Reference No: 10110/g

INROADS CONSULTING
GEOTECHNICAL & CIVIL ENGINEERS

REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SUBSTATION FOR THE NEW TAUNUS – DIEPKLOOF 132 kV POWERLINE

OCTOBER 2010

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REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SUBSTATION FOR THE NEW TAUNUS – DIEPKLOOF 132 kV POWERLINE

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REPORT ON A GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SUBSTATION FOR THE NEW TAUNUS – DIEPKLOOF 132 kV POWERLINE

1. TERMS OF REFERENCE

This report has been prepared at the request of Envirolution Consulting (Pty) Ltd and forms part of the specialist studies required for an Environmental Impact Assessment (EIA). It presents the results of a geotechnical field investigation carried out within the site identified for the development of a new substation located some 2 km west of the existing Taunus Substation in Soweto, Gauteng Province.

2. BACKGROUND TO THE DEVELOPMENT

The development includes the construction of a new 132 kV Powerline which commences at the proposed new Taunus Substation and terminates at Diepkloof Substation, a distance of some 40 km. A site of about 0,6 ha located about 2,0 km west of the existing Taunus substation has been identified for the construction of the new substation. Two other sites of about the same size were also identified and investigated near Lenz township and the better of the two sites, in terms of the geotechnical conditions, was selected for the development of the new substation. Investigation details for the Powerline route and the two alternative substation sites are contained in the report referenced 1073/g and will not form the scope of this report.

3. INVESTIGATION

The field investigation to determine the subsoils underlying the substation site was carried out on 8 September 2010 and entailed setting out and excavating test pits employing a Case 580 Super R Tractor-Loader-Backhoe (TLB) excavator. The pits were excavated at the positions shown on the attached site plan in **Figure 1**, and were positioned so as to cover as much of the area as possible.

4. SITE DESCRIPTION

The area in which the substation site is located is almost flat and is covered by grass. See **Photograph 1** for an overall view of the site.

Photograph 1: Overall view of site from near the western boundary looking east.

5. GEOLOGICAL AND SUBSOIL CONDITIONS

According to the 1:250 000 West Rand (2626) Geological map the site is underlain by “dolomite, chert and remnants of chert breccia of the Rooihoogte Formation” of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup.

Five test pits, referenced TP1 to TP5, were dug within the vicinity of site and the subsoils encountered are described below:

Topsoil: blankets the site to a depth of 0,1 m and comprises medium dense to dense silty sand with many roots.

Aeolian: occurs below the topsoil and extends to an average depth of 0,6 m in the range 0,5 to 0,9 m where it comprises of pinholed silty sand containing abundant roots and is mainly medium dense to dense in consistency but loose and dense in places. The pinholed structure suggests that the soil may be collapsible.

Nodular ferricrete: occurs below the aeolian in test pits TP1, TP4 and TP5 only, where it comprises closely to tightly packed, fine and medium, friable ferruginous nodules with minor to abundant quartz gravels in a matrix of moist silty sand with roots. This horizon is of very loose to loose consistency and extends to an average depth of 0,9 m in the range 0,8 to 1,0 m.

Pebble marker: underlies the aeolian in TP3 only, and comprises tightly packed, sub-rounded sandstone and quartz gravels with abundant ferruginous nodules in a slightly moist, loose, silty sand matrix. It extends to a depth of 1,1 m below surface.

Talus: occurs in TP2, TP4 and TP5 only, and extends to an average depth of 2,2 m in the range 1,8 to 2,6 m where it comprises closely to tightly packed, sub-rounded and rounded, sandstone, quartzite and chert GRAVELS with abundant ferruginous nodules in a matrix of moist, clayey silty sand of dense to very dense consistency. In TP2, however, the consistency is loose and becomes medium dense below a depth of 2,1 m.

Reworked residual chert: underlies either one of the layers described above and extends to an average depth of 2,0 m in the range 1,2 to 3,5 m and comprises sandy clayey silt of firm consistency which is soft and stiff in places.

Residual chert: underlies the reworked layer described above and the pebble marker, where it comprises tightly packed, angular chert gravels with cobbles in a moist, silty sand or sandy silt matrix. It extends to the bottom of the pits at an average depth of 3,1 m and has an overall consistency of dense to very dense. In TP1 it occurs as a stiff clayey silt that extends to the bottom of the pit at a depth of 3,5 m.

The soil profile records for each of the test pits are presented in **Appendix A** of this report.

6. GROUNDWATER

No groundwater seepage was encountered in any of the test pits.

7. LABORATORY TEST RESULTS

The results of the laboratory tests carried out on selected soil samples recovered from the test pits are summarised below and presented in **Appendix B**.

7.1 Foundation Indicator

For more accurate identification and for classification purposes, particle size distribution analysis and Atterberg limit determinations were carried out on samples of the near surface aeolian, nodular ferricrete and reworked residual chert, and the results of these are summarized in **Table 1**.

According to the AASHTO classification system the aeolian and nodular ferricrete classifies as A-2-4 (0) and A-1-b (0) soil types respectively, which are silty sand and sandy gravel of "good" rating for use as subgrade.

In terms of the Unified Soil Classification systems the reworked residual chert classifies as “SC” soil type, this being clayey sand and exhibits a “poor” rating for use as subgrade.

The grading modulus of both the aeolian and reworked residual chert averages 1,04 which reflects the medium grained nature of the soil. The nodular ferricrete on the other hand has a grading modulus of 2,15 which is relatively coarse.

The weighted plasticity index for the reworked residual chert is 9 and both the aeolian and nodular ferricrete are slightly plastic “SP”. Employing the method of Van Der Merwe[1], this suggests that these soil horizons are of low expansive potential.

Table 1: Summary of results of indicator tests

Test Pit No	Description	Depth (m)	LL	PI	PI_{ws}	LS	GM	MIT Size Fraction - %				Classification	
								Gravel	Sand	Silt	Clay	USC	AASHTO
TP1	Aeolian – Silty sand	0.4 – 0.8	18	7	2	3.5	2.23	11	59	30			A-2-4 (0)
TP2	Reworked residual chert – clayey silt	0.1 – 0.5	SP	SP	SP	1.0	0.86	17	42	29	13	SC	A-4 (0)
TP5	Nodular Ferricrete	0.7 – 0.9	19	7	7	4	0.63	60	28	12			A-1-b (0)

LL = liquid limit; PI = plasticity index; PI_{ws} = plasticity index of whole sample; LS = linear shrinkage; GM = grading modulus, USC = unified soil classification, AASHTO = American Association of State Highway and Transportation Officials

7.2 Compaction Tests

Modified AASHTO compaction tests and California Bearing Ratio (CBR) tests were carried out on the aeolian and nodular ferricrete, the results of which are summarised in **Table 2** below.

CBR tests carried out on the aeolian and nodular ferricrete indicate that they classify as G7 and G6 quality materials in accordance with the TRH 14 materials specifications [2.].

Table 2: Summary of Results of Compaction and CBR Tests

Test Pit No	Description	Depth (m)	ρ_d max	omc	CBR					Max Swell	TRH Class
			(kg/m^3)	(%)	@ % compaction					(%)	
					90	93	95	98	100		
TP1	Aeolian - silty sand	0.1 – 0.5	2150	7.9	13.6	25.7	39.2	42.2	43.5	0.2	G8
TP4	Nodular ferricrete	0.5 – 0.8	2241	7.5	23.9	34.6	44.3	63.0	79.6	0.0	G7

8. GEOTECHNICAL ASSESSMENT

A geotechnical assessment of the site has been carried out to classify it in terms of its suitability for development and highlight any constraints that may be evident. These constraints have been proposed by Partridge, Wood and Brink [3], and are discussed in more detail below.

