrete raft, or reinforced strip footing.

Table of Contents

List of Figures

List of Tables

1. INTRODUCTION

Mukona Consulting Engineers (Pty) Ltd were appointed by Steve Tshwete Local Municipality to carry out a feasibility-level geotechnical investigation for the proposed township development at Aerorand South, Middelburg which is situated within the Steve Tshwete Local Municipality in Mpumalanga Province.

This report describes the geotechnical investigation including fieldwork, laboratory testing and analysis, undertaken for the proposed development and provides preliminary geotechnical recommendations including site preparation, foundation type(s), earthworks and excavatability classification.

According to the Client, this geotechnical investigation acts as an infill study for a previous geotechnical investigation carried out within this site. This historic report was not made available to Mukona Consulting Engineers during this investigation.

1.1 Purpose

The purpose of the geotechnical investigation can be summarized as follows:

- Provide an overview of the geology of the site;
- Present the fieldwork and testing carried out during the geotechnical investigation;
- Assess and discuss the soil and rock profile, with a specific interest in the depth to a competent founding horizon;
- Assess groundwater conditions as encountered during the site investigation;
- Assess and provide site classification in accordance with the SAICE Code of Practice (for Single Storey Residential Buildings of Masonry Construction, 1995) in so far as it is relevant to the proposed development;
- Highlight the geotechnical considerations that may have an influence on the proposed development;
- Provide geotechnical recommendations, such as founding solutions and re-use potential of existing materials;
- Provide recommendations on the founding depths and the allowable bearing capacity to be adopted for preliminary design;
- Comment on the suitability of the site for the proposed development;
- Provide an excavatability classification for the site as per SANS1200 specification;

- Comment on the corrosivity of soils to buried metals.

1.2 Proposed Development

It is understood that the planned township is located within an area of approximately 101 hectares, and will include residential units (612 stands), institutional buildings (4 stands), municipal buildings (2 stands), public open spaces (6 stands) and construction of road pavements.

1.3 Available Information

The following published information was used during this investigation:

- The 1:250 000 scale geological series map, 2528 PRETORIA, produced by the Council for Geoscience, Pretoria;
- The 1:50 000 scale topographical map, 2529 CD MIDDELBURG, produced by the Surveyor General.
- SANS 10160-4 (2011): Basis of Structural Design and Actions for Buildings and Industrial Structures, Part 4: Seismic Actions and General Requirements for Building. SABS Standards Division; and
- Seismic hazard maps from Kijko et al. (2003) - Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa. Report number 2003-0053, Council for Geoscience, Pretoria.
- Inception report for the geotechnical investigation at Aerorand South Township, Middelburg, Mpumalanga, prepared for the Steve Tshwete Local Municipality by Mukona Consulting Engineers, referenced Report No. MK/18/480, dated 13 November 2018.

1.4 Information Supplied

The following information was supplied by the Client:

- Site locality plan in pdf format;
- A layout map showing underground services (wet and dry) within the site.

2. SITE DESCRIPTION

2.1 Location

The proposed site is located south of Middelburg approximately 3km north of the N4 highway, within the Steve Tshwete Local Municipality in Mpumalanga Province. The proposed site is bound to the east by Sondagsrivier Street and Middelburg Mall. To the north it is bound by Mandela drive and a township. The remaining boundaries comprise undeveloped land.

Access to the site is via unpaved tracks along Sondagsrivier Street and Mandela Drive. The site is a "greenfield" site located at the approximate centre coordinates of 25°48'33.05"S, 29°26'53.10"E. The location of the site is shown in **Appendix A**.

2.2 Topography

The site slopes gently towards the west and northwest at a gradient of approximately 2%. The area occurs at elevations ranging between 1522m and 1537m above mean sea level (amsl).

Surface runoff, particularly during periods of heavy or prolonged rainfall is expected to be in the form of sheetwash towards the west and northwest.

An extract of the 1:50 000 topographical map series is attached in **Appendix B**.

2.3 Climate

The climate in Aerorand is generally warm in summer and moderately cold in winter. The average annual rainfall is 831mm per annum, most of which occurs in heavy isolated falls between November and April. The greatest amount of rainfall occurs in January with an average of 230mm. The average midday temperatures range from 23°C in June to 38°C in October.

The climatic regime plays a fundamental role in the development of the soil profile and the weathering of rock. Weinert (1964) demonstrated that chemical decomposition is the predominant mode of rock weathering in areas where the climatic "N-value" is less than 5. In areas where the climatic N-value is between 5 and 10, disintegration is the predominant form of weathering, although some chemical decomposition of the primary rock minerals still takes place. Where the climatic N-value is greater than 10, secondary minerals do not develop to an appreciable extent and all weathering takes place by mechanical disintegration of the rock.

Weinert's climatic N-value for the area is less than 2. This implies that rocks are extensively weathered, often to depths of several metres, and decomposition is pronounced.

3. GEOHAZARD

3.1 Seismic Hazard / Activities

Two types of seismic activities occur in South Africa, namely:

- Regions of natural seismic activity (Zone I), and
- Regions of mining-induced and natural seismic activity (Zone II).

In accordance with the seismic hazard zones contained in SANS 10160-4 (2011), the site falls outside Zone I and Zone II, as shown in Figure 1.

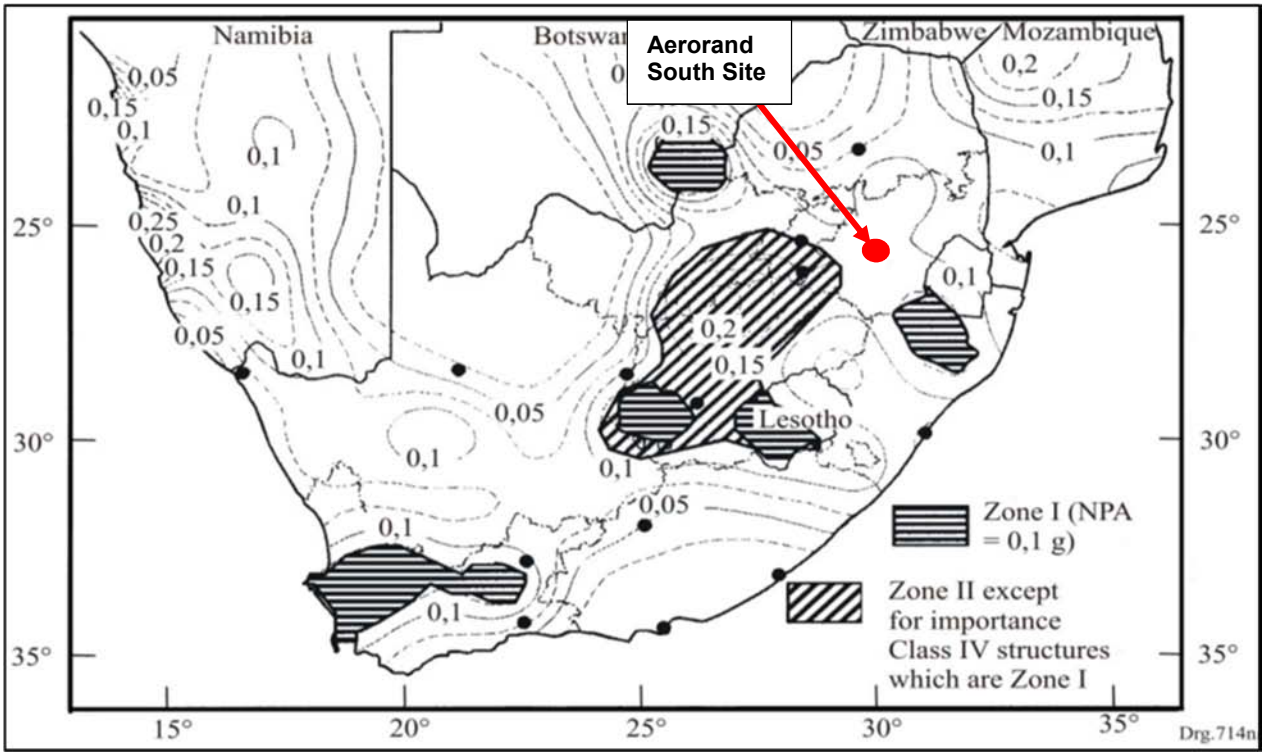


Figure 1: Seismic Hazard Zones of South Africa (SANS 10160-4, 2011)

Both the seismic hazard zones map (Figure 1 above) and the seismic hazard map of South Africa (Figure 2 below) produced by Kijko (2003) show that the site is situated in the area where the peak ground acceleration with a 10% probability of exceedance in a 50-year period is approximately 0.10 to 0.12g.

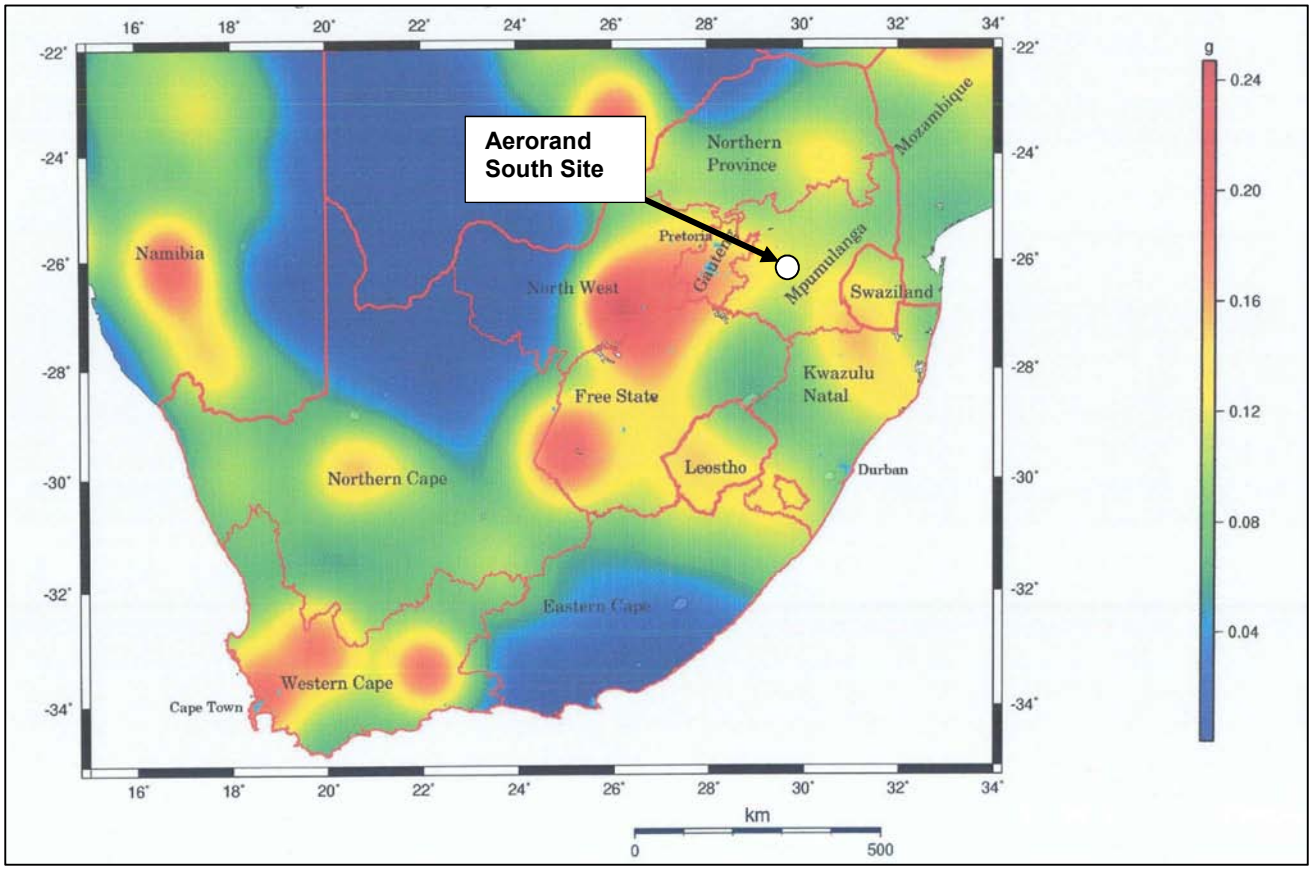


Figure 2: Seismic Hazard Map of South Africa, Kijko et. al. (2003)

3.2 Ground Subsidence

Subsidence occurs in areas with large underground cavities typically resulting from large scale shallow to very shallow mining and from dolomite/limestone dissolution. It may also appear where thick deposits of unconsolidated material exist.

No signs of previous subsidence were evident during the site investigation and no mining activity has occurred in this area.

3.3 Sinkhole Formation

Similar to subsidence, sinkhole formation occurs in areas with very large to extremely large underground cavities resulting from poorly designed shallow underground activities. Dissolution of dolomites or limestones over millions of years, may lead to cavity formations which later manifest as sinkholes.

The available geological map and field observations indicate that the site is not underlain by dolomite.

3.4 Landslides and Mudslides

The probability of landslides and mudslides occurring within this area are remote. This is primarily due to the low relief and relatively flat gradient of the area.

3.5 Rockfalls and Rockslides

The probability of the occurrence of rockfalls and rockslides is low due to the low relief and shallow gradient.

3.6 Volcanic Activities

South Africa has seen its last volcanic activity approximately 65 million years ago during the massive historical eruption of the Drakensberg Lava forming the Basaltic Drakensberg Mountain Ranges that we see today. Recent studies showed no signs of the possibility of volcanic eruption in the foreseeable future.

4. METHOD OF INVESTIGATION

Based on the “Site Investigation Code of Practice” (SAICE Geotechnical Division, 2010), which provides standards for “acceptable engineering practice”, the level of this investigation should be considered as feasibility level, which entails a detailed desktop study and a limited intrusive investigation to a maximum depth of 3m below current ground level within the footprint of the proposed development.

This investigation has accordingly been designated as a Phase 1 investigation. The requirements for a Phase 2 investigation should be based on the nature of the proposed structures.

4.1 Desktop Study

The desktop study included a review of the regional topographical and geological maps and seismic hazard maps of South Africa.

4.2 Test Pits

Thirty-five (35) test pits designated TP1 through to TP35 were excavated across the site on the 15th November 2018 (20no.) and 24th May 2019 (15no.) using a Tractor Loader Backhoe (TLB), supplied by Coastal Hire Contractors.

Each test pit, which was deemed safe to enter, was profiled by an engineering geologist in accordance with the “Guidelines for Soil and Rock Logging in South Africa”, 2nd Impression 2002, sampled as necessary and loosely backfilled.

The test pits were positioned such that broad coverage of the underlying geological and subsoil conditions could be determined. The test pit coordinates and depth of excavation are provided in Table 1.

The test pit positions are indicated on the layout drawing attached as **Appendix C**. Detailed test pit profiles and site pictures are attached in **Appendix D** respectively.

Table 1: Summary of test pit information

TP ID.	Handheld GPS Coordinates		Final Depth (m)	Comment
	Latitude (S)	Longitude (E)		
TP01	25°48′23.276″	29°26′50.236″	1.7	Partial refusal of TLB on residual shale
TP02	25°48′20.642″	29°26′52.875″	2.5	Partial refusal of TLB on soft shale
TP03	25°48′19.577″	29°26′50.651″	2.3	Partial refusal of TLB on residual shale
TP04	25°48′24.658″	29°26′55.712″	2.3	Partial refusal of TLB on residual shale
TP05	25°48′21.500″	29°26′57.558″	1.2	Refusal of TLB on Honeycomb Ferricrete
TP06	25°48′18.213″	29°26′59.050″	1.3	Refusal of TLB on honeycomb ferricrete
TP07	25°48′28.322″	29°27′0.802″	2.4	Refusal of TLB on ferruginised residual quartzitic sandstone
TP08	25°48′25.849″	29°27′3.172″	1.8	Refusal of TLB on ferruginised residual quartzitic sandstone
TP09	25°48′21.614″	29°27′1.972″	1.4	Refusal of TLB on ferruginised residual quartzitic sandstone
TP10	25°48′17.869″	29°27′3.759″	2.1	Refusal of TLB on residual sandstone
TP11	25°48′30.512″	29°27′6.087″	2.3	Refusal of TLB on residual sandstone
TP12	25°48′24.300″	29°27′6.500″	0.9	Refusal of TLB on hardpan ferricrete
TP13	25°48′22.111″	29°27′6.905″	2.5	Refusal of TLB on ferruginised residual quartzitic sandstone
TP14	25°48′18.467″	29°27′6.834″	2.0	Partial refusal of TLB on ferruginised residual quartzitic sandstone
TP15	25°48′27.787″	29°27′8.428″	2.1	Partial refusal on residual sandstone
TP16	25°48′20.936″	29°27′9.953″	2.5	Refusal of TLB on ferruginised residual quartzitic sandstone
TP17	25°48′16.991″	29°27′9.603″	1.7	Partial refusal of TLB on ferruginised residual quartzitic sandstone
TP18	25°48′31.695″	29°27′11.804″	0.9	Refusal of TLB on honeycomb ferricrete
TP19	25°48′25.077″	29°27′12.609″	2.1	Partial refusal of TLB on ferruginised residual quartzitic sandstone
TP20	25°48′17.931″	29°27′13.033″	1.8	Partial refusal of TLB on quartzitic sandstone
TP21	25°48'26.78"S	29°26'37.81"E	2.3	Partial refusal of TLB on very dense to very soft rock sandstone
TP22	25°48'27.74"S	29°26'45.18"E	2.4	Partial refusal of TLB on boulders (Colluvium)
TP23	25°48'31.32"S	29°26'40.19"E	2.2	Partial refusal of TLB on very stiff residual shale
TP24	25°48'30.24"S	29°26'50.76"E	0.95	Refusal of TLB on hardpan ferricrete
TP25	25°48'32.51"S	29°26'59.79"E	2.4	Partial refusal of TLB on very soft rock sandstone
TP26	25°48'38.28"S	29°27'6.32"E	2.3	Partial refusal of TLB on dense ferruginised residual shale

Test Pit ID.	Handheld GPS Coordinates		Final Depth (m)	Comment
TP27	25°48'37.33"S	29°26'57.09"E	2.4	Partial refusal of TLB on dense ferruginised residual shale
TP28	25°48'36.09"S	29°26'46.41"E	2.6	Partial refusal of TLB on very soft rock shale
TP29	25°48'38.16"S	29°26'36.96"E	0.8	Refusal of TLB on hardpan ferricrete
TP30	25°48'45.74"S	29°26'38.31"E	0.75	Refusal of TLB on hardpan ferricrete
TP31	25°48'45.12"S	29°26'54.38"E	2.5	Partial refusal of TLB on medium dense ferruginised shale
TP32	25°48'45.28"S	29°27'4.00"E	2.5	Partial refusal of TLB on medium dense ferruginised shale
TP33	25°48'45.50"S	29°27'10.60"E	2.4	Partial refusal of TLB on very soft rock sandstone sandstone
TP34	25°48'53.38"S	29°27'4.83"E	2.7	Partial refusal of TLB on medium dense ferruginised shale
TP35	25°48'43.25"S	29°26'45.44"E	2.3	Partial refusal of TLB on stiff residual shale

4.3 Dynamic Probe Light (DPL)

Although DPL testing was not part of the scope of work for the near surface geotechnical investigation, nine (9) DPL tests were carried out adjacent to selected test pits in order to provide an empirical indication of the consistency of the subsoils with depth. The DPL tests were designated according to its position adjacent to the respective test pits.

The DPL test is carried out by driving a 36mm diameter, 90-degree cone into the soil with a 10kg hammer falling through 500mm. The penetration resistance is expressed as number of blows per 300mm penetration. The locations of the DPL tests are indicated on the layout drawing attached in **Appendix B**, with the DPL test results attached in **Appendix E**. The summary of information obtained from the DPL test is shown below in Table 2.

Table 2: Summary of DPL location and refusal depths

DPL ID.	Handheld GPS Coordinates		Location	Final Depth (m)	Comment
	Latitude (S)	Longitude (E)			
DPL02	25°48′20,642	29°26′52,875″	Adjacent to TP02	1.2	Refusal of DPL
DPL04	25°48′24,658″	29°26′55,712″	Adjacent to TP04	0.9	Refusal of DPL
DPL05	25°48′21,500″	29°26′57,558″	Adjacent to TP05	1.5	Refusal of DPL
DPL06	25°48′18,213″	29°26′59,050″	Adjacent to TP06	0.6	Refusal of DPL
DPL08	25°48′25,849″	29°27′3,172″	Adjacent to TP08	0.3	Refusal of DPL
DPL11	25°48′30,512″	29°27′6,087″	Adjacent to TP11	0.6	Refusal of DPL
DPL14	25°48′18,467″	29°27′6,834″	Adjacent to TP14	0.6	Refusal of DPL
DPL15	25°48′27,787″	29°27′8,428″	Adjacent to TP15	0.3	Refusal of DPL
DPL20	25°48′17,931″	29°27′13,033″	Adjacent to TP20	0.9	Refusal of DPL

4.4 Dynamic Cone Penetrometer (DCP)

As part of the near surface geotechnical investigation, six (6) Dynamic Cone Penetrometer (DCP) tests were carried out adjacent to selected test pits on the site.

The DCP test provides an empirical indication of the consistency of the subsoils with depth. It is carried out by driving a 20mm diameter, 60-degree cone into the soil with an 8kg hammer falling through 575mm. The penetration resistance is expressed as no. of blows per 100mm penetration. A summary of location and depths of the DCP tests are shown in Table 3. Full DCP results are presented in **Appendix F**.

Table 3: Summary of DCP location and refusal depths

TP ID.	Handheld GPS Coordinates		Final Depth (m)	Comment
	Latitude	Longitude		
DCP23	25°48'31.32"S	29°26'40.19"E	1.0	Maximum Depth
DCP27	25°48'37.33"S	29°26'57.09"E	1.0	Maximum Depth
DCP28	25°48'36.09"S	29°26'46.41"E	1.0	Maximum Depth
DCP29	25°48'38.16"S	29°26'36.96"E	0.2	Refusal
DCP32	25°48'45.28"S	29°27'4.00"E	1.0	Maximum Depth
DCP34	25°48'53.38"S	29°27'4.83"E	1.0	Maximum Depth

4.5 Laboratory Testing

To confirm the visual assessments of the engineering properties of the soil, a number of representative disturbed samples were taken and submitted for laboratory testing. The laboratory testing comprised of the following:

- Sixteen (16) foundation indicator tests were taken to determine the basic engineering properties of the in-situ materials;
- Three (3) bulk samples were taken for moisture / density relationship and CBR testing to determine the compaction characteristics of the in-situ material;
- Six (6) samples were taken for chemical tests to determine the pH and conductivity characteristics of the in-situ material.

The individual test results are summarised and discussed in section 6.

5. REGIONAL & SITE GEOLOGY

5.1 Regional Geology

From a review of the 1:250 000 geological series map, **2528 PRETORIA**, the site is mantled by shale, sandstone, conglomerate and some volcanic rocks. The sedimentary rocks belong to the Loskop Formation within the Transvaal Sequence. The sandstone within the area is pink to grey in colour with massive to coarsely bedded feldspathic texture with grit and conglomeratic layers, interbedded with lesser maroon fine-grained sandstone and siltstone.

These rocks are underlain by tillite and shale of the Dwyka Group within the Karoo Sequence. An extract of the geological map is presented in **Appendix G**.

5.2 Site Geology

A summary of the generalised soil profiles encountered during the site investigation is provided in Table 4.

Table 4: Summary of test pit profiles

TP ID.	Depth (m)												
	Transported	Pebble Marker	Reworked residual sandstone	Residual sandstone	Reworked Residual Quartzitic Sandstone	Residual Quartzitic Sandstone	Quartzitic Sandstone	Ferricrete	Shaly Sandstone	Residual Shale	Soft Shale	Groundwater	Depth of Refusal/ End of hole
TP01	0-0.45	-	-	-	-	-	-	-	-	0.45-1.7	-	-	1.7
TP02	0-0.45	-	-	-	-	-	-	-	-	0.45-1.7	1.7-2.5	-	2.5
TP03	0-0.5	-	-	-	-	-	-	-	-	0.5-2.3	-	-	2.3
TP04	0.0-0.2	0.2-0.7	-	-	-	-	-	-	-	0.7-2.3	-	-	2.3
TP05	0.0-0.25	-	-	0.25-0.5	-	-	-	0.5-1.2 (honeycomb)	-	-	-	-	1.2
TP06	0.0-0.5	-	-	0.5-1.2 (ferruginised)	-	-	-	1.2-1.35 (honeycomb)	-	-	-	-	1.3
TP07	0.0-0.4	-	0.4-0.9	-	-	0.9-2.4 (ferruginised)	-	-	-	-	-	-	2.4
TP08	0.0-0.25	-	-	-	-	0.25-1.8 (ferruginised)	-	-	-	-	-	-	1.8
TP09	0.0-0.4	-	0.4-0.8	-	-	0.8-1.4 (ferruginised)	-	-	-	-	-	-	1.4
TP10	0.0-0.52	-	-	0.52-1.5 (ferruginised). 1.5-2.1	-	-	-	-	-	-	-	-	2.1
TP11	0.0-0.5	-	-	0.5-2.3	-	-	-	-	-	-	-	-	2.3
TP12	0.0-0.3	-	-	-	-	-	-	0.3-0.9 (nodular)	-	-	-	-	0.9
TP13	0.0-0.45	0.45-0.7	-	-	-	0.7-2.5 (ferruginised)	-	-	-	-	-	-	2.5
TP14	0.0-0.3	0.3-0.5	-	-	-	0.5-0.9.	-	-	-	-	-	-	2

TP ID.	Depth (m)												
	Transported	Pebble Marker	Reworked residual sandstone	Residual sandstone	Reworked Residual Quartzitic Sandstone	Residual Quartzitic Sandstone	Quartzitic Sandstone	Ferricrete	Shaly Sandstone	Residual Shale	Soft Shale	Groundwater	Depth of Refusal/ End of hole
						0.9-2.0 (ferruginised)							
TP15	0.0-0.3	-	0.3-0.9	0.9-1.6 (ferruginised). 1.6-2.1	-	-	-	-	-	-	-	-	2.1
TP16	0.0-0.4	-	-	-	0.4-0.8	0.8-2.5 (ferruginised)	-	-	-	-	-	-	2.5
TP17	0.0-0.3	0.3-0.4	-	-	-	0.4-1.7 (ferruginised)	-	-	-	-	-	-	1.7
TP18	0.0-0.4	-	-	0.4-0.7	-	-	-	0.7-0.9 (honeycomb)	-	-	-	-	0.9
TP19	0.0-0.5	-	-	-	-	0.5-2.3 (ferruginised)	-	-	-	-	-	-	2.1
TP20	0.0-0.4	-	-	-	-	0.4-1.3 (ferruginised); 1.3-1.8	1.3-1.8	-	-	-	-	-	1.8
TP21	0.0-1.4	-	-	1.4-1.8	-	-	-	-	1.8-2.3	-	-	-	2.3
TP22	0.0-1.1 1.1-2.4	-	-	-	-	-	-	-	-	-	-	-	2.4
TP23	0.0-0.8	-	-	-	-	-	-		-	0.8-1.9 1.9-2.2	-	-	2.2
TP24	0.0-0.55	-	-	-	-	-	-	0.55-0.85 0.85-0.95	-	-	-	-	0.95
TP25	0.0-0.3 0.3-1.2	-	-	-	-	-	-	-	1.2-2.3	-	-	-	2.3

TP ID.	Depth (m)												
	Transported	Pebble Marker	Reworked residual sandstone	Residual sandstone	Reworked Residual Quartzitic Sandstone	Residual Quartzitic Sandstone	Quartzitic Sandstone	Ferricrete	Shaly Sandstone	Residual Shale	Soft Shale	Groundwater	Depth of Refusal/ End of hole
TP26	0.0-0.3 0.3-1.10	-	-	-	-	-	-	-	-	1.1-2.3	-	-	2.3
TP27	0.0-0.25 0.25-1.25	1.25-1.7	-	-	-	-	-	-	-	1.7-2.4 (ferruginised)	-	-	-
TP28	0.0-0.45	-	-	-	-	-	-	-	-	0.45-1.40 1.40 – 1.65	1.65 – 2.5	-	2.5
TP29	0.0-0.5	-	-	-	-	-	-	0.5-0.80	-		-	-	0.8
TP30	0.0-0.70							0.7-0.75					0.75
TP31	0.0-1.8	1.8-1.95	-	-	-	-	-	-	-	1.95-2.5	-	-	2.5
TP32	0.0-2.0	2.0-2.2								2.2-2.5			2.5
TP33	0.0-0.8	0.8-1.4	-	-	-	-	-	-	1.4-2.4		-	-	2.4
TP34	0.0-2.4	-							-	2.4-2.7			2.7
TP35	0.0-1.2		-	-	-	-	-	-		1.2-2.3	-	-	2.3

5.2.1 Transported Material

The colluvium blankets the entire site and was described as a “dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravels, with abundant fine roots”. This horizon occurs at surface and extends to an average depth of 0.4m below current ground level.

In four (4) test pits, the transported layer is underlain by a (300mm thick) pebble marker which comprises light brown, dense, silty SAND, with abundant sub-rounded quartz and sandstone pebbles.

5.2.2 Residual Sandstone (fine-grained)

The residual sandstone layer encountered was overlain by a reworked layer as well as a ferruginised residual layer in some of the test pits.

The **ferruginised residual sandstone** was encountered in three (3) test pits and was described as “reddish brown grey stained orange, medium dense to dense, clayey silty SAND with abundant ferruginised black gravels”. This horizon was intersected to depths ranging between 1.2m and 1.6m below current ground level.

The **residual sandstone** layer encountered in six (6) test pits was described as “yellowish brown, dense to very dense, ferruginised GRAVEL in a matrix of silty sand”. This horizon was intersected to depths ranging between 0.5m and 2.3m below current ground level.

5.2.3 Residual Quartzitic Sandstone

The residual quartzitic sandstone was intersected in nine (9) test pits and is typically slightly ferruginised. The residual quartzitic sandstone was described as reddish brown, dense to very dense, clayey silty SAND with minor to abundant grey mottled orange, coarse grained sandstone cobbles. This horizon was intersected to depths ranging between 1.3m and 2.4m below current ground level.

5.2.4 Soft Quartzitic Sandstone

This horizon was only encountered at one test pit (TP 20), and is described as “brownish pink, highly weathered coarse grained, very soft to soft sandstone rock”. This horizon was intersected at depths ranging between 1.3m and 1.8m below current ground level.

5.2.5 Shaly Sandstone

The shaly sandstone was encountered in three (3) test pits and is described as “purple – red/purple yellowish grey, very highly weathered to completely weathered, fine to medium grained, very dense to very soft rock”. This horizon was intersected at depths ranging between 1.2m and 2.4m below current ground level.

5.2.6 Pedogenic Material (Ferricrete)

Honeycombed ferricrete was encountered in three (3) test pits and was described as “yellowish brown, dense to very dense, clayey silty SAND, in a matrix of subangular sandstone and quartz pebbles”. This horizon was intersected to depths ranging between 0.9m and 1.35m below current ground level.

5.2.7 Residual Shale

The residual shale was encountered in four (4) test pits and was described as “yellow brown and red brown, stiff to very stiff, silty CLAY with abundant red and yellowish brown (interlayered), laminated shale fragments with occasional patches of light grey silty CLAY”. This horizon was intersected to depths ranging between 1.7m and 2.3m below current ground level.

In one test pit, TP02, very soft to soft rock (shale) was encountered at depths between 1.7m and 2.5m below ground surface. The shale was described as “red and yellowish brown (interlayered), laminated, fine grained, shale fragments with minor patches of light grey silty clay”.

5.3 Groundwater

No groundwater seepage was recorded in any of the test pits excavated during this investigation. However, ferruginisation below the transported soils and within the residual soils, in some test pits, is indicative of a fluctuating water regime at shallow depths within the soil profile.

6. GEOTECHNICAL EVALUATION

The results of laboratory tests carried out on samples recovered from site are summarized and discussed in the sections below and are included as **Appendix H**.

6.1 Engineering and Material Characteristics

Thirteen (13) disturbed soil samples, considered to be representative of the material on site, were subjected to foundation indicator testing (as per SANS 3001 test methods). The laboratory testing was conducted by Soillab Laboratory Services. The results are attached in **Appendix H1** and are summarized in Table 5.

