4-4 TECHNICAL NOTES (Field Survey I)

The Preparatory Survey for the Project
for the Upgrading and the Construction of Secondary Schools
aimed at promoting Inclusive Education in Lesotho

Technical Notes

Based on the Minutes of Discussions signed between the Ministry of Education and Training (hereinafter referred to as "MOET") and the Japan International Cooperation Agency on November 12, 2015, the Preparatory Survey Team (hereinafter referred to as "the Team") conducted the site survey and summarized the results in this technical note. Both sides confirmed the items described below. It was confirmed that the Team will further assess the appropriateness of the components and the scale of the facilities, and the number of target sites, then final components and the scale of the facilities and equipment will be determined and finalized based on the result of the study in Japan and the budget limitation of the Government of Japan.

1. Candidate sites for the Project

1) MOET proposed Mohale's Hoek at Mohale's Hoek district as the alternative site of Letlapeng at Mohale's Hoek district that was excluded from the list through the discussion during December 9-13, 2015. The Team agreed with this proposal from MOET and conducted the survey on that site.

2) The Team reported that three of new sites (N4 Matsolong/Matsoaing, N5 Nkoeng, and N7 Linakeng Ha Mothuntsane) are located under steeply inclined land shape which will be a hindrance to construction of barrier-free facility to implement inclusive education. As land shape is one of the selection criteria, further study in Japan is necessary in this regard. Final candidate sites and prioritized order for the Project are as shown in the table below.

	Code	Site	District
Priority-A (Existing Sites)			
	E1	Abia	Maseru
	E2	Motsekuoa	Mafeteng
	E3	Mt. Royal	Leribe
	E4	St.Catherune	Maseru
	E5	Masenate	Leribe
Priority-B (New Sites, by prioritized order)			
1	N8	Mohale's Hoek	Mohale's Hoek
2	N2	Mosalemane	Berea
3	N1	Ha Sebaki	Mafeteng
4	N6	Matobe	Leribe

G MIC

5	N4	Matsolong/Matsoaing	Butha-Buthe
6	N5	Nkoeng	Leribe
7	N7	Linakeng Ha Mothuntsane	Butha-Buthe

2. Project components and priority

The Team confirmed final components and priorities for the Project requested by Lesotho side as shown in ANNEX-1 and 2. Care Centre for St.Catherine and Resource room for other schools are added as component items.

Component items which described as B in the Minutes of Discussions have been studied through the survey and those items are revised as A (confirmed necessary) or B (confirmed necessary but to be studied further) or C (out of the scope of the Project as the schools have existing and usable facilities).

The followings are the results of discussions between MOET and the Team.

- Both sides confirmed that the number of beds in boarding facilities will be equivalent with 10 to 15 % of the total number of students, and the size of the schools is to be more than 2 streams for appropriate operation of the boarding facilities.

3. Basic concept for design/layout of facilities

This Project is to construct secondary schools accessible to children with disabilities. Thus, barrier-free facilities will be embedded as a basic concept of design/layout in the Project (e.g. Ramps, pass ways, and toilets accessible to children with disabilities as well as other user-friendly devices). Barrier-free design items will be considered through the study according to the conditions of each target school site.

4. Soft-Component

MOET submitted the request for the Soft-Component programme to the Team. Both sides confirmed that the programme will be studied and determined in Japan.

5. Environmental clearance

The Team confirmed that MOET will submit the application form for environmental clearance to the Department of Environment by 15th of December, 2015.

ANNEX-1 List of facility components and priorities for the Project

ANNEX-2 List of equipment and its priorities

Maseru, Lesotho
November 30, 2015

Mapaseka Kolotsane
Principal Secretary
Ministry of Education and Training
Kingdom of Lesotho

MINISTRY OF EDUCATION
PRINCIPAL SECRETARY
30 NOV 2015
P.O. BOX 47, MASERU 100
TEL.: 22 323956

Hiroyuki Iguchi
Chief of Consultant
Preparatory Survey Team
Japan International Cooperation Agency

ANNEX-1 List of facility components and priorities for the Project

Sites	Classroom (no. of rooms)	Science-Laboratory	ICT Room	Administration Block	Teacher/Staff House (no. of houses)	Boarding Facilities	Dining Hall	Kitchen	Toilet Block	Care Centre*1	Resource Room*2	Improvement of accessibility in the premises*3
Existing Sites												
E1 Abia	A(5)	A	A	C	A(1)	A	A	B	A	-	B	A
E2 Motsekuoa	A(10)	A	A	A	A(1)	A	B	B	A	-	B	A
E3 Mt. Royal	C	C	C	C	A(1)	A	B	B	A	-	B	A
E4 St.Catherine	B(2)	C	C	A	A(1)	C	C	C	A	A	-	A
E5 Masenate	under study											
New Sites												
N8 Mohale's Hoek	A(10)	A	A	A	A(4)	A	A	A	A	-	B	
N2 Mosalemane												
N1 Ha Sebaki												
N6 Matobe	A(5)											
N4 Matsolong/Matsoaing												
N5 Nkoeng												
N7 Linakeng Ha Mothuntsane												

Remarks

A: Confirmed Necessary (First priority)

B: Confirmed Necessary but to be studied further (Second priority)

C: Out of the scope of the Project

*1 This means re-construction of 'CATCH CENTRE' in the St.Catherine, a facility especially for children with visual impairment.

*2 Resource Room is to accommodate several types of children with disabilities

*3 Items vary depending on the site conditions at each existing school site.

ANNEX-2 List of equipment and its priorities

No. of equipment	Equipment Name	Q'ty	Priority(*1)
E1:Abia High School (No.234014)			
AB-1	Adjustable table	35	A
AB-2	Mat	1	A
AB-3	Walking frame set	1	A
AB-4	Balance ball	1	A
AB-5	Parallel bars	1	A
AB-6	Cushion for stretching set	1	A
AB-7	Electronic scale	10	A
AB-8	Microscope	10	A
AB-9	Skeleton model	2	A
AB-10	Electric sewing machine	30	A
AB-11	Electronic stove with oven	4	A
AB-12	Refrigerator	1	A
AB-13	Adjustable ironing board	2	A
AB-14	Laptop PC	1	B
AB-15	Desktop PC	5	C
AB-16	Mini lathe machine	1	C
AB-17	Volleyball set	1	C
E2:Motsekuoa High School (No.235004)			
MO-1	Adjustable table	30	A
MO-2	Mat	1	A
MO-3	Walking frame set	1	A
MO-4	Balance ball	1	A
MO-5	Parallel bars	1	A
MO-6	Cushion for stretching set	1	A
MO-7	Wheel chair	10	A
MO-8	Microscope	3	A
MO-9	Ripple tank	1	A
MO-10	Oscilloscope set	1	A
MO-11	Van Der graff generator	1	A
MO-12	Electric sewing machine	20	A
MO-13	Electronic stove with oven	1	A
MO-14	Gas stove with oven	1	A
MO-15	Refrigerator with slide door	1	A
MO-16	Projector	1	C
MO-17	Laptop PC	1	C
MO-18	Screen for projector	1	C
MO-19	Desktop PC	10	C
MO-20	Desktop PC Desk	10	C
MO-21	Desktop PC Chair	10	C
E3:Mt. Royal High School (No.232009)			
MR-1	Projector	4	A
MR-2	Screen for projector	4	A
MR-3	Copy Machine	1	A
MR-4	Chair for sign language interpreter	6	A
MR-5	Desktop PC	20	A
MR-6	Desktop PC Desk	20	A
MR-7	Desktop PC Chair	20	A
MR-8	Microscope	6	A
MR-9	Laptop PC	4	B
MR-10	Thicknesser	1	C
MR-11	Printer	1	C
E4:St. Catharine High School (No. 244002)			
SC-1	Desktop PC with software for visual impairment	6	A
SC-2	Desktop PC Desk for 2 persons	3	A
SC-3	Desktop PC Chair	3	A
SC-4	Electrical perkins brailler	5	A

SC-5	Embossed world map	1	A
SC-6	Slates and stylus set	10	A
SC-7	Graphics printer	1	A
SC-8	Zyfuse heater	1	A
SC-9	Large print keyboard	10	A
SC-10	Talking measuring scale	5	A
SC-11	Talking calculator	10	A
SC-12	Mount button machine	1	A
SC-13	Item identification device with voice	10	A
SC-14	Braille display	2	A
SC-15	Portable braille display	2	A
SC-16	Integrated desk and chair	30	A
SC-17	Engrave machine	1	A
SC-18	Voice recorder	10	A
E5:Masenate High School (No. 202013)			
under study			
New School Site (*2)			
NE-1	Merlin magnifier	3	A
NE-2	Reading stand	3	A
NE-3	Voice recorder	1	A
NE-4	Projector	1	A
NE-5	Screen for projector	1	A
NE-6	Photocopy machine	1	A
NE-7	Adjustable table	5	A
NE-8	Desktop PC	45	A
NE-9	Desktop PC Desk	45	A
NE-10	Desktop PC Chair	45	A
NE-11	Printer	2	A
NE-12	Laptop pc	1	B
NE-13	Desktop PC with software for visual impairment	3	C
NE-14	Desktop PC Desk for visual impairment	3	C
NE-15	Desktop PC Chair for visual impairment	3	C
NE-16	Electrical parkins brailler	3	C
NE-17	Embossed world map	1	C
NE-18	Slates and stylus set	3	C
NE-19	Graphics printer	1	C
NE-20	Zytuse heater	1	C
NE-21	Large key board	3	C
NE-22	Talking measuring scale	3	C
NE-23	Talking calculator	3	C
NE-24	Mount button machine	1	C
NE-25	Item identification device with voice	3	C
NE-26	Braille display	2	C
NE-27	Engrave machine	1	C
NE-28	CD player	3	C
NE-29	Embosser	1	C
NE-30	Scanner	1	C
NE-31	Electric table sow	1	C
NE-32	Electric band sow	1	C
NE-33	Electric table drill	1	C
NE-34	Electric sewing machine	10	C
NE-35	Electric stove	4	C
NE-36	Refrigerator	1	C

*1: A: Equipment that is indispensable for inclusive education and subject
B: Equipment that is deemed necessary but it is necessary to further study
C: Equipment that is deemed necessary but not as indispensable as "priority A and B"

*2:These equipments are for each new school

4-5 TECHNICAL NOTES (Field Survey I-2)

The Preparatory Survey for the Project
for the Upgrading and the Construction of Secondary Schools
aimed at promoting Inclusive Education in Lesotho

Technical Notes

Based on the Minutes of Discussions signed between the Ministry of Education and Training (hereinafter referred to as "MOET") and the Japan International Cooperation Agency on August 3, 2016, the Preparatory Survey Team (hereinafter referred to as "the Team") conducted the site survey and The Team confirmed final components and priorities for the Project requested by Lesotho side as shown in ANNEX-1 and 2.

It was confirmed that the Team will further assess the appropriateness of the components and the scale of the facilities, and the number of target sites, then final components and the scale of the facilities and equipment will be determined and finalized based on the result of the study in Japan and the budget limitation of the Government of Japan.

ANNEX-1 List of facility components and priorities for the Project
ANNEX-2 List of equipment and its priorities

Maseru, Lesotho
August 10, 2016

Mapaseka Kolotsane
Principal Secretary
Ministry of Education and Training
Kingdom of Lesotho

Hiroyuki Iguchi
Chief of Consultant
Preparatory Survey Team
Japan International Cooperation Agency

ANNEX-1 List of facility components and priorities for the Project

Order of priority	Sites		Classroom (no of rooms)	Science/ICT Laboratory	Administration Block	Resource room/Care Centre	Boarding facilities*1	Feeding Kitchen & Dining	Toilet	Teacher/Staff House (no of houses)	Improvement of accessibility in the premises*2
Priority-A Existing Sites											
1	E2	Motsekuoa	A(5) B(5)	A	A	A	A	A	A	B(1)	A
	E4	St.Catherine	-	-	A	A	A	-	A*3	-	A
	E5	Masenate	-	-	A	-	-	-	-	-	-
2	E1	Abia	A(5)	A	-	A	A	A	A	B(1)	A
3	E3	Mt. Royal	-	-	-	-	A	-	A	-	B
Priority-B New Sites											
4	N8	Mohale's Hoek	A(10)	A	A	A	A	A	A	A(2)	-
5	N2	Mosalemane									
6	N1	Ha Sebaki									

*1: Size of Boarding facilities are to be studied based on the number of learners with disability at each site.

*2: Items to be improved are depends on the site conditions at each site.

*3: 1 block for staffs and boys

Legend

A Indispensable

B Necessary but not as exigent as "A"

In case of shortage of the Project budget, reduction of the target sites and/or facility components shall be considered as following order.

1 New Sites (by order of priority)

2 Components-B

3 Existing Sites (by order of priority)

ANNEX-2 List of Equipment

No. of equipment	Equipment Name	Q'ty	Priority(*1)
E1:Abia High School (No.234014)			
AB-2	Mat	1	A
AB-3	Walking frame set	1	A
AB-4	Balance ball	1	A
AB-5	Parallel bars	1	A
AB-6	Cushion for stretching set	1	A
AB-7	Electronic scale	10	B
AB-8	Microscope	10	B
AB-9	Skeleton model	2	B
AB-10	Electric sewing machine	20	B
AB-11	Electronic stove with oven	4	B
AB-12	Refrigerator	1	B
AB-13	Adjustable ironing board	2	C
E2:Motsekuoa High School (No.235004)			
MO-2	Mat	1	A
MO-3	Walking frame set	1	A
MO-4	Balance ball	1	A
MO-5	Parallel bars	1	A
MO-6	Cushion for stretching set	1	A
MO-8	Microscope	3	B
MO-9	Ripple tank	1	B
MO-10	Oscilloscope set	1	B
MO-11	Van Der graff generator	1	B
MO-12	Electric sewing machine	20	B
MO-13	Electronic stove with oven	1	B
MO-14	Gas stove with oven	1	B
MO-15	Refrigerator with slide door	1	C
E3:Mt. Royal High School (No.232009)			
MR-1	Projector	2	A
MR-2	Screen for projector	2	A
MR-3	Copy Machine	1	A
MR-5	Desktop PC	20	A
MR-8	Microscope	6	B
MR-9	Laptop PC	2	A
E4:St. Catharine High School (No. 244002)			
SC-5	One set of Embossed world map	1	A
SC-9	Large print keyboard	17	A
SC-10	Talking measuring scale	5	A
SC-11	Talking calculator	10	A
SC-12	Mountbatten machine	1	A
SC-13	Item identification device with voice	10	A
SC-17	Engrave machine	1	A
SC-18	Voice recorder	16	A
SC-19	Large size printer	1	A
New School Site (*2)			
NE-1	Merlin magnifier	3	A
NE-2	Reading stand	3	B
NE-3	Voice recorder	1	A
NE-4	Projector	1	A
NE-5	Screen for projector	1	A
NE-6	Photocopy machine	1	A
NE-8	Desktop PC	45	A
NE-11	Printer	2	A
NE-12	Laptop pc	1	A

*1: A: Equipment that is indispensable for the ccurriculum and inclusive education
B: Equipment that is deemed necessary but not as exigent as "priority A"
C: Equipment that is deemed necessary but to be covered by Lesotho side

*2:These equipments are for each new school

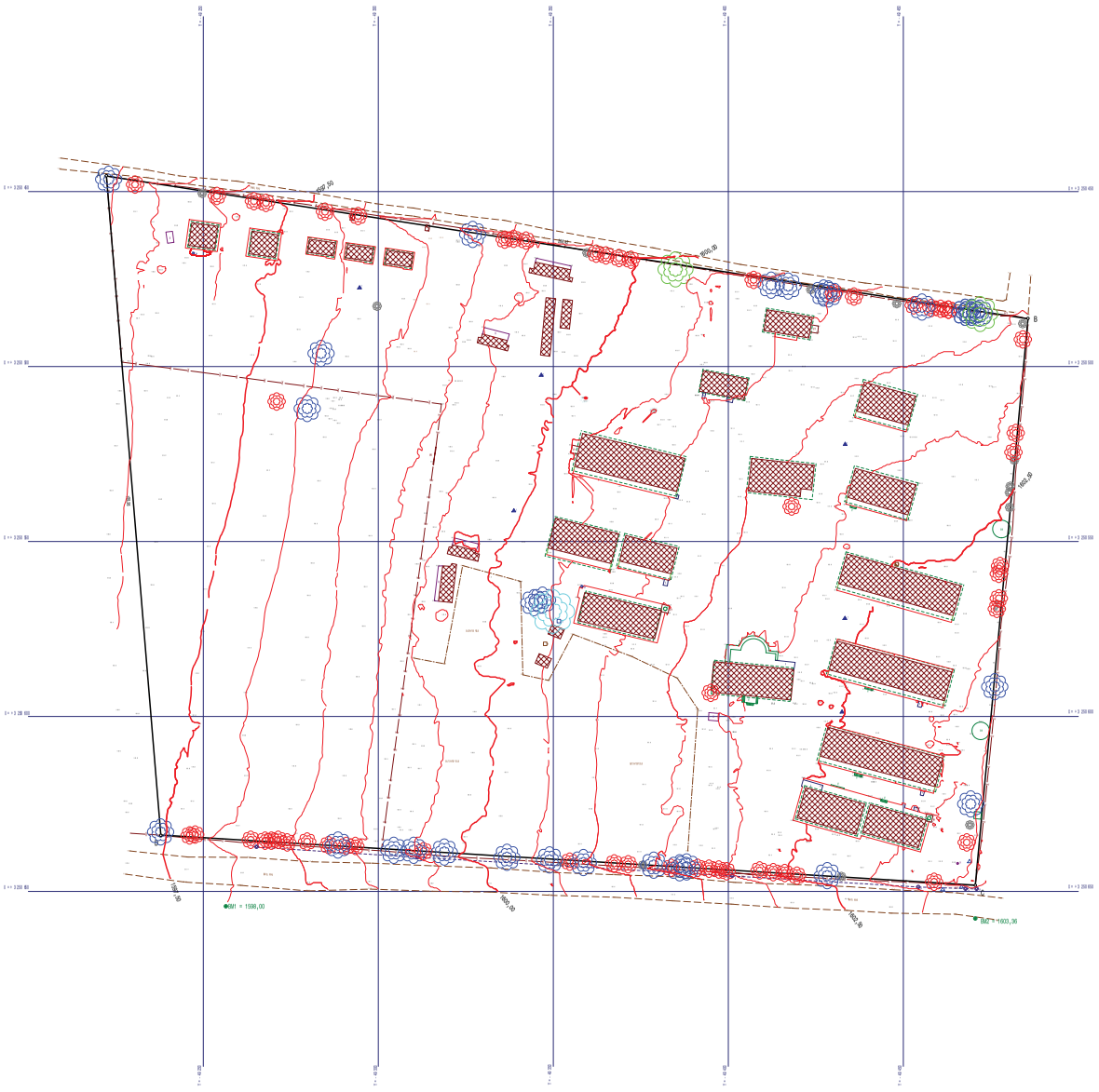
5. References

No.	Name	Type	Date	Issue/Writer
1	Vision 2020	Digital Copy	2003	Govt. of Lesotho
2	National Strategic Development Plan 2012/13–2016/17	Digital Copy	2012	Govt. of Lesotho
3	Education Sector Strategic Plan 2005-2015	Digital Copy	2005	MoET
4	Education Sector Plan 2016-2025 (Draft #1)	Paper	—	MoET
5	The National Disability and Rehabilitation Policy: Mainstreaming Persons with Disabilities into Society	Digital Copy	2011	Ministry of Health and Social Walfare
6	The National Disability Mainstreaming Plan	Digital Copy	2015	Lesotho National Federation of the Disabled
7	Syllabi and Teachers' Guides for Roll-out	Paper	2015	MoET
8	Tender Document IFB No. GOL/W001-01/2016/17 Construction of Science Laboratory at Tlohang Secondary School in Quthing	Paper	2016	MoET
9	Public Procurement Regulations	Digital Copy	2007	Minister of Finance and Development Planning
10	Government of Lesotho Procurement Manual	Digital Copy	2007	Minister of Finance and Development Planning
11	Environment Act 2008	Digital Copy	2008	Govt. of Lesotho

6. Other Relevant Data

6-1 Topographic Survey Map of the Project Site

ABIA - MASERU



SCALE 1 : 500 (A0)

A-140

REF: E1-ABIA-1

DETAIL SURVEY
ABIA HIGH SCHOOL
MASERU

LEGEND

BH = BOREHOLE	ST = STEPS
C/E = CLEANING EYE	T = TAP
EP = ELECTRIC POLE	TP = TELEPHONE POLE
MH = MANHOLE COVER	V = VALVE
R = RAMP	WT = WATER TANK
S = STAY	WTP = WATER TANK PLATFORM
SS = SEPTIC TANK	

CO-ORDINATE SYSTEM:
APPROXIMATE - LO27(WGS84)

NOTE:
THE FIGURE ABCDA REPRESENTS ABIA HIGH SCHOOL,
BEING APPROXIMATE 4.3415 HECTARES IN EXTENT

BENCH MARK DESCRIPTIONS:
BM1 ..... CENTRE OF MANHOLE COVER
BM2 ..... 12mm ROUND IRON PEG IN CONCRETE

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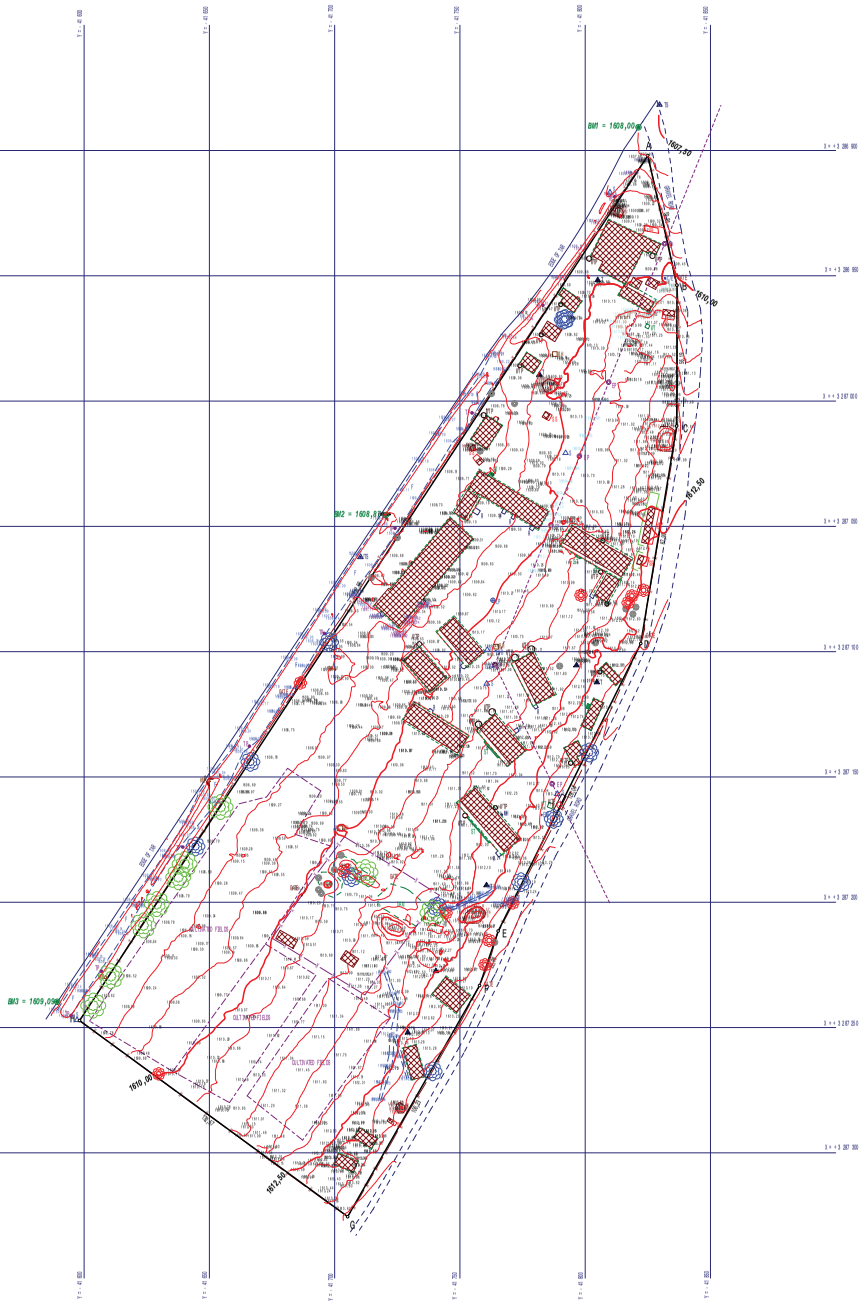
PREPARED BY: J.G. JANSE VAN RENSBURG PLS 1172 DECEMBER 2015

E1-Abia

MOTSEKUOA - MAFETENG



SCALE 1 : 750

A-141

REF: E2-MOTSEKUOA

DETAIL SURVEY
MOTSEKUOA HIGH SCHOOL
MAFETENG

LEGEND

BH = BOREHOLE	R = RAMP
C = CULVERT	S = STAY
C/E = CLEANING EYE	SS = SEPTIC TANK
EDB = ELECTRIC DISTRIBUTION BOX	ST = STEPS
EP = ELECTRIC POLE	T = TAP
F = FURROW	TP = TELEPHONE POLE
KMP = KILOMETER POLE	TS = TRAFFIC SIGN
LP = LIGHT POLE	TS = TRAFFIC SIGN
MH = MANHOLE COVER	WT = WATER TANK
P = PUMP	WTP = WATER TANK PLATFORM(OLD)

CO-ORDINATE SYSTEM:
APPROXIMATE - LO27(WGS84)

NOTE:
THE FIGURE ABCDEFHGJA REPRESENTS MOTSEKUOA HIGH SCHOOL, BEING APPROXIMATE 4.0442 HECTARES IN EXTENT

BENCH MARK DESCRIPTIONS:
BM1 ..... HOLE IN CONCRETE NEXT TO TAR
BM2 ..... HOLE IN CONCRETE(CULVERT)
BM3 ..... 12mm ROUND IRON PEG IN TAR

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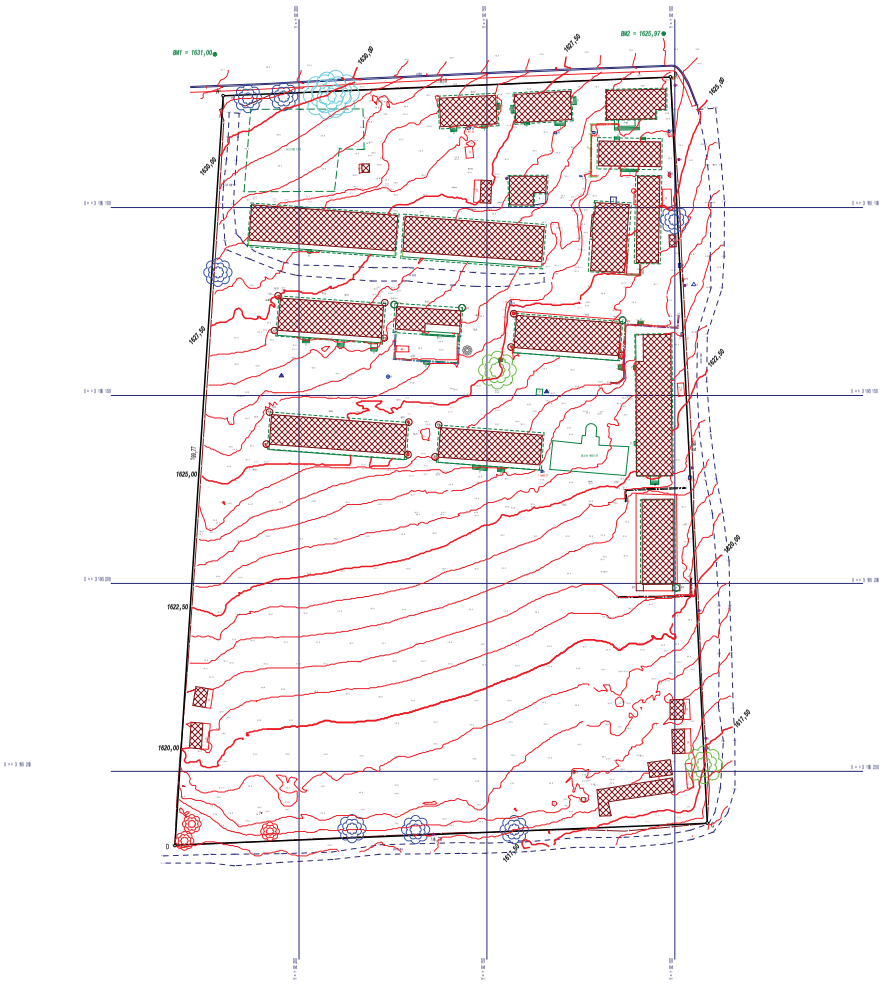
E2-Motsekuoa

MT ROYAL - LERIBE

SCALE 1 : 500(A0)



A-142

E3-Mt. Royal

REF: E3-MT ROYAL

DETAIL SURVEY
MT ROYAL HIGH SCHOOL
LERIBE

LEGEND

BH = BOREHOLE	SS = SEPTIC TANK
EDB = ELECTRIC DISTRIBUTION BOX	ST = STEPS
I = INVERT	T = TAP
LP = LIGHT POLE	TB = TELEPHONE BOOTH
MH = MANHOLE COVER	TP = TELEPHONE POLE
R = RAMP	WT = WATER TANK
RW = RETAINING WALL	WTP = WATER TANK PLATFORM
S = STAY	

NOTE:
THE FIGURE ABCDA REPRESENTS MT ROYAL HIGH SCHOOL, BEING APPROXIMATE 2.5920 HECTARES IN EXTENT

BENCH MARK DESCRIPTIONS:
BM1,BM2 ..... HOLE IN CONCRETE(FURROW)

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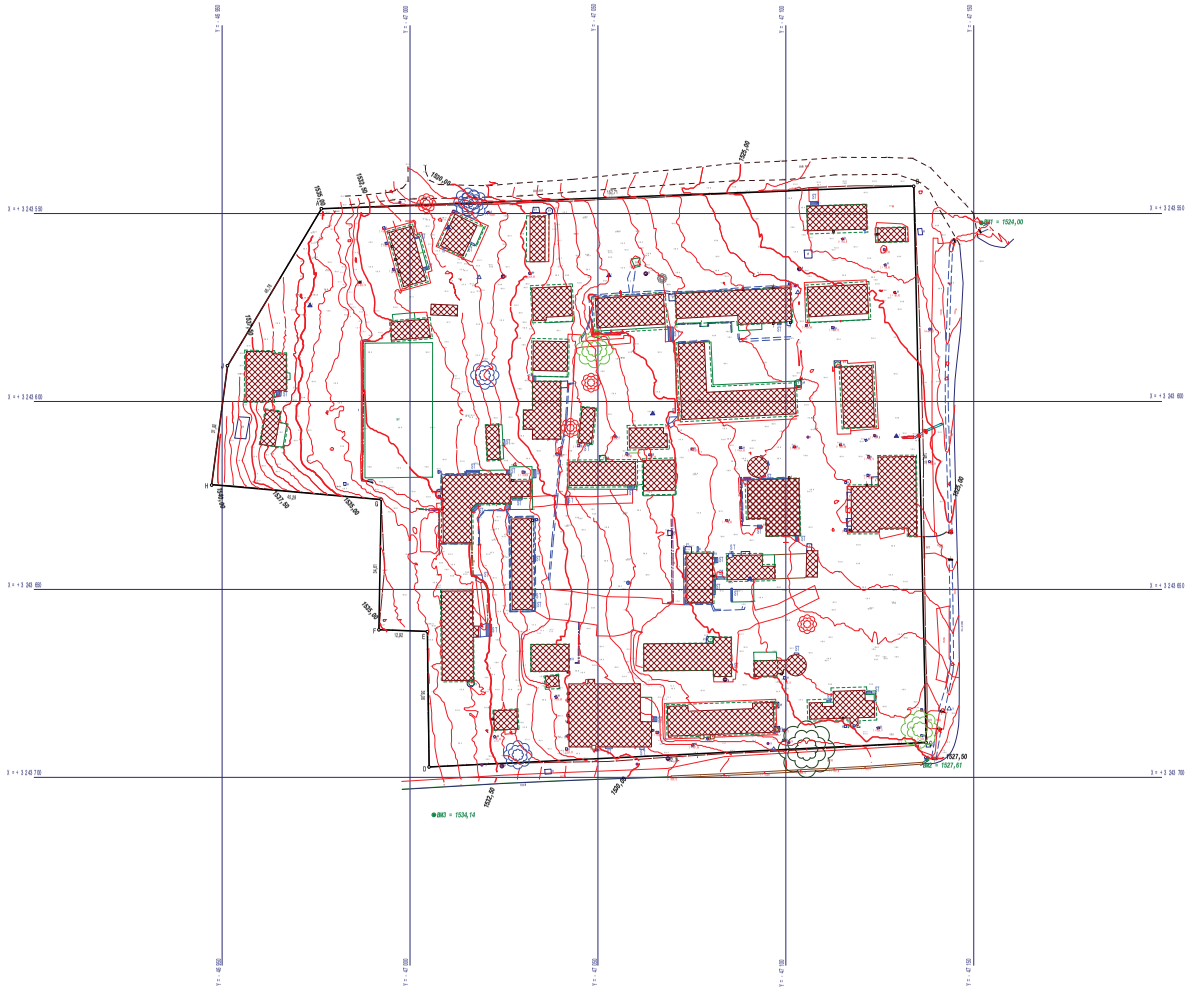
ST CATHERINE - MASERU

SCALE 1 : 500(A0)



A-143

E4-St. Catherine

REF: E4-ST CATHERINE

DETAIL SURVEY
ST CATHERINE HIGH SCHOOL
MASERU

LEGEND

C = CULVERT
CP = CAR PORT
D = DRAIN
EDB = ELECTRIC DISTRIBUTION BOX
EP = ELECTRIC POLE
F = FURROW
G = GRID
I = INVERT
LP = LIGHT POLE
MH = MANHOLE COVER
R = RAMP
RW = RETAINING WALL
S = STAY
ST = STEPS
T = TAP
TP = TELEPHONE POLE
WT = WATER TANK
WTP = WATER TANK PLATFORM

CO-ORDINATE SYSTEM:
APPROXIMATE - LO27(WGS84)

NOTE:
THE FIGURE ABCDEFGHJA REPRESENTS ST CATHERINE HIGH SCHOOL, BEING APPROXIMATE 2.3550 HECTARES IN EXTENT

BENCH MARK DESCRIPTIONS:
BM1 ..... HOLE IN MANHOLE RIM
BM2,BM3 ..... HOLE IN CONCRETE

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PREPARED BY: J.G. JANSE VAN RENSBURG PLS 1172 DECEMBER 2015

6-2 Report of the Geotechnical Investigation on the Site

DRENNAN MAUD (PTY) LTD

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OUR REF: 31181-2

YOUR REF:

Matsuda Consultants International Co. Ltd.
43-3 Yoyogi 3 Chome Shibuya-ku
Tokyo,
JAPAN
151-0053

1st February 2016

Attention: Mr H. Iguchi

Email: iguchi@matsucon.co.jp

Dear Sirs,

GEOTECHNICAL INVESTIGATION FOR PROPOSED LESOTHO SCHOOLS UPGRADE PROJECT : ABIA HIGH SCHOOL, MASERU - LESOTHO

1. INTRODUCTION

Drennan Maud (Pty) Ltd was requested by Matsuda Consultants to submit a fee proposal for the provision of geotechnical services for the proposed Lesotho school's upgrade project.

A work proposal and cost estimate, compiled in accordance with the requirements detailed in the Project brief document supplied by Matsuda Consultants, was provided on the 28th October, following which appointment to proceed was received in November 2015.

A project meeting held in Maseru, Lesotho on the 23rd November 2015 was atternded by representatives of Drennan Maud (Pty) Ltd and Matsuda Consultants, with the outcome of the meeting being the finalisation of the scope of works, and obtaining information pertaining to the various school sites and predetermined positions of the required field testing.

The field work component of the project commenced on the 1st December 2015 with the Abia high school facility visited on the 2nd December 2015, during which the assessment of the site was undertaken.

The site observations, geotechnical assessment and recommendations for the proposed development at the Abia high school is provided herewith in this report.

2. INFORMATION SUPPLIED

Information supplied for the purpose of the assessment included the following;

- Google Earth image of the site and proposed development area.
- Cadastral plan of the site.
- 1:500 scale, contoured (0.5m interval) survey plan of the site compiled by indicating all existing structures and site boundaries.

Information consulted to aid in the assessment of the site included previous assessments carried out in the nearby vicinity and the 1:250 0000 scale geological map of Lesotho (Northern map).

The proposed development at the Abia High school will comprise the construction of an unknown amount of single storey, reinforced concrete frame structures with brick infill along with ablution facilities. The exact layout of the proposed structures across the proposed development area has not yet been finalised.

3. SITE DESCRIPTION

The site is located approximately 7.5km south east, as the crow flies, of the Maseru city centre in the Kingdom of Lesotho.

The site, which comprises an existing high school facility, is relatively level to gently sloping at approximately 2° in an easterly direction with a planar to slightly convex conformation across its entire area (Plate 1 - Appendix D).

The proposed development areas are located towards the central southern and western portions of the site and comprise currently vacant, previously ploughed/cultivated areas (Plate 2).

The existing school structures comprise single storey brick structures with several existing ventilated pit latrine facilities located across the site (Plate 3).

The layout of the site can be appreciated fully in the survey site plan included as Figure 1 of this report.

4. FIELD WORK

Field work comprised the manual excavation of test pits and hand auger holes coupled with material sampling, percolation testing and supplemented with Dynamic Cone Penetrometer (DCP) testing.

A total of 3 pits, comprising 1 test pit (TP1) and two percolation pits (PT1-2) were excavated to depths ranging between 1.0 - 1.3m depth to assess the subsoil conditions below the site, obtain soil samples for laboratory testing and conduct percolation tests to determine the subsoil percolation characteristics of the site.

In addition 2 hand auger holes (AH 1 - 2) were excavated using a hand auger apparatus to a maximum depth of 2.5m below existing ground level.

The subsoils encountered within the pits and removed from the hand auger holes were examined and logged by an Engineering Geologist in accordance with the Guidelines for Soil and Rock Logging in South Africa, 2nd impression 2002 edited by A.B.A Brink and R.M.H Williams. The subsoil profiles are included in Appendix A of this report.

A total of 9 DCP tests were carried out across the investigated portion of the site to determine the subsoil consistency and depth to weathered bedrock if located at a shallow to moderate depth below the surface. The graphical results of the DCP testing are included as Appendix B of this report.

To aid in the interpretation of the DCP results, Table 1 below is provided and indicates the correlation between the number of blows required to progress the probe a distance of 300mm and the respective consistency of the subsoil for non-cohesive and cohesive material. However, it should be noted that this table is specific to Drennan Maud (Pty) Ltd equipment and thus should only be consulted as a guide.

Table 1 : Subsoil Consistency Inferred from the DCP Test Results

Cohesive Soils		Non-Cohesive Soils	
DCP Blow Count Blow / 300mm (SPT 'N' Value)	**Subsoil Consistency**	**DCP Blow Count Blows / 300mm (SPT 'N' Value)**	**Subsoil Consistency**
0 - 4 (<2)	Very Soft	0 - 8 (<4)	Very Loose
4 - 8 (2 - 4)	Soft	8 - 18 (4 - 10)	Loose
8 - 15 (4 - 8)	Firm	18 - 54 (10 - 30)	Medium Dense
15 - 24 (8 - 15)	Stiff	54 - 90 (30 - 50)	Dense
24 - 54 (15 - 30)	Very Stiff	>90 (50 - 80)	Very Dense
> 54	Hard		

Several representative soil samples were retrieved from the subsoil excavations and submitted to a local laboratory (Material Testing Laboratory) for testing with certain samples retained and returned to Thekwini Soils Laboratory in Durban for specialized testing. A complete list of the samples taken and testing carried out is provided in Section 6 below with the results thereof included in Appendix C of this report.

Percolation testing was carried out in PT1 and PT2 in accordance with the SABS 0400 1987 standards which states a test hole is excavated on site to a suitable depth with a smaller 300mm x 300mm x 300mm hole excavated at the base of the pit. The smaller hole is filled to a height of no less than 300mm and maintained at such a level for a period of no less than 4hours.

At the end of the 4 hour period the level of the water is topped up and the time at which the test starts is noted. The drop in level of the water as it soaks away over a subsequent period of 30 minutes is measured. The time taken for the water level to drop by 25mm increments is measured with the average of this time during the 30minute period taken as the percolation rate. Where such percolation rate is less than 30minutes the soils on site are deemed suitable for potential effluent disposal via subsoil percolation. Should the water level not drop by 25mm within the 30 minute period the subsoils are considered unsuitable.

The results of the percolation testing are discussed further in Section 7 of the report.

5. GEOLOGY AND SOILS

Consultation of the Lesotho geological map indicates the site is underlain by Molteno Formation bedrock which comprises primarily sandstone along with subordinate mudstone horizons, along with the colluvial and residual material derived therefrom.

No weathered bedrock was encountered within the subsoil excavations and DCP probes and thus is inferred at depths greater than 3.6m beyond the scope of the shallow investigation.

The weathered bedrock located at unknown depth is overlain by residual material encountered from approximately 1.6m depth occurring as red brown, brown and orange brown patched yellow, firm to stiff, gravelly sandy clay to clayey silty sand containing occasional ferricrete nodules.

The residual material is overlain by approximately 1 - 1.5m thick horizon of medium dense to dense colluvial material described as orange brown, intact, slightly gravelly, silty sand to clayey silty sand . The colluvium was consistently intersected at a depth of 0.3 depth and overlain by a thin mantle of brown silty sand topsoil material (Plate 4 and 5).

No ground water seepage was encountered within any of the subsoil excavations and thus the permanent ground water level is anticipated at depths in excess of 2.5m below existing ground level. However, the presence of ferricrete nodules in the slightly more clayey, less permeable colluvium/residual material suggest a seasonal perched ground water table likely occurs during the wetter summer months.

6. LABORATORY ANALYSES

6.1 Laboratory Testing

The complete schedule of the laboratory samples and the testing conducted thereon is included in Table 2 below;

Table 2: Schedule of Laboratory Testing

Pos	Material Description	Depth (m)	Laboratory Test			
			Ind	Mod	CBR	Swell
TP1	Orange brown, silty SAND - Colluvium	0.35 - 0.75	✔*	✔	✔	✔*
TP1	Red/orange brown, clayey, silty SAND - Colluvium	0.75 - 1.3	✔	✔	✔	
PT2	Light brown, silty CLAY - Colluvium/Topsoil	0 .0 - 0.3	✔	✔	✔	
AH1	Orange/red, sandy, silty CLAY - Residual	1.6 - 2.35	✔*			

* - Denotes Samples tested by Thekwini Soil Lab in Durban

Due to the non-cohesive nature of the subsoils exposed within the pits no undisturbed triaxial sample could be retrieved. As such the triaxial testing was substituted for recompacted swell testing.

6.2 Laboratory Results

The laboratory test summary is provided in Appendix C of this report along with swell test results. However, for ease of reference the results of the laboratory testing are provided herewith in Tables 3 - 4 below;

6.2.1 *Grading Analyses*

Table 3 - Summary of Grading Analysis Results

Pos	Depth (m)	Description	LL %	PI	LS %	%Silt & Clay	Revised US Classification	
							Group	Subgrade Rating
TP1	0.35 - 0.75	Silty SAND	22.1	7.8	3.3	48.1	A-4	Fair
TP1	0.75 - 1.3	Clayey, silty, SAND	28.3	10.8	4.7	49.8	A-4	Fair
PT2	0 .0 - 0.3	Silty SAND	N il	N.P.	N.P.	21.9	A-4	Fair
AH1	1.6 - 2.35	Sandy, silty CLAY	34	17.7	10	58.7	A-6	Poor

N.P. - Non-plastic

6.2.2 *Mod AASHTO Density and CBR Testing*

Table 4 - Summary of Density Testing Results

Pos	Depth (m)	Material	Mod AASHTO Density (kg/m^3)	OMC (%)	CBR Results			TRH 14
					90 %	98 %	Swell %	
TP1	0.35 - 0.75	Silty SAND	2024	10.9	5.0	6.0	0.2	G9
TP1	0.75 - 1.3	Clayey, silty SAND	1848	14.3	9.0	13.0	0.3	G8
PT2	0.0 - 0.3	Silty SAND	1964	11.2	8.0	11.0	0.2	G8

6.2.3 *Swell Testing*

Swell testing on the disturbed sample taken from 0.35 - 0.75m recompacted to 90% Mod AASHTO desity returned a nominal swell value of 1.79%, thus indicating the colluvial material is only slightly active.

7. GEOTECHNICAL ASSESSMENT

The site is very gently sloping to level and thus only minor earthworks will be required for the preparation of building platforms. In this regard, excavation in the subsoils to required platform and foundation level will classify as 'soft' excavation according to SABS 1200 D standards. However, should manual labour be used for the excavation of foundation and service trenches excavation will be laboured and time consuming in the generally, dry, dense, fine to medium grained sandy subsoils.

The generally sandy silty near surface subsoils are considered highly susceptible to erosion via flowing water and wind forces. Dust suppression will be required to minimise dust during construction process (especially once covering vegetation is removed) and stormwater management should be in place across the site to minimise potential erosion. Concentrated outflows of storm water run-off should be avoided to reduce potential erosion to a minimum.

The clayey residual soils encountered below the site are considered to be potentially slightly active in the sense that the materials may undergo volume change (shrink and swell) with a change in the moisture content of the soil.

The subsoils underlaying the site are in general consistently medium dense to dense to maximum probed depths of 3.6m and thus the risk of significant collapse potential in the subsoils is considered low.

The near surface colluvial material classifies as G8 - G9 type material (after TRH 14 - 1985) and thus considered suitable for the creation of fill embankments should any be necessary across the site or as subgrade material. The more clayey residual subsoils classify as A-6 type material and thus unlikely to meet the minimum requirements of a G10 type material and hence unsuitable for use as bulk fill and subgrade material. However, this should be confirmed through additional testing at the time of construction.

After saturation of the subsoils for a minimum of 4 hour period in accordance with the SABS 400 standards, the percolation rate within PT1 and PT2 was measured to be on average 11 and 12 minutes per 25mm drop in water level respectively. As such the subsoils are considered suitably permeable for the disposal of effluent via subsoil percolation in a french drain and septic tank system. In terms of Table 3 of SABS 0400-1987 standards the rate of application of effluent to subsoil areas in french drains should not exceed 75 litres per square meter per day.

In light of the above geotechnical appraisal, the site is considered suitable for the proposed development. Notwithstanding the above the following geotechnical recommendations are provided for the planning and construction phases of the development. These amount to no more than sound building practices appropriate for the prevailing subsoil conditions.

8. DEVELOPMENT RECOMMENDATIONS

8.1 Earthworks

Depending on the layout of the proposed structures, cut and fill embankments, if required on site, will likely be limited to a maximum height in the order of 1.0 - 1.5m. As such it is recommended that cut and fill batters are laid back at a maximum batter of 1:2 (26°).

Fills should be constructed of suitable granular material placed in layers of maximum 300mm loose thickness and compacted to 95% Mod ASSHTO dry density prior to the placement of the next layer.

All cut and fill slopes as well as unpaved areas should be grassed as soon as possible after construction to bind the soil and minimise the potential for soil erosion across the development area.

8.2 Founding

Due to the consistency of the subsoils underlying the site and nature of the proposed development, it is recommended that the single storey structures are founded on conventional reinforced strip footings or reinforced ground beams spanning column bases.

The foundations should be taken to a minimum depth of 1.0m below final platform depth to bear into medium dense subsoils. An allowable bearing capacity of 150 kPa can be applied for foundation design in the medium dense subsoils.

Ideally structures should be positioned as much as practically possible in areas of cut to simplify founding of the proposed structure.

However, should the structures span from cut to fill, foundations below the fill portion of the platform should be taken through the entire depth the fill into similar, in-situ, medium dense colluvium across the entire area of the structure.

Furthermore, where structures span the prick of the cut to fill platform, the floor slab of the structure should be isolated from all walls, columns and foundations to allow for differential settlement below that may occur below the structure. The structure should also incorporate judiciously placed construction joints into its design to accommodate for any such differential settlement that may occur across the structures.

8.3 Site Drainage

All stormwater run-off from all new roof areas should be collected in Jo-Jo storage tanks (or some equivalent) to be used on site for general purposes.

Runoff from all paved/hardened ground surfaces should be collected in suitably designed drains to discharge into a minimum of 3m downslope of any structure via spreader system or into a suitably sized soak pit. Discharge of concentrated stormwater onto unprotected ground surface should be strictly avoided.

The site should be graded post construction to avoid stormwater from pooling on building platforms or adjacent to structures and infiltrating the subsoils at foundation level.

8.4 Sanitation

It is unknown whether a water borne sewerage system exists in the area. If available, the connection thereto would be a suitable option.

If no such system exists, given the percolation rate of the subsoils and availability of running water on site, the use of a french drain and septic tank system for the disposal of effluent via subsoil percolation is considered suitable. However, this will be dependant on the amount of people the new ablution facilities are anticipated to support and the available space for evapotranspiration. Once this information is available more detailed calculation can be carried out to determine the feasibility of a septic tank system.

Should it not be possible to support the school on a septic tank system the schools sanitation needs can be accommodated via Ventilation Improved Pit (VIP) latrine as is currently used on site.

The design and construction of the pit latrines is essential as proper functioning toilets are essential for positive user experience and thus continued good public health.

The pits may be lined or unlined depending on whether latrines are going to be permanent (emptied on a semi regular basis via vacuum tanker if available in the area) or temporary (pit closed once full and superstructure relocated).

Permanent VIP latrines should be positioned on site such that, when at full capacity they are easily accessible via vacuum tanker.

9. CONCLUSION

The development of additional classrooms and ablution facilities at the existing Abia High school is considered feasible from a geotechnical perspective as there exists no geotechnical factors that would preclude the proposed developed.

That being said, it is recommended that the geotechnical considerations highlighted in this report and the development recommendations provided are taken into consideration in the design and construction of the project to ensure the long term integrity of the proposed structures. These amount to no more than sound building practices appropriate for the prevailing subsoil conditions.

We trust that the information provided in this report fulfils your immediate requirements. Should you have any further requirements please do not hesitate to contact the undersigned.

