

**GEOTECHNICAL INVESTIGATION**  
**For United Nations Development Programme (UNDP)**  
**Medical Stores Limited's Regional Warehouse Hubs**  
**CHIPATA**



**FINAL REPORT**

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**TITLE: Geotechnical Investigation for United Nations Development Programme (UNDP) Medical Stores Limited's Regional Warehouse Hubs CHIPATA**

### **Geotechnical Report**

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## 1. Introduction

Rankin Engineering Consultants was contracted by the United Nations Development Programme (UNDP) 18<sup>th</sup> August 2016 to carry out geo-technical investigations at the proposed sites for Mongu, Choma, Mansa, Mpika and Chipata Medical Stores Limited's Regional Warehouse Hubs. This report presents the findings based on the tests carried out in the field and laboratory testing.

Field testing included test pit, DPSH and SPT's.

Laboratory testing of samples included Sieve Analysis, Atterberg Limits, Moisture Content, MDD and CBR.

Field investigation was carried out over the period of 24<sup>th</sup> to 27<sup>th</sup> August 2016.

The map of the investigation area is included in Appendix A.

## 2. Technical Standards

The following technical standards were applied to this project:

BS EN 1997-2:2007 Geotechnical Design – Ground Investigation and testing

BS 1377-9:1990 Methods of test for Soils for Civil Engineering Purposes – In-situ tests

SANS 3001-GR1: 2013 Wet preparation and particle size analysis

BS 1377-2: 1990 Tests 1.2, 1.3 and 1.4 Liquid Limit, Plastic Limit & Plasticity Index, Linear Shrinkage

SANS 3001-GR30: 2013 Determination of the maximum dry density and optimum moisture content

SANS 3001-GR40: 2013 Determination of the California bearing ratio

BS 1377-2: 1990 Moisture Content



### 3. General Description of Project Area

The investigated area is located in Multi Facility Economical Zone (MFEZ) Chipata along Chadiza Road. It is rural, dominated by grass vegetation, with some small vegetable farms developed.

The whole area is covered by moist brown loose to medium dense clayey sand in the upper layers and moist dark brown loose to dense gravelly clayey sand with iron oxides at depth.

### 4. Geology

The geology of the Chipata Terrane is by far the most distinct and lithologically complex of all the terranes. It consists predominantly of variably retrogressed mafic, felsic and pelitic granulite, with subordinate hornblende-biotite gneiss, variably deformed granitoid and undeformed syenite. Hypersthene-bearing granitoids (charnockites) with abundant garnet-pyroxene-bearing mafic boudins predominate, while garnet- and cordierite-bearing pelitic granulites indicate that these lithologies underwent high-temperature/moderate-pressure tectonometamorphism [*Schenk and Appel, 2001, 2002*].

Metamorphic monazite from pelitic granulite in the Chipata Terrane (unknown locality) has been dated at circa 1046 Ma [*Schenk and Appel, 2001, 2002*]. In places, the granulites are crosscut and retrogressed along high-strain amphibolite-facies shear zones. The contact zones between the granulite and lower-grade hornblende and biotite gneisses are not exposed and the relationship between them is unclear. In general the lower-grade gneisses were derived from highly deformed K-feldspar-bearing porphyritic augen granite, but in places it is clear that some of the gneisses have a sedimentary parentage. The augen gneisses are locally intruded by decimeter-scale, undeformed amphibolite dikes and coarse-grained, syenite. There is evidence for magma mingling between the mafic and syenitic melts indicating that they were intruded contemporaneously. Limited geochemical data indicate that the augen gneisses are calc-alkaline whereas the mafic amphibolites suggest formation in a continental extensional setting [*Tembo et al., 2002*; Mapani et al., submitted manuscript, 2006]. Occasionally there are isolated outcrops of undeformed K-feldspar-bearing porphyritic granite and garnet-bearing pelitic migmatite but their relation to the surrounding granulite/gneiss and timing of intrusion/migmatization are not known.<sup>1</sup>

---

<sup>1</sup> U-Pb sensitive high-resolution ion microprobe (SHRIMP) zircon geochronology of granitoid rocks in eastern Zambia: Terrane subdivision of the Mesoproterozoic Southern Irumide Belt. S. P. Johnson, B. De Waele, K. A. Liyungu

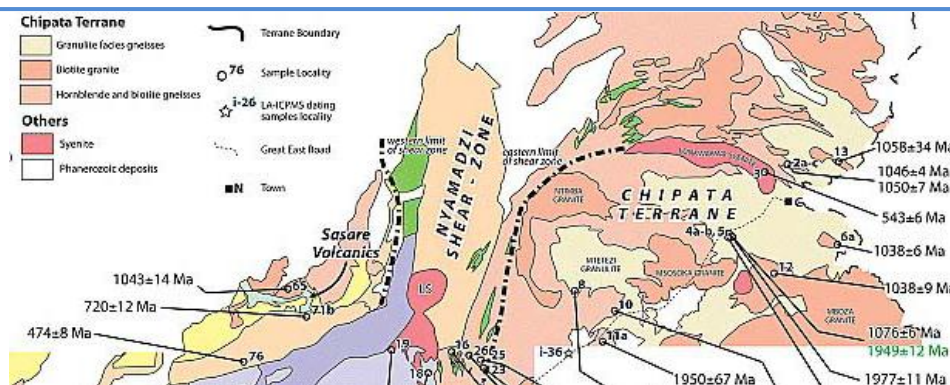


Figure 1: Map of Chipata Terrane

## 5. Methodology

The field work comprised a combination of soil profiling using undisturbed methods to extract samples of the soil to 5.0 metres depth where conditions allowed, combined with In-situ testing using Standard Penetration Test (SPT) 'down the hole' at every 1m level. Laboratory testing was done to classify the soil types encountered and to determine their engineering characteristics. Test pitting was also carried out on one point.

## 6. Results of field work

### 6.1 SPT

A total of 4 SPT tests were carried out at the test locations as shown on the map in Appendix A. The SPT test was performed using a split cone, with a 150mm seating blow. This test is used to directly determine the allowable bearing capacity under in-situ conditions. The number of blows required to advance the cone through the final 300mm of a 450mm test range is reported as the 'N' value. The SPT test records are included in Appendix B. A summary and interpretation is given in Table 1.

The allowable bearing capacity is a function of the foundation size and depth. Without knowing these in advance, an approximation of bearing capacity for various widths at the top of the excavation has been used.

It should be borne in mind that conditions at the time of testing may not be the worst condition that can be experienced over the life of the foundation, particularly with respect to saturated conditions in soils which are highly susceptible to softening under moisture. Reference should therefore also be made to soil classification results.



## 6.1.1 Analysis of SPT results

The SPT values recorded were processed using relationships developed by Bowles based on Meyerhof relationships. Calculated values for the site are given in the table below.

Chipata						
Point ID	Depth	N Value	Proposed founding depth (m)	Possible foundation width (m)	Average SPT in zone of influence	Allowable bearing capacity (kPa)
SPT1	1	17	2.0	0.8	13	155
	2	9		1	13	155
	3	56		1.5	13	155
SPT2	1	24	2.0	0.8	12	145
	2	8		1	12	145
	3	18		1.5	17	205
	4	10		2	18	220
	5	32				
SPT3	1	13	2.0	0.8	13	155
	2	40		1	13	155
	2.45	40		1.5	13	155
SPT4	1	17	2.0	0.8	15	180
	2	8		1	15	180
	3	6		1.5	13	155
	4	31		2	14	165
	5	7				

Table 1: Bearing Capacity based on SPT N Values

The results indicate that on Chipata site, an allowable bearing capacity of 155kPa at a minimum founding depth of 2.0 metres below the ground surface may be appropriate.

At the site, the materials in the proposed founding layer are moist brown clayey sand. The soil matrix itself appears loose to medium dense.

As the field testing was done during the dry season, it is anticipated that lower results would have been achieved during the rainy season. Reference is therefore made to the laboratory results.




## 6.2 Trial Pits

A total of 1 Trial Pits tests were carried out at the test locations as shown on the map in Appendix A.

Conditions on site allowed excavation as deep as 3.0m due to presence of very dense gravelly clayey sand.

The soil profiles (Appendix C) in trial pit revealed that the whole area is covered by moist brown loose to medium dense clayey sand in the upper layers.

Point ID	GPS Coordinates		Photo
	E	N	Tested Sample
1	461727	8486029	
	Sample: Moist dark brown very dense gravelly clayey sand with iron oxides		
	Depth: 0.7-3.0m		

## 7. Results of laboratory testing

Laboratory testing was used to classify materials and to corroborate the results of the SPT testing. The tests included Sieve Analysis, Atterberg Limits, Moisture Content, MDD and CBR.

A total of 4 undisturbed samples from the SPT borings were obtained for testing.

Soils were non-cohesive with low plasticity and moisture contents ranging from 6.4% to 7.4%. Bulk Unit weight was not possible to measure, as conditions did not allow obtaining a representative sample. The materials exhibit low shrinkage. The CBR of the material was 30%.

The actual lab test results are presented in Appendices D to H.



