UNIVERSITY OF MPUMALANGA

DEVELOPMENT OF 3000 BEDS (GEOTECHNICAL INVESTIGATION)

Date: 02 FEBRUARY 2021

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	Role	Name	Signature	Date
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1 INTRODUCTION

By mid-December 2020, AES Consulting appointed Latavha Pty Limited to undertake the Geotechnical investigation study for the proposed development of 3000 beds for the University of Mpumalanga. The physical and geotechnical nature of the site needs to be investigated to facilitate the civil engineering design and foundation solution. Latavha was advised that the development comprises of a new building blocks and its associated structures.

The report presents the finding of the site with regards to the Revised Edition of the Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa which was published in September 2002.

This report discusses the method of investigation, geotechnical conditions encountered on-site, material characteristics, recommendations and general considerations.

2 TERMS OF REFERENCE

The appointment was to do an engineering geotechnical investigation for the proposed development. The following were to be address:

a) The geotechnical characteristics of the site
b) Soil conditions
c) Geotechnical constraints
d) Geohydrology
e) Recommendations

3 OBJECTIVES

Preliminary study is commissioned to established whether or not the parcel of land is suitable for development. This includes:

a) Determine the geological origin of the material on site.
b) Assess the suitability of site for the proposed project, e.g. site geology and soil conditions, possible adverse geological conditions, possible unstable ground conditions and existing undermining.
c) Identify problem areas at a sufficiently early stage.
d) Determine the engineering properties of the near surface soil.

e) Comment on the founding conditions
f) Carry out appropriate laboratory test of the near surface soils.
g) To comment upon any constrains that may impact upon the design and constructions of proposed development.

4 AVAILABLE INFORMATION

a) A 1:250 000 "2530" Barberton scale Geological Map from Council for Geoscience
b) Topographical maps and google earth images provided by the client.

Laboratory test results from tests conducted on selectively retrieved soil horizons retrieved during this investigation were available at the time of writing this report.

5 BIOPHYSICAL DESCRIPTION

5.1 Site Location and Description

The proposed site for the development of the student accommodations is situated in Mpumalanga, Nelspruit town. The site is situated on the northern side of N4 road and it is approximately 4.8km east of the Riverside mall. The area falls under the Mbombela local Municipality, Mpumalanga Province.

The total area of the proposed new student accommodations site covers approximately 24,7 hectares.

Table 1: Coordinates of the proposed site.

Latitude	-25.434718°
Longitude	31.013552°

Figure 1: Locality map for the site under investigation.

5.2 Climate and Hydrology

The Nelspruit lies on 719m above sea level. The climate in Nelspruit is mild, and generally warm and temperate. In winter, there is much less rainfall than in summer. This climate is considered to be Cwa according to the Köppen-Geiger climate classification. The temperature in Nelspruit averages 19.8 °C. Precipitation is about 796 mm per year. Precipitation is the lowest in June, with an average of 11 mm. Most precipitation falls in January, with an average of 130 mm. At an average temperature of 23.6 °C, January is the hottest month of the year. In July, the average temperature is 14.6 °C. It is the lowest average temperature of the whole year. Between the driest and wettest months, the difference in precipitation is 119 mm. The average temperatures vary during the year by 9.0 °C.

The climatic N-value (after Weinert 1980) for the area is moderate (2 – 5), which implies that chemical decomposition is the dominant mode of rock weathering. The importance of this is thus chemical breakdown of rock material will take place, which may result into the formation of expansive clay if the suitable parent material is available.

5.3 Surface water

There is no evident of a stream running within the proposed site, but few streams were observed around the proposed site.

5.4 Land use

Some part of the proposed area seems to have been used for agricultural activities and wildlife conservation before, and the other part is still pristine.

6 METHOD OF INVESTIGATION

The geotechnical investigation commenced with a desktop study, which entailed obtaining as much information as possible of the site that may provide indication of the most likely sub-soil and associated geotechnical conditions prevailing within the area. By determining the underlying geological setting together with prevailing topographical and climatic condition, the weathering characteristic of the host rock can be estimated and the indication of the most likely geotechnical condition underlying the site can be established.

The desktop study was followed by a site reconnaissance which was carried on 11th January 2021. This was done through walking over the entire area whilst noting and recording information for visible surface information from this phase of investigation, together with desktop study provided preliminary assessment of the geotechnical condition underlying the site and identify areas necessary for further investigation.

Field investigation was carried out on 13th January 2021 and entailed setting out fourteen trial pits excavated using TLB machine. These trial pits were strategically located to give representative soil profiles. Trial pits referred as UM 01 to UM 14 were excavated at position shown on the attached plan.

Data collated during desktop phase, field investigation and sample analyses have been used to compile this report with interpretation

7 FIELDWORK

7.1 Trial pits

The site investigation was carried on the 13th January 2021 and lasted for a day. Fourteen trial pits were excavated using a TLB machine. Trial pits were excavated within the proposed school and the maximum depth reached was 1,6m below the surface.

The soil profiles were described according to the standard method proposed by Jennings, Brink and Williams (1973).

Disturbed samples of the most prominent soil horizons were taken and submitted to a SANAS accredited soil laboratory for CBR and foundation indicators tests. The trial pits were loosely backfilled after profiling.

The position of the trial pits was determined with the aid of a hand-held GPS, the test holes profile is presented in Appendix A of this report and its approximate location is indicated on a trial pits locality plan attached in Appendix C.

Figure 2: A photograph showing a typical trial pit on site

Table 2: Summary of trial pits.

Test pits name	End of hole	Depth (m)	Material at base of test pit	Water seepage
UM 01	Refusal	0,4	Granite bedrock	No seepage or groundwater encountered
UM 02	Refusal	1,3	Granite bedrock	No seepage or groundwater encountered
UM 03	Refusal	1,1	Granite bedrock	No seepage or groundwater encountered
UM 04	Refusal	0,4	Granite bedrock	No seepage or groundwater encountered
UM 05	Refusal	0,6	Granite bedrock	No seepage or groundwater encountered
UM 06	Refusal	0,5	Granite bedrock	No seepage or groundwater encountered
UM 07	Refusal	0,5	Granite bedrock	No seepage or groundwater encountered
UM 08	Refusal	1,6	Granite bedrock	No seepage or groundwater encountered
UM 09	Refusal	0,4	Granite bedrock	No seepage or groundwater encountered
UM 10	Refusal	1,6	Granite bedrock	No seepage or groundwater encountered
UM 11	Refusal	0,6	Granite bedrock	No seepage or groundwater encountered
UM 12	Refusal	1,6	Granite bedrock	No seepage or groundwater encountered
UM 13	Refusal	1,3	Granite bedrock	No seepage or groundwater encountered

Test pits name	End of hole	Depth (m)	Material at base of test pit	Water seepage
UM 14	Refusal	0,8	Granite bedrock	No seepage or groundwater encountered

Table 3: Investigated area site photo logs.

Photo Logs: UMP Student Accommodations	
	
	

7.2 Laboratory testing

Recovered soil samples were submitted to specialized testing laboratory, a SANAS accredited soil laboratory in Pretoria where appropriate laboratory tests were conducted to determine the engineering properties of the existing layers.

The following tests were conducted:

a) Foundation Indicator tests

b) CBR and Mod

8 UNDERLYING GEOLOGY AND SOIL PROFILE

8.1 Local geology

As shown in (Fig. 2) the study area is entirely underlain by Znm (potassic gneiss and migmatite with some phenocrysts; strongly porphyroblastic; veined by granodiorite) belong to the Nelspruit suite.

Granite is a coarse-grained igneous rock composed mostly of quartz, alkali feldspar, and plagioclase. It forms from magma with a high content of silica and alkali metal oxides that slowly solidifies underground.

The soils are predominately sandy in the uplands with a low clay content, with clay soils in the bottom lands (Mucina and Rutherford, 2006). The main underlying rock formation is Quartz-feldspar rocks of the Makhutswi Gneiss (Swazian) domain.

Figure 3: Site geological map.

8.2 Soil profile

Our interpretation of soil and groundwater conditions at the project site is based on information obtained at the test pits location only. This information has been used as the basis for our conclusions.

Descriptions of the various soil horizon as encountered in the test pits are given in the sub-sections below.

8.2.1 Colluvium

The colluvium horizon forms the most upper layers of the site. This horizon is characterised by slightly moist, dark reddish brown to grey, loose to medium in consistency and with intact structure, soil type was sandy gravel and gravelly sand with plants roots at some place. Material found here are loose, unconsolidated sediments that have been deposited either by gravity or downslope creep, or a variable combination of these processes.

8.2.2 Residual granite

The residual granite horizon was found just below the colluvium horizon. It is characterised by slightly moist, dark reddish brown to yellowish, medium dense to dense in consistency, intact, gravelly sand to sandy gravels with roots.

8.2.3 Weathered granite

The weathered granite was only encountered on trial pit (UM11) and is characterised by light grey weathered granite rock with coarse grained and medium hardness.

