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Augmented Report to LDM Consulting (Pty) Ltd on the Results of a Geotechnical Investigation for the Proposed Additions and Alterations at the uMalusi Council for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng

Reference: JHB031-19.R01
Revision 2

Dated: 08 July2020

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Report Title	Augmented Report to LDM Consulting (Pty) Ltd on the Results of a Geotechnical Investigation for the Proposed Additions and Alterations at the uMalusi TVETCouncil for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng			
Report Reference	JHB031-19.R01 Revision 2	**Responsible Person**	Mr F. Jumoorty	
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1	25 Feb2020	Measurements and Observations of Existing Foundation Section added, Amendment to Foundation Recommendations after deeper geotechnical investigation.	Mrs H. Pillay / Mr B. Hariram	Mr A. Ramroop
2	08 July 2020	Name change of project location	Mrs H. Pillay	Mr. A. Ramroop

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Approval

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Title	Engineering Geologist	**Title**	Geotechnical Engineer

Abbreviations and Definitions

Abbreviation	Definition
AASHTO	American Association of State Highway and Transportation
CBR	California Bearing Ratio
E	East
EGL	existing ground level
Geosure	Geosure Gauteng (Pty) Ltd
GM	grading modulus
IMC	insitu moisture content
kN/m^2	kilonewtons per metre square
LL	liquid limit
LS	linear shrinkage
m	metre (s)
MDD	maximum dry density
mm	millimetre
No.	number
N	North
OMC	optimum moisture content
PI	plasticity index
SANS	South African National Standards
S	South
TLB	Tractor Loader Backhoe
TRH	Technical Recommendations for Highways (1985)

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TABLE OF CONTENTS

Appendix A: Inspection Pit Profiles
Borehole Profiles and Photographs

Appendix B: Results of CBR Dynamic Cone Penetrometer (DCP) Tests
Appendix C: Laboratory Test Results

Figure 1.Rev 2: Site Plan

Augmented Report to LDM Consulting (Pty) Ltd on the Results of a Geotechnical Investigation for the Proposed Additions and Alterations at the uMalusi Council for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng

Reference: JHB031-19.R01 Revision 2 **Date: 08 July2020**

1. INTRODUCTION AND TERMS OF REFERENCE

Geosure Gauteng (Pty) Ltd, hereafter referred to as Geosure, was requested by LDM Consulting Engineers (Pty) Ltd to provide a quotation for a geotechnical investigation, as stated in the letter titled "*Umalusi TVET College – Additions and Alterations to Existing Office Block including Ablutions (Brief for Geotechnical Investigation and Report)*", referenced "200/309/Geotech Brief" and dated 29 October 2019, for the proposed additions and alterations to the uMalusi Council for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng.

Geosure submitted a proposal and cost estimate referenced p874-19 (Umalusi TVET)/Revision 2/ng and dated 18 November 2019.

Subsequently, Geosure was appointed by LDM Consulting Engineers (Pty) Ltd, hereafter referred to as the Client, to carry out the geotechnical investigation as proposed.

Subsequent to the completion of the geotechnical investigation as outlined in the above-mentioned proposal, the architectural arrange of the proposed building columns were confirmed with Geosure. This arrangement necessitated a deeper geotechnical investigation to assess the viability of a piled foundation solution.

Geosure therefore submitted an additional proposal and cost estimate referenced JHB031-19.001 (uMalusi TVET Additional Investigation)/hp and dated 19 January 2020.

Subsequently, Geosure was appointed by the client, to carry out the additional geotechnical investigation as proposed.

2. SCOPE OF REPORT

This augmented report details the results of the geotechnical investigation for the proposed additions and alterations at the uMalusi Council for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng.

The slope and subsurface conditions at the positions profiled on the site are described and comment is made on the general stability of the site. Recommendations for earthworks, drainage, materials excavatability and foundations are made.

A previous report referenced JHB031-19.R01 Revision 0 and dated 09 December 2019 detailing the results of the shallow geotechnical investigation was issued to the Client. This report has been subsequently augmented and revised to include the results of a deeper geotechnical investigation.

3. GUIDELINES FOR METHODOLOGY OF INVESTIGATION

The fieldwork for the investigation was carried out according to guidelines relevant to geotechnical investigations of this nature.

The formation and weathering of geological materials are discontinuous processes and unexpected variations in soil, rock and groundwater regimes may occur even on sites where the conditions seem to be uniform or consistent. Variations in what is reported here may become evident during construction and it is thus imperative that an appropriately qualified and experienced Competent Person inspects all critical stages of development including, but not limited to, excavations to assess the conditions encountered and to assist in the interpretation of observations at variance with the information supplied in this report.

This report was prepared for use by LDM Consulting Engineers (Pty) Ltd and their professional team for the purpose stated and should not be relied upon for any other purpose.

4. INFORMATION USED

The following information was referenced to assist with the fieldwork and preparation of this report:

i. A 1:250 000 Regional Geological Map titled "*2528 Pretoria*", dated 1986 and published by the Council for Geoscience of South Africa;

ii. An architectural plan referenced 210-01 titled "*Proposed Ground Floor Layout*", prepared by LDM Consulting Engineers (Pty) Ltd to scales as shown and dated 01 November 2019;

iii. An architectural plan referenced 100-01 titled "*Site and Locality Plan*", prepared by LDM Consulting Engineers (Pty) Ltd to scales as shown and dated 01 November 2019;

iv. Low resolution aerial imagery sourced from Google Earth (2019).

5. SITE DESCRIPTION

The site is located in Pretoria at approximate latitude and longitude 25°44'34.09"South and 28°16'24.28"E, respectively. The existing development comprises a double storey structure.

Topographically, the site is relatively flat lying. It should be noted that abundant service pipes were located in the vicinity of the proposed development in the north western portion of the site.

Plate 1 below provides an indication of the site locality whilst Plates 2 and 3 provide a general view of the site.

Plate 1: Locality Plan (sourced from Google Earth)

Plate 2: View across the north western portion of the site

Plate 3: View along the eastern portion of the site

6. FIELDWORK

The fieldwork for the shallow investigation was initially conducted on 20 November 2019 and comprised the following:

i. Terrain Appraisal;
ii. Inspection Pits; and
iii. CBR Dynamic Cone Penetrometer (DCP) tests.

Additional fieldwork, which comprised the drilling of geotechnical boreholes, was conducted over the period 29 January 2020 to 30 January 2020.

6.1 Terrain Appraisal

Prior to commencing with the subsurface investigation, a reconnaissance of the site was carried out to identify the topography and associated landforms, map the surface geology and note allied features of geotechnical significance.

6.2 Inspection Pits

Five (5 No.) inspection pits, designated IP1 through IP5, were excavated using hand tools to refusal / final depths in the range 1.2m (IP4 refers) to 2.5m (IP1 refers) below existing ground level (EGL).

The positions of the inspection pits are given in Figure 1 Rev 1 at the end of this report.

The inspection pits were profiled using the South African Geoterminology Guidelines (Brink and Bruin, 2002). Disturbed samples were retrieved and the inspection pits were reinstated on completion of profiling and sampling. Copies of the detailed profiles and photographs are given in Appendix A.

6.3 CBR Dynamic Cone Penetrometer (DCP) Tests

Five (5 No.) CBR Dynamic Cone Penetrometer (DCP) tests, designated DC1 through DC5, were carried out at the approximate positions given in Figure 1 Rev 1. The DCP tests were advanced to refusal / final depths in the range 1.3m (DC4 refers) to 3.0m (DC1, DC2, DC3 and DC5 refer) below EGL.

The results of the DCP tests comprising plots of blow counts versus depth are given in Appendix B.

6.4 Geotechnical Boreholes

Two (2 No.) geotechnical rotary core boreholes, designated BH1 and BH2, were drilled by RF Geotechnical Services at the approximate positions shown in Figure 1 Rev 1 to an approximate depth of 13m below EGL.

The boreholes were of NXC and NWD4 diameters cased through soft materials to maintain sidewall stability. In sands and in firm to very stiff cohesive soils, Standard Penetration Tests (SPTs) were carried out at approximately 1.5m intervals to quantify resistance to penetration and to retrieve disturbed samples for profiling and laboratory testing. Material that was too hard for SPTs was drilled and sampled by the NWD4 core barrel.

The samples and cores were profiled by Geosure using the South African Geoterminology Guidelines (Brink & Bruin, 2002).

Copies of the detailed borehole profiles and their corresponding photographs are given in Appendix A of this report.

7. GEOLOGY AND SUBSURFACE CONDITIONS

According to the geological map of the area (refer to Plate 3), the site and surrounds are predominantly underlain by volcanic rocks of the Pretoria Group.

Plate 3: Geological Map of the Study Area (Council for Geoscience, "*2528 – Pretoria*", 1988)

During the initial investigation, fill, colluvium and residual soils were encountered in the inspection pits. In addition to the above horizons, weathered shale rock was encountered during the geotechnical borehole drilling investigation. Generalised descriptions of the observed soil and rock layers in order of increasing depth is given below.

The geological horizons observed during the investigation are briefly described below:

a) **Unit 1: Fill** – Concrete surface bed / brickwork / slab.

b) **Unit 2: Fill** – This fill layer can be described as slightly moist, medium brown mottled light brown and orange brown/dark brown, loose to medium dense, medium-grained, gravelly clayey SAND/clayey SAND / soft to firm, sandy silty CLAY/sandy CLAY with thick roots and rock fragments. The fill layer generally extended to approximate depths in the range 0.5m (IP5 refers) to 1.4m (IP2 refers) below EGL.

c) **Unit 3: Colluvium** - This colluvial layer can be described as slightly moist, dark brown, soft to firm, sandy CLAY. The colluvial layer was encountered in IP4 and IP5 and extended to approximate depths of 0.6m (IP4 refers) and 0.75m (IP5 refers) below EGL, respectively.

d) **Unit 4: Residual Shale** - The residual layer can generally be described as slightly moist, light orange brown mottled khaki brown/orange brown, firm to stiff, sandy silty CLAY/gravelly sandy CLAY/sandy CLAY with occasional gravel or cobble sized fragments. The residual layer (s) extended to the final depths of inspection pits and to approximate depths of 9.50 (BH2 refers) and 9.60m (BH1 refers) below EGL in geotechnical boreholes.

e) **Unit 5: Soft Weathered Shale Rock** – This unit can be described as medium brown stained khaki brown, highly weathered, fine grained, very highly fractured, soft rock with interstitial clay along the fractures. Soft weathered shale rock extended to the approximate depths of 10.0m (BH2 refers) and 10.5m (BH1 refers) below EGL in geotechnical boreholes.

f) **Unit 6: Medium Hard Weathered Shale Rock** – This unit can be described as medium brown banded khaki brown, slightly to moderately weathered, fine grained, medium hard rock. Medium hard weathered shale rock extended to the final depths of geotechnical boreholes.

8. GROUNDWATER

No groundwater seepage was encountered in the inspection pits during the course of the investigation. Groundwater was encountered during geotechnical borehole drilling at the approximate depths of 6.0m (BH2 refers) and 6.5m (BH1 refers) below EGL. This is indicative of the level of the groundwater table at the time of the investigation as influenced by weather conditions prior to and during the investigation.

There is, however a potential for the development of a perched groundwater condition and/or fluctuations in groundwater levels in response to rainfall patterns which are likely to be elevated and more intense during periods of high rainfall and depressed or dormant during periods of low rainfall.

An elevated groundwater condition may reduce the depth of the capillary fringe below EGL thereby reducing the shear strengths of affected materials. Furthermore, the relief of artesian pressure may occur during the installation of deep foundations when this condition prevails.

Due cognisance of the above surface and subsurface groundwater condition must be taken during design and construction of the proposed development. If necessary, consideration would need to be given to installing subsoil drainage during and post-construction.

9. LABORATORY TESTS

The following laboratory tests were scheduled on soil samples retrieved from the site:

i) Grading Analysis, Atterberg Limits;
ii) Hydrometer analysis; and
iii) Unconfined Compressive Strength (UCS) on rock.

The results of the laboratory tests are summarised in Table 1 and Table 2 and are given in Appendix C.

Table 1: Summary of Laboratory Test Results: Sieve analysis, Atterberg Limits and Insitu Moisture Content Tests

FIELD NO.	DEPTH (m)	DESCRIPTION	PARTICLE SIZE DISTRIBUTION (%)				ATTERBERG LIMITS (%)			GM	IMC (%)	Material Code and Classification	Recommended material usage
			GRAVEL	SAND	SILT	CLAY	LL	PI	LS				
FILL													
IP1	0.5-0.75	Medium brown mottled light brown, gravelly clayey SAND with roots and rock fragments – Fill	28	45	10	17	22	5	1.3	1.44	10.2	A-2-4 (0) SM-SC *Low	These materials generally classify in the range <G10 to G7 and may be considered suitable subgrade material subject to screening. Use of selected fill is possible subject to laboratory confirmation of CBR strengths.
RESIDUAL SHALE													
IP1	1.0-2.5	Light orange brown mottled khaki brown, gravelly sandy CLAY	12	30	12	38	32	7	1.9	0.84	15.1	A-4 (1) ML/OL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.
IP5	0.75-1.5	Orange brown, sandy CLAY	0	49	14	37	30	9	3.8	0.57	9.5	A-4(2) CL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.
BH1	1.4 – 4.0	Light khaki brown mottled light orange sandy silty CLAY	15	35	16	34	32	9	3.1	0.91	14.7	A-4 (2) CL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.
BH1	6.0 – 7.95	Light khaki brown mottled light orange sandy silty CLAY	5	23	19	53	38	7	2.5	0.40	19.6	A-4 (6) ML/OL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.
BH2	3.7 – 6.0	Light reddish brown mottled light orange sandy silty CLAY	7	37	18	38	32	12	4.4	0.65	14.3	A-6 (5) CL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.
BH2	6.0 – 8.35	Light khaki brown mottled light orange sandy silty CLAY	2	33	18	47	34	12	3.9	0.44	24.7	A-6 (6) CL *Low	These materials generally classify in the range <G10 to G10 and may be considered suitable material for general fill only.