Table 5: Summary of foundation indicator test results

Test Pit ID.	Depth (mm)	Description	Soil Composition (USCS)					Atterberg Limits			GM	NMC	PE	USCS	AASHTO
			% Passing 0.425mm	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	LL (%)	PI (%)	LS (%)					
COLLUVIUM															
TP18	0.0-0.4	Silty SAND	84	13	14	71	2	_	NP	0	0.94	_	L	SM	A-2-4 (0)
RESIDUAL SHALE															
TP01	0.45-1.7	Clayey SAND with gravel	41	11	22	37	30	35	13	6.5	1.74	9.5	L	SC	A-2-6 (1)
TP02	0.9-2.5	Sandy CLAY	71	24	27	44	5	34	13	6.5	0.94	10.1	L	CL	A-6(4)
REWORKED RESIDUAL SANDSTONE															
TP15	0.3-0.9	Silty clayey SAND	87	20	24	54	2	22	7	3.5	0.72	2.7	L	SM-SC	A-4 (0)
RESIDUAL SANDSTONE															
TP11	0.5-2.5	Silty clayey SAND	80	11	24	60	5	17	5	1.5	0.93	3.3	L	SM-SC	A-2-4 (0)
TP15	0.9-1.6	Clayey SAND	64	14	23	49	14	26	8	4	1.24	_	L	SC	A-4 (0)
TP15	1.6-2.1	Sandy CLAY	91	20	53	26	1	43	19	5	0.4	13.1	M	CL	A-7-6 (13)
TP18	0.4-0.7	Clayey SAND with gravel	56	11	15	55	19	23	9	4	1.52	3.5	L	SC	A-2-4 (0)
RESIDUAL QUARTZITIC SANDSTONE															
TP13	0.7-2.5	Clayey SAND	54	21	21	48	10	36	13	6.5	1.35	7.2	L	SC	A-6(2)
TP16	0.39-1.3	Silty clayey SAND	44	6	15	72	7	24	7	2.5	1.79	-	L	SM-SC	A-2-4 (0)
TP16	1.3-2.5	Clayey SAND	59	15	23	55	7	32	12	5.5	1.26	8	L	SC	A-6 (1)
PEDOGENIC MATERIAL															
TP12	0.3-0.9	Silty SAND with gravel	49	3	15	61	21	_	NP	0	1.73	_	L	SM	A-1b (0)
TP18	0.7-0.9	Silty clayey SAND with gravel	47	8	15	53	24	26	6	2	1.7	3.7	L	SM-SC	A-1b (0)

***Notes**: GM = Grading Modulus; LL = Liquid Limit; PI = Plasticity Index; LS = Linear Shrinkage; NMC = Natural Moisture Content; PE = Potential Expansiveness; USCS = Unified Soil Classification System; AASHTO = American Association of State Highway Officials; SC = Clayey Sands, poorly-graded, sand-clay mixtures; CL = Inorganic Clay of low to medium plasticity, gravelly clays, sandy clay, silty clay; SM = Silty Sand, sand-silt mixture; Nd = Not Determined*

6.2 Compaction Characteristics Tests

Three (3) representative disturbed soil samples were submitted for moisture / density relationship and CBR (strength) tests and the results are attached in **Appendix H2** and are summarized in Table 6.

Table 6: Summary of compaction characteristics and CBR results

Test Pit ID.	Depth (mm)	Description	OMC (%)	MDD (kg/m3)	Max Swell (%)	CBR at Mod. AASHTO Compaction Effort				COLTO
						90 (%)	93 (%)	95 (%)	98 (%)	
RESIDUAL SANDSTONE										
TP18	0.4-0.7	Clayey SAND with gravel	8.1	2133	0	15	20	24	33	G7
RESIDUAL QUARTZITIC SANDSTONE										
TP16	0.39-1.3	Silty clayey SAND	7.4	2157	0.1	19	30	41	65	G6
PEDOGENIC MATERIAL										
TP18	0.7-0.9	Silty clayey SAND with gravel	8.6	2157	0	19	25	30	39	G6

6.3 Chemical Tests

Three (3) samples were submitted for chemical tests to determine the pH and conductivity characteristics of the in-situ material.

Corrosive soils contain chemical constituents that can react with construction materials, such as concrete and ferrous metals, that may damage foundations and buried pipelines. Electrical resistivity, chloride content, and pH level are indicators of the soil's tendency to corrode ferrous metals. Soil corrosion is a geologic hazard that affects buried metals and concrete that is in direct contact with soil or bedrock. Metals are typically attacked by chloride solutions, whereas high sulfate levels are harmful to concrete.

Guideline values for interpretation of soil conductivity is presented in Table 7 and Table 8.

Table 7: Guideline values for interpretation of soil conductivity.

Soil Conductivity (mS/m)	Resistivity (R) Ohm/cm	Degree of Corrosiveness
More than 50	0 – 2 000	Extremely corrosive
25-50	2 000 – 4 000	Very corrosive
20-25	4 000 – 5 000	Corrosive
10-20	5 000 – 10 000	Mildly corrosive
Less than 10	>10 000	Not generally corrosive

Table 8: Guideline values for interpretation of pH tests

pH	Degree of Acidity
< 4.0	Extremely acidic
4 - 5.4	Strongly acidic
5.5 - 6.4	Moderately Acidic
6.5 - 7.0	Slightly Acidic
7.1 - 7.4	Slightly Alkaline
7.5 - 8.5	Moderately Alkaline
>8.4	Strongly Alkaline

The pH and conductivity results are included as **Appendix H3** and a summary of the results is presented in Table 9.

Table 9: Interpretation of conductivity tests

TP ID.	Depth (m)	Material Description	Conductivity mS/m	Corrosiveness	pH	Degree of Acidity
RESIDUAL SANDSTONE						
TP18	0.4-0.7	Clayey SAND with gravel	5.8	Not generally corrosive	6.28	Moderately Acidic
RESIDUAL QUARTZITIC SANDSTONE						
TP16	0.39-1.3	Silty clayey SAND	0.9	Not generally corrosive	6.24	Moderately Acidic
PEDOGENIC MATERIAL						
TP18	0.7-0.9	Silty clayey SAND with gravel	3.8	Not generally corrosive	6.58	Slightly Acidic

6.4 Discussion of Laboratory Results

6.4.1 Colluvium

The **Transported Soils** (1 sample) classifies as silty SAND with gravel **(SM)** in terms of the United Soils Classification System (USCS). The **SM** sample has a coarse fraction (>0.075mm) of 73% and is non-plastic. It exhibits low potential expansiveness based on the Van der Merwe method of heave prediction.

It classifies as A-2-4 according to the AASHTO Classification System, which rates as excellent to good quality for use as subgrade layers.

6.4.2 Residual Shale

The **Residual Shale** (2 samples) classify as sandy CLAY **(CL)**, and clayey SAND with gravel **(SC)** in terms of the United Soils Classification System (USCS).

The **CL** sample has a fine fraction (<0.075mm) of 51% and exhibits low plasticity with a Liquid Limit (LL) of 34% and Plasticity Index (PI) of 13%. The material has an in-situ moisture content of 10.1% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-6(4) according to the AASHTO Classification System, which rates as fair to poor quality for use as subgrade layers.

The **SC** sample has a coarse fraction (>0.075mm) of 67% and exhibits low plasticity with a Liquid Limit (LL) of 35% and Plasticity Index (PI) of 13%. It classifies as A-2-6 according to the AASHTO Classification System, which rates as excellent to good quality for use as subgrade layers.

6.4.3 Reworked Residual Sandstone

The **Reworked Residual Sandstone** (1 sample) classifies as silty clayey SAND with gravel **(SM-SC**) in terms of the United Soils Classification System (USCS).

This sample has a coarse fraction (>0.075mm) of 56% and exhibits low plasticity with a Liquid Limit (LL) of 22% and Plasticity Index (PI) of 7%. The material has an in-situ moisture content of 2.7% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction.

This sample classifies as A-4(0) according to the AASHTO Classification System, which rates as fair to poor quality for use as subgrade layers.

6.4.4 Residual Sandstone

In terms of the United Soil Classification System (USCS), the residual sandstone soils classify as follows:

- 1no. silty clayey SAND (SM-SC);
- 2no. clayey SAND with gravel (SC); and
- 1no. sandy CLAY (CL).

The **SM-SC** sample has a coarse fraction (>0.075mm) of 65% and exhibits low plasticity with a Liquid Limit (LL) of 17% and Plasticity Index (PI) of 5%. The material has an in-situ moisture content of 3.3% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-2-4(0) according to the AASHTO Classification System, which rates as excellent to good quality for use as subgrade layers.

The **SC** sample (which is partially ferruginised) has a coarse fraction (>0.075mm) ranging between 63% and 74% and exhibits low plasticity with the Liquid Limit (LL) ranging between 23% and 26%, with a Plasticity Index (PI) of 9%. The material has an in-situ moisture content of 3.5% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-2-4(0), and A-4 (0) according to the AASHTO Classification System, which rates as excellent to good and fair to poor quality for use as subgrade layers respectively.

The **CL** sample has a fine fraction (<0.075mm) of 73% and exhibits medium plasticity with a Liquid Limit (LL) of 43% and Plasticity Index (PI) of 19%. The material has an in-situ moisture content of 13.1% and exhibits medium potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-7-6(13) according to the AASHTO Classification System, which rates as poor quality for use as subgrade layers.

The moisture/density relationship test yielded a maximum dry density of 2133 kg/m^3 at Modified AASHTO compaction effort and optimum moisture contents of 8.1%. The swell potential is 0%, with CBR values of 20% and 24% at 93% and 95% Modified AASHTO compaction density respectively.

The **SC** material classifies as G7 (COLTO) quality material. However, the residual soils are variable between **SM-SC** and **CL** materials, and therefore careful selection of this material should be carried out for use as an engineering fill

Results of chemical tests indicate that the residual sandstone is generally not corrosive, with a degree of acidity of moderately acidic.

6.4.5 Residual Quartzitic Sandstone

In terms of the United Soil Classification System (USCS), the soils classify as follows:

- 1no. silty clayey SAND (SM-SC); and
- 2no. clayey SAND, with gravel (SC).

The **SM-SC** sample has a coarse fraction (>0.075mm) of 79% and exhibits low plasticity with a Liquid Limit (LL) of 24% and Plasticity Index (PI) of 7%. The material exhibits low potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-2-4(0) according to the AASHTO Classification System, which rates as excellent to good quality for use as subgrade layers.

The **SC** sample has a coarse fraction (>0.075mm) ranging between 58% and 62% and exhibits low plasticity with the Liquid Limit (LL) ranging between 32% and 36%, with Plasticity Index (PI) between 12% and 13%. The material has an in-situ moisture content ranging between 7.2% and 8% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction. It classifies as A-6-(2) according to the AASHTO Classification System, which rates as fair to poor quality for use as subgrade layers.

The moisture/density relationship test yielded a maximum dry density of 2157kg/m^3 at Modified AASHTO compaction effort and optimum moisture contents of 7.4%. The swell potential is 0.1%, with CBR values of 30% and 41% at 93% and 95% Modified AASHTO compaction density respectively.

The residual quartzitic sandstone classifies as G6 (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

Results of chemical tests indicate that the residual quartzitic sandstone is generally not corrosive, with a degree of acidity of moderately acidic.

6.4.6 Pedogenic Material

The **Pedogenic Material** (2 samples) classify as silty clayey SAND with gravel **(SM-SC**), and silty SAND with gravel **(SM)** in terms of the United Soils Classification System (USCS).

The **SM-SC** sample has a coarse fraction (>0.075mm) of 77% and exhibits low plasticity with a Liquid Limit (LL) of 26% and Plasticity Index (PI) of 6%. The material has an in-situ moisture content of 3.7% and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction.

The **SM** sample has a coarse fraction (>0.075mm) of 82% and has a non-plastic nature and exhibits low potential expansiveness based on the Van der Merwe method of heave prediction.

The sample classifies as A-1b(0) according to the AASHTO Classification System, which rates as excellent to good quality for use as subgrade layers.

The moisture/density relationship test yielded a maximum dry density of 2157kg/m^3 at Modified AASHTO compaction effort and optimum moisture contents of 8.6%. The swell potential is 0%, with CBR values of 25% and 30% at 93% and 95% Modified AASHTO compaction density respectively.

The pedogenic material classifies as G6 (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

Results of chemical tests indicate that the pedogenic material is generally not corrosive, with a degree of acidity of slightly acidic.

6.5 DPL Consistency / Strength

The results of the DPL tests were correlated with SPT N-values in order to determine the consistency and indicative shear strength parameters for the soil. The SPT test is widely used as an indicator of the density and compressibility of granular soils as well as the consistency of cohesive soils.

The following empirical correlation between the DPL value and the Standard Penetration Test (SPT N-value) is adopted:

Equivalent SPT N-value = 0.55 x DPL (no. of blows/300mm).

A summary of the DPL results, equivalent SPT N values and consistency descriptions are provided in Table 8, while the detailed DPL results are attached in **Appendix E**.

The DPL results typically indicate a medium dense upper horizon from surface to 0.3m with SPT N values ranging between 13 and 30. It is underlain by a dense layer, with medium dense zones, ranging from 0.3 to 1.2m with the SPT N values between 9 and 50. Below this, the in-situ soils are generally very dense with SPT N values between 31 and 50.

A summary of SPT N-values is given in Table 10.

Table 10: Summary of equivalent SPT N-values derived from DPL tests

DPL ID.	Depth (m)				
	0.3	**0.6**	**0.9**	**1.2**	**1.5**
DPL02	30	39	47	Refusal	-
DPL04	13	28	Refusal	-	-
DPL05	13	9	11	31	Refusal
DPL06	22	Refusal	-	-	-
DPL08	Refusal	-	-	-	-
DPL11	28	Refusal	-	-	-
DPL14	23	Refusal	-	-	-
DPL15	Refusal	-	-	-	-
DPL20	16	17	Refusal	-	-
Average	**27**	**35**	**40**	**40**	**Refusal**
Consistency	**medium dense**	**dense**	**dense**	**dense**	**very dense**
Notes:					
Consistency Description	***Very Loose***	***Loose***	***Medium Dense***	***Dense***	***Very Dense***
SPT N-value	***0 – 4***	***4– 10***	***30-Oct***	***30 – 50***	***>50***

Based on the average DPL test results, the in-situ soils are generally dense becoming very dense below 0.9m. A plot of the average DPL and equivalent SPT N values is provided Figure 3.

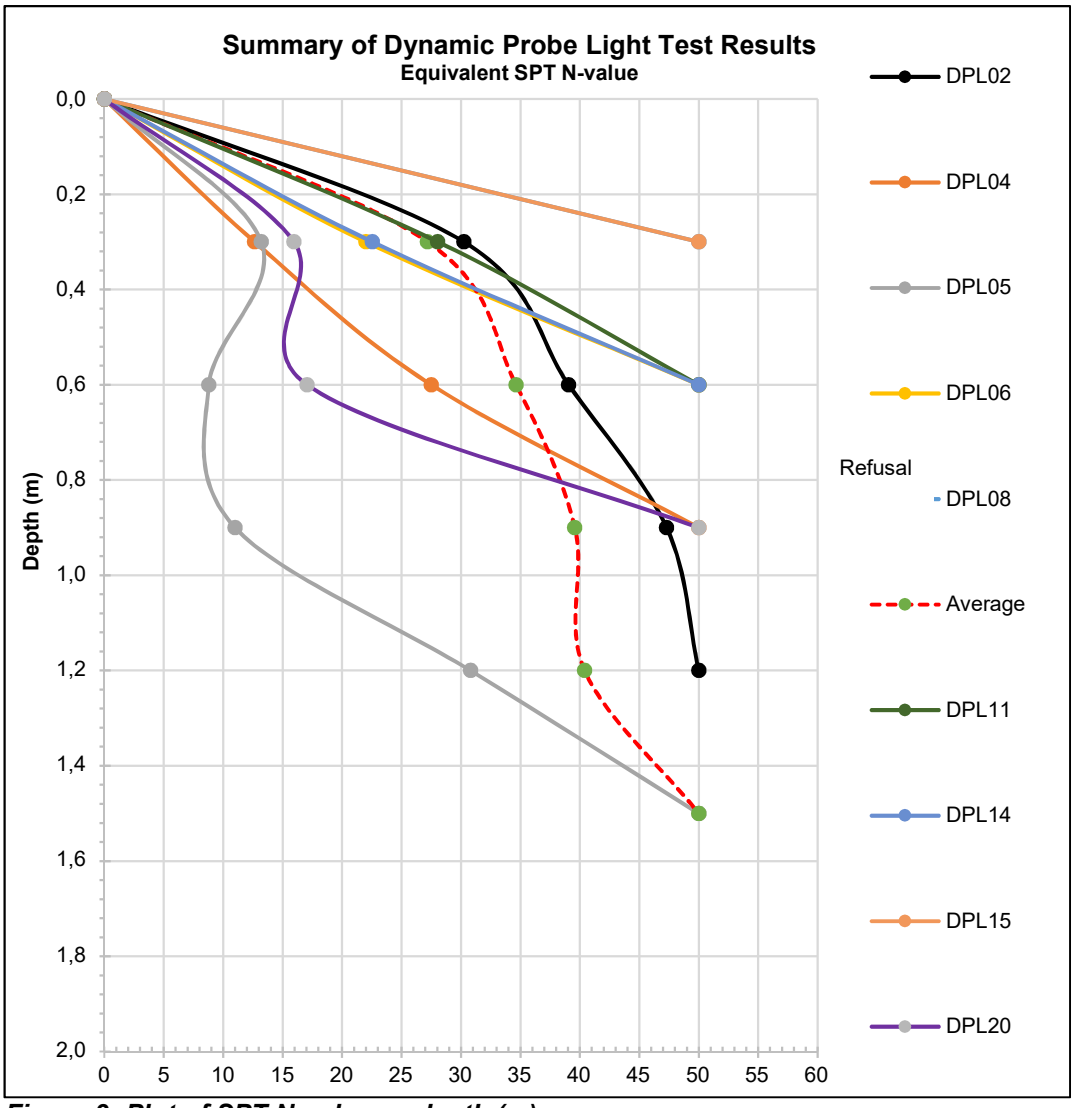


Figure 3: Plot of SPT N-value vs depth (m)

6.6 DCP Consistency / Strength

DCP tests were conducted adjacent to selected excavated test pits in order to determine the consistency and shear strength of the soils. Based on the DCP test results, the in-situ soils are generally dense to medium dense with depth.

It is inferred that in some occasions, refusal of the DCP occurred on a hardpan ferricrete layer. A plot of the DCP results is provided in Figure 4. The DCP results are provided in **Appendix F**.

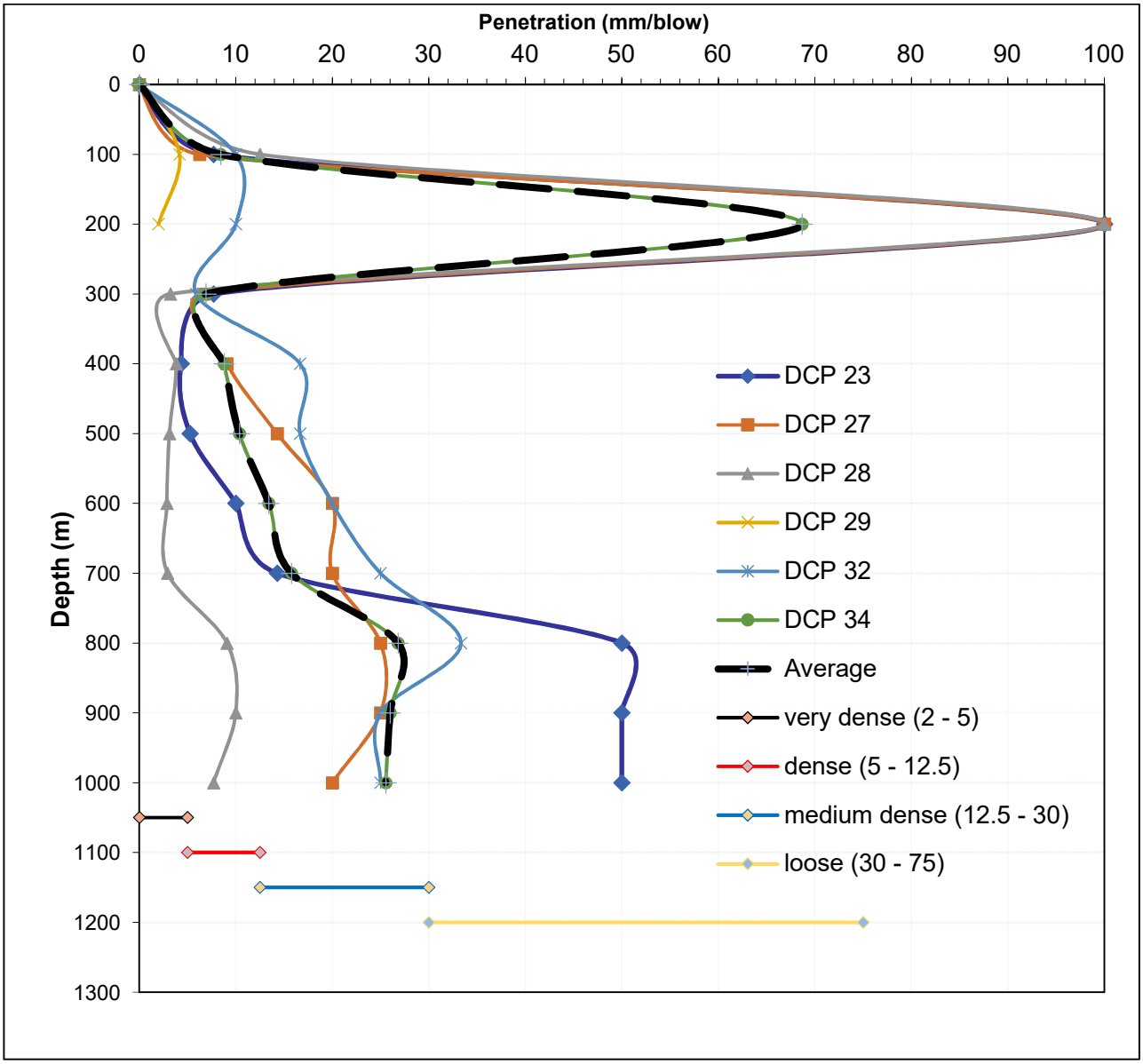


Figure 4: Plot of DCP, penetration (mm/blow) vs depth (mm)

7. RECOMMENDATIONS

7.1 Site Zonation

According to the SAICE Code of Practice (Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction, 1995), the site can be classified into three zones, namely:

- Zone1 - Site Class **R/S**;
- Zone 2 - Site Class **S1**; and
- Zone 3 - Site Class **P** (potential flood zone).

The zonation map is attached in Appendix I.

7.1.1 Zone 1 – (Site Class R/S)

Site Class R/S is defined as follows:

- Rock/hardpan/boulders (R) at shallow depth less than 1.5m.
- Compressible soils (S) with the nature of the founding material comprising fine grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravely soils. Expected total soil movement is less than 10mm.

7.1.2 Zone 2 – (Site Class S1)

- Site Class **S1** is defined as compressible soils with the nature of the founding material comprising fine grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravely soils. Expected total soil movement is between than 10mm and 20mm.

7.1.3 Zone 3 – (Site Class P)

- Site Class **P (potential flood zone)** is defined as a zone with a potential of flooding during heavy rains.

Considering the prevailing geotechnical conditions, the following recommendations are given, with all depths related to current ground level.

7.2 Earthworks

It is recommended that all earthworks are carried out in accordance with SANS 1200 (current version). All topsoil and transported material should be cleared from the footprint of the proposed development and stockpiled for later site rehabilitation.

7.3 Foundations

Development recommendations at this site are as follows (foundation design falls outside the scope of this geotechnical investigation):

- Concrete raft foundation
- Strip Foundation
- Modified Strip foundations

7.3.1 Concrete raft foundation

The recommended foundation type is a reinforced concrete raft foundation founded on the residual soils at a depth of 0.5m below existing ground level. The following construction procedures applies:

- All topsoil and transported soils to be stripped to spoil to a depth of 0.5m below existing ground level;
- Rip and recompact the residual soils to 93% Mod AASHTO density at –1% to +2% OMC;
- Reinforced concrete raft foundations can then be placed at a depth of 0.5m onto the compacted soil;
- The allowable bearing capacity should be limited to 100kPa with a subgrade modulus of 50kPa adopted for the in-situ soils.

7.3.2 Compaction of In-Situ Soils below Footings

An alternative recommendation is a 600mm wide strip footing to be founded at a minimum depth of 0.6m below existing ground level. The following construction procedures are applicable.

- Foundation trenches for 600mm wide strip footing to be over-excavated to 1.0m wide by 1.5m deep, below existing ground level;
- Replace with G6/G7 quality material and compact in 200mm loose thickness to 93% Modified AASHTO compaction to underside of foundation (0.6m);
- Strip footings 600mm wide should be constructed at a depth of 0.6m utilizing a maximum allowable bearing capacity of 100kPa.

7.3.3 Modified Normal Foundations

The recommended foundation type is a reinforced strip footing founded on the residual soils at a depth of 0.5m below existing ground level. The following construction procedures applies:

- Reinforced strip footings.
- Articulation joints at some internal and all external doors.
- Light reinforcement in masonry.
- Site drainage and service/plumbing precautions
- Foundation pressure not to exceed 50 kPa

7.4 Roads and Terraces

The design of the road pavement layers must take into account the traffic intensity and anticipated axle loading. The road pavement should be laid on the newly constructed earthworks, approximately 300mm thick.

The results of the CBR and indicator tests were used to classify the in-situ soils to determine their suitability for use in the construction of terraces and pavement layers. The in-situ soils all classify as G6 and G7 quality material according to TRH14 and are therefore considered suitable for use as engineering fill or for use in road pavement layer works.

7.5 Excavation Classification

Based on the test pits, it is anticipated that the site would classify as “soft excavation”, to depths of between 0.9m and 1.5m for areas with pedogenic material, and between 1.7m and 2.5m for areas with residual material. The excavation classification is in accordance with SANS 1200DA classification, using similar equipment as employed during this investigation. Below these depths very dense material is likely to be intersected.

It is recommended that the sides of any excavations deeper than 1.5m should be battered to 1:1.5, to ensure enough slope stability to prevent collapse of the sidewalls. During periods of heavy rainfall however, the sides of the excavations should be regularly examined, to ensure the safety of the excavation for personnel and equipment working in them.

7.6 Groundwater Management

Groundwater was not encountered in any of the trial pits excavated on site, however ferruginisation and moist conditions were observed in some test pits. Ferruginisation of the soil profile is of significance as it is indicative of a historically variable water regime at a shallow depth in the soil profile.

Appropriate subsoil drainage systems should be allowed during construction of buildings.

7.7 Areas Subject to Flooding

The site topography is generally flat and surface run-off water would generally be towards the north and northwest. A number of dry water pans or ponds were observed on site (closer to TP 12 and TP01) and the impact of flooding to the study area has not been assessed as it falls outside of our current scope of work. It is recommended that a formal flood line study be conducted if deemed necessary.

7.8 Construction Problems

Difficulty in excavation especially in areas where pedogenic material (ferricrete) is envisaged during construction.

7.9 Additional Investigations

It is important to note that this report is for a feasibility level investigation, and a design-level (or footprint) investigation has to be conducted once the site development plan is available.

7.10 General

All test pits were loosely backfilled upon completion of the fieldwork. In order to avoid the possibility of localised settlement occurring below structures due to the consolidation settlement of this loose backfill, it is recommended that each test hole be identified and adequately backfilled in 150mm layers, to at least 90% Mod AASHTO density.

8. CONCLUSIONS

From the above discussion, the following conclusions may be drawn:

i. The study area is suitable for the construction of the Proposed Township development in Aerorand South, Middelburg, Mpumalanga Province.

ii. The area investigated is underlain by transported soils (colluvium) and residual soils (sandstone and shale) derived from sedimentary bedrock. Pedogenic material (cemented in-situ soils mainly by iron, forming ferricrete) was also encountered.

iii. Excavation on site is likely to classify as “soft” to depths of between 0.9m and 1.5m for areas where pedogenic material is encountered, and between 1.7m and 2.5m for areas where residual material is encountered.

iv. Groundwater seepage was not observed in any of the test pits, which were excavated up to a maximum depth of 2.5m. However, ferruginisation of the soil profile is of significance, as it is indicative of a historically variable water regime at a shallow depth.

v. The site class designation according to the building regulations is R/S, S1 and P.

vi. Class R denotes rock/hardpan/boulders (R) at shallow depth less than 1.5m and Class S denotes compressible soils with expected total soil movement is less than 10mm.

vii. Class S1 denotes compressible soils with expected total soil movements between 10mm and 20mm.

viii. Class P denotes a potential flood zone.

ix. The residual quartzitic sandstone, and pedogenic material classify as G6 (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

x. The residual sandstone classifies as G7 (COLTO) quality material. It is therefore considered suitable for use in the construction of engineered fills or as selected layers in the pavement structure for roads.

xi. Any structures should be placed on either a concrete raft, individual strip footings on compacted soils, or reinforced strip footing foundations.

9. REPORT PROVISIONS

i. This investigation is aimed at providing the engineers with an indication of the prevailing engineering geological conditions in the study area.

ii. The investigation was planned as a feasibility level study to establish the suitability of the site for the proposed development.

iii. While every effort has been made during the fieldwork phase of this investigation to identify the various soil horizons, their problems and distribution, it is impossible to guarantee that isolated zones of varying material have not been missed.

iv. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity.

v. The engineers are, nevertheless, strongly urged to inspect all excavations to assure themselves that conditions are not at variance with those described in this report.

vi. The design of geotechnical structures, analysis of structures and services and management of the risk fall outside the scope of this investigation.

vii. Test pits were backfilled after the field investigation but were not re-compacted and some test pit positions may occur within the footprints of proposed structures.

10. REFERENCES

[1]. Weinert, H.H. (1980). The Natural Road Construction Materials of Southern Africa. H & R Academia Publ., Pretoria, 298 pp.

[2]. Jennings, J. E. B, Brink, A. B. A Williams, (January 1973) Revised Guide to Soil Profiling for civil Engineering Purposes in Southern Africa. The Civil Engineer in S A, P 3-12.

[3]. SAIGE-AEG-SAICE (Geotech Div.). Guidelines for Soil and Rock Logging in SA

[4]. 1:250 000 Geological series Map, **2528 PRETORIA**, published by Council for Geoscience, Pretoria.

[5]. 1:50 000 Topographical Map, **2529 CD MIDDELBURG** (1987 - 2nd Edition) published by the Chief Directorate: Surveys and Mapping.

[6]. Department of Public Works document, (June 2007), Identification of Problematic Soils in Southern Africa.

[7]. Van der Merwe, DH. The prediction of heave from the plasticity index and the percentage of clay fraction of soil. The Civil Engineer in South Africa, p.103-107. June 1973.

[8]. Whitlow, R. basic Soil Mechanics, Fourth Edition, 2001. Pearson Education Limited, table 11.2, p462.

[9]. SANS-10400-H (2012). Edition 3: The application of the national building regulation – Part H: Foundations. ISBN 978-0-626.

[10]. SANS-10160-4 (2011). Part 4: Seismic actions and general requirements for. ISBN 978-0-626-26431-4.

[11]. Bieniawski, Z. T, (1989) Engineering Rock Mass Classification Pub. John Wiley& Sons New York.

[12]. Terzaghi, K (1943) Theorectical soil mechanics Pub. John Wiley& Sons New York.

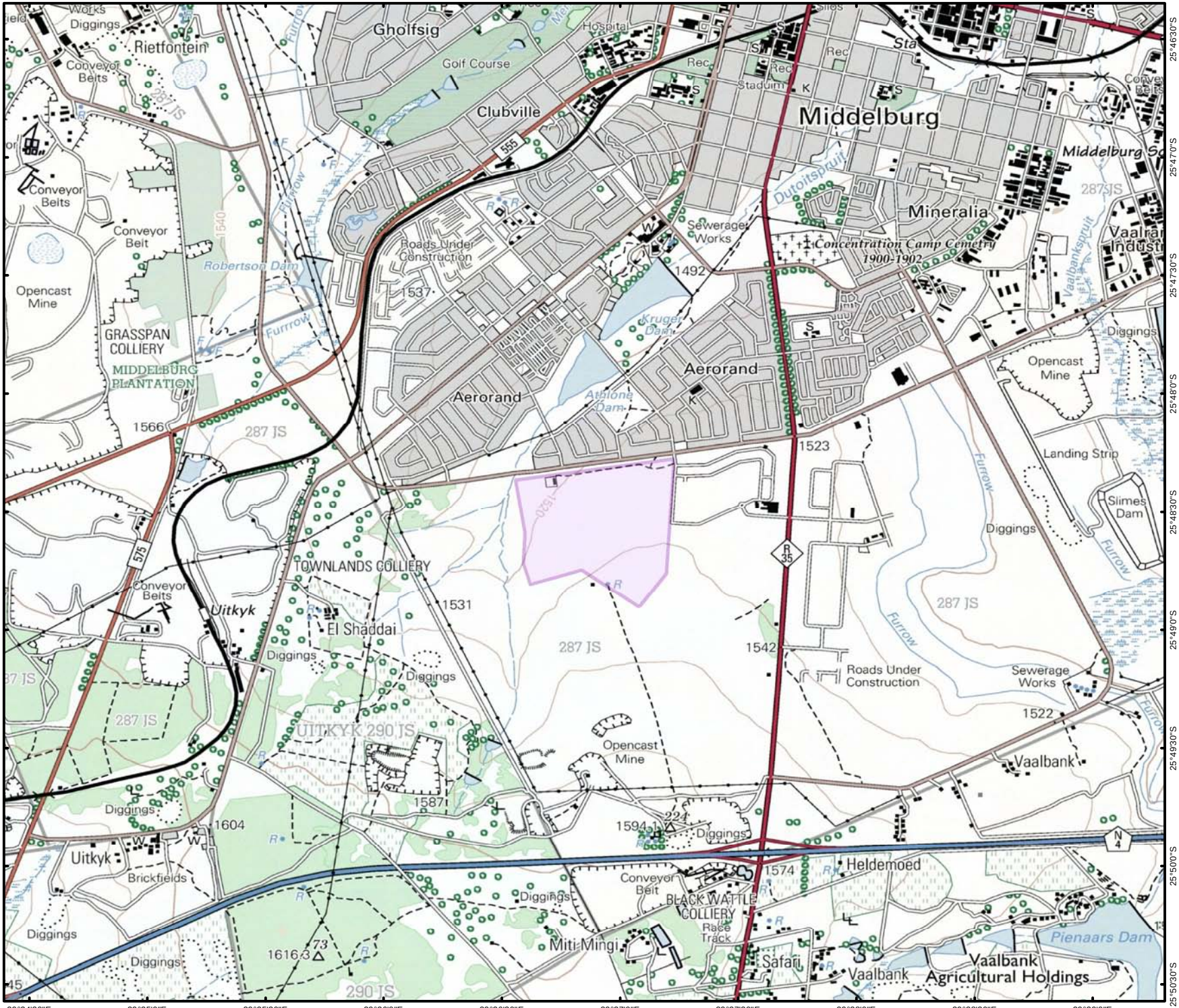
[13]. SAICE (1995). Code of Practise for Foundations and Superstructures for Single Storey Residential buildings of Masonry Construction. First Edition. The Joint Structural Division, Johannesburg. ISBN 0-620-19317-4.