Table 2: Laboratory test summary

Chipata

Lab #	ID #	Visual Description	Depth  (m)	USCS classification	Moisture Content (%)	Linear  Shrinkage	Sieve analysis							PI	Shrinkage  Product	Grading  Co-efficient	Plasticity  Modulus	Grading  Modulus	Proctor		CBR		
							% passing sieve size (mm)												MDD  (Kg/m³)	OMC  (%)			
						0,075	0,425	2,0	5,0	28,0	50,0	63,0	93%	95%	98%								
3259	TP1	Moist brown loose to medium dense clayey sand (Residential)	0.7-3.0	SC													2175	7.7	31	30	-		
3260	SPT1	Moist brown loose to medium dense clayey sand (Residential)	0-2.4	SC	7.1	7.14	30.1	75.8	99.5	100	100	100	100	15.5	541	24	467	0.9					
3261	SPT2	Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)	2.6-5.0	SC	7.4	6.43	24.2	50.8	73.9	80.3	91.4	92.0	100	10.8	327	33	261	1.5					
3262	SPT3	Moist brown medium dense to dense clayey sand (Residential)	0-2.0	SC	6.4	8.57	30.9	72.1	98.7	99.5	100	100	100	18.2	618	28	562	1.0					
3263	SPT4	Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)	2.7-5.0	SC	7.2	5.96	23.4	46.9	70.3	86.1	100	100	100	13.4	280	46	314	1.6					

SC Clayey sands, poorly graded sand-clay mixtures



## 8. Conclusions

From the investigation carried out, the following conclusions can be drawn:

- An allowable bearing capacity of 155kPa would be the maximum recommended.
- The soil at this site is mostly moist brown loose to medium dense clayey sand in the upper layers and moist dark brown loose to dense gravelly clayey sand with iron oxides at depth.
- SPT'N' Values reveal that soil stratum is loose to medium dense from ground level up to 2.7m and dense up to investigated depth.
- Groundwater was not encountered within the boreholes up to 5.0m depth during investigation.
- A minimum foundation depth of 2.0m is proposed.
- In-situ materials can be used as fill and as road pavement layers. Compacted to 95% MDD, a CBR of at least 30 is expected.
- All foundations for a single structure should be placed in the same strata and therefore should be at the same level.




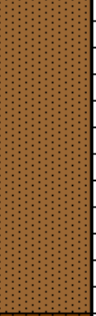
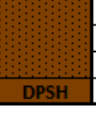
## **Appendix A – Map**





## **Appendix B – SPT test records**


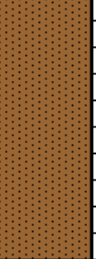



RECORD FOR SUBSURFACE EXPLORATION										 <b>RANKIN</b> Engineering Consultants RANKIN HOUSE, CHOZI ROAD, NORTHMEAD P.O. BOX 50566, LUSAKA TEL/FAX +260 - 211 - 290085	
<b>TYPE OF BORING:</b>		SPT 1		<b>DATE OF BORING:</b>		26/08/2016					
<b>PROJECT NAME:</b>		UNDP-Geotechnical Survey for Medical Store Limited's Regional Hubs (Chipata)		<b>BORING No :</b>		BH-1					
<b>OPERATOR'S NAME:</b>		CH									
<b>LOCATION:</b>		0461722 8485986		<b>Elevation:</b>		1099m					
DESCRIPTION	PROFILE	DEPTH m	BLOWS	SAMPLE	N	WC	Y	REMARKS			
Moist brown loose to medium dense clayey sand (Residential)			6								
			8								
			9								
		1.0	17	↓	17						
			3								
			3								
			6								
		2.0	9	↓	9						
Moist dark brown very dense gravelly clayey sand with iron oxides (Residential)			8								
			30								
			26								
		3.0	56	↓	56			No Ground Water Level Found			
		DPSH	3.1	68					Refusal at 3.1m		
			BULK SAMPLE		•	B					
GROUND LEVEL			↓		DISTURBED SAMPLE		•	D			
WATER LEVEL			↓		UNDISTURBED SAMPLE		■	U			
S.P.T			↓		WATER SAMPLE		•	W			
<b>SKETCH MAP OF BORING HOLE</b>											


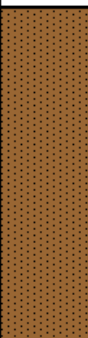
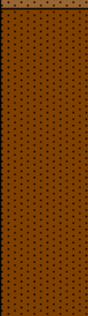




RECORD FOR SUBSURFACE EXPLORATION									
TYPE OF BORING:	SPT 2			DATE OF BORING:	25/08/2016				
PROJECT NAME:	UNDP-Geotechnical Survey for Medical Store Limited's Regional Hubs (Chipata)			BORING No :	BH-2				
OPERATOR'S NAME:	CH								
LOCATION:	0461717	8486058		Elevation:	1094m				
<b>RANKIN</b> Engineering Consultants RANKIN HOUSE, CHOZI ROAD, NORTHMEAD  P.O. BOX 50566, LUSAKA TEL/FAX +260 - 211 - 290085									
DESCRIPTION	PROFILE	DEPTH m	BLOWS	SAMPLE	N	WC	Y	REMARKS	
Moist brown loose to medium dense clayey sand (Residential)			5						
			10						
			14						
		1.0	24	↓	24				
			2						
			3						
			5						
		2.0	8	↓	8				
			6						
			9						
Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)		3.0	18	↓	18				
			7						
			5						
			5						
		4.0	10	↓	10				
			14						
			19						
			13						
		5.0	32	↓	32				
								No Ground Water Level Found	
Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)		5.1	3						
		5.2	7						
		5.3	6						
		5.4	6						
		5.5	9						
		5.6	11						
		5.7	14						
		5.8	13						
		5.9	13						
		6.0	13						
			BULK SAMPLE		•	B			
GROUND LEVEL			DISTURBED SAMPLE		•	D			
WATER LEVEL			UNDISTURBED SAMPLE		■	U			
S.P.T			WATER SAMPLE		•	W			
SKETCH MAP OF BORING HOLE									



RECORD FOR SUBSURFACE EXPLORATION									
TYPE OF BORING:		SPT 3		DATE OF BORING:		26/08/2016		 <b>RANKIN</b> Engineering Consultants RANKIN HOUSE, CHOZI ROAD, NORTHMEAD  P.O. BOX 50566, LUSAKA TEL/FAX +260 - 211 - 290085	
PROJECT NAME:		UNDP-Geotechnical Survey for Medical Store Limited's Regional Hubs (Chipata)		BORING No : BH-3					
OPERATOR'S NAME:		DK							
LOCATION:		0461738 8486068		Elevation:		1025m			
DESCRIPTION	PROFILE	DEPTH m	BLOWS	SAMPLE	N	WC	γ	REMARKS	
Moist brown medium dense to dense clayey sand (Residential)			4						
			6						
			7						
		1.0	13	↓	13				
			7						
			10						
			30						
		2.0	40	↓	40				
Moist dark brown dense gravelly clayey sand with iron oxides (Residential)		2.1						No Ground Water Level Found	
		2.2							
		2.3							
		2.4							
		2.5	29						
		2.6	51						
			BULK SAMPLE		•	B			
GROUND LEVEL			↓						
			DISTURBED SAMPLE		•	D			
WATER LEVEL			↓						
			UNDISTURBED SAMPLE		■	U			
S.P.T			↓						
			WATER SAMPLE		•	W			
SKETCH MAP OF BORING HOLE									



RECORD FOR SUBSURFACE EXPLORATION								 <b>RANKIN</b> Engineering Consultants RANKIN HOUSE, CHOZI ROAD, NORTHMEAD P.O. BOX 50566, LUSAKA TEL/FAX +260 - 211 - 290085	
TYPE OF BORING:		SPT 4		DATE OF BORING:		25/08/2016			
PROJECT NAME:		UNDP-Geotechnical Survey for Medical Store Limited's Regional Hubs (Chipata)		BORING No :		BH-4			
OPERATOR'S NAME:		CH							
LOCATION:		0461741 8485986		Elevation:		1101m			
DESCRIPTION	PROFILE	DEPTH m	BLOWS	SAMPLE	N	WC	Y	REMARKS	
Moist brown loose to medium dense clayey sand (Residential)			6						
			8						
			9						
		1.0	17	↓	17				
			4						
			4						
			4						
		2.0	8	↓	8				
			3						
			3						
Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)		3.0	6	↓	6				
			3						
			6						
			25						
		4.0	31	↓	31				
			3						
			3						
			4						
		5.0	7	↓	7			No Ground Water Level Found	
		Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)		5.1	1				
5.2	1								
5.3	1								
5.4	1								
5.5	4								
5.6	4								
5.7	4								
5.8	6								
5.9	7								
6.0	13								
6.1	8								
6.2	8								
6.3	12								
6.4	12								
6.5	12								
			BULK SAMPLE		•	B			
GROUND LEVEL			DISTURBED SAMPLE		•	D			
WATER LEVEL			UNDISTURBED SAMPLE		■	U			
S.P.T			WATER SAMPLE		•	W			
SKETCH MAP OF BORING HOLE  									