Yours faithfully
DRENNAN MAUD (PTY) LTD

A. JOUBERT Pr.Sci.Nat.

/aj

APPENDIX A
Soil Profiles
(TP 1, PT 1 - 2 & AH 1 - 2)

DRENNAN MAUD (PTY) LTD

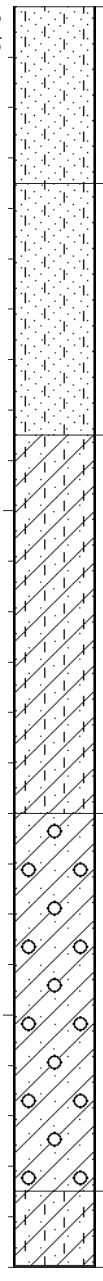
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ABIA HIGH SCHOOL

HOLE No: **AH1**
Sheet 1 of 1

JOB NUMBER: **31181-2**

Scale 1:15



Smpl.	Depth (m)	
		0.00 Dry, light orange brown, loose to medium dense, silty, fine to medium grained SAND – (Topsoil/Colluvium)
		0.35 Slightly moist, orange brown, medium dense, slightly clayey, silty SAND – (Colluvium)
	1	0.85 Slightly moist, orange and red brown, stiff/medium dense, slightly gravelly, silty sandy CLAY to clayey, silty sand in places containing occasional ferricrete nodules – (Colluvium)
0	2	1.60 Slightly moist, red brown, brown and orange brown patched yellow and dark brown, firm to stiff, gravelly, sandy CLAY containing ferricrete nodules – (Residual)
		2.35 Slightly moist, yellow brown mottled orange, brown and red, stiff, slightly gravelly, silty sandy CLAY – (Residual)
		2.50

NOTES

1) No ground water seepage encountered

2) Refusal of hand auger at 2.5m in stiff clay

3) Sample taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 02/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:10
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DRENNAN MAUD (PTY) LTD

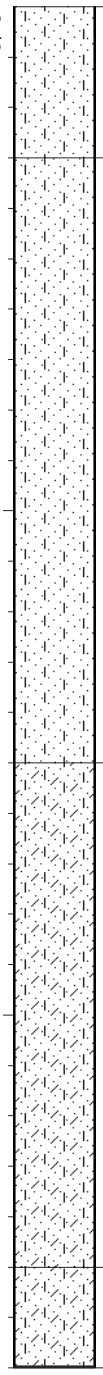
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ABIA HIGH SCHOOL

HOLE No: **AH 2**
Sheet 1 of 1

JOB NUMBER: **31181-2**

Scale 1:15



Smpl.	Depth (m)	
		0.00 Dry, light brown, loose to medium dense, silty SAND – (Topsoil/Colluvium)
		0.30 Slightly moist, light orange and orange, medium dense, slightly clayey, silty SAND – (Colluvium)
1		
		1.50 Slightly moist, dark orange, medium dense, slightly clayey to clayey, silty SAND – (Colluvium)
2		
		2.50 Slightly moist, red brown patched brown speckled yellow, medium dense, slightly gravelly, clayey, silty SAND containing occasional ferricrete nodules – (Colluvium)
		2.70

NOTES

1) No ground water seepage encountered

2) No hand auger refusal encountered

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 02/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH 2**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:10
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Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ABIA HIGH SCHOOL

HOLE No: **PT1**
Sheet 1 of 1

JOB NUMBER: **31181-2**

Scale 1:10

0.00 Dry, light orange brown, medium dense to dense, intact, fine silty SAND containing root material – (Topsoil/Colluvium)

0.35 Dry, orange brown, medium dense to dense, intact, slightly clayey to clayey in places, silty SAND – (Colluvium)

1.00

NOTES

1) No ground water seepage encountered

Smpl.	*Depth (m)*
	1

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 02/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT1**

TYPE SET BY : AJ
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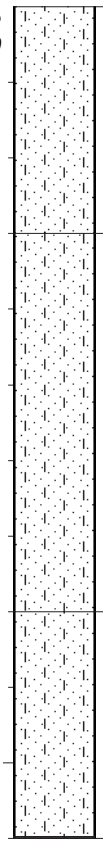
MATSUDA CONSULTING
LESOTHO SCHOOLS – ABIA HIGH SCHOOL

HOLE No: **PT2**
Sheet 1 of 1

JOB NUMBER: **31181-2**

Smpl.	Depth (m)
o IMC	Scale 1:10
	1



0.00 Dry, light brown and orange brown, loose to medium dense, intact, silty, SAND containing root material – (Topsoil/Colluvium)

0.30 Dry to slightly moist, orange brown and orange, medium dense to dense, intact, slightly clayey, silty SAND – (Colluvium)

0.80 Slightly moist, orange and red brown, medium dense, intact, slightly clayey, silty SAND – (Colluvium)

1.10

NOTES

1) No ground water seepage encountered

2) Sample taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 02/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT2**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

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DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ABIA HIGH SCHOOL

HOLE No: TP1
Sheet 1 of 1

JOB NUMBER: 31181-2

Scale 1:10

Smpl.	Depth (m)	
		0.00 Dry, light brown and yellow brown, medium dense to dense, intact to slightly fissured, clayey, silty SAND containing root material – (Topsoil)
		0.35 Dry, orange brown, dense, intact, slightly gravelly, slightly clayey, sandy CLAY containing occasional ferricrete nodules – (Colluvium)
o IMC, Swell		
		0.75 Slightly moist, orange and red brown, dense, clayey, silty SAND to sandy silty clay in places – (Colluvium)
o IMC	*1*	
		1.30 Slightly moist, light yellow brown and brown, loose, intact, gravelly, silty SAND containing ferricrete nodules – (Colluvium)
		1.50

NOTES

1) Hand dug to 1.2m and extended to 1.5m via hand auger – Hand auger refusal encountered at 1.5m in gravelly material

2) No ground water seepage encountered

3) Samples taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 02/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP1

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:10
TEXT : ..C:\DOTIN\SPMASTER.DOC

APPENDIX B
DCP Test Results
(DCP 1 - 9)

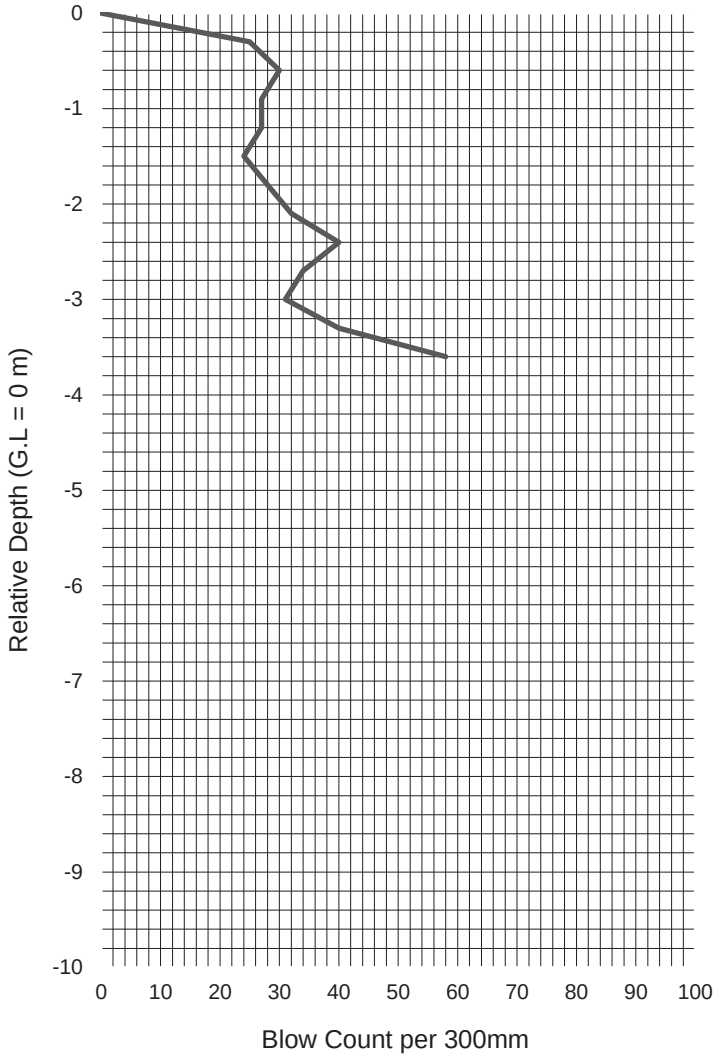
Dynamic Cone Penetrometer

Test No. : 1

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	25
-0.6	30
-0.9	27
-1.2	27
-1.5	24
-1.8	28
-2.1	32
-2.4	40
-2.7	34
-3.0	31
-3.3	40
-3.6	58

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

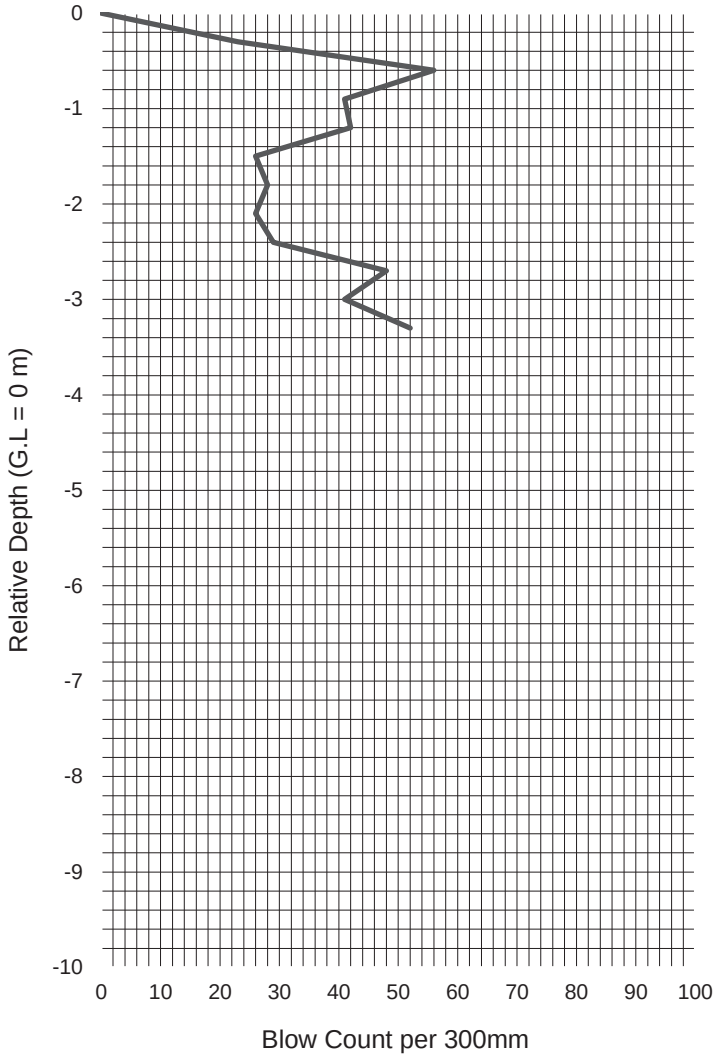
Dynamic Cone Penetrometer

Test No. : 2

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	23
-0.6	56
-0.9	41
-1.2	42
-1.5	26
-1.8	28
-2.1	26
-2.4	29
-2.7	48
-3.0	41
-3.3	52

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

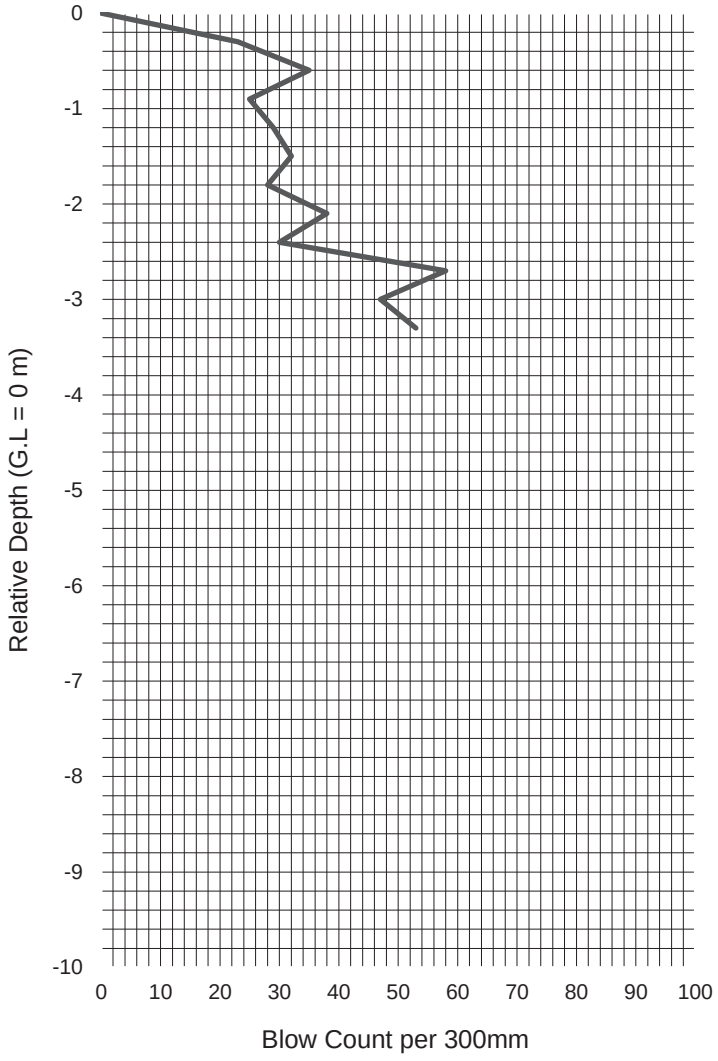
Dynamic Cone Penetrometer

Test No. : 3

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	23
-0.6	35
-0.9	25
-1.2	29
-1.5	32
-1.8	28
-2.1	38
-2.4	30
-2.7	58
-3.0	47
-3.3	53

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

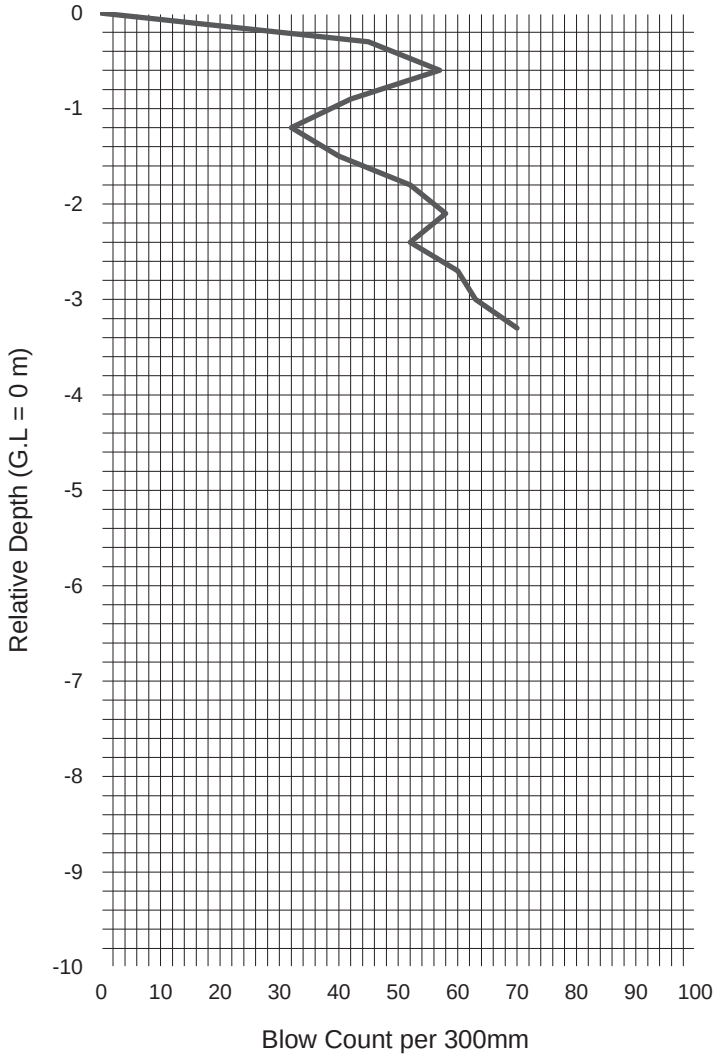
Dynamic Cone Penetrometer

Test No. : 4

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	45
-0.6	57
-0.9	42
-1.2	32
-1.5	40
-1.8	52
-2.1	58
-2.4	52
-2.7	60
-3.0	63
-3.3	70

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

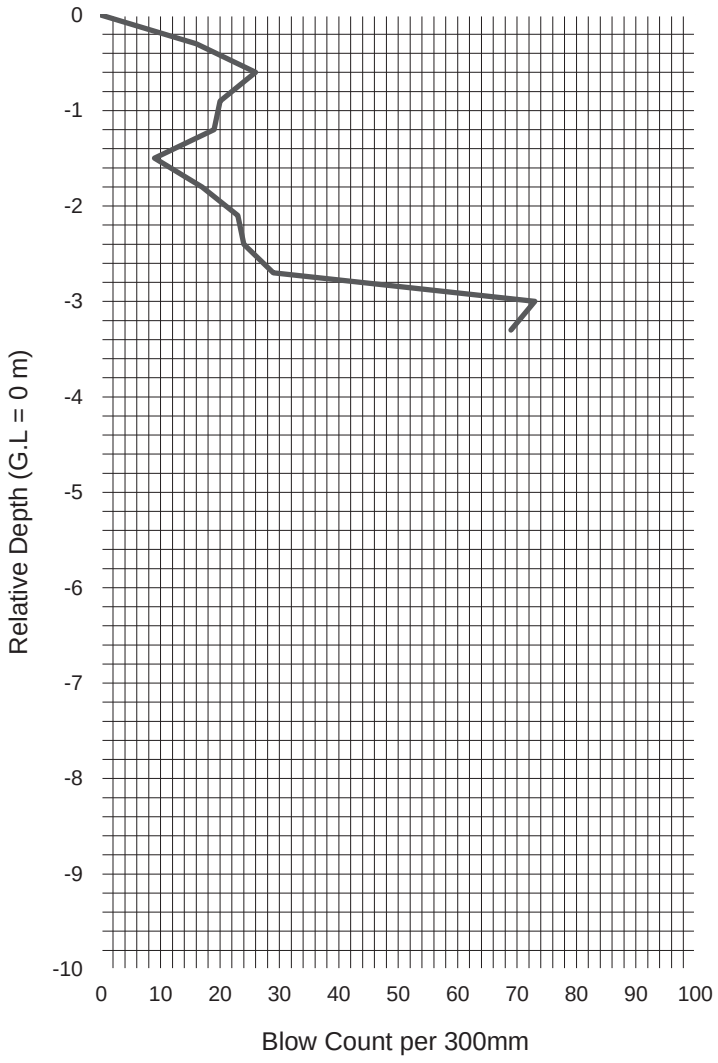
Dynamic Cone Penetrometer

Test No. : 5

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	16
-0.6	26
-0.9	20
-1.2	19
-1.5	9
-1.8	17
-2.1	23
-2.4	24
-2.7	29
-3.0	73
-3.3	69

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

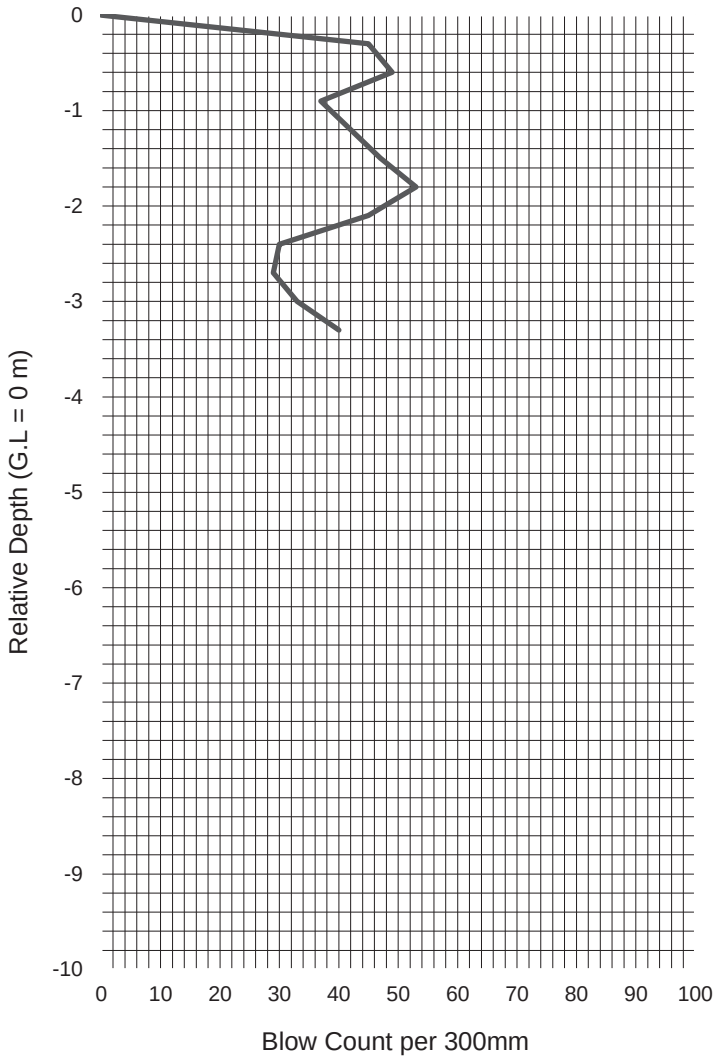
Dynamic Cone Penetrometer

Test No. : 6

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	45
-0.6	49
-0.9	37
-1.2	42
-1.5	47
-1.8	53
-2.1	45
-2.4	30
-2.7	29
-3.0	33
-3.3	40

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

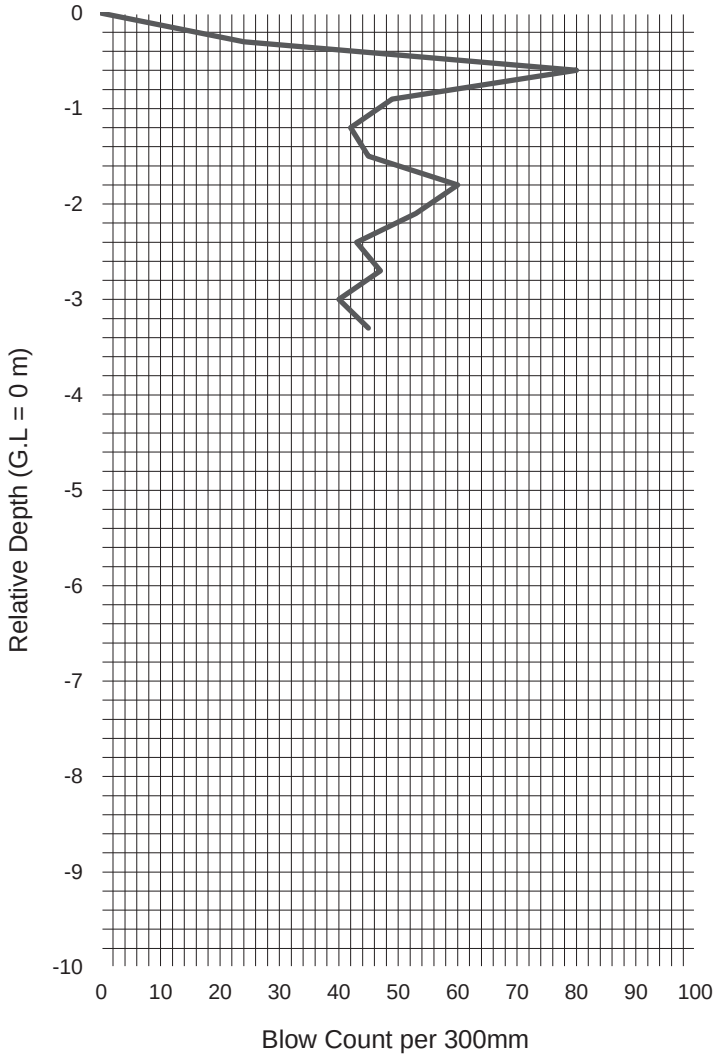
Dynamic Cone Penetrometer

Test No. : 7

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	24
-0.6	80
-0.9	49
-1.2	42
-1.5	45
-1.8	60
-2.1	53
-2.4	43
-2.7	47
-3.0	40
-3.3	45

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

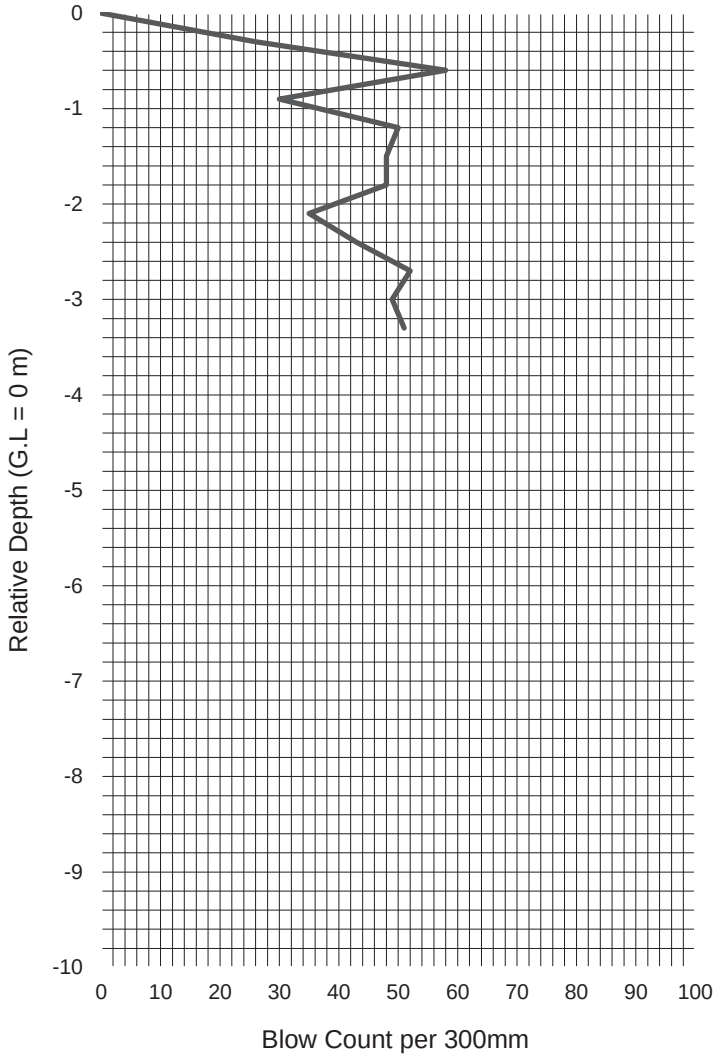
Dynamic Cone Penetrometer

Test No. : 8

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	26
-0.6	58
-0.9	30
-1.2	50
-1.5	48
-1.8	48
-2.1	35
-2.4	43
-2.7	52
-3.0	49
-3.3	51

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

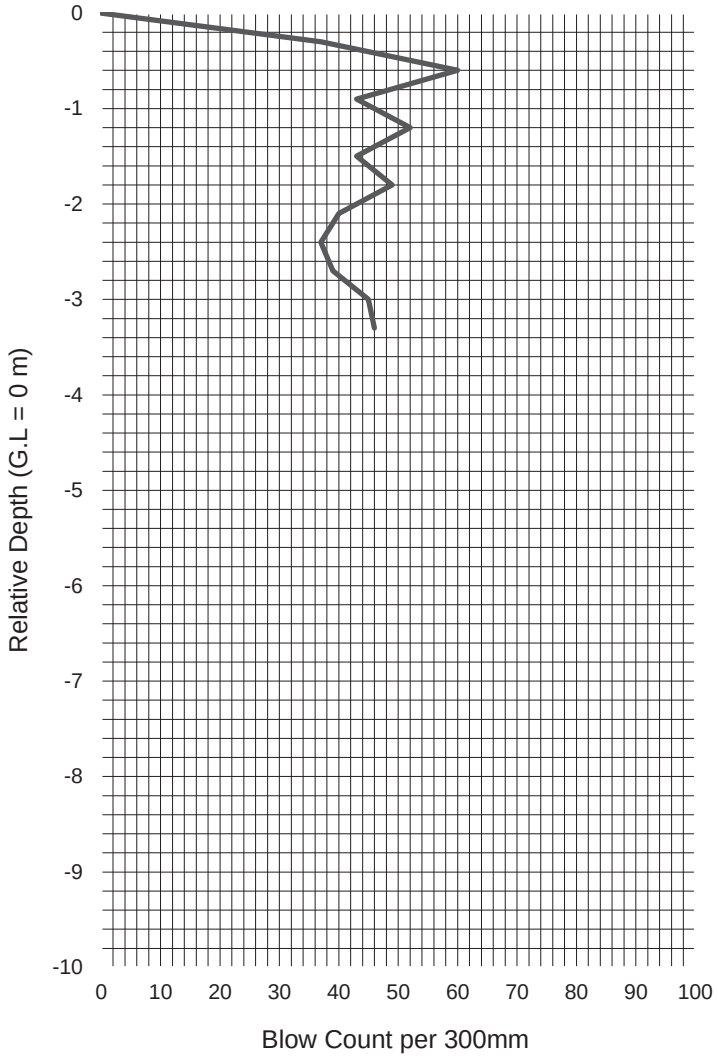
Dynamic Cone Penetrometer

Test No. : 9

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 02-12-2015 Remarks: -
Test Location: Abia High School - Maseru -
Date of Test: 02-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	37
-0.6	60
-0.9	43
-1.2	52
-1.5	43
-1.8	49
-2.1	40
-2.4	37
-2.7	39
-3.0	45
-3.3	46

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

APPENDIX C
Laboratory Test Results Summary

Laboratory Test Summary

THEKWINI SOILS LAB. CC

Job Description: LESTHO SCHOOLS - REF 31181-2
Job no.: 7980
Date: 11/01/16

Lab no.		12089	12099									
Location		TP1	AH1									
Depth		0.35-0.75	1.6-2.35									
Description		-	-									
		-	-									
Binder Material		-	-									
Particle Size (mm)	75											
	53											
	37.5											
	26.5											
	19											
	13.2											
	9.5	100	100									
	4.75	99	100									
	2	98	94									
	0.425	96	87									
	0.25	89	84									
	0.15	71	77									
	0.075	53	62									
Hydrometer	0.05	48	56									
	0.02	46	53									
	0.005	44	49									
	0.002	40	47									
Soil Mortar	Coarse Sand <2.0 >0.425mm	2.0	8.0									
	Fine Sand <0.425>0.05mm	51.3	40.0									
	Silt <0.05 >0.005	3.5	6.7									
	Clay <0.005	43.1	45.2									
Atterberg Limits	Liquid Limit % (m/m)	21	34									
	Plasticity Index	6.8	17.7									
	Linear Shrinkage %	4.7	10									
	Natural MC %	-	-									
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *		A - 4 (1)	A - 6 (8)									
Grading Modulus		0.53	0.57									
TRH 14 (1985) *												

Signature: .....
Title: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESTHO SCHOOLS - REF 31181-2

Ref no.: 7980 **Lab no.:** 12089 **Borehole/Pit no.:** TP1 **Fig no.:** -

Description: -

Depth: 0.35-0.75 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.5
2	97.9
0.425	96.0
0.25	89.3
0.15	71.5
0.075	53.0
0.05	47.6
0.02	45.8
0.005	44.0
0.002	40.4

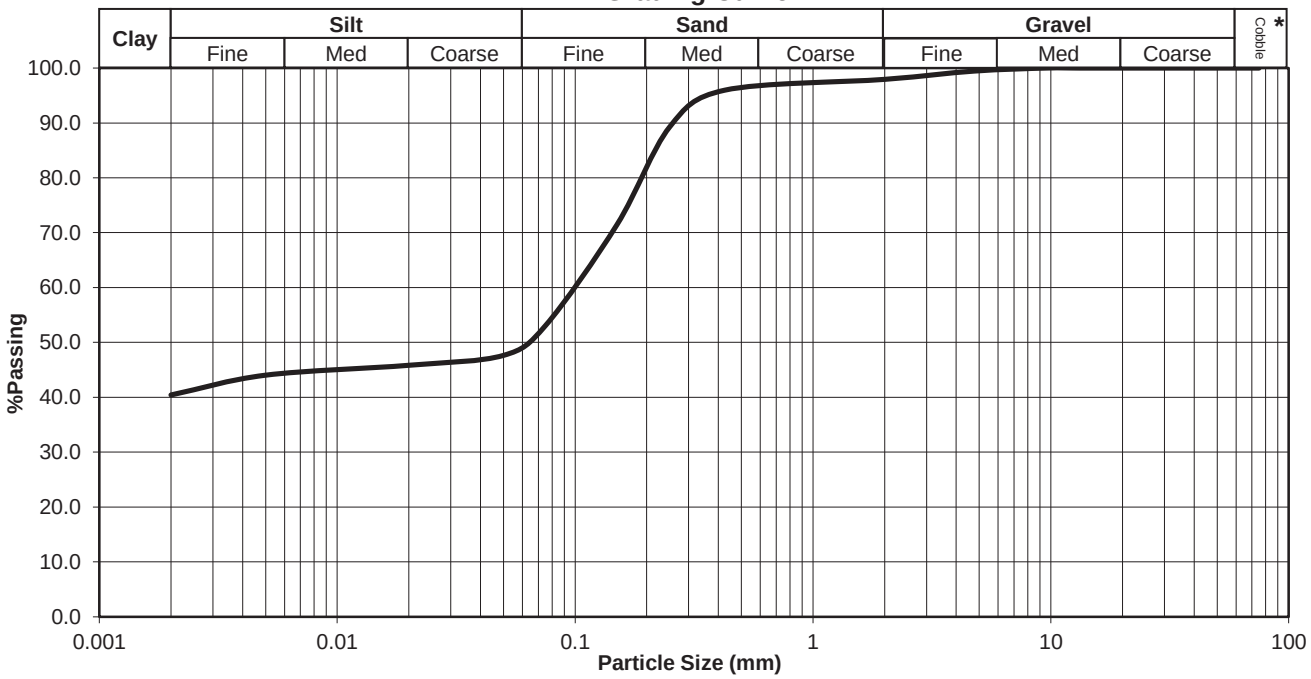
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	2.1
Coarse	0.0
Medium	0.4
Fine	1.7
Sand%	48.1
Coarse	1.8
Medium	15.8
Fine	30.6
Silt%	9.4
Coarse	4.0
Medium	1.7
Fine	3.7
Clay%	40.4

PLASTICITY	
Liquid Limit, %	21
Plasticity Index	6.8
Linear Shrinkage, % (L/L)	4.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	0.53

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	1
AASHTO Soil Classification	A - 4
Unified Classification	CL - ML

Grading Curve



Ref no.: 7980 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.
The results only relate to the samples tested.
The report may not be reproduced except in full.

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESTHO SCHOOLS - REF 31181-2

Ref no.: 7980 **Lab no.:** 12099 **Borehole/Pit no.:** AH1 **Fig no.:** -

Description: -

Depth: 1.6-2.35 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.8
2	94.3
0.425	86.7
0.25	83.7
0.15	77.4
0.075	62.0
0.05	56.5
0.02	52.8
0.005	49.1
0.002	46.6

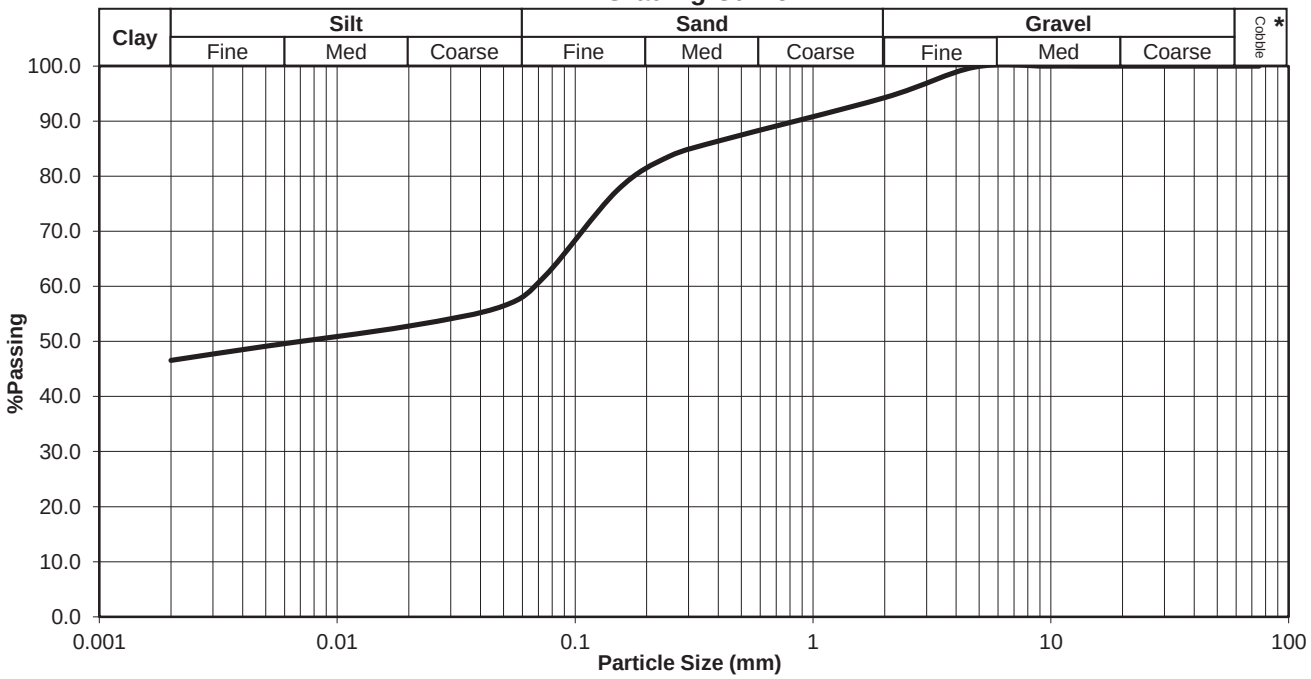
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	5.7
Coarse	0.0
Medium	0.1
Fine	5.6
Sand%	35.6
Coarse	6.7
Medium	7.0
Fine	21.9
Silt%	12.1
Coarse	5.9
Medium	3.4
Fine	2.8
Clay%	46.6

PLASTICITY	
Liquid Limit	34
Plasticity Index	17.7
Linear Shrinkage	10

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.57

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	8
AASHTO Soil Classification	A - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 7980 Fig no.: -

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MATERIALS TESTING LABORATORY

PO Box 0391 Maseru West 0105. Cell: (+266) 28311199
Email: molefen@leo.co.ls

Reporting Form (For Soil and Gravel Samples)						
Project	Abia High School		Client: Drennan Maud		Date reported: 14-12-2015	
Date sampled	02-12-2015		Project No.: 31181			
Sample no		8860	8861	8862		
Position		T.P 1	T.P 1	PT2		
Depth		0.35-0.75m	0.75-1.3m	0.0-3.30m		
Material Description		Reddish Brown silt	Reddish Brown Silt	Brownish sandy Silt		
Sieve analysis % passing	75,0					
	63,0					
	53,0					
	37,5					
	26,5					
	19,0					
	13,2	100.0	100.0			
	4,75	98.5	96.6	100.0		
	2,00	96.3	93.2	99.8		
	0,425	94.1	90.7	97.1		
	0,075	46.3	50.4	44.1		
Soil mortar						
2,00 - 0,425		2.3	2.7	2.7		
0.425 - 0.250		11.0	10.5	6.1		
0.250 - 0.150		13.9	8.3	16.7		
0.150 - 0.075		24.7	25.7	30.3		
<0,075		48.1	54.1	44.2		
Atterberg Constants						
Grading modulus		0.6	0.7	0.6		
Liquid limit		22.1	28.3	Nil		
Plasticity index		7.8	10.8	N/P		
Linear shrinkage		3.3	4.7	Nil		
Classification: TRH14		G9	G8	G8		
Mod. AASHTO						
MDD (kg/m^3)		2024	1848	1964		
OMC (%)		10.9	14.3	11.2		
Mould MC (%)		10.8	14.4	11.1		
% Compaction		99.8	99.9	99.9		
% swell		0.2	0.2	0.2		
NRB						
Dry density (kg/m^3)		1923	1754	1870		
% of MDD		95.0	94.9	95.2		
% swell		0.2	0.3	0.2		
Proctor						
Dry density (kg/m*)		1823	1663	1768		
% of MDD		90.1	90.0	90.0		
% swell		0.2	0.3	0.2		
C.B.R values	100%	7.0	15.0	13.0		
s*	98%	6.0	13.0	11.0		
$	97%	6.0	12.0	10.0		
S- -	95%	6.0	11.0	9.0		
sc.	93%	5.0	9.0	8.0		
	90%	5.0	8.0	6.0		
Bearing Capacity (kPa)						
ITS (kPa)						
UCS (MPa)						

Swell.

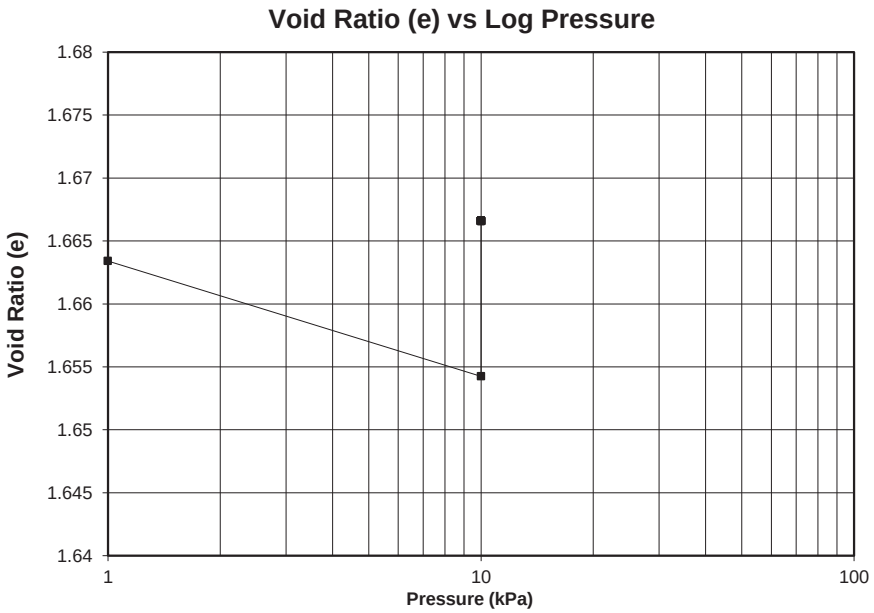
Project:	Abia School		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	TP 1
Date:	7980	**Depth (m):**	0.35 - 0.75
Sample No.:	12089	**Consol No.:**	3
Sample Description:	-	**Ring Dial. (mm):**	76.1
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.69

Container No.:	29	Moisture content before testing (%):	**5.37**
Mass of container (g):	84.39	Moisture content after testing (%):	**23.27**
Mass of wet sample + container before testing (g):	176.37	Dry density before testing (kg/m3):	**1476**
Mass of wet sample + container after testing (g):	191.99	Bulk density before testing (kg/m3):	**1556**
Mass of dry sample + container (g):	171.68	Percentage saturation before test (%):	**8.69**
		Percentage saturation after test (%):	**37.56**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio	Modulus of Compressibility Mv Stress Range(kPa)	Mv (kPa-1)	Stress Range(kPa	Mv (kPa-1)
1	2500	1.663				
10	2464	1.654	1 - 10	**3.82E-04**	1 - 10	**3.82E-04**
10	2508	1.667	10 - 10			

Swell (%)

1.79



Reference no.: 7980

Drennan Maud and Partners

Fig. no. -

APPENDIX D
Plates

Plate 1 : Google Earth image of site indicating existing school boundary marked in red with requested development areas marked in yellow.

Plate 2 : Observer looking downslope from eastern development area in a westerly direction across gently sloping site. TP 1 excavation in midground.

Plate 3 : Example of existing permanent pit latrines on site with single storey school structures located in background.

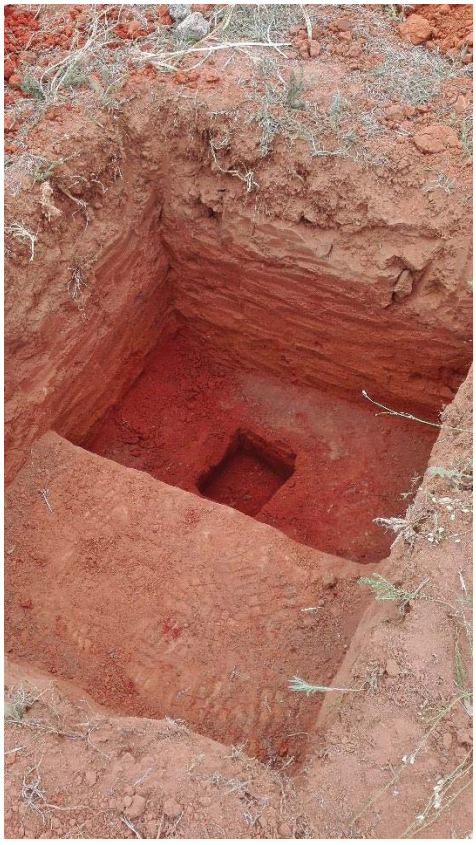
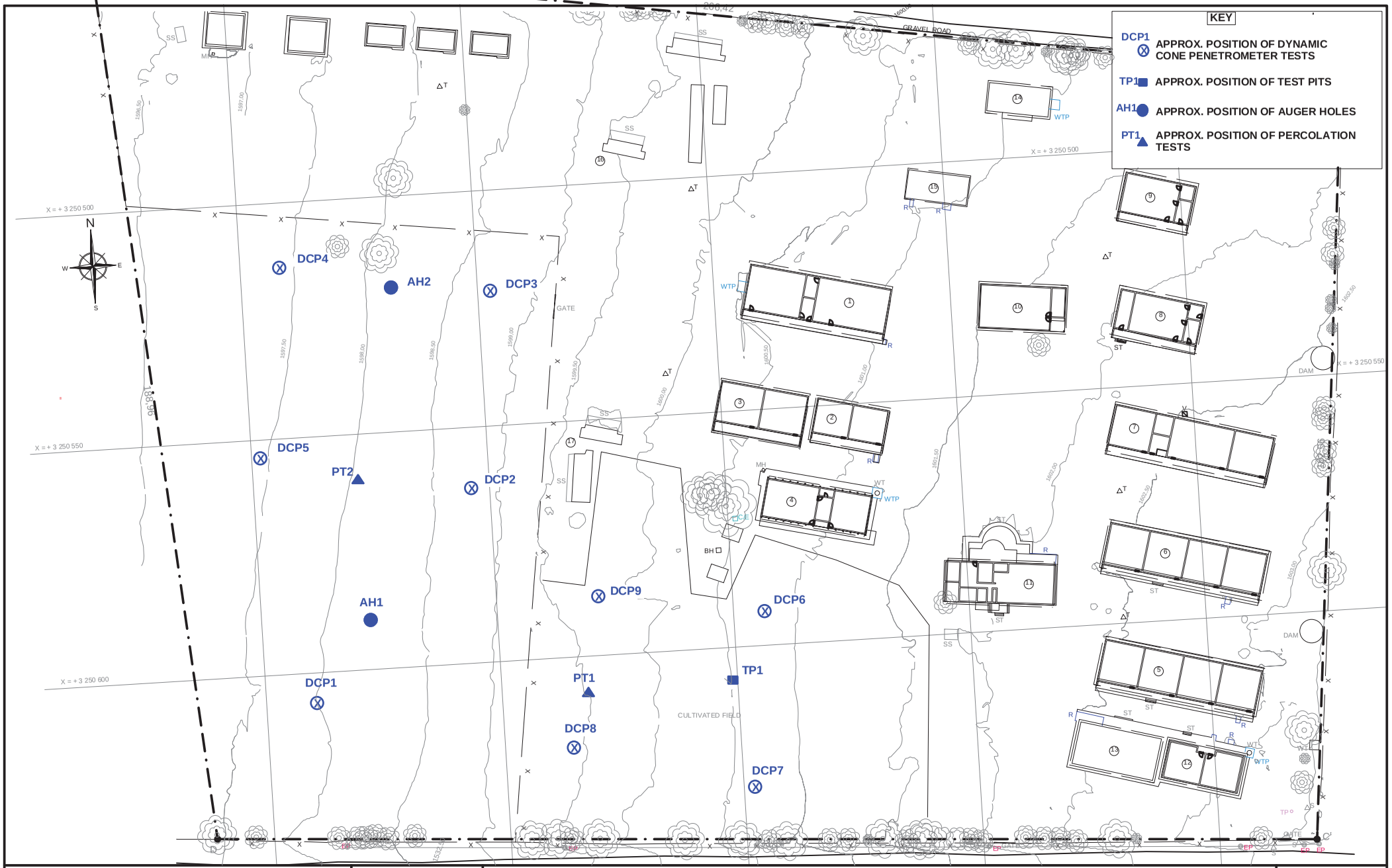


Plate 4 : Subsoil exposed in TP 1 excavated to 1.2m and extended via auger to 1.5m depth.

Plate 5 : Percolation testing and subsoils exposed in PT2 pit.

FIGURE 1
Site Plan



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DESIGNED :	A.J.
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DATE :	18/01/2016
SCALE :	1:750
CHECKED :	

GEOTECHNICAL INVESTIGATION
LESOTHO SCCHOOLS UPGRADE PROJECT
ABIA HIGH SCHOOL - E1

REF. NO. 31181-2

FIG. NO. 1

DRENNAN MAUD (PTY) LTD

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OUR REF: 31181-7

YOUR REF:

Matsuda Consultants International Co. Ltd.
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Tokyo,
JAPAN
151-0053

08th February 2016

Attention: Mr H. Iguchi

Email: iguchi@matsucon.co.jp

Dear Sirs,

GEOTECHNICAL INVESTIGATION FOR PROPOSED LESOTHO SCHOOLS UPGRADE PROJECT : MOTSEKUOA HIGH SCHOOL - LESOTHO

1. INTRODUCTION

Drennan Maud (Pty) Ltd was requested to provide a fee proposal to undertake a series of geotechnical investigations for the proposed Lesotho Schools Upgrade Project.

A letter, Ref 91, dated 28th October 2015, detailing the proposed investigation intended at the various school upgrade sites, as prescribed in the initial project brief document, and the itemised cost thereof was provided.

Subsequent notice of appointment and instruction to proceed with the outlined investigation was received during the course of November 2015, followed by attendance at a project meeting held in Maseru, Lesotho on the 23rd November 2015.

We confirm that the sites that comprise the scope of the upgrade project were visited in due course and the data obtained from each has been assessed.