[14]. Home Building Manual: Part 1 & 2: Revision No.1 dated February 1999, published the NHBRC

11. APPENDICES

- APPENDIX A: TOPOGRAPHICAL MAP
- APPENDIX B: GEOTECHNICAL LAYOUT DRAWING
- APPENDIX C: TEST PIT PROFILES
- APPENDIX D: SITE & TEST PIT PICTURES
- APPENDIX E: DPL TEST RESULTS
- APPENDIX F: DCP TEST RESULTS
- APPENDIX G: GEOLOGICAL MAP
- APPENDIX H: LABORATORY TEST RESULTS
- APPENDIX I: ZONATION MAP

APPENDIX A: TOPOGRAPHICAL MAP



Legend

- Site Boundary
- Buildings / Ruins
- Cemetery / Grave
- Row of Trees
- Main Roads
- Secondary Roads
- Other Roads
- Railway
- Track and Hiking Trail
- Powerline
- Rivers
- Contour Lines
- Cadastral Boundary
- Buildings
- Build up Area
- Mine Dump / Excavation
- Erosion / Sand
- Cultivated Land
- Woodland
- Recreation Ground
- Marsh and Vlei
- Non- Perenial Water
- Water Bodies

CLIENT

STEVE TSHWETE LOCAL MUNICIPALITY

PROJECT

AERORAND SOUTH TOWNSHIP, STEVE TSHWETE LOCALMUNICIPALITY

TITLE

Topographical Map of Aerorand South Township, Mpumalanga
Extract of 1:50 000 Topographical Map 2529CD MIDDELBURG (TVL)

DRAWN: A. Qoboka	DRAWING
DATE: 2018/11/08	MK- 18- 480- Topo- 020

0 0,4 0,8 1,6
Kilometers

SCALE: 1:40 000

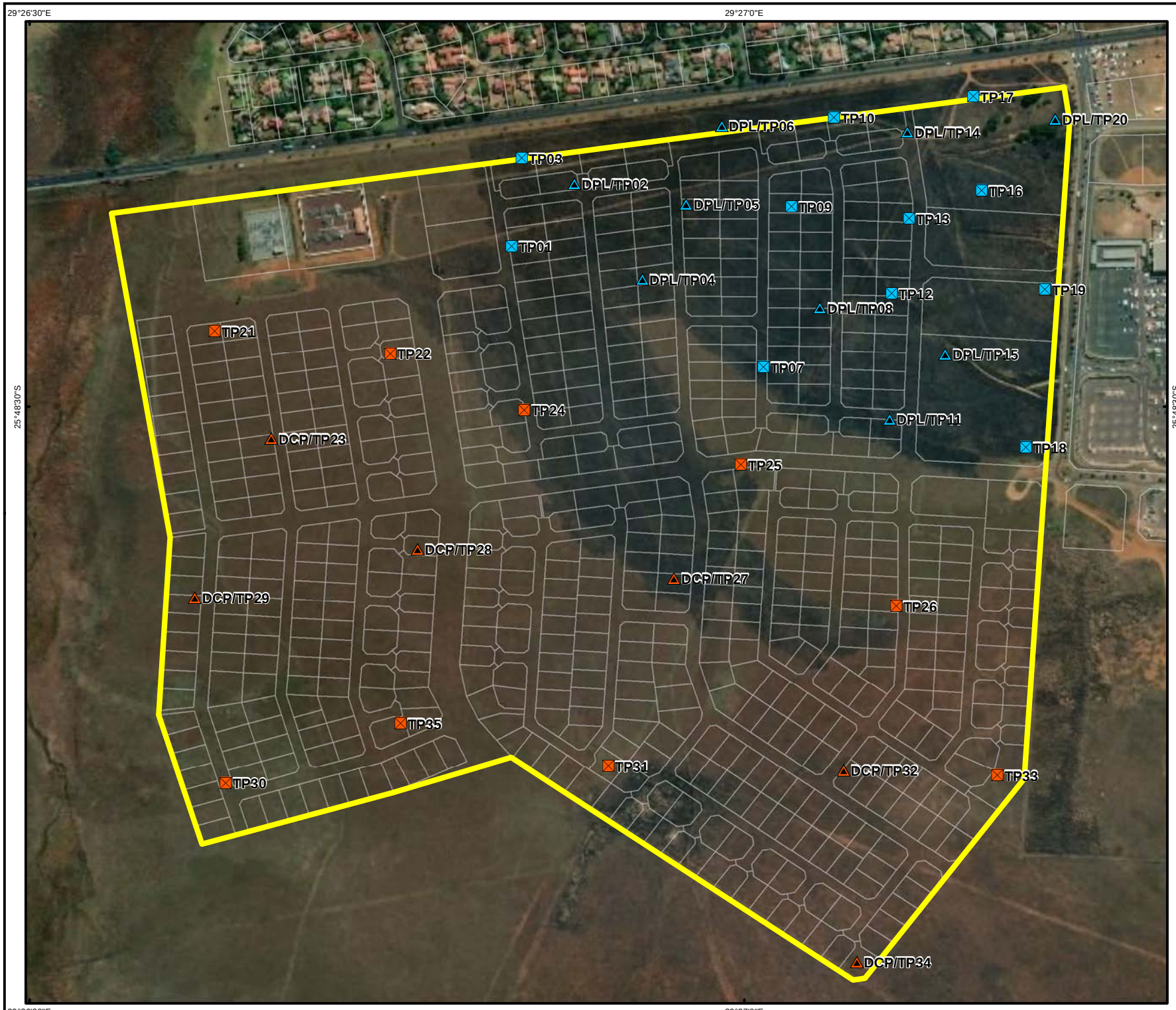
N

Projection: Geographic, Datum: WGS84
Source: Chief Directorate National Geo-Spatial Information
Inset: ESRI Data and Maps

MUKONA CONSULTING ENGINEERS

Mukona Consulting Engineers (Pty) Ltd
International Business Gateway, New Road,
Midridge Office Estate (North),Midrand, 1685
Telephone:0114438293
Mobile:0837850284
Email: Sollyp@mknconsulting.co.za

APPENDIX B: GEOTECHNICAL LAYOUT DRAWING



LEGEND

- ADDITIONAL TEST PITS
- ADDITIONAL DCP & TEST PITS
- EXISTING TEST PITS
- EXISTING DPL & TEST PITS
- FARM BOUNDARY
- MIDDELBURG FARM ERFs

CLIENT

STEVE TSHWETE LOCAL MUNICIPALITY

PROJECT

GEOTECHNICAL INVESTIGATION FOR AERORAND SOUTH TOWNSHIP STEVE TSHWETE MUNICIPALITY

TITLE

GEOTECHNICAL LAYOUT PLAN AERIAL IMAGERY- ESRI BASEMAPS

DRAWN: A. Qoboka	DRAWING
DATE: 2019/06/04	MK-1 8- 480- GLP097

0 0,05 0,1 0,2
Kilometers

SCALE: 1:6 500

N

Projection: Geographic, Datum: WGS84
Source: Chief Directorate National Geo-Spatial Information
Inset: ESRI Data and Maps

Mukona Consulting Engineers (Pty) Ltd
International Business Gateway, New Road,
Midridge Office Estate (North),Midrand, 1685
Telephone:0114438293
Mobile:0837850284
Email: Sollyp@mukonagroup.com

APPENDIX C: TEST PIT PROFILES

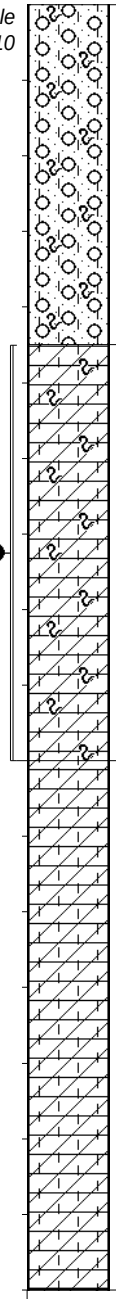
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00

Dry, reddish brown, loose to medium dense, silty SAND with scattered black ferruginised gravels and abundant fine roots: **Colluvium**.

0.45

Slightly moist, reddish brown, firm to stiff, silty CLAY, with abundant interlayered red and yellowish brown, laminated shale fragments and minor fine roots: **Residual Shale**.

1.00

Moist, yellow brown and red brown, stiff to very stiff, silty CLAY, with abundant red and yellowish brown (interlayered), laminated shale fragments and with occasional patches of light grey silty CLAY **Residual Shale**.
Note:
The material transitions to very soft shale at the bottom of the test pit.

1.70

NOTES

1) Refusal of TLB at 1.7m.
2) No water seepage observed.
3) Disturbed sample CBR/FI at 0.45--1m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION : Vertical
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,806
Y-COORD : 29,4472

HOLE No: TP01

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

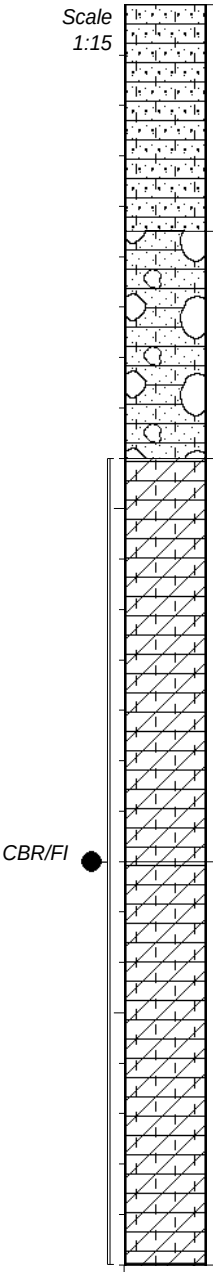
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 – Dry, brown, medium dense, silty SAND with scattered black ferruginised gravelsand minor sandstone pebbles, **Colluvium**

0.45 – Dry, light to dark brown, medium dense, silty SAND, with minor interlayered reddish and yellowish brown, subangular shale cobbles: **Residual shale**.

0.90 – Slightly moist, reddish brown, stiff, silty CLAY, with abundant interlayered red and yellowish brown, laminated shale fragments: **Residual shale**.

1.70 – Red and yellowish brown (interlayered), laminated, fine grained, shale fragments with minor patches of light grey silty clay: **Soft Shale**

2.50

NOTES

1) Slow advance of TLB at 2.5m.
2) No water seepage observed.
3) Disturbed sample CBR/FI at 0.9--2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8057
Y-COORD : 29,4480

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP02

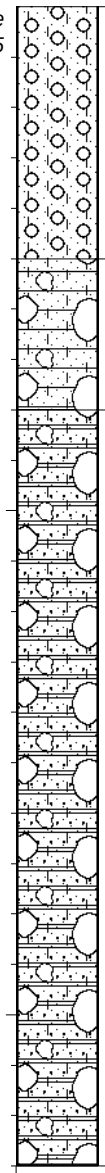
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP03
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravels **Colluvium**

0.50 Dry, light to dark brown, medium dense, silty SAND, with minor interlayered reddish and yellowish brown, interlayered, subangular shale cobbles: **Residual shale**.

0.80 Slightly moist, light to dark brown, dense, silty SAND, with abundant reddish brown subangular shale cobbles, and with patches of white shale: **Residual shale** .
Note:
There is a thin weathered purple sandstone layer from 1.0 to 1.2m.

2.30

NOTES

1) Slow advence of TLB at 2.3m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,805
Y-COORD : 29,447

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP03

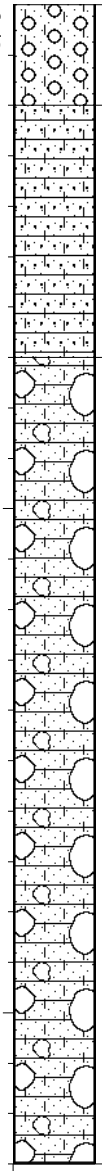
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP04
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Dry, brownish grey, medium dense, silty SAND with scattered black ferruginised gravels **Colluvium**.

0.20 Dry, light brown, dense, silty SAND, with abundant sub-rounded quartz and sandstone pebbles: **Pebble marker** .

0.70 Slightly moist, light to dark brown, dense to very dense, silty SAND, with abundant reddish brown subangular shale cobbles: **Residual Shale**

2.30

NOTES

1) Slow advance of TLB at 2.3m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8068
Y-COORD : 29,4488

TYPE SET BY : LN
SETUP FILE : STANDARD.SET
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP04

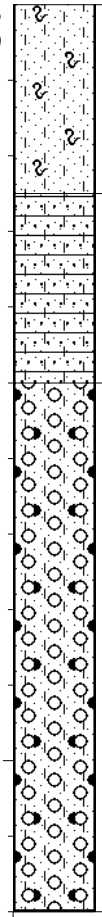
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP05
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00	Dry, greyish brown, loose medium dense, silty SAND with abundant fine roots, **Colluvium**.
0.25	Dry to Slightly moist, yellowish brown, loose medium dense, silty SAND: **Residual Sandstone** .
0.50	Dry, light grey stained orange mottled black, dense to very dense (moderately cemented), ferruginised GRAVEL, in a matrix of yellowish brown, silty sand:**Honeycomb Ferricrete**.
1.20	

NOTES

1) Refusal of TLB at 1.2m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,805
Y-COORD : 29,4493

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP05

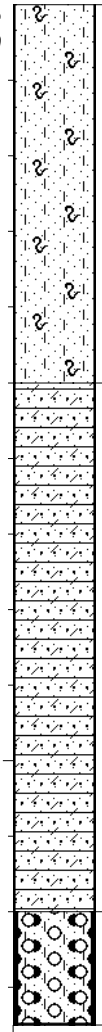
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP06
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00 Slightly moist, yellowish brown, loose, silty SAND with fine roots, **Colluvium**.

0.50 Slightly moist, yellowish brown, very dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised residual sandstone**.

1.20 Dry, light grey stained orange mottled black, very dense (strongly cemented), ferruginised GRAVEL, with minor brown silty sand: **Hardpan Ferricrete**.

1.35

NOTES

1) Refusal of TLB at 1.35m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,805
Y-COORD : 29,4497360

TYPE SET BY : LN
SETUP FILE : STANDARD.SET
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP06

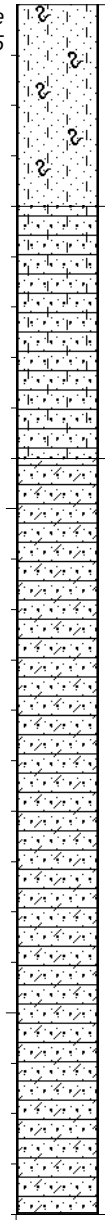
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP07
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00
Dry, greyish brown, loose to medium dense, silty SAND, with abundant fine roots: **Colluvium**.

0.40
Dry to Slightly moist, yellowish brown, loose to medium dense, silty SAND: **Reworked residual Sandstone** .

0.90
Slightly moist, reddish brown, very dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised Residual Quartzitic Sandstone**
Note:
Becomes very dense at 2.2m.

2.40

NOTES

1) Slow advence of TLB at 2.4m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,807
Y-COORD : 29,4502

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP07

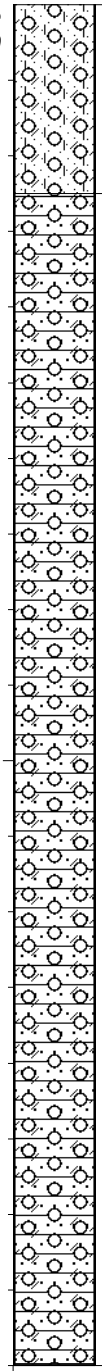
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP08
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00

Dry, greyish brown, medium dense to dense, clayey silty SAND, with abundant black, sub-rounded ferruginised gravels: **Colluvium**.

0.25

Slightly moist, light and dark brown stained orange mottled black, dense to very dense, clayey ferruginised GRAVEL: **Ferruginised Residual Quartzitic Sandstone**.

1.80

NOTES

1) Refusal of TLB at 1.8m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,807
Y-COORD : 29,4508

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP08

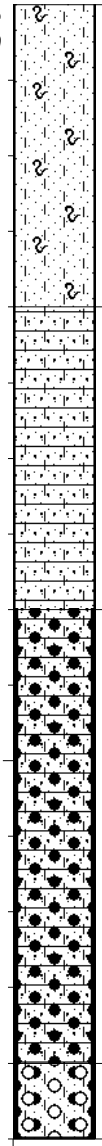
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP09
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00 Dry, greyish brown, medium dense, silty SAND with abundant fine roots, **Colluvium**.

0.40 Dry to Slightly moist, yellowish brown, medium dense, silty SAND: **Reworked residual Sandstone** .

0.80 Dry, light to dark brown, dense to very dense, silty SAND, with reddish brown mottled black ferricrete nodules: **Ferruginised Residual Quartzitic Sandstone**
Note: Hardpan ferricrete at the base, very soft rock.

1.40 Dry, brown stained orange mottled black, very dense (strongly cemented), ferruginised GRAVEL, with minor reddish brown silty sand: **Hardpan Ferricrete**.

1.50

NOTES

1) Refusal of TLB at 1.5m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,806
Y-COORD : 29,45051

TYPE SET BY : LN
SETUP FILE : STANDARD.SET
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP09

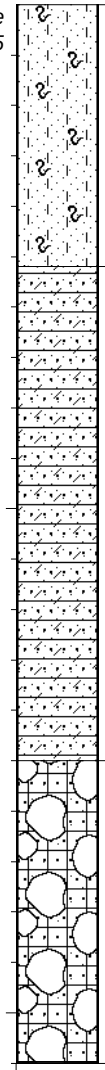
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP10
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, yellowish brown, loose, silty SAND with fine roots, **Colluvium**.

0.52 Slightly moist, reddish brown, very dense, clayey SAND with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised residual Sandstone**

1.50 Moist, reddish brown, stained orange mottled black, stiff to very stiff, sandy SILT with scattered round Slightly weathered sandstone boulders: **Residual Sandstone**.

2.10

NOTES

1) Slow advence of TLB at 2.1m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,80496
Y-COORD : 29,45104

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP10

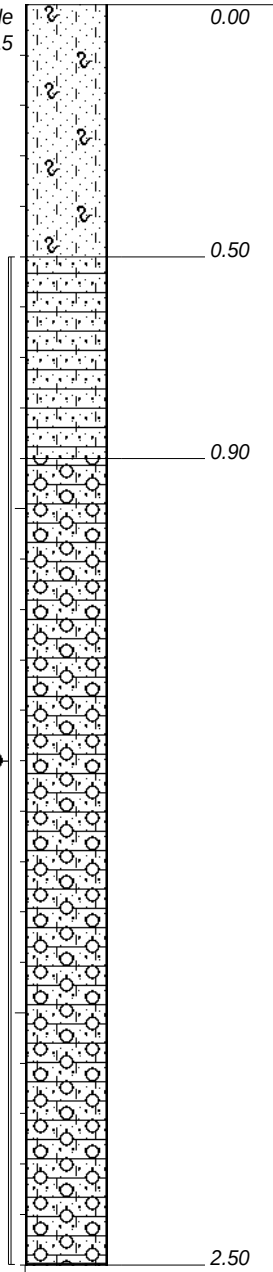
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP11
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 — Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravelsand abundant fine roots with termite mounds, **Colluvium**.

0.50 — Dry, brownish grey, medium dense, silty SAND with abundant black ferruginised pebbles: **Reworked Residual Sandstone**.

0.90 — Slightly moist, yellowish brown, dense to very dense, ferruginised GRAVEL, in a matrix of silty sand: **Residual Sandstone**.
Note:
Layer slightly ferruginised

2.50

NOTES

1) Refusal of TLB at 2.5m.
2) No water seepage observed.
3) Disturbed sample CBR/FI at 0.50--2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8084
Y-COORD : 29,45169

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

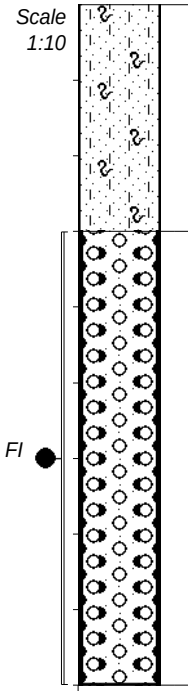
HOLE No: TP11

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP12
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 – 0.30: Dry, greyish brown, very loose to loose, silty SAND with abundant fine roots, **Colluvium**.

0.30 – 0.90: Dry to Slightly moist, yellowish brown mottled black and red, dense to very dense, sandy ferruginised GRAVEL: **Honeycomb ferricrete** .
Note:
Becomes hardpan ferricrete the base.

NOTES

1) Refusal of TLB at 0.9m.
2) No water seepage observed.
3) Disturbed sample FI at 0.30--0.9m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8070
Y-COORD : 29,4517

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

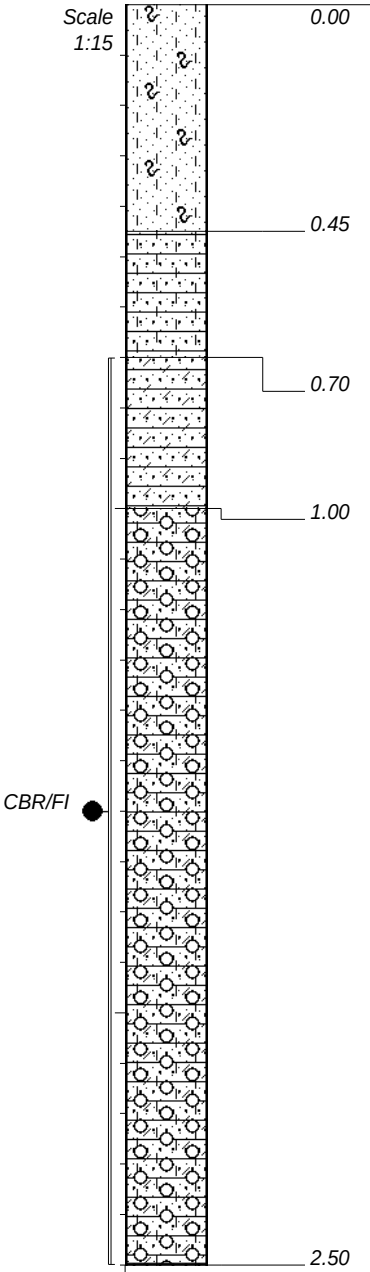
HOLE No: TP12

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP13
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 – Dry, yellowish brown, loose, silty SAND with abundant fine roots, **Colluvium**.

0.45 – Dry, yellowish brown and red, loose to medium dense, silty SAND in a matrix of rounded and sub-rounded pebbles and cobles of sandstone (light grey and white) and sandstone (reddish brown): **Pebble marker** .

0.70 – Slightly moist, yellowish brown, dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Residual Quartzitic Sandstone**.

1.00 – Slightly moist, reddish brown, dense to very dense, clayey silty SAND, with abundant grey mottled orange sandstone gravel: **Ferruginised Residual Quartzitic Sandstone** .
Note: Becomes very dense from 2.2m.

2.50

NOTES

1) Refusal of TLB at 2.5m.
2) No water seepage observed.
3) Disturbed sample CBR/FI at 0.7--2.5m

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,806
Y-COORD : 29,45191

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP13

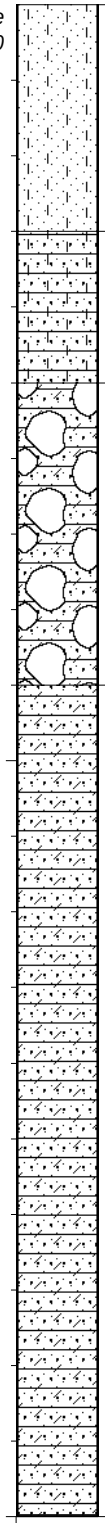
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP14
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00

Slightly moist, yellowish to brown, loose to medium dense, silty SAND, **Colluvium**.

0.30

Dry, yellowish brown and red, medium dense, silty SAND in a matrix of rounded and sub-rounded pebbles and cobles of sandstone (light grey and white) and sandstone (reddish brown): **Pebble marker** .

0.50

Slightly moist to moist, reddish brown, dense to very dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Residual Quartzitic Sandstone**
Note:
1. Sandstone boulders at 0.6m.
2.
becomes dense at 0.9m

0.90

Slightly moist to moist, reddish brown, very dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised residual Quartzitic Sandstone**

2.00

NOTES

1) Refusal of TLB at 2.0m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,80512
Y-COORD : 29,4518

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

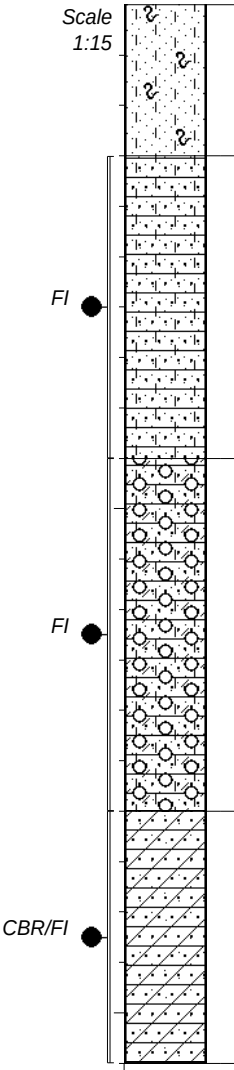
HOLE No: TP14

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP15
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00	Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravelsand abundant fine roots with termite mounds, **Colluvium**.
0.30	Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravelsand termite mounds: **Reworked Residual Sandstone**.
0.90	Slightly moist, reddish brown grey stained orange, medium dense to dense, clayey silty SAND, with abundant ferruginised gravel: **Ferruginised Residual Sandstone**.
1.60	Slightly moist, grey stained orange mottled black, firm to stiff, sandy CLAY: **Residual Sandstone** Note: slickensided structure is present at places.
2.10	

NOTES

1) Refusal of TLB at 2.1m.
2) No water seepage observed.
3) Disturbed sample FI at 0.3--0.9m.
4) Disturbed sample FI at 0.9--1.6m.
5) Disturbed sample CBR/FI at 1.6--2.1m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8077
Y-COORD : 29,452341

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

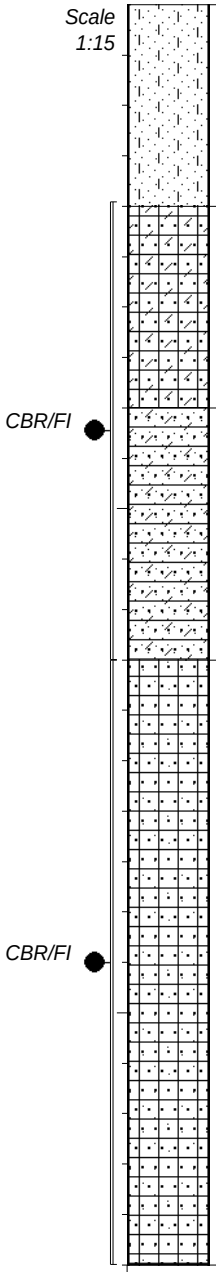
HOLE No: TP15

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP16
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 Slightly moist, yellowish to brown, loose, silty SAND: **Colluvium**.

0.40 Slightly moist to moist, yellowish brown and reddish brown, medium dense to dense, clayey SILT with abundant or in a matrix of subangular sandstone pebbles:**Reworked residual Quartzitic Sandstone**

0.80 Slightly moist to moist, reddish brown, very dense, clayey SAND, with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised residual Quartzitic Sandstone**

1.30 Slightly moist, light grey stained red, firm to stiff, sandy SILT, with scattered sandstone pebble: **Residual Quartzitic Sandstone**

2.50

NOTES

1) Refusal of TLB at 2.5m.
2) No water seepage observed.
3) Disturbed sample CBR/FI at 0.39--1.3m.
4) Disturbed sample CBR/FI at 1.3--2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8058
Y-COORD : 29,45276

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP16

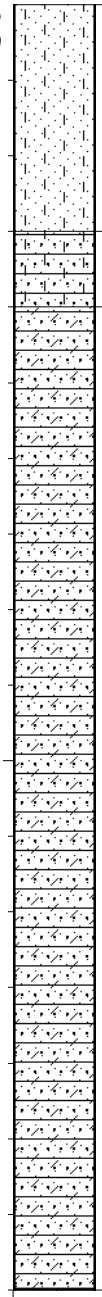
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP17
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00 Slightly moist, yellowish to brown, loose, silty SAND, **Colluvium**.

0.30 Dry, yellowish brown and red, loose medium dense, silty SAND in a matrix of rounded and sub-rounded pebbles and cobles of sandstone (light grey and white) and sandstone (reddish brown): **Pebble marker**.

0.40 Slightly moist to moist, reddish brown, very dense, clayey SAND with abundant or in a matrix of subangular sandstone pebbles: **Ferruginised residual Quartzitic Sandstone**.

1.70

NOTES

1) Refusal of TLB at 1.7m.

2) No water seepage observed.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8047
Y-COORD : 29,45266

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

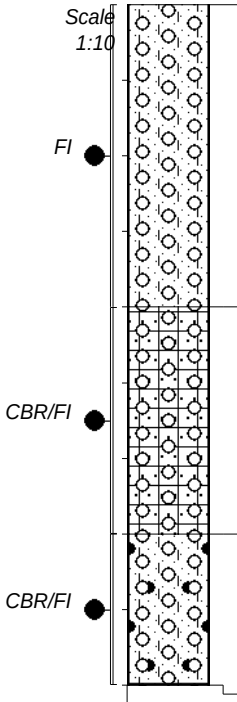
HOLE No: TP17

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP18
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 — Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravels: **Colluvium**.

0.40 — Dry, yellowish brown, medium dense, ferruginised gravels in a matrix of silty SILT : **Ferruginised Residual Sandstone** .

0.70 — Slightly moist, light grey stained orange mottled black, dense to very dense (moderately cemented), ferruginised GRAVEL, in a matrix of yellowish brown, silty sand: **Honeycomb ferricrete**

0.90

NOTES

1) Refusal of TLB at 0.9m.
2) No water seepage observed.
3) Disturbed sample FI at 0.0--0.4m.
4) Disturbed sample CBR/FI at 0.4--0.7m.
5) Disturbed sample CBR/FI at 0.7--0.9m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,808
Y-COORD : 29,4532

TYPE SET BY : LN
SETUP FILE : STANDARD.SET
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP18

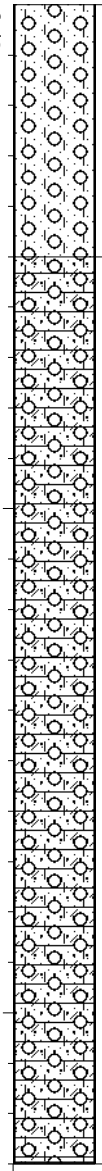
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP19
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00

Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravels: **Colluvium**.

0.50

Slightly moist, reddish brown, dense to very dense, clayey silty SAND with abundant grey mottled orange sandstone gravel: **Ferruginised residual Quartzitic Sandstone** .

Note:
1. there is minor scattered sandstone fragments at 2.1m and below.
2. There is no gravels above 2.1m.

2.30

NOTES

1) Refusal of TLB at 2.3m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,806
Y-COORD : 29,45350

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP19

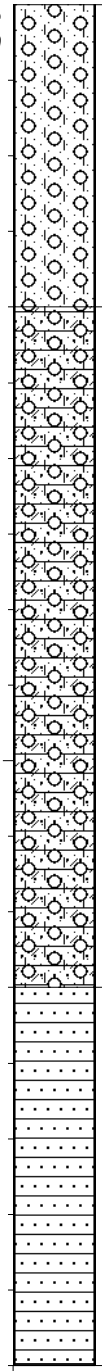
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP20
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00

Dry, brownish grey, loose to medium dense, silty SAND with scattered black ferruginised gravels: **Colluvium**.
Note: there is minor gravel.