## **Appendix C – SPT and Test Pits Logging**

Figure 2: SPT Logging

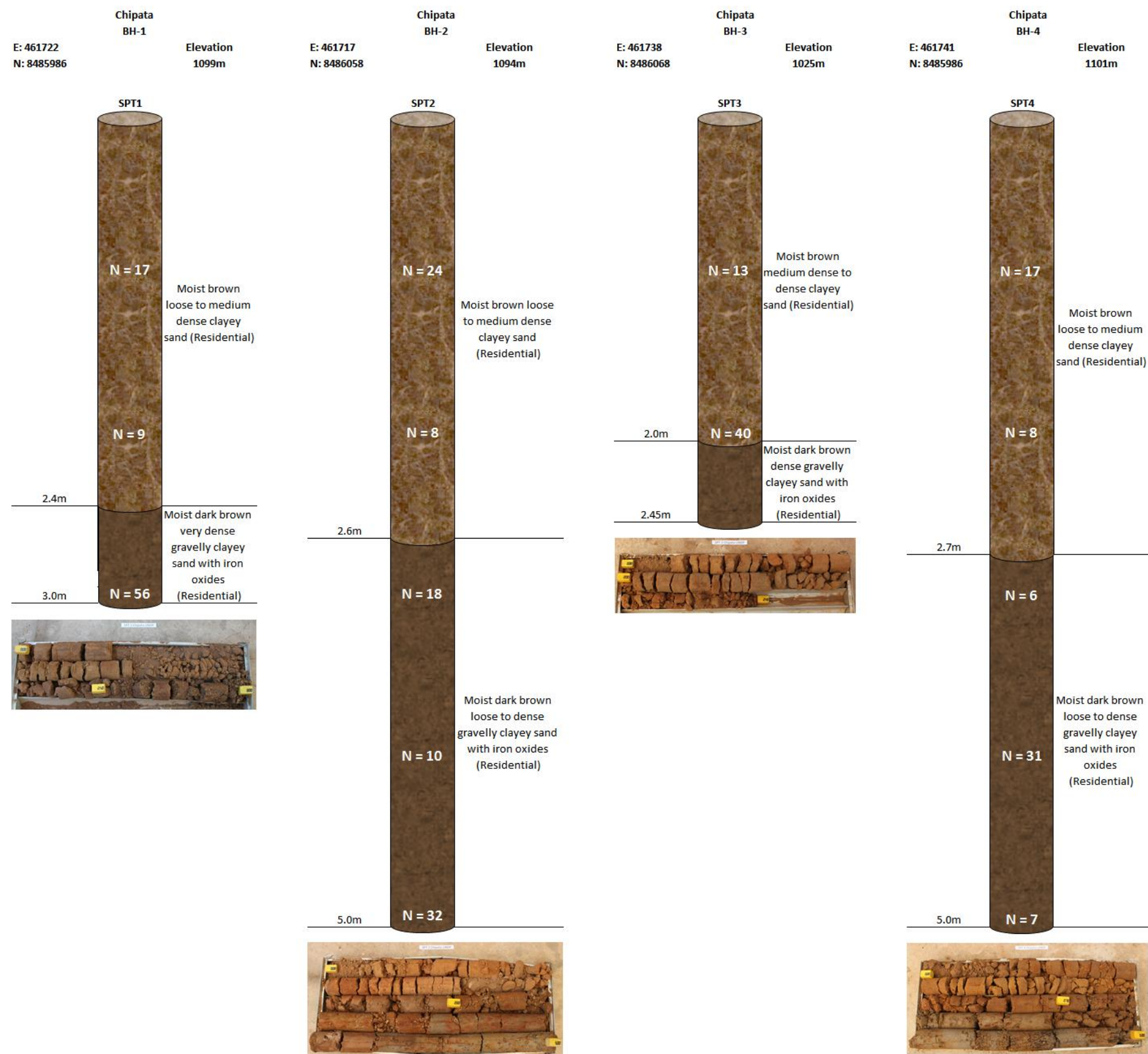
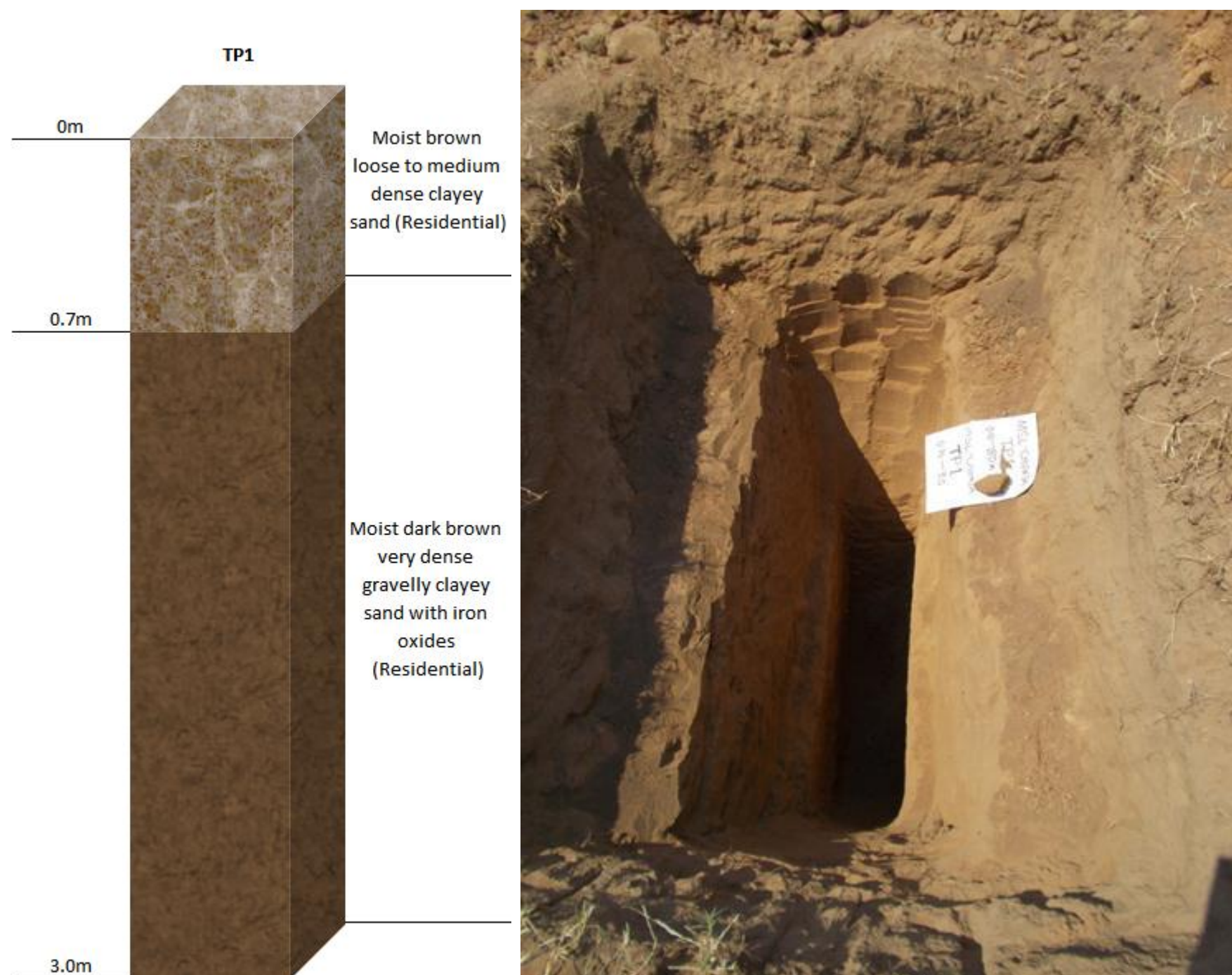