Set down below are our site observations and geotechnical assessment of the prevailing subsoil conditions at the existing Motsekuoa school as well as our recommendations for the proposed development.

2. SUPPLIED INFORMATION

Information supplied by the client for the purpose of the investigation included the following;

- Google Earth image of the site indicating the predetermined number and location of field testing to be carried out on site.
- Cadastral site plan of the existing school property
- Contoured survey plan of the school property indicating the layout of existing structures on site.

3. PROPOSED DEVELOPMENT

The proposed upgrade of the existing Motsekuoa school will comprise the construction of an unknown amount of single storey, reinforced concrete frame / brickwork infill school buildings along with ablution facilities.

No indication of the proposed earthworks or layout of the intended structures across the proposed development area was provided at this preliminary stage.

4. FIELD WORK

The site was visited on the 8th December 2015 during which time the geotechnical investigation of the site was carried out.

The attached site plan, Figure 1 of this report, indicates the approximate positions of the field testing relative to the site boundaries whilst description of the field work carried out on site is provided below;

4.1 Subsoil Excavations

A total of 3 pits, including 1 test pit (TP1) and two percolation test pits (PT1-2) were excavated to depths ranging between 1.0 - 1.3m depth to assess the subsoil conditions below the site, obtain soil samples for laboratory testing and conduct percolation tests to determine the subsoil percolation characteristics of the site.

In addition 3 hand auger holes (AH1-3) were excavated using a hand auger apparatus to a maximum depth of 2.6m.

The materials encountered within the pits and removed from the hand auger holes were examined and logged by an Engineering Geologist in accordance with the Guidelines for Soil and Rock Logging in South Africa 2nd impression 2002. The subsoil profiles are included in Appendix A of this report.

4.2 Dynamic Cone Pentrometer (DCP) Testing

A total of 9 DCP tests were carried out across the investigated portion of the site to determine the subsoil consistency and depth to weathered bedrock if located at a shallow to moderate depth below the surface. The graphical results of the DCP testing are included as Appendix B of this report.

To aid in the interpretation of the DCP results, Table 1 below is provided and indicates the correlation between the number of blows required to progress the probe a distance of 300mm and the respective consistency of the subsoil for non-cohesive and cohesive material. However, it should be noted that this table is specific to Drennan Maud (Pty) Ltd equipment and thus should only be consulted as a guide.

Table 1 : Subsoil Consistency Inferred from the DCP Test Results

Cohesive Soils		Non-Cohesive Soils	
DCP Blow Count Blow / 300mm (SPT 'N' Value)	**Subsoil Consistency**	**DCP Blow Count Blows / 300mm (SPT 'N' Value)**	**Subsoil Consistency**
0 - 4 (<2)	Very Soft	0 - 8 (<4)	Very Loose
4 - 8 (2 - 4)	Soft	8 - 18 (4 - 10)	Loose
8 - 15 (4 - 8)	Firm	18 - 54 (10 - 30)	Medium Dense
15 - 24 (8 - 15)	Stiff	54 - 90 (30 - 50)	Dense
24 - 54 (15 - 30)	Very Stiff	>90 (50 - 80)	Very Dense
> 54	Hard		

4.3 Percolation Testing

Percolation testing was carried out as per SABS 0400 - 1987 standards within subsoil excavations designated PT1 and PT2 to determine the percolation rate of the prevailing subsoils.

Note, percolation testing as per method stipulated in the initial project brief document was attempted but found to be impractical due to the significant time required for each test and the slow percolation rates of the subsoils. As such, the method was abandoned and testing as per SABS 0400 -1987 standards, the standards currently utilised in South Africa for percolation testing, was adopted.

SABS 0400 -1987 requires percolation testing to be carried out in the following manner;

A test hole is excavated on site to a suitable depth with a smaller 300mm x 300mm x 300mm hole excavated at the base of the pit. The smaller hole is filled to a height of no less than 300mm and maintained at such a level for a period of no less than 4hours.

At the end of the 4 hour period the level of the water is topped up and the time at which the test is noted. The drop in level of the water as it soaks away over a subsequent period of 30 minutes is measured. The time taken for the water level to drop by 25mm increments is measured with the average of this time during the 30minute period taken as the percolation rate. Where such percolation rate is less than 30minutes the soils on site are deemed suitable for potential subsoil percolation. Should the water level not drop by 25mm within the 30 minute period the subsoils are considered unsuitable.

The results of the percolation testing are discussed further in Section 7 of this report.

4.4 Material Sampling

Several representative soil samples were retrieved from the subsoil excavations and submitted to a local laboratory (Materials Testing Laboratory) for testing with certain samples retained and returned to Thekwini Soils Laboratory in Durban for speacialised testing.

The schedule of samples obtained and testing conducted thereon is provided in Table 2 below;

Table 2: Schedule of Laboratory Testing

Pos	Material Description	D epth (m)	Laboratory Test			
			Ind	Mod	CBR	Triax
TP1	Grey brown, clayey silty SAND - Colluvium/Topsoil	0.0 - 0.3	✔	✔	✔	
TP1	Grey mottled orange, silty CLAY - Residual	0.3 - 1.1	✔*			✔*
PT1	Dark brown/grey, silty CLAY - Residual	0.2 - 0.7	✔	✔	✔	
PT2	Dark brown, silty CLAY - Colluvium/Residual	0.35 - 1.0	✔	✔	✔	
AH1	Grey mottled orange, silty CLAY - Residual	0.8 - 2.6	✔*			

The results of the various above listed laboratory tests are included in Appendix C of this report and discussed further in Section 6.

5. SITE DESCRIPTION

5.1 Locality and Topography

The site is located on the outskirts of the rural town of Motsekuoa along the main road between the towns of Morija and Mafeteng towards the south western portion of Lesotho.

The existing school site is relatively level to gently sloping in a westerly direction at approximately 2° with a planar to slightly convex slope conformation.

The proposed development area comprises the currently vacant area along the western boundary of the site as well as a portion of the currently ploughed field to the immediate south thereof (Plate 1 - Appendix D).

The school site is characterisded by a number of existing single storey structures, some of which display significant cracking in the walls thereof, likely induced by heave within the underlying subsoils (Plate 2).

5.2 Geology and Soils

Inspection pit and hand auger excavations revealed the following general profile below the investigated area;

DEPTH (m)	MATERIAL DESCRIPTION
0.00 - 0.2 / 0.5	Dry to slightly moist, brown and grey brown, medium dense, clayey SAND to sandy clay - (Topsoil/colluvium)
0.2 / 0.5 - 0.7 / 2.6	Slightly moist, brown and grey brown mottled orange and khaki brown, very stiff, slickensided, fissured, slightl;y sandy and gravelly, silty CLAY containing occasional ferricrete/calcrete nodules - (Residual)

DCP probes, which reveal very similar results across the entire investigated area, indicate the upper sandy subsoils are generally medium dense to dense/very stiff, thereunder becoming consistently very stiff with depth. DCP refusal was encountered at depths ranging between 2.65 - 2.85m below existing ground level on inferred deeply weathered bedrock or very stiff/hard residual material.

5.3 Groundwater Conditions

No ground water seepage was encountered within any subsoil excavations or noted on the extraction of the DCP apparatus. As such permanent ground water level is located at depth below the site beyond the scope of the shallow investigation. However, a perched ground water table, during wetter climatic periods is likely given the presence of ferricrete/calcrete nodules encountered within the residual soil profile.

6. LABORATORY TEST RESULTS

6.1 Topsoil

The clayey sandy material has a clay and silt content of 17.8% and grading modulus of 0.6. The material has a liquid limit of 22.8%, plasticity index of 6.2 and linear shrinkage value of 2.0%. In terms of the above the material classifies as an A-2-4 type material (after AASHTO clasification).

The material has a Mod AASHTO density of 1849 kg/m^3 at an optimum moisture content of 13% with CBR values of 6 and 8 recorded at a compaction effort of 90% and 98% Mod AASHTO density respectively with a CBR swell value of 0.3. In terms of TRH 14 - 1985 standards the material classifies as G9 type material.

6.2 Residual/Colluvium

The material, which classifies as slightly sandy and silty clay with clay contents ranging between 54.4 to 60% and grading moduli ranging from 0.16 - 0.29. The material has a liquid limit range of 25.4 - 48.5%, plasticity index range of 9.2 - 30.8 and linear shrinkage values ranging from 4.0 - 12.7%. In terms of the above the clayey material classifies as A-6 to A-7-6 type material after the AASHTO classification system. The clayey material has a medium potential expansiveness rating.

The residual material encountered within PT1 and 2 are similar and have Mod AASHTO densities of 1874kg/m^3 and 1866 kg/m^3 at optimum moisture contents of 14.3% and 9% respectively. CBR values ranging between 3 - 4% at 90% Mod AASHTO density increasing to 4 - 6% at 98% Mod AASHTO density were recorded for the samples with CBR swell values ranging between 0.2 - 0.3%. In terms of the above the material classifies marginally as a G10 type material (after TRH 14 -1985 standards).

However, we consider that the CBR swell values in the residual material should be higher (>1.5) given the clayey nature of the material and thus the material is more likely to classify as a G10+ material.

Triaxial (consolidated drained) testing carried out on the residual material (TP1 0.3 - 1.1m) indicates the material has a internal friction angle 'Φ' of 19° with a cohesion 'C' of 20 kPa.

7. GEOTECHNICAL APPRAISAL

The subsoils underlying the development area are considered highly problematic in terms of potential expansiveness (i.e. the material is subject to significant volume change with fluctuations in the material in situ moisture content). Large surface fissures within the upper clayey subsoils (Plate 4) indicate the severity of the volume change which can be highly destructive to structures place thereon if not properly constructed to accommodate potential heave/shrinkage.

The upper sandier material is susceptible to erosion via wind and flowing water.

No unduly hard material is expected and 'soft' excavation after SABS 1200D can be assumed throughout the scope of the earthworks. Manual excavation in the stiff clay soils will prove challenging and time consuming.

Despite laboratory testing indicating the materials classify as G10 type material, given the clayey nature thereof and associated potential expansiveness the materials are considered unsuitable for use as bulk fill and subgrade material. The material will not lend themselves easily to compaction for the creation of fill embankments.

Due to the clayey nature of the subsoils, it is not unexpected that the percolation testing carried out in PT1 and 2 both met with failure as after the initial soaking period the time taken for a 25mm incremental drop in water level exceeded the maximum allowed 30 minutes. As such the percolation rate within the clayey soils is considered unsuitable and hence effluent disposal via subsoil percolation is deemed unfeasible on site.

8. DEVELOPMENT RECOMMENDATIONS

Despite the clayey subsoils and the problems associated therewith, the proposed development on site is considered feasible provided the recommendations given below, appropriate for the prevailing subsoils, are adhered to during the design and construction phases of development.

8.1 Earthworks

No earthworks layout has been provided at this stage. However, given the level nature of the site only minor earthworks are envisaged across the development area

All cut embankments in the upper colluvium and underlying residual material should be restricted to a maximum batter of 1:2 (26°). Post construction all cut batters should be vegetated to avoid the onset of erosion thereon.

The creation of fills on site should be avoided where practically possible (structures ideally placed entirely in cut). However, if necessary, fills should be constructed of suitable granular, inert material (G10 or better) placed in layers of 300mm loose thickness and compacted to a maximum of 93% Mod AASHTO density prior to the placement of the next layer.

The out batter of all fill embankments should be limited to 1:2 (26°) and should be grassed as soon as possible after construction to minimise the potential for soil erosion thereon.

8.2 Founding

Given the clayey expansive nature of the subsoils it is imperative that foundations are placed at a suitable depth below platform level to mitigate the potential of heave below the foundations.

In this regard the foundations should be taken to a minimum depth of 1.2m below final platform level into stiff clayey subsoils located in the moisture stable zone.

For foundations taken into the stiff clayey subsoils an allowable bearing capacity of 100 kPa can be applied for foundation design.

Structures can be supported on reinforced ground beams spanning column bases or reinforced strip footings.

Where residual material is located at subgrade level below floor slabs, the potentially expansive material should be boxed out to a depth of 300mm and replaced with inert gravelly material. Furthermore the floor slab should be isolated from all walls, columns and foundations to allow for potential differential movement below the floor slab. The structure should also incorporate judiciously placed construction joints in its design.

Lastly it is considered prudent to incorporate a 1.0m wide concrete apron around the perimeter of the structure to keep the moisture content within the subsoils as constant as possible. In this regard flower beds adjacent to the structure or drainage channels that may leak with time should be strictly avoided.

8.3 Site Drainage

Stormwater from all roof area should be channelled by roof gutter to discharge into Jo-Jo storage tanks (or some equivalent) for later general use on site.

The use of soak pits on site for stormwater disposal is considered not feasible within the clay subsoils.

Storm water from all paved/hardened areas should be channeled via surface drains to discharge a suitable distance downslope via energy dissipater (spreader system).

The platforms should be graded such that water is efficiently guided into suitably placed drains and not allowed to pond on the surface and infiltrate into potentially active subsoils at foundation level.

8.4 Sanitation

Disposal of effluent via subsoil percolation in a septic tank and french drain system is unfeasible on site.

As such effluent produced on site from the new development should be dealt with in one of the following two ways;

Effluent may be stored in conservancy tanks, provided there exists a vacuum tanker in the nearby vicinity that can empty the tanks on a weekly basis (depending on the size and amount of users). If no such service is locally available on a regular basis this means of effluent disposal will be unfeasible.

Alternatively, the most practical means of effluent disposal in terms of long term viability at rural schools would be a Ventilated Improved Pit (VIP) latrine system. This system could be designed and located such that it could be easily connected to a flushing system in the future should one become available.

In this regard the pits can be designed as permanent structures with a lined pit sunken deeply into the residual clay soil that can be emptied periodically by a vacuum tanker or manually when required (every 3 to 4 years depending on size and number of users).

Alternatively, the structure may be designed as temporary units and relocated once the pit is full. However, this may depend on the amount of space available on site.

The hand basin water should ideally not be discharged into the pit as this could lead to premature filling of the pit and increased need for desludging. It may be possible to discharge just this water into a shallow soak pit. The wash basin taps should be of reduced pressure and a push button type to reduce the risk of taps being left running.

9. CONCLUSION

The proposed additions at the Motsekuoa school as part of the Lesotho Schools Upgrade project are considered feasible.

However, to ensure the long term integrity of the proposed structures, the earthworks, founding and drainage recommendations set out in this report should be strictly adhered to.

These amount to no more than sound building practices appropriate for the proposed development and the prevailing active clay soils.

We trust that the information provided in this report meets with your immediate requirements in this matter and will be pleased to furnish you with any additional information you may require.

Yours faithfully
DRENNAN MAUD (PTY) LTD

A. JOUBERT Pr.Sci.Nat.

/aj

APPENDIX A
Soil Profiles
(TP 1, PT1 - 2 & AH 1 - 3)

DRENNAN MAUD (PTY) LTD

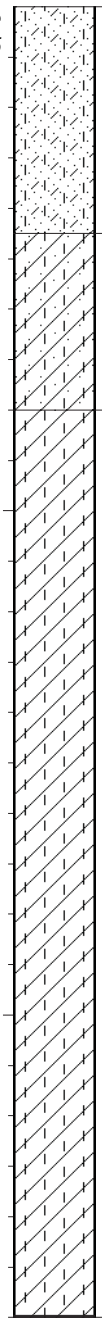
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH1**
Sheet 1 of 1

JOB NUMBER: **31181-7**

Scale 1:15



Smpl.	Depth (m)	
		0.00 Dry to slightly moist, grey brown, loose, clayey, silty, SAND – (Topsoil/Colluvium)
		0.45 Slightly moist, brown mottled orange, firm, slightly gravelly, sandy, silty CLAY – (Residual)
		0.80 Slightly moist, light grey mottled orange and yellow speckled black and white, firm to stiff, slightly gravelly and sandy, silty CLAY containing occasional ferricrete nodules – (Residual)
	1	
o l		
	2	
		2.60

NOTES

1) No ground water seepage encountered

2) Semi refusal (poor recovery) of hand auger at 2.6m in very stiff material or completely weathered material

3) Sample taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/12/2015

DATE : 08/02/16 10:07
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH1**

D06B DRENNAN MAUD & PARTNERS *dot.PLOT 5008 J&W*

DRENNAN MAUD (PTY) LTD

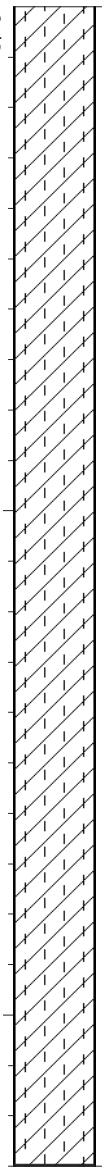
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH 2**
Sheet 1 of 1

JOB NUMBER: **31181-7**

Scale 1:15



0.00

Slightly moist, brown and grey brown mottled orange and speckled black and white in places, very stiff, slightly gravelly, silty CLAY containing occasional ferricrete nodules – (Residual)

1

2

2.30

NOTES

1) No ground water seepage encountered

2) No hand auger refusal encountered although hard excavation was encountered in the stiff material with depth

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/12/2015

DATE : 08/02/16 10:07
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH 2**

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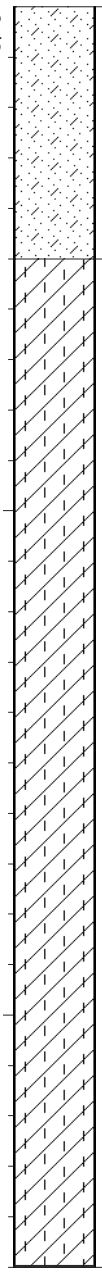
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH3**
Sheet 1 of 1

JOB NUMBER: **31181-7**

Scale 1:15



0.00

Dry, brown and grey brown, medium dense to dense, slightly gravelly, clayey SAND – (Topsoil/Colluvium)

0.50

Slightly moist, brown and grey brown mottled orange brown and khaki brown, very stiff, fissured, slightly gravelly in places, slightly sandy and gravelly, silty CLAY containing occasional ferricrete and calcrete nodules – (Residual)

1

2

2.50

NOTES

1) No ground water seepage encountered

2) No hand auger refusal encountered

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE :
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/12/2015

DATE : 08/02/16 10:07
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH3**

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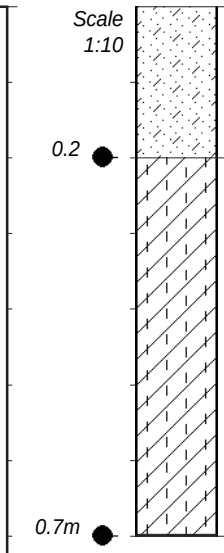
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **PT1**
Sheet 1 of 1

JOB NUMBER: **31181-7**



Dry, grey brown, medium dense, fissured, clayey SAND containing root material – (Topsoil/Colluvium)

Dry to slightly moist, dark brown mottled orange, stiff to very stiff, fissured, slightly sandy and gravelly, silty CLAY – (Residual)

IMC

NOTES

1) Pit excavated to 0.7m via hand digging – hard hand digging in very stiff to hard clay

2) No ground water seepage encountered

3) Sample taken from 0.2 – 0.7m for laboratory testing

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 08/02/16 10:07
TEXT : ..C:\DOTIN\SPMASTER.DOC

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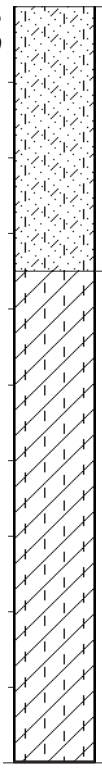
MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **PT2**
Sheet 1 of 1

JOB NUMBER: **31181-7**

Scale 1:10



0.00

Dry, grey brown, medium dense, intact, slightly gravelly, clayey, silty, SAND – (Topsoil/Colluvium)

0.35

Dry, dark brown, very stiff, fissured, slightly sandy, silty CLAY – (Residual)

1

1.00

o
IMC

NOTES

1) No ground water seepage encountered

2) Hard hand digging encountered at base of excavation

3) Sample taken for laboratory testing

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT2**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 08/02/16 10:07
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Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: TP1
Sheet 1 of 1

JOB NUMBER: 31181-7

Smpl.	Depth (m)
o IMC	Scale 1:10
	0.00 Dry, grey brown, medium dense, fissured, clayey, silty, SAND containing root material – (Topsoil)
	0.30 Slightly moist, grey and grey brown mottled orange, very stiff, slickensided, fissured, slightly sandy, silty, CLAY – (Residual)
Tria	1
	1.10

NOTES

1) Hand dug to 1.1m – hard hand digging at 1.1m depth in very stiff clay

2) No ground water seepage encountered

3) Samples taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 08/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP1

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 08/02/16 10:07
TEXT : ..C:\DOTIN\SPMASTER.DOC

APPENDIX B
DCP Test Results
(DCP 1 - 9)

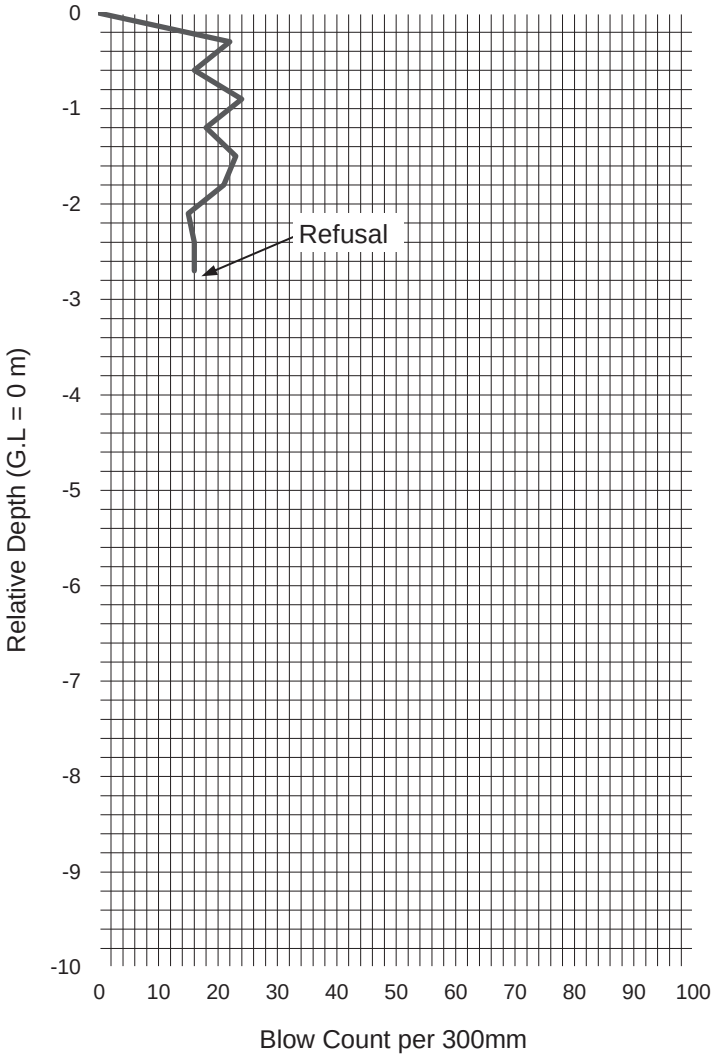
Dynamic Cone Penetrometer

Test No. : 9

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 08-12-2015 Remarks: -
Test Location: Mosekuoa School - Lesotho -
Date of Test: 08-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	22
-0.6	16
-0.9	24
-1.2	18
-1.5	23
-1.8	21
-2.1	15
-2.4	16
-2.7	16

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

APPENDIX C
Laboratory Test Results Summary

Laboratory Test Summary

THEKWINI SOILS LAB. CC

Job Description: LESOTHO SCHOOLS - REF31181-7
Job no.: 7980
Date: 11/01/16

Lab no.		12093	12101									
Location		TP1	AH1									
Depth		0.3-1.1	0.8-2.6									
Description		-	-									
		-	-									
Binder Material		-	-									
Particle Size (mm)	75											
	53											
	37.5											
	26.5											
	19											
	13.2											
	9.5	100										
	4.75	98	100									
	2	97	100									
	0.425	96	100									
	0.25	92	97									
	0.15	86	92									
	0.075	78	84									
Hydrometer	0.05	74	76									
	0.02	65	69									
	0.005	58	65									
	0.002	54	60									
Soil Mortar	Coarse Sand <2.0 >0.425mm	1.5	0.4									
	Fine Sand <0.425>0.05mm	25.4	24.3									
	Silt <0.05 >0.005	16.0	10.5									
	Clay <0.005	57.1	64.8									
Atterberg Limits	Liquid Limit % (m/m)	47.9	48.5									
	Plasticity Index	24.4	30.8									
	Linear Shrinkage %	12.7	12									
	Natural MC %	-	-									
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *		A - 7 - 6 (19)	A - 7 - 6 (26)									
Grading Modulus		0.29	0.16									
TRH 14 (1985) *												

Signature: .....
Title: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOLS - REF31181-7

Ref no.: 7980 **Lab no.:** 12093 **Borehole/Pit no.:** TP1 **Fig no.:** -

Description: -

Depth: 0.3-1.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	98.0
2	97.4
0.425	95.9
0.25	91.6
0.15	86.0
0.075	77.9
0.05	74.3
0.02	65.2
0.005	58.0
0.002	54.4

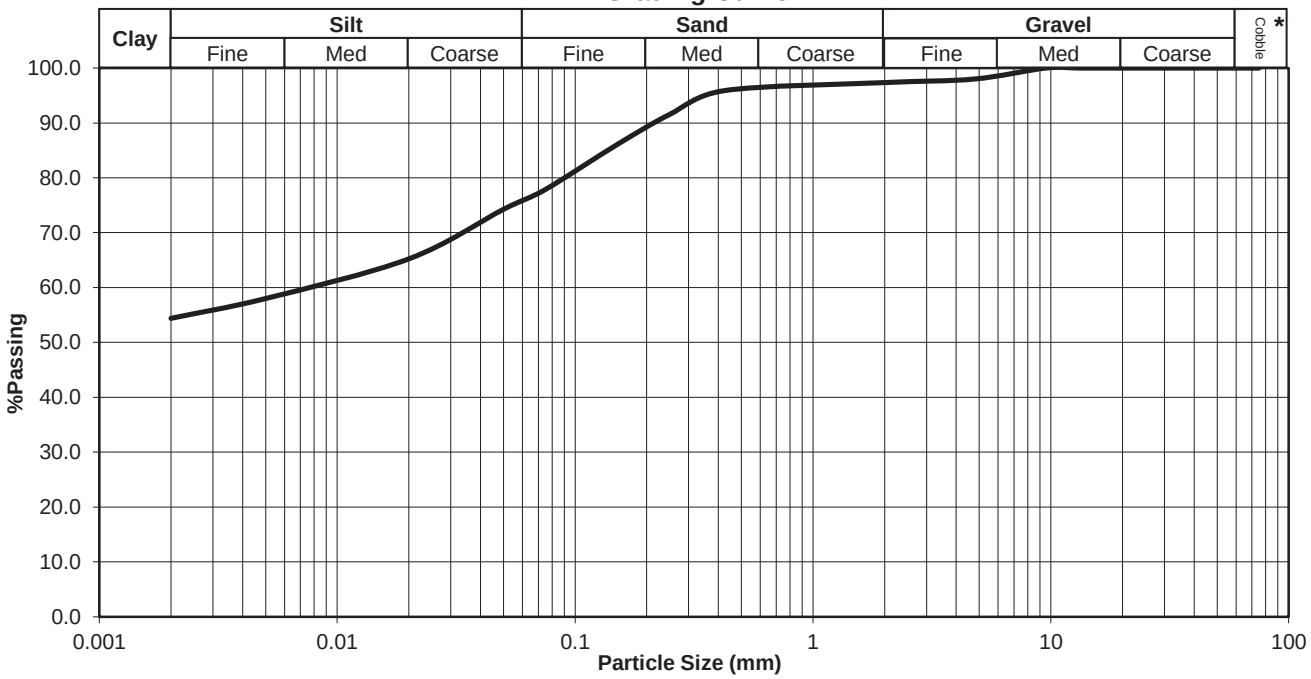
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	2.6
Coarse	0.0
Medium	1.5
Fine	1.2
Sand%	21.7
Coarse	1.3
Medium	7.3
Fine	13.1
Silt%	21.3
Coarse	10.5
Medium	6.7
Fine	4.1
Clay%	54.4

PLASTICITY	
Liquid Limit, %	47.9
Plasticity Index	24.4
Linear Shrinkage, % (L/L)	12.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	0.29

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	19
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 7980 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.
The results only relate to the samples tested.
The report may not be reproduced except in full.

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOLS - REF31181-7

Ref no.: 7980 **Lab no.:** 12101 **Borehole/Pit no.:** AH1 **Fig no.:** -

Description: -

Depth: 0.8-2.6 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	100.0
2	100.0
0.425	99.6
0.25	96.8
0.15	92.3
0.075	84.0
0.05	75.6
0.02	69.3
0.005	65.0
0.002	60.0

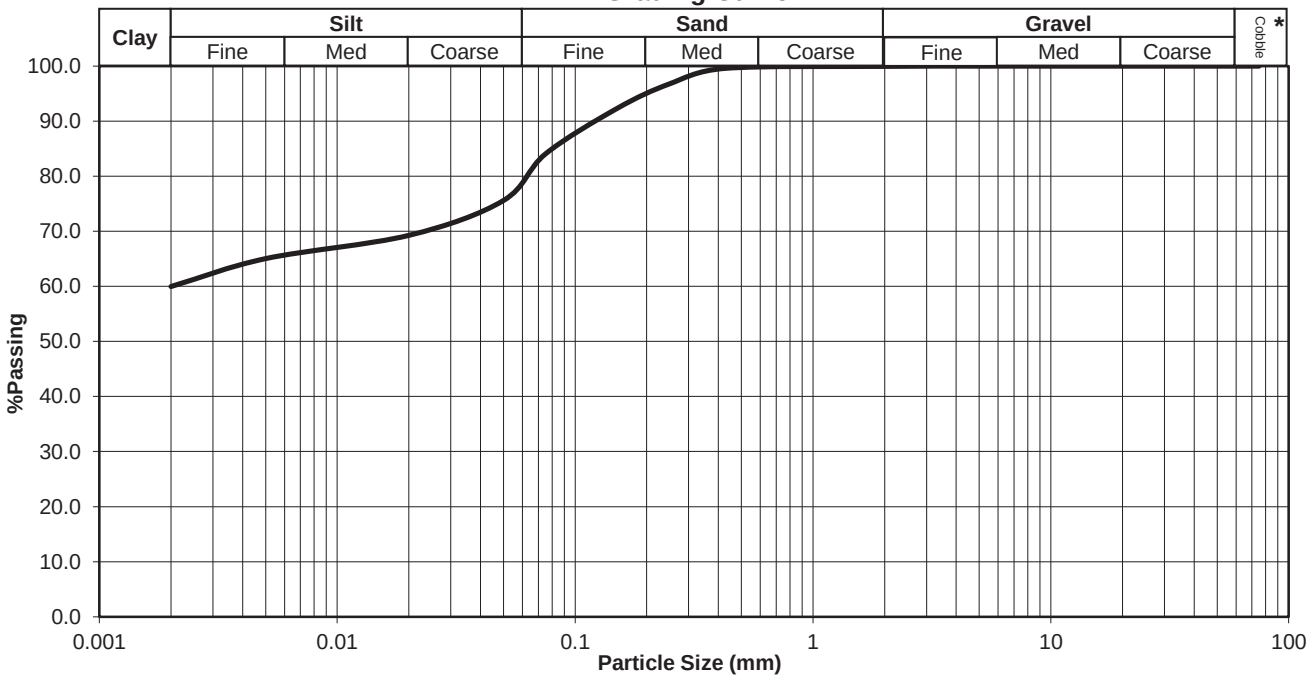
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	0.0
Coarse	0.0
Medium	0.0
Fine	0.0
Sand%	21.0
Coarse	0.3
Medium	5.1
Fine	15.6
Silt%	19.0
Coarse	9.7
Medium	3.9
Fine	5.3
Clay%	60.0

PLASTICITY	
Liquid Limit	48.5
Plasticity Index	30.8
Linear Shrinkage	12

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.16

CLASSIFICATION *	
Potential Expansiveness	Medium
Group Index	26
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 7980 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.

The results only relate to the samples tested.

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MATERIALS TESTING LABORATORY

PO Box 0391 Maseru West 0105. Cell: (+266) 28311199
Email: molefen@leo.co.ls

Reporting Form (For Soil and Gravel Samples)						
Project	Lesotho Schools		Client: Drennan Maud		Date reported: 14-12-2015	
Date sampled	14-12-2015				Project nu: 31181	
Sample no		8883	8884	8885		
		Motsekuoa School	Motsekuoa School	Motsekuoa School		
Position		TP1	PT1	PT2		
Depth		0.0-0.3m	0.2-0.7m	0.35-1.0m		
Material Description		Greyish Clay + Stones	Blackish Clay	Blackish Clay		
Sieve analysis % passing	75,0					
	63,0					
	53,0					
	37,5					
	26,5					
	19,0					
	13,2	100	100			
	475	99.3	93.4	100		
	2,00	98.4	89.2	99.8		
	0,425	97.4	86.6	98.6		
	0,075	47	33.4	40.2		
Soil mortar						
2,00 - 0,425		1.0	2.9	1.2		
0.425 - 0.250		12.1	15.2	13.9		
0.250 - 0.150		17.9	18.5	17.9		
0.150 - 0.075		21.2	25.9	26.9		
<0,075		17.8	37.4	40.3		
Atterberg Constants						
Grading modulus (GM)		0.6	0.9	0.6		
Liquid limit		22.8	25.4	26.1		
Plasticity index		6.2	11.6	9.2		
Linear shrinkage		2.0	6.0	4.0		
Classification: TRH14		G9	G10	G10		
Mod. AASHTO						
MDD (kg/m^3)		1849	1874	1866		
OMC (%)		13	14.3	9.0		
Mould MC (%)		13.2	14.1	9.2		
% Compaction		99.9	99.8	100.0		
% swell			0.2	0.2		
NRB						
Dry density (kg/m^3)		1757	1780	1773		
% of MDD		95.5	95.0	95.0		
% swell		0.3	0.3	0.2		
Proctor						
Dry density (kg/m*)		1665	1688	1680		
% of MDD		90.1	90.1	90.0		
% swell		0.3	0.2	0.2		
C.B.R values	100%	9	4	7		
S*	98%	8	4	6		
$	97%	8	4	6		
S- -	95%	8	4	5		
sc.	93%	7	3	5		
	90%	6	3	4		
Bearing Capacity (kPa)						

CONSOLIDATED DRAINED TRIAXIAL TEST

SUMMARY OF RESULTS

THEKWINI SOILS LAB. CC

V.A.T. REGISTRATION NO. 4590210961.

68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992

P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Motsekuoa School, Lesotho
Ref no.: 7980
Lab no.: 12093 **Depth:** 0.80 - 1.10
Description: **Position:** TP1
-

Test 1

Inputs					
L (cm)	7.92	Lo (cm)	7.92	MC Before (%)	15.7
A (cm^2)	11.95	Ao (cm^2)	11.95	MC After (%)	18.8
V (cc)	94.61	Vo (cc)	94.61	Bulk Density (kg/m3)	2017
		Prooving Ring	1.00	Dry Density (kg/m3)	1743
		Sigma3	100		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.95	0	0	0	0	0	0
12.09	1.59	70.8	-0.42	135.4	35.4	1.71
12.07	1.89	67.0	-0.85	133.5	33.5	1.67
12.05	2.03	68.8	-1.16	134.4	34.4	1.69
12.09	2.42	86.8	-1.27	143.4	43.4	1.87
12.16	3.24	95.2	-1.48	147.6	47.6	1.95
12.24	4.08	103.4	-1.69	151.7	51.7	2.03
12.29	4.77	111.1	-2.01	155.6	55.6	2.11
12.39	5.61	116.6	-2.11	158.3	58.3	2.17
12.50	6.45	121.8	-2.11	160.9	60.9	2.22
12.58	7.27	127.3	-2.33	163.6	63.6	2.27
12.67	8.10	131.0	-2.54	165.5	65.5	2.31
12.73	8.93	135.8	-2.96	167.9	67.9	2.36
12.82	9.76	139.5	-3.17	169.7	69.7	2.39
12.94	10.59	141.9	-3.17	171.0	71.0	2.42
13.03	11.43	144.6	-3.38	172.3	72.3	2.45
13.16	12.26	146.9	-3.38	173.5	73.5	2.47
13.25	13.09	148.8	-3.59	174.4	74.4	2.49
13.35	13.92	149.8	-3.81	174.9	74.9	2.50
13.45	14.75	151.6	-4.02	175.8	75.8	2.52
13.55	15.58	152.5	-4.23	176.3	76.3	2.53
13.66	16.41	153.4	-4.44	176.7	76.7	2.53
13.76	17.21	154.4	-4.65	177.2	77.2	2.54
13.83	18.03	154.9	-5.07	177.4	77.4	2.55

Test 2

Inputs					
L (cm)	7.92	Lo (cm)	7.92	MC Before (%)	15.3
A (cm^2)	11.95	Ao (cm^2)	11.95	MC After (%)	17.5
V (cc)	94.61	Vo (cc)	94.61	Bulk Density (kg/m3)	2017
		Prooving Ring	1.00	Dry Density (kg/m3)	1748
		Sigma3	200		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.95	0	0	0	0	0	0
12.09	1.42	111.8	-0.21	255.9	55.9	1.56
12.08	1.72	108.8	-0.63	254.4	54.4	1.54
12.07	1.85	110.4	-0.85	255.2	55.2	1.55
12.08	2.15	138.2	-1.06	269.1	69.1	1.69
12.16	2.91	151.1	-1.16	275.6	75.6	1.76
12.26	3.69	164.5	-1.16	282.2	82.2	1.82
12.30	4.35	176.0	-1.48	288.0	88.0	1.88
12.40	5.12	185.7	-1.48	292.9	92.9	1.93
12.51	5.93	194.4	-1.48	297.2	97.2	1.97
12.59	6.73	203.4	-1.69	301.7	101.7	2.02
12.70	7.52	209.4	-1.69	304.7	104.7	2.05
12.78	8.30	216.6	-1.90	308.3	108.3	2.08
12.86	9.09	222.1	-2.11	311.1	111.1	2.11
12.95	9.90	227.5	-2.33	313.7	113.7	2.14
13.06	10.69	231.5	-2.33	315.7	115.7	2.16
13.15	11.49	235.9	-2.54	317.9	117.9	2.18
13.25	12.29	240.2	-2.75	320.1	120.1	2.20
13.37	13.08	242.4	-2.75	321.2	121.2	2.21
13.49	13.89	244.4	-2.75	322.2	122.2	2.22
13.59	14.69	247.7	-2.96	323.9	123.9	2.24
13.69	15.48	249.5	-3.17	324.7	124.7	2.25
13.78	16.26	251.3	-3.38	325.6	125.6	2.26
13.91	17.05	253.1	-3.38	326.5	126.5	2.27

Test 3

Inputs					
L (cm)	7.92	Lo (cm)	7.92	MC Before (%)	15.5
A (cm^2)	11.95	Ao (cm^2)	11.95	MC After (%)	17.1
V (cc)	94.61	Vo (cc)	94.61	Bulk Density (kg/m3)	2017
		Prooving Ring	1.10	Dry Density (kg/m3)	1746
		Sigma3	300		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.95	0	0	0	0	0	0
12.06	1.33	195.3	-0.42	397.7	97.7	1.65
12.04	1.61	200.8	-0.85	400.4	100.4	1.67
12.05	1.73	203.3	-0.85	401.7	101.7	1.68
12.07	2.04	252.1	-1.06	426.1	126.1	1.84
12.15	2.80	276.6	-1.16	438.3	138.3	1.92
12.23	3.56	298.0	-1.27	449.0	149.0	1.99
12.28	4.18	312.8	-1.48	456.4	156.4	2.04
12.38	4.96	323.4	-1.48	461.7	161.7	2.08
12.46	5.75	332.8	-1.69	466.4	166.4	2.11
12.56	6.52	338.7	-1.69	469.4	169.4	2.13
12.64	7.31	344.4	-1.90	472.2	172.2	2.15
12.75	8.10	348.2	-1.90	474.1	174.1	2.16
12.86	8.89	351.0	-1.90	475.5	175.5	2.17
12.95	9.69	352.9	-2.11	476.4	176.4	2.18
13.04	10.51	352.0	-2.33	476.0	176.0	2.17
13.12	11.28	352.1	-2.54	476.1	176.1	2.17
13.21	12.06	351.4	-2.75	475.7	175.7	2.17
13.33	12.86	349.7	-2.75	474.8	174.8	2.17
13.45	13.65	344.8	-2.75	472.4	172.4	2.15
13.55	14.42	341.5	-2.96	470.8	170.8	2.14
13.64	15.19	339.1	-3.17	469.5	169.5	2.13
13.74	15.97	336.6	-3.38	468.3	168.3	2.12
13.87	16.79	331.6	-3.38	465.8	165.8	2.11

CONSOLIDATED DRAINED TRIAXIAL TEST
SUMMARY OF RESULTS

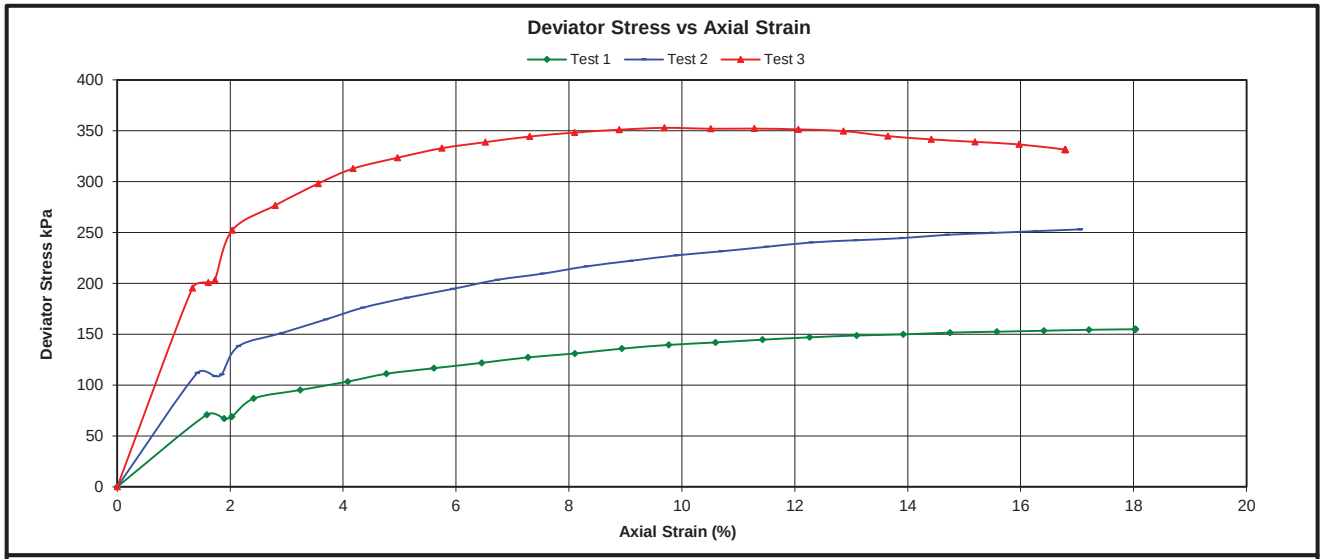
THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

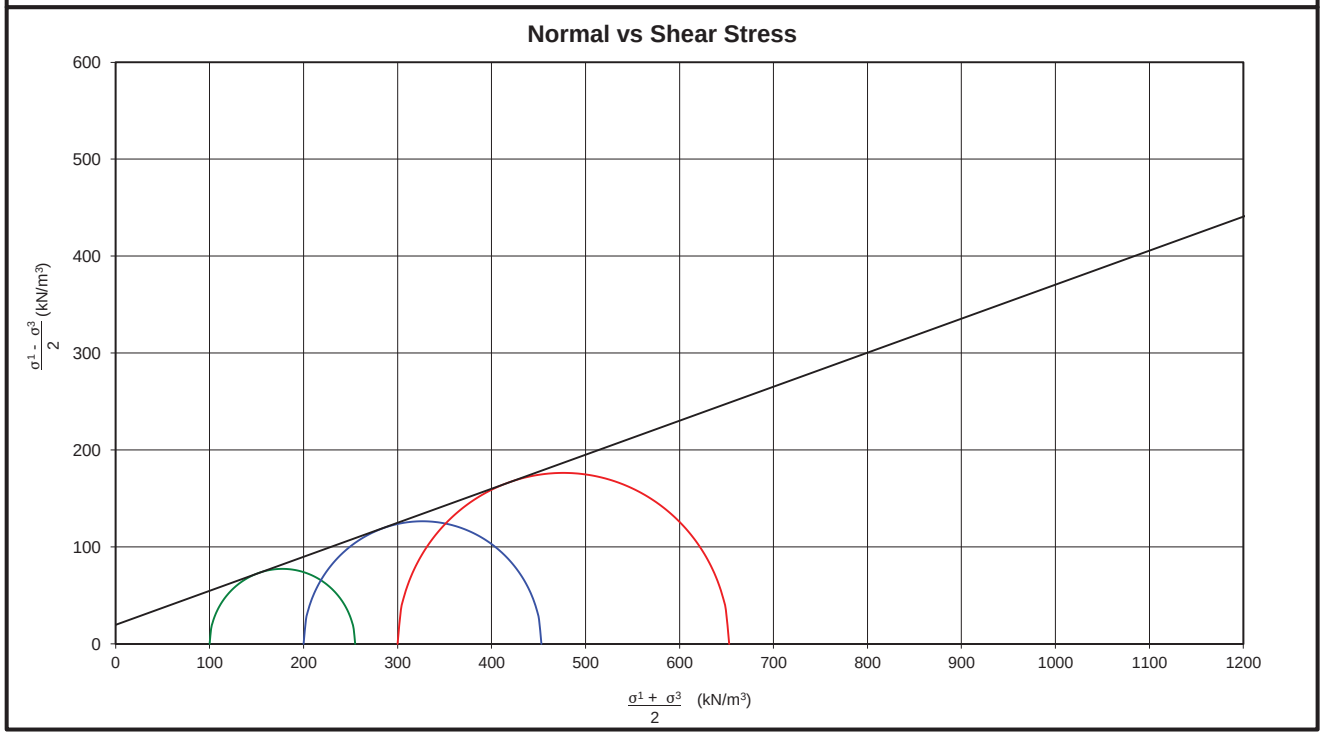
Project: Motsekuoa School, Lesotho
Ref no.: 7980
Lab no.: 12093
Depth: 0.80 - 1.10 **Description:**
Position: TP1 -

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	100	200	300
Dry Density (kg/m^3)	1332	1748	1746
NMC(%)	15.7	15.3	15.5
Axial Strain (%)	18.0	17.1	9.7
$\frac{\sigma^1 + \sigma^3}{2}$	177.4	326.5	476.4
$\frac{\sigma^1 - \sigma^3}{2}$	77.4	126.5	176.4
$\frac{V\triangle}{Vo}$	-5.07	-3.38	-2.11

Shear Strength Perameters

Angle of Internal Friction (0^0)	19
Cohesion (kPa)	20





APPENDIX D
Plates

Plate 1 : Google Earth image of site with existing school boundary marked in red and identified development/investigation area marked in yellow.

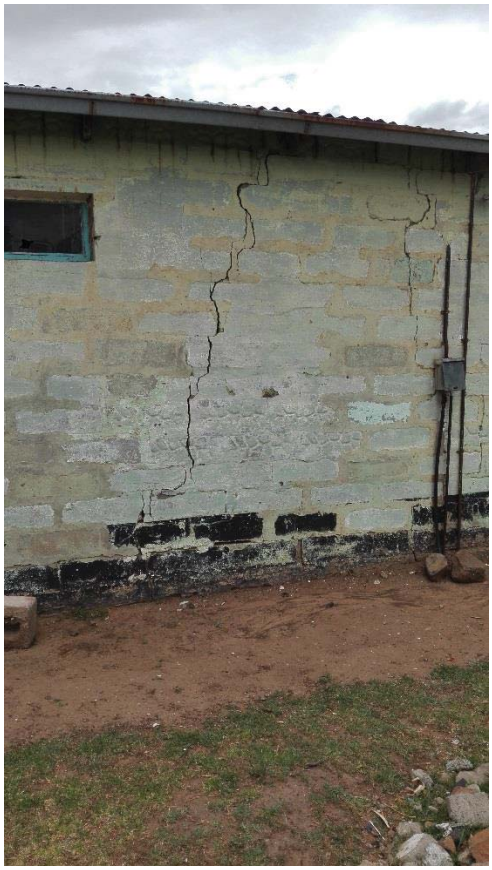


Plate 2 : Certain existing single storey school structure with significant cracking/structural damage.

Plate 3 : Typical dark grey clayey subsoils exposed in PT2 pit in which percolation test carried out.

