REPORT TO

MDT ENVIRONMENTAL (PTY) LTD

ON A

SPECIALIST PRELIMINARY

GEOTECHNICAL INVESTIGATION

FOR THE PROPOSED

ESKOM MKUZE SUBSTATION,

IPHIVA 3A

Ref № 31833-1

SEPTEMBER 2017

DRENNAN MAUD (PTY) LTD
GEOTECHNICAL ENGINEERS &
ENGINEERING GEOLOGISTS

Durban Head Office
68 Peter Mokaba Ridge, Tollgate, 4001
P.O. Box 30464, Mayville, 4058
Tel : +27 31 201 8992 Fax : +27 31 201 7920
www.drennanmaud.com

EXECUTIVE SUMMARY

Drennan Maud (Pty) Ltd carried out a preliminary geotechnical investigation in August 2017 at Iphiva 3A for the proposed Eskom Mkuze Substation which forms part of Eskom's Northern KZN Strengthening Programme. Iphiva 3A is an additional candidate site to the three sites investigated during May 2017, namely Iphiva 4, Iphiva 5 and Iphiva 6. The geotechnical investigation was undertaken as a specialist study for the Environmental Impact Assessment.

Based on the field investigation, Iphiva 3A has an undulating topography with deeply incised valleys to the north and east. It is characterised by a thin mantle of hillwash material directly overlying Letaba Formation amygdaloidal basalt except in the northwestern region, where a thin layer of residual basalt is encountered above the basalt bedrock.

Regarding material suitability, the hillwash, residual basalt and weathered basalt bedrock are considered suitable for use as engineered fill and layer works; however, these materials are likely to be a thin horizon with limited volume.

In general, the hillwash, residual and highly weathered bedrock classifies as "Soft Excavation" (after SANS 1200D-1988) below which 'Intermediate" rapidly becoming "Hard Excavation" is to be expected for the weathered basalt bedrock. "Soft Excavation" at Iphiva 3A is expected to depths ranging between 1.0 and 2.0 m below existing ground level across majority of the site. Exception is the northwestern region of the site where "Soft Excavation" is expected to depths ranging between 3.0 and 4.0 m below current ground level.

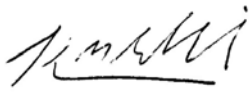
Earthwork plans have not been provided in this preliminary stage; however, major cutting / filling is envisioned due to the site's undulating topography. The more gentle terrain in the central and southern regions may; however, only require minor earthworks to develop (< 2 - 3 m). Permanent batters of 1:2 (26°) are recommended for all cuts and fill slopes. Temporary cut slopes of limited height (< 3 m) may be steepened to 1:1 (45º). Herringbone subsoil drainage is recommended in seepage areas (valley / channel depressions) which are going to be filled over.

Founding of structures will be variable depending on structure type, loading and positioning due to the variable geology of the site. The founding recommendations assume an upper 1.5 m good quality granular fill capping (G5 / G6 / G7 / G8 type) as commonly found at Eskom sites. Small and lightly loaded structures can be founded using strip footings / pads / raft type foundations supported in the upper 1.5 m engineered fill capping. Shallow strip footing / column base pad foundations taken into bedrock are recommended where depth to bedrock is less than 1.5 m. Where thick new fills or *in situ* soils overlie weathered bedrock, heavier and sensitive structures may require stiffened rafts or rafts / ground beams supported on piles to bedrock.

A seismic assessment of the Mkuze area indicates the proposed sites have an MMI value of VI with a peak horizontal ground acceleration of 50-100 cm/s^2 (0.05-0.10 g) for a 50 year period.

Based on the prevailing geotechnical conditions, all four candidate sites are developable. Iphiva 3A and Iphiva 6 has shallow bedrock (0.10-0.60 m) which is suitable for founding; however, this results in costly excavation issues for earthworks / service trenches. Furthermore, Iphiva 3A requires extensive earthworks and drainage to overcome the undulating topography. Conversely, bedrock depths are deeper at Iphiva 4 and 5 (0.40-4.00 m) resulting in deep founding solutions for heavier / sensitive structures; however, less costly excavation issues for earthworks / service trenches.

DOCUMENT CONTROL

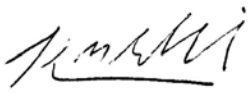
Report Title		Specialist Preliminary Geotechnical Investigation for the Proposed Eskom Mkuze Substation, Iphiva 3A		
Report Reference		31833-1	**Responsible Person**	K. Ribbink
Client Name		MDT Environmental (Pty) Ltd	**Client Contact Details**	1761 Tezula Estate, Uranium Street, Witkoppen ext 107 2191
Revision	**Date**		**Current Revision**	
00	18/09/17			
01	09/10/17	Revisions based on Eskom Feedback	01	
Approval				
Author's Signature			**Reviewer's Signature**	
Name		J. Lodge	**Name**	K. Ribbink
Title		Eng. Geol.	**Title**	Pr. Sci. Nat
Professional Body		N/A	**Professional Body**	SACNASP
Registration Number		N/A	**Registration Number**	400051/99

The ground conditions described in this report refer specifically to those encountered in the inspection pits and penetrometer tests carried out across the various sites. It is therefore quite possible that ground conditions may vary from those in the above mentioned testing positions.

This information in this report is given in good faith, as an indication of the materials and conditions likely to be encountered during construction. However, there is no warranty that the information is totally representative of the entire area and no responsibility will be accepted for any consequences arising from actual conditions being different from those indicated in this document.

DECLARATION OF INDEPENDENCE

K. Ribbink and J. Lodge, who are Engineering Geologists from Drennan Maud (Pty) Ltd, are independent consultants to MDT Environmental (Pty) Ltd (Consultants for ESKOM Holdings SOC Ltd), i.e. they have no business, financial, personal or other interest in the activity, application or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of these specialists performing such work.



18 September 2017

Signature of Engineering Geologist (Pr. Sci. Nat.): K. Ribbink Date

18 September 2017

Signature of Engineering Geologist: J. Lodge Date

CONTENTS

CONTENTS

REPORT TO MDT ENVIRONMENTAL ON A SPECIALIST PRELIMINARY GEOTECHNICAL INVESTIGATION FOR THE PROPOSED ESKOM MKUZE SUBSTATION, IPHIVA 3A

1. INTRODUCTION AND TERMS OF REFERENCE

At the request of Ms Terry Calmeyer of MDT Environmental (Pty) Ltd (MDT), Drennan Maud (Pty) Ltd (DML) provided a quotation to carry out a preliminary geotechnical investigation for the proposed Eskom Mkuze Substation further to the three candidate sites investigated in May 2017. The Mkuze Substation forms part of Eskom's Northern KZN Strengthening Programme. The quotation, ref 91 dated 20th July 2017, was submitted to MDT and DML was subsequently appointed by Ms Calmeyer on behalf of Eskom Holdings SOC Ltd (Eskom) on 27th July 2017. The geotechnical investigation was undertaken as a specialist study for the Environmental Impact Assessment (EIA).

The aim of the preliminary geotechnical investigation is to ascertain the geotechnical subsoil conditions relative to the proposed earthworks and to identify potential problems by determining the following geotechnical properties relevant to the development:

- Site geology and stratigraphy
- Soil and rock classification
- Potential geotechnical problems
- Identification of areas of steep and potentially unstable zones
- Earthworks and platform construction recommendations
- Excavatability of material on site as per SANS 1200D specifications
- Establish the on site sources available to obtain suitable material for fill
- Site drainage
- Soil corrosion protection
- Recommended potential foundation solutions
- Seismic assessment and classification of the site

The site was visited on the 8th August 2017 at which time the geotechnical investigation was carried out.

The findings of the geotechnical investigation, assessment of the results and subsequent recommendations for the proposed development are discussed herewith below.

2. INFORMATION SUPPLIED AND PREVIOUS WORK

Information supplied to DML for the purpose of this investigation included:

- Terms of Reference for Specialist Studies for Eskom's Northern KwaZulu-Natal Strengthening Project
- National Environmental Management Act's Environmental Impact Assessment Regulations, 2014 (GN 982)
- Kmz file of the site location
- Figure 6.3: Location of Iphiva 3

In addition to the above, the geotechnical report to MDT (previously known as ILISO Consulting Environmental Management) for the three initial candidate sites for the Eskom Mkuze Substation conducted by DML was consulted, namely:

- Report reference 31833, titled "Report to ILISO Consulting Environmental Management (Pty) Ltd on a Specialist Preliminary Geotechnical Investigation for the Proposed Eskom Mkuze Substation", dated July 2017.

3. PROPOSED DEVELOPMENT

It is understood that the proposed development consists of the construction of the new Iphiva 400/132 kV Substation near the town of Mkuze in Northern KwaZulu-Natal (KZN). The new Iphiva Substation will be integrated into the 400 kV network by two 400 kV lines and approximately 65 km of 132 kV distribution powerlines in order to alleviate current and future network constraints in Northern KZN.

The proposed Iphiva 400/132 kV Substation earthworks will be 400 m x 400 m in size within a 600 m x 600 m footprint within a 1 km x 1 km study area. The substation will comprise of the standard electrical equipment such as transformers, reactors, busbars and isolators. The substation will have a microwave radio communication mast that could be up to 70 m high. Oil and fuel storage facilities will be bunded. Construction and / or upgrade of access roads to the substation will be required to accommodate the large heavy loads.

In addition to the original three candidate sites identified by the client as possible locations for the proposed substation, namely Iphiva 4, Iphiva 5 and Iphiva 6, a fourth site has been identified, Iphiva 3A, which forms the basis of this report.

4. SITE DESCRIPTION

The additional 1 km x 1 km study area for the proposed Iphiva Substation, Iphiva 3A, is located to the southwest of Mkuze in Northern KZN, across the N2 National Road. The site is accessed via the P234, approximately 6.3 to 7.9 km from the intersection with the N2. The southern boundary of the site is located 100 m north of the P234 dirt road.

The site has an undulating topography particularly to the north and east of the project area as valleys have been deeply incised by tributaries of the Ubani River, which is a tributary of the Mkuze River to the north. A drainage line in the form of underdeveloped channels and dongas is evident parallel to the western boundary of the site with a flow direction to the south. The central and southern region of the study area is relatively level.

The site is part of privately owned farm land; however, it was vacant at the time of the investigation apart from a few dwellings in the northwestern corner. Vegetation is in the form of short grasses and numerous aloes with some thorn trees and shrubs. The ground is covered with abundant subangular to rounded basalt cobbles to large boulders.