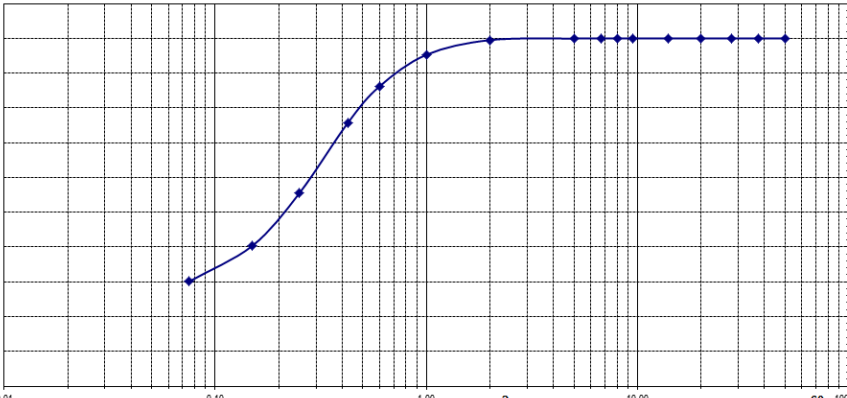
Figure 3: Test Pits Logging






## **Appendix D - Sieve Analysis Results**


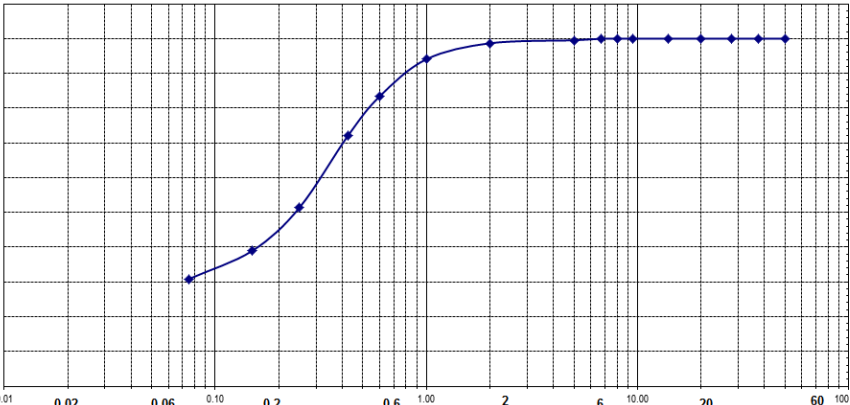


WET SIEVE ANALYSIS		FORM: SANS 3001-GR1: 2013																					
CLIENT:	United Nations Development Programme (UNDP)			Rankin Engineering Consultants Rankin House Chozoi Road Lusaka, Zambia Tel/Fax: 260-1-291195																			
PROJECT:	Medical Store Limited's Regional Hubs-Chipata																						
SUPERVISOR:	DL	DATE:	10/9/2016																				
OPERATOR:	TK	SAMPLE SOURCE:	SPT1 (0.2-4m)																				
DATE OF SOAKING:	10/9/2016	Soil Description	Moist brown loose to medium dense clayey sand (Residential)																				
DATE OF TESTING:	12/9/2016	Lab No.	3260																				
Initial Dry Mass (m <sub>1</sub> ) 1694 g																							
Sieve Opening (mm)	Mass Retained (g)		% Retained (m) $\frac{m}{m_1} \times 100$	% Passing (p)	Cumulative % passing																		
	Actual	Corrected																					
75.0	0			100.0	100																		
63.0	0	0	0.0	100.0	100																		
50.0	0	0	0.0	100.0	100																		
37.5	0	0	0.0	100.0	100																		
28.0	0	0	0.0	100.0	100																		
20.0	0	0	0.0	100.0	100																		
Passing 20 mm (m <sub>2</sub> )	1694	1694.1																					
total (checked with m <sub>1</sub> )	1694.1																						
retained (m <sub>3</sub> )	412.1																						
retained and washed (m <sub>4</sub> )	294.7																						
Correction factor	$\frac{m_2}{m_3}$	4.11																					
14.0	0	0	0.0	100.0	100																		
9.5	0	0	0.0	100.0	100																		
8.0	0	0	0.0	100.0	100																		
6.7	0	0	0.0	100.0	100																		
5.0	0.2	1	0.0	100.0	100																		
2.0	1.9	8	0.5	99.5	99																		
1.0	17.3	71	4.2	95.3	95																		
0.6	37.4	154	9.1	86.2	86																		
0.425	43.1	177	10.5	75.8	76																		
0.250	83.5	343	20.3	55.5	55																		
0.150	62.2	256	15.1	40.4	40																		
0.075	42.6	175	10.3	30.1	30																		
<0.075 (+ 117.4)	123.9	509	30.1																				
TOTAL		1694																					
Grading Modulus: $GM = \frac{300 - \%<2mm - \%<0.425mm - \%<0.075mm}{100}$					0.9																		
Grading Coefficient: $GC = \frac{(\%<28.0 - \%<0.425) \times (\%<5.0mm)}{100}$					24.2																		
USCS classification					SC																		
SIEVE SIZE BY LOG SCALE																							
																							
<table border="1"><tr><td>Medium</td><td>Coarse</td><td>Fine</td><td>Medium</td><td>Coarse</td><td>Fine</td><td>Medium</td><td>Coarse</td><td>Cobbles</td></tr><tr><td colspan="2">Silt</td><td colspan="2">Sand</td><td colspan="2">Gravel</td><td colspan="3"></td></tr></table>						Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Silt		Sand		Gravel				
Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles															
Silt		Sand		Gravel																			


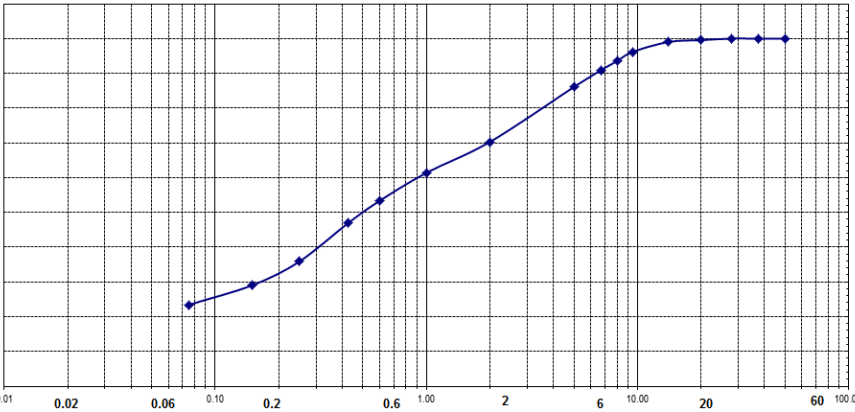


WET SIEVE ANALYSIS		FORM: SANS 3001-GR1: 2013		 <b>Rankin</b> Engineering Consultants Rankin House Chozi Road Lusaka, Zambia Tel/Fax: 260-1-291195																																	
CLIENT:	United Nations Development Programme (UNDP)																																				
PROJECT:	Medical Store Limited's Regional Hubs-Chipata																																				
SUPERVISOR:	DL	DATE:	10/9/2016																																		
OPERATOR:	TK	SAMPLE SOURCE:	SPT2 (2.6-5.0m )																																		
DATE OF SOAKING:	10/9/2016	Soil Description	Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)																																		
DATE OF TESTING:	12/9/2016	Lab No.	3261																																		
Initial Dry Mass ( $m_1$ ) <b>3617 g</b>																																					
Sieve Opening (mm)	Mass Retained (g)		% Retained ( $\frac{m}{m_1} \times 100$ )	% Passing (p)	Cumulative % passing																																
	Actual	Corrected																																			
75.0	0			100.0	100																																
63.0	0	0	0.0	100.0	100																																
50.0	290.7	291	8.0	92.0	92																																
37.5	0	0	0.0	92.0	92																																
28.0	19.1	19	0.5	91.4	91																																
20.0	10.7	11	0.3	91.1	91																																
Passing 20 mm ( $m_2$ )	3297	3296.8																																			
total (checked with $m_1$ )	3617.3																																				
rifled ( $m_3$ )	426.1																																				
rifled and washed ( $m_4$ )	319.3																																				
Correction factor $\frac{m_2}{m_3}$		7.74																																			
14.0	0	0	0.0	91.1	91																																
9.5	19.3	149	4.1	87.0	87																																
8.0	8.8	68	1.9	85.1	85																																
6.7	9.3	72	2.0	83.1	83																																
5.0	13.4	104	2.9	80.3	80																																
2.0	29.9	231	6.4	73.9	74																																
1.0	33.0	255	7.1	66.8	67																																
0.6	41.3	320	8.8	58.0	58																																
0.425	33.8	262	7.2	50.8	51																																
0.250	56.6	438	12.1	38.7	39																																
0.150	37	286	7.9	30.7	31																																
0.075	30.5	236	6.5	24.2	24																																
<0.075 (+ 106.8)	113.2	876	24.2																																		
TOTAL		3617																																			
Grading Modulus: $GM = (300 - \%<2mm - \%<0.425mm - \%<0.075mm)/100$					1.5																																
Grading Coefficient: $GC = (\%<28.0 - \%<0.425) \times (\%<5.0mm)/100$					32.7																																
USCS classification					SC																																
SIEVE SIZE BY LOG SCALE																																					
<table border="1"> <thead> <tr> <th>Sieve Size (mm)</th> <th>% Passing</th> </tr> </thead> <tbody> <tr><td>0.075</td><td>24.2</td></tr> <tr><td>0.150</td><td>30.7</td></tr> <tr><td>0.250</td><td>38.7</td></tr> <tr><td>0.425</td><td>50.8</td></tr> <tr><td>0.6</td><td>58.0</td></tr> <tr><td>0.85</td><td>66.8</td></tr> <tr><td>1.18</td><td>73.9</td></tr> <tr><td>2.0</td><td>80.3</td></tr> <tr><td>2.5</td><td>83.1</td></tr> <tr><td>4.75</td><td>85.1</td></tr> <tr><td>7.5</td><td>87.0</td></tr> <tr><td>15.0</td><td>91.1</td></tr> <tr><td>30.0</td><td>91.4</td></tr> <tr><td>60.0</td><td>92.0</td></tr> <tr><td>75.0</td><td>100.0</td></tr> </tbody> </table>						Sieve Size (mm)	% Passing	0.075	24.2	0.150	30.7	0.250	38.7	0.425	50.8	0.6	58.0	0.85	66.8	1.18	73.9	2.0	80.3	2.5	83.1	4.75	85.1	7.5	87.0	15.0	91.1	30.0	91.4	60.0	92.0	75.0	100.0
Sieve Size (mm)	% Passing																																				
0.075	24.2																																				
0.150	30.7																																				
0.250	38.7																																				
0.425	50.8																																				
0.6	58.0																																				
0.85	66.8																																				
1.18	73.9																																				
2.0	80.3																																				
2.5	83.1																																				
4.75	85.1																																				
7.5	87.0																																				
15.0	91.1																																				
30.0	91.4																																				
60.0	92.0																																				
75.0	100.0																																				