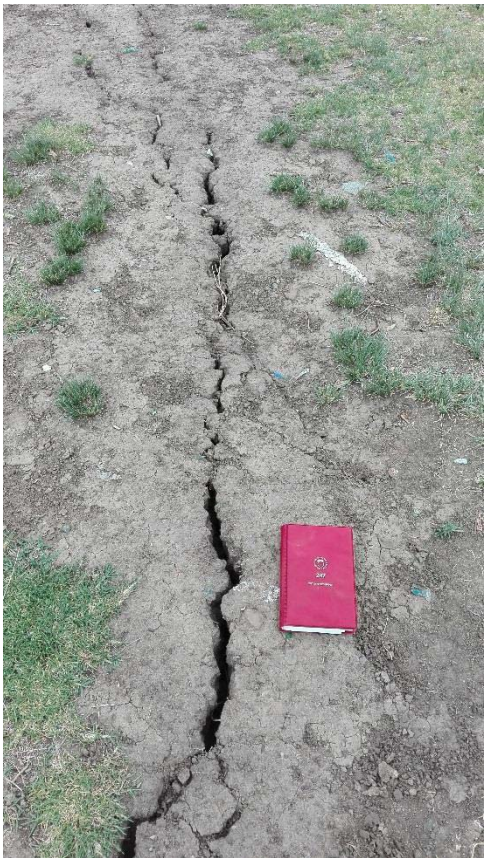
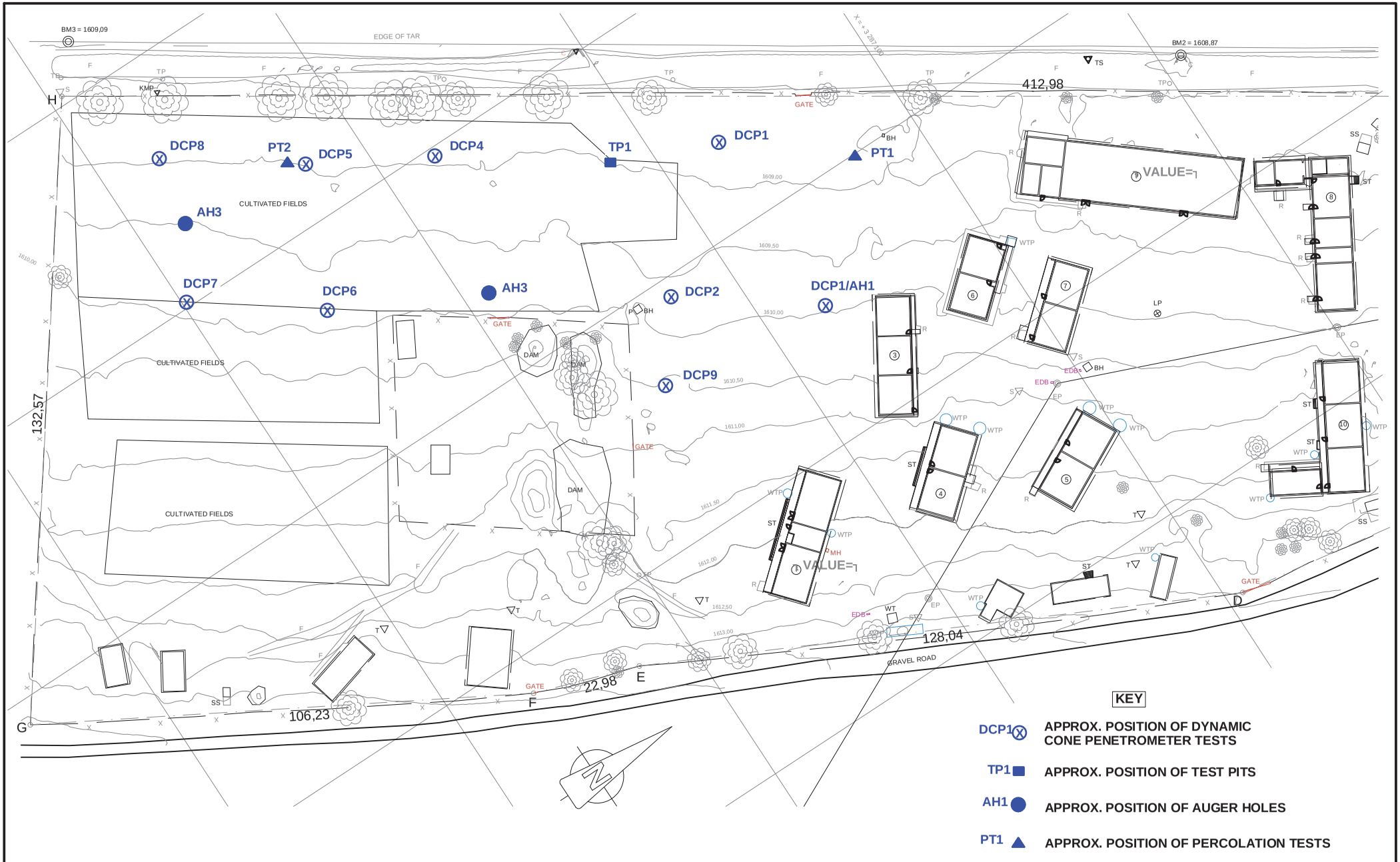


Plate 4 : Very widely open desiccation cracks at ground level within the active clayey subsoils.

FIGURE 1
Site Plan



A-211

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SCALE :	1:750
CHECKED :	

GEOTECHNICAL INVESTIGATION
LESOTHO SCHOOLS UPGRADE PROJECT
MOTSEKUOA HIGH SCHOOL - E2

REF. NO. 31181-7

FIG. NO. 1

DRENNAN MAUD (PTY) LTD

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Our Ref : 31181-7A

Your Ref :

1st August 2017

Matsuda Consultants International Co Ltd
3-43-3 Yoyogi Shibuya
TOKYO
151-0053
JAPAN

Attention: Mr Devi Jang Gurung Email: devijg@matsucon.co.jp

Dear Sirs,

ADDITIONAL GEOTECHNICAL INVESTIGATION AND SOIL ASSESSMENT - MOTSEKUOA SCHOOL - LESOTHO

1. INTRODUCTION

Drennan Maud (Pty) Ltd carried out an investigation of the Motsekuoa School in the Kingdom of Lesotho in December 2015, the finding of which were presented in out report Ref 31181-7, dated 8th February 2016.

However, with reference to your email of 19 May 2017 it is understood that due to discrepancies in the laboratory results between the local laboratory used in Lesotho and the laboratory in Durban, Drennan Maud (Pty) Ltd was requested to carry out additional field work and testing to confirm the active nature of the subsoils underlying the site and the degree of expansiveness thereof.

In this regard Drennan Maud (Pty) Ltd supplied Matsuda Consultants with a work proposal and cost estimate document, reference No. 31181-7-91.2, for which subsequent approval and appointment to proceed was received from yourselves, dated 19th June 2017.
The site was visited on the 4th July 2017 at which time the additional field testing and retrieval of soil samples for laboratory testing was carried out.

Our site observations, details and results of the laboratory testing, geotechnical assessment and recommendations based thereon for the proposed development are provided in this report.

However, it is recommended that this report is read in conjunction with our above mentioned original report, as the geotechnical assessment and recommendations provided therein are still considered valid and applicable.

2. SUPPLIED INFORMATION

Information supplied to Drennan Maud (Pty) Ltd by Matsuda Consulting for the purpose of the assessment included the following;

- Contoured site plan of the school site
- Proposed development layout plan indicating 9 different testing positions spaced on a grid across the development area
- Section indicating a proposed soil raft founding solution (Appendix 4)

The survey plan provided has been used as the site plan of this report included herewith as Drawing 31181-7A-02.

3. SITE DESCRIPTION

3.1 Locality and Topography

The site locality and layout can be appreciated in the site image and survey drawing included as Drawings 31181-7A-01 and 31181-7A-02 of this report respectively.

The site is located on the outskirts of the rural town of Motsekuoa along the main road between the towns of Morija and Mafeteng towards the south western portion of Lesotho.

The existing school site is relatively level to gently sloping in a westerly direction at approximately 2° with a planar to slightly convex slope conformation.

The proposed development area comprises the currently vacant area along the western boundary of the site as well as a portion of the currently ploughed field to the immediate south thereof (Appendix B - Plate 1-4).

The school site is characterised by a number of existing single storey structures, some of which display significant cracking in the walls thereof, likely induced by heave within the underlying subsoils (Appendix B - Plate 5).

4. FIELD WORK

The site was visited on the 4th July 2017 at which time the field work which comprised the following was carried out.

The test positions were carried out across the development footprint at the various positions indicated on the site plan accompanying this report.

4.1 Inspection Pits

A total of six inspection pits, designated IP 1 - 6, were excavated by hand to depths ranging between 1.0 - 1.2m below existing ground level to determine the nature of the subsoils below the footprint of the development area. The pits were extended to depths ranging between 1.4 - 2.0m via hand auger at the base of the pit.

The material exposed in the inspection pits was examined and logged by an Engineering Geologist in accordance with the Guidelines for Soil and Rock Logging in South Africa, edited by A.B.A Brink and R.M.H Bruin, 2nd Impression 2002. This included recording the following parameters;

For Soil : Moisture content, colour, consistency, soil structure (where applicable), soil type and origin.

4.2 Auger Holes

Three hand augers (AH 1 - 3) were excavated to a maximum depth of 2.1m below existing ground level.

The materials removed within the auger hole were examined and logged by an Engineering Geologist in accordance with the above mentioned standards.

The soil profiles for the inspection pits and auger holes are included in Appendix A of this report and further discussed in Section 5 below. In addition, photography of the individual pits and auger positions as well as typical material exposed/removed therefrom is included in Appendix A.

4.3 Material Sampling

Representative samples of the prevailing subsoil materials underlying the site were retrieved from the inspection pits and hand auger holes at various depths and returned to Thekwini Soils Laboratory, a SANAS accredited laboratory in Durban, South Africa for testing. Undisturbed samples were sampled from depths ranging between 0.6 - 1.2m whilst samples from the hand auger holes were taken at set depths of 0.9 - 1.1 and 1.9 - 2.1m.

The undisturbed samples were subjected to free/rapid swell testing as well as full grading analyses to 2μ (hydrometer) as well as Atterberg limit and moisture content determinations with the disturbed samples subjected to full grading analyses, hydrometer and Atterberg Limit determinations.

Table 1 overleaf is included as a full schedule of the samples retrieved on site, their location and depth as well as the testing subjected thereto.

Table 1 : Schedule of Laboratory Testing

Test Position (Grid Position)	Material Description	Depth (m)	Laboratory Test		
			Ind	M.C.	Swell
AH1 (P2)	Olive grey, sandy, silty clay - (Residual)	1.0 - 1.2	✔		
AH1 (P2)	Grey mottled yellow, sandy, silty CLAY - (Residual)	1.9 - 2.1	✔		
AH2 (P8)	Grey/dark grey, sandy, silty CLAY - (Residual)	0.9 - 1.1	✔		
AH2 (P8)	Grey/dark grey, sandy, silty CLAY - (Residual)	1.9 - 2.1	✔		
AH3 (P9)	Grey, sandy, sandy, silty CLAY - (Residual)	0.9 - 1.1	✔		
AH3 (P9)	Olive grey, sandy, silty CLAY - (Residual)	1.9 - 2.1	✔		
IP1 (P1)*	Grey, sandy, silty CLAY - (Residual)	1.0 - 1.2	✔	✔	✔
IP2 (P5)*	Dark grey/grey mottled orange, silty CLAY - Residual)	0.8 - 1.0	✔	✔	✔
IP3 (P3)*	Grey/Olive grey, sandy, silty CLAY - (Residual)	0.8 - 1.0	✔	✔	✔
IP4 (P7)*	Dark brown mottled orange, silty CLAY - (Colluvium/Residual)	0.6 - 0.8	✔	✔	✔
IP5 (P4)*	Grey/olive grey, silty CLAY - (Residual)	1.0 - 1.1	✔	✔	✔
IP6 (P6)*	Olive grey, silty, CLAY - (Residual)	0.9 - 1.1	✔	✔	✔

Note * - Denotes Undisturbed sample

The results of the various above listed laboratory tests are included in Appendix C of this report and discussed further in Section 7.

5. GEOLOGY AND SOILS

5.1 Regional Geology

According to the 1: 250 000 scale Geological map of Lesotho (northern sheet) the Motsekuoa area is underlain by sandstone and subordinate siltstone/mudstone of the Molteno Formation and the residual and colluvial material derived therefrom.

5.2 Prevailing Subsoil Profile

Inspection pit and hand auger excavations revealed the following general profile below the investigated area;

DEPTH (m)	MATERIAL DESCRIPTION
0.00 - 0.2 / 0.4	Dry to slightly moist, brown and grey brown, loose to medium dense (tilled), clayey SAND to sandy clay - (Topsoil/colluvium)
0.2 / 0.4 - 0.4 / 0.9	Slightly moist, dark brown mottled grey, stiff, fissured, silty CLAY - (Colluvium)
0.4 / 0.9 - > 1.4 / 2.1	Slightly moist to moist in places, Grey and olive grey mottled orange and khaki brown, stiff to very stiff, slickensided, fissured, slightly gravelly in places with depth, silty CLAY containing occasional ferricrete/calcrete nodules - (Residual)

5.3 Ground Water

No ground water seepage was encountered within any of the inspection pits or auger holes to depths in the in order of 2.1m below existing ground level.

However, the presence of ferricrete and calcrete nodules, generally encountered from a depths ranging between 1.2 - 1.5m indicates the potential for a seasonally perched ground water table at these depths below existing ground level.

5.4 Subsoil Consistency

No DCP testing was carried out as part of the additional assessment.

However from previous DCP testing carried out on site the upper clayey sandy subsoils are generally medium dense to dense/very stiff, thereunder becoming consistently very stiff with depth. DCP refusal was encountered at depths ranging between 2.65 - 2.85m below existing ground level on inferred deeply weathered bedrock or very stiff/hard residual material.

However, it should be noted that the clays underlying the site will vary in consistency based on the in-situ moisture (i.e when dry will appear harder/stiffer whereas when moist will tend to reflect a soft to firm consistency therein)

6. LABORATORY ANALYSES

6.1 Laboratory Testing

6.1.1 Full Grading, Hydrometer and Atterberg Limits Determination (TMH 1, A1 - A5)

The following tests were carried out in accordance with the respective procedures indicated below as stipulated within the TMH handbook;

Sieve Analysis	TMH1 A1(a)
Liquid Limit	TMH1 A2
Plastic Limit & Plasticity Index	TMH1 A3
Linear Shrinkage	TMH1 A4
Particle Size Analysis (Hydrometer)	ASTM D422

6.1.2 Free/Rapid Swell Testing (ASTM D4546 Method B)

The free swell test was carried out in accordance with the ASTM D4546 - Method B procedure, a summary of which is detailed below;

The sample is carefully trimmed into a ring approximately 76mm wide and 20mm high. The weight and dimensions are recorded then the sample is placed into the oedometer cell above a porous disc, a second porous disk is placed above the sample followed by the load cap. It is then held in place by a collar which is screwed down

The top of the cell is then covered with plastic to prevent the sample from drying out then placed into the load frame, the dial gauge is then set above the sample and initial reading is taken, a 10 kpa load is then placed on the sample and allowed to settle until equilibrium is reached after which a reading is taken on the dial gauge before it is flooded and allowed to swell.

After the sample has reached its maximum swell (Equilibrium) the sample is then loaded to 25kpa, 50kpa, 100kpa, 200kpa.

After completion of settlement the water is then drained from the cell, the applied load is removed and the sample extracted to be weighed after test and recorded. Finally, the sample is placed into an oven to dry at 107° Celcius.

The oedometer apparatus once set up as described above is depicted in Appendix B of this report, Plate 6.

6.2 Laboratory Results

6.2.1 Grading Analyses

Table 2 : Summary of Grading Analyses

Pos. (Depth)	Description	LL %	PI	LS %	% Clay	Classification		V.d. Merwe Class.
						AASHTO	Unified	
AH1 (0.9 - 1.1m)	Grey, sandy, silty CLAY - Res.	45.6	27.2	9.3	44.2	A-7-6 (19)	CL / OL	High
AH1 (1.9 - 2.1m)	Grey, sandy, silty CLAY - Res.	48.2	27.4	10.0	45.6	A-7-6 (19)	CL / OL	High
AH2 (0.9 - 1.1m)	Grey, sandy, silty CLAY - Res.	44.0	22.6	10.7	44.2	A-7-6 (15)	CL / OL	Low
AH2 (1.9 - 2.1m)	Grey, silty CLAY - Res.	50.9	28.9	9.3	47.6	A-7-6 (22)	CH/ OH	High
AH3 (0.9 - 1.1m)	Grey, sandy, silty CLAY - Res.	41.0	19.7	10.7	42.6	A-7-6 (13)	CL / OL	Low
AH3 (1.9 - 2.1m)	Grey, sandy, silty CLAY - Res.	39.9	18.2	9.3	44.1	A-6 (12)	CL / OL	Low
IP1 (1.0 - 1.2m)	Grey, sandy, silty CLAY - Res.	41.5	19.5	10.0	44.2	A-7-6 (13)	CL / OL	Low
IP2 (0.8 - 1.0m)	Gr ey, silty CLAY - Residual	48.0	26.3	13.3	49.7	A-7-6 (20)	CL / OL	Low
IP3 (1.0 - 1.2m)	Grey, sandy, silty CLAY - Res.	54.5	29.6	10.0	53.2	A-7-6 (24)	CH/OH	Medium
IP4 (0.6 - 0.8m)	Brown, sandy, silty CLAY -Coll	37.8	18.3	9.3	41.4	A-6 (13)	CL / OL	Low
IP5 (0.9 - 1.1m)	Gr ey, silty CLAY - Residual	48.0	19.6	11.3	48.0	A-7-6 (15)	ML / OL	Low
IP6 (1.0 - 1.1m)	Gr ey, silty CLAY - Residual	53.2	26.3	10.7	45.3	A-7-6 (19)	CH/ OH	Medium

6.2.2 Rapid/Free Swell Testing

Table 3 : Summary of Free/Rapid Swell Test Results

IP	Depth (m)	Specific Gravity	Moisture Content (%)	Bulk density (kg/m^3)	Swell %	Est. Swell pressure (kPa)
1	1.0 - 1.2	2.68	15.6	1377	14.03	230
2	0.8 - 1.0	2.69	22	1279	14.03	220
3	0.8 - 1.0	2.67	24	1379	7.77	58
4	0.6 - 0.8	2.65	14.6	1293	15.06	400
5	1.0 - 1.1	2.66	24.3	1300	11.79	140
6	0.9 - 1.1	2.67	23.5	1196	9.29	70

7. GEOTECHNICAL APPRAISAL

The appraisal of the site in terms of excavatability, subsoil percolation and problematic soils underlying the site provided in the initial report are still considered valid and applicable.

However for ease of reference these geotechnical considerations are summarised hereunder;

7.1 Excavatability

The subsoils will classify as 'soft excavation' after SABS 1200 D standards to depths in excess of 2.0m below existing ground level within the colluvial and residual clayey subsoils.

Manual labour within the materials is also achievable however, will be considerably more onerous and time consuming given the stiff consistency of the clay underlying the site.

7.2 Subsoil Percolation

Due to the clayey nature of the subsoils, effluent disposal via subsoil percolation in a septic tank and french drain system is considered unfeasible on site due to the unacceptably slow percolation rate achieved during percolation testing carried out on site during the initial assessment thereof.

7.3 Soil Expansiveness

Based on the Atterberg determination, the plasticity indices of the clayey residual material range between approximately 18 to 30, and thus depending on the materials relative clay content classify as either low (<2%), medium (2%) or highly (4%) active in terms of the Van der Merwe's potential swell prediction chart.

As such the clayey material encountered below the entire development footprint and surrounding area should be generally considered potentially moderately to highly active and are likely to fluctuate with variations in the materials in-situ moisture content.

The fissured and slicken-sided nature of the clayey material is evidence of such volume change on a seasonal basis (swell when wet and shrink when dry).

Furthermore, rapid/free swell testing indicates that the clayey materials at depths ranging between 0.6 - 1.2m below existing ground level have swell percentages ranging between approximately 8 - 15%.

As such, taking into consideration the thickness of the residual material there exists the potential for considerable, catastrophic heave to occur below structures in the highly active clays (For a 2m thick clay horizon swell amounts may range between 160 - 300mm).

Swell testing also revealed that loads ranging between approximately 60 - 400 kPa (in general in the order of 150 - 200kPa) would be required on the active soils to negate the heave therein.

8. GEOTECHNICAL RECOMMENDATIONS

8.1 Founding Recommendations

Given the highly expansive nature of the clayey subsoils underlying the site, as confirmed by the laboratory testing, it is imperative that foundations are placed at a suitable depth below final platform level and various other measures incorporated to mitigate the potential of heave below the foundations and floor slabs of the structures.

Founding measures presented in Appendix 4 (Typical section of the project facility), include the following;

- Excavations below column bases or reinforced strip footings are taken to a depth of 1.5m and backfilled within inert, granular material to a founding depth of 0.9m below platform level (i.e 0.6m thick).

- Installation of water isolation sheet between in-situ material and base of foundation trench

- Over excavation of in-situ material below the floor slab and perimeter of the structure to a depth of 0.9m and backfilling with inert granular material to platform level.

- Installation of perimeter drains surrounding the structure.

- Construction of an impermeable concrete apron slab at the surface around the perimeter of the structure.

With regards to the above measures, these are considered suitable for the nature of the soils underlying the site and degree of expansiveness thereof.

If need be, we consider these could be scaled down somewhat whereby the in-situ soils are over-excavated to a depth of 1.2m and foundations are placed at 0.6m below floor slab layerworks level, whilst the water insulation sheet may be omitted.

However, it is recommended that a subsoil drain with adequate fall is installed at the base of the soil raft to discharge a suitable distance down slope, to prevent the potential formation of a 'bath type' feature within the granular materials.

It is recommended that a bearing capacity of 100 - 150kPa is applied for the design of the foundations placed on the re-compacted granular material.

Furthermore, it is recommended that the floor slab should be isolated from all walls, columns and foundations to allow for potential differential movement (settlement of granular material or potential heave) below the floor slab. The structure should also incorporate judiciously placed construction joints in its design.

8.2 General

Recommendations provided in the initial report regarding earthworks, site drainage and on-site effluent disposal are still considered applicable and should be consulted and adhered to during the planning and construction of the proposed development.

9. CONCLUSION

Following the additional assessment and laboratory testing of the clayey subsoils at the Motsekuoa High school, the prevailing clayey material located from surface level to depths in excess of 2.0m below existing ground level are considered to be highly active, hence certain measures should be incorporated into the design and construction of the proposed new school development to ensure that new structures are not negatively effected by potential heave in the active soils.

In this regard the soil raft solution proposed by yourselves is considered suitable for the nature of the active soils and the degree of expansiveness.

It is recommended that this report is read in conjunction with the our original report (Ref. 31181-7) in which recommendations pertaining to site drainage, onsite effluent disposal and earthworks are provided and are still considered valid, hence should be considered and adhered to during construction.

We trust that the information provided in this report meets with you immediate requirements in this regard and will be pleased to furnish you with any additional information you may require.

Yours faithfully,
DRENNAN MAUD (PTY) LTD

A. JOUBERT Pr.Sci.Nat.

/Encl.	Appendix A	-	Soil Profiles and Photography
	Appendix B	-	Plates 1 - 6
	Appendix C	-	Laboratory Results
	Drawing 1	-	Locality Plan
	Drawing 2	-	Site Plan

/aj

APPENDIX A
Soil Profiles
(IP 1 - 6 & AH 1 - 3)

DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **IP1 – P1**
Sheet 1 of 1

JOB NUMBER: **31181-7A**

Scale 1:10

Smpl.	Depth (m)	
		0.00 Dry to slightly moist, grey brown, loose to medium dense, slightly fissured, silty, sandy, CLAY containing occasional root material – (Topsoil)
		0.30 Slightly moist, dark brown, stiff to very stiff, fissured, sandy, silty CLAY – (Colluvium)
		0.60 Slightly moist, grey and olive grey mottled orange and khaki brown, fissured, slicken-sided, slightly gravelly, sandy, silty CLAY containing occasional white nodules of calcrete and black nodules of ferricrete – (Residual)
1	1.0	
I, Swell		
	1.2m	
		1.60

NOTES

1) Hand dug to 1.2m and extended to 1.6m via hand auger at base of pit prior to hand auger refusal in very stiff clay

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 1.0 – 1.2m

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **IP1 – P1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
TEXT : ..C:\DOTIN\SPMASTER.DOC

IP1

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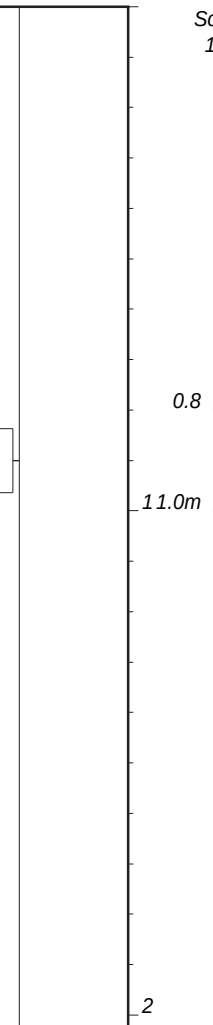
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: IP2 – P5
Sheet 1 of 1

JOB NUMBER: 31181-7A



Smpl.	Depth (m)	
	0.00	Dry to slightly moist, brown and grey brown, loose, intact, clayey, silty SAND – (Topsoil)
	0.30	Slightly moist, dark brown mottled grey, stiff, fissured, slightly sandy, silty, CLAY – (Colluvium)
	0.60	Slightly moist to moist, dark grey and grey mottled orange and khaki brown, stiff to very stiff, fissured, slicken-sided, silty CLAY – (Residual)
I, Swell	0.8	
	1 1.0m	
	2	
	2.00	

NOTES

1) Hand dug to 1.2m and extended to 2.0m via hand auger at base of pit prior to hand auger refusal in very stiff clay

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 0.8 – 1.0m

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: IP2 – P5

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
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IP2

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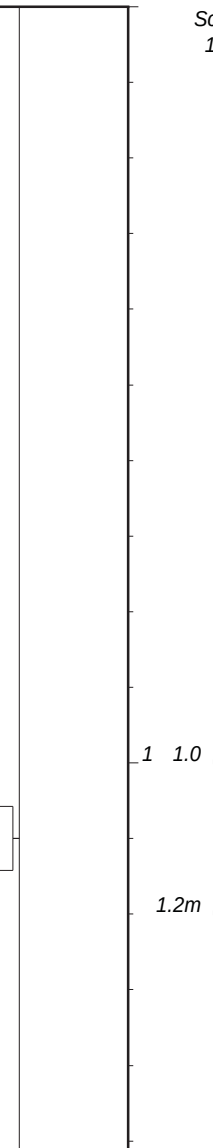
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: IP3 – P3
Sheet 1 of 1

JOB NUMBER: 31181-7A



0.00 – Dry, brown and grey brown, loose, intact, silty, clayey SAND – (Topsoil)

0.20 – Slightly moist, dark brown and brown, firm to stiff, fissured, sandy, silty CLAY – (Colluvium)

0.40 – Slightly moist to moist, grey and olive grey mottled orange and khaki brown speckled white in places, stiff, fissured to intact with depth, slicken-sided, sandy, silty, CLAY becoming slightly gravelly with depth containing occasional concretion nodules – (Residual)

1.50

Smpl.	Depth (m)
I, Swell	1.0
	1.2m

NOTES

1) Hand dug to 1.2m and extended to 1.5m via hand auger at base of pit prior to hand auger refusal in gravelly, very stiff clay

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 1.0 – 1.2m

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: IP3 – P3

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
TEXT : ..C:\DOTIN\SPMASTER.DOC

IP3

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LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: IP4 – P7
Sheet 1 of 1

JOB NUMBER: 31181-7A

Scale 1:10

Smpl.	Depth (m)	
		0.00 Slightly moist, grey brown, loose, intact, clayey, silty SAND – (Topsoil)
		0.25 Slightly moist to moist, dark brown and very dark brown mottled orange, brown and olive grey, stiff, fissured, slicken-sided, sandy, silty, CLAY – (Colluvium/Residual)
	0.6 ●	
	0.8m ●	
I, Swell		*0.90* Slightly moist to moist, grey mottled olive grey, orange and khaki brown, stiff to very stiff, fissured, slicken-sided, sandy, silty CLAY becoming slightly gravelly from 1.2m – (Residual)
	1	
		1.40

NOTES

1) Hand dug to 1.0m and extended to 1.4m via hand auger at base of pit prior to hand auger refusal in gravelly, very stiff clay

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 0.6 – 0.8m

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: IP4 – P7

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
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IP4

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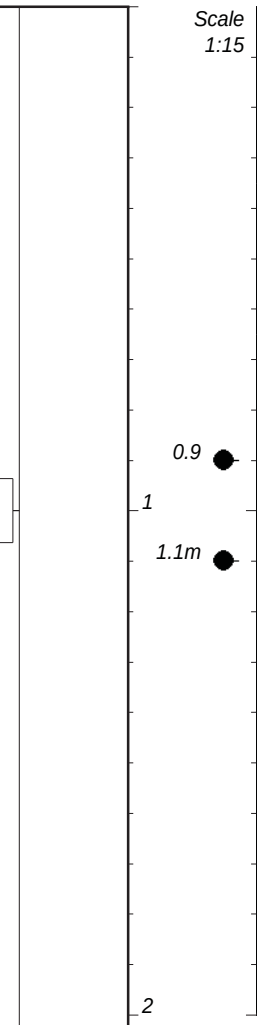
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **IP5 – P4**
Sheet 1 of 1

JOB NUMBER: **31181-7A**



Dry to slightly moist, brown and grey, loose, intact to slightly fissured, clayey, silty, SAND to sandy, silty clay with depth – (Topsoil)

Slightly moist, dark brown and brown streaked orange, stiff, fissured, slicken-sided, sandy, silty CLAY – (Colluvium/Residual)

Slightly moist to moist, grey and olive grey mottled orange and khaki brown, stiff to very stiff, fissured, slicken-sided, silty CLAY – (Residual)

Smpl.	*Depth (m)*
I, Swell	

NOTES

1) Hand dug to 1.1m and extended to 2.0m via hand auger at base of pit.

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 0.9 – 1.1m

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **IP5 – P4**

TYPE SET BY : AJ
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IP5

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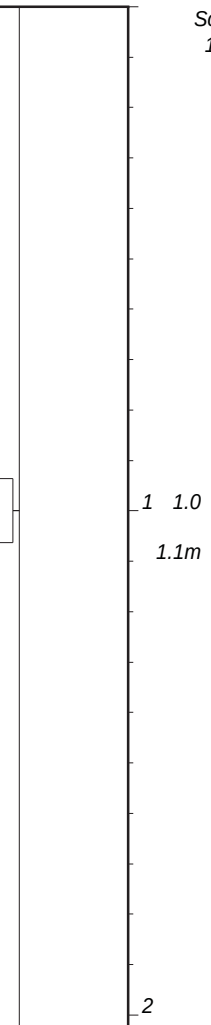
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: IP6 – P6
Sheet 1 of 1

JOB NUMBER: 31181-7A



Slightly moist, brown, stiff, fissured, slightly sandy, silty, CLAY containing root material – (Topsoil)

Slightly moist, brown, grey and dark grey, intact, medium dense, gravelly, clayey SAND containing foreign material such as wood, plastic and metal – (Fill)

Moist to slightly wet, olive grey mottled khaki brown and orange, streaked orange and speckled white, stiff to very stiff, fissured, slicken-sided, slightly gravelly, silty, CLAY – (Residual)

I, Swell

NOTES

1) Hand dug to 1.1m and extended to 2.0m via hand auger at base of pit.

2) No ground water seepage encountered

3) Sample taken for laboratory testing from 1.0 – 1.1m

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

DATE : 01/08/17 09:51
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: IP6 – P6

IP6

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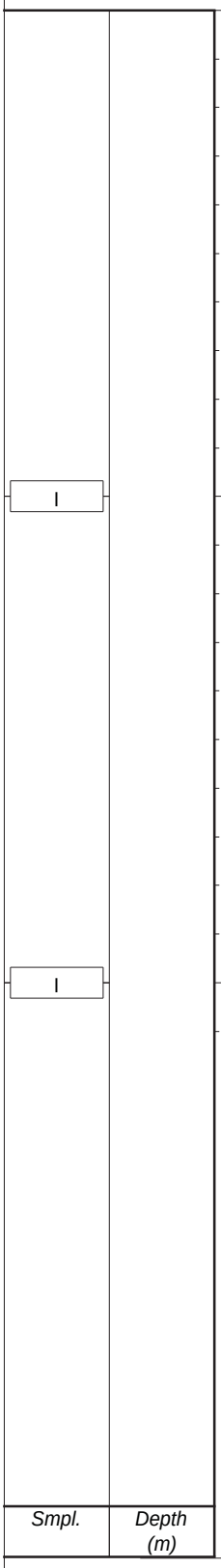
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH1 – P2**
Sheet 1 of 1

JOB NUMBER: **31181-7A**



Dry to slightly moist, brown and grey brown, loose, clayey, silty SAND – (Topsoil/colluvium)

Slightly moist, grey brown and brown mottled orange and yellow becoming more grey mottled yellow with depth, stiff, slicken-sided, sandy, silty, CLAY – (Residual)

Slightly moist, olive grey and grey mottled orange and yellow, stiff to very stiff, slicken-sided, sandy, silty CLAY becoming slightly gravelly from 1.2m containing occasional calcrete and ferricrete nodules – (Residual)

NOTES

1) No hand auger refusal but hard hand auger digging in stiff clay

2) No ground water seepage encountered

3) Samples taken for laboratory testing from 0.9 – 1.1m and 1.9 – 2.1m

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH1 – P2**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
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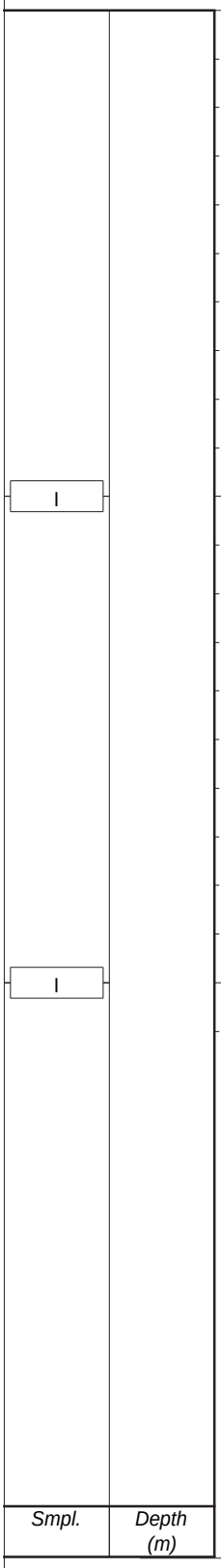
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH2 – P8**
Sheet 1 of 1

JOB NUMBER: **31181-7A**



Slightly moist, brown and dark brown, loose to medium dense, clayey, silty, SAND containing root material – (Topsoil)

Slightly moist, dark brown and grey brown mottled orange, stiff, sandy, silty CLAY – (Colluvium/Residual)

Slightly moist to moist, grey and dark grey mottled orange and yellow becoming olive grey and khaki brown mottled orange with depth and speckled white, stiff to very stiff, slightly gravelly with depth, sandy, silty CLAY containing occasional ferricrete and calcrete nodules – (Residual)

NOTES

1) No hand auger refusal but hard hand auger digging in stiff clay

2) No ground water seepage encountered

3) Samples taken for laboratory testing from 0.9 – 1.1m and 1.9 – 2.1m

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

DATE : 01/08/17 09:51
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH2 – P8**

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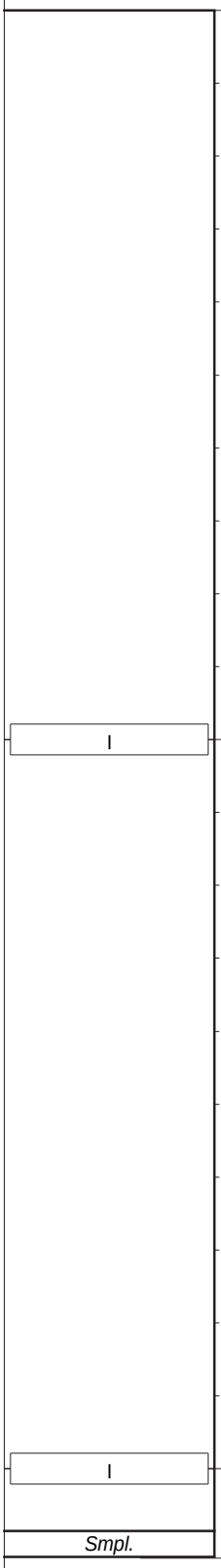
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOTSEKUOA SCHOOL

HOLE No: **AH3 – P9**
Sheet 1 of 1

JOB NUMBER: **31181-7A**



0.00 Slightly moist, brown, loose, fissured, slightly clayey, silty, SAND containing root material – (Topsoil)

0.20 Slightly moist, dark brown to grey brown mottled orange, stiff, slightly gravelly, silty, CLAY containing occasional rounded nodules – (Colluvium)

0.60 Slightly moist, grey and olive grey mottled khaki brown and orange, stiff to very stiff, slicken-sided, slightly gravelly, sandy, silty, CLAY – (Residual)

2.00

NOTES

1) No hand auger refusal but hard hand auger digging in stiff clay

2) No ground water seepage encountered

3) Samples taken for laboratory testing from 0.9 – 1.1m and 1.9 – 2.1m

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/07/2017

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH3 – P9**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 01/08/17 09:51
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APPENDIX B
Plates

PLATES:

Plate 1: Observer standing towards southern portion of development area looking in a westerly direction across current ploughed area.

Plate 2: Observer standing towards southern portion of development area looking in a northerly direction across current ploughed area with existing pig sty in the background.

Plate 3: Observer standing towards southern portion of development area looking in a easterly direction across current ploughed/crop area at AH3 position in the mid ground.

Plate 4: Observer standing towards central eastern portion of development area looking in a westerly direction adjacent to currently fenced pig sty area.

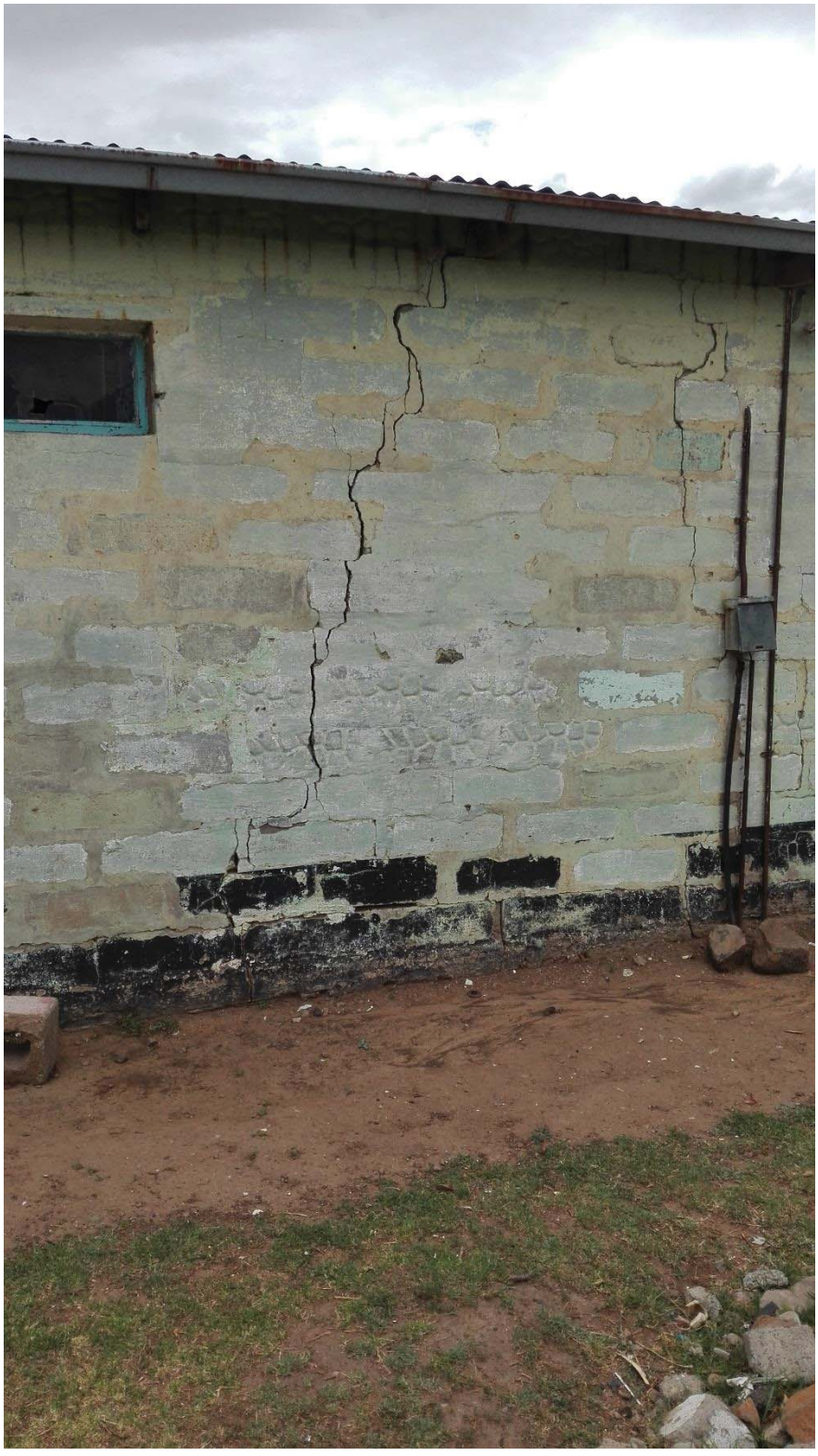

Plate 5: Example of existing school buildings subject to significant cracking due to heave within the underlying active soils.

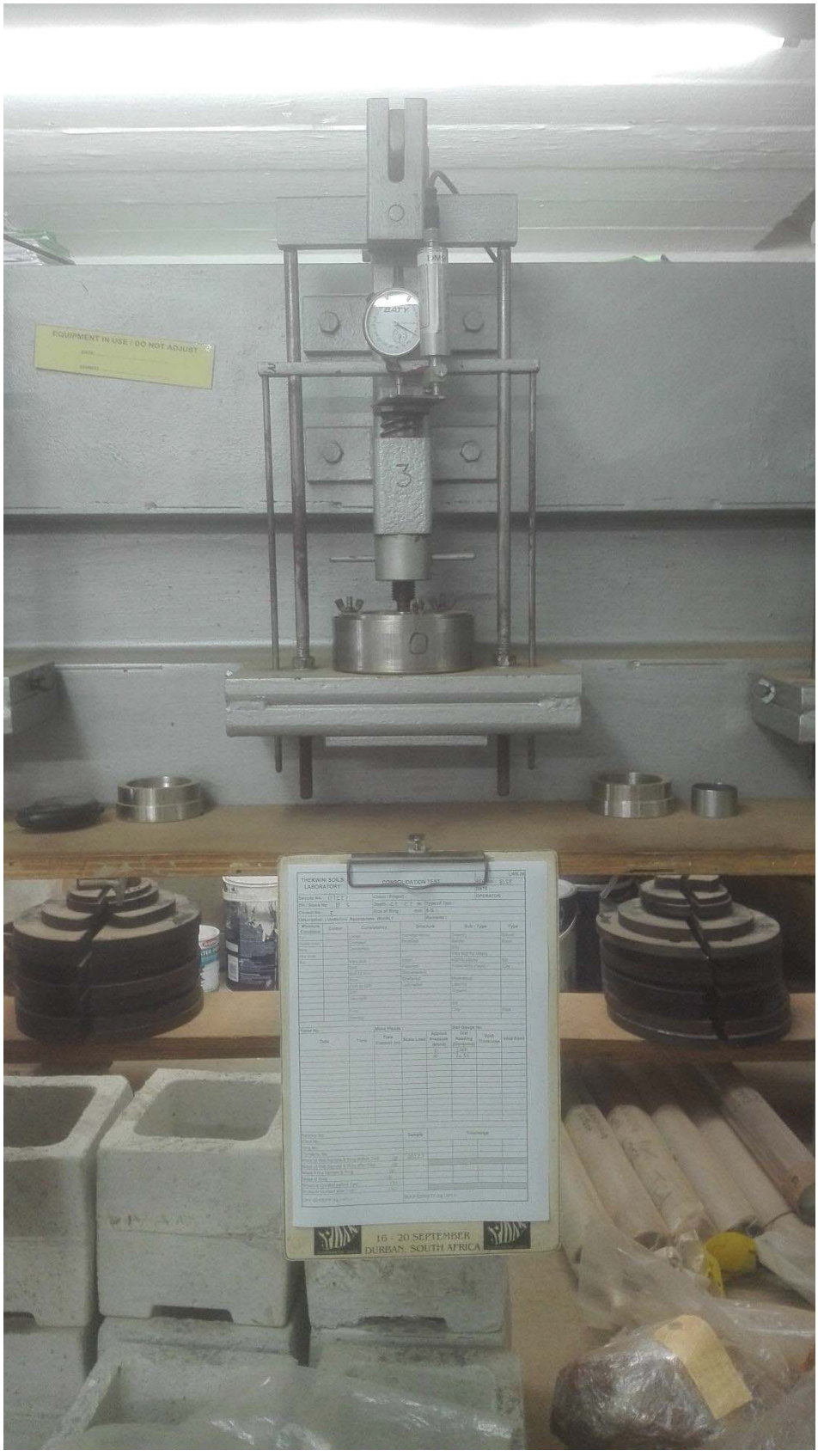

Plate 6: Set up of oedometer apparatus – Thekwini Soils Laboratory- South Africa

APPENDIX C
Laboratory Test Results Summary

Laboratory Test Summary

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job Description: Motsekuoa School Lesotho - Ref.31181
Job no.: 8479
Date: 31-07-2017

Lab no.			07079	07080	07081	07082	07083	07084	07085	07086	07087	07088
Location			AH.1 (P2)	AH1 (P2)	AH.2 (P8)	AH.2 (P8)	AH3 (P9)	AH.3 (P9)	IP.1 (P1)	IP.2 (P5)	IP.3 (P3)	IP.4 (P7)
Depth			1.0 - 1.2	1.9 - 2.1	0.9 - 1.1	1.9 - 2.1	0.9 - 1.1	1.9 - 2.1	1.0 - 1.2	0.8 - 1.0	0.8 - 1.0	0.6 - 0.8
Description			Residual	Residual	Residual	Residual	Residual	Residual	Residual	Residual	Residual	Colluvium
			-	-	-	-	-	-	-	-	-	-
Binder Material			-	-	-	-	-	-	-	-	-	-
Particle Size (mm)	75	Cumulative % Passing										
	53											
	37.5											
	26.5											
	19					100	100					
	13.2		100	100	100	98	94	100	100	100		
	9.5		99	99	97	98	94	97	94	92	100	100
	4.75		98	98	97	98	94	96	91	89	100	99
	2		97	96	95	97	94	95	89	89	98	97
	0.425		96	93	93	95	93	94	87	87	95	95
	0.25		91	88	87	90	88	89	84	85	91	91
	0.15		84	82	82	84	82	83	80	81	86	86
	0.075		75	73	72	76	72	72	72	76	79	75
Hydrometer	0.05	% Passing	68	69	68	74	67	68	65	72	77	68
	0.02		56	55	56	62	54	54	53	60	63	53
	0.005		49	50	51	52	49	51	48	54	56	46
	0.002		44	46	44	48	43	44	44	50	53	41
Soil Mortar	Coarse Sand <2.0 >0.425mm	% Passing	1.8	2.9	2.2	2.1	1.3	1.4	2.2	1.8	2.9	1.8
	Fine Sand <0.425>0.05mm		31.7	30.4	31.7	25.4	32.1	31.9	33.8	27.7	22.8	31.5
	Silt <0.05 >0.005		18.5	17.9	16.1	21.2	17.9	16.2	16.6	17.7	20.4	21.4
	Clay <0.005		48.0	48.8	50.1	51.3	48.7	50.4	47.3	52.8	53.9	45.4
Atterberg Limits	Liquid Limit % (m/m)		45.6	48.2	44	50.9	41	39.9	41.5	48	54.5	37.8
	Plasticity Index		27.2	27.4	22.6	28.9	19.7	18.2	19.5	26.3	29.6	18.3
	Linear Shrinkage %		9.3	10	10.7	9.3	10.7	9.3	10	13.3	10	9.3
	Natural MC %		-	-	-	-	-	-	-	-	-	-
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *			A - 7 - 6 (19)	A - 7 - 6 (19)	A - 7 - 6 (15)	A - 7 - 6 (22)	A - 7 - 6 (13)	A - 6 (12)	A - 7 - 6 (13)	A - 7 - 6 (20)	A - 7 - 6 (24)	A - 6 (13)
Grading Modulus			0.32	0.37	0.40	0.32	0.42	0.39	0.51	0.49	0.28	0.33
TRH 14 (1985) *												

Technical Signitory: .....