8.2.4 Granite bedrock

All trial pits end of hole was due to refusal on granite bedrock. It was described as light greyish, coarse grained and medium to hard granite.

8.3 Laboratory soil testing

8.3.1 CBR and Foundation indicators

Representative samples of various soil horizons were collected for Indicator tests in order to determine their basic geotechnical properties, estimate potential expansivity. The tests performed for this investigation are summarised below.

Table 4: Summary of foundation indicators

TEST PIT NO:	DEPTH (m)	DESCRIPTION	LIQUID LIMIT	PLASTICITY INDEX	LINEAR SHRINKAGE	GRADING MODULUS	UNIFIED SOIL CLASSIFICATION	POTENTIAL EXPANSIVENESS
UM 01	0.0-0.4	Gravelly sand	-	NP	0	1.37	SM	NP
UM 04	0.0-0.6	Gravelly sand	-	NP	0	1.64	SM	NP
UM 02	0.6-1.3	Gravelly sand	34	17	8	1.51	SC	Low
UM 08	0.8-1.6	Gravelly sand	-	NP	0	1.39	SM	NP
UM 10	0.3-1.6	Sandy gravel	33	12	6	1.93	SC	Low
UM13	0.4-1.3	Gravelly sand	26	9	4	1.74	SC	Low
UM 14	0.2-0.6	Gravelly sand	-	SP	0.5	1.81	SM	NP

One of the major design factors for building structures is the shrinking and swelling potential of fine-grained soils. The shrink/swell movements can be estimated using the Plasticity Index (PI). Generally, the higher the PI of a material, the greater the potential for soil movements during moisture changes; the results of the Atterberg Limits tests indicate that the soil at the site has non plastic to low expansion potential.

Shrink-swell movement occurs in response to soil moisture content changes beneath the slab. Moisture changes occur beneath the slab due to seasonal changes in the relative amount of rainfall and evaporation potential. Also, soil moisture changes result from the construction of a slab-on-grade floor due to the presence of the slab/vapor barrier/grade beam system. The installation of the slab, vapor barrier, and grade beams reduces the natural moisture transfer from the subsurface beneath the building and generally causes the soil moisture content to increase in the soil beneath the building after construction. Another significant cause of soil moisture change is changes in vegetation, particularly trees, associated with landscaping.

Material was sampled and classify as sandy gravel and gravelly sand with a grading modulus of between 1.37 and 1.93. Soils with a good gradings are generally characterized with higher grading modulus. Coarse grained soil has some good compatibility characteristics compared to finer material and can normally carry much heavier loads without deformation than finer materials. The material sampled has a linear shrinkage ranges between 0% and 8% for all the samples which may be associated with a non-plastic to low expansive potential according to Van Der Merwe's Classification System.

The Liquid Limit of the samples ranges between 26% and 34%. Furthermore, the laboratory tests indicate that the samples have high gravel and sand content. The low Plasticity Index indicate that the samples will exhibit a non to low potential expansiveness (Van der Merwe, 1964).

Material on-site are classified as SC and SM class in accordance to Unified Soil Classification System (USCS), where SC is clayey sand, sand- clay mixture with Atterberg limits above A-line with PI> 7 and SM is silty sands, sand-silt mixtures with Atterberg limits below A- line or PI < 4.

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Table 5: Summary of CBR results

TEST PIT NO:	DEPTH (m)	DESCRIPTION	LIQUID LIMIT	PLASTICITY INDEX	LINEAR SHRINKAGE	GRADING MODULUS	OMC %	MDD (kg/m3)	CBR- Results (% Compaction)				Classification
									93	95	98	100	COLTO: 1998
UM 02	0.6-1.3	gravelly sand	34	17	8	1.51	9.1	1994	8	11	19	27	>G9
UM 08	0.8-1.6	gravelly sand	-	NP	0	1.39	6.5	2087	27	53	145	282	G6
UM 10	0.3-1.6	Sandy gravel	33	12	6	1.93	8.2	2063	11	16	26	35	G8

Three samples were collected and submitted for CBR testing. The samples indicate good to poor compaction characteristics of the surficial soils with the grading modulus ranging between 1.39 and 1.93. The CBR tested classifies as G6 to >G9 according to COLTO classification.

8.4 Outcrops

The south eastern part of the site and few patches within the investigated site is covered by boulders and outcrops of granite. The granite found on site was described to be light greyish, coarse grained and very hard granite.

Figure 4: A photographs showing outcrops.

9 WATER LEVEL MEASUREMENTS

Groundwater was not encountered during test pits excavation or profiling. Maximum depth reached was at 1.6.m depth below ground level. It should be noted that groundwater levels determined during excavation may not accurately reflect the true groundwater conditions, and therefore should only be considered as approximate.

10 INTERRUPTION TO SERVICES

It is evident that the development is cross cutting through underground services and as such it is advisable that this service be identified to minimize interruption during construction.

11 DEMOLITIONS

Prior to the start of earthwork, the existing structures on the site will require demolition and removal including the building, foundation slabs pavement and walls. It is not known if the existing buildings contain any buried structures. It should be anticipated that the buried remnants of previous construction could also be encountered anywhere on the site including walls, slabs, etc.

Any void created from the demolition should be properly backfilled to the limits determined by the project geotechnical engineer. Any soils loosened or disturbed during the demolition should be removed.

12 GEOTECHNICAL ASSESSMENT

12.1 Problem soils

Problem soils such as dolomite and marshy areas were not encountered on site.

12.2 Collapsible soil

The sidewalls for all trial pits were stable during excavation and profiling. Soil with an open structure that may exhibit collapsible conditions were not encountered.

12.3 Groundwater seepage

Groundwater was not encountered during test pits excavation or profiling. Maximum depth reached was at 1.6m depth below ground level.

12.4 Expansive soils

The site is mainly underlain by sandy gravel and gravelly sand, therefore, problems associated with expansive soils such as differential volume change of the soil (heaving and shrinking) are not anticipated on the site.

12.5 Undermined areas or ground

The site has not been subject to underground mining. No occurrences of mining were found in our desktop study.

12.6 Erodibility of the soil

During the site investigation, visible signs of surface soil erosion were not identified in the form of erosion gullies and rills to indicate that the material could be erodible. The risk of erosion on the proposed site is not expected.

12.7 Sinkholes and sub-surface subsidence

The geological conditions underlying the site do not lend themselves to the formation of sinkholes or surface subsidence such as dolines.

12.8 Excavatebility of ground

The maximum depth to which the inspection pits were excavated during the field investigation give a good indication of the depths to which excavations with a TLB or similar plant can be achieved with relative ease. Based on this, as well as engineering experience with subsoils of similar nature, the classes of excavation which should be expected and catered for during excavations into the various materials considered to classify as “soft to hardrock” excavation in terms of SANS 1200D.

CLASSIFICATION	DESCRIPTION
Restricted excavation	
Soft	Material which can be efficient removed by a back-acting excavator having a fly wheel power > 0.10 kW for each mm of tined bucket width.
Intermediate	Material which can be efficient removed by a back-acting excavator having a fly wheel power > 0.10 kW for each mm of tined-bucket width or with the use of pneumatic tools before removal by a machine capable of removing soft material.

Hard rock	Material that cannot be removed without blasting or wedging and splitting.
Non-restricted excavation	
Soft	Material which can be efficiently removed or loaded, without prior ripping, by any of the following plant: A bulldozer or a track type front end loader having an approximate mass of 22 tonne and a fly wheel power of 145 kW. A tractor-scrapper unit having an approximate mass of 28 tonne and fly wheel power of 245 kW, pushed during loading by a bulldozer equivalent to that described above.
Intermediate	Material which can be efficiently ripped by a bulldozer having an approximate mass of 35 tonne and a fly wheel power of 220 kW.
Hard rock	Material which cannot be efficiently ripped by a bulldozer having an approximate mass of 35 tonne and a fly wheel power of 220 kW.
Boulder class A	Material containing more than 40% by volume of boulders of size between 0.03 m3 and 20 m3, in a matrix of soft material or smaller boulders.
Boulder class B	Material containing 40% or less by volume of boulders of size between 0.03 m3 and 20 m3, in a matrix of soft material or smaller boulders.

All trial pits were excavated with Backhoe Loader. Based on engineering properties of material underlying the proposed area; material on-site is classified soft to hardrock excavation (SANS 1200D).

13 CONCLUSIONS AND RECOMMENDATIONS

13.1 Limitation of the investigation

During the investigation, some shortcomings were experienced which resulted in not getting the desired outcomes of the investigation.