8.1 Collapsible / Compressible soil profile

The site is covered by pinholed medium dense aeolian sand which is underlain by loose nodular ferricrete and a pebble marker that extend to a depth of up to 1,1 m below surface.
The pinholed structure and loose consistency exhibited by these in-situ soils suggest that structures founded on them may undergo significant differential settlement. However, the presence of shallow dense to very dense talus and stiff residual chert suggests that these settlements will be fairly nominal.

8.2 Shallow seepage or ground water level

As mentioned in **Section 6** of this report, no groundwater seepage was evident during the course of carrying out the investigation.

8.3 Expansive soil profile

The indicator test results suggest that the in-situ soils blanketing the sites generally have low clay content and are of low plasticity, and employing the method of Van Der Merwe they can be classified as being of low expansive potential.

8.4 Erodability of the soil profile

No erosion channels of any significance were noted during the investigation and, provided that storm water run-off is properly controlled, surface erosion is not likely to pose a significant problem to any proposed development.

8.5 Excavatability

The excavation characteristics of the soil horizons have been evaluated according to the South African Bureau of Standards standardised excavation classification for earthworks (SABS – 1200D) and earthworks (small works – SABS 1200DA)[4]. In terms of this classification and the *in-situ* soil consistencies as profiled, the relationships given below are generally applicable.

"soft excavation" - very loose/very soft through to dense or stiff.
"intermediate excavation" - very dense/very stiff through to very soft rock.
"hard excavation" - soft rock or better.

From the test pits dug on site it was found that "soft excavation" up to a depth of 3,5 m below surface using a TLB is possible, however, cognisance should be taken of refusal which occurred in test pit TP3 where "intermediate excavation" or "hard excavation" may be required. Partial refusal occurred at a depth of 2,8 m on very dense to very soft rock residual chert gravels.

8.6 Instability of areas of soluble rock

According to the geological map, dolomite underlies the site and instability associated with this rock type may occur. A detailed dolomite hazard assessment will therefore have to be undertaken before development takes place.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Founding Conditions

Based on the findings of this investigation, the major impact on development in terms of the subsoil conditions underlying the site is one of collapse settlement due to the presence of loose nodular ferricrete and pebble marker extending to a depth of up to 1,1 m below surface. However, the presence of shallow competent dense talus and residual chert gravels and stiff clayey silt below this depth suggests that foundations for the structures can be founded on conventional footings at a depth of 1,0 m below the present ground surface.

It is important to ensure that the foundations are placed on material of uniform consistency since excessive differential settlements may occur where one foundation rests on a dense talus gravel and an adjacent one on loose talus or soft sandy clayey silt.
As a result all foundation excavations should be inspected by an experienced engineer prior to pouring of concrete, since soft or loose spots can be present below the founding material as it was evident in TP2.
It is reiterated that dolomite underlies the site and instability associated with it must be assessed prior to any development being carried out.

9.2 Services

The TLB backacter used to put down the test pits excavated to depths of up to 3,5 m below the present ground surface, however, partial refusal as shallow as at 2,8 m occurred in test pit TP 3 and, as a result, excavation much deeper than this is likely to be “intermediate” or even “hard”.

9.3 Suitability of soils for use in pavement layers

The aeolian meets with the requirement of a G7 quality soil and is therefore not considered suitable for use as selected subgrade.

The nodular ferricrete meets with the requirements of a G6 quality material, and is therefore suitable for use as a selected layer and subbase in pavement layerworks.

10. GENERAL

All materials used for fill and layerworks should be tested by an approved laboratory to ensure compliance with the specifications. This includes field compaction densities.

11. REFERENCES

1) Van der Merwe, D.H. *The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction.* Trans. S.A. Ins. Civ. Eng. No. 6, 1964.

2) Technical Recommendations for Highways TRH 14 (1989): *Guidelines for Road Construction Materials*, Committee of State Road Authorities.

3) Partridge TC, Wood CK and Brink ABA. *Priorities for urban expansion within the PWV metropolitan region: The primacy of geotechnical constraints*. South African Geographical Journal, Vol. 75, pp 9 – 13. . 1993.

4) SABS 1200. *Standardised Excavation Classification for Earthworks*.

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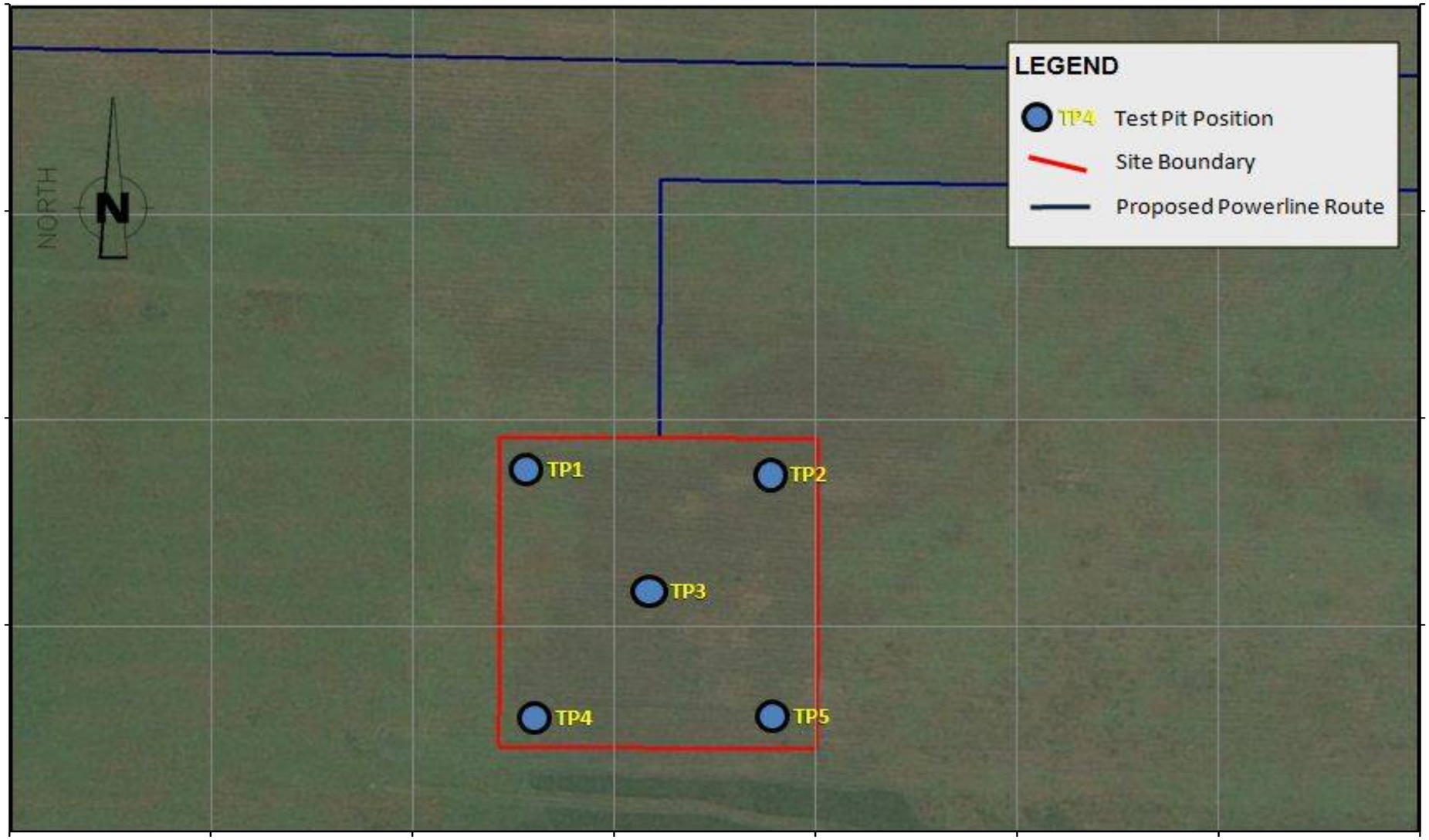