TEST REPORT

MATERIALS ANALYSIS

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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07079 **Borehole/Pit no.:** AH.1 (P2)
Description: Residual

Depth: 1.0 - 1.2 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	99.1
4.75	98.2
2	97.3
0.425	95.5
0.25	90.5
0.15	84.4
0.075	74.8
0.05	67.7
0.02	56.0
0.005	48.9
0.002	44.2

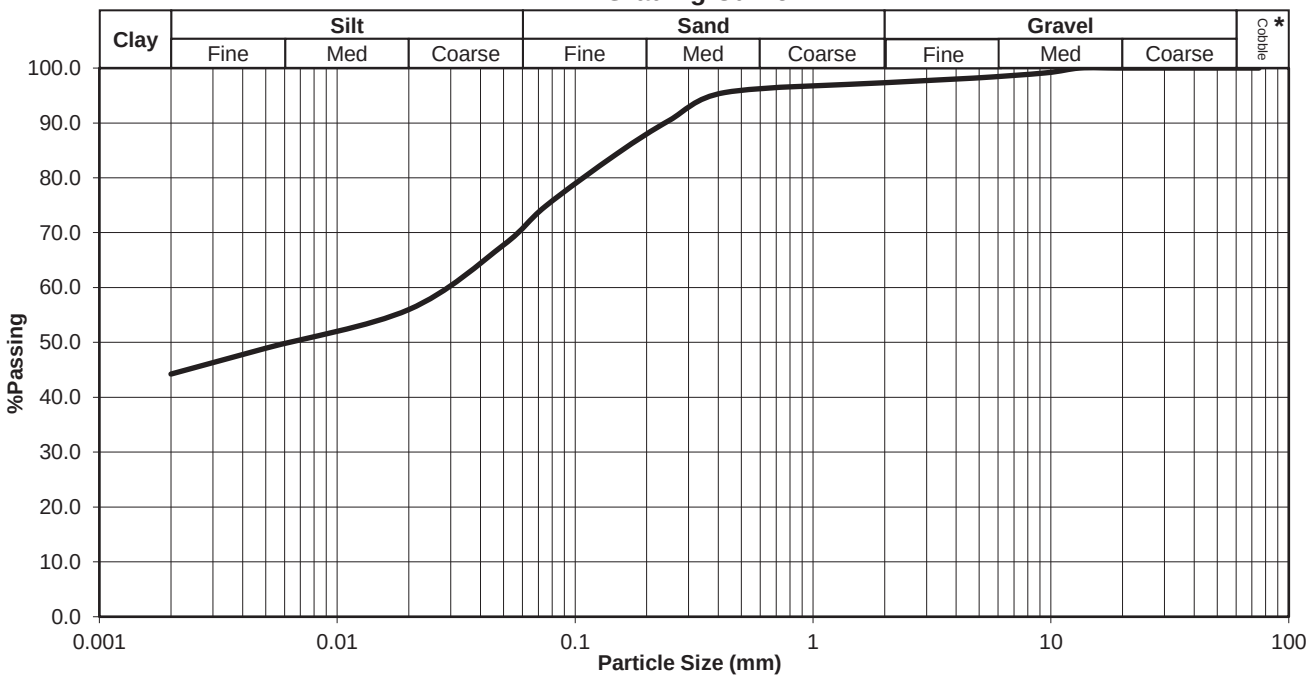
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	2.7
Coarse	0.0
Medium	1.6
Fine	1.1
Sand%	26.8
Coarse	1.6
Medium	8.3
Fine	16.9
Silt%	26.3
Coarse	14.6
Medium	6.6
Fine	5.2
Clay%	44.2

PLASTICITY	
Liquid Limit, %	45.6
Plasticity Index	27.2
Linear Shrinkage, % (L/L)	9.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	0.32

CLASSIFICATION *	
Potential Expansiveness	High
Group Index	19
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07080 **Borehole/Pit no.:** AH1 (P2)
Description: Residual
Depth: 1.9 - 2.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	99.1
4.75	98.4
2	96.1
0.425	93.3
0.25	87.7
0.15	82.0
0.075	73.3
0.05	68.7
0.02	54.8
0.005	50.2
0.002	45.6

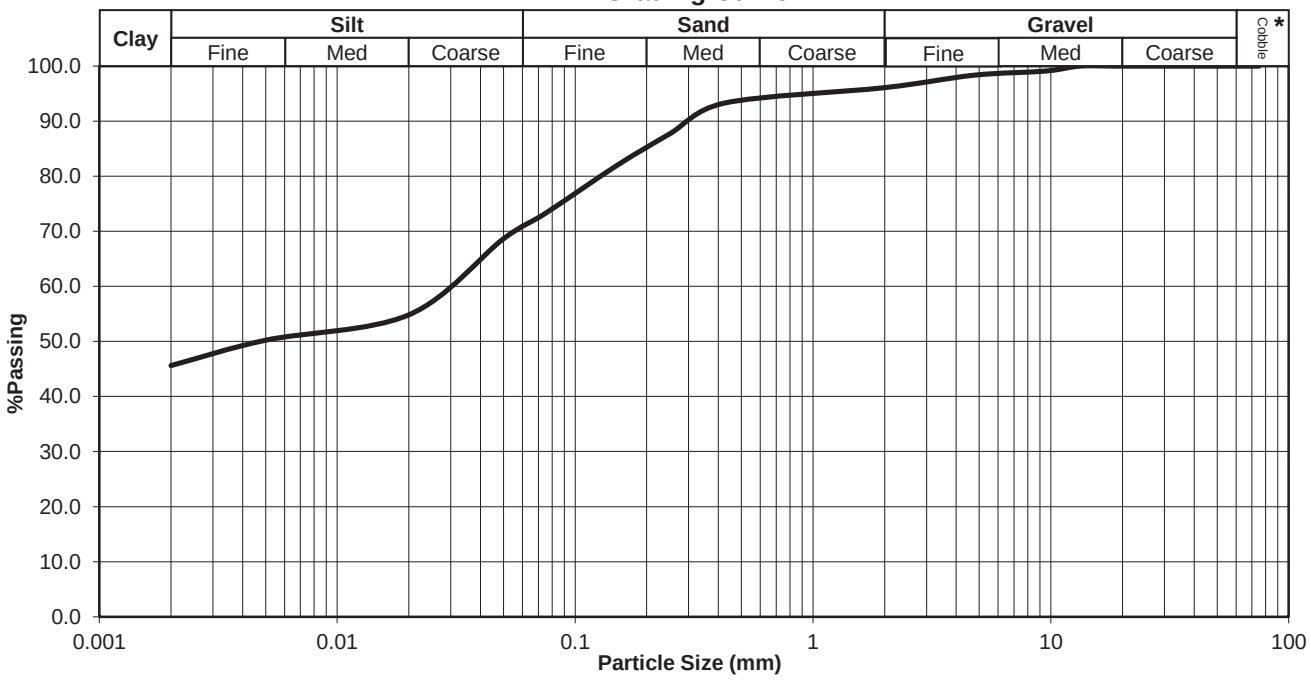
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	3.9
Coarse	0.0
Medium	1.5
Fine	2.5
Sand%	25.6
Coarse	2.5
Medium	8.8
Fine	14.3
Silt%	24.9
Coarse	15.7
Medium	4.3
Fine	4.9
Clay%	45.6

PLASTICITY	
Liquid Limit	48.2
Plasticity Index	27.4
Linear Shrinkage	10

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.37

CLASSIFICATION *	
Potential Expansiveness	High
Group Index	19
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07081 **Borehole/Pit no.:** AH.2 (P8)
Description: Residual

Depth: 0.9 - 1.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	97.2
4.75	96.7
2	94.8
0.425	92.8
0.25	87.5
0.15	81.6
0.075	72.3
0.05	67.6
0.02	55.9
0.005	51.2
0.002	44.2

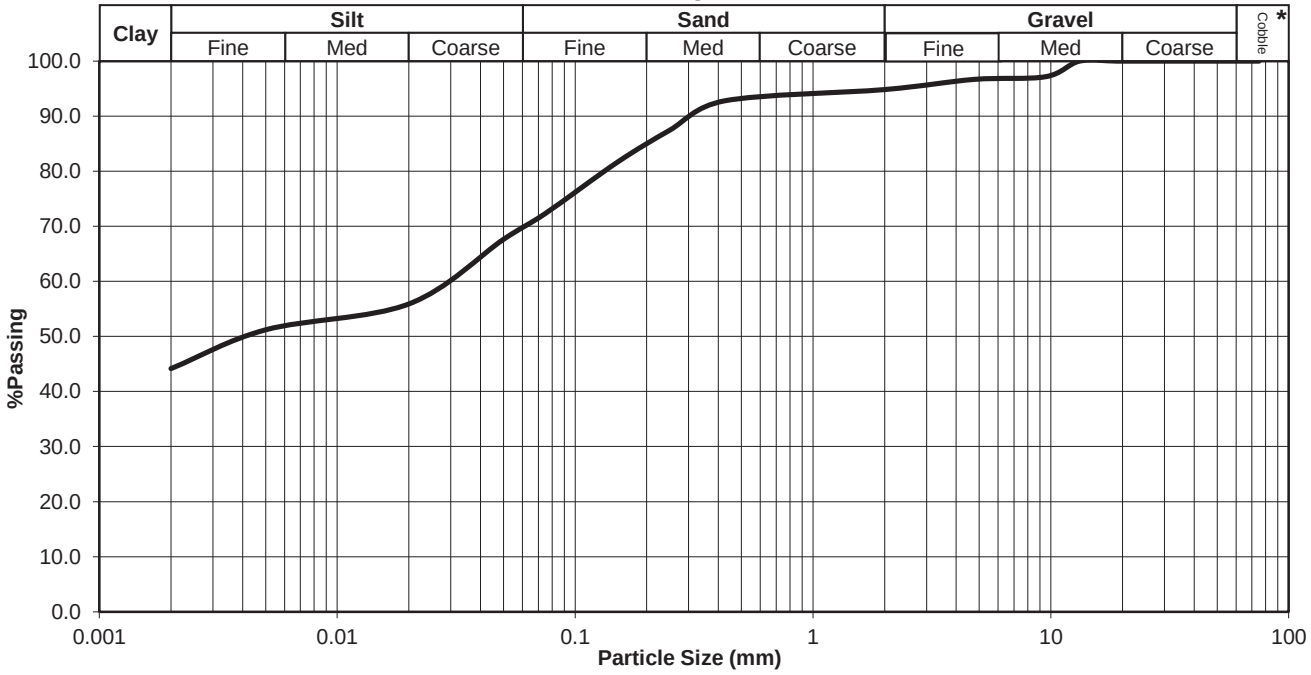
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	5.2
Coarse	0.0
Medium	3.2
Fine	2.0
Sand%	25.3
Coarse	1.8
Medium	8.5
Fine	15.0
Silt%	25.4
Coarse	13.6
Medium	4.4
Fine	7.4
Clay%	44.2

PLASTICITY	
Liquid Limit	44
Plasticity Index	22.6
Linear Shrinkage	10.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.40

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	15
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07082 **Borehole/Pit no.:** AH.2 (P8)
Description: Residual

Depth: 1.9 - 2.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	98.1
9.5	98.1
4.75	97.9
2	96.9
0.425	94.9
0.25	89.7
0.15	84.3
0.075	76.4
0.05	74.0
0.02	62.0
0.005	52.4
0.002	47.6

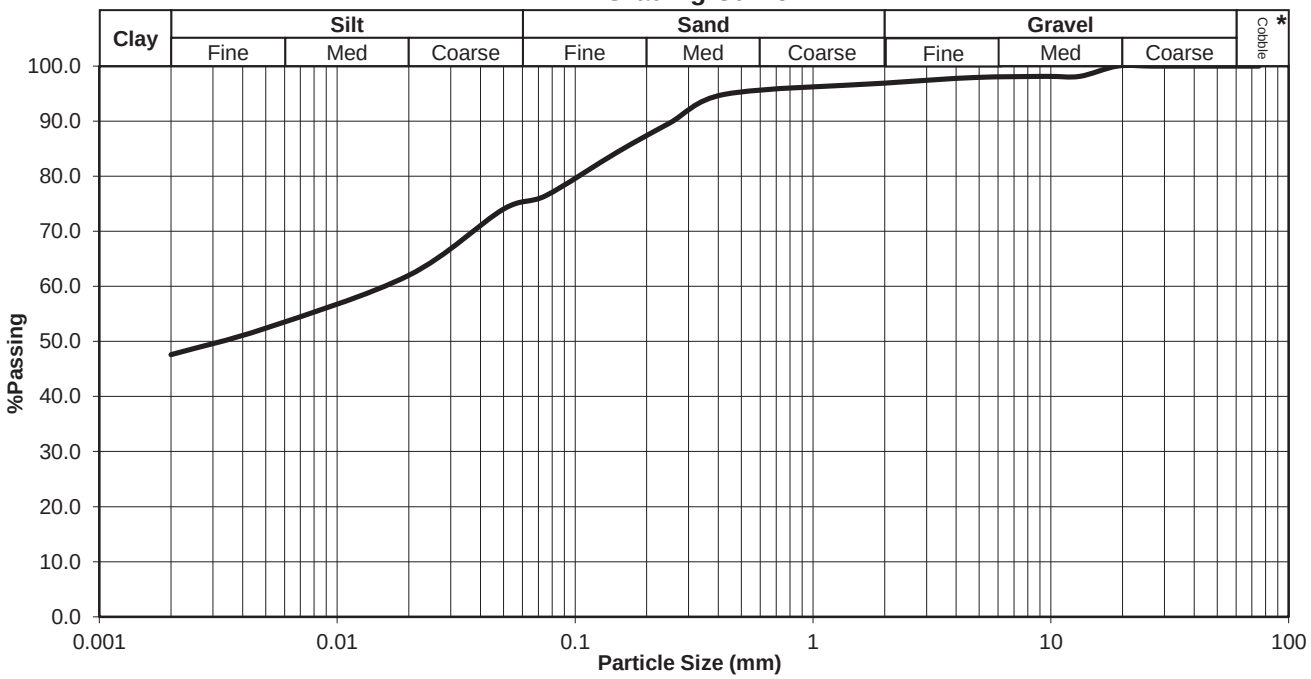
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	3.1
Coarse	0.0
Medium	2.0
Fine	1.1
Sand%	21.9
Coarse	1.8
Medium	8.1
Fine	12.0
Silt%	27.4
Coarse	13.0
Medium	9.0
Fine	5.4
Clay%	47.6

PLASTICITY	
Liquid Limit	50.9
Plasticity Index	28.9
Linear Shrinkage	9.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.32

CLASSIFICATION *	
Potential Expansiveness	High
Group Index	22
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CH or OH

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07083 **Borehole/Pit no.:** AH3 (P9)
Description: Residual

Depth: 0.9 - 1.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	94.3
9.5	94.3
4.75	94.1
2	93.8
0.425	92.5
0.25	87.9
0.15	82.3
0.075	72.0
0.05	67.5
0.02	53.9
0.005	49.4
0.002	42.6

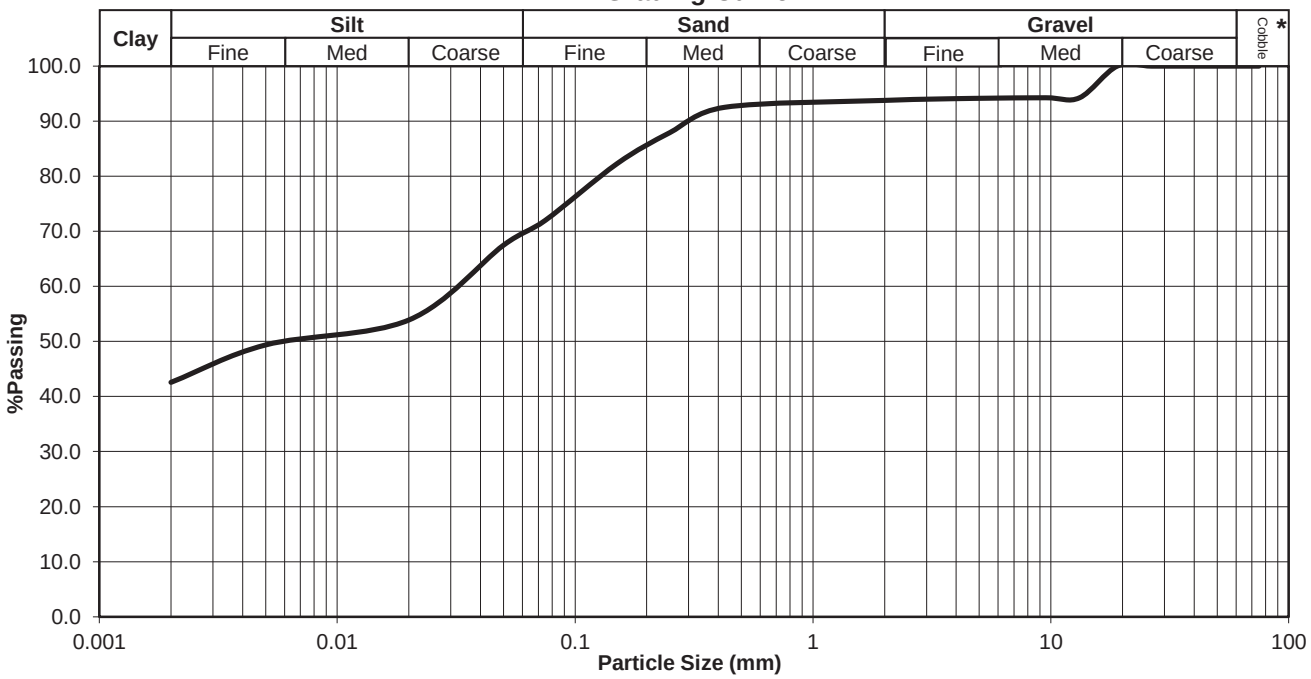
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	6.2
Coarse	0.0
Medium	5.8
Fine	0.4
Sand%	24.5
Coarse	1.1
Medium	7.6
Fine	15.8
Silt%	26.7
Coarse	15.4
Medium	4.2
Fine	7.1
Clay%	42.6

PLASTICITY	
Liquid Limit	41
Plasticity Index	19.7
Linear Shrinkage	10.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.42

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	13
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07084 **Borehole/Pit no.:** AH.3 (P9)
Description: Residual
Depth: 1.9 - 2.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	96.8
4.75	95.8
2	95.1
0.425	93.8
0.25	89.0
0.15	82.9
0.075	72.3
0.05	67.6
0.02	53.5
0.005	51.2
0.002	44.1

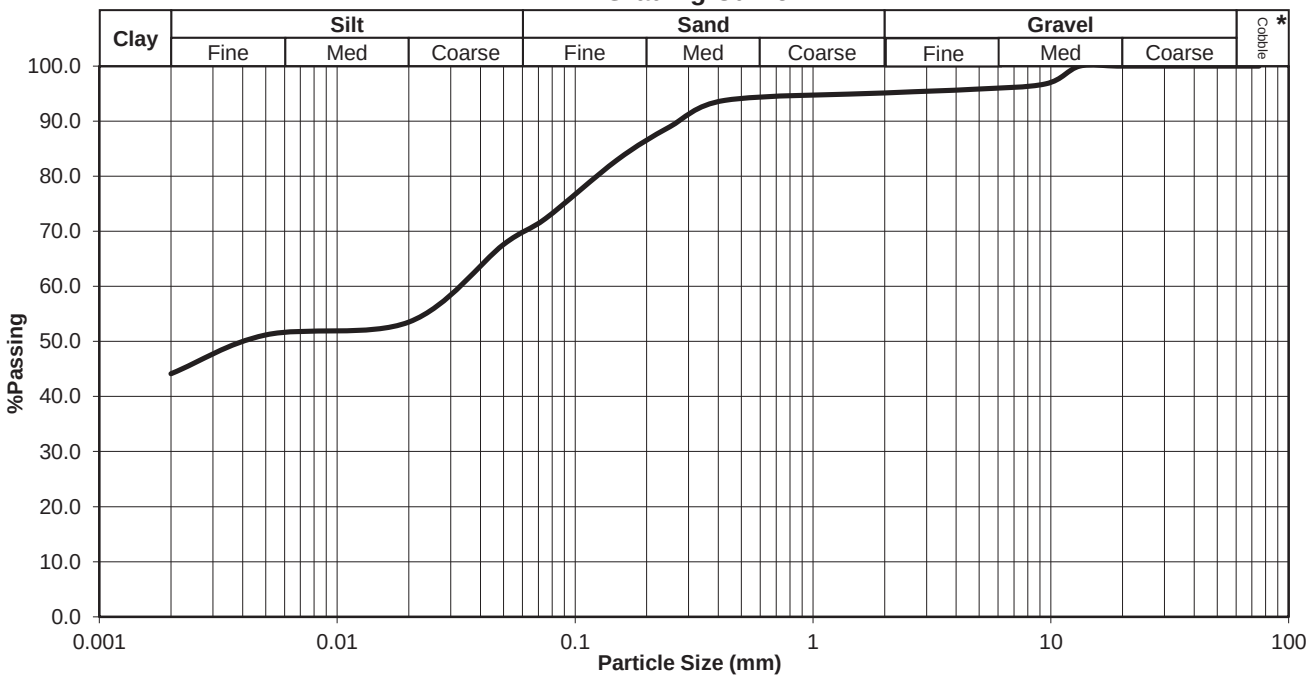
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	4.9
Coarse	0.0
Medium	3.9
Fine	0.9
Sand%	25.6
Coarse	1.2
Medium	8.0
Fine	16.5
Silt%	25.4
Coarse	16.0
Medium	2.2
Fine	7.2
Clay%	44.1

PLASTICITY	
Liquid Limit	39.9
Plasticity Index	18.2
Linear Shrinkage	9.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.39

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	12
AASHTO Soil Classification	A - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07085 **Borehole/Pit no.:** IP.1 (P1)
Description: Residual
Depth: 1.0 - 1.2 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	93.9
4.75	91.3
2	89.4
0.425	87.4
0.25	84.4
0.15	80.1
0.075	71.8
0.05	65.4
0.02	52.7
0.005	48.4
0.002	44.2

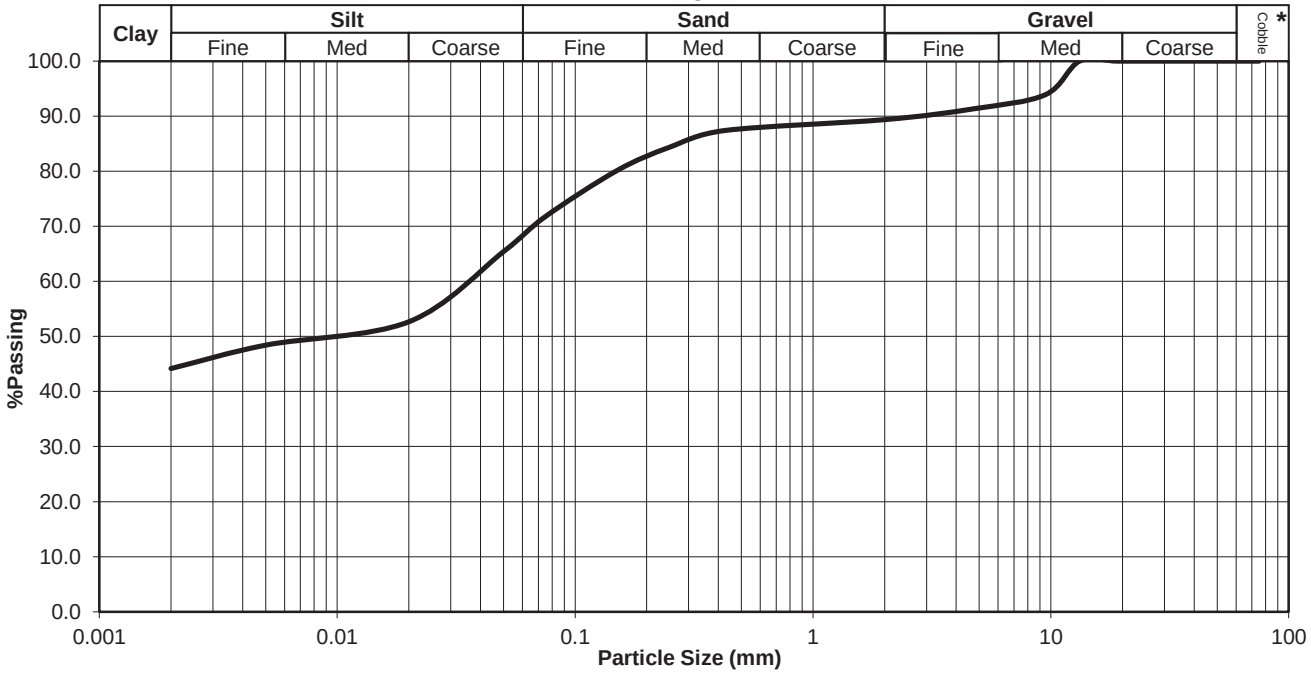
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	10.6
Coarse	0.0
Medium	8.0
Fine	2.7
Sand%	21.4
Coarse	1.8
Medium	5.4
Fine	14.3
Silt%	23.8
Coarse	15.3
Medium	4.0
Fine	4.5
Clay%	44.2

PLASTICITY	
Liquid Limit	41.5
Plasticity Index	19.5
Linear Shrinkage	10

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.51

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	13
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07086 **Borehole/Pit no.:** IP.2 (P5)
Description: Residual
Depth: 0.8 - 1.0 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	91.9
4.75	89.4
2	88.6
0.425	87.0
0.25	85.4
0.15	80.9
0.075	75.8
0.05	71.8
0.02	59.8
0.005	53.7
0.002	49.7

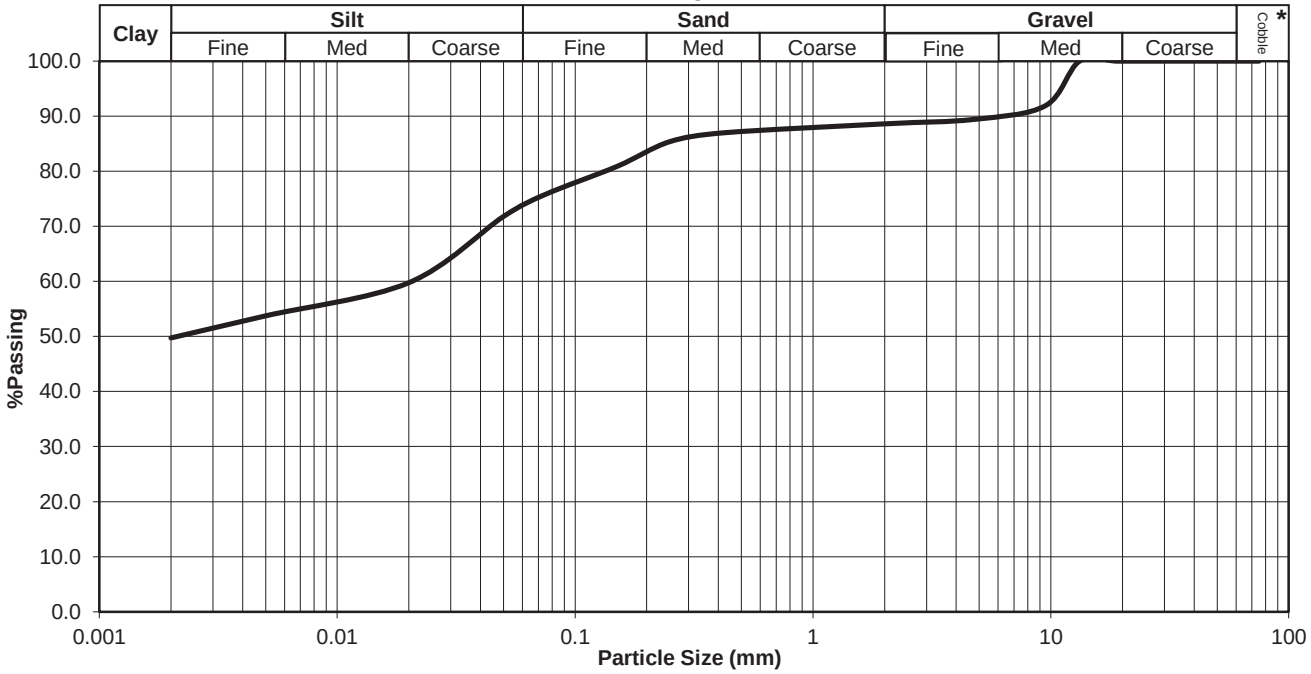
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	11.4
Coarse	0.0
Medium	9.9
Fine	1.5
Sand%	15.2
Coarse	1.4
Medium	4.0
Fine	9.7
Silt%	23.7
Coarse	13.6
Medium	5.6
Fine	4.4
Clay%	49.7

PLASTICITY	
Liquid Limit	48
Plasticity Index	26.3
Linear Shrinkage	13.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.49

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	20
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CL or OL

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07087 **Borehole/Pit no.:** IP.3 (P3)
Description: Residual
Depth: 0.8 - 1.0 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.5
2	97.8
0.425	95.0
0.25	91.3
0.15	86.3
0.075	78.9
0.05	76.6
0.02	62.5
0.005	55.5
0.002	53.2

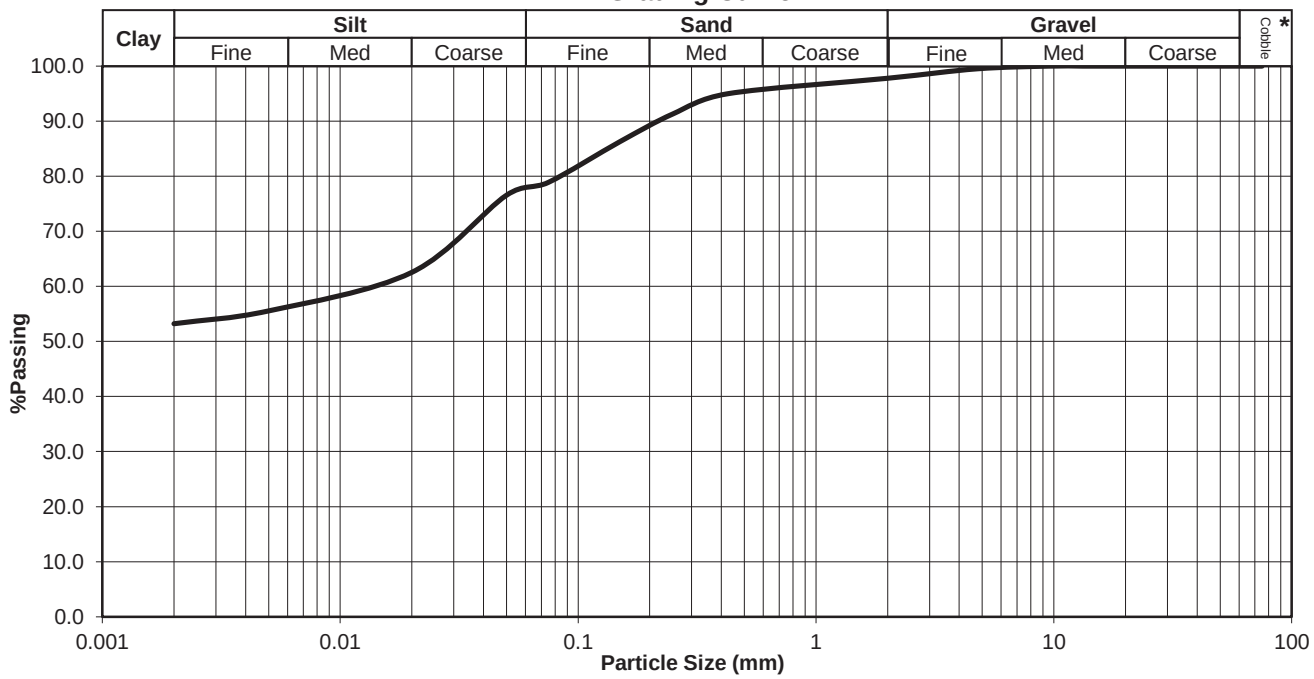
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	2.2
Coarse	0.0
Medium	0.4
Fine	1.8
Sand%	20.3
Coarse	2.5
Medium	6.5
Fine	11.3
Silt%	24.3
Coarse	14.9
Medium	6.5
Fine	2.8
Clay%	53.2

PLASTICITY	
Liquid Limit	54.5
Plasticity Index	29.6
Linear Shrinkage	10

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.28

CLASSIFICATION *	
Potential Expansiveness	Medium
Group Index	24
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CH or OH

Grading Curve



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Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07088 **Borehole/Pit no.:** IP.4 (P7)
Description: Colluvium

Depth: 0.6 - 0.8 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	98.8
2	96.9
0.425	95.2
0.25	91.1
0.15	85.8
0.075	75.2
0.05	68.0
0.02	53.5
0.005	46.2
0.002	41.4

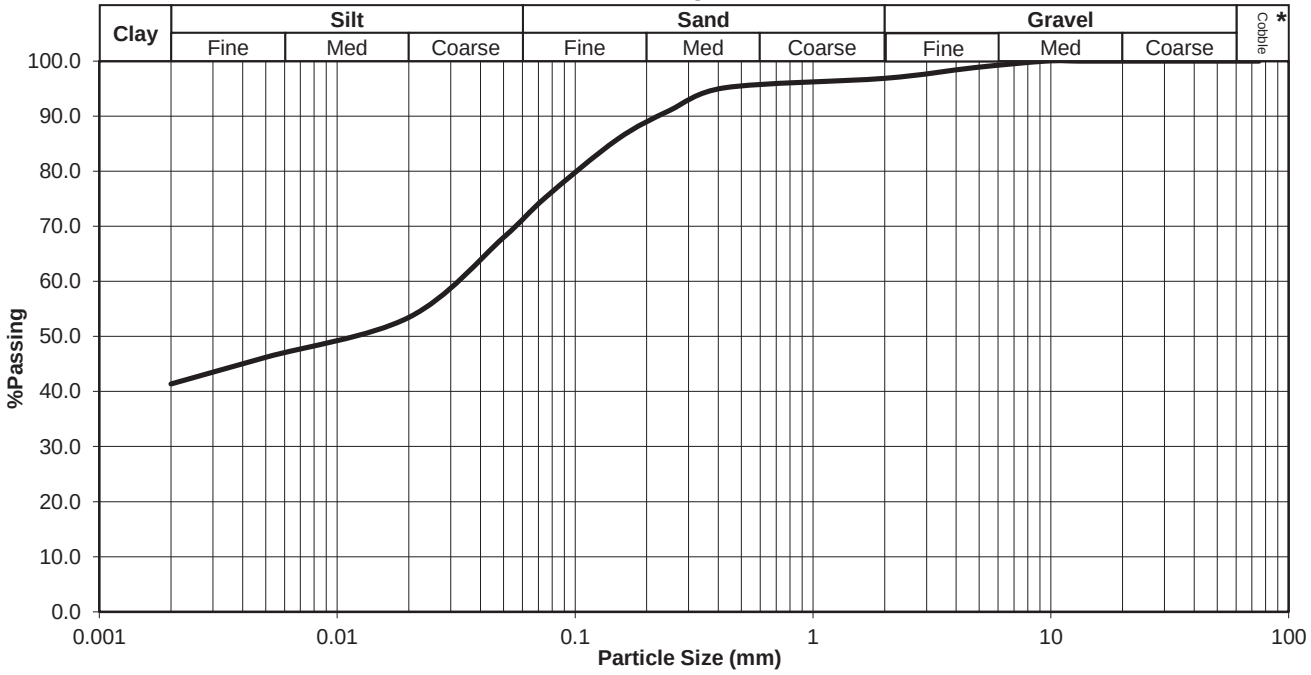
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	3.1
Coarse	0.0
Medium	0.9
Fine	2.2
Sand%	26.0
Coarse	1.5
Medium	6.9
Fine	17.5
Silt%	29.5
Coarse	17.4
Medium	6.8
Fine	5.3
Clay%	41.4

PLASTICITY	
Liquid Limit	37.8
Plasticity Index	18.3
Linear Shrinkage	9.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.33

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	13
AASHTO Soil Classification	A - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 8479 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.
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Laboratory Test Summary

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Job Description: Motsekuoa School Lesotho - Ref.31181
Job no.: 8479
Date: 31-07-2017

Lab no.		07089	07090									
Location		IP.5 (P4)	IP.6 (P6)									
Depth		1.0 - 1.1	0.9 - 1.1									
Description		Residual	Residual									
		-	-									
Binder Material		-	-									
Particle Size (mm)	75											
	53											
	37.5											
	26.5											
	19											
	13.2	100	100									
	9.5	97	95									
	4.75	94	91									
	2	90	89									
	0.425	89	87									
	0.25	86	83									
	0.15	82	79									
	0.075	74	72									
Hydrometer	0.05	72	68									
	0.02	59	58									
	0.005	52	49									
	0.002	48	45									
Soil Mortar	Coarse Sand <2.0 >0.425mm	1.5	2.5									
	Fine Sand <0.425>0.05mm	27.3	31.0									
	Silt <0.05 >0.005	19.5	18.2									
	Clay <0.005	51.6	48.2									
Atterberg Limits	Liquid Limit % (m/m)	48	53.2									
	Plasticity Index	19.6	26.3									
	Linear Shrinkage %	11.3	10.7									
	Natural MC %	-	-									
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *		A - 7 - 6 (15)	A - 7 - 6 (19)									
Grading Modulus		0.46	0.52									
TRH 14 (1985) *												

Technical Signitory: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07089 **Borehole/Pit no.:** IP.5 (P4)
Description: Residual
Depth: 1.0 - 1.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	96.9
4.75	93.5
2	90.3
0.425	88.9
0.25	86.1
0.15	81.9
0.075	74.5
0.05	72.3
0.02	59.0
0.005	52.4
0.002	48.0

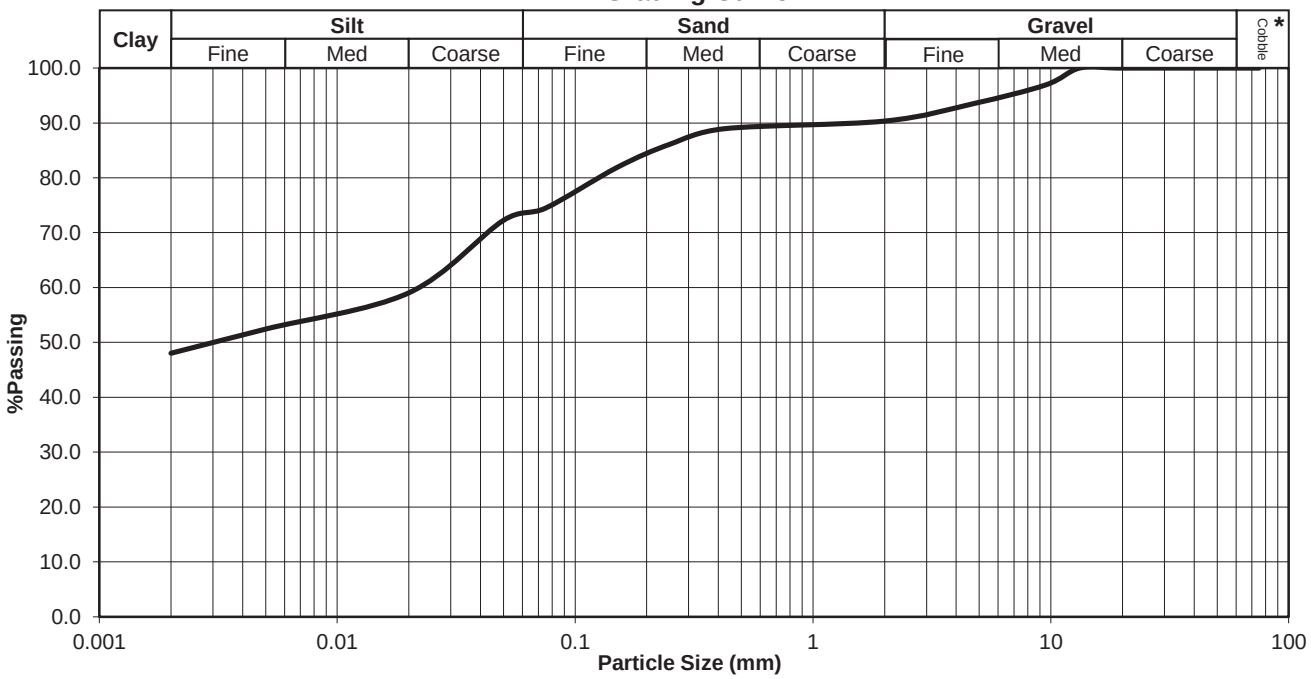
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	9.7
Coarse	0.0
Medium	5.6
Fine	4.1
Sand%	17.2
Coarse	1.2
Medium	5.1
Fine	10.9
Silt%	25.1
Coarse	14.1
Medium	6.2
Fine	4.8
Clay%	48.0

PLASTICITY	
Liquid Limit, %	48
Plasticity Index	19.6
Linear Shrinkage, % (L/L)	11.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	0.46

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	15
AASHTO Soil Classification	A - 7 - 6
Unified Classification	ML or OL

Grading Curve



Ref no.: 8479 Fig no.: -

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TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
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68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Motsekuoa School Lesotho - Ref.31181

Ref no.: 8479 **Lab no.:** 07090 **Borehole/Pit no.:** IP.6 (P6)
Description: Residual
Depth: 0.9 - 1.1 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	95.4
4.75	91.5
2	89.0
0.425	86.8
0.25	83.5
0.15	79.2
0.075	72.4
0.05	68.2
0.02	57.8
0.005	49.5
0.002	45.3

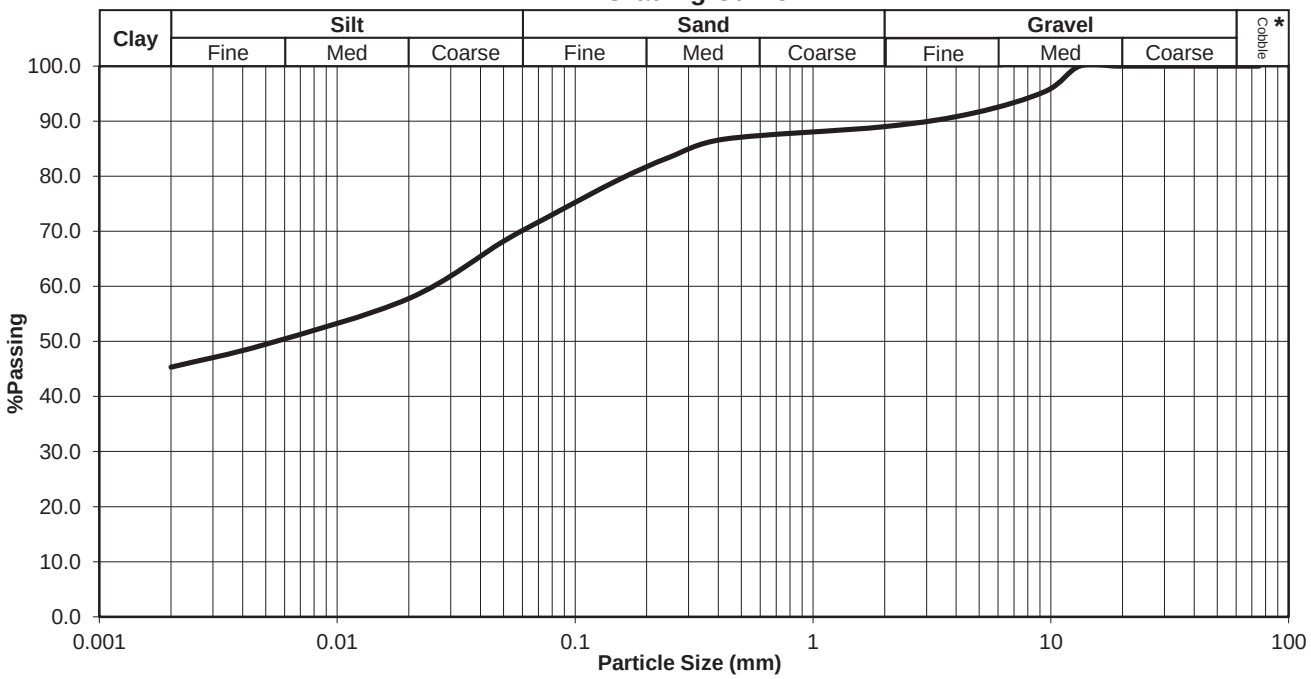
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	11.0
Coarse	0.0
Medium	7.5
Fine	3.5
Sand%	19.2
Coarse	2.0
Medium	5.7
Fine	11.5
Silt%	24.5
Coarse	12.1
Medium	7.8
Fine	4.7
Clay%	45.3

PLASTICITY	
Liquid Limit	53.2
Plasticity Index	26.3
Linear Shrinkage	10.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.52

CLASSIFICATION *	
Potential Expansiveness	Medium
Group Index	19
AASHTO Soil Classification	A - 7 - 6
Unified Classification	CH or OH

Grading Curve



Ref no.: 8479 Fig no.: -

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One-Dimensional Swell.

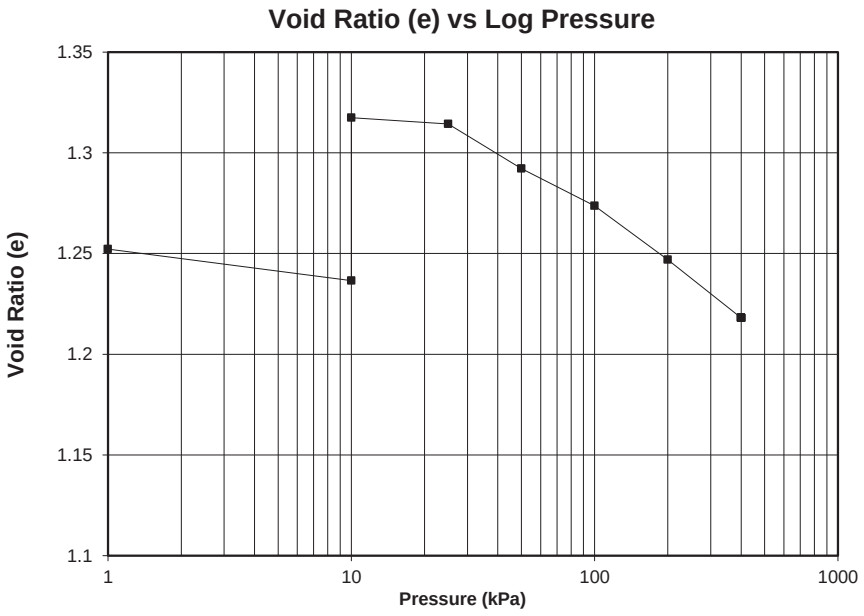
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.1 P1
Date:	31-07-2017	**Depth (m):**	1.0 - 1.2
Sample No.:	07085	**Consol No.:**	4
Sample Description:	-	**Ring Dial. (mm):**	76.45
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.682

Container No.:	T70	Moisture content before testing (%):	**15.61**
Mass of container (g):	83.62	Moisture content after testing (%):	**19.43**
Mass of wet sample + container before testing (g):	203.7	Dry density before testing (kg/m3):	**1191**
Mass of wet sample + container after testing (g):	207.67	Bulk density before testing (kg/m3):	**1377**
Mass of dry sample + container (g):	187.49	Percentage saturation before test (%):	**33.43**
		Percentage saturation after test (%):	**42.78**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio
1	2500	1.252
10	2431	1.237
10	2772	1.317
25	2755	1.314
50	2657	1.292
100	2571	1.274
200	2445	1.247
400	2302	1.218

Swell

14.03



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

One-Dimensional Swell.

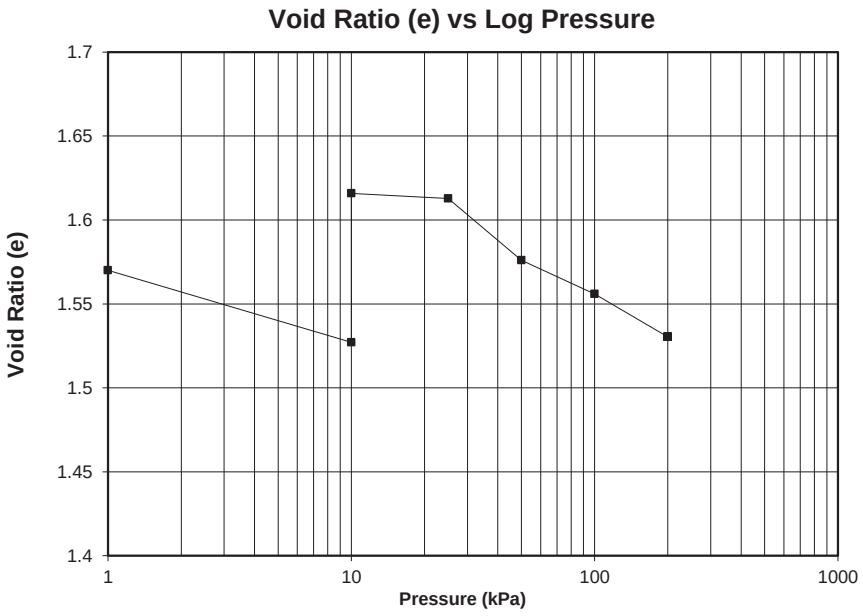
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.2 P5
Date:	31-07-2017	**Depth (m):**	0.8 - 1.0
Sample No.:	07086	**Consol No.:**	5
Sample Description:	-	**Ring Dial. (mm):**	76.75
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.694

Container No.:	36	Moisture content before testing (%):	**22.04**
Mass of container (g):	81.81	Moisture content after testing (%):	**25.87**
Mass of wet sample + container before testing (g):	194.27	Dry density before testing (kg/m3):	**1048**
Mass of wet sample + container after testing (g):	197.8	Bulk density before testing (kg/m3):	**1279**
Mass of dry sample + container (g):	173.96	Percentage saturation before test (%):	**37.82**
		Percentage saturation after test (%):	**45.55**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio
1	2500	1.570
10	2338	1.527
10	2666	1.616
25	2651	1.613
50	2510	1.576
100	2428	1.556
200	2320	1.530

Swell

14.03



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

One-Dimensional Swell.

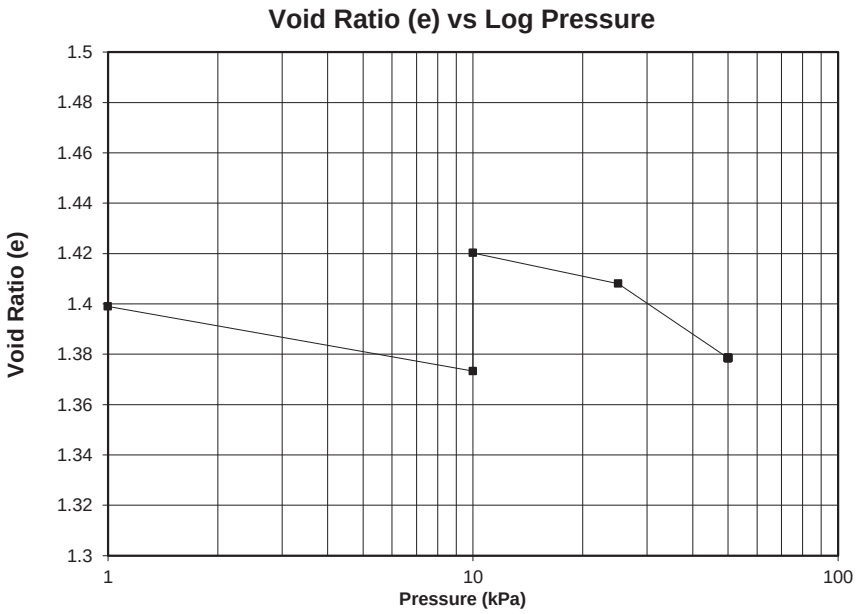
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.1 P3
Date:	31-07-2017	**Depth (m):**	0.8 - 1.0
Sample No.:	07087	**Consol No.:**	7
Sample Description:	-	**Ring Dial. (mm):**	76.15
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.667

Container No.:	24	Moisture content before testing (%):	**24.00**
Mass of container (g):	81.06	Moisture content after testing (%):	**25.64**
Mass of wet sample + container before testing (g):	200.36	Dry density before testing (kg/m3):	**1112**
Mass of wet sample + container after testing (g):	201.94	Bulk density before testing (kg/m3):	**1379**
Mass of dry sample + container (g):	177.27	Percentage saturation before test (%):	**45.75**
		Percentage saturation after test (%):	**49.61**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio
1	2500	1.399
10	2395	1.373
10	2581	1.420
25	2529	1.408
50	2407	1.378

Swell

7.77



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

One-Dimensional Swell.