- Existing underground services layout was not available during the investigation
- The site had outcrops

13.2 Conclusions

a) Based on the fieldwork findings there are no geotechnical constraints within the proposed area, therefore the site is suitable for the proposed project.
b) No groundwater seepage encountered in any of the trial pits excavated on site
c) The site comprises of colluvium horizon at the top underlain by residual granite and granite bedrock.
d) The CBR tested classifies as G6 to >G9 according to COLTO classification.
e) The in-situ soil found at this site has some poor to good compatibility characteristics and therefore material that classify as G6 on site can be used as backfilling layers during construction stage.
f) Material on-site are classified as SC and SM class in accordance to Unified Soil Classification System (USCS).
g) According to Van der Merwe (1964) these material layers has a non-plastic to low potential for swell and is considered to be not potential expansive.
h) Higher quality material will have to be brought to site during construction stage, there is not enough material on site to satisfy the quantities needed for backfilling, therefore material will have to be sourced.
i) Control of surface water is essential on this site to protect the proposed development against the ingress of water.
j) Heavy duty dump proof membrane must be placed which will not allow water to pass through.

13.3 Site clearing, grading and excavation

Site clearing that will be required prior to construction will involve the removal of surface vegetation and floor slabs.

13.4 Earthwork construction

It is recommended that all earthworks be carried out along the guidelines given in SANS 1200 and should be carried out in a manner to promote stable development of the site.

The following measures are recommended:

a) Site earthworks of road cuts and embankments should be carefully planned together with buildings site earthworks.

b) Ensure that buildings platforms are graded to discharge along contour and not downslope.

c) Driveways should be hardened.

13.5 Site classification

For urban planning purpose the site is zoned according to the NHBRC classification systems. The entire site is classified as a Zone R/C1/S1 site.

13.6 Foundation recommendations

13.6.1 Pad Footing

The site is covered by transported material i.e. colluvium soil which is underlain by non to low expansive residual granite. It might be economically feasible to consider Pad foundation for the proposed three storey structures. The foundation should be placed on a soft bedrock expected at approximately 0.5m to 1.5m below ground level, compact the floor of excavation to 98% Modified AASHTO density before constructing the foundation. The zonation map attached shows the different depth of the bedrock.

Dig up to 300mm and re-compact the in-situ for surface beds, concreate reinforcement mesh may be used.

Alternatively, deep strip footing with reinforcement may be considered at the same depth with concreate reinforcement mesh.

13.7 Rippability and Trenchability

Soft to hardrock excavation in terms of SABS 1200 is anticipated using light earthmoving equipment due to the nature of the underlying soils.

13.8 Sub-surface Drainage

It is strongly recommended that the subsurface drains need to be installed to manage the groundwater in the area.

13.9 Precautionary measures

The following precautionary measures should be adopted

a) The ground should be shaped to accelerate the flow of rainwater away from the building.

14 CONSTRUCTION MONITORING

14.1 Excavation inspection

The excavation needs to be inspected by a competent person prior to placing any concrete.

14.2 Control testing

Regular checks on the quality and compaction of the backfill to the terraces should be made.

15 REFERENCES

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APPENDIX A

SOIL PROFILE

Latavha
Putting a plan in action

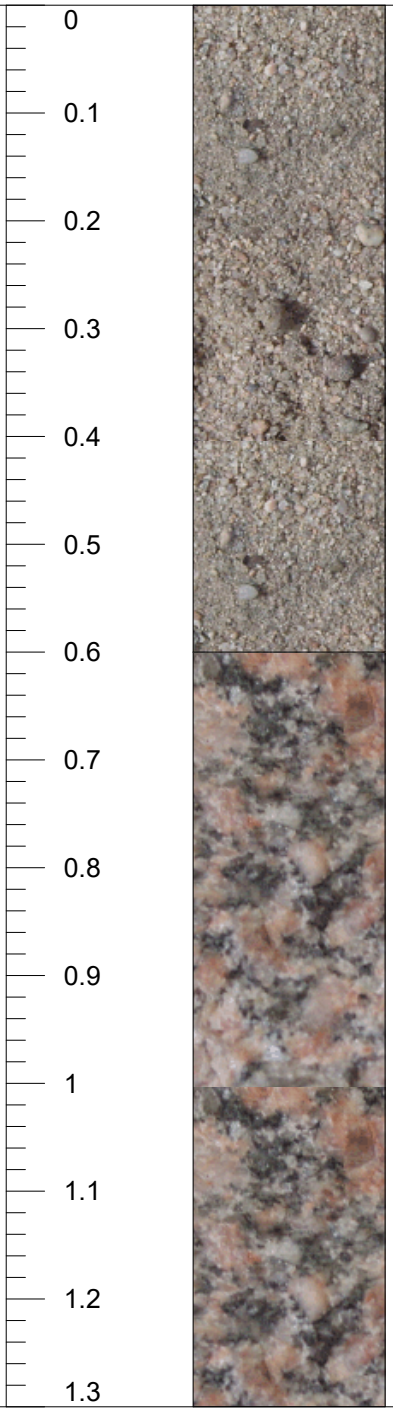
Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.433291°
Hole No:	UM 01	Lon:	31.015211°

Slightly moist, dark brown, loose, intact, gravelly sand. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
FI sample taken @ 0,0-0,4m
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434010°
Hole No:	UM 02	Lon:	31.015614°



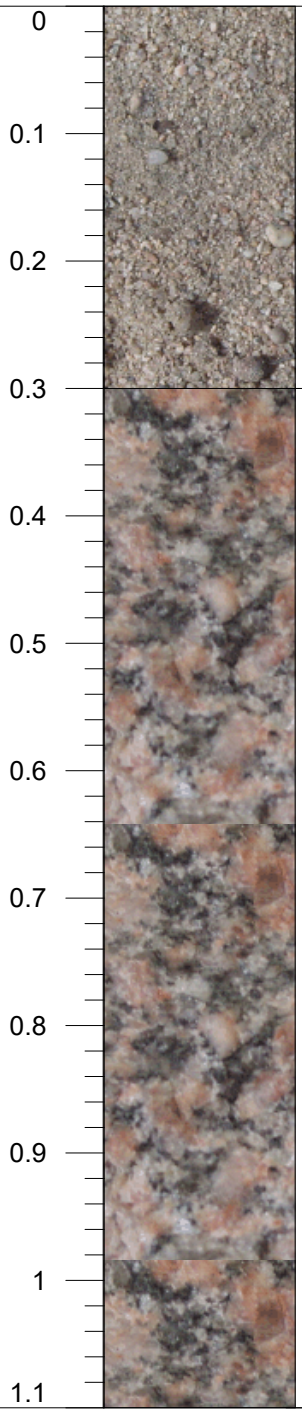
Slightly moist, reddish brown, medium dense, intact, gravelly sand with granite cobbles. COLLUVIUM

Slightly moist, dark reddish brown, medium dense, intact, gravelly sand. RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
CBR sample taken @ 0,6-1,3m
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434309°
Hole No:	UM 03	Lon:	31.015260°



Slightly moist, reddish brown, medium dense, intact, sandy gravels.
COLLUVIUM

Slightly moist, dark reddish brown, medium dense, intact, gravelly sand.
RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
CBR sample taken @ 0,6-1,3m
Stable sidewalls.

Latavha
Putting a plan in action

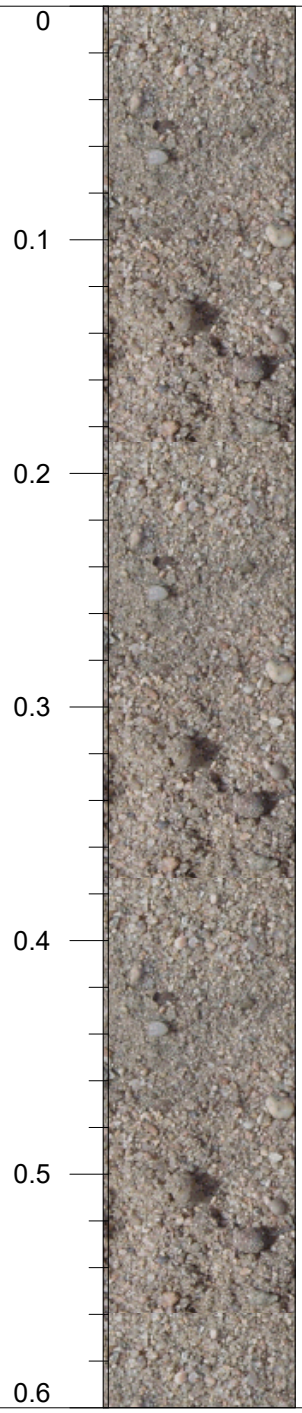
Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434099°
Hole No:	UM 04	Lon:	31.014807°

Slightly moist, light brown, loose, intact, gravelly sand. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.433973°
Hole No:	UM 05	Lon:	31.014327°



Slightly moist, dark grey, loose to medium dense, intact, gravelly sand with quartzite cobbles. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
FI sample taken @ 0,0-0,6m
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.433598°
Hole No:	UM 06	Lon:	31.014876°

Slightly moist, dark grey, loose to medium dense, intact, gravelly sand. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

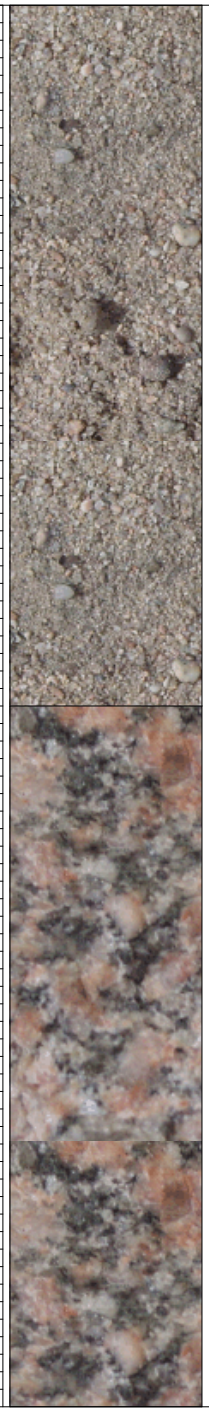
Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.433449°
Hole No:	UM 07	Lon:	31.014497°

Slightly moist, dark grey, loose to medium dense, intact, gravelly sand. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.433822°
Hole No:	UM 08	Lon:	31.013488°



Slightly moist, reddish brown, medium dense, intact, silty sand. COLLUVIUM

Slightly moist, dark reddish brown, medium dense to dense, intact, gravelly sand. RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
CBR sample taken @ 0.8-1,6m
Stable sidewalls.

Latavha
Putting a plan in action

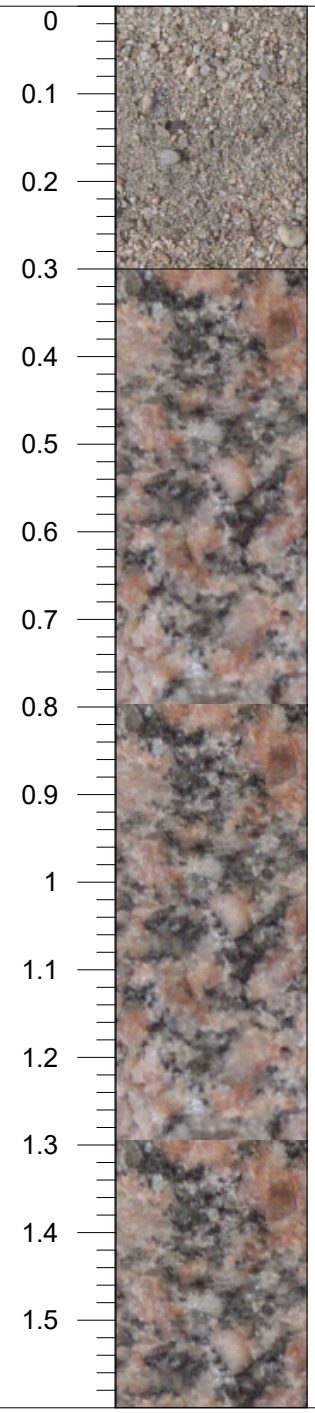
Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434470°
Hole No:	UM 09	Lon:	31.012644°

Slightly moist, orange brown, loose to medium dense, intact, silty sand with plants roots. COLLUVIUM

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434592°
Hole No:	UM 10	Lon:	31.013395°



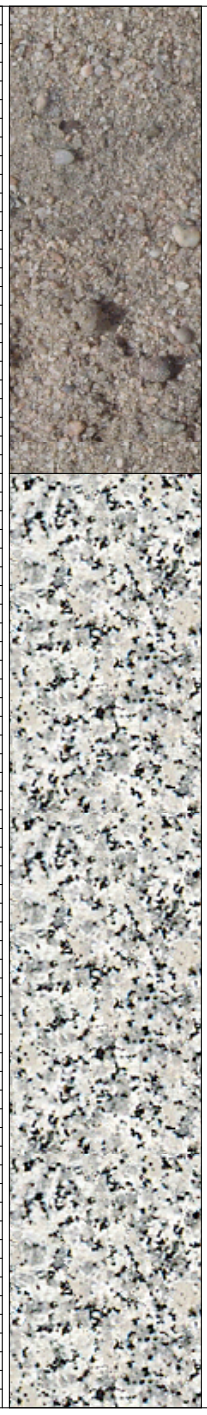
Slightly moist, reddish brown, medium dense, intact, gravelly sand.
COLLUVIUM

Slightly moist, dark reddish brown, medium dense, intact, sandy gravel.
RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
CBR sample taken @0,3-1,6m
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.434267°
Hole No:	UM 11	Lon:	31.013862°



Slightly moist, light grey, medium dense, intact, sandy gravels. COLLUVIUM

Light grey, weathered granite, coarse grained, medium to hardrock. WEATHERED GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.435304°
Hole No:	UM 12	Lon:	31.012958°

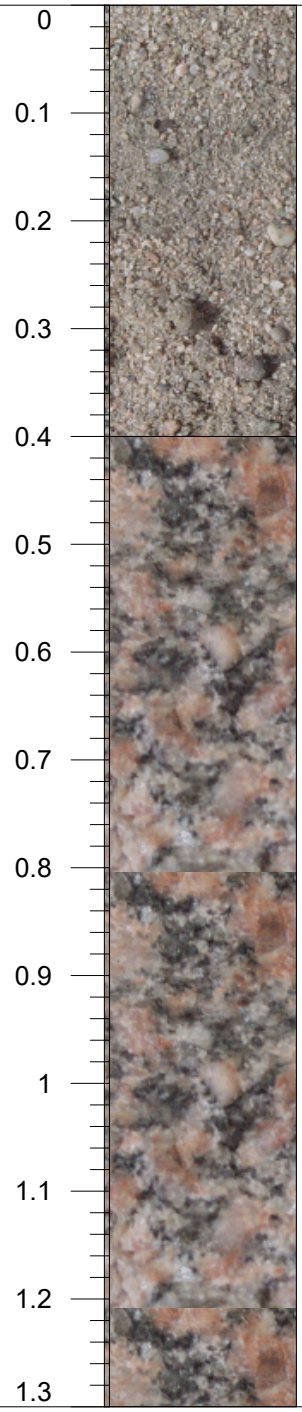
Slightly moist, reddish brown, medium dense, intact, gravelly sand.
COLLUVIUM

Slightly moist, dark reddish brown, medium dense, intact, sandy gravel.
RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
No sample taken
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.435785°
Hole No:	UM 13	Lon:	31.013179°



Slightly moist, light grey, medium dense, intact, gravelly sand with grass roots.
COLLUVIUM

Slightly moist, dark reddish yellowish, medium dense, intact, gravelly sand.
RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
FI sample taken @ 0,4-1.3m
Stable sidewalls.

Latavha
Putting a plan in action

Project:	UMP 3000 beds		
Profiled:	R Maumela	Client:	AES Consulting
Machine:	TLB Machine	Date Drilled:	13-Jan-21
Diameter:	Trench	Date Profiled:	13-Jan-21
Orientation:	Vertical	Lat:	-25.435566°
Hole No:	UM 14	Lon:	31.012098°

Slightly moist, light grey brown, medium dense, intact, gravelly sand with grass roots. COLLUVIUM

Slightly moist, dark reddish yellowish, medium dense to dense, intact, gravelly sand with boulders. RESIDUAL GRANITE

End of Hole with refusal on a granite bedrock
No seepage or groundwater encountered.
FI sample taken @ 0,2-0,6m
Stable sidewalls.

APPENDIX B

LABORATORY RESULTS

PARTICLE SIZE ANALYSIS

Sample No.	01
Soillab Sample No.	S21-0039-01
Depth (m)	0.0 - 0.4
Position	UM 01
Material Description	DARK BROWN 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	98
14.0 mm	97
5.0 mm	95
2.00 mm	90
0.425 mm	57
0.075 mm	16
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
59 µm	12
35 µm	9
14 µm	5
6 µm	4
2 µm	2
% Clay	4
% Silt	8
% Sand	78
% Gravel	10
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	NP
Linear Shrinkage (%)	0.0
Grading Modulus	1.37
Classification	A-2-4 (0)
Unified Classification	SM
Chart Reference	

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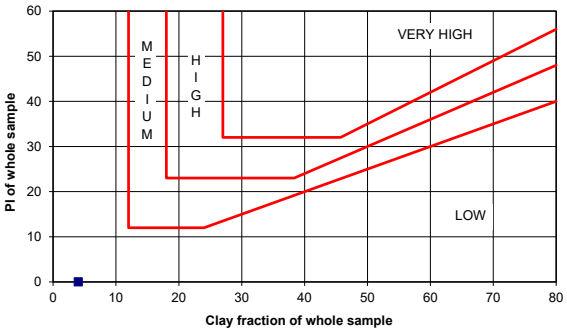
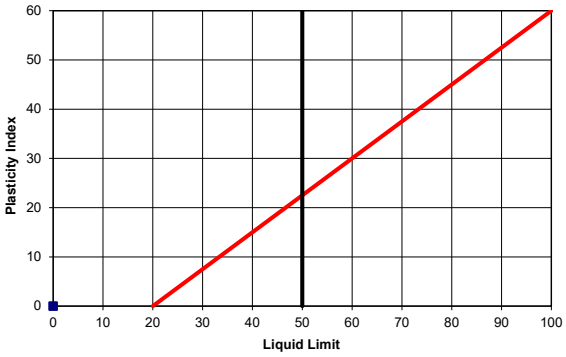
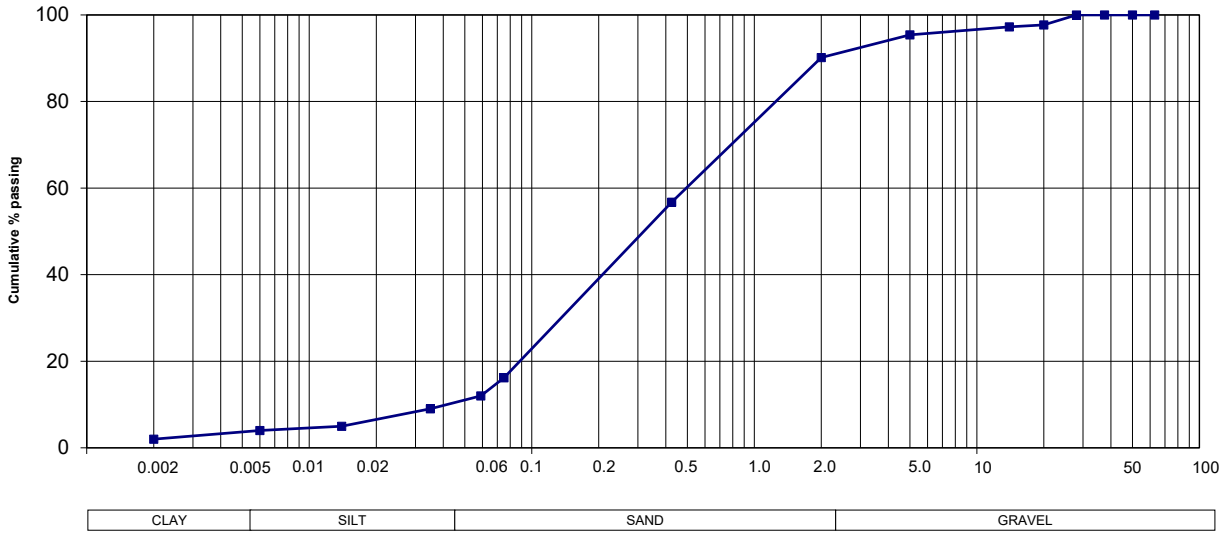
JOB No. : S21-0039
DATE : 2021/02/04

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	02
Soillab Sample No.	S21-0039-02
Depth (m)	0.0 - 0.6
Position	UM 04
Material Description	DARK GREY 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	96
14.0 mm	94
5.0 mm	84
2.00 mm	75
0.425 mm	45
0.075 mm	16
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
59 µm	11
34 µm	9
14 µm	6
6 µm	4
2 µm	2
% Clay	4
% Silt	7
% Sand	64
% Gravel	25
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	NP
Linear Shrinkage (%)	0.0
Grading Modulus	1.64
Classification	A-1-b (0)
Unified Classification	SM
Chart Reference	

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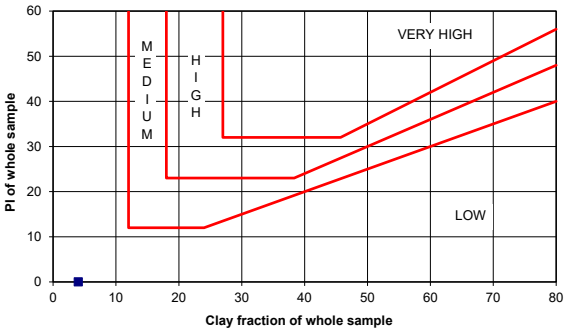
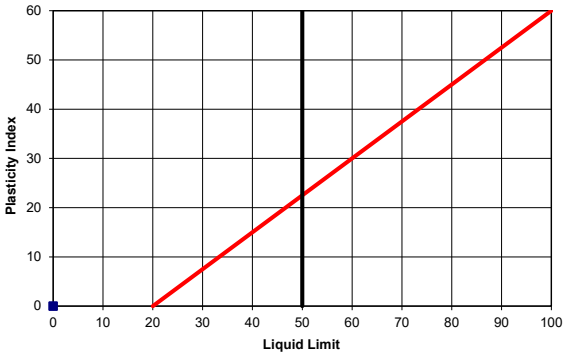
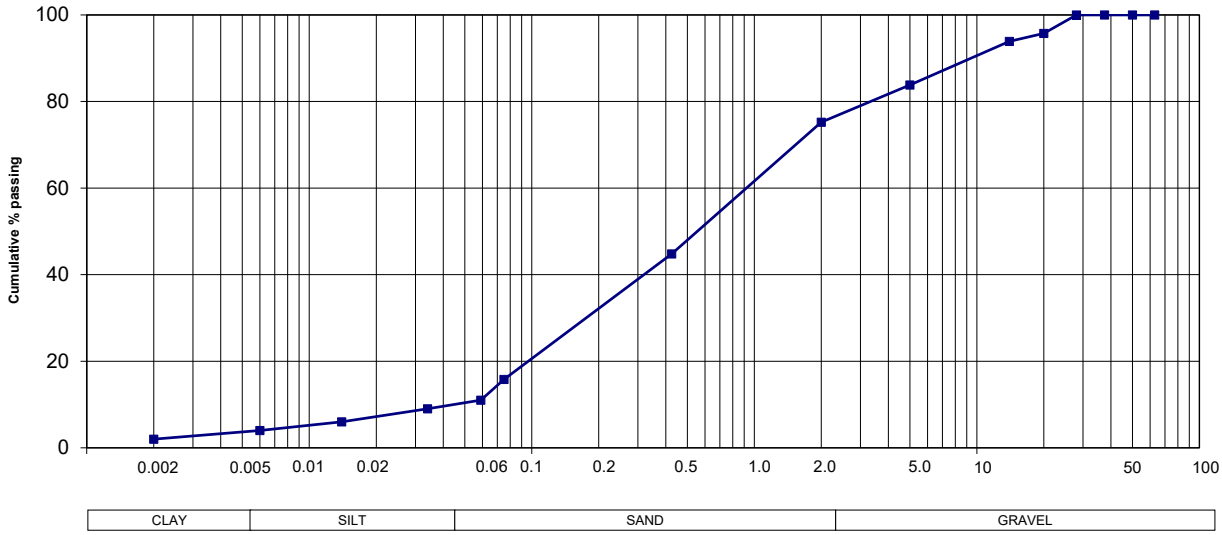
JOB No. : S21-0039
DATE : 2021/02/04

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	03
Soillab Sample No.	S21-0039-03
Depth (m)	0.4 - 1.3
Position	UM 013
Material Description	DARK YELLOW WEATHERED GRANITE 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	94
2.00 mm	75
0.425 mm	34
0.075 mm	17
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
57 µm	12
33 µm	10
14 µm	8
6 µm	6
2 µm	4
% Clay	6
% Silt	6
% Sand	63
% Gravel	25
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	26
Plasticity Index	9
Linear Shrinkage (%)	4.0
Grading Modulus	1.74
Classification	A-2-4 (0)
Unified Classification	SC
Chart Reference	

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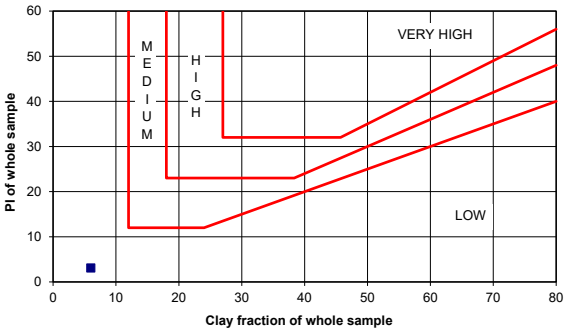
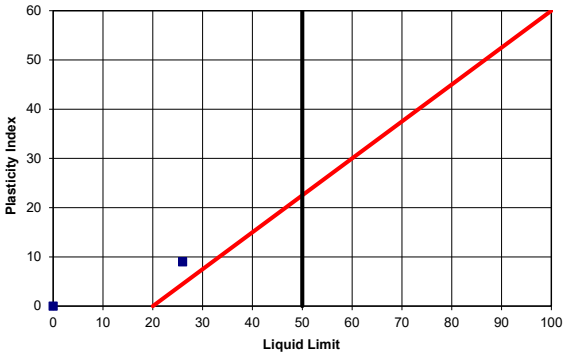
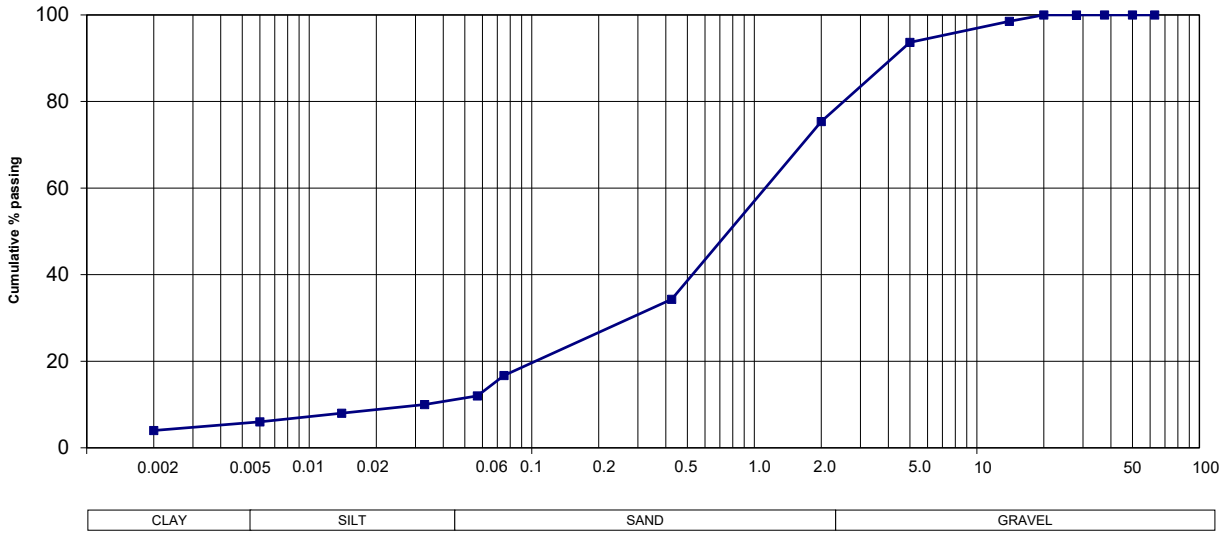
DATE : 2021/02/04

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	04
Soillab Sample No.	S21-0039-04
Depth (m)	0.2 - 0.6
Position	UM 014
Material Description	DARK YELLOW WEATHERED GRANITE 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	97
28.0 mm	94
20.0 mm	92
14.0 mm	91
5.0 mm	81
2.00 mm	68
0.425 mm	36
0.075 mm	15
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	10
34 µm	8
14 µm	7
6 µm	5
2 µm	4
% Clay	5
% Silt	5
% Sand	58
% Gravel	32
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	SP
Linear Shrinkage (%)	0.5
Grading Modulus	1.81
Classification	A-1-b (0)
Unified Classification	SM
Chart Reference	

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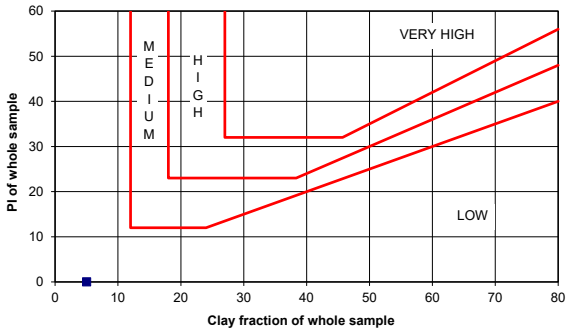
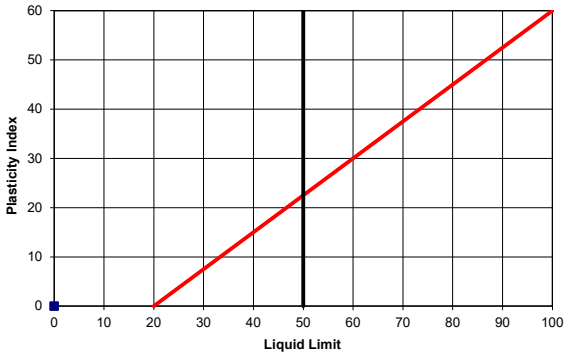
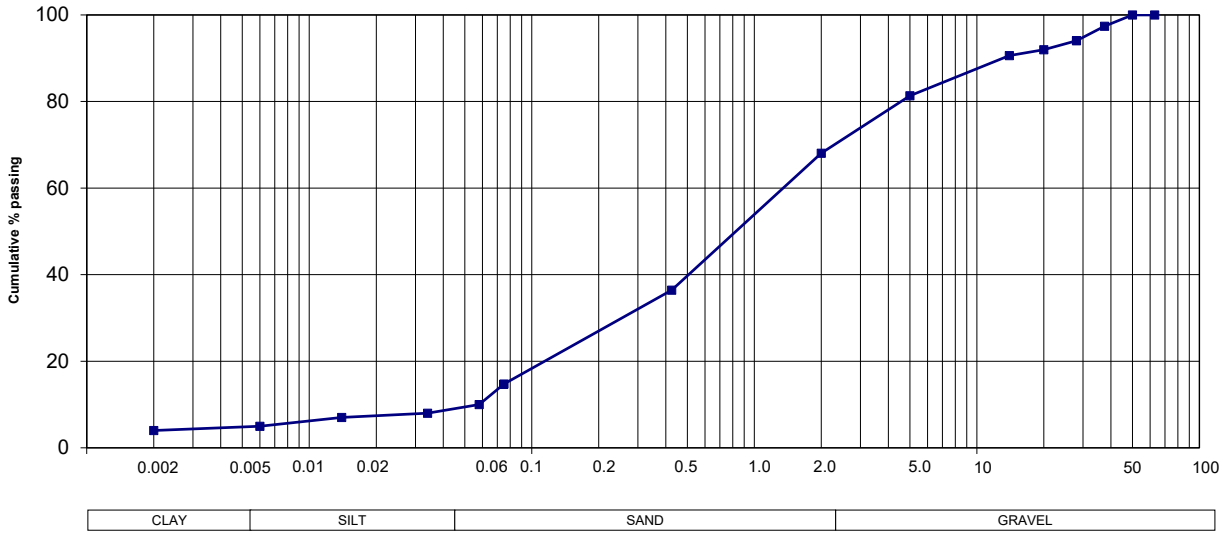
POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	05
Soillab Sample No.	S21-0039-05
Depth (m)	0.6 - 1.3
Position	UM 02
Material Description	DARK REDDISH BROWN WEATHERED GRANITE 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	91
2.00 mm	70
0.425 mm	48
0.075 mm	31
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
53 µm	25
31 µm	22
13 µm	19
6 µm	18
2 µm	17
% Clay	18
% Silt	7
% Sand	45
% Gravel	30
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	34
Plasticity Index	17
Linear Shrinkage (%)	8.0
Grading Modulus	1.51
Classification	A-2-6 (1)
Unified Classification	SC
Chart Reference	

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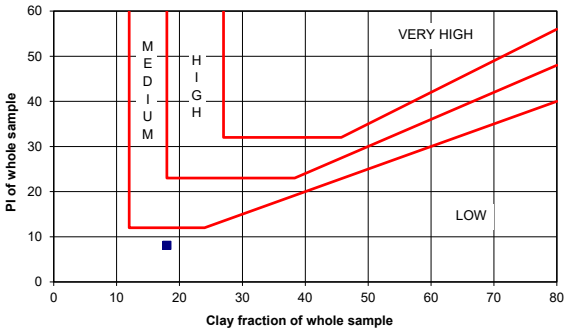
POTENTIAL EXPANSIVENESS



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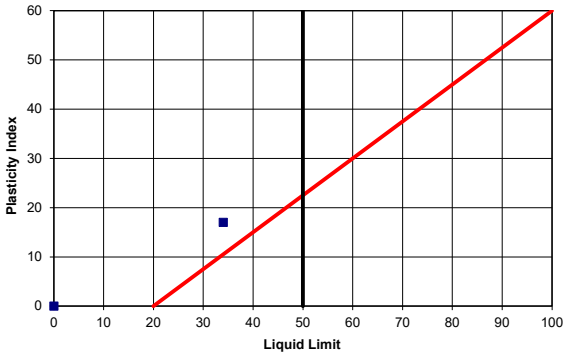

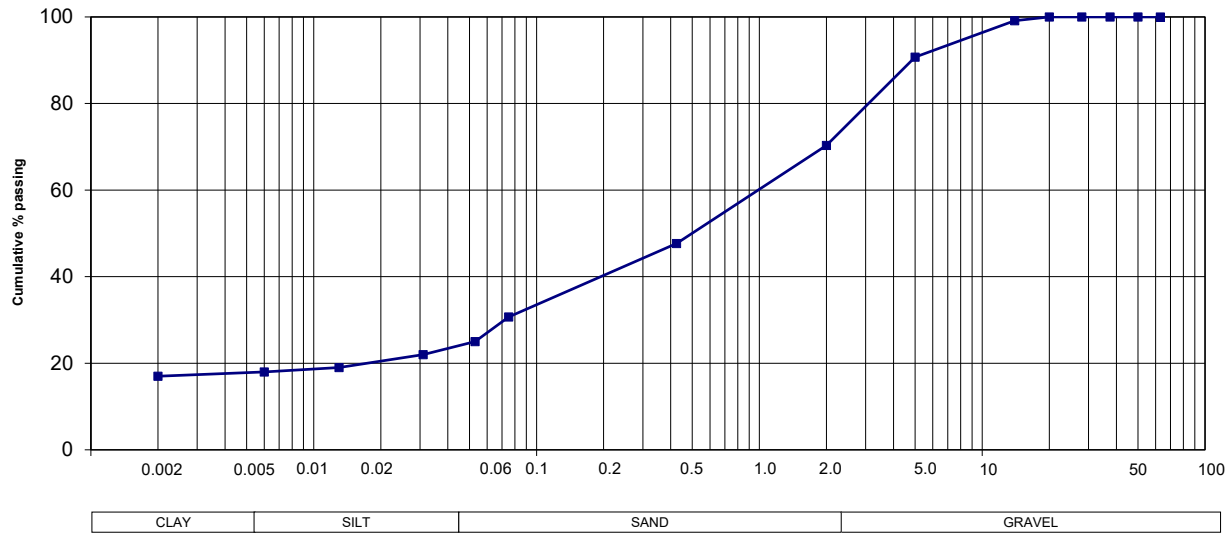

Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	06
Soillab Sample No.	S21-0039-06
Depth (m)	0.8 - 1.6
Position	UM 08
Material Description	DARK REDDISH BROWN WEATHERED GRANITE 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	96
2.00 mm	86
0.425 mm	54
0.075 mm	21
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
58 µm	17
34 µm	13
14 µm	11
6 µm	9
2 µm	7
% Clay	9
% Silt	8
% Sand	69
% Gravel	14
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	
Plasticity Index	NP
Linear Shrinkage (%)	0.0
Grading Modulus	1.39
Classification	A-2-4 (0)
Unified Classification	SM
Chart Reference	

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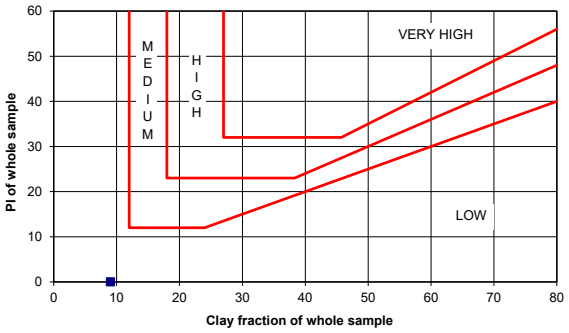
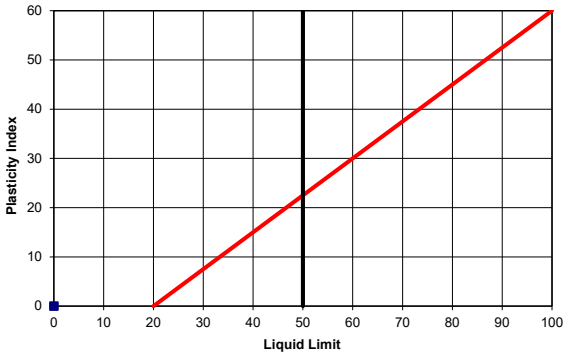
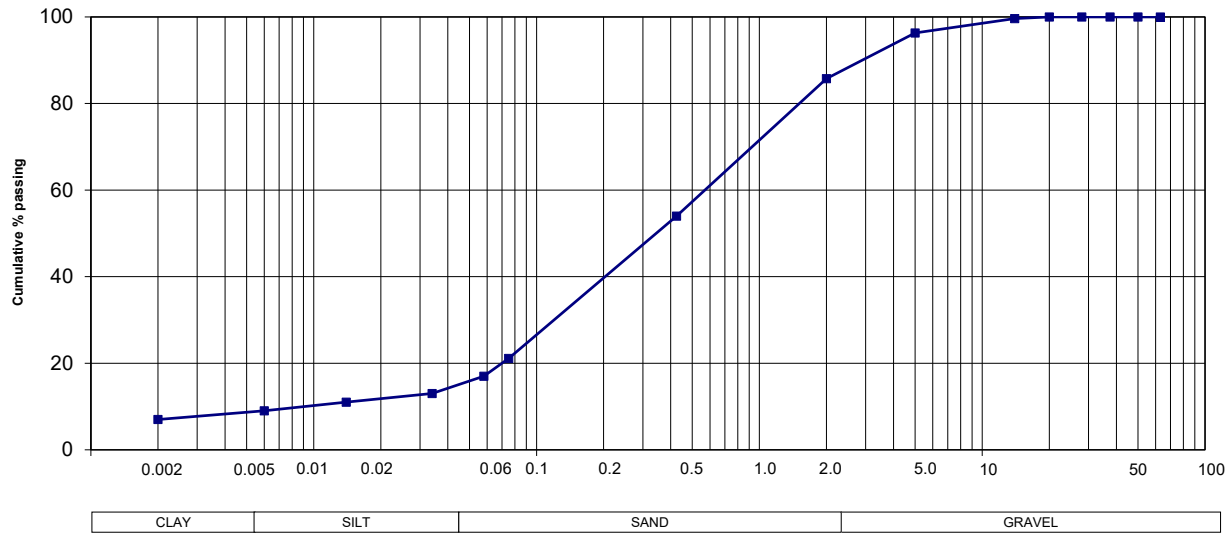
POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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PARTICLE SIZE ANALYSIS

Sample No.	07
Soillab Sample No.	S21-0039-07
Depth (m)	0.3 - 1.6
Position	UM 10
Material Description	DARK BROWN WEATHERED GRANITE 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	98
5.0 mm	77
2.00 mm	53
0.425 mm	32
0.075 mm	22
HYDROMETER ANALYSIS (% PASSING) **(SANS 3001:GR3)**	
54 µm	16
32 µm	14
13 µm	12
6 µm	10
2 µm	9
% Clay	10
% Silt	6
% Sand	37
% Gravel	47
ATTERBERG LIMITS **(SANS 3001:GR10)**	
Liquid Limit	33
Plasticity Index	12
Linear Shrinkage (%)	6.0
Grading Modulus	1.93
Classification	A-2-6 (0)
Unified Classification	SC
Chart Reference	

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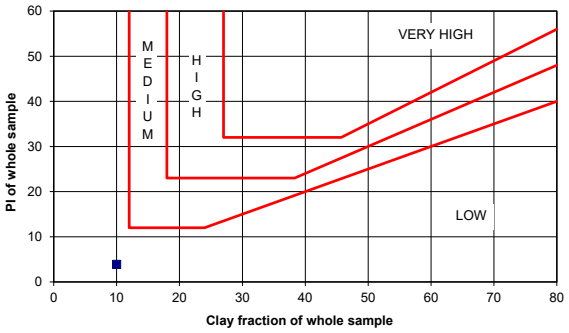
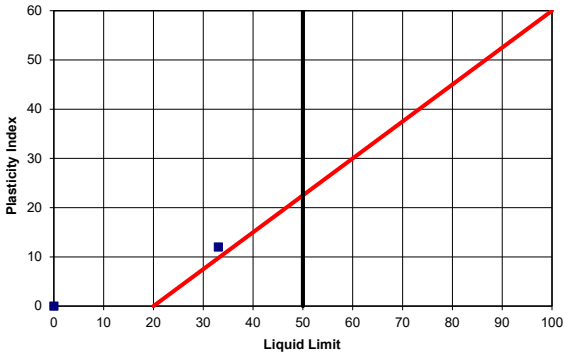
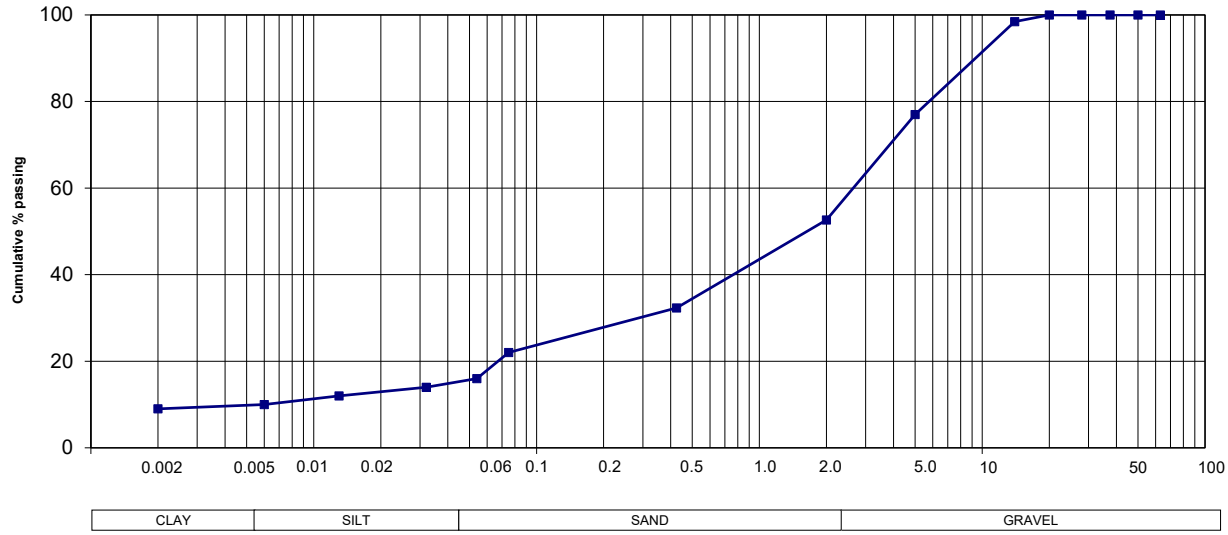
JOB No. : S21-0039
DATE : 2021/02/04

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





Note: Standard Relative Density of 2.650 was used.

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Project Description

Client:	LATAVHA PTY LIMITED			Soillab Job No.:	S21-0039
Job Description:	UNIVERSITY OF MPUMALANGA			Contract Number:	
Date:	2021/02/04			Reference Number:	

Sample Description

Soillab Sample No.:	S21-0039-05	S21-0039-06	S21-0039-07	
Sample Description:	UM 02	UM 08	UM 10	
Sample Depth:	0.6 - 1.3	0.8 - 1.6	0.3 - 1.6	
Material Description:	DARK REDDISH BROWN WEATHERED GRANITE	DARK REDDISH BROWN WEATHERED GRANITE	DARK BROWN WEATHERED GRANITE	

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	100	
20,00 mm	100	100	100	
14,00 mm	99	100	98	
5,00 mm	91	96	77	
2,000 mm	70	86	53	
0,425 mm	48	54	32	
0,075 mm	31	21	22	

Soil-mortar percentages - SANS 3001-PR5

Coarse Sand	2.000-0.425mm	32	37	39	
Coarse Fine Sand	0.425-0.250mm	11	18	9	
Medium Fine Sand	0.250-0.150mm	6	11	5	
Fine Fine Sand	0.150-0.075mm	7	8	5	
Silt and clay	<0.075mm	44	25	42	

Constants

Grading Modulus	SANS 3001-PR5	1.51	1.39	1.93	
Liquid Limit		34		33	
Plasticity Index	SANS 3001-GR10	17	NP	12	
Linear Shrinkage		8.0	0.0	6.0	

MOD AASHTO - SANS 3001-GR30

Max Dry Density (kg/m³)	1994	2087	2063	
Optimum Moisture Content (%)	9.1	6.5	8.2	

CBR - SANS 3001-GR40

MOD AASHTO				
Moulding Moisture Content (%)	9.2	6.2	8.3	
Dry Density (kg/m³)	1998	2045	2064	
% of Max Dry Density	100.2	98.0	100.0	
100% MOD CBR (%)	27	144	36	
% Swell	0.3	0.1	0.9	
NRB				
Dry Density (kg/m³)	1875	1941	1994	
% of Max Dry Density	94.0	93.0	96.6	
100% NRB CBR (%)	9	27	20	
% Swell	0.4	0.4	0.9	
PROCTOR				
Dry Density (kg/m³)	1776	1835	1875	
% of Max Dry Density	89.1	87.9	90.9	
100% PROCTOR CBR (%)	4	5	8	
% Swell	0.5	0.1	0.9	
CBR (%)				
100% Mod AASHTO	27	282	35	
98% Mod AASHTO	19	145	26	
97% Mod AASHTO	16	103	22	
95% Mod AASHTO	11	53	16	
93% Mod AASHTO	8	27	11	
90% Mod AASHTO	5	10	7	
COLTO Classification:	**>G9**	**G6**	**G8**	

APPENDIX C

TEST PIT LOCATION


Trial pits Map
UMP Student Accommodation
Legend
Trial pits
UM 01
UM 07
UM 06
UM 08
UM 05
UM 02
UM 04
UM 11
UM 03
UM 09
UM 10
UM 12
UM 14
UM 13
Google Earth
Image © 2021 Maxar Technologies
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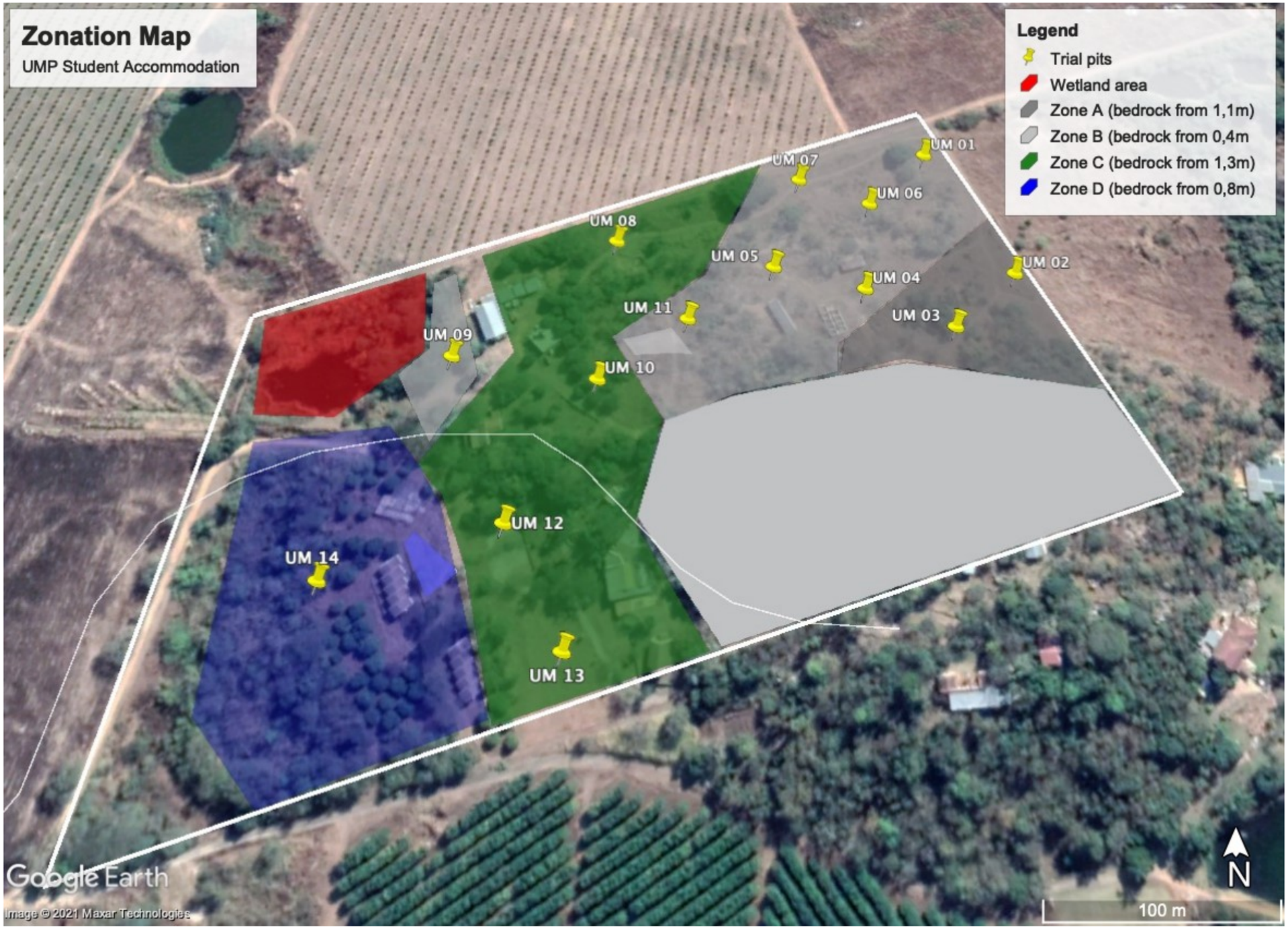
Zonation Map
UMP Student Accommodation
Legend
Trial pits
Wetland area
Zone A (bedrock from 1,1m)
Zone B (bedrock from 0,4m
Zone C (bedrock from 1,3m)
Zone D (bedrock from 0,8m)
UM 01
UM 02
UM 03
UM 04
UM 05
UM 06
UM 07
UM 08
UM 09
UM 10
UM 11
UM 12
UM 13
UM 14
Google Earth
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