0.40

Slightly moist, reddish brown, medium dense to dense, clayey silty SAND with abundant grey mottled orange sandstone gravel: **Ferruginised residual Quartzitic Sandstone** .

1.30

Brownish pink, highly weathered, coarse grained, very soft to soft sandstone rock: **Quartzitic Sandstone**.

1.80

NOTES

1) Refusal of TLB at 1.8m.
2) No water seepage observed.
3) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25,8049
Y-COORD : 29,4536

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP20

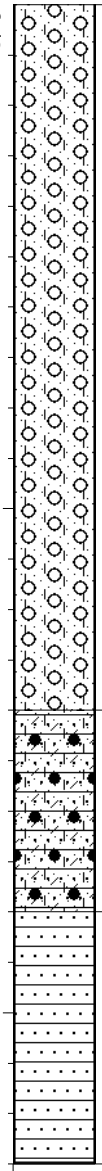
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP21
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00

Tightly packed, sub-rounded to rounded, fine to medium GRAVEL in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is medium dense: **Colluvium**.

1.40

Slightly moist, brownish red, dense, intact, clayey silty SAND with ferricrete nodules: **Ferruginised Residual Sandstone**.

1.80

Purple red, very highly to completely weathered, fine to medium grained, very dense to very soft rock: **Shaly Sandstone**.

2.30

NOTES

1) No water seepage observed.

2) End of hole at 2.3m

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.80744
Y-COORD : 29.44384

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP21

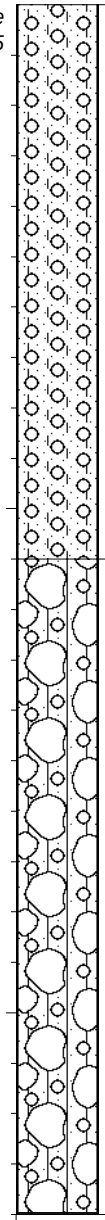
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP22
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00

Tightly packed, sub-rounded to rounded, fine to coarse GRAVEL in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is medium dense: **Colluvium**.

1.10

Slightly moist, orangey red, firm, intact, sandy SILT with abundant rounded coarse gravel and boulders:**Colluvium**.

2.40

NOTES

1) No water seepage observed.

2) End of hole at 2.4m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.80771
Y-COORD : 29.44588

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP22

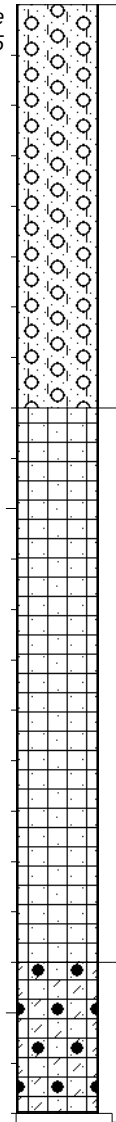
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP23
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00

Tightly packed, sub-rounded to rounded, fine to coarse GRAVEL in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is loose: **Colluvium**.

0.80

Slightly moist, brownish red, firm, intact, sandy SILT: **Residual Shale**.

1.90

Moist, yellowish brown and brownish red stained black, stiff to very stiff, clayey sandy SILT with zones of light grey clayey silt and slightly cemented ferricrete: **Residual Shale**.

2.20

NOTES

1) No water seepage observed.

2) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.8087
Y-COORD : 29.4445

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP23

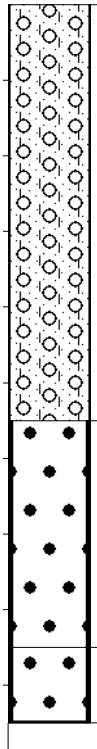
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP24
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00 Tightly packed, sub-rounded to rounded, fine to coarse GRAVEL in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is loose to medium dense: **Colluvium**.

0.55 Yellow and red, speckled black, moderately to well cemented, medium dense, hardpan: **Ferricrete**.

0.85 Yellow and red, speckled black, well to very well cemented, very dense, hardpan: **Ferricrete**.

0.95

NOTES

1) Refusal of TLB at 0.95m.

2) No water seepage observed.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.8084
Y-COORD : 29.44743

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP24

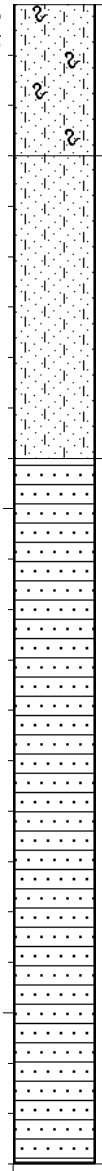
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP25
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, greyish brown, loose, intact, silty SAND with abundant fine roots, **Colluvium**.

0.30 Slightly moist, orangey yellow, dense to very dense, intact, silty SAND: **Colluvium**.

0.90 Yellowish grey, very highly to completely weathered, fine to medium grained, very dense to very soft rock: **Shaly Sandstone**.

2.30

NOTES

1) No water seepage observed.

2) End of hole at 2.3m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.80903
Y-COORD : 29.44994

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP25

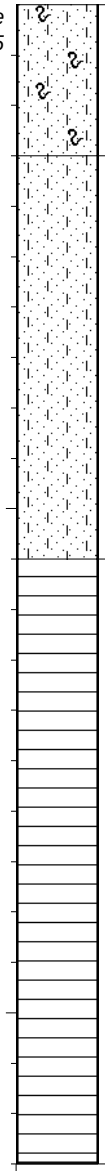
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP26
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, greyish brown, loose to medium dense, intact, silty SAND with abundant fine roots, **Colluvium**.

0.30 Slightly moist, orangey red, loose, intact, silty SAND: **Colluvium**.

1.10 Slightly moist to moist, grey stained black and dusky red, medium dense to dense, moderately cemented: **ferruginised residual shale**.

2.30

NOTES

1) No water seepage observed.

2) End of hole at 2.3m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81063
Y-COORD : 29.45175

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

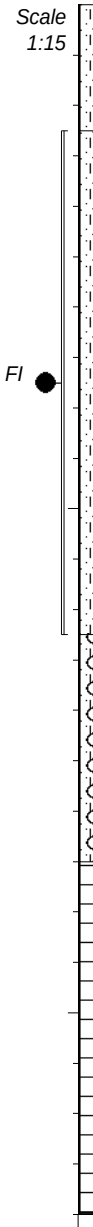
HOLE No: TP26

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP27
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 Slightly moist, greyish brown, loose to medium dense, intact, silty SAND with abundant fine roots, **Colluvium**.

0.25 Slightly moist, orangey red, loose, intact, silty SAND: **Colluvium**.

1.25 Slightly moist, yellowish red mottled black, dense, intact, gravelly silty SAND with scattered rounded to well-rounded gravel: **Pebble Maker**.

1.70 Slightly moist to moist, grey stained black and dusky red, medium dense to dense, moderately cemented: **ferruginised residual shale**.

2.40

NOTES

1) No water seepage observed.
2) Disturbed sample taken for FI at 0.25--1.25m.
3) End of hole at 2.4m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81037
Y-COORD : 29.44919

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP27

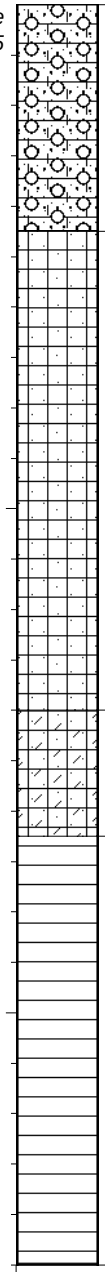
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP28
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00

Tightly packed, sub-rounded to rounded, fine to coarse GRAVEL of quartz and sandstone in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is loose to medium dense: **Colluvium**.

0.45

Slightly moist, orangey red, firm, intact, sandy SILT with abundant shale rock fragments: **Residual Shale**.

1.40

Slightly moist, orangey greyish yellow, soft to firm, micro-shattered, clayey sandy SILT with abundant shale rock fragments: **Residual Shale**.

1.65

Light grey stained orangey yellow, very highly weathered to completely weathered, fine grained, medium dense to dense to very soft rock: **Shale**.

2.50

NOTES

1) No water seepage observed.

2) End of hole at 2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81002
Y-COORD : 29.44623

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP28

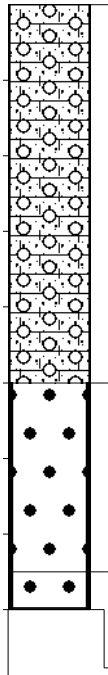
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP29
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00

Tightly packed, sub-rounded to rounded, fine to coarse GRAVEL of quartz and sandstone in a matrix of slightly moist, reddish brown, silty sand. Overall consistency is loose to medium dense: **Colluvium**.

0.50

Purple red stained orange, well cemented, dense, hardpan: **Ferricrete**.

0.75

Purple red stained orange, very well cemented, very dense, hardpan: **Ferricrete**.

0.80

NOTES

1) Refusal of TLB at 0.8m.

2) No water seepage observed.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.8106
Y-COORD : 29.4436

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP29

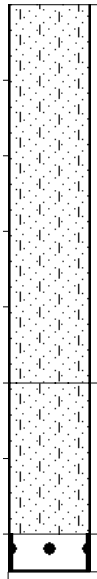
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP30
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:10



0.00 Slightly moist, grey, very loose to loose, intact, silty SAND: **Alluvium**.

0.50 Moist, grey stained orange, very dense, intact, silty SAND: **Alluvium**.

0.70 Orange mottled black, very well cemented, very dense, hardpan: **Ferricrete**.

0.75

NOTES

1) Refusal of TLB at 0.75m.

2) MOist to very moist at the bottom of the test pit.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

ELEVATION :
X-COORD : -25.8127
Y-COORD : 29.44397

HOLE No: TP30

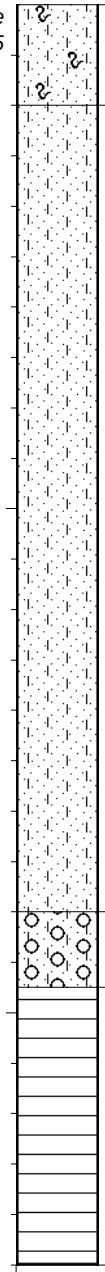
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP31
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, greyish brown, loose to medium dense, intact, silty SAND with abundant fine roots, **Colluvium**.

0.20 Slightly moist, orangey red, loose, intact, silty SAND: **Colluvium**.

1.80 Slightly moist to moist, red mottled black, dense, intact, gravelly silty SAND with scattered rounded to well-rounded gravel: **Pebble Maker**.

1.95 Slightly moist to moist, grey stained black and dusky red, medium dense, moderately cemented: **ferruginised residual shale**.

2.50

NOTES

1) No water seepage observed.

2) End of hole at 2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81253
Y-COORD : 29.44844

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP31

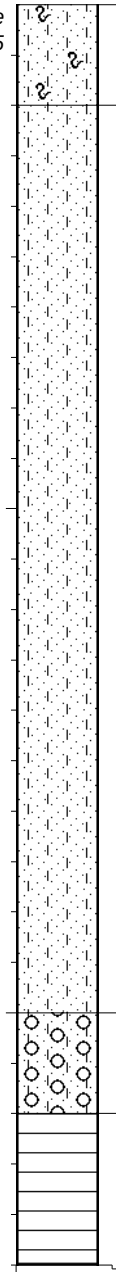
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP32
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, greyish brown, loose to medium dense, intact, silty SAND with abundant fine roots, **Colluvium**.

0.20 Slightly moist, orangey red, loose, intact, silty SAND: **Colluvium**.

2.00 Slightly moist, red mottled black, dense, intact, gravelly silty SAND with scattered rounded to well-rounded gravel: **Pebble Maker**.

2.20 Slightly moist, grey stained black and dusky red, medium dense, moderately cemented: **ferruginised residual shale**.

2.50

NOTES

1) No water seepage observed.

2) End of hole at 2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81258
Y-COORD : 29.45111

TYPE SET BY : LN
SETUP FILE : STANDARD.SET
DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP32

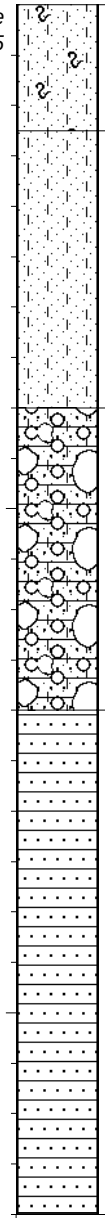
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP33
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00	Slightly moist, greyish brown, loose, intact, silty SAND with abundant fine roots, **Colluvium**.
0.25	Slightly moist, orangey yellow, dense to very dense, intact, silty SAND: **Colluvium**.
0.80	Closely packed, sub-rounded to rounded, fine to coarse GRAVEL of sandstone with cobbles in a matrix of slightly moist, greyish yellow, silty sand. Overall consistency is loose: **Pebble Marker**.
1.40	Yellowish grey, very highly to completely weathered, fine to medium grained, very dense to very soft rock: **Shaly Sandstone**.
2.40	

NOTES

1) No water seepage observed.

2) End of hole at 2.5m.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81264
Y-COORD : 29.45294

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP33

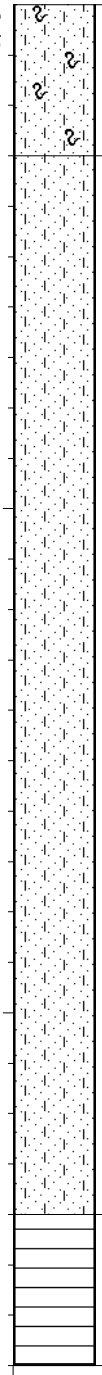
MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP34
Sheet 1 of 1

JOB NUMBER: MK/18/480

Scale 1:15



0.00 Slightly moist, greyish brown, loose, intact, silty SAND with abundant fine roots, **Colluvium**.

0.30 Slightly moist, orangey yellow, dense to very dense, intact, silty SAND: **Colluvium**.

2.40 Slightly moist to moist, grey stained black and dusky red, medium dense, moderately cemented: **ferruginised residual shale**.

2.70

NOTES

1) No water seepage observed.

2) No sample taken.

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81483
Y-COORD : 29.45134

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

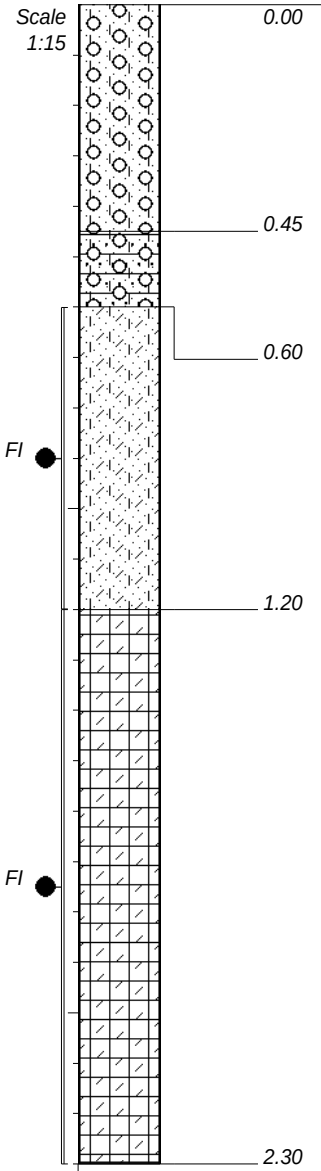
HOLE No: TP34

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

HOLE No: TP35
Sheet 1 of 1

JOB NUMBER: MK/18/480



0.00 — Slightly moist, dark greyish brown, loose to medium dense, silty SAND with scattered black ferruginised gravels: **Colluvium**.

0.45 — Abundant, coarse GRAVEL of sandstone in a matrix of slightly moist, brown, silty sand. Overall consistency is medium dense: **Colluvium**.

0.60 — Slightly moist, purple-red mottled black, dense, micro-shattered, clayey silty SAND: **Colluvium**.

1.20 — Slightly moist to moist, grey stained orange mottled black, stiff, micro-shattered, clayey SILT: **Residual Shale**.

2.30

NOTES

1) Slow progress due he stiffness of the residual shale.
2) No water seepage observed.
3) Disturbed sample taken for FI at 0.6--1.2m
4) Disturbed sample taken for FI at 1.2--2.3m

CONTRACTOR : Coastal Hire
MACHINE : JCB 3DX Super
DRILLED BY : Takalani and Mthuthuzeli
PROFILED BY : L Netshilindi & L Pfuluwani

INCLINATION :
DIAM : 0.6m
DATE : 15/11/2018 & 24/05/2019
DATE : 15/11/2018 & 24/05/2019

ELEVATION :
X-COORD : -25.81201
Y-COORD : 29.44596

TYPE SET BY : LN
SETUP FILE : STANDARD.SET

DATE : 03/06/2019 16:58
TEXT : ..AerorandSouthProject.txt

HOLE No: TP35

MUKONA
CONSULTING ENGINEERS
Tel: +27 11 443 8293 / 3536
Fax2emal: +27 86 571 2958
Email: info@mukonagroup.com

Steve Tshwete Local Municipality
Geotechnical Investigation
Aerorand South
Middelburg
Mpumalanga Province

LEGEND
Sheet 1 of 1

JOB NUMBER: MK/18/480

	BOULDERS	{SA01}
	GRAVELS/gravel	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	SANDSTONE	{SA11}
	SHALE	{SA12}
	HARDPAN FERRICRETE	{SA23}{SA29}
	HONEYCOMB FERRICRETE/ferricrete nodules	{SA24}
	WELL CEMENTED	{SA29}
Name ●	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
	COBBLES	{SA58}

CONTRACTOR : *INCLINATION :* *ELEVATION :*
MACHINE : *DIAM :* *X-COORD :*
DRILLED BY : *DATE :* *Y-COORD :*
PROFILED BY : *DATE :*

TYPE SET BY : LN *DATE : 03/06/2019 16:58*
SETUP FILE : STANDARD.SET *TEXT : ..AerorandSouthProject.txt*