Ref: 10110/g	**ENVIROLUTION CONSULTING (PTY) LTD** **ESKOM SUBSTATION (TAUNUS - DIEPKLOOF 132 kv)** **SITE PLAN SHOWING POSITIONS OF TEST PITS**	**Figure 1**

APPENDIX A

SOIL PROFILES

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Tel: (011) 443 7811
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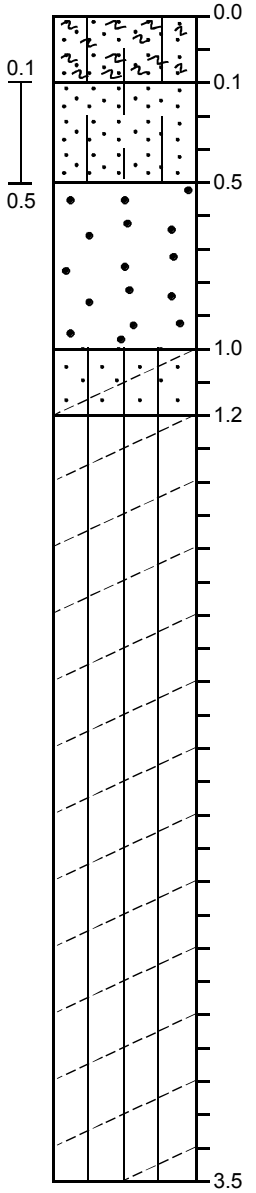
PROFILE SHEET

TP1

Envirolution Consulting (Pty) Ltd
Eskom Substation (Taunus-Diepkloof 132 kv)

X 2906618
Y -075906



0.0 – 0.1: Dry to slightly moist, brown, dense, SILTY SAND with abundant roots. *Topsoil.*

0.1 – 0.5: Moist, slightly red brown, medium dense to dense becoming loose below 0,3 m, pinholed, SILTY SAND with traces of fine ferruginous nodules. *Aeolian.*

0.5 – 1.0: Closely to tightly packed, sub-rounded and rounded, fine and medium, ferruginous NODULES in a matrix as above. *Nodular ferricrete.*

Overall consistency is loose to very loose.

1.0 – 1.2: Moist, dark red brown, firm to stiff, shattered/jointed, SANDY CLAYEY SILT. *Reworked residual chert.*

1.2 – 3.5: Moist, dark red brown speckled and mottled white and orange, stiff, intact and slightly shattered and slickensided, CLAYEY SILT with very occasional weathered chert gravels. *Residual chert.*

NOTES:
1. Bottom of hole at 3,5 m. Not to refusal.
2. No ground water seepage encountered.
3. Bulk sample taken from 0,1 to 0,5 m.
4. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: Bears Plant Hire
Machine: Case 580 Super R

Profiled by: MC Shuping
Date profiled: 08/09/2010

▽ Water seepage ▼ Standing water ■ Undisturbed sample ● Disturbed sample I Bulk sample ⊢ *In-situ* test

Ref: 10110/g

Sheet 1 of 1

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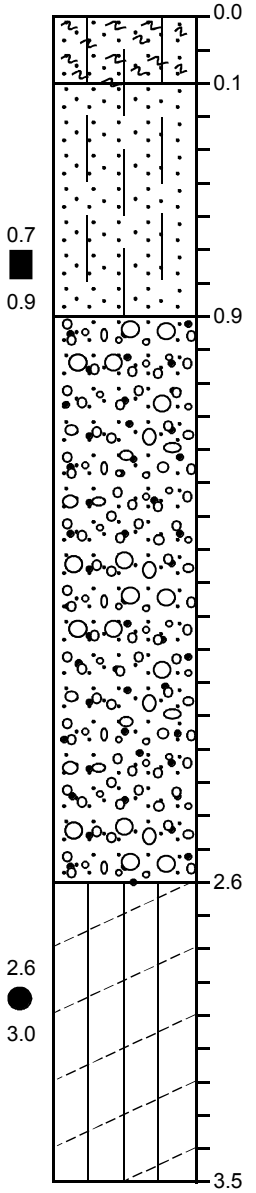
PROFILE SHEET

TP2

Envirolution Consulting (Pty) Ltd
Eskom Substation (Taunus-Diepkloof 132 kv)

X 2906680
Y -075900



0.0 – 0.1: Dry, brown, medium dense to dense, SILTY SAND with abundant roots. *Topsoil.*

0.1 – 0.9: Slightly moist becoming moist, red brown, medium dense to dense becoming loose to medium, pinholed, SILTY SAND with traces of fine ferruginous nodules. *Aeolian.*

0.9 – 2.6: Closely to tightly packed, sub-rounded and rounded, ferruginous NODULES with abundant, sandstone and chert gravels and minor cobbles in a matrix as above. Talus.

Overall consistency is loose becoming medium dense below 2,1 m.

Contains up to 1,0 m thick pockets comprising dense gravels.

2.6 – 3.5: Moist, dark red brown mottled light yellow, firm, intact, CLAYEY SILT. *Reworked residual chert.*

NOTES:
1. Bottom of hole at 3,5 m. Not to refusal.
2. No ground water seepage encountered.
3. Undisturbed sample taken from 0,7 to 0,9 m.
4. Disturbed sample taken from 2,6 to 3,0 m.
5. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: Bears Plant Hire
Machine: Case 580 Super R

Profiled by: MC Shuping
Date profiled: 08/09/2010

▽ Water seepage ■ Undisturbed sample ⌶ Bulk sample
▼ Standing water ● Disturbed sample ⊢ *In-situ* test

Ref: 10110/g

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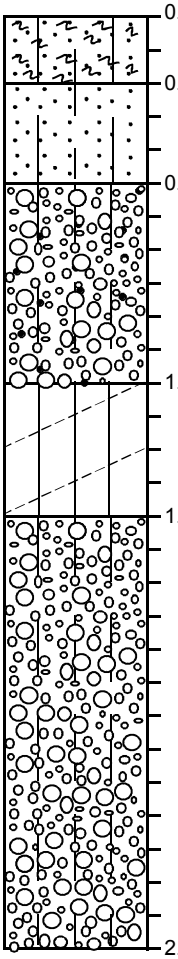
PROFILE SHEET

TP3

Envirolution Consulting (Pty) Ltd
Eskom Substation (Taunus-Diepkloof 132 kv)

X 2906653
Y -075870



0.0 – 0.1	Dry, brown, medium dense to dense, pinholed, SILTY SAND with roots. *Topsoil.*
0.1 – 0.45	Slightly moist, slightly red brown, medium dense, pinholed, SILTY SAND. *Aeolian.*
0.45 – 1.1	Tightly packed, sub-rounded and rounded, fine, medium and coarse, sandstone and quartz GRAVELS in a matrix as above with abundant ferruginous nodules. *Pebble marker.* Overall consistency is loose.
1.1 – 1.4	Moist, dark red brown speckled and mottled white, soft, pinholed, CLAYEY SILT with abundant friable chert gravels. *Reworked residual chert.*
1.4 – 2.8	Tightly packed, angular, chert GRAVELS and COBBLES in a matrix as above. *Residual chert.* Overall consistency is dense to very dense. Contains occasional pockets of firm clayey silt.