WET SIEVE ANALYSIS		FORM: SANS 3001-GR1: 2013		 <b>Rankin</b> Engineering Consultants Rankin House Chozi Road Lusaka, Zambia Tel/Fax: 260-1-291195																			
CLIENT:	United Nations Development Programme (UNDP)																						
PROJECT:	Medical Store Limited's Regional Hubs-Chipata																						
SUPERVISOR:	DL	DATE:	10/9/2016																				
OPERATOR:	TK	SAMPLE SOURCE:	SPT3 (0-2.0m )																				
DATE OF SOAKING:	10/9/2016	Soil Description	Moist brown medium dense to dense clayey sand (Residential)																				
DATE OF TESTING:	12/9/2016	Lab No.	3262																				
Initial Dry Mass ( $m_1$ ) <b>2133 g</b>																							
Sieve Opening (mm)	Mass Retained (g)		% Retained ( $\frac{m}{m_1} \times 100$ )	% Passing (p)	Cumulative % passing																		
	Actual	Corrected																					
75.0	0			100.0	100																		
63.0	0	0	0.0	100.0	100																		
50.0	0	0	0.0	100.0	100																		
37.5	0	0	0.0	100.0	100																		
28.0	0	0	0.0	100.0	100																		
20.0	0	0	0.0	100.0	100																		
Passing 20 mm ( $m_2$ )	2133	2132.5																					
total (checked with $m_1$ )	2132.5																						
rifled ( $m_3$ )	481.6																						
rifled and washed ( $m_4$ )	339.7																						
Correction factor $\frac{m_2}{m_3}$		4.43																					
14.0	0	0	0.0	100.0	100																		
9.5	0	0	0.0	100.0	100																		
8.0	0.3	1	0.1	99.9	100																		
6.7	0	0	0.0	99.9	100																		
5.0	2.0	9	0.4	99.5	100																		
2.0	4.2	19	0.9	98.7	99																		
1.0	22.1	98	4.6	94.1	94																		
0.6	51.5	228	10.7	83.4	83																		
0.425	54.4	241	11.3	72.1	72																		
0.250	99.8	442	20.7	51.3	51																		
0.150	59.5	263	12.4	39.0	39																		
0.075	39.2	174	8.1	30.9	31																		
<0.075 (+ 141.9)	148.6	658	30.9																				
TOTAL		2133																					
Grading Modulus: $GM = (300 - \%<2mm - \%<0.425mm - \%<0.075mm) / 100$					1.0																		
Grading Coefficient: $GC = (\%<28.0 - \%<0.425) \times (\%<5.0mm) / 100$					27.8																		
USCS classification					SC																		
SIEVE SIZE BY LOG SCALE																							
																							
<table border="1"> <tr> <td>Medium</td> <td>Coarse</td> <td>Fine</td> <td>Medium</td> <td>Coarse</td> <td>Fine</td> <td>Medium</td> <td>Coarse</td> <td>Cobbles</td> </tr> <tr> <td colspan="2">Silt</td> <td colspan="2">Sand</td> <td colspan="2">Gravel</td> <td colspan="3"></td> </tr> </table>						Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Silt		Sand		Gravel				
Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles															
Silt		Sand		Gravel																			



WET SIEVE ANALYSIS		FORM: SANS 3001-GR1: 2013		 <b>Rankin</b> Engineering Consultants Rankin House Chozi Road Lusaka, Zambia Tel/Fax: 260-1-291195																			
CLIENT:	United Nations Development Programme (UNDP)																						
PROJECT:	Medical Store Limited's Regional Hubs-Chipata																						
SUPERVISOR:	DL	DATE:	10/9/2016																				
OPERATOR:	TK	SAMPLE SOURCE:	SPT4 (2.7-5.0m )																				
DATE OF SOAKING:	10/9/2016	Soil Description	Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)																				
DATE OF TESTING:	12/9/2016	Lab No.	3263																				
Initial Dry Mass (m <sub>1</sub> ) <b>2555 g</b>																							
Sieve Opening (mm)	Mass Retained (g)		% Retained (m)*100 (m <sub>1</sub> )	% Passing (p)	Cumulative % passing																		
	Actual	Corrected																					
75.0	0			100.0	100																		
63.0	0	0	0.0	100.0	100																		
50.0	0	0	0.0	100.0	100																		
37.5	0	0	0.0	100.0	100																		
28.0	0	0	0.0	100.0	100																		
20.0	11.2	11	0.4	99.6	100																		
Passing 20 mm (m <sub>2</sub> )	2544	2543.8																					
total (checked with m <sub>1</sub> )	2555																						
rifled (m <sub>3</sub> )	607.2																						
rifled and washed (m <sub>4</sub> )	470.3																						
Correction factor $\frac{m_2}{m_3}$		4.19																					
14.0	3.3	14	0.5	99.0	99																		
9.5	17.3	72	2.8	96.2	96																		
8.0	16	67	2.6	93.6	94																		
6.7	16.3	68	2.7	90.9	91																		
5.0	29.2	122	4.8	86.1	86																		
2.0	96.4	404	15.8	70.3	70																		
1.0	54.2	227	8.9	61.4	61																		
0.6	49.3	207	8.1	53.3	53																		
0.425	39.2	164	6.4	46.9	47																		
0.250	67.2	282	11.0	35.9	36																		
0.150	41.5	174	6.8	29.1	29																		
0.075	34.4	144	5.6	23.4	23																		
<0.075 (+ 136.9)	142.9	599	23.4																				
TOTAL		2555																					
Grading Modulus: $GM = (300 - \%<2mm - \%<0.425mm - \%<0.075mm)/100$					1.6																		
Grading Coefficient: $GC = (\%<28.0 - \%<0.425) \times (\%<5.0mm)/100$					45.7																		
USCS classification					SC																		
SIEVE SIZE BY LOG SCALE																							
																							
<table border="1"> <tr> <td>Medium</td> <td>Coarse</td> <td>Fine</td> <td>Medium</td> <td>Coarse</td> <td>Fine</td> <td>Medium</td> <td>Coarse</td> <td>Cobbles</td> </tr> <tr> <td colspan="2">Silt</td> <td colspan="2">Sand</td> <td colspan="2">Gravel</td> <td colspan="3"></td> </tr> </table>						Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Silt		Sand		Gravel				
Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles															
Silt		Sand		Gravel																			



## **Appendix E - Atterberg Limit Results**



**R a n k i n**

Engineering Consultants  
Rankin House  
Chosi Road  
Lusaka, Zambia  
Tel/Fax: 260-1-291195

## CONE PENETROMETER

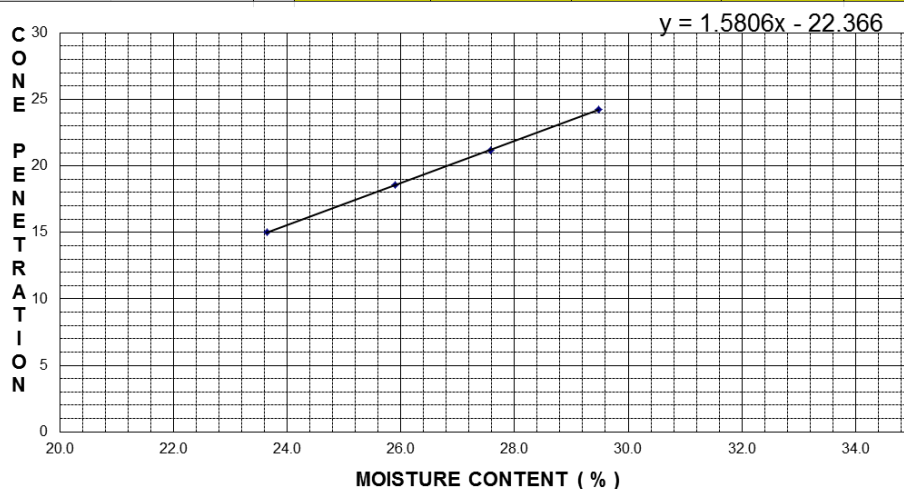
### Liquid and Plastic Limits

Linear Shrinkage and Shrinkage Product

PROJECT :	Medical Store Limited's Regional Hubs-Chipata	DESCRPTN :	SPT1 (0 - 2.4m) Moist brown loose to medium dense clayey sand (Residential)		
CLIENT :	United Nations Development Programme (UNDP)	LAB No :	3260	DATE :	14/09/2016
RESPONSIBLE TECHNICIAN :	TK	CHECKED :	DL	APPROVED :	SR