LEGEND
SUMMARY OF SYMBOLS

APPENDIX D: SITE & TEST PIT PICTURES

Geotechnical Investigation

Site and Test Pit Photos

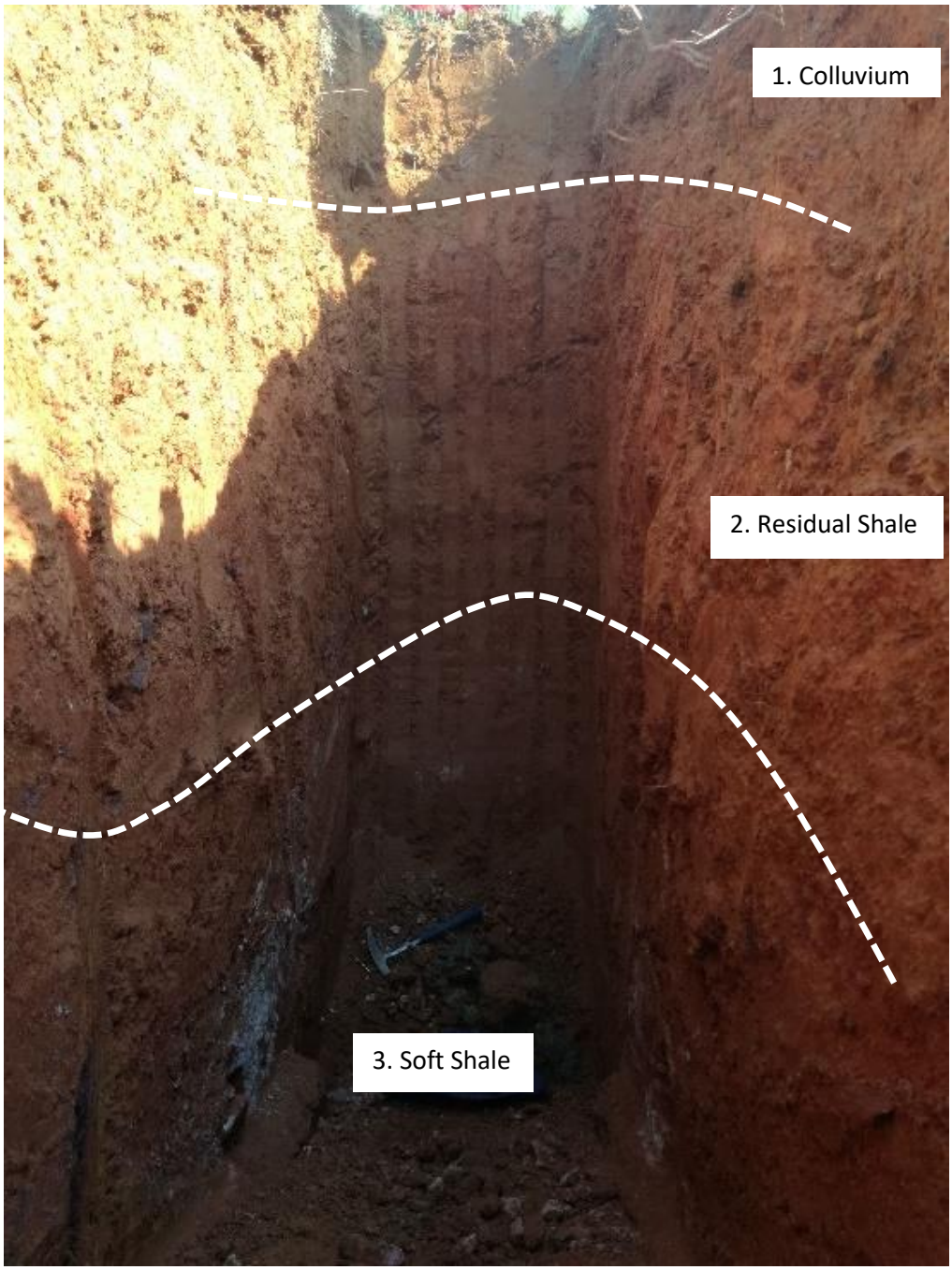


Figure 1 Typical Profile depicting residual shale at TP02

Figure 2. Soft Shale at the bottom of TP02

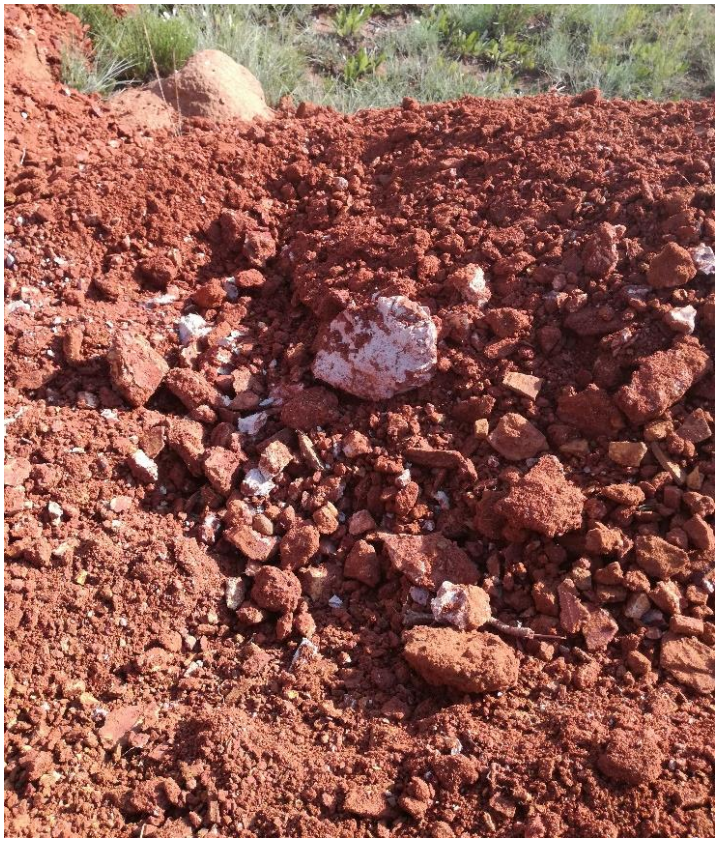


Figure 3 Typical Shale spoil at TP02

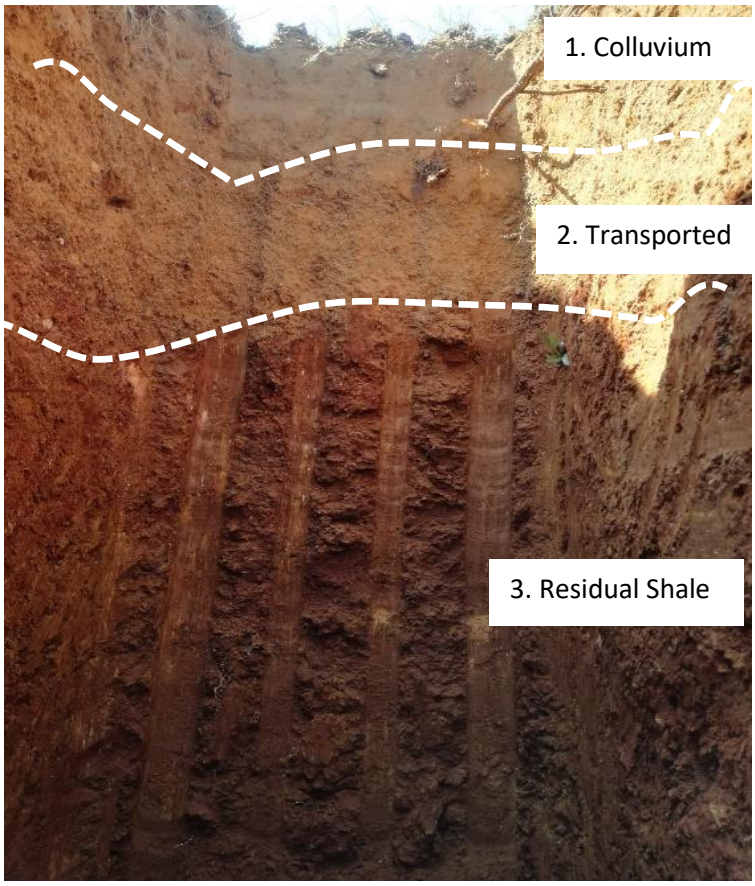


Figure 4 Typical Profile depicting residual shale at TP04

Figure 5 Typical shale fragments encountered at TP02 and TP04

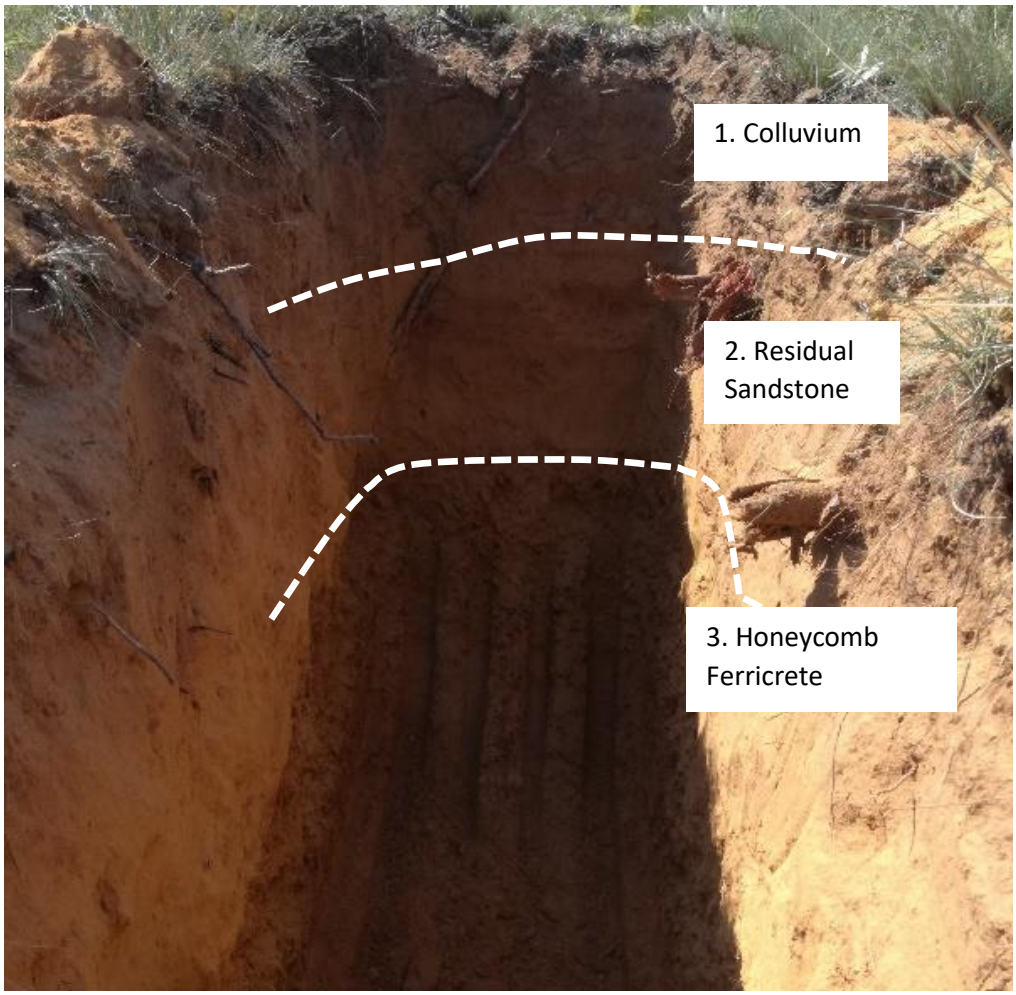


Figure 6 Typical Profile depicting Ferricrete at TP05

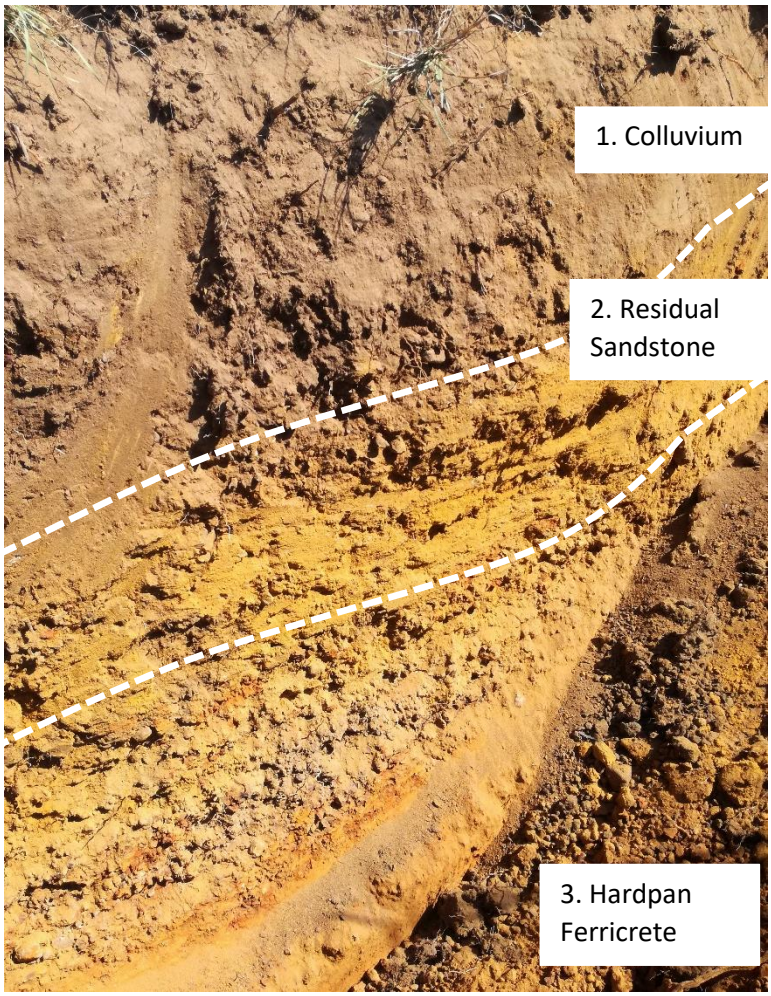


Figure 7 Typical Profile depicting Ferricrete at TP18

Figure 8 Typical Ferricrete spoil at TP18

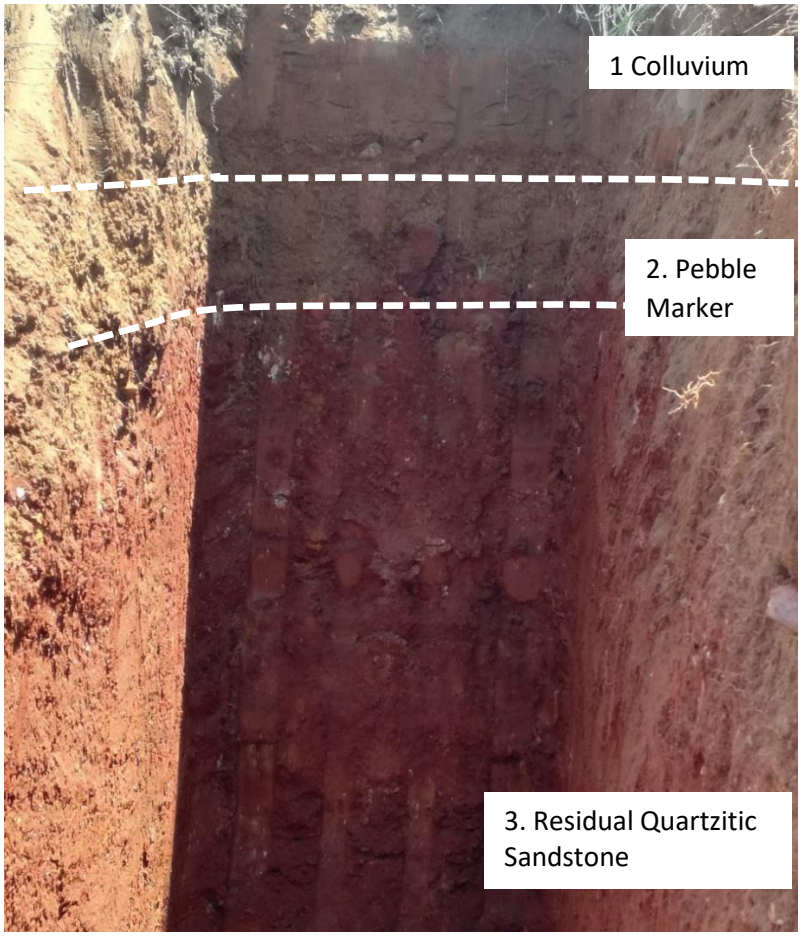


Figure 9 Typical profile depicting Residual quartzitic Sandstone at TP 14

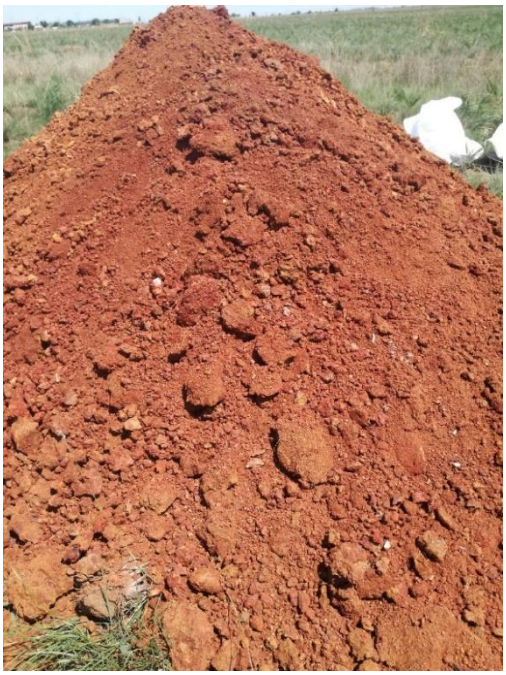


Figure 10 Typical Residual Quartzitic Sandstone spoil at TP14

Figure 11 Typical Residual Quartzitic Sandstone spoil at TP14

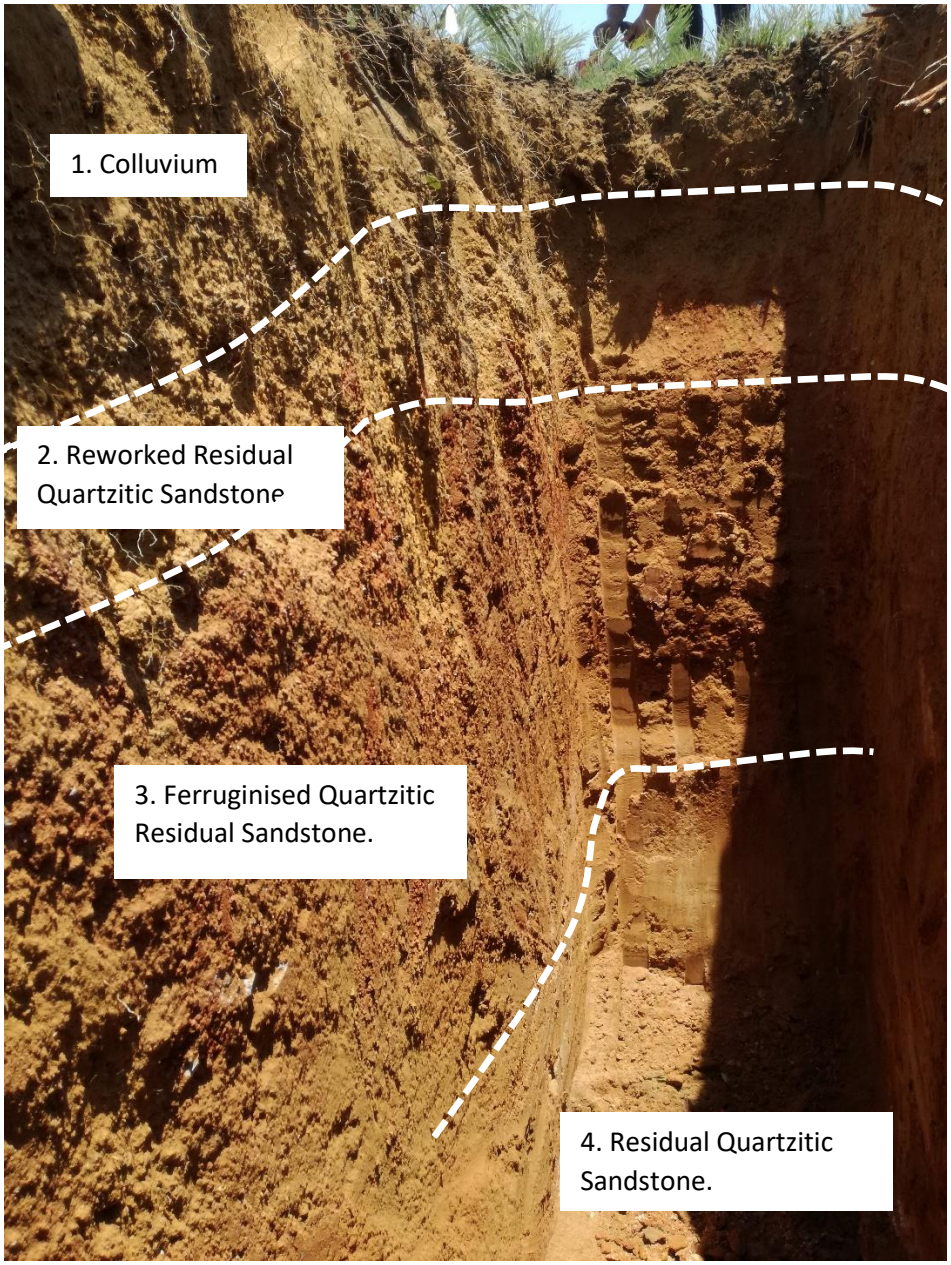


Figure 12 Typical Profile depicting Quartzitic Sandstone at TP16

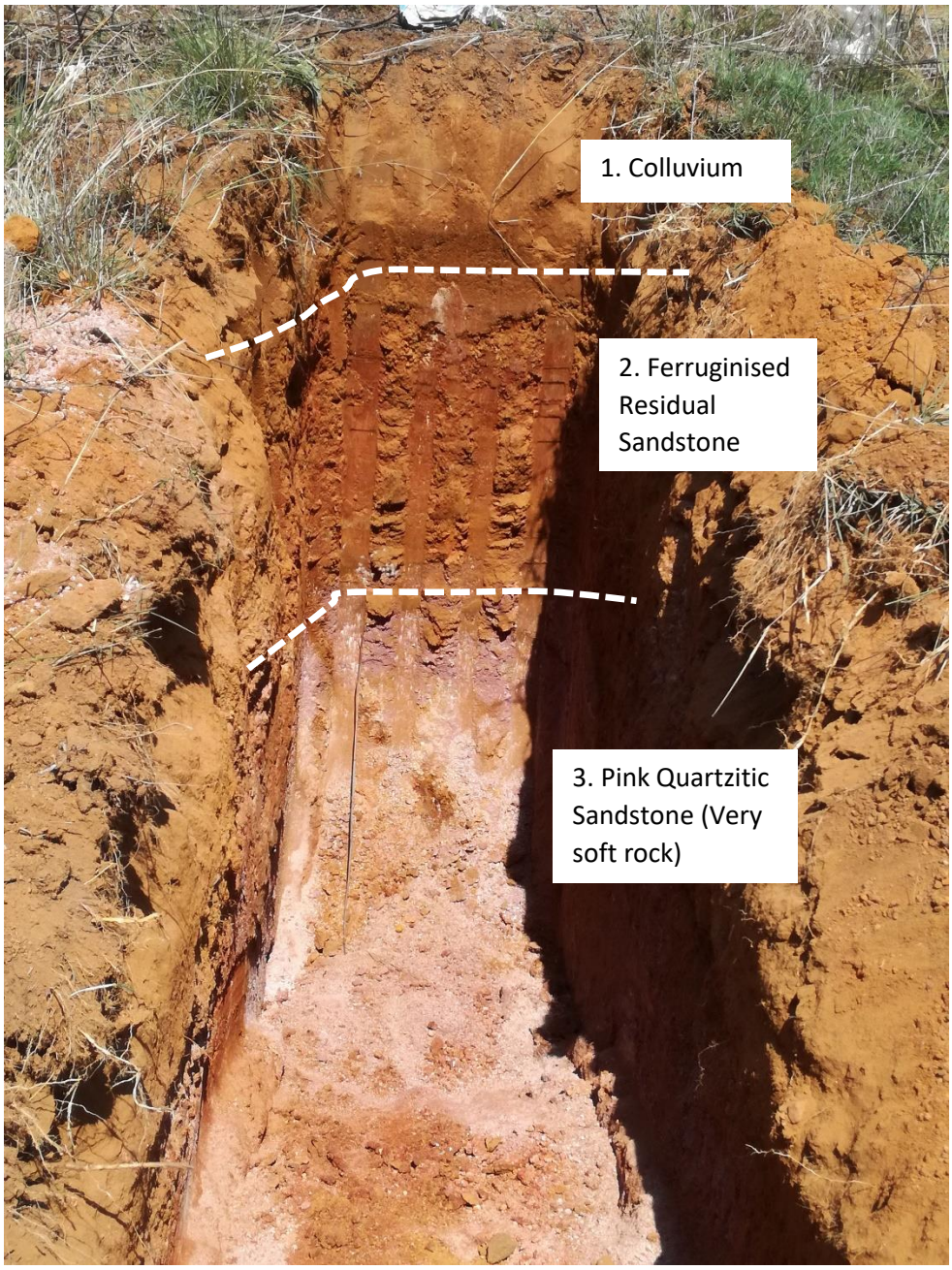


Figure 13 Typical Profile depicting Residual Quartzitic Sandstone at TP20

Figure 14 Typical Residual Quartzitic Sandstone fragments at TP20

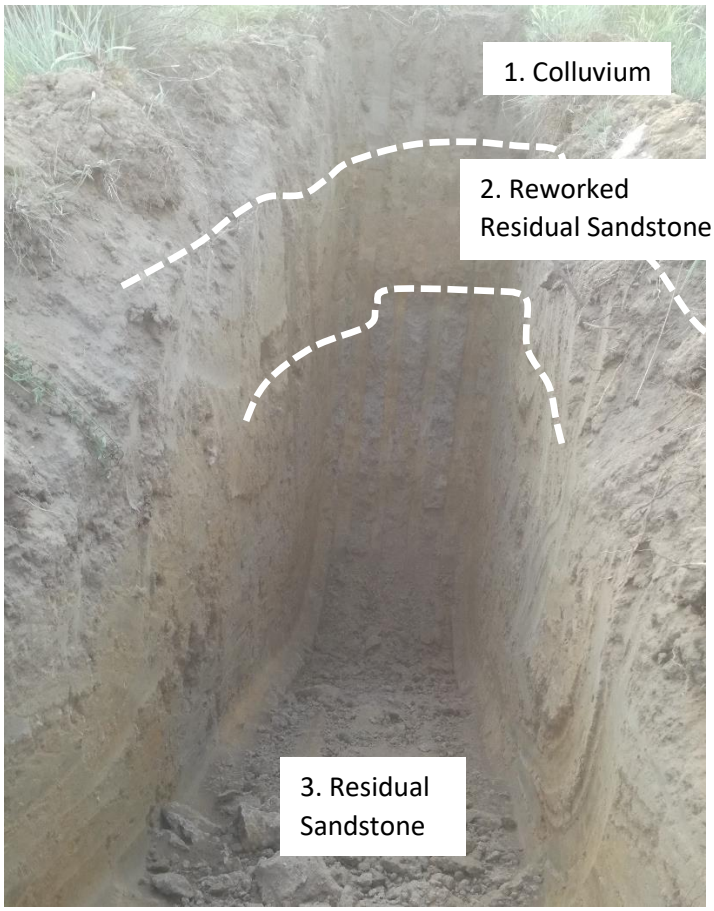


Figure 15 Typical Profile depicting Sandstone at TP11

Figure 16 Typical Residual Sandstone spoil at TP11

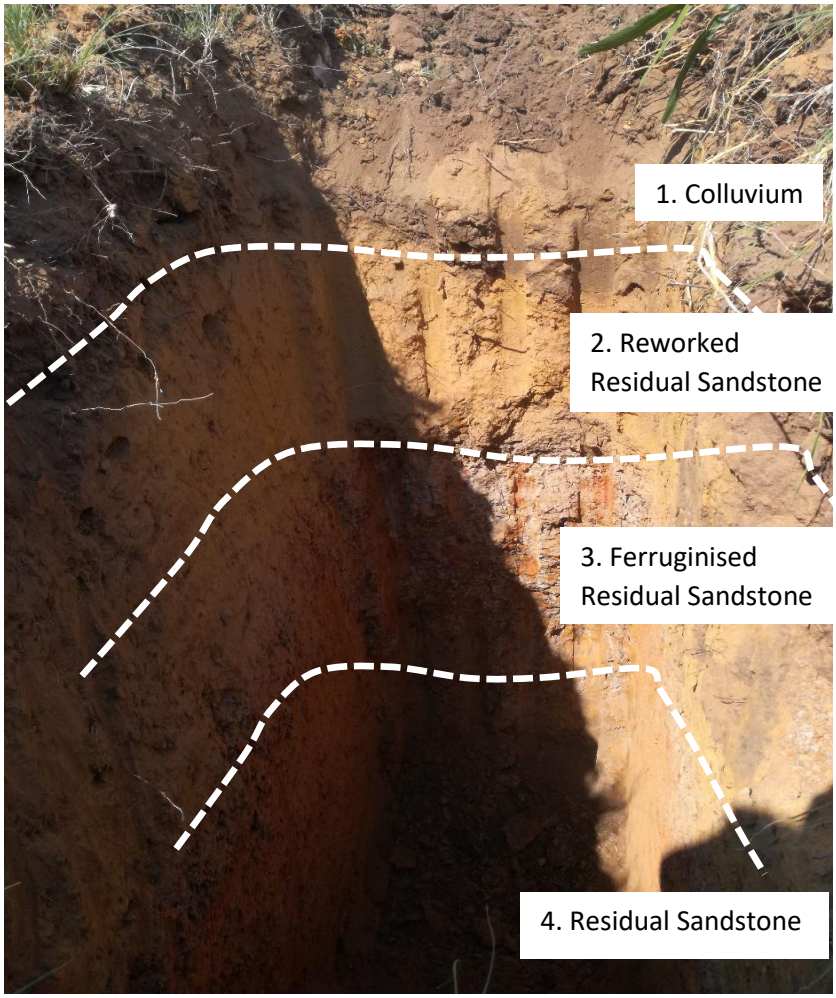


Figure 17 Typical Profile depicting Residual Sandstone at TP15

Figure 18 Typical Residual Sandstone at the bottom of TP15

Figure 19 Man-made trench (drainage channel) encountered close to TP15

Figure 20 DPL Test being conducted adjacent to TP02

Figure 21: Grey alluvial material underlain by hardpan ferricrete encountered in TP29

Figure 22: Yellow very dense to very soft rock shale encountered in TP28

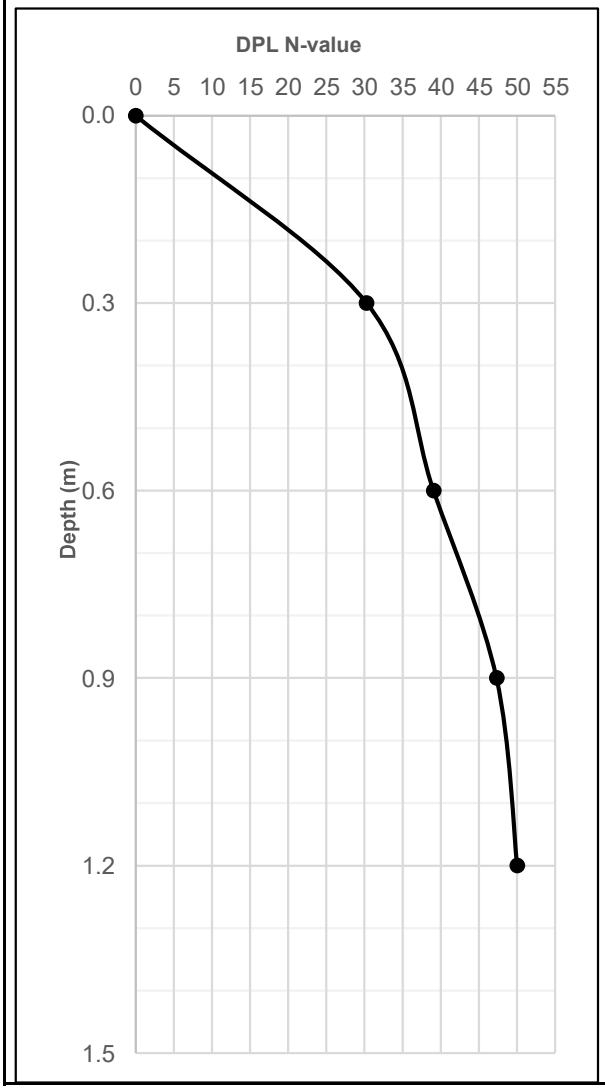
Figure 23: Orangey red transported material encountered in TP27, TP31, TP32 and TP34

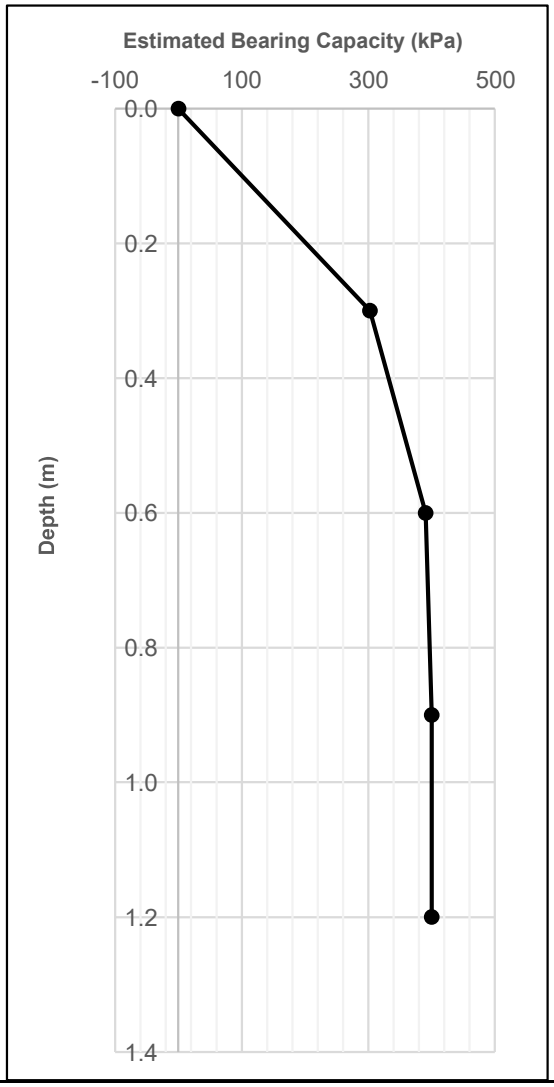
APPENDIX E: DPL TEST RESULTS

PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL02
DPL LOCATION:	Adjacent to TP02
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	55	30	dense	303
0.6	71	39	dense	391
0.9	86	47	dense	>400
1.2	Refusal	Refusal	very dense	>400

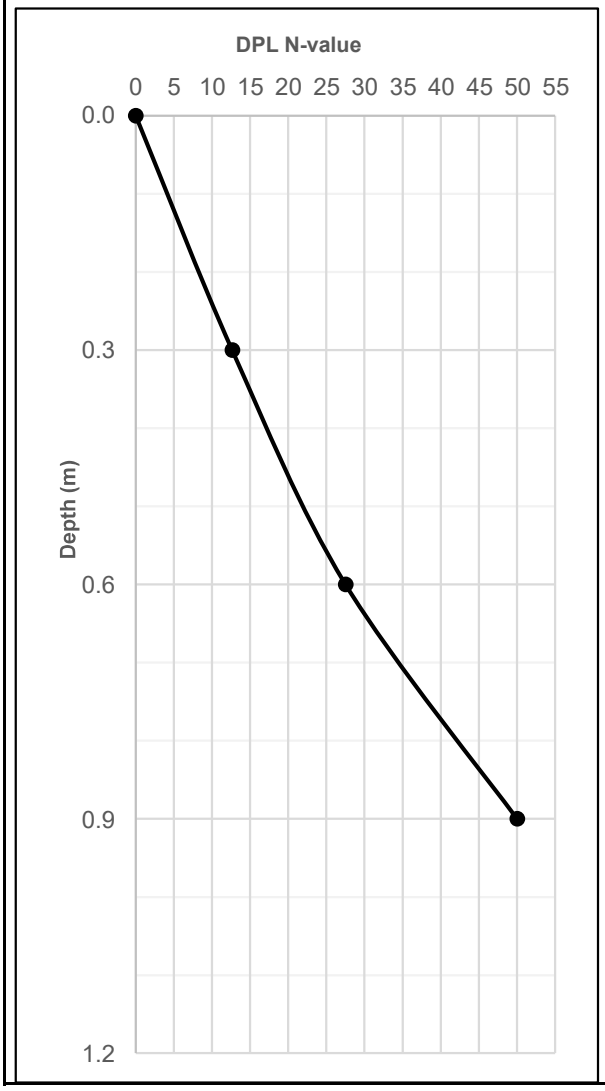


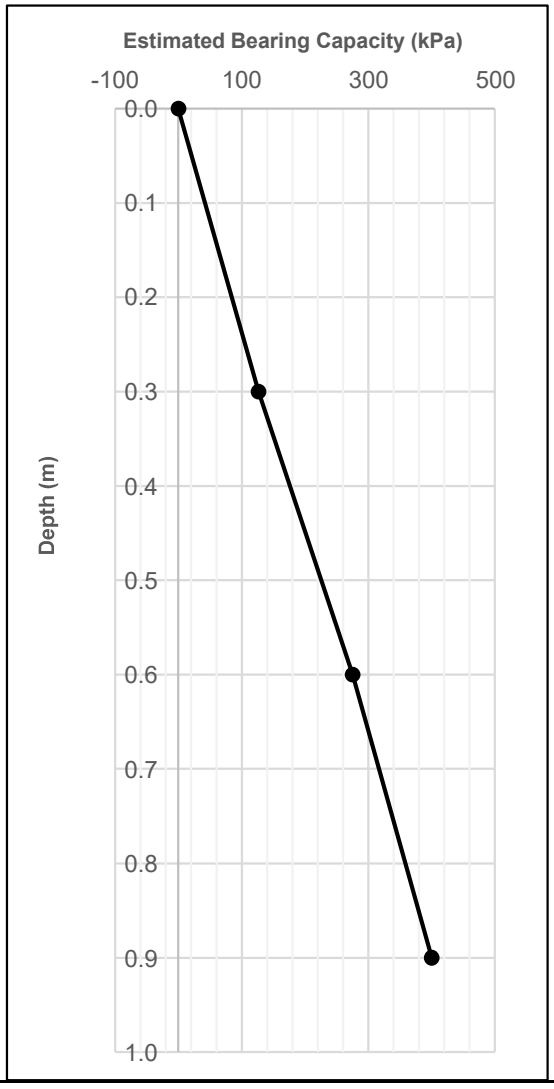


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL04
DPL LOCATION:	Adjacent to TP04
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	23	13	medium dense	127
0.6	50	28	medium dense	275
0.9	Refusal	Refusal	very dense	>400

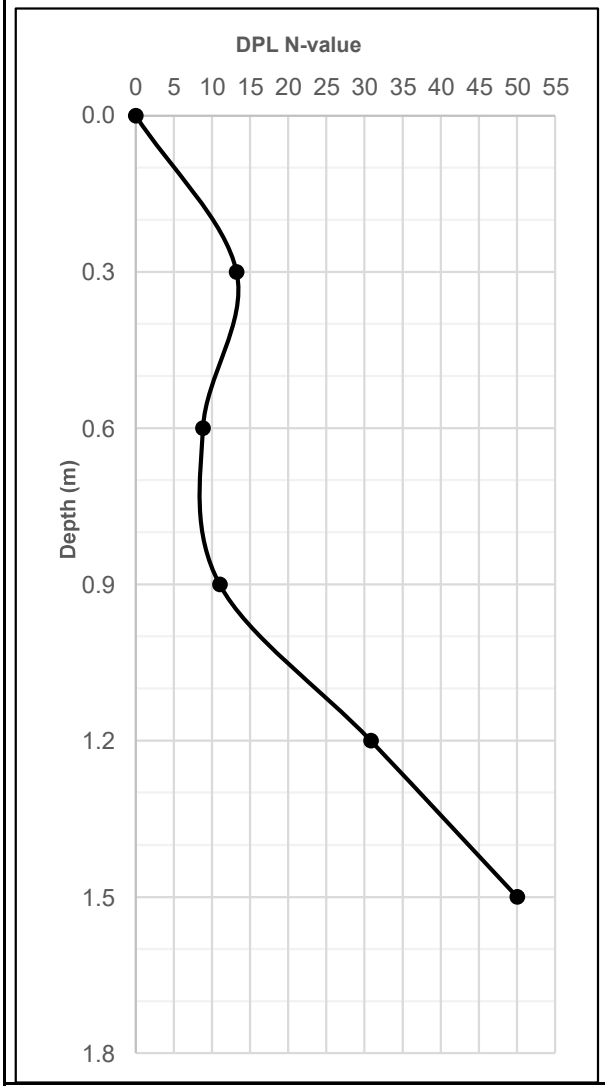


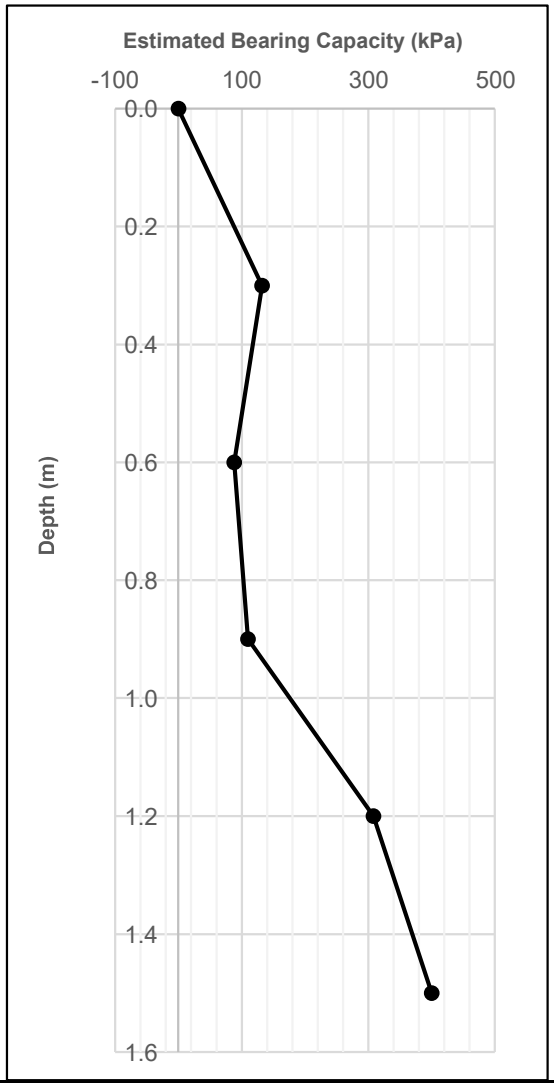


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL05
DPL LOCATION:	Adjacent to TP05
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	24	13	firm	132
0.6	16	9	loose	88
0.9	20	11	medium dense	110
1.2	56	31	dense	308
1.5	Refusal	Refusal	very dense	>400

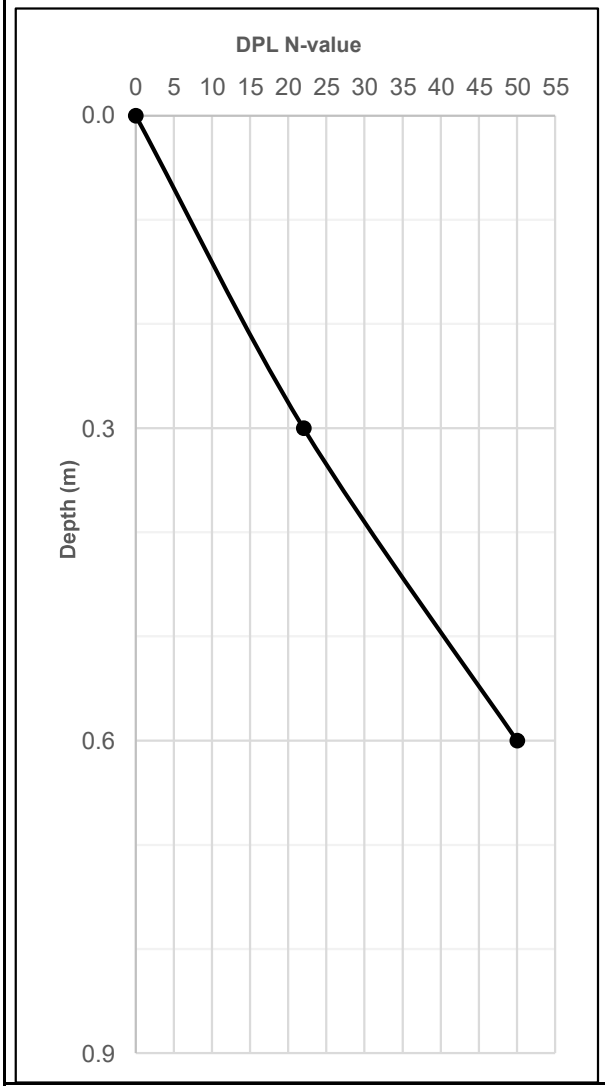


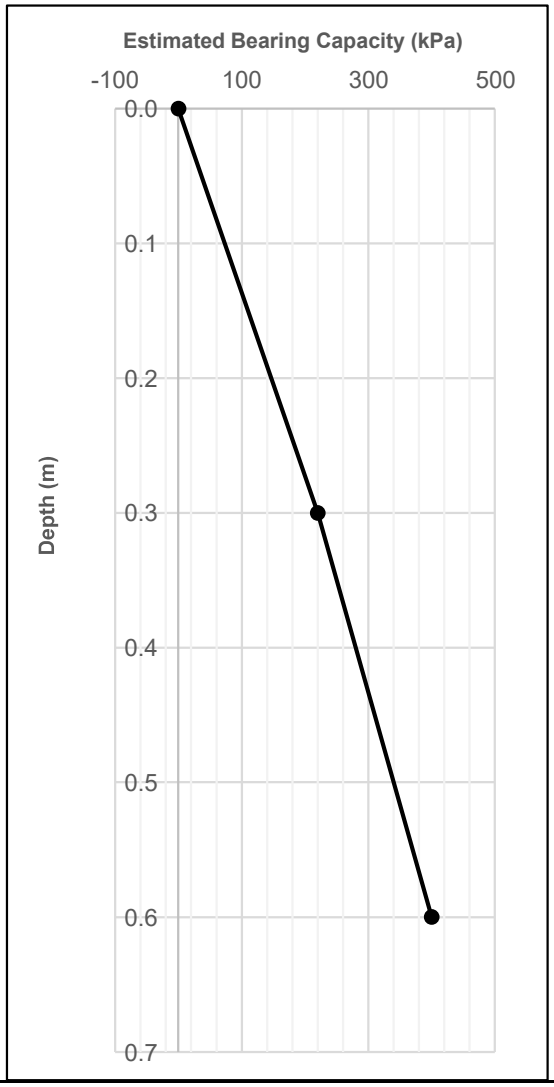


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL06
DPL LOCATION:	Adjacent to TP06
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	40	22	firm	220
0.6	Refusal	Refusal	very dense	>400