NOTES:
1. Bottom of hole at 2,8 m. Partial refusal on very dense chert gravels.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: Bears Plant Hire
Machine: Case 580 Super R

Profiled by: MC Shuping
Date profiled: 08/09/2010

▽ Water seepage
▼ Standing water
■ Undisturbed sample
● Disturbed sample
I Bulk sample
⊢ *In-situ* test

Ref: 10110/g

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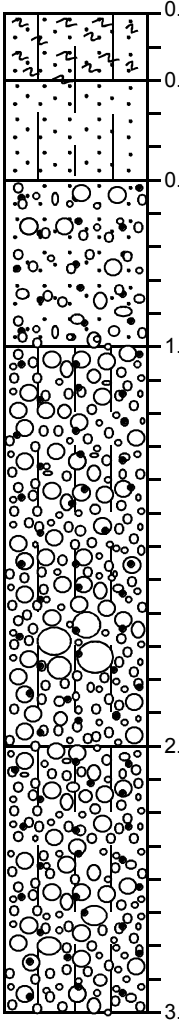
PROFILE SHEET

TP4

Envirolution Consulting (Pty) Ltd
Eskom Substation (Taunus-Diepkloof 132 kv)

X 2906621
Y -075836



0.0 – 0.1: Dry, brown, medium dense to dense, SILTY SAND with roots. *Topsoil.*

0.1 – 0.45: Slightly moist, red brown, medium dense, SILTY SAND with few rounded gravels. *Aeolian.*

0.45 – 1.0: Closely packed, sub-rounded, rounded and sub-angular, ferruginous NODULES with abundant quartz GRAVELS in a matrix of moist, brown silty sand. *Nodular ferricrete.*

Overall consistency is loose.

1.0 – 2.1: Closely to tightly packed, sub-rounded and rounded, sandstone and quartzite GRAVELS with abundant ferruginous nodules in a matrix of moist, red brown, clayey silty sand. *Talus.*

Overall consistency is dense to very dense.

2.1 – 3.0: Tightly packed, angular, chert GRAVELS with COBBLES and small BOULDERS in a matrix of moist, red brown, clayey sandy silt. *Residual chert.*

Overall consistency is dense to very dense.

NOTES:
1. Bottom of hole at 3,0 m. Partial refusal on very dense to very soft rock chert.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: Bears Plant Hire
Machine: Case 580 Super R

Profiled by: MC Shuping
Date profiled: 08/09/2010

▽ Water seepage ▼ Standing water ■ Undisturbed sample ● Disturbed sample ⌶ Bulk sample ⊢ *In-situ* test

Ref: 10110/g

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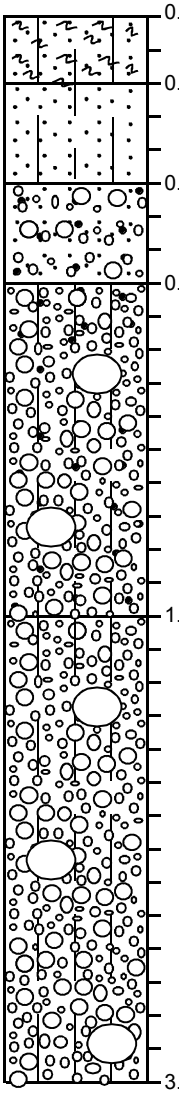
PROFILE SHEET

TP5

Envirolution Consulting (Pty) Ltd
Eskom Substation (Taunus-Diepkloof 132 kv)

X 2906680
Y -075841



0.0 – 0.1: Dry, brown, dense, pinholed, SILTY SAND with many roots. *Topsoil.*

0.1 – 0.45: Slightly moist, brown, medium dense to dense, pinholed, SILTY SAND with few fine roots. *Aeolian.*

0.45 – 0.8: Closely to tightly packed, sub-rounded, rounded, sub-angular, fine and medium, ferruginous NODULES with quartz GRAVELS in a matrix as above with roots. *Nodular ferricrete.*

Overall consistency is loose.

0.8 – 1.8: Tightly packed, sub-angular, rounded, sandstone GRAVELS with abundant ferruginous NODULES in a matrix of dark red brown, clayey sandy silt with many fine roots. *Pebble marker.*

Overall consistency is dense to very dense.

1.8 – 3.2: Tightly packed, angular, fine, medium and coarse, chert GRAVELS, COBBLES and small BOULDERS in a matrix of slightly moist, dark red brown, clayey silt. *Residual chert.*

Overall consistency is very dense.

In places contains pockets of moist, brown mottled, light grey, firm, clayey silt.

NOTES:
1. Bottom of hole at 3,2 m. Not to refusal.
2. No ground water seepage encountered.
3. Co-ordinates determined from Garmin hand-held GPS to WGS 84 system.

Contractor: Bears Plant Hire
Machine: Case 580 Super R

Profiled by: MC Shuping
Date profiled: 08/09/2010

▽ Water seepage ▼ Standing water ■ Undisturbed sample ● Disturbed sample ⌶ Bulk sample ⊢ *In-situ* test

Ref: 10110/g

APPENDIX B

LABORATORY TEST RESULTS

A SANAS accredited testing laboratory No T0062
36/38 Fourth Street, Booysens Reserve, Johannesburg 2091
P O Box 82223, Southdale 2135
Tel: +27 (0)11 835-3117 • Fax: +27 (0)11 835-2503
Email: jhb@civilab.co.za • Website: www.civilab.co.za