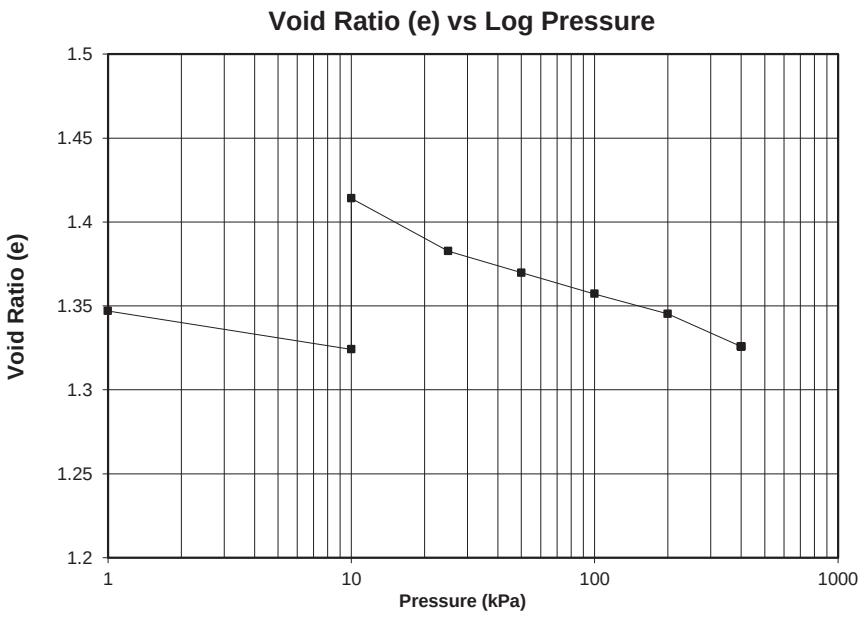
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.4 P7
Date:	31-07-2017	**Depth (m):**	0.6 - 0.8
Sample No.:	07088	**Consol No.:**	5
Sample Description:	-	**Ring Dial. (mm):**	76.75
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.649

Container No.:	38	Moisture content before testing (%):	**14.55**
Mass of container (g):	81.81	Moisture content after testing (%):	**19.37**
Mass of wet sample + container before testing (g):	195.47	Dry density before testing (kg/m3):	**1129**
Mass of wet sample + container after testing (g):	200.25	Bulk density before testing (kg/m3):	**1293**
Mass of dry sample + container (g):	181.03	Percentage saturation before test (%):	**28.62**
		Percentage saturation after test (%):	**38.70**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio
1	2500	1.347
10	2404	1.324
10	2768	1.414
25	2637	1.383
50	2580	1.370
100	2521	1.357
200	2460	1.345
400	2360	1.326

Swell

15.06



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

One-Dimensional Swell.

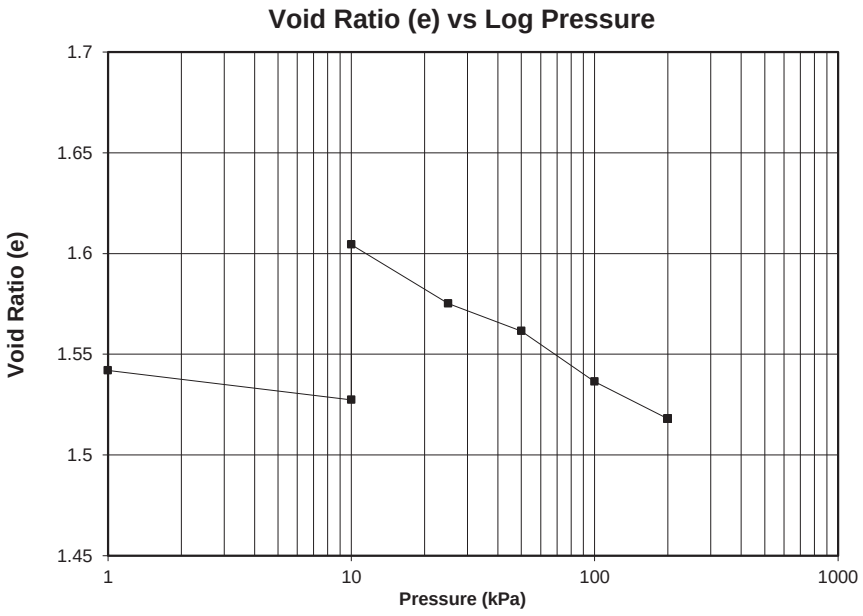
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.5-P4
Date:	31-07-2017	**Depth (m):**	1.0 - 1.1
Sample No.:	07089	**Consol No.:**	8
Sample Description:	-	**Ring Dial. (mm):**	76.1
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.658

Container No.:	-	Moisture content before testing (%):	**24.34**
Mass of container (g):	83.81	Moisture content after testing (%):	**26.86**
Mass of wet sample + container before testing (g):	196.18	Dry density before testing (kg/m3):	**1046**
Mass of wet sample + container after testing (g):	198.45	Bulk density before testing (kg/m3):	**1300**
Mass of dry sample + container (g):	174.18	Percentage saturation before test (%):	**41.96**
		Percentage saturation after test (%):	**47.03**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio				
1	2500	1.542				
10	2442	1.527				
10	2730	1.604				
25	2617	1.575				
50	2561	1.562				
100	2459	1.536				
200	2377	1.518	100 - 200	**7.28E-05**	1 - 200	**4.76E-05**

Swell

11.79



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

One-Dimensional Swell.

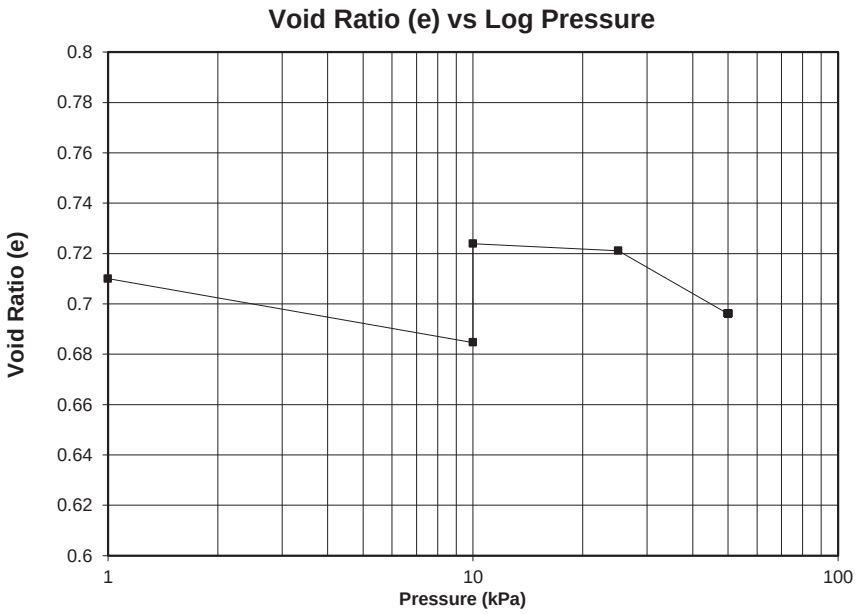
Project:	Motsekuoa School Lesotho		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	IP.6 P6
Date:	31-07-2017	**Depth (m):**	0.9 - 1.1
Sample No.:	07090	**Consol No.:**	6
Sample Description:	-	**Ring Dial. (mm):**	76.35
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.674

Container No.:	36	Moisture content before testing (%):	**-23.54**
Mass of container (g):	36	Moisture content after testing (%):	**17.48**
Mass of wet sample + container before testing (g):	140.01	Dry density before testing (kg/m3):	**1564**
Mass of wet sample + container after testing (g):	195.82	Bulk density before testing (kg/m3):	**1196**
Mass of dry sample + container (g):	172.04	Percentage saturation before test (%):	**-88.67**
		Percentage saturation after test (%):	**67.15**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio
1	2500	0.710
10	2356	0.685
10	2574	0.724
25	2555	0.721
50	2411	0.696

Swell

9.29



Reference no.: 8479

Drennan Maud and Partners

Fig. no. -

DRAWING 31181-7A-01
Locality Plan

LEGEND

Approx. extent of proposed of school site

Approx. extent of proposed new development area

Approximate position of test positions

CLIENT
Matsuda Consulting

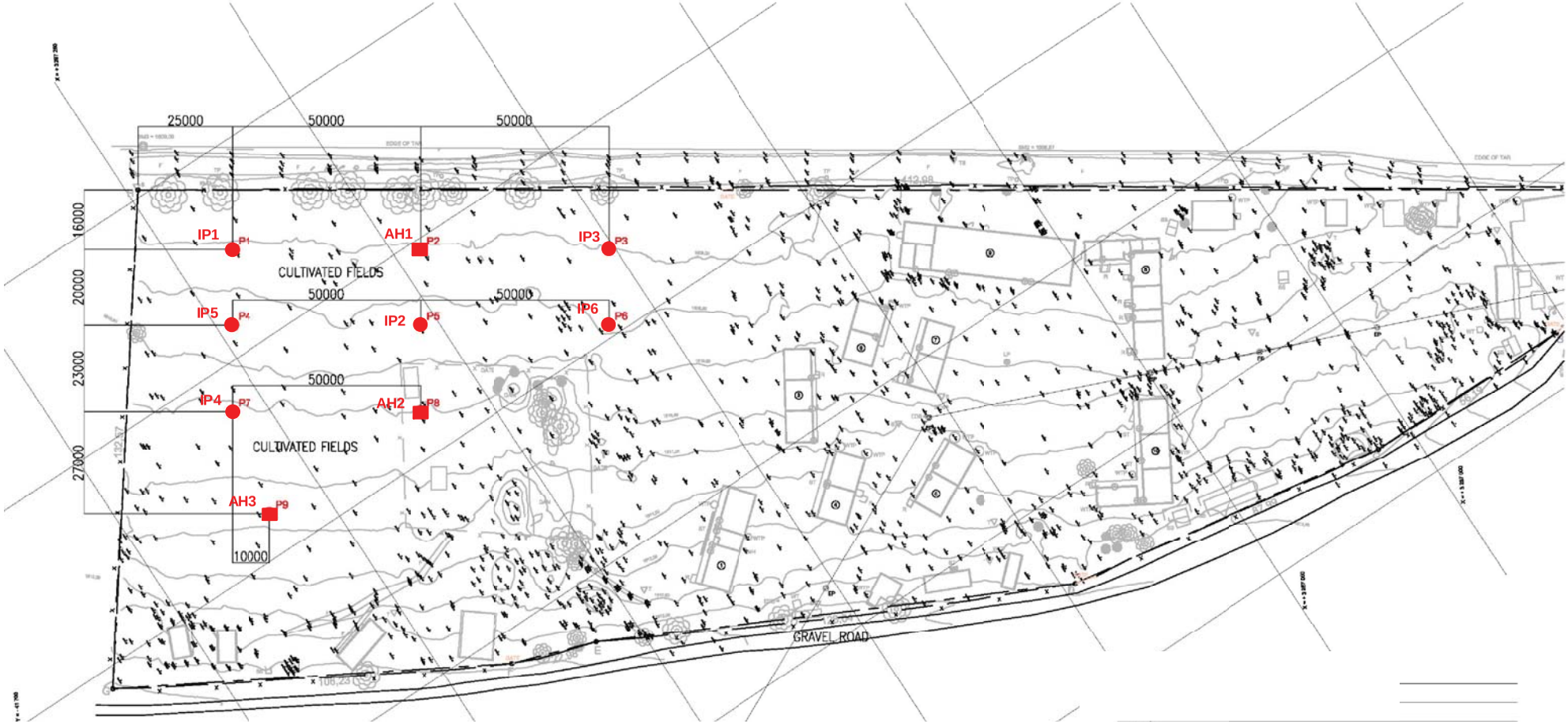
PROJECT
Motsekuoa High School – Lesotho

TITLE
Locality Image

REF. 31181-7A-01

Additional Geotechnical Assessment for the Proposed development of the Motsekuoa High School - Lesotho

DRAWING 31181-7A-02
Site Plan



KEY

IP1 ■ PROPOSED TEST PIT POSITIONS (± 1,0m - 1,2m)
UNDISTURBED SAMPLE POSITIONS

AH1 ● PROPOSED AUGER HOLE POSITIONS (± 2m)
DISTURBED SAMPLE POSITIONS

DRENNAN MAUD (PTY) LTD
Geotechnical Engineers & Engineering Geologists

68 Peter Mokaba Ridge
Tollgate
DURBAN
4001
Telephone 031-201-8992

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MAYVILLE
4058
Telefax 031-201-7920
e-mail:info@drennanmaud.com

DESIGNED :	A.J.
DRAWN :	S.P.
DATE :	25/7/2017
SCALE :	N.T.S.
CHECKED :	

ADDITIONAL GEOTECHNICAL ASSESSMENT
MOTSEKUOA HIGH SCHOOL

DRAWING NO.

31181-7A

DRENNAN MAUD (PTY) LTD

GEOTECHNICAL ENGINEERS AND ENGINEERING GEOLOGISTS
Incorporating Drennan Maud & Partners (Est.1975) and GAP Consulting

Reg. No. 2014/038872/07

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OUR REF: 31181-4

YOUR REF:

Matsuda Consultants International Co. Ltd.
43-3 Yoyogi 3 Chome Shibuya-ku
Tokyo,
JAPAN
151-0053

1st February 2016

Attention: Mr H. Iguchi

Email: iguchi@matsucon.co.jp

Dear Sirs,

GEOTECHNICAL INVESTIGATION FOR PROPOSED LESOTHO SCHOOLS UPGRADE PROJECT : MOUNT ROYAL SCHOOL (E3), HLOTSI - LESOTHO

1. INTRODUCTION

Drennan Maud (Pty) Ltd was requested by Matsuda Consultants to carry out a geotechnical investigation for the above mentioned school, which is included as part of the Lesotho schools upgrade project.

The aim of the investigation was to provided geotechnical information specific to the proposed development area for the design and construction of the new school structures.

The field work was carried out in accordance with the project agreement document, and comprised the manual excavation of inspection pits/hand auger holes, percolation and Dynamic cone penetrometer testing and material sampling for laboratory testing.

Recorded hereunder are the details of the investigation, assessment of prevailing site conditions and our recommendations for the proposed development.

2. INFORMATION SUPPLIED

Information provided for the purpose of the investigation at a project kick-off meeting held on the 23rd November 2015 and attended by Drennan Maud (Pty) Ltd and Matsuda Consultants representatives included the following;

- Cadastral site plan of the Mount Royal School.

- Aerial image of the school indicating the site boundaries and approximate positions of various tests to be carried out on site.

Subsequent to the investigation being carried out a 1:500 scale, contoured survey plan of the site was provided.

3. PROPOSED DEVELOPMENT

The proposed development is to comprise the construction of an unknown number of single storey, reinforced concrete frame school structures with brick infill and steel roofing. In addition it is believed ablution facilities will also be constructed.

No indication of the exact placement and layout of the proposed structures across the investigated development area was provided.

4. SITE DESCRIPTION

The site layout can be appreciated from the survey site plan attached herewith as Figure 1 as well as Google Earth image of the site included as Plate 1 - Appendix D.

The existing Mount Royal school is located approximately 1.5m north east, as the crow flies, from the centre of the town of Hlotse which is positioned towards the northern portion of Lesotho.

The rectangular school site is located on the mid to upper portion of a gently sloping hillside. The existing school structures are positioned across the northern, upper portion of the property, with the lower southern portion, currently utilised as a sports field, representing the proposed development area (Plate 1).

The upper northern limit and lower southern limit of the development area are elevated at 1624m amsl and 1619m amsl respectively representing a 5m height difference across the development area.

The development area and site in general slopes gently in a south easterly direction at approximately 4° with a planar to slightly convex slope conformation (Plates 2 -3).

The area is largely vacant with the exception of goal posts, existing ablution facilities towards the south western corner (Plate 4) and groundsman dwelling towards the lower south eastern corner of the school property.

Portions of the investigated area were denuded of grass with hard, well compacted ground exposed at the surface (Plate 5).

5. FIELD WORK

The field work component of the investigation was carried out on the 4th December 2015 and comprised the following;

5.1 Inspection Pits

Three inspection pit, designated (TP1, PT1 and PT2), were excavated by-hand to depths ranging between 0.9 - 1.35m below existing ground level before being halted due to hard hand digging in very dense material.

The pits were excavated at the predetermined positions indicated on the site plan attached herewith (Figure 1) to determine the nature of the subsoils and for sampling purposes.

Material exposed in the excavation sidewalls was examined and logged by an Engineering Geologist in accordance with the Guidelines for Soil and Rock Logging in South Africa edited by A.B.A Brink and R.M.H Bruin, 2nd impression 2002. This included recording the following parameters

For Soil : Moisture content, colour, consistency, soil structure (where applicable), soil type and origin.
For Rock : Weathering, colour, bedding and joint spacing, hardness, rock type and origin.

The soil profiles are included in Appendix A of this report.

5.2 Auger Holes

In addition to the inspection pits, 3 hand auger (AH 1 - 3) were excavated at the approximate positions indicated on the site plan, to depths ranging between 0.95 - 1.1m at which depth refusal (no material recovery) was encountered in the very dense subsoils.

The material recovered from the hand auger holes was examined and logged as described above with the soil profiles also included in Appendix A of this report.

5.3 Dynamic Cone Penetrometer (DCP) Testing

DCP tests (DCP 1 -9) were conducted at predetermined positions across the development area to determine the consistency of the subsoils and depth to bedrock if located at shallow to moderate depth below the surface.

DCP test results are presented graphically in Appendix B of this report, whilst Table 1 below provides a basis for interpreting the subsoil consistency based on the rate (measured as blows per 300mm penetration) at which the probe penetrates the subsoils.

Table 1 : Subsoil Consistency Inferred from the DCP Test Results

Cohesive Soils		Non-Cohesive Soils	
DCP Blow Count Blow / 300mm (SPT 'N' Value)	Subsoil Consistency	DCP Blow Count Blows / 300mm (SPT 'N' Value)	Subsoil Consistency
0 - 4 (<2)	Very Soft	0 - 8 (<4)	Very Loose
4 - 8 (2 - 4)	Soft	8 - 18 (4 - 10)	Loose
8 - 15 (4 - 8)	Firm	18 - 54 (10 - 30)	Medium Dense
15 - 24 (8 - 15)	Stiff	54 - 90 (30 - 50)	Dense
24 - 54 (15 - 30)	Very Stiff	>90 (50 - 80)	Very Dense
> 54	Hard		

Note that the values depicted in the above table are specific to DML test equipment and thus should be used merely as a guide.

5.4 Material Sampling

Bulk disturbed samples of the prevailing subsoils were obtained and delivered to a local laboratory (Materials Testing Laboratory) in Lesotho whilst certain samples earmarked for more specialised testing were returned to Thekwini soils laboratory in Durban, South Africa for testing.

A schedule of the samples collected and the testing carried out thereon is included in Section 6 below with the results of the testing included as Appendix C of this report.

5.5 Percolation Testing

Percolation testing was carried out in accordance with SABS 0400 - 1987 standards within PT1 and PT2 to determine the average percolation rate for the prevailing subsoils.

The results of the percolation testing are discussed further in Section 7 of the report.

6. GEOLOGY AND SOILS

The site, according to the 1:250 000 scale geological map of Lesotho (northern sheet), is underlain by Elliot Formation sandstone and the indicative reddish/orange brown colluvial and residual material derived therefrom.

6.1 Weathered Sandstone

The weathered bedrock was not encountered within any subsoil excavations taken to depths ranging between 0.9 - 1.35m below existing ground level. The weathered bedrock which typically occurs as highly weathered, very soft rock to soft rock is inferred to be located at depths below the site in excess of the scope of the shallow investigation.

6.2 Colluvium/Residual

The weathered bedrock located at unknown depth below the site is overlain by typically dry, light brown/brown to orange and pinkish red brown, medium dense to very dense, silty sand of likely colluvial or residual origin becoming slightly clayey and gravelly with depth.

The colluvial/residual material is encountered to depths in excess of 1.3m below existing ground level and is capped by a mantle of topsoil/colluvium comprising brown, dense to very dense, slightly clayey silty sand ranging from 0.2 - 0.8m thick in places (Plate 6 and 7).

6.3 Subsoil Consistency

The results of the DCP probes all display dense to very dense conditions in the upper 0.3m thereunder becoming medium dense to occasionally dense immediately prior to refusal at depths ranging between 1.0 - 1.75m depth.

DCP refusal is inferred to have occurred in very dense/hard clayey subsoils at depth or on a possible weakly cemented, dense pedocrete horizon within the colluvial/residual subsoils.

6.4 Groundwater

No groundwater seepage was encountered within any of the subsoil excavation with no evidence of seasonal perched ground water noted either. The hardened upper topsoil surface will generally preclude the infiltration of ground water and promote rapid run-off across the sloping development area.

Notwithstanding the above, it should be noted that the area is going through an extended drought period. As such during wetter periods, should ground water enter the subsoils upslope of the site, seepage may be encountered within the soil profile where perched on dense material or more clayey horizons.

7. LABORATORY ANALYSES

7.1 Laboratory Testing

The complete schedule of the laboratory samples and the testing conducted thereon is included in Table 2 below;

Table 2: Schedule of Laboratory Testing

Pos	Material Description	Depth (m)	Laboratory Test			
			Ind	Mod	CBR	Swell
TP1	Brown, silty SAND - Topsoil/colluvium	0.2 - 0.75	✔	✔	✔	
TP1	Orange/pink red brown, clayey, silty SAND - Colluvium	0.75 - 1.35	✔*	✔	✔	✔*
PT1	Brown, silty SAND - Colluvium	0.0 - 0.9	✔	✔	✔	

* - Denotes Samples tested by Thekwini Soil Lab in Durban
- Swell sample recompacted to 90% Mod AASHTO density

7.2 Laboratory Results

The laboratory test summary is provided in Appendix C of this report along with shear box and consolidation test results. However, for ease of reference the results of the laboratory testing are provided herewith in Tables 3 and 4 below;

7.2.1 *Grading Analyses*

Table 3 - Summary of Grading Analysis Results

Pos	Depth (m)	Description	LL %	PI	LS %	%Silt & Clay	Revised US Classification	
							Group	Subgrade Rating
TP1	0.2 - 0.75	Silty SAND	22.2	5.8	3.3	56.7	A-4	Fair
TP1	0.75 - 1.35	Clayey, silty, SAND	33.5	14.1	8.7	50.3	A-6	Poor
PT1	0.0 - 0.9	Silty SAND	24.7	7.1	3.3	59.6	A-4	Fair

7.2.2 *Mod AASHTO Density and CBR Testing*

Table 4 - Summary of Density Testing Results

Pos	Depth (m)	Material	Mod AASHTO Density (kg/m^3)	OMC (%)	CBR Results			TRH 14
					90 %	98 %	Swell %	
TP1	0.2 - 0.75	Silty SAND	1832	11.3	7	15	0.3	G8
TP1	0.75 - 1.35	Clayey, silty SAND	1772	17.2	6	9	0.3	G9
PT1	0.0 - 0.9	Silty SAND	1776	15.2	9	11	0.3	G8

7.2.3 Swell Testing

The bulk disturbed sample recompacted to 90% Mod AASHTO density returned a swell percentage of 1.79% and thus is considered to be only slightly active.

8. GEOTECHNICAL ASSESSMENT

The site is stable in its current conformation and no stability concerns exist provided recommendations regarding possible cut and fill batters are adhered to during construction.

Problems associated with the prevailing subsoil are primarily limited to its susceptibility to erosion by wind and flowing water forces across the sloping site. Management of stormwater run-off during and after construction in conjunction with planting grass vegetation will be necessary to minimise potential erosion on site. The sandy subsoils are not considered to be overly active or collapsible given the low swell percentage and medium dense to dense consistency of the subsoils respectively.

The generally medium dense to dense subsoils classify as ‘soft’ excavation according to SABS 1200D standards to depths of at least ranging between 1.0 - 1.75m below existing ground level. Manual excavation will be laboured and time consuming within the medium to dense subsoils.

Subsoil encountered on site classify as silty sand ranging between A-2-7 to A-4 type material in terms of the AASHTO classification and as G8 to G9 type material according to TRH 14 - 1985 standards. As such the materials are considered suitable for use as bulk fill, and subgrade material.

Percolation testing carried out indicates the average subsoil percolation rate within PT1 and PT2 was measured as 15min and 7min respectively. As such the subsoils are sufficiently permeable for disposal of storm water/waste water via subsoil percolation means.

Indicative settlement analyses carried out for a typical single storey structure placed on strip footings or column bases at a depth of 1.0m with an allowable bearing pressure of 150kPa returned nominal anticipated settlement amounts of less than 10mm.

Based on the above the site is considered suitable for the proposed development as there exists no geotechnical aspect that would preclude development.

9. GEOTECHNICAL RECOMMENDATIONS

As no indication of the proposed development layout or earthworks plan has been provided the following recommendations are provided in a general sense.

9.1 Earthworks

Given the sloping nature of the site and anticipated small size of the proposed school structures, cutting and filling for the creation of relatively small building platforms is likely to be limited to a maximum of 1 - 2m height.

In this regard the following general recommendations are provided for the construction of cut and/or fill embankments on the site.

9.1.1 Cuts

All unsupported cuts in the sandy silty material should be laid back a maximum batter of 1:2 (26°) whilst temporary batters in the dense subsoils can be increased to 1:1,5.

Cut off drains should be placed along the crest of cut embankment to prevent storm water run-off from cascading onto the cut batter and inducing soil erosion thereon. To mitigate potential soil erosion all unsupported cut batters should be grassed as soon as possible after construction.

9.1.2 Fills

Fills should be constructed through the placement of layers of maximum 300mm loose thickness and the subsequent adequate compaction thereof to 95% Mod AASHTO density of the sandy fill material prior to the placement of the next layer. The maximum particle size of any fill material should be restricted to two thirds the layer thickness.

The outer batter of all fill embankment should be restricted to 1:2 (26°) and should be grassed post construction to minimise potential erosion thereon.

It should be noted that newly constructed fill can be expected to settle within itself up to 1 - 2% of the height of the fill (i.e 10 to 20mm for 1 - 2m high fills). Although most of this settlement will likely take place during construction, should structures span the prick of the cut to fill platform, some consideration should be lent to potential differential settlement below the structure.

9.2 Site Drainage

Stormwater management is considered important on site given the potential for soil erosion. In this regard stormwater from all roof areas should be captured in roof gutters and channelled to discharge into Jo-Jo storage tanks (or some equivalent) adjacent to respective structures for later general use on site.

Run-off from all paved/hardened surface should be channelled effectively in surface drains to discharge into soak pits or be dispersed at the surface via a spreader system. The soak pit and spreader system should be placed a minimum of 3m downslope of all structures. Concentrated flow onto open ground or unprotected batters should be strictly avoided.

The site should be graded to facilitate effective storm water management on site and prevent water ponding on the platforms and adjacent to structures.

Should subsoil seepage be encountered in any cut face it should be dealt with symptomatically as and when it occurs. Subsoil seepage is likely to be short lived and occur immediate after rainfall events.

9.3 Founding

Founding of structures on site is largely dependant on the proposed earthworks (final level of cut and fill platforms) as well as the layout of structures on the platforms.

In areas of proposed cut where dense subsoils requiring hard hand picking to remove is located at shallow depths below platform level, the single storey structures can be supported on strip footings taken into the dense colluvial/residual subsoils at a depth of 1.0m below platform level.

Where the depth of fill and underlying in-situ material combine such that the depth to dense founding material is located in excess of 1.5m (i.e the depth to which strip footings can typically be installed practically/economically), it is recommended that the structure be founded on ground beams spanning column bases taken through the fill to bear into dense subsoils material.

Within the medium dense to dense founding medium at a depth of 1.0m below existing ground level an allowable bearing of pressure of 150 kPa can be adopted for foundation design.

Ideally structures should be placed in cut portions of platforms as much as practically possible to simply the founding thereon.

The floor slab of structures spanning the prick of the cut to fill platform and thus subject to potential differential settlement should be isolated from all walls, columns and foundations. Furthermore, construction joints should be incorporated into the design of the buildings to accommodate any potential differential settlement that may occur below the structures.

9.4 Sanitation

It is inferred that new ablution facilities to be constructed on site will comprise ventilation improved pit (VIP) latrines as is currently used on site.

The use of the such a means of effluent disposal on site is considered feasible. Should the latrine structure be intended as permanent it should be suitably lined and positioned such that it is easily accessible by a vacuum tanker for emptying when required.

The state of the VIP latrine should be kept in good working order to ensure the toilets are relatively pleasant to use.

10. CONCLUSION

The development of proposed new classrooms and sanitation systems at the Mount Royal school is considered feasible provided the geotechnical considerations and development recommendations provided in this report are consulted and adhered to during the design and construction phases of the development.

We trust that the information contained within this report meets with your requirements in this regard. Should you require any additional information please contact the undersigned.

Yours faithfully
DRENNAN MAUD (PTY) LTD

A. JOUBERT Pr.Sci.Nat.

/aj

APPENDIX A
Soil Profiles
(TP 1, PT 1-2 & AH 1-3)

DRENNAN MAUD (PTY) LTD

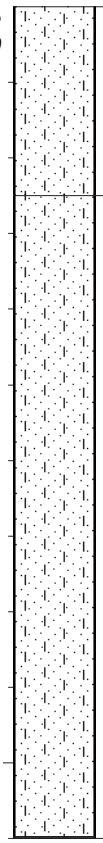
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: **AH1**
Sheet 1 of 1

JOB NUMBER: **31181-4**

Scale 1:10



0.00

Dry, dark brown, medium dense, slightly clayey, silty, fine to medium grained SAND – (Topsoil/Colluvium)

0.25

Slightly moist, orange to red brown, loose to medium dense with depth, slightly clayey, silty SAND – (Colluvium/Residual)

1

1.10

NOTES

1) No ground water seepage encountered

2) Refusal of hand auger at 1.1m in very dense material

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 15:14
TEXT : ..C:\DOTIN\SPMASTER.DOC

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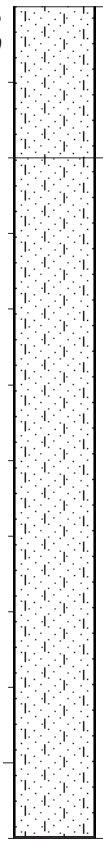
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: **AH 2**
Sheet 1 of 1

JOB NUMBER: **31181-4**

Scale 1:10



0.00 Dry, light brown, medium dense, silty SAND – (Topsoil/Colluvium)

0.20 Slightly moist, orange, medium dense, slightly clayey, silty SAND – (Colluvium/Residual)

1

1.10

NOTES

1) No ground water seepage encountered

2) Hand auger refusal encountered at 1.1m in very dense material

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH 2**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 15:14
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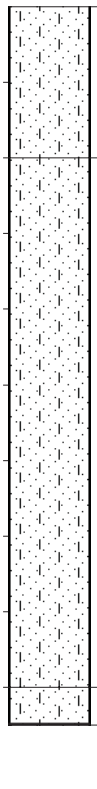
MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: **AH 3**
Sheet 1 of 1

JOB NUMBER: **31181-4**

Scale 1:10



Smpl.	Depth (m)	
		0.00 Dry, brown, dense, silty SAND – (Topsoil/Colluvium)
		0.20 Slightly moist, orange and red brown with depth, medium dense, slightly clayey, silty SAND – (Colluvium)
	1	*0.90* Slightly moist, orange and pinkish red, medium dense to very dense, silty SAND – (Colluvium/Residual)
		0.95

NOTES

1) No ground water seepage encountered

2) Hand auger refusal encountered at 0.95m

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/12/2015

DATE : 22/02/16 15:14
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH 3**

D06B DRENNAN MAUD & PARTNERS *dot.PLOT 5008 J&W*

DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: **PT1**
Sheet 1 of 1

JOB NUMBER: **31181-4**

Scale 1:10

Smpl.	Depth (m)	
o IMC		
	0.00	Dry to slightly moist, brown and dark brown, dense to very dense, intact, silty SAND containing root material – (Topsoil/Colluvium)
	0.50	Slightly moist, orange brown, medium dense, intact, slightly clayey, silty SAND – (Colluvium/Residual)
	0.90	

NOTES

1) No ground water seepage encountered

2) Hard hand digging encountered at 0.9m in very dense material

3) Sample taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 15:14
TEXT : ..C:\DOTIN\SPMASTER.DOC

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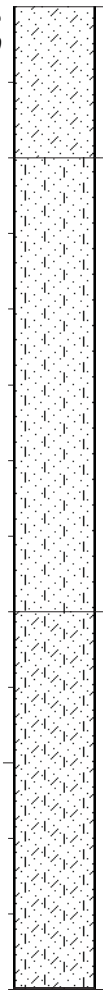
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: **PT2**
Sheet 1 of 1

JOB NUMBER: **31181-4**

Scale 1:10



Smpl.	Depth (m)	
		0.00 Dry, brown, very dense, intact to slightly fissured, clayey, SAND containing root material – (Topsoil)
		0.20 Dry, light brown and brown, medium dense, intact, slightly clayey, silty SAND – (Colluvium)
	1	*0.80* Dry to slightly moist, orange and pinkish red brown, very dense, clayey, silty SAND – (Colluvium/Residual)
		1.30

NOTES

1) No ground water seepage encountered

2) Hard hand digging encountered at base of excavation in very dense material

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 04/12/2015

DATE : 22/02/16 15:14
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT2**

DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – MOUNT ROYAL SCHOOL

HOLE No: TP1
Sheet 1 of 1

JOB NUMBER: 31181-4

Smpl.	Depth (m)	
o IMC		Scale 1:10
		0.00 Dry, brown, dense, intact to slightly fissured, clayey, SAND containing root material – (Topsoil)
		0.20 Dry, light brown and brown, medium dense, intact, slightly clayey, silty SAND – (Colluvium)
	1	0.75 Dry to slightly moist, orange and pinkish red brown, medium dense to very dense, gravelly SAND – (Colluvium/Residual)
o IMC, Swell		1.35

NOTES

1) Hand dug to 1.1m and extended to 1.35m via hand auger – Hand auger refusal encountered at 1.35m in very dense material

2) No ground water seepage encountered

3) Samples taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 04/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP1

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 15:14
TEXT : ..C:\DOTIN\SPMASTER.DOC

APPENDIX B
DCP Test Results
(DCP 1 - 9)

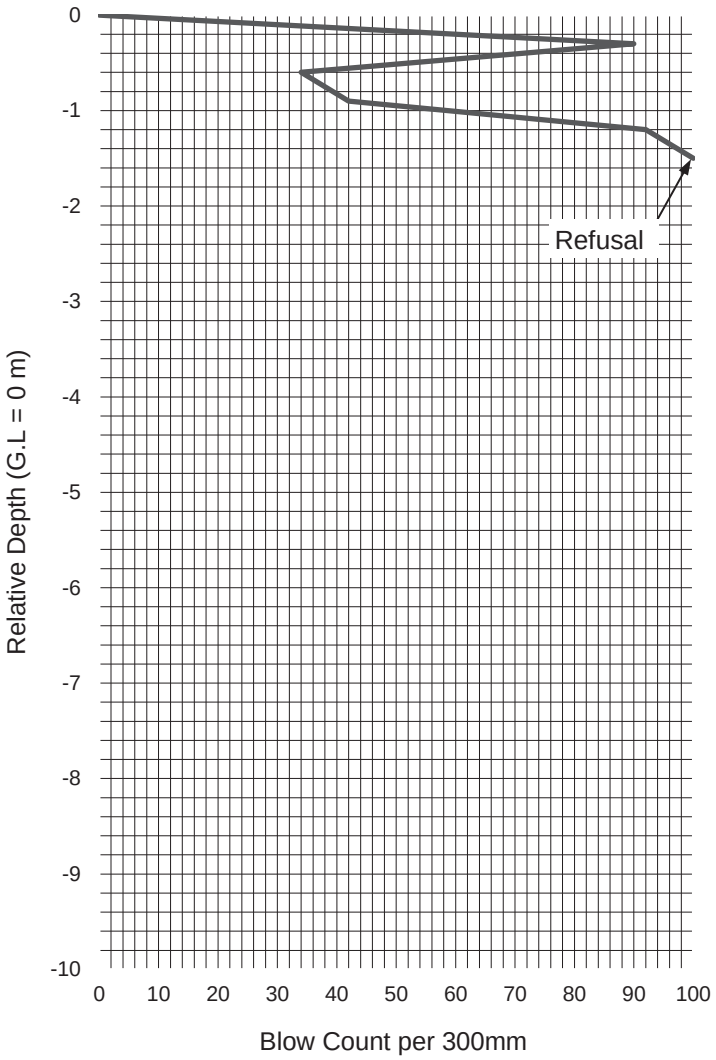
Dynamic Cone Penetrometer

Test No. : 1

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	90
-0.6	34
-0.9	42
-1.2	92
-1.5	100

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

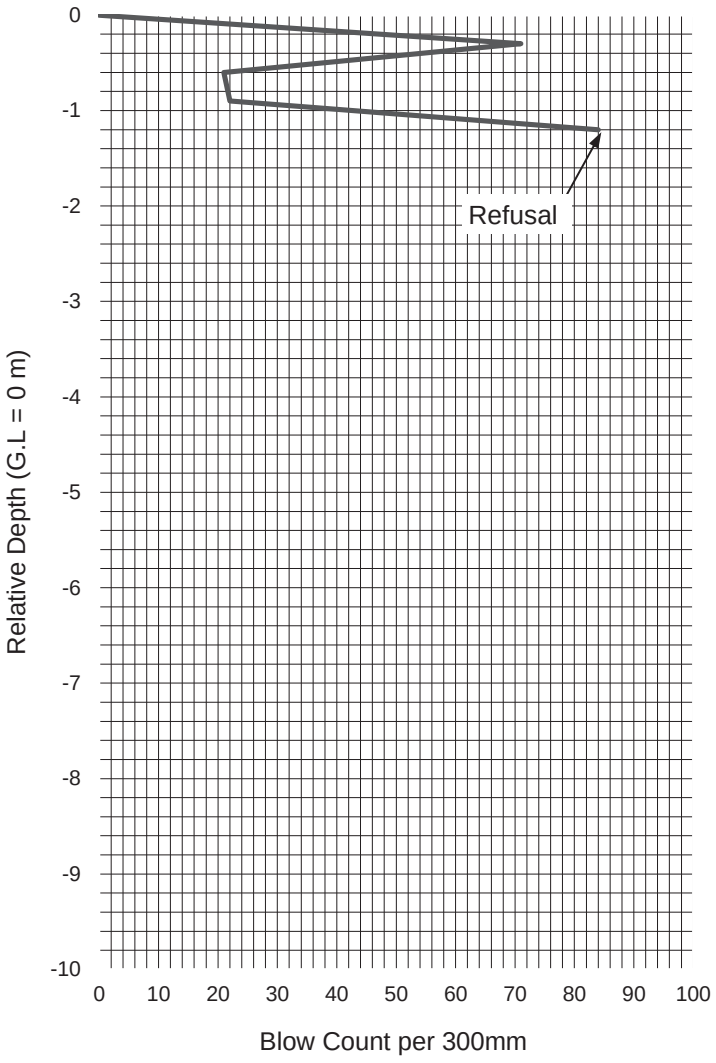
Dynamic Cone Penetrometer

Test No. : 2

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	71
-0.6	21
-0.9	22
-1.2	84

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

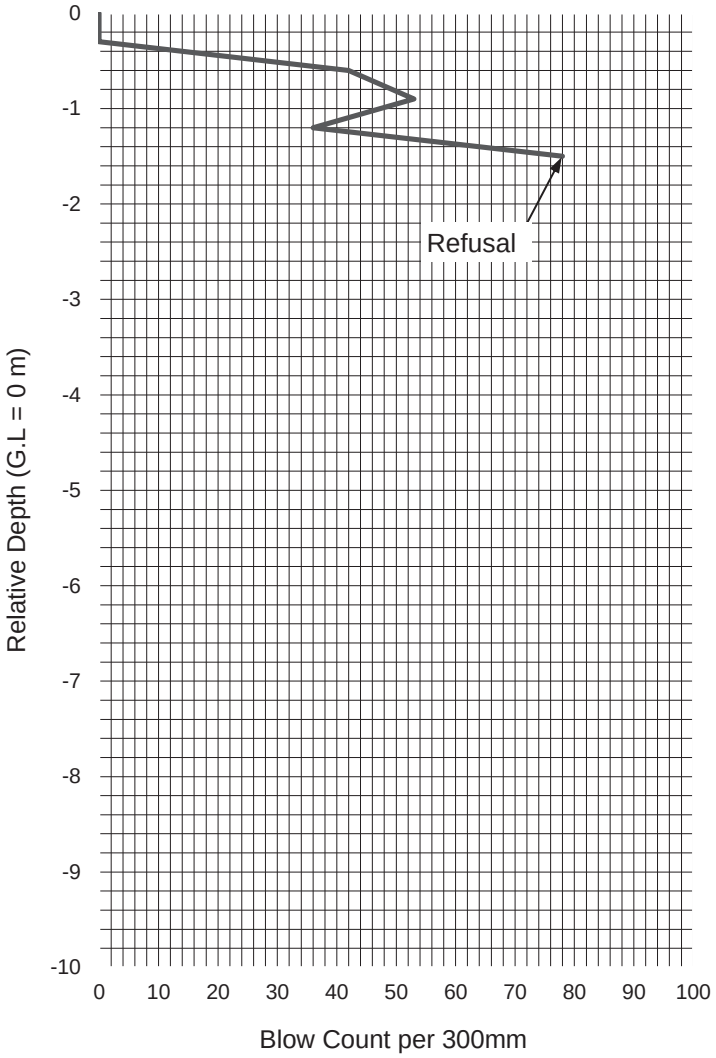
Dynamic Cone Penetrometer

Test No. : 3

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	0
-0.6	42
-0.9	53
-1.2	36
-1.5	78

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

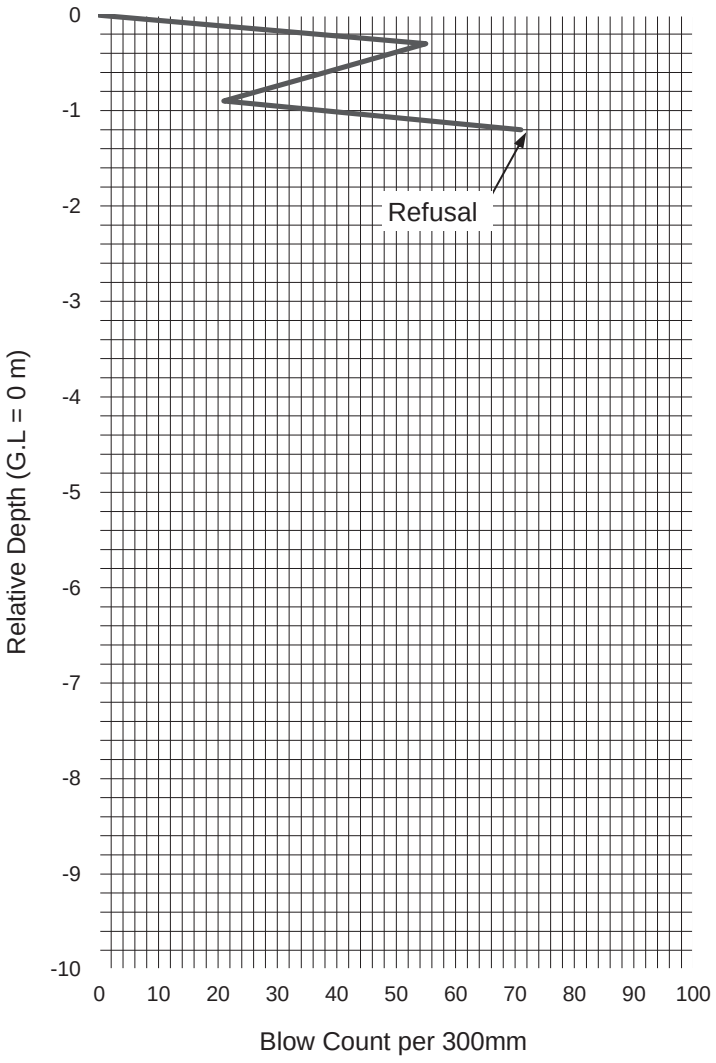
Dynamic Cone Penetrometer

Test No. : 4

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	55
-0.6	38
-0.9	21
-1.2	71

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

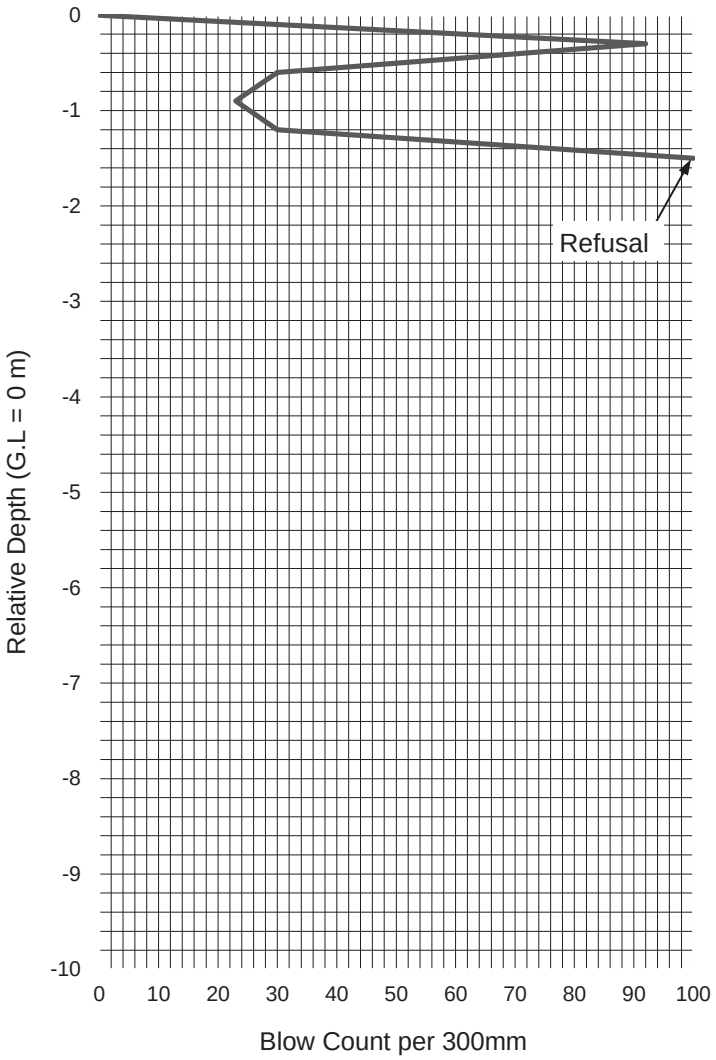
Dynamic Cone Penetrometer

Test No. : 5

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	92
-0.6	30
-0.9	23
-1.2	30
-1.5	100

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

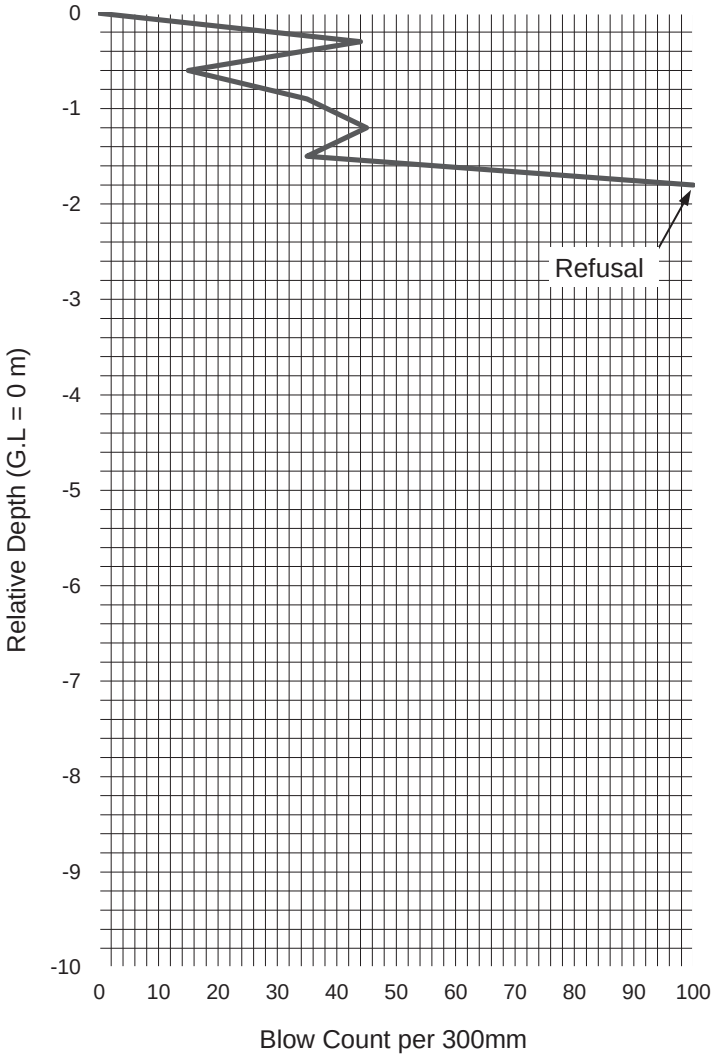
Dynamic Cone Penetrometer

Test No. : 6

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	44
-0.6	15
-0.9	35
-1.2	45
-1.5	35
-1.8	100

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

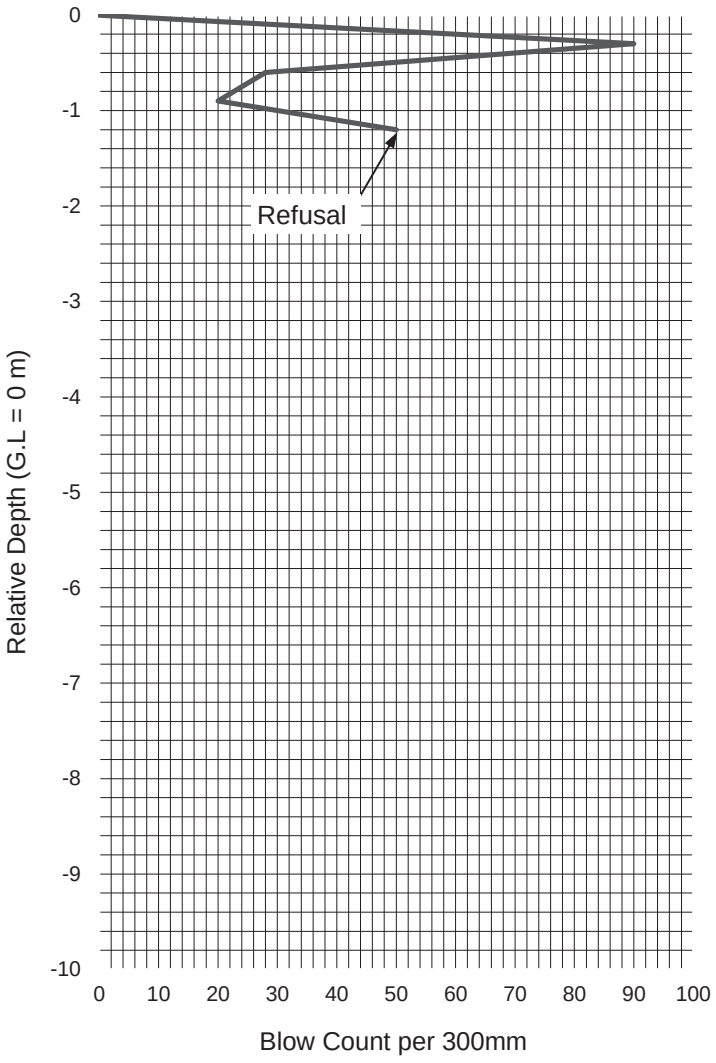
Dynamic Cone Penetrometer

Test No. : 7

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	90
-0.6	28
-0.9	20
-1.2	50

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

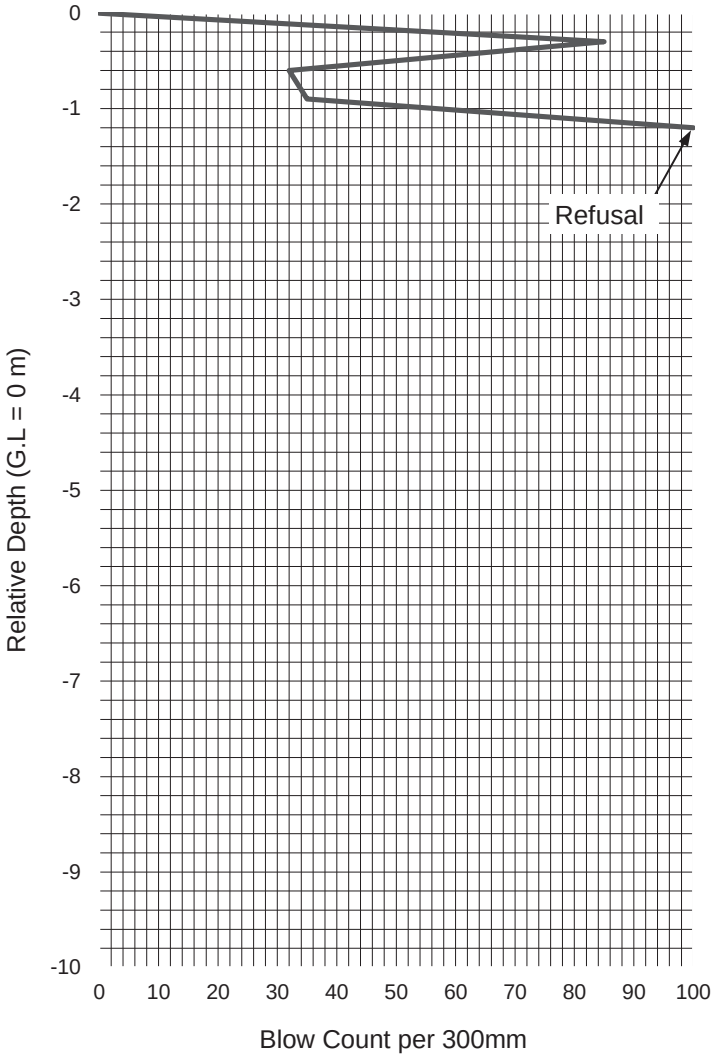
Dynamic Cone Penetrometer

Test No. : 8

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	85
-0.6	32
-0.9	35
-1.2	100

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

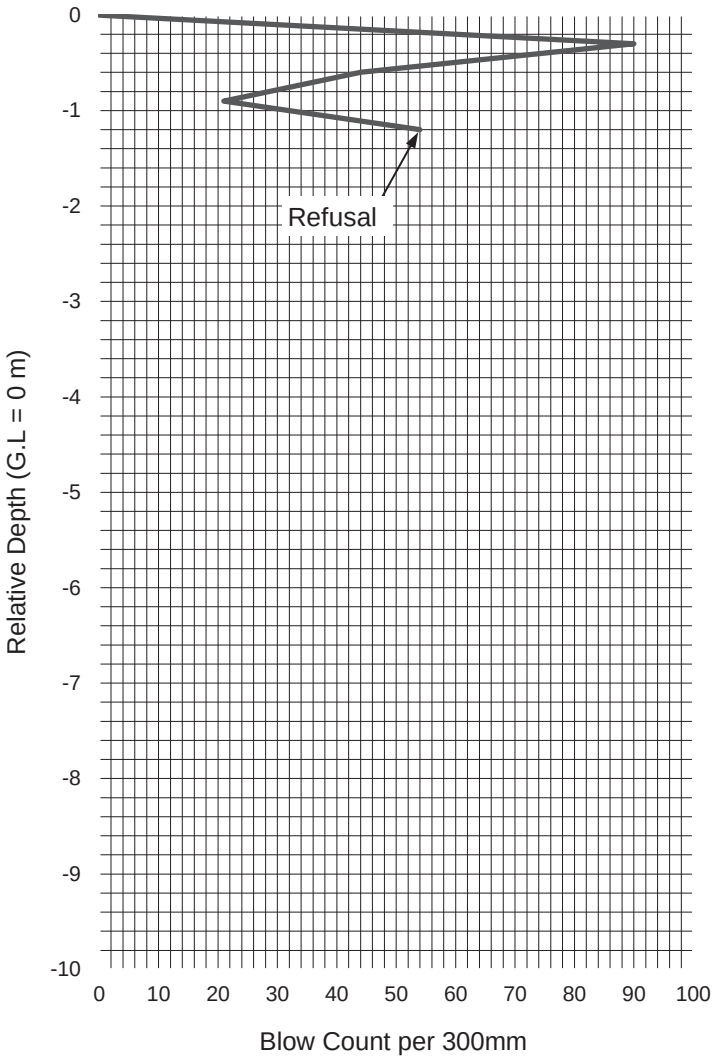
Dynamic Cone Penetrometer

Test No. : 9

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 04-12-2015 Remarks: -
Test Location: Mt Royal High School - Maseru -
Date of Test: 04-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	90
-0.6	44
-0.9	21
-1.2	54

Blow Count vs Depth



Reference No. : 31181

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60^{o} cone a distance of 300mm.