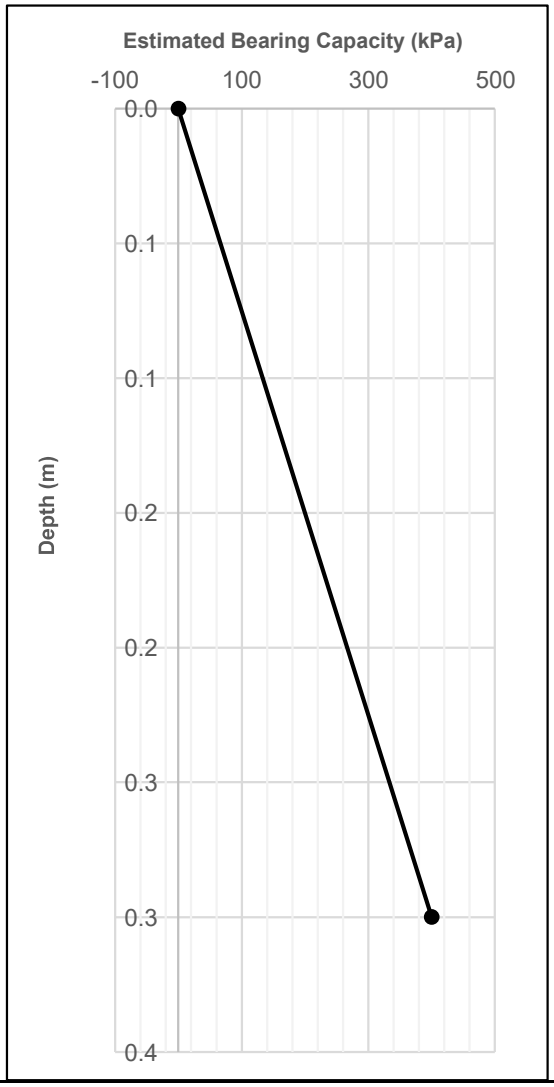




PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL08
DPL LOCATION:	Adjacent to TP08
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

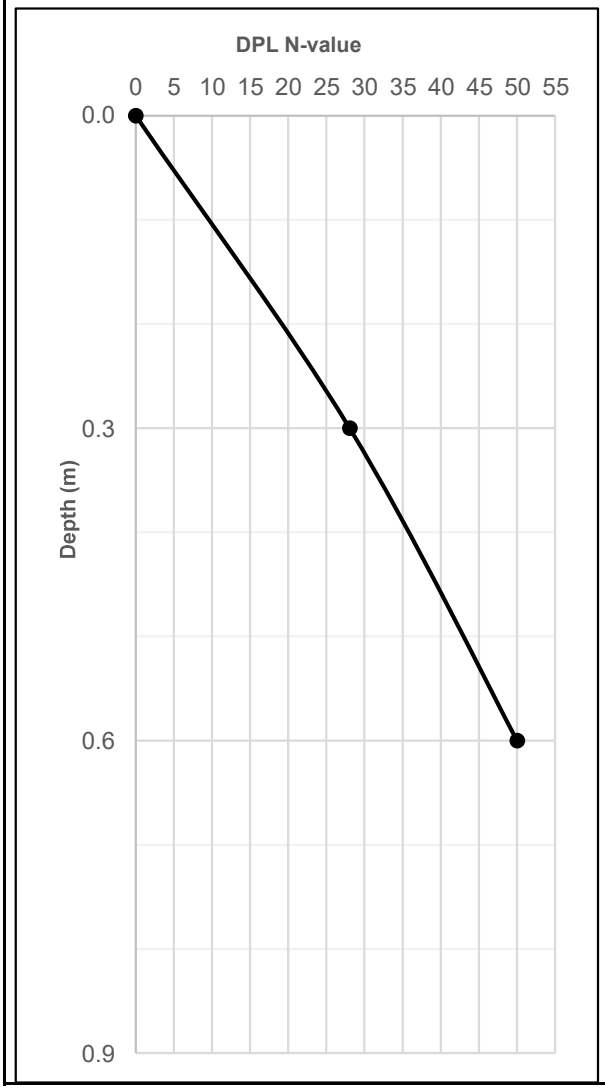
DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	Refusal	Refusal	very stiff	>400

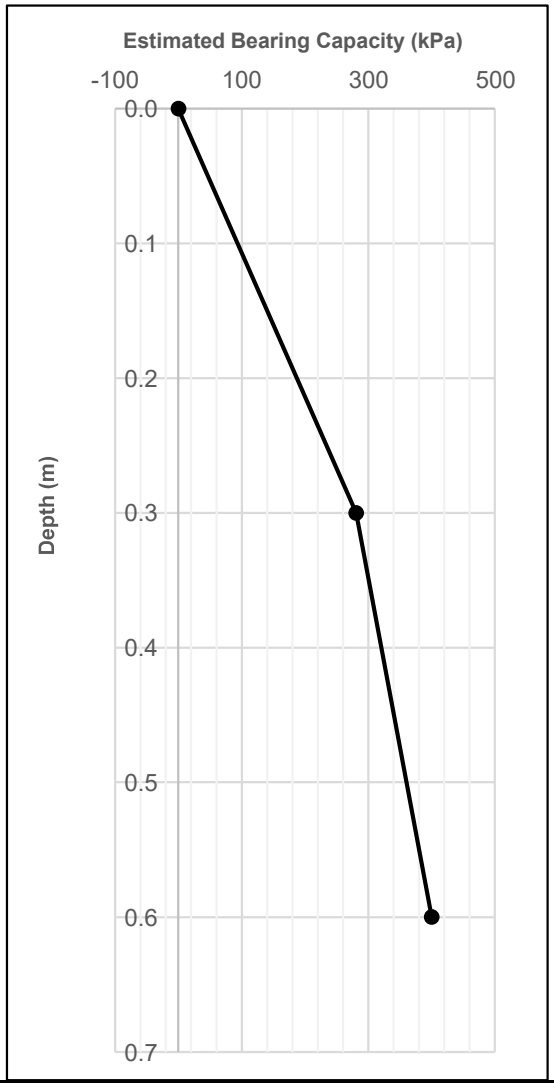


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL11
DPL LOCATION:	Adjacent to TP11
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	51	28	medium dense	281
0.6	Refusal	Refusal	very dense	>400

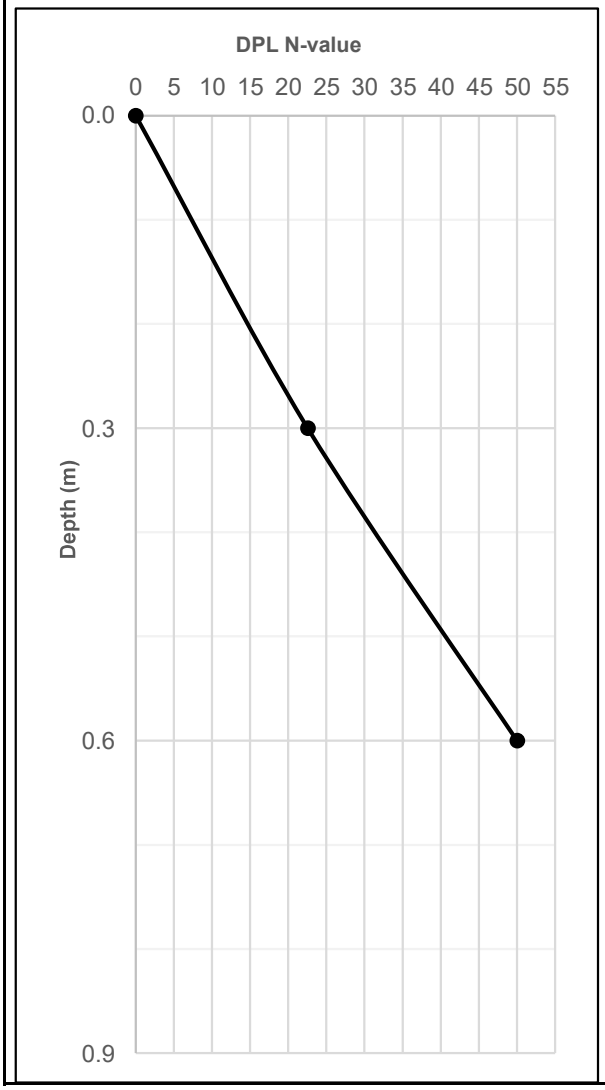


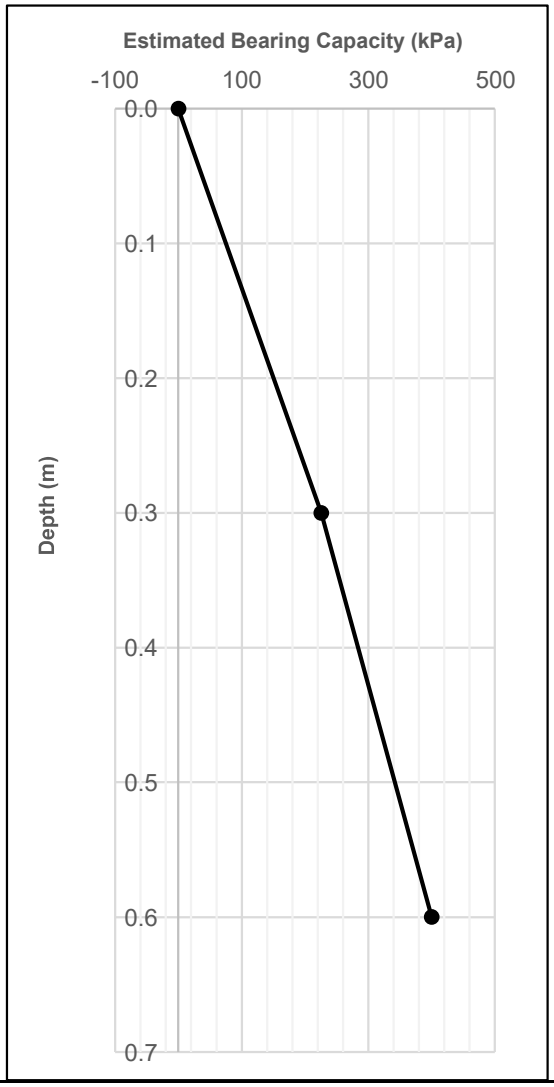


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL14
DPL LOCATION:	Adjacent to TP14
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	41	23	firm	226
0.6	refusal	Refusal	very stiff	>400

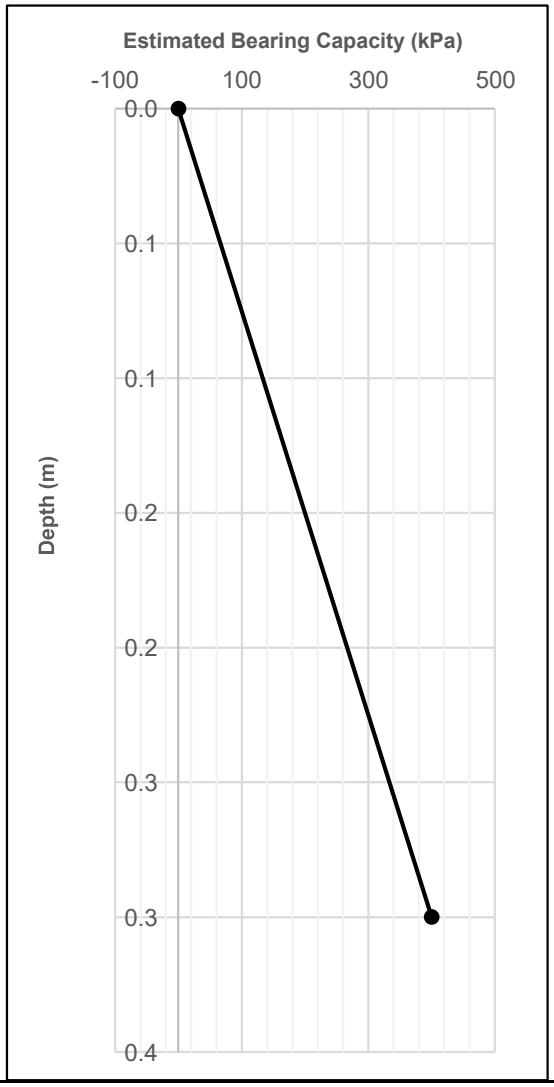




PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL15
DPL LOCATION:	Adjacent to TP15
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

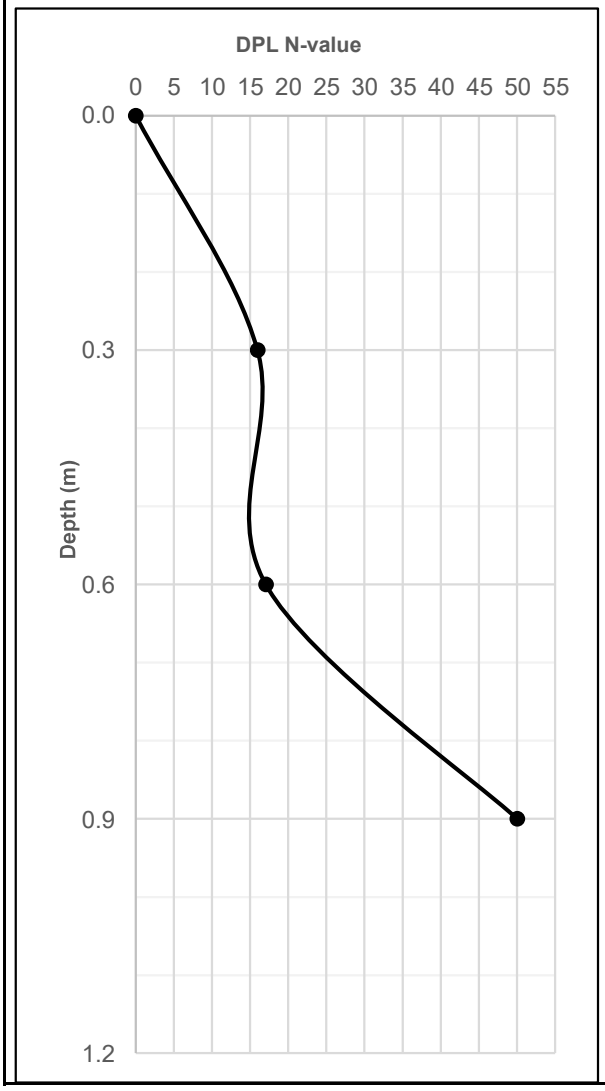
DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	Refusal	Refusal	very dense	>400

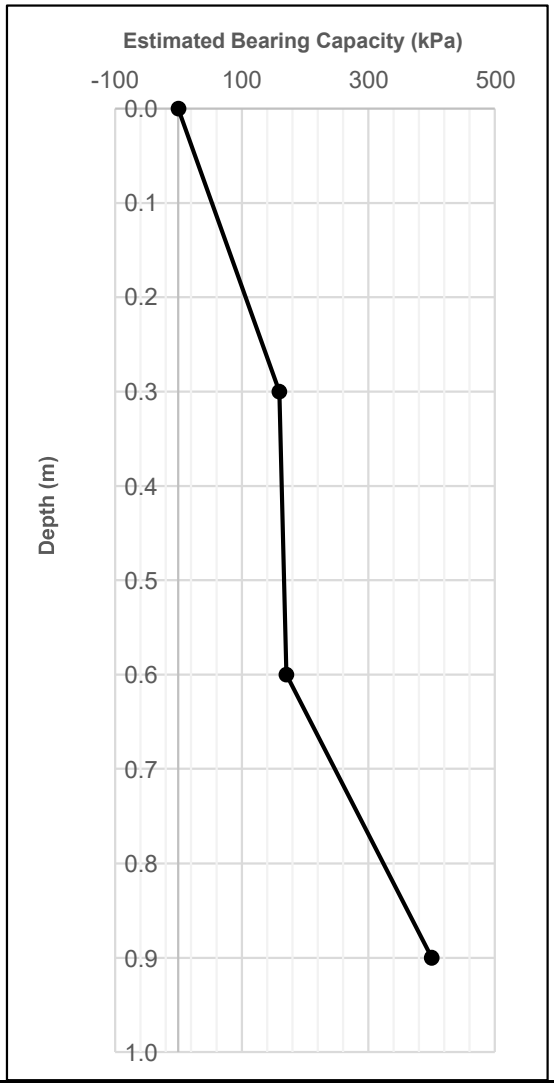


PROJECT:	Aerorand Township Development
LOCATION:	Middelburg Mpumalanga
DATE:	16/11/2018
CONTRACTOR:	Mukona Consulting Engineers
DPL No:	DPL20
DPL LOCATION:	Adjacent to TP20
COMPLETED BY:	L Netshilindi

MUKONA
CONSULTING ENGINEERS

DEPTH (m)	DPL N-Value	EQU. SPT N-Value	CONSISTENCY DESCRIPTION	ESTIMATED BEARING CAPACITY (kPa)
0.0	-			
0.3	29	16	firm	160
0.6	31	17	firm	171
0.9	Refusal	Refusal	very stiff	>400





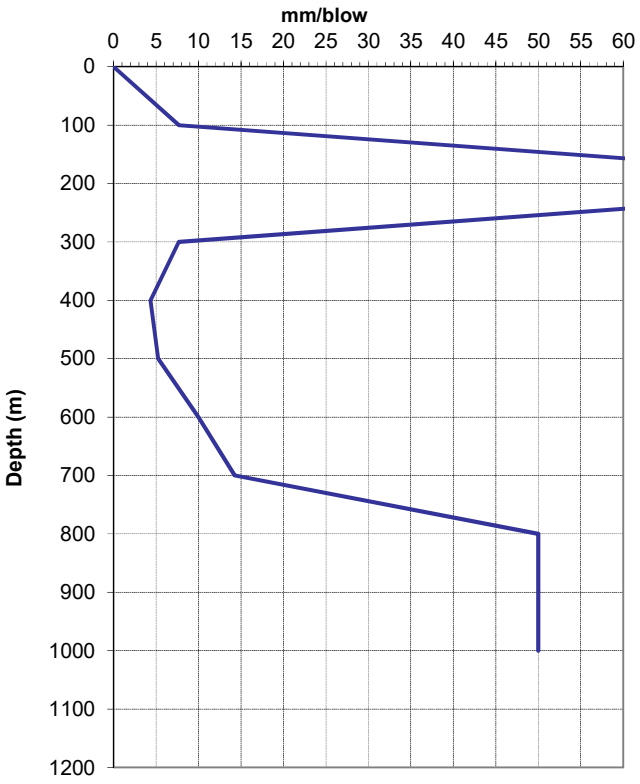
APPENDIX F: DCP FIELD TEST

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP23

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	13	8	Dense
200	1	100	V.Loose
300	13	8	Dense
400	23	4	V.Dense
500	19	5	Dense
600	10	10	Dense
700	7	14	Med.Dense
800	2	50	Loose
900	2	50	Loose
1000	2	50	Loose



THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

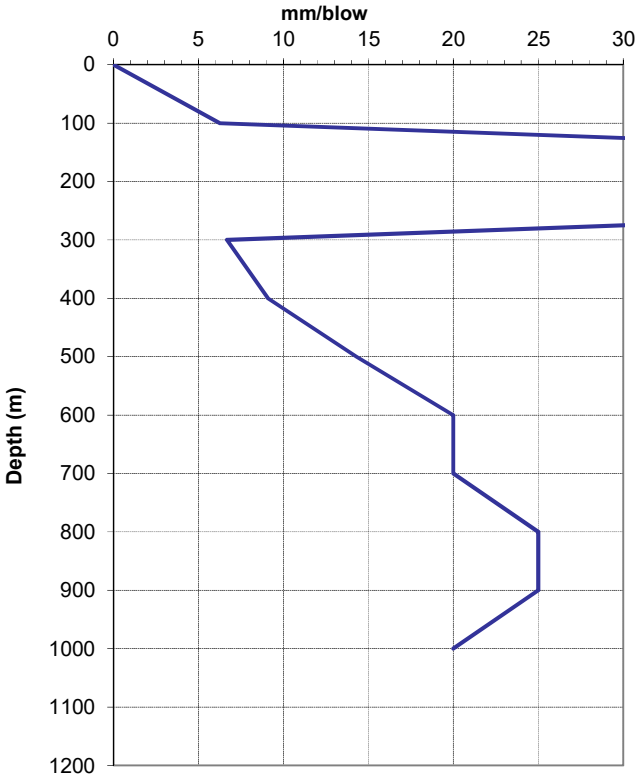
1 Started from the surface

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP27

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	16	6	Dense
200	1	100	V.Loose
300	15	7	Dense
400	11	9	Dense
500	7	14	Med.Dense
600	5	20	Med.Dense
700	5	20	Med.Dense
800	4	25	Med.Dense
900	4	25	Med.Dense
1000	5	20	Med.Dense



THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

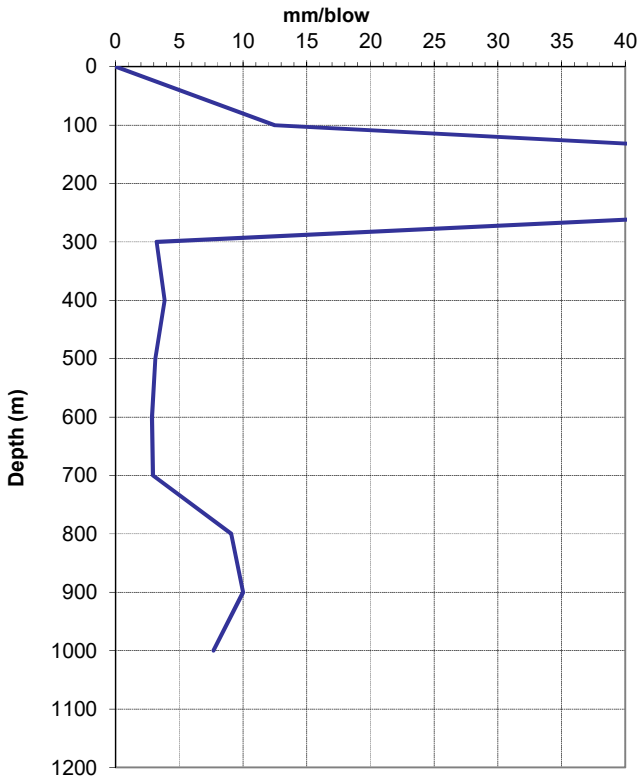
1 Started from the surface

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP28

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	8	13	Med.Dense
200	1	100	V.Loose
300	31	3	V.Dense
400	26	4	V.Dense
500	32	3	V.Dense
600	35	3	V.Dense
700	34	3	V.Dense
800	11	9	Dense
900	10	10	Dense
1000	13	8	Dense



THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

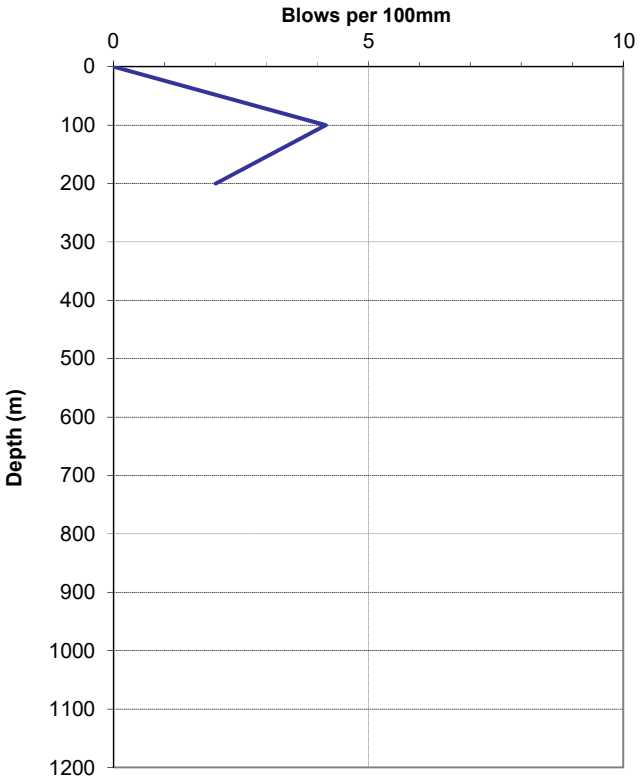
1 Started from the surface

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP29

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	24	4	V.Dense
200	50	2	V.Dense
300			
400			
500			
600			
700			
800			
900			
1000			



THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

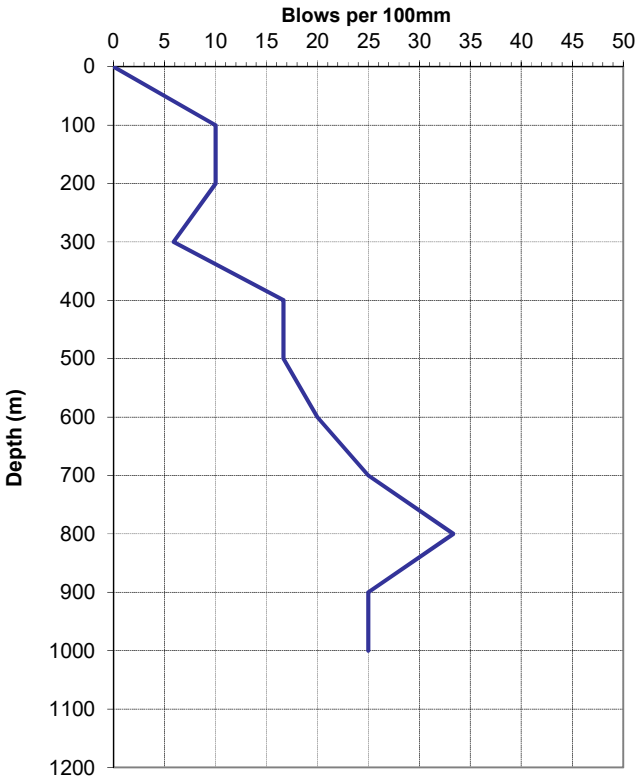
1 Started from the surface

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP32

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	10	10	Dense
200	10	10	Dense
300	17	6	Dense
400	6	17	Med.Dense
500	6	17	Med.Dense
600	5	20	Med.Dense
700	4	25	Med.Dense
800	3	33	Loose
900	4	25	Med.Dense
1000	4	25	Med.Dense



THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

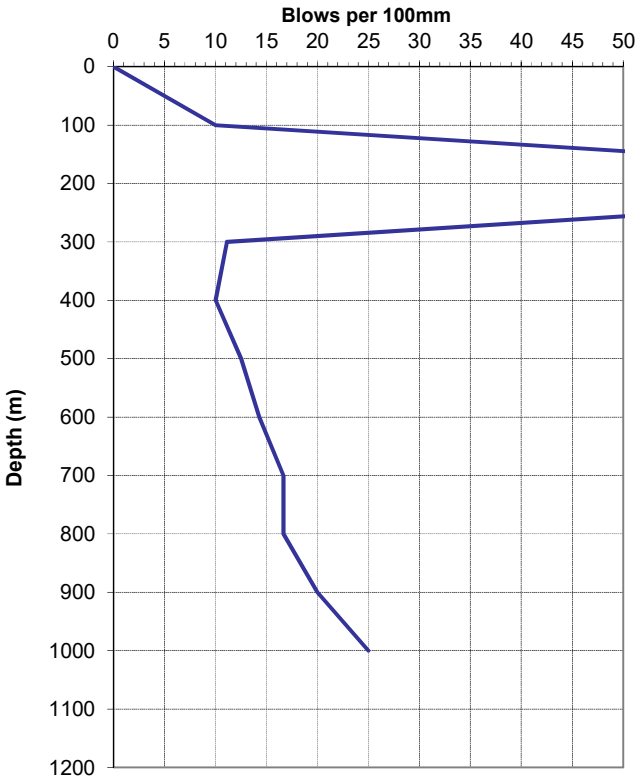
1 Started from the surface

Client	Steve Tshwete Local Municipality
Location	Aerorand South
Date tested	24/05/2019
Job Ref No.	MK/18/480
Contract No.	
Operator	Lutendo Pfuluwani
Final Depth	1000mm
Test No.	DCP34

MUKONA
CONSULTING ENGINEERS

DCP PENETROMETER REPORT

Depth (mm)	blows/ 100mm	mm/blow	Inferred Consistency
0	0	0	
100	10	10	Dense
200	1	100	V.Loose
300	9	11	Dense
400	10	10	Dense
500	8	13	Med.Dense
600	7	14	Med.Dense
700	6	17	Med.Dense
800	6	17	Med.Dense
900	5	20	Med.Dense
1000	4	25	Med.Dense

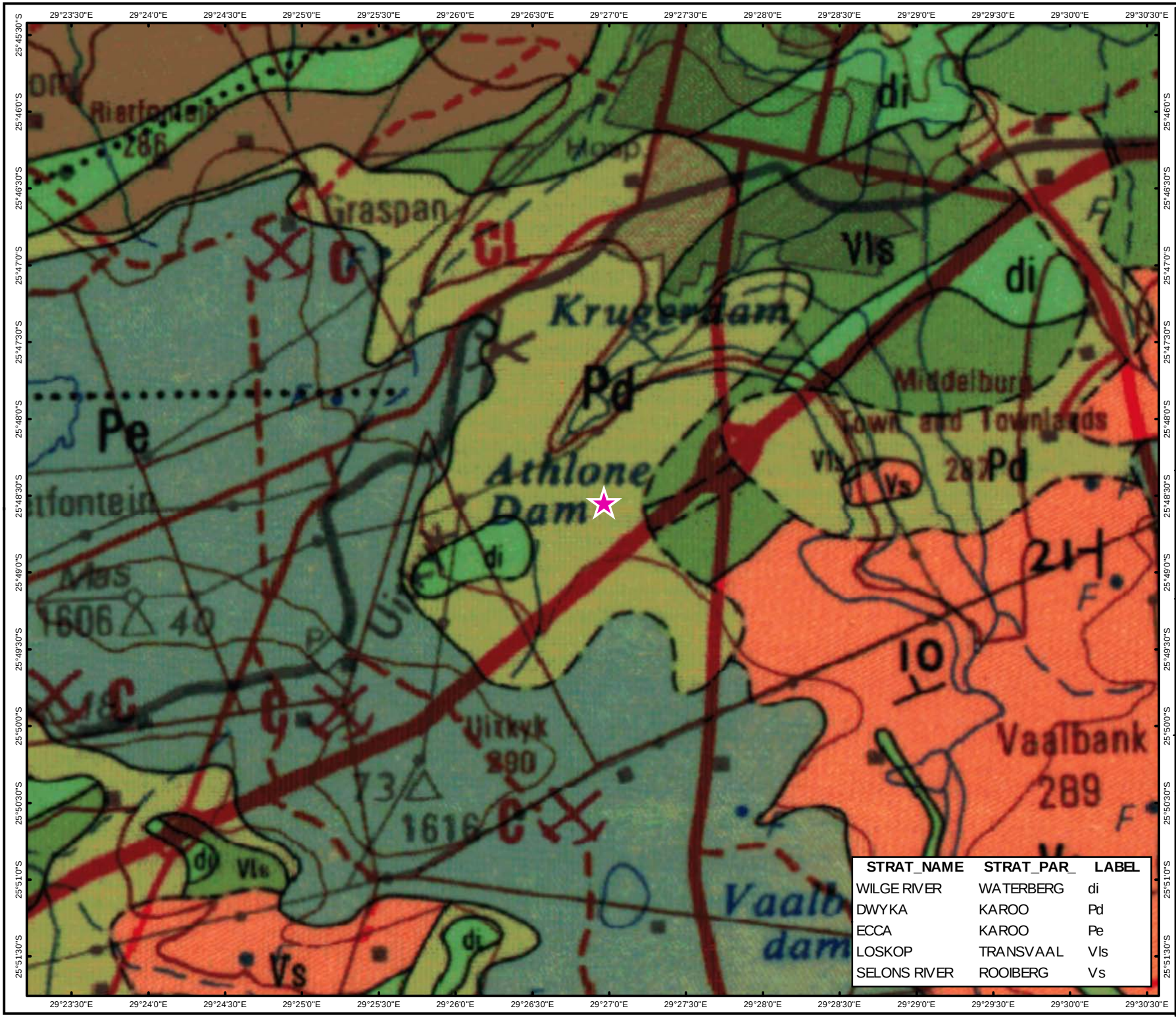


THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Remarks

1 Started from the surface

APPENDIX G: GEOLOGICAL MAP



Legend

★ Site Location

Lithology

- di- Diabase (from Vaalian to Mongolian)
- Pd- Tillite, shale
- Pe- Shale, shly sandstone, grit, sandstone, conglomerate, coal in places near base and top.
- Vls- shale, sandstone, conglomerate, volcanic rocks.
- Vs- Porphyritic Amygdaloidal red Rhyolite, subordinated andesite, black rhyolite, tuff, rhyolite, agglomerate, quartzite

CLIENT

STEVE TSHWETE LOCAL MUNICIPALITY

PROJECT

AERORAND SOUTH TOWNSHIP
STEVE TSHWETE MUNICIPALITY

TITLE

Geology Map of Aerorand South
Extract of geological map series; 2528 PRETORIA

DRAWN: A. Qoboka	DRAWING
DATE: 2018/11/08	MK- 18- 480- Geol- 033

0 0,5 1 2
Kilometers

SCALE: 1:60 000

N

Projection: Geographic, Datum: WGS84
Source: Chief Directorate National Geo-Spatial Information
Inset: ESRI Data and Maps