Civilab
Civil Engineering Testing Laboratories

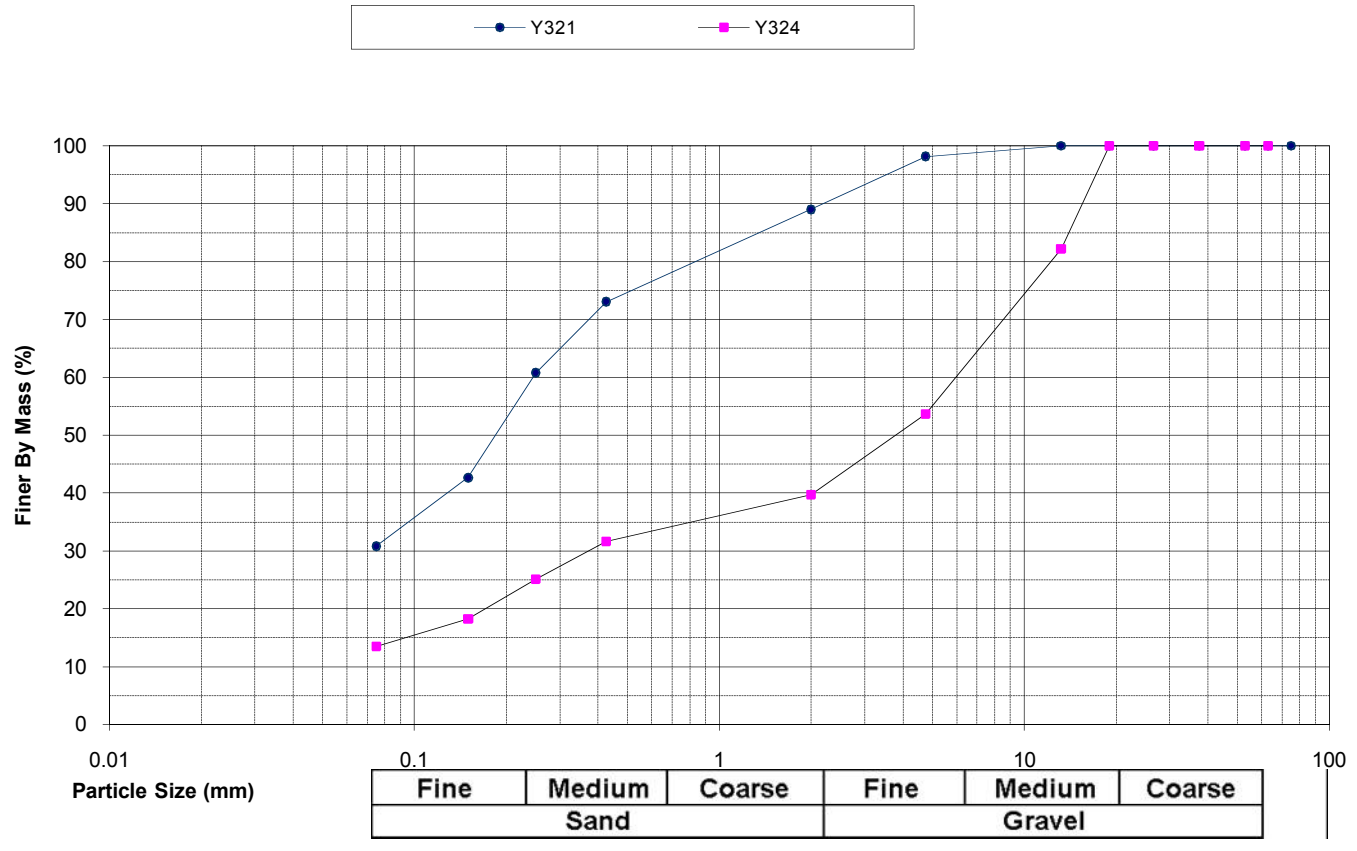
Road Indicator Test Data

Project	ESKOM SUBSTATION		
Project No.	1039/F21/09/2010	Date	23 September 2010

Sample No.	Y321	Y324	
Field Ref. No.	TP 1	TP 5	
Depth	0.10 - 0.50	0.50 - 0.80	
Sieve size	%Passing	% Passing	% Passing
75	100	100	
63	100	100	
53	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	100	82	
4.75	98	54	
2.00	89	40	
0.425	73	32	
0.25	61	25	
0.15	43	18	
0.075	31	13	

Sample No.	Y321	Y324	
%Coarse Sand	18	20	
%Fine Sand	47	46	
%Silt and Clay	35	34	
NMC %	Not Tested	Not Tested	
Liquid Limit	SP	SP	
Plasticity Index	SP	SP	
Linear Shrink.	1.	1.	
Overall P.I.	SP	SP	
Grading Modulus	1.07	2.15	
H.R.B.	A-2-4 (0)	A-1-b (0)	

The results reported relate only to the samples tested.
Documents may only be reproduced or published in their full context.



Analyses according to methods A1(a), A2, A3 and A5 of TMH1 (1986) and method A4 of TMH1 (1970).
Remarks:

A SANAS accredited testing laboratory No T0062
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Email: jhb@civilab.co.za • Website: www.civilab.co.za

Civilab
Civil Engineering Testing Laboratories

Foundation Indicator Test Data

Project	ESKOM SUBSTATION		
Project No.	1039/F21/09/2010	Date	20 September 2010

Sample No.	Y323		
Field Ref. No.	TP 2		
Depth	2.60 - 3.00		
Sieve size	%Passing	% Passing	% Passing
75	100		
63	100		
53	100		
37.5	100		
26.5	100		
19.0	100		
13.2	100		
4.75	94		
2.00	83		
0.85	76		
0.425	66		
0.250	61		
0.150	55		
0.075	49		
0.04	32		
0.02	25		
0.006	18		
0.002	13		

Sample No.	Y323		
%Gravel	17		
%Sand	42		
%Silt	29		
%Clay	13		
NMC %	Not Tested		
Liquid Limit	28		
Plasticity Index	13		
Linear Shrink.	5.5		
Overall P.I.	9		
Grading Modulus	1.01		
H.R.B.	A-6 (4)		
Unified	SC		
Weston swell (%) at 1 kPa			

Analysis as per method D422 of ASTM of 1985
The results reported relate only to the samples tested.
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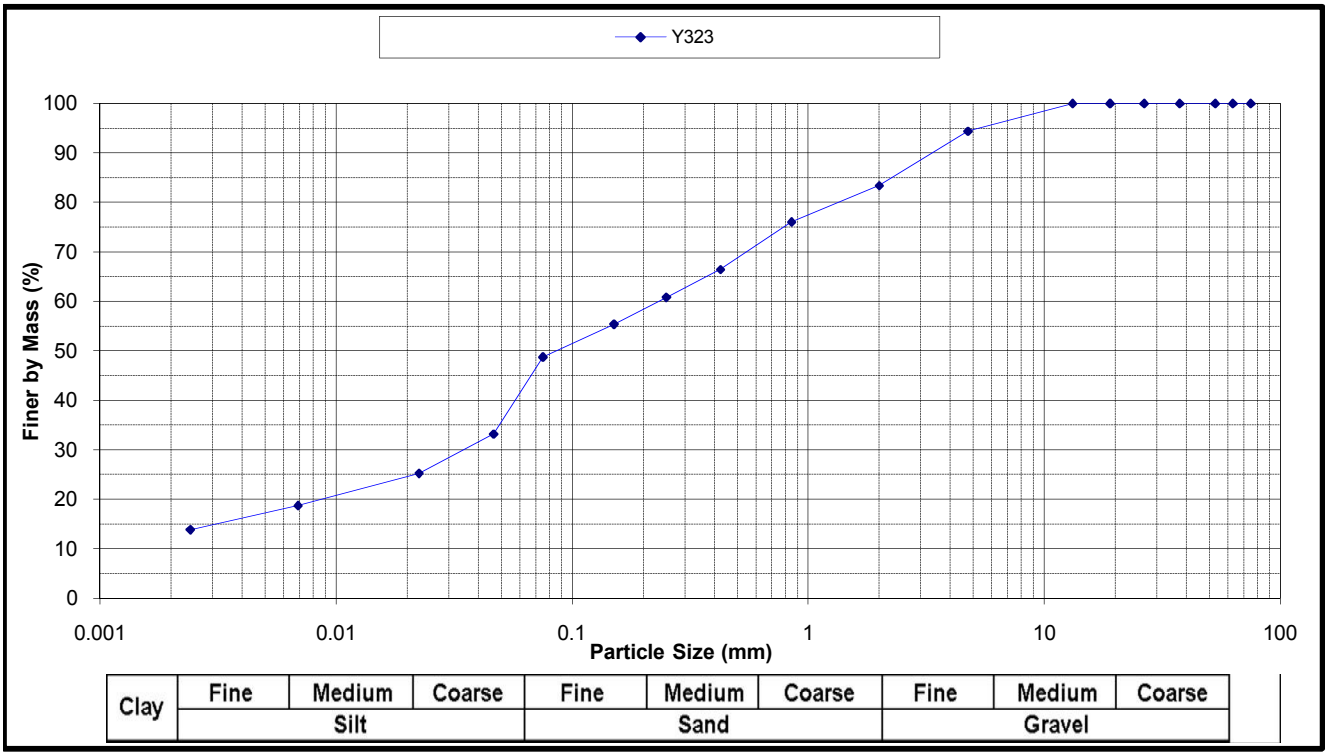

