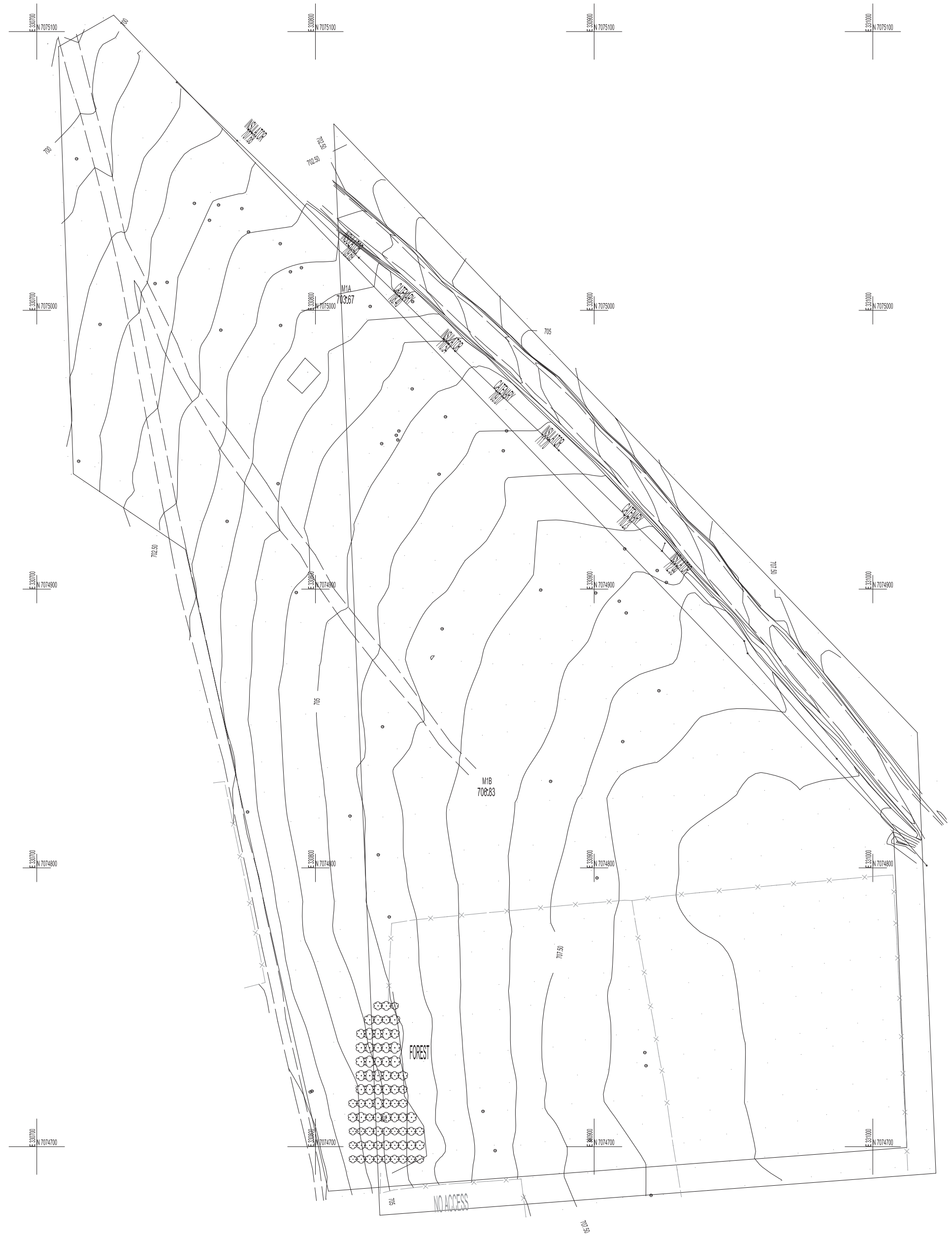
5. 参考資料

番号	資料名	形態	発行年	発行機関
1	National Development Strategy, Vision 2022	電子ｺﾋﾟｰ	1997 年	Govt. of Swaziland
2	Smart Programme on Economic Empowerment and Development	電子ｺﾋﾟｰ	2005 年	Govt. of Swaziland
3	Poverty Reduction Strategy and Action Plan	電子ｺﾋﾟｰ	2007 年	Govt. of Swaziland
4	Ministries' Action Plans to 2018 and 2022	電子ｺﾋﾟｰ	―	Govt. of Swaziland
5	National Education and Training Improvement Programme	電子ｺﾋﾟｰ	2011 年	MoET
6	Free Primary Education Act of 2010	電子ｺﾋﾟｰ	2010 年	MoET
7	The Swaziland Education and Training Sector Policy	電子ｺﾋﾟｰ	2011 年	MoET
8	SEN Statistics 2015	電子ｺﾋﾟｰ	2015 年	MoET
9	School guide regulation procedure	印刷物	1978 年	MoET
10	International General Certificate of Secondary Education (IGCSE) Consultative document 2005	印刷物	2005 年	MoET
11	SGCSE Design and Technology Syllabus 6902 November 2015 and November 2016 Examinations	電子ｺﾋﾟｰ	2015 年	MoET
12	Swaziland's curriculum for the 21th century Curriculum framework discussion document	印刷物	2014 年	MoET
13	List of potential suppliers of school furniture	印刷物	2015 年	MoET
14	Tender Documents 192 of 2015/16 Invitation to tender for the supply and delivery of school furniture for selected primary and secondary schools throughout the country	印刷物	2015 年	MoET
15	Environment Management (Act No.5 of 2002)	電子ｺﾋﾟｰ	2002 年	SEA
16	Environmental Audit, Assessment and Review Regulations	電子ｺﾋﾟｰ	2000 年	SEA
17	Public Procurement Regulations	電子ｺﾋﾟｰ	2015 年 4 月	SPPRA
18	Public Procurement Procedures	電子ｺﾋﾟｰ	2016 年	SPPRA
19	The value added tax act, 2011 (Act No. 12 of 2011) The value added tax regulations, 2012	電子ｺﾋﾟｰ	2012 年	SRA
20	Swaziland National Standard Building construction – Accessibility and usability of the built environment (SZNS ISO 20154 :2011)	書籍	2015 年	Swaziland Standard Authority
21	Swaziland Schools 2010	地図	2010 年	Surveyor General's Department
22	Establishment Circular Number1 of 2016 Implementation of the revised salary grading and pay structure for government established positions emanating from the salary review exercise 2016/17	印刷物	2016 年 7 月	Ministry of Public Service
23	List of registered company	電子ｺﾋﾟｰ	2015 年	CIC
24	Swaziland Protected Area Map	電子ｺﾋﾟｰ	―	Swaziland National Trust Commission

6. その他の資料・情報

6-1 敷地測量図



M1-Boyane

General Notes

SURVEY SYSTEM UTM 36J ITRF2005
HEIGHTS AMSL (SA GEOID 2010)

M1A	330811.056	7075004.826	703.677	12MM
M1B	330861.597	7074828.171	706.840	12MM

LEGEND

Graves, Route/Km Marker, Sign Board, Sign Gantry, Cats Eye, Parking Meter, Waste Bin, Speed Bump, Bollard, SOS Phone, Flag Pole, Post Box, Aircon, Stormwater Manhole, Grid Inlet, Drain, Catch Pit, Drain Outlet, Telephone Pole Wood, Telephone Pole Steel, Telephone Pole Concrete, Telkom Manhole, Telephone Booth, Telkom DB, Radio Mast, Sewer Manhole, Cess Pit, Sewer Pipe, Inspection Eye, Light Pole Steel, Light Pole Wood, Light Pole Concrete, Light Bollard, Wood Pylon, Steel Pylon, Concrete Pylon, Stay, Lightning Rod, DB Board, Intercom, Boom, Camera, Traffic Light, Cable Marker, Electrical Manhole

Tree, Bush, Rail Signal, Rail Control Box, Rail Telephone, Rail Km Mark, Switch, Bottom Peizometer, Discharge, Tailings Valve, Penstock Ring, Monitoring Point, Water Meter, Tap, Water Valve, Fire Hydrant, Borehole, Water Manhole, Water Sprinkler, Gas Manhole, Gas Valve

Paving, White line, Yellow Line, Fence, Electric Fence, Palisade Fence, Balcony Line, Wall (Symbol), Gate, Steel Fence, Armco, Parking line

Survey Point, Town Survey Mark

No.	Revision/Issue	Date

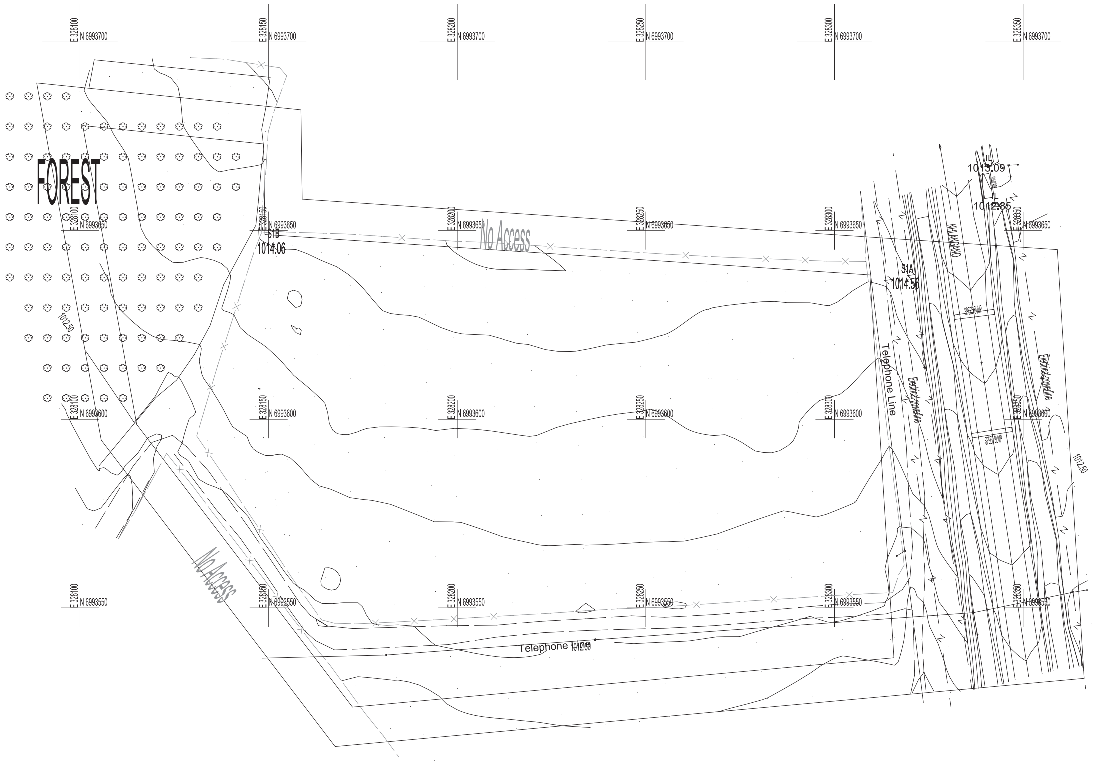
INITIO EARTH SCIENCES
PO BOX 7497
PALM COURT
SOUTH AFRICA 1715
TEL +2711 7954007
FAX +2711 7954008
www.iesciences.com
initio@iafrica.com

Project: BOYANE MATSUDA

Sheet: 1 OF 1

Date: DECEMBER 2015

Scale: 1:1500

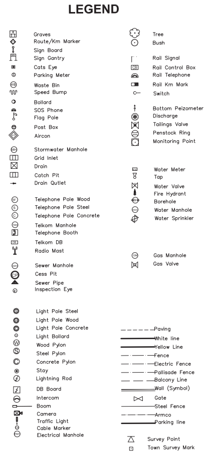


S1-Eqinisweni

General Notes

SURVEY SYSTEM UTM 36J ITRF2005
HEIGHTS AMSL (SA GEOID 2010)

S1B	328151.29	6993646.28	1014.06	12MM
S1A	328319.30	6993636.93	1014.56	12MM



No.	Revision/Issue	Date

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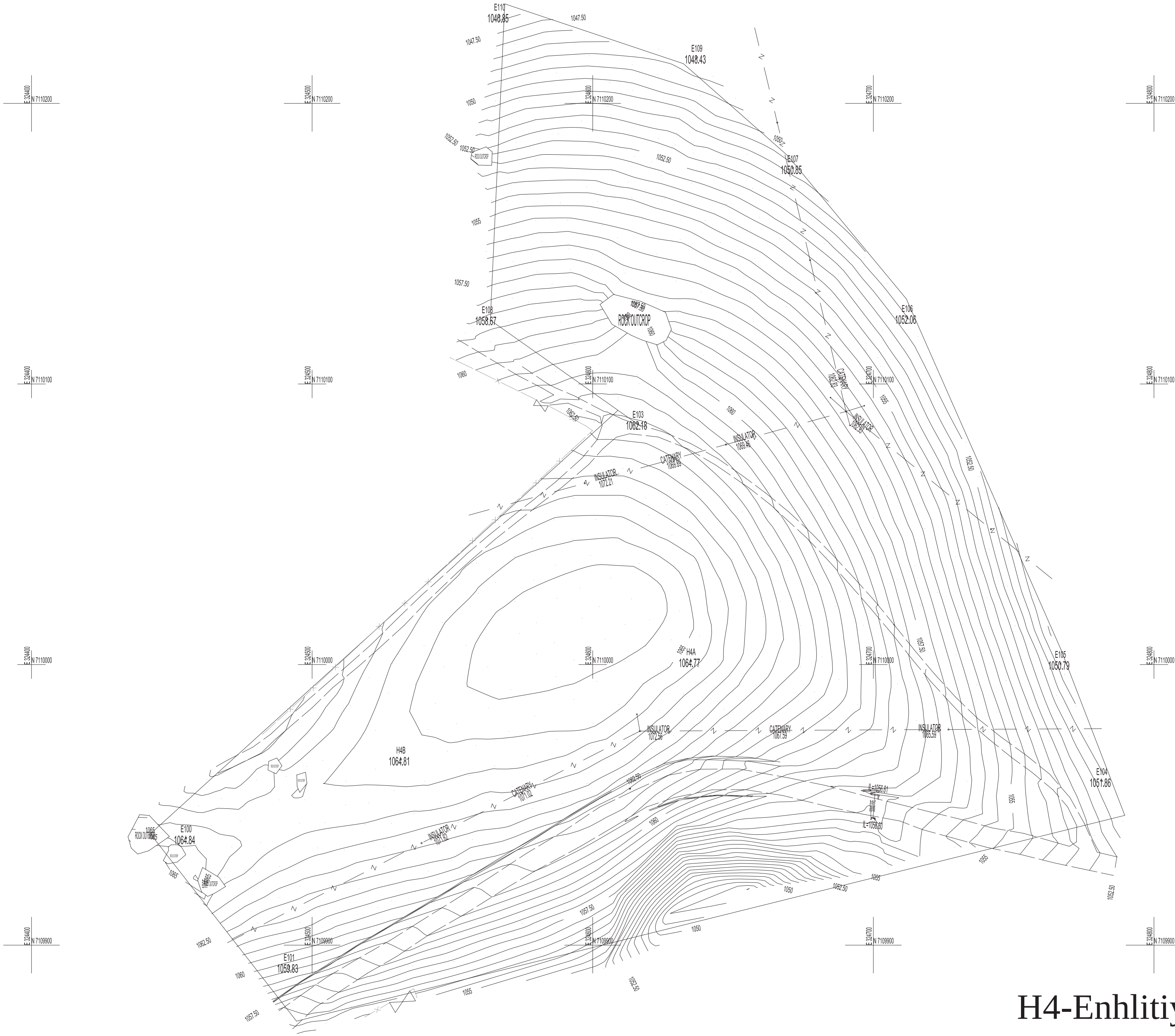
INITIO EARTH SCIENCES Professional Surveyors

Project:EQINISWENI Matsuda

Date: DECEMBER 2015

Scale: 1:500

Sheet: 1 OF 1



A-147

General Notes

SURVEY SYSTEM UTM 36J ITRF2005
HEIGHTS AMSL (SA GEOID 2010)

H4A	324635.038	7110001.527	1064.769	12MM
H4B	324531.660	7109966.465	1064.807	12MM

CORNER NUMBER	E	N	HEIGHT (AMSL)	DESCRIPTION
E100	324455.119	7109938.395	1064.844	12MM
E101	324491.842	7109892.602	1059.832	12MM
E103	324616.168	7110086.127	1062.184	12MM
E104	324781.436	7109958.806	1051.858	12MM
E105	324766.685	7110000.572	1050.786	12MM
E106	324712.082	7110123.858	1052.064	12MM
E107	324671.309	7110177.244	1050.853	12MM
E108	324562.464	7110123.406	1058.669	12MM
E109	324637.122	7110216.614	1048.428	12MM
E110	324566.813	7110231.283	1046.850	12MM

LEGEND

No.	Revision/Issue	Date

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Project: ENHLITIYWENI MATSUDA

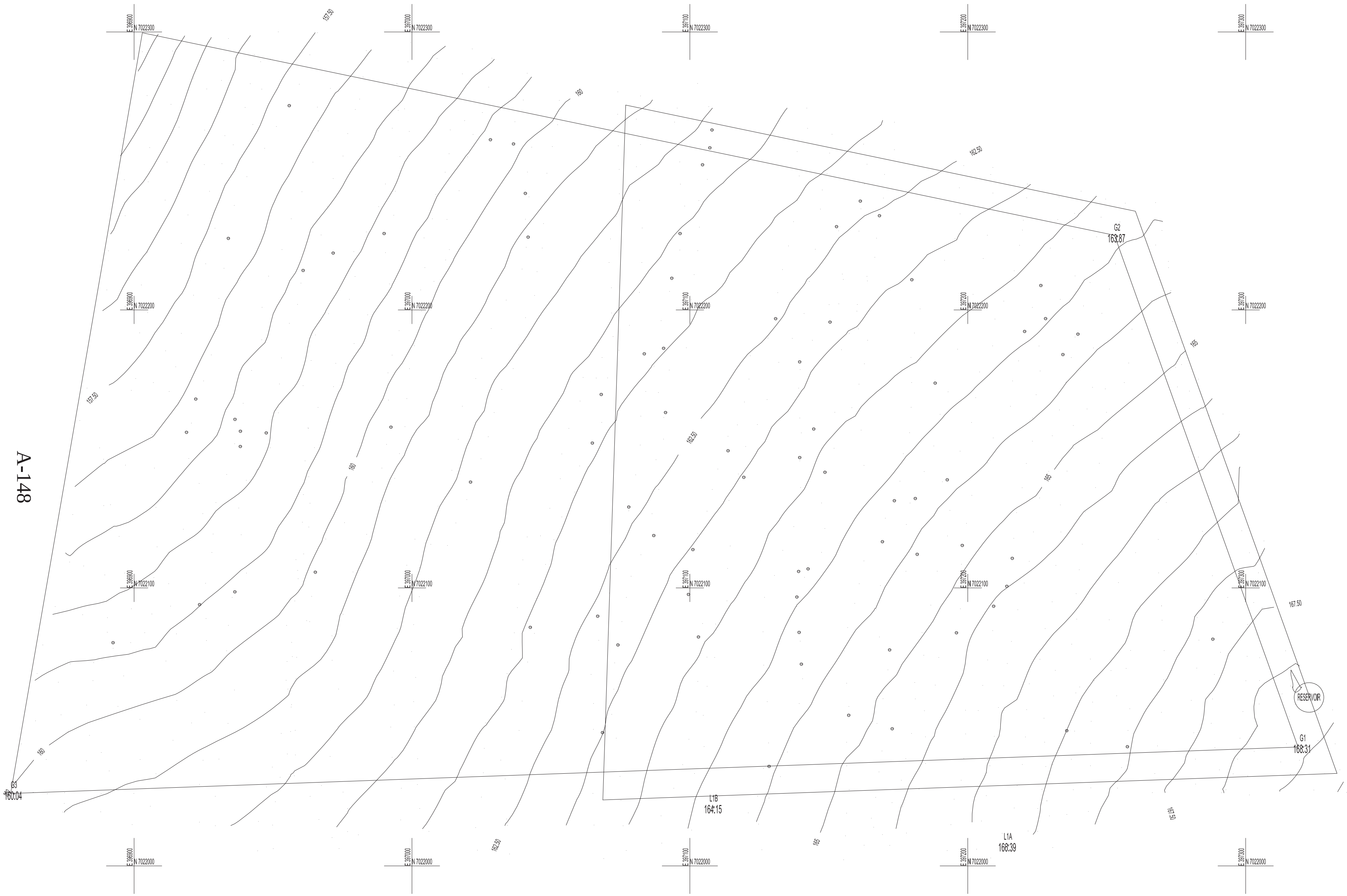
Sheet: 1 OF 1

Date: DECEMBER 2015

Scale: 1:500

H4-Enhlitiyweni

A-148



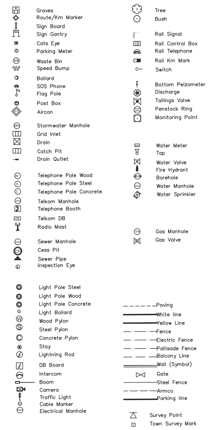
L1-Gamula

General Notes

SURVEY SYSTEM UTM 36J ITRF2005
HEIGHTS AMSL (SA GEOID 2010)

G1	397320.598	7022043.025	168.313	12MM
L1B	397108.596	7022021.334	164.149	12MM
G2	397253.765	7022226.704	163.871	12MM
G3	396856.759	7022026.190	160.041	12MM
L1A	397214.477	7022007.603	166.388	12MM

LEGEND



No.	Revision/Issue	Date

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Project: GAMULA Matsuda	Sheet: 1 OF 1
Date: NOVEMBER 2015	
Scale: 1:500	

6-2 地盤調査結果

M1-Boyane

SOIL TESTING SERVICES

GEOTECHNICAL REPORT – BOYANE

CONSTRUCTION OF NEW SECONDARY SCHOOLS AND UP-GRADING OF FACILITIES IN EXISTING SECONDARY SCHOOLS AIMED AT PROMOTING INCLUSIVE EDUCATION IN THE KINGDOM OF SWAZILAND

FOR

MATSUDA CONSULTANTS INTERNATIONAL CO. LTD

SOIL TESTING SERVICES

CIVIL ENGINEERING LABORATORY

Lot 321, Samora Machel Street
P.O. Box A233
Swazi Plaza
Mbabane H101
Swaziland

MARCH 2016

TABLE OF CONTENTS

GEOTECHNICAL REPORT - BOYANE

1.0 INTRODUCTION

This report is based on the Preparatory Survey on "the Project for the Construction of New Secondary Schools and Upgrading of Facilities in Existing Secondary Schools aimed at Promoting Inclusive Education" based upon request from the Government of Swaziland to the Japan International Cooperation Agency (JICA). The survey is to obtain geotechnical data and information at Boyane, central Swaziland, where the proposed Boyane High School will be constructed, for the design of earthworks, foundation and structures of the buildings.

2.0 SCOPE OF WORK

The following activities were expected to be executed in the cause of the study.

(1) Field works on each site
- Dynamic Cone Penetration test (DCP)
  Nine (09) points, depth up to Two (02) m from the ground level
- Soil Sampling
- Percolation Test Two (02) points

(2) Laboratory testing (for each sample)
- Triaxial Compression Test
- Moisture Density Test
- Particle Size Analysis
- Atterberg limit test

3.0 SITE DESCRIPTION

Location and Topography

The new Boyane High School is to be built in a gentle sloping site facing north. The site is located at Boyane, an area past Ludzeludze, next to Boyane Primary School. Part of the area is the garden and football pitch of the primary school. The rest of the area lies outside the Boyane Primary School in an area currently used a grazing land. It is vegetated by indigenous grass cover and iron wood trees and some wattle trees.

Rainfall and Drainage

Boyane is an area located in the Middleveld climatic zone of the country. It has a 720m elevation with summer rainfall received between October and March. The average annual rainfall is 600mm with a temperate climate. Winters are generally harsh and known to experience frost.

The Boyane area has no watercourse way running through it. Off site there is a small stream that drains the area. Water supply in the area is through an established rural water scheme. Alternative water can be sourced through drilling for underground water.

Access

Boyane is easily accessible along the way from Manzini to Mbekelweni. The area is about 2km from the tar road after a turnoff at Soweto area. It is accessed through a dusty distributor road with no wearing course.

4.0 GENERAL GEOLOGY OF SITE

The proposed school site is underlain by granodiorite, a medium to coarse grained crystalline rock. Its composition varies from quartz diorite to hornblende granodiorite to biotite granodiorite. The granodiorite suite has been intruded by small fairly localized diabase dykes. They trend approximately north to south or east to west, which corresponds to the general tectonic trends of the region. The granodiorite suite can also be associated with the intrusion of quartz veins which often indicate the presence of tectonic faulting.

Depth to granodiorite bedrock can be highly variable and can be expected to be overlain by a weathered rock to soil derived from complete weathering of the bedrock. This soil profile can in itself be overlain by soils of colluvial origin, typically, gravity transported in the site.

A scanned and cropped geological map of the area is presented in Appendix A. It is taken from a 1:50 000 geological map sheet 12 (2631 AD) published by the Swaziland Geological Survey Department

5.0 GEOTECHNICAL FIELD INVESTIGATIONS AND LABORATORY TESTING

Methods of Investigation and Testing

Field investigations, sampling and laboratory testing has been designed to provide information as follows:

Trial Pits

Two Trial Pits (TP) were excavated at positions determined by the client with pits attaining some depth of 2.4m using a Tractor Loader Backhoe (TLB), 4x4 capability with 600mm bucket width and flywheel power rating of at least 70kW. The aim of the excavation of the trial pits was to determine the soil stratigraphy, and extraction of soil samples.

All test pits had stable walls and were profiled using profiling standard procedure outlined in the Association of Engineering Geologists (South African Section), 'Guidelines for soil and rock logging in SA" (1990). Representative soil samples were taken from the soil profile for laboratory testing. Bulk samples of the residual soil material were taken; topsoil and sub-soil layers were recorded and are shown in detail in Trial Pit profiles. The stratigraphy revealed by each pit was carefully logged with special notes taken of the thickness and conditions of the various layers.

Dynamic Cone Penetration Test (DCP)

Dynamic Cone Penetrometer (DCP) tests were conducted at 9 positions around the site. The exact locations of all DCP tests carried out were performed at positions determined by Matsuda Consultants International Co., Ltd.

Prior to the performance of a series of tests, the zero reading of the penetrometer was determined. The dynamic penetrometer tests were then performed by taking readings of cone penetration after a number of blows depending on the consistency of the layer being penetrated. The tests were terminated at maximum depths of 2000mm wherever possible.