MUKONA CONSULTING ENGINEERS
Mukona Consulting Engineers (Pty) Ltd
International Business Gateway, New Road,
Midridge Office Estate (North),Midrand, 1685
Telephone:0114438293
Mobile:0837850284
Email: Sollyp@mknconsulting.co.za

APPENDIX H: LABORATORY RESULTS

- APPENDIX H1: FOUNDATION INDICATOR
- APPENDIX H2: MOISTURE / DENSITY & CBR
- APPENDIX H3: CHEMICAL (pH and Conductivity))

APPENDIX H1: FOUNDATION INDICATOR TEST RESULTS

SOILLAB (PTY) LTD
Registration Number 1971/000112/07
Part of the SMEC Group

sanas T-0284

Engineering Materials Laboratory
SMEC Building, 230 Albertus Street
La Montagne, Pretoria, 0184
Tel: (+27) (12) 813 4900
Email: info@soillab.co.za
PO Box 72928, Lynnwood Ridge,
South Africa, 0040

Client:	MUKONA CONSULTING ENGINEERS (PTY) LTD
Project:	AERORAND SOUTH GEOTECH - MK-18-480
Project No.:	S18-2207
Date:	2018/12/10

MOISTURE CONTENT - SANS 3001-GR20

Sample No.:	Description:	Moisture Content (%)
S18-2207-01	0.45 - 1.7	9.5
S18-2207-02	0.9 - 2.5	10.1
S18-2207-03	0.5 - 2.5	3.3
S18-2207-05	0.7 - 2.5	7.2
S18-2207-08	1.6 - 2.1	13.1
S18-2207-09	0.39 - 1.3	2.7
S18-2207-10	1.3 - 2.5	8.0
S18-2207-12	0.4 - 0.7	3.5
S18-2207-13	0.7 - 0.9	3.7

Note: Items marked with a star (*) is Not Accredited

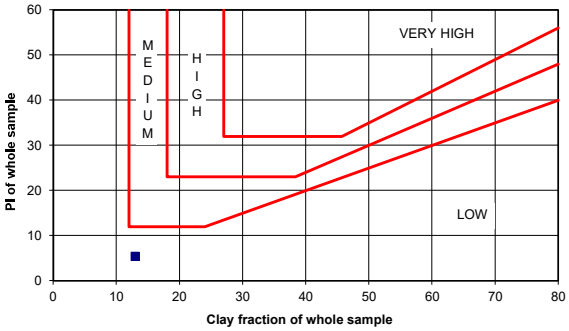
Soillab is a SANAS accredited Testing Laboratory according to the Accreditation Scope

PARTICLE SIZE ANALYSIS

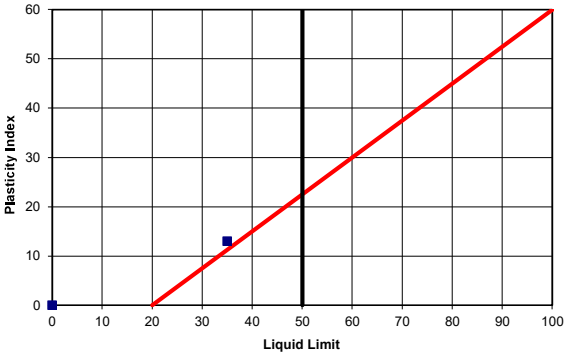
Sample No.	1
Soillab Sample No.	S18-2207-01
Depth (m)	0.45 - 1.7
Position	TP 01
Material Description	DARK YELLOWISH ORANGE SHALE & FERRICRETE SANDY GRAVEL
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	99
20.0 mm	99
14.0 mm	97
5.0 mm	70
2.00 mm	51
0.425 mm	41
0.075 mm	33
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
54 µm	23
32 µm	19
13 µm	16
6 µm	13
2 µm	11
% Clay	13
% Silt	10
% Sand	28
% Gravel	49
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	35
Plasticity Index	13
Linear Shrinkage (%)	6.5
Grading Modulus	1.74
Classification	A-2-6 (1)
Unified Classification	SC
Chart Reference	

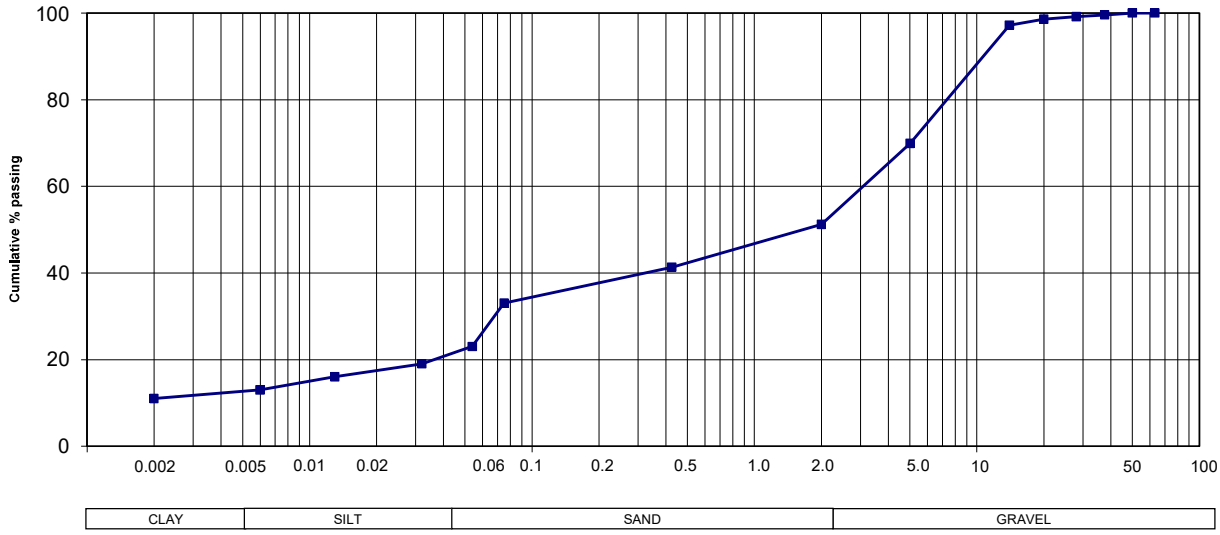
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





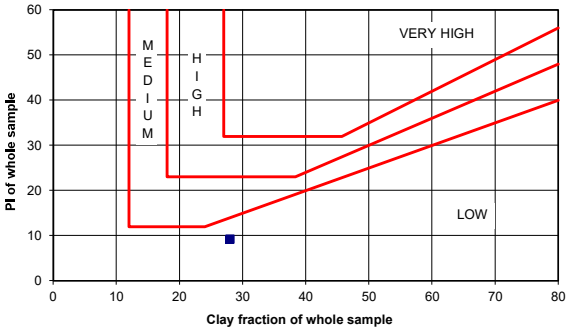
SOILLAB Part of the SMEC Group
Soillab is a SANAS accredited Testing Laboratory.
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

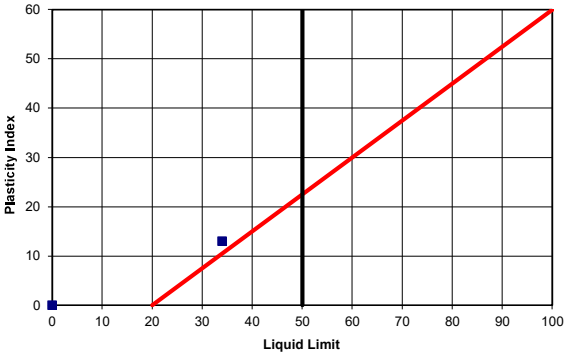
Sample No.	2
Soillab Sample No.	S18-2207-02
Depth (m)	0.9 - 2.5
Position	TP 02
Material Description	PALE RED SHALE & FERRICRETE CLAYEY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	95
2.00 mm	84
0.425 mm	71
0.075 mm	51
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
52 µm	46
30 µm	43
13 µm	34
6 µm	28
2 µm	24
% Clay	28
% Silt	18
% Sand	38
% Gravel	16
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	34
Plasticity Index	13
Linear Shrinkage (%)	6.5
Grading Modulus	0.94
Classification	A-6 (4)
Unified Classification	CL
Chart Reference	

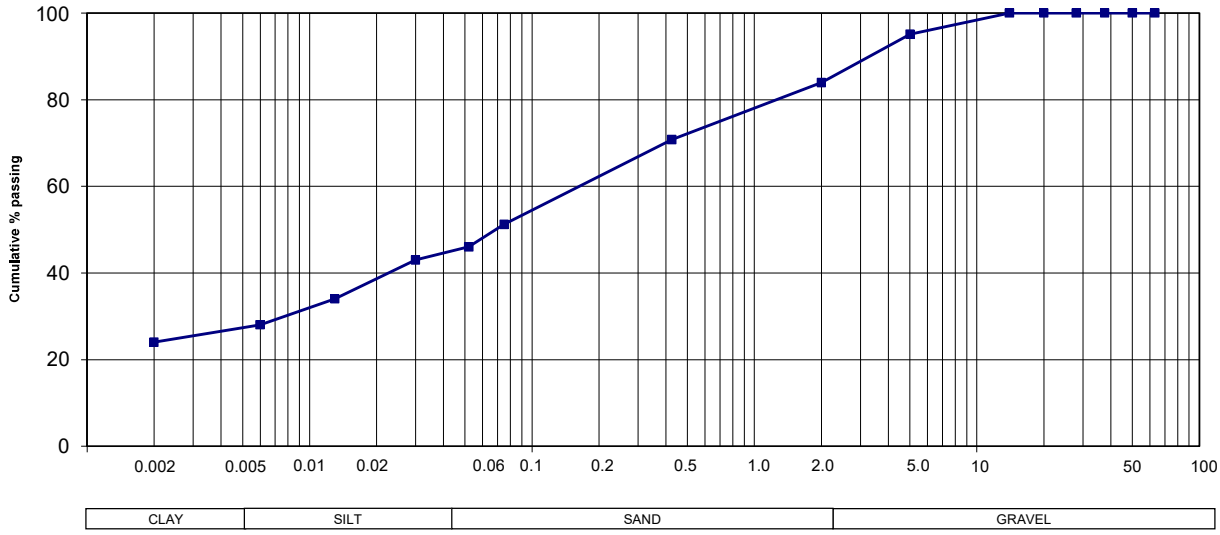
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





SOILLAB Part of the SMEC Group
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

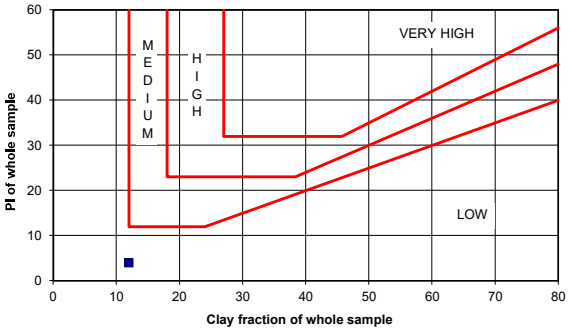
Soillab is a SANAS accredited Testing Laboratory.

PARTICLE SIZE ANALYSIS

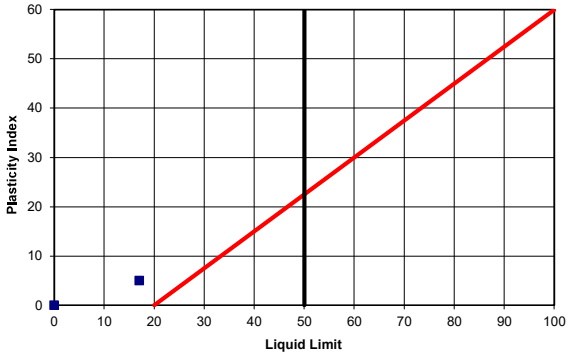
Sample No.	3
Soillab Sample No.	S18-2207-03
Depth (m)	0.5 - 2.5
Position	TP 11
Material Description	DARK YELLOWISH ORANGE SILTY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	96
2.00 mm	92
0.425 mm	80
0.075 mm	35
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	25
34 µm	22
14 µm	14
6 µm	12
2 µm	11
% Clay	12
% Silt	13
% Sand	67
% Gravel	8
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	17
Plasticity Index	5
Linear Shrinkage (%)	1.5
Grading Modulus	0.93
Classification	A-2-4 (0)
Unified Classification	SM & SC
Chart Reference	

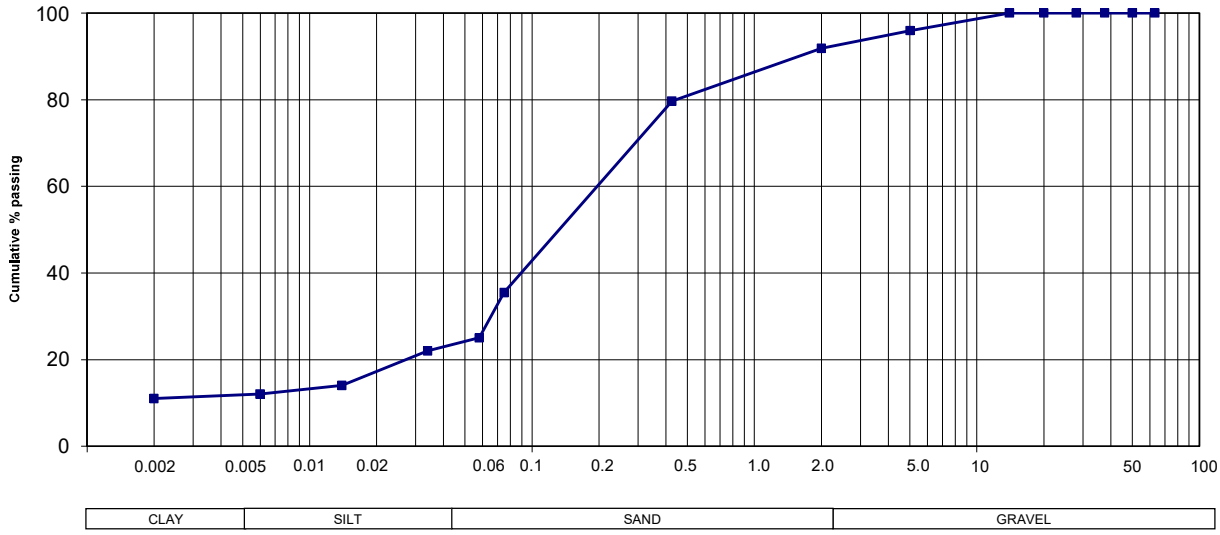
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

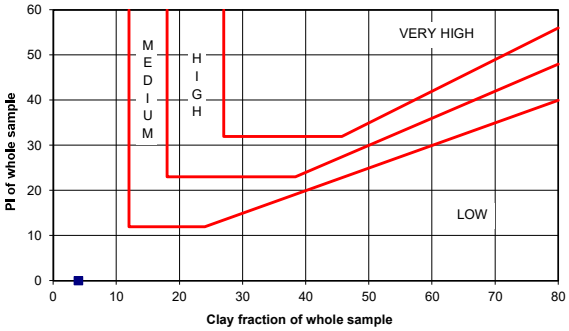
Soillab is a SANAS accredited Testing Laboratory.

PARTICLE SIZE ANALYSIS

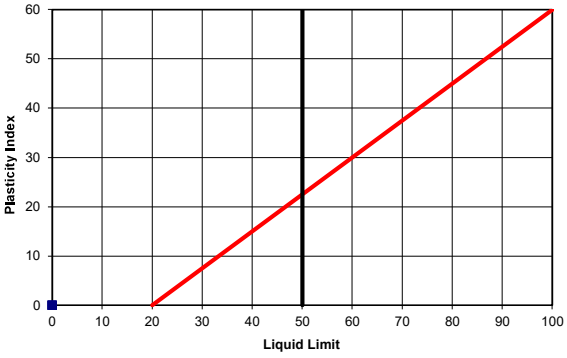
Sample No.	4
Soillab Sample No.	S18-2207-04
Depth (m)	0.3 - 0.9
Position	TP 12
Material Description	DARK YELLOWISH ORANGE FERRICRETE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	99
20.0 mm	97
14.0 mm	96
5.0 mm	79
2.00 mm	60
0.425 mm	49
0.075 mm	18
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
59 µm	13
35 µm	10
14 µm	6
6 µm	4
2 µm	3
% Clay	4
% Silt	9
% Sand	47
% Gravel	40
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	NP
Linear Shrinkage (%)	0.0
Grading Modulus	1.73
Classification	A-1-b (0)
Unified Classification	SM
Chart Reference	

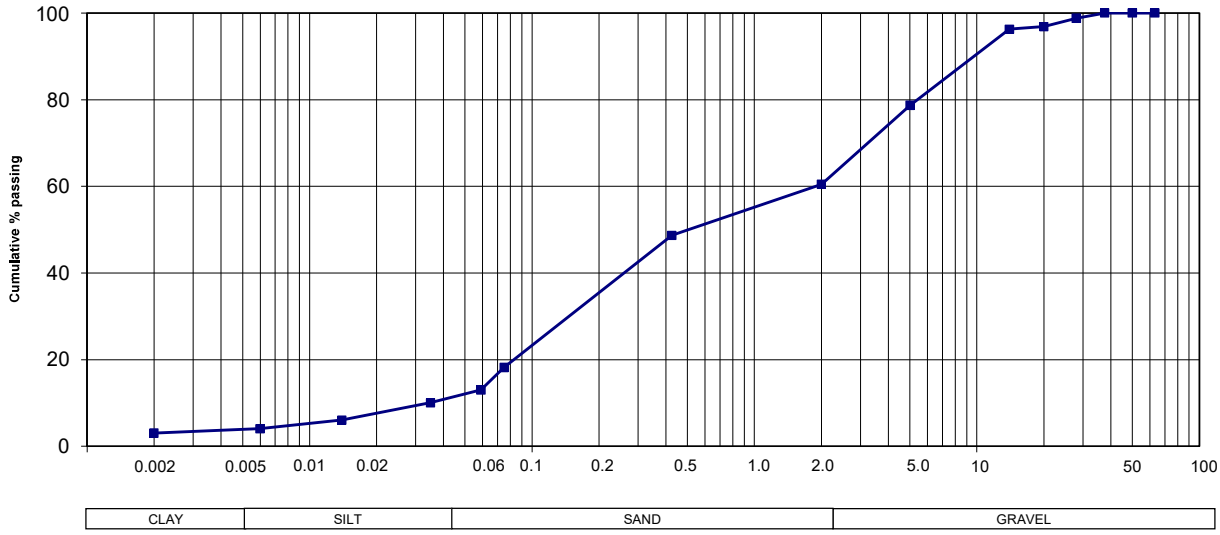
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





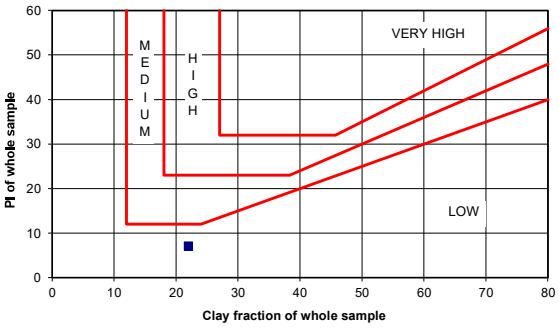
SOILLAB Part of the SMEC Group
sanas T 0284
Soillab is a SANAS accredited Testing Laboratory.
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

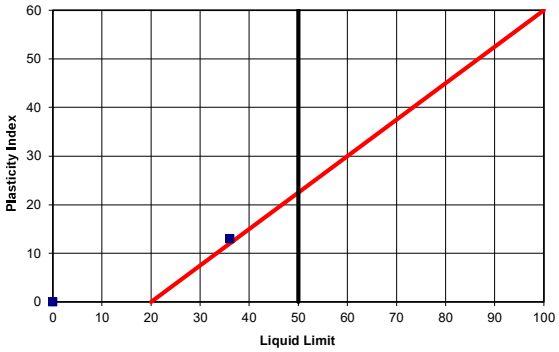
Sample No.	5
Soillab Sample No.	S18-2207-05
Depth (m)	0.7 - 2.5
Position	TP 13
Material Description	LIGHT RED FERRICRETE & QUARTZITE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	90
2.00 mm	69
0.425 mm	54
0.075 mm	42
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
53 µm	32
31 µm	29
13 µm	24
6 µm	22
2 µm	21
% Clay	22
% Silt	10
% Sand	37
% Gravel	31
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	36
Plasticity Index	13
Linear Shrinkage (%)	6.5
Grading Modulus	1.35
Classification	A-6 (2)
Unified Classification	SC
Chart Reference	

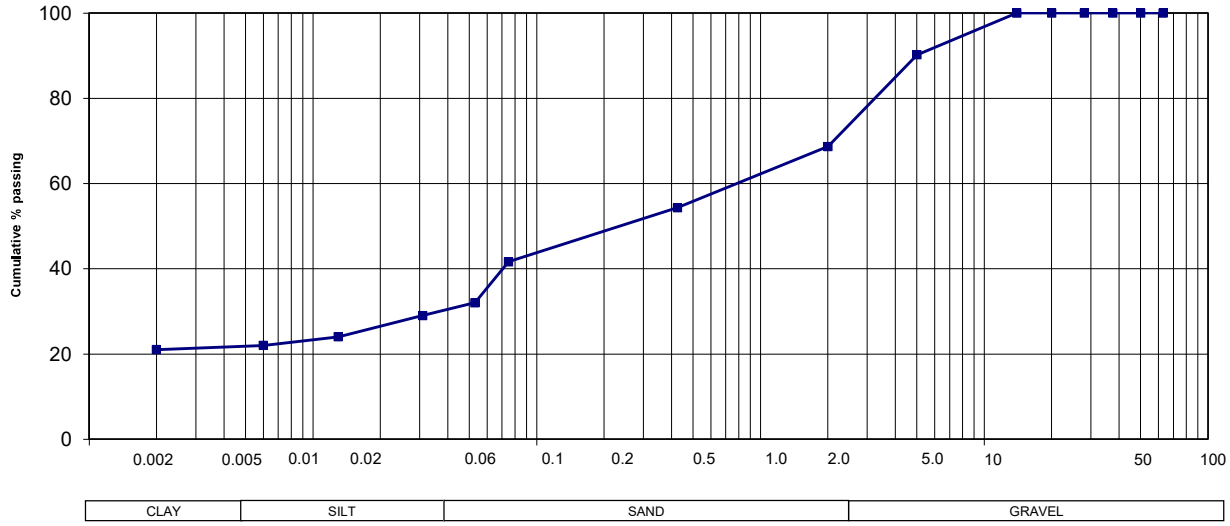
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



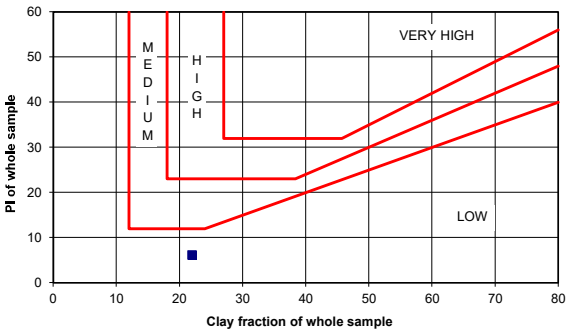


PARTICLE SIZE ANALYSIS

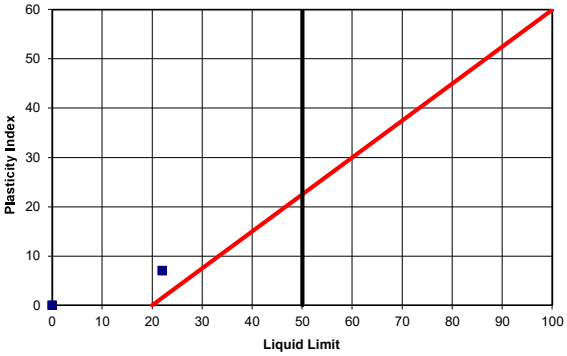
Sample No.	6
Soillab Sample No.	S18-2207-06
Depth (m)	0.3 - 0.9
Position	TP 15
Material Description	DARK YELLOW FERRICRETE CLAYEY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	98
2.00 mm	97
0.425 mm	87
0.075 mm	44
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
56 µm	36
32 µm	33
13 µm	26
6 µm	22
2 µm	20
% Clay	22
% Silt	14
% Sand	61
% Gravel	3
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	22
Plasticity Index	7
Linear Shrinkage (%)	3.5
Grading Modulus	0.72
Classification	A-4 (0)
Unified Classification	SM & SC
Chart Reference	

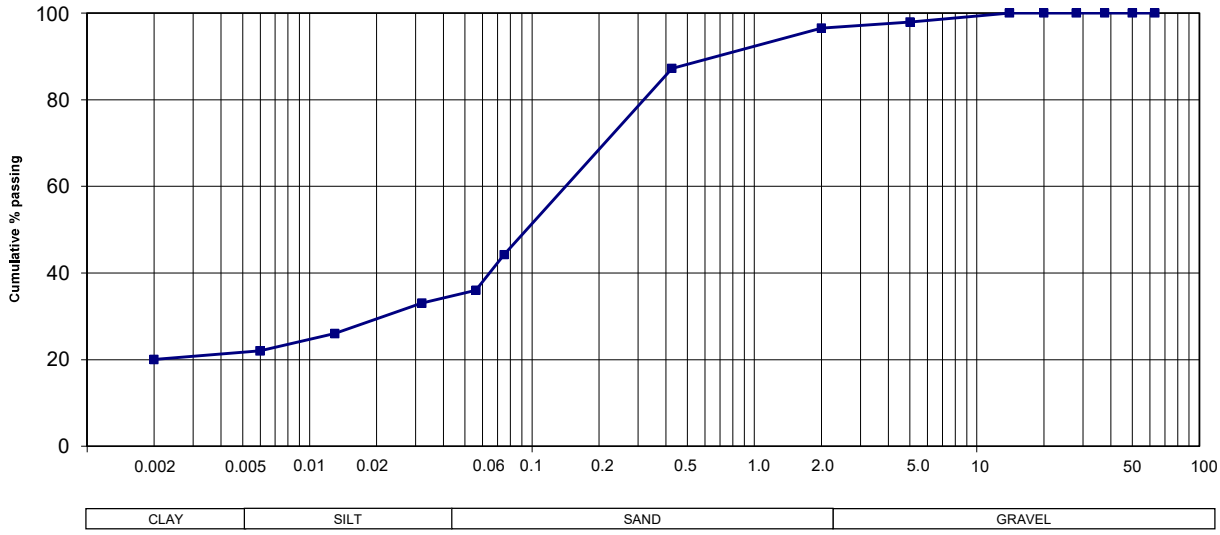
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





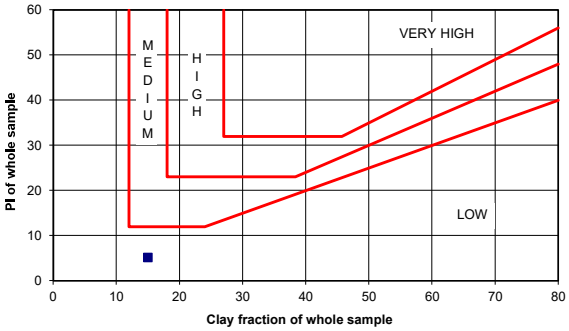
SOILLAB Part of the SMEC Group
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

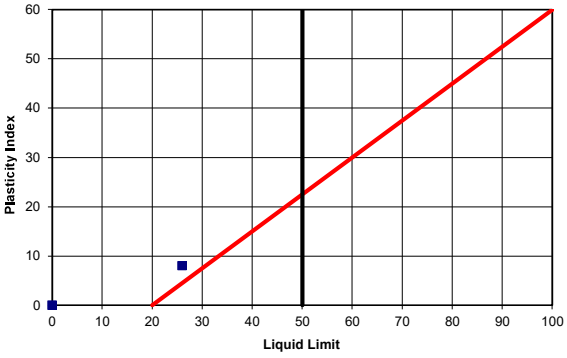
Sample No.	7
Soillab Sample No.	S18-2207-07
Depth (m)	0.9 - 1.6
Position	TP 15
Material Description	DARK YELLOW FERRICRETE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	86
2.00 mm	75
0.425 mm	64
0.075 mm	37
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
55 µm	30
32 µm	27
13 µm	18
6 µm	15
2 µm	14
% Clay	15
% Silt	15
% Sand	45
% Gravel	25
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	26
Plasticity Index	8
Linear Shrinkage (%)	4.0
Grading Modulus	1.24
Classification	A-4 (0)
Unified Classification	SC
Chart Reference	

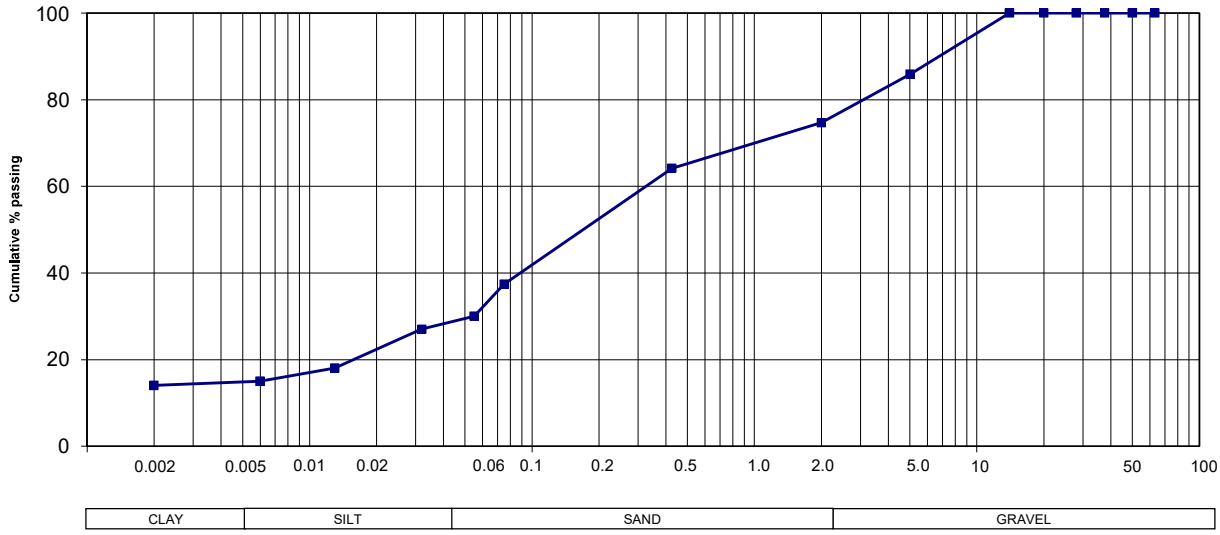
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





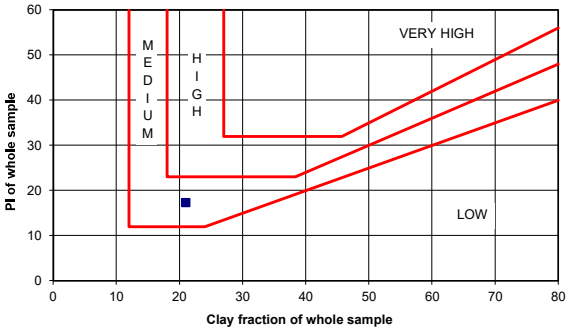
SOILLAB Part of the SMEC Group
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

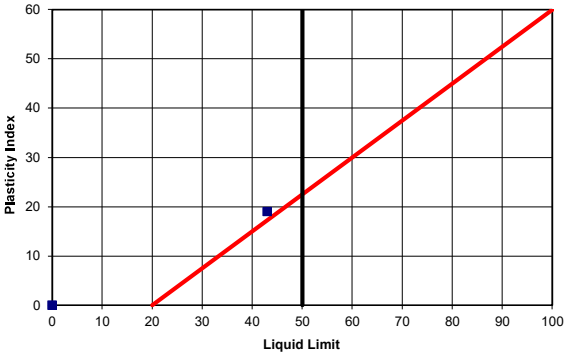
Sample No.	8
Soillab Sample No.	S18-2207-08
Depth (m)	1.6 - 2.1
Position	TP 15
Material Description	DARK YELLOW CLAYEY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	99
2.00 mm	96
0.425 mm	91
0.075 mm	73
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
57 µm	34
33 µm	31
14 µm	23
6 µm	21
2 µm	20
% Clay	21
% Silt	13
% Sand	62
% Gravel	4
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	43
Plasticity Index	19
Linear Shrinkage (%)	5.0
Grading Modulus	0.40
Classification	A-7-6 (13)
Unified Classification	CL
Chart Reference	