Remarks:

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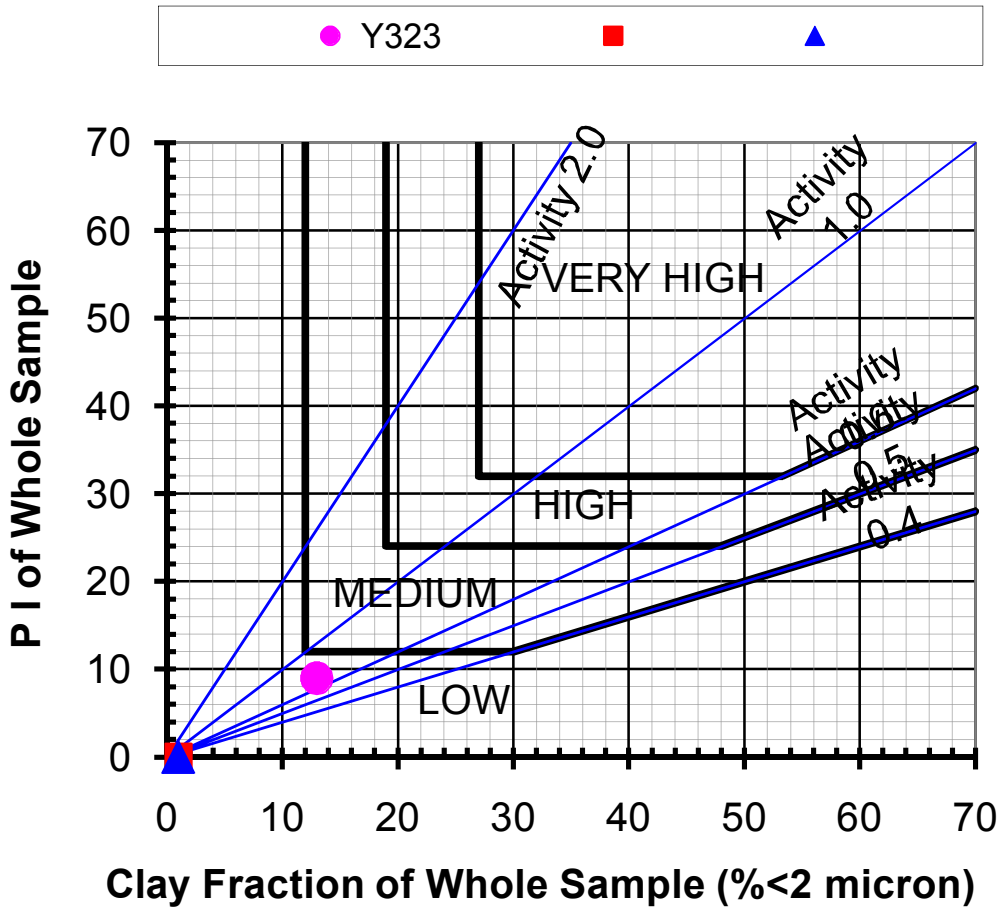
Activity Diagram After D H van der Merwe



Plotted Values:

Sample	Clay Frac	PI
Y323	13.0	9.0

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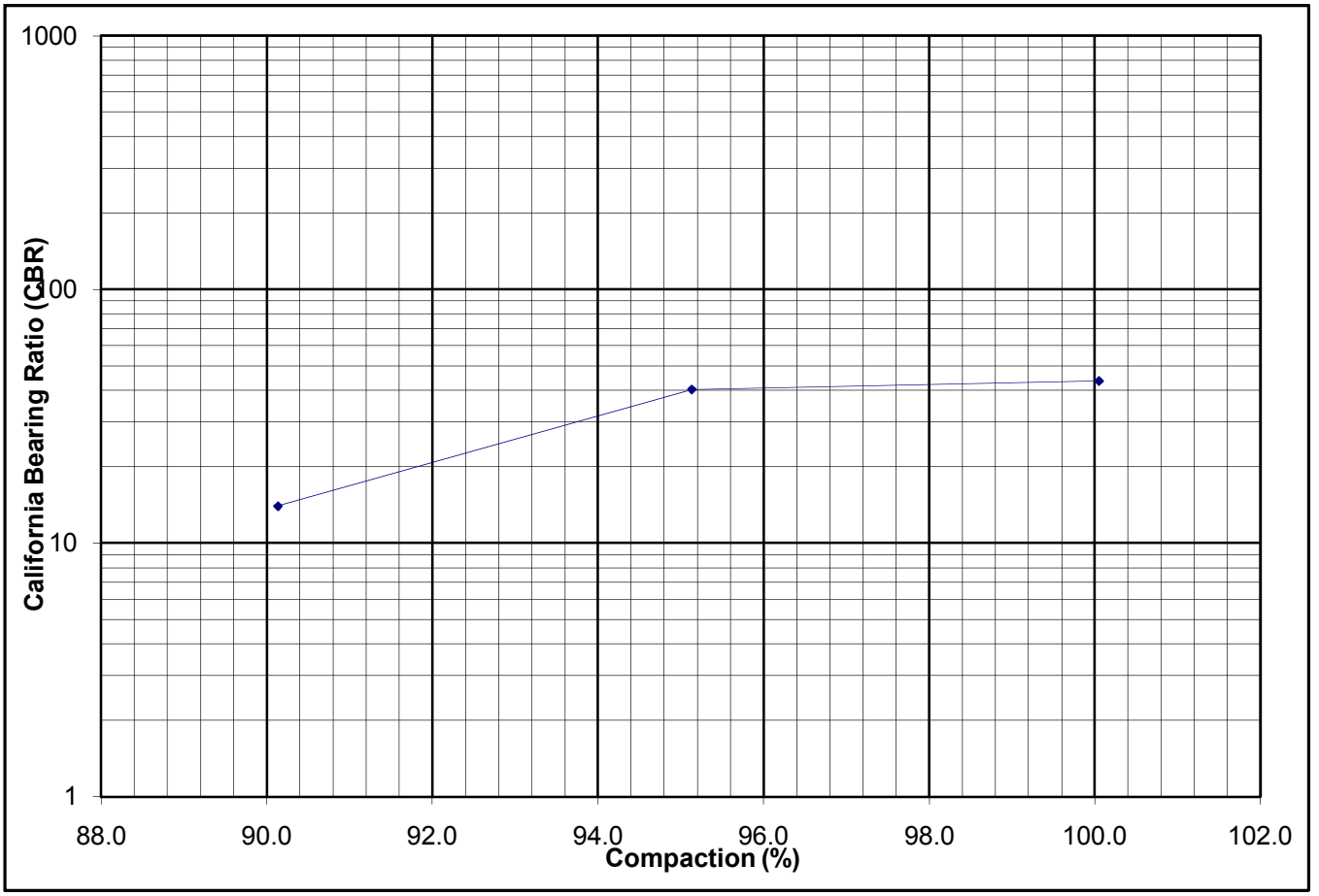
California Bearing Ratio Results