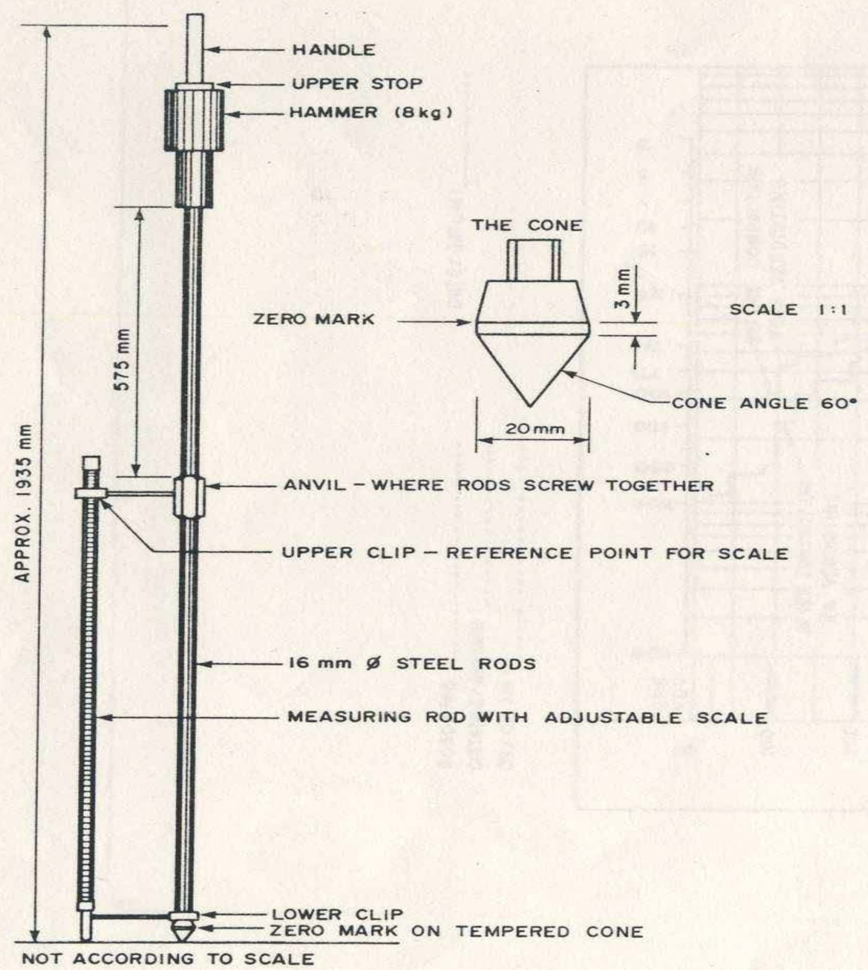


FIGURE ST6/I THE DYNAMIC CONE PENETROMETER

Percolation Test

The percolation test consist of digging a 300 mm diameter hole to the stratum for which information is required, cleaning and backfilling the bottom with coarse sand or gravel, filling the hole with water and providing a soaking period of sufficient length to achieve saturation. During the soaking period, water is added as necessary to prevent loss of all water. The percolation rate is then obtained by filling the hole to a prescribed water level and measuring the drop in water level over a set time. The times required for soaking and for measuring the percolation rate vary with the soil type.

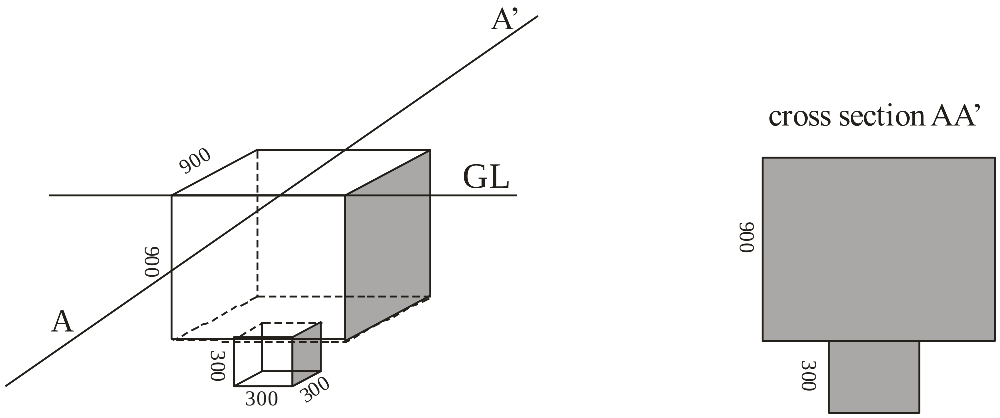


Figure 2. Cross section of percolation test pit

Laboratory Testing

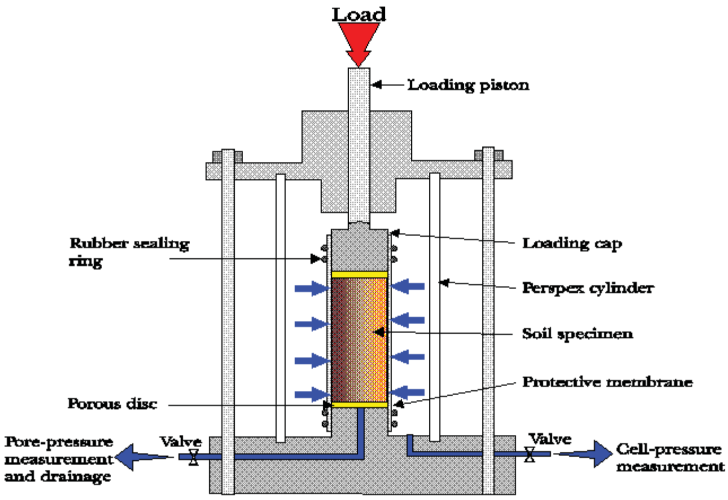
Laboratory tests were performed by Soil Testing Services (Pty) Ltd in Mbabane. As specified by Matsuda Consultants International Co., Ltd this testing comprised of foundation indicator testing only.

The following laboratory tests were executed for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)

Stress Triaxial Stress Tests: Unconsolidated - Undrained (BS 1377-7:1990 Clause 7)

Stress Triaxial Stress Tests were conducted at Metrolab Group, Republic of South Africa according to the standard **BS 1377-7:1990 Clause 7**. This involved subjecting a cylindrical soil sample to radial stresses (confining pressure) and controlled increases in axial stresses or axial displacements. The cylindrical soil specimen was of ~50mm diameter and ~100mm height dimension. As this is cohesive soil samples were prepared directly from saturated compacted samples, either undisturbed or remolded. The specimen was vertically enclosed with a thin rubber membrane and placed between two rigid ends inside a pressure chamber. The upper plate can move vertically and apply vertical stresses to the specimen. The axial strain/stress of the sample is controlled through the movement of this vertical axis. Also, the confining pressure is controlled by the water pressure surrounding the sample in the pressure chamber. The volume change of the sample is also controlled by measuring the exact volume of moving water.



Triaxial apparatus

6.0 INTERPRETIVE INFORMATION

Site Stratigraphy

The stratigraphy of the Boyane High School site can be summarized as colluvial and residual soils.

Colluvial soils on the site generally consist of some 300mm thick layer of slightly moist slightly moist, dark brown soft to dense topsoil. In Trial Pit 453 some 1280mm colluvial layer was intercepted below the top soil and consists of moist, dark red, slightly dense, sandy clay. This layer lies directly above residual layer from the weathering of the granodiorite suite.

The residual soils are derived from complete in-situ weathering of the granodiorite suite expected underneath. In this site the granodiorite was not encountered. The soils are moist, soft and intact silt-clay. The dark red soil in profile shows colour variation from light yellowish orange/ dark red/ light reddish orange to light red/ light reddish brown/ dark yellow.

Materials

The table below summarizes some of the laboratory test results and the complete test results are presented in Appendix B

Test Pit No.	Sample no & depth(m)	Horizon	O.M.C%	LL	PI	Shrinkage	Soil Class AASHTO
452	0.5-2.0	Residual granodiorite	16.3	46	10	4	A-7-5(7)
453	1.6-2.4	Residual granodiorite	14.0	48	16	7.5	A-7-5(10)

Engineering Geological Evaluation

Groundwater

Groundwater inflow was not encountered in any of the excavated test pits. It is expected that the groundwater table will occur at depth at the fresh rock soil interface.

Expansive soils

No soils susceptible to swelling or heaving were encountered on site, and problematic movements associated with expansion are not expected.

From the Foundation Indicator tests carried out all the horizons tested displayed a “low” potential for expansiveness classification.

Potentially Collapsible Soils

The soil horizons encountered are not considered to be collapsing in nature. It is, therefore, not anticipated that any special precautions will need to be taken with regard to collapsible soils.

Percolation Rate

The soils in this area are suitable for a normal French drain. Both percolation tests positions displays good seepage and as such are suitable for normal French drain development.

Bearing Capacity

The laboratory triaxial compression tests the Boyane High School site with unconsolidated undrained (UU) shear strength (c_u) of between 424kPa and 1100kPa display allowable bearing capacity of between an estimated 727kPa and 1886kPa. Based on the correlation chart (Appendix C) of maximum bearing stress that can be applied to the foundation such that it is safe against instability due to shear failure the site’s allowable bearing capacity is highly safe for building development.
From the field Dynamic Cone Penetrometer (DCP) tests, for most of the tests positions, it reveals safe bearing capacities above 79kPa for single story buildings. For most of the test positions, at depths >1.2m, the bearing capacities of the soil drops below this threshold to some 52kPa and

below. However, for test positions DCP 8 and 9 the low bearing capacities of 52kPa are reached at shallow depths (600mm). This has to be taken into consideration during designing the foundation.

Based on the above field test, the residual soil is relatively homogenous, save for the last three tests site and buildings can be founded at depths of 800 to 1000mm as it is below the colluvial soil.

Excavatibility

There were no recorded excavation refusals during pitting to the depths of 2.4m. It is anticipated that excavation to bedrock level will be of soft excavation class at the site. No major instabilities were recorded during the excavation of the test pits which further suggests that excavation may safely extend vertically to depths of about 3.00m without the need for lateral support, if of a temporary nature (during construction) and in the dry season.

Seismicity

One type of seismic activities occurs in Swaziland, and that is natural seismic activity. There is no mining-induced seismic activity. In accordance with the Seismic Hazard Zone map contained in the draft SANS 10160-4, southern Swaziland is classified as Zone 1 and is subject to natural seismic activity only. Boyane is in central part of Swaziland and falls outside this area. The South African "loading" code, SABS 0160-4:2011, shows that Boyane is situated in an area where the peak ground acceleration with a 10% probability of being exceeded in a 50 year period is some 100 cm/sec^2.

The soil profile of the site can be described as slightly soft, intact, silt-clay with shear strength between 424 and 1100kPa c_u. The contrasting identified ground types in accordance with the consolidated undrained shear strength and soil profile, type 2 and 3 respectively, indicates that the lacking v_s profile at the site is taken as "the most reliable predictor of the site dependent characteristics of the seismic action at stable sites".

7.0 CONCLUSION AND RECOMMENDATIONS

- The absence of rock outcrop on the site suggests that bedrock will only be present at depth. The bedrock surface is likely to be undulatory and, therefore, highly variable in depth.
- No special precaution has to be taken as no water seepage was experienced in any of the Trial Pits and no problem of dampness is thus expected.
- The soils are of intermediate plasticity and it is expected that they will be prone to erosion. Precaution is expected to be taken during site clearing to avoid excessive soil erosion.

Building Foundations

The allowable bearing capacity of the sand clays is estimated at 727kPa and silt clays at 1886kPa. This is safe to establish a foundation on the site for any building structure.

Field and laboratory test recommend that foundations be placed on the residual soil, at depths of 800 to 100mm, on the weathered granodiorite.

From the other Foundation Indicator tests carried out all the horizons tested displayed a “low” potential for expansiveness classification. As the soils are not susceptible to swelling or heaving it is not expected that significant swell-shrink movement of the footing will occur.

Despite the low expansive potential of the soils it is worth taking the following precautions:

- Attention to proper site drainage and storm water runoff management is essential to prevent ponding of water near structures.
- Water supply pipes and sewers must be maintained and leaks or blockages timeously detected and repaired.
- No water loving vegetation or large trees may be allowed to grow within 15m of any structure and it is not recommended to allow gardening directly around the structures. Instead concrete aprons should be installed to prevent wetting of foundations.

Parking Areas and Roadways

The material quality at surface display a good bearing capacity from DCP analyses and for the construction of parking can easily be stabilized and paved. But for roadways it cannot be used as fill. It is recommended that material for pavements layers required for road works be imported from outside the site.

NOTE:

- Additional investigations or at least an assessment of the ground conditions exposed during construction can often result in significant construction cost and time savings.

GENERAL NOTES ON THE REPORT

The information and recommendations contained within this report relate to data supplied by Soil Testing Services, comprising test pit profiles, DCP penetration data, soil percolation test results and soil grading tests.

The report has been compiled on the assumption that all the data supplied by Soil Testing Services (and the assumptions made in this report where this supplied data is inadequate) is correct and is generally representative of the site area.

Prepared for Geo Solutions

Noah Nhleko
BSc (Biology & Chemistry); PhD Geology

APPENDIX A

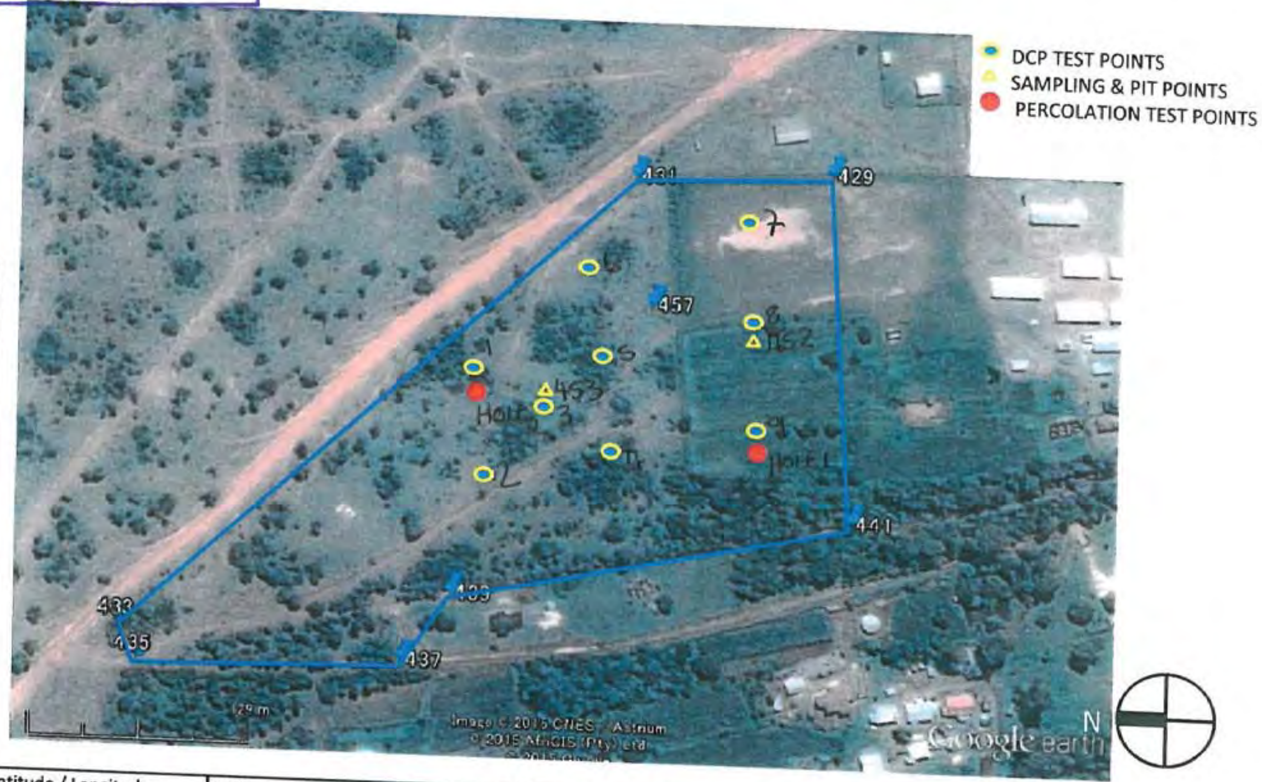
A) Tractor Loader Backhoe (TLB)

B) Typical Trial Pit

SOIL TESTING SERVICES
(SWAZILAND) (PTY) LTD
P.O. BOX A2.., S..ZI PLAZA
TEL: 404 195.. 404 2227
SOIL LABORATORY

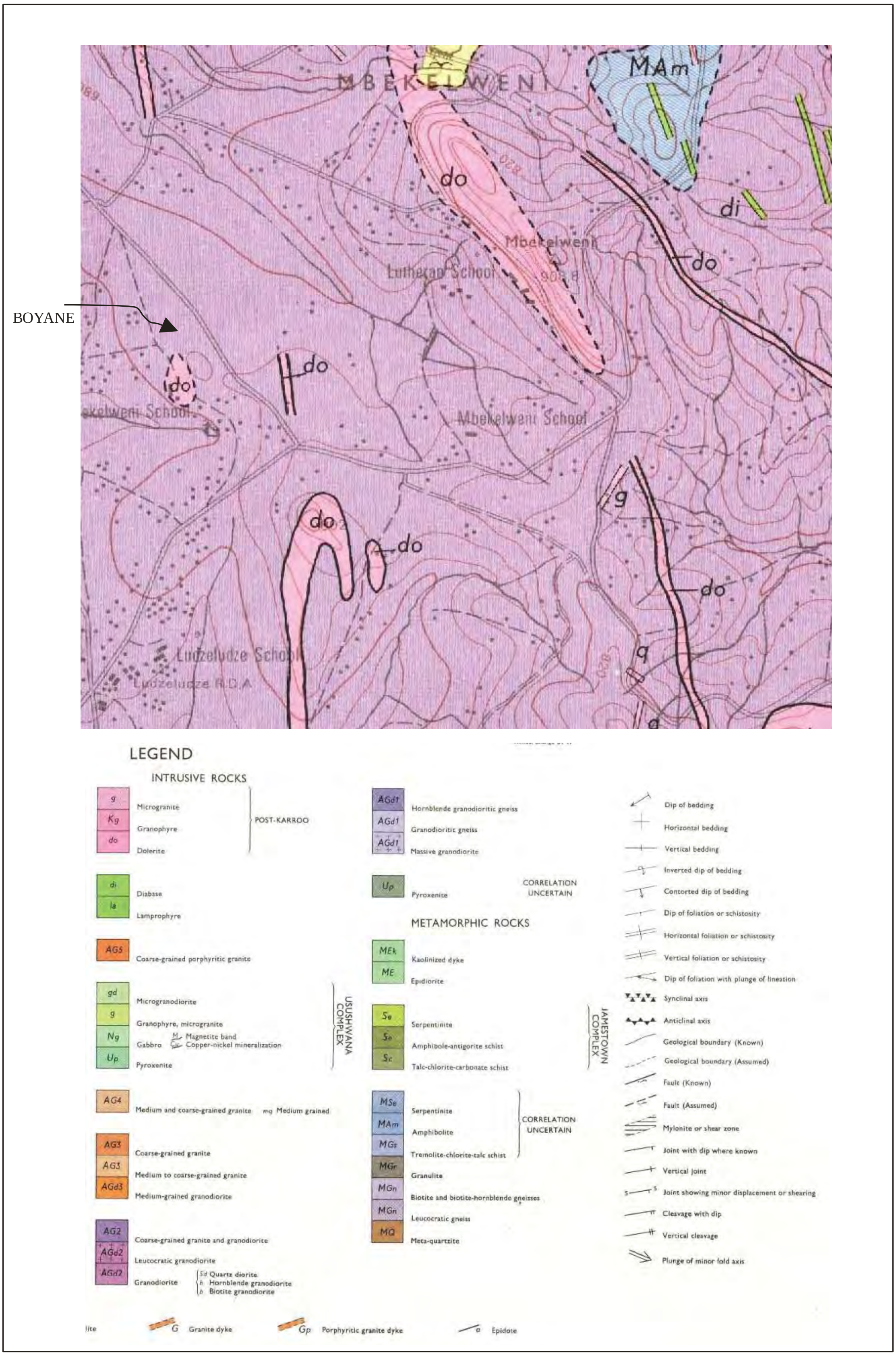
Site Name :
M1
BOYANE
Region :
Manzini
Contact Person
Mr. DRAMINI SICELO
Cel: 7607 1911
Ms. LENNY N. HLAWE
Cel: 7618 7755

Other information
The boundary of the site is indicated by blue line. All boundary points have been staked with red sprayed rebars. If you contact to the person mentioned above, they show you the boundary points. The Surveyor should excavete two pits in total indicated in the map.



Boundary Point	Latitude / Longitude	Note
429	S26 26.278 E31 18.315	Reference of boundary point
431	S26 26.216 E31 18.313	Ditto
433	S26 26.056 E31 18.147	Ditto
435	S26 26.062 E31 18.135	Ditto
437	S26 26.145 E31 18.137	Ditto

Boundary Point	Latitude / Longitude	Note
439	S26 26.160 E31 18.161	Reference of boundary point
441	S26 26.285 E31 18.190	Ditto


BOYANE
MBEKELWENI
MAm
do
di
Mbekelweni
Lutheran School
Mbekelweni School
g
q
Ludzeludze School
Ludzeludze R.D.A.
LEGEND
INTRUSIVE ROCKS
g Microgranite
Kg Granophyre
do Dolerite
POST-KARROO
di Diabase
la Lamprophyre
AG5 Coarse-grained porphyritic granite
gd Microgranodiorite
g Granophyre, microgranite
Ng Gabbro M Magnetite band Cu Copper-nickel mineralization
Up Pyroxenite
USUSHWANA COMPLEX
AG4 Medium and coarse-grained granite mg Medium grained
AG3 Coarse-grained granite
AG3 Medium to coarse-grained granite
AGd3 Medium-grained granodiorite
AG2 Coarse-grained granite and granodiorite
AGd2 Leucocratic granodiorite
AGd2 Granodiorite Sd Quartz diorite h Hornblende granodiorite b Biotite granodiorite
AGd1 Hornblende granodioritic gneiss
AGd1 Granodioritic gneiss
AGd1 Massive granodiorite
Up Pyroxenite
CORRELATION UNCERTAIN
METAMORPHIC ROCKS
MEk Kaolinized dyke
ME Epidiorite
Se Serpentinite
Sa Amphibole-antigorite schist
Sc Talc-chlorite-carbonate schist
JAMESTOWN COMPLEX
MSe Serpentinite
MAm Amphibolite
MGs Tremolite-chlorite-talc schist
CORRELATION UNCERTAIN
MGr Granulite
MGn Biotite and biotite-hornblende gneisses
MGn Leucocratic gneiss
MQ Meta-quartzite
Dip of bedding
Horizontal bedding
Vertical bedding
Inverted dip of bedding
Contorted dip of bedding
Dip of foliation or schistosity
Horizontal foliation or schistosity
Vertical foliation or schistosity
Dip of foliation with plunge of lineation
Synclinal axis
Anticlinal axis
Geological boundary (Known)
Geological boundary (Assumed)
Fault (Known)
Fault (Assumed)
Mylonite or shear zone
Joint with dip where known
Vertical joint
Joint showing minor displacement or shearing
Cleavage with dip
Vertical cleavage
Plunge of minor fold axis
G Granite dyke
Gp Porphyritic granite dyke
e Epidote

APPENDIX B

Project	Trial Pit No.	Location	Date
Matsuda consultants International Ltd	TP 452	Boyane	04/12/2016

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizons	Topsoil	520	0-520		dark brown		moist
	silt-clay, highly weathered Granodiorite	1480	520-2000		dark red Inprofile, light red/ light reddish brown/ dark yellow.	slightly soft, intact	Moist

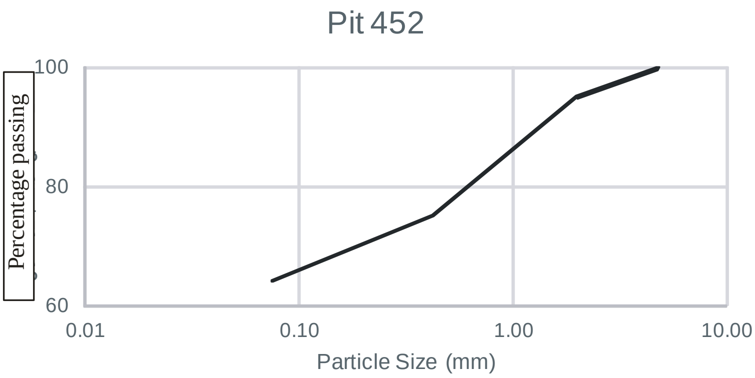
Project	Trial Pit No.	Location	Date
Matsuda consultants International Ltd	TP 453	Boyane	04/12/2016

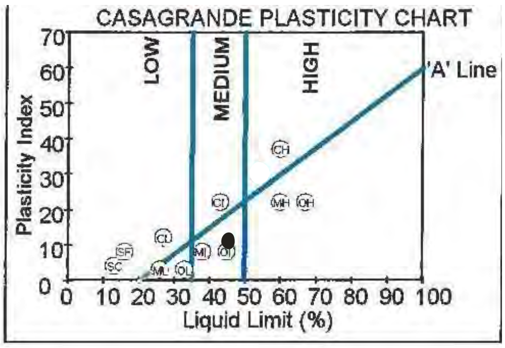
Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizons	Topsoil	300	0-300		dark brown		slightly moist
	sandy clay	1280	300-1580		dark red	slightly dense	Moist
	silt-clay, highly weathered Granodiorite	820	1580-2400		dark red Inprofile, light yellowish orange/ dark red/ light reddish orange	slightly soft, intact	moist

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 452	Date	
Project	Boyane High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	
13.2	
4.75	100
2.00	95
0.425	75
0.075	64