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage
SM - Unified Classification
OMC - Optimum Moisture Content
MDD - Maximum Dry Density
G10 - Classification in Terms of TRH14 (1985)
IMC - Insitu Moisture Content
GM - Grading Modulus
CBR - California Bearing Ratio
A-2-4(0) - AASHTO Classification
*Low - Expansiveness according to van der Merwe (1964)

Table 2: Summary of Laboratory Test Results: Uniaxial Compressive Strength Tests

BOREHOLE No.	DEPTH (m)	DESCRIPTION	UCS (MPa)
BH1	10.6-10.7	Slightly to moderately weathered, medium hard rock	15.1
BH1	12.2-12.3	Slightly to moderately weathered, medium hard rock	14.2
BH2	10.5-10.6	Slightly to moderately weathered, medium hard rock	18.1
BH2	12.4-12.5	Slightly to moderately weathered, medium hard rock	14.5

10. DISCUSSION

10.1 Proposed Development

The proposed additions include new ablutions along the north western portion of the existing building and a proposed car park along the eastern portion of the site. A new canopy will be installed on the northern side of the existing structure.

Information received by Geosure indicates that the new car park and a double storey ablution block unit occupy an area totalling approximately 150m².

The anticipated wall line (service) loads is approximately 150kN/m with a maximum tolerable differential settlement limited to 10mm.

Foundation loads for the proposed canopy structure were not made available to Geosure.

10.2 Global Stability

The fill, colluvium and residual soils observed at the site are considered highly susceptible to rapid erosion by uncontrolled stormwater runoff. Furthermore, open excavations in these soils are considered likely to display rapid sidewall collapse.

Sound earthworks and drainage controls to engineer's design and monitoring of the earthworks and site drainage works by the engineer's representative in consultation with the geotechnical professional, are therefore recommended.

On the basis of our observations, the site is considered stable from a geotechnical perspective in its current condition investigated and suitable for the development as proposed provided the recommendations set down below in this report are adopted and certified by Geosure. Measures amount to no more than sound development practices appropriate to the site conditions anticipated and nature of the architectural scheme known to Geosure.

10.3 Trenchability Assessment

"Soft" excavation in terms of SANS 1200 is generally anticipated within the soil cover (fill, colluvium and residual soils) as well as very soft rock varieties.

The soft to medium hard rock are likely to classify as "Intermediate" to "Hard" material excavation in terms of SANS 1200 and harder rock varieties are likely to classify as "Hard" material excavation in terms of SANS 1200.

Limited "Intermediate" and "Boulder" excavations to the depths investigated cannot be discounted and it is recommended that a contingency amount be allowed for "Intermediate" and "Boulder" excavations at shallower depths due to likely geological variations.

10.4 Earthworks

It is recommended that all earthworks be carried out in accordance with SANS 1200 (current version). All vegetation, topsoil and unsuitable subgrade material should be cleared from areas over which fills are to be built. Under fills of more than three metres in height, further subgrade improvement may be necessary.

10.4.1 General Fills

Fill slopes should be formed to not exceed a batter of 1 vertical to 2 horizontal (≤ 26°) and a height of 1.5m where retaining systems are not provided. Slopes exceeding 1.5m in height will need to be designed and inspected by a competent geotechnical practitioner to ensure long term stability.

General fills should be placed in layers not exceeding 0.25m when placed in loose condition, and compacted to a minimum of 93% of Modified AASHTO maximum dry density within 1 – 2 percent (wet / dry) of Optimum Moisture Content (OMC). Boulder's larger than 0.2m in size should not be included in the fill material. Large boulders or builder's rubble within the fill could affect compaction and mask voids into which fines could later migrate, resulting in subsidence. Boulders / rubble may also adversely affect foundation excavations.

Density control testing of fill material should be undertaken at appropriate intervals during fill construction.

The sandy materials on site are considered highly erodible and sloughable due to uncontrolled surface water runoff and special consideration will need to be given to prevent erosion by uncontrolled stormwater runoff both during and after construction.

Platforms should also be shaped to direct water away from the fill embankments and buildings. The use of earth bunds along the edge of fill embankments is recommended to prevent water from overtopping and eroding fill embankments.

All banks should be grassed as soon as possible, preferably commencing during construction.

10.4.2 General Cuts

Cuts in insitu soils may be formed to not exceed a batter of 1 vertical to 2 horizontal (≤ 26°) and a height of not more than 1.5m where retaining systems are not provided. Slopes exceeding 1.5m in height will need to be designed and inspected by a geotechnical professional to ensure long term stability.

Cuts in weathered rock may be formed to batters of 1 vertical to 0.75 horizontal and to a height not greater than 3.0m where retaining walls are not provided. Where daylighting bedding planes are encountered during construction, it is recommended that a geotechnical specialist be appointed to inspect the cutting and assess the global stability of the slope.

Sidewall collapse of excavations not battered back or shored is considered likely. The construction and selection of appropriate retaining structures to engineer's detail will be critical as temporary vertical / oversteep slopes are likely to be unstable.

Where excavations intersect or approach the water table, the sidewalls will tend to become unstable and need to be drained and laterally supported or battered back at slopes of the order of 1 vertical in 5 horizontal.

Workers should not enter any excavations deeper than 1.5m that are not shored or battered back. Steeper batters can be considered but will be subject to inspection and approval by a geotechnical professional on site during construction. It remains, however, the responsibility of the contractor/engineer on site to ensure excavations are safe and shored in line with requirements as set down in the current "Occupational Health and Safety" Act 85 (1993 as amended).

10.5 Classification of Material and Recommended Usage

The subgrade materials underlying the site have been classified in terms of their suitability for use in construction based on field observations and laboratory testing. Material classifications and recommended usage is given in Table 1 of this report (Section 9 refers).

10.6 Measurements and Observations of Existing Foundations

The foundations of the existing building were exposed, and the following observations were made:

i. Ground water seepage was not observed.

ii. The depths to the top of the foundation were approximately 0.3m and 0.4m below existing ground level.

iii. The width of the foundations measured from the edge of the outer wall was approximately 0.1m.

iv. The thickness of the foundations was in the approximate range 0.15 to 0.2m.

A summary of the observations at each of the locations where the footings were exposed are given in Table 3 below.

Table 3: Summary of Observations at Locations where Foundations were Exposed

IP No.	FOOTING DETAILS			Founding Material
	Depth below EGL (mm)	Width from the Edge of the Outer Wall (mm)	Thickness (mm)	
IP1	300	-	150	Fill
IP2	400	100	200	Fill

10.7 Inferred Founding Conditions

Typical inferred characteristics of the founding conditions at the positions investigated are listed below:

i. Rock was not observed at the inspection positions to the depths investigated.

ii. The fill and colluvial soils are considered poor founding horizons due to their collapsible nature.

iii. Low bearing capacities of the fill, colluvial and residual soils.

iv. A risk of shallow groundwater seepage activity at shallow depths at the positions investigated, potentially increasing with depth.

v. Shale rock is anticipated at an approximate depth of 10.0m below EGL (as inferred from geotechnical borehole profiles)

vi. Groundwater was encountered at an approximate depth on 6.0m below EGL (as inferred from geotechnical borehole profiles).

10.8 Foundation Recommendations

Initially, information received by Geosure indicates that a new car park and double storey ablution block unit totalling an approximate area of 150m² is to be constructed on the site. The anticipated line (service) loads is approximately 150kN/m with a maximum differential settlement limited to 10mm.

After discussions between Geosure and the structural engineers, it is understood that the proposed architectural scheme of the two-storey development now requires reinforced concrete column bases. Foundations limited to a net permissible bearing pressure of 100kN/m^2 are likely to have uneconomically large dimensions and are likely to experience differential and total settlement greater than the acceptable limits of the structure.

In general, construction of large shallow foundation adjacent to the existing structure may be difficult and there is risk that the foundations of the existing structure may be undermined during construction of the new foundations.

As such, it is recommended that consideration be given to the use of a piled foundation for the proposed structures.

The following foundation solutions have been considered for the proposed development and are discussed in Sections 10.8.1 through 10.8.3:

i. Reinforced concrete spread and strip foundations on residual soils; or

ii. Reinforced concrete spread and strip foundations on improved ground.

iii. Piled foundations.

10.8.1 Reinforced Concrete Strip/Spread Footings on Residual Soils

It is considered that reinforced concrete strip / spread footings are likely to prove a suitable foundation solution for lightly loaded structures such as the canopy.

It is recommended that foundation loads be transferred through "soft to firm" soil horizons to found on "firm to stiff" residual soils, at moisture stable depths, where a maximum net allowable bearing pressure of 75kN/m^2 is considered applicable.

For budgetary purposes and inferring from field observations, such conditions are considered to occur from depths in the range 1.2m to 1.5m below EGL.

Actual founding levels will be dependent on final platform levels, the minimum moisture stable depth generally of 1.5m below final ground level, and site verification by the geotechnical professional during construction.

Anticipated total settlements for a footing width of 1.0m founded on approved "firm to stiff" residual soils, subject to the above bearing pressures, are not anticipated to exceed 10mm to 15mm, with differential settlement taken as 50% of total settlement.

Actual settlements will vary proportionately on the sizing of footings as well as final foundation loads.

The clay soils within moisture unstable levels observed are likely to display volumetric changes (i.e. heave and shrink) in response to cyclical fluctuations in ground moisture content. Accordingly, construction of surface bed floors to engineer's detail must address this phenomenon.

10.8.2 Reinforced Concrete Spread, Strip or Raft foundations on Improved Ground

For higher allowable bearing pressures for shallow foundations, consideration could be given to the implementation of reinforced concrete spread /strip foundations to engineer's detail for structures not exceeding two storeys in height. These foundations should be founded on improved ground / engineered fill to geotechnical engineer's design.

General guidelines with regards to improved ground are presented below, as follows:

i. Undercut and spoil all poorly consolidated soils from beneath foundation level to a level to be confirmed in a geotechnical design layout;

ii. Should the excavation intersect groundwater seepage, the excavation should then be backfilled with clean free draining coarse sand to engineer's detail;

iii. The excavation will need to be backfilled and compacted with granular material to a dense soil consistency to engineer's detail;

iv. Installation of the foundation on the improved ground may then proceed.

The design of the ground improvement is to be carried out by an experienced geotechnical specialist such as Geosure.

A net allowable bearing pressure of 100kN/m^2 is considered applicable to the afore-mentioned ground improvement guideline. The ground improvement should be designed to allow a minimum immediate settlement of approximately 10-15mm. Differential settlement can be taken as 50% of total settlement.

Foundation dimensions for the ground improvement option may be uneconomically large for column foundations, therefore the foundation option discussed in section 10.8.3 is preferred for column foundations.

10.8.3 Piled Foundations

Should the applied column foundation pressures exceed the allowable bearing pressures of the residual soils and ground improvement given in this report, then consideration should be given to the use of a piled foundation.

The conventional auger pile type would be suited to the subsurface conditions anticipated on site. Consideration could also be given to the use of pressure grouted Continuous Flight Augered (CFA) piles.

Pile working loads for various pile diameters are given as a guideline only for budgetary purposes in Table 4, overleaf. A detailed pile design must be carried out by the piling contractor.

Table 4: Typical Pile Sizes and Allowable Working Loads

Pile Type	Diameter (mm)	Typical Working Load (kN)#
Auger	250	245
	300	350
	350	480
	400	625
	450	795

#Based on an assumed shaft stress of 5MPa

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 existing foundations / new pile caps and factors of safety or partial factors in accordance with the design code adopted by the structural engineer.

All piles should be socketed into shale rock with a minimum UCS of 10 MPa by a depth of at least 3 pile diameters. Inferring from the boreholes drilled, shale rock of this quality is likely to be encountered at an approximate depth of 10.5 m below EGL.

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 10mm. Additional settlement due to grouping of piles would depend on spacing, depth and number of piles in each group.

It is recommended that low energy Frequency Response dynamic pile integrity tests be carried out on all piles before they are covered by a pile cap. Quality assurance tests should 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.

10.9 Drainage

A critically important factor in the stable development of the site is the control and removal of both surface and groundwater and wastewater from the site.

Earthworks and drainage measures should be designed in such a way as to prevent ponding of, or high concentrations of, stormwater or groundwater anywhere on the site, both during and after the development. Stormwater from roofed and paved surfaces is to be led off site into the nearest municipal stormwater connection facility or approved disposal position. Under no circumstances is disposal by soakaway for stormwater and wastewater to be considered.

Any terrace(s) should be shaped to a gradient to prevent water ponding on the surface and should be graded to direct water away from the fill edges and foundations.

The need for subsoil drains and dewatering will need to be assessed on site during construction in consultation with the geotechnical professional.

11. SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

i. This report details the results of a geotechnical investigation for the proposed additions and alteration to the existing uMalusi Council for Quality Assurance in General and Further Education and Training College, Pretoria, Gauteng.

ii. The site was observed to be underlain by fill, colluvial and residual soils in addition to weathered shale rock.

iii. Groundwater seepage was observed at the approximate depths of 6.5m and 6.0m below EGL at BH1 and BH2, respectively. No groundwater seepage was encountered at inspection pits.

iv. The fill materials observed on site are considered susceptible to rapid erosion by uncontrolled stormwater runoff. Furthermore, open excavations, even to shallow depths, are considered likely to display rapid sidewall collapse.

v. Nonetheless, it is considered that the site is generally stable and suitable for the proposed development, provided that the recommendations given in this report are adhered to. Measures amount to no more than sound development controls appropriate to the site conditions expected and the development proposals known to Geosure at the time of preparation of this report.

vi. All earthworks should be carried out in a manner to promote stable development of the site. It is recommended that earthworks be carried out along the guidelines given in SANS 1200 (current version).

vii. Guidelines for general cuts and fills are provided in Section 10.4.1 and 10.4.2, respectively.

viii. Consideration should be given to the use of the foundation options discussed in Section 10.8.1 and 10.8.2. for lightly loaded structures, such as canopies for the parking area.

ix. Consideration should be given the use of piled foundations, as discussed in section 10.8.3 for the proposed double storey ablution. Owing to the column arrangement proposed by the client in the architectural schematic, this is the preferred option.

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 Geosure 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 expense.

12. REFERENCES

i. Brink, A., & Bruin, R. (2002). Guidelines for Soil and Rock Logging in South Africa. *Proceedings of the Geoterminology Workshop*. South Africa: Association of Engineering Geologists, South African Institute of Civil Engineering and South African Institute for Engineering and Environmental Geologists.

ii. Google earth. (2019). *AfriGIS (Pty) Ltd*. Retrieved 27 06, 2019, from Google earth: www.googlearth.com

iii. South African Bureau of Standards. (1990). *Standard Specification for Civil Engineering Construction, D: Earthworks*. South Africa: South African Bureau of Standards.

APPENDIX A

INSPECTION PIT PROFILES

GEOSURE (Pty) Ltd
P O Box 1461, Westville, 3630, South Africa
Tel: (031) 266-0458
email: geosure@ iafrica.com

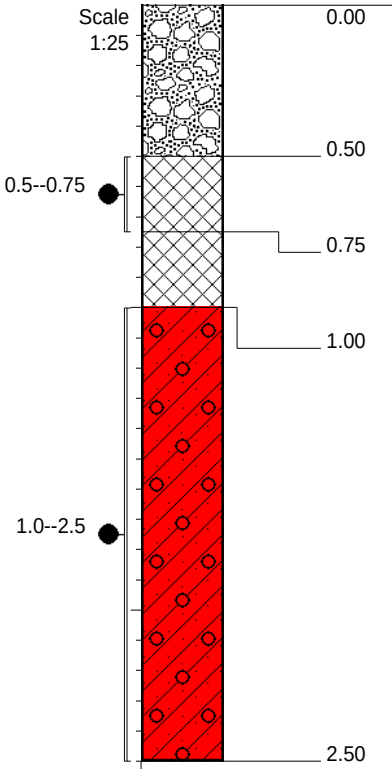
Geotechnical, Environmental & Groundwater Engineering
Pile Integrity Testing & Civil Engineering Laboratory

Fax: 086 689-5506
www.geosure.co.za

LDM
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: IP1
Sheet 1 of 1

JOB NUMBER: J031-19



0.00 Concrete surface bed and slab.

0.50

0.5--0.75 Slightly moist, medium brown mottled light brown, medium dense, gravelly clayey SAND with thick roots and rock fragments. FILL.

0.75

Slightly moist, medium brown mottled orange brown, firm, sandy silty CLAY with occasional rock fragments. FILL.

1.00

Slightly moist, light orange brown mottled khaki brown, firm to stiff, gravelly sandy CLAY. Residuum.

1.0--2.5

2.50

NOTES

1) No groundwater seepage observed.

2) Samples taken at:
S1 0,5--0,75 (1 x Ind)
S2 1,0--2,5 (1 x Ind)

3) Inspection pit extended using hand auger from 1,1m below EGL.

4) Final depth at 2,5m below EGL.

CONTRACTOR : -
MACHINE : By hand
DRILLED BY :
PROFILED BY : H.Pillay
TYPE SET BY : P.Khalili
SETUP FILE : STANDARD.SET

INCLINATION : -
DIAM : -
DATE : 20 November 2019
DATE : 20 November 2019
DATE : 08/07/20 15:12
TEXT : ..C:\LOGS\PITS1.TXT

ELEVATION : -
X-COORD : 28.2729433 E
Y-COORD : -25.7426552 S

HOLE No: IP1

GEOSURE (Pty) Ltd
P O Box 1461, Westville, 3630, South Africa
Tel: (031) 266-0458
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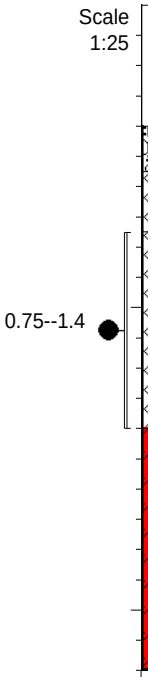
LDM
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: IP2
Sheet 1 of 1

JOB NUMBER: J031-19

Scale 1:25



0.00	Brickwork.
0.40	Concrete slab.
0.55	Slightly moist, medium brown mottled light brown, firm, sandy CLAY with thick roots and rock fragments. FILL.
0.75	Slightly moist, medium brown mottled orange brown, firm, sandy silty CLAY with occasional rock fragments. FILL.
1.40	Slightly moist, light orange brown mottled khaki brown, firm to stiff, sandy silty CLAY. Residuum.
2.20	

NOTES

1) No groundwater seepage observed.

2) Sample taken at:
S1 0,75--1,4 (1 x Ind)

3) Inspection pit extended using hand auger from 1,0m below EGL.

4) Final depth at 2,2m below EGL.

CONTRACTOR : -
MACHINE : By hand
DRILLED BY :
PROFILED BY : H.Pillay
TYPE SET BY : P.Khalili
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : -
DATE : 20 November 2019
DATE : 20 November 2019
DATE : 08/07/20 15:12
TEXT : ..C:\LOGS\PITS1.TXT

ELEVATION : -
X-COORD : 28.2728662 E
Y-COORD : -25.7426244 S

HOLE No: IP2

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Tel: (031) 266-0458
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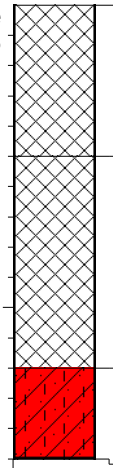
LDM
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: IP3
Sheet 1 of 1

JOB NUMBER: J031-19

Scale 1:25



0.00	Slightly moist, dark brown, soft to firm, sandy CLAY with thick roots and rock pieces. FILL.
0.50	Slightly moist, medium brown mottled orange brown, firm, sandy silty CLAY. FILL.
1.20	Slightly moist, light orange brown mottled khaki brown, firm to stiff, sandy silty CLAY. Residuum.
1.50	

NOTES

1) No groundwater seepage observed.

2) Final depth at 1,5m below EGL.

CONTRACTOR : -
MACHINE : By hand
DRILLED BY :
PROFILED BY : H.Pillay
TYPE SET BY : P.Khalili
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : -
DATE : 20 November 2019
DATE : 20 November 2019
DATE : 08/07/20 15:12
TEXT : ..C:\LOGS\PITS1.TXT

ELEVATION : -
X-COORD : 28.2729195 E
Y-COORD : -25.7424906 S

HOLE No: IP3

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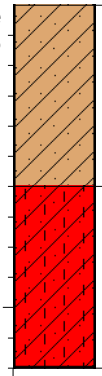
LDM
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: IP4
Sheet 1 of 1

JOB NUMBER: J031-19

Scale 1:25



0.00 Slightly moist, dark brown, soft to firm, sandy CLAY. Colluvium.

0.60 Slightly moist, orange brown, firm to stiff, sandy silty CLAY. Residual.

1.20

NOTES

1) No groundwater seepage observed.

2) Slow advance of excavation.

3) Final depth at 1,2m below EGL.

CONTRACTOR : -
MACHINE : By hand
DRILLED BY :
PROFILED BY : H.Pillay
TYPE SET BY : P.Khalili
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : -
DATE : 20 November 2019
DATE : 20 November 2019
DATE : 08/07/20 15:12
TEXT : ..C:\LOGS\PITS1.TXT

ELEVATION : -
X-COORD : 28.2734365 E
Y-COORD : -25.7429566 S

HOLE No: IP4

GEOSURE (Pty) Ltd
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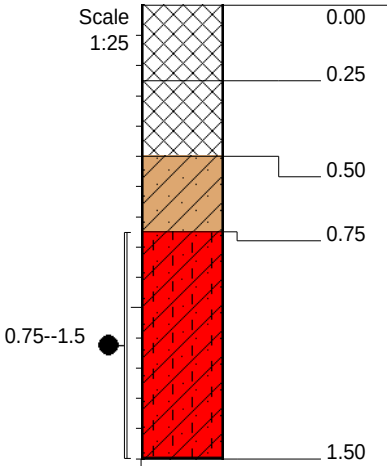
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: IP5
Sheet 1 of 1

JOB NUMBER: J031-19



0.00 – 0.25: Slightly moist, light brown, loose, clayey SAND with roots. FILL.

0.25 – 0.50: Slightly moist, orange brown mottled greyish brown, soft to firm, sandy CLAY with rock pieces. FILL.

0.50 – 0.75: Slightly moist, dark brown, soft to firm, sandy CLAY. Colluvium.

0.75 – 1.50: Slightly moist, orange brown, firm to stiff, sandy silty CLAY to sandy CLAY. Residual.

NOTES

1) No groundwater seepage observed.

2) Sample taken at:
S1 0,75--1,5 (1 x Ind)

3) Final depth at 1,5m below EGL.

CONTRACTOR : -
MACHINE : By hand
DRILLED BY :
PROFILED BY : H.Pillay
TYPE SET BY : P.Khalili
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM : -
DATE : 20 November 2019
DATE : 20 November 2019
DATE : 08/07/20 15:12
TEXT : ..C:\LOGS\PITS1.TXT

ELEVATION : -
X-COORD : 28.2734100 E
Y-COORD : -25.7428029 S

HOLE No: IP5

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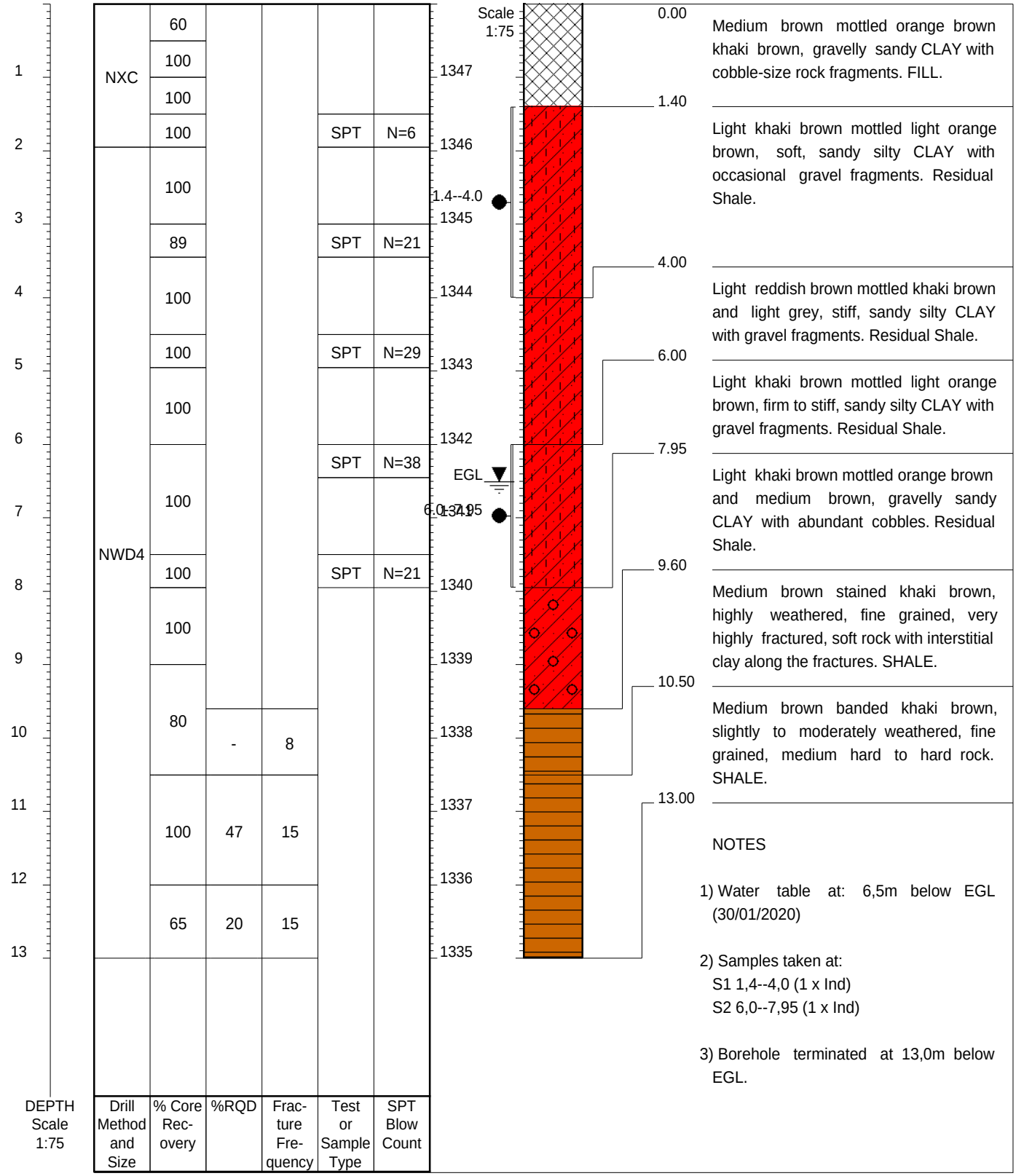
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: BH1
Sheet 1 of 1

JOB NUMBER: JHB031-19



Medium brown mottled orange brown khaki brown, gravelly sandy CLAY with cobble-size rock fragments. FILL.