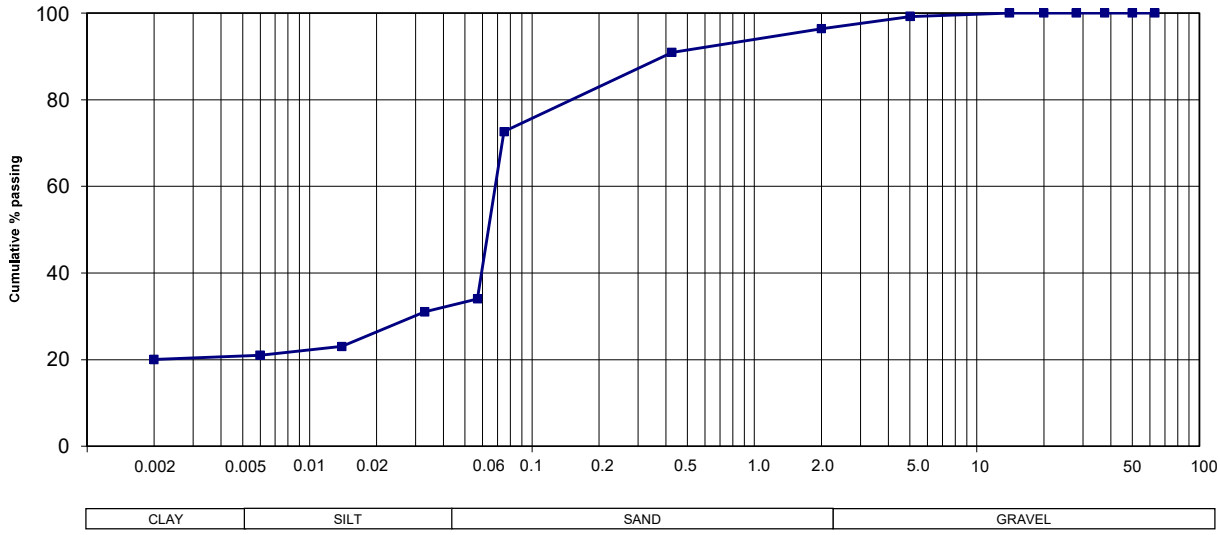
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





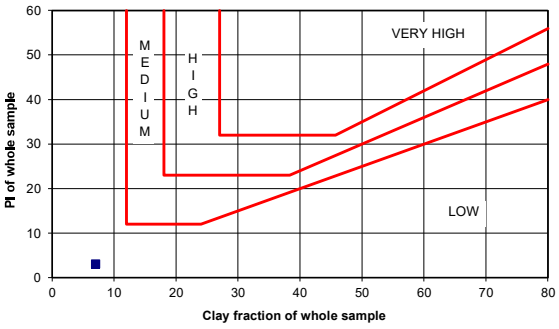
SOILLAB Part of the SMEC Group
Soillab is a SANAS accredited Testing Laboratory.
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

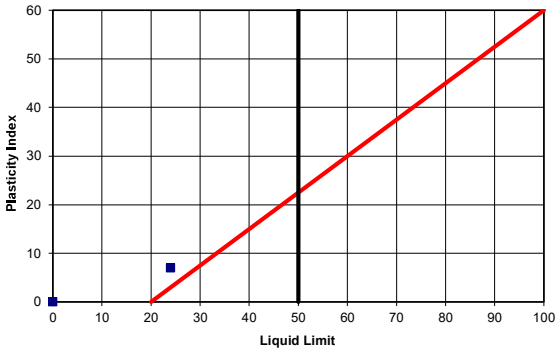
Sample No.	9
Soillab Sample No.	S18-2207-09
Depth (m)	0.39 - 1.3
Position	TP 16
Material Description	DARK YELLOWISH ORANGE QUARTZITE & FERRICRETE SANDY GRAVEL
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	100
5.0 mm	93
2.00 mm	57
0.425 mm	44
0.075 mm	21
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	14
34 µm	12
14 µm	9
6 µm	7
2 µm	6
% Clay	7
% Silt	7
% Sand	43
% Gravel	43
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	24
Plasticity Index	7
Linear Shrinkage (%)	2.5
Grading Modulus	1.79
Classification	A-2-4 (0)
Unified Classification	SM & SC
Chart Reference	

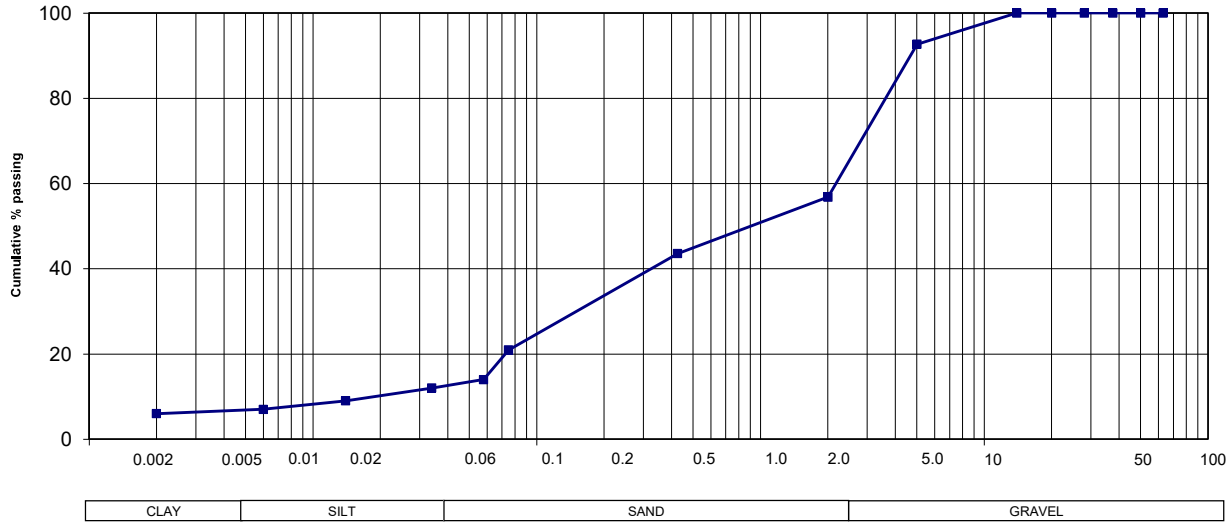
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



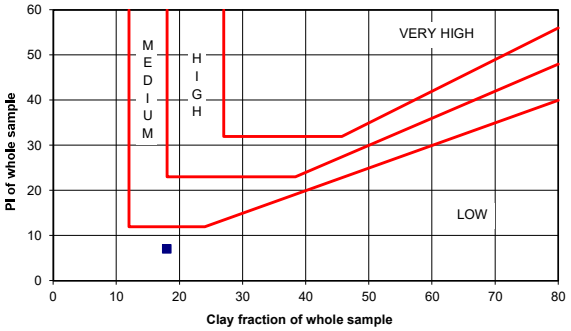


PARTICLE SIZE ANALYSIS

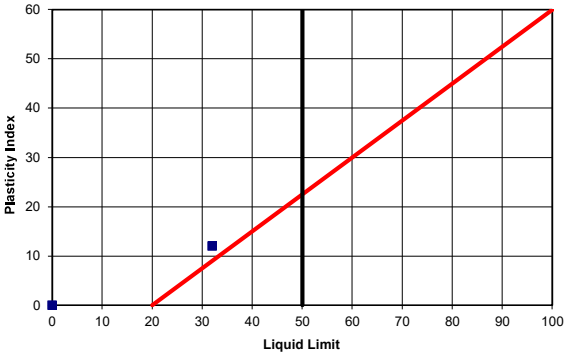
Sample No.	10
Soillab Sample No.	S18-2207-10
Depth (m)	1.3 - 2.5
Position	TP 16
Material Description	LIGHT REDDISH ORANGE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	97
5.0 mm	93
2.00 mm	77
0.425 mm	59
0.075 mm	38
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
55 µm	30
32 µm	28
13 µm	22
6 µm	18
2 µm	15
% Clay	18
% Silt	12
% Sand	47
% Gravel	23
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	32
Plasticity Index	12
Linear Shrinkage (%)	5.5
Grading Modulus	1.26
Classification	A-6 (1)
Unified Classification	SC
Chart Reference	

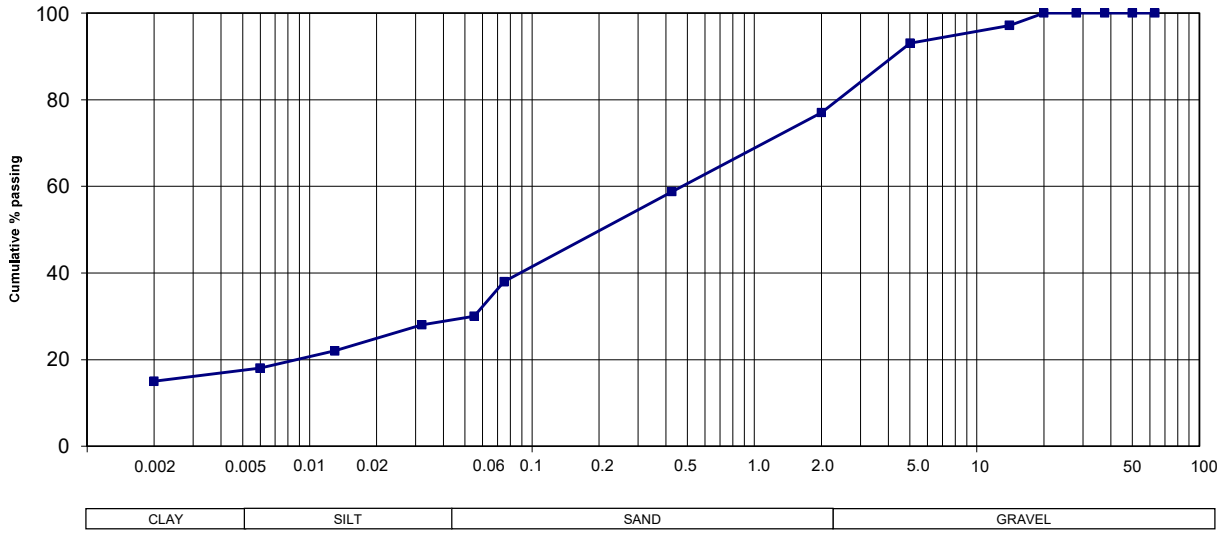
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





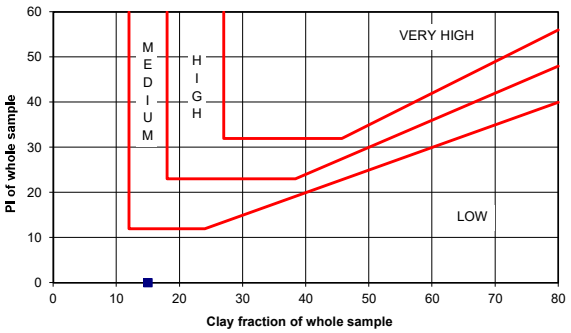
SOILLAB Part of the SMEC Group
sanas T 0284
Soillab is a SANAS accredited Testing Laboratory.
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

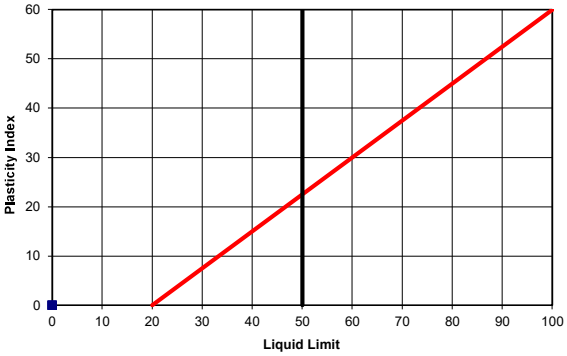
Sample No.	11
Soillab Sample No.	S18-2207-11
Depth (m)	0.0 - 0.4
Position	TP 18
Material Description	DARK BROWN FERRICRETE CLAYEY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	99
20.0 mm	99
14.0 mm	99
5.0 mm	98
2.00 mm	96
0.425 mm	84
0.075 mm	27
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
59 µm	23
34 µm	20
14 µm	16
6 µm	15
2 µm	13
% Clay	15
% Silt	8
% Sand	73
% Gravel	4
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	NP
Linear Shrinkage (%)	0.0
Grading Modulus	0.94
Classification	A-2-4 (0)
Unified Classification	SM
Chart Reference	

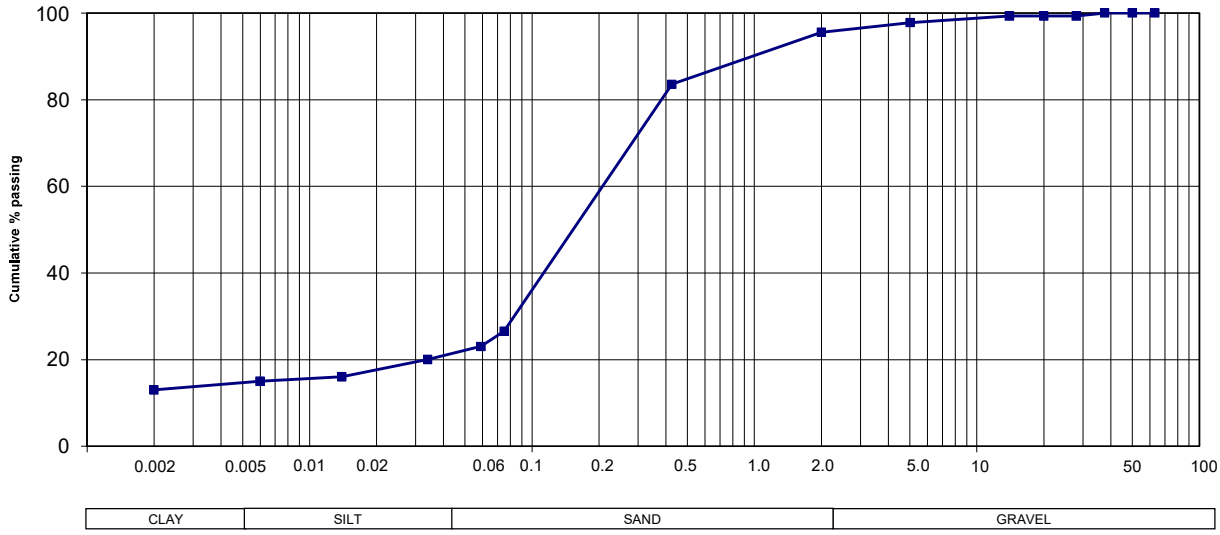
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





SOILLAB Part of the SMEC Group
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

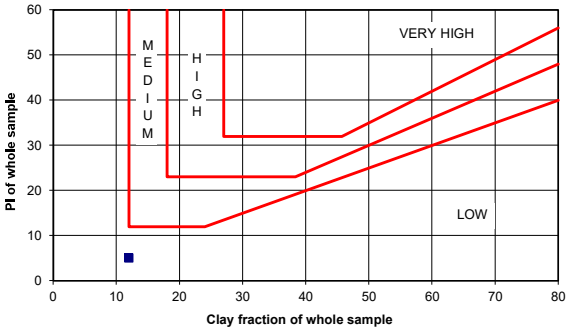
Soillab is a SANAS accredited Testing Laboratory.

PARTICLE SIZE ANALYSIS

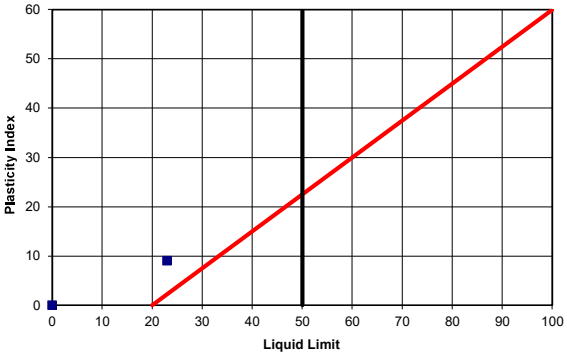
Sample No.	12
Soillab Sample No.	S18-2207-12
Depth (m)	0.4 - 0.7
Position	TP 18
Material Description	DARK YELLOWISH ORANGE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	100
20.0 mm	100
14.0 mm	99
5.0 mm	81
2.00 mm	66
0.425 mm	56
0.075 mm	26
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	20
33 µm	17
14 µm	14
6 µm	12
2 µm	11
% Clay	12
% Silt	8
% Sand	46
% Gravel	34
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	23
Plasticity Index	9
Linear Shrinkage (%)	4.0
Grading Modulus	1.52
Classification	A-2-4 (0)
Unified Classification	SC
Chart Reference	

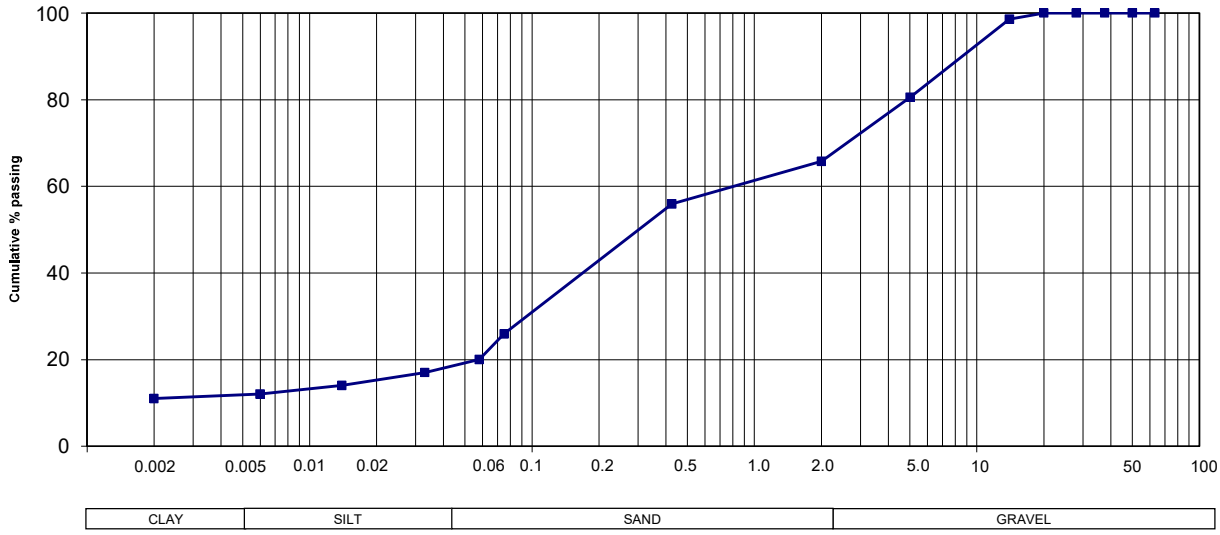
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





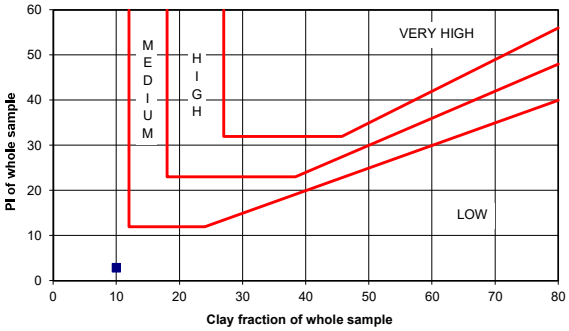
SOILLAB Part of the SMEC Group
Soillab is a SANAS accredited Testing Laboratory.
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

PARTICLE SIZE ANALYSIS

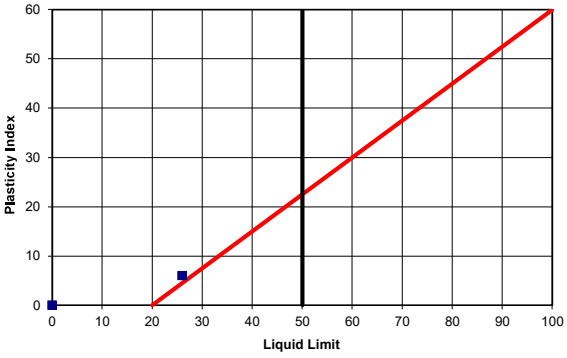
Sample No.	13
Soillab Sample No.	S18-2207-13
Depth (m)	0.7 - 0.9
Position	TP 18
Material Description	DARK YELLOWISH ORANGE GRAVELLY SAND
Relative density on < 2 mm **(SANS 5844)**	2.65
Organic Material	
Moisture (%) / Dispersion (%)	
SCREEN ANALYSIS (% PASSING) **(SANS 3001:GR1)**	
63.0 mm	100
50.0 mm	100
37.5 mm	100
28.0 mm	99
20.0 mm	98
14.0 mm	96
5.0 mm	76
2.00 mm	60
0.425 mm	47
0.075 mm	23
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	17
33 µm	15
14 µm	11
6 µm	10
2 µm	8
% Clay	10
% Silt	7
% Sand	43
% Gravel	40
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	26
Plasticity Index	6
Linear Shrinkage (%)	2.0
Grading Modulus	1.70
Classification	A-1-b (0)
Unified Classification	SM & SC
Chart Reference	

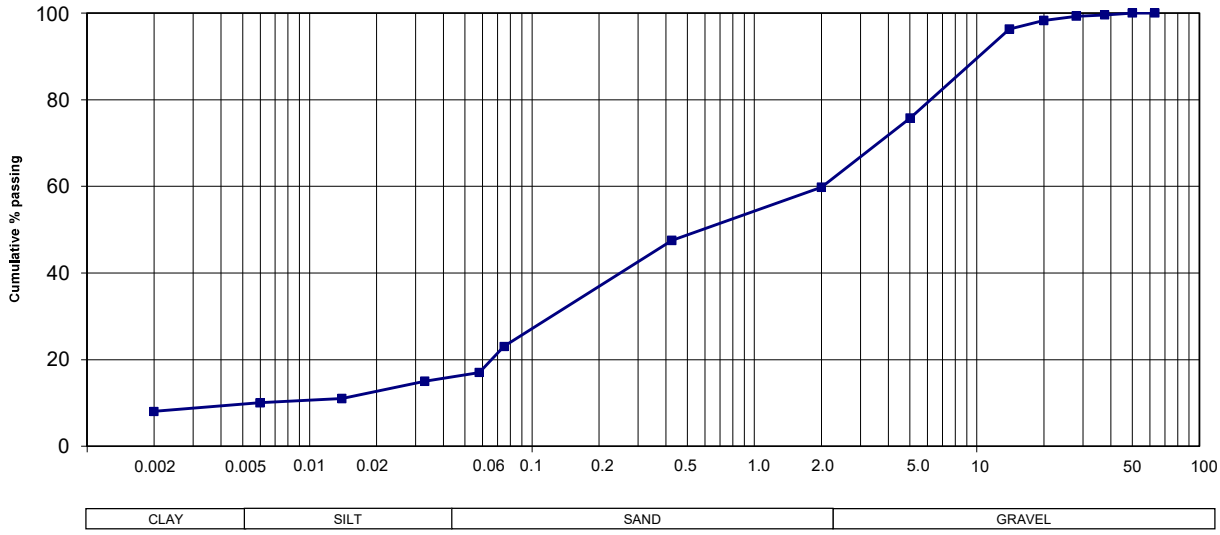
PROJECT : AERORAND SOUTH GEOTECH-MK-18-480
JOB No. : S18-2207
DATE : 2018-12-10

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





SOILLAB Part of the SMEC Group
Engineering Materials Laboratory
T +27 12 813 4900 E info@soillab.co.za
Soillab Pretoria
www.soillab.co.za

APPENDIX H2: COMPACTION TEST RESULTS

SOILLAB (PTY) LTD
Registration Number 1971/000112/07
Part of the SMEC Group
sanas T-0284
Engineering Materials Laboratory
VKE CENTRE, 230 Albertus Street
La Montagne, Pretoria, 0184
Tel: (+27) (12) 813 4900
Fax: (+27) (12) 481 3941 / 3812
Email: info@soillab.co.za
PO Box 72928, Lynnwood Ridge,
South Africa, 0040

Project Description

Client:	MUKONA CONSULTING ENGINEERS (PTY) LTD	Soillab Job No.:	S18-2207
Job Description:	AERORAND SOUTH GEOTECH-MK-18-480	Contract Number:	
Date:	2018/12/10	Reference Number:	

Sample Description

Soillab Sample No.:	S18-2207-09	S18-2207-12	S18-2207-13	
Sample Description:	TP 16	TP 18	TP 18	
Sample Depth:	0.39 - 1.3	0.4 - 0.7	0.7 - 0.9	
Material Description:	DARK YELLOWISH ORANGE QUARTZITE & FERRICRETE	DARK YELLOWISH ORANGE	DARK YELLOWISH ORANGE	

Screen Analysis (% Passing) - SANS 3001-GR1

75,00 mm	100	100	100	
63,00 mm	100	100	100	
50,00 mm	100	100	100	
37,50 mm	100	100	100	
28,00 mm	100	100	99	
20,00 mm	100	100	98	
14,00 mm	100	99	96	
5,00 mm	93	81	76	
2,000 mm	57	66	60	
0,425 mm	44	56	47	
0,075 mm	21	26	23	

Soil-mortar percentages - SANS 3001-PR5

Coarse Sand	2.000-0.425mm	23	15	21	
Coarse Fine Sand	0.425-0.250mm	15	13	13	
Medium Fine Sand	0.250-0.150mm	13	16	14	
Fine Fine Sand	0.150-0.075mm	12	16	15	
Silt and clay	<0.075mm	37	39	39	

Constants

Grading Modulus	SANS 3001-PR5	1.79	1.52	1.70	
Liquid Limit	SANS 3001-GR10	24	23	26	
Plasticity Index		7	9	6	
Linear Shrinkage		2.5	4.0	2.0	

MOD AASHTO - SANS 3001-GR30

Max Dry Density (kg/m³)	2157	2133	2157	
Optimum Moisture Content (%)	7.4	8.1	8.6	

CBR - SANS 3001-GR40

MOD AASHTO				
Moulding Moisture Content (%)	7.4	8.0	8.6	
Dry Density (kg/m³)	2167	2118	2187	
% of Max Dry Density	100.5	99.3	101.4	
100% MOD CBR (%)	94	37	53	
% Swell	0.1	0.0	0.0	
NRB				
Dry Density (kg/m³)	2073	2025	2078	
% of Max Dry Density	96.1	94.9	96.3	
100% NRB CBR (%)	48	24	34	
% Swell	0.1	0.1	0.0	
PROCTOR				
Dry Density (kg/m³)	1955	1922	1967	
% of Max Dry Density	90.6	90.1	91.2	
100% PROCTOR CBR (%)	21	15	21	
% Swell	0.1	0.1	0.1	
CBR (%)				
100% Mod AASHTO	88	40	47	
98% Mod AASHTO	65	33	39	
97% Mod AASHTO	55	30	36	
95% Mod AASHTO	41	24	30	
93% Mod AASHTO	30	20	25	
90% Mod AASHTO	19	15	19	
COLTO Classification:	**G6**	**G7**	**G6**	

APPENDIX H3: CHEMICAL TEST RESULTS

SOILLAB (PTY) LTD
Part of the SMEC Group
Registration Number 1971/000112/07
sanas T-0284
Engineering Materials Laboratory
SMEC Building, 230 Albertus Street
La Montagne, Pretoria, 0184
Tel: (+27) (12) 813 4900
Email: info@soillab.co.za
PO Box 72928, Lynnwood Ridge,
South Africa, 0040

Client: MUKONA CONSULTING ENGINEERS
Project: AERORAND SOUTH GEOTECH - MK-18-480
Project No.: S18-2207
Date: 2018/11/26

pH & CONDUCTIVITY - TMH 1 A20 & A21T

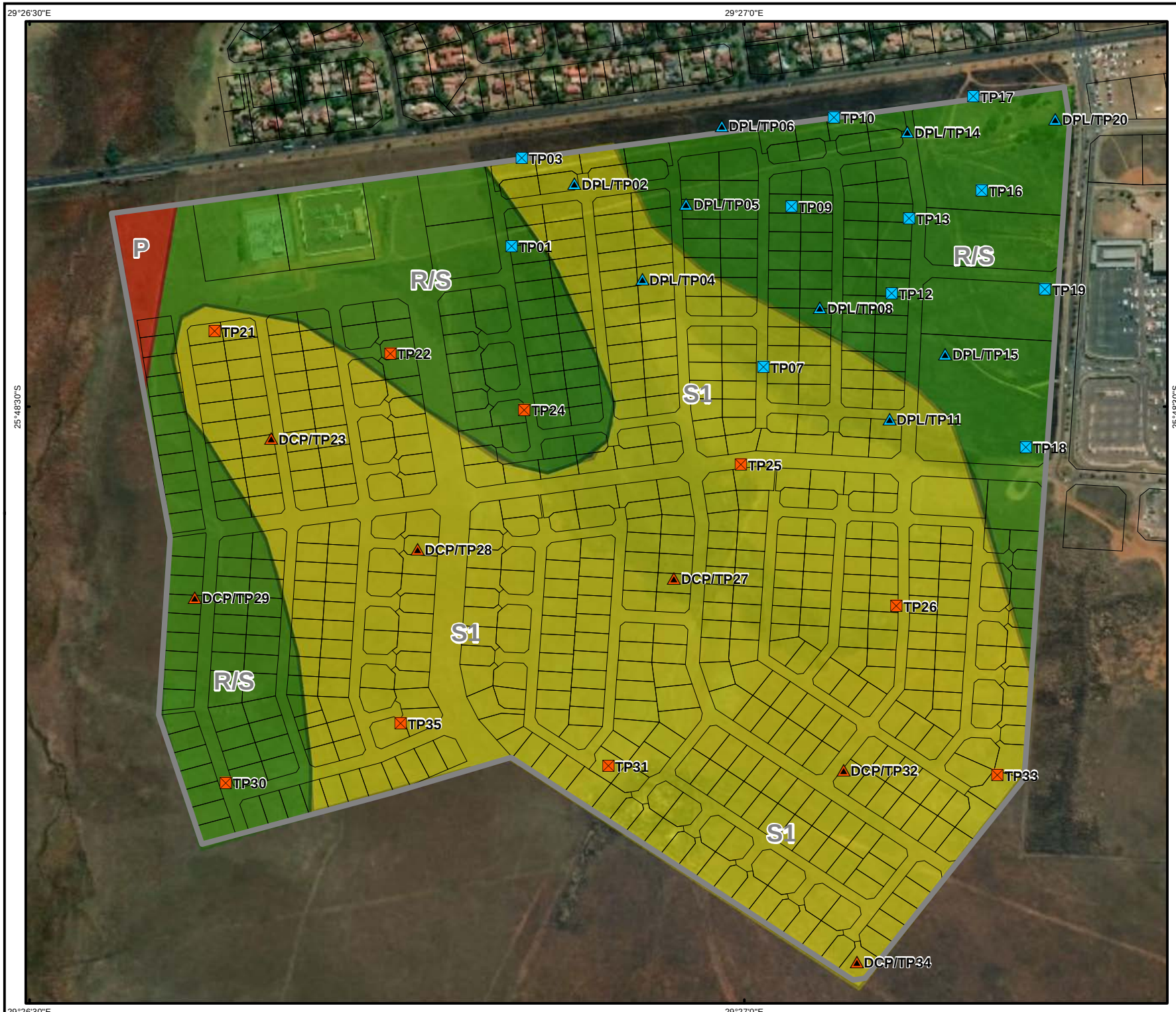
Sample No	Sample Position	Depth (m)	pH	Electrical Conductivity S/m
S18-2207-09	TP 16	0.39-1.3	6.24	0.0009
S18-2207-12	TP 18	0.4-0.7	6.28	0.0058
S18-2207-13	TP 18	0.7-0.9	6.58	0.0038

Comments:

Note: Items marked with a star (*) is Not Accredited

Soillab is a SANAS accredited Testing Laboratory according to the Accreditation Scope

APPENDIX I: ZONATION MAP



LEGEND

- ADDITIONAL TEST PITS
- ADDITIONAL DCP & TEST PITS
- EXISTING TEST PITS
- EXISTING DPL & TEST PITS
- FARM BOUNDARY
- MIDDELBURG FARM ERFs

ZONES

- ZONE 1 - R/S
- ZONE 2 - S1
- ZONE 3 - P (Potential Flood Zone)

NHBRC SITE CLASS	GEOTECHNICAL PROBLEM	FOUNDATION RECOMMENDATIONS
R/S	Low Settlement Difficulty of excavation	Strip Foundation Concrete Raft
S1	Moderate Settlement	Modified Normal Foundation Concrete Raft
P	Potential Flood Zone	No Development

CLIENT

STEVE TSHWETE LOCAL MUNICIPALITY

PROJECT

GEOTECHNICAL INVESTIGATION FOR AERORAND SOUTH TOWNSHIP STEVE TSHWETE MUNICIPALITY

TITLE

ZONATION MAP & GEOTECHNICAL LAYOUT PLAN AERIAL IMAGERY- ESRI BASEMAPS

DRAWN: A. Qoboka	DRAWING
DATE: 2019/06/03	MK-1 8- 480- GLP062

0 0,05 0,1 0,2
Kilometers

SCALE: 1:6 500

N

Projection: Geographic, Datum: WGS84
Source: Chief Directorate National Geo-Spatial Information
Inset: ESRI Data and Maps

Mukona Consulting Engineers (Pty) Ltd
International Business Gateway, New Road,
Midridge Office Estate (North),Midrand, 1685
Telephone:0114438293
Mobile:0837850284
Email: Sollyp@mukonagroup.com