Project:	ESKOM SUBSTATION		
Project No.:	1039/F21/09/2010	Date:	20 Sep 2010
Field Reference:	TP 1	Lab. Sample Ref:	Y321
Depth (m):	0.1 - 0.5	Remarks:	Untreated
Description:	-		

CBR at			Swell	Final Moisture Content	Mod AASHTO Data		CBR Compaction Data		
2.54 (mm)	5.08 (mm)	7.62 (mm)	(%)	(%)	Max Dry Density (kg/m³)	Optimum Moisture (%)	Dry Density (kg/m³)	Com-paction (%)	Moisture Content (%)
44	63	66	0.2	9.1	2150	7.9	2151	100.1	7.8
40	37	34	0.2	10.6			2045	95.1	
14	8	7	0.2	11.6			1938	90.1	

Interpolated Data	**Compaction**	**90%**	**93%**	**95%**	**98%**	**100%**
	CBR	**13.6**	**25.7**	**39.2**	**42.2**	**43.5**



The samples were tested in accordance with Method A8 of TMH1 of 1990.
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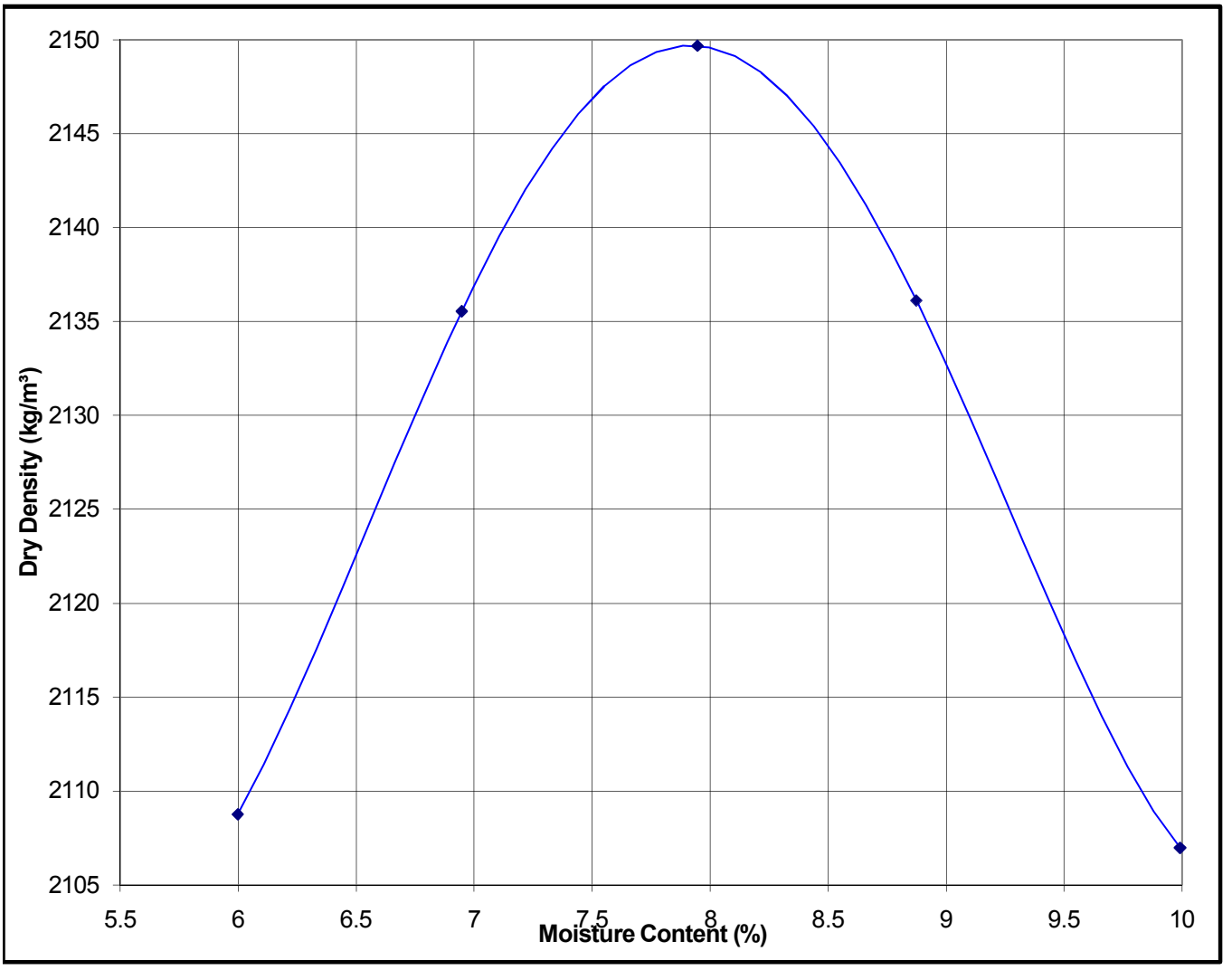
Moisture Density Relationship

Project:	ESKOM SUBSTATION		
Project No.:	1039/F21/09/2010	Date:	13 September 2010
Field Reference:	TP 1	Laboratory Ref.:	Y321
Depth (m):	0.1 - 0.5	Remarks:	Untreated
Description:	-		

Compactive Effort: **Mod. AASHTO**

Percent Water Content (%):	8.9	10.0	7.9	6.9	6.0				
Dry Density (kg/m^3):	2136	2107	2150	2136	2109				

Maximum Dry Density:	**2150 kg/m^3**	**Optimum Moisture Content:**	**7.9 %**



Analysis according to Method A7 of TMH1 of 1986.
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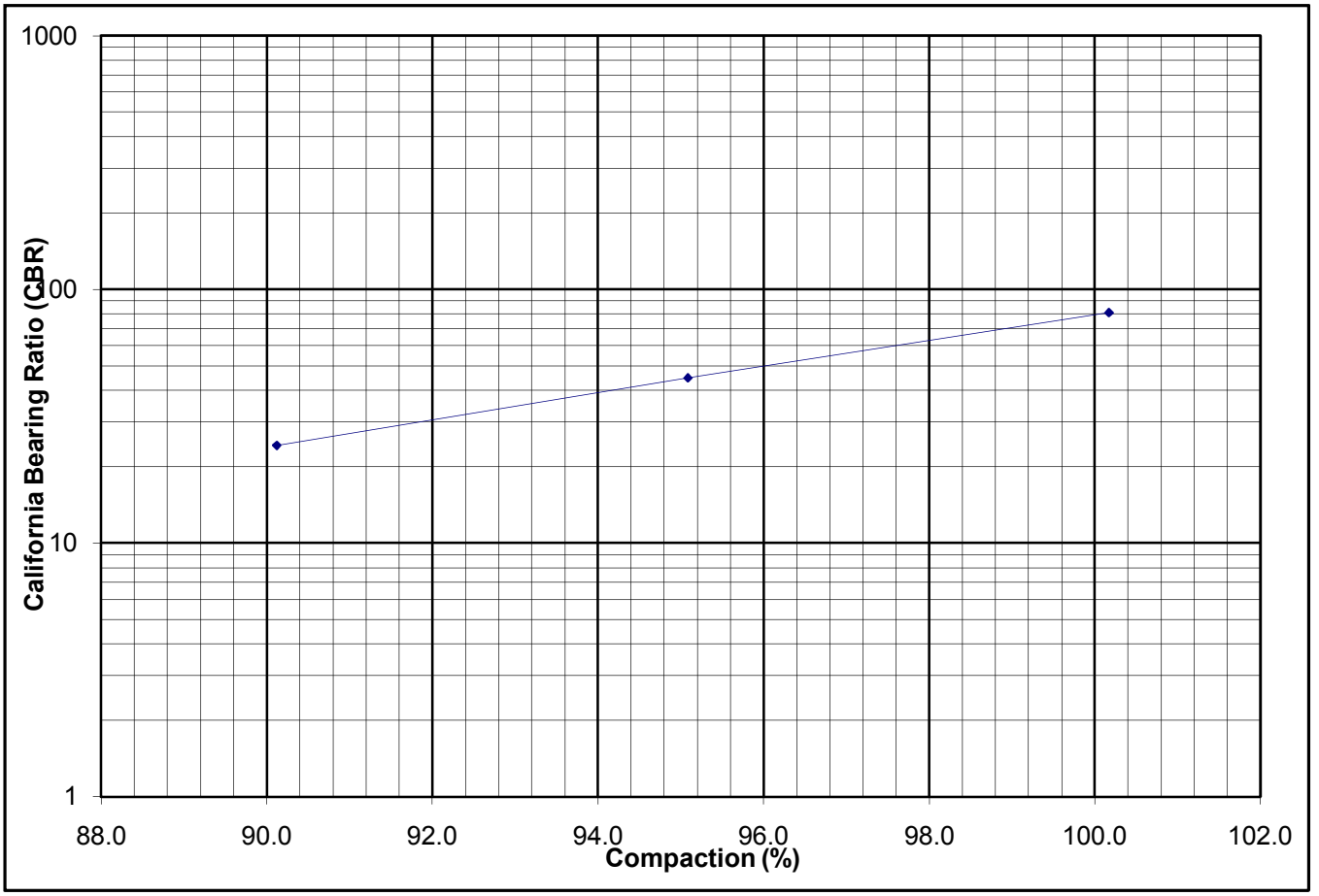
California Bearing Ratio Results