Light khaki brown mottled light orange brown, soft, sandy silty CLAY with occasional gravel fragments. Residual Shale.

Light reddish brown mottled khaki brown and light grey, stiff, sandy silty CLAY with gravel fragments. Residual Shale.

Light khaki brown mottled light orange brown, firm to stiff, sandy silty CLAY with gravel fragments. Residual Shale.

Light khaki brown mottled orange brown and medium brown, gravelly sandy CLAY with abundant cobbles. Residual Shale.

Medium brown stained khaki brown, highly weathered, fine grained, very highly fractured, soft rock with interstitial clay along the fractures. SHALE.

Medium brown banded khaki brown, slightly to moderately weathered, fine grained, medium hard to hard rock. SHALE.

NOTES

1) Water table at: 6,5m below EGL (30/01/2020)

2) Samples taken at:
S1 1,4--4,0 (1 x Ind)
S2 6,0--7,95 (1 x Ind)

3) Borehole terminated at 13,0m below EGL.

CONTRACTOR : RF Geotechnical Services
MACHINE : GY200
DRILLED BY : -
PROFILED BY : H.Pillay

TYPE SET BY : P.Khalili
SETUP FILE : STANDARG.SET

INCLINATION : -
DIAM : N
DATE : 29-30 January 2020
DATE : 10 February 2020

DATE : 08/07/20 16:35
TEXT : ..C:\LOGS\BH1.TXT

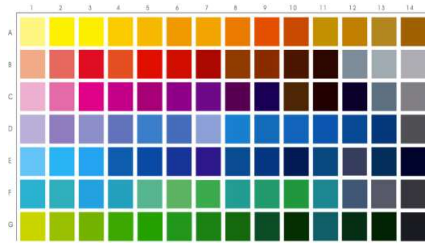
ELEVATION : 1348m
X-COORD : 28.2729201 E
Y-COORD : -25.7426673 S

HOLE No: BH1
-

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

CLIENT:	LDM Consulting (Pty) Ltd
PROJECT:	Umalusi Council for Quality Assurance in General and Further Education and Training
REFERENCE NO.:	JHB031-19
BOREHOLE NO.:	**BH1**
DEPTH:	0.0m to 13.0
BOX NO.:	1,2 and 3 of 3



Box 1 of 3

Box 2 of 3

Box 3 of 3

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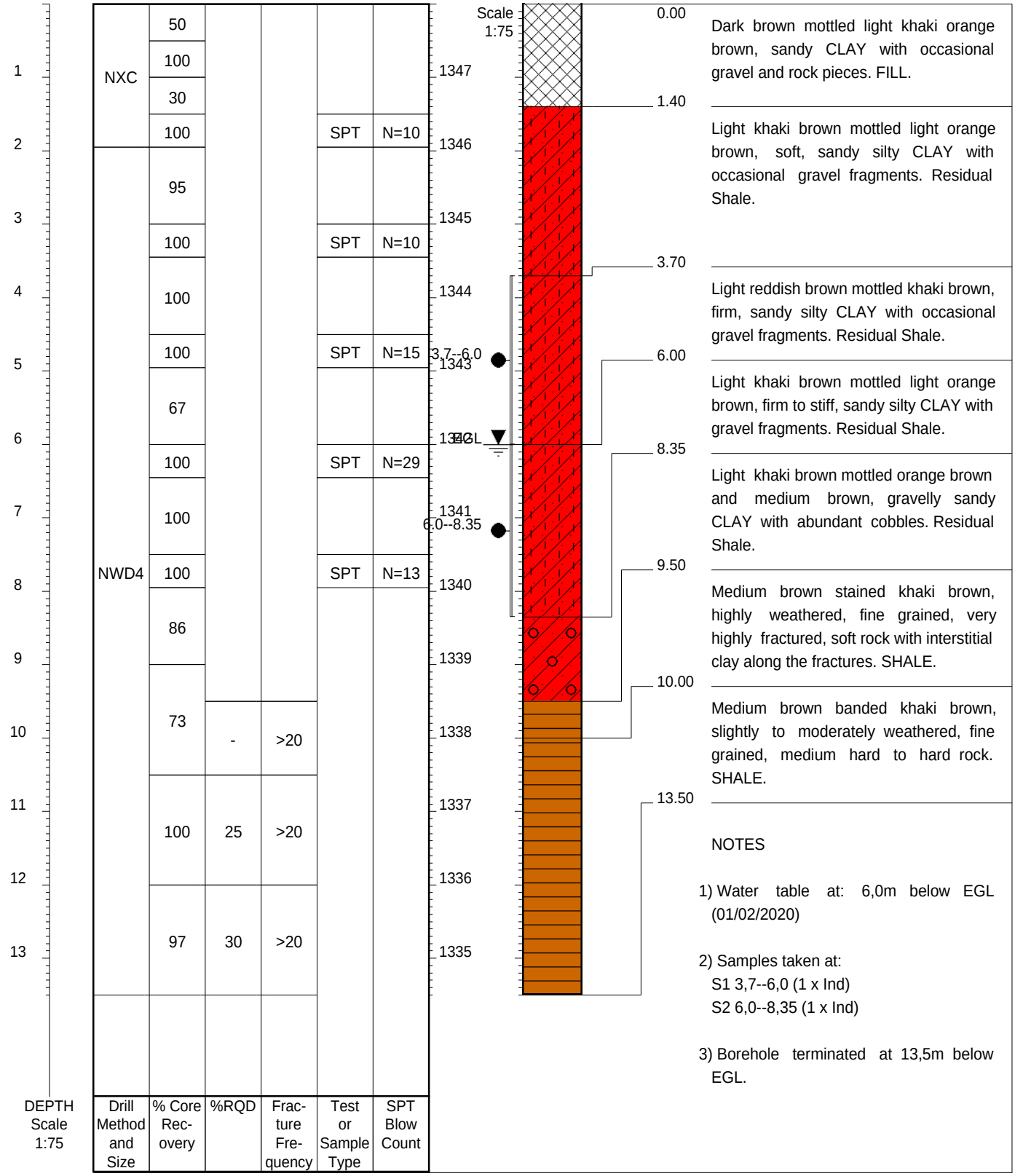
LDM Consulting (Pty) Ltd
Proposed Additions and Alterations at the Existing Office Block and Ablutions at Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng

HOLE No: BH2
Sheet 1 of 1

JOB NUMBER: JHB031-19



Dark brown mottled light khaki orange brown, sandy CLAY with occasional gravel and rock pieces. FILL.

Light khaki brown mottled light orange brown, soft, sandy silty CLAY with occasional gravel fragments. Residual Shale.

Light reddish brown mottled khaki brown, firm, sandy silty CLAY with occasional gravel fragments. Residual Shale.

Light khaki brown mottled light orange brown, firm to stiff, sandy silty CLAY with gravel fragments. Residual Shale.

Light khaki brown mottled orange brown and medium brown, gravelly sandy CLAY with abundant cobbles. Residual Shale.

Medium brown stained khaki brown, highly weathered, fine grained, very highly fractured, soft rock with interstitial clay along the fractures. SHALE.

Medium brown banded khaki brown, slightly to moderately weathered, fine grained, medium hard to hard rock. SHALE.

NOTES

1) Water table at: 6,0m below EGL (01/02/2020)

2) Samples taken at:
S1 3,7--6,0 (1 x Ind)
S2 6,0--8,35 (1 x Ind)

3) Borehole terminated at 13,5m below EGL.

CONTRACTOR : RF Geotechnical Services
MACHINE : GY200
DRILLED BY : -
PROFILED BY : H.Pillay

TYPE SET BY : P.Khalili
SETUP FILE : STANDARG.SET

INCLINATION : -
DIAM : N
DATE : 31 January - 1 February 2020
DATE : 10 February 2020

DATE : 08/07/20 16:35
TEXT : ..C:\LOGS\BH2.TXT

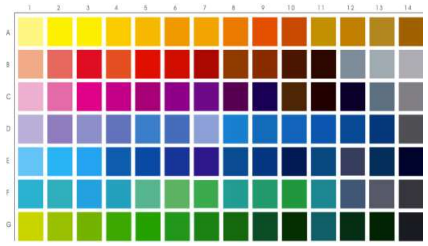
ELEVATION : 1348m
X-COORD : 28.2728521 E
Y-COORD : -25.7426371 S

HOLE No: BH2
-

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

CLIENT:	LDM Consulting (Pty) Ltd
PROJECT:	Umalusi Council for Quality Assurance in General and Further Education and Training
REFERENCE NO.:	JHB031-19
BOREHOLE NO.:	**BH2**
DEPTH:	0.0m to 13.5
BOX NO.:	1,2 and 3 of 3



Box 1 of 3

Box 2 of 3

Box 3 of 3

APPENDIX B

CBR DYNAMIC CONE PENETROMETER TESTS

GEOSURE (PTY) LTD.

Geotechnical Engineering Consultants

Tel: (031) 266 0458 Fax: 086 689 5506 Email: info@geosure.co.za

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Client: LDM **Ref.No.** J031-19

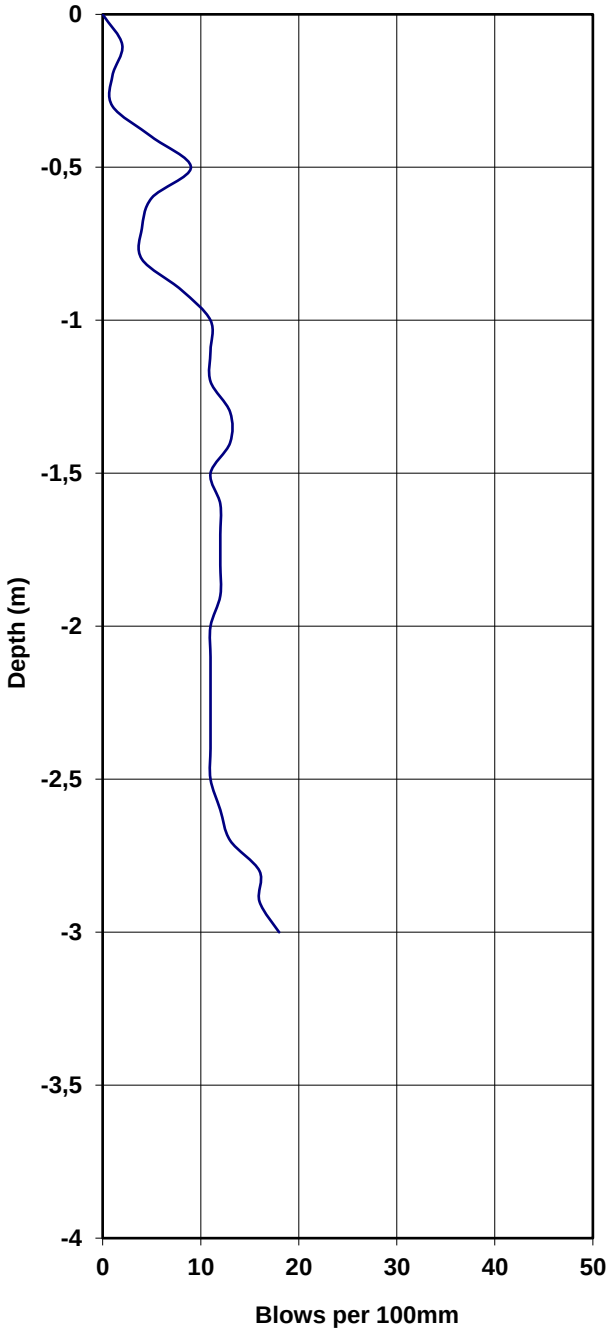
Project: Existing Office Block and Ablutions **Date:** 20-11-2019

Section: Umalusi Council for Quality Assurance in General and Further Education and Training **Operator:** H.Pillay

CBR Penetrometer Probe ---------- Test No. DC 1

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

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0,1	2	Loose	<30 deg	3
0,2	1	Very Loose	<29 deg	2
0,3	1	Very Loose	<29 deg	2
0,4	5	Med.Dense	32 deg	8
0,5	9	Stiff	75 kPa	15
0,6	5	Firm	40 kPa	8
0,7	4	Soft	35 kPa	7
0,8	4	Soft	35 kPa	7
0,9	8	Firm	65 kPa	14
1	11	Stiff	90 kPa	19
1,1	11	Stiff	90 kPa	19
1,2	11	Stiff	90 kPa	19
1,3	13	Stiff	110 kPa	23
1,4	13	Stiff	110 kPa	23
1,5	11	Stiff	90 kPa	19
1,6	12	Stiff	100 kPa	21
1,7	12	Stiff	100 kPa	21
1,8	12	Stiff	100 kPa	21
1,9	12	Stiff	100 kPa	21
2	11	Stiff	90 kPa	19
2,1	11	Stiff	90 kPa	19
2,2	11	Stiff	90 kPa	19
2,3	11	Stiff	90 kPa	19
2,4	11	Stiff	90 kPa	19
2,5	11	Stiff	90 kPa	19
2,6	12	Stiff	100 kPa	21
2,7	13	Stiff	110 kPa	23
2,8	16	Stiff	130 kPa	29
2,9	16	Stiff	130 kPa	29
3	18	Stiff	150 kPa	33
	End			



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Geotechnical Engineering Consultants

Tel: (031) 266 0458 Fax: 086 689 5506 Email: info@geosure.co.za

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Client: LDM **Ref.No.** J031-19

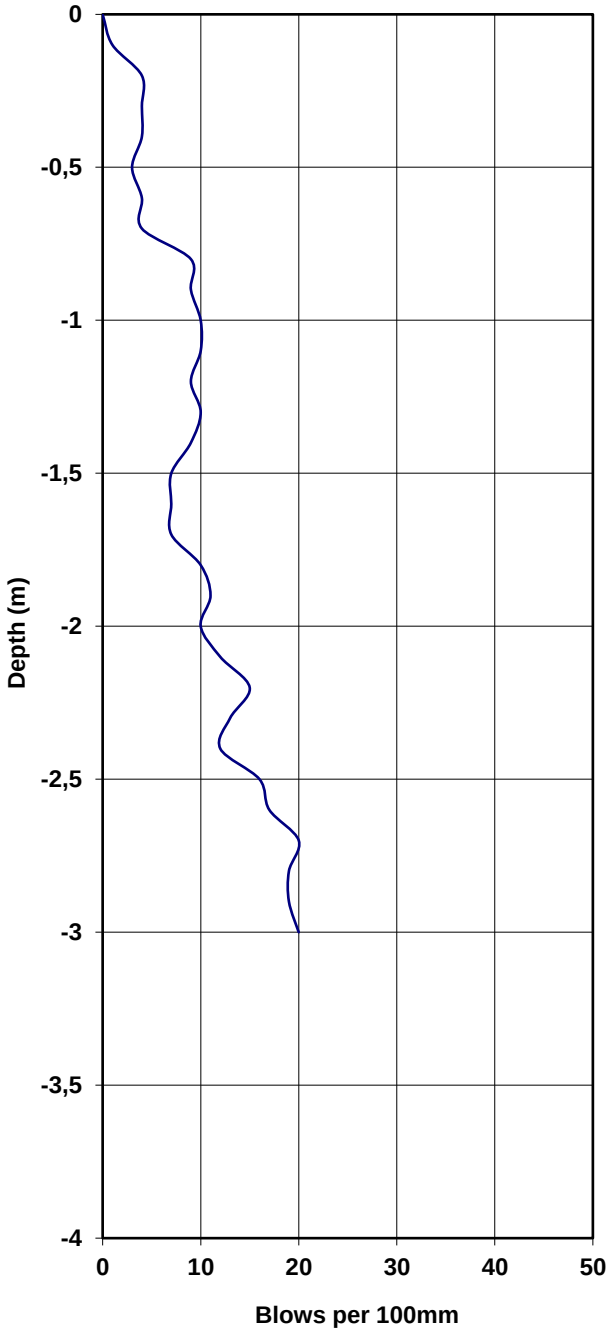
Project: Existing Office Block and Ablutions **Date:** 20-11-2019

Section: Umalusi Council for Quality Assurance in General and Further Education and Training **Operator:** H.Pillay

CBR Penetrometer Probe ---------- Test No. DC 2

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

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0,1	1	Very Loose	<29 deg	2
0,2	4	Med.Dense	30 deg	7
0,3	4	Med.Dense	30 deg	7
0,4	4	Med.Dense	30 deg	7
0,5	3	Loose	<30 deg	5
0,6	4	Soft	35 kPa	7
0,7	4	Soft	35 kPa	7
0,8	9	Stiff	75 kPa	15
0,9	9	Stiff	75 kPa	15
1	10	Stiff	85 kPa	17
1,1	10	Stiff	85 kPa	17
1,2	9	Stiff	75 kPa	15
1,3	10	Stiff	85 kPa	17
1,4	9	Stiff	75 kPa	15
1,5	7	Firm	60 kPa	12
1,6	7	Firm	60 kPa	12
1,7	7	Firm	60 kPa	12
1,8	10	Stiff	85 kPa	17
1,9	11	Stiff	90 kPa	19
2	10	Stiff	85 kPa	17
2,1	12	Stiff	100 kPa	21
2,2	15	Stiff	125 kPa	27
2,3	13	Stiff	110 kPa	23
2,4	12	Stiff	100 kPa	21
2,5	16	Stiff	130 kPa	29
2,6	17	Stiff	140 kPa	31
2,7	20	Very Stiff	>150 kPa	37
2,8	19	Very Stiff	>150 kPa	35
2,9	19	Very Stiff	>150 kPa	35
3	20	Very Stiff	>150 kPa	37
	End			



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Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Client: LDM **Ref.No.** J031-19

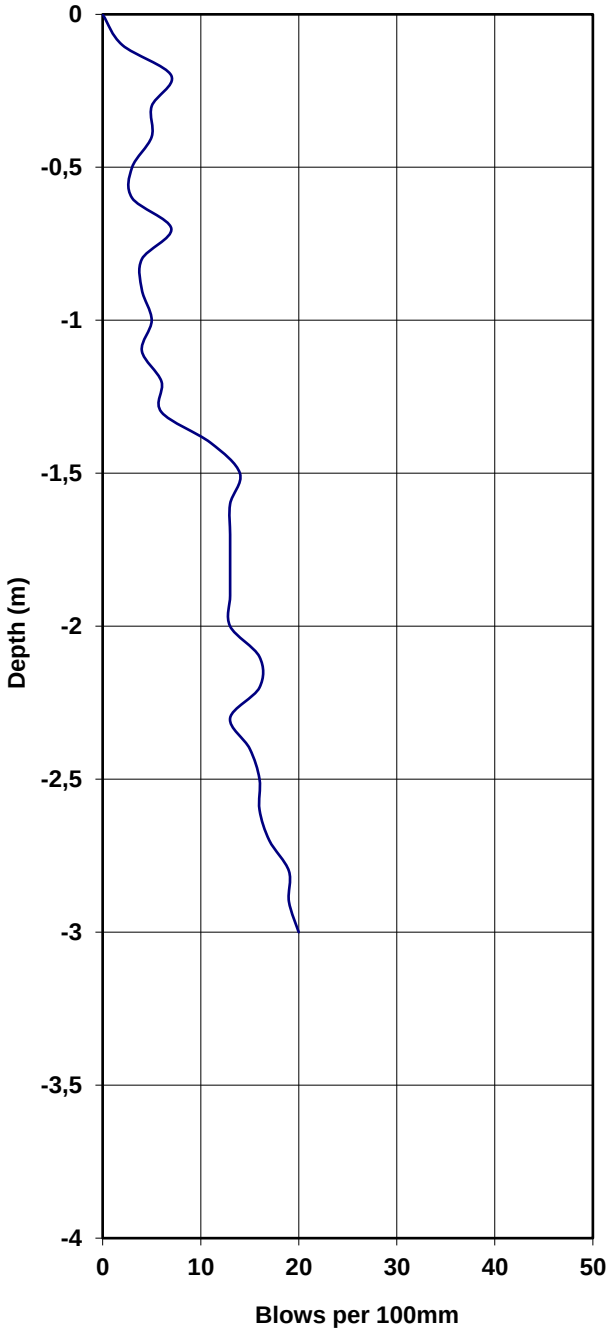
Project: Existing Office Block and Ablutions **Date:** 20-11-2019

Section: Umalusi Council for Quality Assurance in General and Further Education and Training **Operator:** H.Pillay

CBR Penetrometer Probe ---------- Test No. DC 3

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

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0,1	2	Soft	20 kPa	3
0,2	7	Firm	60 kPa	12
0,3	5	Firm	40 kPa	8
0,4	5	Firm	40 kPa	8
0,5	3	Soft	25 kPa	5
0,6	3	Soft	25 kPa	5
0,7	7	Firm	60 kPa	12
0,8	4	Soft	35 kPa	7
0,9	4	Soft	35 kPa	7
1	5	Firm	40 kPa	8
1,1	4	Soft	35 kPa	7
1,2	6	Firm	50 kPa	10
1,3	6	Firm	50 kPa	10
1,4	11	Stiff	90 kPa	19
1,5	14	Stiff	115 kPa	25
1,6	13	Stiff	110 kPa	23
1,7	13	Stiff	110 kPa	23
1,8	13	Stiff	110 kPa	23
1,9	13	Stiff	110 kPa	23
2	13	Stiff	110 kPa	23
2,1	16	Stiff	130 kPa	29
2,2	16	Stiff	130 kPa	29
2,3	13	Stiff	110 kPa	23
2,4	15	Stiff	125 kPa	27
2,5	16	Stiff	130 kPa	29
2,6	16	Stiff	130 kPa	29
2,7	17	Stiff	140 kPa	31
2,8	19	Very Stiff	>150 kPa	35
2,9	19	Very Stiff	>150 kPa	35
3	20	Very Stiff	>150 kPa	37
	End			



GEOSURE (PTY) LTD.

Geotechnical Engineering Consultants

Tel: (031) 266 0458 Fax: 086 689 5506 Email: info@geosure.co.za

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Client: LDM **Ref.No.** J031-19

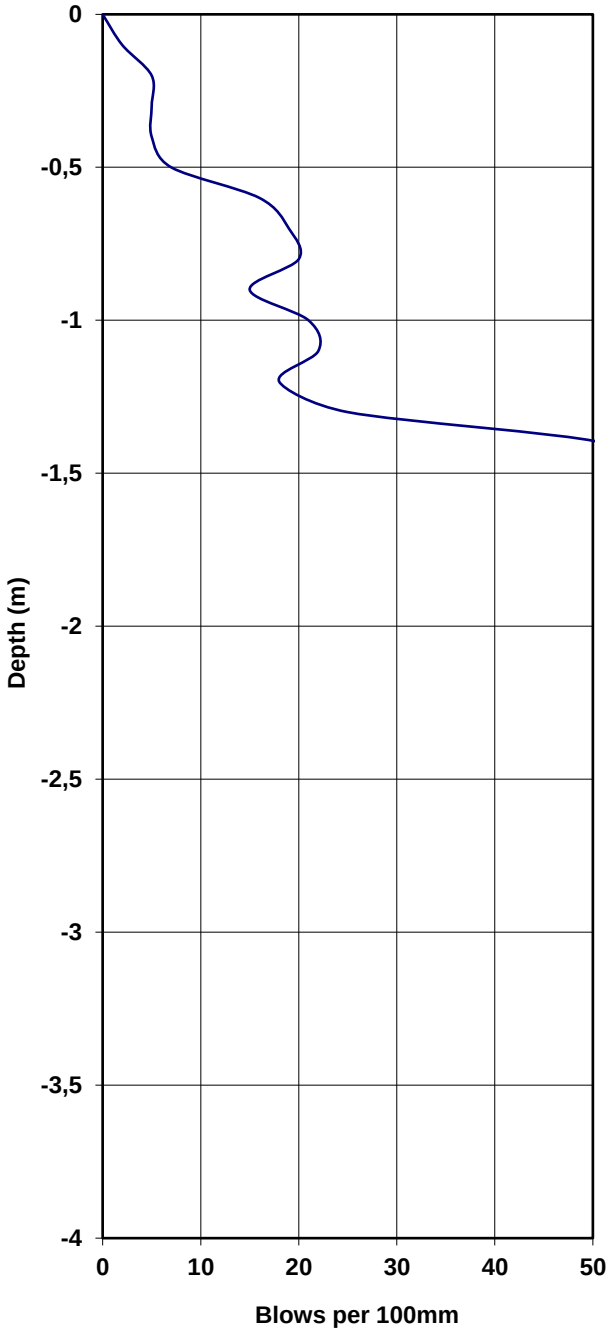
Project: Existing Office Block and Ablutions **Date:** 20-11-2019

Section: Umalusi Council for Quality Assurance in General and Further Education and Training **Operator:** H.Pillay

CBR Penetrometer Probe ---------- Test No. DC 4

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

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0,1	2	Soft	20 kPa	3
0,2	5	Firm	40 kPa	8
0,3	5	Firm	40 kPa	8
0,4	5	Firm	40 kPa	8
0,5	7	Firm	60 kPa	12
0,6	16	Stiff	130 kPa	29
0,7	19	Very Stiff	>150 kPa	35
0,8	20	Very Stiff	>150 kPa	37
0,9	15	Stiff	125 kPa	27
1	21	Very Stiff	>150 kPa	40
1,1	22	Very Stiff	>150 kPa	42
1,2	18	Stiff	150 kPa	33
1,3	25	Very Stiff	>150 kPa	49
	Refusal			



GEOSURE (PTY) LTD.

Geotechnical Engineering Consultants

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Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Client: LDM **Ref.No.** J031-19

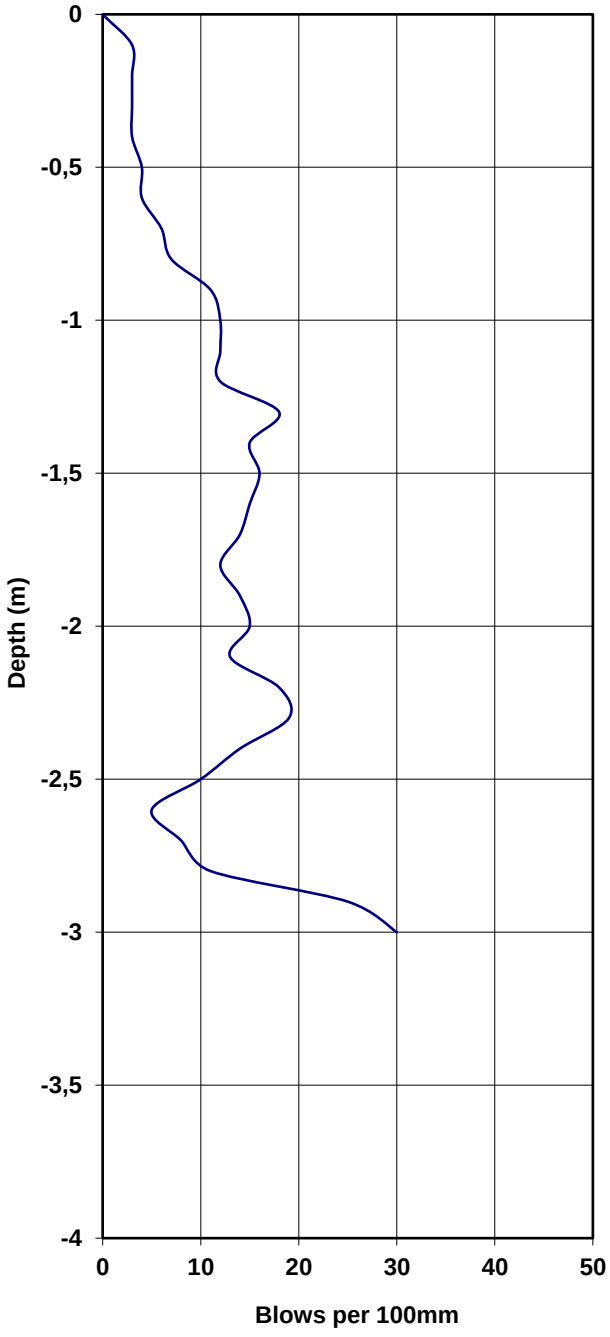
Project: Existing Office Block and Ablutions **Date:** 20-11-2019

Section: Umalusi Council for Quality Assurance in General and Further Education and Training **Operator:** H.Pillay

CBR Penetrometer Probe ---------- Test No. DC 5

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

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0,1	3	Loose	<30 deg	5
0,2	3	Loose	<30 deg	5
0,3	3	Soft	25 kPa	5
0,4	3	Soft	25 kPa	5
0,5	4	Soft	35 kPa	7
0,6	4	Soft	35 kPa	7
0,7	6	Firm	50 kPa	10
0,8	7	Firm	60 kPa	12
0,9	11	Stiff	90 kPa	19
1	12	Stiff	100 kPa	21
1,1	12	Stiff	100 kPa	21
1,2	12	Stiff	100 kPa	21
1,3	18	Stiff	150 kPa	33
1,4	15	Stiff	125 kPa	27
1,5	16	Stiff	130 kPa	29
1,6	15	Stiff	125 kPa	27
1,7	14	Stiff	115 kPa	25
1,8	12	Stiff	100 kPa	21
1,9	14	Stiff	115 kPa	25
2	15	Stiff	125 kPa	27
2,1	13	Stiff	110 kPa	23
2,2	18	Stiff	150 kPa	33
2,3	19	Very Stiff	>150 kPa	35
2,4	14	Stiff	115 kPa	25
2,5	10	Stiff	85 kPa	17
2,6	5	Firm	40 kPa	8
2,7	8	Firm	65 kPa	14
2,8	11	Stiff	90 kPa	19
2,9	25	Very Stiff	>150 kPa	49
3	30	Very Stiff	>150 kPa	>55
	End			



APPENDIX C

LABORATORY TEST RESULTS

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

CLIENT : Geosure Gauteng (Pty) Ltd
PHYSICAL ADDRESS : Wynberg
ATTENTION : Mrs H Pillay
PROJECT : Umalusi Building

TEST REPORT REFERENCE NUMBER: JHB031-19

Dear Madam,

Enclosed herewith, please find the original reports pertaining to the above-mentioned project.

Date Received	10-02-2020
Date Tested	12-02-2020 to 19-02-2020
Sample Location	Refer to report
Sampling Method	Not Specified
Sample Condition	Good
Sampling Environmental Condition	Not Specified
Sampler(s) Name	Mrs H Pillay
Total Number of Pages	8

Test Carried Out			
SANS3001 GR1		TMH1 Method C3	
SANS3001 GR10 & GR12		TMH1 Method C4a	
SANS3001 GR20		TMH1 Method B6	
SANS3001 GR40		Hydrometer Analysis - ASTM D422	✓
TMH1 Method A20		SABS865:1994	✓
TMH1 Method A21T		SANS 5862-1	
TMH1 Method A15d		SANS 5860, 5861-1, 5861-2, 5861-3	
TMH1 Method A16T		TMH1 Method B9	

✓ - Tick denotes tests that were carried out.

We would like to take this opportunity of thanking you for your continued support.
Should you have any queries please do not hesitate to contact me.

Yours faithfully

Nik Sivanarain For Geosure (Pty) Ltd

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Gauteng Branch
P. O. Box 32381, Kyalami 1684
Tel.: 0861 GEOSURE / 0861 436 7873
Fax: 086 689 8327
Mobile: 083 377 6559
Email: gauteng@geosure.co.za

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists
GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

LABORATORY AND HEAD OFFICE ADDRESS: 122 Intersite Avenue, Umgeni Business Park, Durban, 4091

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HEAD OFFICE CONTACT INFO.: Tel.: +27(0) 31 266 0458 Fax: 086 689 5506
Mobile: +27(0) 82 784 0544 e-mail:geosure@iafrica.com

WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd — **Our Ref.** : GG022010

Project : Umalusi Building — **Your Ref.** : JHB031-19

Date Tested : 12-02-20 to 19-02-20

Attention : Mrs H Pillay — **Date Reported** : 19-02-2020

Sample No.		ST188	ST189	ST190	ST191	
Field No.		BH1	BH1	BH2	BH2	
Position in Field						
Depth (m)		1.4 - 4.0	6.0 - 7.95	3.7 - 6.0	6.0 - 8.35	
Material Description		Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale	Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale	Light Reddish Brown Mottled Khaki Brown Sandy Silty CLAY with occ. Gravel - Residual Shale	Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale	
Sieve Analysis (Wet Preparation) - SANS3001 GR 1 - Percent Passing Sieve Size						
% Passing	**75.0 mm**	100	100	100	100	
	63.0 mm	100	100	100	100	
	50.0 mm	100	100	100	100	
	37.5 mm	100	100	100	100	
	28.0 mm	100	100	100	100	
	20.0 mm	100	99	100	100	
	14.0 mm	96	98	100	100	
	5.00 mm	93	97	99	99	
	2.00 mm	85	95	93	98	
	0.425 mm	74	92	83	92	
	0.075 mm	51	73	59	66	
Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)						
% Passing	**0.060 mm**	50	72	56	65	
	0.050 mm	49	71	54	64	
	0.040 mm	48	70	53	64	
	0.026 mm	47	69	50	63	
	0.015 mm	44	65	48	59	
	0.010 mm	40	63	46	57	
	0.0074 mm	39	61	44	55	
	0.0036 mm	36	57	40	50	
	0.0020 mm	34	53	38	47	
	0.0015 mm	32	52	37	45	
Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range						
Coarse Sand	**%**	13	4	11	6	
Coarse Fine Sand	**%**	8	5	7	8	
Medium Fine Sand	**%**	11	8	11	11	
Fine Fine Sand	**%**	8	7	8	8	
Silt & Clay	**%**	60	77	64	68	
Grading Modulus		0.91	0.40	0.65	0.44	
Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)						
Liquid Limit	**%**	32	38	32	34	
Plasticity Index	**%**	9	7	12	12	
Linear Shrinkage	**%**	3.1	2.5	4.4	3.9	
AASHTO Classification (Group Index)*		A-4 (2)	A-4 (6)	A-6 (5)	A-6 (6)	
Unified Classification*		CL	ML/OL‡	CL	CL	
Moisture Content	**%**	14.7	19.6	14.3	24.7	

Remarks: Date Received: 10-02-2020

Sampled by Client.

*Opinions expressed herein fall outside the scope of SANAS accreditation.

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

LABORATORY AND HEAD OFFICE ADDRESS: 122 Intersite Avenue, Umgeni Business Park, Durban, 4091

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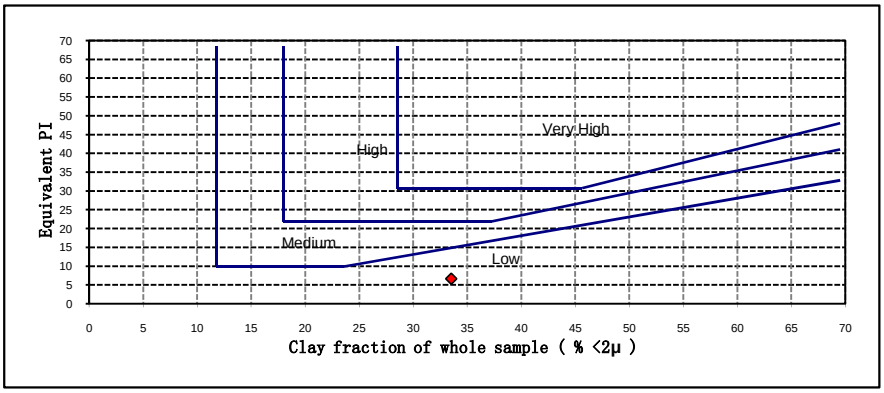
WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd
Project : Umalusi Building
Attention : Mrs H Pillay

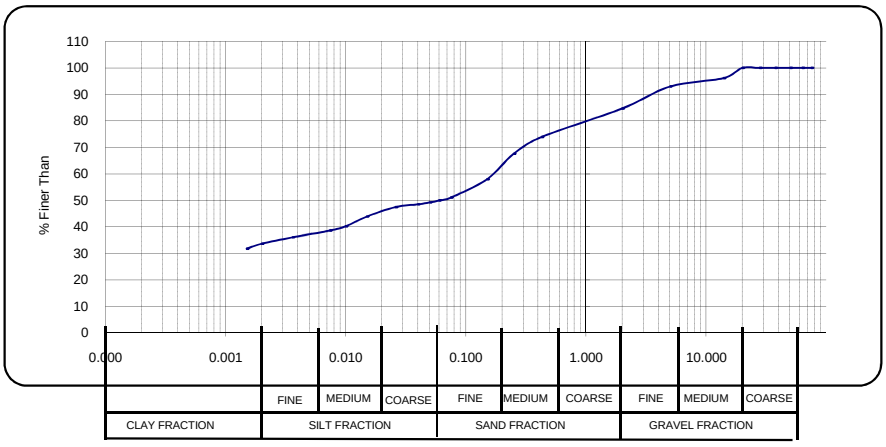
Job No. : GG022010
Your Ref.No. : JHB031-19
Date Tested : 12-02-20 to 19-02-20
Date Reported : 19-02-2020

Sample Number : ST188
Field No. : BH1
Sample Description : Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale
Equivalent PI : 7 **Clay fraction of whole sample (% <2µ)** : 34

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



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GEOSURE (Pty) Ltd

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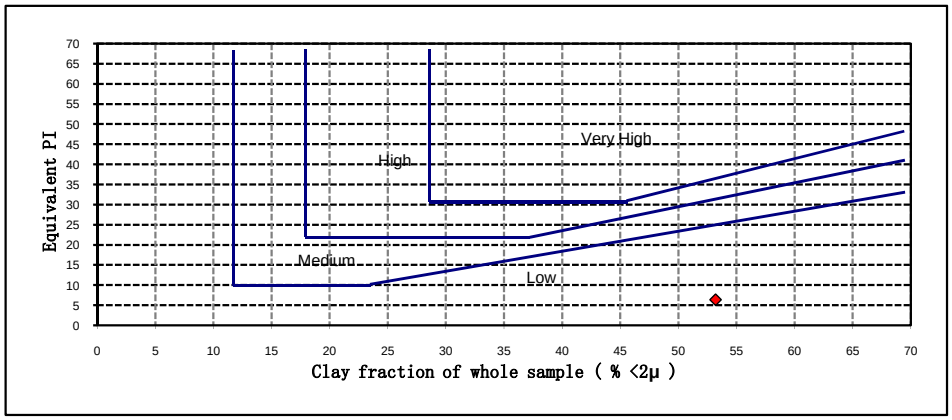
WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd
Project : Umalusi Building
Attention : Mrs H Pillay

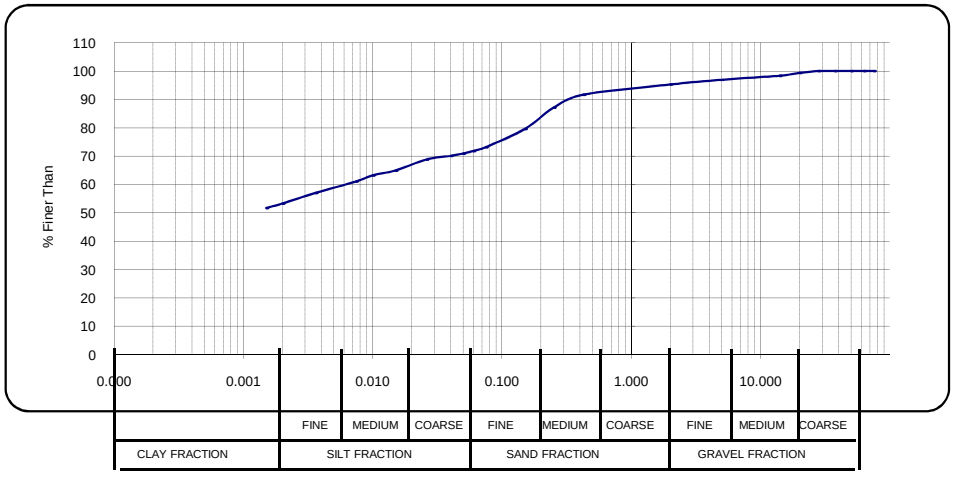
Job No. : GG022010
Your Ref.No. : JHB031-19
Date Tested : 12-02-20 to 19-02-20
Date Reported : 19-02-2020

Sample Number : ST189
Field No. : BH1
Sample Description : Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale
Equivalent PI : 6 **Clay fraction of whole sample (% <2μ)** : 53

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



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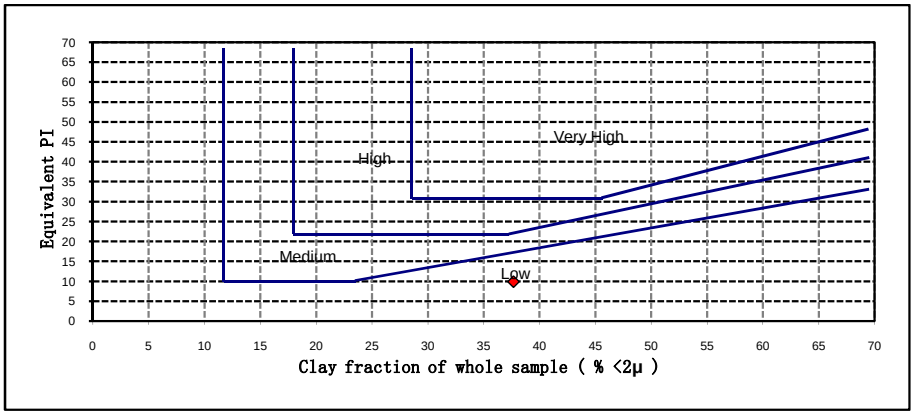
WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd
Project : Umalusi Building
Attention : Mrs H Pillay

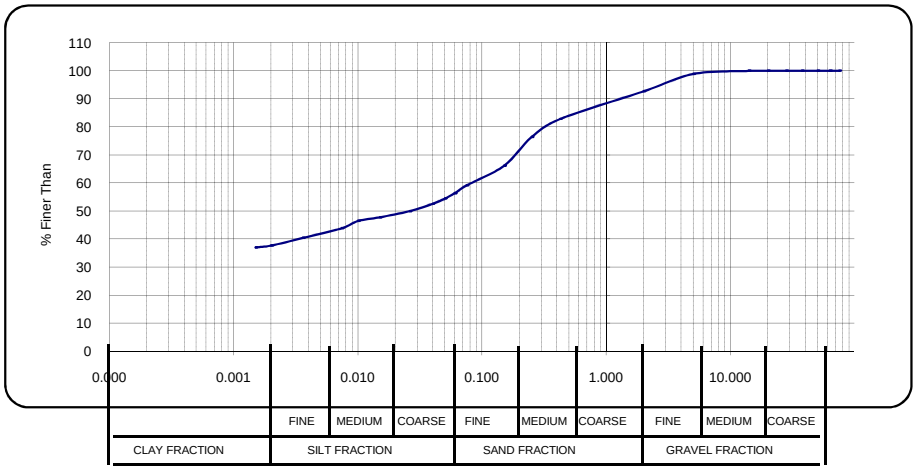
Job No. : GG022010
Your Ref.No. : JHB031-19
Date Tested : 12-02-20 to 19-02-20
Date Reported : 19-02-2020

Sample Number : ST190
Field No. : BH2
Sample Description : Light Reddish Brown Mottled Khaki Brown Sandy Silty CLAY with occ. Gravel - Residual Shale
Equivalent PI : 10 **Clay fraction of whole sample (% <2μ)** : 38

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

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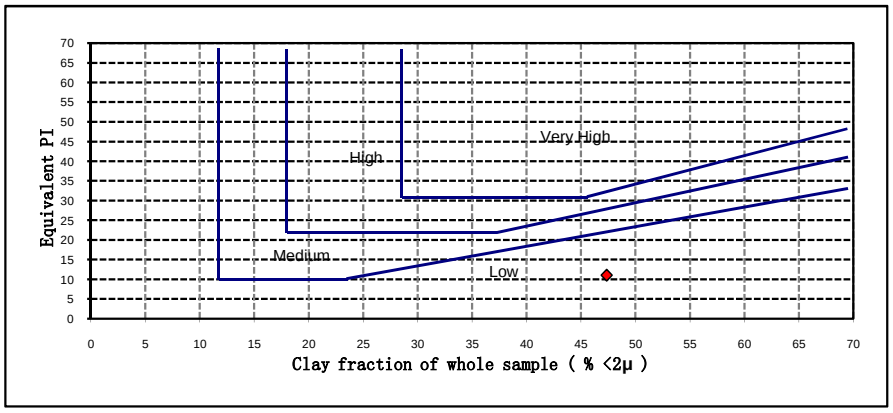
WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd
Project : Umalusi Building
Attention : Mrs H Pillay

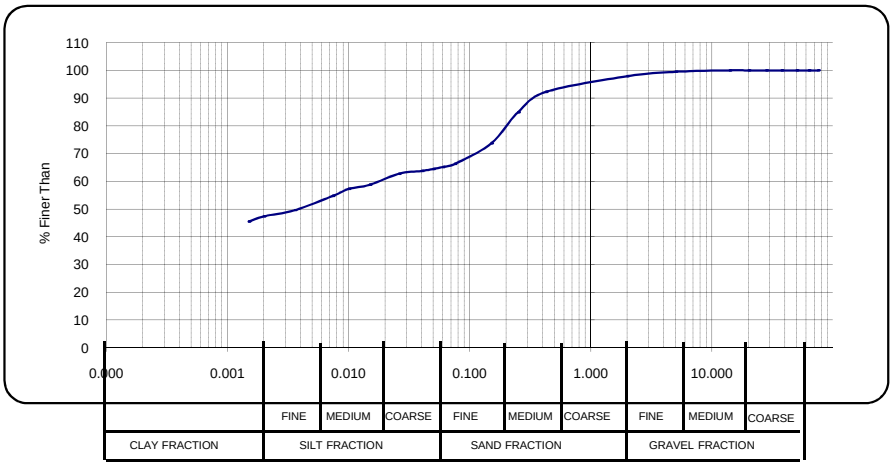
Job No. : GG022010
Your Ref.No. : JHB031-19
Date Tested : 12-02-20 to 19-02-20
Date Reported : 19-02-2020

Sample Number : ST191
Field No. : BH2
Sample Description : Light Khaki Brown Mottled Light Orange Brown Sandy Silty CLAY - Residual Shale
Equivalent PI : 11 **Clay fraction of whole sample (% <2μ)** : 47

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

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WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd **Job No :** GG022010
Project : Umalusi Building **Your Ref. :** JHB031-19
Attention : Mrs H Pillay **Date Reported :** 19-02-2020

UCS CORE REPORT
Test Method : SABS 865:1994

Sample No.	ST192	ST193
Core Ref. No. / Field No.	BH1	BH1
Diameter of Core (mm)	50.00	49.00
Drilled Length of Core (mm)	110	110
Length Of Core After Capping (mm)	110.00	110.00
Area (mm2)	1963	1886
Diameter/Length Ratio	0.45	0.45
Date Cored	Unknown	Unknown
Date Received	10-02-20	10-02-20
Date Tested	19-02-20	19-02-20
Age at Test	-	-
Mass (g)	498	499
Load (kN)	26.1	23.4
STRENGTH (MPa)	15.1	14.2

Remarks: Information supplied by client.

For Geosure

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

LABORATORY AND HEAD OFFICE ADDRESS: **122 Intersite Avenue, Umgeni Business Park, Durban, 4091**

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Mobile: +27(0) 82 784 0544 **e-mail:geosure@iafrica.com**

WEBSITE: **www.geosure.co.za**

Client : Geosure Gauteng (Pty) Ltd **Job No :** GG022010
Project : Umalusi Building **Your Ref. :** JHB031-19
Attention : Mrs H Pillay **Date Reported :** 19-02-2020

UCS CORE REPORT
Test Method : SABS 865:1994

Sample No.	ST194	ST195
Core Ref. No. / Field No.	BH2	BH2
Diameter of Core (mm)	50.00	50.00
Drilled Length of Core (mm)	90	100
Length Of Core After Capping (mm)	90.00	100.00
Area (mm2)	1963	1963
Diameter/Length Ratio	0.56	0.50
Date Cored	Unknown	Unknown
Date Received	10-02-20	10-02-20
Date Tested	19-02-20	19-02-20
Age at Test	-	-
Mass (g)	420	501
Load (kN)	32.0	25.4
STRENGTH (MPa)	18.1	14.5

Remarks: Information supplied by client.

For Geosure

Consulting Engineering Geologists, Geotechnical Engineers, Geotechnicians & Geotechnical Quality Assurance Specialists

GEOSURE (Pty) Ltd

CLIENT : Geosure Gauteng (Pty) Ltd
PHYSICAL ADDRESS : Wynberg
ATTENTION : Mrs H Pillay
PROJECT : Umalusi TVET College

TEST REPORT REFERENCE NUMBER: JHB031-19

Dear Madam,

Enclosed herewith, please find the original reports pertaining to the above-mentioned project.

Date Received	26-11-19
Date Tested	28-11-19 to 05-12-19
Sample Location	Refer to report
Sampling Method	Not Specified
Sample Condition	Good
Sampling Environmental Condition	Not Specified
Sampler(s) Name	Mrs H Pillay
Total Number of Pages	5

Test Carried Out			
SANS3001 GR1	✓	TMH1 Method C3	
SANS3001 GR10 & GR12	✓	TMH1 Method C4a	
SANS3001 GR20	✓	TMH1 Method B6	
SANS3001 GR40		Hydrometer Analysis - ASTM D422	✓
TMH1 Method A20		SANS 5863	
TMH1 Method A21T		SANS 5862-1	
TMH1 Method A15d		SANS 5860, 5861-1, 5861-2, 5861-3	
TMH1 Method A16T		TMH1 Method B9	

✓ - Tick denotes tests that were carried out.

We would like to take this opportunity of thanking you for your continued support.
Should you have any queries please do not hesitate to contact me.

Yours faithfully

Nik Sivanarain For Geosure (Pty) Ltd

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GEOSURE (Pty) Ltd

Reg.No.: 92/03145/07

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WEBSITE: www.geosure.co.za

Client : Geosure Gauteng (Pty) Ltd — **Our Ref.** : GG111921

Project : Umalusi TVET College — **Your Ref.** : JHB031-19

Date Tested : 28-11-19 to 05-12-19

Attention : Mrs H Pillay — **Date Reported** : 10-12-19

Sample No.			ST166	ST167	ST168		
Field No.			IP1	IP1	IP5		
Position in Field			L2	L4	L4		
Depth (m)			0.5 - 0.75	1.0 - 2.5	0.75 - 1.5		
Material Description			Medium Brown Mottled Light Brown gravelly clayey SAND with Roots and Rock Fragments - Fill	Light Orange Brown Mottled Khaki Brown Sandy Silty CLAY - Residuum	Orange Brown Sandy Silty CLAY - Residuum		
Sieve Analysis (Wet Preparation) - SANS3001 GR 1 - Percent Passing Sieve Size							
% Passing	**75.0**	**mm**	100	100	100		
	63.0	**mm**	100	100	100		
	50.0	**mm**	100	100	100		
	37.5	**mm**	100	100	100		
	28.0	**mm**	100	100	100		
	20.0	**mm**	97	100	100		
	14.0	**mm**	90	100	100		
	5.00	**mm**	80	95	100		
	2.00	**mm**	72	88	100		
	0.425	**mm**	56	78	91		
	0.075	**mm**	28	50	52		
Hydrometer Analysis - ASTM - D422 - Percent Passing Particle Diameter (<0.425mm)							
% Passing	**0.060**	**mm**	27	50	51		
	0.050	**mm**	27	50	51		
	0.040	**mm**	27	50	51		
	0.026	**mm**	26	49	50		
	0.015	**mm**	23	47	49		
	0.010	**mm**	23	45	45		
	0.0074	**mm**	22	43	45		
	0.0036	**mm**	19	39	41		
	0.0020	**mm**	17	38	37		
	0.0015	**mm**	17	37	37		
Mechanical analysis - SANS3001 GR1 - Percent of Soil Mortar (<2 mm) for Grain Size range							
Coarse Sand		**%**	23	11	8		
Coarse Fine Sand		**%**	12	10	11		
Medium Fine Sand		**%**	17	14	18		
Fine Fine Sand		**%**	9	8	11		
Silt & Clay		**%**	38	57	52		
Grading Modulus			1.44	0.84	0.57		
Atterberg Limits - SANS3001 GR10, GR12 (<0.425mm)							
Liquid Limit		**%**	22	32	30		
Plasticity Index		**%**	5	7	9		
Linear Shrinkage		**%**	1.3	1.9	3.8		
AASHTO Classification (Group Index)*			A-2-4 (0)	A-4 (1)	A-4 (2)		
Unified Classification*			SM-SC	ML/OL‡	CL		
Moisture Content		**%**	10.2	15.1	9.5		

Remarks:	Date Received: 26-11-19
	Sampled by Client.
	*Opinions expressed herein fall outside the scope of SANAS accreditation.

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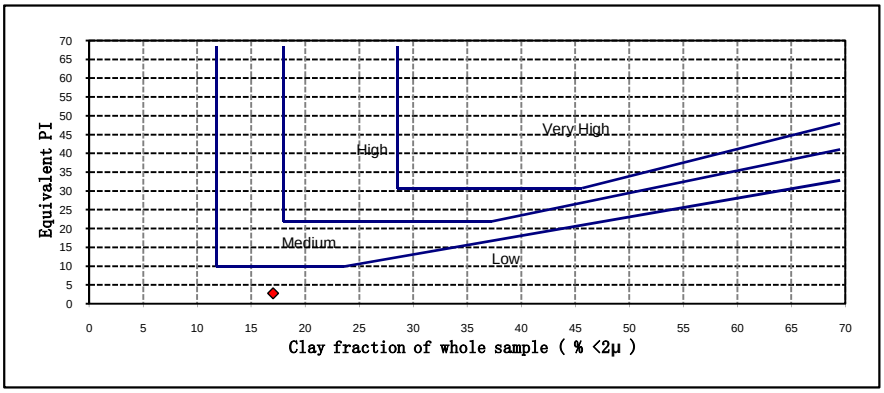
Attention : Mrs H Pillay

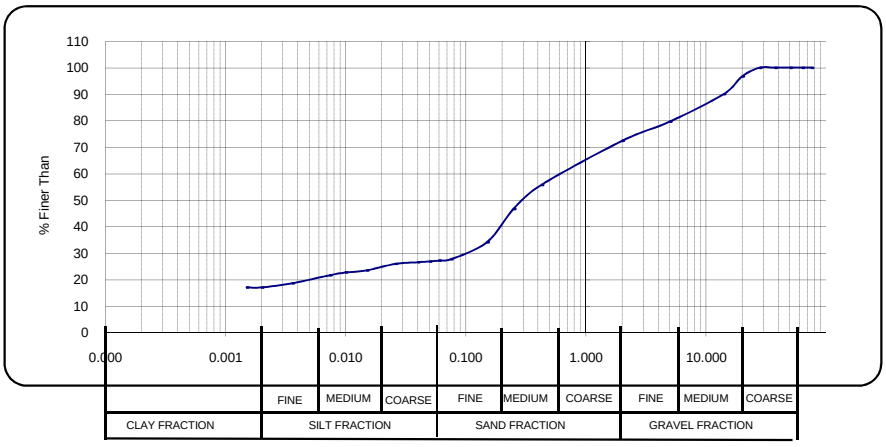
Job No. : GG111921
Your Ref.No. : JHB031-19
Date Tested : 28-11-19 to 05-12-19
Date Reported : 10-12-19

Sample Number : ST166
Field No. : IP1
Sample Description : Medium Brown Mottled Light Brown Sandy CLAY with Roots and Rock Fragments - Fill
Equivalent PI : 3 **Clay fraction of whole sample (% <2μ)** : 17

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



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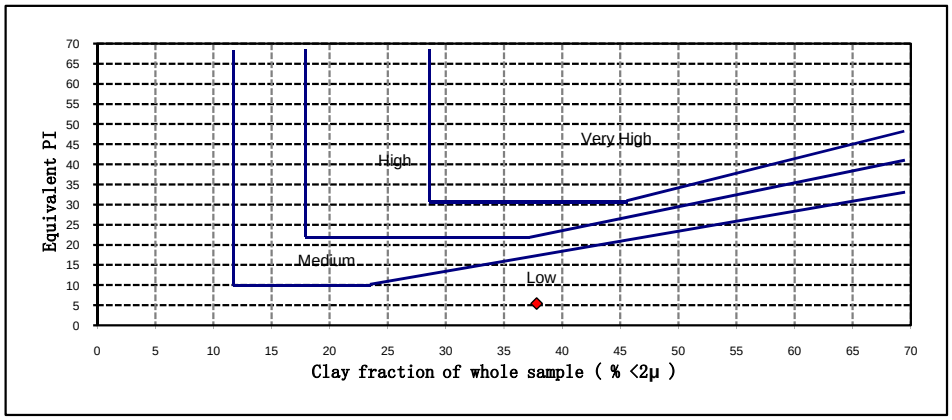
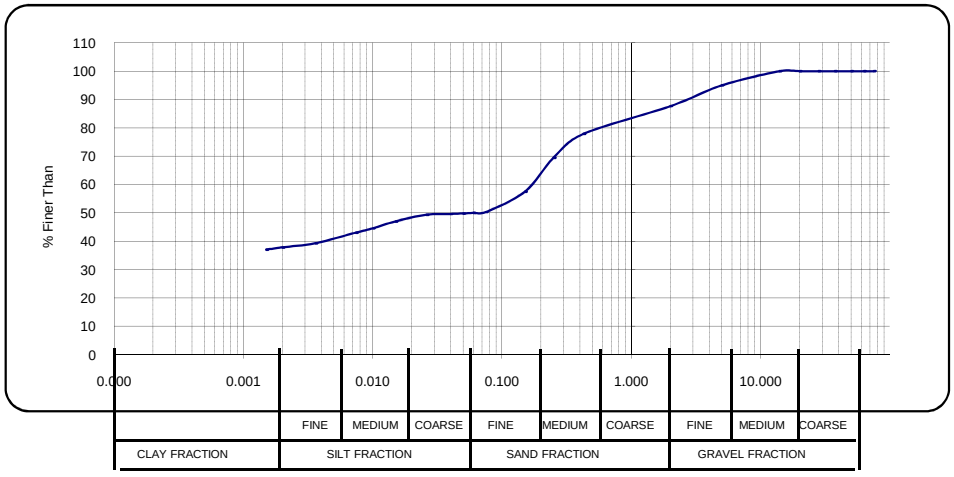
Date Tested : 28-11-19 to 05-12-19
Date Reported : 10-12-19

Sample Number : ST167
Field No. : IP1
Sample Description : Light Orange Brown Mottled Khaki Brown Sandy Silty CLAY - Residuum
Equivalent PI : 5 **Clay fraction of whole sample (% <2µ)** : 38

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART



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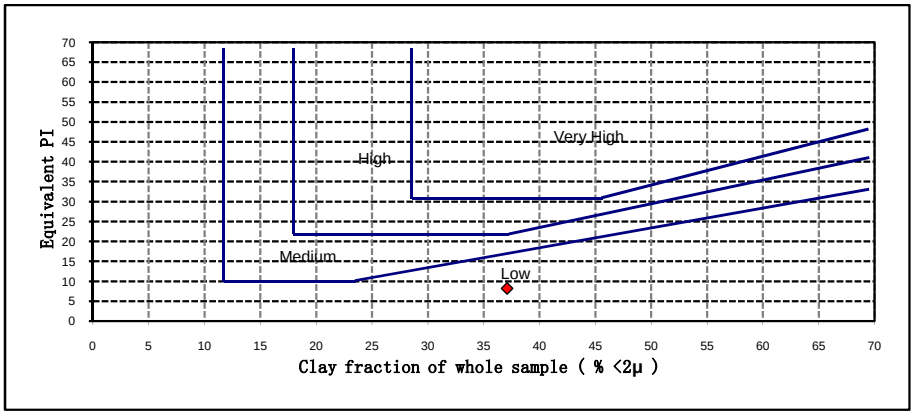
Attention : Mrs H Pillay

Job No. : GG111921
Your Ref.No. : JHB031-19
Date Tested : 28-11-19 to 05-12-19
Date Reported : 10-12-19

Sample Number : ST168
Field No. : IP5
Sample Description : Orange Brown Sandy Silty CLAY - Residuum
Equivalent PI : 8 **Clay fraction of whole sample (% <2μ)** : 37

POTENTIAL EXPANSIVENESS GRAPH



PARTICLE SIZE DISTRIBUTION CHART

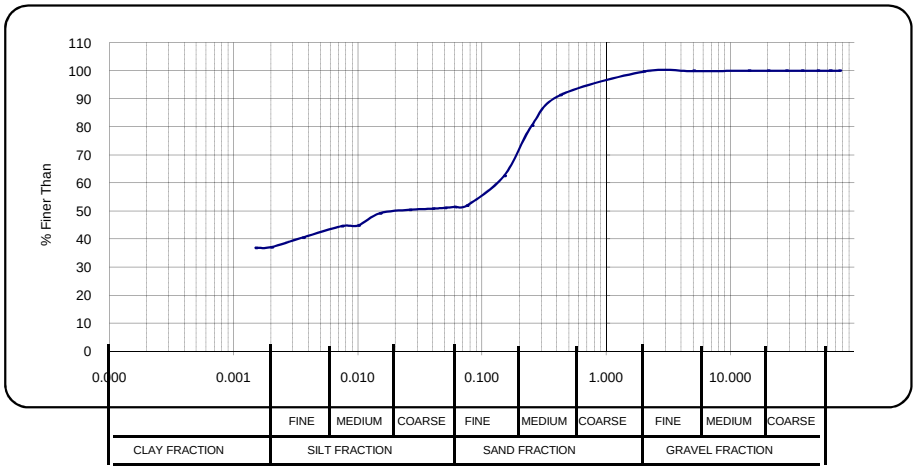
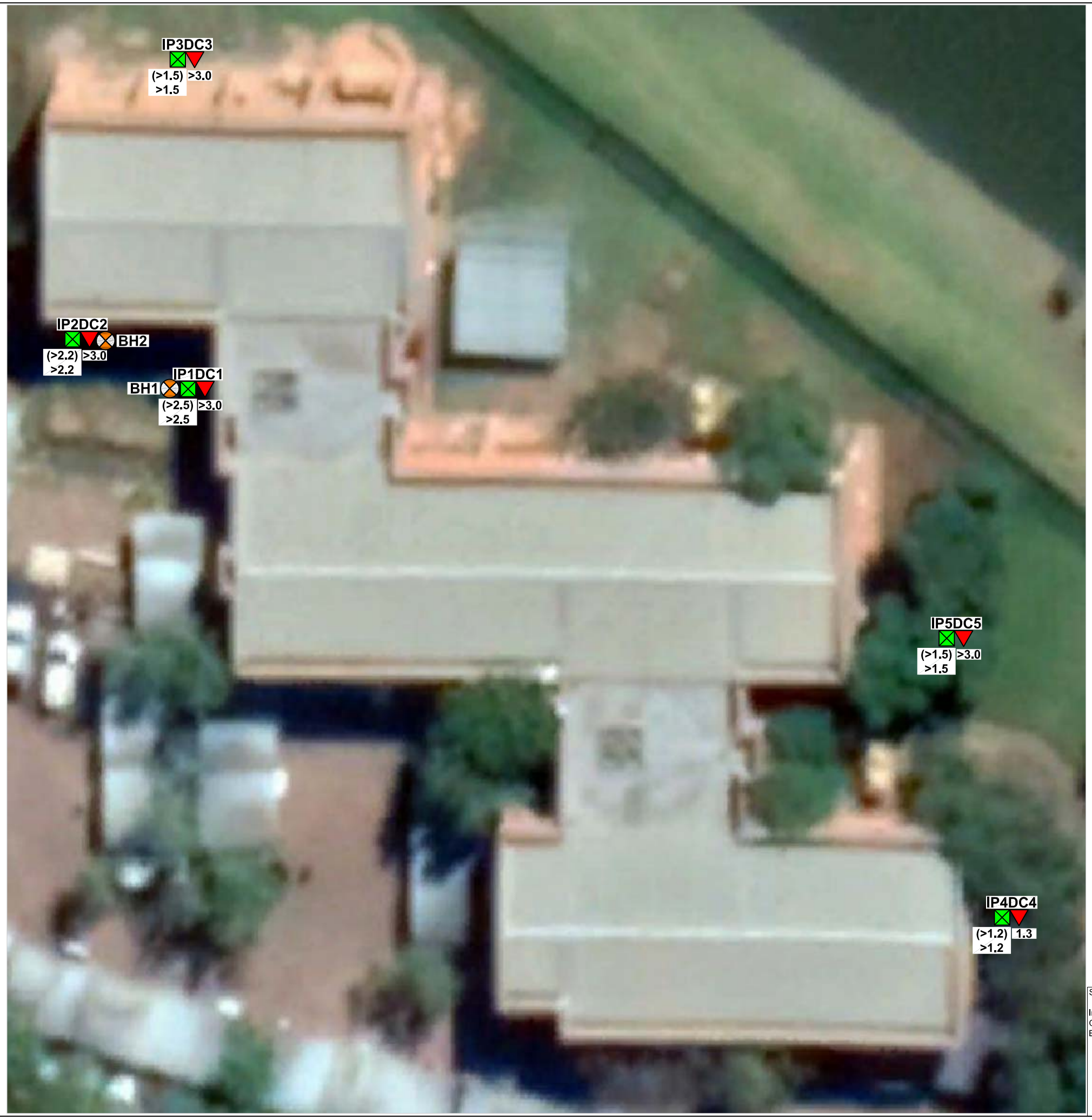
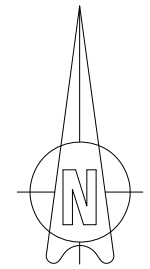


FIGURE 1

SITE PLAN





KEY:

IP1 (>2.5) >2.5 — Approximate position of Inspection Pit showing depth to rock () and depth to refusal in metres below existing ground level.

DC1 >3,0 — Approximate position of CBR Dynamic Cone Penetrometer Test showing depth to refusal in metres below existing ground level.

BH1 — Approximate position of Borehole.

Co ordinates: S-25.742655 E 28.272943

Aerial image sourced from Google Earth

Site plan showing approximate positions of:

Inspection Pits;
CBR Dynamic Cone Penetrometer (DCP) Tests; and
Boreholes.

SCALE 1:250

0 2,5 5
Metres

LDM Consulting Engineers

Proposed Additions & Alterations at the Umalusi Council for Quality Assurance in General and Further Education and Training, Gauteng - Geotechnical Investigation

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DATE: 08-07-2020
DRAWN BY: V.G
CHECKED BY: H.P
REFERENCE NO. J031-19

Figure 1.Rev1