APPENDIX C
Laboratory Test Results Summary

Laboratory Test Summary

THEKWINI SOILS LAB. CC

Job Description: LESOTHO SCHOOLS - REF 31181-4
Job no.: 7980
Date: 11/01/16

Lab no.		12091										
Location		TP1										
Depth		0.75-1.35										
Description		-										
		-										
Binder Material		-										
Particle Size (mm)	75											
	53											
	37.5											
	26.5											
	19	100										
	13.2	79										
	9.5	79										
	4.75	76										
	2	69										
	0.425	57										
	0.25	53										
	0.15	36										
	0.075	15										
Hydrometer	0.05	14										
	0.02	14										
	0.005	12										
	0.002	11										
Soil Mortar	Coarse Sand <2.0 >0.425mm	17.9										
	Fine Sand <0.425>0.05mm	70.3										
	Silt <0.05 >0.005	1.8										
	Clay <0.005	10.0										
Atterberg Limits	Liquid Limit % (m/m)	40.6										
	Plasticity Index	10.9										
	Linear Shrinkage %	7.3										
	Natural MC %	-										
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *		A - 2 - 7 (0)										
Grading Modulus		1.59										
TRH 14 (1985) *												

Signature: .....
Title: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOLS - REF 31181-4

Ref no.: 7980 **Lab no.:** 12091 **Borehole/Pit no.:** TP1 **Fig no.:** -

Description: -

Depth: 0.75-1.35 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	79.1
9.5	79.1
4.75	76.4
2	69.2
0.425	56.8
0.25	52.8
0.15	36.2
0.075	14.9
0.05	14.4
0.02	13.6
0.005	12.1
0.002	10.8

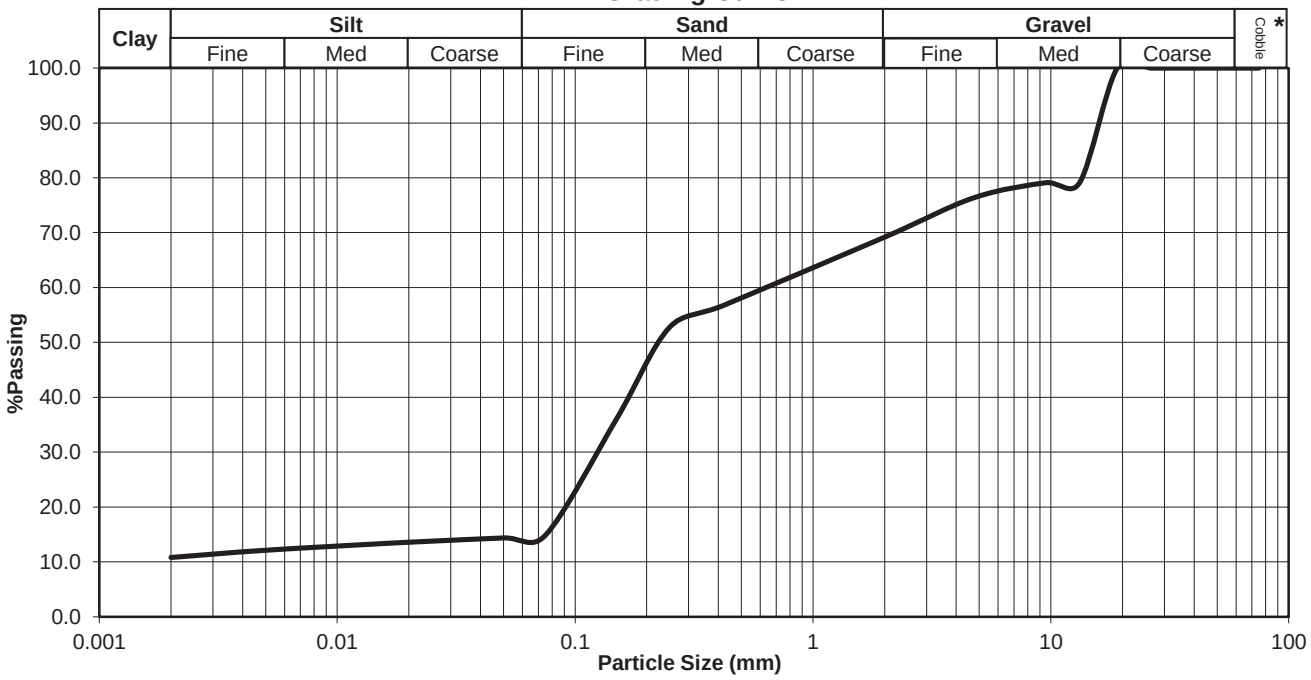
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	30.8
Coarse	0.0
Medium	22.9
Fine	7.9
Sand%	54.6
Coarse	11.0
Medium	13.7
Fine	29.9
Silt%	3.8
Coarse	1.0
Medium	1.4
Fine	1.4
Clay%	10.8

PLASTICITY	
Liquid Limit, %	40.6
Plasticity Index	10.9
Linear Shrinkage, % (L/L)	7.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	1.59

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 7
Unified Classification	SM

Grading Curve



Ref no.: 7980 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.
The results only relate to the samples tested.
The report may not be reproduced except in full.

MATERIALS TESTING LABORATORY

PO Box 0391 Maseru West 0105. Cell: (+266) 28311199
Email: molefen@leo.co.ls

Reporting Form (For Soil and Gravel Samples)						
Project	Lesotho Schools		Client: Drennan Maud		Date reported: 14-12-2015	
Date sampled	14-12-2015				Project nu 31181	
Sample no		8875	8876	8877		
		Mount Royal School	Mount Royal School	Mount Royal School		
Position		PT1	TP 1	TP1		
Depth		0.0-0.9m	0.2-0.75m	0.75-1.35m		
Material Description		Reddish Brown Silt	Brownish Silt	Brownish Silt		
Sieve analysis % passing	75,0					
	63,0					
	53,0					
	37,5					
	26,5					
	19,0					
	13,2			100		
	475			99.8		
	2,00	100	100	99.4		
	0,425	99.8	99.6	98.9		
	0,075	59.6	56.7	50.0		
Soil mortar						
2,00 - 0,425		0.2	0.4	0.5		
0.425 - 0.250		3.9	5.2	9.6		
0.250 - 0.150		11.6	13.5	15.1		
0.150 - 0.075		24.6	24.3	24.5		
<0,075		59.6	56.7	50.3		
Atterberg Constants						
Grading modulus (GM)		0.4	0.4	0.5		
Liquid limit		24.7	22.2	33.5		
Plasticity index		7.1	5.8	14.1		
Linear shrinkage		3.3	3.3	8.7		
Classification: TRH14		G8	G8	G9		
Mod. AASHTO						
MDD (kg/m^3)		1776	1832	1772		
OMC (%)		15.2	11.3	17.2		
Mould MC (%)		15.1	11.1	17.0		
% Compaction		100.0	100.0	99.9		
% swell		0.3	0.3	0.3		
NRB						
Dry density (kg/m^3)		1686	1741	1683		
% of MDD		94.9	95.0	95.0		
% swell		0.4	0.3	0.5		
Proctor						
Dry density (kg/m*)		1598	1649	1596		
% of MDD		90.0	90.0	90.1		
% swell		0.4	0.3	0.3		
C.B.R values	100%	12	15	5.0		
s*	98%	11	13	9		
$	97%	11	12	8		
S- -	95%	10	10	8		
sc.	93%	10	9	7		
	90%	9	7	6		
Bearing Capacity (kPa)						

Swell.

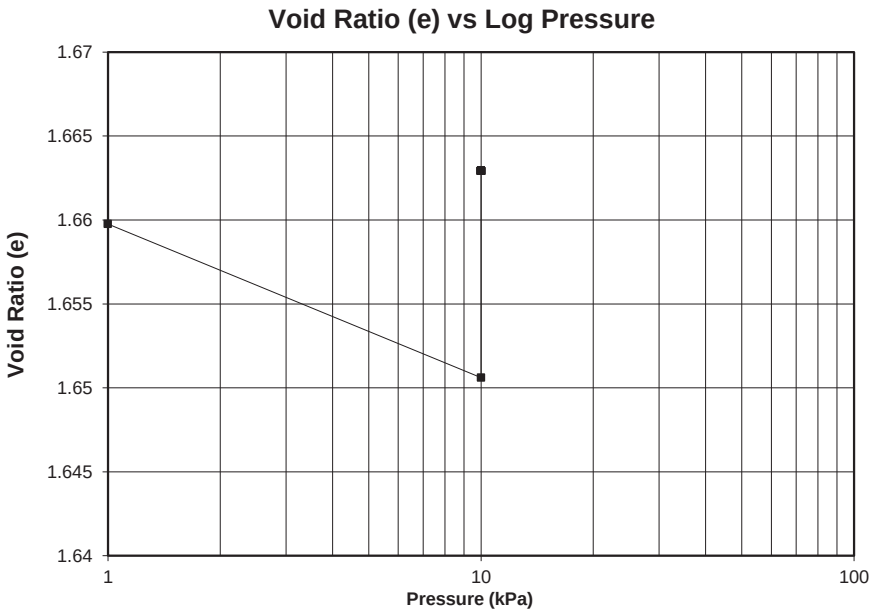
Project:	Mount Royal		
Client.:	Drennan Maud (Pty) Ltd	**Hole/Block:**	TP 1
Date:	01-02-2016	**Depth (m):**	0.75 - 1.35
Sample No.:	12091	**Consol No.:**	3
Sample Description:	-	**Ring Dial. (mm):**	76.1
		Gauge Divs.(mm):	0.002
		Specific Gravity:	2.65

Container No.:	28	Moisture content before testing (%):	**21.36**
Mass of container (g):	0	Moisture content after testing (%):	**27.36**
Mass of wet sample + container before testing (g):	104.5	Dry density before testing (kg/m3):	**1456**
Mass of wet sample + container after testing (g):	109.67	Bulk density before testing (kg/m3):	**1767**
Mass of dry sample + container (g):	86.11	Percentage saturation before test (%):	**34.10**
		Percentage saturation after test (%):	**43.60**

Applied Pressure (KPa)	Dial Reading (divs)	Void Ratio	Modulus of Compressibility Mv Stress Range(kPa)	Mv (kPa-1)	Stress Range(kPa	Mv (kPa-1)
1	2500	1.660				
10	2464	1.651	1 - 10	**3.82E-04**	1 - 10	**3.82E-04**
10	2508	1.663	10 - 10			

Swell (%)

1.79



Reference no.: 7980

Drennan Maud and Partners

Fig. no. -

APPENDIX D
Plates

Plate 1 : Mt Royal school boundary marked in red with approximate extent of development / investigated area marked in yellow.

Plate 2 : Development area looking in a south westerly direction

Plate 3 : Gently sloping site: Observer located along western boundary looking in south easterly direction.

Plate 4 : Exisitng Pit latrine ablution facilities located at south western corner of the site.

Plate 5: Denuded, hardened ground surface. Observer positioned centrally on site looking in north easterly direction towards existing single storey structures.

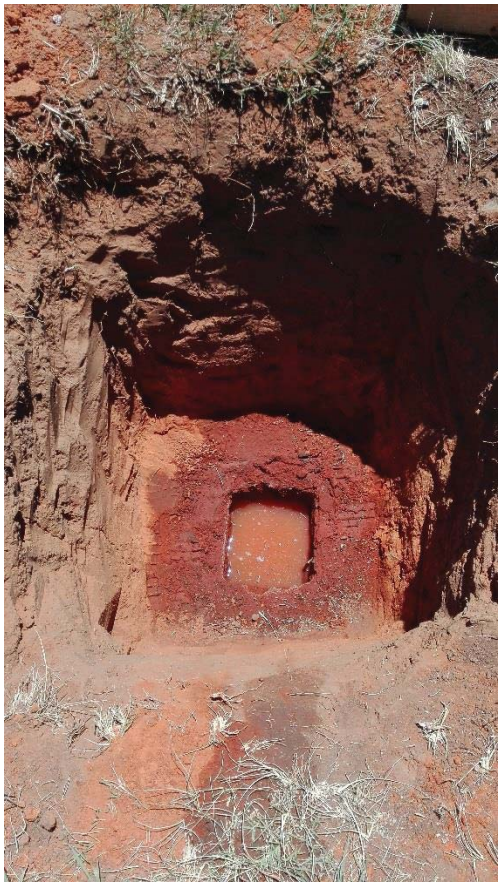


Plate 6 and 7 : Subsoils exposed in PT2 and TP 1.

FIGURE 1
Site Plan

DRENNAN MAUD (PTY) LTD
Geotechnical Engineers & Engineering Geologists

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DESIGNED :	A.J.
DRAWN :	S.P.
DATE :	20/01/2016
SCALE :	1:750
CHECKED :	

GEOTECHNICAL INVESTIGATION
LESOTHO SCHOOLS UPGRADE PROJECT
MOUNT ROYAL HIGH SCHOOL - E3

REF. NO. 31181-4

FIG. NO. 1

A-307

DRENNAN MAUD (PTY) LTD

GEOTECHNICAL ENGINEERS AND ENGINEERING GEOLOGISTS
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OUR REF: 31181-1

YOUR REF:

Matsuda Consultants International Co. Ltd.
43-3 Yoyogi 3 Chome Shibuya-ku
Tokyo,
JAPAN
151-0053

29th January 2016

Attention: Mr H. Iguchi

Email: iguchi@matsucon.co.jp

Dear Sirs,

GEOTECHNICAL INVESTIGATION FOR PROPOSED LESOTHO SCHOOLS UPGRADE PROJECT : ST CATHERINE'S SCHOOL (E4), MASERU - LESOTHO

1. INTRODUCTION

Drennan Maud (Pty) Ltd was requested to carry out a number of geotechnical investigations at various existing and proposed school sites within the Kingdom of Lesotho for the above mentioned school upgrade project.

The geotechnical investigations of the respective sites were carried out during early December 2015, in terms of the agreed scope of works detailed in the project agreement document.

The observations, geotechnical assessment and recommendations based thereon for the proposed additions at the existing St Catherine's school in Maseru, Lesotho are detailed and discussed here below in this report.

2. PROPOSED DEVELOPMENT

Based on information provided by yourselves at an initial site meeting held in the company of Drennan Maud (Pty) Ltd and Matsuda Consultant representatives on the 23 November 2015, as well as subsequent email correspondence, the proposed development at the St Catherine's School will comprise the construction of a 2 storey, reinforced concrete frame structure with brick infill and steel roofing.

Sections, plans or elevations of the proposed structure/s as well as site plan indicating the relative placement within the confines of the site have not been provided as yet, although a preliminary indication was supplied during the initial project meeting mentioned above.

3. SITE DESCRIPTION

The St Catherine's school is located towards the centre of Maseru along Lerotholi Road and Assisi Road. The layout of the school can be appreciated in the survey site plan attached as Figure 1 of this report as well as Google Earth image included as Plate 1.

The areas provisionally earmarked for potential development includes the rectangular shaped area located along the central northern boundary of the site and the area to the immediate east of the existing derelict tennis courts (refer to Plate 1).

The proposed development area along the northern boundary comprises an existing small cultivated area that slopes gently (4°) in an easterly direction with a planar slope conformation (Plate 2). The area adjacent to the tennis courts is roughly level to gently sloping in an easterly direction and is currently unoccupied.

The existing school buildings comprise both single and double storey, brick and stone structures. Visual appraisal of the existing single storey classroom buildings revealed no significant cracking of current school buildings.

During the course of the site assessment several man hole covers for possible existing storm water and/or sewerage disposal systems were noted across the school premises (Plate 3). However, the functionality of the system could not be ascertained at the time. Given the sites position in the centre of Maseru, it is most probable that there exists a municipal sewerage and/or storm water system in the area. Furthermore, running water is also available on site.

4. FIELD WORK

Prior to our arrival on site the approximate positions of all field testing to be carried out on site in accordance with the project agreement was identified remotely at the initial project meeting.

The site was visited on the 1st December 2015 during which time the field work component of the assessment, which comprised the following, was carried out.

* ***Test Pitting*** - A single test pit (TP1) was manually excavated to a depth in the order of 1.5m and was subsequently extended via hand auger apparatus, if possible, to examine the subsoils underlying the site and for sampling purposes.

* ***Auger Holes*** - Three hand auger holes (AH1-3) were excavated across the assessment areas to maximum excavated depths of 2.5m or until hand auger refusal was met at shallower depths.

* ***Percolation Testing*** - Two percolation test pits, designated PT1-PT2, were excavated manually to maximum depths of 1.3m or until hard hand digging in the dense subsoils was met at shallower depths. Percolation testing therein was carried out as per SABS 0400 standards to determine the percolation rate of the prevailing subsoils.

Note: Percolation testing as per method stipulated in the initial project brief document was attempted but found to be impractical due to the significant time required for each test and the slow percolation rates of the subsoils. As such, the method was abandoned and testing as per SABS 0400 standards, the standards currently utilised in South Africa for percolation testing, was adopted.

* ***Dynamic Cone Penetrometer (DCP) Testing*** - A total of nine DCP tests (DCP1-9) were carried out across the two development areas to determine the subsoil consistency, by recording the amount of blows required for a hammer of known weight to drive a cone apparatus 300mm into the subsoils.

To aid in the interpretation of the DCP results, the relationship between the number of blows and consistency of the cohesive and non-cohesive subsoils is provided in Table 1 below.

Table 1 : Subsoil Consistency Inferred from the DCP Test Results

Cohesive Soils		Non-Cohesive Soils	
DCP Blow Count Blow / 300mm (SPT 'N' Value)	Subsoil Consistency	DCP Blow Count Blows / 300mm (SPT 'N' Value)	Subsoil Consistency
0 - 4 (<2)	Very Soft	0 - 8 (<4)	Very Loose
4 - 8 (2 - 4)	Soft	8 - 18 (4 - 10)	Loose
8 - 15 (4 - 8)	Firm	18 - 54 (10 - 30)	Medium Dense
15 - 24 (8 - 15)	Stiff	54 - 90 (30 - 50)	Dense
24 - 54 (15 - 30)	Very Stiff	>90 (50 - 80)	Very Dense
> 54	Hard		

Note: The above table is provided as a guide as it is empirically derived and specific to Drennan Maud equipment.

* **Material Sampling** - Several disturbed bulk and indicator as well as undisturbed samples were retrieved from representative horizons within the excavated pits/auger holes and submitted to either a local Lesotho laboratory (Material Testing Laboratory) or returned to Thekwini Soils laboratory in Durban, South Africa for specialised analyses.

The soils exposed within the test and percolation pits as well as those removed from the auger holes were examined and logged by an Engineering Geologist in accordance with the Guidelines for Soil and Rock Logging in South Africa edited by A.B.A Brink and R.M.H Bruin, 2nd impression 2002. This included recording the following parameters

For Soil : Moisture content, colour, consistency, soil structure (where applicable), soil type and origin.
For Rock : Weathering, colour, bedding and joint spacing, hardness, rock type and origin.

The soil profiles, graphical DCP results and laboratory testing results summary are included as Appendices A, B and C of this report respectively.

The approximate positions of the various testing carried out on site is indicated on the survey site plan, Figure 1 of this report.

5. GEOLOGY AND SOILS

The site is underlain by Elliot Formation sandstone which generally comprises medium to coarse grained sandstone. Weathered bedrock was not encountered within any of the subsoil excavations or probes and thus is located at unknown depth below the site in excess of the scope of the shallow investigation.

The weathered bedrock is overlain by colluvial/residual material derived therefrom.

Grey mottled orange brown, clayey sandy of colluvial or residual origin occurs within TP1, AH1 and PT1 located across the lower portion of the northern development site at depths in the order of 0.5m below existing ground level.

AH2 ands PT2 located on the upper portion of the northern investigated area encountered orange brown, medium dense to dense, slightly gravelly, clayey sand material of colluvial origin at depths of 0.2 - 0.4m to a maximum excavatable depth of 0.6m.

The clayey material is in turn overlain from the surface by a mantle of light brown and grey silty sand ranging from 0.2 - 0.5m thick.

AH3 located centrally within the north western development area revealed the area is underlain by slightly gravelly, silty sand colluvial/fill material to a maximum excavated depth of 0.8m, and is in turn overlain by a thin horizon of topsoil material.

In general the upper sandy subsoil is generally loose through its upper 300mm thereunder becoming consistently increasingly medium dense to dense with depth to maximum probed depths of 4.8m.

No ground water seepage was encountered within the inspection pits. However, given the clayey nature of the subsoils, the presence of a seasonally perched water table at shallow depths below the surface should not be excluded, especially during the wetter summer months.

The general subsoil conditions prevailing across the site are depicted in Plate 4 -6 included in Appendix D herewith.

6. LABORATORY ASSESSMENT

6.1 Laboratory Testing

The complete schedule of the laboratory samples and the testing conducted thereon is included in Table 2 below;

Table 2: Schedule of Laboratory Testing

Pos	Material Description	Depth (m)	Laboratory Test			
			Ind	Mod	CBR	Triax
TP1	Light brown, silty SAND - Topsoil/colluvium	0.0 - 0.5	✔	✔	✔	
TP1	Khaki grey/orange brown, sandy CLAY - Colluvium	0.5 - 1.5	✔	✔	✔	✔*
TP1	Grey/orange, sandy CLAY - Colluvium/Residual	1.5 - 2.3	✔*			
PT2	Orange brown, clayey SAND - Colluvium	0.2 - 0.8	✔	✔	✔	
AH1	Grey mottled orange, sandy, CLAY - Colluvium/Residual	0.5 - 1.2	✔*			

* - Denotes Samples tested by Thekwini Soil Lab in Durban

6.2 Laboratory Results

The laboratory test summary is provided in Appendix C of this report along with shear box and consolidation test results. However, for ease of reference the results of the laboratory testing are provided herewith in Tables 3 - 5 below;

6.2.1 *Grading Analyses*

Table 3 - Summary of Grading Analysis Results

Pos	Depth (m)	Description	LL %	PI	LS %	%Silt & Clay	Revised US Classification	
							Group	Subgrade Rating
TP1	0.0 - 0.5	Silty SAND	N il	N.P.	0.0	31.4	A-2-4	Good
TP1	0.5 - 1.5	Sandy CLAY	17.1	5.4	1.3	61.2	A-4	Fair
TP1	1.5 - 2.3	Sandy, CLAY	21	8.6	6.0	58.2	A-4	Fair
PT2	0.2 - 0.8	Silty SAND	17.5	S.P.	N il	21.9	A-2-4	Good
AH1	0.5 - 1.2	Sandy, CLAY	24.2	10.4	6.7	67.9	A-6	Poor

N.P. - Non-plastic S.P. - Slightly plastic

6.2.2 *Mod AASHTO Density and CBR Testing*

Table 4 - Summary of Density Testing Results

Pos	Depth (m)	Material	Mod AASHTO Density (kg/m^3)	OMC (%)	CBR Results			TRH 14
					90 %	98 %	Swell %	
TP1	0.0 - 0.5	Silty SAND	1956	9.4	19	30	0.0	G6
TP1	0.5 - 1.5	Clayey, silty SAND	2076	9.3	8.0	14	0.2	G8
PT2	0.2 - 0.8	Silty SAND	1924	9.4	7.0	12	0.2	G8

6.2.3 Traixial Testing

Table 5 - Summary of Triaxial Results

Pos (Depth)	Material Type	Cohesion 'C' (kPa)	Angle of Internal Friction 'Φ'	Bulk Density (kg/m^3)
TP1(0.5 - 1.5m)	Sandy CLAY	19	30	1927

7. GEOTECHNICAL APPRAISAL

7.1 Problematic soils

The upper sandy subsoils are highly susceptible to erosion via flowing water and wind forces. As such adequate measures to manage stormwater run-off and dust suppression should be adopted on site to mitigate any potential soil erosion across the development areas.

The sandy clay material encountered at depth is considered to be slightly active in the sense that the material may undergo some slight volume change with a fluctuation in the materials in-situ moisture content.

7.2 Subsoil Consistency

DCP probes carried out across the proposed development areas indicate the upper 0.3m of material is generally loose, thereafter becoming medium dense to depths ranging between 0.6 - 1.5m. Thereunder the subsoils are generally dense to depths ranging between 1.5 - 3.6m below existing ground level at which point the probes were halted in the dense material.

In terms of the subsoil consistency a bearing capacity of 150 kPa is considered suitable within the medium dense to dense material encountered at depths in the order of 1.2m below existing ground level.

7.3 Material suitability

Laboratory testing indicates the sandy clay material classifies as an A-4 to A-6 material (after AASHTO classification) and G8 material after TRH 14 -1985 standards.

However, despite the laboratory test results, due to the high clay content within the sandy clay material these subsoils are generally considered poor for filling and layerworks purposes.

The upper silty sandy subsoils classify as A-2-4 type material and G6 type material according to AASHTO and TRH 14 - 1985 standards respectively. As such the material is considered suitable for use as bulk fill, subgrade and selected layer material. The use of the fine grained sandy material for use subbase, if required on site, should be left up to the discretion of the on-site engineer.

Base and possible subbase material will have to be imported to site if required from a local quarry source.

7.4 Percolation testing

Percolation testing was carried out in terms of SABS 0400 standards which requires a test hole is excavated on site to a suitable depth with a smaller 300mm x 300mm x 300mm hole excavated at the base of the pit. The smaller hole is filled to a height of no less than 300mm and maintained at such a level for a period of no less than 4 hours.

At the end of the 4 hour period the level of the water is topped up and the time at which the test starts is noted. The drop in water level as it soaks away over a subsequent period of 30 minutes is measured. The time taken for the water level to drop by 25mm increments is measured with the average of this time during the 30minute period taken as the percolation rate. Where such percolation rate is less than 30minutes the soils on site are deemed suitable for potential subsoil percolation. Should the water level not drop by 25mm within the 30 minute period the subsoils are considered unsuitable.

Percolation test pits were excavated to depths of 0.8m for both PT1 and PT2 with testing therein carried out as per above mentioned method. For PT1 there was no discernable drop in the water level during the course of the initial 6hour soaking period and thus the percolation test fails and the percolation rate in the clayey subsoils is unsuitable for effluent disposal via subsoil percolation.

Similarly, for PT2, the time taken for a 25mm drop in water level within the dense subsoils exceeded the 30 minute time period and thus the subsoils are considered unsuitable for effluent disposal via subsoil percolation.

7.5 Settlement Analyses

Settlement analyses were carried out to determine the anticipated amount of settlement below the proposed structures. However, no details regarding the anticipate loading of the proposed structure was provided and thus settlement analyses were carried out on indicative loads ranging between 150, 300 and 500 kN, at an allowable bearing pressure of 150 kPa, on column bases and strip footings of various dimensions placed at a depth of 1.2m and using the lower bound worst case DCP results.

The results of the analyses indicate settlement amounts are anticipated to be less than 10mm and therefore likely to fall within tolerable limits for the proposed structures. Nevertheless it is recommended that the structures are constructed to accommodate some differential settlement i.e. suitably spaced construction joints.

8. DEVELOPMENT RECOMMENDATIONS

Based on the geotechnical assessment of the site the following recommendations for the proposed development are as follows. However, the recommendations are provided in a general capacity given no details of the proposed earthworks and final platform levels have been provided at this stage.

8.1 Earthworks

With regards to any cutting and filling required on site the following general recommendations are provided;

8.1.1 Cuts

All permanent unsupported batters within the sandy sediment should be trimmed back to a maximum safe batter of 1:2 (26.5°). Batters in the generally medium dense to dense and/or clayey sandy/sandy clay subsoils can be increased on a temporary basis to 1:1,5 (33°). All excavations greater than 1.2m deep should abide by these batter restrictions or be suitably shored to ensure safe working conditions during construction.

Where the above permanent batters cannot be accommodated within the confines of the site, cut slopes should be supported by a suitably designed retaining structure.

To mitigate potential soil erosion all permanent unsupported cut embankments should be sodded and grassed as soon as possible after construction has been completed.

8.1.2 Fills

Fills should be constructed of suitable granular material. In this regard the prevailing upper sandy subsoils are considered suitable. The fill material should be placed in layers of 300mm loose thickness and compacted to 93% or 95% of the materials Mod AASHTO dry density for more clayey and sandy material respectively prior to the placement of the next layer.

Fill batters should be restricted to a maximum batter of 1:1,75 (30°) for a well compacted engineered fill provided it is restricted to a height of no more than 3.0m.

Fill embankments should be vegetated as soon as possible to reduce the likelihood of soil erosion thereon.

8.2 Site drainage

Adequate on site drainage, both during and after construction, is considered necessary to ensure erosion within the sandy subsoils is kept to a minimum.

All runoff from roof areas should be captured to discharge into Jo-Jo tanks (or some equivalent) for later use on site as is currently practised. Runoff from all paved areas or hardened surfaces must be channelled into suitable placed surface drains to discharge into the existing municipal stormwater management system. Given the poor subsoil percolation rates soak pits are deemed unsuitable.

The site should be suitably graded such that stormwater is not allowed to pool adjacent to existing or proposed structures and infiltrate into potential collapsible subsoils.

Concentrated run-off onto exposed embankments should be avoided. In addition to minimise potential erosion surface drains can be placed at the crest of cut and fill embankments to prevent water from flowing over the crest thereof.

Any potential perched subsoil seepage encountered out of cut embankments should be dealt with symptomatically as and when it occurs.

8.3 Founding

Based on the anticipated amount of settlement determined through indicative settlement analyses it is likely that the settlement amounts will fall within tolerable limits. As such it is considered suitable that the proposed development is founded on reinforced ground beams spanning column bases or reinforced strip footings placed at a depth of 1.2m below ground level in the moisture stable zone. The foundations should be taken through all fill material into similar medium dense to dense in-situ subsoils across the entire area of the structure.

A bearing pressure of 150 kpa is considered suitable for the medium dense to dense subsoils underlying the site.

It is recommended that structures be placed as much as practically possible, if not entirely in portions of cut and thus avoid the construction of fills given the generally poor nature of the clayey subsoils on site.

The foundation trenches should be assessed by a Engineering Geologist/Geotechnical professional prior to casting concrete therein to confirm the competency of the founding medium at founding level.

8.4 Sanitation

In terms of the percolation test results and lack of available space on site, effluent disposal via subsoil percolation is considered unfeasible.

As such effluent should be disposed of via municipal sewerage system likely available in the surrounding city area.

Should connection to such a system be problematic it is recommended that the effluent be captured in a suitably sized conservancy tank that is positioned such that it can be pumped clear on a regular basis by a vacuum tanker.

9. CONCLUSION

The proposed school development comprising construction of additional single to two storey structures across the identified available areas at the St Catherine's school is considered feasible, provided the geotechnical considerations and recommendations provided in this report are consulted during the design and construction phase of the development.

These amount to no more than sound building practices appropriate for the prevailing subsoil conditions.

Once the layout of the proposed school development and intended earthworks have been finalised, we recommend Drennan Maud (Pty) Ltd is consulted prior to construction to confirm the suitability thereof and identify any potential problems that may arise or considerations that need to be taken into account.

10. DISCLAIMER

The ground conditions described in this report refer specifically to those encountered in the inspection pits and auger holes at the proposed school site. It is therefore quite possible that conditions at variance with those in the excavated trial pits and augerholes could be encountered elsewhere on the site during construction.

The information in this report is given in good faith, as an indication of materials and conditions likely to be encountered during construction. There is no warranty that the information is totally representative of the entire school site area and no responsibility will be accepted for any consequences arising from the actual conditions being different from those indicated in this document.

We trust that the information provided in this report meets with you immediate requirements in this regard and will be pleased to furnish you with any other information you may require.

Yours faithfully
DRENNAN MAUD (PTY) LTD.

A. Joubert Pr.Sci.Nat.

/aj

APPENDIX A
Soil Profiles
(TP 1, PT1 - 2 & AH 1 - 3)

DRENNAN MAUD (PTY) LTD

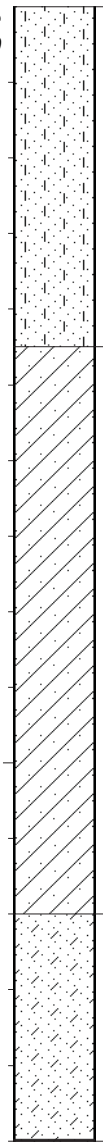
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: **AH1**
Sheet 1 of 1

JOB NUMBER: **31181**

Scale 1:10



0.00 Dry to slightly moist, brown to grey brown with depth, loose to medium dense, silty, fine to medium grained SAND – (Topsoil/Colluvium)

0.45 Slightly moist, grey mottled orange brown, very stiff, sandy, CLAY – (Colluvium/Residual)

o
l

1

1.20 Slightly moist, light orange brown mottled grey, medium dense, clayey SAND to sandy clay in places – (Colluvium/Residual)

1.50

NOTES

1) No ground water seepage encountered

2) Semi refusal of hand auger at 1.5m in dense clayey sand

3) Sample taken for laboratory testing

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 01/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH1**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

DRENNAN MAUD (PTY) LTD

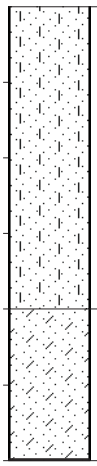
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: **AH2**
Sheet 1 of 1

JOB NUMBER: **31181**

Scale 1:10



0.00 Dry, brown, medium dense, intact, silty, SAND – (Topsoil/Colluvium)

0.40 Dry, orange brown, medium dense to dense, intact, clayey, SAND – (Colluvium)

0.60

NOTES

1) No ground water seepage encountered

2) Hole stopped at 0.6m in dense gravelly material – poor recovery

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 01/12/2015

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH2**

DRENNAN MAUD (PTY) LTD

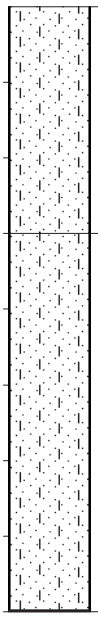
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: **AH 3**
Sheet 1 of 1

JOB NUMBER: **31181**

Scale 1:10



0.00 Slightly moist, brown, loose to medium dense, slightly gravelly, silty SAND – (Topsoil/Fill)

0.30 Slightly moist, orange brown, medium dense to dense, slightly clayey, silty SAND – (Colluvium/Fill)

0.80

NOTES

1) Hand auger refusal encountered in dense silty sand at 0.8m

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND AUGER
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION :
DIAM : NA
DATE : NA
DATE : 01/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **AH 3**

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

DRENNAN MAUD (PTY) LTD

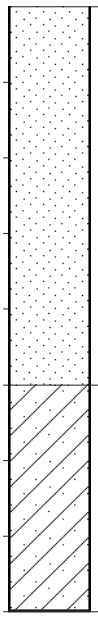
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: PT1
Sheet 1 of 1

JOB NUMBER: 31181

Scale 1:10



0.00 Dry to slightly moist, brown, loose to medium dense, intact, SAND – (Topsoil/Colluvium)

0.50 Slightly moist to moist, orange brown mottled grey and grey brown, medium dense to very stiff, intact, sandy CLAY – (Colluvium/Residual)

0.80

NOTES

1) No ground water seepage encountered

2) Percolation test – No discernible level drop after 6 hours – Test Fail

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 01/12/2015

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: PT1

DRENNAN MAUD (PTY) LTD

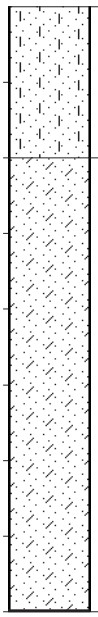
Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: **PT2**
Sheet 1 of 1

JOB NUMBER: **31181**

Scale 1:10



0.00 Dry, brown, medium dense, intact, silty, SAND – (Topsoil/Colluvium)

0.20 Dry, orange brown, medium dense to dense, intact, clayey SAND – (Colluvium)

0.80

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IMC

NOTES

1) No ground water seepage encountered

2) Sample taken for laboratory testing

3) Percolation Test carried out – Test Fail >30min per 25mm drop

Smpl.	*Depth (m)*

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

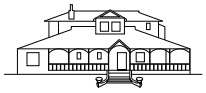
INCLINATION :
DIAM : NA
DATE : NA
DATE : 01/12/2015

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **PT2**

DRENNAN MAUD (PTY) LTD



Geotechnical Engineers & Engineering Geologists

MATSUDA CONSULTING
LESOTHO SCHOOLS – ST CATHERINES

HOLE No: TP1
Sheet 1 of 1

JOB NUMBER: 31181

Smpl.	Depth (m)	Scale 1:15		
			0.00	Dry to slightly moist, light brown, loose to medium dense, silty, fine to medium grained SAND – (Topsoil/Colluvium)
o IMC			0.50	Slightly moist, light khaki grey speckled and blotched orange brown, medium dense to dense, intact, sandy CLAY – (Colluvium/Residual)
o IMC, Triaxial	1		1.50	Slightly moist, light grey mottled orange brown, very stiff, sandy CLAY – (Colluvium/Residual)
o I	2		2.35	

NOTES

1) Hand dug to 1.5m and extended to 2.35m via hand auger – Hand auger refusal encountered at 2.35m in stiff clay

2) No ground water seepage encountered

3) Samples taken for laboratory testing

CONTRACTOR : NA
MACHINE : HAND DUG
DRILLED BY : NA
PROFILED BY : AJ

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 01/12/2015

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TP1

TYPE SET BY : AJ
SETUP FILE : DMPSP.SET

DATE : 22/02/16 13:09
TEXT : ..C:\DOTIN\SPMASTER.DOC

APPENDIX B
DCP Test Results
(DCP 1 - 9)

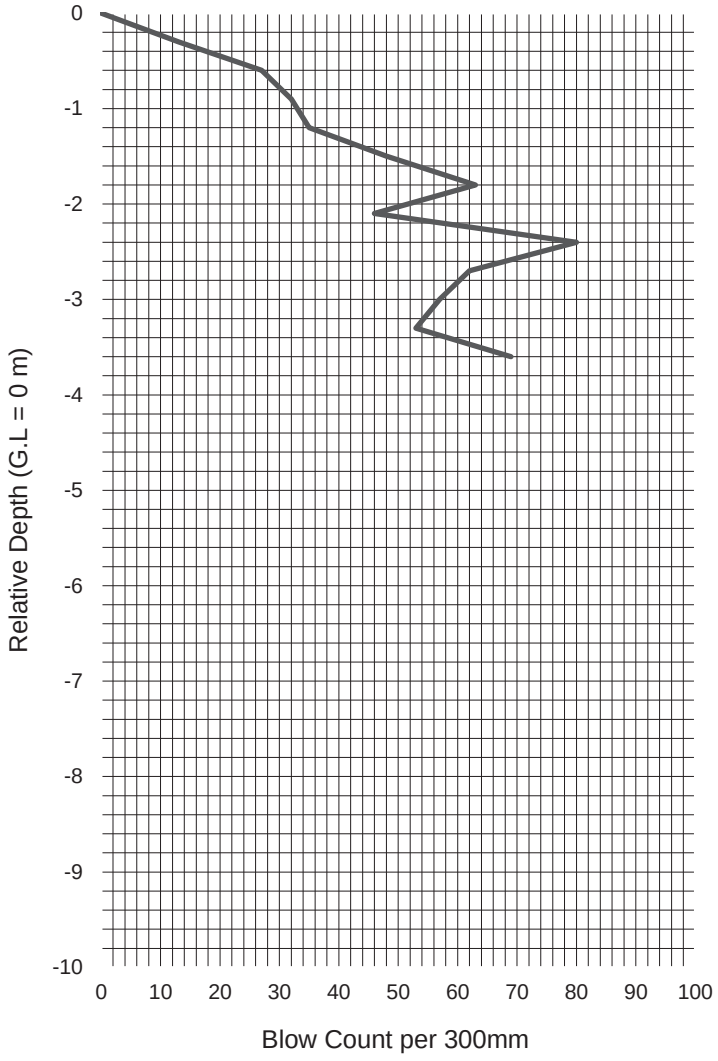
Dynamic Cone Penetrometer

Test No. : 1

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	13
-0.6	27
-0.9	32
-1.2	35
-1.5	48
-1.8	63
-2.1	46
-2.4	80
-2.7	62
-3.0	57
-3.3	53
-3.6	69

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

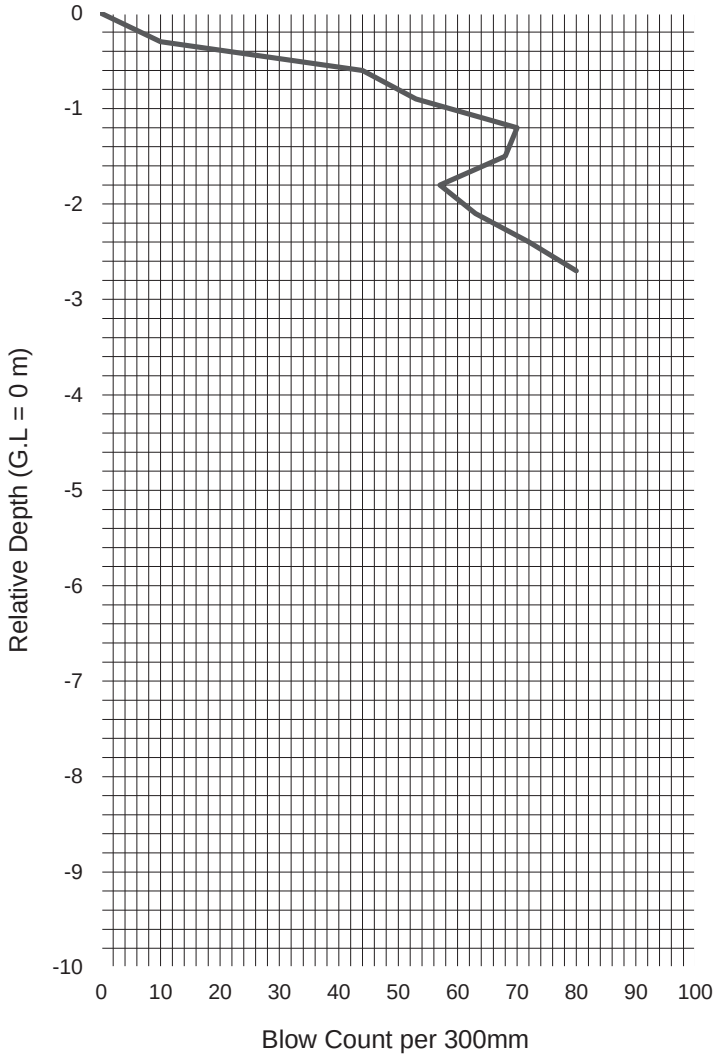
Dynamic Cone Penetrometer

Test No. : 2

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	10
-0.6	44
-0.9	53
-1.2	70
-1.5	68
-1.8	57
-2.1	63
-2.4	72
-2.7	80

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

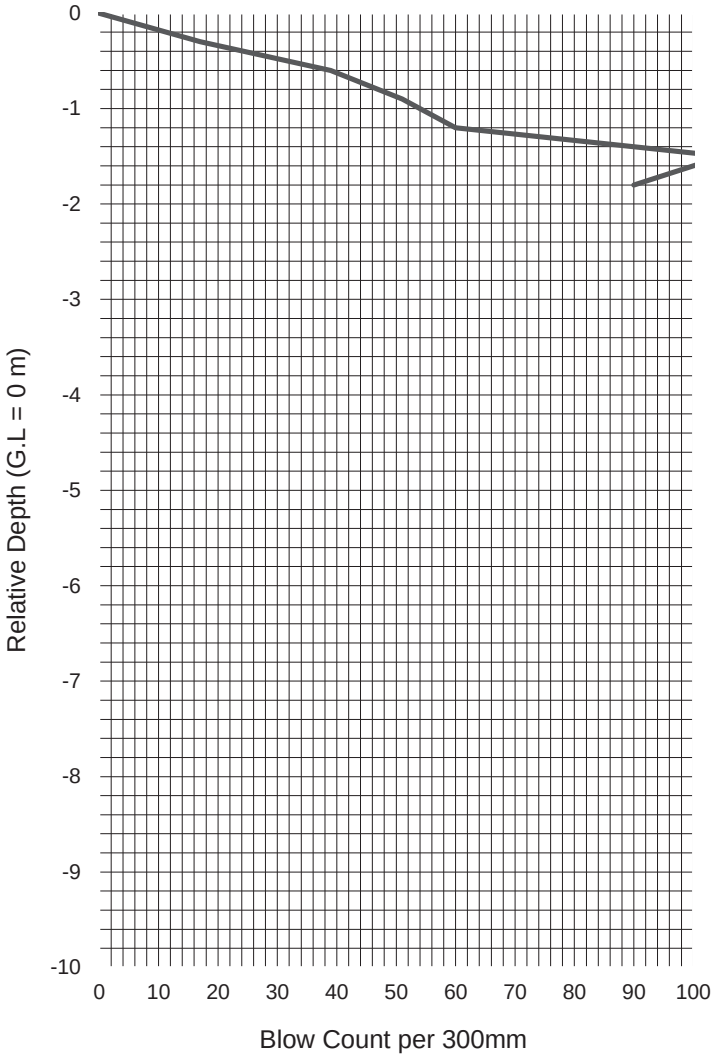
Dynamic Cone Penetrometer

Test No. : 3

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	17
-0.6	39
-0.9	51
-1.2	60
-1.5	105
-1.8	90

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

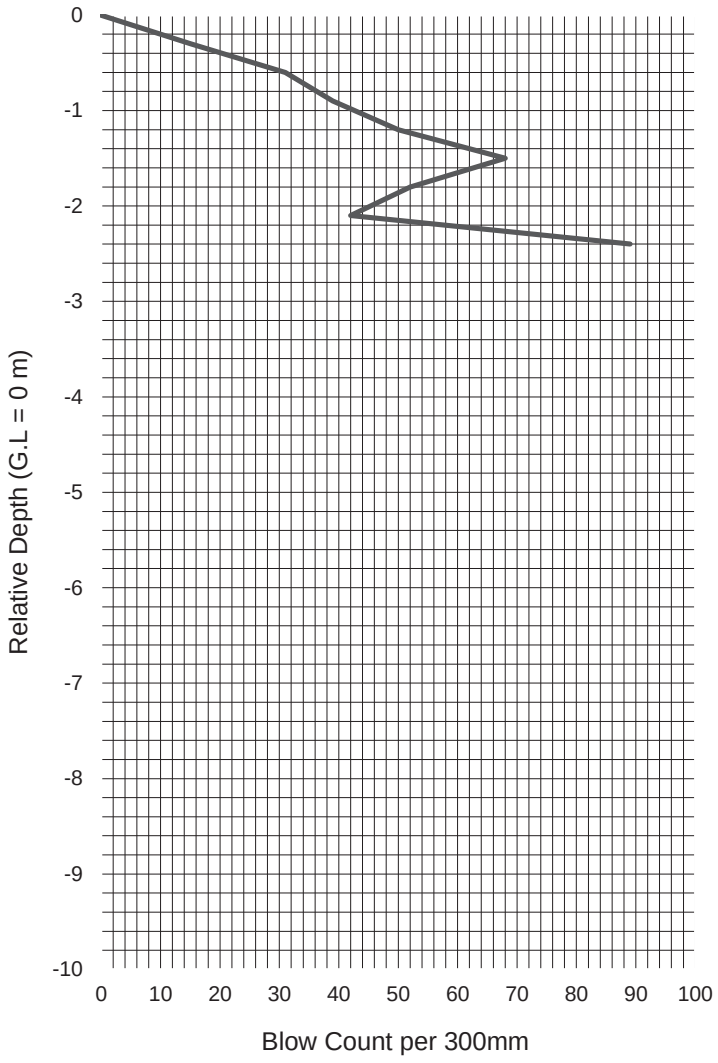
Dynamic Cone Penetrometer

Test No. : 4

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	15
-0.6	31
-0.9	39
-1.2	50
-1.5	68
-1.8	52
-2.1	42
-2.4	89

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

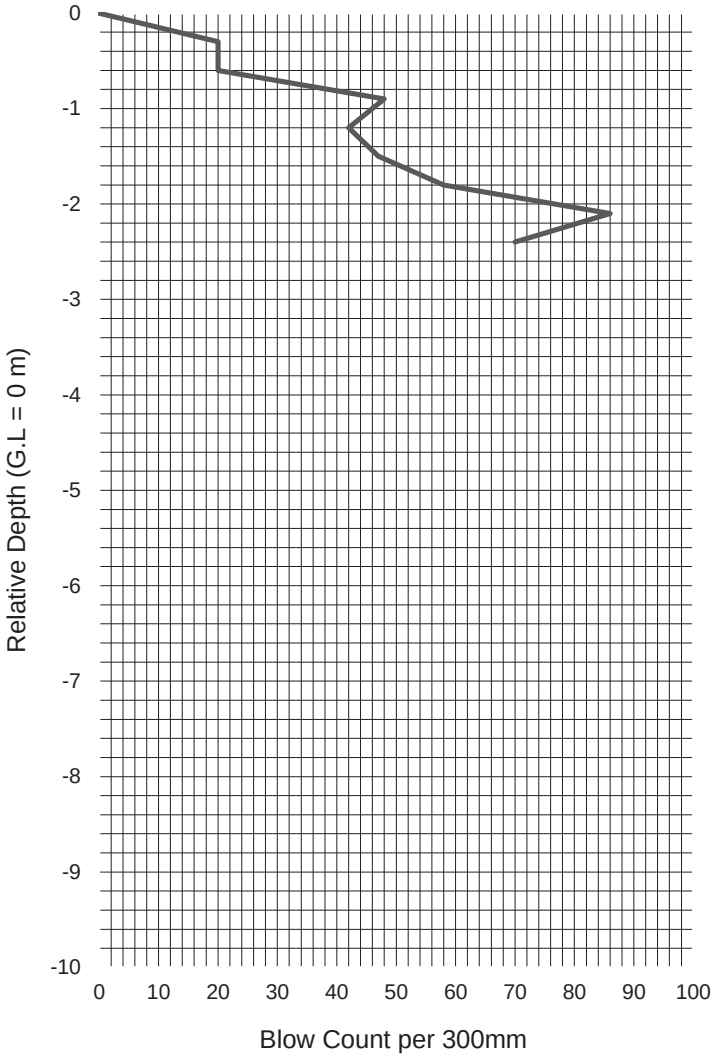
Dynamic Cone Penetrometer

Test No. : 5

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	20
-0.6	20
-0.9	48
-1.2	42
-1.5	47
-1.8	58
-2.1	86
-2.4	70

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

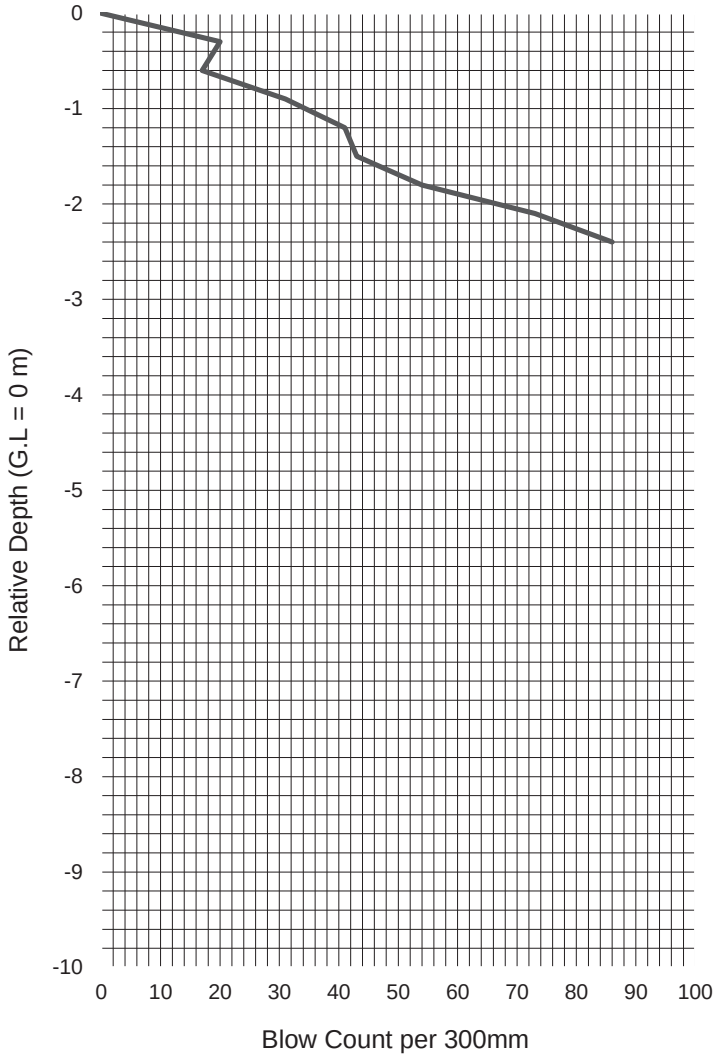
Dynamic Cone Penetrometer

Test No. : 6

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	20
-0.6	17
-0.9	31
-1.2	41
-1.5	43
-1.8	54
-2.1	73
-2.4	86

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

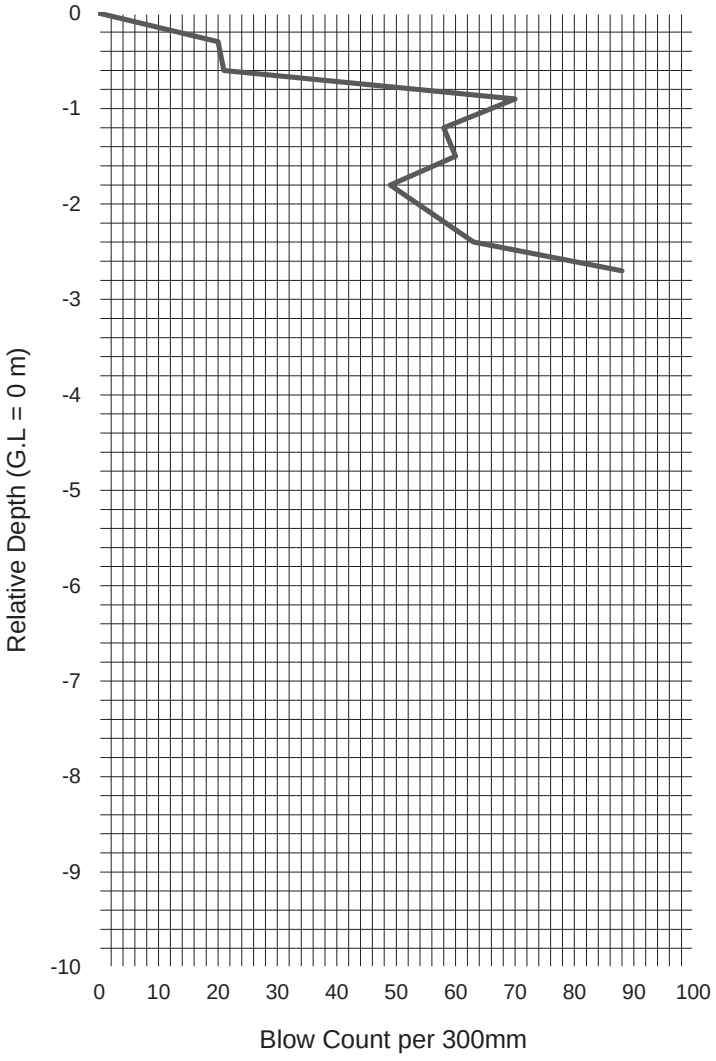
Dynamic Cone Penetrometer

Test No. : 7

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	20
-0.6	21
-0.9	70
-1.2	58
-1.5	60
-1.8	49
-2.1	56
-2.4	63
-2.7	88

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

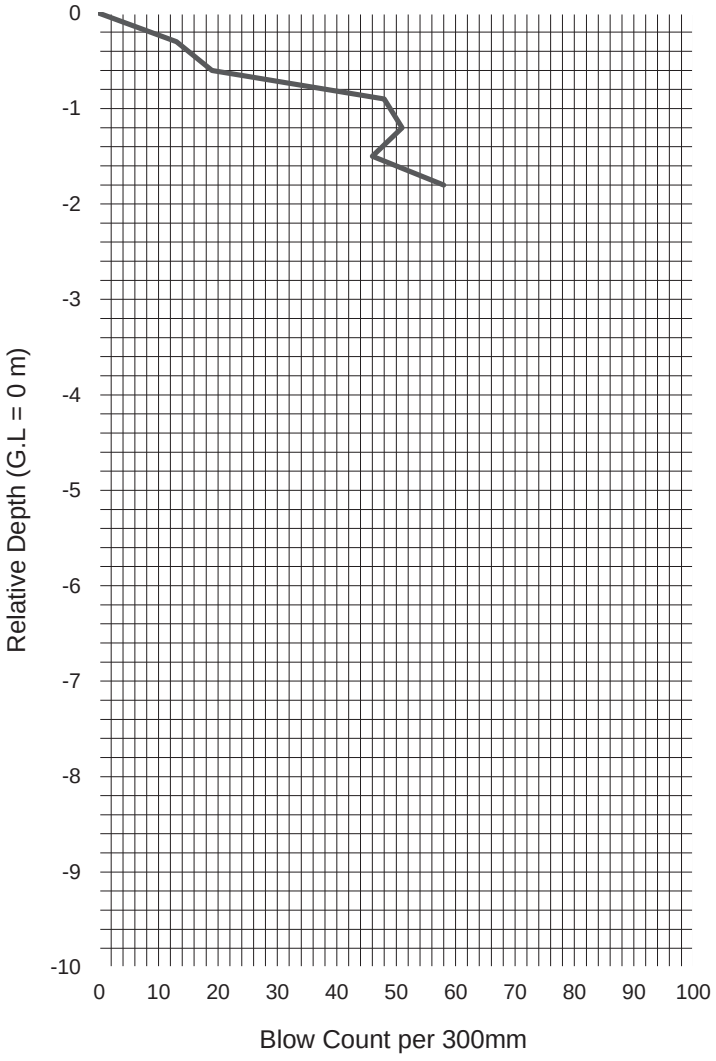
Dynamic Cone Penetrometer

Test No. : 8

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	13
-0.6	19
-0.9	48
-1.2	51
-1.5	46
-1.8	58

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

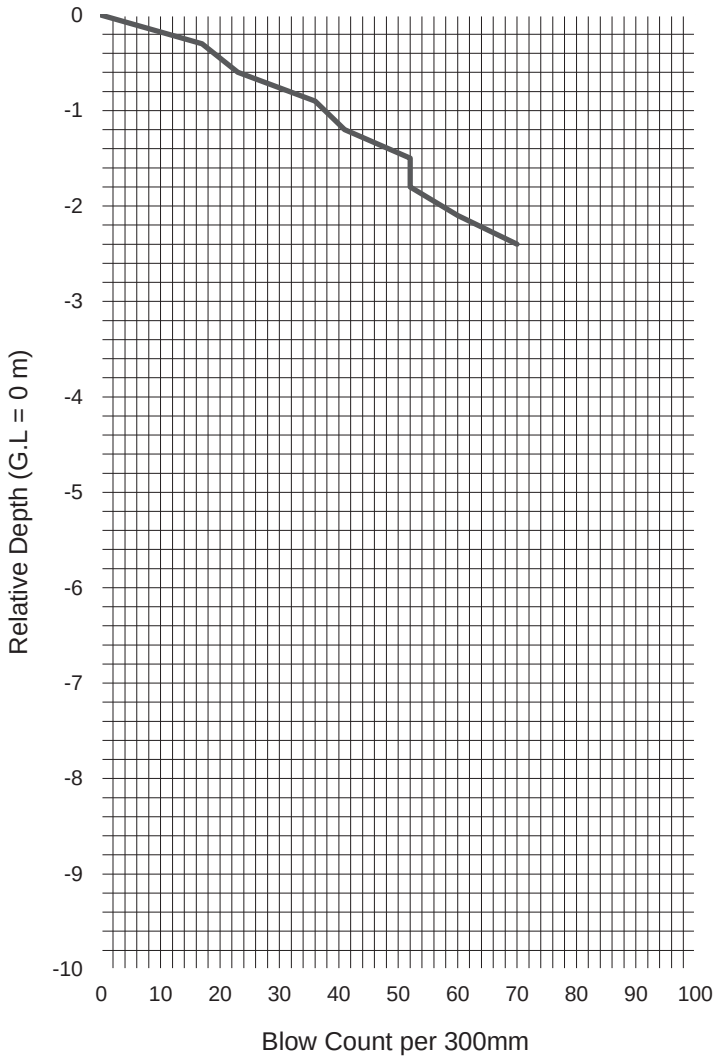
Dynamic Cone Penetrometer

Test No. : 9

Project : **Lesotho Schools Project**
Client: **Matsuda Consulting**
Date: 01-12-2015 Remarks: -
Test Location: St Catherines School - Maseru -
Date of Test: 01-12-2015 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	17
-0.6	23
-0.9	36
-1.2	41
-1.5	52
-1.8	52
-2.1	60
-2.4	70

Blow Count vs Depth



Reference No. : 31181-1

Drennan Maud & Partners.

Fig. No. -

Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60° cone a distance of 300mm.

APPENDIX C
Laboratory Test Results Summary

Laboratory Test Summary

THEKWINI SOILS LAB. CC

Job Description: LESOTHO SCHOOL - REF 31181
Job no.: 7980
Date: 11-01-16

Lab no.		12088	12097	12098								
Location		TP1	TP1	AH1								
Depth		0.5-1.5	1.3-2.35	0.45-1.2								
Description		-	-	-								
		-	-	-								
Binder Material		-	-	-								
Particle Size (mm)	75											
	53											
	37.5											
	26.5											
	19											
	13.2											
	9.5	100	100	100								
	4.75	100	100	99								
	2	99	99	98								
	0.425	99	99	97								
	0.25	95	96	95								
	0.15	87	82	89								
	0.075	63	62	70								
Hydrometer	0.05	60	56	67								
	0.02	57	54	65								
	0.005	57	47	63								
	0.002	52	43	58								
Soil Mortar	Coarse Sand <2.0 >0.425mm	0.8	0.4	1.2								
	Fine Sand <0.425>0.05mm	39.5	44.1	32.2								
	Silt <0.05 >0.005	2.7	8.3	4.7								
	Clay <0.005	57.0	47.2	61.8								
Atterberg Limits	Liquid Limit % (m/m)	17.1	21	24.2								
	Plasticity Index	5.4	8.6	10.4								
	Linear Shrinkage %	1.3	6	6.7								
	Natural MC %	-	-	-								
Mod AASHTO Density	Dry Density kg/m^3											
	OMC %											
CBR	100% MDD											
	98%											
	95%											
	93% (Inferred) *											
	90%											
	CBR Swell (%)											
AASHTO Soil Classification *		A - 4 (0)	A - 4 (2)	A - 6 (4)								
Grading Modulus		0.39	0.40	0.36								
TRH 14 (1985) *												

Signature: .....
Title: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOL - REF 31181

Ref no.: 7980 **Lab no.:** 12088 **Borehole/Pit no.:** TP1 **Fig no.:** -

Description: -

Depth: 0.5-1.5 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.9
2	99.3
0.425	98.5
0.25	95.0
0.15	86.5
0.075	62.8
0.05	60.1
0.02	57.5
0.005	57.5
0.002	52.1

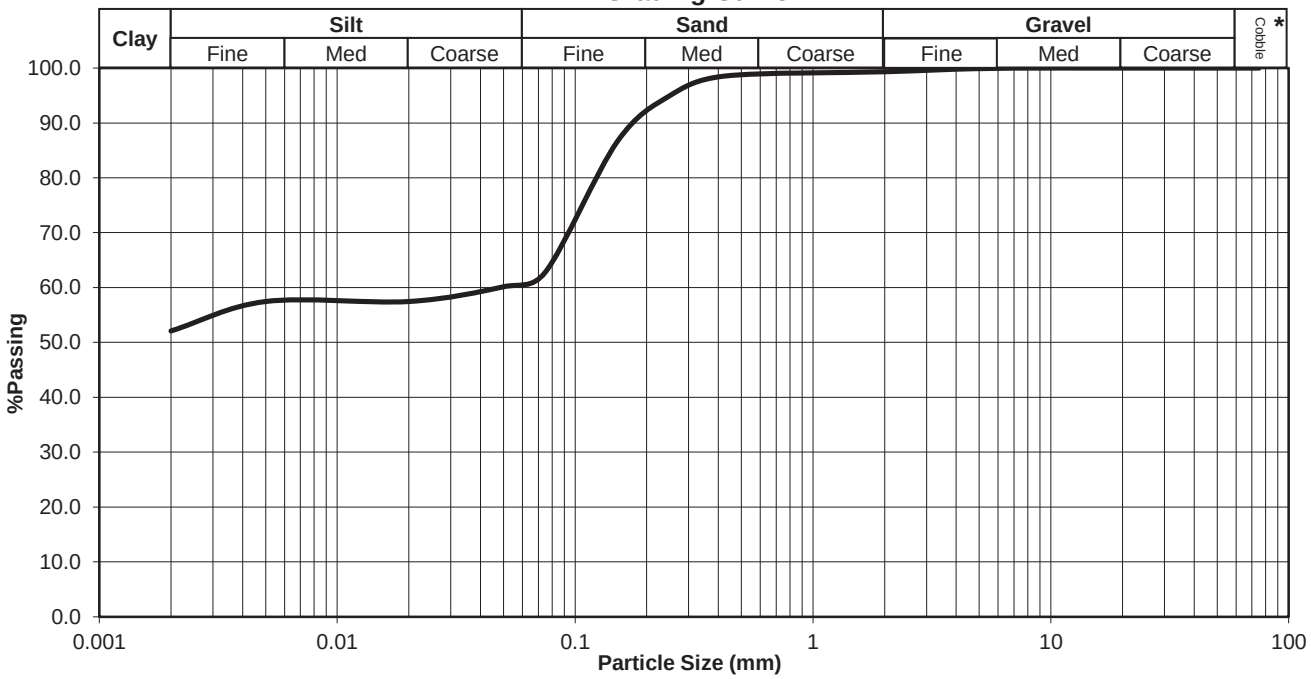
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	0.7
Coarse	0.0
Medium	0.1
Fine	0.6
Sand%	38.1
Coarse	0.7
Medium	7.9
Fine	29.5
Silt%	9.1
Coarse	3.8
Medium	0.0
Fine	5.4
Clay%	52.1

PLASTICITY	
Liquid Limit, %	17.1
Plasticity Index	5.4
Linear Shrinkage, % (L/L)	1.3

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	*
Grading Modulus	0.39

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 4
Unified Classification	CL - ML

Grading Curve



Ref no.: 7980 Fig no.: -

* Information marked with an asterisk is outside the scope of Accreditation.
The results only relate to the samples tested.
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TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOL - REF 31181

Ref no.: 7980 **Lab no.:** 12097 **Borehole/Pit no.:** TP1 **Fig no.:** -

Description: -

Depth: 1.3-2.35 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.9
2	99.5
0.425	99.0
0.25	95.6
0.15	82.0
0.075	61.9
0.05	55.7
0.02	53.6
0.005	47.4
0.002	43.2

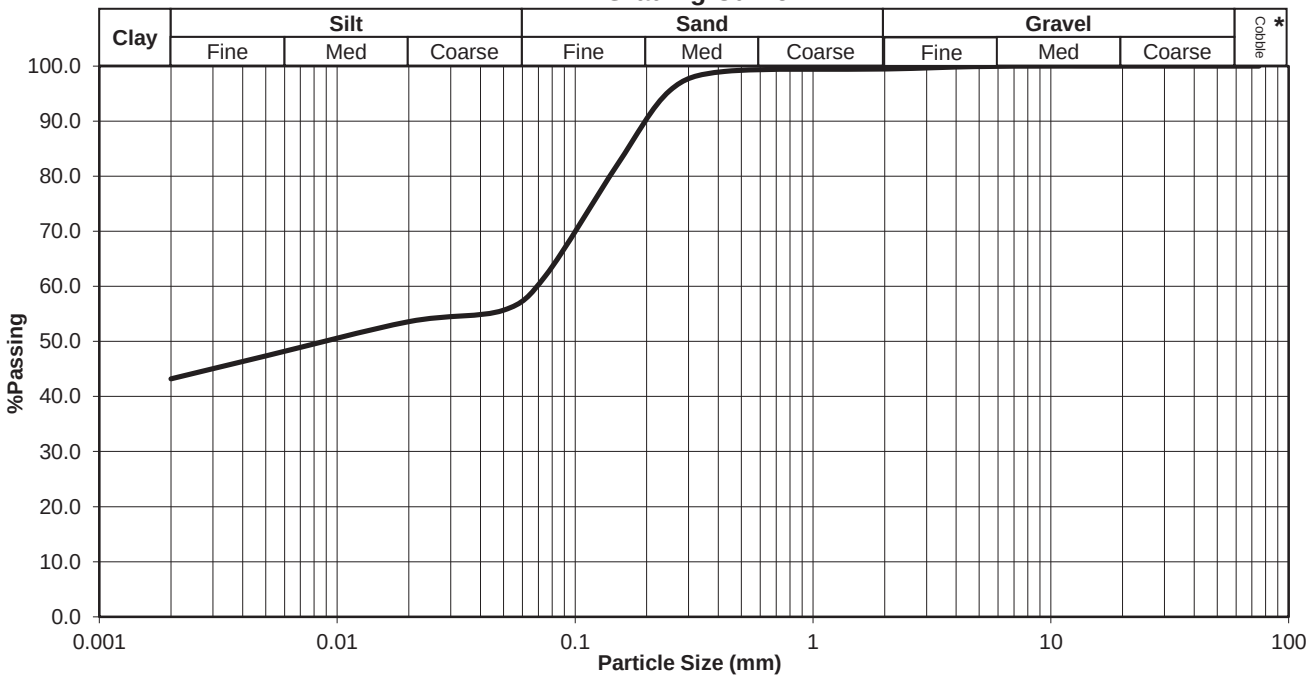
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	0.5
Coarse	0.0
Medium	0.1
Fine	0.5
Sand%	41.3
Coarse	0.4
Medium	10.3
Fine	30.6
Silt%	15.0
Coarse	4.6
Medium	5.8
Fine	4.6
Clay%	43.2

PLASTICITY	
Liquid Limit	21
Plasticity Index	8.6
Linear Shrinkage	6

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.40

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	2
AASHTO Soil Classification	A - 4
Unified Classification	CL or OL

Grading Curve



Ref no.: 7980 Fig no.: -

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TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC

Project: LESOTHO SCHOOL - REF 31181

Ref no.: 7980 **Lab no.:** 12098 **Borehole/Pit no.:** AH1 **Fig no.:** -

Description: -

Depth: 0.45-1.2 -

Test Methods: TMH1 METHOD A1(a), A2, A3 & A4, ASTMD422

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	100.0
37.5	100.0
26.5	100.0
19	100.0
13.2	100.0
9.5	100.0
4.75	99.4
2	97.9
0.425	96.7
0.25	95.3
0.15	89.2
0.075	69.7
0.05	67.4
0.02	65.0
0.005	62.6
0.002	57.9

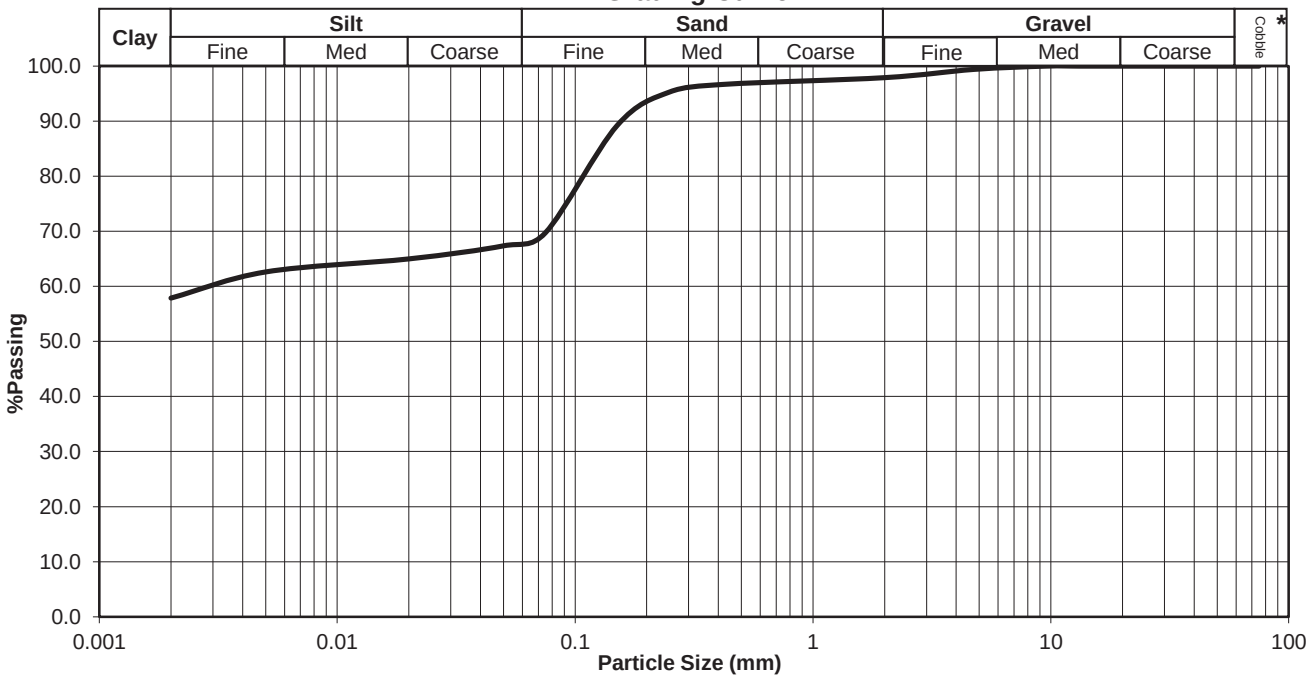
M.I.T SIZE CLASSIFICATION *	
Cobble%	0.0
Gravel%	2.1
Coarse	0.0
Medium	0.4
Fine	1.7
Sand%	29.6
Coarse	1.1
Medium	4.6
Fine	23.9
Silt%	10.4
Coarse	3.3
Medium	2.2
Fine	4.9
Clay%	57.9

PLASTICITY	
Liquid Limit	24.2
Plasticity Index	10.4
Linear Shrinkage	6.7

GRADING	
D10 Size (mm)	<0.002
Uniformity Coefficient	NA
Grading Modulus	0.36

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	4
AASHTO Soil Classification	A - 6
Unified Classification	CL or OL

Grading Curve



Ref no.: 7980 Fig no.: -

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MATERIALS TESTING LABORATORY

PO Box 0391 Maseru West 0105. Cell: (+266) 28311199
Email: molefen@leo.co.ls

Reporting Form (For Soil and Gravel Samples)						
Project	St Catherine's High School	Client: Drennan Maud		Date reported: 14-12-2015		
Date sampled	02-12-2015			Project No.:31181		
Sample no		8857	8858	8859		
Position		T.P 1	T.P 1	PT2		
Depth		0.0-0.5m	0.5-1.5m	0.2-0.8m		
Material Description		Greyish Sandy Silt	Greyish Sandy clay	Greyish Silty Sand		
Sieve analysis % passing	75,0					
	63,0					
	53,0					
	37,5					
	26,5					
	19,0					
	13,2	100.0	100.0	100.0		
	4,75	99.8	98.6	99.8		
	2,00	99.6	97.4	99.1		
	0,425	99.1	96.3	97.1		
	0,075	31.3	48.0	21.7		
Soil mortar						
2,00 - 0,425		0.5	1.1	2.0		
0.425 - 0.250		7.6	8.6	12.8		
0.250 - 0.150		29.7	24.3	34.8		
0.150 - 0.075		30.8	16.5	28.6		
<0,075		31.4	49.5	21.9		
Atterberg Constants						
Grading modulus		0.7	0.6	0.8		
Liquid limit		Nil	Nil	17.5		
Plasticity index		N/P	N/P	S/P		
Linear shrinkage		Nil	Nil	Nil		
Classification: TRH14		G6	G8	G8		
Mod. AASHTO						
MDD (kg/m^3)		1956	2076	1924		
OMC (%)		9.4	9.3	9.3		
Mould MC (%)		9.3	9.3	9.3		
% Compaction		99.9	99.8	100.0		
% swell		0.00	0.2	0.2		
NRB						
Dry density (kg/m^3)		1858	1973	1829		
% of MDD		95.0	95.0	95.1		
% swell		0.00	0.2	0.2		
Proctor						
Dry density (kg/m*)		1764	1873	1734		
% of MDD		90.2	90.2	90.1		
% swell		0.00	0.2	0.2		
C.B.R values	100%	33.0	15.0	13.0		
s*	98%	30.0	14.0	12.0		
$	97%	28.0	12.0	11.0		
S- -	95%	26.0	11.0	10.0		
sc.	93%	23.0	10.0	9.0		
	90%	19.0	8.0	7.0		
Bearing Capacity (kPa)						
ITS (kPa)						
UCS (MPa)						

THEKWINI SOILS LAB. CC

V.A.T. REGISTRATION NO. 4590210961.

68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992

P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

CONSOLIDATED DRAINED TRIAXIAL TEST

SUMMARY OF RESULTS

Project: St Catherines School, Lesotho
Ref no.: 7980
Lab no.: 12088 **Depth:** TP 1
Description: **Position:** 0.5 - 1.5
-

Test 1

Inputs					
L (cm)	8.10	Lo (cm)	8.10	MC Before (%)	11.8
A (cm^2)	11.52	Ao (cm^2)	11.52	MC After (%)	16.1
V (cc)	93.32	Vo (cc)	93.32	Bulk Density (kg/m3)	1933
		Prooving Ring	1.45	Dry Density (kg/m3)	1729
		Sigma3	100		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.52	0	0	0	0	0	0
11.69	1.68	95.3	-0.21	147.7	47.7	1.95
11.73	2.22	96.2	-0.43	148.1	48.1	1.96
11.77	2.99	119.2	-0.86	159.6	59.6	2.19
11.81	3.69	129.9	-1.29	164.9	64.9	2.30
11.84	4.49	144.2	-1.82	172.1	72.1	2.44
11.93	5.29	156.4	-1.93	178.2	78.2	2.56
12.00	6.08	166.2	-2.14	183.1	83.1	2.66
12.07	6.82	174.8	-2.36	187.4	87.4	2.75
12.11	7.61	180.2	-2.89	190.1	90.1	2.80
12.19	8.41	187.2	-3.11	193.6	93.6	2.87
12.28	9.22	193.9	-3.21	197.0	97.0	2.94
12.37	10.02	197.3	-3.43	198.6	98.6	2.97
12.45	10.82	202.8	-3.64	201.4	101.4	3.03
12.53	11.61	210.6	-3.86	205.3	105.3	3.11
12.63	12.41	216.9	-3.96	208.4	108.4	3.17
12.75	13.20	223.9	-3.96	211.9	111.9	3.24
12.85	13.99	229.9	-4.07	214.9	114.9	3.30
12.97	14.77	235.5	-4.07	217.7	117.7	3.35
13.08	15.57	240.1	-4.18	220.0	120.0	3.40
13.20	16.38	245.3	-4.18	222.6	122.6	3.45
13.35	17.19	250.1	-4.07	225.0	125.0	3.50
13.45	18.00	254.6	-4.29	227.3	127.3	3.55
13.56	18.80	258.7	-4.39	229.3	129.3	3.59

Test 2

Inputs					
L (cm)	8.10	Lo (cm)	8.10	MC Before (%)	11.1
A (cm^2)	11.52	Ao (cm^2)	11.52	MC After (%)	14.6
V (cc)	93.32	Vo (cc)	93.32	Bulk Density (kg/m3)	1933
		Prooving Ring	1.00	Dry Density (kg/m3)	1740
		Sigma3	200		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.52	0	0	0	0	0	0
11.66	1.44	93.8	-0.21	246.9	46.9	1.47
11.65	1.95	107.3	-0.86	253.6	53.6	1.54
11.71	2.66	143.9	-1.07	271.9	71.9	1.72
11.74	3.32	167.3	-1.50	283.7	83.7	1.84
11.75	4.07	192.6	-2.14	296.3	96.3	1.96
11.82	4.84	215.9	-2.36	308.0	108.0	2.08
11.89	5.62	238.9	-2.57	319.5	119.5	2.19
11.96	6.34	259.3	-2.79	329.6	129.6	2.30
12.03	7.12	278.4	-3.00	339.2	139.2	2.39
12.08	7.90	297.9	-3.43	349.0	149.0	2.49
12.16	8.68	314.9	-3.64	357.4	157.4	2.57
12.21	9.46	330.7	-4.07	365.4	165.4	2.65
12.29	10.24	345.6	-4.29	372.8	172.8	2.73
12.37	11.03	359.4	-4.50	379.7	179.7	2.80
12.45	11.80	372.2	-4.71	386.1	186.1	2.86
12.53	12.58	384.1	-4.93	392.0	192.0	2.92
12.59	13.37	396.6	-5.36	398.3	198.3	2.98
12.64	14.14	407.4	-5.79	403.7	203.7	3.04
12.73	14.92	417.9	-6.00	408.9	208.9	3.09
12.82	15.71	426.5	-6.22	413.3	213.3	3.13
12.91	16.48	436.7	-6.43	418.3	218.3	3.18
13.02	17.28	444.4	-6.54	422.2	222.2	3.22
13.13	18.08	450.4	-6.64	425.2	225.2	3.25

Test 3

Inputs					
L (cm)	8.10	Lo (cm)	8.10	MC Before (%)	10.4
A (cm^2)	11.58	Ao (cm^2)	11.58	MC After (%)	13.9
V (cc)	93.81	Vo (cc)	93.81	Bulk Density (kg/m3)	1921
		Prooving Ring	1.00	Dry Density (kg/m3)	1740
		Sigma3	300		

Area at Test	%Strain	Deviator Stress (kPa)	Delta V Vo (%)	$\sigma^1 + \sigma^3$ 2	$\sigma^1 - \sigma^3$ 2	σ^1 / σ^3
11.58	0	0	0	0	0	0
11.66	1.30	120.6	-0.64	360.3	60.3	1.40
11.64	1.76	137.2	-1.28	368.6	68.6	1.46
11.69	2.41	185.2	-1.49	392.6	92.6	1.62
11.69	3.03	221.1	-2.13	410.6	110.6	1.74
11.70	3.75	261.1	-2.77	430.5	130.5	1.87
11.74	4.48	298.6	-3.20	449.3	149.3	2.00
11.80	5.20	333.3	-3.41	466.6	166.6	2.11
11.83	5.87	366.2	-3.84	483.1	183.1	2.22
11.90	6.62	395.9	-4.05	498.0	198.0	2.32
11.97	7.39	423.5	-4.26	511.8	211.8	2.41
12.04	8.15	450.0	-4.48	525.0	225.0	2.50
12.11	8.92	473.2	-4.80	536.6	236.6	2.58
12.17	9.69	495.4	-5.12	547.7	247.7	2.65
12.22	10.46	517.1	-5.54	558.5	258.5	2.72
12.29	11.21	536.6	-5.76	568.3	268.3	2.79
12.37	11.96	555.0	-5.97	577.5	277.5	2.85
12.45	12.72	571.4	-6.18	585.7	285.7	2.90
12.53	13.51	587.4	-6.40	593.7	293.7	2.96
12.63	14.28	599.3	-6.50	599.6	299.6	3.00
12.74	15.07	612.4	-6.61	606.2	306.2	3.04
12.83	15.86	624.4	-6.82	612.2	312.2	3.08
12.92	16.64	636.2	-7.04	618.1	318.1	3.12
13.01	17.43	646.9	-7.25	623.4	323.4	3.16

CONSOLIDATED DRAINED TRIAXIAL TEST
SUMMARY OF RESULTS

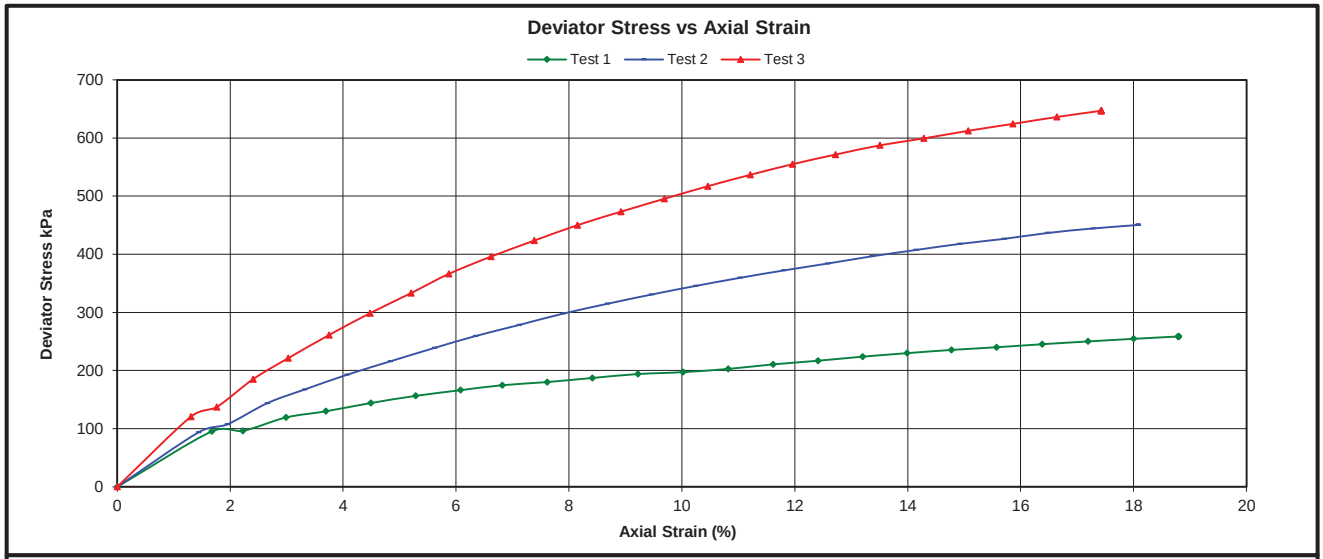
THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961.
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

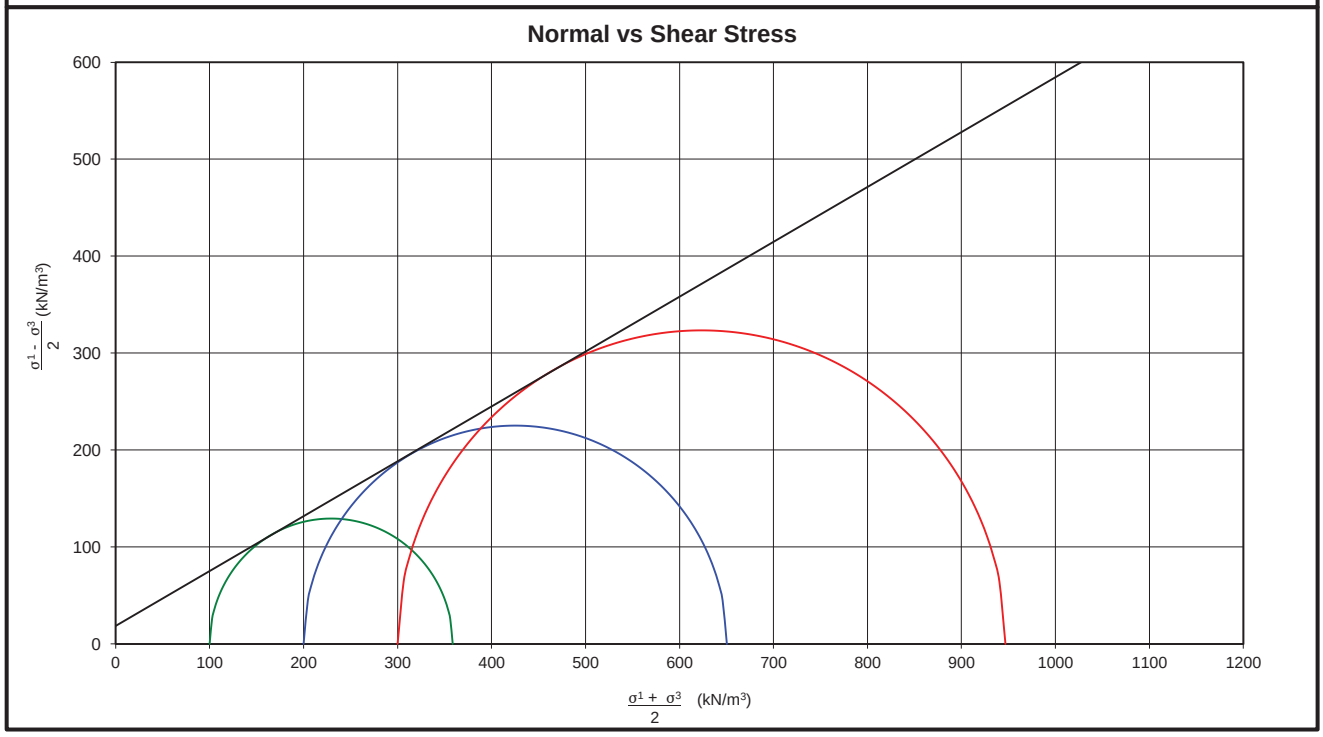
Project: St Catherines School, Lesotho
Ref no.: 7980
Lab no.: 12088
Depth: TP 1 **Description:**
Position: 0.5 - 1.5 -

	Test 1	Test 2	Test 3
Normal Stress (kN/m^2)	100	200	300
Dry Density (kg/m^3)	1332	1740	1740
NMC(%)	11.8	11.1	10.4
Axial Strain (%)	18.8	18.1	17.4
$\frac{\sigma^1 + \sigma^3}{2}$	229.3	425.2	623.4
$\frac{\sigma^1 - \sigma^3}{2}$	129.3	225.2	323.4
$\frac{V\triangle}{Vo}$	-4.39	-6.64	-7.25

Shear Strength Perameters

Angle of Internal Friction (0^0)	30
Cohesion (kPa)	19





APPENDIX D
Plates

Plate 1 : Google Earth image of school site with boundary of property marked in red and approximate extent of development/investigation area marked in yellow.

Plate 2 : Observer looking in a easterly direction across gently sloping northern most development area currently used as cultivated land.

Plate 3 : Example of manhole for possible sewerage / storm water disposal system existing on site.

Plate 4 : Soil profiles exposed in TP 1 excavated to 1.5m depth and extended to 2.35m via auger.

Plate 5 : Soil profile exposed PT1 pit in which percolation test was carried out.

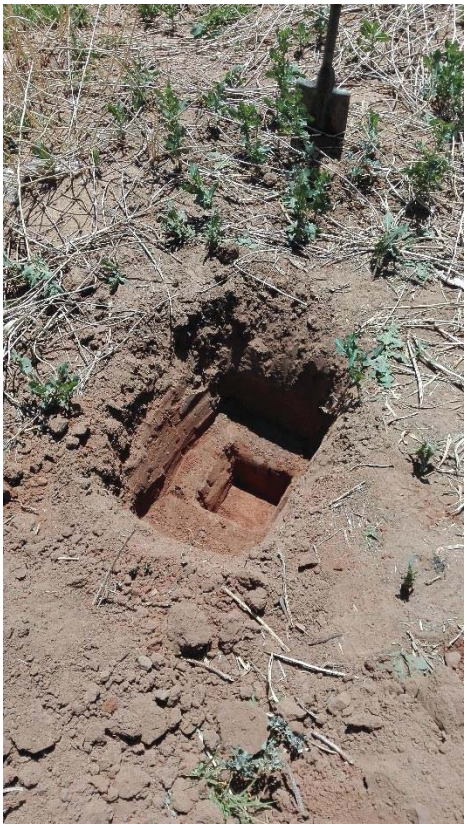
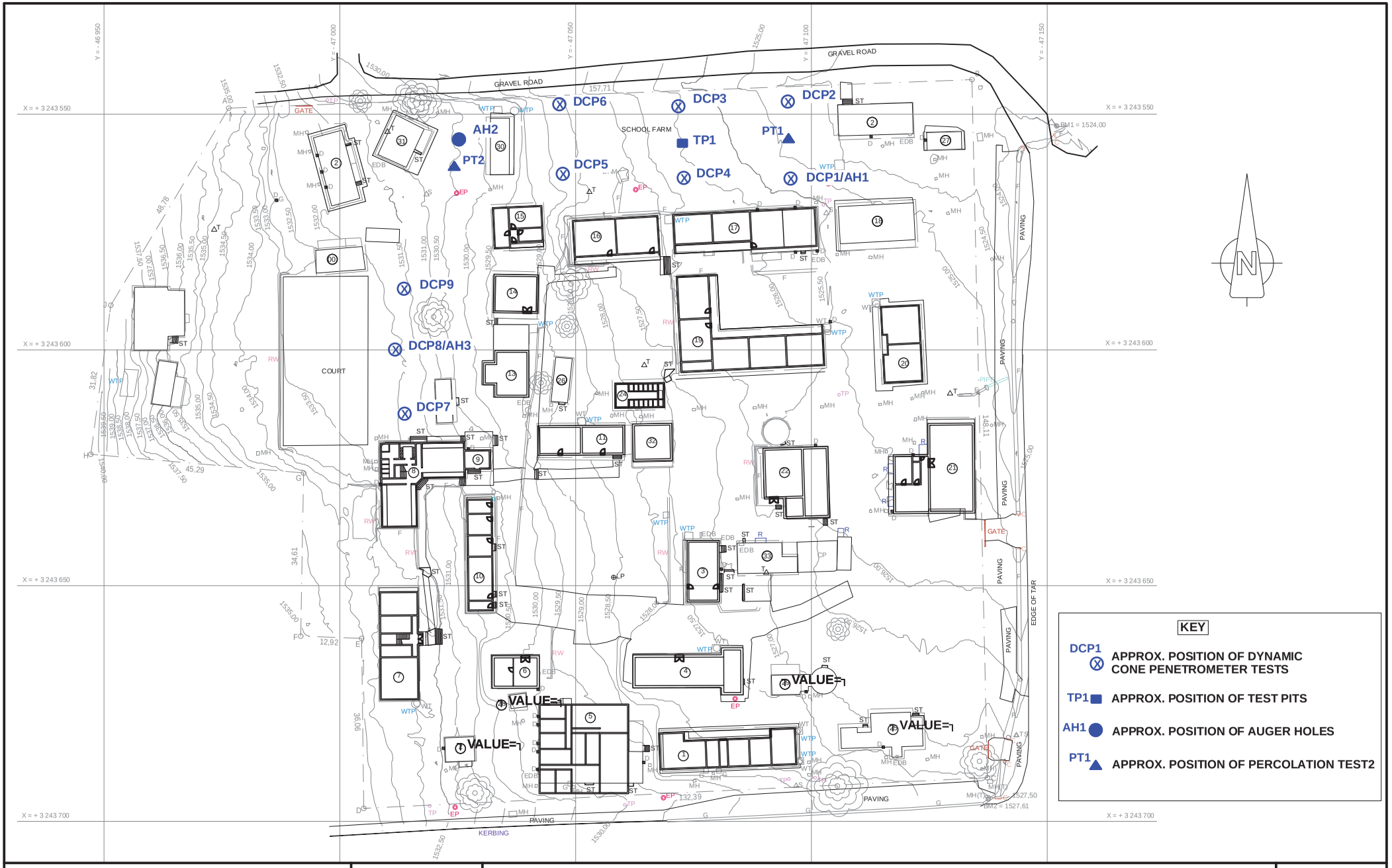


Plate 6 : Soil profile exposed PT2 pit in which percolation test was carried out.

FIGURE 1
Site Plan



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DRAWN :	S.P.
DATE :	18/01/2016
SCALE :	1:750
CHECKED :	

GEOTECHNICAL INVESTIGATION
LESOTHO SCHOOLS UPGRADE PROJECT
ST. CATHERINE'S GIRLS HIGH SCHOOL - E4

REF. NO. 31181

FIG. NO. 1