TEST METHOD TESTS 1.2, 1.3 and 1.4 , ref. BS 1377 : Part 2 : 1990

TEST NO.		LIQUID LIMIT								PLASTIC LIMIT		
		1		2		3		4		1	2	Average
Initial gauge reading	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Final gauge reading	mm	15.0	15.0	18.7	18.5	21.2	21.1	24.5	24.0			
Average penetration	mm	15.0		18.6		21.2		24.3				
Container Number		CM1		H		RK6		RK15		DMO2	DMO4	
Mass of wet soil & container	g	34.0		34.5		34.2		34.2		9.81	10.54	
Mass of dry soil & container	g	30.2		30.3		29.9		29.7		9.53	10.2	
Mass of container	g	14.2		14.1		14.3		14.2		7.08	7.36	
Mass of dry soil	g	16.0		16.2		15.6		15.5		2.5	2.9	
Mass of moisture	g	3.8		4.2		4.3		4.6		0.3	0.3	
Moisture content	%	23.6		25.9		27.6		29.5		11.4	11.2	11.3



Sample preparation :

- a ) As received
- b ) Airdried : ° C
- c ) Washed on 425 µm
- d ) Oven dried : ° C
- e ) Not known

Proportion passing on 425 µm sieve :

76

LIQUID LIMIT

LL = 26.8 %

PLASTIC LIMIT

PL = 11.3 %

PLASTICITY INDEX

PI = 15.5 %

### LINEAR SHRINKAGE and SHRINKAGE PRODUCT

Specimen reference		1	2	3	4	5
Initial Length $L_0$	mm	140				
Oven dried length $L_D$	mm	130				
Linear Shrinkage, $LS = 100 \cdot (1 - (L_D/L_0))$	%	7.14				
Shrinkage Product, $SP = LS \cdot \% < 425\mu m$		542.86				

1 of 1



**R a n k i n**  
Engineering Consultants  
Rankin House  
Chosi Road  
Lusaka, Zambia  
Tel/Fax: 260-1-291195

## CONE PENETROMETER

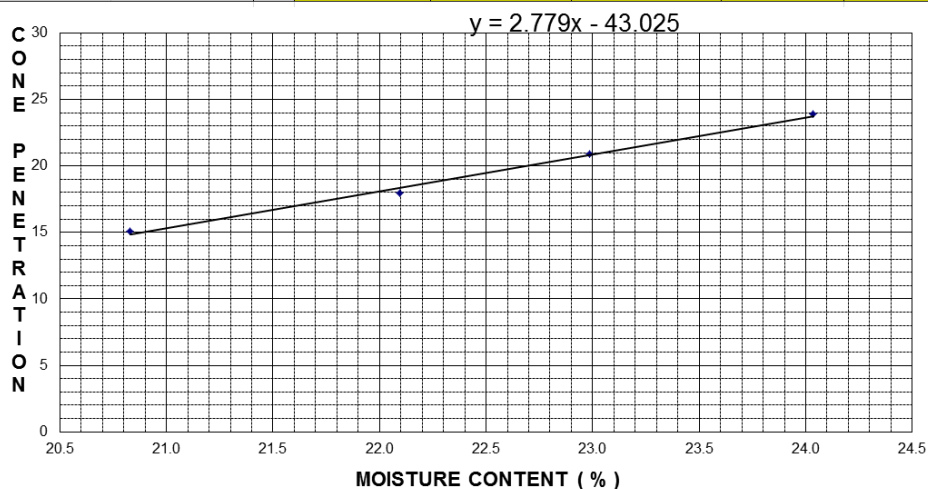
### Liquid and Plastic Limits

Linear Shrinkage and Shrinkage Product

PROJECT :	Medical Store Limited's Regional Hubs-Chipata	DESCRPTN :	SPT2 (2.6 - 5.0m) Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)			
CLIENT :	United Nations Development Programme (UNDP)	LAB No :	3261	DATE :	14/09/2016	
RESPONSIBLE TECHNICIAN :	BZ	CHECKED :	DL	APPROVED :	SR	

TEST METHOD TESTS 1.2, 1.3 and 1.4 , ref. BS 1377 : Part 2 : 1990

TEST NO.		LIQUID LIMIT								PLASTIC LIMIT		
		1		2		3		4		1	2	Average
Initial gauge reading	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Final gauge reading	mm	15.2	15.0	18.0	17.9	21.0	20.8	24.0	23.8			
Average penetration	mm	15.1	18.0	20.9	23.9							
Container Number		F11	IL	RK16	RNK32	OMO3	CK1					
Mass of wet soil & container	g	26.8	27.1	26.5	27.3	11.84	11.78					
Mass of dry soil & container	g	24.6	24.8	24.2	24.8	11.35	11.3					
Mass of container	g	14.0	14.4	14.3	14.4	7.2	7.41					
Mass of dry soil	g	10.6	10.4	9.9	10.4	4.2	3.9					
Mass of moisture	g	2.2	2.3	2.3	2.5	0.5	0.5					
Moisture content	%	20.8	22.1	23.0	24.0	11.8	12.1					11.9



Sample preparation :	
a ) As received	
b ) Airdried : ° C	
c ) Washed on 425 µm	
d ) Oven dried : ° C	
e ) Not known	
Proportion passing on 425 µm sieve :	
	51
LIQUID LIMIT	
LL =	22.7 %
PLASTIC LIMIT	
PL =	11.9 %
PLASTICITY INDEX	
PI =	10.8 %

LINEAR SHRINKAGE and SHRINKAGE PRODUCT							
Specimen reference			1	2	3	4	5
Initial Length	L <sub>0</sub>	mm	140				
Oven dried length	L <sub>D</sub>	mm	131				
Linear Shrinkage, LS = 100* (1-( L <sub>D</sub> /L <sub>0</sub> ))		%	6.43				
Shrinkage Product, SP = LS* % <425um			327.86				

1 of 1



**R a n k i n**  
Engineering Consultants  
Rankin House  
Chosi Road  
Lusaka, Zambia  
Tel/Fax: 260-1-291195

## CONE PENETROMETER

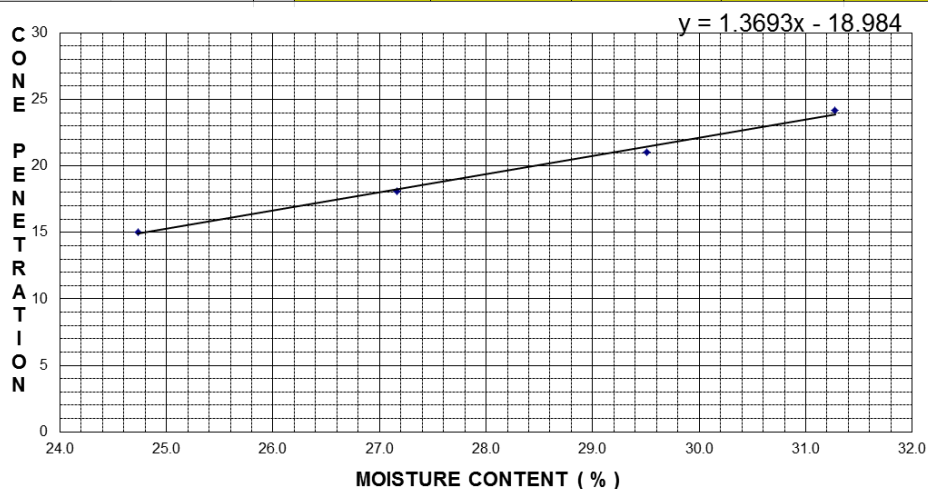
### Liquid and Plastic Limits

Linear Shrinkage and Shrinkage Product

PROJECT :	Medical Store Limited's Regional Hubs-Chipata	DESCRPTN :	SPT 3 (0 - 2.0m) Moist brown medium dense to dense clayey sand (Residential)		
CLIENT :	United Nations Development Programme (UNDP)	LAB No :	3262	DATE :	14/09/2016
RESPONSIBLE TECHNICIAN :	BZ	CHECKED :	DL	APPROVED :	SR

TEST METHOD TESTS 1.2, 1.3 and 1.4 , ref. BS 1377 : Part 2 : 1990

TEST NO.		LIQUID LIMIT								PLASTIC LIMIT		
		1		2		3		4		1	2	Average
Initial gauge reading	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Final gauge reading	mm	15.0	15.1	18.2	18.0	21.0	21.1	24.0	24.3			
Average penetration	mm	15.1	18.1	21.1	24.2							
Container Number		RNK3	ACM1	UU	RNK8	E	J9					
Mass of wet soil & container	g	34.3	34.1	34.0	34.2	9.96	10.06					
Mass of dry soil & container	g	30.4	29.8	29.5	29.4	9.72	9.8					
Mass of container	g	14.5	14.2	14.0	14.2	7.36	7.29					
Mass of dry soil	g	15.9	15.6	15.4	15.2	2.4	2.5					
Mass of moisture	g	3.9	4.2	4.6	4.8	0.2	0.3					
Moisture content	%	24.7	27.2	29.5	31.3	10.2	10.4	10.3				