Project:	ESKOM SUBSTATION		
Project No.:	1039/F21/09/2010	Date:	20 Sep 2010
Field Reference:	TP 5	Lab. Sample Ref:	Y324
Depth (m):	0.5 - 0.8	Remarks:	Untreated
Description:	-		

CBR at			Swell	Final Moisture Content	Mod AASHTO Data		CBR Compaction Data		
2.54 (mm)	5.08 (mm)	7.62 (mm)	(%)	(%)	Max Dry Density (kg/m³)	Optimum Moisture (%)	Dry Density (kg/m³)	Com-paction (%)	Moisture Content (%)
81	127	114	0.0	5.2	2241	7.5	2245	100.2	7.6
45	63	69	0.0	4.6			2131	95.1	
24	24	26	0.0	12.6			2020	90.1	

Interpolated Data	**Compaction**	**90%**	**93%**	**95%**	**98%**	**100%**
	CBR	**23.9**	**34.6**	**44.3**	**63.0**	**79.6**



The samples were tested in accordance with Method A8 of TMH1 of 1990.
The results reported relate only to the samples tested.

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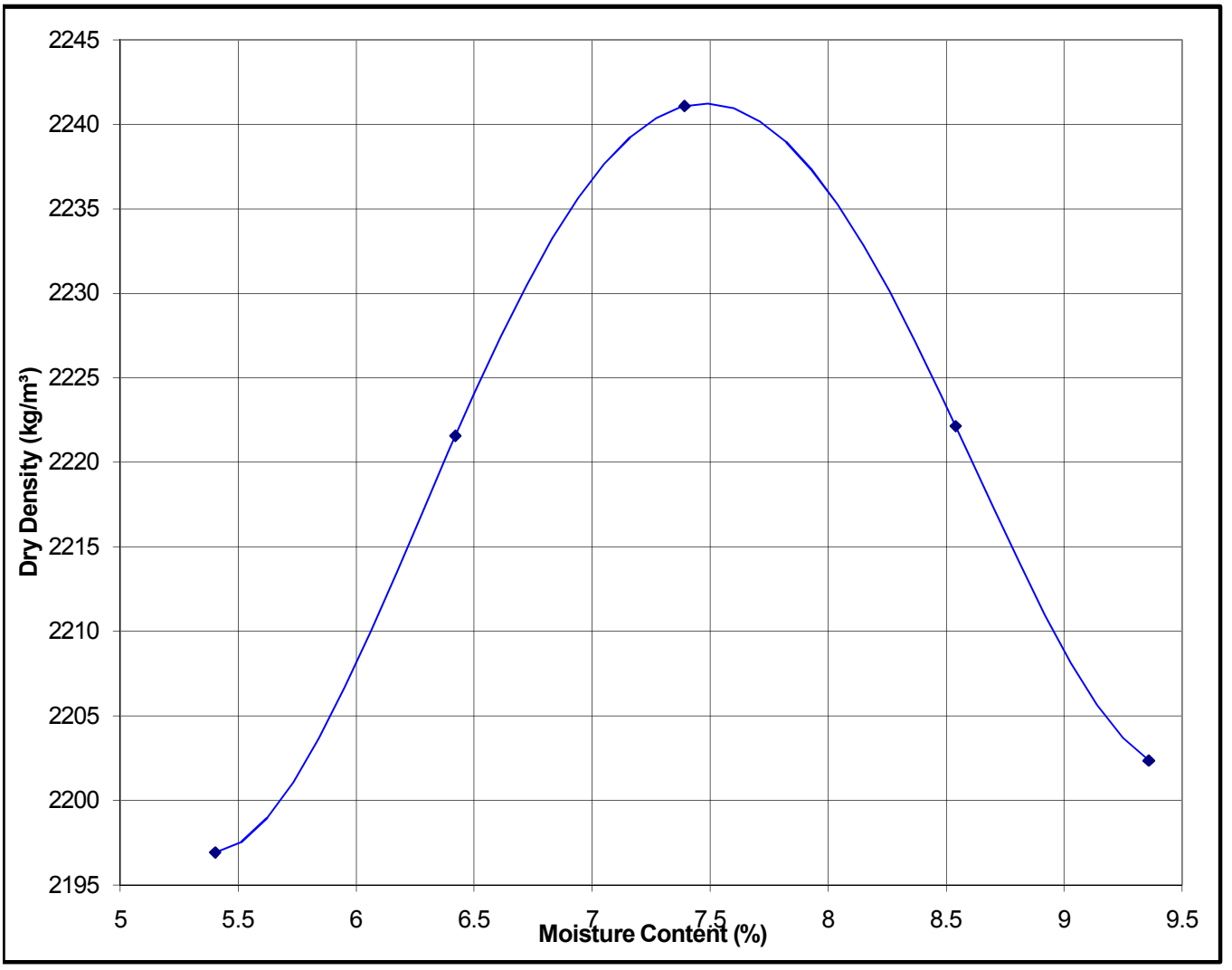
Moisture Density Relationship

Project:	ESKOM SUBSTATION		
Project No.:	1039/F21/09/2010	Date:	14 September 2010
Field Reference:	TP 5	Laboratory Ref.:	Y324
Depth (m):	0.5 - 0.8	Remarks:	Untreated
Description:	-		

Compactive Effort: **Mod. AASHTO**

Percent Water Content (%):	7.4	8.5	6.4	9.4	5.4				
Dry Density (kg/m^3):	2241	2222	2222	2202	2197				

Maximum Dry Density:	**2241 kg/m^3**	**Optimum Moisture Content:**	**7.5 %**



Analysis according to Method A7 of TMH1 of 1986.
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Remarks: