



**BD 370**  
**GEOTECHNICAL INVESTIGATION REPORT FOR**  
**EMKHIWENI SUBSTATION, MPUMALANGA.**



*Prepared by:*

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**ESKOM HOLDINGS LIMITED**

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**Report No.:** BD 370-GE

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APPENDICES

**Appendix A: Geotechnical test positions: Drawing No. BD-370-GE-001-R-00**

**Appendix B: Test Pit (TP) Logs**

**Appendix C: Geological Map of the Area: Drawing No. BD-370-GE-002-R-00**

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**Appendix D: Resistivity tests**

**Appendix E: Laboratory test results**

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***Drawings: Drawing No. BD-370-CI-002-C-00***

**Appendix G: Relevant Photos**

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# **GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED EMKHIWENI SUBSTATION, MPUMALANGA.**

## **1. INTRODUCTION AND TERMS OF REFERENCE**

Bazi Dukhan Consulting Engineers cc was appointed by Eskom Holdings Limited to carry out a detailed geotechnical investigation for the proposed construction of Emkhiweni Substation in Rockdale B near Middelburg, Mpumalanga. The investigation was undertaken from the 22<sup>nd</sup> to the 23<sup>rd</sup> of November 2012. The proposed development would include the installation of the following typical equipment:

- a. Electrical Transformers
- b. Circuit breakers or line termination structures
- c. High Voltage Switchgear
- d. Low Voltage Switchgear
- e. Surge and lightning protection equipment
- f. Control and metering equipment
- g. Office and ancillary buildings
- h. Access roads

The terms of reference are as follows:

- (i) To establish the nature and relevant engineering properties of soil and rock strata underlying the area.
- (ii) To give foundation recommendations for site preparation (earthworks and terracing) and for the design and construction of foundations, substation platforms and access road.
- (iii) To provide geotechnical parameters on which the foundation and ancillary structure designs may be based.
- (iv) To identify any geotechnical problems that may affect the construction of the proposed structures.

## 2. **INFORMATION SUPPLIED**

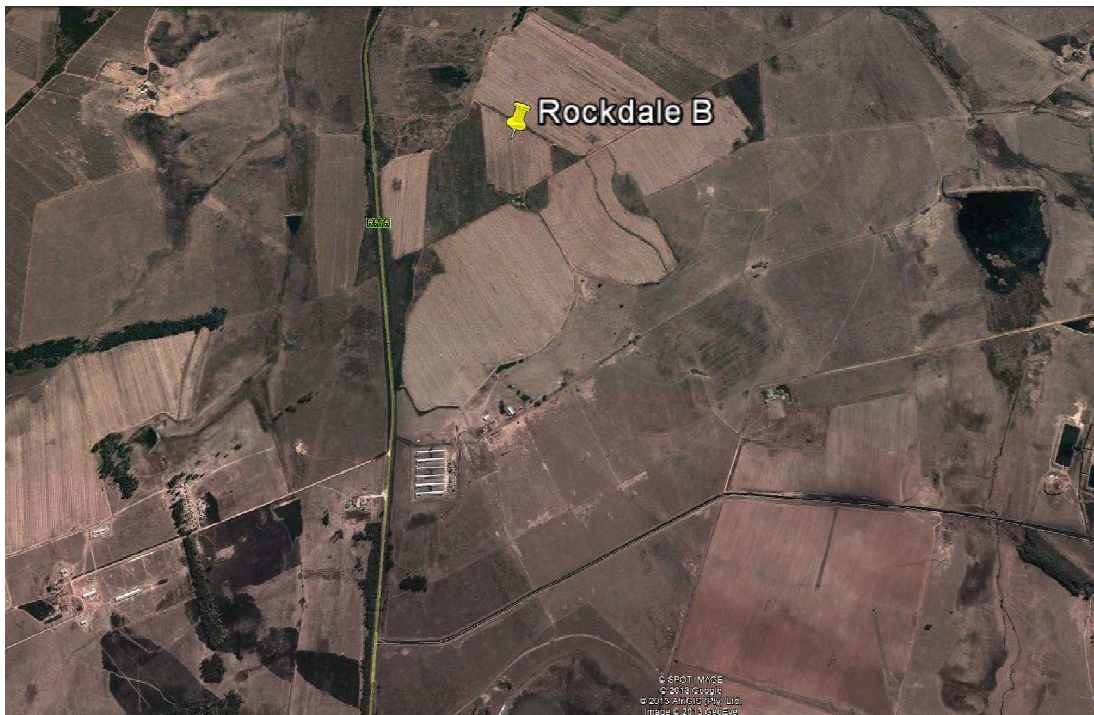
The coordinates at the centre of the site were provided by the client in order to accurately locate the site. A site layout plan was provided showing the terrace coordinates and positions on which the test pits were to be excavated. Preliminary longitudinal sections of the site showing the depth of cut and height of fill were provided. The proposed access road layout plan was also provided.

## 3. **DESCRIPTION OF THE SITE**

### **3.1 Location**

The proposed site is located near Middelburg in the North Eastern Region, Mpumalanga. It is positioned at approximately 4.1 km east of the R575 freeway (Figure 1) and is accessed off a gravel road. The gravel road then leads to a gently sloping cultivated area of land.

Animal activity in the form of burrows observed on the ground was noted on site during the investigation; this renders the proposed site an ecologically sensitive habitat unit. Therefore, the removal of vegetation and underlying subsoil during the construction phase of the structure would result in habitat loss for the existing animal species. Conversely, the investigated arable portion of land is not associated with wetlands or indigenous plant species with high conservation value.



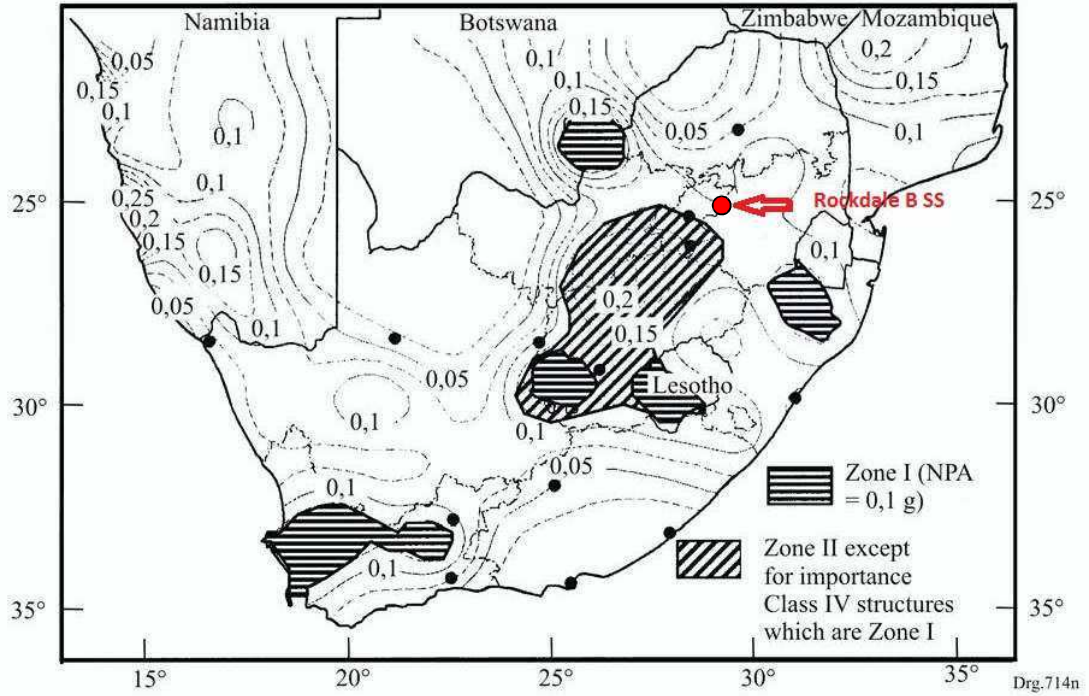
**Figure 1: Image showing the location of the proposed Rockdale B substation site**

#### **4. CLIMATE**

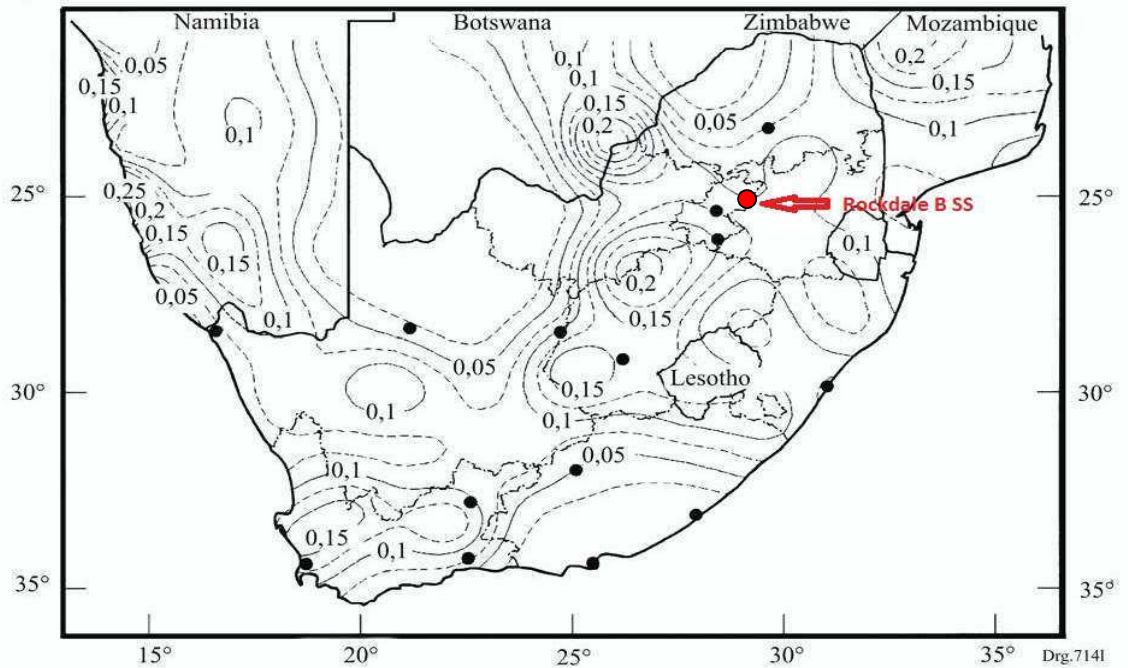
The area in which the site is located is warm, during the winter season the temperature often does not drop below zero. It is a summer rainfall region with little to no rain during the winter season. The “Weinert N-Value”, that describes the climatic environment, is approximately 4, suggesting that the climatic region is moderate. Where “N” is more than “5”, the mode of weathering is predominantly that of disintegration. Where “N” is less than “5” the mode of weathering is decomposition. Decomposition alters and affects those rocks whose minerals are liable to change chemically under atmospheric pressure. The N value is thus less than 5 and decomposition is the predominant mode of weathering.

#### **5. SEISMIC HAZARD ZONING**

According to the SANS 10160-4:2010 code (Ground conditions and seismic action) the proposed site is located in an area where the peak ground acceleration ( $a_g$ ) with a 10% probability of being exceeded in a 50-year period (Figures 2 and 3) is  $0.981 \text{ m/s}^2$ . The reference horizontal peak ground acceleration for this area is expressed as:  $a_g = 0.1 \text{ g}$ , where  $g$  is the gravitational constant ( $9.81 \text{ m/s}^2$ ). Seismic zones (Zone I & Zone II) applicable to South Africa are depicted in Figure 2 below. Zone I represents regions where natural seismic activity occurs, while Zone II represents regions where mining-induced and natural seismic activity prevails. Specifications for designing buildings to be constructed in seismic regions are detailed in the code. The Rockdale region falls outside of these zones (Figure 2).



**Figure 2: Seismic hazard zones of South Africa – SANS 10160-4:2010**



**Figure 3: Seismic hazard map of South Africa: 10% in 50 years nominal peak ground acceleration (g) (9.81m/s<sup>2</sup>) - Council for Geoscience**

## **6. FIELDWORK**

The field work associated with this investigation was carried out on the 22<sup>nd</sup> and the 23<sup>rd</sup> of November 2012, respectively. Test pit positions are coordinated and recorded on the drawing of the site (BD-370-GE-001-R-00), Appendix A. In addition, the subsoil profiles as revealed by the test pits were logged by a professional Geotechnical Engineer.

Twenty Three (23) Test Pits (TP 1 to TP 20, and TP R1, TP R2 & TP R4) were excavated by a 20 ton CAT 324 D LME excavator. A maximum depth of 5m was recorded for TP14, while test pits TP R1 to TP R4 were excavated down to a maximum depth of 1.8m. TP R1, TP R2 and TP R4, respectively, were excavated to establish the nature of the underlying subsoil specifically for design and construction purposes of access roads, hence shallower depths were excavated. The logs for all test pits are attached to Appendix B of this report.

## **7. REGIONAL GEOLOGY & SUBSOILS**

From a study of the Geological maps available for the area (2528 Pretoria: 1:250000 series), it was found that the area is underlain by the Dwyka Tillite and Shale of the Karoo Super-group, shown on drawing No. BD-370-GE-002-R-00, Appendix C. The inferred geological land facets are depicted on drawing no. BD-370-GE-003-R-00, Appendix C. The transported soils encountered on site consist of alluvial deposits which are underlain by residual Tillite which grades into the underlying Dwyka Tillite bedrock at depth.

## **7. SOIL PROFILES**

Based on the findings from the twenty three test pits, the subsoil consists of the following stratigraphic units:

### **Topsoil/Agricultural layer**

The layer was encountered in all test-pits with the exception of TP 14, TP 15, TP 16 and TP 17. The thickness of the layer was generally between 0.10m to 0.70m in thickness. The Agricultural Layer was described as; slightly moist, dark orange brown, loose, gravelly SAND containing nodules of minor ferricrete. The layer thickness for the topsoil/agricultural layer is summarized in Table1

### **Upper Alluvium Layer**

The upper Alluvium Layer was divided into the upper and lower Alluvium Layers. The Upper Alluvium were encountered directly below the Agricultural/topsoil Layer or from the surface as in TP1, TP2, TP3, TP4, TP 14, TP 15, TP 16 and TP 17. The layer generally varied in thickness from 0.40m to 1.60m, with the exception of TP 2, where a maximum thickness of 3.00m was recorded.

The layer generally consists of clayey GRAVEL, silty or gravelly CLAY or sandy SILT. The clayey GRAVEL Alluvium soil profile consisting of the following:

Abundant (>50%), Sub-rounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey SAND. Overall consistency is firm.

The silty CLAY Alluvium soil profile consists of the following:

Slightly moist, orangey brown, mottled yellow, stiff, silty CLAY with occasional cobbles.

The sandy SILT Alluvium soil profile consists of the following:

Slightly moist, orangey brown, stiff, micro-shattered, slightly clayey sandy SILT.

The layer thickness for the upper Alluvium is summarized in Table 1.

### **Lower Alluvium Layer**

The lower Alluvium soil stratum varies in thickness from 0.70m to 3.00m with the exception of TP 14, where a 4.00m thick layer was measured. The average thickness of the layer is in the order of 2.20m.

In cases where the lower Alluvium layer consisted of a silty CLAY, the following typical soil was recorded:

Moist, orangey brown, soft, micro-shattered, silty CLAY.

In cases where the lower Alluvium layer consisted of a clayey sandy SILT, the following typical soil profile was recorded:

Moist, orangey brown, soft, micro-shattered, slightly clayey sandy SILT.

In cases where the lower Alluvium layer consisted of a slightly clayey silty SAND, following typical soil was recorded:

Moist, light orangey brown, very loose, slightly clayey silty SAND. Alluvium.

A maximum depth of excavation of 5.00m was achieved at TP 14 and no bedrock was encountered.

**Upper & Lower Residual Tillite**

An upper Residual Tillite layer was encountered in TP 1 and TP 13 and was 1.20m and 0.40m respectively. The lower Residual Tillite was not encountered in TP 4, TP 5, TP 7, TP 10, TP 14, TP 15, TP 16, TP 17 and TP 18. The lower Residual Tillite layer consists of the following typical soil profile:

Slightly moist, light yellowish brown, firm, micro-fissured, silty CLAY.

In TP 11 @ 3.00m-3.60m, the soil stratum was recorded as:

Slightly moist, light yellow blotched olive grey, firm, slightly gravelly sandy SILT with occasional cobbles in profile.

**Dwyka Tillite bedrock**

The Dwyka Tillite bedrock observed in test pits was described as highly weathered, soft becoming medium hard rock, light yellowish brown, fine grained, medium bedded, widely jointed Dwyka Tillite, Karoo Super-group. The rock layer was encountered in TP1 at 3.7 – 4.0 m, TP2 at 3.7 – 4.3 m, TP3 at 3.0 – 3.7 m, TP8 at 3.2 – 3.5m, TP9 at 3.46 – 3.7 m, 3.6 – 4.6m, TP12 at 3.7 – 4.6m, TP13 at 3.3 – 4.1m, TP19 at 3.5 – 4.2m and TP20 at 3.8 – 4.0m. Refusal was encountered at the maximum depths stated above.

A summary of the stratum thickness for all the test pits is included in Table1.

The soil profile logs are attached to Appendix B of this report.

**Table 1: Summary of Soil Profiles Encountered in Test Pits**

Test Position No.	Agricultural Layer/Topsoil	Upper Alluvium	Lower Alluvium	Upper Residual Tillite	Lower Residual Tillite	Tillite Bedrock	Groundwater Seepage	Comments
TP 1	0.20m	0.50m	0.70m	1.20m	1.10m	@3.70-4.00m	Not Encountered	
TP 2	0.10m	3.30m	-	-	0.30m	@3.70-4.30m	Not Encountered	
TP 3	0.20m	1.60m	0.60m	-	0.60m	@3.00-3.70m	Not Encountered	
TP 4	0.10m	1.40m	2.80m	-	-	-	Not Encountered	
TP 5	0.10m	1.50m	2.20m	-	-	-	Not Encountered	
TP 6	0.20m	1.60m	2.00m	-	-	-	Not Encountered	
TP 7	0.10m	1.40m	2.00m	-	-	-	Not Encountered	
TP 8	0.70m	0.80m	-	-	1.70m	@3.20-3.50m	Not Encountered	
TP 9	0.20m	0.80m	1.76m	-	0.70m	@3.46-3.70m	Not Encountered	
TP 10	0.20m	1.10m	2.10m	-	-	-	Not Encountered	
TP 11	0.40m	0.50m	2.10m	-	0.60m	@3.60-4.60m	Not Encountered	
TP 12	0.35m	1.15m	1.50m	-	0.70m	@3.70-4.60m	Not Encountered	
TP 13	0.20m	1.20m	1.10m	0.40m	0.40m	@3.30-4.10m	Not Encountered	
TP 14	-	1.0m	4.00m	-	-	-	Not Encountered	
TP 15	-	1.50m	3.00m	-	-	-	Not Encountered	
TP 16	-	1.30m	3.00m	-	-	-	Not Encountered	
TP 17	-	1.00m	3.20m	-	-	-	Not Encountered	
TP 18	0.10m	1.00m	1.20m	-	-	-	Not Encountered	
TP 19	0.10m	0.90m	-	-	2.50m	@3.50-4.50m	Not Encountered	
TP 20	0.10m	1.10m	2.60m	-	-	@3.80-4.00m	Not Encountered	
TP R1	0.10m	1.10m	0.60m	-	-	-	Not Encountered	
TP R2	0.10m	0.40m	0.70m	-	-	-	Not Encountered	
TP R4	0.10m	1.20m	0.50m	-	-	-	Not Encountered	

## **9. GEOPHYSICAL SURVEY**

A soil resistivity survey was conducted on site by Engineering & Exploration Geophysical Services cc. The purpose of the soil resistivity survey is to obtain information on ground resistance that is to be used in earth-mat design. The apparent conductivity and resistivity measurements were determined during the survey. The apparent conductivity readings provide an appreciation of lateral changes across the site, whilst the resistivity produces cross-sections showing changes with depth.

A CMD-4 was employed to record near-surface conductivity changes across the site. An ABEM SAS1000 resistivity meter and a 10-64 switch box were employed to collect the resistivity data. The data sets were modelled through the use of a RES2DINV programme which automatically interprets the resistivity variations of the ground. The results obtained from the resistivity survey revealed clear horizontal layering; with a surface resistor that is about 2 to 4 metres in thickness overlying a conductor. The surface layer is notably more resistive in the north-west than in the south-east. The underlying conductor is also more resistive in the north-west. The variation in resistivity of the layers, in particular the surficial resistor, accounts for the changes in apparent conductivity across the site. The underlying cause of the observed variation in resistivity is presumed to be a facies change in the sedimentary rock. The results from the resistivity survey are attached in Appendix D.

## **10. MOISTURE CONDITIONS**

No seepage or groundwater was observed in any of the excavated test pits on site. The Alluvium and ferricrete layers, however, indicate that an old river bed existed in previous geological times and seasonal groundwater could be affected.

## **11. LABORATORY ANALYSIS**

### **11.1 Foundation Indicator (FI) Tests**

Fourteen (14) disturbed samples were extracted from selected test pits for Foundation Indicator testing. Soil properties such as the Atterberg limits and particle size distribution were determined.

In-situ soils usually consist of a mixture of various grain sizes, therefore soils are usually classified in terms of their proportions of gravel, sand, silt and clay. The most widely used classification system for Geotechnical Engineering purposes is the Unified Soil Classification System (USCS). Subgrade soils have been further classified in eight groups (A-1 to A-8) based on their field performance according to the Unified Soil Highway Classification System (Group Index system). This classification system is employed to designate general characteristics such as plasticity, permeability, bearing power, resistance to frost heave, etc. The results obtained from the Foundation Indicator tests were further employed in the classification of soils according to the Unified Soil Classification System (USCS) and the Unified Soil Highway Classification System, respectively, and the results are tabulated below (Table 1). The Foundation Indicator test results are included in Appendix E.

**Table 2: Summary of Foundation Indicator Test Results**

Test Pit	Depth (m)	Description	Particle size (%)				Atterberg Limits %				GM	Potential Expansiveness	Unified Classification	U.S. Highway Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS	WPI				
TP 3	1.8 – 2.4	Yellowish brown Gravelly SAND. Alluvium.	7.3	18.7	40.0	34.0	31.0	11.0	5.0	6	1.58	M	(GM)	A-2-6
TP 4	1.5 – 4.1	Light orangey brown sandy SILT. Alluvium.	14.5	43.5	42.0	0.00	54.0	22.0	11.0	22	0.44	M	ML	A-7-5
TP 4	4.1 – 4.3	Light orangey brown slightly clayey silty SAND. Alluvium.	16.0	31.0	52.0	1.0	49.0	25.0	12.7	24	0.59	M	SM	A-7-6
TP 5	1.6 – 3.6	Orangey brown slightly clayey sandy SILT. Alluvium.	21.9	36.1	36.0	6.0	36.0	16.0	7.9	14	0.62	M	ML	A-6
TP 7	1.5 – 3.3	Orangey brown slightly clayey sandy SILT. Alluvium.	21.3	42.7	32.0	4.0	34.0	18.0	9.1	16	0.52	M	ML	A-6
TP 9	1.0 – 2.76	Dark orangey brown mottled orange & yellow, silty gravelly SAND. Alluvium.	11.2	34.8	40.0	14.0	34	15	7.4	10	0.99	L-M	SM	A-6
TP 9	2.76 -3.46	Light orangey brown slightly gravelly silty SAND. Residual Tillite.	5.9	37.1	48.0	9.0	30	10	4.53	8	0.91	L	SM	A-4

**Table 2 (continued): Summary of Foundation Indicator Test Results**

Test Pit	Depth (m)	Description	Particle size (%)				Atterberg Limits %				GM	Potential Expansiveness	Unified Classification	U. S. Highway Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS	WPI				
TP 11	2.5 – 3.0	Orangey brown mottled yellow, slightly gravelly silty SAND. Alluvium.	17.0	34.0	36.0	13.0	26	12	6.0	9	0.85	L	SM	A-6
TP 11	3.0 – 3.6	Light yellow blotched olive grey, slightly gravelly sandy SILT. Residual Dwyka Tillite.	13.9	40.1	36.0	10.0	30	14	6.6	11	0.78	L-M	ML	A-6
TP 13	2.5-2.9	Peach mottled yellow and orange, slightly gravelly sandy SILT	12.0	39.0	30.0	19.0	32	17	7.8	12	0.98	L-M	ML	A-6(5)
TP 14	0.4 – 1.0	Orangey brown sandy SILT. Alluvium.	27.1	38.9	32.0	2.0	34	17	8.5	16	0.45	M-H	ML	A-6
TP 14	2.4 – 5.0	Orangey brown, slightly sandy clayey SILT. Alluvium	28.1	50.9	20.0	1.0	45	21.0	10.7	20	0.27	M-H	ML	A-7-6
TP 15	0.0-0.8	Dark orangey brown, slightly clayey gravelly sandy SILT. Alluvium.	21.3	29.7	24.0	25.0	36	16	8.1	10	1.05	L-M	ML	A-6(5)
TP 16	3.7 – 4.3	Reddish brown, slightly clayey sandy SILT. Alluvium	4.4	54.6	39.0	2.0	41.0	20.0	9.0	16	0.63	L	ML	A-7-6
TP 17	1.0 – 4.2	Orangey brown , slightly clayey sandy SILT. Alluvium.	19.0	61.0	18.0	2.0	58	35	14.86	33	0.27	M-H	MH	A-7-6
TP 19	1.0 – 3.5	Pale yellowish brown, sandy SILT. Residual Tillite.	12.8	40.2	42.0	5.0	28	11	5.33	9	0.68	L-M	ML	A-6
TP 20	0.1 – 1.2	Orangey brown, sandy GRAVEL	5.4	11.6	24.0	59.0	25.0	9	4.3	3	2.11	L	GM	A – 2 – 4 (0)

Where:

SM: Silty sands, poorly graded sand-silt mixtures.

ML: Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity.

GM: Silty gravels, poorly graded gravel-sand-silt mixture.

MH: Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.

GM: Grading Modulus

LL: Liquid Limit

PI: Plasticity Index

LS: Linear Shrinkage

M – Medium potential expansiveness

L – Low Potential expansiveness

H- High Potential expansiveness

WPI – Weighted Plasticity Index

Table 2 indicates the following:

**Upper Alluvium:**

The Upper Alluvium was encountered in TP3 (1.8 – 2.4m), TP4 (1.5 – 4.1m), TP7 (1.5 – 3.3m), TP9 (1.0 – 2.76m), TP14 (0.4 – 1.0m), TP15 (0.0 – 0.8m) and TP20 (0.1 – 1.2m). The material consists of gravelly SANDS, sandy SILTS, clayey sandy SILTS and sandy GRAVEL. The gravelly SANDS classify as SM according to the Unified Soils Classification System (USCS) and consist typically of Silty sands, sand-silt mixtures. The Grading Modulus ranges from 0.45 – 2.11.

The sandy SILTS and the clayey sandy SILTS classify as ML and MH typically consists of either Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity or Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts .

The material in TP3 (1.8 – 2.4m) and TP20 (0.1 -1.2m) classifies as GC and GM respectively and typically consists of clayey gravels, gravel-sand-clay mixtures or Silty gravels, gravel-sand-silt mixtures.

The Weighted PI for TP4 (1.5 – 4.1) is 22 and plots on the medium Potential expansiveness region of the Van Der Merwe's Chart. This indicates that the material will be subject to medium heave. The majority of the samples have a medium potential expansiveness with the exception of TP17 (1.0 – 4.2m) which has a medium to High

Potential expansiveness with a weighted PI of 33 and TP9 (1.0 – 2.76m) which has a low to medium Potential expansiveness and TP9 (2.76m – 3.46m) and TP20 (0.1 – 1.2m) which has a low potential expansiveness.

**Lower Alluvium:**

The lower Alluvium stratigraphic horizon consists of slightly clayey silty SAND, slightly clayey sandy SILT and slightly gravelly sandy SILT. The lower Alluvium layer was encountered in TP4 (4.1 – 4.3m), TP5 (1.6 – 3.6m), TP11 (2.5 – 3.00m), TP13 (2.5 – 2.9m), TP14 (2.4 – 5.0m) and TP16 (3.7 – 4.3m). The slightly clayey and slightly gravelly sands classify as SM according to the Unified Soils Classification System (USCS) and consists typically of Silty sands, sand-silt mixtures.

The slightly clayey sandy silts classify as ML, according to the Unified Soils Classification System (USCS) and consists typically of Inorganic silts and very fine sands, rock flour, silty or clayey fine sands.

The Weighted PI for TP4 (4.1 – 4.3) is 24 and plots on the medium Potential expansiveness region of the Van Der Merwe's Chart. This indicates that the material will be subject to medium heave. The majority of the samples have a low to medium potential expansiveness with the exception of TP4 (4.1 – 4.3m) and TP5 (1.6 – 3.6m) which has a medium potential expansiveness. The weighted PI of the samples range from 9 to 24. In general, a weighted PI greater than 13 implies that the soil may be subject to heave.

**Residual Dwyka Tillite:**

The residual Tillite was extracted from TP9 (2.76 – 3.46m), TP11 (3.0 – 3.6m) and TP19 (1.0 – 3.5m) for Foundation Indicator tests. The samples were described as either slightly gravelly silty SAND or silty CLAY. The material classified as SC and CL respectively according to the Unified Soils Classification System (USCS). The material typically consists of clayey sands, sand-clay mixtures or Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.

The weighted PI of TP9 (2.76 – 3.46m) is 8 and TP19 (1.0 – 3.5m) it is 9. The material has a low to medium Potential expansiveness.

## 11.2 Consolidation (Oedometer) Tests

Three (3) samples were extracted from TP 4, TP 11 and TP 14, respectively, and were subjected to a one-dimensional consolidation test. The results are summarized in Table 3 below. The results obtained from this test were further used to determine the pre-consolidation pressure ( $\sigma_c$ ) value, which is the maximum effective vertical stress that has acted on the clay in the past. The results presented below indicate that the alluvial deposits analyzed have low in-situ dry densities and high water content values. The Young's moduli values calculated at various effective stresses (unloading portion of the log  $\sigma$  vs.  $e$  curve) indicated in the table below are low. The lab results are included in Appendix E.

**Table 3: Summary of Consolidation test results**

Test Pit	Depth (m)	Description	Initial Dry density (Kg/m <sup>3</sup> )	Initial Void Ratio ( $e_1$ )	Water Content before test (%)	Young's Modulus (E) (kPa)	
						10 - 100 kPa	100 - 400 kPa
TP 4	1.5 – 4.1	Light orangey brown sandy SILT	1489	0.9159	22.7	2.57	18.1
TP 11	2.5 – 3.0	Orangey brown mottled yellow silty gravelly silty SAND	1498	0.7508	18.3	3.02	31.9
TP 14	0.4 – 1.0	Orangey brown silty CLAY	1466	0.8289	19.5	8.57	28.0

## 11.3 Compaction Characteristics Tests

Nine (9) samples were extracted from selected test pits for MOD and CBR analysis, and the maximum dry density as well as the optimum moisture content was determined. The samples were also classified in accordance with the TRH 14 guidelines.

The highly weathered Dwyka Tillite bedrock in TP3 (3.0 – 3.7) is a sandy GRAVEL, which has a low CBR strength of 13 at 95% Mod AASHTO density and classifies as a G8 material in accordance with the TRH 14 Guidelines. The material is considered

unsuitable for use in the construction of platforms. TP R1 (0.1 – 1.2m) and TP R4 (0.1 – 1.3m) are located along the proposed access roads. The pavement layer-works for the Tar access Road (818m) was shown in a typical cross section. The intended layer works consists of the following:

- Surfacing – 19 mm single seal with double slurry seal.
- 150 mm Base- graded stone compacted to 88% Apparent density (maxi size 37.5 mm; Fines PI<6).
- 150 mm Subbase – imported GRAVEL stabilized with 3% cement and compacted to 95% Mod AASHTO at OMC (Min GM = 1.5, Min U.C.S 750 kN/m<sup>2</sup> Max size 63mm).
- 150 mm selected subgrade – imported gravel compacted to 93% Mod AASHTO MDD at OMC (CBR >=15; Min GM = 0.5; MAX PI = 3GM + 10).
- 150 mm Roadbed Preparation – Rip and re-compact in-situ to 90 % Mod AASHTO at OMC (CBR >=7).

The CBR values for TP R1 and TPR4 are 6 and 8 at 90 % Mod AASHTO. It is suggested that the Roadbed preparation be ripped and re-compacted to 93% Mod AASHTO density which will result in an improved CBR of 11 in TP R1 (0.1 – 1.2m) and a CBR of 15 in TP R4(0.1 – 1.3m). A selected subgrade layer comprising a G7 will have to be imported from a commercial source. The subbase layer requires a material of G5 quality or C4. The base material for the access road should be at least a G2 material. The base and subbase material should also be obtained from a commercial source.

The clayey GRAVEL in TP 11 (0.4 – 0.9m) has a high CBR value of 33 at 95% Mod AASHTO and classifies as a G6 material in accordance with the TRH14 Guidelines. The material is considered suitable for use in the construction of the platforms. This Alluvium material is variable and where the more clayey material was encountered the material does not classify as a G6. The volume of G6 obtained from this area will not be sufficient to construct all of the platforms and the shortfall of G6 should be obtained from a commercial source.

The clayey GRAVEL obtained from TP 20 at 0.1 – 1.2 m classifies as a G7 according to the TRH 14 guidelines. This min CBR required for the construction of the platforms should be 25 at 95% Mod AASHTO density. The CBR rating of the material is 19 at 95% Mod AASHTO density. It is suggested that G6 material be obtained from a commercial source for the construction of the required platforms.

The results are included in Appendix E.

The laboratory test results are summarized in Table 3 below:

**Table 4: Summary of Compaction test results**

Test Pit	Depth (m)	Description	OMC (%)	Swell (%)	MDD (kg/m <sup>3</sup> )	CBR at various densities						TRH 14
						90%	93%	95%	97%	98%	100%	
TP 3	3.0 – 3.7	Light yellowish brown stained dark orange Dwyka Tillite	14.9	0.47	1860	7	11	13	16	17	20	G8
TP 11	0.4 – 0.9	Orangey brown silty clayey GRAVEL	10.5	0.10	2081	16	26	33	47	54	68	G6
TP 15 x2 bags	0.0 – 0.8	Dark orangey brown clayey SAND	17.3	1.52	1869	6	8	10	11	12	13	G9
TP 17	0.0 – 0.6	Orangey brown clayey SAND	15.7	0.71	1847	3	6	8	10	11	13	G10
TP 20 x 2 Bags	0.1 – 1.2	Orangey brown silty clayey GRAVEL	12.2	0.87	2077	9	15	19	25	27	33	G7
TP R1	0.3 – 1.2	Dark brown silty SAND.	10.3	10.1	1991	19	29	36	43	46	53	G6
TP R2	0.1 – 1.2	Orangey brown silty clayey GRAVEL	14.2	0.47	1958	6	11	14	17	19	22	G8
TP R4	0.1 – 1.3	Pale brown clayey SAND	10.1	0.24	2065	8	15	19	22	24	27	G8

#### **11.4 Potential Corrosiveness of In-situ soil**

Soils constitute the most complex environment known to metallic corrosion. Corrosion of metallic elements in soil can vary from relatively rapid material loss to negligible effects.

The factors that influence this are:

- The heterogeneity of the soil (long-line currents)
- Aeration (oxygen and moisture to the metallic element)
- Groundwater
- Electrical conductivity of the soil(reciprocal of resistivity)
- Chemical properties of the soil
- Bacterial attack
- Stay currents in the soil, and
- Soils potential to support sulphate reducing bacteria.

Soil pH can be used as an indication of corrosion loss potential for metals in soil. Conductivity of a soil also gives an indication of corrosion loss potential of buried metallic elements. The term “pH” is defined as the acidity or alkalinity of a solution that is assigned a number on a scale from 0 to 14. A value of 7 represents neutrality; lower numbers indicate increasing acidity and higher numbers increasing alkalinity.

Corrosion is defined as the degradation of a material or its properties due to a reaction with the environment. Corrosion exists in virtually all materials, but is most often associated with metals. Metallic corrosion is a naturally occurring process in which the surface of a metallic structure is oxidized or reduced to a corrosion product such as rust by chemical or electrochemical reaction with the environment.

A chemical analysis for aggressivity was also undertaken to assess the corrosivity of the underlying subsoil towards concrete and metals according to the pH, corrosivity indices defined in Table 2 below as well as the electrical conductivity. Basson Further testing was undertaken to determine the aggressiveness of the subsoil towards concrete using the Basson Aggressive Index (Table 4). The guidelines for interpreting the soil conductivity test results are provided in Table 5.

**Table 5: Interpretation of Corrosivity Indices**

Index	Aggressive	Neutral	Non-Aggressive
Stability pH (pHs)	>pH	=pH	<pH
Langelier Index	Neg. Value	Zero	Pos. Value
Ryznar Index	>7.5	6-7	<6
Basson Aggressiveness Index	<10	10-12	>12

**Table 6: Guidelines for interpreting soil conductivity data**

Soil conductivity (mS/m)	Corrosion classification
More than 50	Extremely corrosive
25 – 50	Very corrosive
20 - 25	Corrosive
10 - 20	Mildly corrosive
Less than 10	Not generally corrosive

Further testing was undertaken to determine the aggressiveness of the subsoil towards concrete using the Final Aggressiveness Index (Table 8). The test results are tabulated in Table 7.

**Table 7: Guidelines for assessing the Final Index**

Final Index	Aggressiveness	Recommendation
Under 350	Non to mildly aggressive	Use concrete class as required for structural design.
350 – 750	Mildly to fairly aggressive	Good concrete design and construction essential
750 - 1000	Highly aggressive	Identify dominant corrosion sub-index Follow recommendations
Over 1000	Very highly corrosive	Do not use in contact with unprotected concrete

**Table 8: Final Aggressiveness Index (Nc) test results**

Test Pit	Aggressiveness Index (Nc)
TP 15	859
TP 17	808
TP 20	1038

The chemical test results are summarized in Table 9.

**Table 9: Summary of chemical test results**

Test Pit	Depth (m)	Description	EC Conductivity mS/cm	pH	Langelier Index	Ryznar Index	Corrosivity	Basson Index
TP 15	0.0 – 0.8 m	Dark orangey brown clayey SAND	7.5	6.4	-4.3	15	Corrosive	Aggressive
TP 17	0.0 – 0.6 m	Orangey brown clayey SAND	9.4	6.4	-3..96	14.3	Corrosive	Aggressive
TP 20	0.1 – 1.2 m	Orangey brown silty clayey Gravel	2.1	5.7	-5.35	16.4	Corrosive	Aggressive

From the chemical test results tabulated above, it is evident that almost all the materials tested can be potentially corrosive to buried metallic elements. The final aggressiveness indices indicate that the soil is highly to very highly corrosive towards concrete. The concrete in contact with the soil should be protected.

## **12. Platform Design**

All fill or cut embankments should be battered at 1 vertical: 2 horizontal at this site.

Placement of fill layers should be undertaken in layers not exceeding 150mm thick when placed loose and compacted using suitable compaction plant to achieve 95% Modified A.A.S.H.T.O maximum dry density.

Where the natural ground slopes at angles steeper than 1: 6 (9 degrees), the fill material will require to be benched into the slope to promote stability of the compacted fill. Benches should be 0.5m deep and 3.0m wide.

Earthworks at this site should be undertaken in accordance with SANS 1200 DA series.

In general, the Residual Tillite in TP1, TP2, TP3, TP8, TP9, TP11, TP12, TP13, and TP19 vary in thickness from 0.3m to 2.5m. The excavation class is soft within the residual Tillite layer. The Alluvium was encountered in all twenty three (23) test pits. The thickness varies from 0.4m to 4m. The excavation is classed as soft in these test pits.

The excavation of the underlying Tillite bedrock to a depth of 1,0m is classified as intermediate. The excavation beyond this depth is classified as Hard rock excavation where blasting may be required to remove the rock at greater depths beyond the 1m depth from rock head surface.

Top soil stripping of 150mm shall be undertaken over the whole area to be worked. Top soil, together with any grass or other suitable vegetation shall be conserved. It shall either be used immediately or stockpiled for later use.

The fill platforms shall be constructed of G6 or better quality material (in terms of TRH14 materials classification system) in layers of 150mm thickness and compacted at OMC (optimum moisture content) to a density of 95% of modified AASHTO maximum dry density.

Sections of the fill platform below 1.50m below platform level may be constructed of G6 quality material compacted to 93% of modified AASHTO maximum dry density

Once the earthworks operations are complete and unless otherwise specified, the stockpiled top soil shall be laid at depths not less than 75mm thickness to finish the slopes.

Preliminary structural design of the platforms is given in Drawing No. BD-393-GE-003-R-00 in Appendix A.

## **12.1 Construction Cost Evaluation**

The estimate is intended to provide a comparative assessment and is not an inclusive cost estimate.

**Table 10 – Estimated rates for construction in the Rockdale area**

<b>Description</b>	<b>Unit</b>	<b>Rate</b>
Cut and borrow to fill, including free-haul up to 1.0km (a) Gravel in compacted layer thickness of 200mm and less (b) Compacted to 95% Modified AASHTO maximum dry density	m <sup>3</sup>	R 150.00
Extra over item above for excavating and breaking down material in : (a) Intermediate excavation (b) Hard excavation	m <sup>3</sup> m <sup>3</sup>	R90.00 R450.00
Cut to spoil, including free-haul up to 0.5 km. Material obtained from: (a) Soft excavation (b) Intermediate excavation (c) Hard excavation	m <sup>3</sup> m <sup>3</sup> m <sup>3</sup>	R85.00 R150.00 R450.00
Platform preparation and the compaction of material: (a) Compacted to 95% Modified AASHTO maximum dry density	m <sup>3</sup>	R 55.00
Single stage crushing	m <sup>3</sup>	R 95.00

The removal of poor quality material and replacement with engineered fill has been taken into account when determining the material quantities.

The preliminary construction cost estimate in Appendix E includes the following:

- 1) Cut to borrow of usable material
- 2) E.O. intermediate excavation
- 3) Hard excavation to spoil for hard rock
- 4) Additional cut to fill for material shortfall

### **13. AVAILABILITY OF CONSTRUCTION MATERIALS**

From the compaction characteristics tests, the in-situ material is not suitable for use in the construction of the platforms. It is also necessary to import material for the soil improvement measures required in the construction of the soil raft beneath the transformer base.

A commercial source of G6 material is available from Quadro Sand Witbank, and the contact details are as follows:

Contact person: Heidi: tel.: (013) 697 0541, e-mail: quadrosand@vodamail.co.za

### **14. GEOTECHNICAL CONSIDERATIONS**

The following aspects have a major influence for the proposed development:

For electrical transformers to be installed on the site, the settlement is the governing criteria. The allowable bearing pressures for heavy transformers may be in the order of 130 kPa or more. The pre-consolidation pressure was calculated to range from 63 – 91 kPa. The over-consolidation ratio is 1.2 which falls between 0.8 -1.5 for a normally consolidated alluvial clay. The anticipated settlement is of the order of 85 mm. The importance of the pre-consolidation pressure can be illustrated by the following facts:

- o Where the applied foundation stress does not exceed the difference between the pre-consolidation pressure and the in-situ effective pressure, the observed settlements of the structure will generally be less than 10mm.
- o Where the applied foundation stress exceeds the difference between the pre-consolidation pressure and the in-situ effective pressure, much larger settlements will be measured.

It should be noted that a clay which has recently (from a geological point of view) been deposited and come to equilibrium under its own weight but has not undergone significant secondary consolidation may be classified as a “young” normally consolidated clay. Such a clay is characterized by the fact that it is just capable of carrying the overburden weight of soil and any additional load – as for instance a recent fill – will also be classified with respect to its compressibility as a “young” clay deposit.

For lightly loaded single storey buildings an allowable bearing pressure of 50 kPa is anticipated. For double storey buildings, an allowable bearing pressure of 150 kPa is anticipated. In order to evaluate the long-term settlement of the underlying clay, consolidation and swell tests were undertaken on undisturbed clay sample.

- The elastic and long-term settlements evaluated above may be tolerated, but the upper transported layers are loose and additional settlement will occur. Soil improvement measures will therefore be required. In order to rationalize settlements due to the differential movement, soil improvement measures as detailed below are required for the transformer and buildings.
- Subsoil materials should be removed to a depth of 2.5 meter below existing ground level. The lower 2 m of the excavation should be replaced with an inert granular soil such as a G5/G6 and compacted in 150mm layers to 95 % Mod A.A.S.H.T.O maximum dry density. The transformer foundations should be constructed on the engineered layer at 0.5 m below existing ground level. These soil improvement measures should be undertaken prior to construction of any additional fill platforms. Based on the above soil improvement measures an allowable bearing pressure in the order of 150 – 200 kPa can be used for design purposes. Alternatively, single storey buildings can be constructed on a concrete raft foundation.
- The fill platforms will be constructed using material from a commercial source.
- Settlements for the initial and consolidation for the various foundation widths was calculated for the range of foundation pressures from 50 kPa to 250 kPa and is summarized in Figure 4 below.

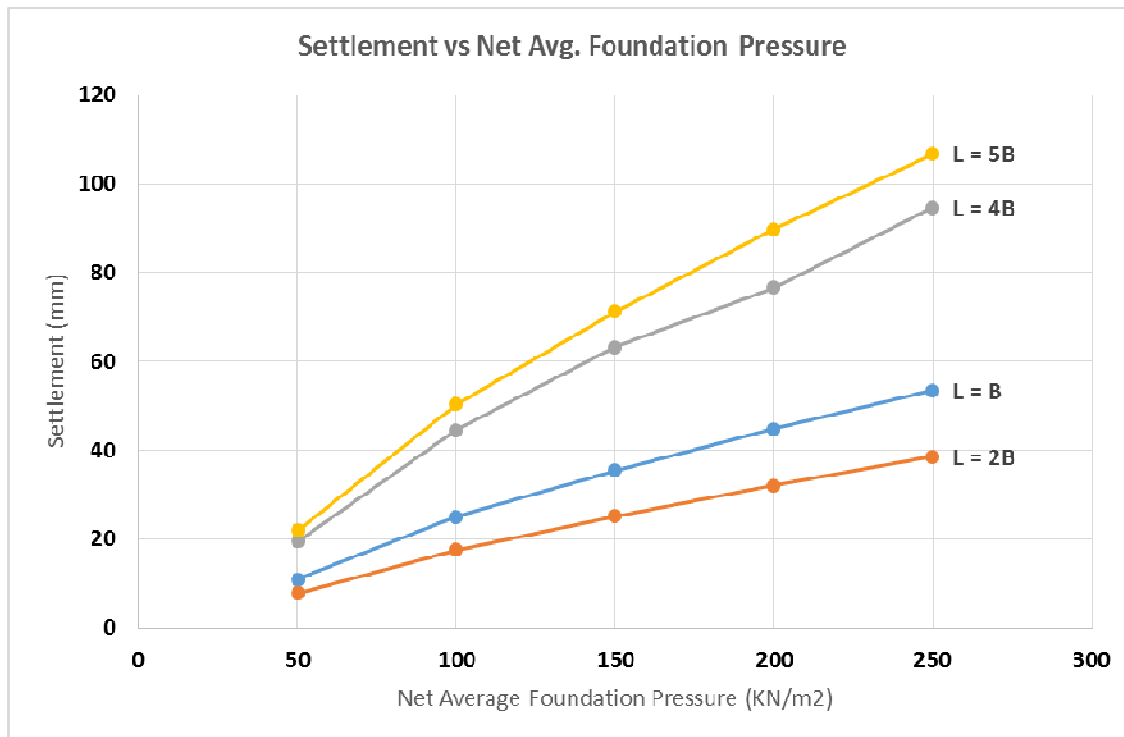


Figure 4: Settlement vs Net Average Foundation Pressure

## **15. RECOMMENDATIONS**

### **15.1 Transformer founding conditions**

In order to rationalize settlements due to the differential movement, soil improvement measures will be required. Below are the soil improvement measures required for the transformer and buildings (Single Storey Buildings).

The settlement evaluation for varying sizes of foundations was assessed and summarized in figure 4. The range of foundation pressures induced by the transformers is expected to be in the order of 100 – 150 kPa. The transformer plinth foundation dimensions is assumed to vary by  $L = 4B$  or  $L = 5B$ . Based on the settlement evaluation from Figure 4, the settlement at 150 kPa for  $L = 4B$  and  $L = 5B$  is in the order of 60 and 70mm respectively. For a Net Average Foundation Pressure of 200 kPa for  $L = 4B$  and  $L = 5B$ , the settlement of the foundations in the order of 90 – 110mm.

These total settlements are excessive in the long-term. The differential settlements may be expected to be half of the value for the total settlements and are more significant for the performance of the plinth foundations. A stiffer concrete plinth foundation may be required, in addition to the proposed soil improvement measures highlighted in the report.

### **Soil Improvement Measures**

Subsoil materials should be removed to a depth of 2.5 meter below existing ground level. The lower 2m of the excavation should be replaced with an inert granular soil such as a G5/G6 and compacted in 150mm layers to 95 % Mod A.A.S.H.T.O maximum dry density. The transformer foundations should be constructed on the engineered layer at 0.5 m below existing ground level. These soil improvement measures should be undertaken prior to construction of any additional fill platforms. Based on the above soil improvement measures an allowable bearing pressure in the order of 150 – 200 kPa can be used for design purposes.

## **15.2 Founding of offices and ancillary structure**

The offices and ancillary buildings can be constructed on conventional reinforced strip footings. Based on the results from Figure 4, where the foundation base dimensions are  $L = B$ , and net average foundation pressures are expected to be between 150 – 200 kPa, settlement values were found to be in the order of 35 – 45mm. Based on the results from Figure 4, should strip footings with dimensions  $L = 4B$  be used, then settlement values of 60 – 77mm can be expected.

Soil improvement measures (as per page 27) are thus required beneath all strip foundations in order to rationalize the settlement. The total settlement will be limited to 25mm and the differential settlement will be limited to 12.5mm, on application of the proposed soil improvement measures.

Alternatively, single storey buildings can be constructed on a concrete raft foundation.

## **15.3 Road Layerworks**

As stated previously, the intended layerworks for the tar access road (818m) is as follows:

TP R1 (0.1 – 1.2m) and TP R4 (0.1 – 1.3) are located along the proposed access roads. The pavement layer-works for the Tar access Road (818m) are shown in a typical cross section (Appendix F). The intended layer works consists of the following:

- Surfacing – 19 mm single seal with double slurry seal.
- 150 mm Base- graded stone compacted to 88% Apparent density (maxi size 37.5 mm; Fines  $PI < 6$ ).
- 150 mm Subbase – imported GRAVEL stabilized with 3% cement and compacted to 95% Mod AASHTO at OMC (Min GM = 1.5, Min U.C.S 750 kN/m<sup>2</sup> Max size 63mm).
- 150 mm selected subgrade – imported gravel compacted to 93% Mod AASHTO MDD at OMC (CBR  $\geq 15$ ; Min GM = 0.5; MAX PI = 3GM + 10).
- 150 mm Roadbed Preparation – Rip and re-compact in-situ to 90 % Mod AASHTO at OMC (CBR  $\geq 7$ ).

Based on test results from TP R1 and TP R4, the subgrade material classifies as a G6 & G8 according to TRH4 Guidelines. It is anticipated that a G6/G7 selected layer will need to be imported for the road layer-works. The upper pavement layer-works should be imported from a commercial source.

## **16. CONCLUSION**

The report presents the findings of the geotechnical investigation undertaken for the construction of the proposed Emkhiweni Sub-Station (near Middelburg), Mpumalanga. Various field tests were undertaken in order to provide a suitable founding option for the new transformer.

Based on the findings from the twenty three test pits, the subsoil consists of the following typical soil profile:

- *0.00– 0.4 m*: slightly moist, dark orangey brown, loose, gravelly SAND containing nodules of “pea- size” ferricrete. Roots noted in upper 0.2m. Agricultural layer/Topsoil.
- *0.4 – 0.9 m*: abundant (>50%), sub-rounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey GRAVEL. Overall consistency is medium dense. NODULAR FERRICRETE.  
Notes: 1. Nodules are oxidized and black stained. 2. Occasional mixed sub-angular boulder gravel (600 – 700 mm) noted in profile. Alluvium.
- *0.9 – 2.5 m*: slightly moist, orangey brown, stiff, intact, silty, CLAY, with closely packed, well rounded cobbles (up to 60 mm in diameter) occurring in minor traces and traces of boulders (up to 500mm in diameter) in profile. Alluvium.
- *2.5 – 3.0 m*: moist, orangey brown mottled yellow, firm, silty gravelly CLAY. Alluvium.
- *3.0 – 3.6 m*: slightly moist, light yellow blotched olive grey, firm, gravelly silty CLAY, with occasional cobbles in profile. Residual Dwyka Tillite.
- *3.6 – 4.6 m*: highly weathered, soft becoming medium hard, light yellowish brown, fine grained, medium bedded, widely jointed, Dwyka Tillite. Karoo Super-group.

Field work undertaken for the above site was aimed at assessing and determining the optimal foundation design options for the construction of the Emkhiweni Sub-Station. Detailed below are the Soil improvement measures that are required for the transformer and buildings:

Subsoil materials should be removed to a depth of 2.5 meter below existing ground level. The lower 2 m of the excavation should be replaced with an inert granular soil such as a G5/G6 and compacted in 150mm layers to 95 % Mod A.A.S.H.T.O maximum dry density. The transformer foundations should be constructed on the engineered layer at 0.5 m below existing ground level. These soil improvement measures should be undertaken prior to construction of any additional fill platforms. Based on the above soil improvement measures an allowable bearing pressure in the order of 150 – 200 kPa can be used for design purposes. Alternatively, single storey buildings can be constructed on a concrete raft foundation.

Based on test results from TP R1 and TPR4, the subgrade material classifies as a G6 & G8 according to TRH4 Guidelines. It is anticipated that a G7 selected layer will need to be imported for the road layer-works. The upper pavement layer-works should be imported from a commercial source.

G6 material should be used to construct the terraces required

In general, the Residual Tillite in TP1, TP2, TP3, TP8, TP9, TP11, TP12, TP13, and TP19 vary in thickness from 0.3 m to 2.5m. The excavation class is soft within the residual Tillite layer. The Alluvium was encountered in all the test pits. The thickness varies from 0.4m to 4m. The excavation is classed as soft in these test pits.

The excavation of the underlying Tillite bedrock to a depth of 1,0m is classified as intermediate. The excavation beyond this depth is classified as Hard rock excavation where blasting may be required to remove the rock at greater depths beyond the 1m depth from rock head surface.

## 17. **REPORT PROVISIONS**

While every effort has been made during the field-work phase of this investigation to identify the various soil and rock horizons, their problems and distribution, it is impossible to guarantee that isolated zones of varying material have not been missed. The investigation was, however, thorough and conditions are not expected to vary a great deal from those described in this report.

The engineers are, nevertheless, strongly urged to inspect all excavations to assure themselves that conditions are not at variance with those described in this report. Disparities in sub-soil conditions should be referred to an expert.

### Warning:

Test pits were backfilled after the field investigation but were not re-compacted.

Test pits positions occur within the footprints of proposed structure as they were located with a hand held GPS accurate to 3m.

**18. REFERENCES:**

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## ***APPENDIX A: GEOTECHNICAL TEST POSITIONS***

***DRAWING NO. BD-370-GE-001-R-00***





## **APPENDIX B: *TEST PIT (TP) LOGS***



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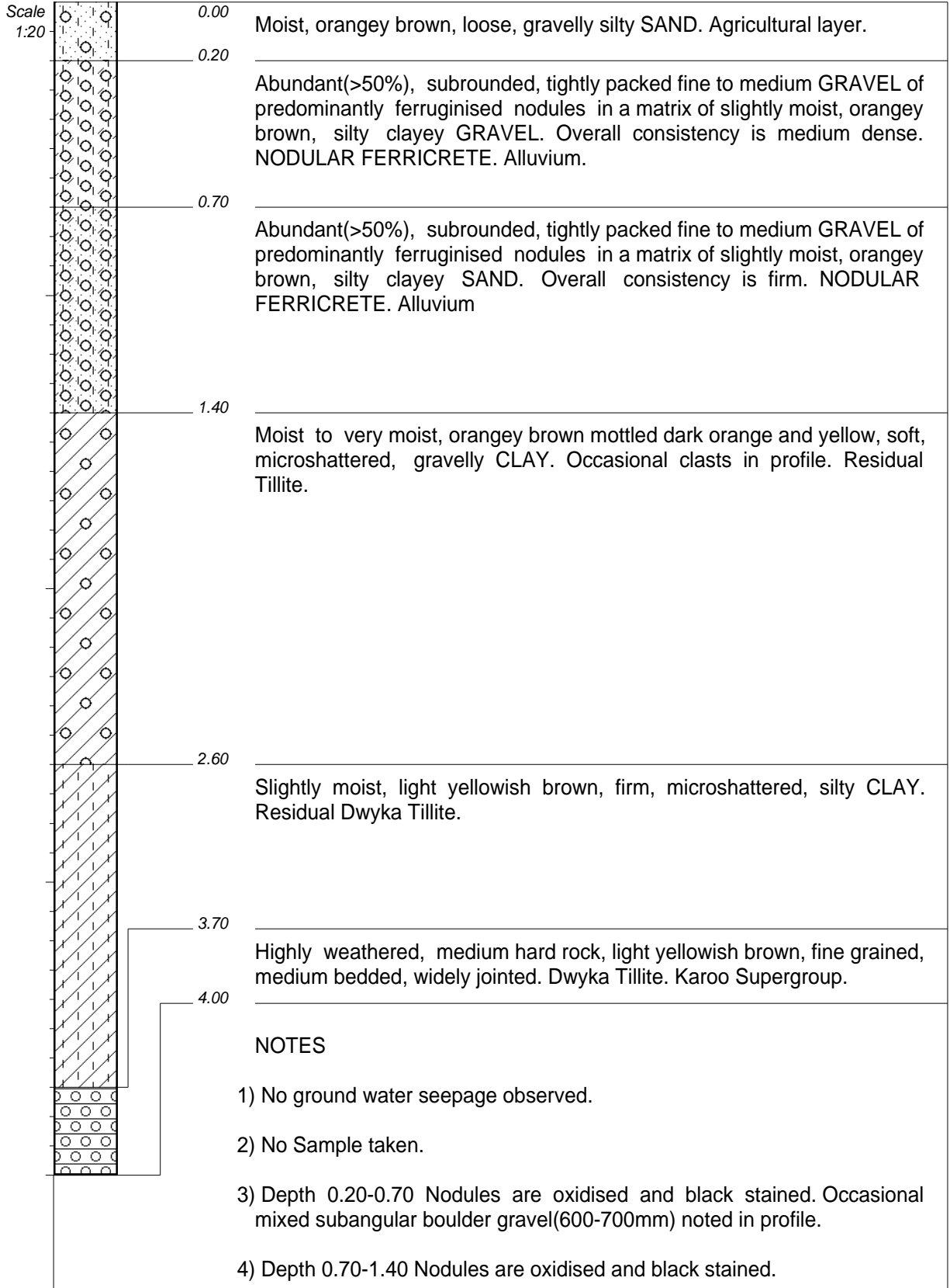
NATIONAL HOME BUILDERS  
NHBRC  
REGISTRATION COUNCIL

ESKOM HOLDINGS LIMITED  
ROCKDALE B SUBSTATION

P.O Box 37612, Overport 4067  
Tel: (031) 209 3900  
Fax: (031) 309 8742  
Email: bazi@bazidukhan.co.za

HOLE No: TP 01  
Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
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DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
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HOLE No: TP 01



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150 9001

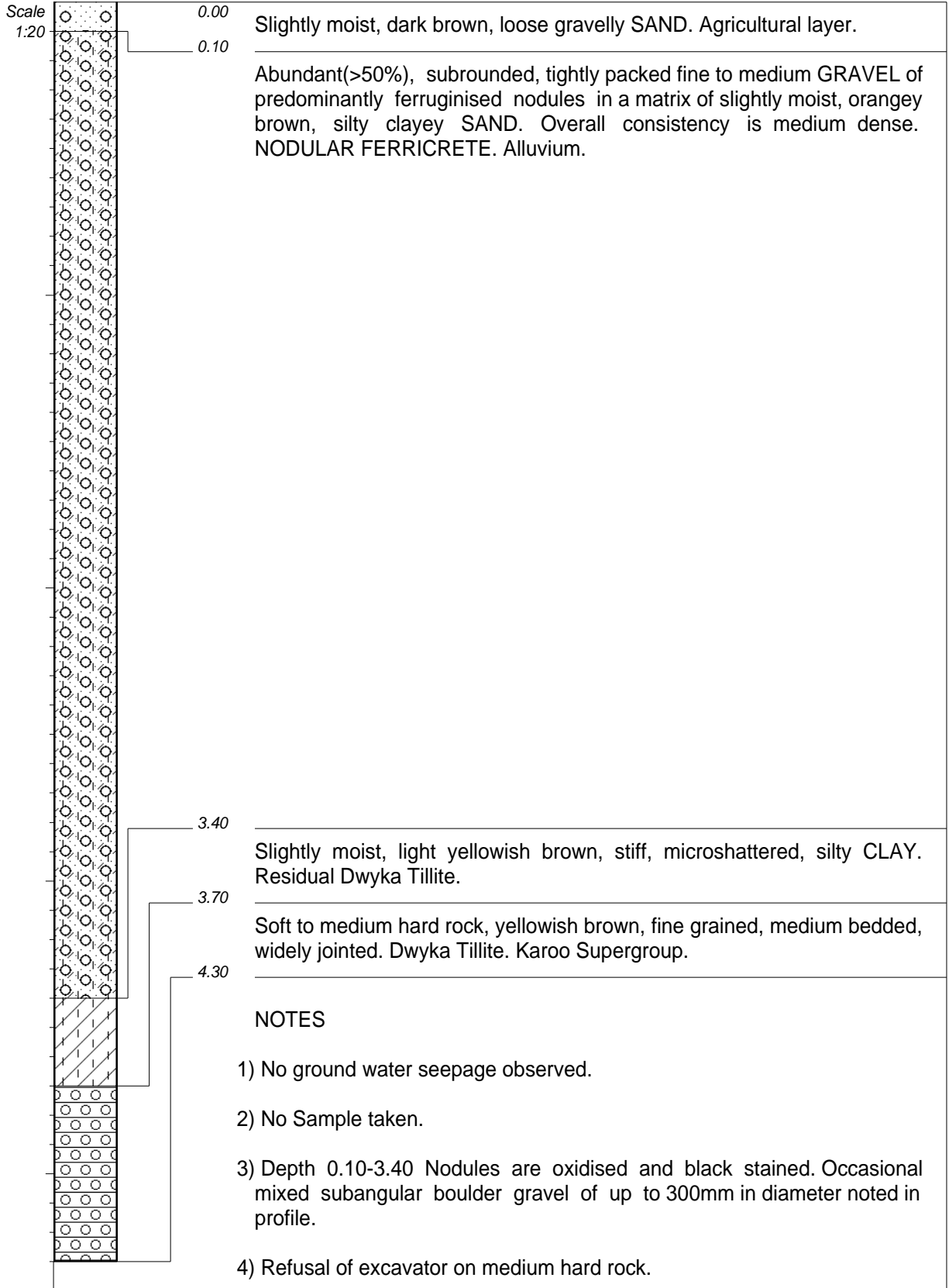
NATIONAL HOME-BUILDERS  
REGISTRATION COUNCIL  
NHBRC

ESKOM HOLDINGS LIMITED  
ROCKDALE B SUBSTATION

P.O Box 37612, Overport 4067  
Tel: (031) 209 3900  
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Email: bazi@bazidukhan.co.za

HOLE No: TP 02  
Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
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HOLE No: TP 02



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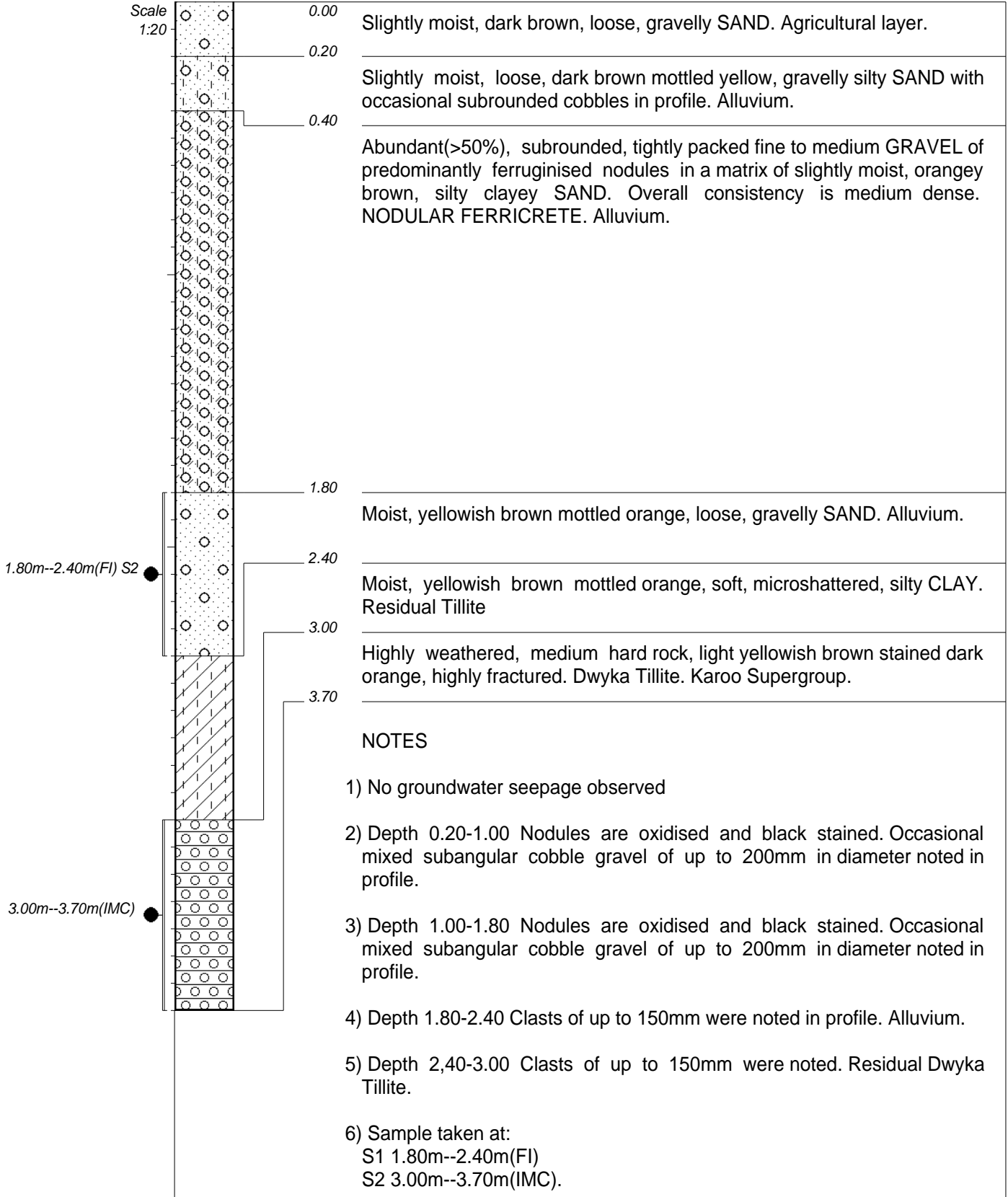
NATIONAL WATER USER  
REGISTRATION COUNCIL  
NHBRC

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HOLE No: TP 03  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No groundwater seepage observed
- 2) Depth 0.20-1.00 Nodules are oxidised and black stained. Occasional mixed subangular cobble gravel of up to 200mm in diameter noted in profile.
- 3) Depth 1.00-1.80 Nodules are oxidised and black stained. Occasional mixed subangular cobble gravel of up to 200mm in diameter noted in profile.
- 4) Depth 1.80-2.40 Clasts of up to 150mm were noted in profile. Alluvium.
- 5) Depth 2,40-3.00 Clasts of up to 150mm were noted. Residual Dwyka Tillite.
- 6) Sample taken at:  
S1 1.80m--2.40m(FI)  
S2 3.00m--3.70m(IMC).

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 862 895. 52  
Y-COORD : -40 283. 38

HOLE No: TP 03



SABS  
150 9001

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ESKOM HOLDINGS LIMITED  
ROCKDALE B SUBSTATION

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Email: bazi@bazidukhan.co.za

HOLE No: TP 04  
Sheet 1 of 1

JOB NUMBER: BD 370

Scale  
1:20

0.00  
0.10

Moist, dark orangey brown, loose, silty SAND. With abundant roots in profile. Agricultural layer.

Abundant(>50%), subrounded, tightly packed fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey SAND. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

1.50

AGGLOMERATE/TILLITE(SA10)

Moist, light orangey brown, soft, microshattered, sandy SILT. Alluvium.

4.10

1.50m--4.10m(FI) S2

Moist, light orangey brown, very loose, slightly clayey silty SAND. Alluvium.

4.30

NOTES

- 1) No ground water seepage observed.
- 2) No refusal of excavator.
- 3) Depth 0.10-1.50 Nodules are oxidised and black stained.
- 4) Depth 1.50-4.10 Occasional cobbles noted in profile.
- 5) Sample taken at:  
S1 1.50m--4.10m(FI)  
S2 4.10--4.30m(FI)
- 6) Undisturbed sample for oedometer taken at 1.50m--4.10m.

4.10--4.30m(FI)

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12

ELEVATION :  
X-COORD : 2 862 973. 79  
Y-COORD : -40 333. 33

HOLE No: TP 04

DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT



SABS  
150 9001

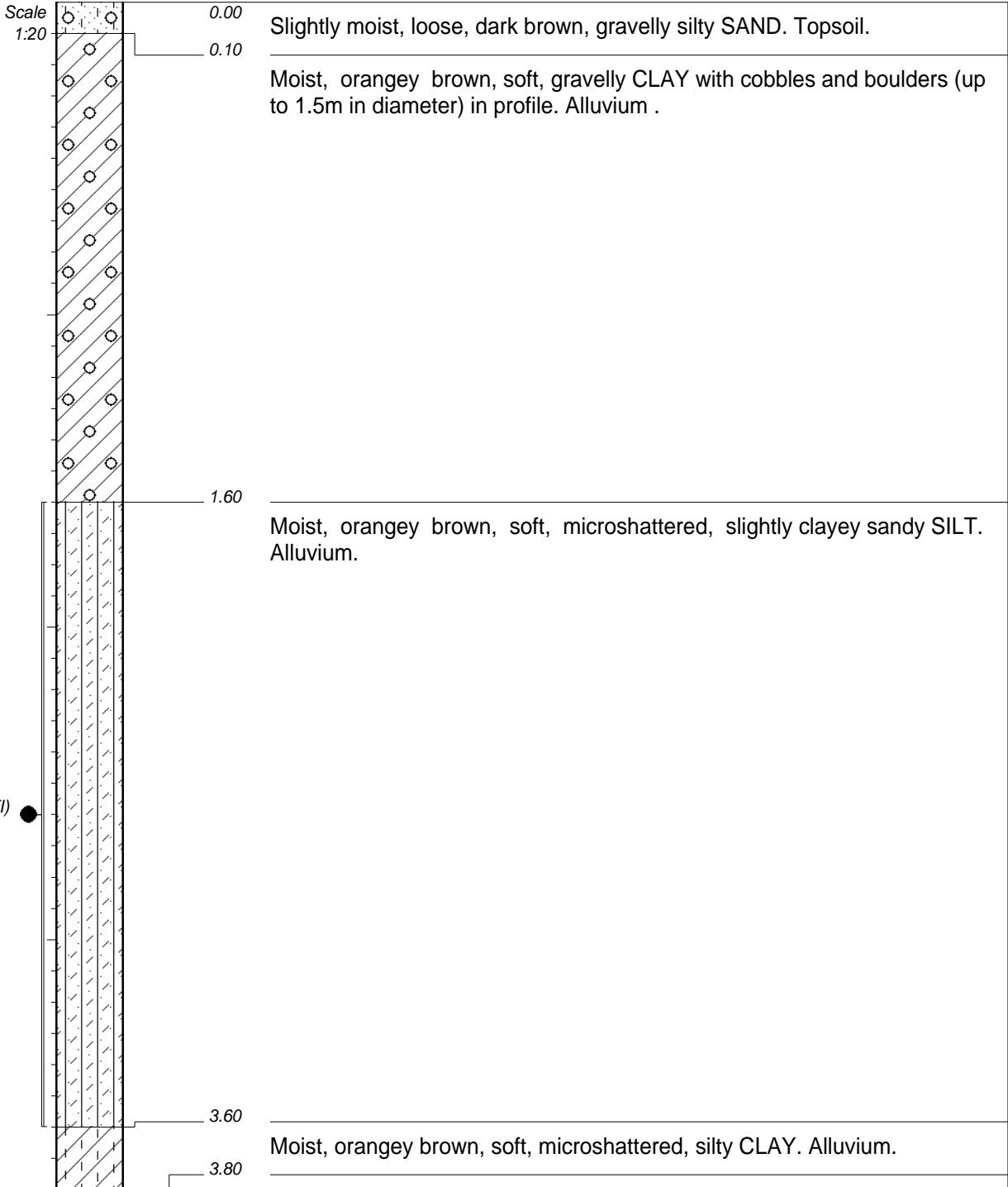
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HOLE No: TP 05  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Sample taken at:  
S1 1.60m--3.60m(FI).

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 069. 43  
Y-COORD : -40 394. 37

HOLE No: TP 05



SABS  
150 9001

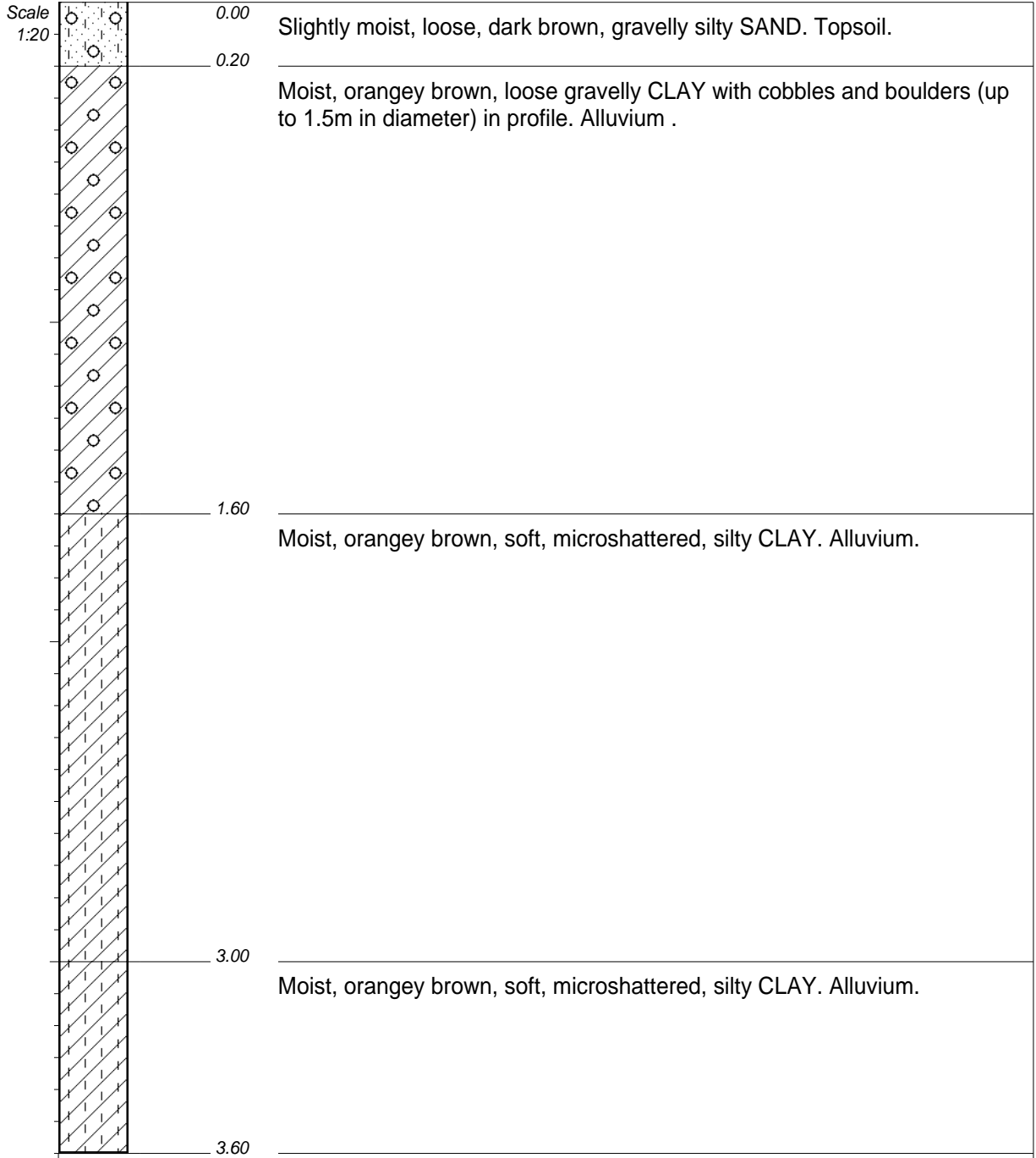
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REGISTRATION COUNCIL  
NMBRC

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HOLE No: TP 06  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) No Sample taken.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 127. 48  
Y-COORD : -40 303. 41

HOLE No: TP 06



SABS  
150 9001

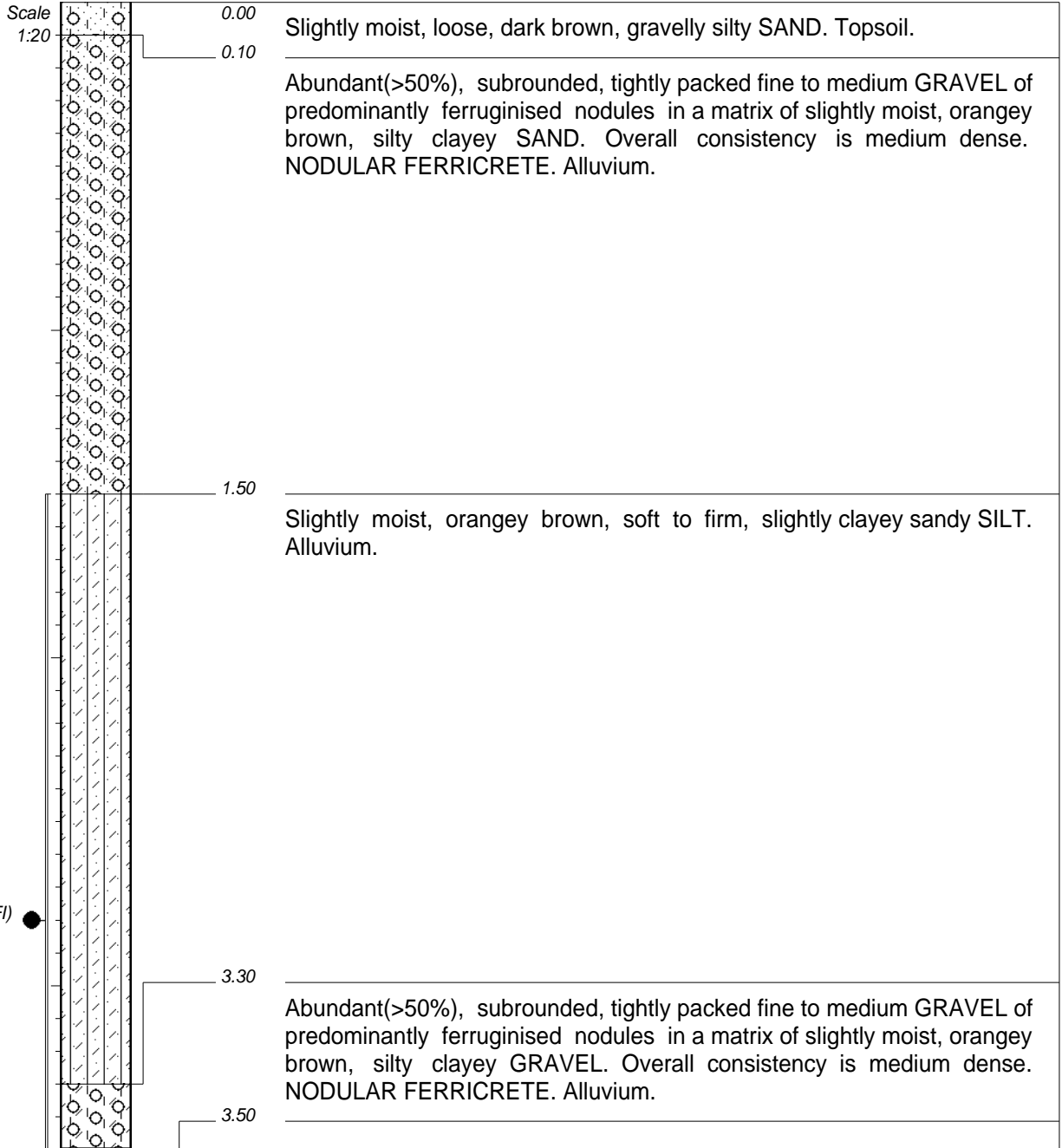
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HOLE No: TP 07  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Sample taken at:  
S1 1.50m--4.10m(FI).
- 3) Depth 0.10-1.50 Nodules are oxidised and black stained.
- 4) Depth 3.30-3.50 Nodules are oxidised and black stained.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 031. 84  
Y-COORD : -40 242. 37

HOLE No: TP 07



SABS  
1 5 0 9 0 0 1

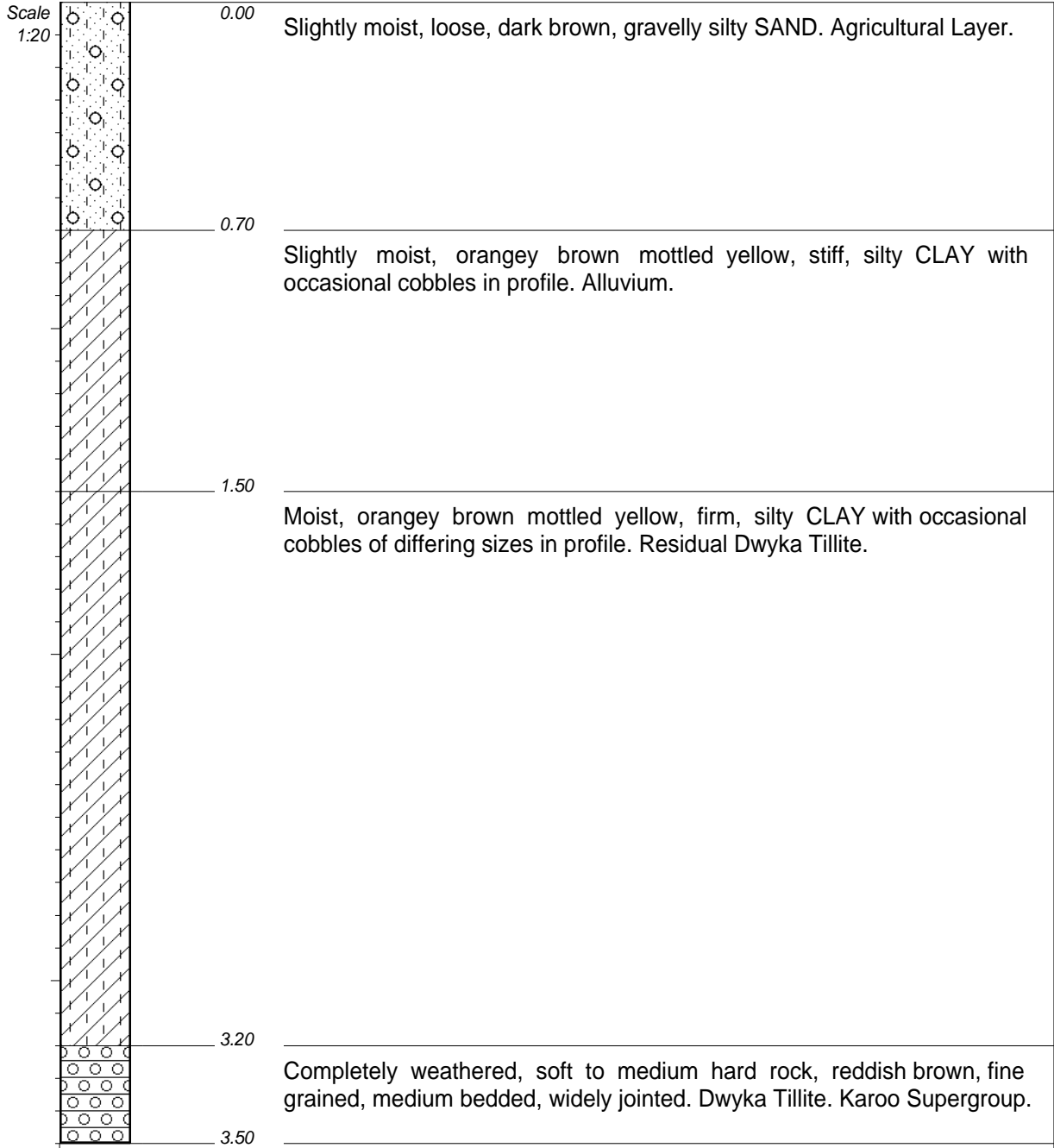
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HOLE No: TP 08  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) No Samples taken.

CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
 X-COORD : 2 862 953. 57  
 Y-COORD : -40 192. 42

HOLE No: TP 08



SABS  
1 5 0 9 0 0 1

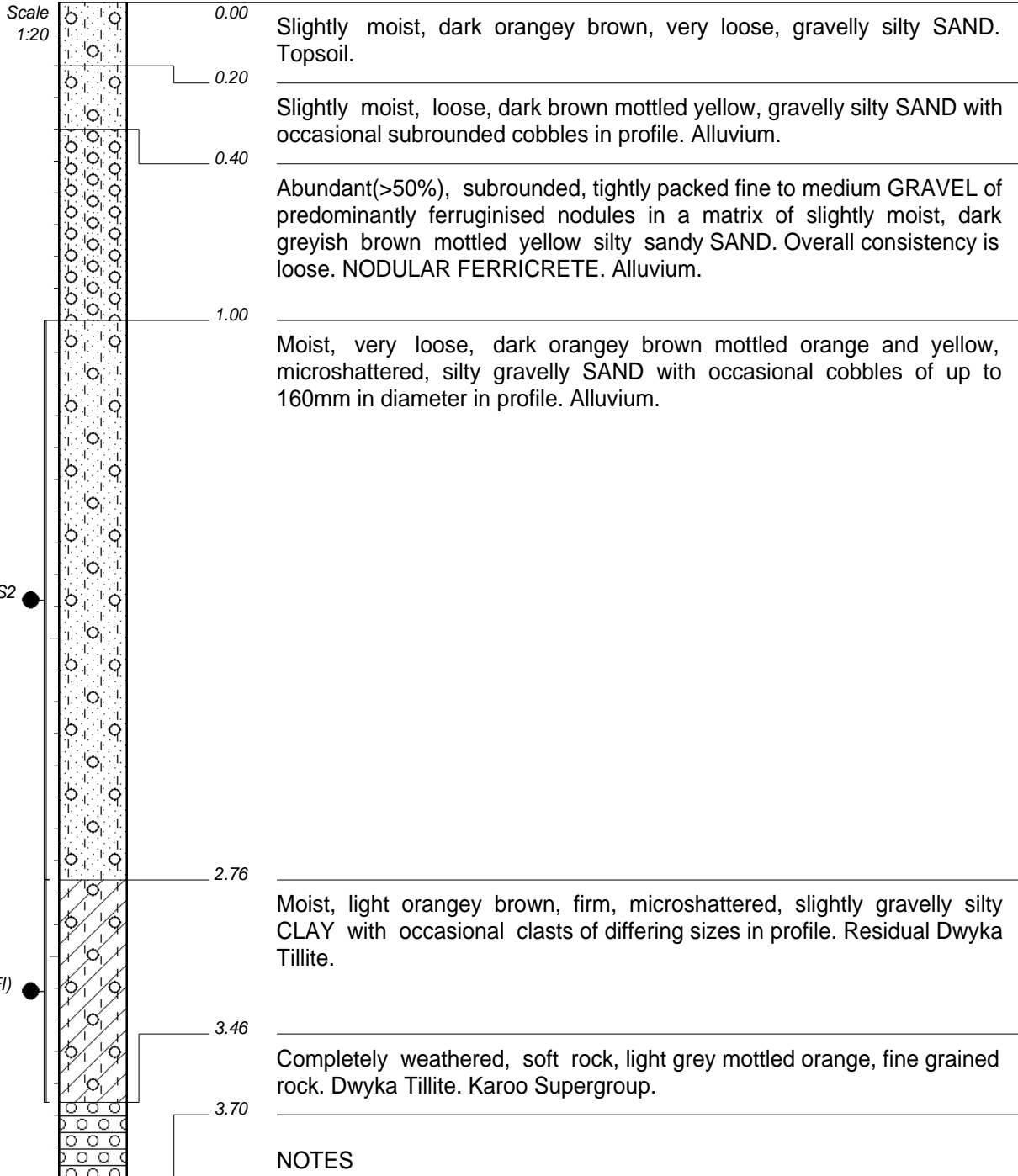
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HOLE No: TP 09  
Sheet 1 of 1

JOB NUMBER: BD 370



1.00m--2.76m(FI) S2

2.76--3.46m(FI)

NOTES

- 1) No ground water seepage observed.
- 2) Sample taken at:  
S1 1.00m--2.76m(FI)  
S2 2.76--3.46m(FI).
- 3) Depth 0.40-1.00 Nodules are oxidised and black stained.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12

ELEVATION :  
X-COORD : 2 862 875. 30  
Y-COORD : -40 142. 47

HOLE No: TP 09

DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT



SABS  
150 9001

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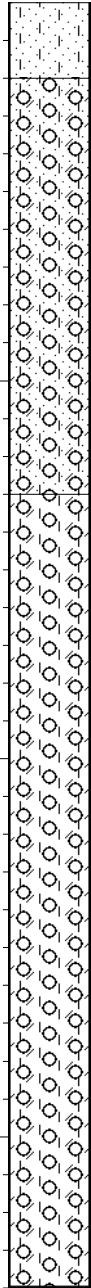
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HOLE No: TP 10  
Sheet 1 of 1

JOB NUMBER: BD 370

Scale  
1:20



0.00

Slightly moist, dark orangey brown, loose, silty SAND with abundant roots in profile. Agricultural layer.

0.20

Abundant(>50%), subrounded, tightly packed fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown silty clayey SAND. Overall consistency is medium dense NODULAR FERRICRETE. Alluvium.

1.30

Abundant(>50%), subrounded, tightly packed fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown silty clayey GRAVEL. Overall consistency is medium dense. Alluvium.

3.40

NOTES

- 1) No ground water seepage observed.
- 2) No Samples taken.
- 3) Depth 0.20-1.30 Nodules are oxidised and black stained.
- 4) Depth 1.30-3.40 Nodules are oxidised and black stained. Occasional mixed subangular boulder gravel (300-800mm) noted in profile.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12

ELEVATION :  
X-COORD : 2 862 797. 04  
Y-COORD : -40 092. 52

TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

HOLE No: TP 10



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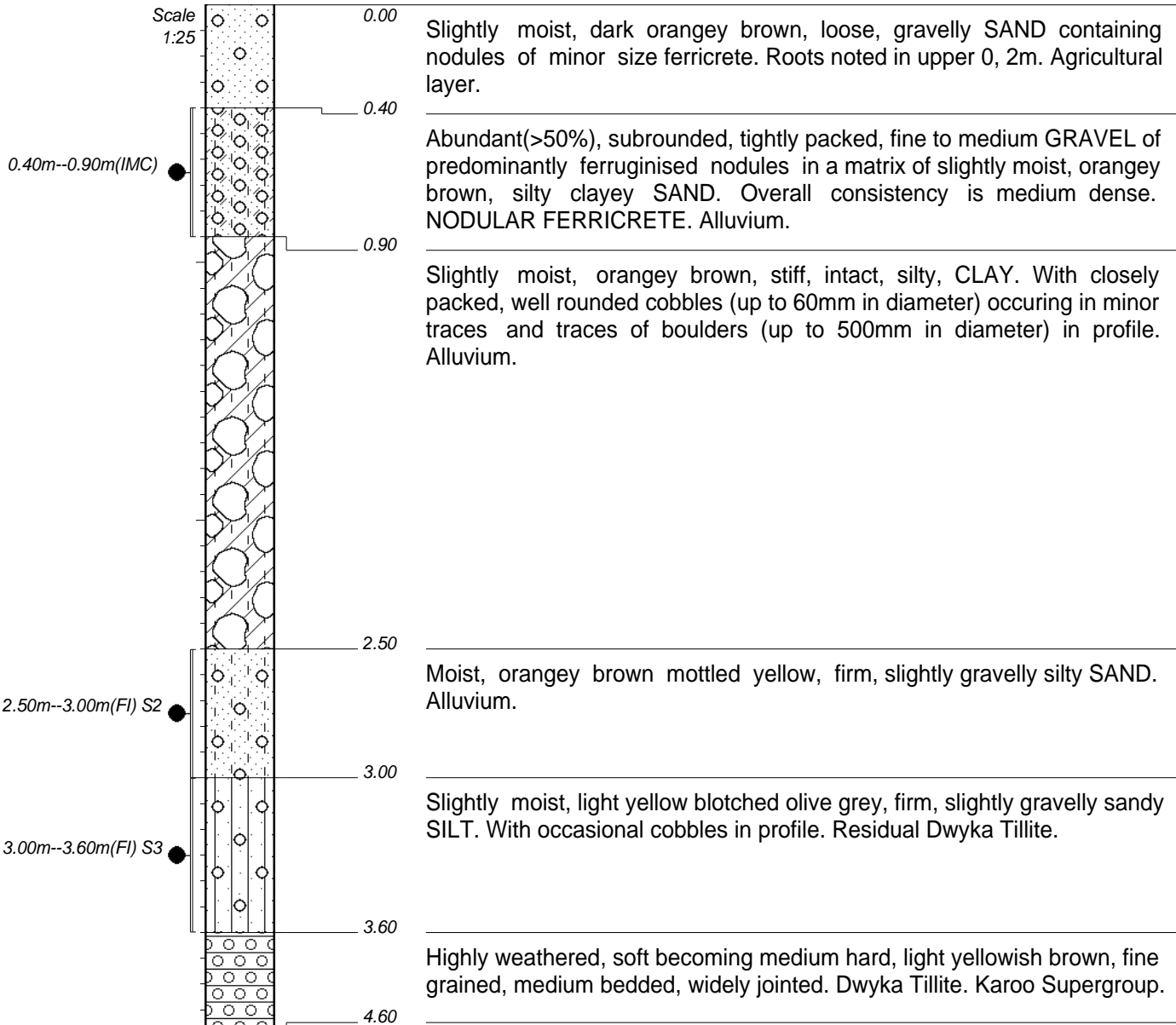
SABS  
150 9001



ESKOM HOLDINGS LIMITED  
 ROCKDALE B SUBSTATION

HOLE No: TP 11  
 Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Depth 0.40-0.90 Nodules are oxidised and black stained. Occasional mixed subangular boulder gravel (600-700mm) noted in profile.
- 3) Sample taken at:  
 S1 2.50m--3.00m(FI)  
 S2 3.00m--3.60m(FI)  
 S3 0.40m--0.90m(IMC).
- 4) Undisturbed sample for oedometer taken at 2.50m--3.00m.

CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
 X-COORD : 2 862 850. 84  
 Y-COORD : -40 008. 23

HOLE No: TP 11



SABS  
150 9001

NATIONAL HOME BUILDERS  
NHBC  
REGISTRATION COUNCIL

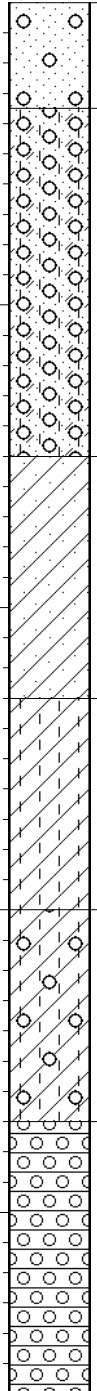
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HOLE No: TP 12  
Sheet 1 of 1

JOB NUMBER: BD 370

Scale  
1:25



0.00

Slightly moist, dark orangey brown, loose, gravelly SAND containing nodules of minor size ferricrete. Roots noted in upper 0, 2m. Agricultural layer.

0.35

Abundant (>50%), subrounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey SAND. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

1.50

Moist, dark orangey brown, stiff, microshattered, sandy CLAY. With occasional cobbles (up to 60mm in diameter) and boulders (up to 150mm in diameter) in profile. Alluvium.

2.30

Moist, dark orangey brown blotched yellow and light orange, stiff, microshattered, silty CLAY. With occasional cobbles (up to 60mm in diameter) and boulders (up to 150mm in diameter) in profile. Alluvium.

3.00

Slightly moist, light yellow blotched olive grey, firm, gravelly silty CLAY. With occasional cobbles in profile. Residual Dwyka Tillite.

3.70

Highly weathered, soft becoming medium hard, light yellowish brown, fine grained, medium bedded, widely jointed. Dwyka Tillite. Karoo Supergroup.

4.60

NOTES

- 1) No ground water seepage observed.
- 2) Depth 0.35-1.50 Nodules are oxidised and black stained. Occasional mixed subangular boulder gravel (600-700mm) noted in profile.
- 3) No sample taken.
- 4) Excavator refused at 4.60m on medium hard rock.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12

ELEVATION :  
X-COORD : 2 862 929. 10  
Y-COORD : -40 058. 18

TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

HOLE No: TP 12



SABS  
150 9001

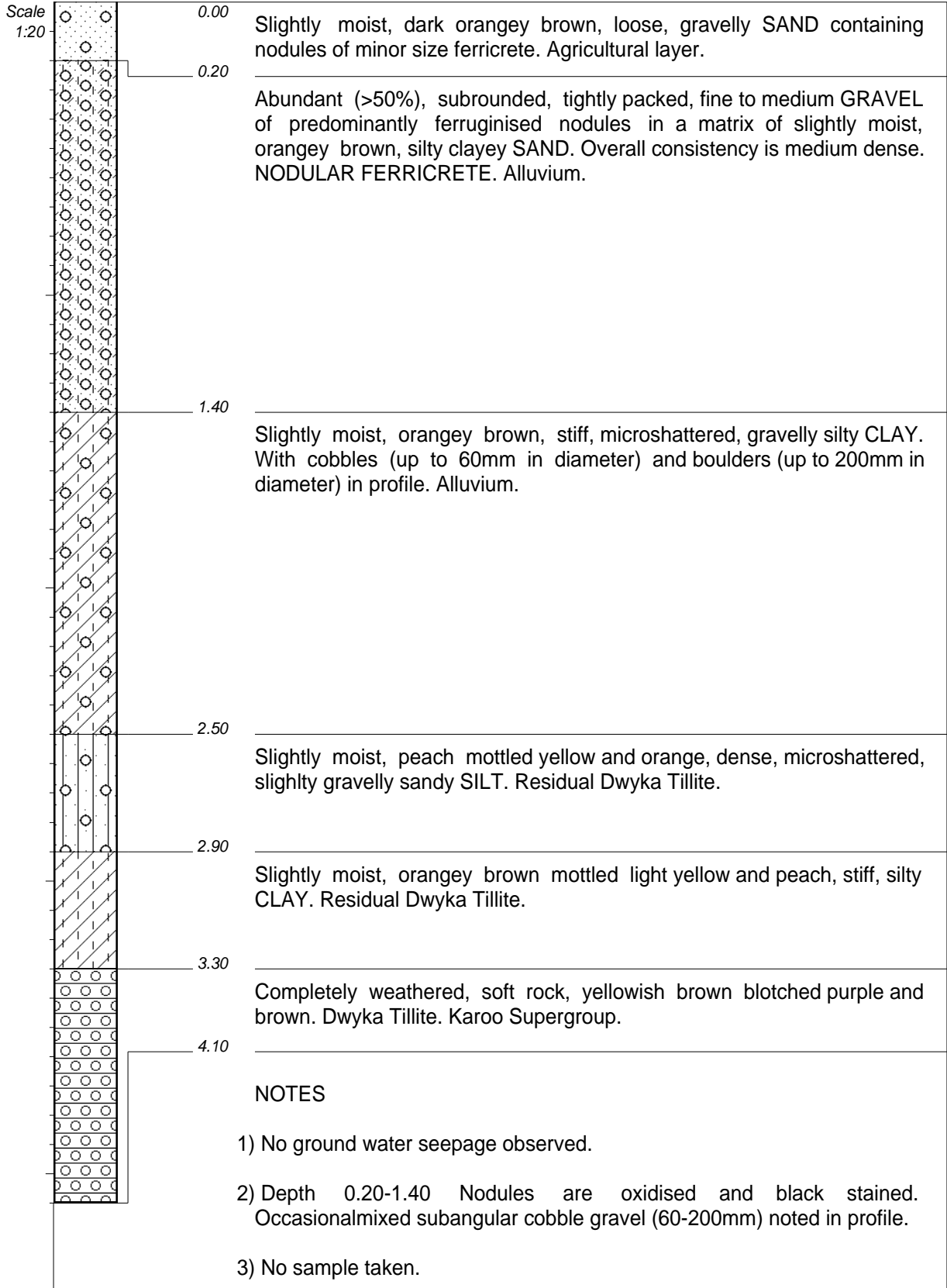
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REGISTRATION COUNCIL

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HOLE No: TP 13  
Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 007. 37  
Y-COORD : -40 108. 13

HOLE No: TP 13



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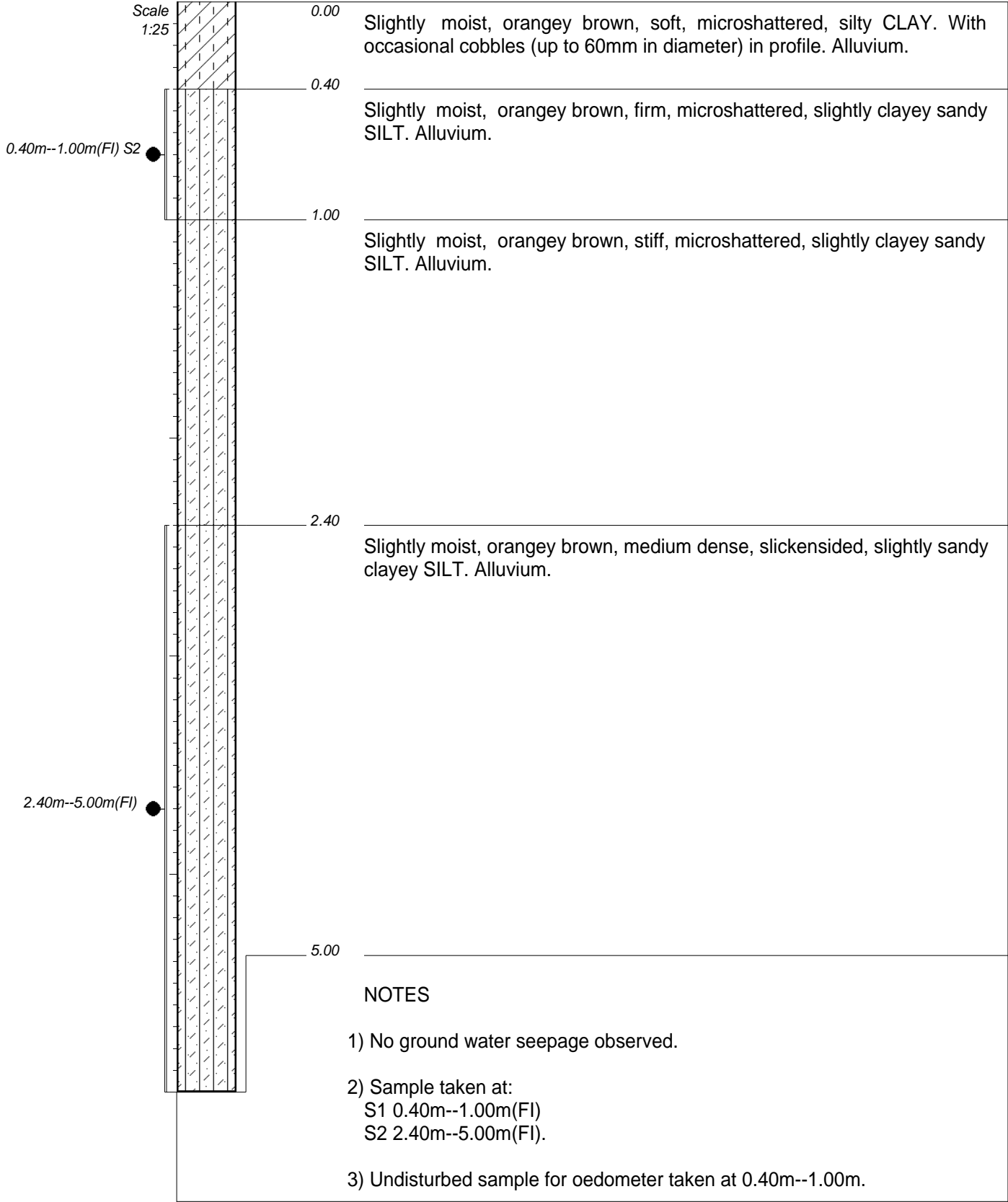
SABS  
150 9001



ESKOM HOLDINGS LIMITED  
 ROCKDALE B SUBSTATION

HOLE No: TP 14  
 Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Sample taken at:  
 S1 0.40m--1.00m(FI)  
 S2 2.40m--5.00m(FI).
- 3) Undisturbed sample for oedometer taken at 0.40m--1.00m.

CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
 X-COORD : 2 863 085. 63  
 Y-COORD : -40 158. 08

HOLE No: TP 14



SABS  
150 9001

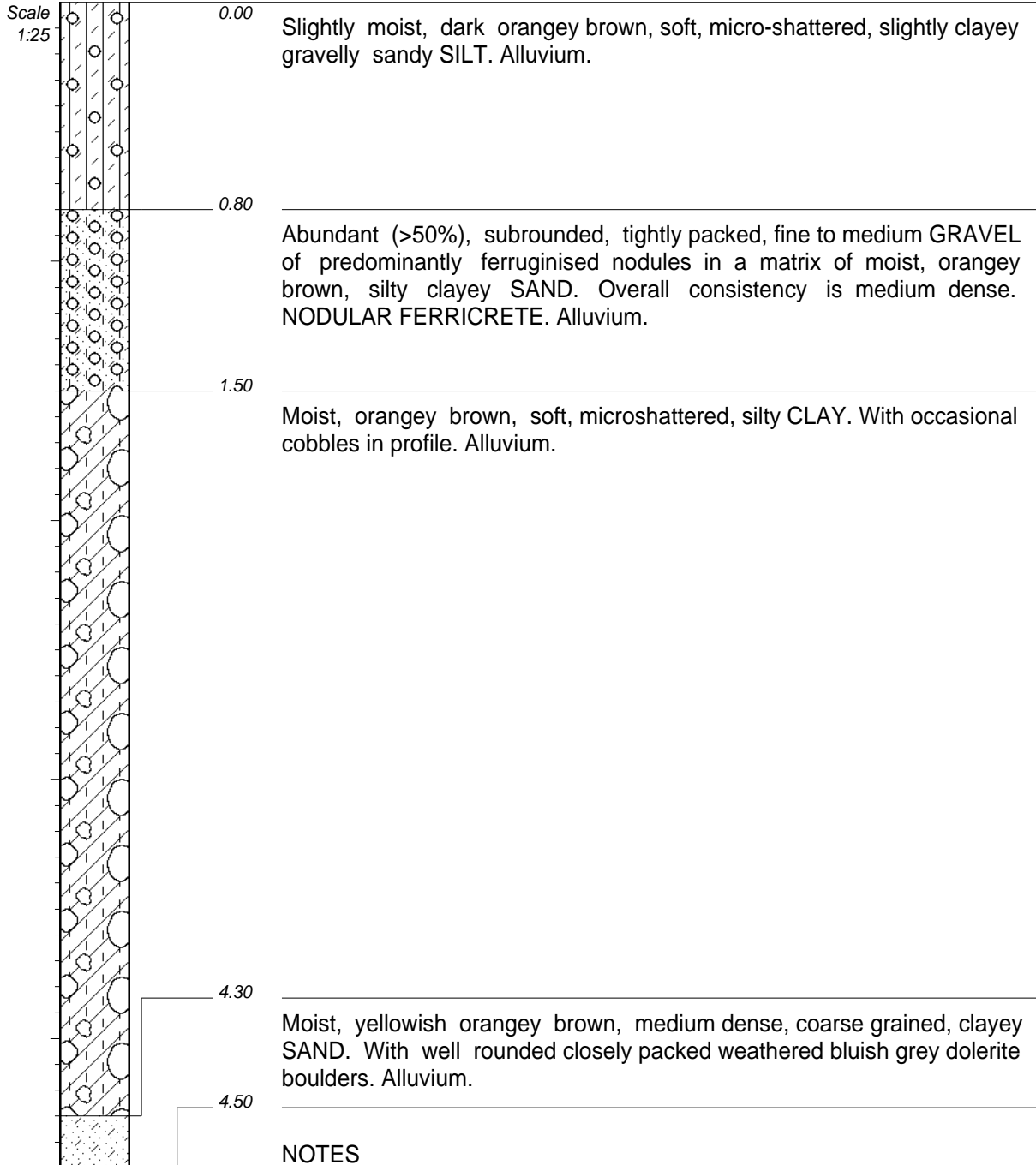
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HOLE No: TP 15  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Depth 0.80-1.50 Nodules are oxidised and black stained.
- 3) Two samples taken at:  
S1 0.00m--0.80m(IMC)
- 4) Sample for chemical (BRE, Conductivity) analysis taken at 0.00m--0.80m.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 181. 27  
Y-COORD : -40 219. 11

HOLE No: TP 15



SABS  
150 9001

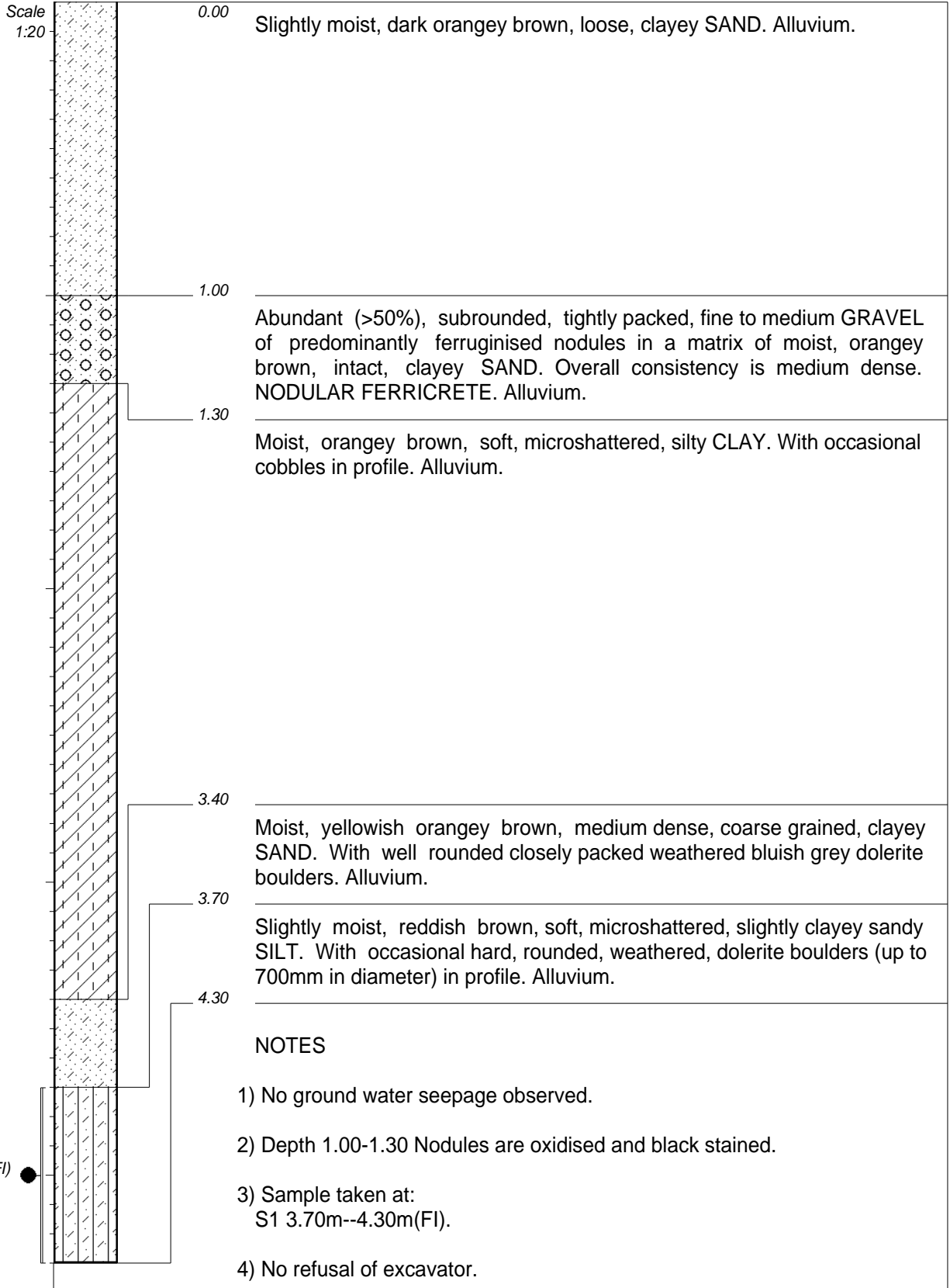
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HOLE No: TP 16  
Sheet 1 of 1

JOB NUMBER: BD 370



NOTES

- 1) No ground water seepage observed.
- 2) Depth 1.00-1.30 Nodules are oxidised and black stained.
- 3) Sample taken at:  
S1 3.70m--4.30m(Fl).
- 4) No refusal of excavator.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 231. 22  
Y-COORD : -40 140. 85

HOLE No: TP 16



SABS  
150 9001

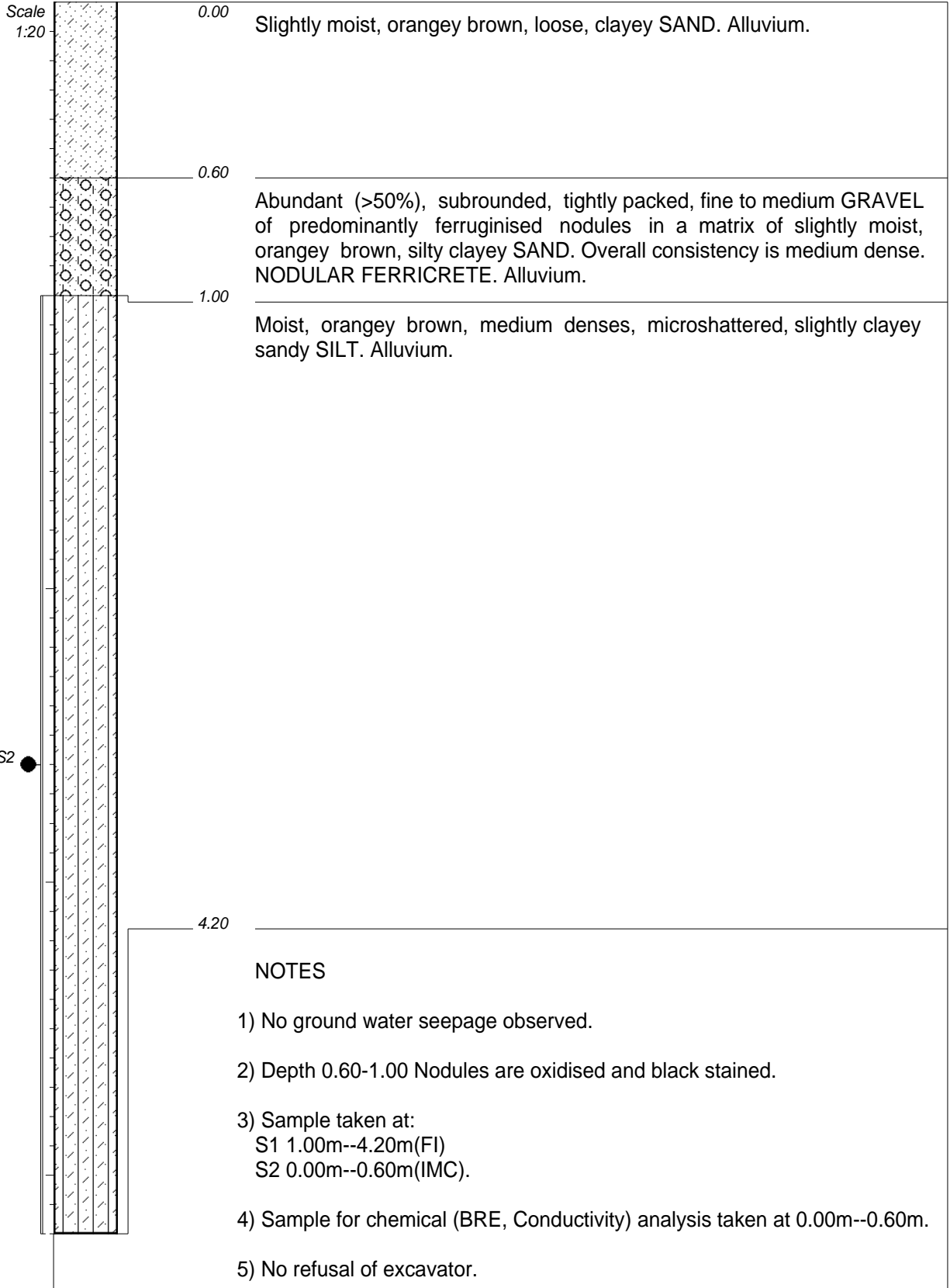
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REGISTRATION COUNCIL

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Email: bazi@bazidukhan.co.za

HOLE No: TP 17  
Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 863 135. 59  
Y-COORD : -40 079. 81

HOLE No: TP 17



SABS  
150 9001

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INSTITUTE  
NHRIC  
REGISTRATION COUNCIL

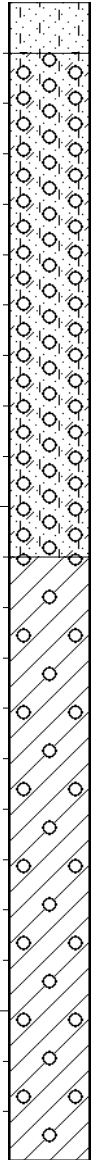
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HOLE No: TP 18  
Sheet 1 of 1

JOB NUMBER: BD 370

Scale  
1:15



0.00

Slightly moist, dark brown, very loose, silty SAND. With abundant roots in profile. Alluvium.

0.10

Abundant (>50%), subrounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey SAND. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

1.10

Slightly moist, orangey brown mottled yellow, stiff, microshattered, gravelly CLAY. With randomly distributed cobbles in profile. Alluvium.

2.30

NOTES

- 1) No ground water seepage observed.
- 2) Depth 0.10-1.10 Nodules are oxidised and black stained.
- 3) No sample taken.
- 4) Excavator refused on hard rock.

CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12

ELEVATION :  
X-COORD : 2 863 057. 32  
Y-COORD : -40 029. 86

TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

DATE : 02/05/2013 18:29  
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HOLE No: TP 18



SABS  
150 9001

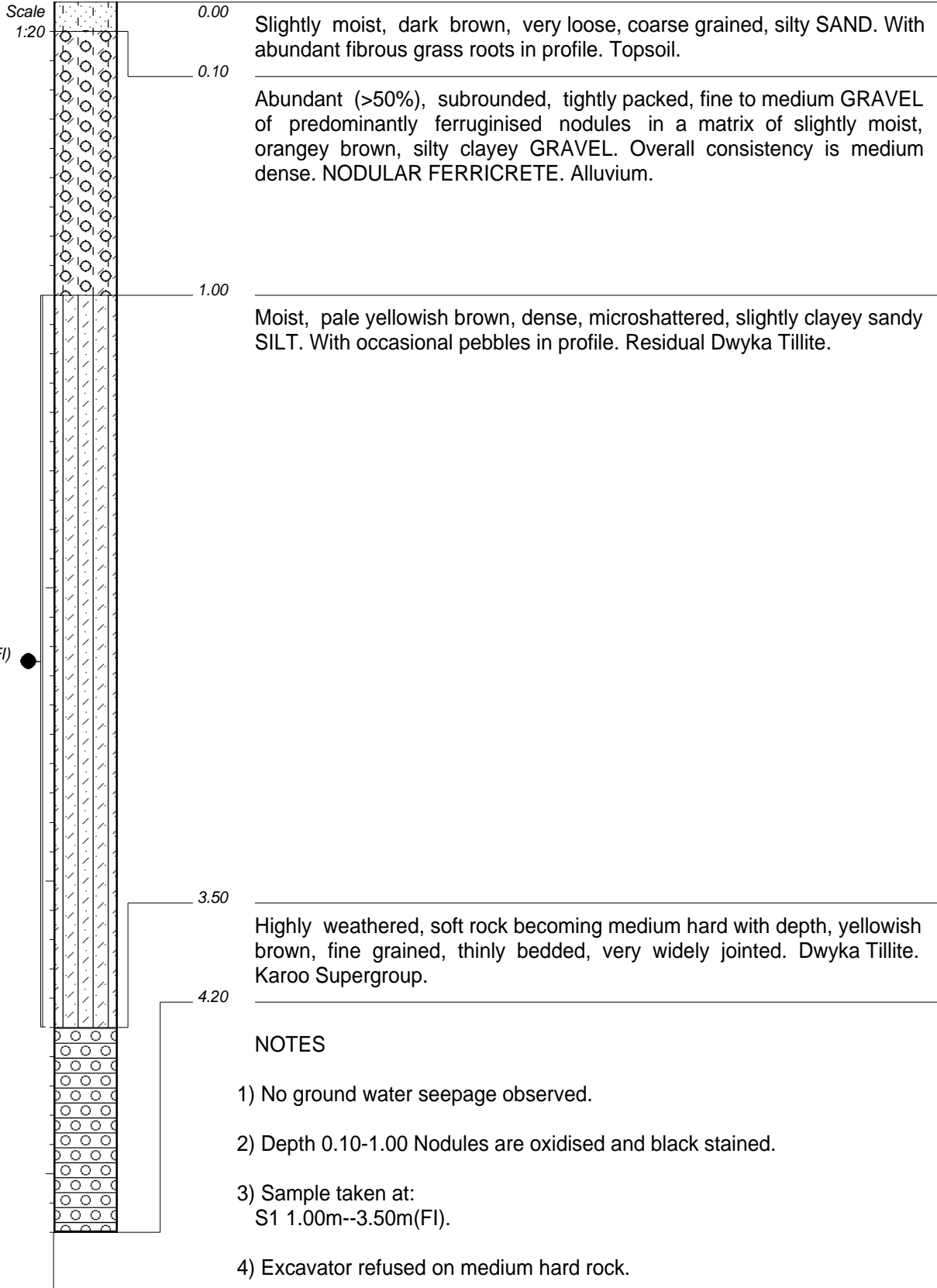
NATIONAL HOME-BUILDERS  
REGISTRATION COUNCIL  
NBRC

ESKOM HOLDINGS LIMITED  
ROCKDALE B SUBSTATION

P.O Box 37612, Overport 4067  
Tel: (031) 209 3900  
Fax: (031) 309 8742  
Email: bazi@bazidukhan.co.za

HOLE No: TP 19  
Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
MACHINE : 324D LME EXCAVATOR  
DRILLED BY :  
PROFILED BY : B. A. DUKHAN  
TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

INCLINATION :  
DIAM :  
DATE : 22/11/12-23/11/12  
DATE : 22/11/12-23/11/12  
DATE : 02/05/2013 18:29  
TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
X-COORD : 2 862 979. 05  
Y-COORD : -39 979. 91

HOLE No: TP 19



P.O Box 37612, Overport 4067  
 Tel: (031) 209 3900  
 Fax: (031) 309 8742  
 Email: bazi@bazidukhan.co.za

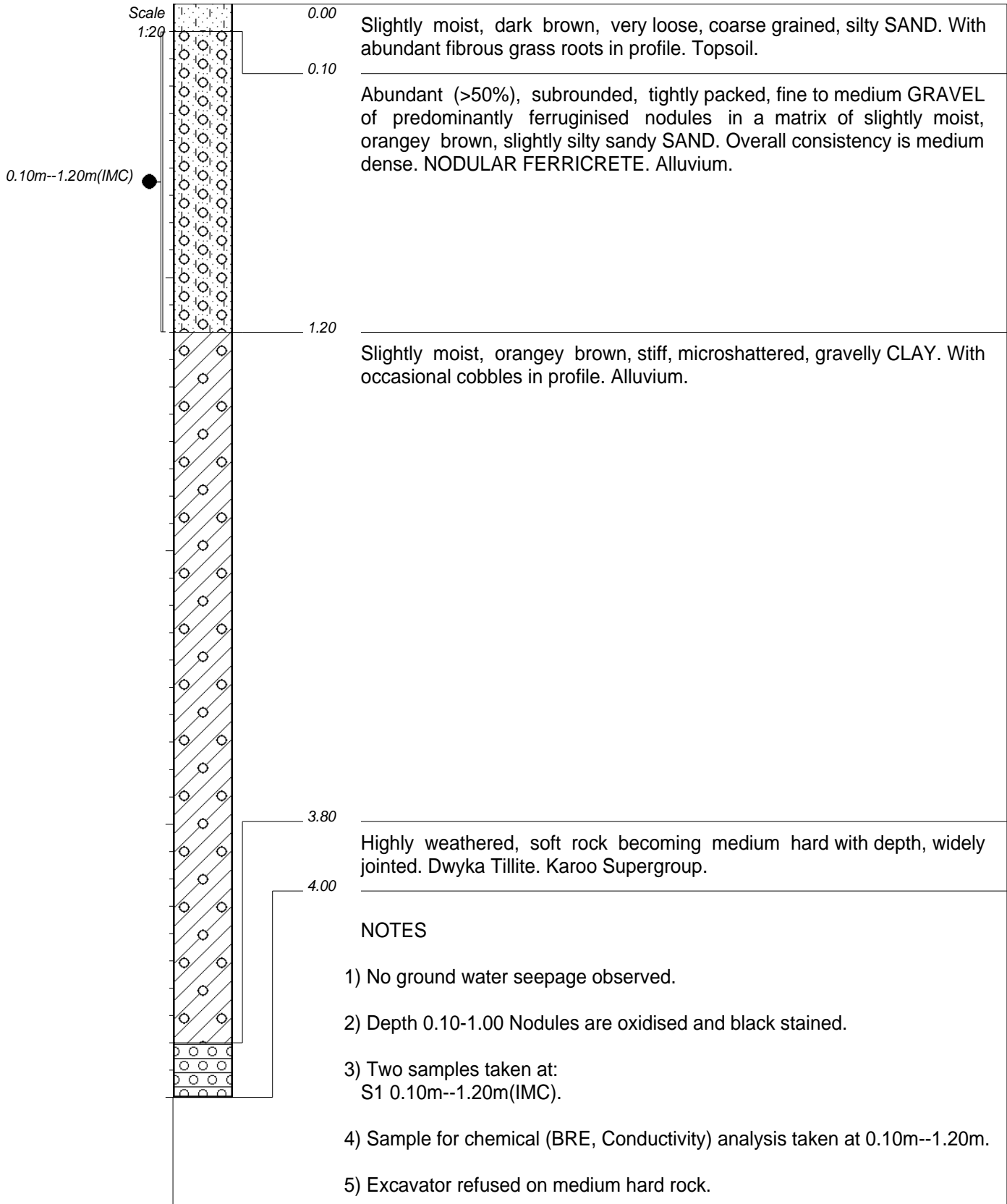
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 NHBRC  
 REGISTRATION COUNCIL

ESKOM HOLDINGS LIMITED  
 ROCKDALE B SUBSTATION

HOLE No: TP 20  
 Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
 X-COORD : 2 862 900. 79  
 Y-COORD : -39 929. 96

HOLE No: TP 20



P.O Box 37612, Overport 4067  
 Tel: (031) 209 3900  
 Fax: (031) 309 8742  
 Email: bazi@bazidukhan.co.za

SABS  
150 9001

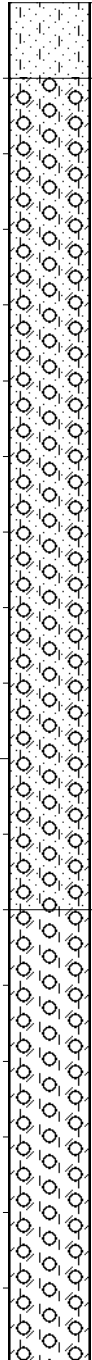
NATIONAL WATER RESEARCH INSTITUTE  
**NHR**  
 REGENERATION COUNCIL

**ESKOM HOLDINGS LIMITED  
 ROCKDALE B SUBSTATION**

**HOLE No: TP R1  
 Sheet 1 of 1**

**JOB NUMBER: BD 370**

Scale  
1:10



0.00

Slightly moist, orangey brown, medium dense, fine silty SAND. With occasional roots in profile. Topsoil.

0.10

Abundant (>50%), subrounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, slightly clayey silty SAND. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

0.10m--1.20m(IMC)

1.20

Abundant (>50%), subrounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, silty clayey GRAVEL. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

1.80

**NOTES**

- 1) No ground water seepage observed.
- 2) Depth 0.10-1.20 Nodules are oxidised and black stained. Occasional unsorted pebbles were also noted in profile.
- 3) Depth 1.10-1.80 Nodules are oxidised and black stained.
- 4) Sample taken at:  
S1 0.10m--1.20m(IMC).

CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12

ELEVATION :  
 X-COORD : 2 863 586. 92  
 Y-COORD : -39 680. 63

TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

**HOLE No: TP R1**



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 Tel: (031) 209 3900  
 Fax: (031) 309 8742  
 Email: bazi@bazidukhan.co.za

SABS  
150 9001

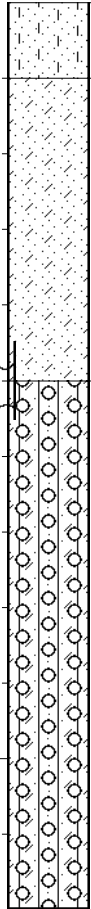
NATIONAL HOME-BUILDERS  
**NHBRC**  
 REGISTRATION COUNCIL

**ESKOM HOLDINGS LIMITED  
 ROCKDALE B SUBSTATION**

**HOLE No: TP R2**  
 Sheet 1 of 1

**JOB NUMBER: BD 370**

Scale  
1:10



0.00

Slightly moist, dark brown, very loose, silty SAND. Topsoil.

0.10

Slightly moist, dark brown, medium dense, clayey SAND. Alluvium.

0.50

Abundant (>50%), subrounded, tightly packed, fine to medium GRAVEL of predominantly ferruginised nodules in a matrix of slightly moist, orangey brown, slightly clayey sandy SILT. Overall consistency is medium dense. NODULAR FERRICRETE. Alluvium.

1.20

**NOTES**

- 1) No ground water seepage observed.
- 2) Depth 0.50-1.20 Nodules are oxidised and black stained. Occasional quartz cobbles were also noted in proile.
- 3) No sample taken.

**CONTRACTOR :**  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

**INCLINATION :**  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

**ELEVATION :**  
 X-COORD : 2 863 215. 46  
 Y-COORD : -40 262. 66

**HOLE No: TP R2**



P.O Box 37612, Overport 4067  
 Tel: (031) 209 3900  
 Fax: (031) 309 8742  
 Email: bazi@bazidukhan.co.za

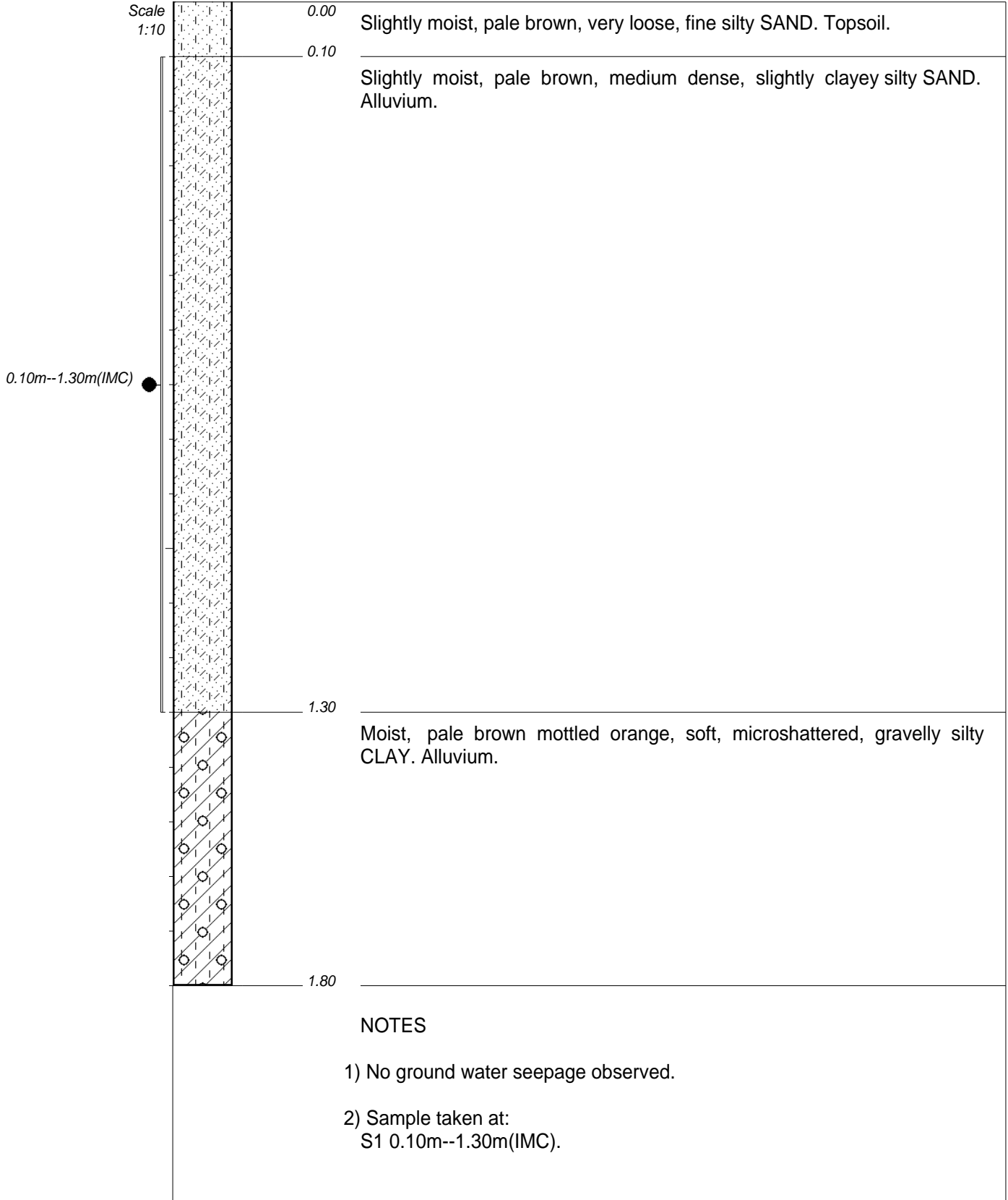
SABS  
150 9001

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 ROCKDALE B SUBSTATION

HOLE No: TP R4  
 Sheet 1 of 1

JOB NUMBER: BD 370



CONTRACTOR :  
 MACHINE : 324D LME EXCAVATOR  
 DRILLED BY :  
 PROFILED BY : B. A. DUKHAN  
 TYPE SET BY : Z. Mbatha  
 SETUP FILE : STANDARD.SET

INCLINATION :  
 DIAM :  
 DATE : 22/11/12-23/11/12  
 DATE : 22/11/12-23/11/12  
 DATE : 02/05/2013 18:29  
 TEXT : ..LEBSUBSTATIONhotplot.TXT

ELEVATION :  
 X-COORD : 2 863 391. 37  
 Y-COORD : -40 002. 78

HOLE No: TP R4



SABS  
150 9001

NATIONAL HOME-BUILDERS  
NHBRC  
REGISTRATION COUNCIL

ESKOM HOLDINGS LIMITED  
ROCKDALE B SUBSTATION

P.O Box 37612, Overport 4067  
Tel: (031) 209 3900  
Fax: (031) 309 8742  
Email: bazi@bazidukhan.co.za

LEGEND

Sheet 1 of 1

JOB NUMBER: BD 370

	BOULDERS	{SA01}
	GRAVEL	{SA02}
	GRAVELS/gravel	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	TILLITE	{SA10}
	CONGLOMERATE/agglomerate/tillite	{SA10}
	DISTURBED SAMPLE	{SA38}
	COBBLES	{SA58}

Name ●

CONTRACTOR :  
MACHINE :  
DRILLED BY :  
PROFILED BY :

INCLINATION :  
DIAM :  
DATE :  
DATE :

ELEVATION :  
X-COORD :  
Y-COORD :

TYPE SET BY : Z. Mbatha  
SETUP FILE : STANDARD.SET

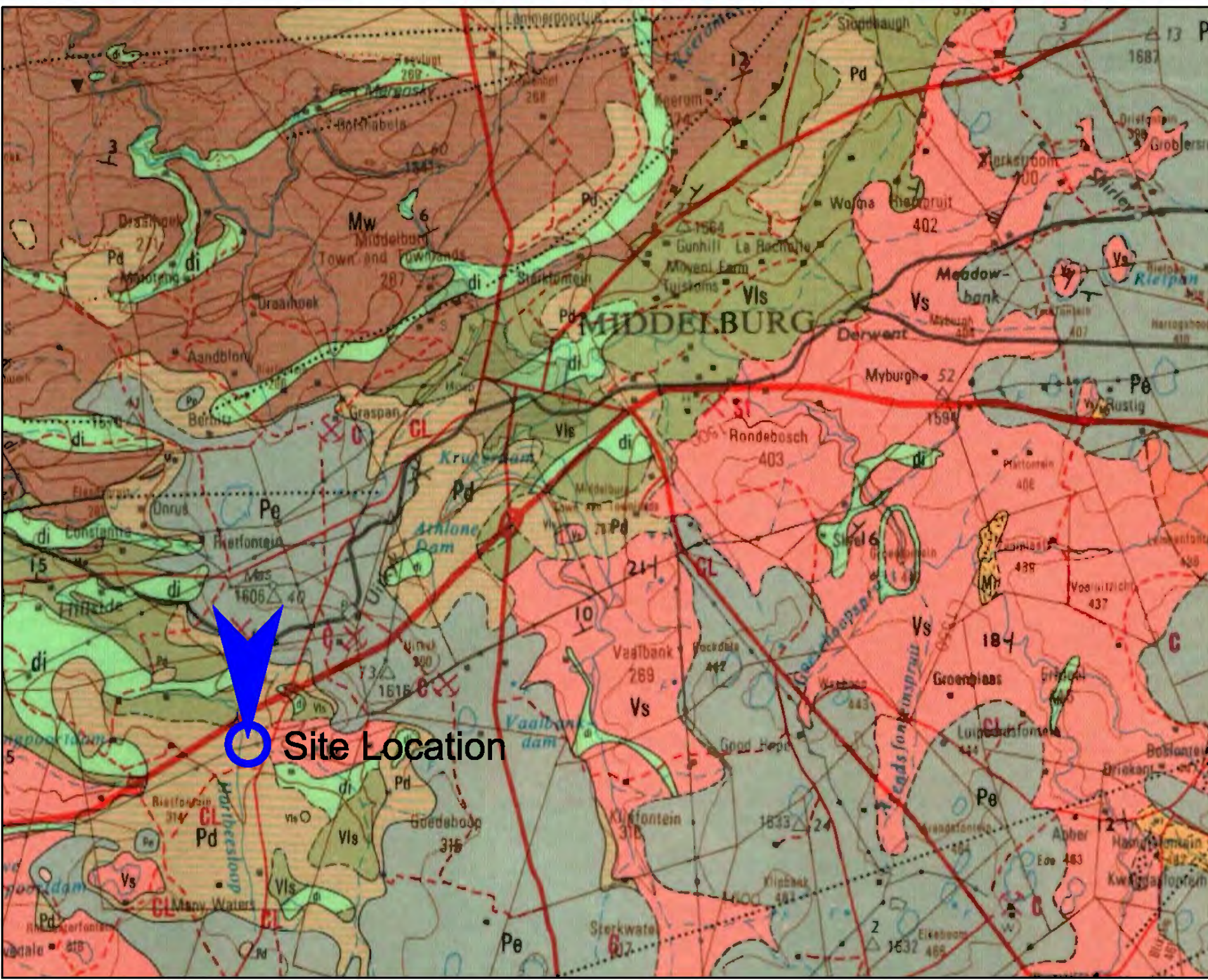
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LEGEND

SUMMARY OF SYMBOLS



***APPENDIX C: GEOLOGICAL MAP OF THE AREA:  
DRAWING NO. BD-370-GE-002-R00  
INFERRED GEOLOGICAL LAND  
FACETS:  
DRAWING NO. BD-370-GE-003-R00***



**Legend :**  
 Pd : Tillite, Shale

REV	DATE	DRAWN	CHECKED	DESCRIPTION



**BAZI DUKHAN CONSULTANTS**  
 SRBS  
 C.I.C. No. : 2008/00618023  
 V.A.T Reg. No. 400247817  
 Office 303A - 313, Third Floor  
 The Warehouse House  
 112 - 118 Standard Hill  
 Durban, 4001  
 Tel : (031) 258 3800  
 Fax : (031) 258 3808  
 Cell : 085 231 8691  
 Email: bazi@bazi.dukhan.co.za

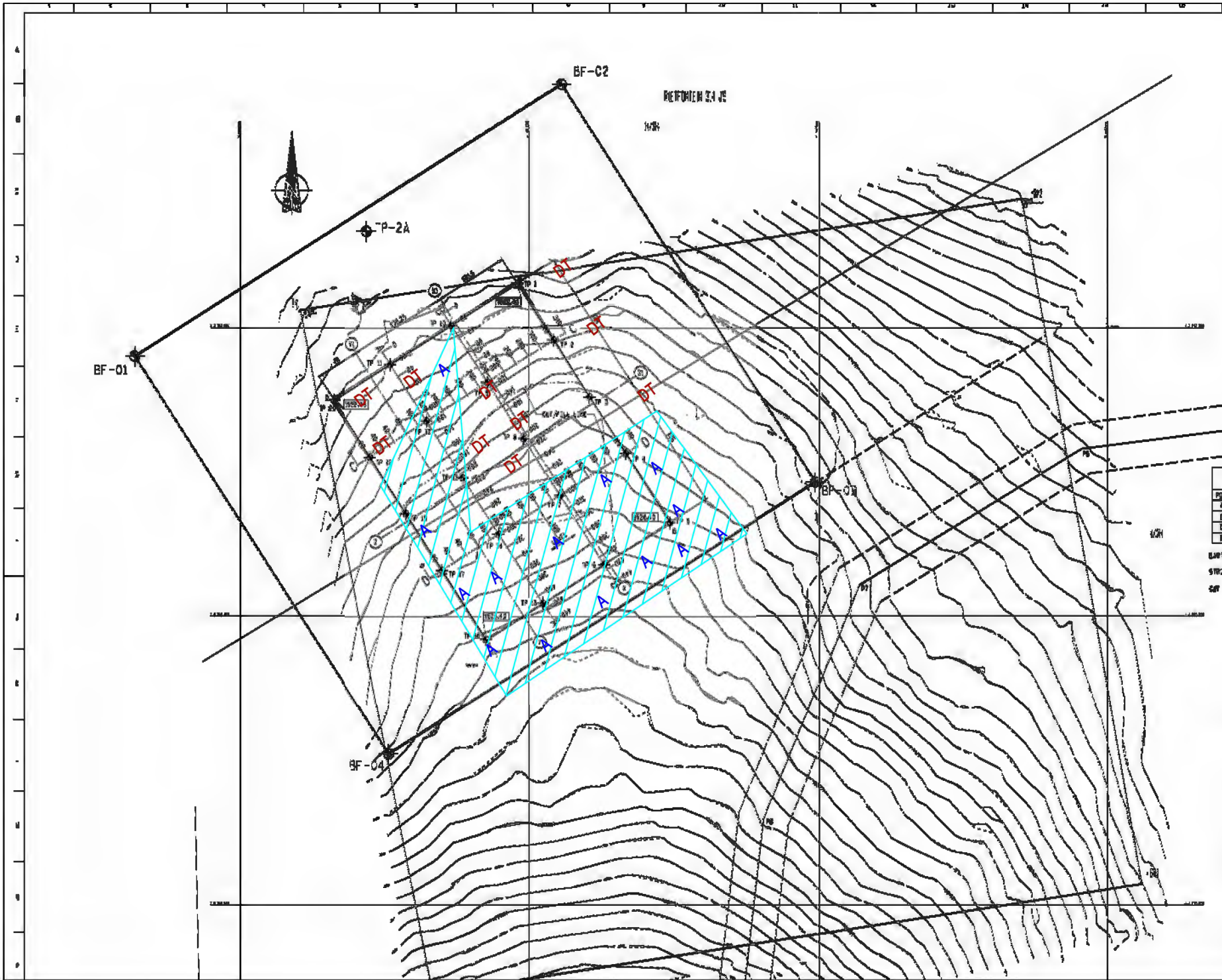
**PROJECT**  
 EKOM ROODDALE B SUBSTATION

**DRAWING**  
 GEOLOGICAL MAP

RESPONSIBLE PERSON	DATE
DESIGNED: BD P/ Eng: 20/06/10	07/11/10
DRAWN: BK	07/12/10
CHECKED: BD P/ Eng: 20/06/10	07/12/10
APPROVED: BD P/ Eng: 20/06/10	07/12/10

PROJECT NUMBER: **BD-370-GE-002-R-00**

**DRAWING STATUS CODES :**  
 R=REPORT T=TRUCK O=CONSTRUCTION  
 D=DRAWY P=PRELIMINARY A=AS-BUILT  
 COPYRIGHT RESERVED



**NOTES:**

- DT : Dwyka Tillite
- A : Alluvium
- Old river bed existed in previous geological times

REV	DATE	DRAWN	CHECKED	DESCRIPTION



**BAZI DUKHAN**  
CONSULTANTS PTY LTD

C.K. No. : 2008/009199/03  
V.A.T Reg. No. 405247917  
Office 309A - 313, Third Floor  
The Wheeler House Tel : (031) 209 3900  
112 - 113 Stamford Hill Fax : (031) 209 3696  
Durban, 4001 Call : 063 231 8561  
E-mail: bazi@bazidukhan.co.za

PROJECT  
**ESKOM  
ROCKDALE B SUBSTATION**

DRAWING  
**ROCKDALE B INFERRED GEOLOGICAL LAND FACETS**

	RESPONSIBLE PERSON	DATE
DESIGNED	BD Pr Eng: 20070210	07.12.2012
DRAWN	SK	07.12.2012
CHECKED	ZM	07.12.2012
APPROVED	BD Pr Eng: 20070210	07.12.2012
SCALE	AS SHOWN	SHEET SIZE A4

PROJECT NUMBER DRAWING NUMBER STATUS REVISION  
**BD-370-GE-003-R-00**

DRAWING STATUS CODES:  
 B - REPORT      T - TENDER      C - CONSTRUCTION  
 D - DRAFT      P - PRELIMINARY      A - AS BUILT  
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## **APPENDIX D: *RESISTIVITY TEST***

# ENGINEERING & EXPLORATION GEOPHYSICAL SERVICES CC

CK94/10526/23 Geophysical Contractors



170 Jakaranda Street,  
Doringkloof,  
Gauteng, 0157  
012 - 6673369 (tel.) 6675186 (fax)  
E-mail: eegs@iafrica.com  
22<sup>nd</sup> November, 2012

BAZI DUKHAN CONSULTING ENGINEERS CC

P O Box 37612

Overpoort, 4067

Attn: Mr Bazi Dukhan

Dear Sir,

## SOIL RESISTIVITY SURVEY, (EMKHIWENI) ROCKDALE B SUBSTATION

### 1. Introduction

The methods and results are given here of a soil resistivity survey carried out on the proposed substation site called (Emkhiweni) Rockdale B, which is about 13km to the south-west of Middelburg. The object of the survey is to supply information about ground resistance that is to be used to in earthmat design.

The substation is to be erected on what is now arable land. The site appears to be underlain by sedimentary rock of the Karoo Group though igneous rock of the Rooiberg Group is mapped a short distance away (2528 Pretoria Geological Map).

Fieldwork was performed on the 16<sup>th</sup> and 22<sup>nd</sup> November. The survey consisted of both apparent conductivity and resistivity measurements. The apparent conductivity readings give an appreciation of lateral changes across the site whilst the resistivity supplies cross sections showing changes with depth. The centre points of the resistivity traverses as measured with a Garmin GPS are tabulated below.

Table 1: Centre points of resistivity traverses (Lo29 WGS84)

Cross	Lo Y	Lo X
'1/2	-40110	2863015
'3/4	-40285	2863020
'5/6	-39945	2862955

## **2. Instrumentation, data collection methods and reduction procedure**

### 2.1 Instrumentation

A CMD-4 was used to record near-surface conductivity changes across the site. This electromagnetic instrument consists of two coplanar coils about four metres apart. A 10kHz signal is introduced into the ground using one coil, and its effect recorded with the second coil. The magnitude of the out of phase response is proportional to the apparent conductivity of the ground. When the transmitter dipole is orientated vertically, the measurement is a bulk sample of conductivity to a depth of six metres. The data are automatically recorded along with station positions obtained from an attached Garmin GPS.

An ABEM SAS1000 resistivity meter and 10-64 switch box were used to collect the resistivity data. Resistivity measurements are obtained by injecting a current into the ground through two electrodes and measuring the resulting potential between another electrode pair. By systematically increasing the electrode separation in a fashion otherwise known as a vertical electrical sounding, a picture is obtained of resistance variations with depth. A set of adjacent soundings is known as a continuous vertical electrical sounding (CVES) and such a data set provides a resistivity image or cross section of the ground. The ABEM system automates the collection of such data set by accessing multiple electrodes through a multicore cable.

### 2.2 Data collection

A Wenner configuration (equally spaced electrodes set in a line) was used for the resistivity imaging, as is required for this type of survey. A cable with electrode takeouts every metre was employed for the work and measurement were taken with electrode separations of 1, 2, 3, 4, 6, 8, 12, 16, 20 and 24 metres.

### 2.3 Data reduction and presentation

Processing the conductivity data was carried out by contouring the data.

The resistivity data sets were modeled using RES2DINV, a program that automatically interprets the resistivity variations of the ground by fitting internally-generated model data to the field data through several iterations. The results of the operation are cross-sections showing lateral and vertical changes in resistivity.

As well as being modelled the resistivity data sets are also tabulated and graphed. The tables record average apparent resistivity values ( $\rho$ ) for each electrode separation along with resistance values (R) calculated using the relationship  $\rho = 2\pi aR$ , where 'a' is the electrode separation.

### 3. Results

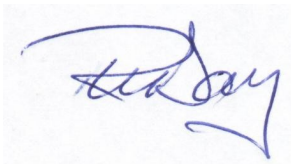
The apparent conductivity results and traverse arrangement are indicated on figure 1 and the resistivity models are presented in figures 2 to 4. The 'cooler' colours (blue-green) indicate lower resistivity values whilst the 'hotter' colours (yellow-red) show higher resistivity values. The summarised data are presented in an appendix.

The apparent conductivity results show a clear division in conditions; broadly, apparent conductivity varies around 10 mS/m in the north-west whilst in the south-east values are about double that level (figure 1). Although irregular, the boundary between the two levels is well defined.

Resistivity traverses 5 and 6 are in the low conductivity area, models 1 and 2 straddle the boundary whilst models 3 and 4 lie within the high conductivity zone (Figure 1). All the models show clear horizontal layering, with a resistor that is about two to four metres thick overlying a conductor (figures 2 to 4). The surface layer is markedly more resistive in the north-west than in the south-east, a change that can be observed on line 1 model at 55 metres (figure 2). The underlying conductor is also more resistive in the north-west. On models 3 and 4 there is a basement resistor at a depth of about eight metres. A less marked increase in resistivity occurs at a similar depth on 1 and 2 but no such feature appears in the models for lines 5 and 6.

The variation in resistivity of the layers, particularly the surficial resistor, accounts for the changes in apparent conductivity across the site. The underlying cause of the variation is presumed to be a facies change in the sedimentary rock.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'R.W. Day', is written over a light blue rectangular background.

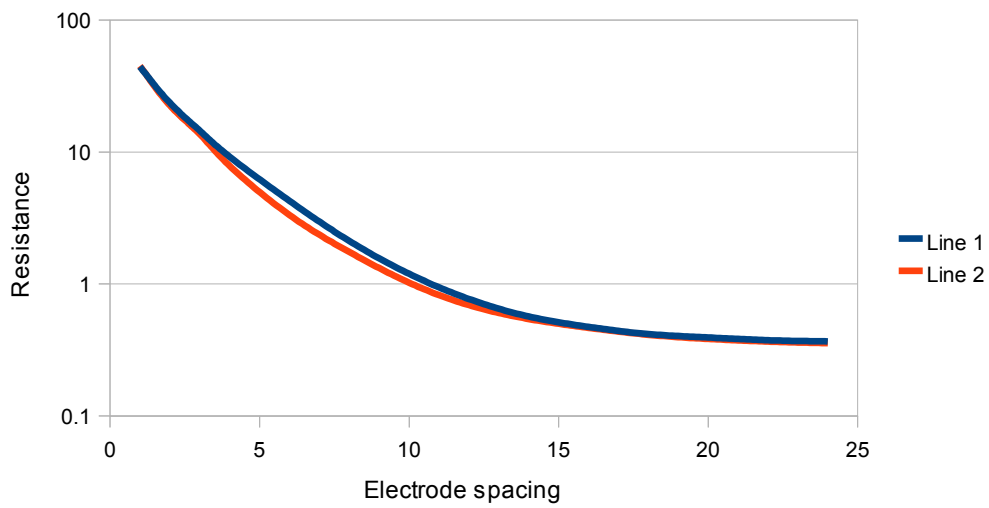
R.W.Day. Pr.Sci.Nat.

APPENDIX  
SOIL RESISTIVITY RESULTS  
(EMKHIWENI) ROCKDALE B SUBSTATION SITE

A = electrode separation (metres)  
Count = number of sample with that electrode separation  
Mean = average of apparent resistivity measurements (ohm metres)  
Median = median of resistivity measurements (ohm metres)  
Rho = resistance calculated from median (ohms)

Line 1					Line 2				
A	Count	Mean	Median	Resistance	A	Count	Mean	Median	Resistance
1	38	278	278	44.28	1	38	280	283	44.98
2	55	280	297	23.61	2	55	281	283	22.55
3	32	276	274	14.51	3	32	259	258	13.67
4	35	213	231	9.19	4	35	202	197	7.84
6	32	142	161	4.26	6	32	128	126	3.33
8	29	95	107	2.12	8	29	85	88	1.75
10	26	69	75	1.19	10	26	63	64	1.02
12	23	54	58	0.77	12	23	52	52	0.69
14	20	48	50	0.57	14	20	48	48	0.54
16	17	46	48	0.47	16	17	46	47	0.47
18	14	47	47	0.42	18	14	47	47	0.41
20	11	49	49	0.39	20	11	49	48	0.38
22	8	52	52	0.38	22	8	51	51	0.37
24	5	55	55	0.37	24	5	54	54	0.36

Plot of resistance against electrode separation



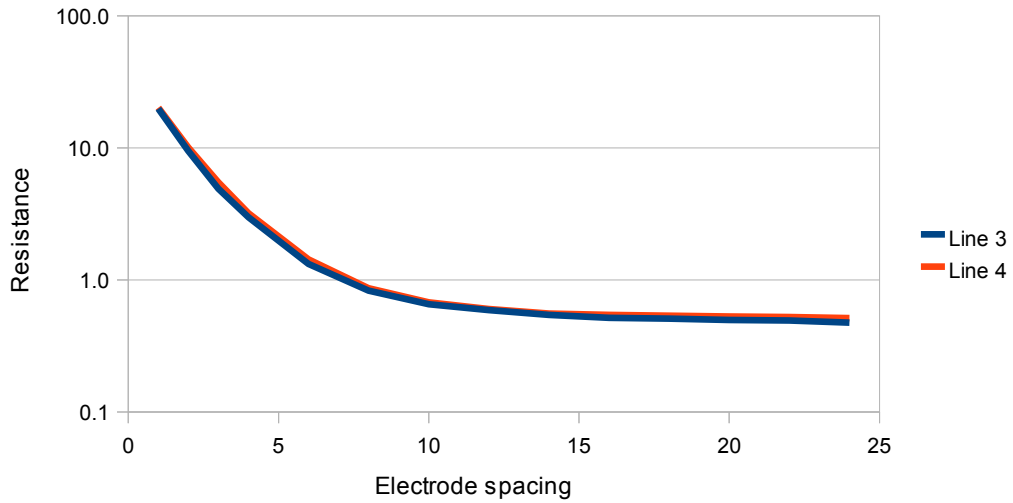
Line 3

A	Count	Mean	Median	Resistance
1	38	128	124	19.75
2	55	120	119	9.50
3	32	92	93	4.91
4	35	79	75	2.98
6	32	53	50	1.32
8	29	43	42	0.83
10	26	42	41	0.65
12	23	44	45	0.59
14	20	48	48	0.54
16	17	52	52	0.52
18	14	57	58	0.51
20	11	63	63	0.50
22	8	69	68	0.49
24	5	72	72	0.48

Line 4

A	Count	Mean	Median	Resistance
1	38	127	127	20.15
2	55	126	127	10.08
3	32	103	103	5.48
4	35	82	80	3.19
6	31	54	54	1.43
8	28	44	44	0.87
10	25	43	42	0.67
12	22	45	45	0.60
14	18	49	49	0.56
16	16	55	55	0.54
18	12	60	61	0.54
20	10	67	66	0.53
22	8	74	72	0.52
24	4	77	77	0.51

Plot of resistance against electrode separation



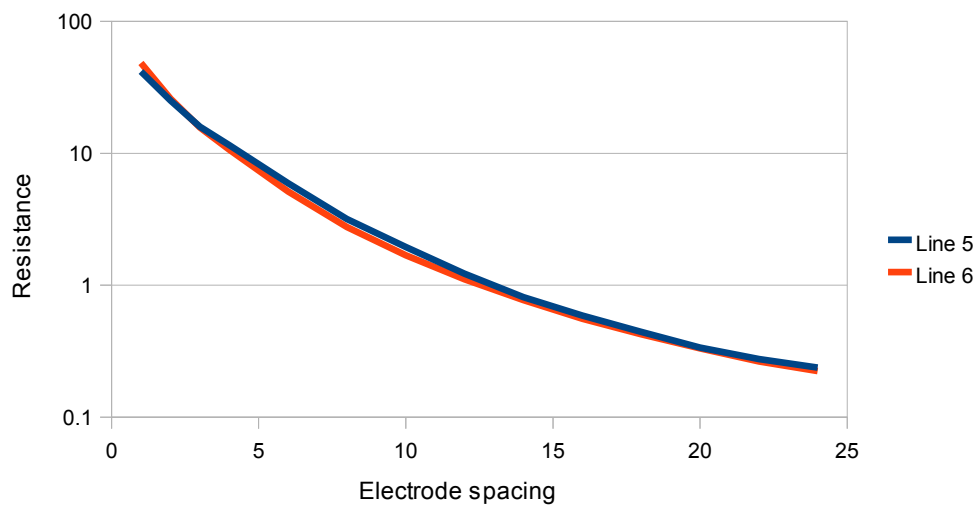
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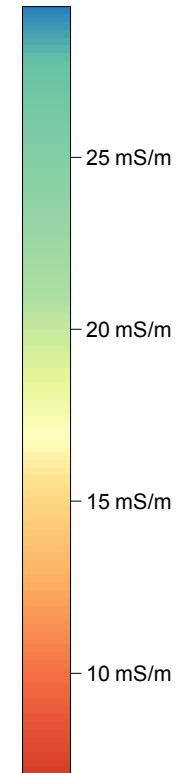
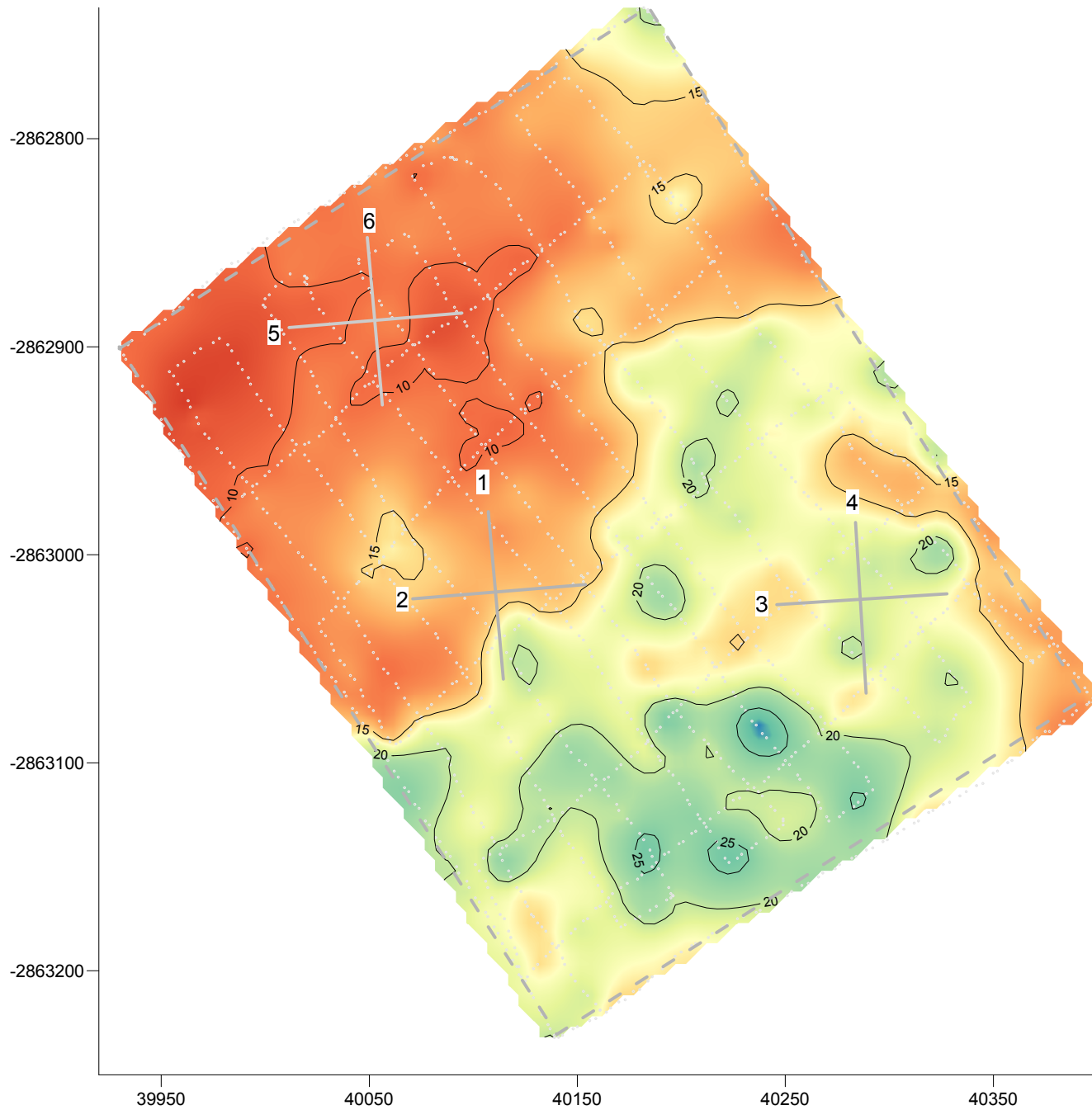
A	Count	Mean	Median	Resistance
1	38	265	261	41.57
2	55	322	316	25.11
3	32	287	300	15.92
4	35	284	290	11.53
6	32	215	223	5.92
8	29	159	160	3.18
10	26	121	122	1.95
12	23	93	92	1.22
14	20	72	71	0.81
16	17	59	59	0.59
18	14	50	50	0.44
20	11	43	42	0.34
22	8	38	38	0.28
24	5	35	36	0.24

Line 6

A	Count	Mean	Median	Resistance
1	38	315	303	48.24
2	55	321	326	25.92
3	32	294	295	15.63
4	35	275	268	10.66
6	32	202	193	5.12
8	29	146	139	2.77
10	26	110	106	1.68
12	23	85	84	1.11
14	20	68	68	0.77
16	17	56	56	0.56
18	14	48	48	0.42
20	11	41	42	0.33
22	8	37	37	0.26
24	5	34	34	0.22

Plot of resistance against electrode separation





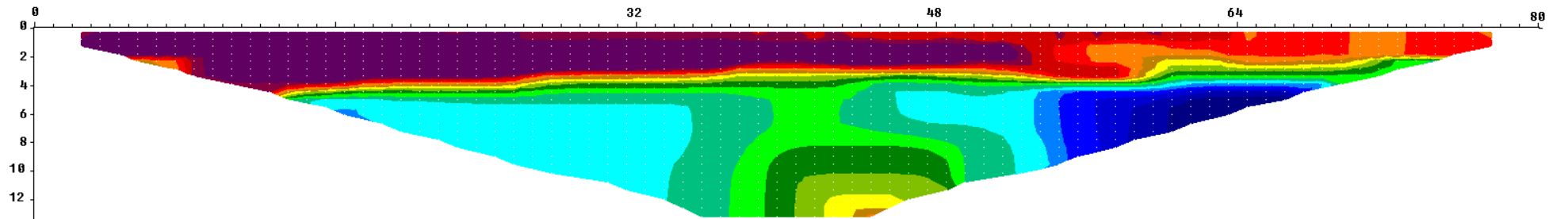
Contour interval 5 mS/m

Resistivity traverse

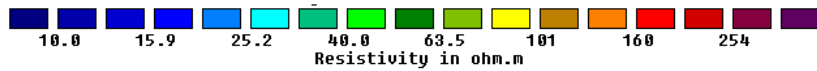
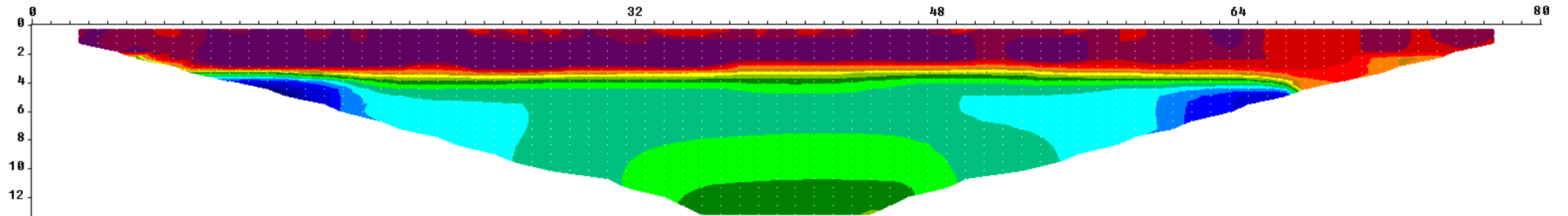
Coordinates -Lo29 WGS84

**Rockdale B Substation**  
**Figure 1: Apparent conductivity map**  
 Prepared for Bazi Dukham CE by E&EGS CC, November 2012

Line 1: N-S



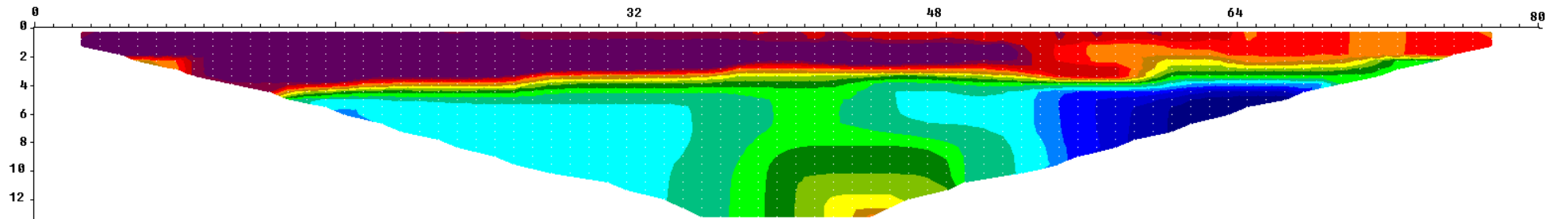
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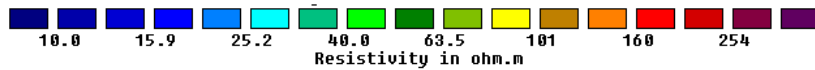
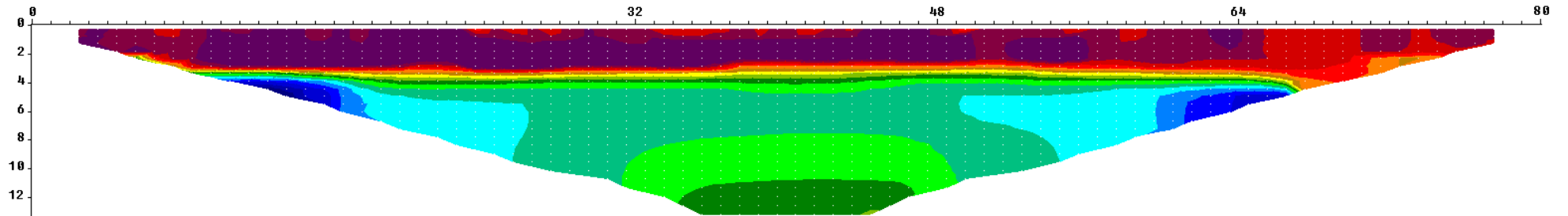
**Rockdale B Substation**  
**Figure 2: Resistivity models 1 & 2**

Prepared for Bazi Dukham CE by E&EGS CC, November 2012

Line 1: N-S



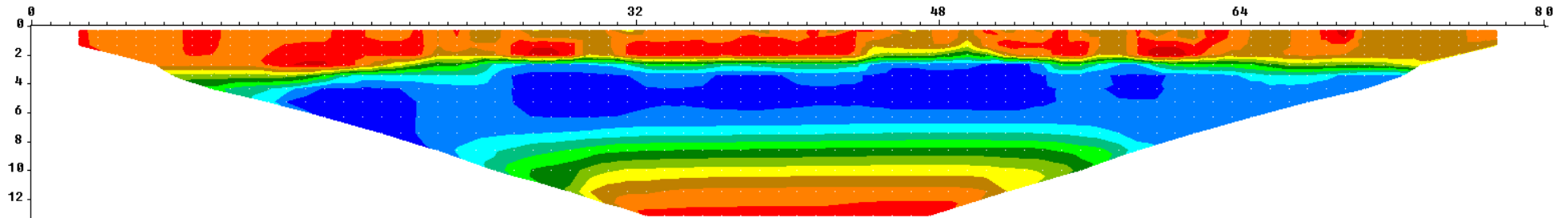
Line 2: W-E



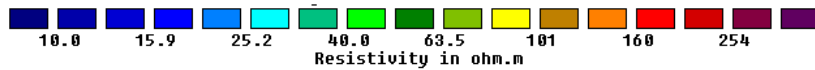
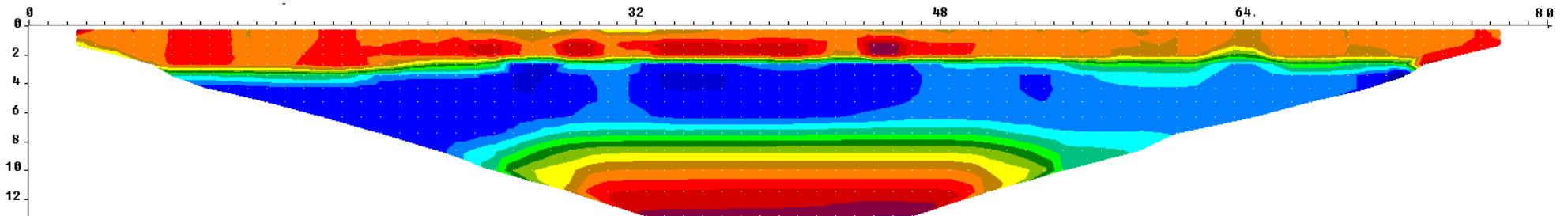
**Rockdale B Substation**  
**Figure 2: Resistivity models 1 & 2**

Prepared for Bazi Dukham CE by E&EGS CC, November 2012

Line 3: W-E

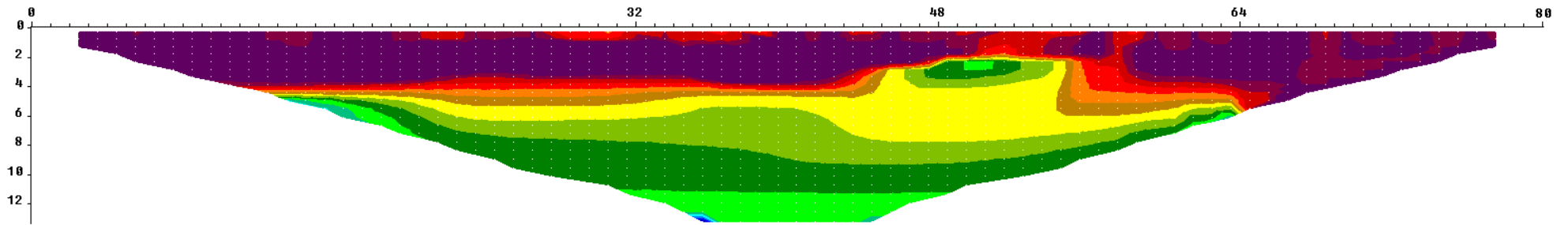


Line 4: N-S

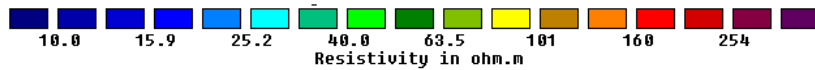
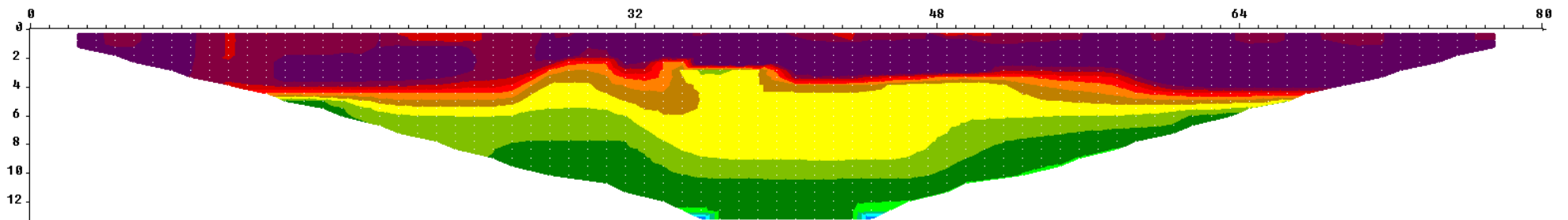


**Rockdale B Substation**  
**Figure 3: Resistivity models 3 & 4**  
Prepared for Bazi Dukham CE by E&EGS CC, November 2012

Line 5: W-E



Line 6: N-S



**Rockdale B Substation**  
**Figure 4: Resistivity models 5 & 6**

Prepared for Bazi Dukham CE by E&EGS CC, November 2012



## **APPENDIX E: *LABORATORY RESULTS***



**FOUNDATION INDICATOR ( TMH 1 : A1, A2, A3, A4, A5 & A6 )**

**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** N/A  
**LAYER :** 3000-3700mm  
**SAMPLE No. :** I/ 3538  
**SAMPLE DESCRIPTION :** Light Yellow Orange  
Shale & Sandstone

Material description		
Soil analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	95
	19.0	92
	13.2	89
	4.75	80
	2.000	72
	0.425	57
	0.250	46
	0.150	37
	0.075	26
0.050	18	
0.005	8	
0.002	2.6	
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	15.0
	0.425 - 0.250	11.0
	0.250 - 0.150	9.0
	0.150 - 0.075	11.0
	< 0.075	36.1
Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	296.4	
Grading Coefficient	18.4	
Grading modulus	1.45	
Atter- berg Limits	Liquid Limit	29
	Plasticity Index	10
	Linear Shrinkage	5.2
Unified Soil Classification	SC	
U.S. Highway Classification	A-2-4(0)	
pH - Value	N/A	
Conductivity mS/cm	N/A	

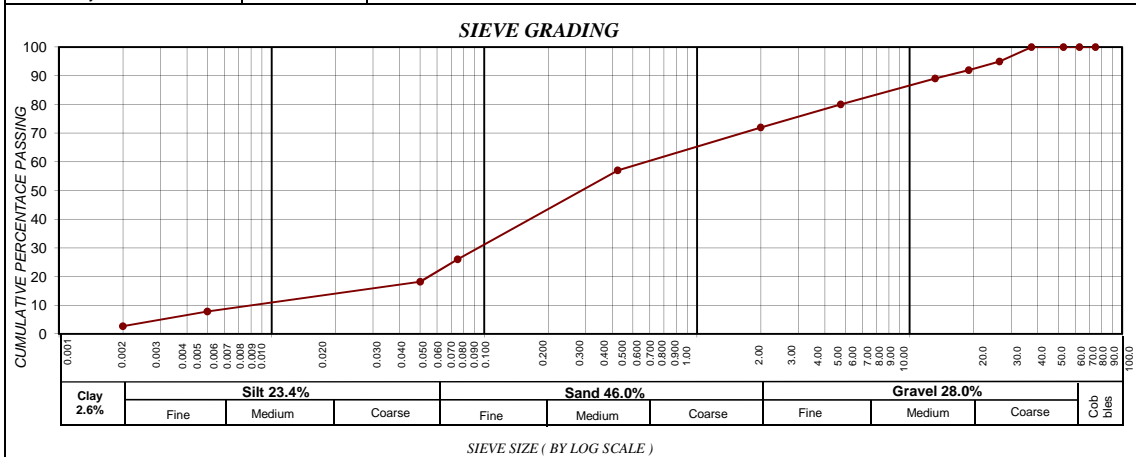
POTENTIAL EXPANSION	
PLASTICITY INDEX	PERCENTAGE CLAY
Activity 2.0	Activity 1.0
Activity 0.7	Activity 0.6
Activity 0.5	
VERY HIGH	HIGH
MEDIUM	LOW

PLASTICITY CHART	
PLASTICITY INDEX	LIQUID LIMIT (LL)
CASGRANDE "A" LINE	
CH	OH and MH
CL - ML	ML and OL

PERFORMANCE AS WEARING COURSE	
SHRINKAGE PRODUCT	GRADING COEFFICIENT
Slippery	Erodible Materials
Good - dusty	Good
Ravels	Ravels and Corrugates





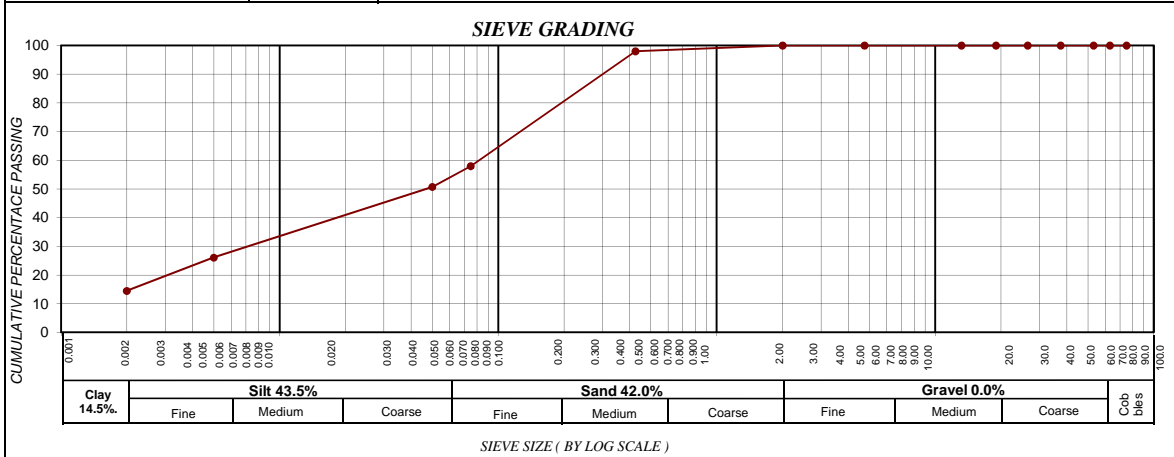
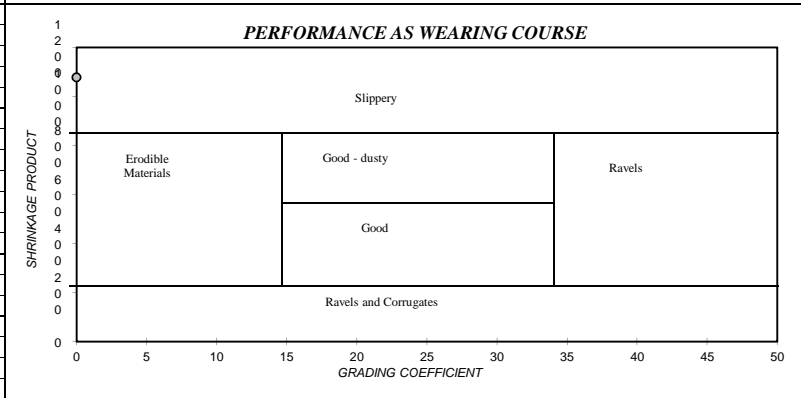
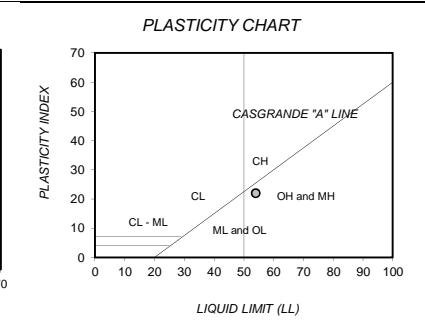
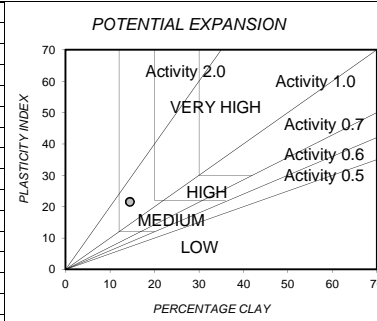
**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP4  
**LAYER :** 1500-4100mm  
**SAMPLE No. :** I/ 3539  
**SAMPLE DESCRIPTION :** Light Yellow Orange Ferrinodules & Quartzetic Sand

**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	100
	0.425	98
	0.250	85
	0.150	72
	0.075	58
0.050	51	
0.005	26	
0.002	14.5	

Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	2.0
	0.425 - 0.250	13.0
	0.250 - 0.150	13.0
	0.150 - 0.075	14.0
	< 0.075	58.0

Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	1078.0	
Grading Coefficient	0.0	
Grading modulus	0.44	
Atterberg Limits	Liquid Limit	54
	Plasticity Index	22
	Linear Shrinkage	11
Unified Soil Classification	CH	
U.S. Highway Classification	A-7-5(10)	
pH - Value	N/A	
Conductivity mS/cm	N/A	



CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP4

LAYER : 4100-4300mm

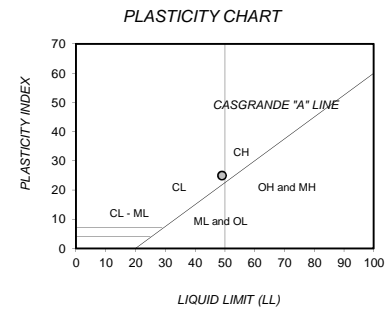
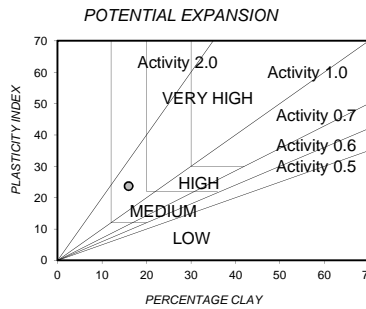
SAMPLE No. : I/ 3540

SAMPLE DESCRIPTION : Dark Red Orange

Ferricrete & Quartzetic Sand

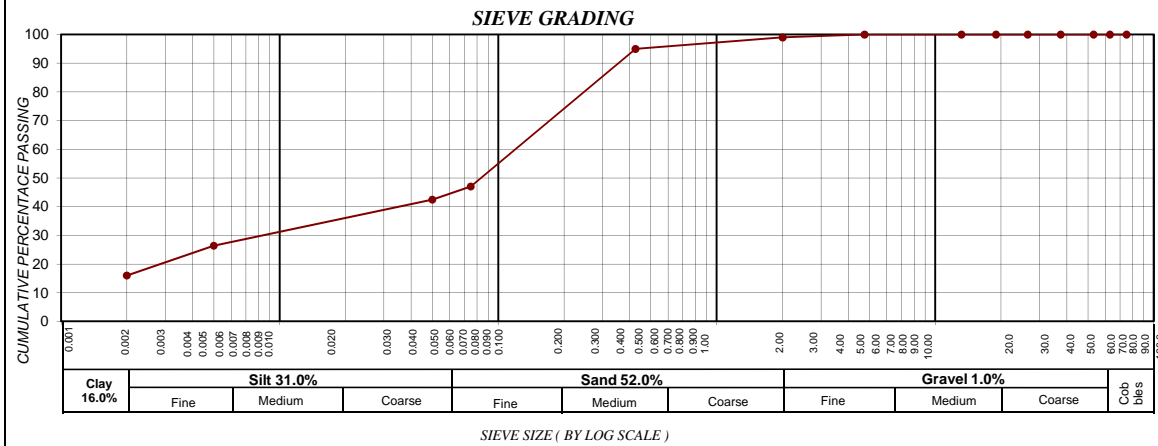
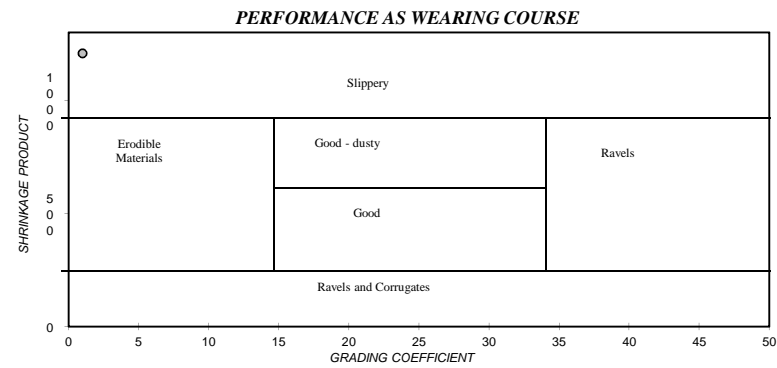
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	99
	0.425	95
	0.250	80
	0.150	75
	0.075	47
0.050	42	
0.005	26	
0.002	16.0	



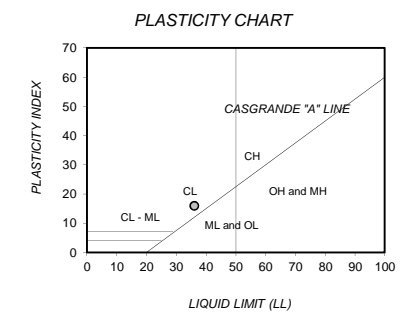
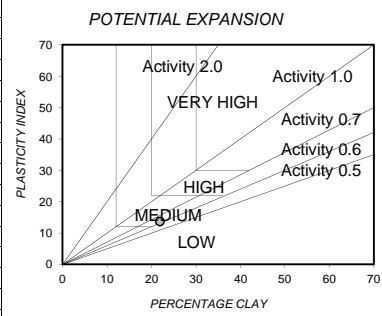
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	4.0
	0.425 - 0.250	15.0
	0.250 - 0.150	5.0
	0.150 - 0.075	28.0
	< 0.075	47.5

Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	1206.5	
Grading Coefficient	1.0	
Grading modulus	0.59	
Atter- berg Limits	Liquid Limit	49
	Plasticity Index	25
	Linear Shrinkage	12.7
Unified Soil Classification	CL	
U.S. Highway Classification	A-7-6(7)	
pH - Value	N/A	
Conductivity mS/cm	N/A	

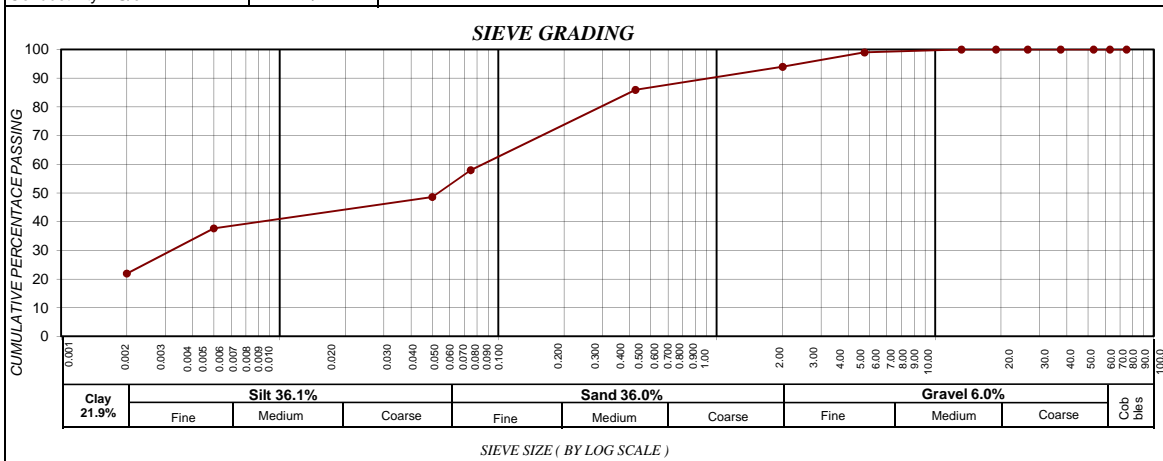
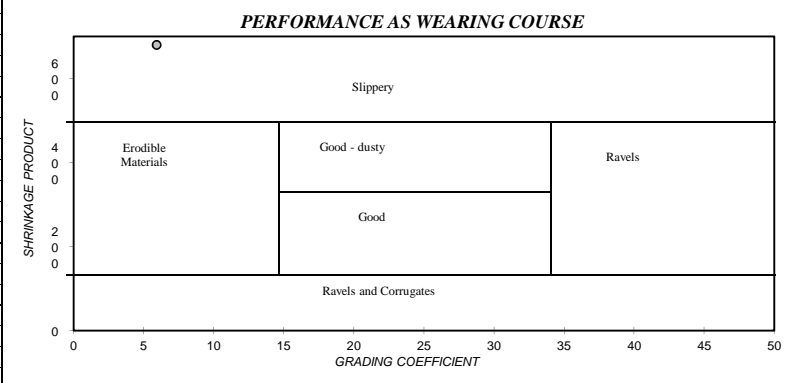


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP5  
**LAYER :** 1600-3600mm  
**SAMPLE No. :** I/ 3541  
**SAMPLE DESCRIPTION :** Dark Red Orange Ferrinodules & Quartzetic Sand

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	99
	2.000	94
	0.425	86
	0.250	77
	0.150	68
	0.075	58
0.050	49	
0.005	38	
0.002	21.9	



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	8.0
	0.425 - 0.250	9.0
	0.250 - 0.150	9.0
	0.150 - 0.075	10.0
	< 0.075	61.7
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		679.4
Grading Coefficient		5.9
Grading modulus		0.62
Atterberg Limits	Liquid Limit	36
	Plasticity Index	16
	Linear Shrinkage	7.9
Unified Soil Classification		CL
U.S. Highway Classification		A-6(7)
pH - Value		N/A
Conductivity mS/cm		N/A



CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP7

LAYER : 1500-3300mm

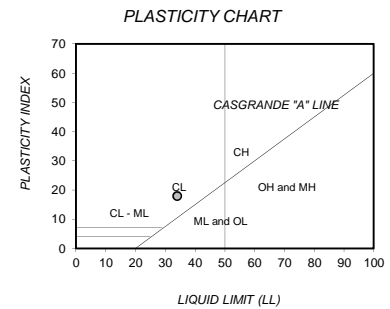
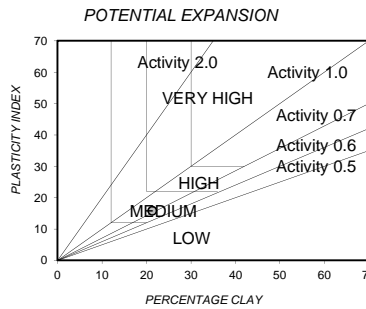
SAMPLE No. : I/ 3542

SAMPLE DESCRIPTION : Dark Red Orange

Ferrinodules & Quartzetic sand

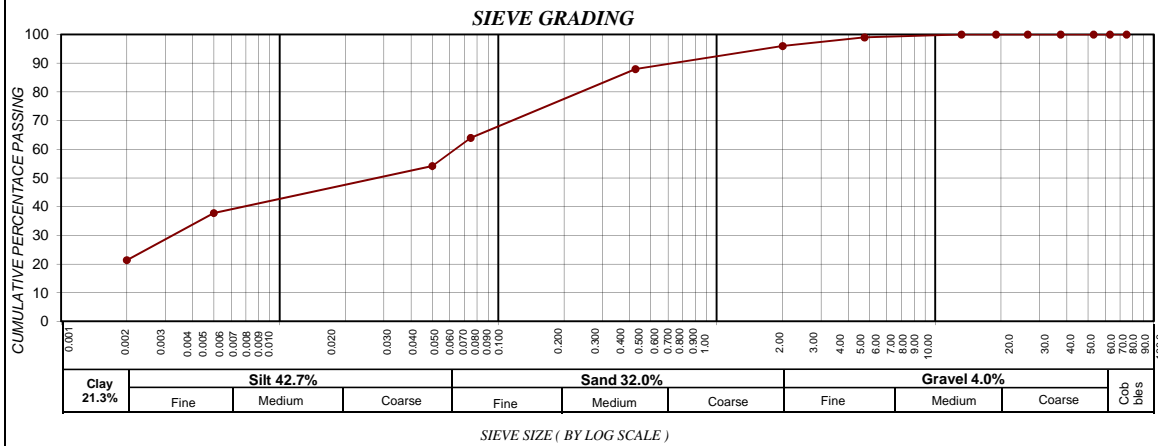
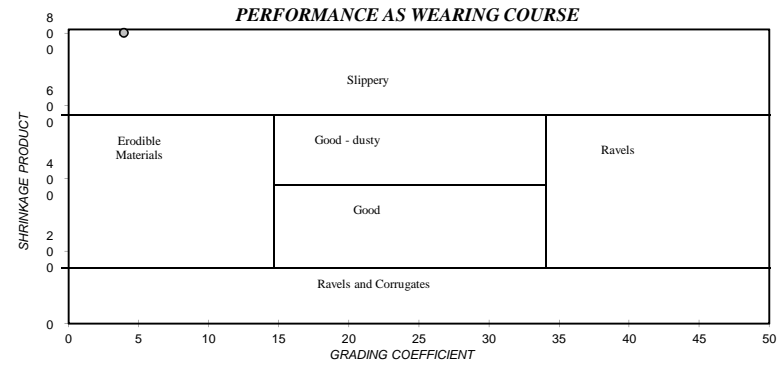
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	99
	2.000	96
	0.425	88
	0.250	80
	0.150	72
	0.075	64
0.050	54	
0.005	38	
0.002	21.3	



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	8.0
	0.425 - 0.250	8.0
	0.250 - 0.150	8.0
	0.150 - 0.075	8.0
	< 0.075	66.7

Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	800.8	
Grading Coefficient	4.0	
Grading modulus	0.52	
Atterberg Limits	Liquid Limit	34
	Plasticity Index	18
	Linear Shrinkage	9.1
Unified Soil Classification	CL	
U.S. Highway Classification	A-6(9)	
pH - Value	N/A	
Conductivity mS/cm	N/A	





CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP9

LAYER : 1000-2760mm

SAMPLE No. : I/ 3543

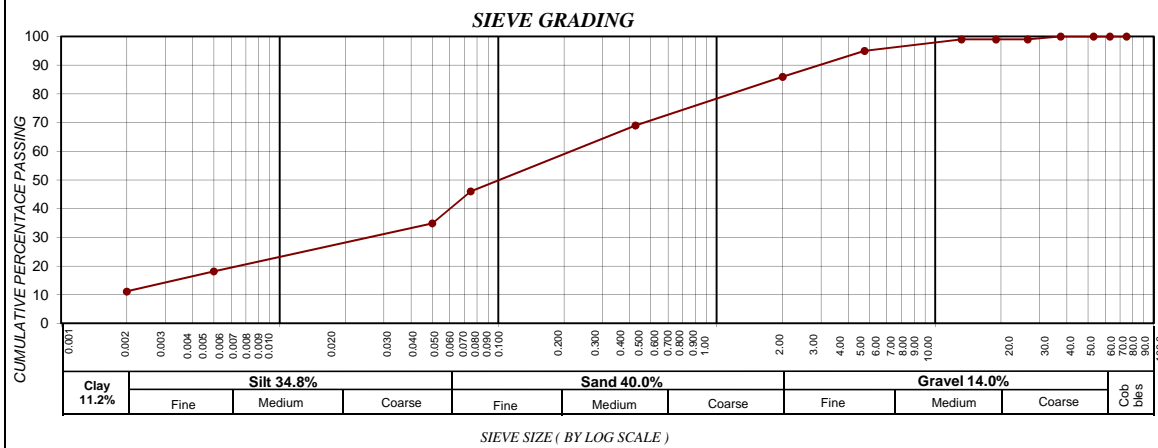
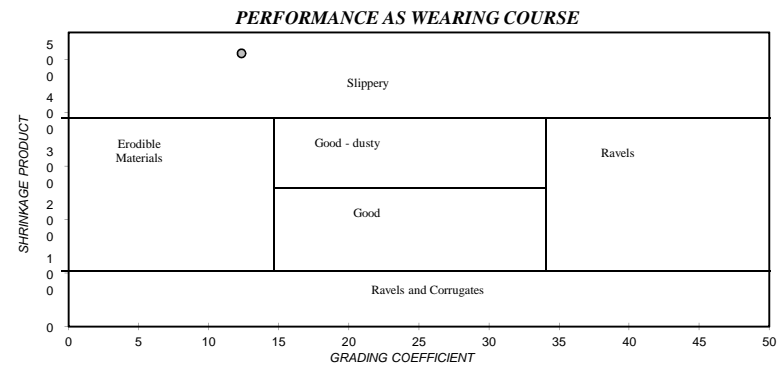
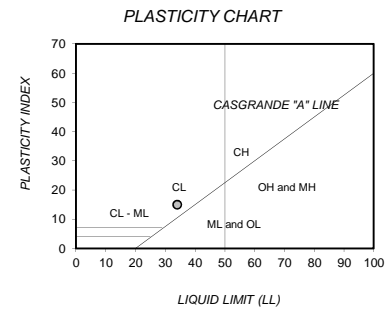
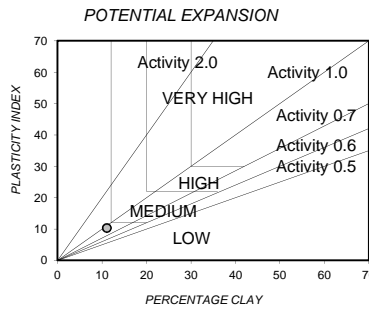
SAMPLE DESCRIPTION : Dark Red Orange  
Shale & Ferricrete

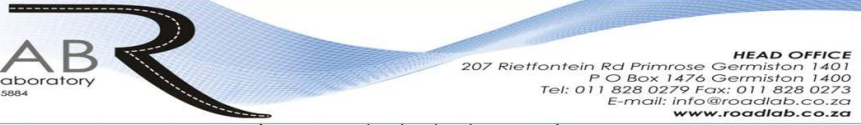
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	99
	19.0	99
	13.2	99
	4.75	95
	2.000	86
	0.425	69
	0.250	62
	0.150	55
	0.075	46
0.050	35	
0.005	18	
0.002	11.2	

Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	17.0
	0.425 - 0.250	7.0
	0.250 - 0.150	7.0
	0.150 - 0.075	9.0
	< 0.075	53.5

Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	510.6	
Grading Coefficient	12.4	
Grading modulus	0.99	
Atterberg Limits	Liquid Limit	34
	Plasticity Index	15
	Linear Shrinkage	7.4
Unified Soil Classification	CL	
U.S. Highway Classification	A-6(4)	
pH - Value	N/A	
Conductivity mS/cm	N/A	

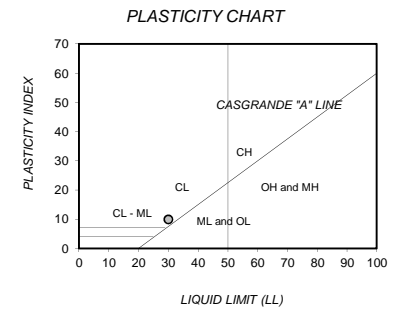
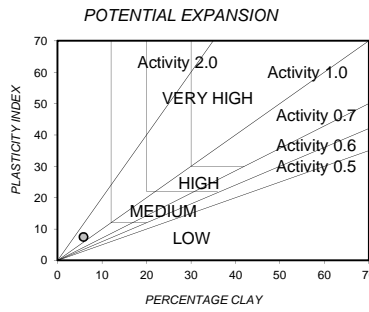




**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP9  
**LAYER :** 2760-3460mm  
**SAMPLE No. :** I/ 3544  
**SAMPLE DESCRIPTION :** Light Yellow Orange Shale

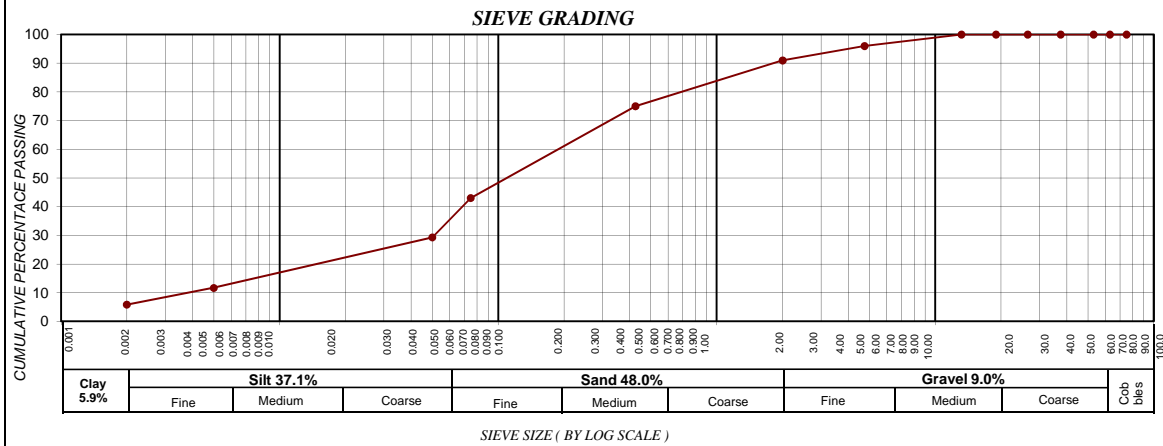
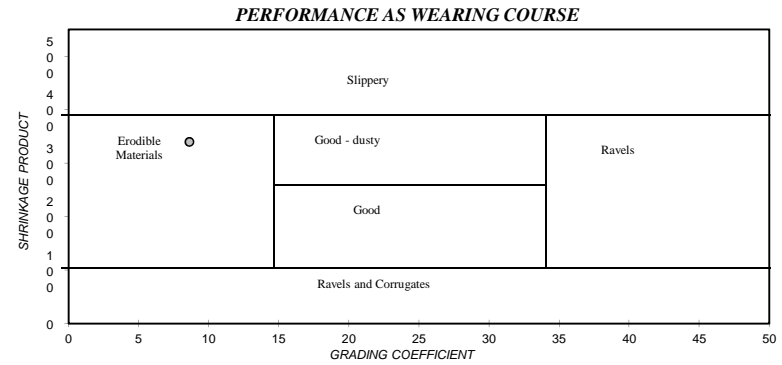
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	96
	2.000	91
	0.425	75
	0.250	65
	0.150	55
	0.075	43
0.050	29	
0.005	12	
0.002	5.9	



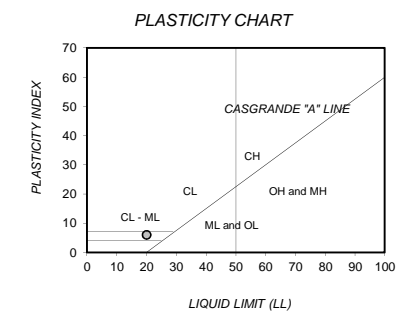
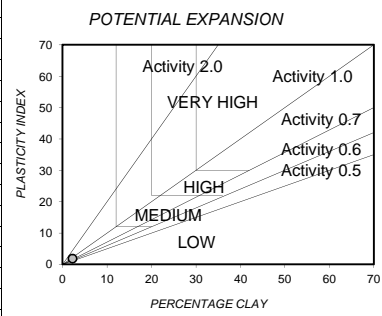
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	16.0
	0.425 - 0.250	10.0
	0.250 - 0.150	10.0
	0.150 - 0.075	12.0
	< 0.075	47.3

Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	339.8	
Grading Coefficient	8.6	
Grading modulus	0.91	
Atterberg Limits	Liquid Limit	30
	Plasticity Index	10
	Linear Shrinkage	4.53
Unified Soil Classification	ML	
U.S. Highway Classification	A-4(2)	
pH - Value	N/A	
Conductivity mS/cm	N/A	

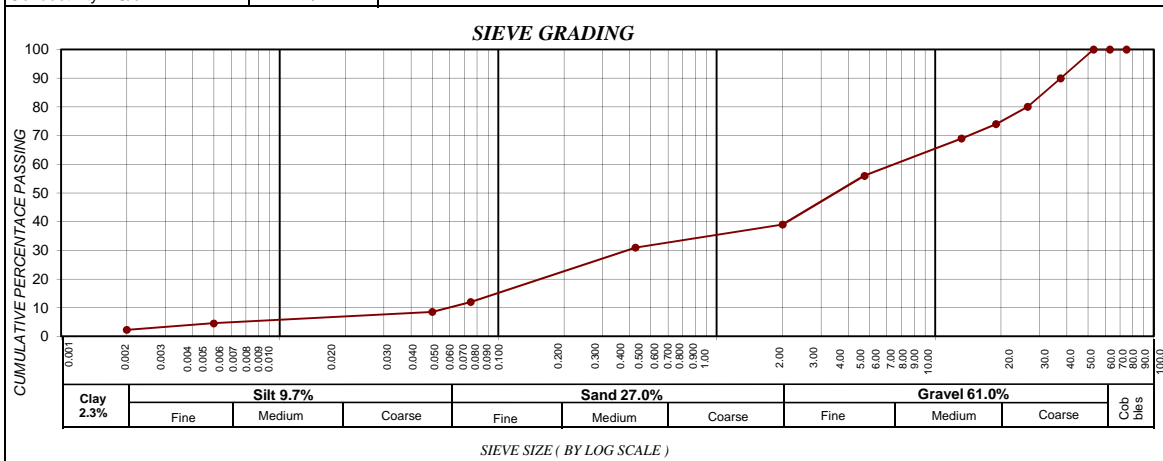
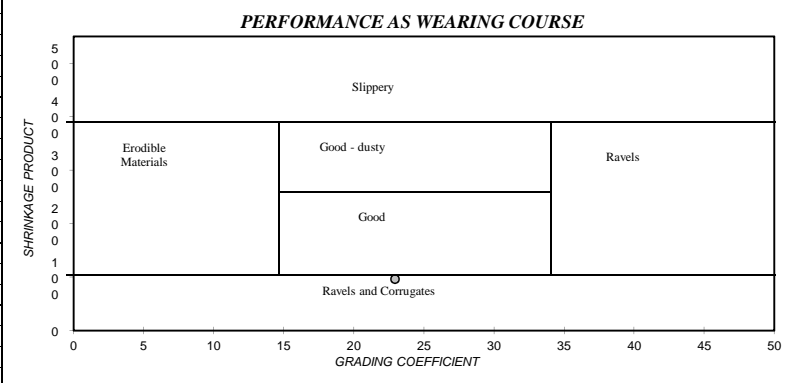


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** N/A  
**LAYER :** 400-900mm  
**SAMPLE No. :** I/ 3545  
**SAMPLE DESCRIPTION :** Dark Red Orange Ferricrete & Quartzite

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	90
	26.5	80
	19.0	74
	13.2	69
	4.75	56
	2.000	39
	0.425	31
	0.250	25
	0.150	19
	0.075	12
0.050	9	
0.005	5	
0.002	2.3	



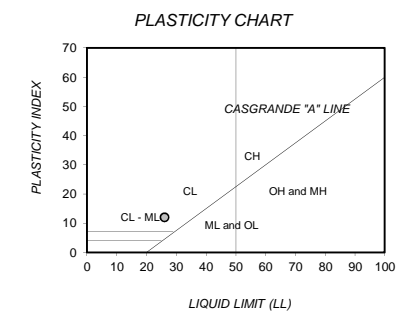
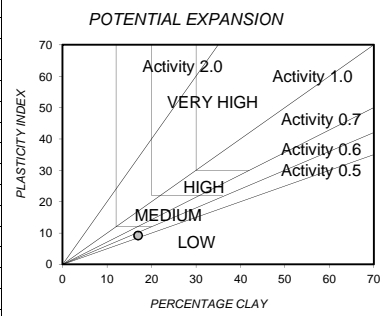
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	8.0
	0.425 - 0.250	6.0
	0.250 - 0.150	6.0
	0.150 - 0.075	7.0
	< 0.075	30.8
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		10.0
Shrinkage Product		96.1
Grading Coefficient		23.0
Grading modulus		2.18
Atter- berg Limits	Liquid Limit	20
	Plasticity Index	6
	Linear Shrinkage	3.1
Unified Soil Classification		SC
U.S. Highway Classification		A-1-b(0)
pH - Value		N/A
Conductivity mS/cm		N/A



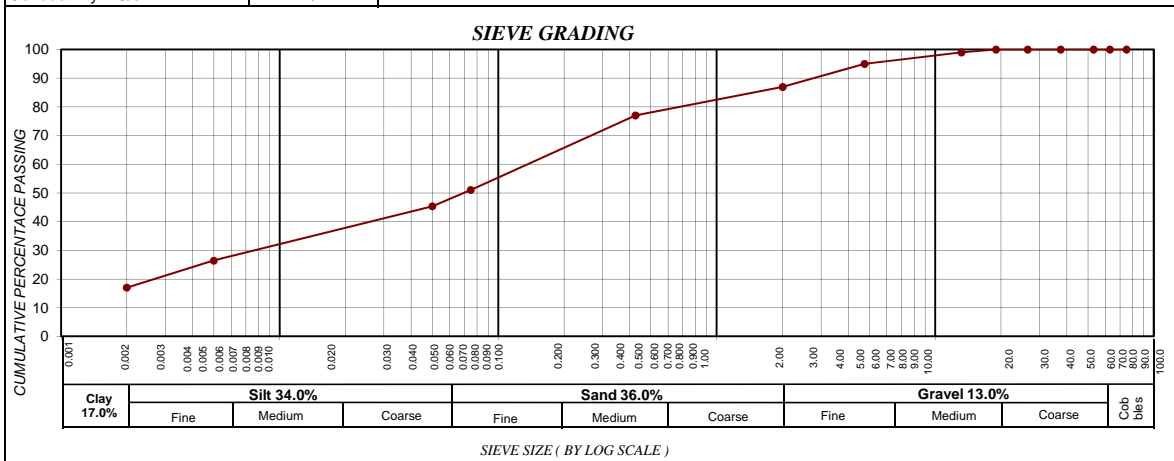
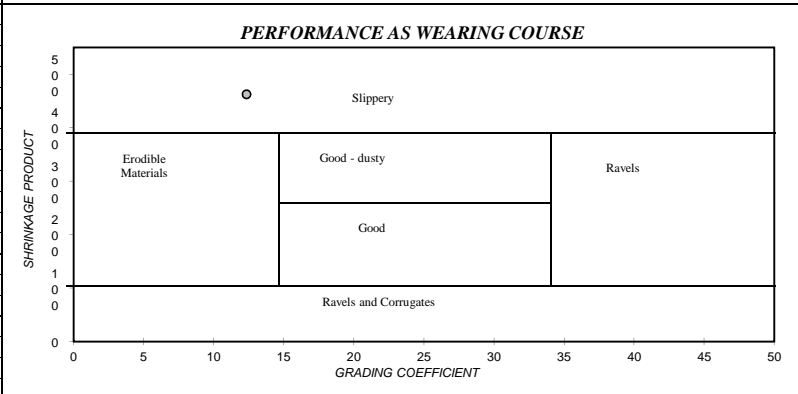


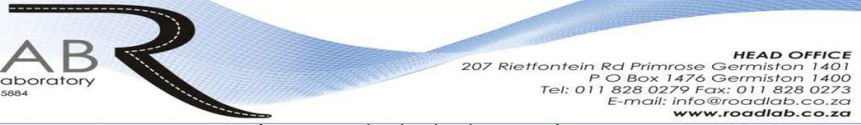
**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP11  
**LAYER :** 2500-3000mm  
**SAMPLE No. :** I/ 3546  
**SAMPLE DESCRIPTION :** Dark Yellow Orange Ferrinodules & Shale

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	99
	4.75	95
	2.000	87
	0.425	77
	0.250	68
	0.150	60
	0.075	51
	0.050	45



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	10.0
	0.425 - 0.250	9.0
	0.250 - 0.150	8.0
	0.150 - 0.075	9.0
	< 0.075	58.6
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		462.0
Grading Coefficient		12.4
Grading modulus		0.85
Atter- berg Limits	Liquid Limit	26
	Plasticity Index	12
	Linear Shrinkage	6
Unified Soil Classification		CL
U.S. Highway Classification		A-6(4)
pH - Value		N/A
Conductivity mS/cm		N/A

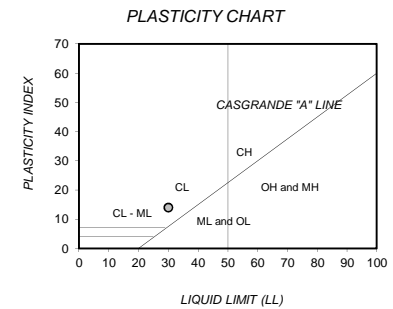
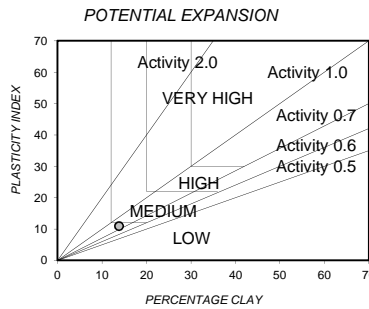




**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP11  
**LAYER :** 3000-3600mm  
**SAMPLE No. :** I/ 3547  
**SAMPLE DESCRIPTION :** Light Yellow Orange Shale

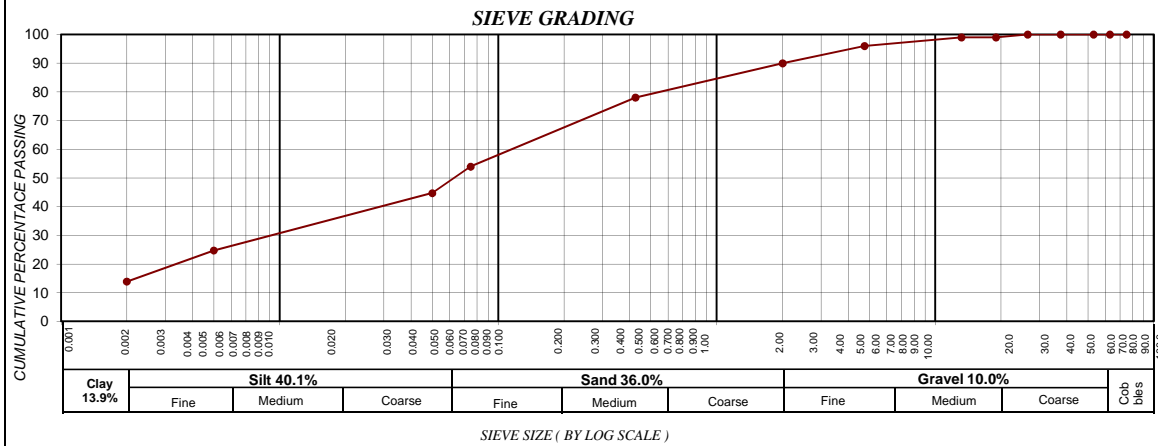
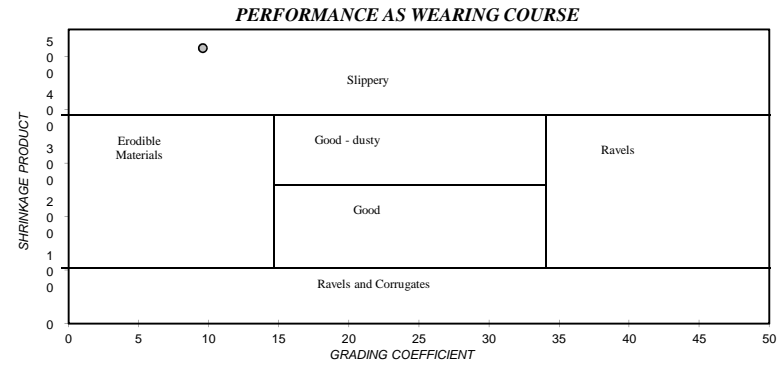
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	99
	13.2	99
	4.75	96
	2.000	90
	0.425	78
	0.250	70
	0.150	64
	0.075	54
0.050	45	
0.005	25	
0.002	13.9	



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	12.0
	0.425 - 0.250	8.0
	0.250 - 0.150	6.0
	0.150 - 0.075	10.0
	< 0.075	60.0

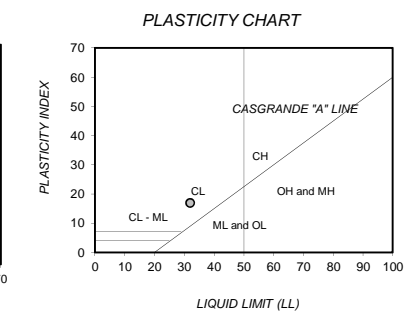
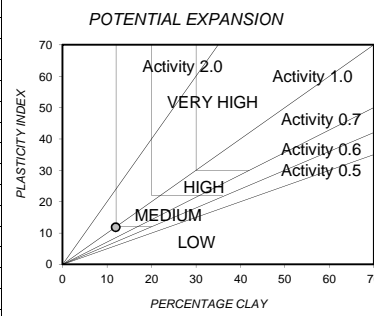
Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	514.8	
Grading Coefficient	9.6	
Grading modulus	0.78	
Atterberg Limits	Liquid Limit	30
	Plasticity Index	14
	Linear Shrinkage	6.6
Unified Soil Classification	CL	
U.S. Highway Classification	A-6(6)	
pH - Value	N/A	
Conductivity mS/cm	N/A	



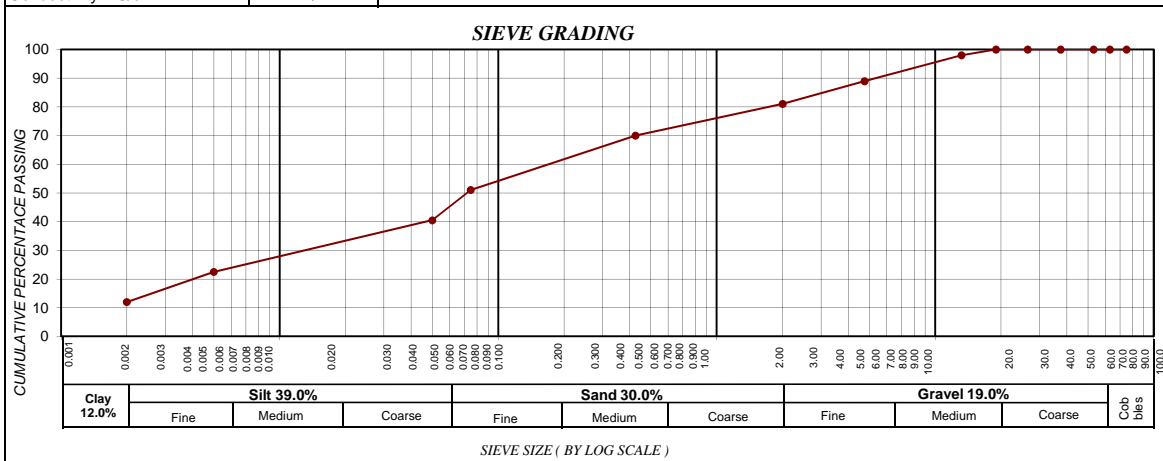
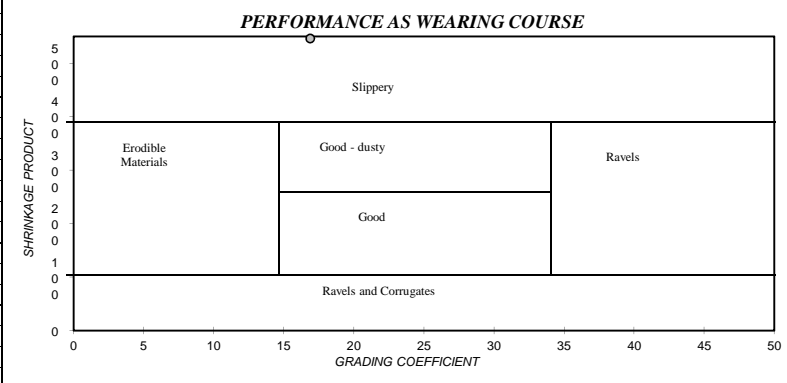


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP13  
**LAYER :** 2500-2900mm  
**SAMPLE No. :** I/ 3548  
**SAMPLE DESCRIPTION :** Dark Red Orange Shale

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	98
	4.75	89
	2.000	81
	0.425	70
	0.250	64
	0.150	57
	0.075	51
0.050	41	
0.005	23	
0.002	12.0	



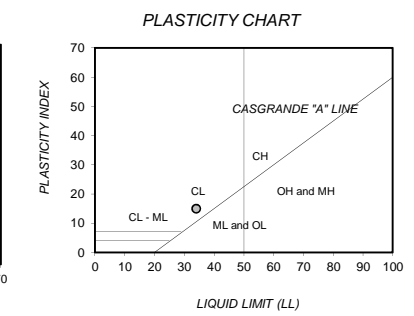
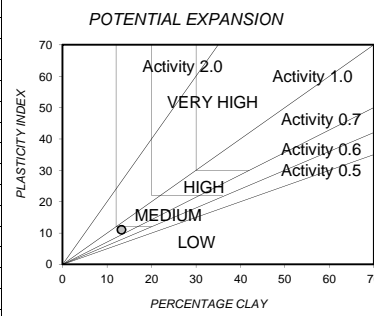
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	11.0
	0.425 - 0.250	6.0
	0.250 - 0.150	7.0
	0.150 - 0.075	6.0
	< 0.075	63.0
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		546.0
Grading Coefficient		16.9
Grading modulus		0.98
Atter- berg Limits	Liquid Limit	32
	Plasticity Index	17
	Linear Shrinkage	7.8
Unified Soil Classification		CL
U.S. Highway Classification		A-6(5)
pH - Value		N/A
Conductivity mS/cm		N/A



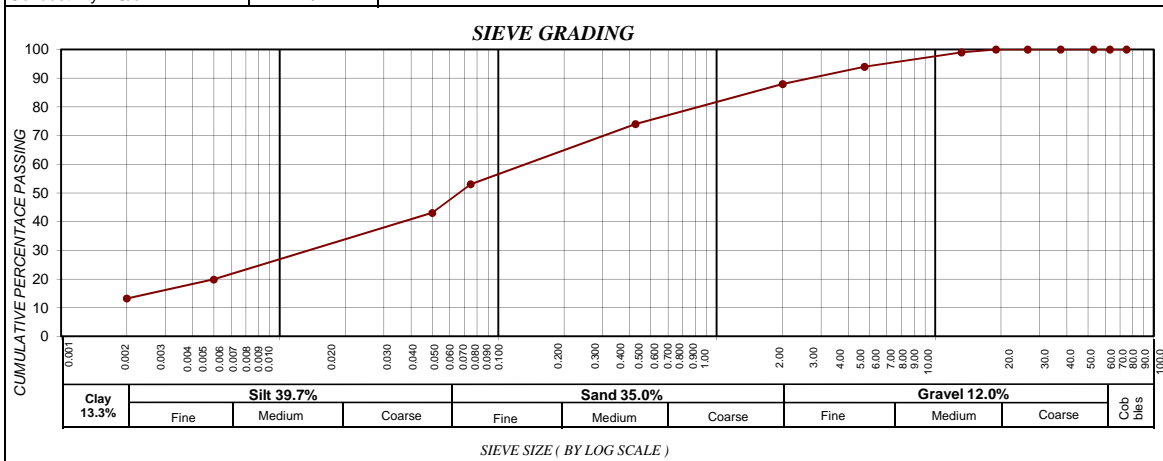
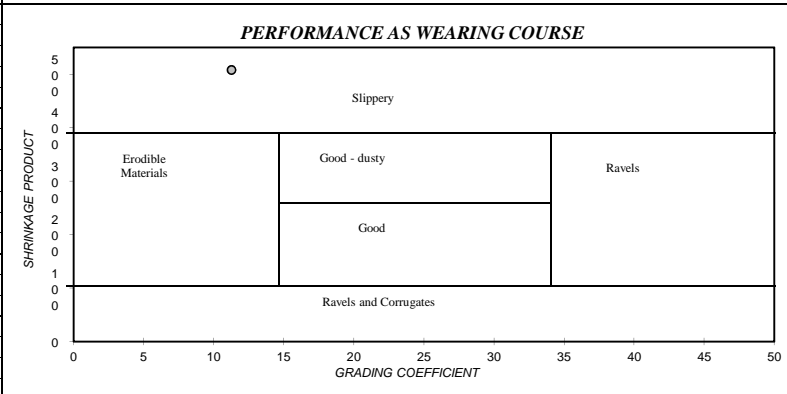


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** N/A  
**LAYER :** 2900-3300mm  
**SAMPLE No. :** I/ 3549  
**SAMPLE DESCRIPTION :** Light Red Orange Shale

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	99
	4.75	94
	2.000	88
	0.425	74
	0.250	67
	0.150	60
	0.075	53
	0.050	43



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	14.0
	0.425 - 0.250	7.0
	0.250 - 0.150	7.0
	0.150 - 0.075	7.0
	< 0.075	60.2
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		507.6
Grading Coefficient		11.3
Grading modulus		0.85
Atterberg Limits	Liquid Limit	34
	Plasticity Index	15
	Linear Shrinkage	6.86
Unified Soil Classification		CL
U.S. Highway Classification		A-6(5)
pH - Value		N/A
Conductivity mS/cm		N/A



CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP14

LAYER : 400-1000mm

SAMPLE No. : I/ 3550

SAMPLE DESCRIPTION : Light Red Orange

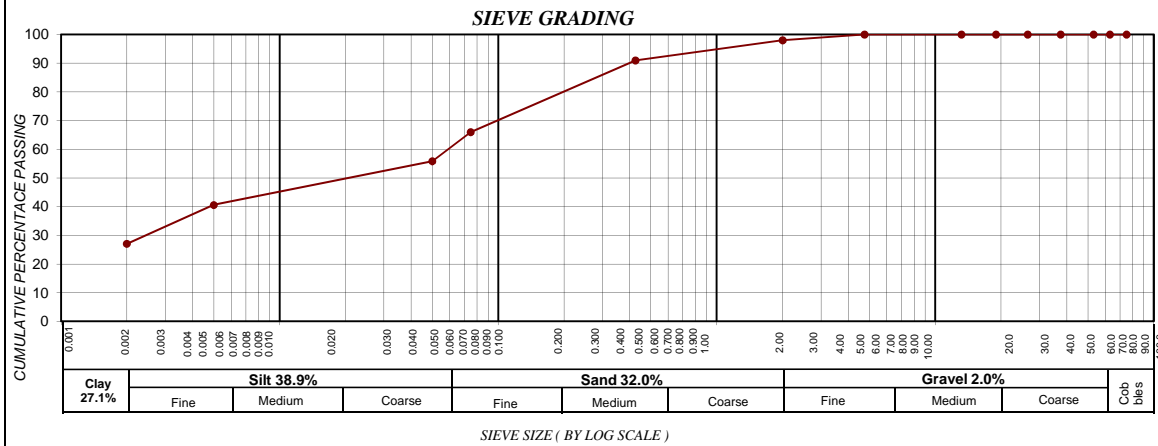
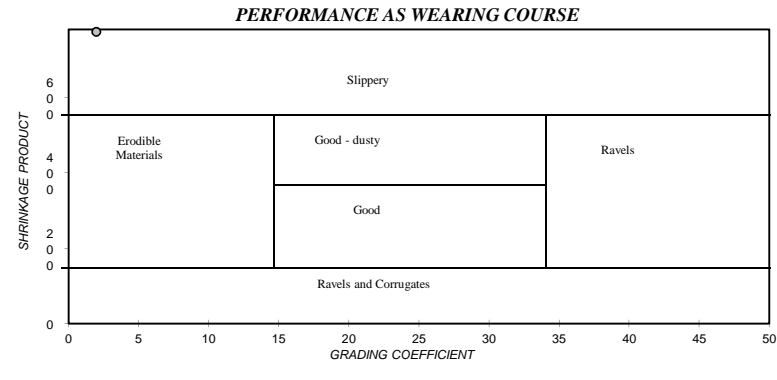
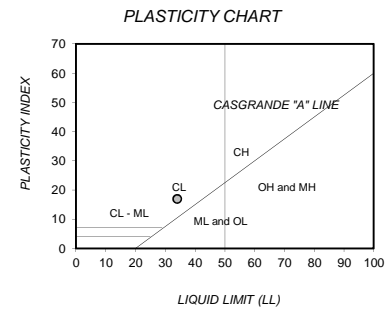
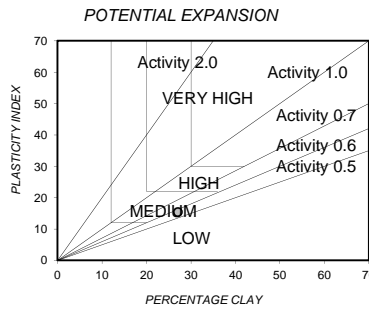
Ferricrete & Quartzetic Sand

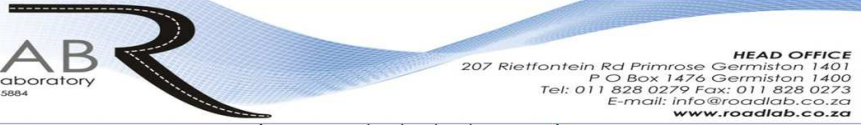
**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	98
	0.425	91
	0.250	84
	0.150	75
	0.075	66
0.050	56	
0.005	41	
0.002	27.1	

Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	7.0
	0.425 - 0.250	7.0
	0.250 - 0.150	9.0
	0.150 - 0.075	9.0
	< 0.075	67.3

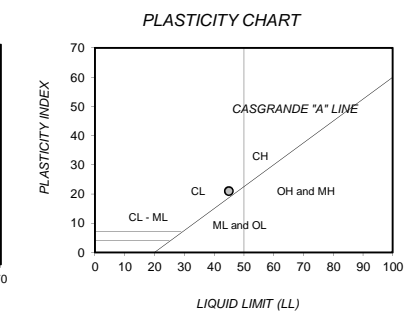
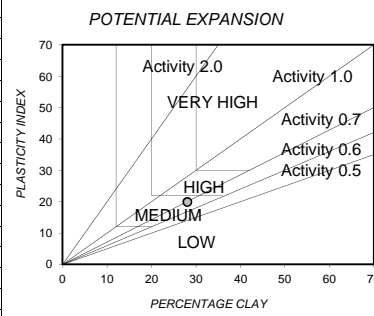
Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	773.5	
Grading Coefficient	2.0	
Grading modulus	0.45	
Atterberg Limits	Liquid Limit	34
	Plasticity Index	17
	Linear Shrinkage	8.5
Unified Soil Classification	CL	
U.S. Highway Classification	A-6(9)	
pH - Value	N/A	
Conductivity mS/cm	N/A	



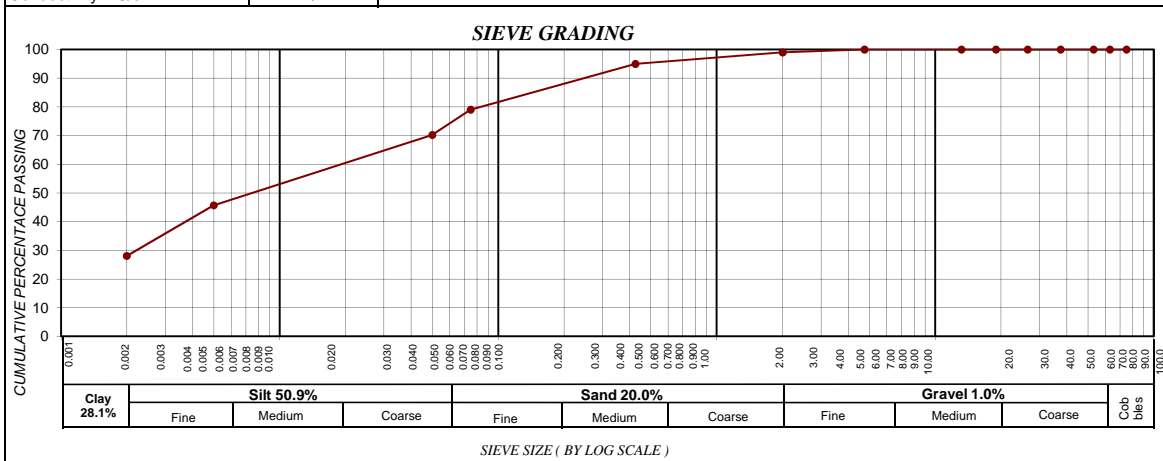
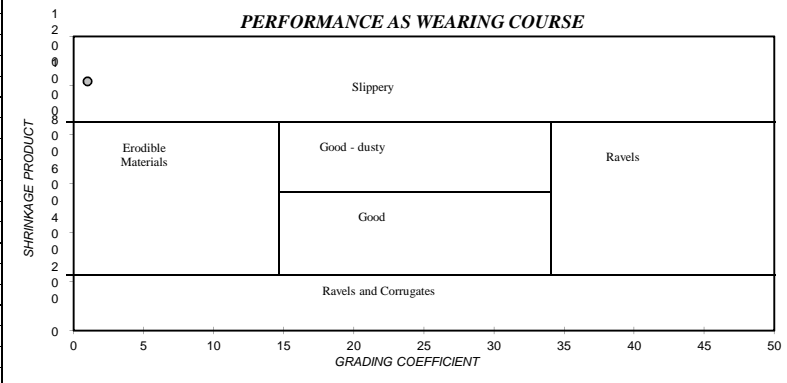


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP14  
**LAYER :** 2400-5000mm  
**SAMPLE No. :** I/ 3551  
**SAMPLE DESCRIPTION :** Light Red Orange Ferricrete & Quartzetic Sand

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	99
	0.425	95
	0.250	90
	0.150	85
	0.075	79
	0.050	70



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	4.0
	0.425 - 0.250	5.0
	0.250 - 0.150	5.0
	0.150 - 0.075	6.0
	< 0.075	79.8
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		1016.5
Grading Coefficient		1.0
Grading modulus		0.27
Atterberg Limits	Liquid Limit	45
	Plasticity Index	21
	Linear Shrinkage	10.7
Unified Soil Classification		CL
U.S. Highway Classification		A-7-6(13)
pH - Value		N/A
Conductivity mS/cm		N/A

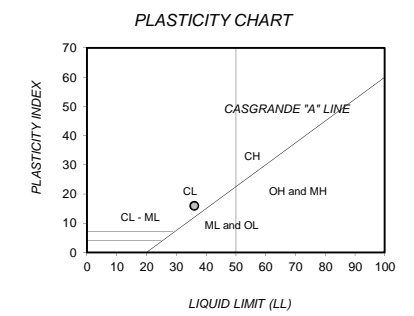
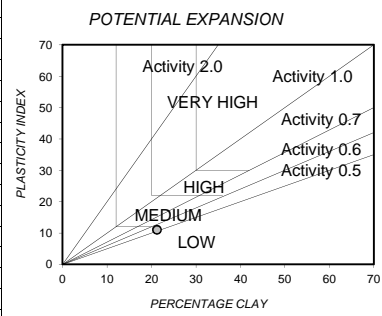




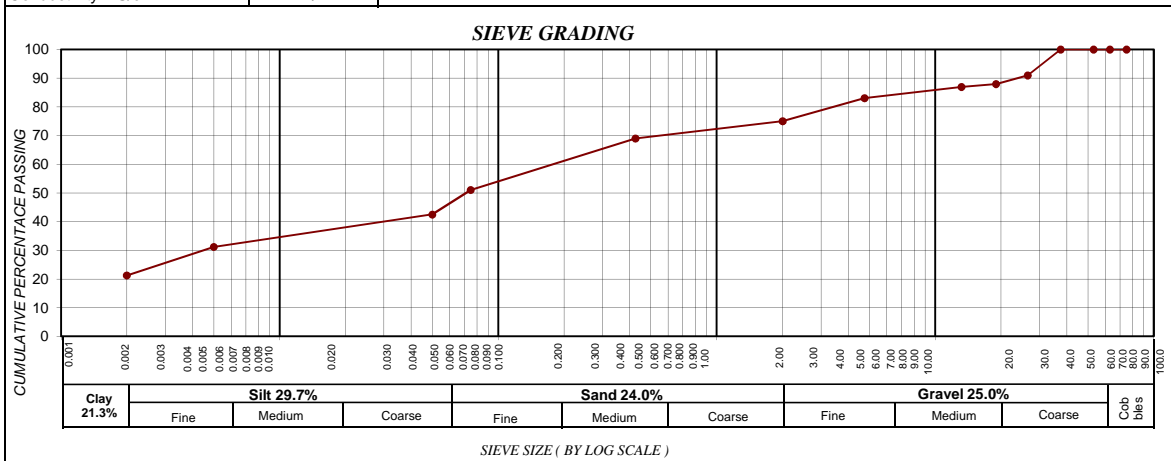
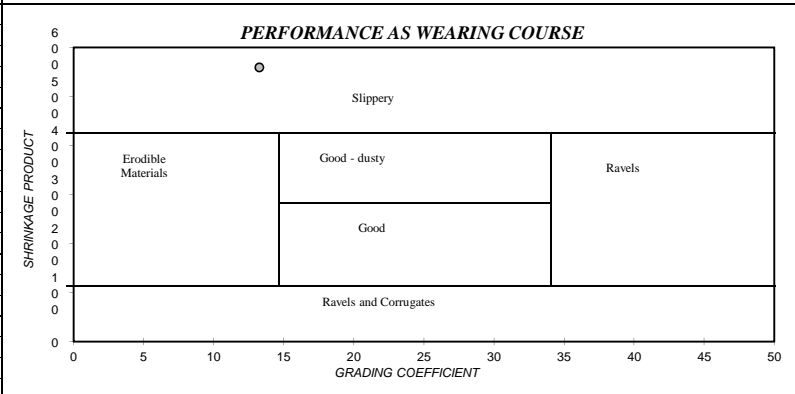
**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale

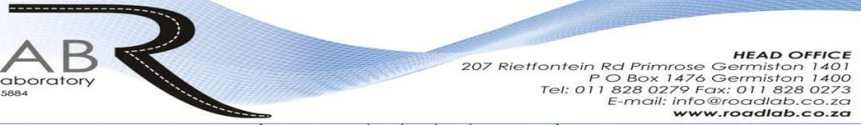
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP15  
**LAYER :** 0-800mm  
**SAMPLE No. :** I/ 3552  
**SAMPLE DESCRIPTION :** Dark Red Orange  
Ferrinodules & Quartzite

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	91
	19.0	88
	13.2	87
	4.75	83
	2.000	75
	0.425	69
	0.250	64
	0.150	57
	0.075	51
0.050	43	
0.005	31	
0.002	21.3	



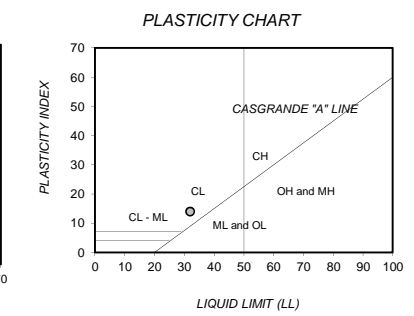
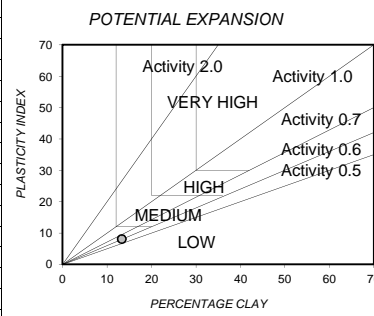
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	6.0
	0.425 - 0.250	5.0
	0.250 - 0.150	7.0
	0.150 - 0.075	6.0
	< 0.075	68.0
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		558.9
Grading Coefficient		13.3
Grading modulus		1.05
Atter- berg Limits	Liquid Limit	36
	Plasticity Index	16
	Linear Shrinkage	8.1
Unified Soil Classification		CL
U.S. Highway Classification		A-6(5)
pH - Value		N/A
Conductivity mS/cm		N/A



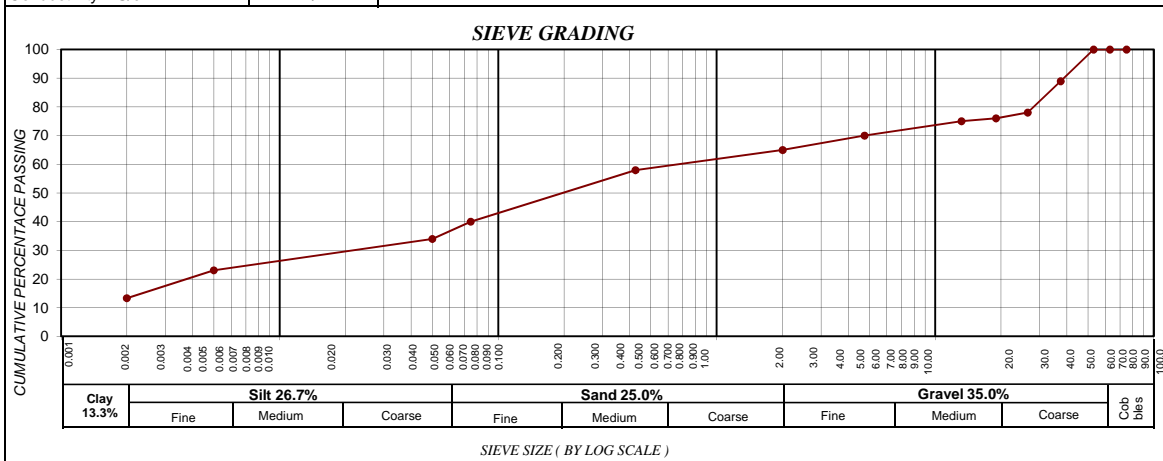
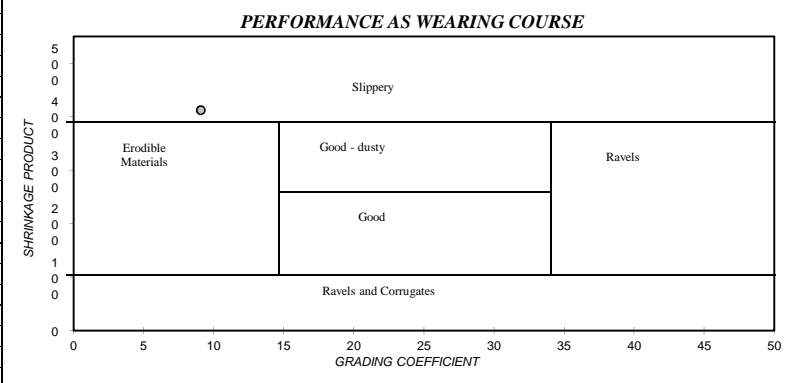


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** N/A  
**LAYER :** 0-600mm  
**SAMPLE No. :** I/ 3555  
**SAMPLE DESCRIPTION :** Light Red Orange Ironstone & Ferrinodules

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	89
	26.5	78
	19.0	76
	13.2	75
	4.75	70
	2.000	65
	0.425	58
	0.250	52
	0.150	47
	0.075	40
0.050	34	
0.005	23	
0.002	13.3	

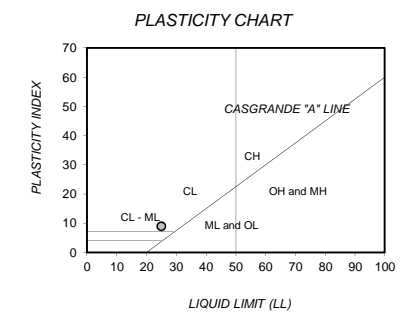
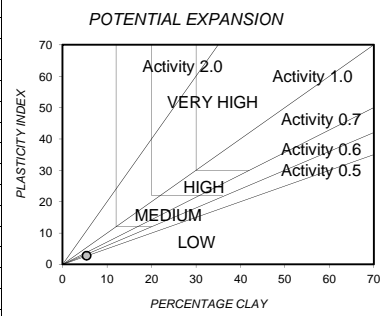


Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	7.0
	0.425 - 0.250	6.0
	0.250 - 0.150	5.0
	0.150 - 0.075	7.0
	< 0.075	61.5
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		11.0
Shrinkage Product		411.8
Grading Coefficient		9.1
Grading modulus		1.37
Atter- berg Limits	Liquid Limit	32
	Plasticity Index	14
	Linear Shrinkage	7.1
Unified Soil Classification		CL
U.S. Highway Classification		A-6(2)
pH - Value		N/A
Conductivity mS/cm		N/A

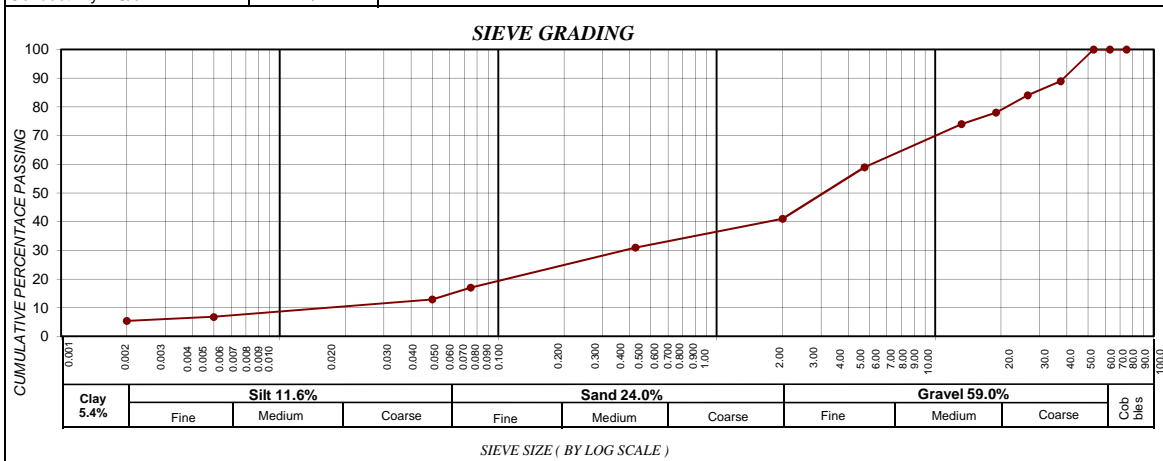
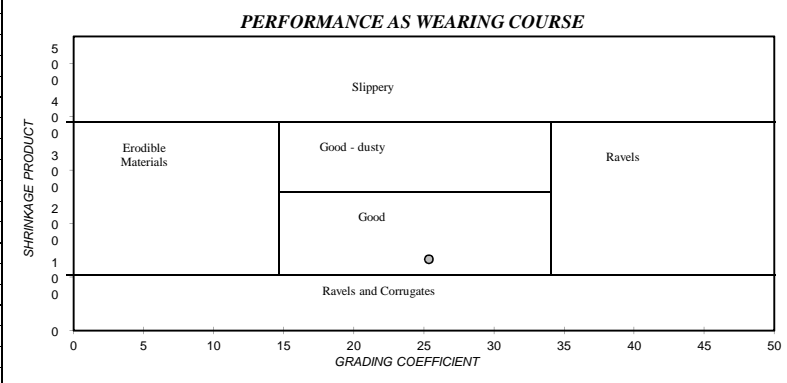


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP20  
**LAYER :** 1000-3500mm  
**SAMPLE No. :** I/ 3557  
**SAMPLE DESCRIPTION :** Dark Red Orange Ferricrete & Ferrinodules

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	89
	26.5	84
	19.0	78
	13.2	74
	4.75	59
	2.000	41
	0.425	31
	0.250	27
	0.150	22
	0.075	17
0.050	13	
0.005	7	
0.002	5.4	

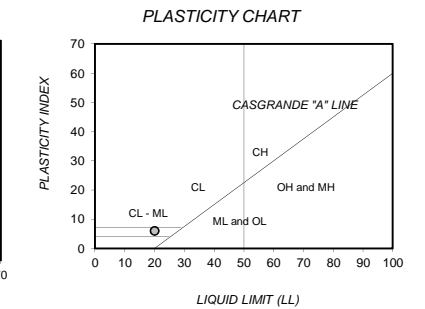
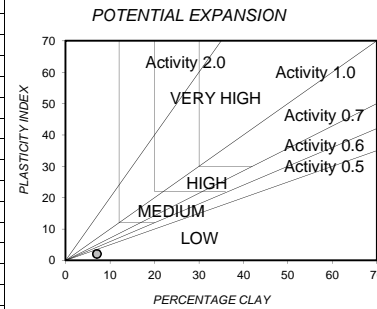


Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	10.0
	0.425 - 0.250	4.0
	0.250 - 0.150	5.0
	0.150 - 0.075	5.0
	< 0.075	41.5
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		11.0
Shrinkage Product		133.3
Grading Coefficient		25.4
Grading modulus		2.11
Atter- berg Limits	Liquid Limit	25
	Plasticity Index	9
	Linear Shrinkage	4.3
Unified Soil Classification		SC
U.S. Highway Classification		A-2-4(0)
pH - Value		N/A
Conductivity mS/cm		N/A

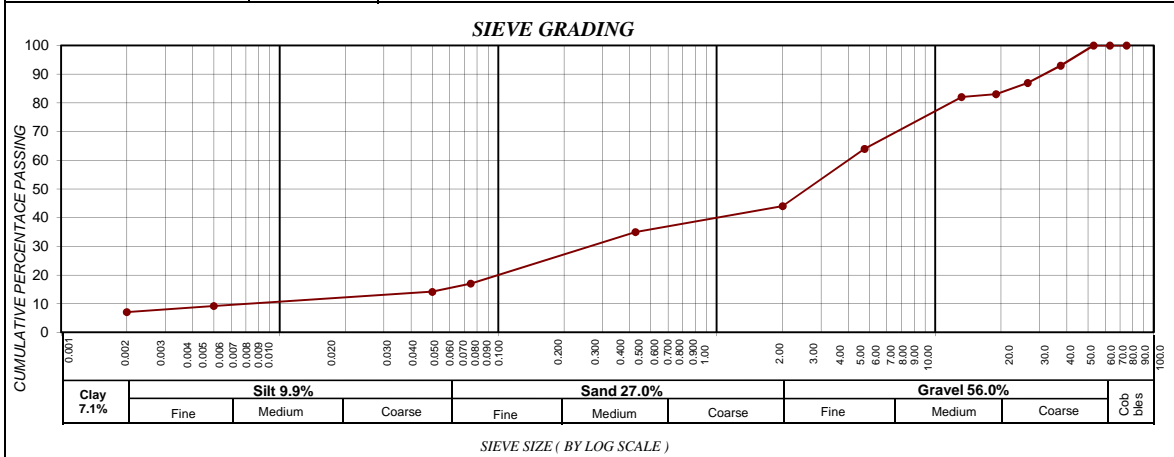
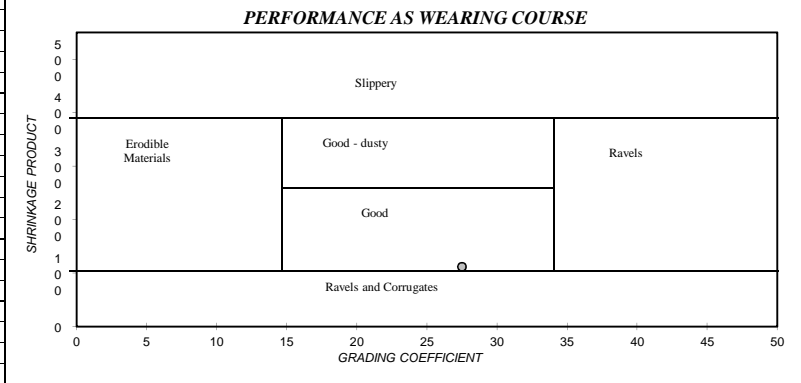


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP R1  
**LAYER :** 300-1200mm  
**SAMPLE No. :** I/ 3558  
**SAMPLE DESCRIPTION :** Light Red Orange Ferricrete & Sandstone

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	93
	26.5	87
	19.0	83
	13.2	82
	4.75	64
	2.000	44
	0.425	35
	0.250	30
	0.150	23
	0.075	17
0.050	14	
0.005	9	
0.002	7.1	

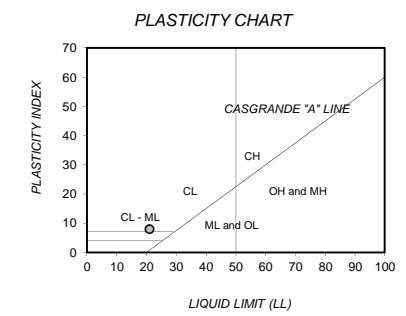
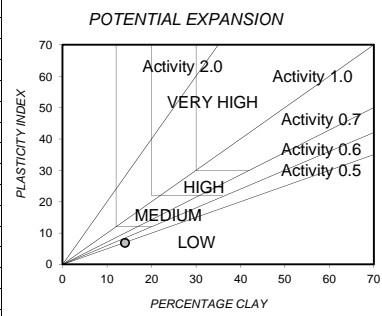


Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	9.0
	0.425 - 0.250	5.0
	0.250 - 0.150	7.0
	0.150 - 0.075	6.0
	< 0.075	38.6
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		7.0
Shrinkage Product		112.0
Grading Coefficient		27.5
Grading modulus		2.04
Atter- berg Limits	Liquid Limit	20
	Plasticity Index	6
	Linear Shrinkage	3.2
Unified Soil Classification		SC
U.S. Highway Classification		A-1-b(0)
pH - Value		N/A
Conductivity mS/cm		N/A

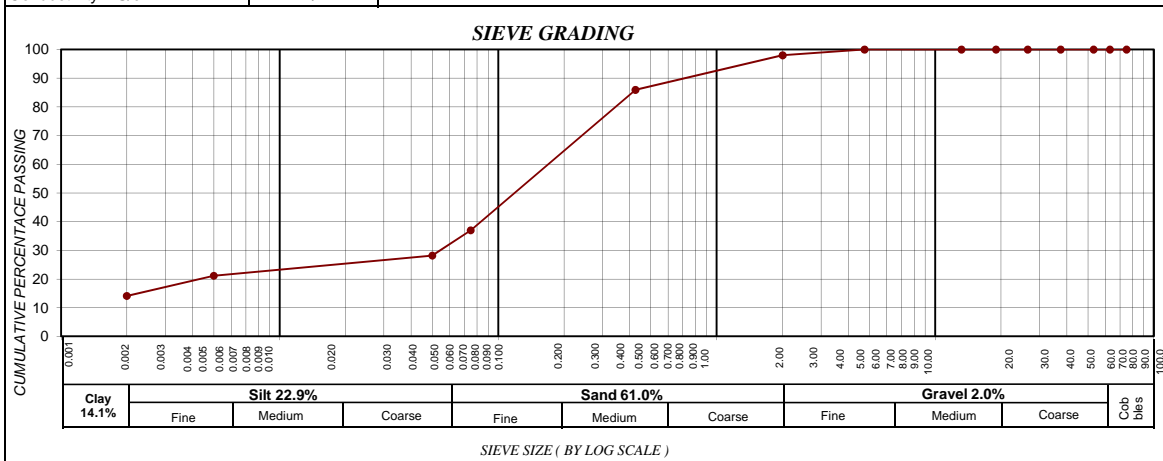
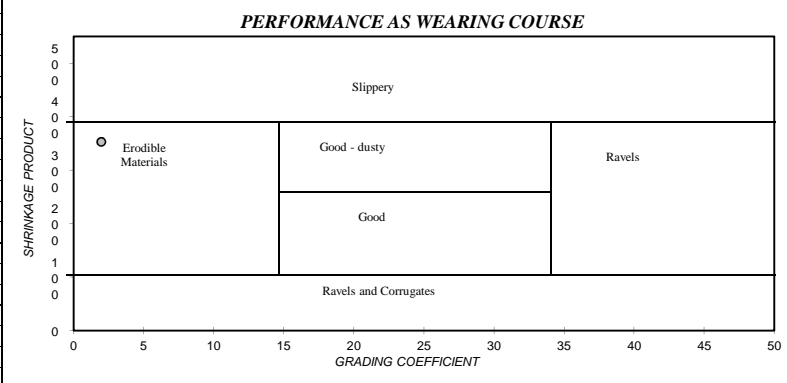


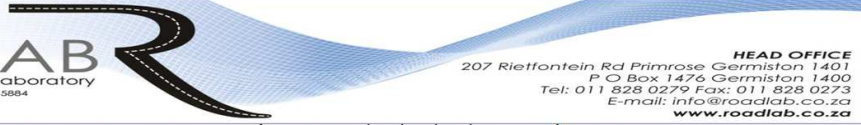
**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** RP R4  
**LAYER :** 100-1300mm  
**SAMPLE No. :** I/ 3560  
**SAMPLE DESCRIPTION :** Light Yellow Orange  
Quartzetic Sand

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	98
	0.425	86
	0.250	70
	0.150	54
	0.075	37
0.050	28	
0.005	21	
0.002	14.1	



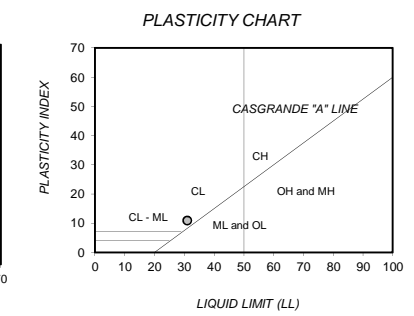
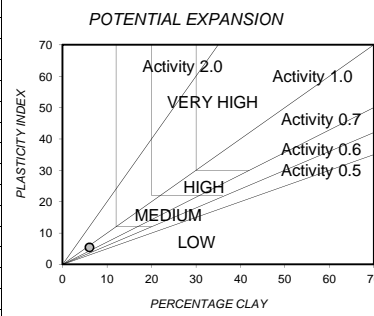
Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	12.0
	0.425 - 0.250	16.0
	0.250 - 0.150	16.0
	0.150 - 0.075	17.0
	< 0.075	37.8
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		352.6
Grading Coefficient		2.0
Grading modulus		0.79
Atter- berg Limits	Liquid Limit	21
	Plasticity Index	8
	Linear Shrinkage	4.1
Unified Soil Classification		ML
U.S. Highway Classification		A-4(1)
pH - Value		N/A
Conductivity mS/cm		N/A



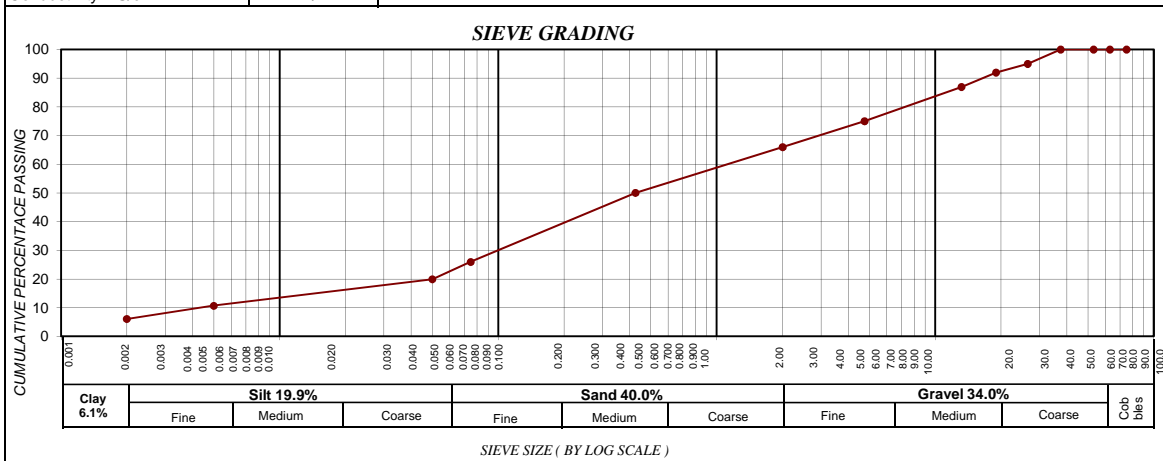
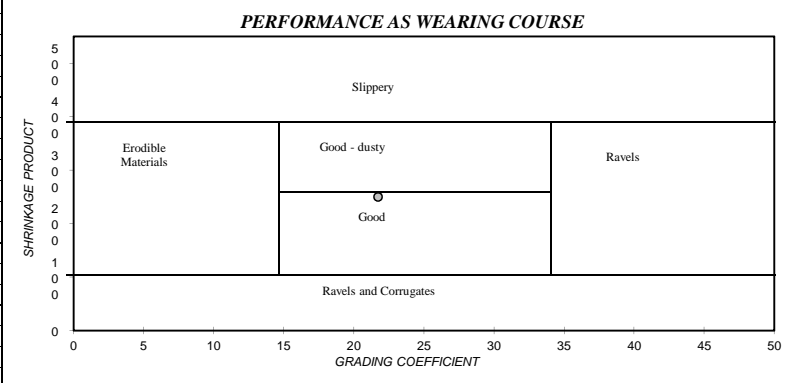


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP3  
**LAYER :** 1800-2400mm  
**SAMPLE No. :** I/ 3537  
**SAMPLE DESCRIPTION :** Light Red Orange Shale

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	95
	19.0	92
	13.2	87
	4.75	75
	2.000	66
	0.425	50
	0.250	43
	0.150	35
	0.075	26
0.050	20	
0.005	11	
0.002	6.1	



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	16.0
	0.425 - 0.250	7.0
	0.250 - 0.150	8.0
	0.150 - 0.075	9.0
	< 0.075	39.4
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		250.0
Grading Coefficient		21.8
Grading modulus		1.58
Atterberg Limits	Liquid Limit	31
	Plasticity Index	11
	Linear Shrinkage	5
Unified Soil Classification		SC
U.S. Highway Classification		
pH - Value		N/A
Conductivity mS/cm		N/A



CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP16

LAYER : 3700-4300mm

SAMPLE No. : I/ 3553

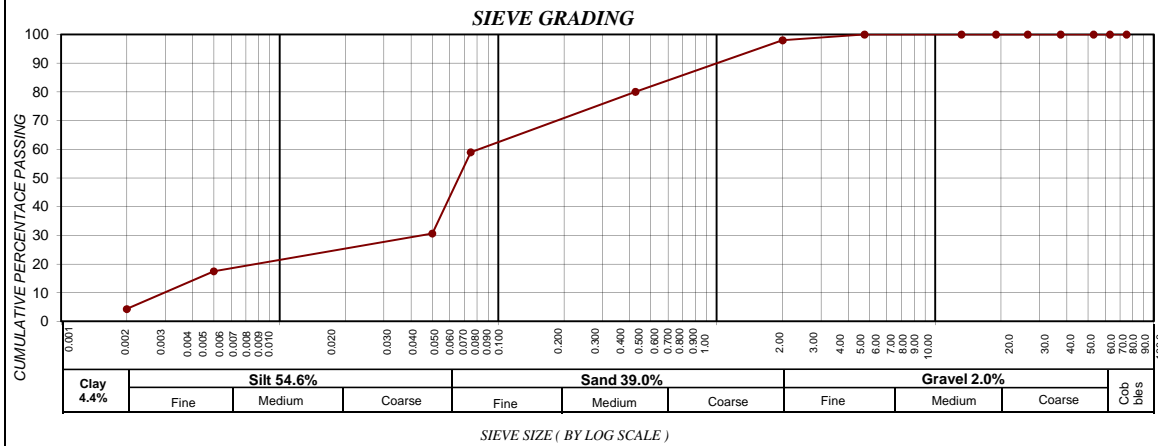
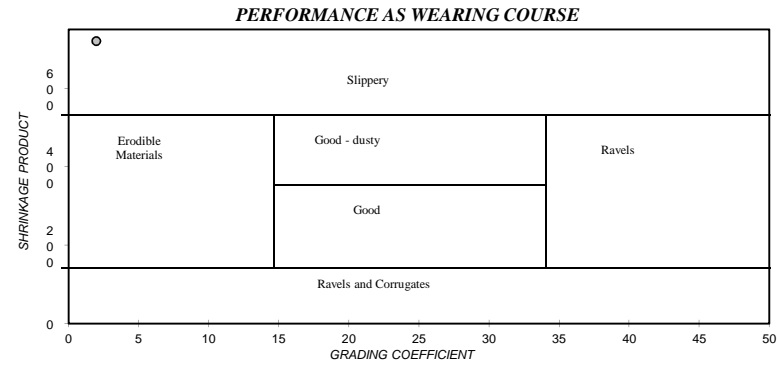
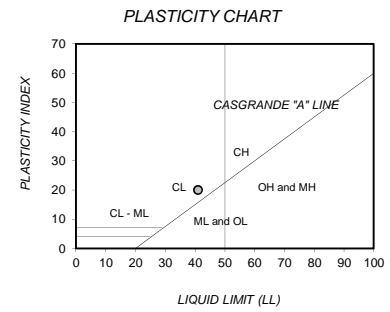
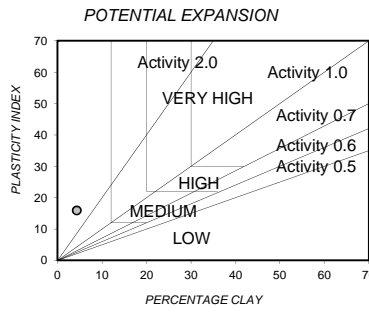
SAMPLE DESCRIPTION : Dark Red Orange  
Weathered Dolerite

**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	100
	2.000	98
	0.425	80
	0.250	74
	0.150	65
	0.075	59
0.050	31	
0.005	17	
0.002	4.4	

Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	18.0
	0.425 - 0.250	6.0
	0.250 - 0.150	9.0
	0.150 - 0.075	6.0
	< 0.075	60.2

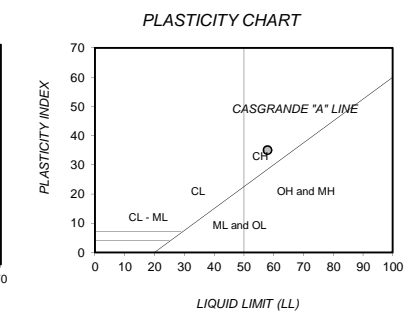
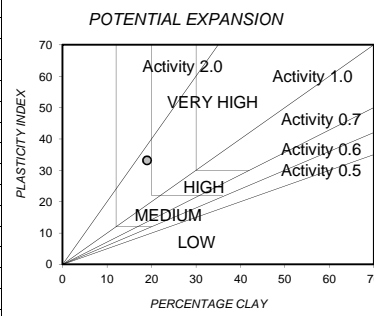
Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	0.0	
Shrinkage Product	720.0	
Grading Coefficient	2.0	
Grading modulus	0.63	
Atterberg Limits	Liquid Limit	41
	Plasticity Index	20
	Linear Shrinkage	9
Unified Soil Classification	CL	
U.S. Highway Classification	A-7-6(9)	
pH - Value	N/A	
Conductivity mS/cm	N/A	



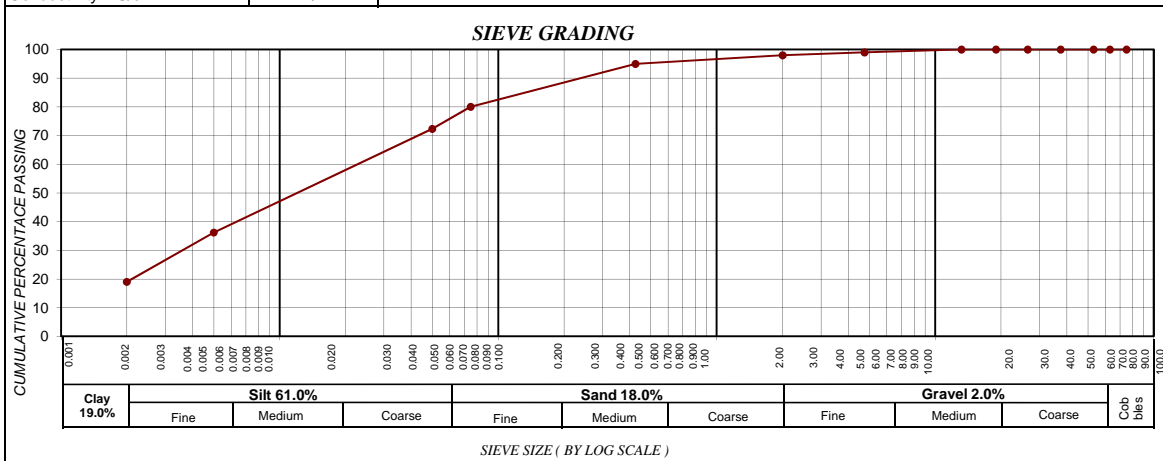
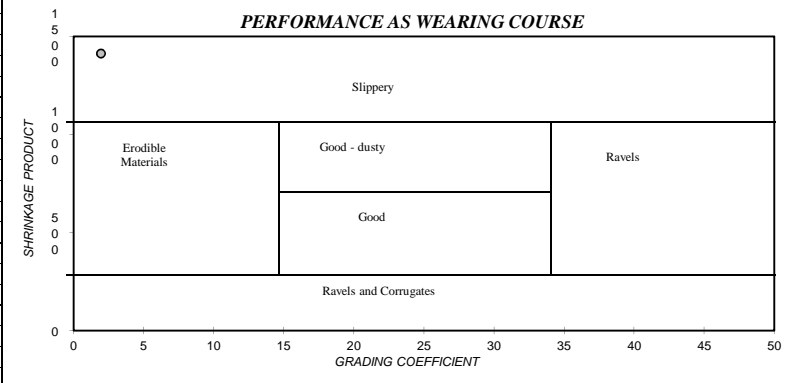


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP17  
**LAYER :** 1000-4200mm  
**SAMPLE No. :** I/ 3554  
**SAMPLE DESCRIPTION :** Light Red Ferrinodules

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	99
	2.000	98
	0.425	95
	0.250	90
	0.150	85
	0.075	80
0.050	72	
0.005	36	
0.002	19.0	



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	3.0
	0.425 - 0.250	5.0
	0.250 - 0.150	5.0
	0.150 - 0.075	5.0
	< 0.075	81.6
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		1411.7
Grading Coefficient		2.0
Grading modulus		0.27
Atterberg Limits	Liquid Limit	58
	Plasticity Index	35
	Linear Shrinkage	14.86
Unified Soil Classification		CH
U.S. Highway Classification		A-7-6(20)
pH - Value		N/A
Conductivity mS/cm		N/A





CLIENT : Bazi Dukhan

PROJECT: Substation Rockdale

DATE REPORTED : 04-Dec-12

CHAINAGE : TP R2

LAYER : 1000-1200mm

SAMPLE No. : I/ 3559

SAMPLE DESCRIPTION : Dark Red Orange

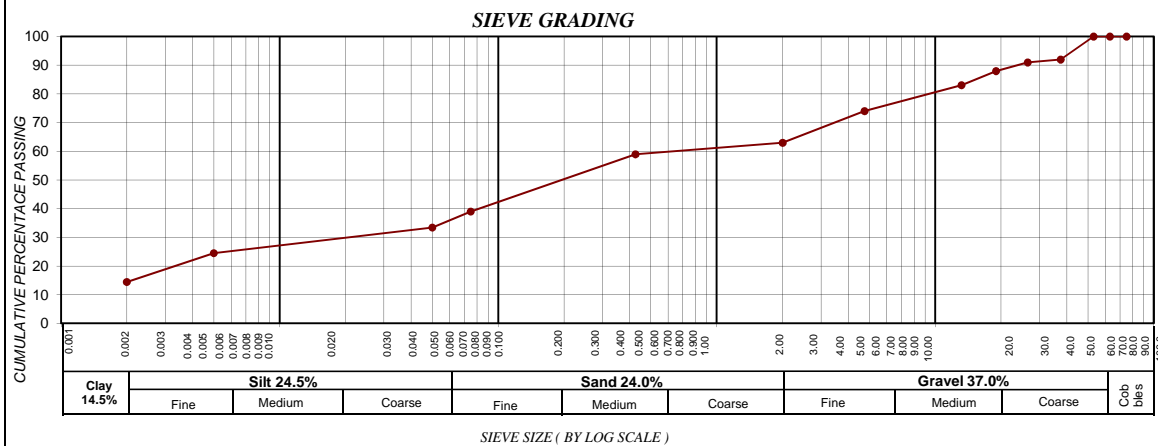
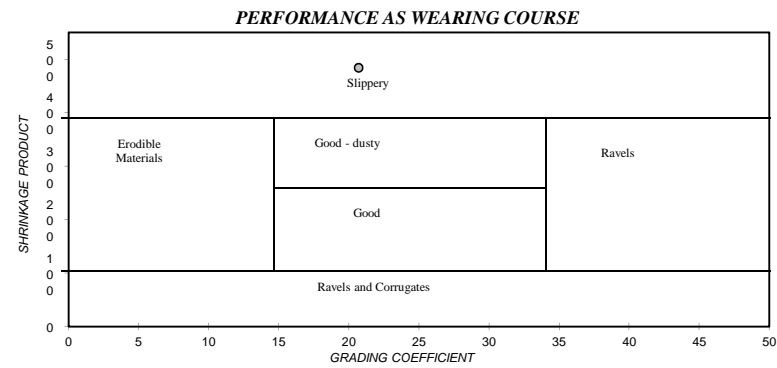
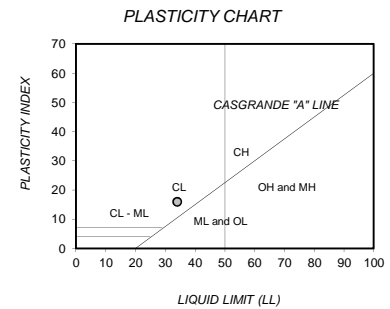
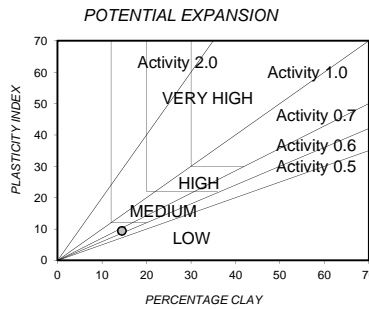
Ferricrete & Ferrinodules

**Material description**

Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	92
	26.5	91
	19.0	88
	13.2	83
	4.75	74
	2.000	63
	0.425	59
	0.250	53
	0.150	45
	0.075	39
0.050	33	
0.005	25	
0.002	14.5	

Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	4.0
	0.425 - 0.250	6.0
	0.250 - 0.150	8.0
	0.150 - 0.075	6.0
	< 0.075	61.9

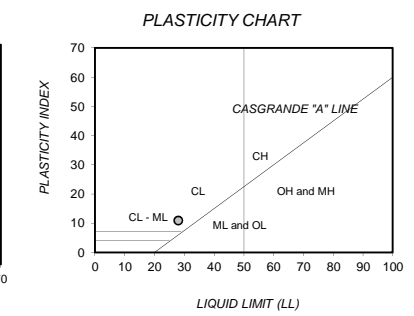
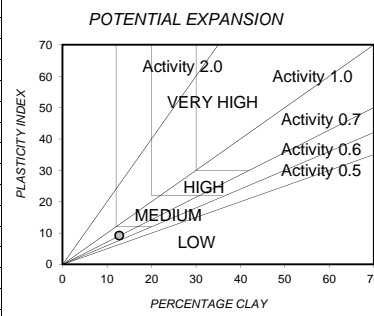
Effective size	0.005	
Uniformity Coefficient	22.8	
Curvature Coefficient	7.4	
Oversize Index	8.0	
Shrinkage Product	483.8	
Grading Coefficient	20.7	
Grading modulus	1.39	
Atterberg Limits	Liquid Limit	34
	Plasticity Index	16
	Linear Shrinkage	8.2
Unified Soil Classification	CL	
U.S. Highway Classification	A-6(2)	
pH - Value	N/A	
Conductivity mS/cm	N/A	



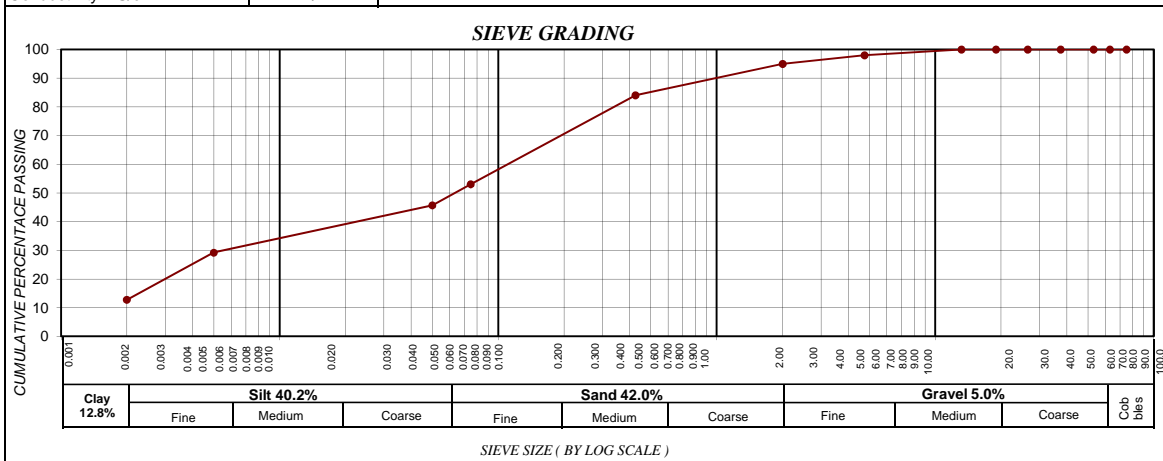
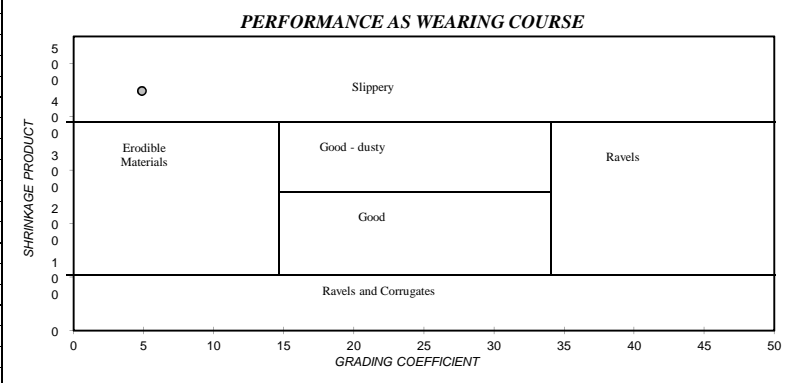


**CLIENT :** Bazi Dukhan  
**PROJECT:** Substation Rockdale  
**DATE REPORTED :** 04-Dec-12  
**CHAINAGE :** TP19  
**LAYER :** 1000-3500mm  
**SAMPLE No. :** I/ 3556  
**SAMPLE DESCRIPTION :** Yellowish Shale & Quartzite

Material description		
Sieve analysis Cumulative percentage passing (mm)	75.0	100
	63.0	100
	53.0	100
	37.5	100
	26.5	100
	19.0	100
	13.2	100
	4.75	98
	2.000	95
	0.425	84
	0.250	75
	0.150	65
	0.075	53
	0.050	46



Soil Mortar Analysis % < 2.00mm	2.000 - 0.425	11.0
	0.425 - 0.250	9.0
	0.250 - 0.150	10.0
	0.150 - 0.075	12.0
< 0.075	55.8	
Effective size		0.005
Uniformity Coefficient		22.8
Curvature Coefficient		7.4
Oversize Index		0.0
Shrinkage Product		447.7
Grading Coefficient		4.9
Grading modulus		0.68
Atterberg Limits	Liquid Limit	28
	Plasticity Index	11
	Linear Shrinkage	5.33
Unified Soil Classification		ML
U.S. Highway Classification		A-6(3)
pH - Value		N/A
Conductivity mS/cm		N/A





12140

2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.	I/ 3538			
CONTAINER USED FOR SAMPLING	Black Sampling Bags			
SIZE / WEIGHT OF SAMPLE	±70kg's			
MOISTURE CONDITION OF SAMPLE ON ARRIVAL	Slightly Moist			
HOLE No. / Km. / CHAINAGE	TP3			
LAYER TESTED / SAMPLED FROM	3000-3700mm			
DATE SAMPLED	2012/11/26			
DATE RECEIVED	2012/11/26			
CLIENTS MARKING	None			
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	100		
	26.5	95		
LYSIS (mm) (TMH A1a)	19.0	92		
	13.2	89		
	4.75	80		
	2.00	72		
	0.425	57		
	0.075	26		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	29.0		
	P.I.	10.0		
	LS%	5.2		
GM		1.45		
CLASSIFI - CATION	H.R.B.*	A-2-4(0)		
	COLTO*	<G9		
	T.R.H. 14*	G8		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	14.9		
	MDD(KG/M <sup>3</sup> )	1860		
C.B.R.	COMP MC	14.5		
	% SWELL	0.47		
U.C.S. (TMH A13T)	100%	20		
	98%	17		
C.B.R. (TMH A8)	97%	16		
	95%	13		
	93%	11		
	90%	7		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE				
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

\*Opinions & Interpretations are not included in our schedule of Accreditation  
SANAS Accredited Laboratory No. T 0296

The samples were subjected to analysis according to TMH 1  
The results reported relate only to the sample tested

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Compiled By : Roxanne Volker

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2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3545		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		N/A		
LAYER TESTED / SAMPLED FROM		400-900mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	90		
	26.5	80		
	19.0	74		
LYSIS (mm)	13.2	69		
	4.75	56		
	2.00	39		
	0.425	31		
(TMH A1a)	0.075	12		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	20.0		
	P.I.	6.0		
	LS%	3.1		
GM		2.18		
CLASSIFI - CATION	H.R.B.*	A-1-b(0)		
	COLTO*	G6		
	T.R.H. 14*	G6		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	10.5		
	MDD(KG/M <sup>3</sup> )	2081		
C.B.R.	COMP MC	10.3		
	% SWELL	0.10		
U.C.S. (TMH A13T)	100%	68		
	98%	54		
	97%	47		
C.B.R. (TMH A8)	95%	33		
	93%	26		
	90%	16		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE		CBR		
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

\*Opinions & Interpretations are not included in our schedule of Accreditation  
SANAS Accredited Laboratory No. T 0296

The samples were subjected to analysis according to TMH 1  
The results reported relate only to the sample tested

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2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3552		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		TP15		
LAYER TESTED / SAMPLED FROM		0-800mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	100		
	26.5	91		
LYSIS (mm) (TMH A1a)	19.0	88		
	13.2	87		
	4.75	83		
	2.00	75		
	0.425	69		
	0.075	51		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	36.0		
	P.I.	16.0		
	LS%	8.1		
GM		1.05		
CLASSIFI - CATION	H.R.B.*	A-6(5)		
	COLTO*	<G9		
	T.R.H. 14*	G9		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	17.3		
	MDD(KG/M <sup>3</sup> )	1869		
C.B.R.	COMP MC	17.1		
	% SWELL	1.52		
U.C.S. (TMH A13T)	100%	13		
	98%	12		
	97%	11		
C.B.R. (TMH A8)	95%	10		
	93%	8		
	90%	6		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE		CBR		
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

\*Opinions & Interpretations are not included in our schedule of Accreditation  
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2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3555		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		TP17		
LAYER TESTED / SAMPLED FROM		0-600mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	89		
	26.5	78		
LYSIS (mm) (TMH A1a)	19.0	76		
	13.2	75		
	4.75	70		
	2.00	65		
	0.425	58		
	0.075	40		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	32.0		
	P.I.	14.0		
	LS%	7.1		
GM		1.37		
CLASSIFI - CATION	H.R.B.*	A-6(2)		
	COLTO*	<G9		
	T.R.H. 14*	G10		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	15.7		
	MDD(KG/M <sup>3</sup> )	1847		
C.B.R.	COMP MC	15.5		
	% SWELL	0.71		
U.C.S. (TMH A13T)	100%	13		
	98%	11		
	97%	10		
C.B.R. (TMH A8)	95%	8		
	93%	6		
	90%	3		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE				
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

\*Opinions & Interpretations are not included in our schedule of Accreditation  
SANAS Accredited Laboratory No. T 0296

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Compiled By : Roxanne Volker

12140

2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3557		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		TP20		
LAYER TESTED / SAMPLED FROM		100-1200mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	89		
	26.5	84		
LYSIS (mm) (TMH A1a)	19.0	78		
	13.2	74		
	4.75	59		
	2.00	41		
	0.425	31		
	0.075	17		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	25.0		
	P.I.	9.0		
	LS%	4.3		
GM		2.11		
CLASSIFI - CATION	H.R.B.*	A-2-4(0)		
	COLTO*	G7		
	T.R.H. 14*	G7		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	12.2		
	MDD(KG/M <sup>3</sup> )	2077		
C.B.R.	COMP MC	12.0		
	% SWELL	0.87		
U.C.S. (TMH A13T)	100%	33		
	98%	27		
	97%	25		
C.B.R. (TMH A8)	95%	19		
	93%	15		
	90%	9		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE		CBR		
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

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SANAS Accredited Laboratory No. T 0296

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2012/12/04

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PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.	I/ 3558			
CONTAINER USED FOR SAMPLING	Black Sampling Bags			
SIZE / WEIGHT OF SAMPLE	±70kg's			
MOISTURE CONDITION OF SAMPLE ON ARRIVAL	Slightly Moist			
HOLE No. / Km. / CHAINAGE	TP R1			
LAYER TESTED / SAMPLED FROM	300-1200mm			
DATE SAMPLED	2012/11/26			
DATE RECEIVED	2012/11/26			
CLIENTS MARKING	None			
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	93		
	26.5	87		
LYSIS (mm) (TMH A1a)	19.0	83		
	13.2	82		
	4.75	64		
	2.00	44		
	0.425	35		
	0.075	17		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	20.0		
	P.I.	6.0		
	LS%	3.2		
GM		2.04		
CLASSIFI - CATION	H.R.B.*	A-1-b(0)		
	COLTO*	G6		
	T.R.H. 14*	G6		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	10.3		
	MDD(KG/M <sup>3</sup> )	1991		
C.B.R.	COMP MC	10.1		
	% SWELL	0.35		
U.C.S. (TMH A13T)	100%	53		
	98%	46		
	97%	43		
C.B.R. (TMH A8)	95%	36		
	93%	29		
	90%	19		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE				
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

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SANAS Accredited Laboratory No. T 0296

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12140

2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3559		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		TP R2		
LAYER TESTED / SAMPLED FROM		100-1200mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	92		
	26.5	91		
LYSIS (mm) (TMH A1a)	19.0	88		
	13.2	83		
	4.75	74		
	2.00	63		
	0.425	56		
	0.075	39		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	34.0		
	P.I.	16.0		
	LS%	8.2		
GM		1.42		
CLASSIFI - CATION	H.R.B.*	A-6(2)		
	COLTO*	<G9		
	T.R.H. 14*	G8		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	14.2		
	MDD(KG/M <sup>3</sup> )	1958		
C.B.R.	COMP MC	14.0		
	% SWELL	0.47		
U.C.S. (TMH A13T)	100%	22		
	98%	19		
C.B.R. (TMH A8)	97%	17		
	95%	14		
	93%	11		
	90%	6		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE				
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

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SANAS Accredited Laboratory No. T 0296

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Compiled By : Roxanne Volker

12140

2012/12/04

Bazi Dukhan Consulting Engineers  
PO Box 37612  
Overport  
4067

Attention: Mr. N Khan

**Test Report : SUBSTATION ROCKDALE- SITE INVESTIGATION CBR TEST REPORT**

Please find the Mr. N Khan  
The unambiguous description of the sample/s as received are as follows :

SAMPLE INFORMATION & PROPERTIES				
SAMPLE No.		I/ 3560		
CONTAINER USED FOR SAMPLING		Black Sampling Bags		
SIZE / WEIGHT OF SAMPLE		±70kg's		
MOISTURE CONDITION OF SAMPLE ON ARRIVAL		Slightly Moist		
HOLE No. / Km. / CHAINAGE		TP R4		
LAYER TESTED / SAMPLED FROM		100-1300mm		
DATE SAMPLED		2012/11/26		
DATE RECEIVED		2012/11/26		
CLIENTS MARKING		None		
DESCRIPTION OF SAMPLE (COLOUR & TYPE)				
GRADING ANALYSIS - % PASSING SIEVES (TMH1 1986 : METHOD A1 (a))				
SIEVE	75.0	100		
	63.0	100		
ANA -	53.0	100		
	37.5	100		
	26.5	100		
LYSIS (mm) (TMH A1a)	19.0	100		
	13.2	100		
	4.75	100		
	2.00	98		
	0.425	86		
	0.075	37		
ATTERBERG LIMITS ANALYSIS (TMH1 1986 : METHOD A2 & A3 ; TMH1 1979)				
ATTERBERG LIMITS (TMH A2&A3)	LL%	21.0		
	P.I.	8.0		
	LS%	4.1		
GM		0.79		
CLASSIFI - CATION	H.R.B.*	A-4(0)		
	COLTO*	<G9		
	T.R.H. 14*	G8		
CALIFORNIA BEARING RATIO (TMH1 1986 : METHOD A7, A13T, A8 & A16T) / UNCONFINED COMPRESSIVE STRENGTH (TMH1 1986 : METHOD A7, A14 & A16T)				
MOD AASHTO (TMH A7)	OMC%	10.1		
	MDD(KG/M <sup>3</sup> )	2065		
C.B.R.	COMP MC	9.9		
	% SWELL	0.24		
U.C.S. (TMH A13T)	100%	27		
	98%	24		
	97%	22		
C.B.R. (TMH A8)	95%	19		
	93%	15		
	90%	8		
MOD ITS (kPa) (A16T)		N/A		
PROCTOR ITS (kPa)		N/A		
STABILISED WITH	IN LAB			
	ON SITE	Neat CBR		
TEST TYPE		CBR		
SAMPLED BY		Roadlab		
DELIVERED BY		Roadlab		
SAMPLED ACCORDING TO ENVIRONMENTAL CONDITION		Clients Requirements Hot		
REMARKS & NOTES		None		

**Remarks :**

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Compiled By : Roxanne Volker

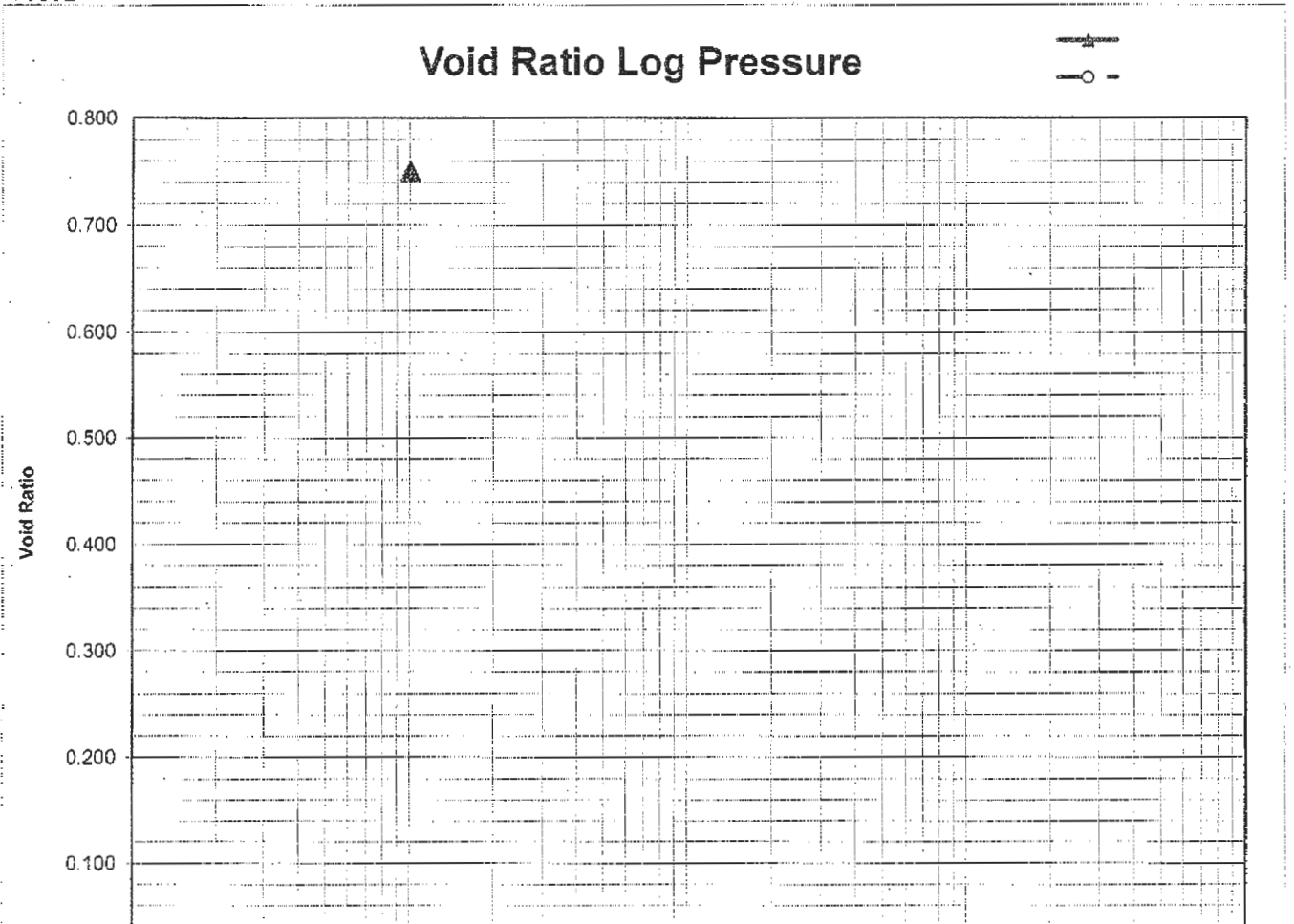
## Consolidation Tests

Project: ROCKDALE			
Project No.: 2012-B-1149		Sample No.: 1149-2	
Borehole No: 1 / 3546 - TP 11		Depth: 2.5 - 3.0	
Date Received: 27/11/2012		Date Tested: 10/12/2012	

### Test 1

Effect. Stress (kPa)	10	10								
Strain (%)	0.05	0.00								
Mv (1/MPa)										
Void Ratio	0.7499	0.7508								

### Test 2



# Consolidation Tests

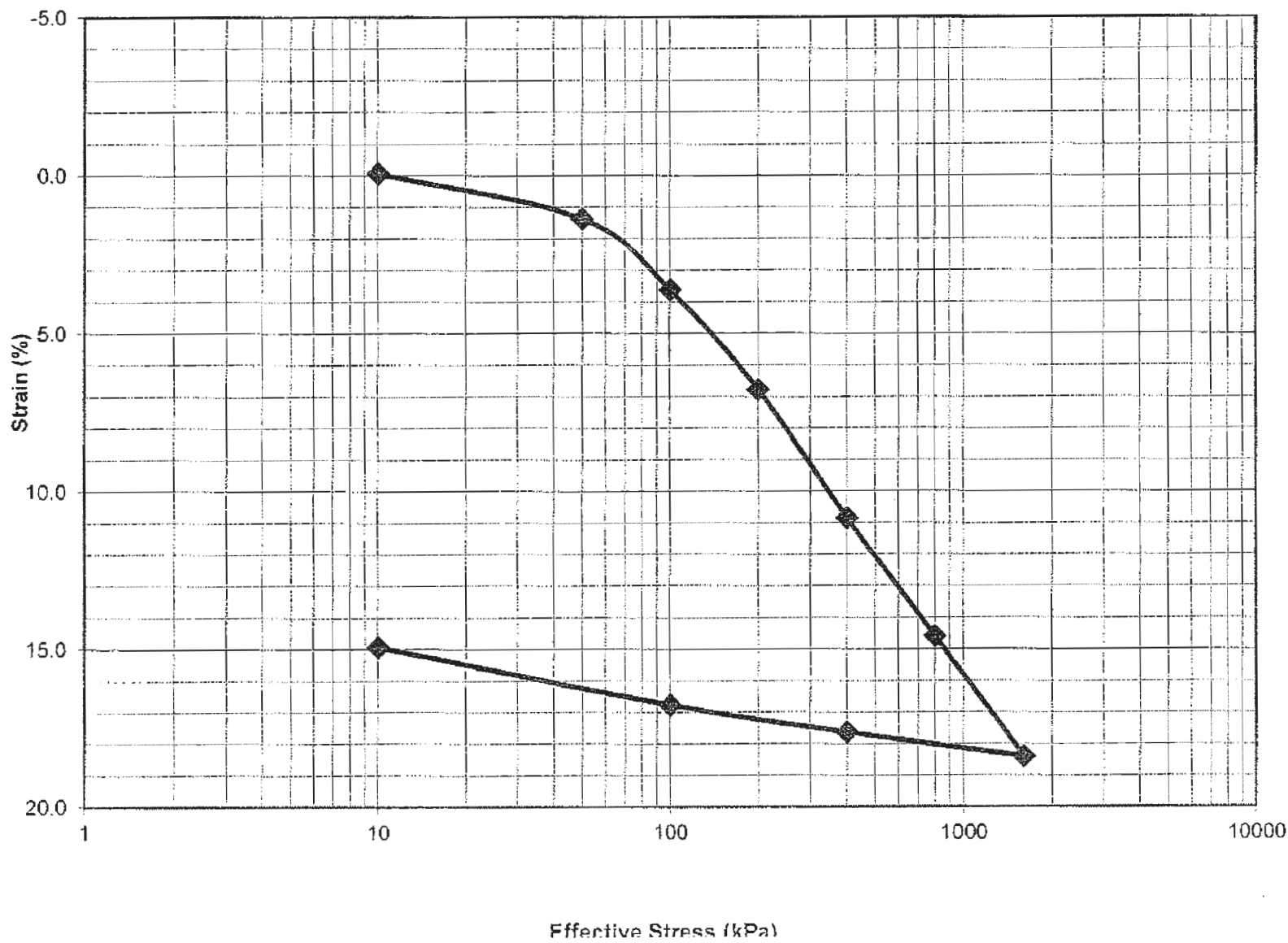
Project: ROCKDALE		Sample No.: 1149-1A	
Project No.: 2012-B-1149		Depth: 1.5 - 4.1	
Borehole No: I / 3539 - TP 4		Date Tested: 09/01/2013	
Date Received: 27/11/2012			

## Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10
Strain (%)	-0.06	1.37	3.62	6.79	10.85	14.60	18.39	17.64	16.77	14.94
Mv (1/MPa)		0.3586	0.4503	0.3162	0.2031	0.0937	0.0474	0.0063	0.0290	0.2036
Void Ratio	0.9129	0.8855	0.8424	0.782	0.7043	0.6326	0.5601	0.5745	0.5911	0.6261

## Test 2

### Strain Log Pressure



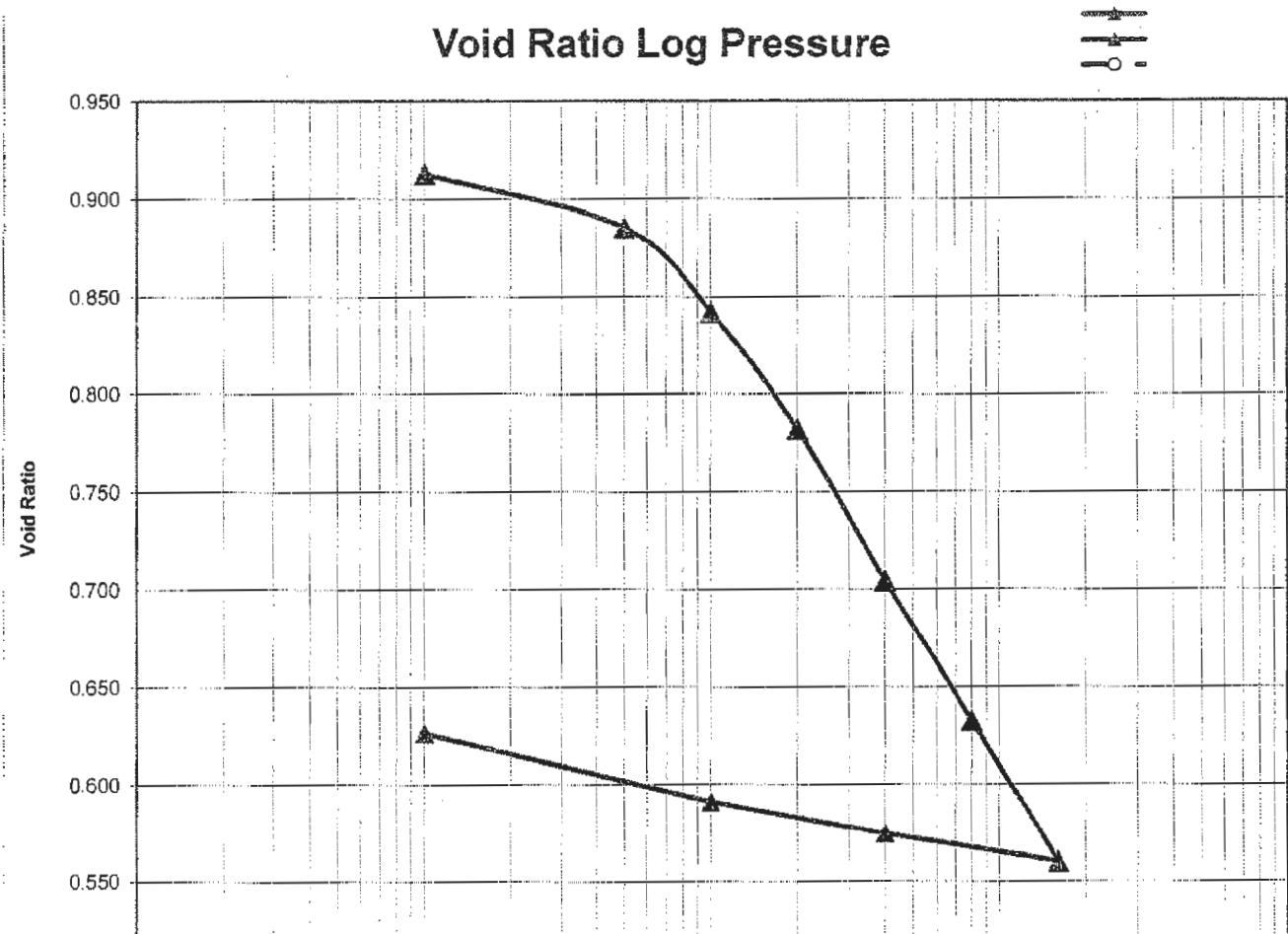
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-1A
Borehole No: 1 / 3539 - TP 4	Depth: 1.5 - 4.1
Date Received: 27/11/2012	Date Tested: 09/01/2013

### Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10
Strain (%)	-0.06	1.37	3.62	6.79	10.85	14.60	18.39	17.64	16.77	14.94
Mv (1/MPa)		0.3586	0.4503	0.3162	0.2031	0.0937	0.0474	0.0063	0.0290	0.2036
Void Ratio	0.9129	0.8855	0.8424	0.782	0.7043	0.6326	0.5601	0.5745	0.5911	0.6261

### Test 2





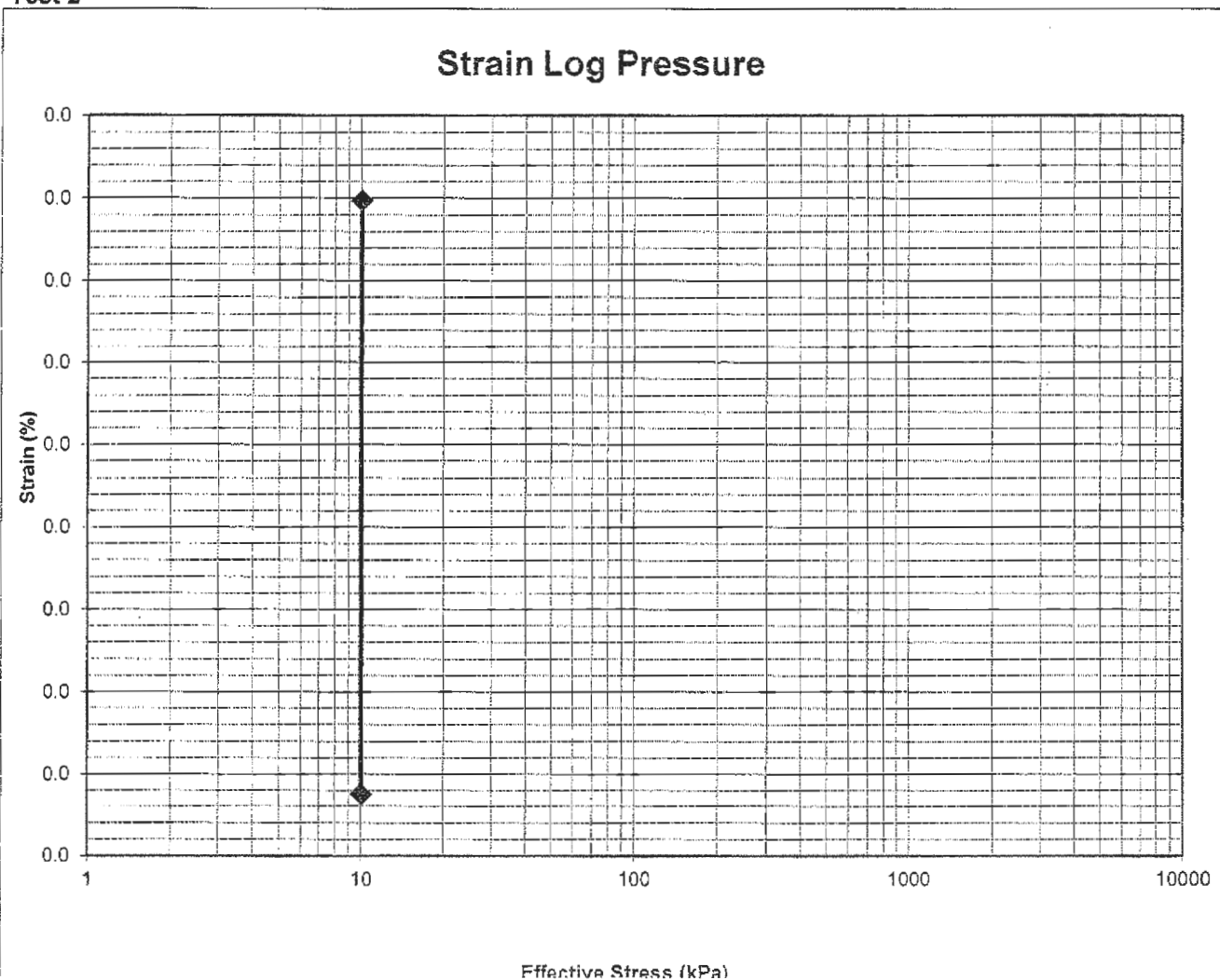
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-1
Borehole No: 1 / 3539 - TP 4	Depth: 1.5 - 4.1
Date Received: 27/11/2012	Date Tested: 10/12/2012

### Test 1

Effect. Stress (kPa)	10	10								
Strain (%)	0.04	0.01								
Mv (1/MPa)										
Void Ratio	0.9151	0.9158								

### Test 2



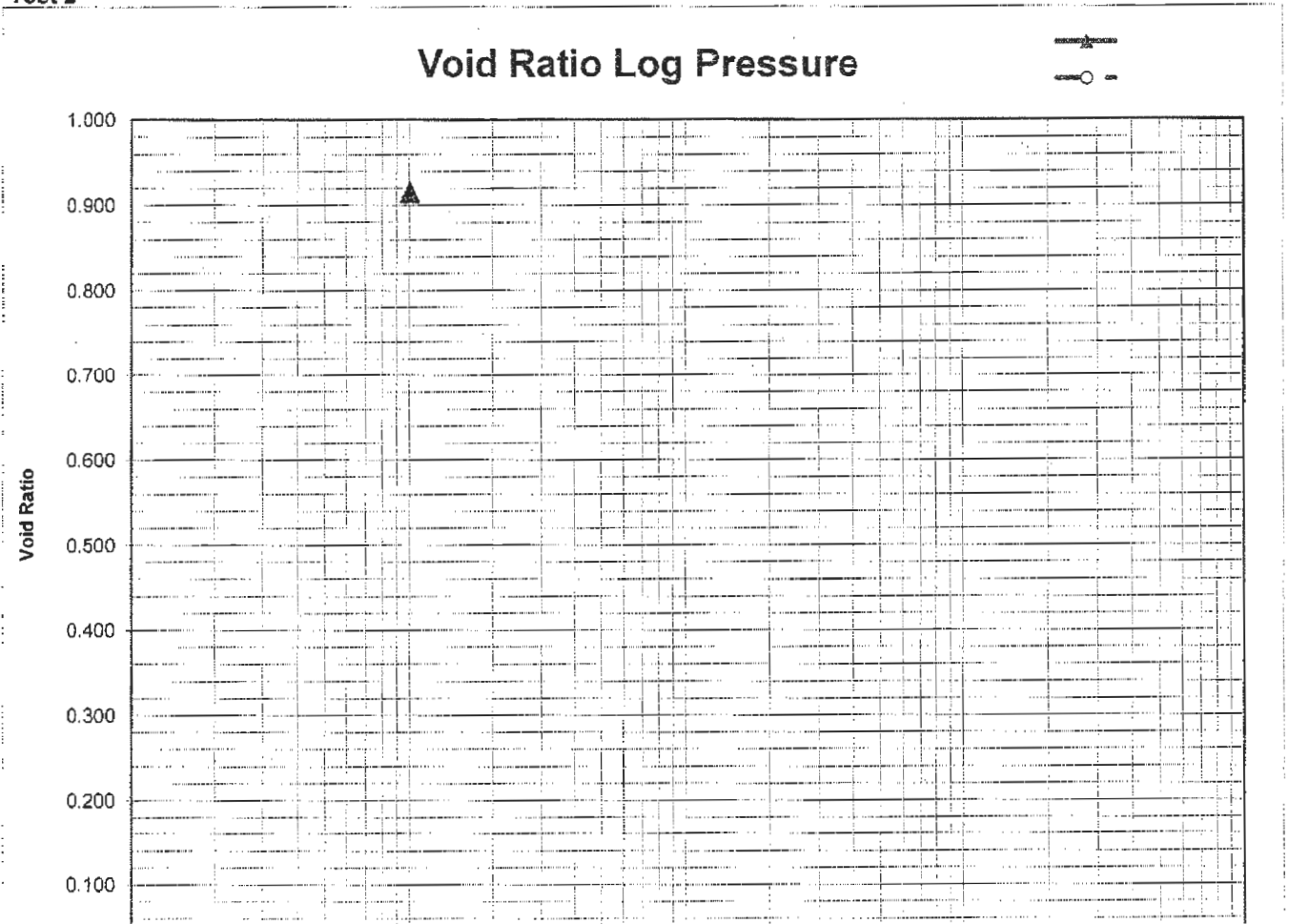
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-1
Borehole No: 1 / 3539 - TP 4	Depth: 1.5 - 4.1
Date Received: 27/11/2012	Date Tested: 10/12/2012

### Test 1

Effect. Stress (kPa)	10	10								
Strain (%)	0.04	0.01								
Mv (1/MPa)										
Void Ratio	0.9151	0.9158								

### Test 2





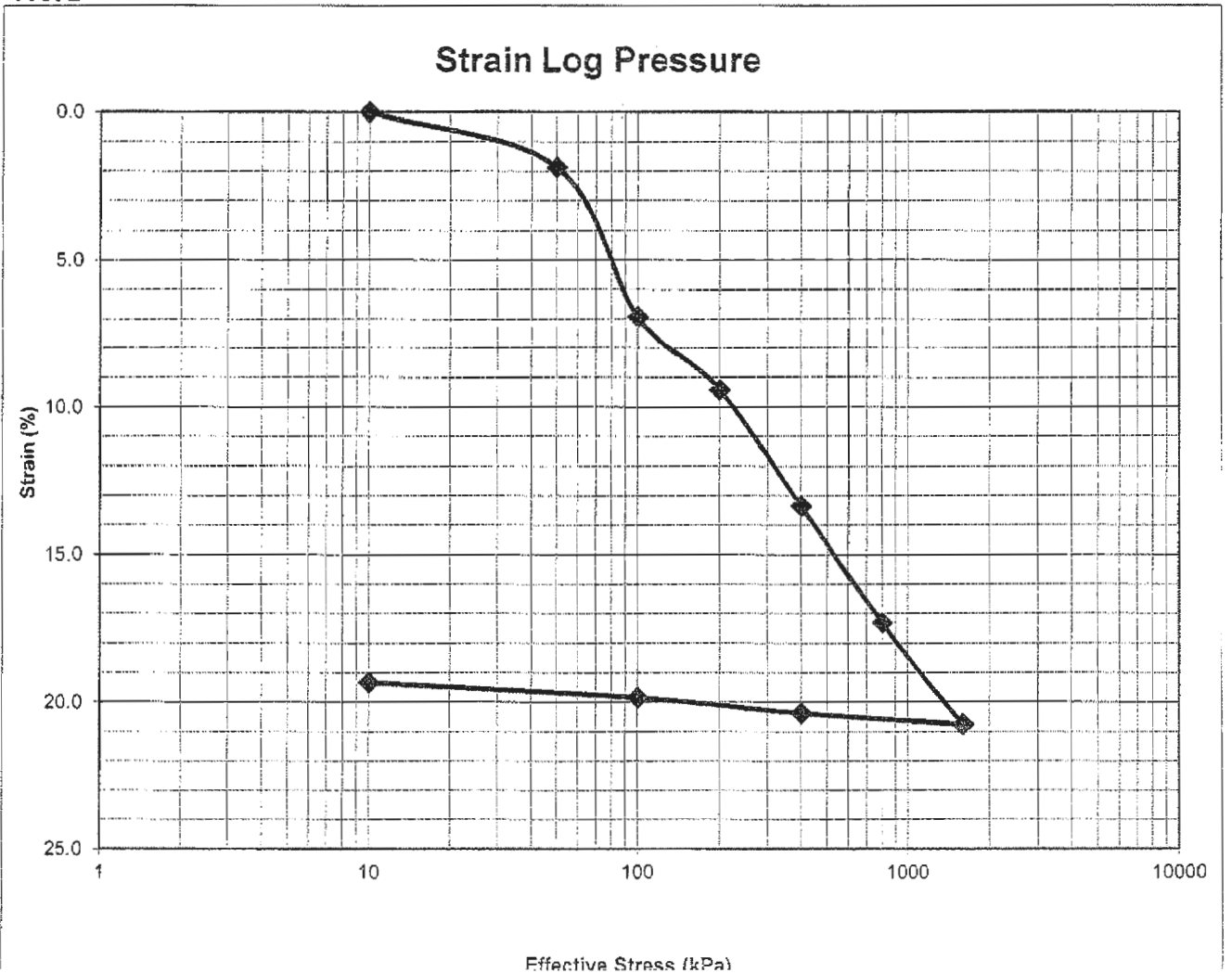
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-3A
Borehole No: 1 / 3550 - TP 14	Depth: 0.4 - 1.0
Date Received: 27/11/2012	Date Tested: 09/01/2013

### Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10
Strain (%)	0.01	1.88	6.93	9.43	13.37	17.34	20.76	20.40	19.86	19.34
Mv (1/MPa)		0.4667	1.0110	0.2497	0.1972	0.0992	0.0427	0.0030	0.0177	0.0578
Void Ratio	1.0173	0.9796	0.8777	0.8273	0.7477	0.6676	0.5987	0.606	0.6167	0.6272

### Test 2



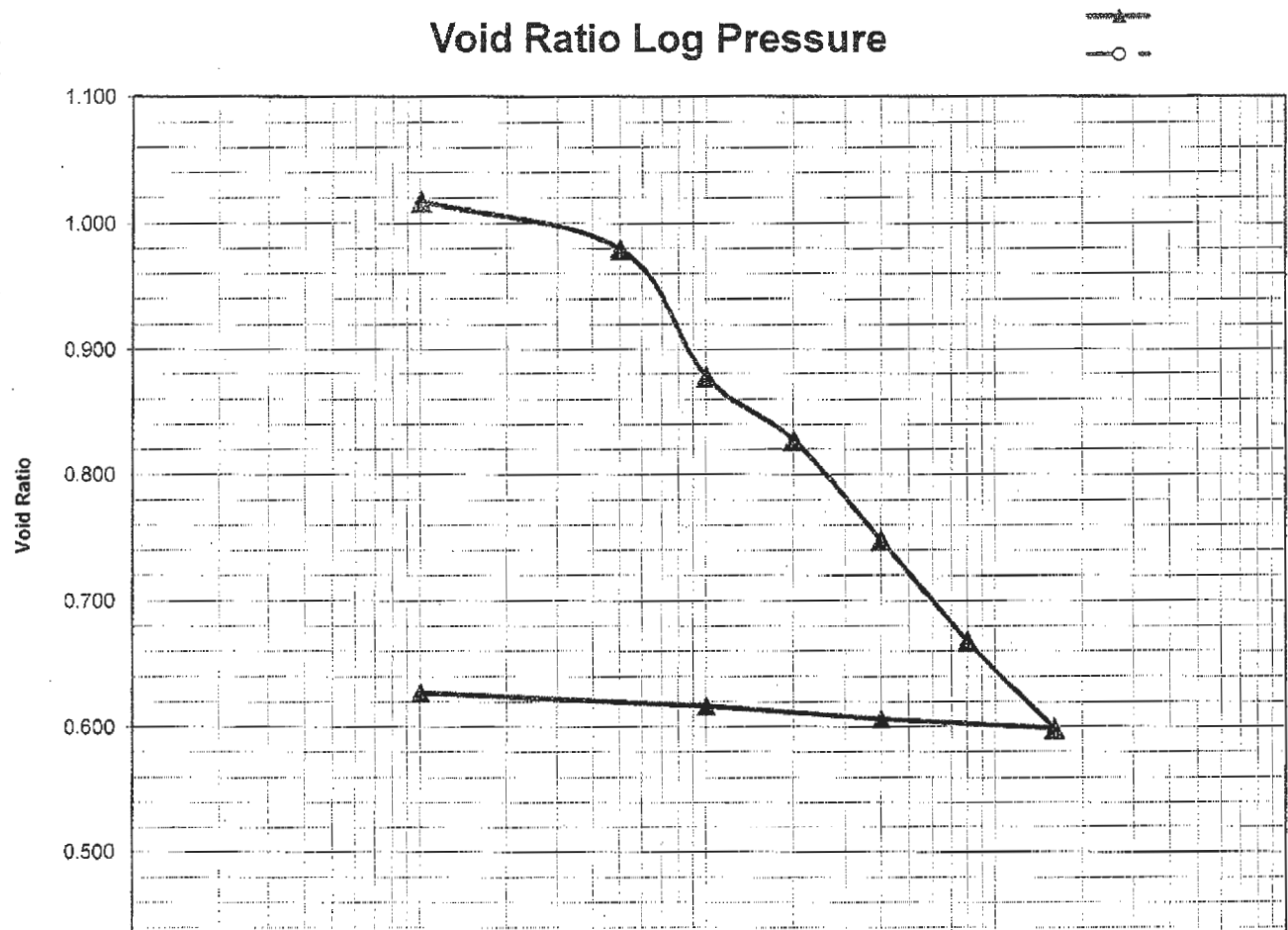
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-3A
Borehole No: 1 / 3550 - TP 14	Depth: 0.4 - 1.0
Date Received: 27/11/2012	Date Tested: 09/01/2013

### Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10
Strain (%)	0.01	1.88	6.93	9.43	13.37	17.34	20.76	20.40	19.86	19.34
Mv (1/MPa)		0.4667	1.0110	0.2497	0.1972	0.0992	0.0427	0.0030	0.0177	0.0578
Void Ratio	1.0173	0.9796	0.8777	0.8273	0.7477	0.6676	0.5987	0.606	0.6167	0.6272

### Test 2



# Consolidation Tests

Project: ROCKDALE		Test 1					
Project No.:	2012-B-1149	Sample No.:	1149-3				
Borehole No.:	1 / 3550 - TP 14	Depth:	0.4 - 1.0				
Date Received:	27/11/2012	Date Tested:	10/12/2012				
Remarks:	An undisturbed sample soaked @ 10kPa. Swell: 0.19%						
Machine No.	2	Ring No.	36	Height (mm)	19.4	Diameter (mm)	76.1

## Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
239.8	249.2	214.6	85.2	19.5%	26.7%

Pre-Determined Particle Specific Gravity | 2.682

### Initial Parameters

Void Ratio	0.8289	Degree of Saturation (%)	63.0	Dry Density (Kg/m3)	1466
------------	--------	--------------------------	------	---------------------	------

Effect. Stress (kPa)	10	10	0	0	0	0	0	0	0	0	0
Dial Correction (u)	0	0	0	0	0	0	0	0	0	0	0
HH:MM:SS	√Minutes	Dial Readings in Microns						Initial Dial Reading		6663	
00:00:00	0.00	6663									
00:15:00	3.87		6692								
01:00:00	7.75	6658	6693								
18:00:00	32.86		6695								
20:00:00	34.64		6695								
End of Primary Cons		6658	6695								
Number of Readings:		2	4	0	0	0	0	0	0	0	

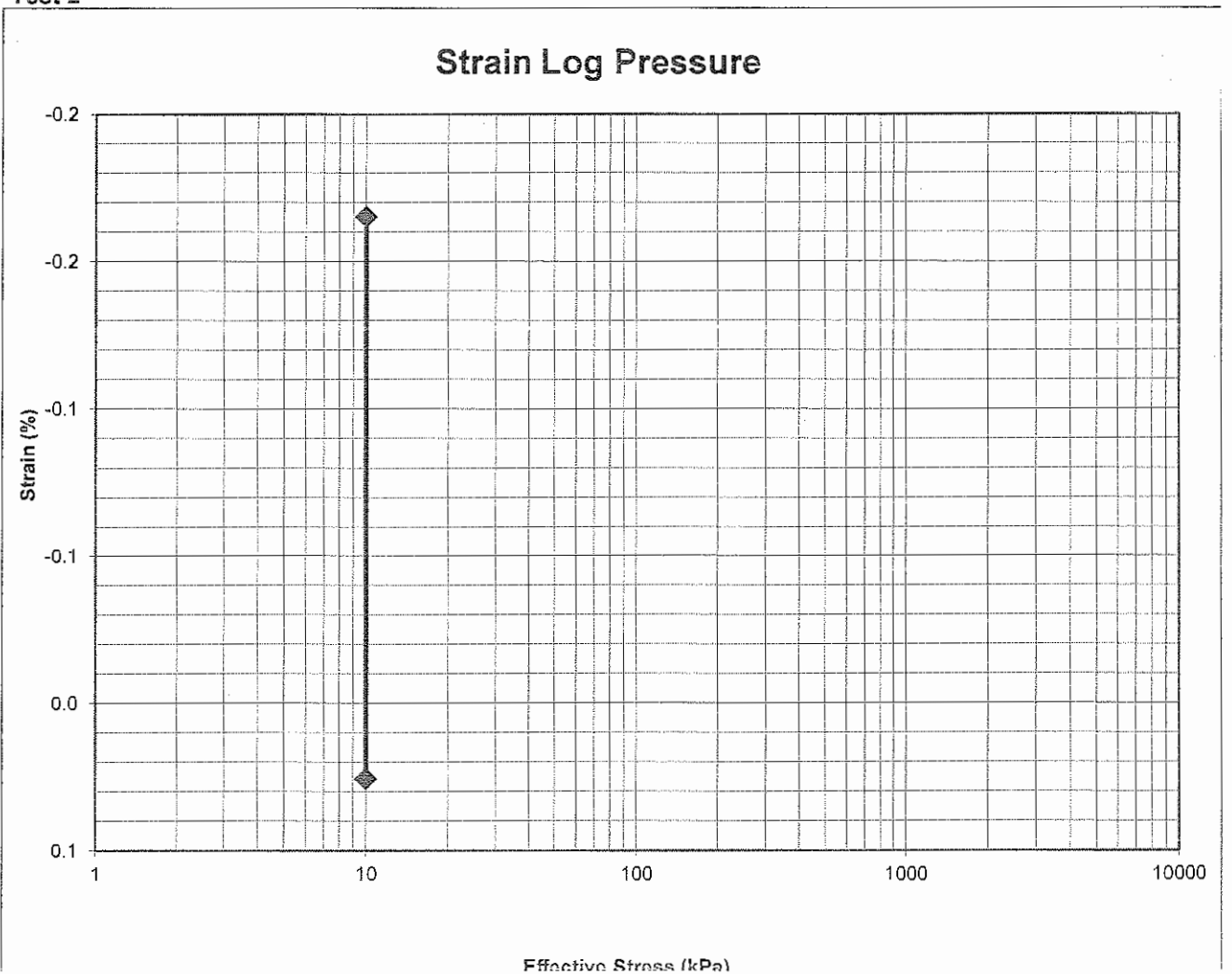
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-3
Borehole No: I / 3550 - TP 14	Depth: 0.4 - 1.0
Date Received: 27/11/2012	Date Tested: 10/12/2012

### Test 1

Effect. Stress (kPa)	10	10							
Strain (%)	0.03	-0.16							
Mv (1/MPa)									
Void Ratio	0.8284	0.8319							

### Test 2



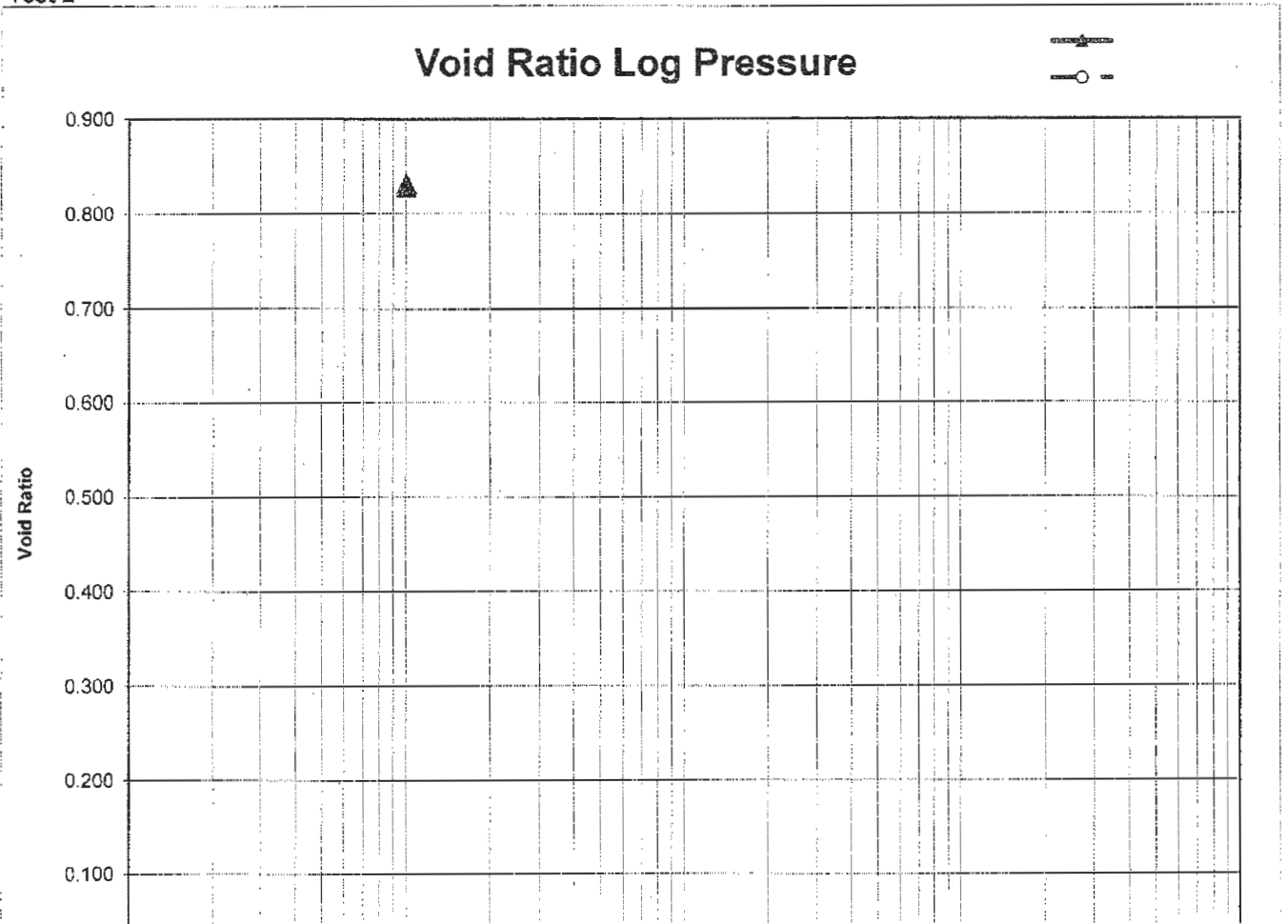
## Consolidation Tests

Project: ROCKDALE		Sample No.: 1149-3	
Project No.: 2012-B-1149		Depth: 0.4 - 1.0	
Borehole No: I / 3550 - TP 14		Date Tested: 10/12/2012	
Date Received: 27/11/2012			

### Test 1

Effect. Stress (kPa)	10	10								
Strain (%)	0.03	-0.16								
Mv (1/MPa)										
Void Ratio	0.8284	0.8319								

### Test 2





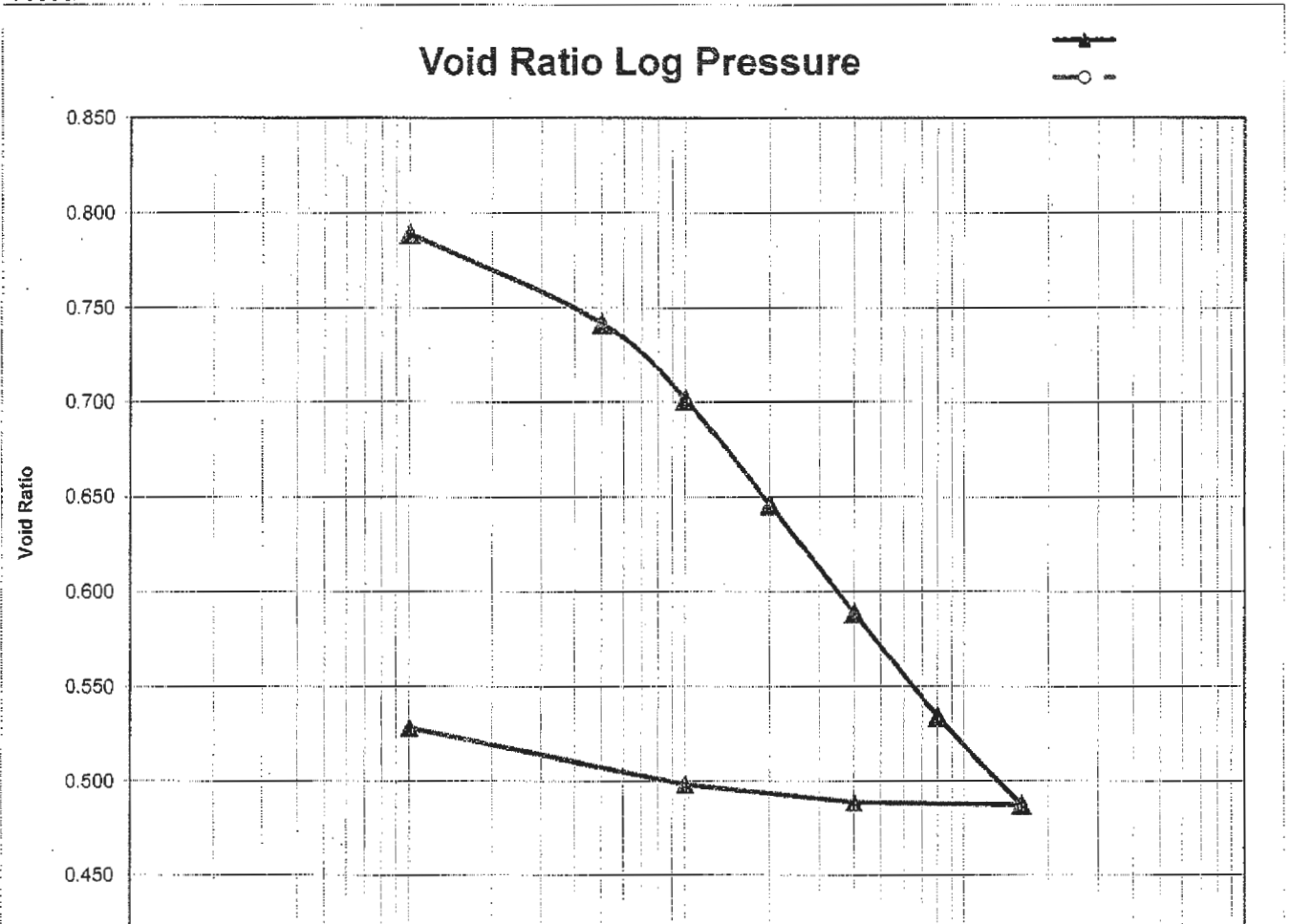
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-2A
Borehole No: 1/ 3546 - TP 11	Depth: 2.5 - 3.0
Date Received: 27/11/2012	Date Tested: 09/01/2013

### Test 1

Effect. Stress (kPa)	10	50	100	200	400	800	1600	400	100	10
Strain (%)	-0.35	2.30	4.58	7.69	10.90	13.96	16.58	16.50	15.97	14.30
Mv (1/MPa)		0.6626	0.4559	0.3118	0.1602	0.0765	0.0327	0.0006	0.0177	0.1852
Void Ratio	0.7893	0.742	0.7014	0.6458	0.5886	0.5341	0.4874	0.4888	0.4982	0.528

### Test 2



# Consolidation Tests

Project: ROCKDALE		Test 1					
Project No.:	2012-B-1149	Sample No.:	1149-2				
Borehole No.:	1 / 3546 - TP 11	Depth:	2.5 - 3.0				
Date Received:	27/11/2012	Date Tested:	10/12/2012				
Remarks:	An undisturbed sample soaked @ 10kPa. Swell: 0.05%						
Machine No.	2	Ring No.	13	Height (mm)	20.2	Diameter (mm)	75.3

## Masses for Water Content Determination (g)

Wet Sample and Ring		Dry Sample and Ring	Ring Only	Water Content	
Before Test	After Test			Before Test	After Test
265.0	274.0	239.9	102.66	18.3%	24.8%

Pre-Determined Particle Specific Gravity    2.671

### Initial Parameters

Void Ratio	0.7508	Degree of Saturation (%)	65.1	Dry Density (Kg/m3)	1526
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Effect. Stress (kPa)	10	10	0	0	0	0	0	0	0	0
Dial Correction (u)	0	0	0	0	0	0	0	0	0	0
HH:MM:SS	√Minutes	Dial Readings in Microns							Initial Dial Reading	7104
00:00:00	0.00	7104								
01:00:00	7.75	7094								
16:00:00	30.98		7106							
17:00:00	31.94		7105							
18:00:00	32.86		7105							
End of Primary Cons		7094	7105							
Number of Readings:		2	3	0	0	0	0	0	0	0

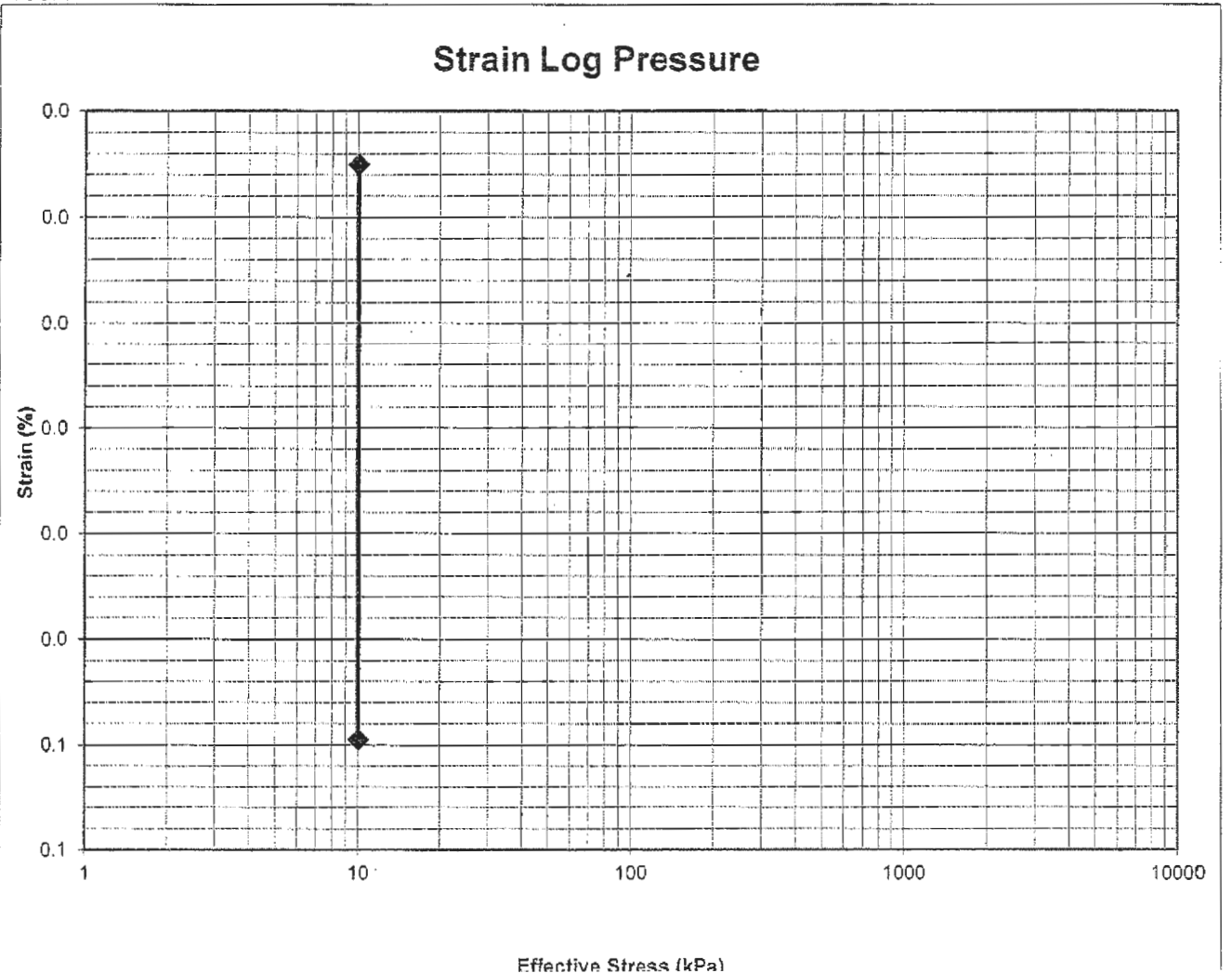
## Consolidation Tests

Project: ROCKDALE	
Project No.: 2012-B-1149	Sample No.: 1149-2
Borehole No: 1 / 3546 - TP 11	Depth: 2.5 - 3.0
Date Received: 27/11/2012	Date Tested: 10/12/2012

### Test 1

Effect.Stress (kPa)	10	10								
Strain (%)	0.05	0.00								
Mv (1/MPa)										
Void Ratio	0.7499	0.7508								

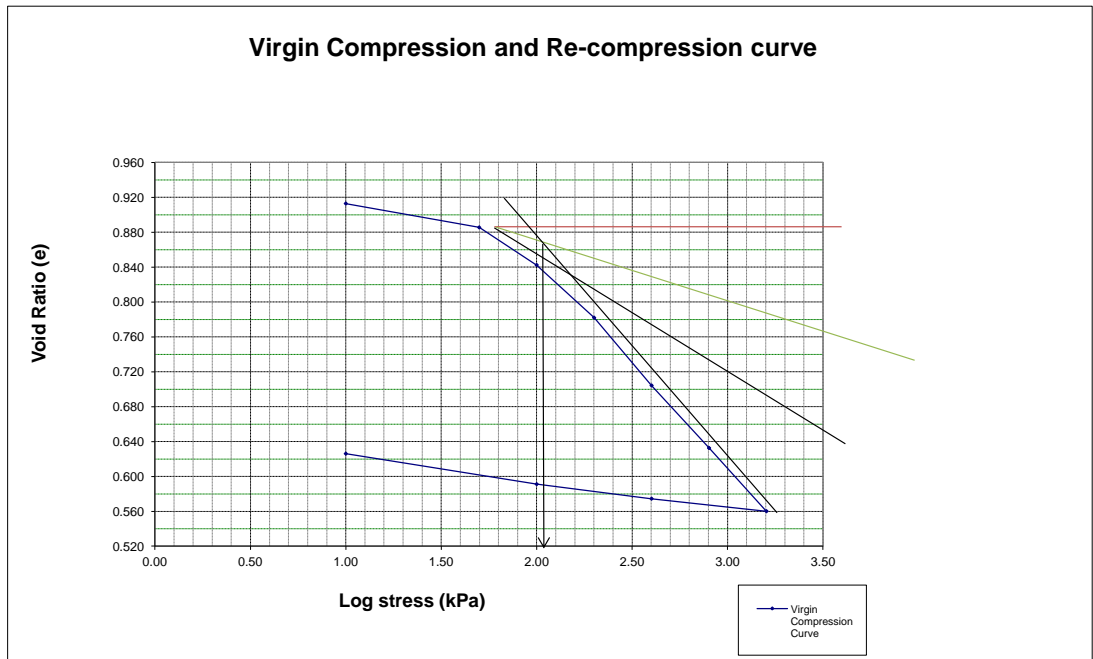
### Test 2



stress	log stress	void Ratio
10	1.00	0.913
50	1.70	0.886
100	2.00	0.842
200	2.30	0.782
400	2.60	0.704
800	2.90	0.633
1600	3.20	0.560
400	2.60	0.575
100	2.00	0.591
10	1.00	0.626

TP4 (1.5 - 4.1 m)

P1 (kPa)	P2 (kPa)	e1	e2	a	mv
10	50	0.9129	0.8855	0.000685	0.358095
10	100	0.9129	0.8424	0.000783	0.4095
10	200	0.9129	0.782	0.000689	0.360159
10	400	0.9129	0.7043	0.000535	0.279613
10	800	0.9129	0.6326	0.000355	0.185483
10	1600	0.9129	0.5601	0.000222	0.115995



12140

2013/01/09

Bazi Dukhan Consulting Engineers  
126A First Floor  
Overport City  
Durban  
4001

**ATTENTION:** Mrs. Nasarene Khan

Dear Sir

Test Report : **SUBSTATION ROCKDALE - WATER SAMPLES**

Herewith the laboratory test results as requested by Mrs. N. Khan from Bazi Dukhan .

Analyses in mg/l	Sample Identification:		
	I/3552 (0.0-0.8m) TP15	I/3555 (0.0-0.6m) TP17	I/3557 (0.1-1.2m) TP20
Sample No			
pH value at 25°C	6.4	6.4	5.7
pHs value at 25°C	10.7	10.4	11
Electrical Conductivity in mS/m at 25°C	7.5	9.4	2.1
Total Dissolved Solids *	50	63	14
Total Hardness as CaCO <sub>3</sub>	19	32	3
Calcium Hardness as CaCO <sub>3</sub>	5	12	2
Total Alkalinity as CaCO <sub>3</sub>	<5	<5	<5
Calcium as Ca	2	5	<2
Magnesium as Mg	3	5	<2
Free & Saline Ammonia	<0.2	<0.2	<0.2
Ammonium as NH <sub>4</sub> (calc)	<0.3	<0.3	<0.3
Chloride as Cl	<5	<5	<5
Suphate as SO <sub>4</sub>	<5	<5	<5
Nitrate as N	3.5	5.9	<0.2
Acid Soluble Sulphate	166	66	64
Total Sulphur %	<0.01	0.01	0.01
Langelier Index at 25°C	-4.3	-3.96	-5.35
Ryznar Index at 25°C	15	14.3	16.4
Corrosivity Ratio	2.3	6	2.5
Leaching Index [LCSI]	3436	3234	4152
Spalling Index [SCSI]	1	1	1
Aggressiveness Index [N]	3437	3233	4153
<b>OPTIONAL CORRECTIONS FOR LCSi</b>			
Stagnant [LCSiC]	1718	1616	2076
Turbulent [LCSiC]	6014	5655	7266
<b>CORRECTION FOR TEMPERATURE TO 20°C</b>			
Aggressiveness Index [Nc]	859	808	1038
N7 [Chloride Content]	0.775	1.238	0.870
* TDS Calculated EC X 6.7			
2:1 Distilled Water: Soil Extract			
Sampled By : Client	CLIENTS MARKING: <b>None</b>		
Delivered By : Client			
Sampled According To : Customer Requirements			

Aggressiveness Towards Concrete and Fibre Cement Pipes			
Index	Aggressive	Neutral	Non-Aggressive
a) Stability pH (pHs)	> pH	=pH	< pH
b) Langelier Index	Neg. Value	Zero	Pos. Value
c) Ryznar Index	>7.5	07-Jun	<6

Corrosiveness Towards metals	
Corrosivity	>0.2

Sample Name	Sample Number	Corrosivity Indices	Basson Index
I/3552 (0.0-0.8m) TP15	17232	Corrosive	Aggressive
I/3555 (0.0-0.6m) TP17	17233	Corrosive	Aggressive
I/3557 (0.1-1.2m) TP20	17234	Corrosive	Aggressive

**Remarks :**

The results reported relate only to the sample tested  
Further use of the above information is not the responsibility or liability of Roadlab  
Documents may only be reproduced or published in their full context

Compiled By : Chanel van Biljon



***APPENDIX F: EARTHWORKS PLATFORM  
DRAWINGS***

***DRAWING No. BD-370-CI-001-C-00***

***DRAWING No. BD-370-CI-002-C-00***



**Legend :**

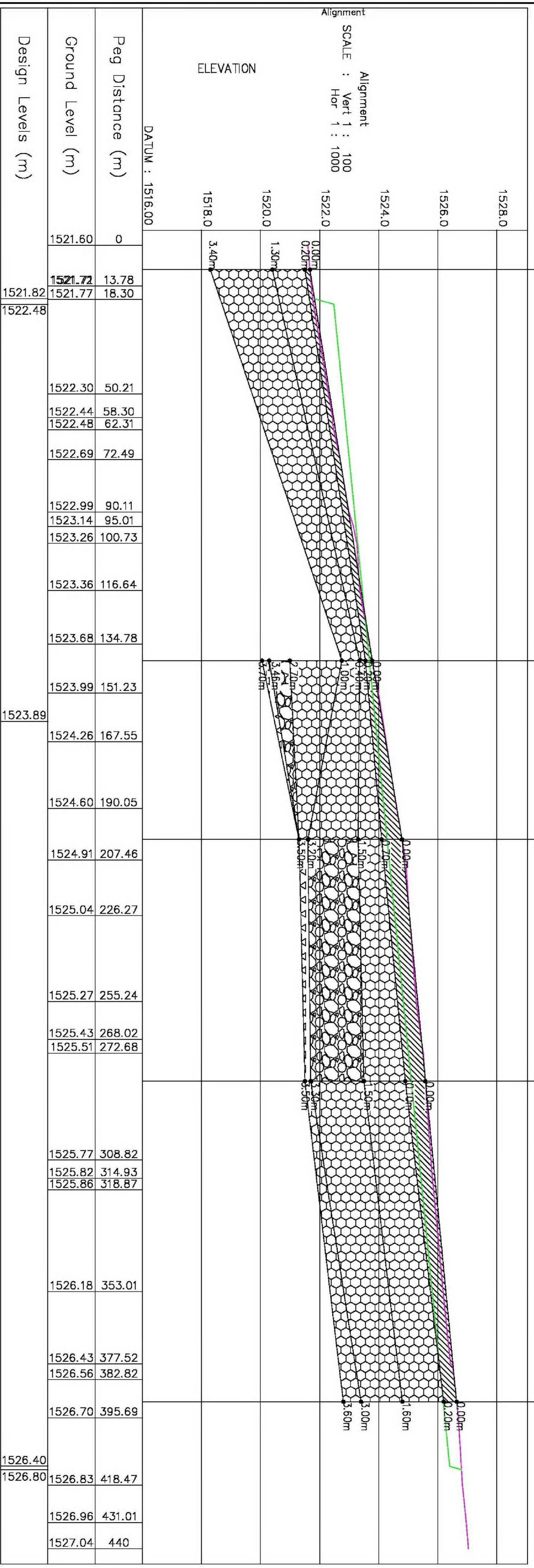
TP 10

TP 9

TP 8

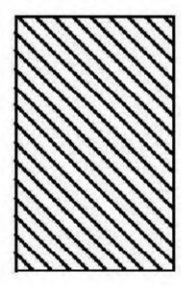
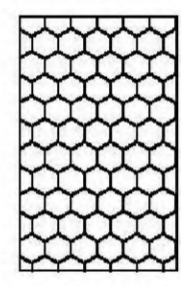
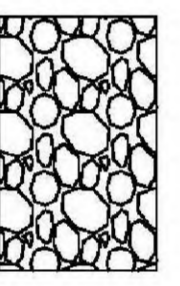
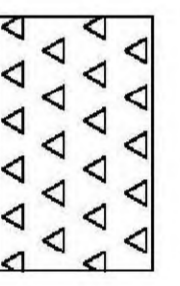
TP 7

TP 6



**SECTION B – B**

**LEGEND:**

-  UNIT 1: AGRICULTURAL LAYER/TOPSOIL
-  UNIT 2: ALLUVIUM
-  UNIT 3: RESIDUAL DWYKA TILLITE
-  UNIT 4: RESIDUAL DWYKA TILLITE/ KAROO SUPERGROUP

**BD-370-CI-001-R-00**

DESIGNED	BO P.Eng. :20070210	DATE	07.12.2012
DRAWN	BS	DATE	07.12.2012
CHECKED	BO P.Eng. :20070210	DATE	07.12.2012
APPROVED	BO P.Eng. :20070210	DATE	07.12.2012
SCALE	AS SHOWN	SHEET SIZE	A4
PROJECT NUMBER	DRAWING NUMBER	STATUS	REVISION

C.K. No. : 2008/088/99/23  
 V.A.T Reg. No. 405024/917  
 Office 309A - 313, Third Floor  
 The Wheeler House  
 112 - 113 Stamford Hill  
 Durban, 4001  
 Email: bazi@bazidurban.co.za  
 Tel : (031) 209 3900  
 Fax : (031) 209 3606  
 Call : 083 231 6561



REV	DATE	DRAWN	CHECKED	DESCRIPTION

**PROJECT**  
 ESKOM  
 ROCKDALE B SUBSTATION

**DRAWING**  
 PLATFORM DESIGN

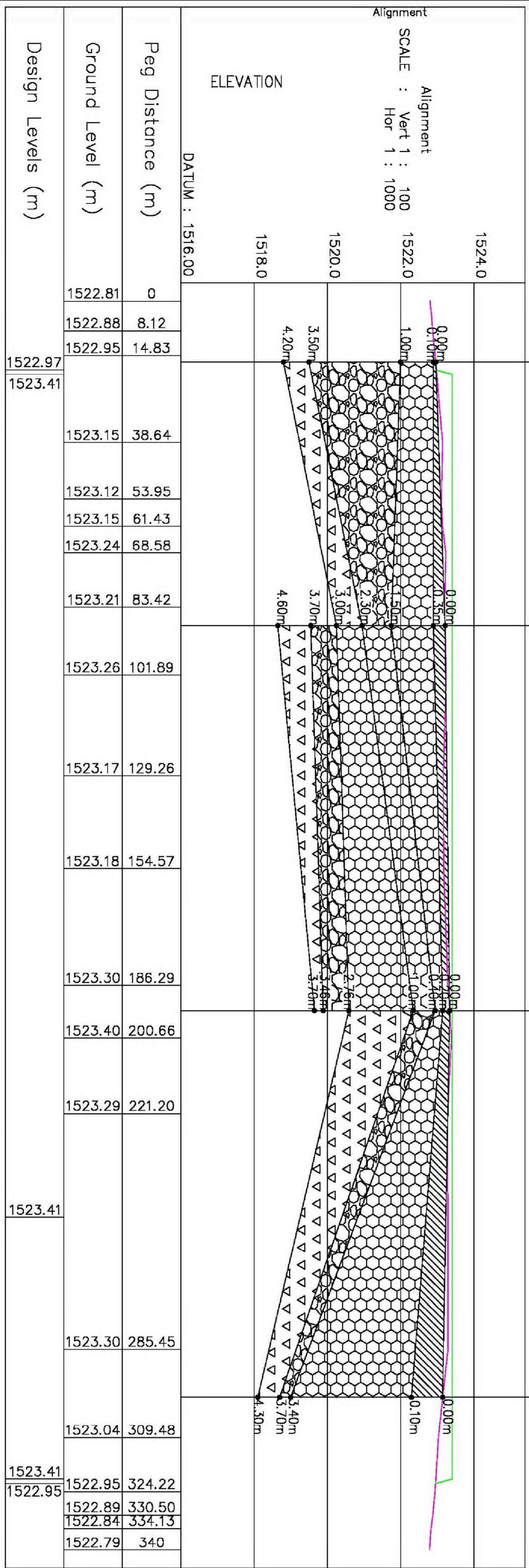
**DRAWING STATUS CODES:**  
 R = REPORT  
 D = DRAW  
 T = TENDER  
 P = PRELIMINARY  
 C = CONSTRUCTION  
 A = AS-BUILT

TP 19

TP 12

TP 9

TP 2



SECTION C - C

LEGEND:

-  UNIT 1: AGRICULTURAL LAYER/TOPSOIL
-  UNIT 2: ALLUVIUM
-  UNIT 3: RESIDUAL DWYKA TILLITE
-  UNIT 4: RESIDUAL DWYKA TILLITE/ KAROO SUPERGROUP

Legend :

REV	DATE	DRAWN	CHECKED	DESCRIPTION



**SRES**  
 C.K. No. : 2008/088199/23  
 V.A.T Reg. No. 405024/917  
 Office 309A - 313, Third Floor  
 The Wheeler House      Tel : (031) 209 3900  
 112 - 113 Stamford Hill      Fax : (031) 209 3909  
 Durban, 4001      Cell : 083 231 8561  
 Email: bazi@bazidukhan.co.za

PROJECT			
ESKOM ROCKDALE B SUBSTATION			
DRAWING PLATFORM DESIGN			
RESPONSIBLE PERSON	DATE		
BO P-Eng : 2007/0210	07.12.2012		
DRAWN	DATE		
SS	07.12.2012		
CHECKED	DATE		
BO P-Eng : 2007/0210	07.12.2012		
APPROVED	DATE		
BO P-Eng : 2007/0210	07.12.2012		
SCALE	SHEET SIZE		
AS SHOWN	A4		
PROJECT NUMBER	DRAWING NUMBER	STATUS	REVISION
BD-370-CL-001-R-00			
DRAWING STATUS CODES :			
R = REPORT	T = TENDER	C = CONSTRUCTION	
D = DRAW	P = PRELIMINARY	A = AS BUILT	

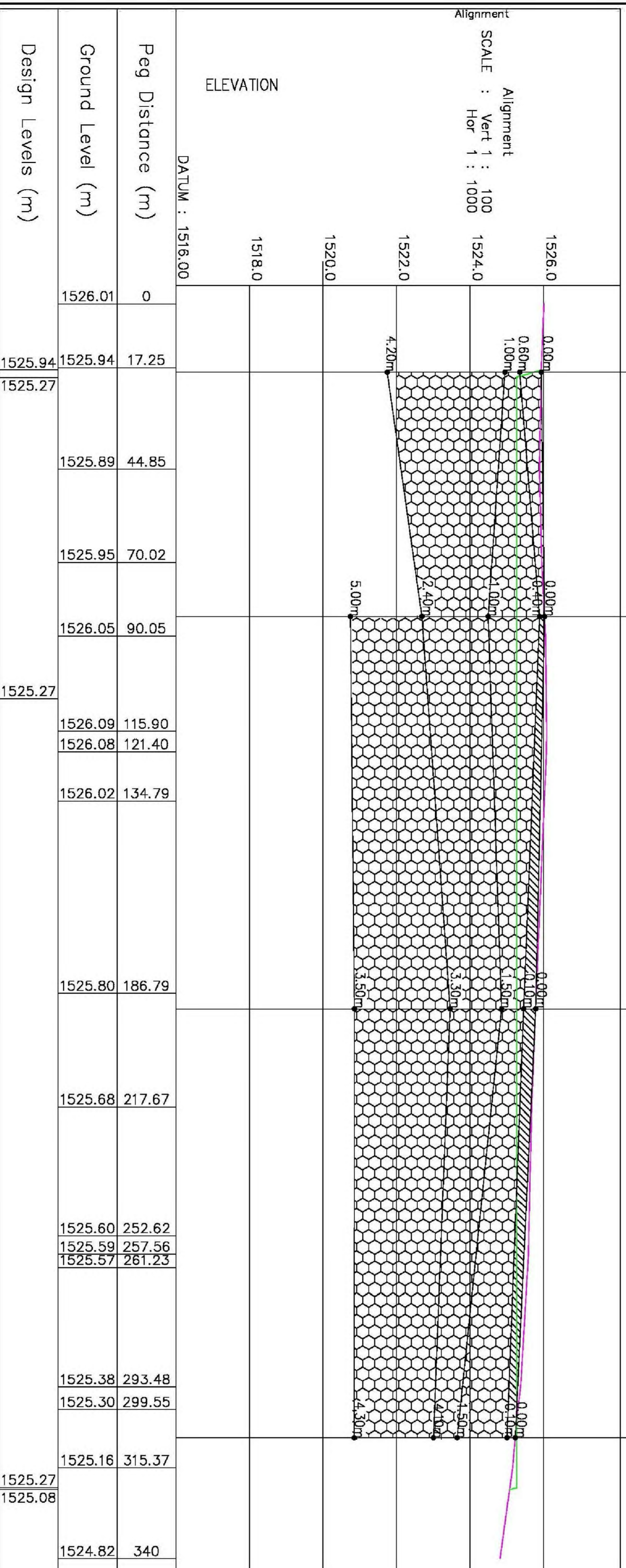
Legend :

TP 17

TP 14

TP 7

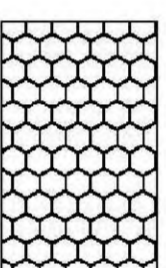
TP 4



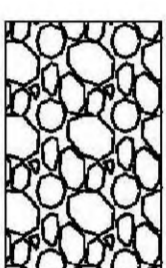
LEGEND:



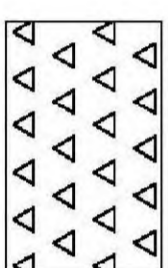
UNIT 1: AGRICULTURAL LAYER/TOPSOIL



UNIT 2: ALLUVIUM



UNIT 3: RESIDUAL DWYKA TILLITE



UNIT 4: RESIDUAL DWYKA TILLITE / KAROO SUPERGROUP

C.K. No. : 2008/0881/99/23  
 V.A.T Reg. No. 405024/917  
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 Durban, 4001  
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 Tel : (031) 209 3900  
 Fax : (031) 209 3909  
 Cell : 083 231 8561



PROJECT  
 ESKOM  
 ROCKDALE B SUBSTATION

DRAWING  
 PLATFORM DESIGN

RESPONSIBLE PERSON	DATE
DESIGNED BD P-Eng : 2007/0210	07.12.2012
DRAWN SS	07.12.2012
CHECKED BD P-Eng : 2007/0210	07.12.2012
APPROVED BD P-Eng : 2007/0210	07.12.2012
SCALE AS SHOWN	SHEET SIZE A4

PROJECT NUMBER DRAWING NUMBER STATUS REVISION  
 BD-370-CL-001-R-00

DRAWING STATUS CODES :  
 R = REPORT  
 D = DRAW  
 T = TENDER  
 P = PRELIMINARY  
 C = CONSTRUCTION  
 A = AS BUILT

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## **APPENDIX G: *RELEVANT PHOTOS***



**Photo 1:** Site image showing arable portion of land



**Photo 2:** Test pit (TP) 12



## **APPENDIX H: *COST ESTIMATE***

# PROPOSED ROCKDALE SUBSTATION

2-May-13

## Cost Estimate - Roads and Services

REV 0

SECTION	DESCRIPTION	QUANTITY	UNIT	RATE	SUB-TOTAL	TOTAL
1 BULK EARTHWORKS						
	Clear and grub	120000	m2	R 12.00	R 1,440,000.00	
	Topsoil removal (300mm Thick)	36000	m3	R 45.00	R 1,620,000.00	
	Cut to Fill	22765	m3	R 67.50	R 1,536,637.50	
	Cut to spoil	23880	m3	R 150.00	R 3,582,000.00	
	Extra over for intermediate excavations	2388	m3	R 250.00	R 597,000.00	
	Extra over for hard rock	400	m3	R 450.00	R 180,000.00	
						R 8,955,637.50
	<b>SUB TOTAL</b>					<b>R 8,955,637.50</b>
	<b>VAT @ 14%</b>					<b>R 1,253,789.25</b>
	<b>TOTAL</b>					<b><u>R 10,209,426.75</u></b>

1 Estimate includes contractors P & G costs (@ 20.0 %).

2 Estimate excludes for contingencies.

3 Estimate only includes services on the site and not connecting to any nearby bulks or resurfacing the access road.

4 Estimate excludes Professional fees, disbursements and site supervision.

5 Estimate excludes for future escalation.

6 Estimate excludes for stormwater attenuation tanks. These will be sized in the stormwater management plan.



**Legend :**

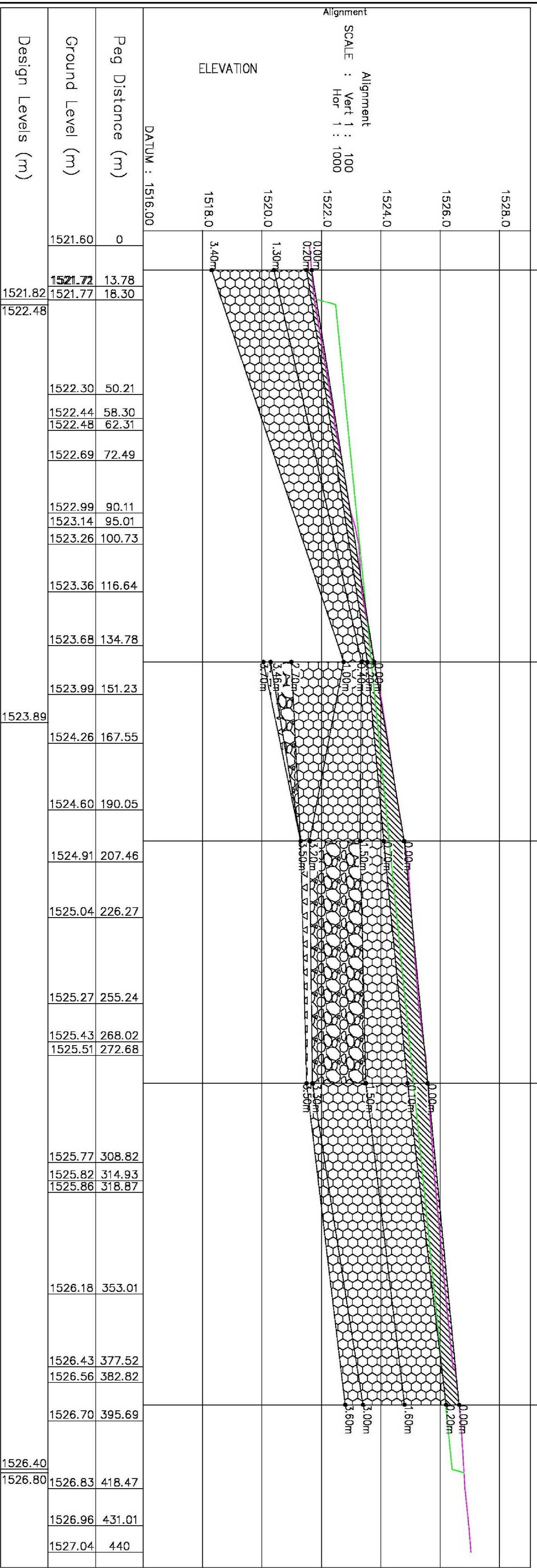
TP 10

TP 9

TP 8

TP 7

TP 6



**SECTION B – B**

**LEGEND:**

	UNIT 1: AGRICULTURAL LAYER/TOPSOIL
	UNIT 2: ALLUVIUM
	UNIT 3: RESIDUAL DWYKA TILLITE
	UNIT 4: RESIDUAL DWYKA TILLITE/ KAROO SUPERGROUP

	
<p>C.K. No. : 2008/089199/23  V.A.T Reg. No. 4050247917  Office 309A - 313, Third Floor  The Wheeler House  112 - 113 Stamford Hill  Durham, 4001  Tel : (031) 209 3900  Fax : (031) 209 3608  Call : 083 231 8561  Email: bar@bazidukhan.co.za</p>	
<p>PROJECT  <b>ESKOM  ROCKDALE B SUBSTATION</b></p>	
<p>DRAWING  <b>PLATFORM DESIGN</b></p>	
RESPONSIBLE PERSON	DATE
DESIGNED BD P. Eng. : 2007/0210	07.12.2012
DRAWN BS	07.12.2012
CHECKED BD P. Eng. : 2007/0210	07.12.2012
APPROVED BD P. Eng. : 2007/0210	07.12.2012
SCALE AS SHOWN	SHEET SIZE A4
PROJECT NUMBER DRAWING NUMBER STATUS REVISION <b>BD-370-CI-001-R-00</b>	
DRAWING STATUS CODES : R = REPORT T = TENDER C = CONSTRUCTION D = DRAW P = PRELIMINARY A = AS BUILT	

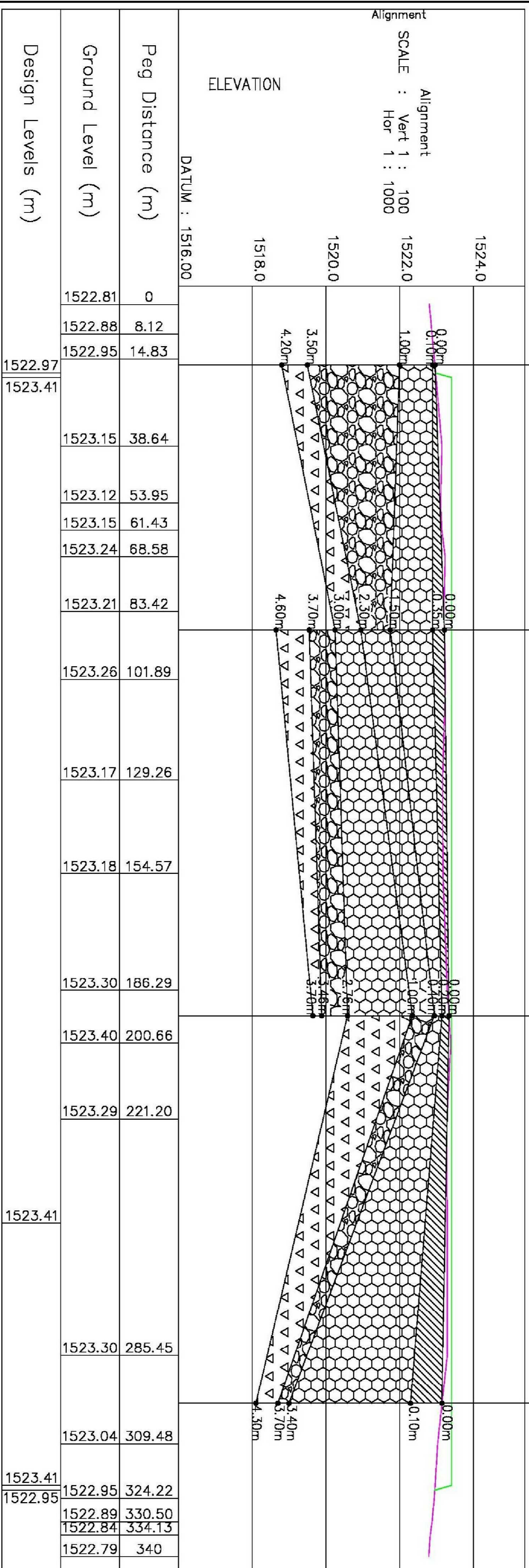
**Legend :**

TP 19

TP 12

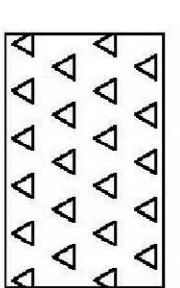
TP 9

TP 2



**SECTION C - C**

**LEGEND:**

-  UNIT 1: AGRICULTURAL LAYER/TOPSOIL
-  UNIT 2: ALLUVIUM
-  UNIT 3: RESIDUAL DWYKA TILLITE
-  UNIT 4: RESIDUAL DWYKA TILLITE/ KAROO SUPERGROUP



**SABS**  
 C.K. No. : 2008/088199/23  
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 Tel : (031) 209 3900  
 Fax : (031) 209 3908  
 Call : 083 231 8561

**PROJECT**  
 ESKOM  
 ROCKDALE B SUBSTATION

**DRAWING**  
 PLATFORM DESIGN

RESPONSIBLE PERSON	DATE
BD P. Eng. :20070210	07.12.2012
BS	07.12.2012
BD P. Eng. :20070210	07.12.2012
BD P. Eng. :20070210	07.12.2012
AS SHOWN	A4

**BD-370-CI-001-R-00**

**DRAWING STATUS CODES :**  
 R = REPORT  
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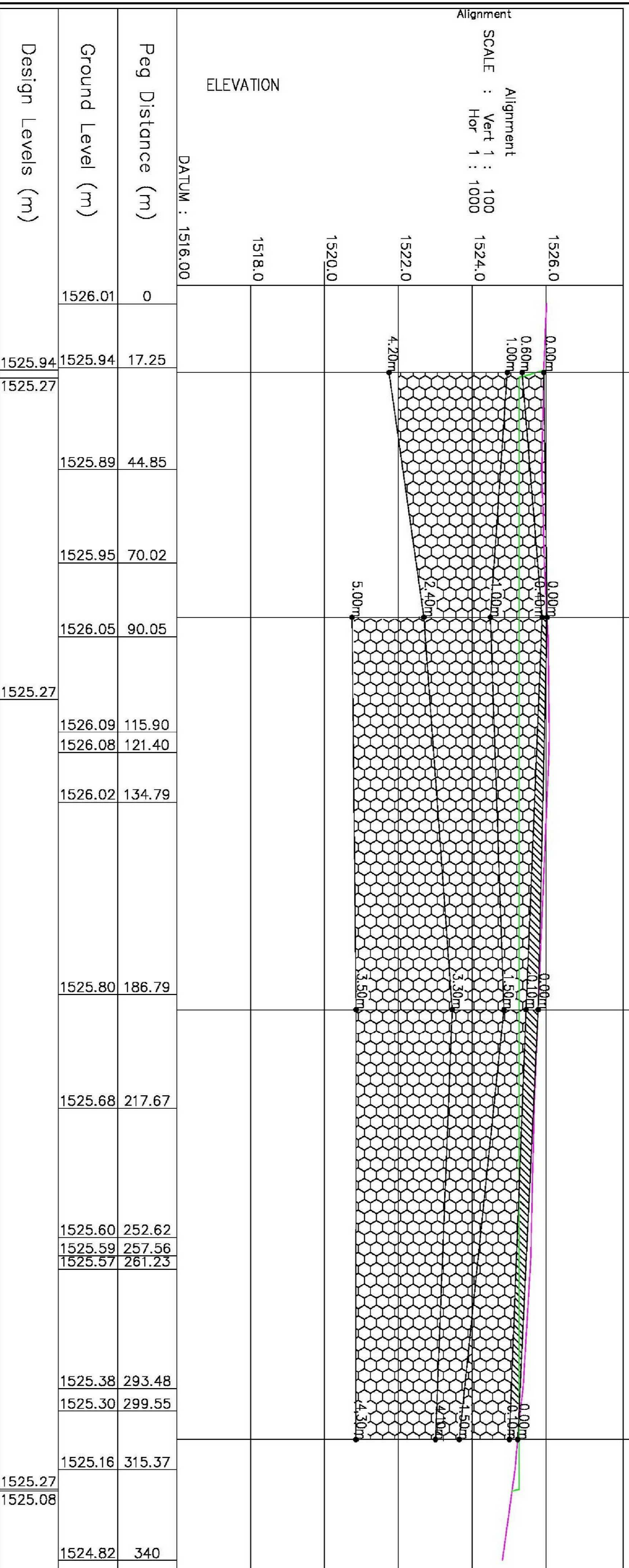
**Legend :**

TP 17

TP 14

TP 7

TP 4



**SECTION D - D**

**LEGEND:**

-  UNIT 1: AGRICULTURAL LAYER/TOPSOIL
-  UNIT 2: ALLUVIUM
-  UNIT 3: RESIDUAL DWYKA TILLITE
-  UNIT 4: RESIDUAL DWYKA TILLITE/ KAROO SUPERGROUP

Peg Distance (m)	Ground Level (m)	Design Levels (m)
0	1526.01	1525.94
17.25	1525.94	1525.27
44.85	1525.89	
70.02	1525.95	
90.05	1526.05	
115.90	1526.09	
121.40	1526.08	
134.79	1526.02	
186.79	1525.80	
217.67	1525.68	
252.62	1525.60	
257.56	1525.59	
261.23	1525.57	
293.48	1525.38	
299.55	1525.30	
315.37	1525.16	
340	1524.82	

REV	DATE	DRAWN	CHECKED	DESCRIPTION



**SABS**  
 ISO 9001  
 C.K. No. : 2008/088199/23  
 V.A.T Reg. No. 4050247917  
 Office 309A - 313, Third Floor  
 The Wheeler House  
 112 - 113 Stamford Hill  
 Durban, 4001  
 Call : 083 231 8561  
 Email: bazi@baziconsulting.co.za

**PROJECT**  
 ESKOM  
 ROCKDALE B SUBSTATION

**DRAWING**  
 PLATFORM DESIGN

RESPONSIBLE PERSON	DATE
BD Pr Eng : 20070210	07.12.2012
BS	07.12.2012
BD Pr Eng : 20070210	07.12.2012
BD Pr Eng : 20070210	07.12.2012
AS SHOWN	A4

**BD-370-CI-001-R-00**

**DRAWING STATUS CODES :**  
 R = REPORT  
 D = DRAFT  
 T = TENDER  
 P = PRELIMINARY  
 C = CONSTRUCTION  
 A = AS BUILT