Sample preparation :	
a ) As received	
b ) Airdried : ° C	
c ) Washed on 425 µm	
d ) Oven dried : ° C	
e ) Not known	
Proportion passing on 425 µm sieve :	
	72
LIQUID LIMIT	
LL =	28.5 %
PLASTIC LIMIT	
PL =	10.3 %
PLASTICITY INDEX	
PI =	18.2 %

LINEAR SHRINKAGE and SHRINKAGE PRODUCT					
Specimen reference		1	2	3	4
Initial Length $L_0$	mm	140			
Oven dried length $L_D$	mm	128			
Linear Shrinkage, $LS = 100 * (1 - (L_D/L_0))$	%	8.57			
Shrinkage Product, $SP = LS * \% < 425\mu m$		617.14			

1 of 1



**R a n k i n**  
Engineering Consultants  
Rankin House  
Chosi Road  
Lusaka, Zambia  
Tel/Fax: 260-1-291195

## CONE PENETROMETER

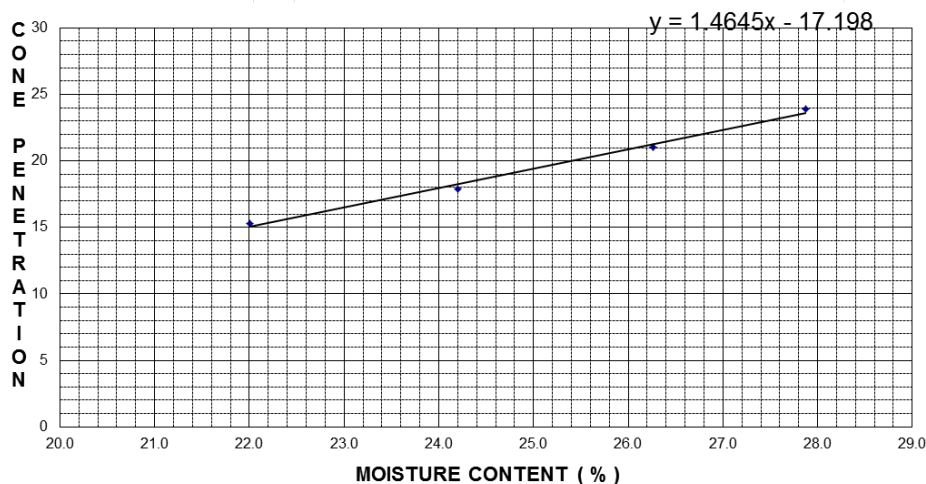
### Liquid and Plastic Limits

Linear Shrinkage and Shrinkage Product

PROJECT :	Medical Store Limited's Regional Hubs-Chipata	DESCRPTN :	SPT 4 (2.7 - 5.0m) Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)		
CLIENT :	United Nations Development Programme (UNDP)	LAB No :	3263	DATE :	14/09/2016
RESPONSIBLE TECHNICIAN :	BZ	CHECKED :	DL	APPROVED :	SR

TEST METHOD TESTS 1.2, 1.3 and 1.4 , ref. BS 1377 : Part 2 : 1990

TEST NO.		LIQUID LIMIT								PLASTIC LIMIT		
		1		2		3		4		1	2	Average
Initial gauge reading	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Final gauge reading	mm	15.4	15.2	18.0	17.8	21.0	21.1	23.8	24.0			
Average penetration	mm	15.3	17.9	21.1	23.9							
Container Number		MD4	LLL	2	RK7	A	JK					
Mass of wet soil & container	g	30.1	29.1	30.3	29.6	10.63	10.85					
Mass of dry soil & container	g	27.3	26.2	26.9	26.3	10.28	10.5					
Mass of container	g	14.5	14.0	14.0	14.2	7.36	7.21					
Mass of dry soil	g	12.8	12.2	12.9	12.0	2.9	3.3					
Mass of moisture	g	2.8	3.0	3.4	3.4	0.4	0.4					
Moisture content	%	22.0	24.2	26.3	27.9	12.0	12.0	12.0				



Sample preparation :	
a ) As received	
b ) Airdried : ° C	
c ) Washed on 425 µm	
d ) Oven dried : ° C	
e ) Not known	
Proportion passing on 425 µm sieve :	
	47
LIQUID LIMIT	
LL =	25.4 %
PLASTIC LIMIT	
PL =	12.0 %
PLASTICITY INDEX	
PI =	13.4 %


LINEAR SHRINKAGE and SHRINKAGE PRODUCT					
Specimen reference			1	2	3
Initial Length $L_0$	mm	151			
Oven dried length $L_D$	mm	142			
Linear Shrinkage, $LS = 100 * (1 - (L_D/L_0))$	%	5.96			
Shrinkage Product, $SP = LS * \% < 425\mu m$		280.13			

1 of 1




## **Appendix F – Moisture Content Results**




MOISTURE CONTENT		FORM M1		 <b>RANKIN</b> ENGINEERING CONSULTANTS <b>RANKIN HOUSE</b> <b>CHOZI ROAD</b> <b>LUSAKA, ZAMBIA</b> Tel/Fax: 260-1-291195	
CLIENT:	United Nations Development Programme (UNDP)				
PROJECT:	Medical Store Limited's Regional Hubs-Chipata				
TECHNICIAN:	DL	DATE 31/08/2016			
SAMPLE SOURCE:	SPT1 (0 - 2.4m) Moist brown loose to medium dense clayey sand (Residential)				
	Lab # 3260				
TEST ref. BS 1377: Part 2 : 1990					
Container Number		RNK35	RNK12	RK6	
Mass of wet soil & container (g) ( $m_2$ )		41.0	45.2	42.4	
Mass of dry soil & container (g) ( $m_3$ )		39.2	43.3	40.5	
Mass of container (g) ( $m_1$ )		14.2	14.2	14.3	
Mass of dry soil (g) ( $m_3 - m_1$ )		25.0	29.0	26.2	
Mass of moisture (g) ( $m_2 - m_3$ )		1.8	2.0	1.9	
Moisture content (%)		7.4%	6.8%	7.3%	
AVERAGE		7.1%			
CHECKED BY:	DL				
DATE:	DATE 31/08/2016				




MOISTURE CONTENT		FORM M1		 <b>RANKIN</b> ENGINEERING CONSULTANTS <b>RANKIN HOUSE</b> <b>CHOZI ROAD</b> <b>LUSAKA, ZAMBIA</b> Tel/Fax: 260-1-291195	
CLIENT:	United Nations Development Programme (UNDP)				
PROJECT:	Medical Store Limited's Regional Hubs-Chipata				
TECHNICIAN:	DL	DATE 31/08/2016			
SAMPLE SOURCE:	SPT2 (2.6 - 5.0m) Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)				
	Lab # 3261				
TEST ref. BS 1377: Part 2 : 1990					
Container Number	JJ	RNK15	RK1		
Mass of wet soil & container (g) ( $m_2$ )	44.7	37.4	43.0		
Mass of dry soil & container (g) ( $m_3$ )	42.6	35.7	41.1		
Mass of container (g) ( $m_1$ )	14.3	14.2	14.1		
Mass of dry soil (g) ( $m_3 - m_1$ )	28.3	21.5	27.0		
Mass of moisture (g) ( $m_2 - m_3$ )	2.1	1.6	1.9		
Moisture content (%)	7.5%	7.5%	7.1%		
AVERAGE	7.4%				
CHECKED BY:	DL				
DATE:	DATE 31/08/2016				



MOISTURE CONTENT		FORM M1		 <b>RANKIN</b> ENGINEERING CONSULTANTS <b>RANKIN HOUSE</b> <b>CHOZI ROAD</b> <b>LUSAKA, ZAMBIA</b> Tel/Fax: 260-1-291195	
CLIENT:	United Nations Development Programme (UNDP)				
PROJECT:	Medical Store Limited's Regional Hubs-Chipata				
TECHNICIAN:	DL	DATE 31/08/2016			
SAMPLE SOURCE:	SPT3 (0 - 2.0m) Moist brown medium dense to dense clayey sand (Residential)				
	Lab # 3262				
TEST ref. BS 1377: Part 2 : 1990					
Container Number	O5	CM1	RK16		
Mass of wet soil & container (g) (m <sub>2</sub> )	55.2	52.3	48.1		
Mass of dry soil & container (g) (m <sub>3</sub> )	52.8	49.9	46.1		
Mass of container (g) (m <sub>1</sub> )	14.1	14.2	14.3		
Mass of dry soil (g) (m <sub>3</sub> - m <sub>1</sub> )	38.7	35.7	31.9		
Mass of moisture (g) (m <sub>2</sub> - m <sub>3</sub> )	2.4	2.3	2.0		
Moisture content (%)	6.3%	6.5%	6.2%		
AVERAGE	6.4%				
CHECKED BY:	DL				
DATE:	DATE 31/08/2016				



MOISTURE CONTENT		FORM M1		 <b>RANKIN</b> ENGINEERING CONSULTANTS <b>RANKIN HOUSE</b> <b>CHOZI ROAD</b> <b>LUSAKA, ZAMBIA</b> Tel/Fax: 260-1-291195	
CLIENT:	United Nations Development Programme (UNDP)				
PROJECT:	Medical Store Limited's Regional Hubs-Chipata				
TECHNICIAN:	DL	DATE 31/08/2016			
SAMPLE SOURCE:		SPT4 (2.7 - 5.0m) Moist dark brown loose to dense gravelly clayey sand with iron oxides (Residential)			
		Lab # 3263			
TEST ref. BS 1377: Part 2 : 1990					
Container Number		F4	RK6	F11	
Mass of wet soil & container (g) (m <sub>2</sub> )		52.5	50.7	51.4	
Mass of dry soil & container (g) (m <sub>3</sub> )		49.9	48.3	48.9	
Mass of container (g) (m <sub>1</sub> )		14.1	14.3	14.0	
Mass of dry soil (g) (m <sub>3</sub> - m <sub>1</sub> )		35.8	33.9	34.9	
Mass of moisture (g) (m <sub>2</sub> - m <sub>3</sub> )		2.6	2.5	2.5	
Moisture content (%)		7.4%	7.2%	7.1%	
AVERAGE		7.2%			
CHECKED BY: DL					
DATE:		DATE 31/08/2016			



## **Appendix G – MDD Test Results**



**RANKIN**  
Engineering Consultants  
Rankin House,  
Chozzi Road  
Lusaka, Zambia  
Tel/Fax: 260-1-291195

Working Sheet

## Compaction Test

**Compaction Test, Test Method CML 1.9**  
**Ref. BS1377:Part4:1990**

**LAB No. 3259**

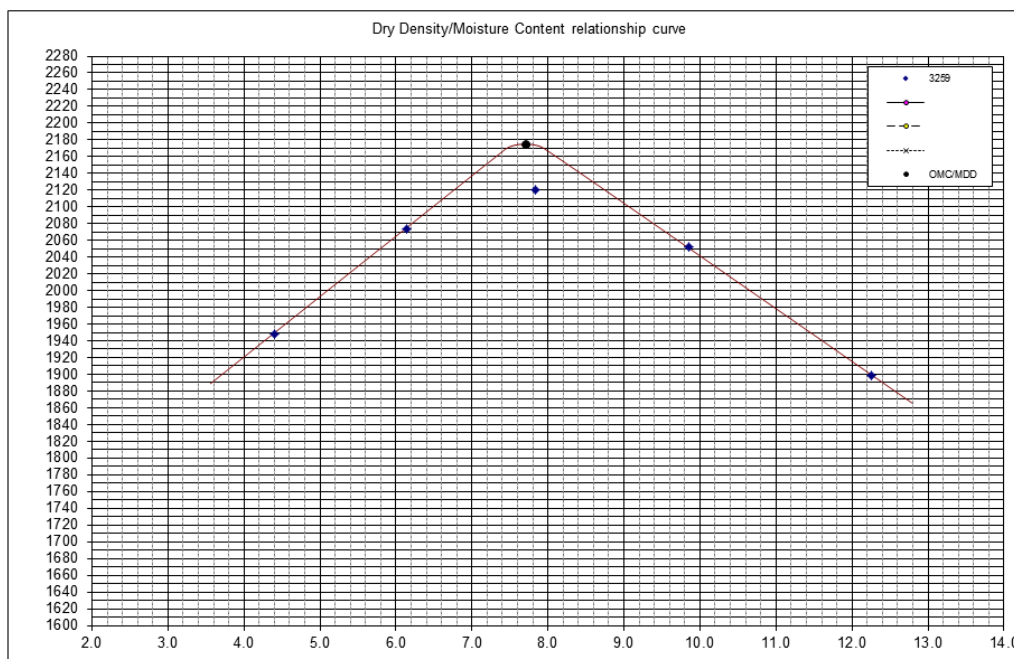
**Client** UNDP **Project:** Medical Store Limited's Regional Hubs-Chipata

**Date Sampled:** 25/08/2016 **Sampled By:** **Sample Description:** Moist brown clayey sand (Residential)

**Sample St.:** **Offset from  $\phi$  (m):** **Lane:** **Work Area:** 0.7-3.0m **Source:** TP1

**Compaction type:**

Mould no.	26	Mass	4616 g				Volume	2305	(m <sup>3</sup> )		
WATER ADDED		2	4	6	8	10					
Weight of mould + sample	g	9303.0	9690.0	9886.0	9813.0	9530.0					
Weight of sample	g	4687.0	5074.0	5270.0	5197.0	4914.0					
Wet Density	kg/m <sup>3</sup>	2033	2201	2286	2255	2131.9					
Dry Density	kg/m <sup>3</sup>	1948	2074	2120	2052	1899					
Factor of mould:											
Moisture Container no.		OM35	OM43	OM38	OM17	OM3					
Weight of wet soil + container	g	730	754	716	726	720					
Weight of dried soil + container	g	708	721	677	673	663					
Weight of container	g	209	183	179	135	198					
Weight of dry soil	g	499.0	538.0	498.0	538.0	465.0					
Moisture Content	%	4.4	6.1	7.8	9.9	12.3					



Optimum Moisture Content: OMC	7.7 %
Maximum Dry Density: MDD	2175 kg/m <sup>3</sup>

Remarks:

For the Engineers

Signature	Date
DL	6/9/2016
SR	6/9/2016

Checked by  
Approved by



## **Appendix H – CBR Test Results**



## Rankin Engineering Cons

### California Bearing Ratio Test Report

Date  
07/09/2016

DL

Checked By

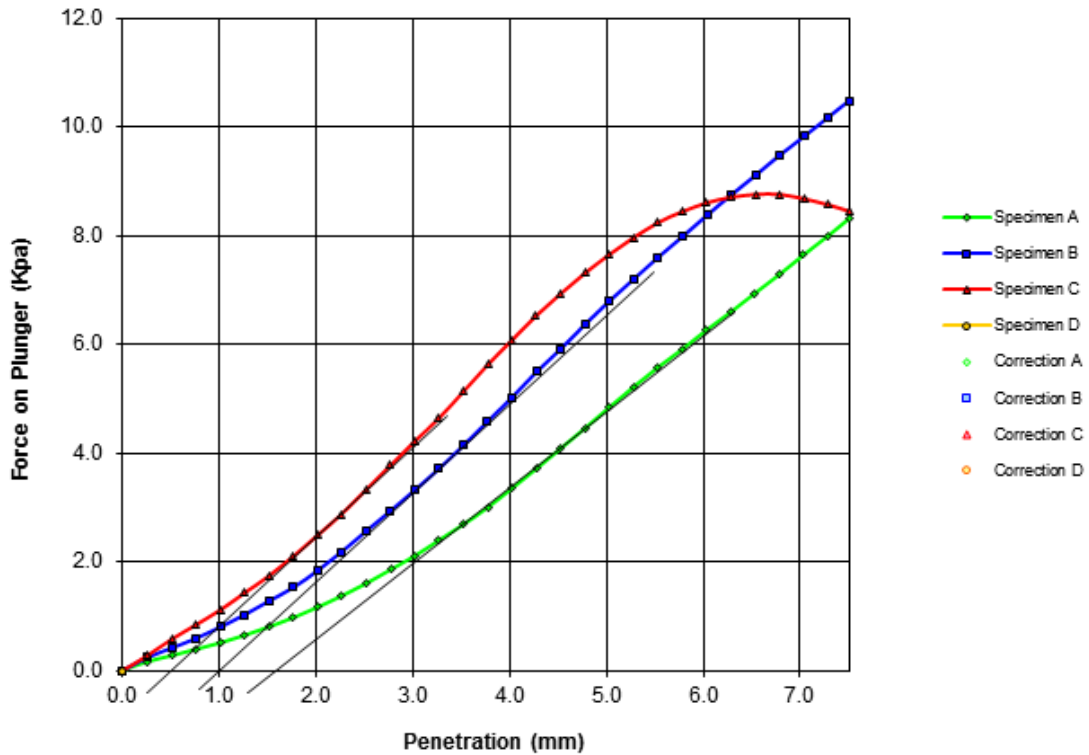
Date  
07/09/2016

Computed By CM

Date 07/09/2016

Tested By CM

### Load Penetration Curve



### CBR Results

Results	A	B	C	
2.54 mm Pen.	29.5	30.3	33.3	%Swell 0.02
5.08 mm Pen.	35.0	41.5	42.0	
Moisture (%)	9.28	9.64	11.40	
Density (g/cm <sup>3</sup> )	2.103	1.969	1.967	
%Compaction	96.70	90.53	90.44	

### Project Information

Project Information		Sample Location	
Project Num		Specimen A	TP (0.7 - 3.0m)
Project	Chipata	Specimen B	TP (0.7 - 3.0m)
Date	7/9/2016	Specimen C	TP (0.7 - 3.0m)
Client	United Nations Development Programme (UNDP)	Specimen D	TP (0.7 - 3.0m)
Test Variables			
Job Ref.		Liquid Limit:	-
Sample Num.	Lab # 3259	Plastic Limit:	-
Remarks	%Compaction	93	95
	%CBR	31	30
		98	-