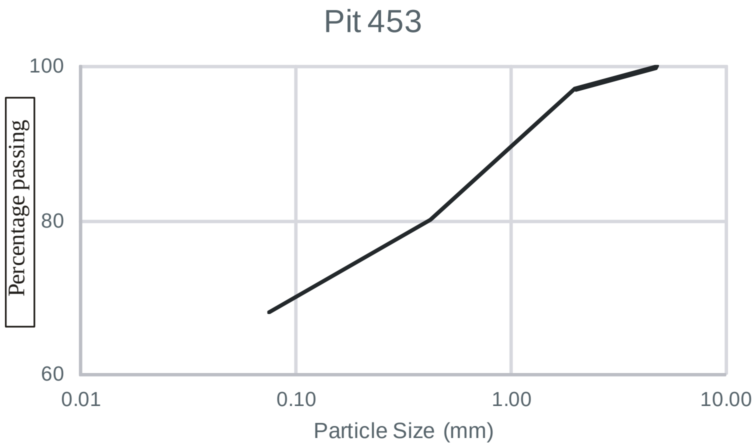
ATTERBERG LIMITS AND OTHER RESULTS

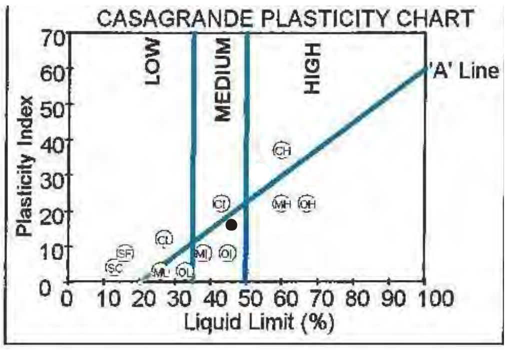
Liquid Limit (LL)	46
Plastic Index (PI)	10
Linear Shrinkage	4
Grading Modulus	0.66
Natural Moisture Content	16.3
PI of whole sample	
AASTHO Classification	A-7-5(7)
TRH 14	

FOUNDATION INDICATOR RESULTS

Client	Matsuda Consultants International	Sample no.	T.P. 453	Date	
Project	Boyane High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	
13.2	
4.75	100
2.00	97
0.425	80
0.075	68





ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	48
Plastic Index (PI)	16
Linear Shrinkage	7.5
Grading Modulus	0.55
Natural Moisture Content	14.0
PI of whole sample	
AASTHO Classification	A-7-5(10)
TRH 14	

SOIL TESTING SERVICES
MATSUDA CONSUNTANTS INTERNATIONAL
BOYANE NEW HIGH SCHOOL
DCP TEST RESULTS
21/01/2015

DCP (1) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	5	20	173
200	6	17	218
300	4	25	129
400	8	17	219
500	5	20	173
600	5	20	173
700	4	25	129
800	4	25	129
900	4	25	129
1000	4	25	129
1100	3	33	89
1200	3	33	89
1300	3	33	89
1400	2	50	52
1500	2	50	52
1600	3	33	89
1700	2	50	52
1800	1	100	21
1900	2	50	52
2000	1	100	21

DCP (2) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	14	7	600
200	12	8	540
300	10	10	426
400	6	17	218
500	6	17	218
600	5	20	173
700	7	14	268
800	5	20	173
900	4	25	129
1000	3	33	89
1100	3	33	89
1200	2	50	52
1300	2	50	52
1400	1	100	21
1500	2	50	52
1600	1	100	21
1700	1	100	21
1800	1	100	21
1900	1	100	21
2000	1	100	21

DCP (3) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	5	20	173
200	5	20	173
300	5	20	173
400	4	25	129
500	2	50	52
600	3	33	89
700	4	25	129
800	3	33	89
900	3	33	89
1000	3	33	89
1100	2	50	52
1200	3	33	89
1300	2	50	52
1400	3	33	89
1500	2	50	52
1600	2	50	52
1700	2	50	52
1800	1	100	21
1900	2	50	52
7000	3	50	52

DCP (4) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	12	8	540
200	9	11	371
300	6	17	219
400	5	20	173
500	5	20	173
600	4	25	129
700	3	33	89
800	3	33	89
900	3	33	89
1000	2	50	52
1100	4	25	129
1200	2	50	52
1300	3	33	89
1400	2	50	52
1500	2	50	52
1600	1	100	21
1700	1	100	21
1800	2	50	52
1900	2	50	52
2000	1	100	21

DCP (5) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	11	9	482
200	21	5	1110
300	14	7	690
400	10	10	429
500	7	14	268
600	8	13	318
700	4	25	129
800	4	25	129
900	4	25	129
1000	3	33	89
1100	3	33	89
1200	4	25	129
1300	3	33	89
1400	3	33	89
1500	4	25	129
1600	3	33	89
1700	4	25	129
1800	4	25	129
1900	5	20	173
2000	3	33	89

DCP (6) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	6	17	218
200	7	14	268
300	7	14	288
400	6	17	219
500	6	17	219
600	6	17	219
700	5	20	173
800	5	20	173
900	3	33	89
1000	5	20	173
1100	4	25	129
1200	4	25	129
1300	4	25	129
1400	4	25	129
1500	4	25	129
1600	3	33	89
1700	2	50	52
1800	3	33	89
1900	3	33	89
2000	2	50	52

DCP (7) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	12	8	540
200	9	11	371
300	7	14	288
400	5	20	173
500	4	25	128
600	3	33	89
700	2	50	52
800	2	50	52
900	2	50	52
1000	2	50	52
1100	3	33	89
1200	3	33	89
1300	2	50	52
1400	1	100	21
1500	2	50	52
1600	1	100	21
1700	1	5	21
1800	2	50	52
1900	1	100	21
2000	2	50	52

DCP (8) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	1	100	21
200	1	100	21
300	3	33	89
400	4	25	129
500	3	33	89
600	3	33	89
700	2	50	52
800	2	50	52
990	1	100	21
1000	2	50	52
1100	2	50	52
1200	1	100	21
1300	2	50	52
1400	2	50	52
1500	2	50	52
1600	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (9) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	2	50	52
200	2	50	52
300	4	25	129
400	4	25	129
500	4	25	129
600	3	33	89
700	2	50	52
800	2	50	52
900	2	50	52
1000	2	50	52
1100	2	50	52
1200	2	50	52
1300	1	100	21
1400	2	50	52
1500	2	50	52
1000	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

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Geotechnical Investigation Log Sheet

PERCOLATION

Client: MATSUDA CONSULTANTS INTERNATIONAL

Project: BOYANE NEW HIGH SCHOOL Date: 22/12/2015

Site: BOYANE

Potential influence of running /standing/seasonal water

Evidence of unusual land use(mining/fill)

HOLE 1 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole.
(2) The hole was used for PERCOLATION investigation
(3The Hole was presosked the day before and and soak for 24 HRS
(4)This hole has a very good seepage suitable for french drain

HOLE 2 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole
(2) The hole was used for PERCOLATION investigation
(3)The Hole was presosked the day before and soak for 25 HRS
(4)This hole has a good seepage suitable for french drain

HOLE 1 Presoaking Time (24hrs)

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
10		2.0		5.0
30		4.0		10.0
50		6.0		10.0
70		8.0		10.0
85		10.0		7.5
100		12.0		7.5
120		14.0		10.0
130		16.0		5.0
150		18.0		10.0
165		20.0		7.5
180		22.0		7.5
200		24.0		10.0
215		26.0		7.5
235		28.0		10.0
250		30.0		7.5
280		32.0		15.0
290		34.0		5.0
300		36.0		5.0
			Average	8.3

HOLE 2 Presoaking Time (25hrs)

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
20		2.0		10.0
30		4.0		5.0
40		6.0		5.0
50		8.0		5.0
70		10.0		10.0
80		12.0		5.0
95		14.0		7.5
110		16.0		7.5
130		18.0		10.0
150		20.0		10.0
160		22.0		5.0
180		24.0		10.0
200		26.0		10.0
210		28.0		5.0
220		30.0		5.0
230		32.0		5.0
240		34.0		5.0
250		36.0		5.0
270		40.0		5.0
280		45.0		2.0
290		50.0		2.0
300		55.0		2.0
			Avarage	6.5

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Tel: 012-800 1299
Fax: 012-800 3034
Email: aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project:	Japanese Schools Boyane
ADDRESS:	P.O. Box A233 Swazi Plaza	Your Ref:	
		Our Ref:	117 626
Attention:	Thulani Vilakati	Date Reported:	12 February 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO	G16-47	HOLE NO	TP 452	DEPTH (m)		JOB NO	117 626
DESCRIPTION							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	103.2	102.3	102.1
Initial Sample Diameter	D_0	(mm)	51.1	51.2	50.2
Initial Sample Weight	W_0	(gr)	397.9	397.8	397.8
Initial Bulk Density	ρ_0	(Mg/m3)	1.88	1.89	1.97
Particle Density	ρ_s	(Mg/m3)	2.47	2.47	2.47

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate		(mm/min)	0.10	0.10	0.10
Membrane Thickness		(mm)	0.30	0.30	0.30
Initial Moisture	w_i%	(%)	16	16	16
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.62	1.62	1.69
Initial Voids Ratio	e_0		0.53	0.52	0.46
Initial Degree of Saturation	S_0	(%)	76	77	88

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	2144.22	2527.94	1930.18
Membrane Correction	m_c	(kPa)	0.969	0.934	1.071
Strain At Max Stress		(%)	1.68	2.59	3.38
Shear Strength	c_u	(kPa)	1072.11	1263.97	965.09
Final Moisture	w_f%	(%)	19	19	20
Final Dry Density	ρ_{df}	(Mg/m3)	1.58	1.59	1.64
Final Voids Ratio	e_f		0.56	0.56	0.51
Final Degree of Saturation	S_f	(%)	82.7	84.5	98.0

Remarks:

Page: 1 of 2

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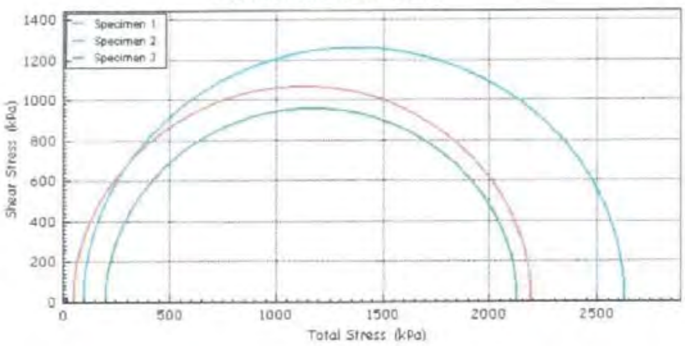
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

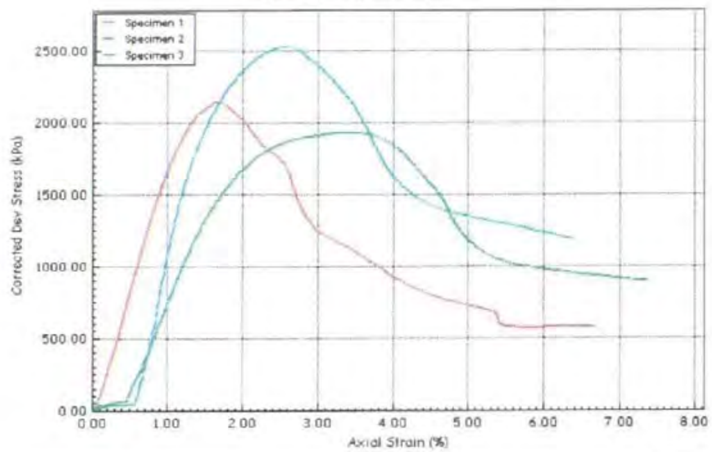
TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16-47	HOLE NO.	TP 452	DEPTH (m):		JOB NO.	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



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Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools
ADDRESS:	P.O. Box A233		Boyane
	Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	14 March 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_46	HOLE NO:	TP453	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	101.8	101.4	100.9
Initial Sample Diameter	D_0	(mm)	50.3	50.3	50.2
Initial Sample Weight	W_0	(gr)	393.0	393.1	393.5
Initial Bulk Density	ρ_0	(Mg/m3)	1.94	1.95	1.97
Particle Density	ρ_s	(Mg/m3)	2.58	2.58	2.58

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10000	0.10000	0.10000
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	$\omega_{i\%}$	(%)	14	14	14
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.70	1.71	1.73
Initial Voids Ratio	e_0	.	0.51	0.51	0.49
Initial Degree of Saturation	S_o	(%)	70	71	73

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	570.41	960.27	1014.58
Membrane Correction	m_c	(kPa)	0.970	1.040	2.258
Strain At Max Stress	$\varepsilon_{f\%}$	(%)	1.56	3.14	8.33
Shear Strength	c_u	(kPa)	285.21	480.13	507.29
Final Moisture	$\omega_{f\%}$	(%)	14	14	14
Final Dry Density	ρ_{df}	(Mg/m3)	1.70	1.71	1.73
Final Voids Ratio	e_f	.	0.51	0.51	0.49
Final Degree of Saturation	S_f	(%)	70.1	71.3	72.7

Remarks :

Page: 1 of 2

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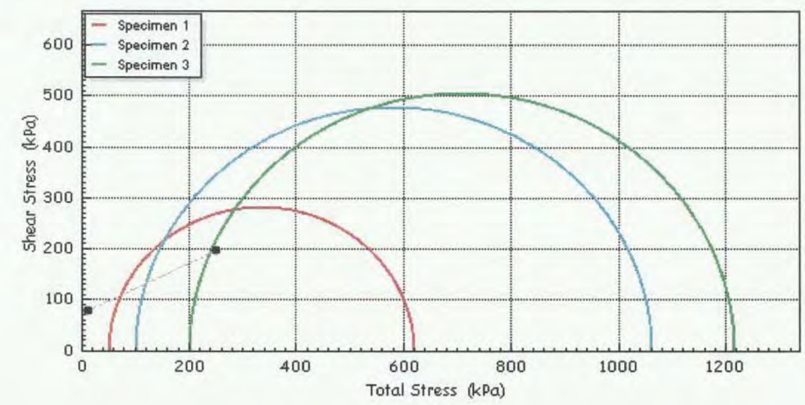
Email : aukek@matrolab.co.za

TEST RESULTS

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 46	HOLE NO:	TP453	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph

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Results only have bearing on the samples tested.
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APPENDIX C

Table 1: Correlation chart of maximum bearing stress (allowable bearing capacity) of rocks and soil materials

Category	Types of rocks and soils	Bearing value (kPa)
Non-cohesive soils	Dense gravel or dense sand and gravel	>600
	Medium dense gravel, or medium dense sand and gravel	<200 to 600
	Loose gravel, or loose sand and gravel	<200
	Compact sand	>300
	Medium dense sand	100 to 300
	Loose sand	<100 *depends on degree of looseness*
Cohesive soils	Very stiff bolder clays & hard clays	300 to 600
	Stiff clays	150 to 300
	Firm clay	75 to 150
	Soft clays and silts	< 75
	Very soft clay	Not applicable
Peat		Not applicable
Made ground		Not applicable

S1-Eqinisweni

SOIL TESTING SERVICES

GEOTECHNICAL REPORT – QINISWENI

CONSTRUCTION OF NEW SECONDARY SCHOOLS AND UPGRADING OF FACILITIES IN EXISTING SECONDARY SCHOOLS AIMED AT PROMOTING INCLUSIVE EDUCATION IN THE KINGDOM OF SWAZILAND

FOR

MATSUDA CONSULTANTS INTERNATIONAL CO. LTD

SOIL TESTING SERVICES
CIVIL ENGINEERING LABORATORY

Lot 321, Samora Machel Street
P.O. Box A233
Swazi Plaza
Mbabane H101
Swaziland

MARCH 2016

TABLE OF CONTENTS

GEOTECHNICAL REPORT - QINISWENI

1.0 INTRODUCTION

This report is based on the Preparatory Survey on "the Project for the Construction of New Secondary Schools and Upgrading of Facilities in Existing Secondary Schools aimed at Promoting Inclusive Education" based upon request from the Government of Swaziland to the Japan International Cooperation Agency (JICA). The survey is to obtain geotechnical data and information at Qinisweni, southern Swaziland, where the proposed Qinisweni High School will be constructed, for the design of earthworks, foundation and structures of the buildings.

2.0 SCOPE OF WORK

The following activities were expected to be executed in the cause of the study.

(1) Field works on each site
- Dynamic Cone Penetration test (DCP)
  Nine (09) points, depth up to Two (02) m from the ground level
- Soil Sampling
- Percolation Test Two (02) points

(2) Laboratory testing (for each sample)
- Triaxial Compression Test
- Moisture Density Test
- Particle Size Analysis
- Atterberg limit test

3.0 SITE DESCRIPTION

Location and Topography

The new Eqinisweni High School site lies in a topographically flat area, with a very gentle slope to the south.

Most of the site consists of an area currently used as a soccer field for the existing Qinisweni Primary School, about 10km from Nhlangano town. It is possibly also used for field and track events during school's athletic competitions. There is indigenous grass cover on the pitch. The remainder portion to the west is currently used for commercial tree farming with grown up eucalyptus forest.

Rainfall and Drainage

The area lies in the Highveld climatic condition of Swaziland. It has an elevation of 1020m above sea level, and like the rest of the country experiences summer rainfall. The area has warm summers and cold winters and receives an annual rainfall of 870mm. In winter the area experiences frost.

There is no stream draining this area besides a water spring to the west of the area. Water is sourced from a community water scheme, and can also be sourced by drilling a borehole.

Access

The site and the nearby primary school are situated along the Nhlangano-Lavumisa tarred road, in 20m proximity. Access to the site will be through opening a short road from the nearby paved road.

4.0 GENERAL GEOLOGY OF SITE

The Qinisweni site is underlain by the quartzo-feldspathic Nhlangano gneiss that is distinguishable by its distinctive pinkish-red weathered color. The rocks are cut by veins of quartz and feldspar which produce a very obvious banding that is commonly folded. The Nhlangano gneiss has a granitoid appearance, but no unambiguous evidence of cross-cutting relationships with other formations is known. The formation is of metamorphic origin than igneous genesis. The outcrop pattern and the distribution of the fold plunge depressions indicate that the gneiss has been folded into a number of domes.

A scanned and cropped geological map of the area is presented in Appendix A. It is taken from a 1:50 000 geological map sheet 12 (2631 AD) published by the Swaziland Geological Survey Department

5.0 GEOTECHNICAL FIELD INVESTIGATIONS AND LABORATORY TESTING

Methods of investigation and testing

Field investigations, sampling and laboratory testing have been designed to provide information as follows:

Trial Pits

Three Trial Pits (TP) were excavated at positions determined by the client with pits attaining some depth of 2.4m using a Tractor Loader Backhoe (TLB), 4x4 capability with 600mm bucket width and flywheel power rating of at least 70kW. The aim of the excavation of the trial pits was to determine the soil stratigraphy, and extraction of soil samples.

All test pits had stable walls and were profiled using profiling standard procedure outlined in the Association of Engineering Geologists (South African Section), 'Guidelines for soil and rock logging in SA" (1990). Representative soil samples were taken from the soil profile for laboratory testing. Bulk samples of the residual soil material were taken; topsoil and sub-soil layers were recorded and are shown in detail in Trial Pit profiles. The stratigraphy revealed by each pit was carefully logged with special notes taken of the thickness and conditions of the various layers.

Dynamic Cone Penetration Test (DCP)

Dynamic Cone Penetrometer (DCP) tests were conducted at 9 positions around the site. The exact locations of all DCP tests carried out were performed at positions determined by Matsuda Consultants International Co., Ltd.

Prior to the performance of a series of tests, the zero reading of the penetrometer was determined. The dynamic penetrometer tests were then performed by taking readings of cone penetration after a number of blows depending on the consistency of the layer being penetrated. The tests were terminated at maximum depths of 2000mm wherever possible.

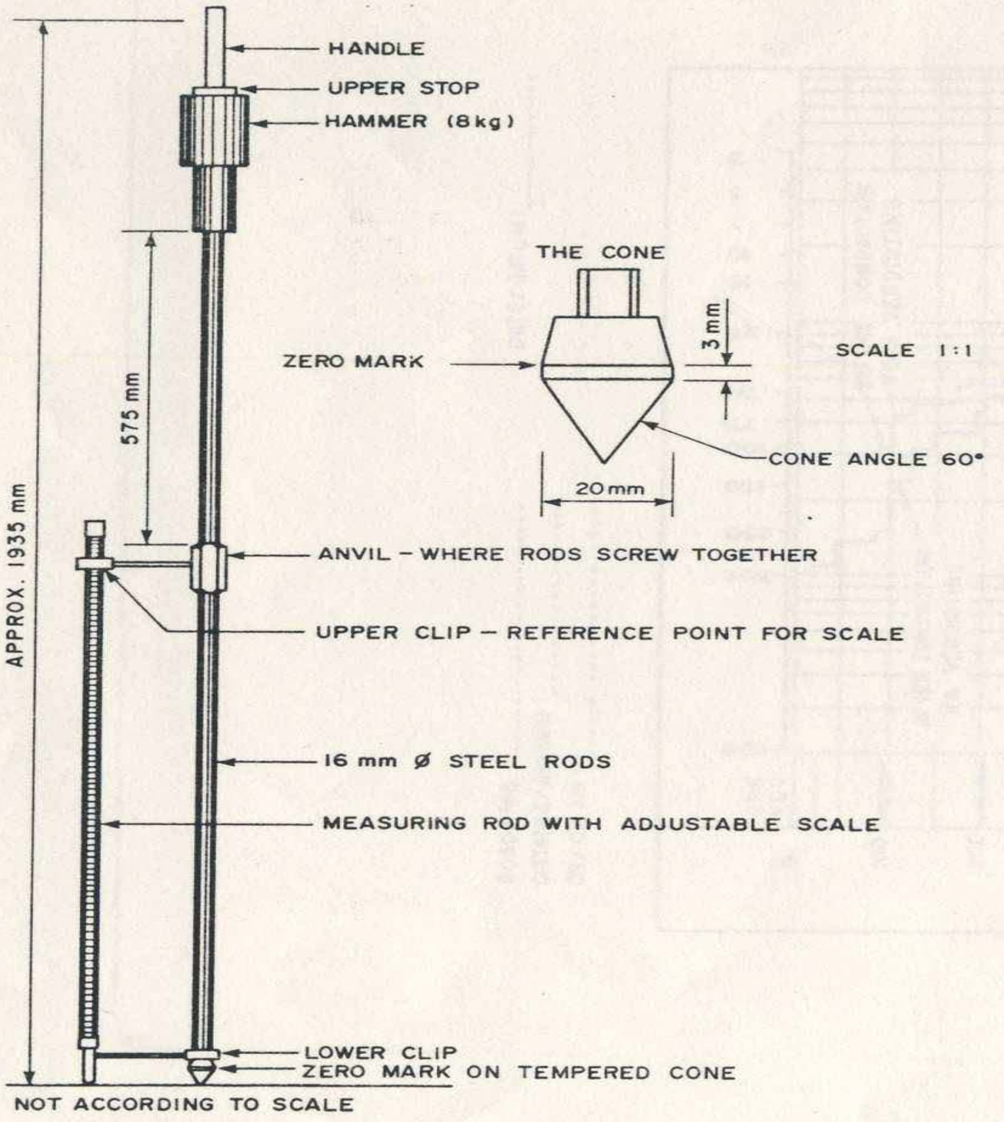


FIGURE ST6/I THE DYNAMIC CONE PENETROMETER

Percolation Test

The percolation test consist of digging a 300 mm diameter hole to the stratum for which information is required, cleaning and backfilling the bottom with coarse sand or gravel, filling the hole with water and providing a soaking period of sufficient length to achieve saturation. During the soaking period, water is added as necessary to prevent loss of all water. The percolation rate is then obtained by filling the hole to a prescribed water level and measuring the drop in water level over a set time. The times required for soaking and for measuring the percolation rate vary with the soil type.

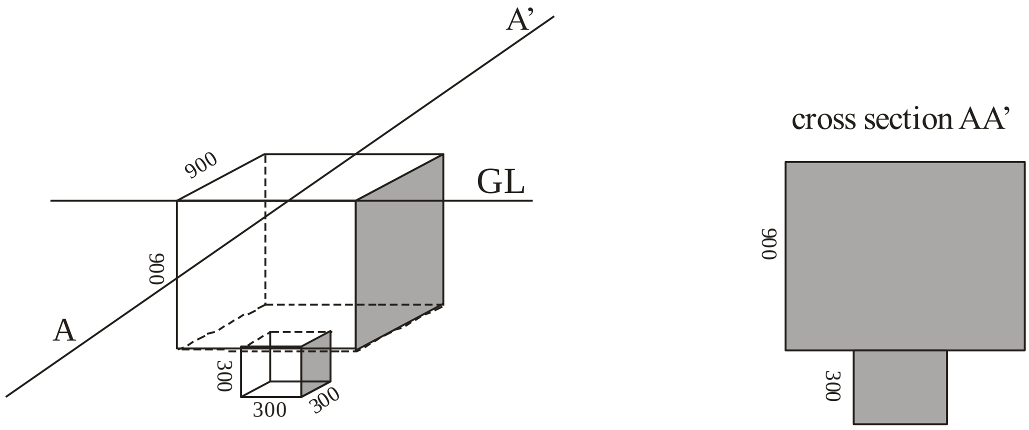


Figure 2. Cross section of percolation test pit

Laboratory Testing

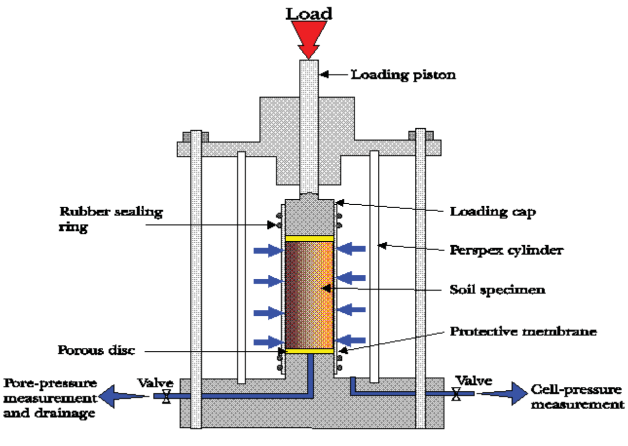
Laboratory tests were performed by Soil Testing Services (Pty) Ltd in Mbabane. As specified by Matsuda Consultants International Co., Ltd this testing comprised of foundation indicator testing only.

The following laboratory tests were executed for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)
- ·specific gravity tests

Stress Triaxial Stress Tests: Unconsolidated - Undrained (BS 1377-7:1990 Clause 7)

Stress Triaxial Stress Tests were conducted at Metrolab Group, Republic of South Africa according to the standard **BS 1377-7:1990 Clause 7**. This involved subjecting a cylindrical soil sample to radial stresses (confining pressure) and controlled increases in axial stresses or axial displacements. The cylindrical soil specimen was of ~50mm diameter and ~100mm height dimension. As this is cohesive soil samples were prepared directly from saturated compacted samples, either undisturbed or remolded. The specimen was vertically enclosed with a thin rubber membrane and placed between two rigid ends inside a pressure chamber. The upper plate can move vertically and apply vertical stresses to the specimen. The axial strain/stress of the sample is controlled through the movement of this vertical axis. Also, the confining pressure is controlled by the water pressure surrounding the sample in the pressure chamber. The volume change of the sample is also controlled by measuring the exact volume of moving water.



Triaxial apparatus

6.0 INTERPRETIVE INFORMATION

Site Stratigraphy

Stratigraphy of the Qinisweni High School site is defined by dark brown topsoil invariably underlain by a thin pebble marker. These soil horizons overly residual soils derived from the in place weathering of the Nhlangano gneiss rock that lies at depth below the existing ground level. In all the Trial Pits this rock unit was not encountered except for the occasional float on site.

The residual soil in this site lies at 600mm depth and consists of various materials mainly distinguishable by colour variation. They comprise of fine grained soils typically dark red, dark yellowish orange or dark reddish orange in color. These soils are mainly moist, slightly soft to slightly dense, silt clay materials.

Materials

The table below summarizes some of the laboratory test results and the complete test results are presented in Appendix B.

Test Pit No.	Sample no & depth(m)	Horizon	O.M.C%	LL	PI	Shrinkage	Soil Class AASHTO
329	0.6-2.2	Residual	9	34	14	3.5	A-7-6(12)
330	0.6-2.3	Residual	14.6	38	18	4.5	A-7-6(12)
331	0.6-2.4	residual	13	35	7	3.5	A-7-6(12)

Engineering Geological Evaluation

Groundwater

Groundwater inflow was not encountered in any of the excavated test pits. It is expected that the groundwater table will occur at depth.

Expansive soils

No soils susceptible to swelling or heaving were encountered on site, and problematic movements associated with expansion are not expected.

From the Foundation Indicator tests carried out all the horizons tested displayed a “low” potential for expansiveness classification.

Potentially Collapsible Soils

The soil horizons encountered are not considered to be collapsing in nature. It is, therefore, not anticipated that any special precautions will need to be taken with regard to collapsible soils.

Percolation Rate

The soils in this area are suitable for a normal French drain. Both percolation tests positions display good seepage and as such are suitable for normal French drain development.

Bearing Capacity

The laboratory triaxial compression tests the Qinisweni High School site with unconsolidated undrained (UU) shear strength (c_u) of between 665kPa and 1109 kPa display allowable bearing capacity of between an estimated 1138kPa and 1900kPa. Based on the correlation chart (Appendix C) of maximum bearing stress that can be applied to the foundation such that it is safe against instability due to shear failure the site's allowable bearing capacity is highly safe for building development.

The Dynamic Cone Penetrometer (DCP) tests confirm the observations made during soil profiling. It displays dense soil material of colluvial nature and relatively soft (slightly soft) for the residual material. The apparent refusal recorded at DCP position 6 can be explained by the possibility of a pebble blocking the cone penetration along the pebble marker horizon. The tests reveal safe bearing capacities notwithstanding the generally low values displayed for the residual soil.

Field tests of both DCP and soil profiling suggest that foundations can be of some 800 to 1000mm depths. This is generally beyond the colluvial and pebble marker layers situated at some 600mm depth.

Excavatibility

There were no recorded excavation refusals during pitting to the depths of 2.4m. It is anticipated that excavation to bedrock level will be of soft excavation class at the site. No major instabilities were recorded during the excavation of the test pits which further suggests that excavation may safely extend vertically to depths of about 3.00m without the need for lateral support, if of a temporary nature (during construction) and in the dry season.

Seismicity

One type of seismic activities occurs in Swaziland, and that is natural seismic activity. There is no mining-induced seismic activity. In accordance with the Seismic Hazard Zone map contained in the draft SANS 10160-4, southern Swaziland is classified as Zone 1 and is subject to natural seismic activity only. Qinisweni area is located in southern Swaziland found in Zone 1 area.. The South African "loading" code, SABS 0160-4:2011, shows that Qinisweni is situated in an area where the peak ground acceleration with a 10% probability of being exceeded in a 50 year period is some 130 cm/sec^2

The soil profile of the site can be described as slightly dense, silt-clay to slightly soft, silt-clay with an average between 665kPa and 1109 kPa c_u shear strength. Considering the undrained shear strength and soil profile this area can be tentatively classified as Ground Type 2. However, the lacking v_s profile at the site is taken as "the most reliable predictor of the site dependent characteristics of the seismic action at stable sites".

7.0 CONCLUSION AND RECOMMENDATIONS

- The absence of rock outcrop on the site suggests that bedrock will only be present at depth. The bedrock surface is likely to be undulatory and, therefore, highly variable in depth.
- No special precaution has to be paid as no water seepage was experienced in any of the Trial Pits and no problem of dampness is thus expected.

Building Foundations

Allowable bearing capacities of between 1138kPa and 1900kPa are safe to base the foundations of building structures in the sand clay soil.

Foundations are recommended to be placed on the residual soil, at depths of 800 to 100mm, to avoid the marked variability of the colluvial soil.

It is recommended that all foundations be placed on the residual soil below the Pebble Marker, but care should be taken to ensure foundations are located at less than 1m depths to avoid the low bearing capacities. This is to avoid the marked variability of the soil material's bearing capacity and ensure no differential settling of the structures/buildings.

From the Foundation Indicator tests carried out all the horizons tested displayed a "low" potential for expansiveness classification. As the soils are not susceptible to swelling or heaving it is not expected that significant swell-shrink movement of the footing will occur.

Despite the low expansive potential of the soils it is worth taking the following precautions:

- Attention to proper site drainage and storm water runoff management is essential to prevent ponding of water near structures.
- Water supply pipes and sewers must be maintained and leaks or blockages timeously detected and repaired.
- No water loving vegetation or large trees may be allowed to grow within 15m of any structure and it is not recommended to allow gardening directly around the structures. Instead concrete aprons should be installed to prevent wetting of foundations.

Parking Areas and Roadways

The material quality at surface display a good bearing capacity from DCP analyses and for the construction of parking can easily be stabilized and paved. But for roadways it cannot be used as fill. It is recommended that material for pavements layers required for road works be imported from outside the site

NOTE:

- Additional investigations or at least an assessment of the ground conditions exposed during construction can often result in significant construction cost and time savings.

GENERAL NOTES ON THE REPORT

The information and recommendations contained within this report relate to data supplied by Soil Testing Services, comprising test pit profiles, DCP penetration data, soil percolation test results and soil grading tests.

The report has been compiled on the assumption that all the data supplied by Soil Testing Services (and the assumptions made in this report where this supplied data is inadequate) is correct and is generally representative of the site area.

Prepared for Geo Solutions

Noah Nhleko
BSc (Biology & Chemistry); PhD Geology

APPENDIX A

A) Tractor Loader Backhoe (TLB)

B) Typical Trial Pit

SOIL TESTING SERVICES
(SWAZILAND) (PTY) LTD
P.O. BOX A233, SWAZI PLAZA
TEL: 404 1956 404 2
SOIL LABORATOR

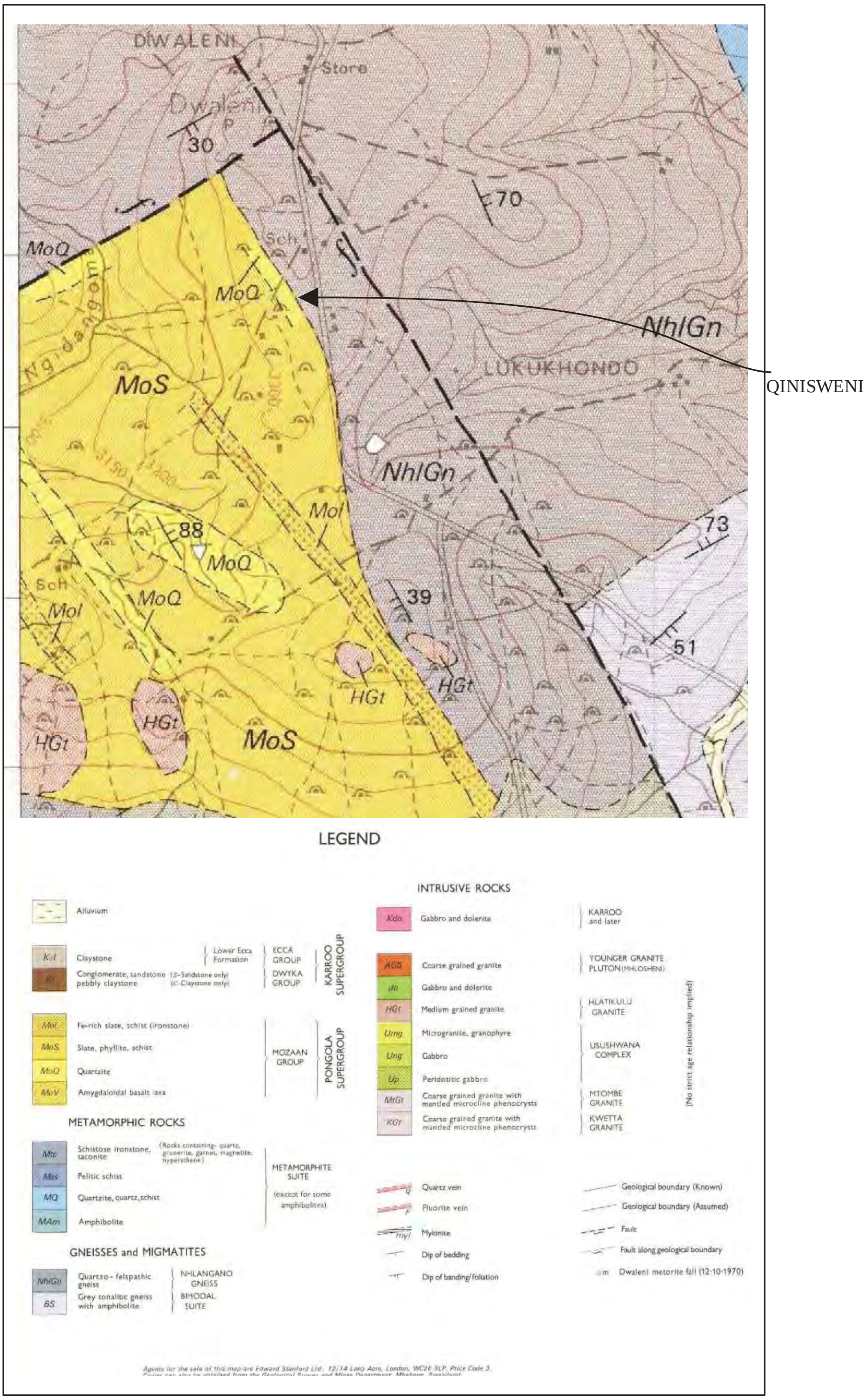
Site Name :
S1
EQINISWENI
Region :
Shiselweni
Contact Person
Ms. BETY NKHONTA
Cel: 76073145

Other information
The bounday of the site is indicated by blue line. All boundary points have been staked with red sprayed rebars. If you contact to the person mentioned above, they show you the boundary points. While the japanese consultant team inspected two pit (No. 329 and 331), the Surveyor should excavete three pits indicated in the map

DCP TEST POINTS
SAMPLING & PIT POINTS
329 S27 10.157 E31 15.969
331 S27 10.189 E31 15.991
PERCOLATION TEST POINTS

Boundary Point	Latitude / Longitude	Note
305	S27 10.152 E31 16.024	Reference of boundary point
307	S27 10.207 E31 16.027	Ditto
309	S27 10.213 E31 15.940	Ditto
311	S27 10.172 E31 15.906	Ditto
313	S27 10.129 E31 15.898	Ditto

Boundary Point	Latitude / Longitude	Note
315	S27 10.132 E31 15.927	Reference of boundary point
317	S27 10.145 E31 15.927	Ditto


DIWALENI
Store
Dwaleni
30
70
MoQ
MoQ
Ngidangomo
NhlGn
LUKUKHONDO
QINISWENI
MoS
NhlGn
Mol
88
MoQ
73
Sch
Mol
MoQ
39
51
HGt
HGt
HGt
HGt
MoS
LEGEND
Alluvium
Claystone
Lower Ecca Formation
ECCA GROUP
Conglomerate, sandstone (S-Sandstone only)
pebbly claystone (C-Claystone only)
DWYKA GROUP
KARROO SUPERGROUP
Fe-rich slate, schist (ironstone)
Slate, phyllite, schist
Quartzite
Amygdaloidal basalt lava
MOZAAN GROUP
PONGOLA SUPERGROUP
METAMORPHIC ROCKS
Schistose ironstone, taconite
(Rocks containing- quartz, grunerite, garnet, magnetite, hypersthene)
Pelitic schist
Quartzite, quartz, schist
Amphibolite
METAMORPHITE SUITE
(except for some amphibolites)
GNEISSES and MIGMATITES
NhlGn
Quartzo - felspathic gneiss
NHLANGANO GNEISS
BS
Grey tonalitic gneiss with amphibolite
BIMODAL SUITE
INTRUSIVE ROCKS
Kdo
Gabbro and dolerite
KARROO and later
AGS
Coarse grained granite
YOUNGER GRANITE PLUTON (MHLOSHENI)
do
Gabbro and dolerite
HGt
Medium grained granite
HLATIKULU GRANITE
Umg
Microgranite, granophyre
Ung
Gabbro
Up
Peridotitic gabbro
USUSHWANA COMPLEX
MtGt
Coarse grained granite with mantled microcline phenocrysts
MTOMBE GRANITE
KGt
Coarse grained granite with mantled microcline phenocrysts
KWETTA GRANITE
(No strict age relationship implied)
Quartz vein
Fluorite vein
Mylonite
Dip of bedding
Dip of banding/foliation
Geological boundary (Known)
Geological boundary (Assumed)
Fault
Fault along geological boundary
Dwaleni metorite fall (12·10·1970)
Agents for the sale of this map are Edward Stanford Ltd. 12/14 Long Acre, London, WC2E 9LP. Price Code 3.

APPENDIX B

Project	Trial Pit No.	Location	Date
Matsuda	TP 329	Eqinisweni	01/12/2016

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	380	0-380		dark reddish brown		slightly dry
	sandy clay (Pebble marker)	220	380-600		dark red	dense	Moist
	silt-clay (Residual soil)	1560	600-2160		dark yellowish orange	slightly dense	Moist

Project	Trial Pit No.	Location	Date
Matsuda	TP 330	Eqinisweni	01/12/2016

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	400	0-400		dark reddish brown		dry
	sandy clay (Pebble marker)	260	400-660		dark red	dense	Moist
	silt-clay residual soil	1570	660-2230		dark reddish orange	slightly dense	Moist

Project	Trial Pit No.	Location	Date
Matsuda	TP 331	Eqinisweni	01/12/2016

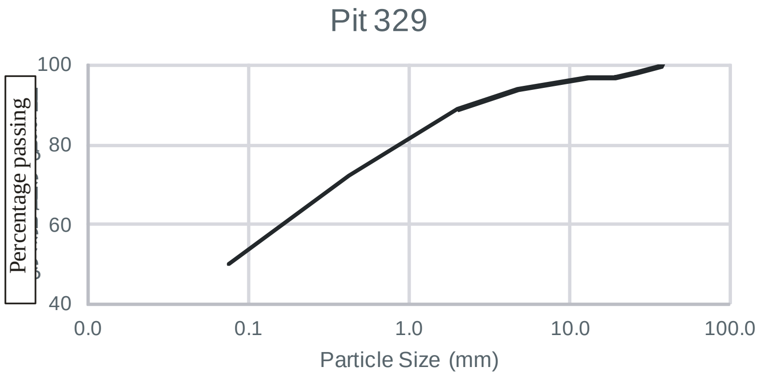
Material and Soil Description

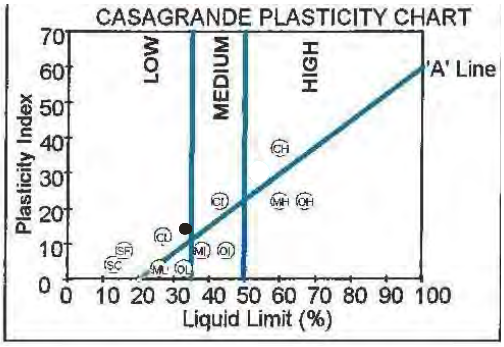
Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	400	0-400		dark brown		dry
	sandy clay (Pebble marker)	230	400-630		dark reddish red	dense	slightly moist
	silt-clay (Residual soil)	1730	630-2400		dark red	slightly soft	Moist

FOUNDATION INDICATOR RESULTS

Client	Matsuda Consultants International	Sample no.	T.P. 329	Date	
Project	Qinisweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	100
26.5	98
19.0	97
13.2	97
4.75	94
2.00	89
0.425	72
0.075	50



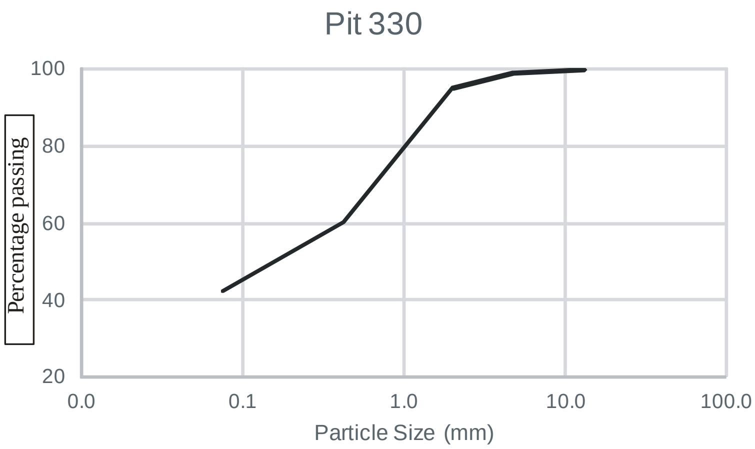


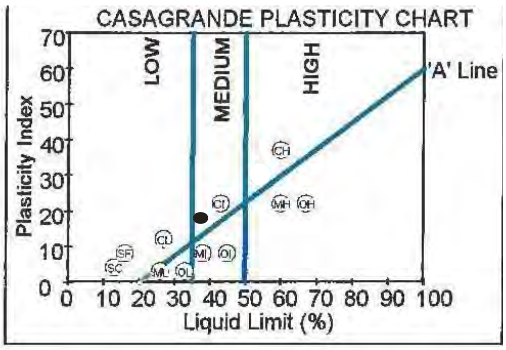
ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	34
Plastic Index (PI)	14
Linear Shrinkage	3.5
Grading Modulus	0.89
Natural Moisture Content	9
PI of whole sample	
AASTHO Classification	A-7-6(12)
TRH 14	

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 330	Date	
Project	Qinisweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	
13.2	100
4.75	99
2.00	95
0.425	60
0.075	42



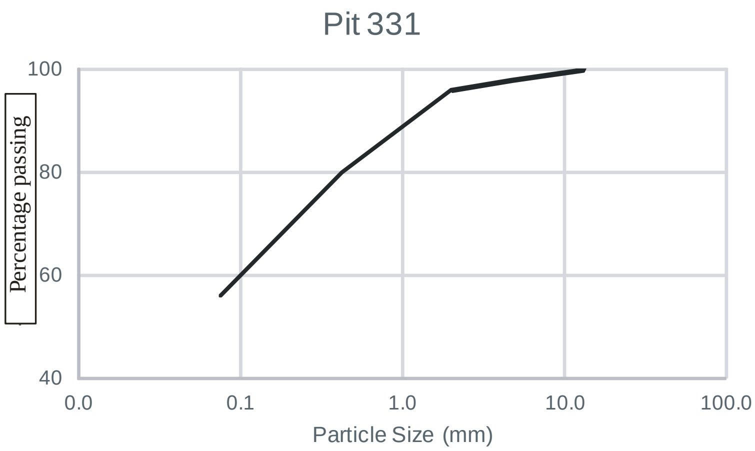


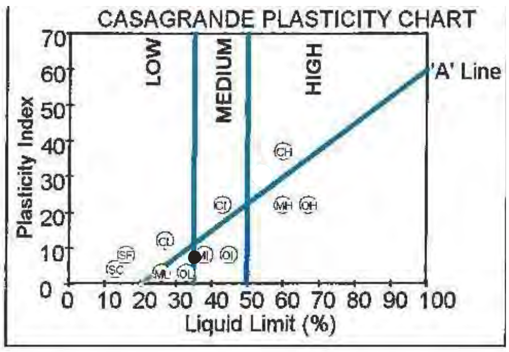
ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	38
Plastic Index (PI)	18
Linear Shrinkage	4.5
Grading Modulus	1.03
Natural Moisture Content	14.6
PI of whole sample	
AASTHO Classification	A-7-6(12)
TRH 14	

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 331	Date	
Project	Qinisweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	
13.2	100
4.75	98
2.00	96
0.425	80
0.075	56





ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	35
Plastic Index (PI)	7
Linear Shrinkage	3.5
Grading Modulus	0.68
Natural Moisture Content	13
PI of whole sample	
AASTHO Classification	A-7-6(12)
TRH 14	

SOIL TESTING SERVICES
MATSUDA CONSUNTANTS INTERNATIONAL
EQINISWENI NEW HIGH SCHOOL
DCP TEST RESULTS
31/12/2015

DCP (1) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	18	6	915
200	10	10	426
300	7	14	268
400	5	20	173
500	4	25	129
600	4	25	129
700	3	33	89
800	3	33	89
900	3	33	89
1000	3	33	89
1100	4	25	129
1200	3	33	89
1300	3	33	89
1400	4	25	129
1500	3	33	89
1600	3	33	89
1700	3	33	89
1800	3	33	89
1900	3	33	89
2000	2	50	52

DCP (2) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	32	3	1933
200	30	3	1778
300	19	5	981
400	20	5	1049
500	16	6	785
600	12	8	540
700	7	14	268
800	6	17	219
900	5	20	173
1000	4	25	129
1100	5	20	173
1200	4	25	129
1300	5	20	173
1400	4	25	129
1500	4	25	129
1600	3	33	89
1700	3	33	89
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (3) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	18	6	915
200	13	8	599
300	22	5	1187
400	10	10	426
500	7	14	268
600	7	14	268
700	5	20	173
800	4	25	129
900	4	25	129
1000	3	33	89
1100	3	33	89
1200	3	33	89
1300	2	50	52
1400	1	100	21
1500	3	33	89
1600	3	33	89
1700	4	25	129
1800	3	33	89
1900	3	33	89
2000	3	33	89

DCP (4) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	21	5	1118
200	17	6	849
300	20	5	1049
400	19	5	991
500	10	10	426
600	7	14	268
700	8	13	318
800	4	25	129
900	3	33	89
1000	3	33	89
1100	2	50	52
1200	2	50	52
1300	2	50	52
1400	2	50	52
1500	2	50	52
1600	1	100	21
1700	2	50	52
1800	3	33	89
1900	3	33	89
2000	3	33	89

DCP (5) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	22	5	1187
200	11	9	482
300	11	9	482
400	11	9	482
500	8	13	318
600	6	17	219
700	3	33	89
800	3	33	89
900	2	50	52
1000	2	50	52
1100	2	50	52
1200	2	50	52
1300	2	50	52
1400	2	50	52
1500	2	50	52
1600	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (6) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	20	5	1049
200	20	5	1049
300	25	4	1402
400	30	3	1778
480	30	3	2376

DCP (7) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	40	3	2585
200	25	4	1402
300	31	3	1856
400	26	4	1476
500	18	6	915
600	12	8	540
700	10	10	426
800	10	10	426
900	6	17	219
1000	5	20	173
1100	5	20	173
1200	4	25	129
1300	4	25	129
1400	4	25	129
1500	3	33	89
1600	3	33	89
1700	4	25	129
1800	3	33	89
1900	3	33	89
2000	3	33	89

DCP (8) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	22	5	1187
200	32	3	1933
300	31	3	1855
400	30	3	1778
500	30	3	1778
600	21	5	1118
700	16	6	785
800	11	9	482
900	9	11	371
1000	7	14	288
1100	2	50	52
1200	3	33	89
1300	3	33	89
1400	4	25	129
1500	4	25	129
1600	4	25	129
1700	4	25	129
1800	3	33	89
1900	2	50	52
2000	2	50	52

DCP (9) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	44	2	2976
200	32	3	1933
300	37	3	2335
400	28	4	1825
500	19	5	981
600	23	4	1258
700	17	6	848
800	13	8	599
900	10	10	426
1000	7	14	288
1100	3	33	89
1200	2	50	52
1300	2	50	52
1400	4	25	129
1500	4	25	129
1600	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

SOIL TESTING SERVICES

Geotechnical Investigation Log Sheet

PERCOLATION

Client: MATSUDA CONSULTANTS INTERNATIONAL

Project: EQINISWENI NEW HIGH SCHOOL   Date: 22/12/2015

Site: EQINISWENI

Potential influence of running /standing/seosonal water

Evidence of unusual land use(mining/fill)

HOLE 1 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole.
(2) The hole was used for PERCOLATION investigation
(3The Hole was presoaked the day before and and soak for 24 HRS
(4)This hole has a very good seepage suitable for french drain

HOLE 2 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole.
(2) The hole was used for PERCOLATION investigation
(3)The Hole was presoaked the day before and soak for 25 HRS
(4)This hole has a good seepage suitable for french drain

HOLE 1 — Presoaking Time (24hrs)

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
50		2.0		25.0
80		4.0		15.0
110		6.0		15.0
120		8.0		5.0
145		10.0		12.5
155		12.0		5.0
170		14.0		7.5
175		16.0		2.5
190		18.0		7.5
205		20.0		7.5
210		22.0		2.5
215		24.0		2.5
220		26.0		2.5
230		28.0		5.0
240		30.0		5.0
260		32.0		10.0
280		34.0		10.0
280		36.0		5.0
300		38.0		5.0
			Average	8.3

HOLE 2 — Presoaking Time (25hrs)

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
15		1.0		15.0
25		2.0		10.0
30		3.0		5.0
50		4.0		20.0
60		5.0		10.0
75		6.0		15.0
85		7.0		10.0
95		8.0		10.0
100		9.0		5.0
110		10.0		10.0
130		15.0		4.0
150		20.0		4.0
160		30.0		1.0
170		40.0		1.0
180		50.0		1.0
200		60.0		2.0
210		70.0		1.0
215		80.0		0.5
220		90.0		0.5
			Average	6.9

SOIL TESTING SERVICES (SWAZILAND) (PTY) LTD
P.O. BOX 2263, SWAZI PLAZA
TEL ... 6, 404 2227

Technical signatory : ... SOIL TESTING SERVICES

MATROLAB GROUP (PTY.) LTD.

- CIVIL ENGINEERING SERVICES -

Reg No.: 2003/029180/07 VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park,0184
P.O. BOX 912387 SILVERTON 0127

Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools Eqinisweni
ADDRESS:	P.O. Box A233 Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	12 February 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO: G16-54	HOLE NO: TP 331	DEPTH (m):	JOB NO: 117 626
DESCRIPTION:			

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	102.1	101.2	101.0
Initial Sample Diameter	D_0	(mm)	50.5	50.6	50.7
Initial Sample Weight	W_0	(gr)	402.7	403.3	403.0
Initial Bulk Density	ρ_0	(Mg/m3)	1.97	1.98	1.98
Particle Density	ρ_s	(Mg/m3)	2.49	2.49	2.49

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10	0.10	0.10
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	ω_i%	(%)	13	13	13
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.74	1.75	1.75
Initial Voids Ratio	e_0		0.43	0.42	0.42
Initial Degree of Saturation	S_o	(%)	75	77	76

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	2025.02	1906.17	2721.13
Membrane Correction	m_c	(kPa)	0.881	0.852	1.008
Strain At Max Stress	ε_f%	(%)	1.87	1.65	2.94
Shear Strength	c_u	(kPa)	1012.51	953.08	1360.56
Final Moisture	ω_f%	(%)	14	14	14
Final Dry Density	ρ_{df}	(Mg/m3)	1.73	1.75	1.74
Final Voids Ratio	e_f		0.44	0.43	0.43
Final Degree of Saturation	S_f	(%)	78.0	78.9	78.6

Remarks :

Page: 1 of 2

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P.O. BOX 912387 SILVERTON 0127

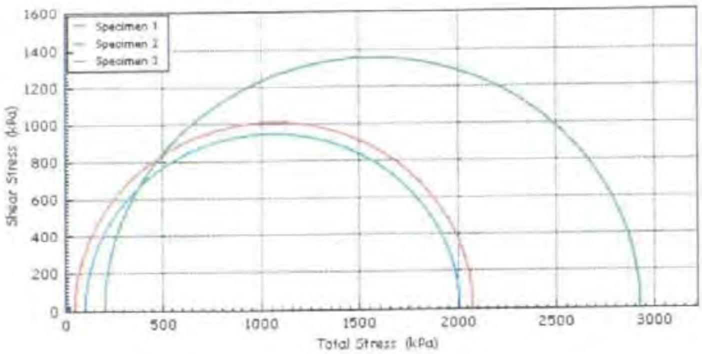
Tel: 012-800 1299
Fax: 012-800 3034
Email: aukek@matrolab.co.za

TEST RESULTS

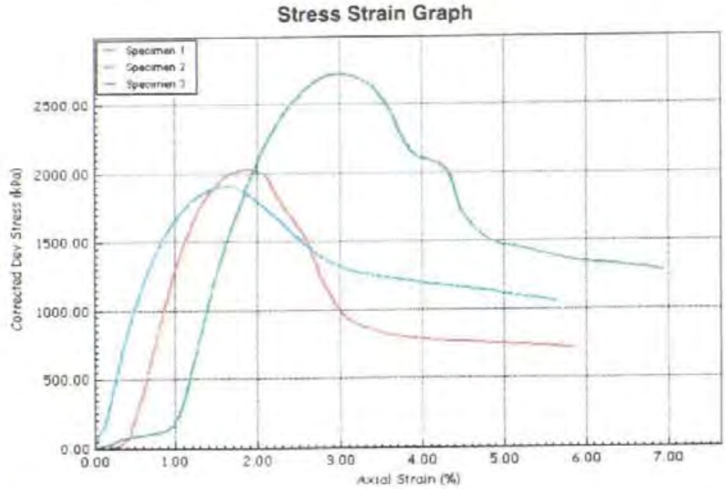
TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO: G16-54	HOLE NO: TP 331	DEPTH (m):	JOB NO: 117 626
DESCRIPTION:			

Total Stress Mohr Circle



Stress Strain Graph



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Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools Eqinisweni
ADDRESS:	P.O. Box A233 Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	14 March 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_53	HOLE NO:	TP 330	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	99.7	99.6	99.6
Initial Sample Diameter	D_0	(mm)	49.8	49.9	49.9
Initial Sample Weight	W_0	(gr)	325.4	327.0	327.7
Initial Bulk Density	ρ_0	(Mg/m3)	1.68	1.68	1.68
Particle Density	ρ_s	(Mg/m3)	2.59	2.59	2.59

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10000	0.10000	0.10000
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	$\omega_i\%$	(%)	15	15	15
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.46	1.46	1.46
Initial Voids Ratio	e_0	.	0.78	0.77	0.77
Initial Degree of Saturation	S_o	(%)	50	50	51

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	1070.87	1292.73	1625.57
Membrane Correction	m_c	(kPa)	0.752	0.883	0.959
Strain At Max Stress	$\varepsilon_f\%$	(%)	0.80	1.80	2.40
Shear Strength	c_u	(kPa)	535.43	646.36	812.78
Final Moisture	$\omega_f\%$	(%)	16	15	15
Final Dry Density	ρ_{df}	(Mg/m3)	1.44	1.46	1.46
Final Voids Ratio	e_f	.	0.80	0.77	0.77
Final Degree of Saturation	S_f	(%)	52.6	49.5	50.6

Remarks :

Page: 1 of 2

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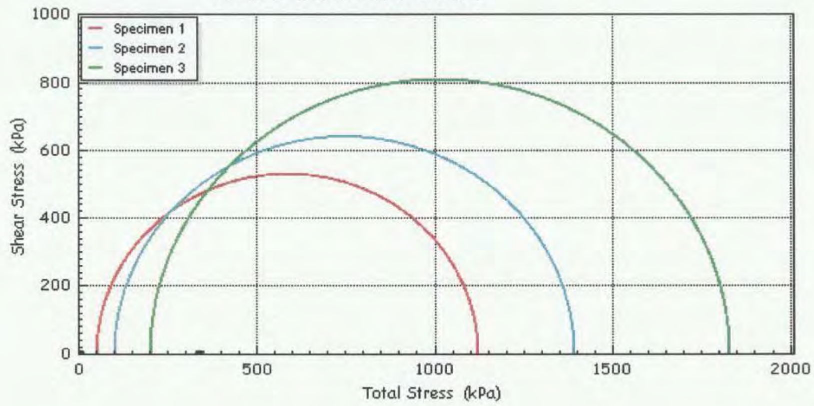
Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

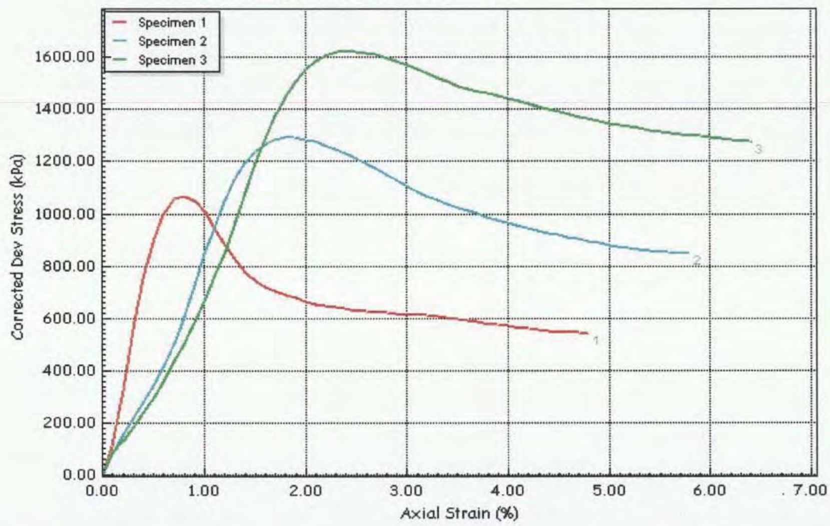
TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 53	HOLE NO:	TP 330	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



Remarks :

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Results only have bearing on the samples tested.
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APPENDIX C

Table 1: Correlation chart of maximum bearing stress (allowable bearing capacity) of rocks and soil materials

Category	**Types of rocks and soils**	**Bearing value (kPa)**
Non-cohesive soils	Dense gravel or dense sand and gravel	>600
	Medium dense gravel, or medium dense sand and gravel	<200 to 600
	Loose gravel, or loose sand and gravel	<200
	Compact sand	>300
	Medium dense sand	100 to 300
	Loose sand	<100 *depends on degree of looseness*
Cohesive soils	Very stiff bolder clays & hard clays	300 to 600
	Stiff clays	150 to 300
	Firm clay	75 to 150
	Soft clays and silts	< 75
	Very soft clay	Not applicable
Peat		Not applicable
Made ground		Not applicable

H4-Enhlitiyweni

SOIL TESTING SERVICES

GEOTECHNICAL REPORT – ENHLITIYWENI

CONSTRUCTION OF NEW SECONDARY SCHOOLS AND UP-GRADING OF FACILITIES IN EXISTING SECONDARY SCHOOLS AIMED AT PROMOTING INCLUSIVE EDUCATION IN THE KINGDOM OF SWAZILAND

FOR

MATSUDA CONSULTANTS INTERNATIONAL CO. LTD

SOIL TESTING SERVICES
CIVIL ENGINEERING LABORATORY

Lot 321, Samora Machel Street
P.O. Box A233
Swazi Plaza
Mbabane H101
Swaziland

MARCH 2016

TABLE OF CONTENTS

GEOTECHNICAL REPORT - ENHLITIYWENI

1.0 INTRODUCTION

This report is based on the Preparatory Survey on "the Project for the Construction of New Secondary Schools and Upgrading of Facilities in Existing Secondary Schools aimed at Promoting Inclusive Education" based upon request from the Government of Swaziland to the Japan International Cooperation Agency (JICA). The survey is to obtain geotechnical data and information at KaNcesi, northern Swaziland, where the proposed Enhlitiyweni High School will be constructed, for the design of earthworks, foundation and structures of the buildings.

2.0 SCOPE OF WORK

The following activities were expected to be executed in the cause of the study.

(1) Field works on each site
- Dynamic Cone Penetration test (DCP)
  Nine (09) points, depth up to Two (02) m from the ground level
- Soil Sampling
- Percolation Test Two (02) points

(2) Laboratory testing (for each sample)
- Triaxial Compression Test
- Moisture Density Test
- Particle Size Analysis
- Atterberg limit test

3.0 SITE DESCRIPTION

Location and Topography

The new Enhlitiyweni High School site is located at KaNcesi in the Hhohho Region. This area is partially flat and sloping on the northern boundary.

The site is grass covered and part of it is a sport field. Although the land is not arable it is not necessarily used as a pasture as it is within homesteads, and cattle can only graze freely in winter.

Rainfall and Drainage

This area has a 1060m elevation and is designated as the Highveld climatic region of the country. The area has warm summers and cold winters. In winter the area experiences frost.

There area is drained by a number of small streams downslope. There are no scour surfaces on the site itself.

Access

The school site can be accessed through a distributor gravel road to Eluvinjelweni. The road leads from the tarred road to Maguga Dam to the north of this area. It is well maintained and has a wearing course.

4.0 GENERAL GEOLOGY OF SITE

The KaNcesi area has a young granite pluton, Mswati granite, as its bedrock. The granite is typically coarse grained and contains megacrysts of microcline and orthoclase. The granite is unfoliated and contains a few aplites and pegmatites. They are sharply cross-cutting and contain apparent xenoliths of earlier granite and mafic bodies. Veins of this granite lie to the south of the area and are disposed roughly concentrically around the Mbabane pluton to the south. The granite is well jointed in rectilinear patterns.

A scanned and cropped geological map of the area is presented in Appendix A. It is taken from a 1:50 000 geological map sheet 5 (2630 BB) published by the Swaziland Geological Survey Department

5.0 GEOTECHNICAL FIELD INVESTIGATIONS AND LABORATORY TESTING

Methods of Investigation and Testing

Field investigations, sampling and laboratory testing has been designed to provide information as follows:

Trial Pits

Three Trial Pits (TP) were excavated at positions determined by the client with pits attaining some depth of 2.1m using a Tractor Loader Backhoe (TLB), 4x4 capability with 600mm bucket width and flywheel power rating of at least 70kW. The aim of the excavation of the trial pits was to determine the soil stratigraphy, and extraction of soil samples.

All test pits had stable walls and were profiled using profiling standard procedure outlined in the Association of Engineering Geologists (South African Section), 'Guidelines for soil and rock logging in SA" (1990). Representative soil samples were taken from the soil profile for laboratory testing. Bulk samples of the residual soil material were taken; topsoil and sub-soil layers were recorded and are shown in detail in Trial Pit profiles. The stratigraphy revealed by each pit was carefully logged with special notes taken of the thickness and conditions of the various layers.

Dynamic Cone Penetration Test (DCP)

Dynamic Cone Penetrometer (DCP) tests were conducted at 9 positions around the site. The exact locations of all DCP tests carried out were performed at positions determined by Matsuda Consultants International Co., Ltd.

Prior to the performance of a series of tests, the zero reading of the penetrometer was determined. The dynamic penetrometer tests were then performed by taking readings of cone penetration after a number of blows depending on the consistency of the layer being penetrated. The tests were terminated at maximum depths of 2000mm wherever possible.

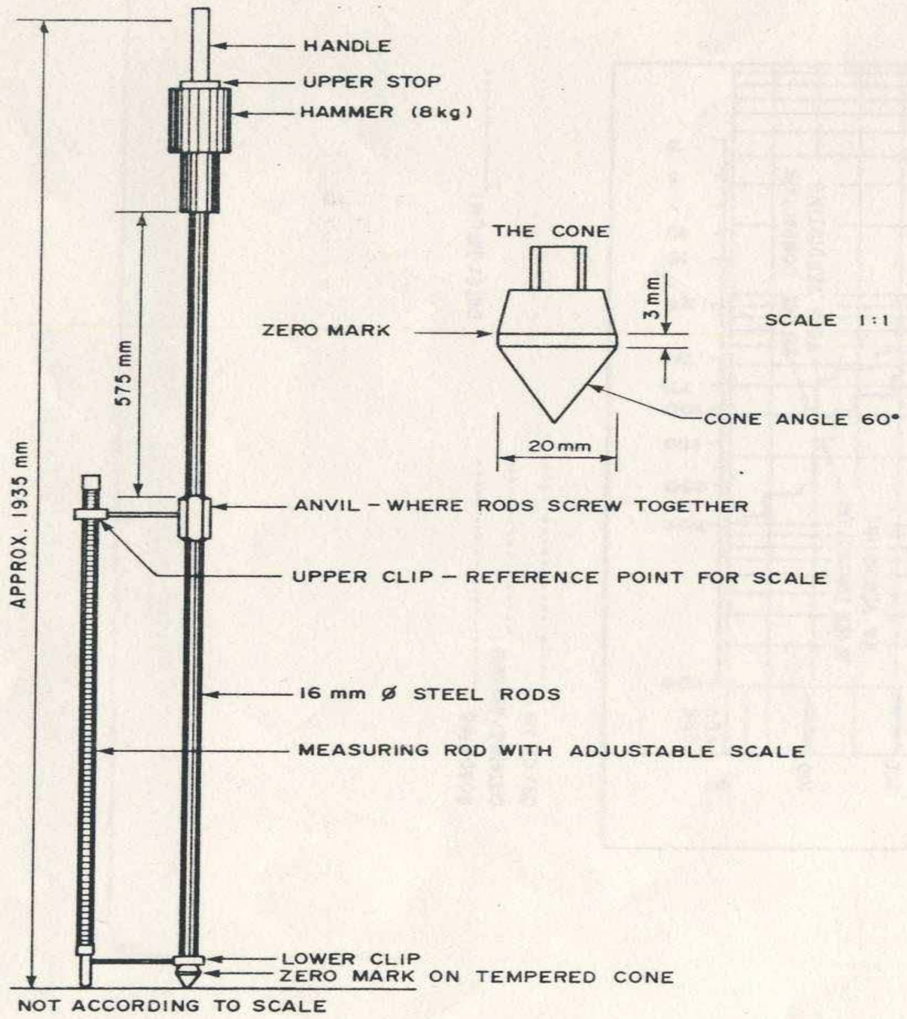


FIGURE ST6/I THE DYNAMIC CONE PENETROMETER

Percolation Test

The percolation test consist of digging a 900x900x900mm deep at the centre 300x300x300mm deep see figure 2 hole to the stratum for which information is required, cleaning and backfilling the bottom with coarse sand or gravel, filling the hole with water and providing a soaking period of sufficient length to achieve saturation. During the soaking period, water is added as necessary to prevent loss of all water. The percolation rate is then obtained by filling the hole to a prescribed water level and measuring the drop in water level over a set time. The times required for soaking and for measuring the percolation rate vary with the soil type.

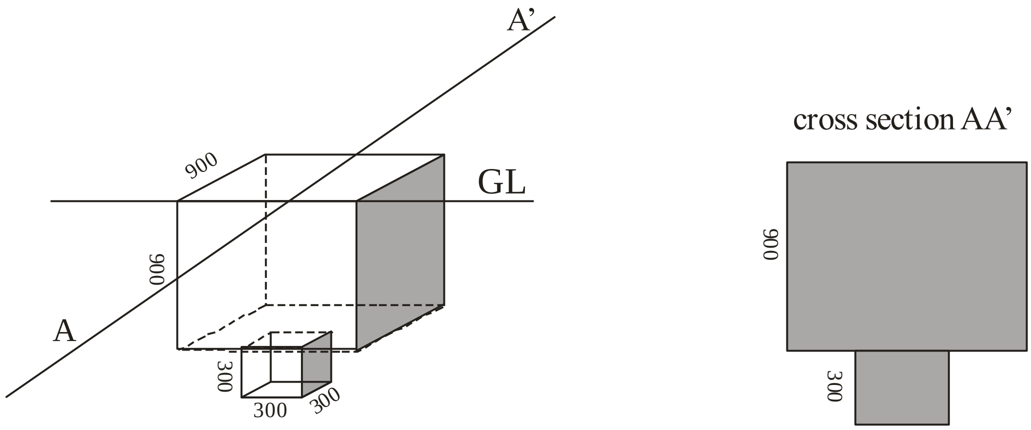


Figure 2. Cross section of percolation test pit

Laboratory Testing

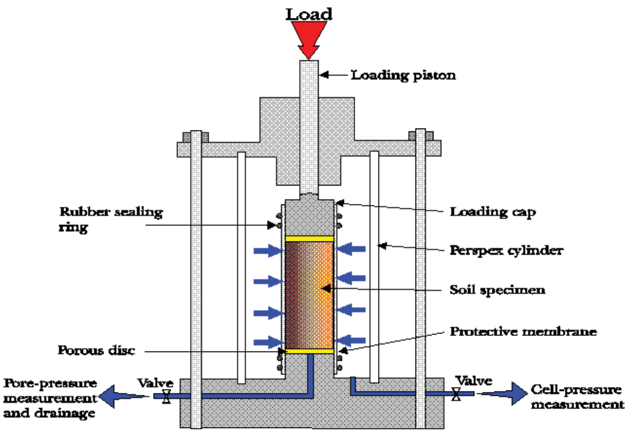
Laboratory tests were performed by Soil Testing Services (Pty) Ltd in Mbabane. As specified by Matsuda Consultants International Co., Ltd this testing comprised of foundation indicator testing only.

The following laboratory tests were executed for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)

Stress Triaxial Stress Tests: Unconsolidated - Undrained (BS 1377-7:1990 Clause 7)

Stress Triaxial Stress Tests were conducted at Metrolab Group, Republic of South Africa according to the standard **BS 1377-7:1990 Clause 7**. This involved subjecting a cylindrical soil sample to radial stresses (confining pressure) and controlled increases in axial stresses or axial displacements. The cylindrical soil specimen was of ~50mm diameter and ~100mm height dimension. As this is cohesive soil samples were prepared directly from saturated compacted samples, either undisturbed or remolded. The specimen was vertically enclosed with a thin rubber membrane and placed between two rigid ends inside a pressure chamber. The upper plate can move vertically and apply vertical stresses to the specimen. The axial strain/stress of the sample is controlled through the movement of this vertical axis. Also, the confining pressure is controlled by the water pressure surrounding the sample in the pressure chamber. The volume change of the sample is also controlled by measuring the exact volume of moving water.



Triaxial apparatus

6.0 INTERPRETIVE INFORMATION

Site Stratigraphy

The stratigraphy of the Enhlitiyweni High School site can be summarized as colluvial and residual soils.

Colluvial soils on the site generally consists some 300mm thick layer of dry dark brown to dark reddish brown topsoil. This is gravity transported soil.

The lower layer of colluvial soils averages about 900mm, except for TP20 where it was not encountered, and consists of moist, slightly dense, sandy clay. It is gravity transported and dark red in colour and represents the lower limit of colluvial soils and directly lies above residual soils.

Residual soils derived from the complete in-situ weathering of the underlying Mswati granite, the underlying rock. This soil lies at depth ranging from 1100mm to 1200mm, and is moist to slightly moist, slightly soft, fissured or intact, silt-clay. At TP20, however, it lies at 230mm depth and very shallow. The residual soil display lateral material variation discernible by their colour variation. They consist of pale red to light red material.

Materials

The table below summarizes some of the laboratory test results and the complete test results are presented in Appendix

Test Pit No.	Sample no & depth(m)	Horizon	O.M.C%	LL	PI	Shrinkage	Soil Class AASHTO
18	1.1-2.1	Residual granite	14.4	50	21	6.5	A-7-6(5)
19	1.2-2120	Residual granite	8.8	47	30	5.5	A-7-6(4)
20	0.23-1.5	Residual granite	11.6	45	16	6.0	A-7-6(4)

Engineering Geological Evaluation

Groundwater

No groundwater inflow was encountered in any of the excavated test pits. It is, however, expected that the groundwater table will occur at depth.

Expansive soils

No soils susceptible to swelling or heaving were encountered on site, and problematic movements associated with expansion are not expected.

From the Foundation Indicator tests carried out all the horizons tested displayed a “medium” to “low” potential for expansiveness classification.

Potentially Collapsible Soils

The soil horizons encountered are not considered to be collapsing in nature. It is, therefore, not anticipated that any special precautions will need to be taken with regard to collapsible soils.

Percolation Rate

The soils in this area are suitable for a normal French drain. Both percolation tests positions displays good seepage and as such are suitable for normal French drain development.

Bearing Capacity

The laboratory triaxial compression tests the site with unconsolidated undrained (UU) shear strength (c_u) of between 952kPa and 1290kPa display allowable bearing capacity of between an estimated 1631kPa and 2210kPa. The correlation chart in Appendix C of maximum bearing stress that can be applied to the foundation such that it is safe against instability due to shear failure the site's allowable bearing capacity is highly safe for any building development.

Field Dynamic Cone Penetrometer (DCP) tests display higher bearing capacities for the upper 1m soils and relatively low bearing capacities at greater depths (>1m). This is in effect result in softer material at depth and slightly dense material near surface. Test positions DCP 8 and 9 display low bearing capacities of 52kPa at shallow depths (300mm). DCP Test no. 5 displays a layered nature of the residual soil.

the field and laboratory tests above indicates that residual soil from the weathered granite is relatively homogenous, and buildings can be founded at depths of 800 to 1000mm on the site.

Excavatibility

There were no recorded excavation refusals during pitting to the depths of 2.1m. It is anticipated that excavation to bedrock level will be of soft excavation class at the site. No major instabilities were recorded during the excavation of the test pits that further suggests that excavation may safely extend vertically to depths of about 3.00m without the need for lateral support, if of a temporary nature (during construction) and in the dry season.

Seismicity

One type of seismic activities occurs in Swaziland, and that is natural seismic activity. There is no mining-induced seismic activity. In accordance with the Seismic Hazard Zone map contained in the draft SANS 10160-4, southern Swaziland is classified as Zone 1 and is subject to natural seismic activity only. KaNcesi area is on the northern part of the country outside the Zone 1 area. The South African "loading" code, SABS 0160-4:2011, shows that Ka Ncesi area is situated in an area where the peak ground acceleration with a 10% probability of being exceeded in a 50 year period is just less than 100 cm/sec^2

The soil profile of the site can be described as slightly soft, intact, silt-clay with an average shear strength between 952kPa and 1290kPa c_u. The contrasting identified ground types in accordance with the consolidated undrained shear strength and soil profile, type 2 and 3 respectively, indicates that the lacking v_s profile at the site is taken as "the most reliable predictor of the site dependent characteristics of the seismic action at stable sites".

7.0 CONCLUSION AND RECOMMENDATIONS

- The absence of rock outcrop on the site suggests that bedrock will only be present at depth. The bedrock surface is likely to be undulatory and of boulder nature as can be seen in the outcrops nearby.
- No special precaution with regards to water seepage and dampness has to be paid as no water seepage was experienced in any of the Trial Pits.
- The soils are of intermediate plasticity and it is expected that they will be prone to erosion. Precaution is expected to be taken during site clearing to avoid excessive soil erosion.

Building Foundations

The allowable bearing capacity of the sandy clays in the site reveals values between 1631kPa and 2210kPa in the new school site. This indicates that the site is relatively homogenous in strength and no major differential settling is expected.

It is recommended that foundations be placed on the residual soil, at depths of 800 to 100mm, to avoid the colluvial soil material.

From the other Foundation Indicator tests carried out all the horizons tested displayed a "low" potential for expansiveness classification. As the soils are not susceptible to swelling or heaving it is not expected that significant swell-shrink movement of the footing will occur.

Despite the low expansive potential of the soils it is worth taking the following precautions:

- Attention to proper site drainage and storm water runoff management is essential to prevent ponding of water near structures.
- Water supply pipes and sewers must be maintained and leaks or blockages timeously detected and repaired.
- No water loving vegetation or large trees may be allowed to grow within 15m of any structure and it is not recommended to allow gardening directly around the structures. Instead concrete aprons should be installed to prevent wetting of foundations.

Parking Areas and Roadways

The material quality at surface display a good bearing capacity from DCP analyses and for the construction of parking can easily be stabilized and paved. But for roadways it cannot be used as fill. It is recommended that material for pavements layers required for road works be imported from outside the site.

NOTE:

- Fluctuations in the level of groundwater can occur due to variations in the rainfall, land-saping, and other factors that may not been evident prior to the start of construction, so the depth of groundwater should be verified to allow for modification of the design, if required.

- Additional investigations or at least an assessment of the ground conditions exposed during construction can often result in significant construction cost and time savings.

GENERAL NOTES ON THE REPORT

The information and recommendations contained within this report relate to data supplied by Soil Testing Services, comprising test pit profiles, DCP penetration data, soil percolation test results and soil grading tests.

The report has been compiled on the assumption that all the data supplied by Soil Testing Services (and the assumptions made in this report where this supplied data is inadequate) is correct and is generally representative of the site area.

Prepared for Geo Solutions

Noah Nhleko
BSc (Biology & Chemistry); PhD Geology

APPENDIX A

A) Tractor Loader Backhoe (TLB)

B) Typical Trial Pit

A-222

SOIL TESTING SERVICES
(SWAZILAND) (PTY) LTD
P.O. BOX A233, SWAZI PLAZA
TEL: 404 1956 404 2227
SOIL LABORATORY

Site Name :
H4
ENHLITIYWENI
Region :
Hhohho
Contact Person
Mr. SAKHI DLAMINI
Cel: 7617 7079

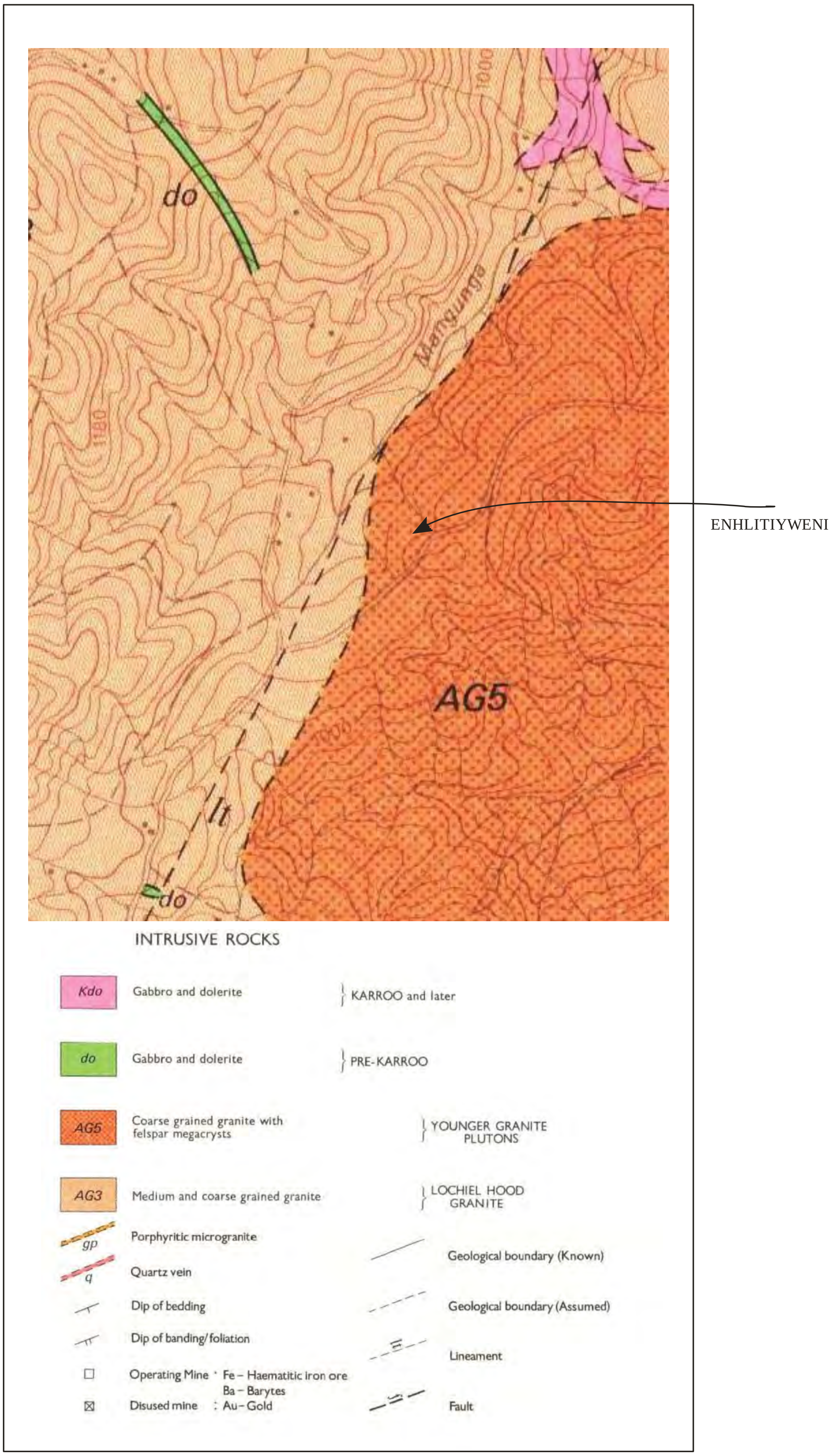
Other information
The bounday of the site is indicated by blue line. All boundary points have been staked with red sprayed rebars. If you contact to the person mentioned above, they show you the boundary points. The Surveyor should excavete <u>three pits</u> in total indicated in the map.

DCP TEST POINTS
SAMPLING & PIT POINTS
PERCOLATION TEST POINTS

N

Boundary Point	Latitude / Longitude	Note
006	S26 07.136 E31 14.855	Reference of boundary point
007	S26 07.114 E31 14.846	Ditto
008	S26 07.046 E31 14.814	Ditto
009	S26 07.018 E31 14.789	Ditto
011	S26 07.000 E31 14.767	Ditto

Boundary Point	Latitude / Longitude	Note
012	S26 06.988 E31 14.729	Reference of boundary point
013	S26 07.049 E31 14.725	Ditto
014	S26 07.070 E31 14.757	Ditto
015	S26 07.148 E31 14.659	Ditto
017	S26 07.173 E31 14.680	Ditto



do
1000
Mangunga
1180
ENHLITIYWENI
AG5
lt
do
INTRUSIVE ROCKS
Kdo Gabbro and dolerite
KARROO and later
do Gabbro and dolerite
PRE-KARROO
AG5 Coarse grained granite with felspar megacrysts
YOUNGER GRANITE PLUTONS
AG3 Medium and coarse grained granite
LOCHIEL HOOD GRANITE
gp Porphyritic micrograite
q Quartz vein
Dip of bedding
Dip of banding/foliation
Operating Mine
Disused mine
Fe – Haematitic iron ore
Ba – Barytes
Au – Gold
Geological boundary (Known)
Geological boundary (Assumed)
Lineament
Fault

APPENDIX B

Project	Trial Pit No.	Location	Date
Matsuda consultants International Ltd	TP 18	KaNcesi (Enhlitiyweni)	9/12/2015

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizons	Topsoil	250	0-250		dark brown		moist
	sandy clay transported soil	810	250-1100		dark red	slightly dense	moist
	silt-clay, highly weathered Mswati granite	1000	1100-2100		light red Inprofile, light yellowish orange/ pale red/ light brown	slightly soft, intact	Moist

Project	Trial Pit No.	Location	Date
Matsuda consultants International Ltd	TP 19	KaNcesi (Enhlitiyweni)	9/12/2015

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizons	Topsoil	330	0-330		dark reddish brown		moist
	sandy clay transported soil	870	330-1200		dark red	slightly dense	moist
	silt-clay, highly weathered Mswati granite	920	1200-2120		pale red Inprofile, light yellowish orange/light reddish brown	slightly soft, fissured	Moist

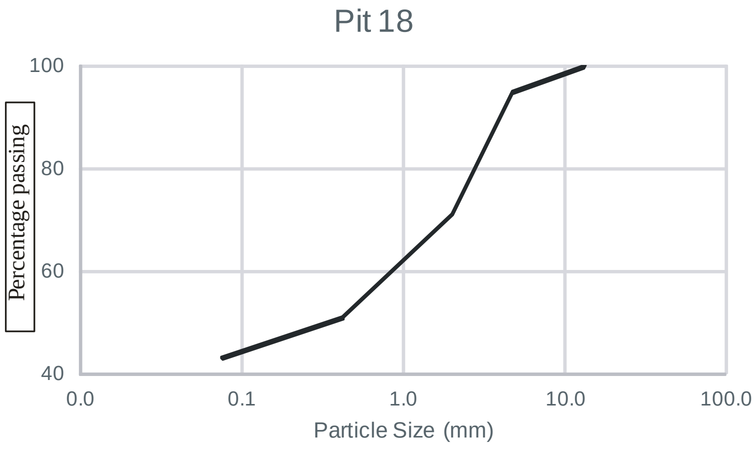
Project	Trial Pit No.	Location	Date
Matsuda consultants International Ltd	TP 20	KaNcesi (Enhlitiyweni)	9/12/2015

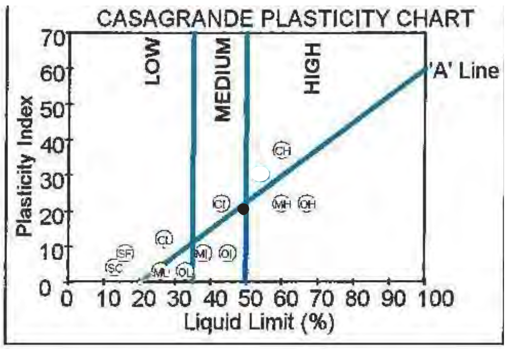
Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizons	Topsoil	230	0-230		dark brown		moist
	silt-clay, highly weathered Mswati granite	1270	230-1500		light red Inprofile, dark red/ light reddish orange/ pale red	slightly dense, intact	moist

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 18	Date	
Project	Enhlitiyweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	
13.2	100
4.75	95
2.00	71
0.425	51
0.075	43



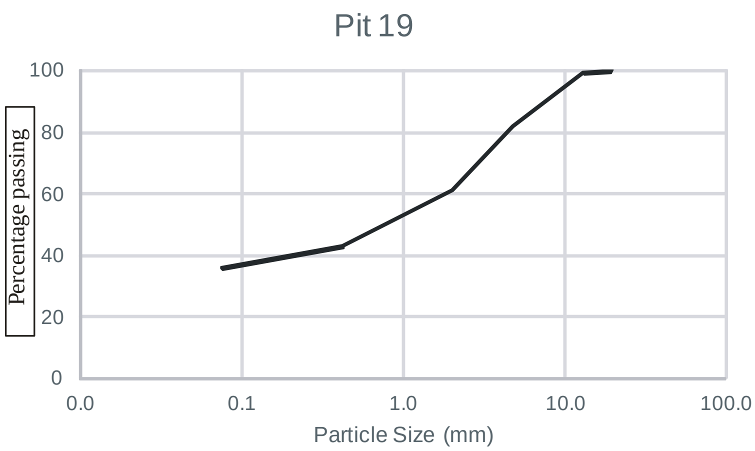


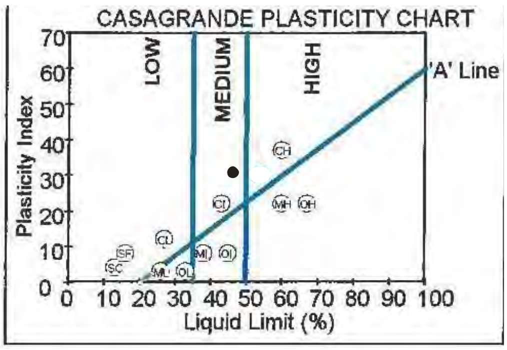
ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	50
Plastic Index (PI)	21
Linear Shrinkage	6.5
Grading Modulus	1.35
Natural Moisture Content	14.4
PI of whole sample	
AASTHO Classification	A-7-6(5)
TRH 14	

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 19	Date	
Project	Enhlitiyweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	100
13.2	99
4.75	82
2.00	61
0.425	43
0.075	36



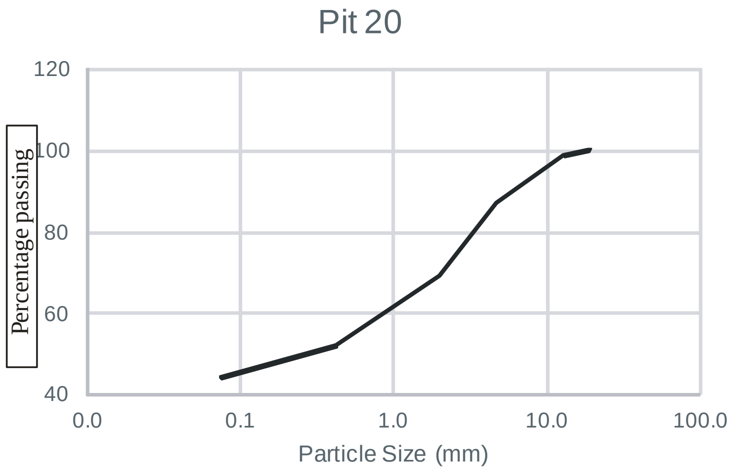


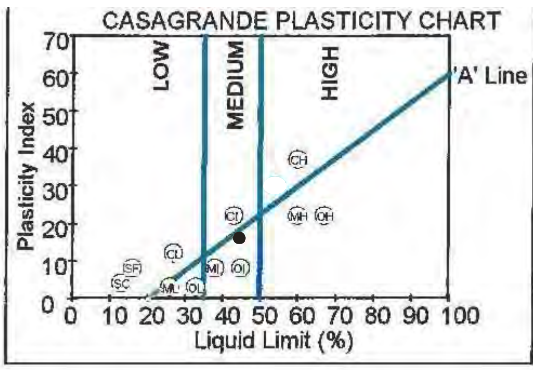
ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	47
Plastic Index (PI)	30
Linear Shrinkage	5.5
Grading Modulus	1.6
Natural Moisture Content	8.8
PI of whole sample	
AASTHO Classification	A-7-6(4)
TRH 14	

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 20	Date	
Project	Enhlitiyweni High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	
26.5	
19.0	100
13.2	99
4.75	87
2.00	69
0.425	52
0.075	44





ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	45
Plastic Index (PI)	16
Linear Shrinkage	6.0
Grading Modulus	1.35
Natural Moisture Content	11.6
PI of whole sample	
AASTHO Classification	A-7-6(4)
TRH 14	

SOIL TESTING SERVICES
MATSUDA CONSUNTANTS INTERNATIONAL
ENHLITIYWENI NEW HIGH SCHOOL
DCP TEST RESULTS
12/1/2015

DCP (1) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	6	17	219
200	9	11	371
300	9	11	371
400	11	9	482
500	6	17	219
600	6	17	219
700	5	20	173
800	5	20	173
900	3	33	89
1000	3	33	89
1100	3	33	89
1200	6	17	219
1300	2	50	52
1400	2	50	52
1500	2	50	52
1600	1	100	21
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (2) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	7	14	268
200	10	10	426
300	10	10	426
400	12	8	540
500	10	10	426
600	9	11	371
700	8	13	318
800	7	14	268
900	5	20	173
1000	5	20	173
1100	16	6	765
1200	16	6	915
1300	12	8	540
1400	8	13	318
1500	3	33	89
1600	4	25	129
1700	3	33	89
1800	3	33	89
1900	1	100	21
2000	2	50	52

DCP (3) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	14	7	860
200	15	7	721
300	13	8	599
400	9	11	371
500	5	20	173
600	5	20	173
700	5	20	173
800	4	25	129
900	4	25	129
1000	4	25	129
1100	3	33	89
1200	2	50	52
1300	2	50	52
1400	3	33	89
1500	2	50	52
1600	4	25	129
1700	3	33	89
1800	3	33	89
1900	2	50	52
2000	2	50	52

DCP (4) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	7	14	268
200	9	11	371
300	12	8	540
400	8	13	318
500	6	17	219
600	5	20	173
700	5	20	173
800	3	33	89
900	3	33	89
1000	3	33	89
1100	3	33	89
1200	2	50	52
1300	3	33	89
1400	2	50	52
1500	2	50	52
1600	3	33	89
1700	3	33	89
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (5) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	6	17	219
200	7	14	268
300	12	8	540
400	12	8	540
500	11	9	482
600	8	13	318
700	6	17	219
800	5	20	173
900	5	20	173
1000	4	25	129
1100	3	33	89
1200	2	50	52
1300	1	100	21
1400	2	50	52
1500	4	25	129
1600	3	33	89
1700	5	20	173
1800	10	10	426
1900	12	8	540
2000	9	11	371

DCP (6) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	6	17	219
200	9	11	371
300	11	9	482
400	9	11	371
500	9	11	371
600	8	13	318
700	6	17	219
800	4	25	129
900	4	25	129
1000	3	33	89
1100	2	50	52
1200	2	50	52
1300	2	50	52
1400	1	100	21
1500	1	100	21
1600	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

DCP (7) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	10	10	426
200	15	7	721
300	13	8	599
400	19	5	981
500	10	10	426
600	8	13	318
700	4	25	129
800	3	33	89
900	4	25	129
1000	3	33	89
1100	3	33	89
1200	4	25	129
1300	5	20	173
1400	3	33	89
1500	5	20	173
1600	2	50	52
1700	2	5	52
1800	2	50	52
1900	3	33	89
2000	5	20	173

DCP (8) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	10	10	426
200	8	13	318
300	3	33	89
400	3	33	89
500	7	14	268
600	2	50	52
700	2	50	52
800	2	50	52
900	2	50	52
1000	2	50	52
1100	3	33	89
1200	22	5	1187
1300	4	25	129
1400	3	33	86
1500	4	25	129
1600	3	33	89
1700	3	33	89
1800	3	33	89
1900	3	33	89
2000	3	33	89

DCP (9) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	10	10	426
200	10	10	426
300	10	10	426
400	4	25	129
500	2	50	52
600	2	50	52
700	2	50	52
800	2	50	52
900	2	50	52
1000	2	50	52
1100	2	50	52
1200	2	50	52
1300	2	50	52
1400	2	50	52
1500	2	50	52
1600	2	50	52
1700	2	50	52
1800	2	50	52
1900	2	50	52
2000	2	50	52

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P.O. BOX 3, SWAZI PLAZA
TEL 404 1956, 404 2227
SOIL LABORATORY

SOIL TESTING SERVICES

Geotechnical Investigation Log Sheet

PERCOLATION

Client: MATSUDA CONSULTANTS INTERNATIONAL

Project: EHLITIYWENI NEW HIGH SCHOOL Date: 19/12/2015

Site: EHLITIYWENI

Potential influence of running /standing/seasonal water

Evidence of unusual land use(mining/fill)

HOLE 1 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole.
(2) The hole was used for PERCOLATION investigation
(3The Hole was presosked the day before and and soak for 24 HRS
(4)This hole has a very good seepage suitable for french drain

HOLE 1 **Presoaking Time (24hrs)**

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
40		2.0		20.0
60		3.0		20.0
80		4.0		20.0
100		5.0		20.0
110		6.0		10.0
120		7.0		10.0
135		8.0		15.0
145		9.0		10.0
155		10.0		10.0
170		11.0		15.0
175		12.0		5.0
185		13.0		10.0
190		14.0		5.0
200		15.0		10.0
205		16.0		5.0
210		17.0		5.0
215		18.0		5.0
225		19.0		10.0
235		20.0		10.0
240		21.0		5.0
245		22.0		5.0
250		23.0		5.0
255		24.0		5.0
260		25.0		5.0
265		26.0		5.0
270		27.0		5.0
300		32.0		6.0
			Average	9.5

HOLE 2 NOTES

(1) A TLB AND PREPARED BY A HAND SPADE was used to excavate the hole
(2) The hole was used for PERCOLATION investigation
(3)The Hole was presosked the day before and soak for 25
(4)This hole has a very good seepage suitable for french drain

HOLE 2 **Presoaking Time (25hrs)**

DEPTH mm		TIME Minutes		SEEPAGE mm/min.
0		0.0		
30		2.0		15.0
50		3.0		20.0
70		4.0		20.0
90		5.0		20.0
110		6.0		20.0
125		7.0		15.0
135		8.0		10.0
150		9.0		15.0
160		10.0		10.0
180		11.0		20.0
190		12.0		10.0
200		13.0		10.0
210		14.0		10.0
215		15.0		5.0
225		16.0		10.0
235		17.0		10.0
260		18.0		25.0
265		19.0		5.0
270		20.0		5.0
275		21.0		5.0
280		22.0		5.0
285		23.0		5.0
290		24.0		5.0
300		25.0		10.0
			Average	11.9

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TEL: +268 404 2227
SOIL LABORATORY

Technical signatory :THULANI S VILAKATI For SOIL TESTING SERVICES

MATROLAB GROUP (PTY.) LTD.

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Reg No.: 2003/029180/07 VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park,0184
P.O. BOX 912387 SILVERTON 0127

Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools
ADDRESS:	P.O. Box A233		ENHLITIWENI
	Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	14 March 2016

TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_83	HOLE NO:	TP 18	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	101.4	99.0	95.2
Initial Sample Diameter	D_0	(mm)	50.0	50.2	51.2
Initial Sample Weight	W_0	(gr)	390.1	392.1	392.6
Initial Bulk Density	ρ_0	(Mg/m3)	1.96	2.00	2.00
Particle Density	ρ_s	(Mg/m3)	2.65	2.65	2.65

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10000	0.10000	0.10000
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	ω_i%	(%)	14	14	14
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.71	1.75	1.75
Initial Voids Ratio	e_0	.	0.55	0.51	0.51
Initial Degree of Saturation	S_0	(%)	70	74	74

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	1477.09	1940.30	2294.15
Membrane Correction	m_c	(kPa)	1.088	1.035	1.116
Strain At Max Stress	ε_f%	(%)	2.49	3.07	3.97
Shear Strength	c_u	(kPa)	738.54	970.15	1147.08
Final Moisture	ω_f%	(%)	14	14	13
Final Dry Density	ρ_{df}	(Mg/m3)	1.72	1.76	1.77
Final Voids Ratio	e_f	.	0.54	0.51	0.50
Final Degree of Saturation	S_f	(%)	68.1	71.7	71.2

Remarks :

Page: 1 of 2

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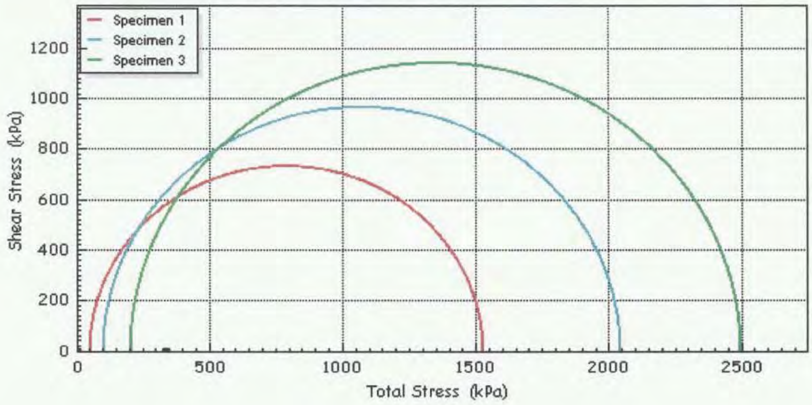
Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

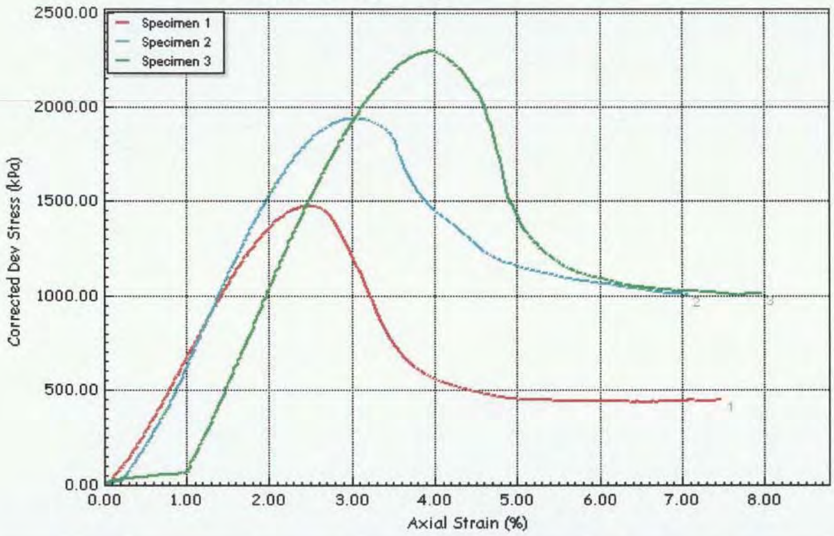
TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 83	HOLE NO:	TP 18	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



Remarks : 0

Page: 2 of 2

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Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools
ADDRESS:	P.O. Box A233		ENHLITIWENI
	Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	14 March 2016

TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_84	HOLE NO:	TP 19	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	101.1	103.4	103.3
Initial Sample Diameter	D_0	(mm)	49.7	50.4	50.5
Initial Sample Weight	W_0	(gr)	394.2	395.7	396.4
Initial Bulk Density	ρ_0	(Mg/m3)	2.01	1.92	1.92
Particle Density	ρ_s	(Mg/m3)	2.55	2.55	2.55

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10000	0.10000	0.10000
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	ω_i%	(%)	8.80	8.80	8.80
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.85	1.76	1.76
Initial Voids Ratio	e_0	.	0.38	0.44	0.45
Initial Degree of Saturation	S_o	(%)	59	50	50

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	2405.33	2596.40	2736.21
Membrane Correction	m_c	(kPa)	0.559	0.987	0.982
Strain At Max Stress	ε_f%	(%)	1.54	2.71	2.69
Shear Strength	c_u	(kPa)	1202.66	1298.20	1368.11
Final Moisture	ω_f%	(%)	12	12	12
Final Dry Density	ρ_{df}	(Mg/m3)	1.80	1.72	1.70
Final Voids Ratio	e_f	.	0.42	0.48	0.49
Final Degree of Saturation	S_f	(%)	71.4	62.3	64.0

Remarks :

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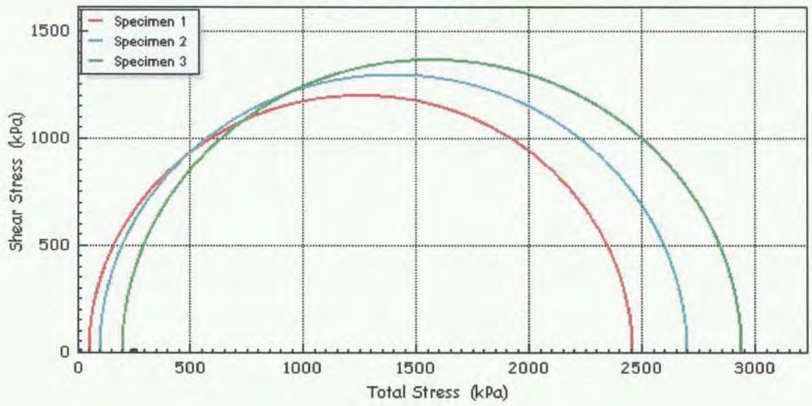
Email : aukek@matrolab.co.za

TEST RESULTS

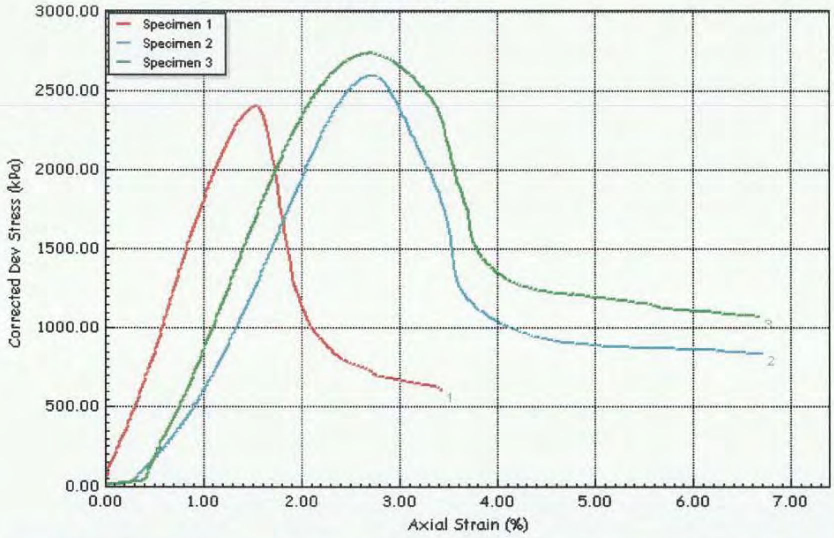
TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 84	HOLE NO:	TP 19	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



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TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools Enhilitiyweni
ADDRESS:	P.O. Box A233 Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	12 February 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16-66	HOLE NO:	TP 20	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	102.9	101.6	102.9
Initial Sample Diameter	D_0	(mm)	50.2	50.2	50.2
Initial Sample Weight	W_0	(gr)	419.3	419.5	419.9
Initial Bulk Density	ρ_0	(Mg/m3)	2.06	2.08	2.06
Particle Density	ρ_s	(Mg/m3)	2.58	2.58	2.58

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10	0.10	0.10
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	$\omega_i\%$	(%)	11	11	11
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.86	1.88	1.86
Initial Voids Ratio	e_0	.	0.39	0.37	0.39
Initial Degree of Saturation	S_0	(%)	72	75	73

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	1112.30	3393.46	1884.24
Membrane Correction	m_c	(kPa)	1.113	0.948	1.102
Strain At Max Stress	$\varepsilon_f\%$	(%)	2.75	2.36	3.65
Shear Strength	c_u	(kPa)	556.15	1696.73	942.12
Final Moisture	$\omega_f\%$	(%)	10	10	11
Final Dry Density	ρ_{df}	(Mg/m3)	1.86	1.89	1.85
Final Voids Ratio	e_f	.	0.38	0.37	0.39
Final Degree of Saturation	S_f	(%)	70.2	73.4	73.8

Remarks :

Page: 1 of 2

Form: Triax 3 - UU | Program: Clisp Studio

for MATROLAB GROUP (PTY) LTD.

MATROLAB GROUP (PTY.) LTD.

- CIVIL ENGINEERING SERVICES -

Reg No.: 2003/029180/07 VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park,0184
P.O. BOX 912387 SILVERTON 0127

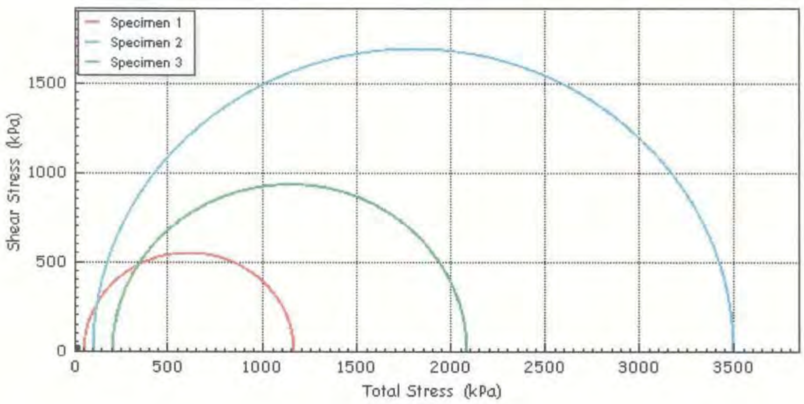
Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

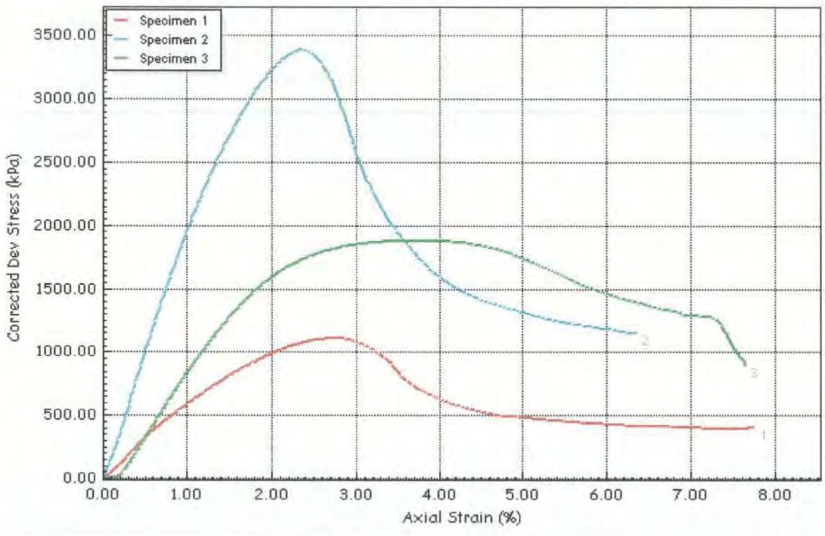
TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16-66	HOLE NO:	TP 20	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



Remarks : Page: 2 of 2

for MATROLAB GROUP (PTY) LTD.

Form: Triax 3 - UU | Program: Clisp Studio

APPENDIX C

Table 1: Correlation chart of maximum bearing stress (allowable bearing capacity) of rocks and soil materials

Category	Types of rocks and soils	Presumed bearing value kPa
Non-cohesive soils	Dense gravel or dense sand and gravel	>600
	Medium dense gravel, or medium dense sand and gravel	<200 to 600
	Loose gravel, or loose sand and gravel	<200
	Compact sand	>300
	Medium dense sand	100 to 300
	Loose sand	<100 *depends on degree of looseness*
Cohesive soils	Very stiff bolder clays & hard clays	300 to 600
	Stiff clays	150 to 300
	Firm clay	75 to 150
	Soft clays and silts	< 75
	Very soft clay	Not applicable
Peat		Not applicable
Made ground		Not applicable

L1-Gamula

SOIL TESTING SERVICES

GEOTECHNICAL REPORT – GAMULA

CONSTRUCTION OF NEW SECONDARY SCHOOLS AND UP-GRADING OF FACILITIES IN EXISTING SECONDARY SCHOOLS AIMED AT PROMOTING INCLUSIVE EDUCATION IN THE KINGDOM OF SWAZILAND

FOR

MATSUDA CONSULTANTS INTERNATIONAL CO. LTD

SOIL TESTING SERVICES

CIVIL ENGINEERING LABORATORY

Lot 321, Samora Machel Street
P.O. Box A233
Swazi Plaza
Mbabane H101
Swaziland

MARCH 2016

TABLE OF CONTENTS

GEOTECHNICAL REPORT – GAMULA

1.0 INTRODUCTION

This report is based on the Preparatory Survey on "the Project for the Construction of New Secondary Schools and Upgrading of Facilities in Existing Secondary Schools aimed at Promoting Inclusive Education" based upon request from the Government of Swaziland to the Japan International Cooperation Agency (JICA). The survey is to obtain geotechnical data and information at Gamula, southeastern Swaziland, where the proposed Gamula High School will be constructed, for the design of earthworks, foundation and structures of the buildings.

2.0 SCOPE OF WORK

The following activities were expected to be executed in the cause of the study.

(1) Field works on each site
- Dynamic Cone Penetration test (DCP)
  Nine (09) points, depth up to Two (02) m from the ground level
- Soil Sampling
- Percolation Test Two (02) points

(2) Laboratory testing (for each sample)
- Triaxial Compression Test
- Moisture Density Test
- Particle Size Analysis
- Atterberg limit test

3.0 SITE DESCRIPTION

Location and Topography

The new school site is located in an area a bit remote of the residential areas of Gamula a few kilometers from Big Bend. The area is currently used as grazing land for the community. During the site investigation there was no grass cover and the main vegetation is thorny shrubs and dry land vegetation.

The topography of the school site is generally defined by a gentle hill slope facing to the west.

Rainfall and Drainage

Gamula receives lies in the Lowveld climatic zone of the country on the leeward side of the Lubombo escarpment. It lies about 170m above sea level and it is a summer rainfall area with rainfall falling between October and March. It experiences least rainfall in Swaziland with an annual average of 400 mm. It is thus semi-arid with dry climate conditions and temperatures range between 15 to more than 40 degrees Celsius in summer.

The hill slope has no scour surface or stream bed. The only water course is to the west beyond the western boundary. This is expected to carry flood water and serves as an ephemeral stream. Source of water is a community water scheme.

Access

The main road running close to the area is the MR8 running between Lavumisa and Big Bend, about 6km from Matata junction. A community road leads from MR8 through the residential areas into a motorable track with no wearing course that serves the community water reservoir. It is expected to offer some challenges during the rainy season with the clayey soil found along the track.

4.0 GENERAL GEOLOGY OF SITE

The site at Gamula is underlain by rhyolitic/rhyodacitic rocks that are interlayered with basalts. No clear *in situ* rocks could be found but the boulders common in the area are pale maroon-brown in colour, but on fresh surfaces are pale reddish or drab green. Randomly oriented insets, usually composed of oligoclase-andesine and orthoclase, are a common feature in the rock. Further, there is augite, titaniferous magnetite and quartz present as coarse-grains set in fine-grained matrix.

The basalt is composed of laths of feldspar and ragged grains of amphibole in which the cores of pyroxene are sometimes present. They may be defined by drab, olive green basalt with small, pea-like amygdales of the Karoo Supergroup. Magnetite is usually abundant and areas of pale green, devitrified basaltic glass are common.

The general structural dip of the Karoo Supergoup is eastwards, and the rocks commonly dip between 25^0 and 35^0. The area within the boundary is unaffected by faulting. However, the western limit of the area suggests a zone of weakness as manifest by the valley.

A scanned and cropped geological map of the area is presented in Appendix A. It is taken from a 1:50 000 geological map sheet 26 (2531 DD) published by the Swaziland Geological Survey Department

5.0 GEOTECHNICAL FIELD INVESTIGATIONS AND LABORATORY TESTING

Methods of Investigation and Testing

Field investigations, sampling and laboratory testing has been designed to provide information as follows:

Trial Pits

Three Trial Pits (TP) were excavated at positions determined by the client with pits attaining some depth of 1.7m using a Tractor Loader Backhoe (TLB), 4x4 capability with 600mm bucket width and flywheel power rating of at least 70kW. The aim of the excavation of the trial pits was to determine the soil stratigraphy, and extraction of soil samples.

All test pits had stable walls and were profiled using profiling standard procedure outlined in the Association of Engineering Geologists (South African Section), 'Guidelines for soil and rock logging in SA" (1990). Representative soil samples were taken from the soil profile for laboratory testing. Bulk samples of the residual soil material were taken; topsoil and sub-soil layers were recorded and are shown in detail in Trial Pit profiles. The stratigraphy revealed by each pit was carefully logged with special notes taken of the thickness and conditions of the various layers.

Dynamic Cone Penetration Test (DCP)

Dynamic Cone Penetrometer (DCP) tests were conducted at 9 positions around the site. The exact locations of all DCP tests carried out were performed at positions determined by Matsuda Consultants International Co., Ltd.

Prior to the performance of a series of tests, the zero reading of the penetrometer was determined. The dynamic penetrometer tests were then performed by taking readings of cone penetration after a number of blows depending on the consistency of the layer being penetrated. The tests were terminated at maximum depths of 2000mm wherever possible.

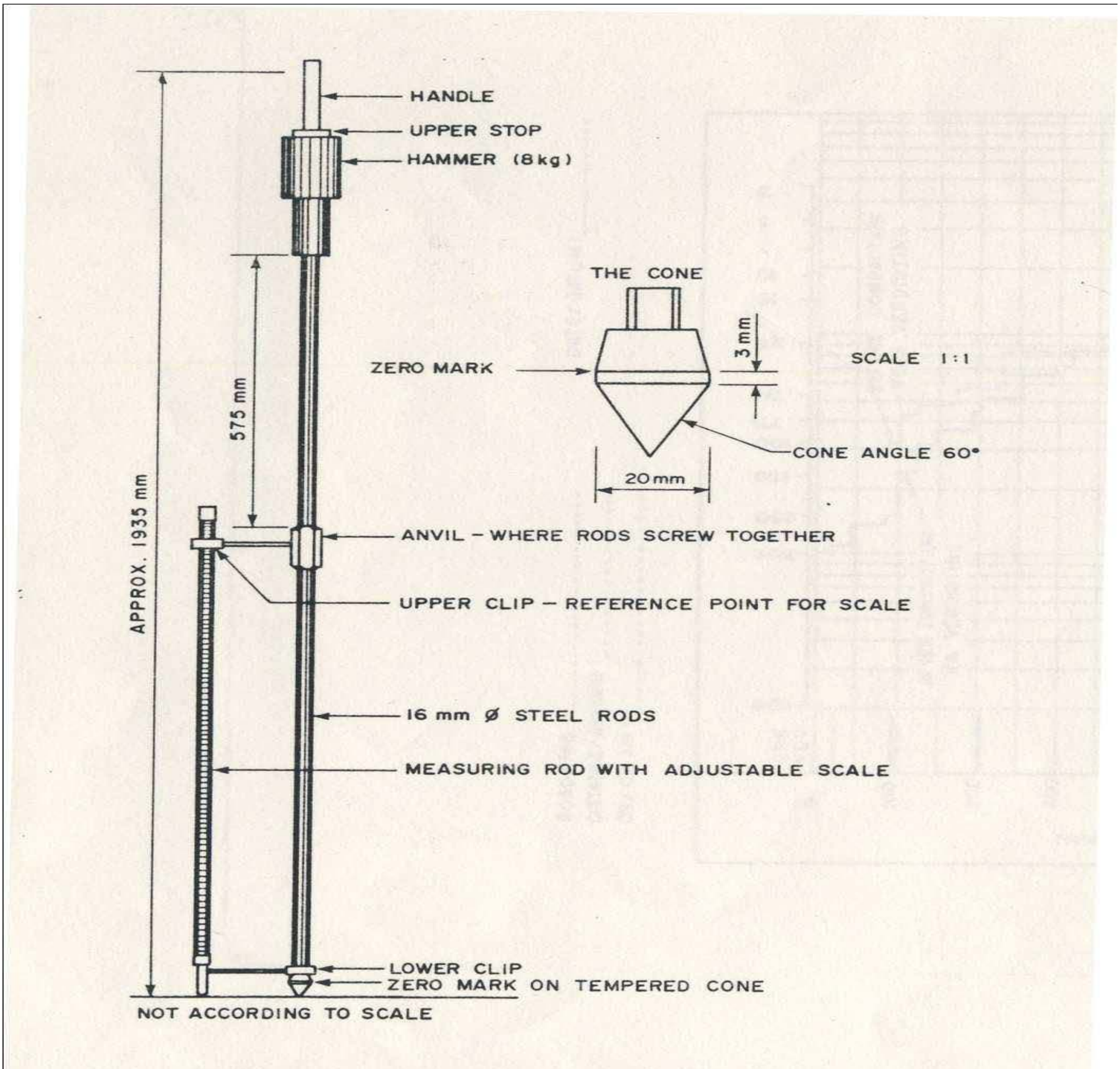


FIGURE ST6/I THE DYNAMIC CONE PENETROMETER

Percolation Test

The percolation test consist of digging a 300 mm diameter hole to the stratum for which information is required, cleaning and backfilling the bottom with coarse sand or gravel, filling the hole with water and providing a soaking period of sufficient length to achieve saturation. During the soaking period, water is added as necessary to prevent loss of all water. The percolation rate is then obtained by filling the hole to a prescribed water level and measuring the drop in water level over a set time. The times required for soaking and for measuring the percolation rate vary with the soil type.

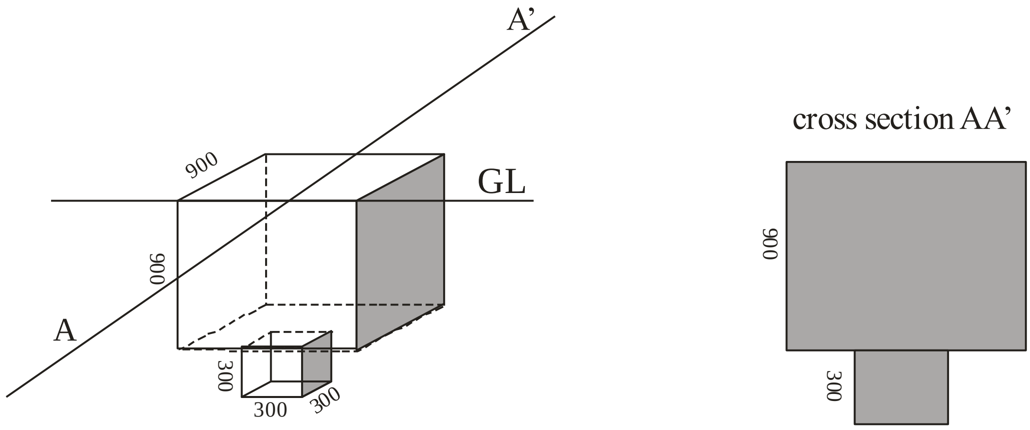


Figure 2. Cross section of percolation test pit

Laboratory Testing

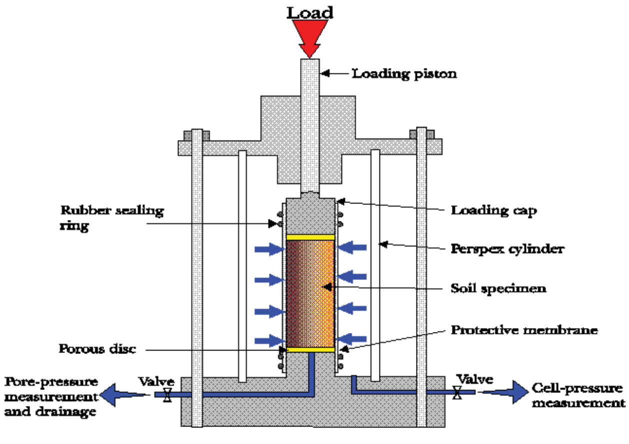
Laboratory tests were performed by Soil Testing Services (Pty) Ltd in Mbabane. As specified by Matsuda Consultants International Co., Ltd this testing comprised of foundation indicator testing only.

The following laboratory tests were executed for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)

Stress Triaxial Stress Tests: Unconsolidated - Undrained (BS 1377-7:1990 Clause 7)

Stress Triaxial Stress Tests were conducted at Metrolab Group, Republic of South Africa according to the standard BS 1377-7:1990 Clause 7. This involved subjecting a cylindrical soil sample to radial stresses (confining pressure) and controlled increases in axial stresses or axial displacements. The cylindrical soil specimen was of ~50mm diameter and ~100mm height dimension. As this is cohesive soil samples were prepared directly from saturated compacted samples, either undisturbed or remolded. The specimen was vertically enclosed with a thin rubber membrane and placed between two rigid ends inside a pressure chamber. The upper plate can move vertically and apply vertical stresses to the specimen. The axial strain/stress of the sample is controlled through the movement of this vertical axis. Also, the confining pressure is controlled by the water pressure surrounding the sample in the pressure chamber. The volume change of the sample is also controlled by measuring the exact volume of moving water.



Triaxial apparatus

6.0 INTERPRETIVE INFORMATION

Site stratigraphy

The stratigraphy of the Gamula High School site can be summarized as colluvial and residual soils. Colluvial soils on the site generally consist of about 500mm thick layer of very dry dark brown topsoil. This is gravity transported soil. At TP 162 another layer of about 600mm defines the lower limit of colluvial soils, and consists of very dry, very dense, sandy clay. It is pale red in colour.

Colluvial soils directly overly residual soils that are derived from moderately weathered rhyolitic/rhyodacitic rock. This soil is dry, very dense, course gravel and the material displays lateral variation in colour from dark reddish brown to light brown.

Materials

The table below summarizes some of the laboratory test results and the complete test results are presented in Appendix B

Test Pit No.	Sample no & depth(m)	Horizon	O.M.C%	LL	PI	Shrinkage	Soil Class AASHTO
162	1.2-1.7	Residual rhyolite	12.6	42	17	4.5	A-2-7(0)
163	1.0-1.5	Residual rhyolite	8.1	21	10	0.0	A-2-7(0)
164	0.5-1.6	Residual rhyolite	9.8	45	20	6.0	A-2-7(0)

Engineering Geological Evaluation

Groundwater

Groundwater inflow was not encountered in any of the excavated test pits. It is, generally, not expected to find groundwater at shallow levels on rhyolites as they are not good aquifers. Water strikes are known at great depth.

Expansive soils

No soils susceptible to swelling or heaving were encountered on site, and problematic movements associated with expansion are not expected.

From the Foundation Indicator tests carried out all the horizons tested displayed a “low” to “medium” potential for expansiveness classification.

Potentially Collapsible Soils

The soil horizons encountered are not considered to be collapsing in nature. It is, therefore, not anticipated that any special precautions will need to be taken with regard to collapsible soils.

Percolation Rate

The soils in this area are suitable for a normal French drain. Both percolation tests positions displays good seepage and as such are suitable for normal French drain development.

Bearing Capacity

The laboratory triaxial compression tests the Boyane High School site with unconsolidated undrained (UU) shear strength (c_u) of between 987kPa and 1389kPa display allowable bearing capacity of between an estimated 1691kPa and 2380kPa. Based on the correlation chart (Appendix C) of maximum bearing stress that can be applied to the foundation such that it is safe against instability due to shear failure the site’s allowable bearing capacity is highly safe for building development.

From the field Dynamic Cone Penetrometer (DCP) tests, for most of the tests it, also, reveals safe bearing capacities by the very course gravel, well above the 79kPa for single story buildings. No certain precautions need to be taken during designing the foundation.

The residual soil is relatively homogenous, and is marked by coarse gravel at variable depths. There buildings will have to be founded at depths of 800 to 1000mm and the common shallow refusals at this area suggest that excavations have to be performed mechanically.

Excavatibility

Trial Pit 163 experienced excavation refusal whereas the other two did not. DCP on the other hand experienced refusals at ca.400mm. This indicates that during excavations for foundations it could be difficult to achieve depths beyond 500mm by hand digging. No instabilities were recorded during the excavation of the test pits which further suggests that excavations may safely be conducted without the need for lateral support, if of a temporary nature (during construction) and in the dry season.

Seismicity

One type of seismic activities occurs in Swaziland, and that is natural seismic activity. There is no mining-induced seismic activity. In accordance with the Seismic Hazard Zone map contained in the draft SANS 10160-4, southern Swaziland is classified as Zone 1 and is subject to natural seismic activity only. Gamula area is to the east-central part of Swaziland and as such falls outside this area. The South African "loading" code, SABS 0160-4:2011, shows that Gamula is situated in an area where the peak ground acceleration with a 10% probability of being exceeded in a 50 year period is just less than 100 cm/sec^2.

The soil profile of the site can be described as very dense, course to very course gravel with average shear strength between 987kPa and 1389kPa c_u. The area can be identified as Ground Type2. A v_s profile at the site is, however, "the most reliable predictor of the site dependent characteristics of the seismic action at stable sites", and is lacking to conclusively predicts the ground seismicity.

7.0 CONCLUSION AND RECOMMENDATIONS

- The absence of rock outcrop on the site suggests that bedrock will only be present at depth. The bedrock surface is likely to be undulatory and, therefore, highly variable in depth.
- No special precaution has to be taken with regards to dampness as no water seepage was experienced in any of the Trial Pits.

- The soils are of intermediate plasticity and it is expected that they will be prone to erosion. Precaution is expected to be taken during site clearing to avoid excessive soil erosion.

Building Foundations

The sandy clay in the site has a far more safe allowable bearing capacity and can support any building development of 2380kPa whereas the gravels are at 1691kPa.

It is recommended that foundations be placed on the residual soil, at depths of 800 to 100mm, to avoid the colluvial soil material.

From the Foundation Indicator tests carried out all the horizons tested displayed a "low" to "medium" potential for expansiveness classification. As the soils are not susceptible to swelling or heaving it is not expected that significant swell-shrink movement of the footing will occur, and it is recommended that foundations be placed on the residual soil at any desirable depth.

Despite the low expansive potential of the soils it is worth taking the following precautions:

- Attention to proper site drainage and storm water runoff management is essential to prevent ponding of water near structures.
- Water supply pipes and sewers must be maintained and leaks or blockages timeously detected and repaired.
- No water loving vegetation or large trees may be allowed to grow within 15m of any structure and it is not recommended to allow gardening directly around the structures. Instead concrete aprons should be installed to prevent wetting of foundations.

Parking Areas and Roadways

The material quality at surface display a good bearing capacity from DCP analyses and for the construction of parking and roadways can easily be stabilized and paved. It can be used for subgrade material as well as in the formation (fill) required for roads. It is recommended that material for pavements layers required for road works be imported from outside the site.

NOTE:

- Additional investigations or at least an assessment of the ground conditions exposed during construction can often result in significant construction cost and time savings.

GENERAL NOTES ON THE REPORT

The information and recommendations contained within this report relate to data supplied by Soil Testing Services, comprising test pit profiles, DCP penetration data, soil percolation test results and soil grading tests.

The report has been compiled on the assumption that all the data supplied by Soil Testing Services (and the assumptions made in this report where this supplied data is inadequate) is correct and is generally representative of the site area.

Prepared for Geo Solutions

NOAH NHLEKO
BSc (Biology & Chemistry); PhD Geology

APPENDIX A

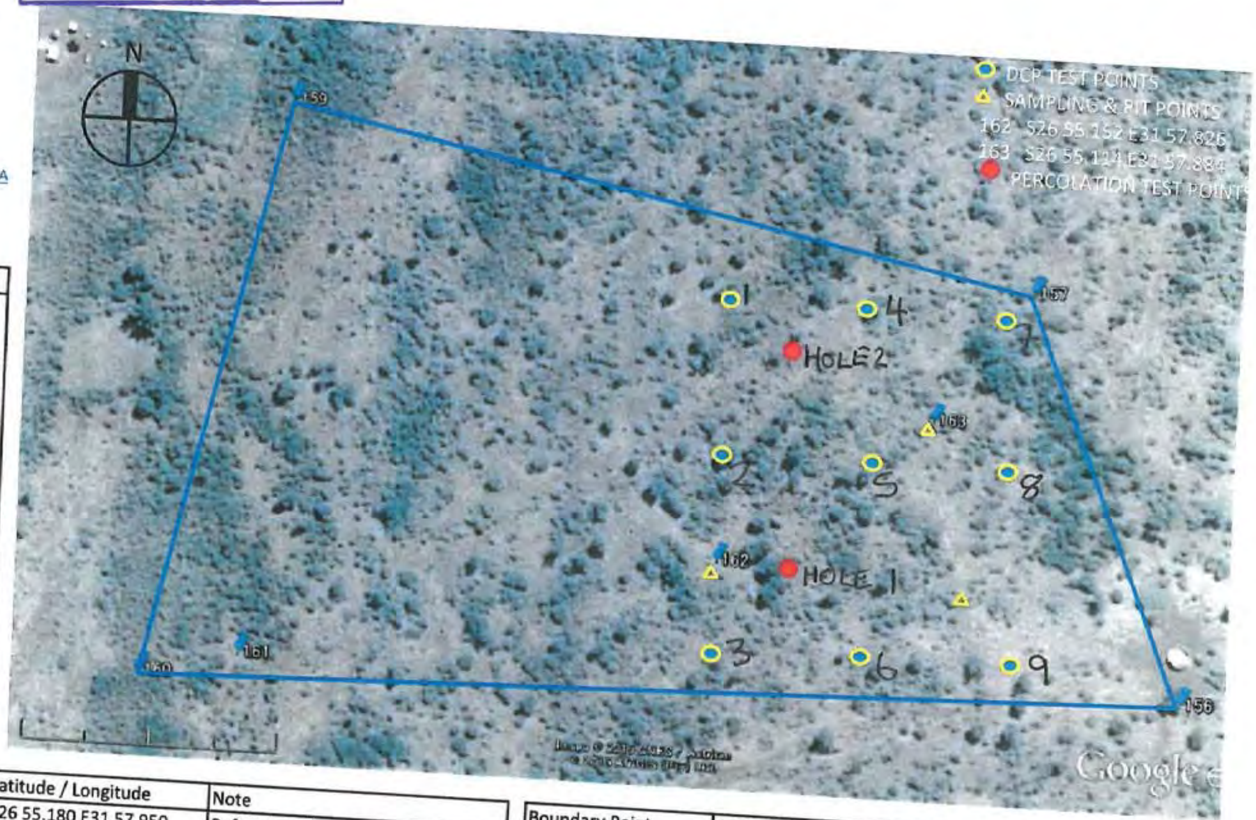
A) Tractor Loader Backhoe (TLB)

B) Typical Trial Pit

SOIL TESTING SERVICES
(SWAZILAND) (PTY) LTD
P.O. BOX A233, SWAZI PLAZA
TEL: 404 1956, 404 2227
SOIL LABORATORY

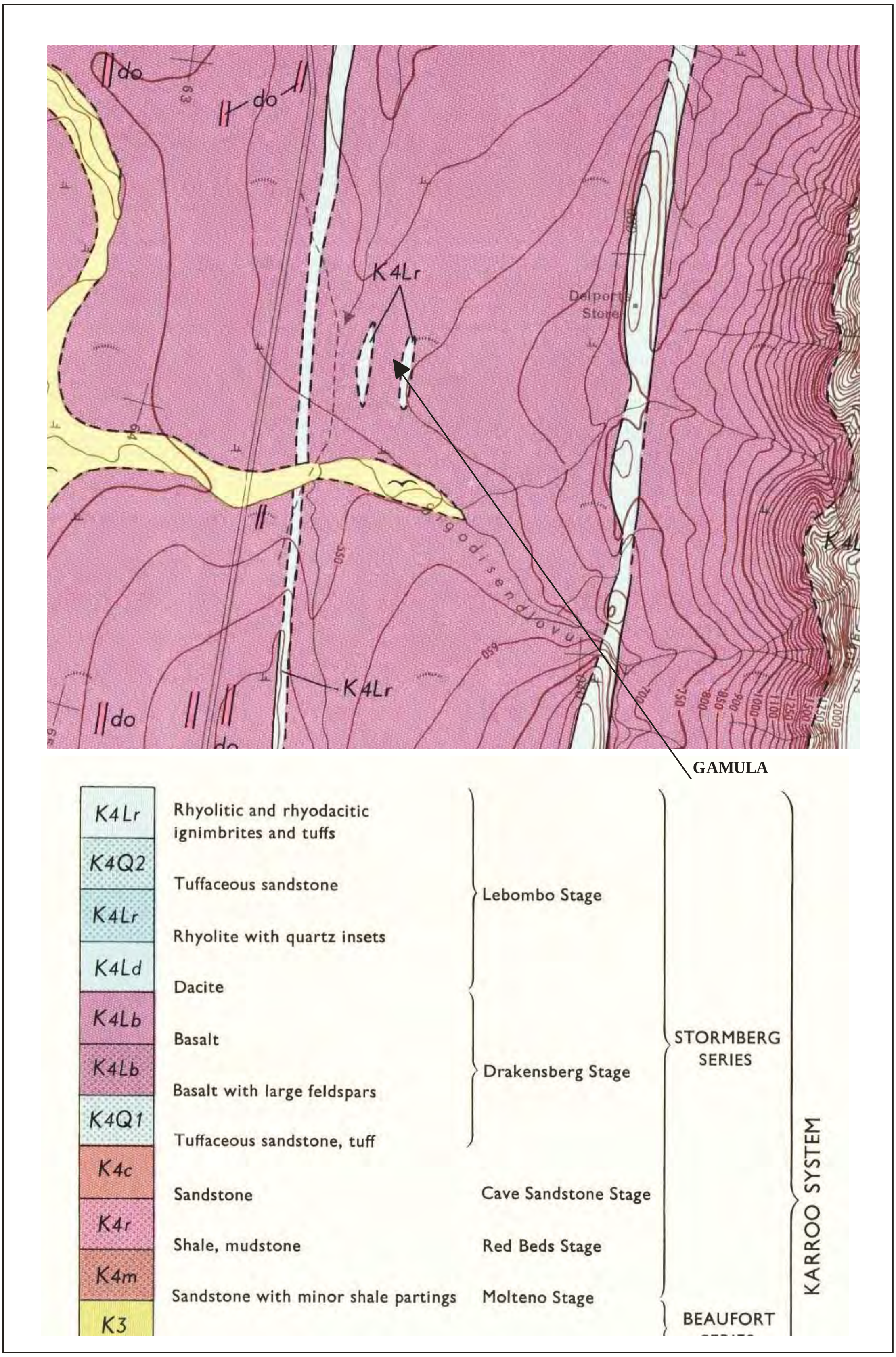
Site Name :
L1
GAMULA
Region :
Lumbobo
Contact Person
Mr. MBONGENI NDZINISA
Cel: 7621 3156

Other information
The bounday of the site is indicated by blue line. All boundary points have been staked by white painted timbers. If you contact to the person mentioned above, they show you the boundary points. While the japanese consultant team inspected two pit (No. 162 and 163), the Surveyor should excavete three pits indicated in the map.



Boundary Point	Latitude / Longitude	Note
156	S26 55.180 E31 57.950	Reference of boundary point
157	S26 55.080 E31 57.911	Ditto
159	S26 55.039 E31 57.700	Ditto
160	S26 55.187 E31 57.670	Ditto

Boundary Point	Latitude / Longitude	Note


do
K4Lr
Delports Store
GAMULA
K4Lr — Rhyolitic and rhyodacitic ignimbrites and tuffs
K4Q2 — Tuffaceous sandstone
K4Lr — Rhyolite with quartz insets
K4Ld — Dacite
Lebombo Stage
K4Lb — Basalt
K4Lb — Basalt with large feldspars
K4Q1 — Tuffaceous sandstone, tuff
Drakensberg Stage
K4c — Sandstone — Cave Sandstone Stage
K4r — Shale, mudstone — Red Beds Stage
K4m — Sandstone with minor shale partings — Molteno Stage
STORMBERG SERIES
K3
BEAUFORT
KARROO SYSTEM

APPENDIX B

Project	Trial Pit No.	Location	Date
Matsuda	TP 162	Gamula	30/11/2015

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	540	0-540		dark brown		very dry
	sandy clay	630	540-1170		pale red	very dense	Very dry
	coarse gravel, Moderately weathered rock, rhyodaciti/rhyolitic rock	530	1170-1700		light brown	very dense	Very dry

Project	Trial Pit No.	Location	Date
Matsuda	TP 163	Gamula	30/11/2015

Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	500	0-500		dark brown		very dry
	very course gravel, Moderately weathered rock, rhyodacitic/rhyolitic rock REFUSAL	530	500-1030		dark reddish brown		Dry

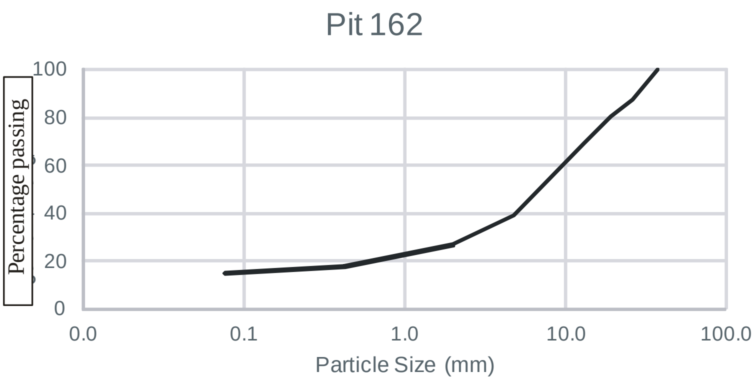
Project	Trial Pit No.	Location	Date
Matsuda Consultant Co. Ltd	TP 164	Gamula	30/11/2015

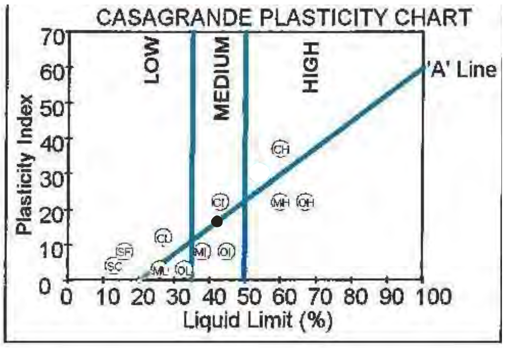
Material and Soil Description

Layer	Stratigraphy	Thickness mm	Depth mm	Layer scheme	Color	Consistency	Moisture
Soil Horizon	Topsoil	440	0-440		dark brown		very dry
	very coarse gravel, Moderately weathered rock, rhyodaciti/rhyolitic rock	760	440-1600		dark reddish brown	very dense	Very dry

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 162	Date	
Project	Gamula High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	100
26.5	87
19.0	80
13.2	69
4.75	39
2.00	27
0.425	18
0.075	15



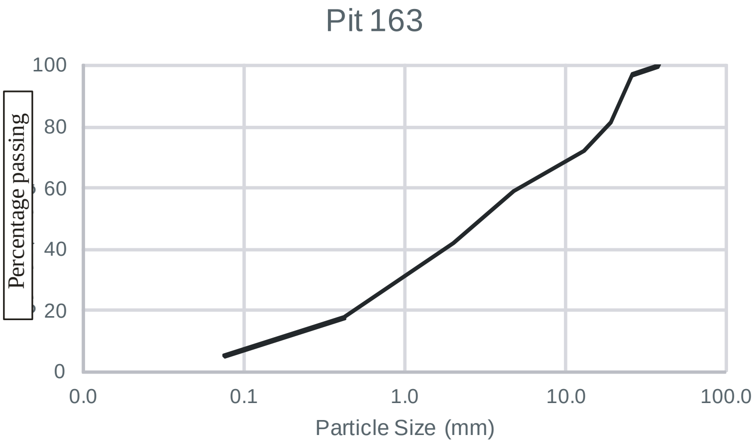


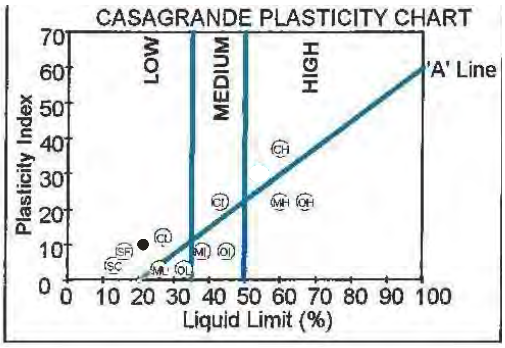
ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	42
Plastic Index (PI)	17
Linear Shrinkage	4.5
Grading Modulus	2.4
Natural Moisture Content	12.6
PI of whole sample	
AASTHO Classification	A-2-7(0)
TRH 14	

FOUNDATION INDICATOR RESULTS					
Client	Matsuda Consultants International	Sample no.	T.P. 163	Date	
Project	Gamula High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	
37.5	100
26.5	97
19.0	81
13.2	72
4.75	59
2.00	42
0.425	18
0.075	5





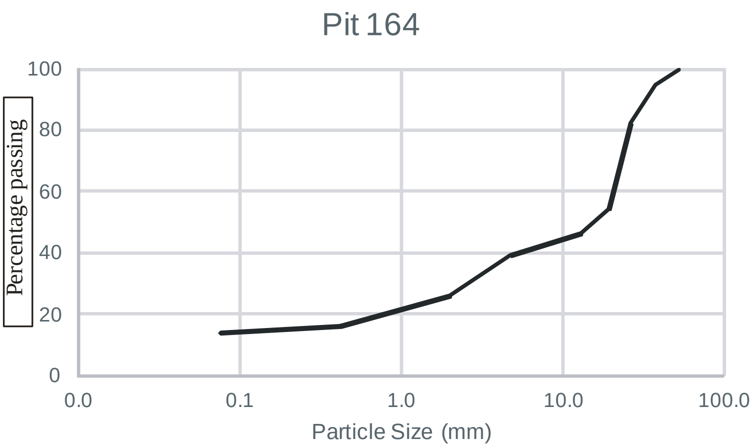
ATTERBERG LIMITS AND OTHER RESULTS

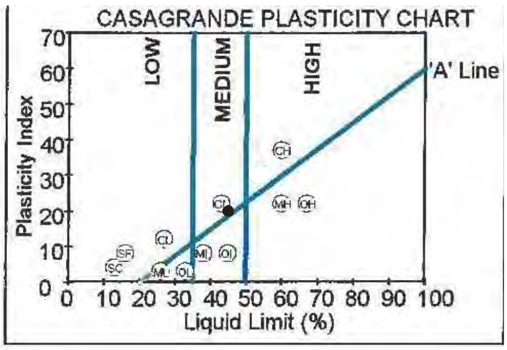
Liquid Limit (LL)	21
Plastic Index (PI)	10
Linear Shrinkage	0.0
Grading Modulus	2.35
Natural Moisture Content	8.1
PI of whole sample	
AASTHO Classification	A-2-4(0)
TRH 14	

FOUNDATION INDICATOR RESULTS

Client	Matsuda Consultants International	Sample no.	T.P. 164	Date	
Project	Gamula High School	Sample Depth		Client	

sieve size mm	Percentage passing
75	
53.0	100
37.5	95
26.5	82
19.0	54
13.2	46
4.75	39
2.00	26
0.425	16
0.075	14





ATTERBERG LIMITS AND OTHER RESULTS

Liquid Limit (LL)	45
Plastic Index (PI)	20
Linear Shrinkage	6.0
Grading Modulus	2.44
Natural Moisture Content	9.8
PI of whole sample	
AASTHO Classification	A-2-4(0)
TRH 14	

SOIL TESTING SERVICES
MATSUDA CONSUNTANTS INTERNATIONAL
GAMULA NEW HIGH SCHOOL
DCP TEST RESULTS

2/1/2016

DCP (1) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	29	3	1701
200	21	5	1118
380	25	7	653
REFUSAL			

DCP (2) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	15	7	721
200	23	4	1258
300	25	4	1402
480	30	6	771
REFUSAL			

DCP (3) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	7	14	268
200	15	7	721
300	25	4	1402
380	28	1	5353
REFUSAL			

DCP (4) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	12	8	540
200	19	5	901
300	25	4	1402
400	25	4	1402
450	29	2	3630
REFUSAL			

DCP (5) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	2	50	52
200	120	1	10793
300	29	3	1701
420	30	4	1402
REFUSAL			

DCP (6) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	8	17	219
200	20	5	1040
300	75	4	1402
320	25	1	11302
REFUSAL			

DCP (7) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	3	33	85
200	14	7	660
300	26	4	1476
430	29	4	1209
REFUSAL			

DCP (8) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	8	17	219
200	25	4	1402
300	76	4	1470
390	30	3	2030
REFUSAL			

DCP (9) NGL

Depth (mm)	No. Blows	mm/blows	kPa
0	0		
100	9	11	371
200	20	5	1040
300	29	3	1701
400	30	3	1770
410	29	0	34019
REFUSAL			

SOIL TESTING SERVICES
(SWAZILAND) (PTY) LTD
BOX A233, SWAZI PLAZA
TEL: 404 1956, 404 2227
SOIL LABORATORY

MATROLAB GROUP (PTY.) LTD.

- CIVIL ENGINEERING SERVICES -

Reg No.: 2003/029180/07 VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park,0184
P.O. BOX 912387 SILVERTON 0127

Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd
ADDRESS:	P.O. Box A233
	Swazi Plaza
Attention:	Thulani Vilakati

Project	Japanese Schools
	Gamula
Your Ref	
Our Ref	117 626
Date Reported	15 March 2016

TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_64	HOLE NO:	TP163	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	100.6	98.9	100.5
Initial Sample Diameter	D_0	(mm)	49.7	50.0	49.9
Initial Sample Weight	W_0	(gr)	379.5	379.5	380.1
Initial Bulk Density	ρ_0	(Mg/m3)	1.94	1.95	1.93
Particle Density	ρ_s	(Mg/m3)	2.48	2.48	2.48

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.07500	0.07500	0.07500
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	ω_i%	(%)	9.00	9.00	9.00
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.78	1.79	1.77
Initial Voids Ratio	e_0	.	0.39	0.38	0.40
Initial Degree of Saturation	S_o	(%)	57	58	56

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	2244.08	2491.46	3600.38
Membrane Correction	m_c	(kPa)	1.012	1.089	1.020
Strain At Max Stress	ε_f%	(%)	2.80	3.51	2.90
Shear Strength	c_u	(kPa)	1122.04	1245.73	1800.19
Final Moisture	ω_f%	(%)	9.10	8.98	9.09
Final Dry Density	ρ_{df}	(Mg/m3)	1.78	1.79	1.77
Final Voids Ratio	e_f	.	0.39	0.38	0.40
Final Degree of Saturation	S_f	(%)	57.6	58.1	56.4

Remarks :

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for MATROLAB GROUP (PTY) LTD.

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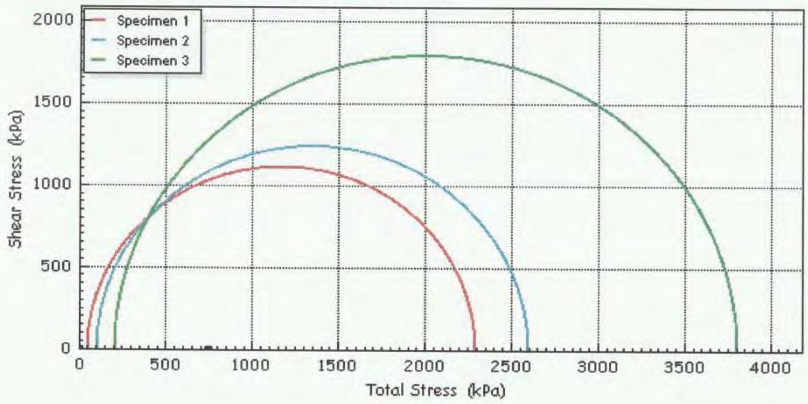
TEST RESULTS

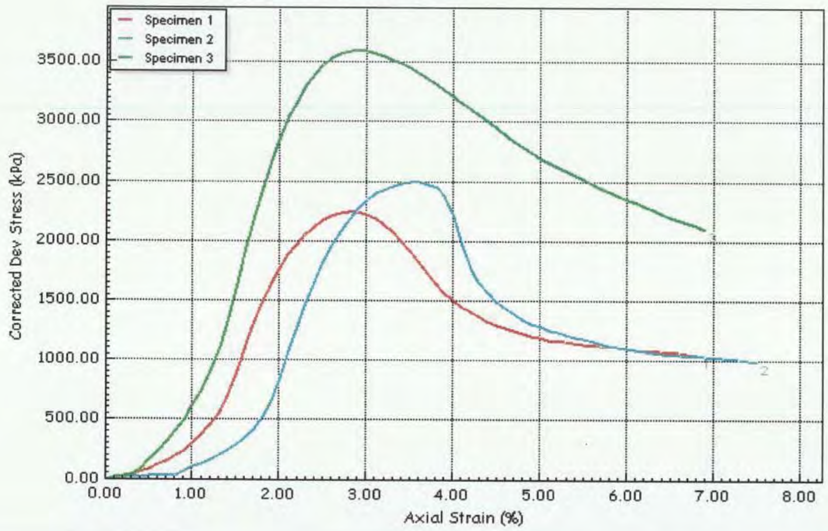
TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 64	HOLE NO:	TP163	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



Remarks :

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Tel. : 012-800 1299
Fax. : 012-800 3034
Email : aukek@matrolab.co.za

TEST RESULTS

CLIENT:	Soil Testing Services SWD (PTY) Ltd	Project	Japanese Schools
ADDRESS:	P.O. Box A233		Gamula
	Swazi Plaza	Your Ref	
		Our Ref	117 626
Attention:	Thulani Vilakati	Date Reported	14 March 2016

TOTAL STRESS TRIAXIAL TEST:
UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16_65	HOLE NO:	TP 164	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Specimen Details			1	2	3
Initial Sample Length	L_0	(mm)	101.1	100.9	100.8
Initial Sample Diameter	D_0	(mm)	50.3	50.1	50.3
Initial Sample Weight	W_0	(gr)	433.1	434.3	434.6
Initial Bulk Density	ρ_0	(Mg/m3)	2.16	2.18	2.17
Particle Density	ρ_s	(Mg/m3)	2.58	2.58	2.58

Initial Conditions			1	2	3
Initial Cell Pressure	σ_3	(kPa)	50	100	200
Strain Rate	m_s	(mm/min)	0.10000	0.10000	0.10000
Membrane Thickness	m_b	(mm)	0.30	0.30	0.30
Initial Moisture	$\omega_i\%$	(%)	9.80	9.80	9.80
Initial Dry Density	ρ_{d0}	(Mg/m3)	1.96	1.99	1.98
Initial Voids Ratio	e_0	.	0.31	0.30	0.31
Initial Degree of Saturation	S_0	(%)	81	85	83

Final Conditions			1	2	3
Max Deviator Stress	$(\sigma_1-\sigma_3)_f$	(kPa)	1586.62	1806.30	2528.12
Membrane Correction	m_c	(kPa)	1.053	0.884	0.923
Strain At Max Stress	$\varepsilon_f\%$	(%)	2.25	1.83	2.17
Shear Strength	c_u	(kPa)	793.31	903.15	1264.06
Final Moisture	$\omega_f\%$	(%)	9.90	10	9.94
Final Dry Density	ρ_{df}	(Mg/m3)	1.96	1.98	1.97
Final Voids Ratio	e_f	.	0.32	0.30	0.31
Final Degree of Saturation	S_f	(%)	81.0	86.7	83.6

Remarks :

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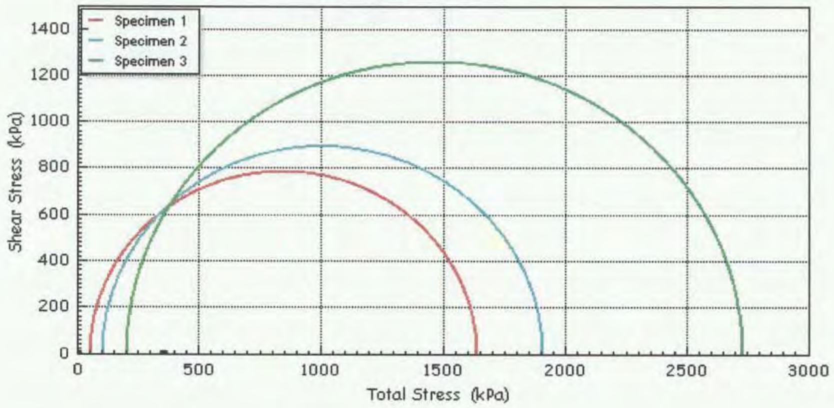
TEST RESULTS

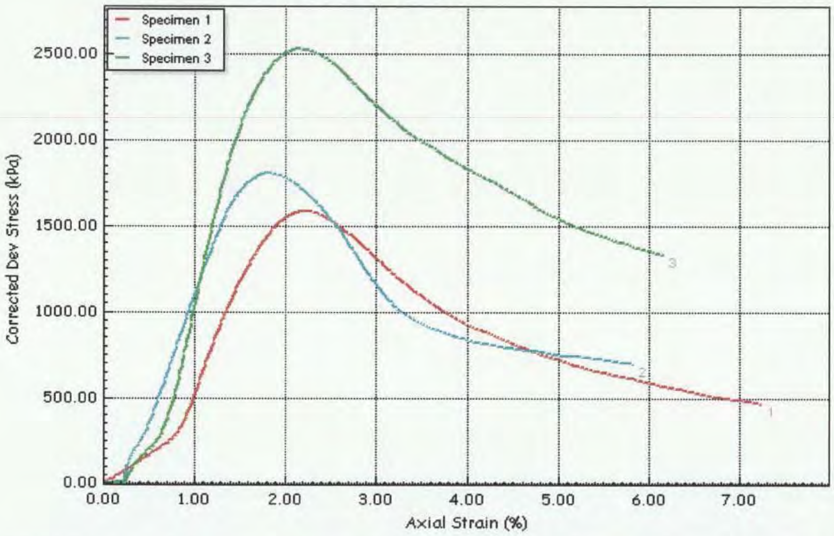
TOTAL STRESS TRIAXIAL TEST: UNCONSOLIDATED UNDRAINED (BS1377-7 : 1990 : Clause 7)

SAMPLE NO.	G16 65	HOLE NO:	TP 164	DEPTH (m):		JOB NO:	117 626
DESCRIPTION:							

Total Stress Mohr Circle



Stress Strain Graph



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Results only have bearing on the samples tested.
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APPENDIX C

Table 1: Correlation chart of maximum bearing stress (allowable bearing capacity) of rocks and soil materials

Category	Types of rocks and soils	Bearing value (kPa)
Non-cohesive soils	Dense gravel or dense sand and gravel	>600
	Medium dense gravel, or medium dense sand and gravel	<200 to 600
	Loose gravel, or loose sand and gravel	<200
	Compact sand	>300
	Medium dense sand	100 to 300
	Loose sand	<100 *depends on degree of looseness*
Cohesive soils	Very stiff bolder clays & hard clays	300 to 600
	Stiff clays	150 to 300
	Firm clay	75 to 150
	Soft clays and silts	< 75
	Very soft clay	Not applicable
Peat		Not applicable
Made ground		Not applicable