Geotechnical Report

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Geotechnical Investigation for the Proposed Additions and Alterations at 96 Rissik Street, Transnet office, Johannesburg CBD.

Document prepared by:

Elite Geotech & Enviro Construction Services

Reg No: 2016/127848/07

Address: 05 Horseshoe Crescent

Amanzimtoti, 4126

Tel: +27 (0)72 2302 125

Email: **njabulo@elitege.co.za**

Document Prepared For:

Lodemann Holdings (Pty) Ltd

Address: Suite 301-Wheeler House,

112 - 116 Mathews Meyiwa Road

Morningside, Durban, 4001

Tel: +27 (0) 31 826 9850

Email: **info@lodemann.co.za**

Geotechnical Investigation for the Proposed Addition and Alterations at the Transnet office on 96 Rissik Street, Johannesburg	
Compiled by Engineering Geologist	Njabulo Mthembu
Reviewed by Snr. Engineering Geologist	Nhlanhla Magigaba

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Executive Summary

Elite Geotech & Environmental Construction Services (Pty) Ltd was appointed by Lodemann Holdings (Pty) Ltd to conduct a geotechnical investigation for proposed addition and alterations at the Transnet office on 96 Rissik Street, Johannesburg. The investigation included test pitting, rotary core drilling, standard penetration tests, and sampling of disturbed and undisturbed samples within the vicinity of the proposed development

The investigation showed that the profile across the site comprises concrete, imported layer (upper and lower), transported layer, and residual andesite layer. Groundwater seepage was intercepted in the drilled hole at a depth of 4.50 m. Ferruginization was encountered on the residual layer, which indicates the seasonal changes in the groundwater levels at the site. Problems due to the groundwater seepage are therefore expected. The site is underlain by a thick succession of expansive cohesive soil of transported and residual origin.

The foundation indicator tests revealed that the transported layer and the residual layer materials at the site have high potential expansiveness. These soils will be detrimental to founding conditions. The foundation design for the lift shaft must take into cognizance the high expansiveness of the underlying materials.

The visual assessment and geotechnical investigation revealed that the existing structure at the site was intact with no visible structural deformation, at the time of the investigation. The installation of a new shaft lift will add more load on the existing foundations, moreover, with the presence of a thick layer of highly expansive and compressible soil profile encountered on the site, it is proposed that the load of the lift shaft is transferred to deeper soil horizons by means of pile foundation:

The additional loads in some parts of the existing structure can trigger settlement of the structure if it’s a significant load. It is recommended that the additional load be supported by the installation of additional pile foundations.

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1 Introduction

Elite Geotech & Environmental Construction Services (Pty) Ltd was appointed by Lodemann Holdings (Pty) Ltd to carry out a geotechnical investigation for the proposed addition and alterations at the Transnet office on 96 Rissik Street Johannesburg, CBD. To meet the requirements for the investigation, the investigation was conducted in accordance with the South African Institute of Civil Engineering Code of Practice (SAICE, 2010). The investigation comprised of desktop study, fieldwork (included test pitting and rotary core drilling, standard penetration tests, and sampling of disturbed and undisturbed samples), and reporting.

The geotechnical investigation was conducted from the 10th to the 15th of February 2022. It included excavation of three test pits up to a depth of 2.0m, drilling of one rotary core borehole up to a depth of 15.0m as well as standard penetration tests, and sampling of undisturbed samples within the vicinity of the site.

The purpose of the investigation was to explore the subsurface conditions, determine the engineering properties of the subsurface soil and provide the foundation recommendations for the development, and expose the existing foundations at the site. This report presents the factual data, analyses, and founding recommendations for the proposed addition and alterations.

2 Available information

At the time of the investigation the following information was available:

- A 1:250 000 scale geological map of the East Rand Sheet 2628 (Council for Geosciences, 1986).
- A 1:250 000 scale soil map of the East Rand Sheet 2628 (Council for Geosciences 1998).
- Seismic hazard Map from SANS 10160. (2011). South African Loading Code SANS 10160 Basis for structural design and actions for buildings and industrial structures – Part 4: Seismic actions and general requirements for buildings, 2011.
- Aerial photographs, sourced from Google Earth Pro®.

3 Site Description

3.1 Site Locality

The site is in an existing Transnet office, on 96 Rissik Street, Johannesburg CBD in the Gauteng Province. It is an existing multi-storey office building. Figure 1 below shows the location of the site area and the positions of the test pits and borehole.

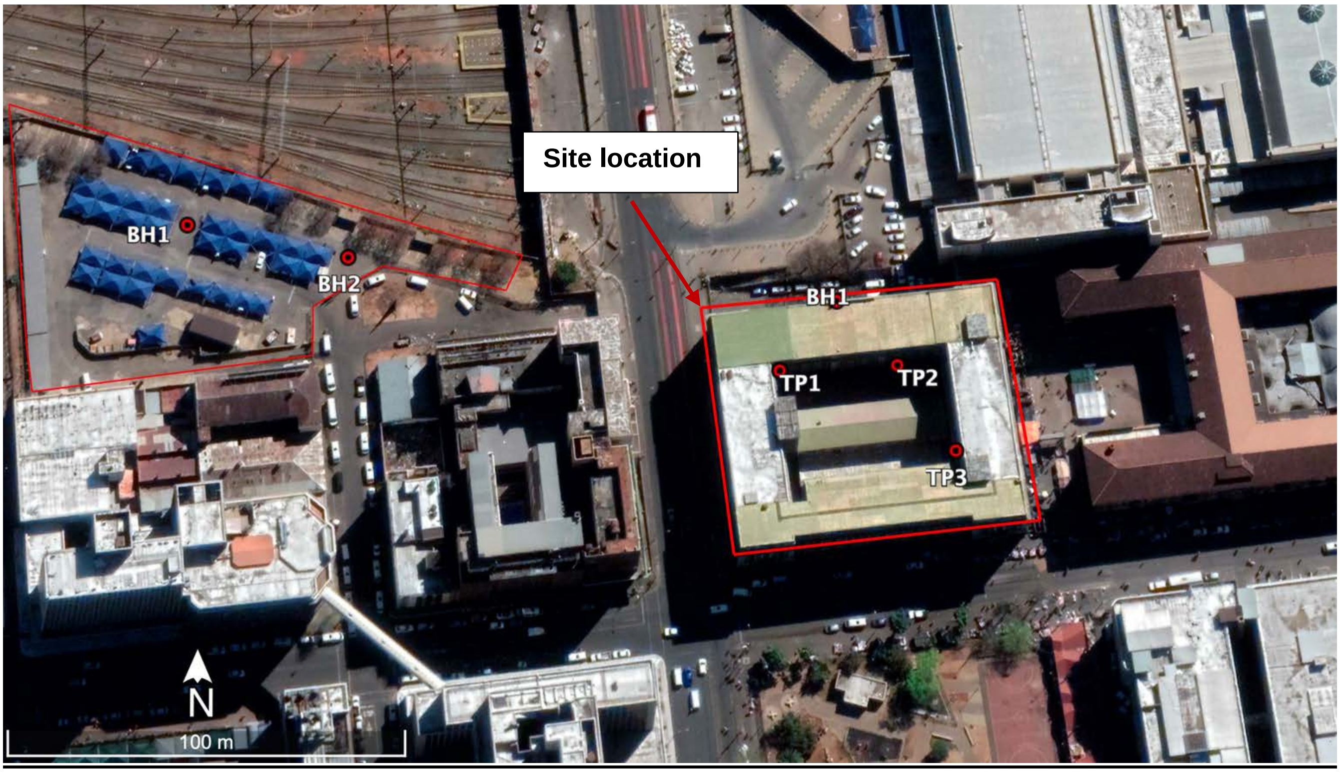


Figure 1: Showing the site boundary in red, test pit, and drilled borehole position.

3.2 Climate

Johannesburg normally receives about 604mm of rain per year, with most rainfall occurring during summer. It receives the lowest rainfall (0 mm) in July and the highest (113mm) in January. The average midday temperature for Johannesburg ranges from 16.6°C in June to 26.2°C in January. The region is coldest during July when the mercury drops to 0.8°C on average during the night (Climate-data.org: 2012).

The Weinert Climatic N-number for the area (Weinert, 1980), which is <5 indicates that the climate is semi-humid and chemical weathering processes are dominant.

3.3 Seismicity

On the published seismic hazard figure of South Africa (SANS 10160-4:2011) the seismic hazard is defined in terms of peak ground acceleration. In South Africa two seismic zones are apparent: Zone I for natural seismic activity and Zone II for regions of mining-induced and natural seismic activity.

According to the seismic hazard map of SANS 10160-4 (2011), the value for the peak ground acceleration of the investigated site occurs in an area with a value of approximately 0.180 g, with a 10% probability that this value will be exceeded in a 50-year period as shown in Figure 2 below. In accordance with SANS 10160-4:2011, the site is located in Zone II and specific seismic design requirements are therefore required.

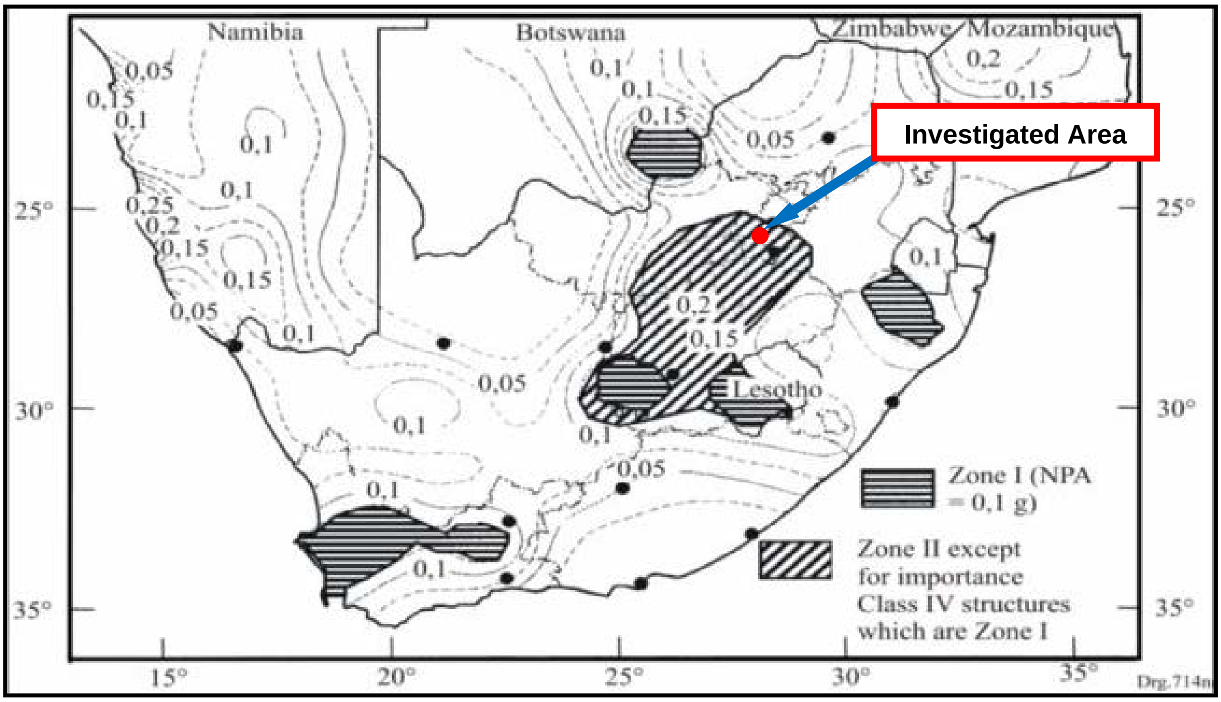


Figure 2: Locality of the site on the seismic hazard map of South Africa.

The peak ground acceleration expresses the seismic hazard and the value of 0.180 m/s^2 may be considered a high level of seismic hazard. A 10% probability exists that this value will be exceeded in a 50-year period.

3.4 General Geology

According to the 1:250 000 geological map of the East Rand Sheet 2628 (Council of Geoscience, 1986), the site area is underlain by breccia, conglomerate, greywacke, and shale **(R-Vp)** of the Platenburg Group, Ventersdorp Supergroup as well as basaltic lava, agglomerate and tuff **(Rk)** of the Klipriviersberg Group, Ventersdorp Supergroup as shown in Figure 3 below.

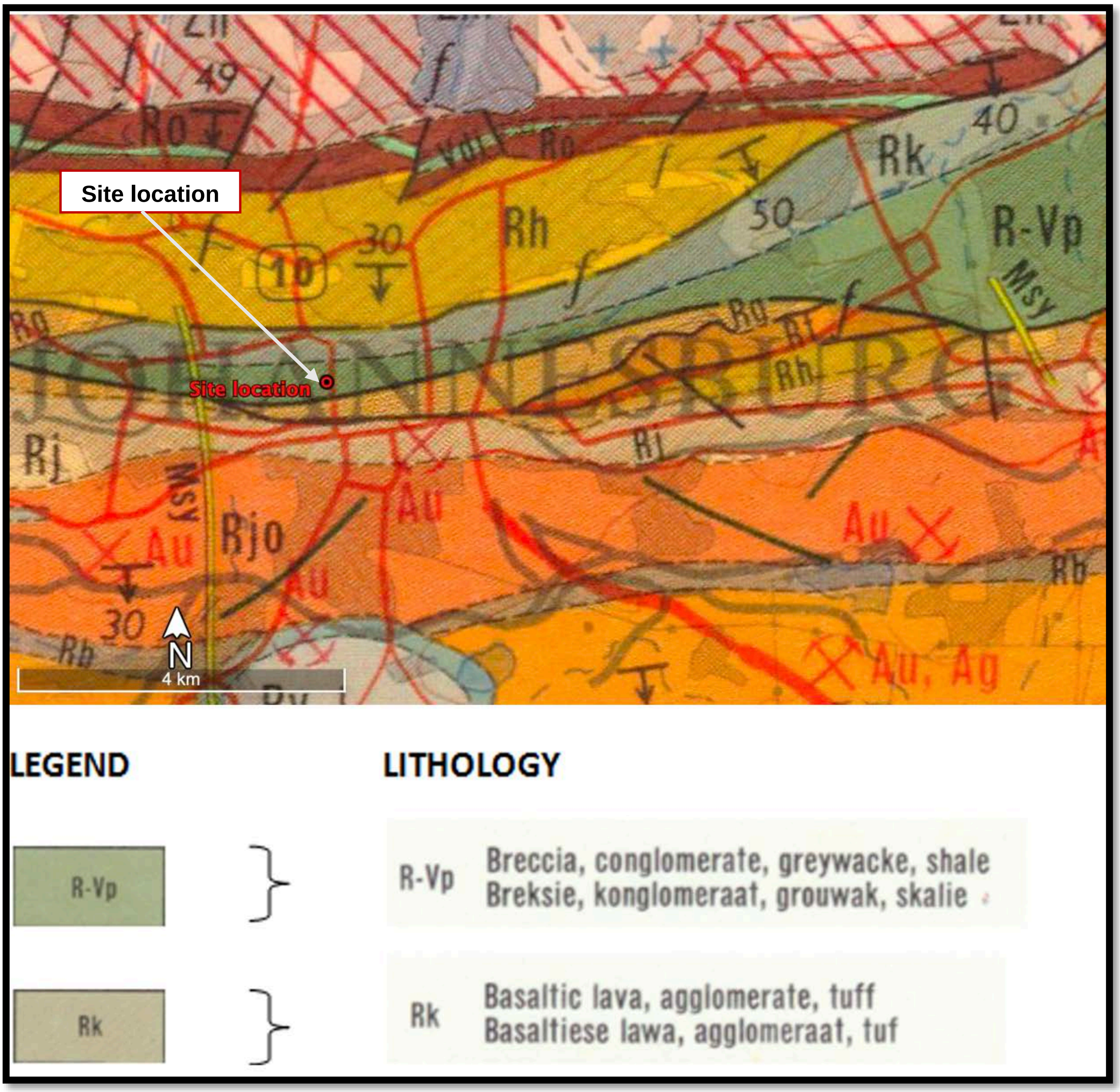


Figure 3: Showing the general geology map of the site, (Geological Survey, 1986).

4 Investigation Methodology

The investigation was carried out in three phases. The first phase was a desktop study, which was followed by the second phase of fieldwork followed by a third phase of reporting. The desktop study was done prior to the going to site. Once the drilling was completed, test pitting and geotechnical logging of the core was done. Representative samples were taken and submitted to a SANAS accredited laboratory for soil testing during the fieldwork.

4.1 Desktop study

The purpose of the study was to give technical guidance on the expected geological and geotechnical conditions on the site. The desk study of the available geological information involved perusing aerial images, available published geological maps, and relevant literature.

4.2 Fieldwork

The fieldwork comprised of the following:

- Walk-Over Survey.
- Borehole Drilling.
- In-situ Soil Testing – Standard Penetration Test (SPT).
- Excavation and profiling of test pits; and
- Collection of representative soil samples for laboratory testing.

4.2.1 Walk over survey

After the desktop study, a site walkover was undertaken within the vicinity of the site to be developed, to assess the current topographical and geological conditions from the surface without any intrusive work.

4.2.2 Borehole drilling

Borehole drilling was carried out by a specialist geotechnical drilling contractor, in accordance with accepted South African Standards (CSRA, 1993). The borehole was drilled up to a depth of 15.00m in the vicinity where the lift shaft is proposed. The borehole was logged in accordance with accepted South African practice (SANS 633:2012). The position of the borehole is listed below in Table 1 with the detailed borehole log attached in Appendix C.

Table 1: Summary of borehole information

Borehole No.	Coordinates (WGS84)		Depth (m)	Water table depth (m)
	Latitude	Longitude		
BH1	26°11'55.08"S	28° 2'30.39"E	15.0	4.50

4.2.3 Field Test - Standard Penetration Tests (SPT)

Standard Penetration Test was conducted by driving a standard 50mm outside diameter thick-walled sampler into the soil at the bottom of a borehole, using repeated blows of a 63.5kg hammer falling through 760mm. The SPT N-value is the number of blows required to achieve a penetration of 300mm, after an initial seating drive of 150mm. Standard Penetration Tests (SPTs) were conducted at regular intervals in the borehole. The test results recorded on the borehole profile descriptions can be summarised in Table 5 as follows:

4.2.4 Test pitting

The investigation comprised excavation and profiling of three (3 No.) test pits. The test pit was excavated using picks and shovels up to a depth of 2.00m. The excavations were loosely backfilled after the completion of soil profiling and sampling. Test pit position was marked using a hand-held GPS, on the UTM grid and WGS84 datum.

A two-person team carried out the test pitting in order to comply with accepted safety requirements as reflected in the Site Investigation Code of Practice (SAICE, 2010). The test pit was set out and profiled by a team of Jennings, J E B, Brink, A B A and Williams, A A B, (1973). Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa. The details of the test pit are summarised in Table 2 below and the detailed test pit soil profile is attached in Appendix B.

Table 2: Summary of the test pit location

Test Pit No.	Coordinates using a GPS		Depth (m)	Remarks
	Southing	Easting		
TP1	26°11'55.67"S	28° 2'29.86"E	2.00	No refusal
TP2	26°11'55.62"S	28° 2'30.95"E	2.00	No refusal
TP3	26°11'56.33"S	28° 2'31.48"E	2.00	No refusal

4.2.5 Sampling

Representative disturbed and undisturbed (Shelby) soil samples from the different soil layers encountered on the sites were taken to a SANAS-accredited laboratory to conduct the material property testing and characterization of the samples' engineering properties.

4.3 Laboratory Testing

Soil testing was conducted on undisturbed and disturbed soil samples, and the tests conducted were for:

- The determination of Foundation Indicators (comprising sieve and hydrometer grading analyses and Atterberg Limits); and
- Determination of shear strength and stiffness (comprising angle of friction and cohesion) (triaxial tests).

5 Results of Geotechnical Investigation

The geological profiles, as recorded in the test pit and borehole, are summarised in Table 3 and Table 4 respectively below. The geotechnical investigation revealed that the profiles encountered across the site comprise the following layers:

- Concrete layer.
- Upper Imported layer (engineered fill),
- Lower Imported layer (engineered fill),
- Transported layer, and
- Residual andesite layer.

Table 3: Borehole log summary.

Borehole No.	Concrete (m)	Imported layer (m)	Transported layer (m)	Residual Andesite (m)
BH1	0 – 0.10	0.10 – 0.50	0.50 – 10.95	10.95 – 15.00

Table 4: Summary of the test pits profile

Test Pit No	Concrete layer (m)	Upper Imported layer (m)	Lower Imported layer (m)	Transported layer (m)
TP1	0 - 0.10	0.10 – 0.20	0.20 – 0.90	0.90 – 2.00
TP2	0 - 0.10	0.10 – 0.25	0.25 – 0.50	0.50 – 2.00
TP3	0 - 0.10	0.10 – 0.20	0.20 – 0.45	0.45 – 2.00

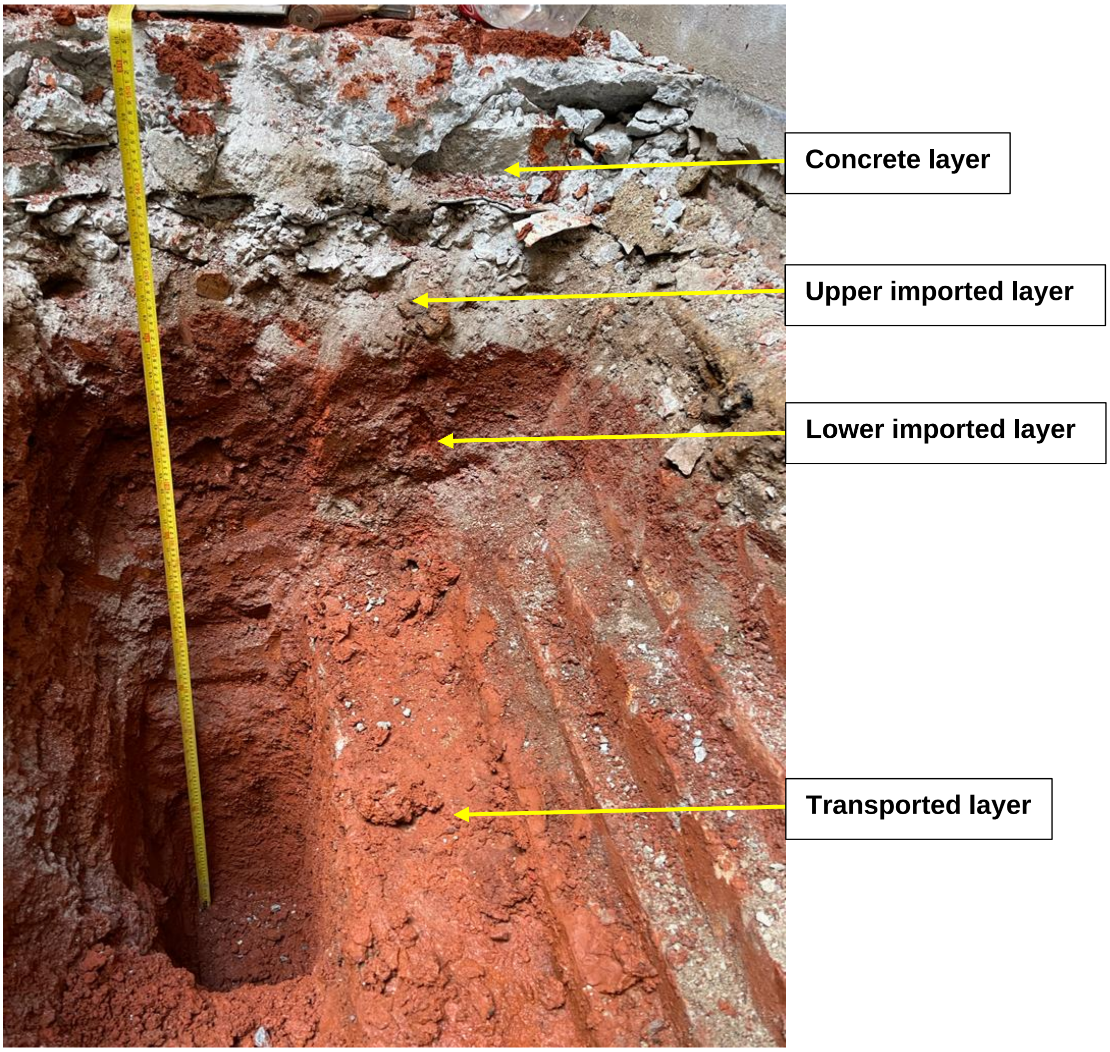


Figure 4: Typical soil profile (TP3)

5.1 Concrete Layer

The top layer is the concrete, which is a mixture of gravel, sand, and cement. It was encountered in all the test pits on site. It had an average thickness of 0.10m.

5.2 Upper Imported Layer

The upper imported layer (engineered fill) underlies the concrete on-site. This layer comprises slightly moist, light grey-brown, gravel in a matrix of fly ash and silty sand. The general consistency of this layer is very dense. This layer extends to an average depth of 0.45m.

5.3 Lower Imported Layer

The lower imported layer (engineered fill) underlies the upper imported layer on-site. This layer comprises moist, reddish-brown, slightly clayey sand with fine slightly ferruginous gravel and cobbles. The general consistency of this layer is dense. This layer extends to a depth of 0.95m on the test pits.

5.4 Transported Layer

The transported layer was described as a sandy clay layer. This layer was profiled as dark reddish-brown with an average thickness of 10.00m. The consistency of this layer is soft to firm.

5.5 Residual Andesite

The residual layer comprises of a yellowish-brown mottled reddish orangey brown of sandy clay. This layer was encountered from a depth of 10.95m to 15.00m in BH1. The consistency was profiled as being firm to stiff.

6 Groundwater conditions

Groundwater seepage was intercepted at 4.50m in the drilled borehole. Ferruginization was encountered on the lower imported layer, indicating the seasonal change of groundwater levels at the site. Problems due to groundwater seepage are therefore expected.

7 Site Conditions

The investigated area is generally gently sloping. The office building to be upgraded it's a multi-storey structure. At the time of the investigation, the office structure was intact with no visible cracks. The office was being evacuated to allow the construction work to proceed. The typical test pits and foundations condition during the time of investigation is shown in Figure 5 below.

Figure 5: Shows the typical excavated test pits during the site investigation

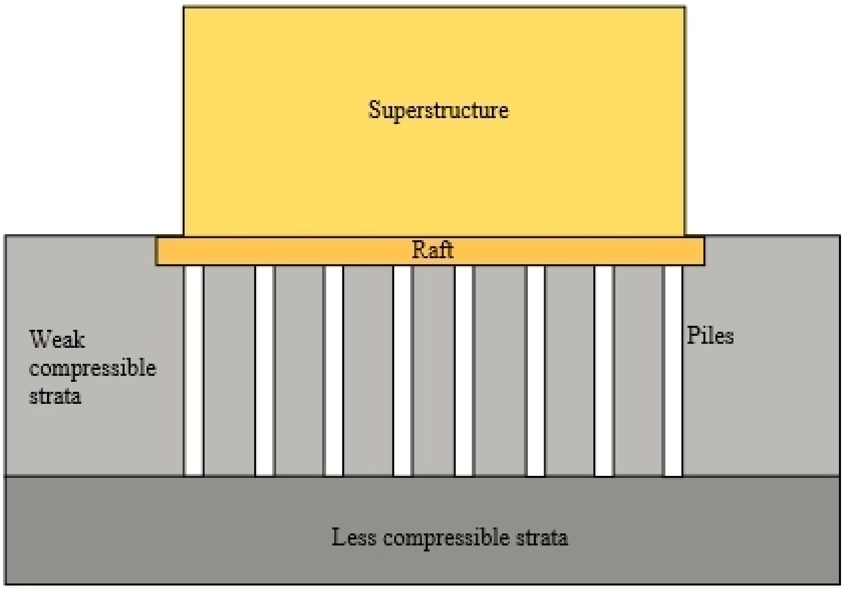


Figure 6:A schematic figure showing the type of foundation supporting the existing structure

The foundation of the existing structure was exposed using pick and shovel, it was noted that the there were bricks around the concrete spread foundation, as shown in Figure 5 above, it was difficult to get the details of the piles (size and length) due to the limitations of the investigation. ***It is presumed that the foundation type is piled raft foundation based on the observations of the shallow investigation and knowledge of the foundations on the adjacent buildings which are placed on a piled raft.*** The typical foundation for the existing structure is as shown in Figure 6 above.

Piled raft founations are typically used for large structures, and in situations where soil is not suitable to prevent excessive settlement. They are a popular choice for high-rise buildings underlain by compressible materials.

They are suitable for such a structure because if there is one or more ineffective piles, the raft can allow some degree of load redistribution to other piles, reducing the influence of the pile’s weakness on the overall performance of the foundation.

It appears that the foundation is providing sufficient support to the building and transferring its load adequately to the underlying soil as there was no sign of excessive settlement, structural deformation, or defects on the existing structure.

8 Field Standard Penetration Tests (SPT)

Standard Penetration Tests (SPTs) were conducted at 1.5m intervals in the borehole. The test results recorded on the borehole profile descriptions can be summarised in Table 5 below: A guideline for the relationship between the N-values and soil consistency is given in Table 6 below.

Table 5: SPT Results for BH1

SPT No	Depth (m)	SPT N-value	Consistency
BOREHOLE 1			
1	3.00	5	Soft
2	4.50	5	Soft
3	6.00	13	Stiff
4	7.75	10	Stiff
5	9.00	19	Very stiff
6	10.50	21	Very stiff
7	12.00	24	Very stiff
8	13.50	27	Very stiff

Table 6: SPT N-value correlation with consistency of soil

Cohesive soils		Non-Cohesive Soils	
N –value	**Material description**	**N –value**	**Material description**
< 2	Very soft	< 5	Very loose
2 – 4	Soft	5 – 10	Loose
4 – 8	Firm	10 – 30	Medium dense
8 – 15	Stiff	30 – 50	Dense
15 – 30	Very stiff	> 50	Very dense

9 Laboratory Tests

9.1 Foundation Indicator Tests

Representative samples were collected for laboratory testing at each test pit position and submitted for foundation indicator tests. The test results are attached in Appendix D and are summarized in Table 7 below:

Table 7: Foundation Indicator results for the site

Hole No.	Depth (m)	Soil Composition				GM	Atterberg Limits			Activity	Unified Soil Classification
		Clay (%)	Silt (%)	Sand (%)	Gravel (%)		LL (%)	WPI (%)	LS (%)		
Transported layer											
BH 1	7.00 – 7.75	19.2	41.4	38.1	1.3	0.16	49.0	20.0	9.0	Medium	ML
Residual andesite layer (from adjacent site)											
BH 2	16.95 – 18.00	36.7	45.3	17.0	0.9	0.14	50.0	18.0	9.0	Medium	MH

Where: GM = Grading modulus
LL = Liquid Limit
PI = Plasticity Index
WPI = Weighted Plasticity Index (PI x % passing the 0.425 mm sieve)
LS = Linear Shrinkage
Activity = Expansiveness of the soil according to Van der Merwe's method
ML = Low plasticity clayey sandy silty
MH = High plasticity clayey silty

From the results, it is evident that:

The **transported materials** at the site consist of low plasticity silt (**ML**). The layer has a low (0.16%) grading modulus. The fine fractions of this material also exhibit a high (49.0%) liquid limit and a moderate (9.0%) linear shrinkage. The weighted plasticity index (WPI) of the layer is moderate (20%), indicating that the material has medium potential expansiveness, according to the method proposed by Van der Merwe (1973).

The materials that make up the **residual andesite layer** at the site consist of high plasticity silt (**MH**). The layer has a very low (0.14%) grading modulus. The fine fractions of this material also exhibit a high (50%) liquid limit and a moderate (9.0%) linear shrinkage. The weighted plasticity index (WPI) of the layer is moderate (18%), indicating that the material has medium potential expansiveness, according to the method proposed by Van der Merwe (1973).

9.2 Consolidated Undrained Triaxial Test

A thin-walled open tube piston, undisturbed (Shelby) sample was retrieved for laboratory testing. The sample was subjected to a consolidated undrained (CU) triaxial test which is used to determine the shear strength and stiffness properties (comprising angle of friction and cohesion) of the soil sample. During the test, the sample is subjected to stress conditions that attempt to simulate the in-situ stresses.

The undisturbed soil sample was subjected to consolidation pressures of 100 kPa, 200 kPa, and 400 kPa respectively. The test results are attached in Appendix D and are summarized in Table 8 below:

Table 8: Triaxial test results summary

Hole No.	Depth (m)	Material type	Shear Parameter of Effective Stress		Shear Parameter of Failure	
			Cohesion (kPa)	Friction angle (degrees)	Cohesion (kPa)	Friction angle (degrees)
Transported Layer						
BH1	2.05 - 2.50	Clayey silt	0	36	3	30
Residual Andesite (from adjacent site)						
BH2	16.95 – 18.0	Clayey silt	7	24	5	22

10 Geotechnical Considerations

10.1 Groundwater level

Groundwater seepage was intercepted at 4.50m in the drilled borehole. Ferruginization was encountered on the lower imported layer which supports the fact that there is a seasonal change in groundwater levels at the site. Problems due to groundwater seepage are therefore expected.

10.2 Expansive soil profile

The foundation indicator test results (see Section 8) indicate the transported layer material and the residual layer materials at the site have high potential expansiveness, according to the method proposed by Van der Merwe (1973). These soils could be detrimental for founding conditions. The foundation design must take into cognisance the expansiveness of the underlying materials.

10.3 Compressible soil profile

The transported and the residual material underlying the site consist of cohesive soils. These materials have a firm to very stiff consistency. It is expected that the materials will be compressible when the moisture conditions change from dry to moist due to rainwater infiltration:

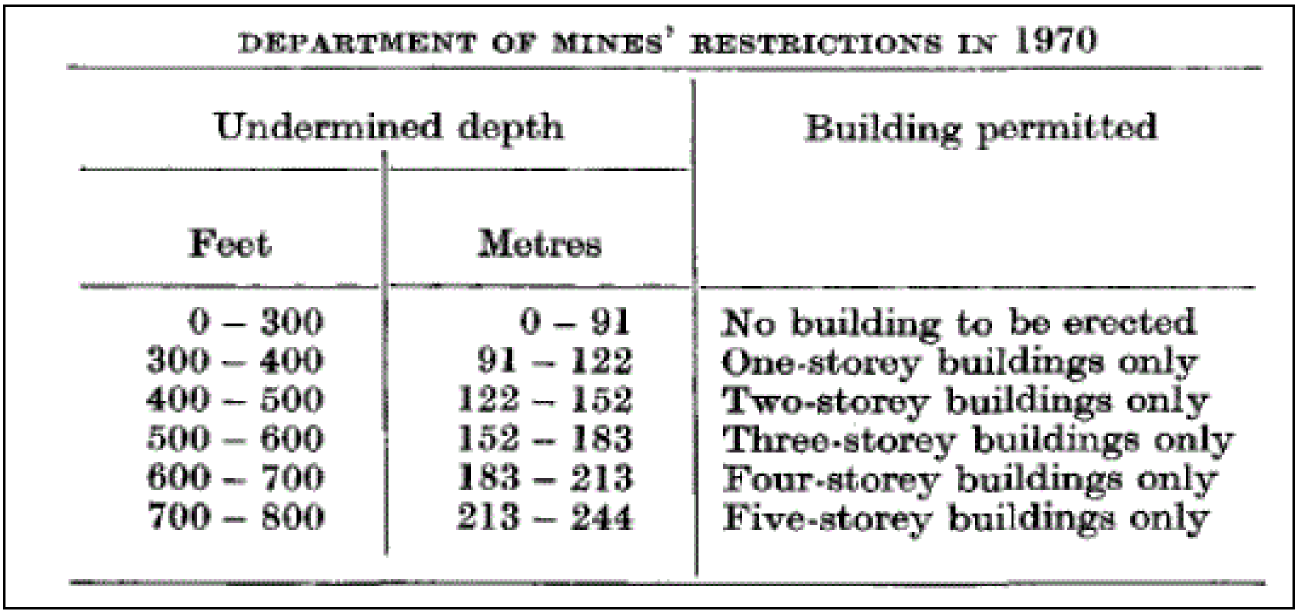
10.4 Undermined Ground

The geological map (refer to Figure 3) indicates that there was a gold mine within close proximity of the site. Referring to a drawing from the Department of Mine Surveys (DME) in Pretoria, confirmed that the site is undermined from depths between approximately 90m to 240m below EGL. It must be noted that there are existing high rise structures adjacent to this site, as well as offices below the investigated site; it can therefore be presumed that the investigated site is suitable for the proposed development. However, it is advisable that DME be consulted prior to any development.

10.5 Seismic activity

The value for the peak ground acceleration of the site occurs in an area with a value of 0.18 m/s^2, with a 10% probability that this value will be exceeded in a 50-year period. According to SANS 10160-4:2011, the site is located in Zone II and site-specific seismic design requirements are therefore required, which is dependent on the Importance Class of the structure. **Development is suitable on this site, provided that the structures are designed according to SANS 10160-4:2011.**

Table 9: Department of Mines Building Restrictions



DEPARTMENT OF MINES' RESTRICTIONS IN 1970

Undermined depth		Building permitted
Feet	Metres	
0 – 300	0 – 91	No building to be erected
300 – 400	91 – 122	One-storey buildings only
400 – 500	122 – 152	Two-storey buildings only
500 – 600	152 – 183	Three-storey buildings only
600 – 700	183 – 213	Four-storey buildings only
700 – 800	213 – 244	Five-storey buildings only

Referring to the above building restrictions (Table 9 above refers), no building should be constructed in an area in which mining activities occur or occurred within a depth of 91m below EGL.

Taking the above restrictions into account and considering the numerous building activities located within 100m of the site, **it is advised that the Department of Mineral Resources be consulted prior to any development on the site.**

11 Recommendations

11.1 General

The visual assessment and geotechnical investigation revealed that the existing structure at the site was intact with no visible deformation, at the time of the investigation. The installation of a new shaft lift will add more load on the existing foundations, moreover, with the presence of a thick layer of highly expansive and compressible soil profile encountered on the site, it is proposed that the load of the lift shaft is transferred to deeper soil horizons by means of pile foundation: With a deep foundation system, we estimate movement between the existing building and the addition to be on the order of about 25mm.

Alternatively, the addition could be constructed on spread footing foundation systems underlain by engineered fill, provided the client is willing to accept a higher associated risk of movement; we estimate movement on the order of about 15mm is possible. Foundation design and construction considerations for all three systems are provided below.

11.1.1 Deep Foundations-Piles

The additional loads in some parts of the existing structure can trigger settlement of the structure if it's a significant load. It is recommended that the additional load be supported by the installation of addition pile foundations. This can be achieved by the one of the following options:

1. Jacked piles under the existing foundations
2. Installing piles adjacent to the existing foundation (presumed to comprise a pile cap and pile foundations)

Other pile types may be considered if there is adequate assurance that the installation equipment and procedures can:

a) ensure that the piles will be advanced to the required founding depth;
b) prove the structural integrity of the pile shafts; and
c) ensure the absence of disturbed material below the pile base.

Typical working loads for various pile diameters are given in Table 10 as a guideline for budgetary purposes only.

Table 10 Guidelines for Typical Pile Diameter and Allowable Working Loads

Pile Type	Pile Diameter (mm)	Typical Working load. (kN)
CFA	250	250
	300	350
	350	450
DCI	355	500
	410	750

Pile lengths will be dependent on the final platform level and the detailed pile design must be provided by the piling contractor. For budgeting purposes, pile lengths are anticipated to be between 9m to12m in length considering that the piles will be Friction (or floating) piles since the competent bedrock at the site is at a depth greater than 25m.

The determination of the required diameter, depth and reinforcing of the piles will also be influenced by factors such as configuration and spacing of the piles in groups beneath the pile caps, depth of the bottom of the pile cap below ground level, and factors of safety or partial factors in accordance with the design code adopted by the structural engineer.

The levels of the pile caps should be designed as shallow as possible to limit requirements associated with temporary dewatering of any wet excavations.

Final pile founding levels will need to be reviewed by the pile designer by observing the piles formed in the field.

It is recommended that static load capacity tests be carried out on selected piles in order to confirm the pile working loads and pile design. The static load capacity tests should be carried out prior to the commencement of the piling contract. Elite's appointment should be extended to review the results of such static load capacity tests.

Axial settlement of single isolated piles, excluding settlement that occurs during construction of the superstructure, should not exceed elastic shortening of the pile shaft plus 12.5mm. Additional settlement due to grouping of piles would depend on spacing, depth and number of piles in each group.

It is also recommended that low energy Frequency Response dynamic pile integrity tests be carried out on all piles before they are covered by a pile cap. It should be specified in the tender document that these quality assurance tests be conducted by an independent specialist consultant to detect potential structural defects such as voids, honeycombing or cracks that would normally be detected by quality assurance procedures for reinforced concrete that was accessible after casting.

The piles foundations must be designed by a structural engineer, based on the findings and material parameters presented in this report.

11.1.2 Shallow Foundation-Spread Footing Recommendations

As an alternative to deep foundations, a spread footing foundation system may be considered for support of the proposed addition when constructed on engineered fill (designed by structural engineer), provided the potential for movement can be tolerated. New fill materials beneath foundations (if required) should be placed and compacted as outlined below:

- Remove the in-situ material in an area 1.0 m wider than the footprint of the structure to a depth of at least 6.0 m. The excavation must be battered at a slope of 60° Stockpile this material separately for potential re-use for landscaping.
- Ensure that all the subsurface water is dried or pumped before remediation resumes.
- Rip the in-situ material to the required depth and treat the clay with 3% lime or cement.
- Compaction should be done with a 3-sided, at least 15 tonne impact roller.
- Place the well-graded G6 material or better quality (according to TRH14) on top of the treated residual material in 150 mm layers and compact each layer to 95% Mod AASHTO effort at optimum moisture content. and compact in 150mm layers to the desired founding level. **The in-situ transported and residual material encountered on-site is considered unsuitable for use as fill material.**
- The spread footing foundations of the proposed structures should be constructed on the compacted G6 material.
- The allowable bearing capacity (FoS=3) of this foundation, prepared as above, should be at least 200 kPa.

Footings should be proportioned on the basis of equal total dead load pressure to reduce differential movement between adjacent footings. Total movement resulting from the anticipated structural loads is estimated to be on the order of 15mm. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction and throughout the life of the structure. Failure to maintain the proper drainage will nullify the movement estimates provided above.

Care needs to be taken when excavating adjacent to existing foundations and slabs-on-grade. It may be necessary to underpin or shore existing structural elements during construction of new foundations. We should be contacted to provide additional recommendations, if necessary. Footings and foundation walls should be detailed and reinforced as necessary to reduce the potential for distress caused by differential foundation movement.

11.2 Foundation Interaction

Based on our observations and review of the proposed elevator plans, the foundation for the elevator addition will be approximately 9-12m above the foundation elevation of the existing building. Care should be used while excavating adjacent to the existing foundations of the building to avoid disturbing these foundation elements. If excavations need to extend below the depths of the existing foundations, we should be contacted to provide additional recommendations. Shoring of the existing foundations will be required.

Differential movement between the existing building and the proposed elevator addition will likely occur; therefore, if possible, we recommend the addition be structurally independent of the existing building. We estimate the differential movement between the addition and the existing building could be about 25mm, if the addition is constructed on a spread footing foundation system. If the proposed addition is constructed on a drilled pier foundation system, we anticipate the differential movement to be on the order of about 12.5mm.

11.3 Summary and Observations

The following observation can be made about the site investigation:

a) The site is underlain by fill, transported, and residual material a overlying weathered andesite rock.
b) In terms of restrictions set down by the Department of Mines (1970), no building should be constructed in an area in which mining activities occur or occurred within a depth of 91m below EGL.
c) It is advised that the Department of Mineral Resources be consulted or informed prior to any construction at the proposed development on the site.
d) Founding options for the proposed building addition and alterations is discussed in Sections 10.1.
e) All construction activities on site need to be carried out in accordance with the current version of SANS 1200.

11.4 Limitations

The results and recommendations presented in this report are largely based on subsurface information from a limited number of borings and our use of generally accepted analytical procedures. The ground conditions given in this report refer specifically to the field tests carried out on site. It is, therefore, quite possible that conditions at variance with those given in this report could be encountered elsewhere on-site during construction. It is therefore important that Elite be appointed to carry out periodic inspections during construction. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expenses. Allowance should also be made for conducting pile testing and pile design for the proposed development and consulting DME prior to any development.

12 References

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Appendix A

Summary of standard soil and rock profile description terminology

STANDARD DESCRIPTIONS USED IN SOIL PROFILING

1. MOISTURE CONDITION

Term	Description
Dry	
Slightly moist	Requires addition of water to reach optimum moisture content for compaction
Moist	Near optimum content
Very Moist	Requires drying to attain optimum content
Wet	Fully saturated and generally below water table

2. COLOUR

The Predominant colours or colour combinations are described including secondary coloration described as banded, streaked, blotched, mottled, speckled or stained.

3. CONSISTENCY

3.1 Non-Cohesive Soils

Term	Description
Very Loose	Crumbles very easily when scraped with geological pick
Loose	Small resistance to penetration by sharp end of geological pick
Medium Dense	Considerable resistance to penetration by sharp end of geological pick
Dense	Very high resistance to penetration to sharp end of geological pick. Requires many blows of hand pick for excavation.
Very Dense	High resistance to repeated blows of geological pick. Requires power tools for excavation

3.2 Cohesive Soils

Term	Description
Very soft	Easily penetrated by thumb. Sharp end of pick can be pushed in 30 - 40mm. Easily moulded by fingers.
Soft	Pick head can easily be pushed into the shaft of handle. Moulded by fingers with some pressure.
Firm	Indented by thumb with effort. Sharp end of pick can be pushed in up to 10mm. Can just be penetrated with an ordinary spade.
Stiff	Penetrated by thumbnail. Slight indentation produced by pushing pick point into soil. Cannot be moulded by fingers. Requires hand pick for excavation.
Very Stiff	Indented by thumbnail. Slight indentation produced by blow of pick point. Requires power tools for excavation.

4. STRUCTURE

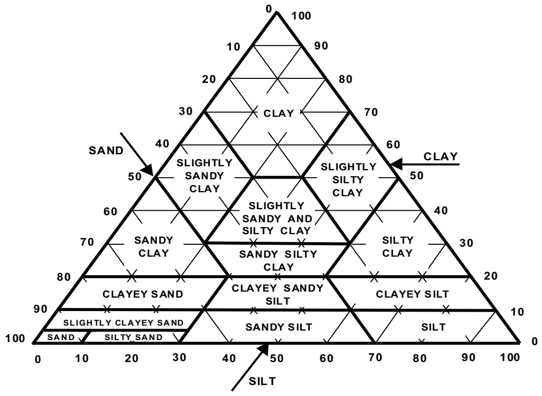
Term	Description
Intact	Absence of fissures or joints
Fissured	Presence of closed joints
Shattered	Presence of closely spaced air filled joints giving cubical fragments
Micro-shattered	Small scale shattering with shattered fragments the size of sand grains
Slickensided	Polished planar surfaces representing shear movement in soil
Bedded Foliated	Many residual soils show structures of parent rock.

5. SOIL TYPE

5.1 Particle Size

Term	Size (mm)
Boulder	>200
Pebbles	60 – 200
Gravel	60 – 2
Sand	2 – 0,06
Silt	0,06 – 0,002
Clay	<0,002

5.2 Soil Classification



6. ORIGIN

6.1 Transported Soils

Term	Agency of Transportation
Colluvium	Gravity deposits
Talus	Scree or coarse colluvium
Hillwash	Fine colluvium
Alluvial	River deposits
Aeolian	Wind deposits
Littoral	Beach deposits
Estuarine	Tidal – river deposits
Lacustrine	Lake deposits

6.2 Residual soils

These are products of in situ weathering of rocks and are described as e.g. Residual Shale

6.3 Pedocretes

Formed in transported and residual soils etc. calcrete, silcrete, manganocrete and ferricrete.

SUMMARY OF DESCRIPTIONS USED IN ROCK CORE LOGGING

1. WEATHERING

Term	Symbol	Diagnostic Features
Residual Soil	W5	Rock is discoloured and completely changed to a soil in which original rock fabric is completely destroyed. There is a large change in volume.
Completely Weathered	W5	Rock is discoloured and changed to a soil but original fabric is mainly preserved. There may be occasional small corestones.
Highly Weathered	W4	Rock is discoloured, discontinuities may be open and have discoloured surfaces, and the original fabric of the rock near the discontinuities may be altered; alternation penetrates deeply inwards, but corestones are still present.
Moderately Weathered	W3	Rock is discoloured, discontinuities may be open and will have discoloured surfaces with alteration starting to penetrate inwards, intact rock is noticeably weaker than the fresh rock.
Slightly Weathered	W2	Rock may be slightly discoloured, particularly adjacent to discontinuities, which may be open and will have slightly discoloured surfaces, the intact rock is not noticeably weaker than the fresh rock.
Unweathered	W1	Parent rock showing no discolouration, loss of strength or any other weathering effects.

2. HARDNESS

Classification	Field Test	Compressive Strength Range MPa
Extremely Soft Rock	Easily peeled with a knife	<1
Very Soft Rock	Can be peeled with a knife. Material crumbles under firm blows with the sharp end of a geological pick.	1 to 3
Soft Rock	Can be scraped with a knife, indentation of 2 to 4 mm with firm blows of the pick point.	3 to 10
Medium Hard Rock	Cannot be scraped or peeled with a knife. Hand held specimen breaks with firm blows of the pick.	10 to 25
Hard Rock	Point load tests must be carried out in order to distinguish between these classifications	25 - 70
Very Hard Rock	These results may be verified by uniaxial compressive strength tests on selected samples.	70 - 200
Extremely Hard Rock		>200

3. COLOUR

The predominant colours or colour combination are described including secondary colouration described as banded, streaked, blotched, mottled, speckled or stained.

4. FABRIC

4.1 Grain Size

Term	Size (mm)
Very Coarse	>2,0
Coarse	0,6 – 2,0
Medium	0,2 – 0,6
Fine	0,06 – 0,2
Very Fine	< 0,06

4.2 Discontinuity Spacing

Description for: Bedding, foliation, laminations	Spacing (mm)	Descriptions for joints, faults, etc.
Very Thickly Bedded	> 2000	Very Widely
Thickly Bedded	600 – 2000	Widely
Medium Bedded	200 – 600	Medium
Thinly Bedded	60 – 200	Closely
Laminated	3 – 60	Very closely
Thinly Laminated	<3	

5. ROCK NAME

Classified in terms of origin:

IGNEOUS	Granite, Diorite, Gabbro, Syenite, , Dolerite, Trachyte, Andesite, Basalt.
METAMORPHIC	Slate, Felsite, Gneiss, Schist, Quartzite
SEDIMENTARY	Shale, Mudstone, Siltstone, Sandstone, Dolomite, Conglomerate, Tillite, Limestone.

6. STRATIGRAPHIC HORIZON

Identification of rock type in terms of stratigraphic horizons.

Appendix B

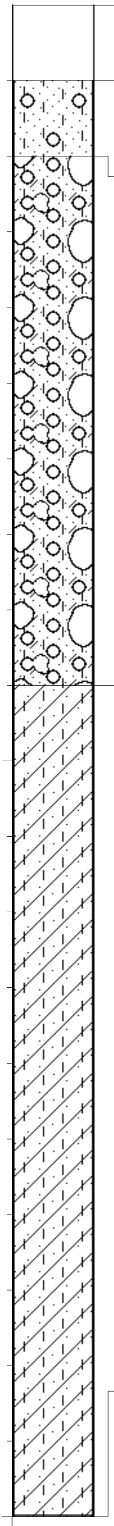
Soil Profile and Borehole Logs Descriptions

96 Rissik Street

HOLE No: TP1
Sheet 1 of 1

JOB NUMBER: 000

Scale
1:10



0.00	Concrete
0.10	Moist, dark grey, very dense, fine gravelly in a matrix of fly ash and silty SAND. **Imported Fill**.
0.20	Moist, reddish brown, dense, slightly clayey silty sand with gravel and cobbles. **Imported Fill**.
0.90	Moist, redish brown, firm, shattered, sandy silty clay. **Transported**.
2.00	

NOTES

1) No ground water seepage encountered.

2) Test pit side walls stable.

3) No sample taken.

4) No refusal on rock.

CONTRACTOR :
MACHINE : by Hand
DRILLED BY :
PROFILED BY : NM

INCLINATION :
DIAM :
DATE : 15/02/2022
DATE : 16/02/2022

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP1

TYPE SET BY :
SETUP FILE : STANDARD.SET

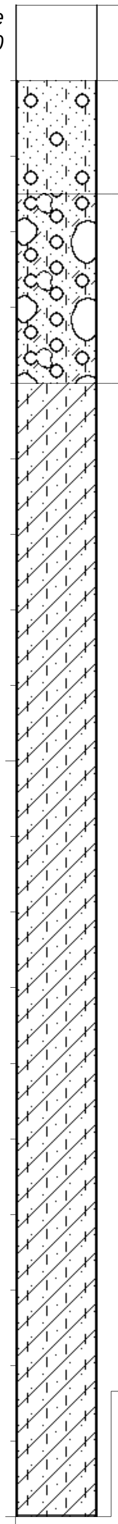
DATE : 15/03/2022 22:32
TEXT : ..n\96RissikStreetlogs.txt

96 Rissik Street

HOLE No: TP2
Sheet 1 of 1

JOB NUMBER: 000

Scale
1:10



0.00	Concrete
0.10	Moist, dark grey, very dense, fine gravelly in a matrix of fly ash and silty SAND. **Imported Fill**.
0.25	Moist, reddish brown, dense, slightly clayey silty sand with gravel and cobbles. **Imported Fill**.
0.50	Moist, redish brown, firm, shattered, sandy silty clay. **Transported**.
2.00	

NOTES

1) No ground water seepage encountered.
2) Test pit side walls stable.
3) No sample taken.
4) No refusal on rock.

CONTRACTOR :
MACHINE : by Hand
DRILLED BY :
PROFILED BY : NM
TYPE SET BY :
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 15/02/2022
DATE : 16/02/2022
DATE : 15/03/2022 22:32
TEXT : ..n\96RissikStreetlogs.txt

ELEVATION :
X-COORD :
Y-COORD :

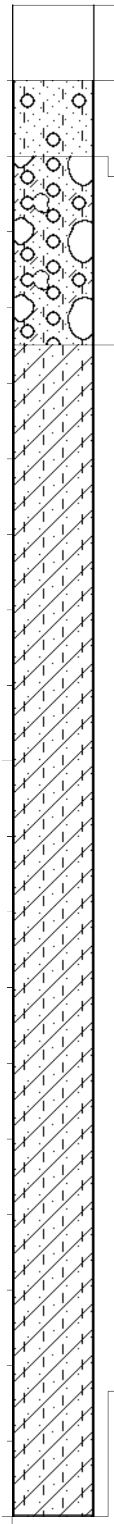
HOLE No: TP2

96 Rissik Street

HOLE No: TP3
Sheet 1 of 1

JOB NUMBER: 000

Scale
1:10



0.00

Concrete

0.10

Moist, dark grey, very dense, fine gravelly in a matrix of fly ash and silty SAND. **Imported Fill**.

0.20

Moist, reddish brown, dense, slightly clayey silty sand with gravel and cobbles. **Imported Fill**.

0.45

Moist, redish brown, firm, shattered, sandy silty clay. **Transported**.

2.00

NOTES
1) No ground water seepage encountered.
2) Test pit side walls stable.
3) No sample taken.
4) No refusal on rock.

CONTRACTOR :
MACHINE : by Hand
DRILLED BY :
PROFILED BY : NM

INCLINATION :
DIAM :
DATE : 15/02/2022
DATE : 16/02/2022

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP3

TYPE SET BY :
SETUP FILE : STANDARD.SET

DATE : 15/03/2022 22:32
TEXT : ..n\96RissikStreetlogs.txt

96 Rissik Street

LEGEND
Sheet 1 of 1

JOB NUMBER: 000

GRAVEL	{SA02}
GRAVELLY	{SA03}
SAND	{SA04}
SANDY	{SA05}
SILTY	{SA07}
CLAY	{SA08}
CLAYEY	{SA09}
COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 15/03/2022 22:32
TEXT : ..n\96RissikStreetlogs.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

HOLE No: BH01
Sheet 1 of 1

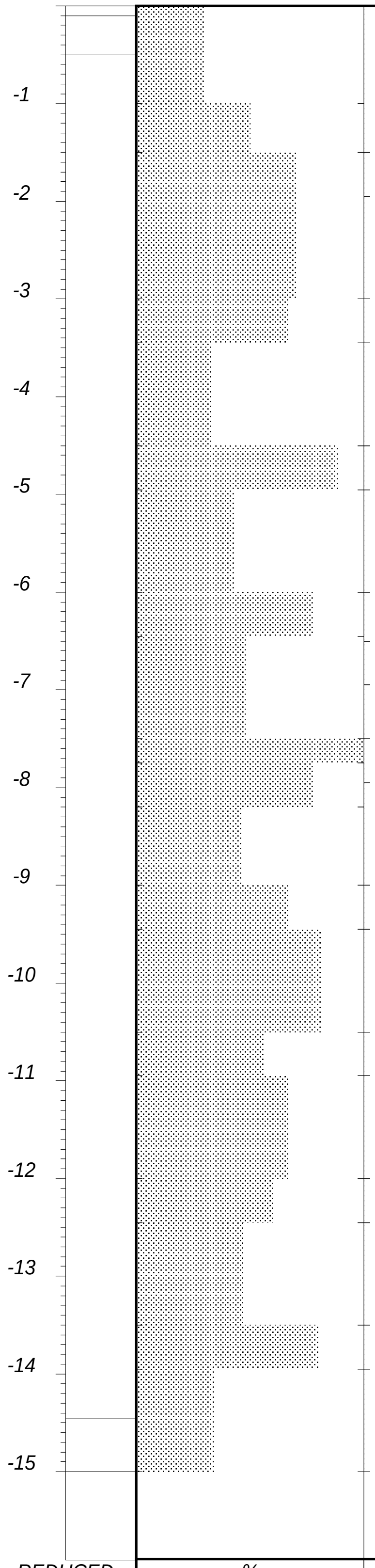
JOB NUMBER: EGE202132

ROCK FABRIC	*GRAIN SIZE*	*JOINT ROUGHNESS*	*ROCK HARDNESS*
MF -massive	*FG -fine grained*	*SLJ-slickensided*	*EHR-extremely hard rock*
BF -bedded	*MG -medium grain*	*SJ -smooth*	*VHR-very hard rock*
FF -foliated	*CG -coarse grain*	*RJ -rough*	*HR -hard rock*
CF -cleaved			*MHR-medium hard rock*
SF -schistose	*JOINT SPACING*	*JOINT SHAPE*	*SR -soft rock*
GF -gneissose	*VCJ-very close spacg*	*CUR-curvilinear*	*VSR-very soft rock*
LF -laminated	*CJ -close spacing*	*PLA-planar*	
	MJ -medium spacing	*UND-undulating*	
	WJ -wide spacing	*STE-stepped*	
	VWJ-very wide spacng	*IRR-irregular*	

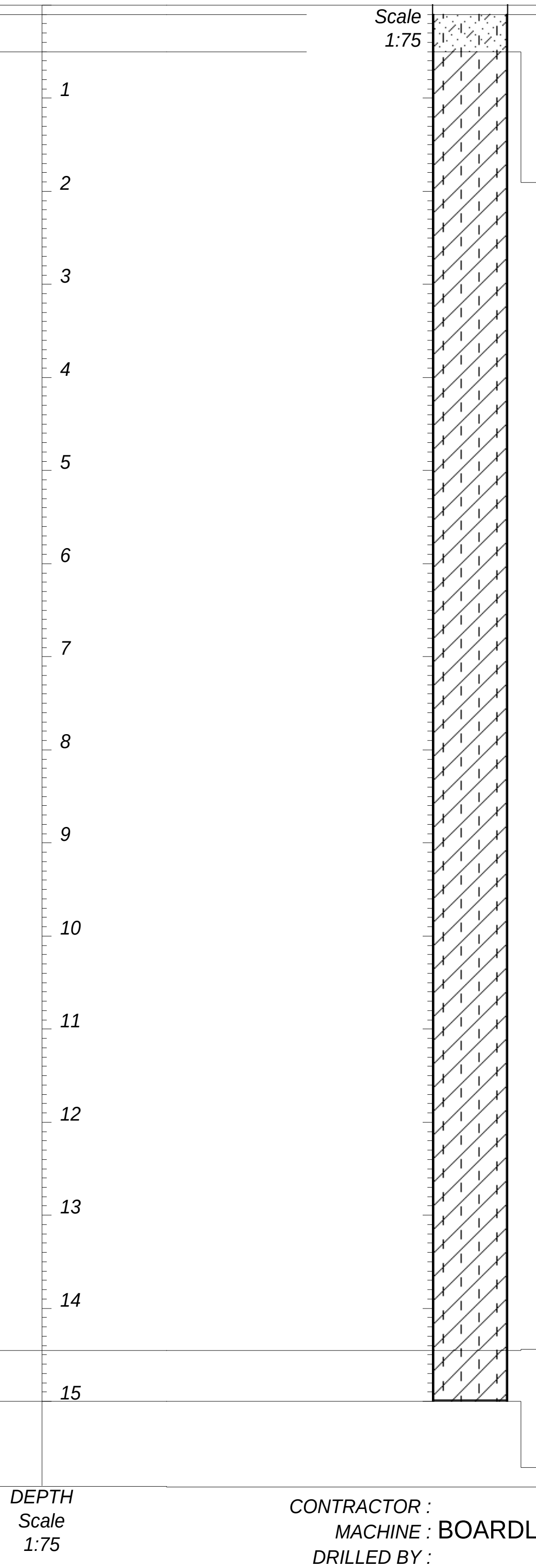
Lodemann Holdings (Pty) Ltd
Geotec BOREHOLE LOG

HOLE No: BH01
Sheet 1 of 1

JOB NUMBER: EGE202132



% RQD	STP-N Is50 (D/A)	Weathering
	5	W6
	5	
	13	
	16	
	19	
	21	
	24	
	27	



0.00	Concreate.
0.10	Moist, light grey mottled reddish-brown to orangey reddish-brown, loose, gravel in a matrix of clayey silty sand. Imported Fill.
0.50	Moist, orangey-brown, soft, shattered, silty clay. Transported.
14.45	Moist, orangey yellowish-brown, firm, shattered, silty clay with very soft rock fragments. Residual andesite.
15.00	

CONTRACTOR :
MACHINE : BOARDLONGYEAR L90
DRILLED BY :
PROFILED BY : NM

TYPE SET BY :
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE : 28/01/2022
DATE : 12/02/2022

DATE : 15/03/2022 22:00
TEXT : ..deman\GeotechlogBH01.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: BH01

dot●PLOT

Lodemann Holdings (Pty) Ltd
Geotec BOREHOLE LOG

LEGEND
Sheet 1 of 1

JOB NUMBER: EGE202132

⁙	SAND	{SA04}
⁞	SILTY	{SA07}
▨	CLAY	{SA08}
⁄	CLAYEY	{SA09}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 15/03/2022 22:00
TEXT : ..deman\GeotechlogBH01.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

Appendix C

In-situ SPT Results

SGS MATROLAB

CONSOLIDATED UNDRAINED TRIAXIAL TEST

BS 1377
Part 8

Client: ELITE ENVIRO CONSTRUCTION **Project:** 96 RISIK STREET **Job no:** 48920
Sample no: BH **Date:** 04/04/2022
Lab no: G22-0295 **Depth (m):** 7.0-7.75

Test Information		
Test Type	-	Consolidated Undrained with PWP measurements, saturated
Sample Condition	-	Undisturbed
Saturation Method		Increments of Cell- and Backpressure
Consolidation Pressures	kPa	200, 400,
Rate of Strain	%/min	0.0104
Failure Criterion	-	Maximum Deviator Stress
Side Drains Used	-	No
Drainage Conditions	-	To One End
Comments	-	Test sample was to short to cut out three test specimense only two were tested as per client request.

Initial Sample Parameters	**Unit**	**Test 1**	**Test 2**	**Test 3**	**Remarks**
Moisture Content	%	48.4	43.9	Not Tested	Complete test specimen
Dry Density	Kg/m³	1152	1230	Not Tested	
Void Ratio	-	1.358	1.207	Not Tested	
Degree of Saturation	%	96.7	98.8	Not Tested	
Initial Height	cm	7.6	7.6	Not Tested	
Initial Diameter	cm	3.8	3.8	Not Tested	
Area (After Consolidation)	cm²	10.746	10.829	Not Tested	Calculated
Relative Density (SG)	-	2.716			Determined

Final Sample Parameters		**Unit**	**Test 1**	**Test 2**	**Test 3**	**Remarks**
Moisture Content		%	47.5	44.8	Not Tested	Complete test specimen
Dry Density		Kg/m³	1233	1309	Not Tested	
Void Ratio		-	1.202	1.075	Not Tested	
Area		cm²	12.800	12.890	Not Tested	Calculated
Eff. Consolidation Pressures		kPa	196	401	Not Tested	
Total Backpressure used		kPa	300	400	Not Tested	Saturation
Final B Parameter		-	0.96	0.96	Not Tested	
Cell Pressure		kPa	500	800	Not Tested	Consolidation & Shear
Axial Strain at Max. Deviator Stress		%	7.31	4.04	Not Tested	
Volume Change		ml	5.6	5.2	Not Tested	During Consolidation
Principal Stresses at Max. Deviator Stress	σ1	kPa	437	844	Not Tested	Corrected
	σ3	kPa	196	401	Not Tested	Corrected
	σ1'	kPa	327	590	Not Tested	Corrected
	σ3'	kPa	86	147	Not Tested	Corrected

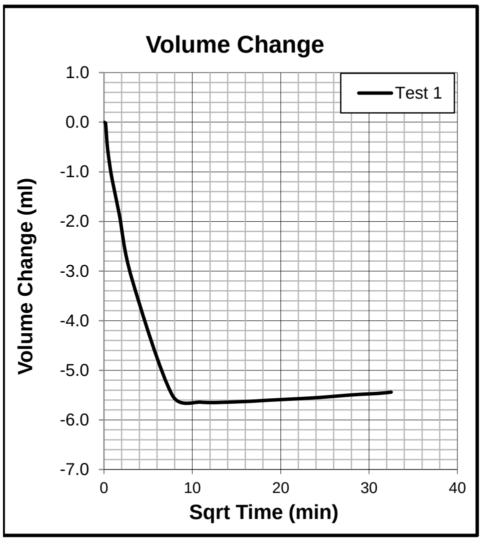
CONSOLIDATED UNDRAINED TRIAXIAL TEST

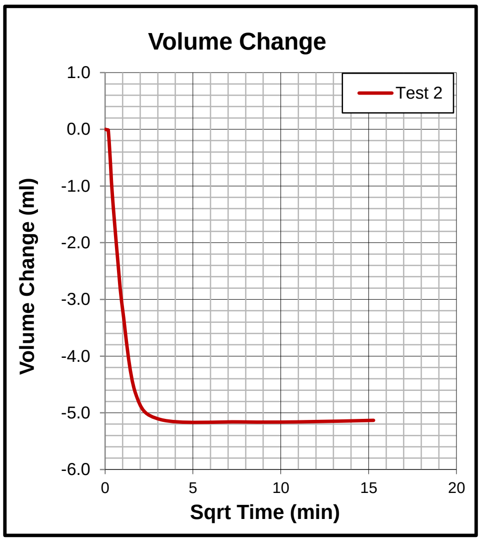
BS 1377
Part 8

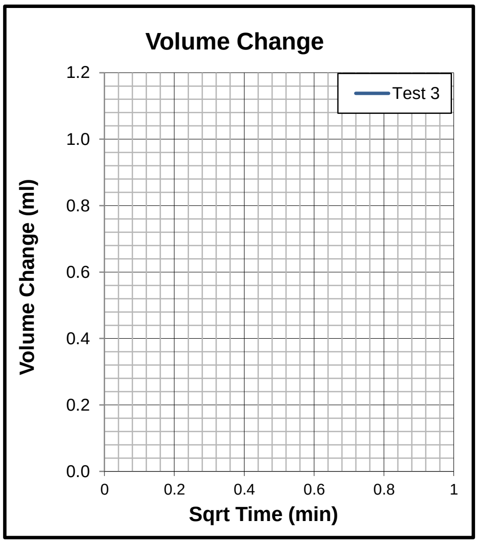
Client: ELITE ENVIRO CONSTRUCTION **Project:** 96 RISIK STREET **Job no:** 48920

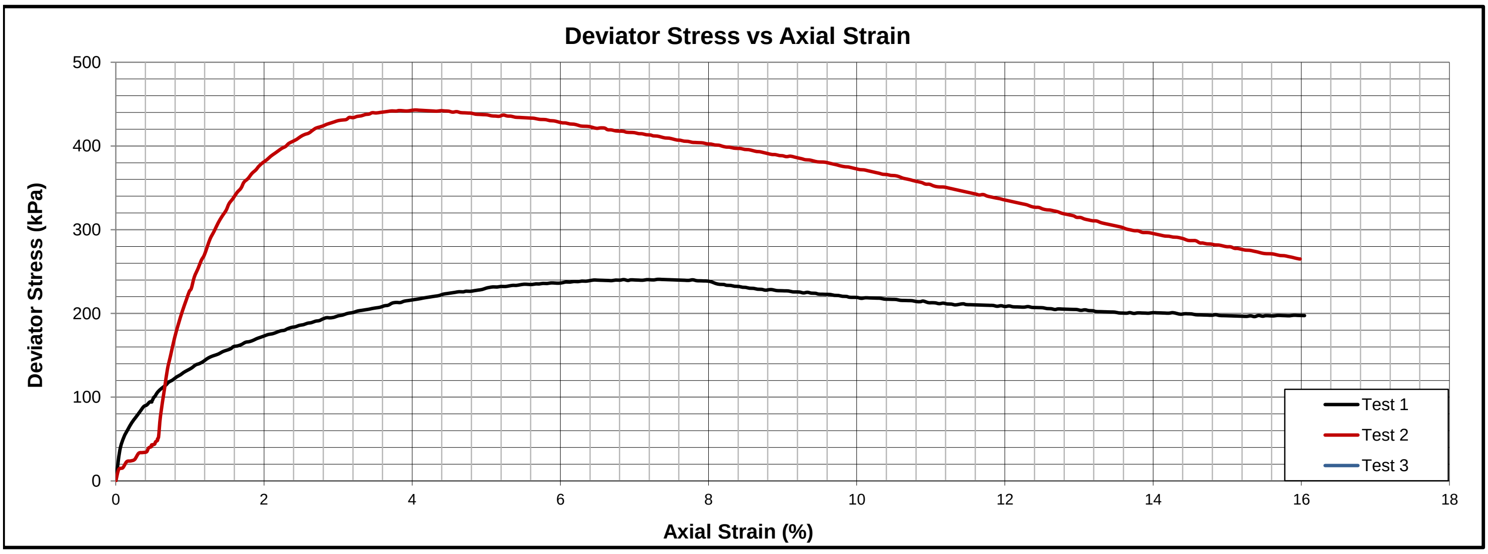
Sample no: BH **Date:** 04/04/2022

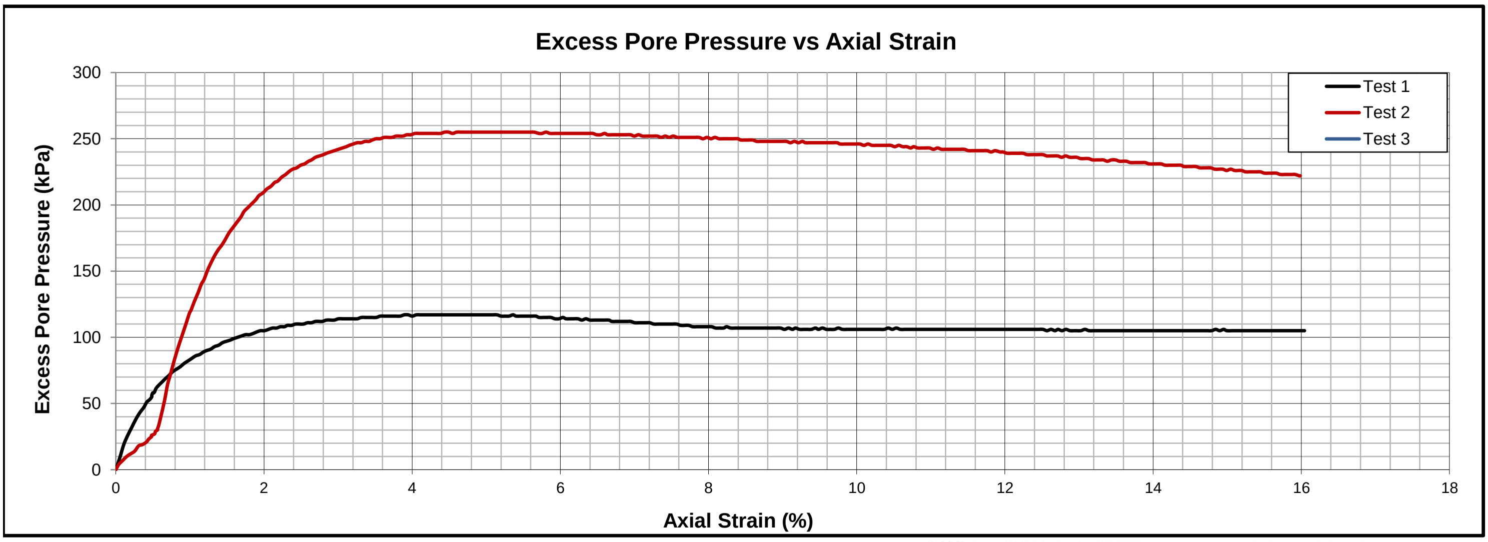
Lab no: G22-0295 **Depth (m):** 7.0-7.75 Sample Condition: Undisturbed











MATROLAB IS NOW PART OF SGS, THE WORLDS'S LEADING INSPECTION, VERIFICATION, TESTING AND CERTIFICATION COMPANY

CONSOLIDATED UNDRAINED TRIAXIAL TEST

BS 1377
Part 8

Client: ELITE ENVIRO CONSTRUCTION **Project:** 96 RISIK STREET **Job no:** 48920

Sample no: BH **Date:** 04/04/2022

Lab no: G22-0295 **Depth (m):** 7.0-7.75 Sample Condition: Undisturbed

Shear Parameters of Effective Stresses		
Angle of Internal Friction	Deg.	**36**
Cohesion	kPa	**0**

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CONSOLIDATED UNDRAINED TRIAXIAL TEST

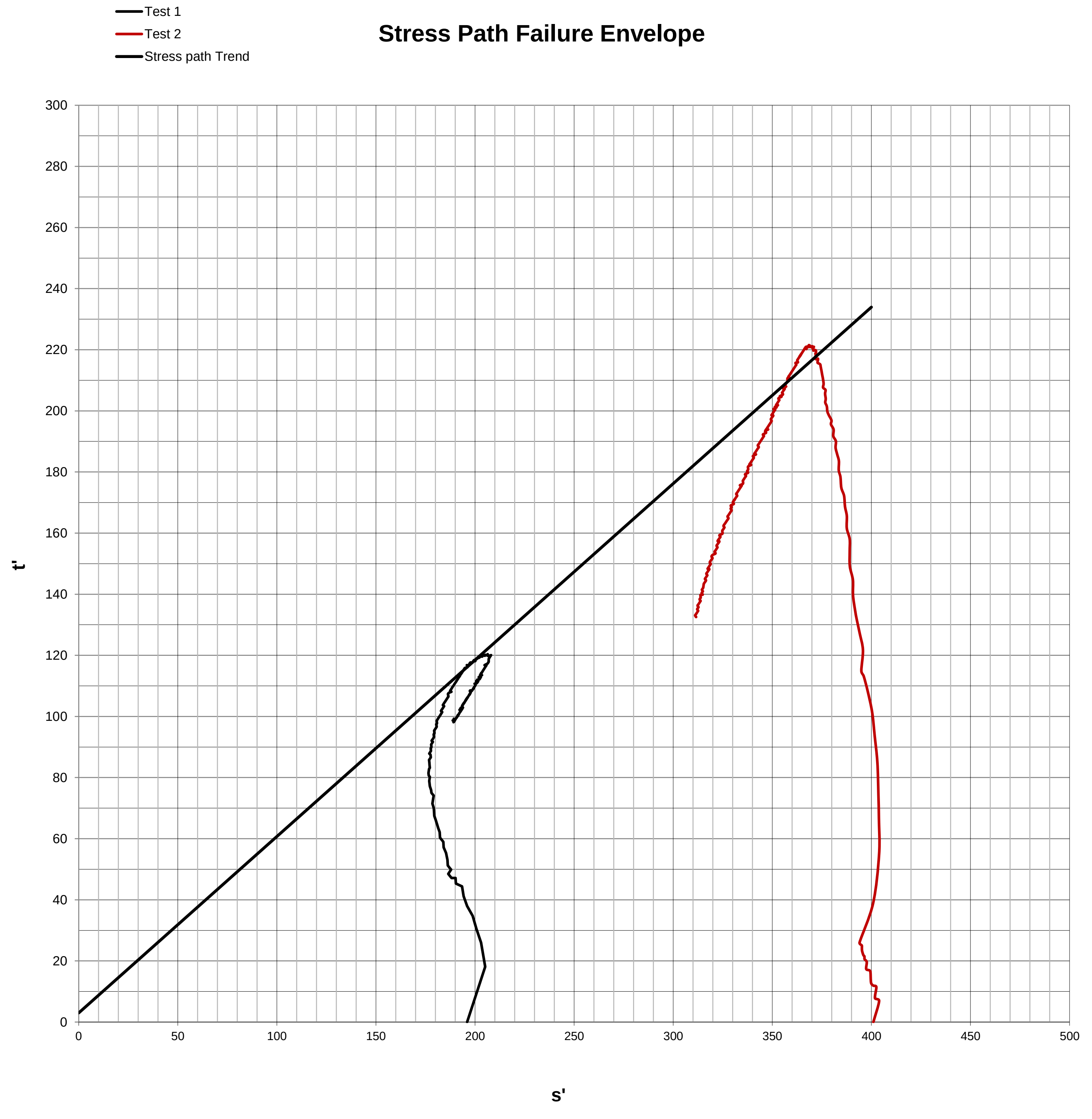
BS 1377
Part 8

Client: ELITE ENVIRO CONSTRUCTION **Project:** 96 RISIK STREET **Job no:** 48920

Sample no: BH **Date:** 04/04/2022

Lab no: G22-0295 **Depth (m):** 7.0-7.75 Sample Condition: Undisturbed

Shear Parameters at Failure		
Angle of Internal Friction	Deg.	**30**
Cohesion	kPa	**3**



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CONSOLIDATED UNDRAINED TRIAXIAL TEST

BS 1377 Part 8

Client: ELITE ENVIRO CONSTRUCTION **Project:** 96 RISIK STREET **Job no:** 48920

Sample no: BH **Date:** 04/04/2022

Lab no: G22-0295 **Depth (m):** 7.0-7.75 Sample Condition: Undisturbed

Test 1

BEFORE TEST

AFTER TEST

Test 2

BEFORE TEST

AFTER TEST

Test 3

BEFORE TEST

AFTER TEST

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SGS MATROLAB

sanas
Testing Laboratory
T0025

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria.
P.O Box 912387,Silverton,0127
Tel. : (012) 800 1299
Fax :
Email : martinus.schwartz@sgs.com

TEST RESULTS

ELITE ENVIRO CONSTRUCTION

Attention: Njabulo Mthembu

Project : 96 Rissik Street

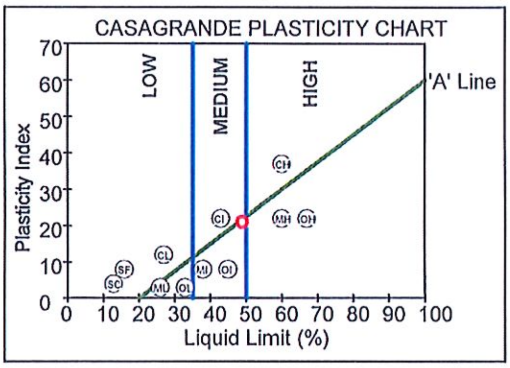
Your Ref :
Our Ref : PL/49123
Date Reported : 31.03.2022

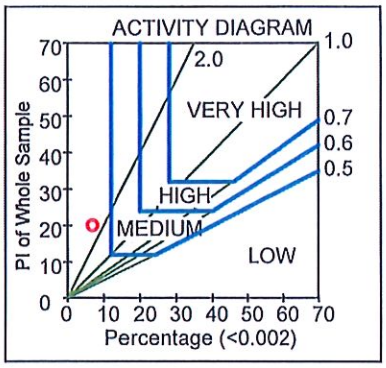
FOUNDATION INDICATOR (ASTM: D422)

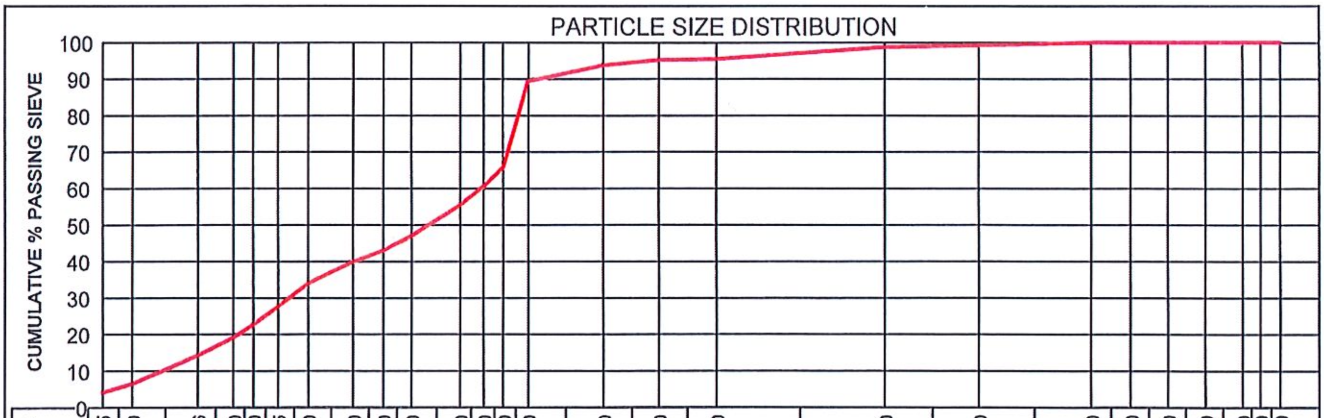
Sample No. : A22/0942
Hole No. : BH
Depth : 6000-6500
Liquid Limit (%) : 49
Plasticity Index : 21
Linear Shrinkage (%) : 9.0
PI of Whole Sample : 20
P.R.A. Classification : A-7-6(14)
Unified Soil Classificati: ML
Activity : 2.86
Heave Classification : LOW
Grading Modulus : 0.16
Percentage (<0.002) : 7.0
Moisture Content (%) : 3.1

Material Description : SANDY SILT

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	19.2	41.4	38.1	1.3	SANDY SILT
Astm	19.2	70.1	10.0	0.7	SANDY SILT
British Standard	6.6	59.3	32.8	1.3	SANDY SILT







Sieve Size (mm)	% Pass. Sieve
0.0015	4
0.0020	7
0.0036	14
0.0050	19
0.0060	23
0.0075	28
0.0100	34
0.0150	40
0.0200	43
0.0260	47
0.0400	55
0.0500	61
0.0600	66
0.0750	89
0.1500	94
0.2500	95
0.4250	96
2.0000	99
4.7500	99
13.200	100
19.000	100
26.500	100
37.500	100
53.000	100
63.000	100
75.000	100

JENN CLAY | SILT | SAND | GRAVEL
ASTM CLAY | SILT | FINE SAND | MEDIUM SAND | COARSE SAND | GRAVEL
BS CLAY | FINE SILT | MEDIUM SILT | COARSE SILT | FINE SAND | MEDIUM SAND | COARSE SAND | FINE GRAVEL | MEDIUM GRAVEL | COARSE GRAVEL

Remarks : Sampled by client.

FORM: A6

4.5.0(SGS)(2021.05.05)

Technical Signatory : Martinus Schwartz/Sunil Dewnath

SANAS Testing Laboratory
T0025

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria.
P.O Box 912387,Silverton,0127
Tel. : (012) 800 1299
Fax :
Email : martinus.schwartz@sgs.com

TEST RESULTS

ELITE ENVIRO CONSTRUCTION

Attention: Njabulo Mthembu

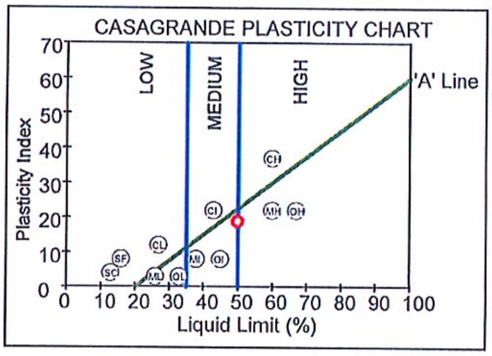
Project : 96 Rissik Street
Your Ref :
Our Ref : PL/49123
Date Reported : 31.03.2022

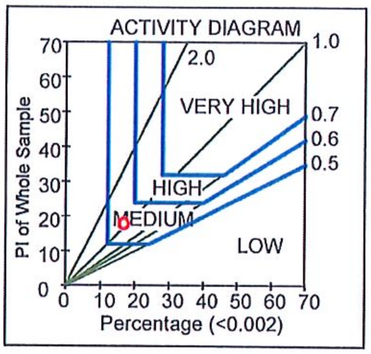
FOUNDATION INDICATOR (ASTM: D422)

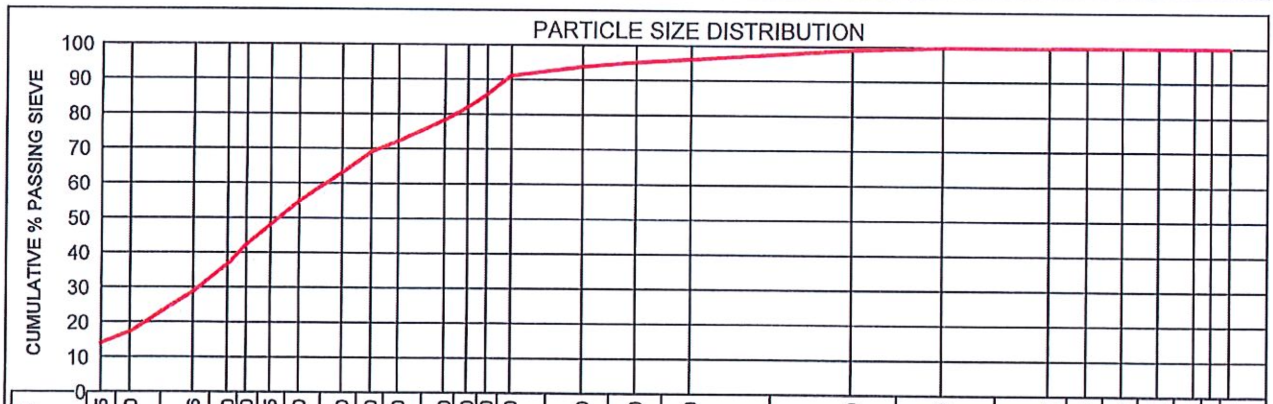
Sample No. : A22/0941
Hole No. : BH 2
Depth : 16950-18000
Liquid Limit (%) : 50
Plasticity Index : 19
Linear Shrinkage (%) : 9.0
PI of Whole Sample : 18
P.R.A. Classification : A-7-5(14)
Unified Soil Classificati: MH
Activity : 1.06
Heave Classification : MEDIUM
Grading Modulus : 0.14
Percentage (<0.002) : 17.0
Moisture Content (%) : 39.1

Material Description : SILTY CLAY

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	36.7	45.3	17.0	0.9	SILTY CLAY
Astm	36.7	54.5	8.7	0.1	SILTY CLAY
British Standard	17.3	68.5	13.3	0.9	SANDY SILT







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0260	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	14	17	29	37	42	48	55	63	69	72	78	82	86	91	94	95	96	99	100	100	100	100	100	100	100	100

JENN CLAY | SILT | SAND | GRAVEL
ASTM CLAY | SILT | FINE SAND | MEDIUM SAND | COARSE SAND | GRAVEL
BS CLAY | FINE SILT | MEDIUM SILT | COARSE SILT | FINE SAND | MEDIUM SAND | COARSE SAND | FINE GRAVEL | MEDIUM GRAVEL | COARSE GRAVEL

Remarks : Sampled by client.

FORM: A6

4.5.0(SGS)(2021.05.05)

Technical Signatory : Martinus Schwartz/Sunil Dewnath

MATROLAB IS NOW PART OF SGS, THE WORLDS`S LEADING INSPECTION, VERFICATION, TESTING AND CERTIFICATION COMPANY.