The locality of the site in relation to Mkuze and the previous study sites is shown in the Locality Plan, Drawing № 31833-1/01. Plates 1 to 4 below have been included to show a perspective of the site.

Plate 1: View along the northern boundary toward the east, photograph taken from position DCP12.

Plate 2: Photograph of one of the northern drainage lines, namely the one within which EXP1 was profiled.

Plate 3: Photograph of one of the eastern drainage lines, namely the position where EXP3 was profiled.

Plate 4: The western drainage line parallel to the western boundary.

5. FIELD WORK

The field work was carried out on the 8th August 2017 and consisted of the following:

- Mechanically excavated inspection pits,
- Dynamic Cone Penetrometer (DCP) testing; and
- Subsoil sampling.

The approximate field test positions are indicated on the Site Plan, Drawing № 31833-1/02.

5.1 Inspection Pits

A total of ten (10 №) inspection pits, designated IP1 to IP10, were mechanically excavated across the site by a JCB 3CX TLB to investigate the nature of the underlying subsoils, depth to bedrock and to obtain samples for laboratory testing. The inspection pits were advanced to maximum reach of the TLB arm or refusal, these depths ranging between 0.60 m (IP5, IP7 and IP8) and 3.00 m (IP1) below existing ground level (EGL).

The disturbed subsoils recovered from the inspection pit excavations were examined and logged by an Engineering Geologist familiar with the procedures of soil and rock logging in terms of the Guidelines for Soil and Rock Logging in South Africa, edited by A.B.A. Brink & R.M.H. Bruin, 2nd Impression 2002, recording the following parameters:

- For soil: moisture condition, colour, consistency, structure (where applicable), soil texture and origin.
- For rock: colour, weathering, fabric, discontinuities, hardness and rock type.

Four (4 №) exposures, designated EXP1 to EXP4, were profiled where rock outcropped at surface.

The detailed profiles as well as their respective photographs are presented in Appendix A of this report.

5.2 Dynamic Cone Penetrometer

A total of fifteen (15 №) Dynamic Cone Penetrometer (DCP) tests, designated DCP1 to DCP15, were carried out to obtain an indication of the consistency of the subsoils underlying the site at shallow to moderate depths and to determine possible depth to bedrock. All DCP tests were advance to refusal depths ranging from 0.20 m (DCP4) to 1.80 m (DCP11) below EGL.

The results of the probes are presented graphically in Appendix B of this report. Table 1 below provides a quick reference of DCP blow counts / 300 mm penetration.

Table 1 : Summary of DCP Test Results (Blow Count / 300 mm Penetration)

Depth (m)	DCP Tests														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.3	52	71	43	-	86	40	63	49	65	59	9	55	73	52	42
0.6	71					25					21				
0.9	103										46				
1.2											50				
1.5											52				
1.8											93				

Table 2 overleaf is provided to aid in the interpretation of the DCP test results in terms of the inferred subsoil consistency. It should be noted that the table is based on the DML probe and should be used as a guide only.

Table 2 : Subsoil Consistency Inferred from the DCP Test Results

Non Cohesive Soils		Cohesive Soils	
№ of blows/300 mm Penetration	**Subsoil Consistency**	**№ Of blows/300 mm Penetration**	**Subsoil Consistency**
<8	Very loose	<4	Very soft
8 - 18	Loose	4 - 8	Soft
19 - 54	Medium dense	9 - 16	Firm
55 - 90	Dense	17 - 24	Stiff
>90	Very dense	25 - 54	Very stiff
		>54	Hard

5.3 Subsoil Sampling

In order to classify materials and to assess their suitability for use in construction and for foundations, a total of four (4 №) disturbed samples were retrieved from representative soil and bedrock horizons within the excavated inspection pits and returned to Thekweni Soils Laboratory in Durban and Waterlab in Pretoria for analysis. Analysis of the samples included the following:

- Full Grading Analysis (Atterberg Limits, Particle Size Distribution, Hydrometer Analysis)
- Mod AASHTO Dry Density
- California Bearing Ratio (CBR)
- pH
- Conductivity
- Chemical Analysis from Soil Extract (Basson Index) and Special Digest (BRE)

A schedule of the laboratory samples and the tests conducted on each is included in Table 3 overleaf.

Table 3 : Laboratory Testing Schedule

IP	Description	Depth (m)	Test				
			Full Indicator	Mod AASHTO	CBR	pH & Conductivity	Basson & BRE
IP1	Residual Basalt	0.50 - 1.30	x	x	x	x	x
IP6	Basalt	0.40 - 1.00	x	x	x		
IP7	Hillwash	0.00 - 0.30	x	x	x	x	x
IP10	Basalt	0.40 - 0.90	x	x	x		

The detailed laboratory results are included in Appendix C of this report and discussed further under Section 7.

6. GEOLOGY AND SOILS

6.1 Regional Geology

Consultation of the 1:250 000 geological series of the area, 2730 Vryheid, shows the general geology (within which the candidate site occurs) to comprise a mantle of transported and residual soils overlying Jurassic Period Letaba Formation basalt of the Lebombo Group. The area has been to a large extent intruded by Jurassic Period Karoo dolerite as well as undergone faulting with major geological faults striking north or northeast. The regional geology of the area is shown on the Geological Plan, Drawing № 31833-1/03.

6.2 Local Geology

The site is entirely underlain by shallow basalt bedrock of Letaba Formation which is generally overlain by a thin mantle of hillwash. Residual soils derived from the basalt were only encountered in the northwestern region of the site, namely in DCP11 and IP1. Based on the test results, the following general subsoil profile is common to the site:

0.00 to 0.20 / 0.60 m (average depth 0.40 m) — Dry to slightly moist, dark brown, very stiff to hard / dense to very dense, sandy gravelly CLAY to clayey gravelly SAND - (Hillwash)

> 0.20 / 0.60 m — Brown speckled dark grey and white, highly weathered, very soft to soft rock BASALT with amygdales - (Letaba Formation). The basalt is expected to become harder rapidly with depth.

OR

	Blue grey stained dark reddish brown, medium to slightly weathered, medium hard to hard rock BASALT - (Letaba Formation)

Exception to the above general geology is the northwestern area of the site (vicinity of IP1) where a residual soil horizon is observed between the hillwash and bedrock layers:

0.50 to 1.30 m Only in the northwestern area of the site	Dry to slightly moist, light brown mottled white, dense to very dense, slightly clayey gravelly SAND - (Residual Basalt)

Plate 5 and 6 below show the typical profiles for the residual basalt overlying basalt bedrock and for hillwash directly overlying bedrock as encountered across the site.

.

Plate 5: Typical subsoil profile of hillwash and residual basalt overlying basalt bedrock (IP1).

Plate 6: Typical shallow subsoil profile of hillwash directly overlying basalt bedrock (IP6).

6.3 Groundwater Seepage

No groundwater seepage was encountered in any of the test positions on site. However, groundwater seepage could be expected to occur during periods of high rainfall in the form of perched groundwater tables along the soil / rock interface.

The lack of seepage at the time of the investigation can possibly be attributed to the investigation taking place during winter / the dry season.

7. LABORATORY TESTING

7.1 Material Classification Test Results

The results of the grading analysis, density and CBR tests for the respective materials sampled on site, are included in Table 4 overleaf for ease of reference. The results are also summarised in the Laboratory Test Summary Tables included in Appendix C of this report along with graphical representation of the materials analysis.

Table 4 : Summary of Material Classification Test Results

(Grading Analysis, Atterberg Limits, Mod AASHTO, Optimum Moisture Content, CBR and Respective Classifications)

IP	Depth (m)	Particle Size (%)				Atterberg Limits (%)			GM	Modified AASHTO		CBR VALUES						Classification (AASHTO) (TRH 14-1985)
		Clay	Silt	Sand	Gravel	LL	PI	LS		MDD (kg/m^3)	OMC (%)	Compaction MDD (%)					Swell (%)	
												90	93	95	98	100		
HILLWASH																		
IP7	0.00 - 0.30	6.9	6	10.6	66.9	35.3	9.6	4.7	2.44	2044	10.6	20	27	34	44	52	0.55	A-2-4; GM; G6
RESIDUAL BASALT																		
IP1	0.50 - 1.30	6.2	6.6	47.8	37.5	38.5	8.6	6	1.98	1930	12.4	25	26	27	29	30	0.00	A-2-4; SM; G6
BASALT																		
IP6	0.40 - 1.00	2.1	1.6	8.1	73.6	35.7	8.2	6	2.78	2166	10.3	6	8	9	13	16	0	A-2-4; GP; G9
IP10	0.40 - 0.90	2.8	2.7	13.3	74	34.8	11.2	6.7	2.67	2122	10	29	34	38	40	42	0	A-2-6; GW - GC; G6

7.2 Chemical Corrosivity Test Results

The results of the pH and conductivity tests (performed by Thekwini Soils Laboratory) are included in Appendix C of this report and are summarised in Table below.

Table 5 : Summary of pH and Conductivity Test Results

IP	Description	Depth (m)	pH	Conductivity (mS/cm)
IP7	Hillwash	0.00 - 0.30	5.9	50
IP1	Residual Basalt	0.50 - 1.30	7.2	19

The results of the Chemical Analysis from Soil Extract (Basson Index) and Special Digest (BRE) performed by a specialist laboratory Waterlab are also included in Appendix C of this report. A summary extract of the results is included in Table 6 below; however, the full set of corrosivity results should be interpreted by Eskom's relevant experts in this regard.

Table 6 : Summary of Basson Index and BRE Test Results

IP	Description	Sample Number	Corrosivity Indices	Basson Index
IP7	Hillwash	11044	Corrosive	Aggressive
IP1	Residual Basalt	11043	Corrosive	Aggressive

8. GEOTECHNICAL ASSESSMENT

8.1 Site Stability

The site is considered stable in its current formation. No evidence of any slope instability both previous or ongoing (i.e. no hummocky topography indicative of mass movement downslope) was observed during the course of the field investigation. The basalt bedrock is known to be a fairly stable rock formation.

However, caution must be exercised during development with regard to cutting and the creating of large fill embankments so as to ensure localised instability is not induced across the site. In this regard, recommendations with respect to cutting and filling and general earthworks have been provided and discussed further in Section 9.1 of this report.

8.2 Problem Soils

8.2.1 Active Soils

Given the slightly clayey nature of the hillwash and the residual basalt encountered, these materials are considered to have low activity in the sense that they may undergo minor volume change upon fluctuation of their natural moisture content (i.e. shrink when dry and expand when wet).

8.2.2 *Potentially Collapsible Soils*

There was no evidence obtained during the field investigation to suggest highly compressible or collapsible soils within the area as the subsoil consistencies are dense to very dense for sandy material.

8.2.3 *Erosive Soils*

The dongas in the western area indicate the upper hillwash is dispersive and erodible; hence, susceptible to erosion by flowing water. This will be exacerbated once the vegetation, the roots of which have a binding effect on the soil, are removed during development. As such erosion control should be accounted for both during and after development.

Any exposed slopes, natural or unsupported cut / fill batters, must be adequately vegetated as soon as possible after construction.

8.3 Seepage Areas

The seepage areas within the development footprint have been highlighted in the Site Plan, Drawing № 31833-1/02. Valley and channel depressions have seasonal seepage as they were dry at the time of the investigation. Seepage areas occur in valley / channel depressions which are to be filled over.

As discussed in Section 6.3, groundwater seepage in the form of perched groundwater tables is expected to occur during periods of high rainfall along the soil / rock interface.

Recommendations with regard to drainage have been provided and discussed in Section 9.2 of this report.

8.4 Excavatability

Inspection pitting indicates “Soft Excavation” (according to SABS 1200D-1988) can be inferred to approximately 1.00 to 1.50 m greater than the inferred bedrock depths shown on Drawing № 31833-1/02, below which ‘Intermediate” rapidly becoming “Hard Excavation” is to be expected. Therefore, “Soft Excavation” can be inferred to depths ranging between 1.00 and 2.00 m below EGL across majority of the site and 3.00 and 4.00 m below EGL in the localised northwestern region of the site.

8.5 Material Suitability

Soil and rock sampling was undertaken in order to:

- Provide an indication of the near surface materials suitability for excavation and reuse in the proposed development as engineered fill in platforms as well as for use in road and pavement layerworks.

- Identify potential problematic soil horizons

The materials have been classified in terms of their suitability for use in engineered fill in platforms and road construction (according to TRH 14-1985 and TRH 20-1990) on the basis of field observations and laboratory testing.

The findings are summarised in Table 7 overleaf. It must be borne in mind that the testing is not definitive and it is recommended that further verification testing be carried out on materials excavated during construction.

Table 7 : Material Classification and Suitability

Material Type	Description	Classification Details	Material Suitability
Hillwash	Dark brown, clayey sand with abundant gravel	Silt & Clay = 12.9% PI = 9.6% LS = 4.7% GM = 2.44 Classifies as A-2-4. G6 quality material.	Good subgrade quality material for use in engineered fill. Suitable for use in pavement layer works. Type B gravel wearing course - Ravels and Corrugates.
Residual Basalt	Light brown, slightly clayey sand with abundant gravel	Silt & Clay = 12.8% PI = 8.6% LS = 6.0% GM = 1.98 Classifies as A-2-4. G6 quality material.	Good subgrade quality material for use in engineered fill. Suitable for use in pavement layer works. Type E gravel wearing course - Good.
Highly Weathered Basalt	Brown speckled dark grey and white, highly weathered, very soft to soft rock	Silt & Clay = 5.5% PI = 11.2% LS = 6.7% GM = 2.67 Classifies as A-2-6. G6 quality material.	Good subgrade quality material for use in engineered fill. Suitable for use in pavement layer works. Type B gravel wearing course - Ravel and Corrugates.
Medium to Slightly Weathered Basalt	Blue grey stained dark reddish brown, medium to slightly weathered, medium hard to hard rock	Silt & Clay = 3.7% PI = 8.2% LS = 6.0% GM = 2.78 Classifies as A-2-4. G9 quality material.	Good subgrade quality material for use in engineered fill. Suitable for use in pavement layer works. Type B gravel wearing course - Ravels and Corrugates.

Although the hillwash, residual basalt and highly weathered basalt is shown to class as G6 material, it is expected to vary (from experience) between a G6 to a G10 type material.

In summation, the above generally shows that the materials on site are suitable for use as engineered fill, layer works and gravel wearing course. However, the acceptable material is expected to be a thin horizon of limited thickness / volume (± 0.50 - 1.00 m thick) across majority of the site as the hard rock basalt will likely excavate as unsuitable oversized material.

Eskom construction sites commonly require a capping of 1.00 to 1.50 m G5/G6/G7/G8 granular material. As such, above and in the laboratory test result summary table (Table 4), there is limited volume of suitable natural gravel meeting these specifications on site and, hence, it is anticipated that the majority of the layer works material will be imported. Alternatively, a crusher could be established to crush the onsite bedrock to achieve G5/G6/G7/G8 type material (expensive).

9. GEOTECHNICAL RECOMMENDATIONS

In terms of the results of the preliminary geotechnical investigation, the development is considered feasible at Iphiva 3A. The constraints and recommendations below regarding the development of the site are provided as a guide and a further in-depth geotechnical investigation is required once earthwork plans and development plans have been provided.

9.1 Earthworks

No earthwork plans have been provided for this preliminary investigation; however, due to the undulating topography of the area, major cutting and filling is envisaged. Should the 400 m x 400 m substation be developed in the relatively flat central or southern portion of the 1 km x 1 km site, earthworks can be limited to minor cuts / fills (<2 to 3 m).

As mentioned in Section 8.5, Eskom sites commonly have a 1.00 to 1.50 m capping of Engineered Fill comprising G5/G6/G7/G8 type material.

All cut and fill slopes should be restricted to a maximum batter of 1:2 (26º). Temporary cut slopes of limited height (< 3 m) during construction may be steepened to a batter of 1:1 (45º) at the discretion of a responsible Engineer.

Fill embankments should be constructed in layers of 300 mm maximum loose thickness and each layer compacted to a minimum of 95% of the materials maximum Mod AASHTO dry density prior to placement of the next layer. Particles exceeding ⅔ of the compacted layer thickness must be removed to spoil.

Prior to placement of new fills, the natural ground should be stripped of the upper organic topsoil and grubbed of any deleterious materials.

Once trees have been removed from site, all roots must be removed to prevent rotting and subsequent settlement. The voids must be filled and compacted in 300 mm layers to a minimum of 95% of the materials maximum Mod AASHTO dry density prior to placement of the next layer.

Cut and fill slopes should be adequately vegetated post-construction to reduce possible erosion. All cut and fills should be inspected during construction by a Geotechnical professional to confirm stability.

9.2 Site Drainage

As discussed in Section 8.3 above, seepage areas occur in valley / channel depressions which are going to be filled over. In order to maintain stability and avoid water tables / pore water pressures building up in the fills, it is recommended that herringbone subsoil drainage be constructed in the depressions prior to filling at approximate positions shown in the Site Plan, Drawing № 31833-1/02.

It is expected that the granular fill layer works capping the platforms will minimise the effects of seepage / perched water tables. During construction, the platforms must be graded such that surface water is not allowed to pond. Sloping back the platforms are recommended together with stormwater cut off drains where necessary.

Once construction is complete, stormwater from roofed and paved areas should be piped or collected in surface drains to discharge into the stormwater system ultimately approved for the proposed development.

9.3 Founding

Founding conditions across the site are considered fair to good in view of the variable geology and will vary depending on:

- structure type / loading,
- location of the structure on site in terms of final cut and fill, and
- depth to bedrock and the thickness of the overlying hillwash and residual materials once platform construction is completed.

As such, the recommended founding must be revisited post earthworks, once it is known what materials are present at the completed platform levels (i.e. a site specific geotechnical investigation should be performed relative to structure type / positioning / loading / materials at platform level).

The following recommended foundations assume an upper 1.5 m good quality granular fill capping (G5/G6/G7/G8 type material). In general:

- In areas where depth to basalt bedrock is located at platform level or at shallow depths (less than 1.50 m) below platform level, the structures can be supported on strip footings or ground beams spanning column bases taken through all newly placed fill, *in situ* soils and completely weathered basalt into hard pickable basalt bedrock. Foundations should be placed no less than 0.50 m into bedrock.

- Where thicker newly placed fill and / or residual soils occur overlying bedrock, namely in the northwestern area, heavy and sensitive structures may require stiffened rafts or rafts / ground beams supported on piles to bedrock.

- Consideration can be given to founding small and lightly loaded structures using strip footings / pads / raft type foundations supported in the upper 1.00 - 1.50 m good quality granular fill capping (G5/G6/G7/G8 type material).

All foundations should be inspected by an experienced Geotechnical Engineer prior to casting to certify against soft spots or seepage zones that may occur within the soil profile.

9.4 Seismic Activity

As per the previous report for Iphiva 4, 5 and 6, the proposed Mkuze Substation has an MMI value of VI with a peak horizontal ground acceleration of 50-100 cm/s^2 (0.05 - 0.1 g) for a 50 year period.

10. SITE SUITABILITY RANKING OF CANDIDATE SITES

The aim of the preliminary geotechnical investigation is essentially to determine the geotechnical subsoil conditions relative to the proposed earthworks, to identify potential problems and ultimately to determine the most suitable site for the proposed development according to the sites geotechnical properties.

Table 8 overleaf lists the geotechnical properties of the candidate sites discussed in the this report and the report on Iphiva 4, 5 and 6 (July 2017) with an indication of which sites are most / least favourable based on those properties.

Table 8 : Summary of Geotechnical Aspects and Preferred Site

Geotechnical Property	Iphiva 3A	Iphiva 4	Iphiva 5	Iphiva 6
Site Stability	✓	✓	✓	✓
Problem Soils	✓	x	x	✓
Site Drainage	x	✓	✓	✓
Soil Corrosion	x	x	x	x
Excavatability	x	✓	✓	x
Material Suitability	✓	x	x	✓
Foundation Solutions	✓	x	x	✓

✓ **denotes more favourable conditions**

x **denotes least favourable conditions**

All four of the proposed sites are developable. However; the main geotechnical problems with **Iphiva 4 and 5** are:

- The presence of potentially active clays of variable thickness from 1.0 to 3.5 m. The negative effects of the clays are; however, minimised if a 1.0 to 1.5 m engineered fill (G5, G6, G7, G8) capping is placed as is commonly done at Eskom sites.

- The lack of onsite suitable materials, i.e. the onsite clays are not suitable for engineered fill of layerworks (no suitable G5 / G6 / G7 / G8 / G9 / G10 type material). These materials will need to be imported or a crusher established on site to crush the basalt bedrock (expensive).

The main geotechnical problems with Iphiva 3A are:

- The undulating topography which will require major cutting and filling as well as drainage systems within the drainage lines / valleys / channels. However, should the proposed development be limited to the central and southern region of the site, the necessity for herringbone drainage should be alleviated and the earthworks less extensive.

- The presence of hard rock basalt bedrock near surface (less than 1.00 m below EGL) will require hard excavation (blasting) which makes excavations costly.

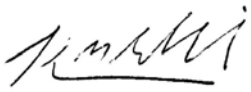
- Due to the limited volume of onsite suitable materials for use in engineered fill and layer works, imported material or the establishment of a crusher on site to crush the basalt bedrock will be required.

The main geotechnical problems with Iphiva 6 include:

- The presence of hard dolerite bedrock which would require hard excavation near surface (± 1.0 m below current ground level) makes excavations for earthworks cuts / service trenches below approximately 1.0 m costly. The negative effects of the shallow bedrock are also; however, minimised should a 1.0 to 1.5 m engineered fill (G5, G6, G7, G8) capping be placed as is common at Eskom sites.

- The lack of onsite suitable materials, i.e. although there is some G9 and G10 quality material there is no suitable G5 - G8 material. These materials will have to be imported or a crusher established to crush the dolerite bedrock.

Based on the foundations of structures alone, Iphiva 6 is marginally more favourable due to its shallower bedrock throughout (± 0.1 - 0.6 m) and the relatively flat topography; however as mentioned, this comes with costly excavation issues for earthworks / services. Similarly, Iphiva 3A is somewhat favourable due to its shallow bedrock (± 0.2 - 0.6 m) and likewise will require costly excavations, even more so as the undulating topography requires major earthworks / cuts and fills. Conversely, bedrock depths are deeper at Iphiva 4 and 5 (± 0.4 - 4.0 m) resulting in deeper founding for heavier / sensitive structures; however, less costly excavation issues for earthworks / service trenches.



K. RIBBINK Pr.Sci.Nat. **J. LODGE (Eng. Geol)**

REFERENCE 31833-1
SEPTEMBER 2017
/kr/jl

DRENNAN MAUD (PTY) LTD
68 Peter Mokaba Ridge, Tollgate,
DURBAN, 4001

APPENDIX A

INSPECTION PIT AND EXPOSURE PROFILES

I3A-IP1 - I3A-IP10

I3A-EXP1 - I3A-EXP4

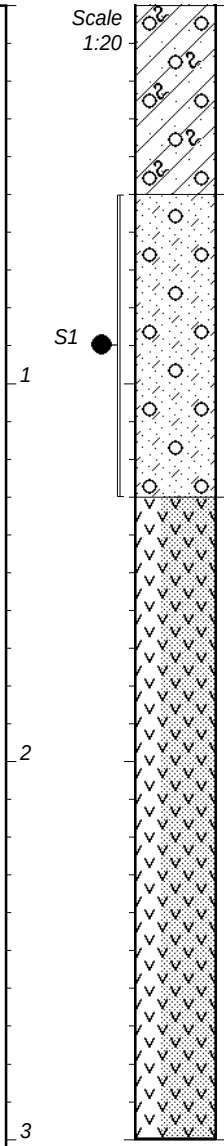
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP1
Sheet 1 of 1

JOB NUMBER: 31833-1



SAMPLE	DEPTH (m)
	0.00
Ind / MOD / CBR / pH / Conduct / BRE / Basson	0.50
S1	
	1.30
	3.00

0.00 – Dry, dark brown, very stiff to hard, pinholed, sandy gravelly CLAY with fine roots – (Hillwash) Gravel comprises fine to coarse, angular to subangular abundant basalt fragments.

0.50 – Dry to slightly moist, light brown mottled white and blotched yellow, dense to very dense, intact, slightly clayey gravelly medium to coarse grained SAND - (Residual Basalt) Gravel comprises medium to coarse, angular abundant basalt and amygdale fragments.

1.30 – Brown speckled dark grey and orange, highly weathered, medium to coarse grained, very closely jointed, very soft to soft rock BASALT with amygdales – (Letaba Formation)
Note: Excavates as sandy medium to coarse gravels and cobbles.

3.00

NOTES

1) Final depth at 3.00m. No refusal but TLB struggling.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP1.

5) Samples taken:
S1 0.50--1.30m (Indicator/Mod AASHTO/CBR/pH/Conductivity/BRE/Basson)

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION : NA
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058797
Y-COORD : -094194

HOLE No: IP1

IP1

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

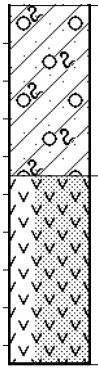
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP2
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20



0.00

Dry, dark brown, very stiff to hard, pinholed, sandy gravelly CLAY with fine roots – (Hillwash) Gravel comprises medium to coarse, angular minor basalt fragments.

0.45

Blue grey stained dark reddish brown, medium to slightly weathered, fine grained, very closely to closely jointed, medium hard to hard rock BASALT – (Letaba Formation)
Note: Excavates as sandy medium to coarse gravels and cobbles.

0.95

1

NOTES

1) Final depth at 0.95m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP2.

5) No samples taken.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3059480
Y-COORD : -094282

HOLE No: IP2

IP2

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

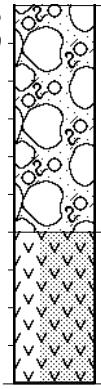
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP3
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20



SAMPLE	DEPTH (m)	
		0.00 Slightly moist, dark brown, dense, pinholed, clayey coarse grained SAND with abundant subangular to subrounded medium to coarse gravels, cobbles and boulders (up to 600mm in size) of basalt and with fine roots – (Hillwash)
		0.60 Blue grey stained brown, medium to slightly weathered, fine grained, closely jointed, hard rock BASALT – (Letaba Formation) Note: Excavates as sandy coarse gravel, cobbles and boulders.
	1	1.00

NOTES

1) Final depth at 1.00m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP3.

5) No samples taken.

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3059282
Y-COORD : -095368

HOLE No: IP3

IP3

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

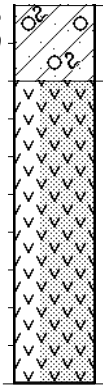
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP4
Sheet 1 of 1

JOB NUMBER: 31833-1



Slightly moist, dark brown, stiff, intact, sandy gravelly CLAY with fine roots – (Hillwash)
Gravel comprises medium to coarse, angular abundant basalt fragments.

Blue grey stained dark reddish brown, medium to slightly weathered, fine grained, very closely jointed, medium hard to hard rock BASALT – (Letaba Formation)
Note: Excavates as slightly sandy coarse gravel and cobbles.

SAMPLE	DEPTH (m)
	1

NOTES

1) Final depth at 1.00m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP4.

5) No samples taken.

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

ELEVATION : -
X-COORD : 3058597
Y-COORD : -095089

HOLE No: IP4

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

IP4

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

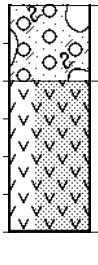
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: **IP5**
Sheet 1 of 1

JOB NUMBER: **31833-1**



SAMPLE	DEPTH (m)	
	0.00	Dry, dark brown, very dense, pinholed, clayey coarse grained SAND with abundant subrounded medium to coarse gravels and cobbles of basalt and with fine roots – (Hillwash)
	0.20	Blue grey, slightly weathered, fine grained, very closely to closely jointed, hard rock BASALT – (Letaba Formation) Note: Excavates as slightly sandy coarse gravel, cobbles and boulders.
	0.60	

NOTES

1) Final depth at 0.60m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP5.

5) No samples taken.

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058903
Y-COORD : -094741

HOLE No: **IP5**

IP5

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

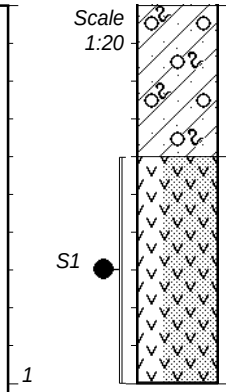
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP6
Sheet 1 of 1

JOB NUMBER: 31833-1



Dry, dark brown, stiff to very stiff, pinholed, sandy gravelly CLAY with fine roots – (Hillwash) Gravel comprises fine to coarse, angular to subangular abundant basalt fragments.

Blue grey stained dark reddish brown, medium weathered, fine grained, very closely to closely jointed, medium hard rock BASALT – (Letaba Formation)
Note: Excavates as sandy medium to coarse gravels and cobbles.

SAMPLE	DEPTH (m)
Ind / MOD / CBR	S1
	1

NOTES

1) Final depth at 1.00m. Hard refusal on medium hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP6.

5) Samples taken:
S1 0.40--1.00m (Indicator/Mod AASHTO/CBR)

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3059084
Y-COORD : -094453

HOLE No: IP6

IP6

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

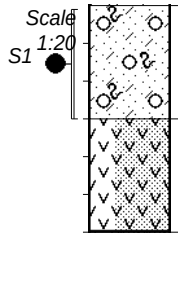
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP7
Sheet 1 of 1

JOB NUMBER: 31833-1

CBR / pH / Conduct / BRE / Basson



0.00

Dry, dark brown, dense, intact to pinholed, clayey gravelly coarse grained SAND with fine roots – (Hillwash) Gravel comprises medium to coarse, angular to subangular abundant basalt fragments.

0.30

Blue grey speckled white stained dark reddish brown, medium to slightly weathered, fine grained, very closely jointed, medium hard to hard rock BASALT with amygdales (average 3mm in size) – (Letaba Formation)
Note: Excavates as sandy medium to coarse gravels and cobbles.

0.60

NOTES

1) Final depth at 0.60m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP7.

5) Samples taken:
S1 0.01--0.30m (Indicator/Mod AASHTO/CBR/pH/Conductivity/BRE/Basson)

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

ELEVATION : -
X-COORD : 3059238
Y-COORD : -094969

HOLE No: IP7

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

IP7

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

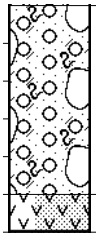
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP8
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20



0.00 Dry, dark brown, dense, intact, clayey medium to coarse grained SAND with abundant angular to subangular medium to coarse gravel and cobbles and with fine roots – (Hillwash)

0.50 Blue grey speckled white stained dark brown, medium to slightly weathered, fine grained, closely jointed, hard rock BASALT with amygdales (up to 5mm in size) – (Letaba Formation)
Note: Excavates as sandy coarse gravel and cobbles.

0.60

NOTES

1) Final depth at 0.60m. Hard refusal on hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP8.

5) No samples taken.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058869
Y-COORD : -095227

HOLE No: IP8

IP8

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

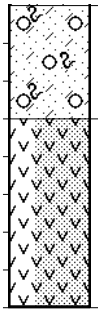
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: IP9
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20



0.00 Slightly moist, dark brown, dense, intact, clayey gravelly coarse grained SAND with fine roots – (Hillwash) Gravel comprises medium to coarse, angular abundant basalt fragments.

0.30 Blue grey speckled white stained dark reddish brown, medium weathered, fine grained, very closely to closely jointed, medium hard rock BASALT with amygdales (up to 5mm in size) – (Letaba Formation)
Note: Excavates as slightly sandy coarse gravel, cobbles and boulders.

0.80

NOTES

1) Final depth at 0.80m. Hard refusal on medium hard rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP9.

5) No samples taken.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058873
Y-COORD : -094990

HOLE No: IP9

IP9

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

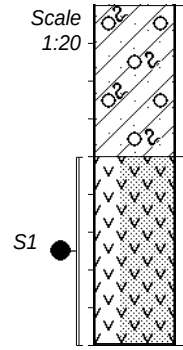
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: **IP10**
Sheet 1 of 1

JOB NUMBER: **31833-1**



Dry, dark brown, very stiff, intact to pinholed, sandy gravelly CLAY with fine roots – (Hillwash) Gravel comprises fine to coarse, angular to subangular abundant basalt fragments.

Brown speckled dark grey and white stained reddish brown, highly weathered, medium grained, very closely to closely jointed, soft rock BASALT with amygdales (average 3mm in size) – (Letaba Formation)
Note: Excavates as sandy medium to coarse gravels and cobbles.

SAMPLE	DEPTH (m)
Ind / MOD / CBR	

NOTES

1) Final depth at 0.90m. Soft refusal on soft rock basalt.

2) No groundwater seepage.

3) No sidewall collapse.

4) Same position as DCP10.

5) Samples taken:
S1 0.40--0.90m (Indicator/Mod AASHTO/CBR)

CONTRACTOR : KC BLOCK & PLANT
MACHINE : TLB – JCB 3CX
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3059135
Y-COORD : -094735

HOLE No: **IP10**

IP10

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

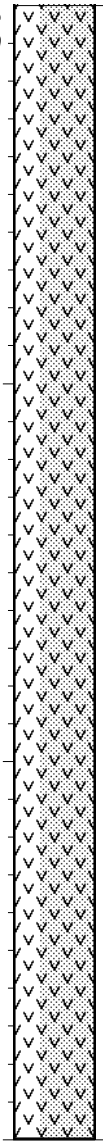
Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: EXP1
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20



SAMPLE	DEPTH (m)
	0.00

Blue grey stained brown, slightly weathered, fine grained, closely to widely jointed, hard rock BASALT – (Letaba Formation)

1

2

3

3.00

NOTES

1) In valley / drainage line.

2) Exposure height = 3.00m.

3) Exposure length = 5.00m.

CONTRACTOR : KC BLOCK & PLANT
MACHINE : NA
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058876
Y-COORD : -094770

HOLE No: EXP1

EXP1

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: EXP2
Sheet 1 of 1

JOB NUMBER: 31833-1

Scale 1:20

0.00

Blue grey stained dark brown occasionally speckled white and yellow, slightly weathered, fine grained, closely to medium jointed, hard rock BASALT with occasional amygdales (up to 5mm in size) – (Letaba Formation)

0.20

NOTES

1) Exposure height = 0.20m.

2) Exposure length = 12.00m.

3) Exposure width = 5.00m.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : NA
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058807
Y-COORD : -095118

HOLE No: EXP2

EXP2

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

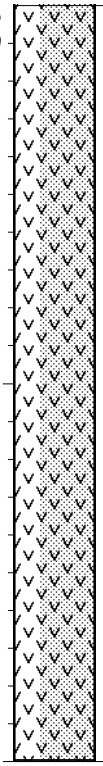
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: EXP3
Sheet 1 of 1

JOB NUMBER: 31833-1



Dark blue grey stained dark reddish brown with white precipitate, slightly weathered to unweathered, fine grained, very closely to widely jointed, hard to very hard rock BASALT – (Letaba Formation)

NOTES

1) In valley / drainage line.

2) Exposure height = 2.00m.

3) Exposure length = 30.00m.

4) Exposure width = 20.00m.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : NA
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

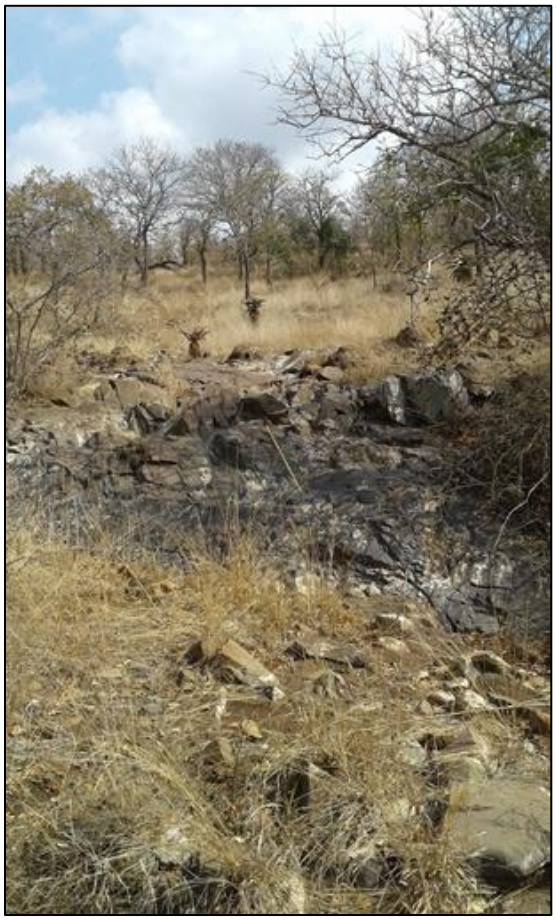
INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

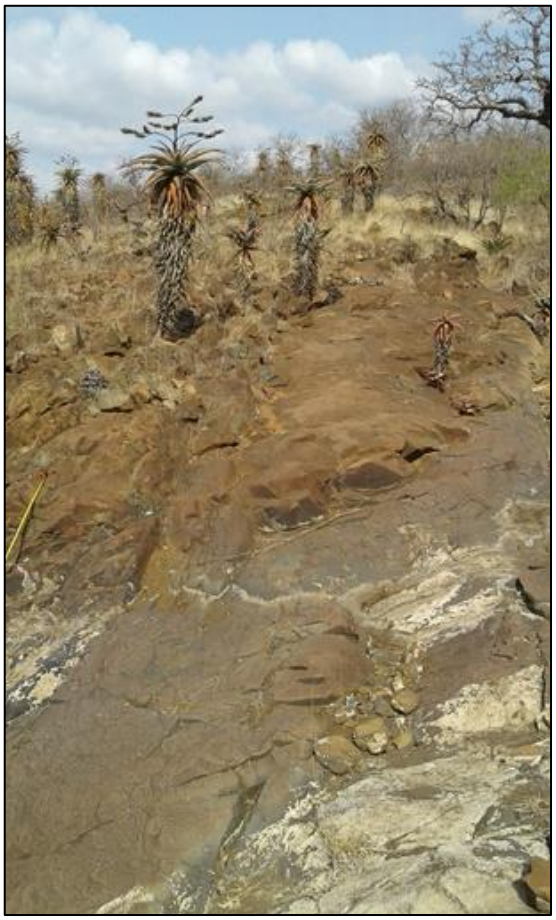
DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058904
Y-COORD : -095253

HOLE No: EXP3

EXP3





REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

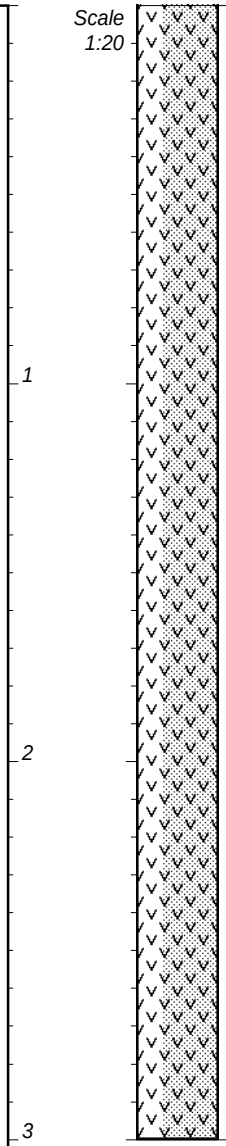
DRENNAN MAUD (PTY) LTD

Geotechnical Engineers & Engineering Geologists

MDT ENVIRONMENTAL
MKUZE SUBSTATION – IPHIVA 3A

HOLE No: EXP4
Sheet 1 of 1

JOB NUMBER: 31833-1



Blue grey stained dark brown, medium to slightly weathered, fine grained, widely to very widely jointed, medium hard to hard rock BASALT with occasional amygdales – (Letaba Formation)

NOTES

1) Exposure height = 3.00m.

2) Exposure length = 15.00m.

3) Exposure width = 3.00m.

SAMPLE	*DEPTH (m)*

CONTRACTOR : KC BLOCK & PLANT
MACHINE : NA
DRILLED BY : NA
PROFILED BY : JL

TYPE SET BY : JL
SETUP FILE : DMPSP.SET

INCLINATION :
DIAM : NA
DATE : NA
DATE : 08/08/2017

DATE : 06/09/17 12:54
TEXT : ..C:\DOTIN\SPMASTER.DOC

ELEVATION : -
X-COORD : 3058915
Y-COORD : -095172

HOLE No: EXP4

EXP4

REF : 31833-1

MKUZE SUBSTATION

DRENNAN MAUD (PTY) LTD

APPENDIX B

DYNAMIC CONE PENETROMETER TEST RESULTS

DCP1 - DCP15

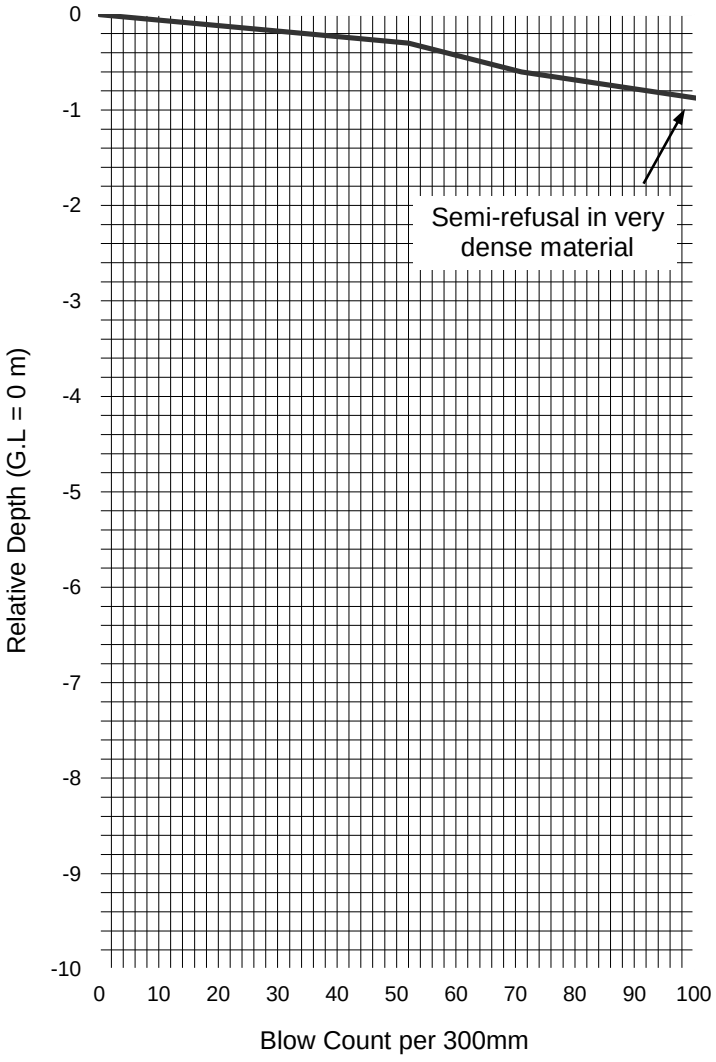
Dynamic Cone Penetrometer

Test No. : 1

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: Same position as IP1
Test Location: **Iphiva 3A** -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	52
-0.6	71
-0.9	103

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

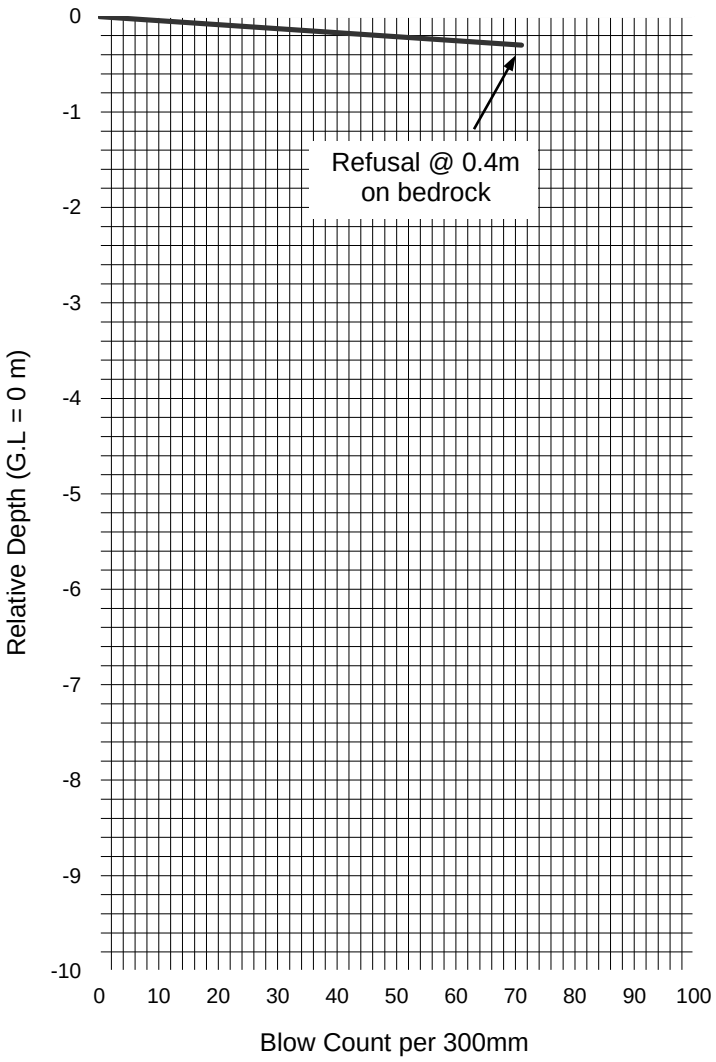
Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60^{o} cone a distance of 300mm.

Dynamic Cone Penetrometer

Test No. : 2

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP2
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	71



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

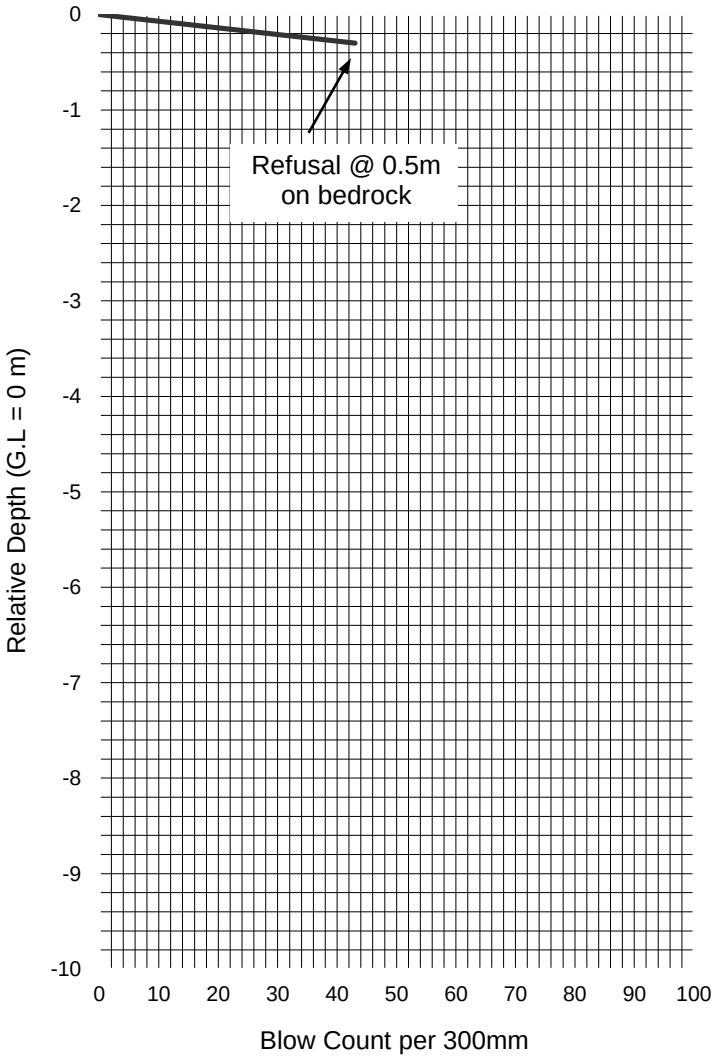
Dynamic Cone Penetrometer

Test No. : 3

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: Same position as IP3
Test Location: **Iphiva 3A** -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	43

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

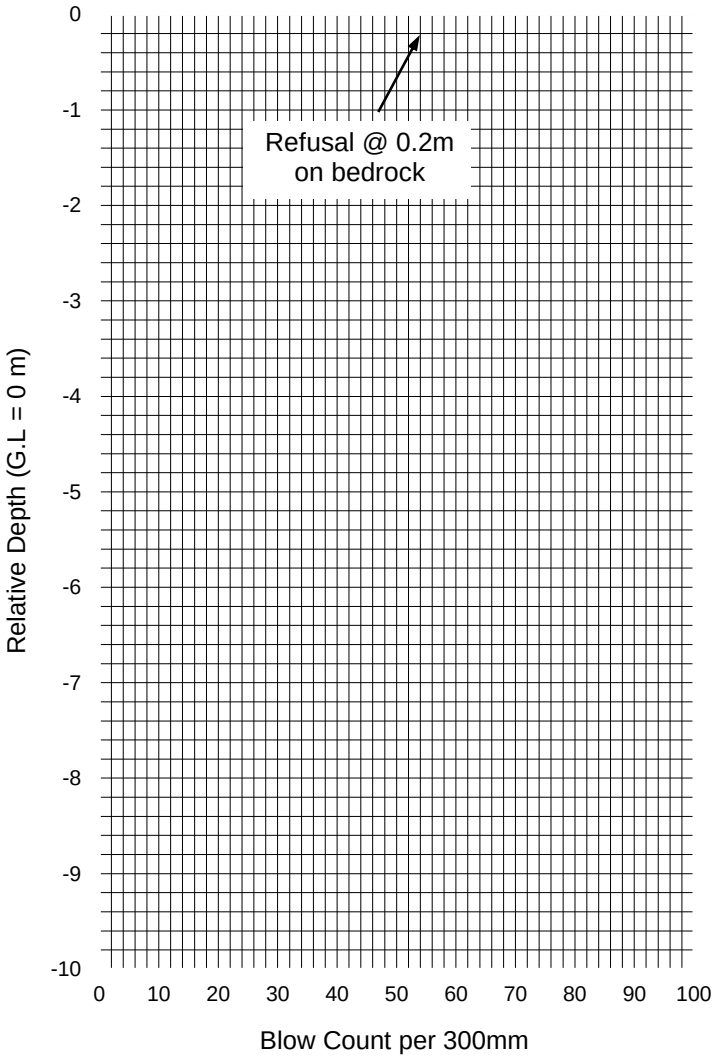
Dynamic Cone Penetrometer

Test No. : 4

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP4
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

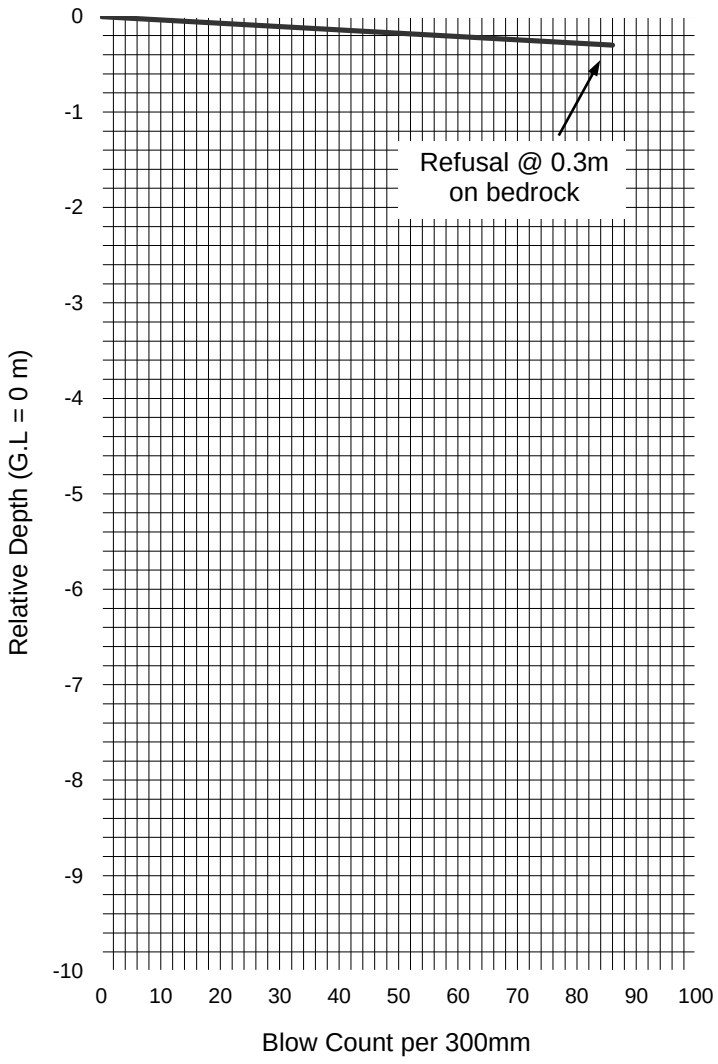
Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60^{o} cone a distance of 300mm.

Dynamic Cone Penetrometer

Test No. : 5

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP5
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	86



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

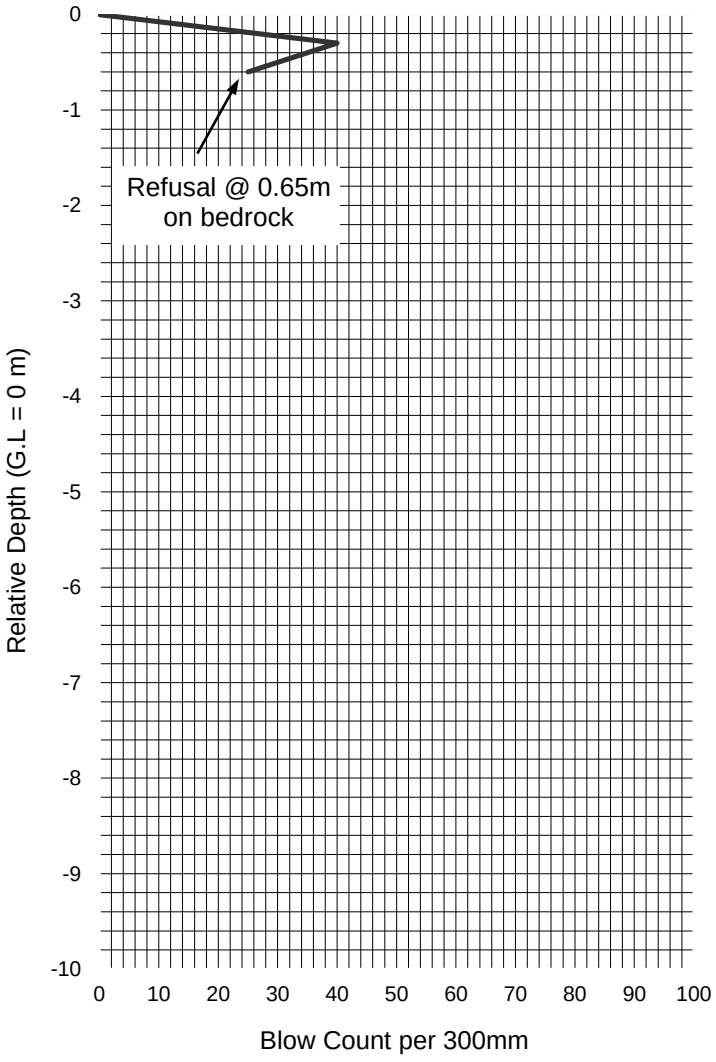
Dynamic Cone Penetrometer

Test No. : 6

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP6
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	40
-0.6	25

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

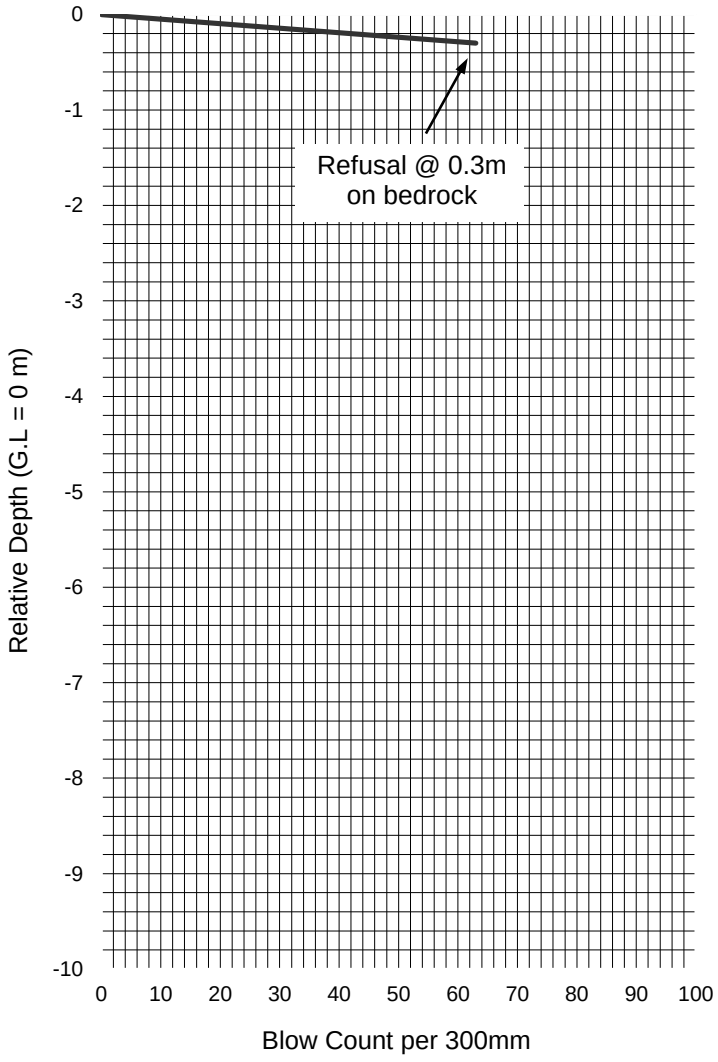
Dynamic Cone Penetrometer

Test No. : 7

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP7
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	63

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

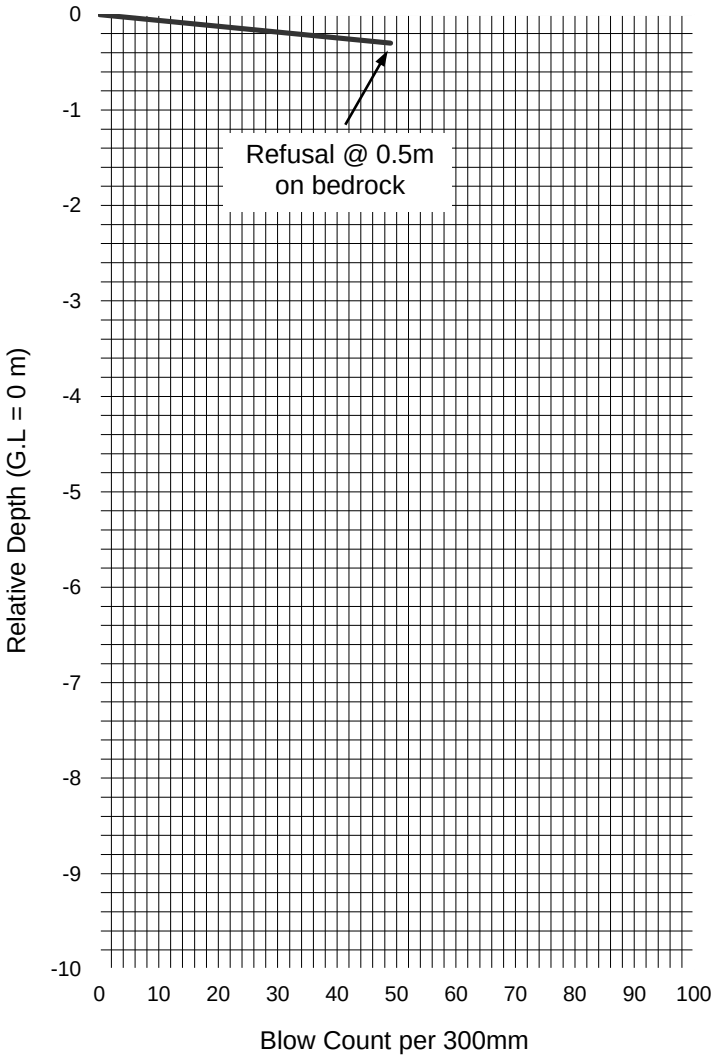
Dynamic Cone Penetrometer

Test No. : 8

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: Same position as IP8
Test Location: **Iphiva 3A** -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	49

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

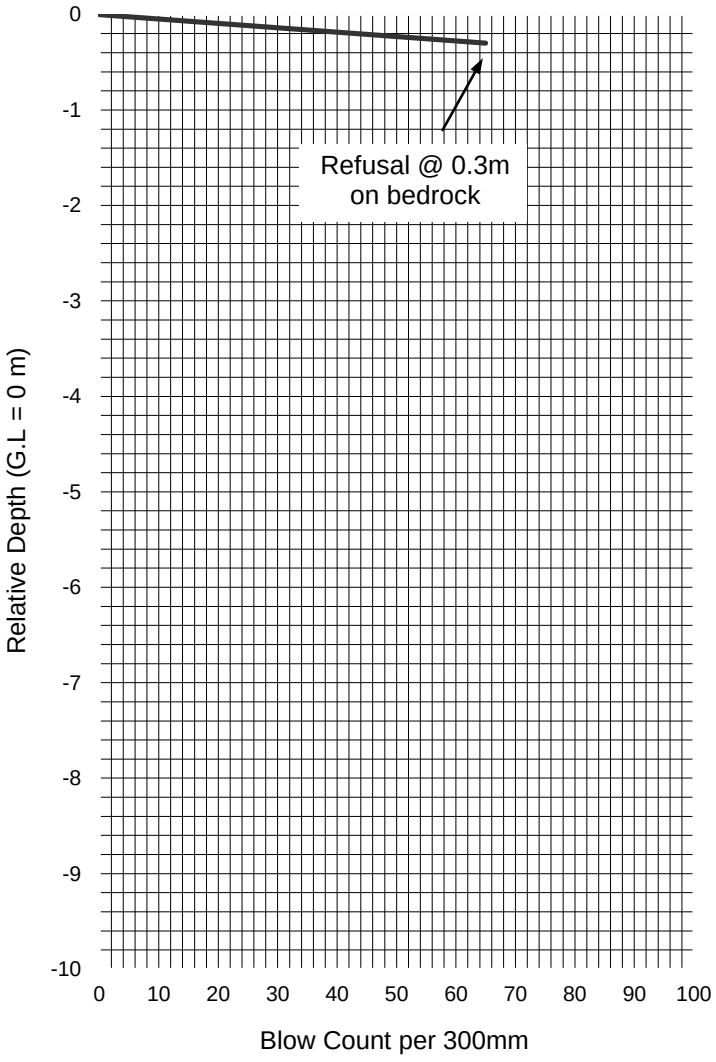
Dynamic Cone Penetrometer

Test No. : 9

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP9
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	65

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

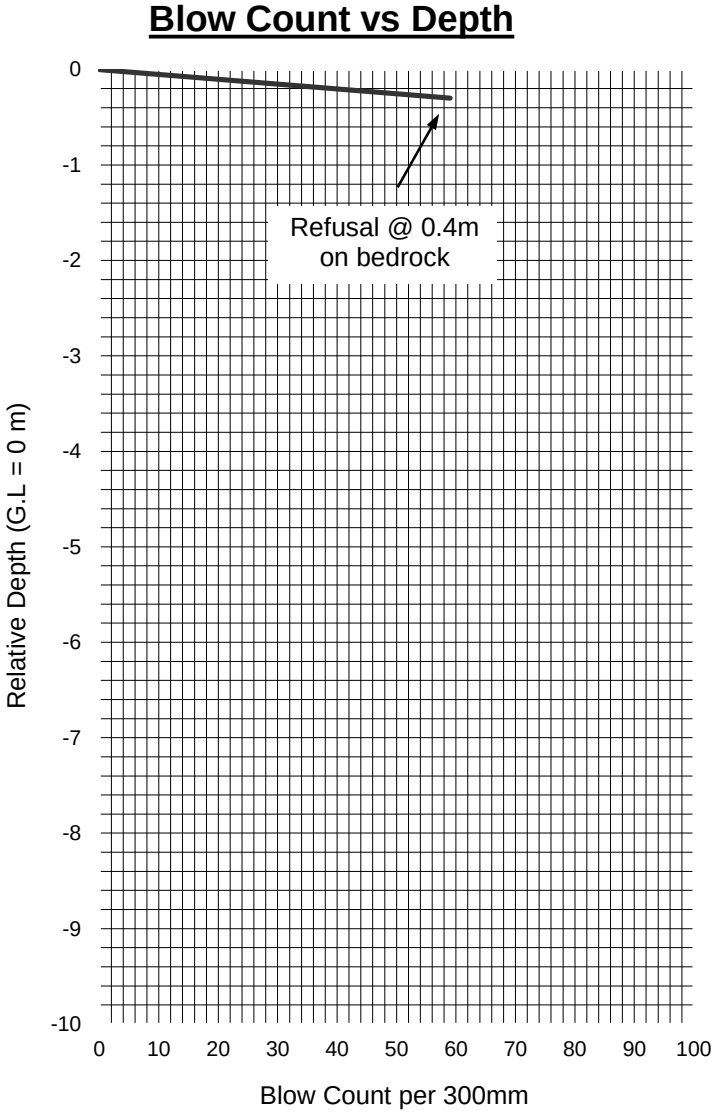
Note: DCP Blow Count equals the number of blows of a 10kg hammer dropping 450mm required to drive a 25mm diameter 60^{o} cone a distance of 300mm.

Dynamic Cone Penetrometer

Test No. : 10

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	Same position as IP10
Test Location:	**Iphiva 3A**		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	59



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

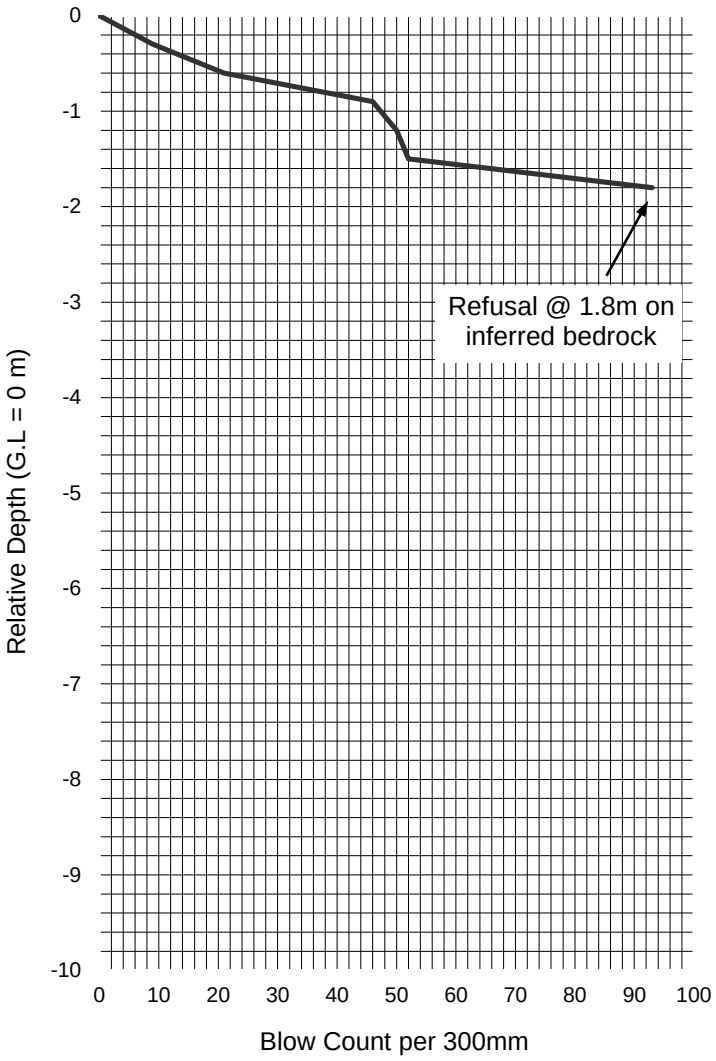
Dynamic Cone Penetrometer

Test No. : 11

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: -
Test Location: Iphiva 3A -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	9
-0.6	21
-0.9	46
-1.2	50
-1.5	52
-1.8	93

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

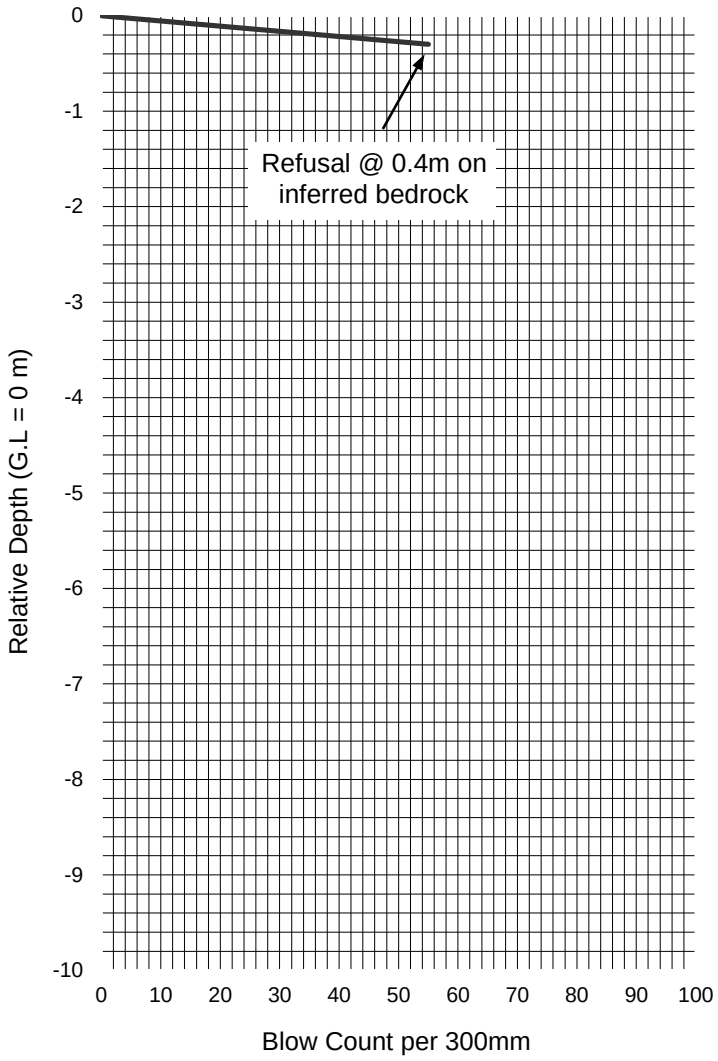
Dynamic Cone Penetrometer

Test No. : 12

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	-
Test Location:	Iphiva 3A		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	55

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

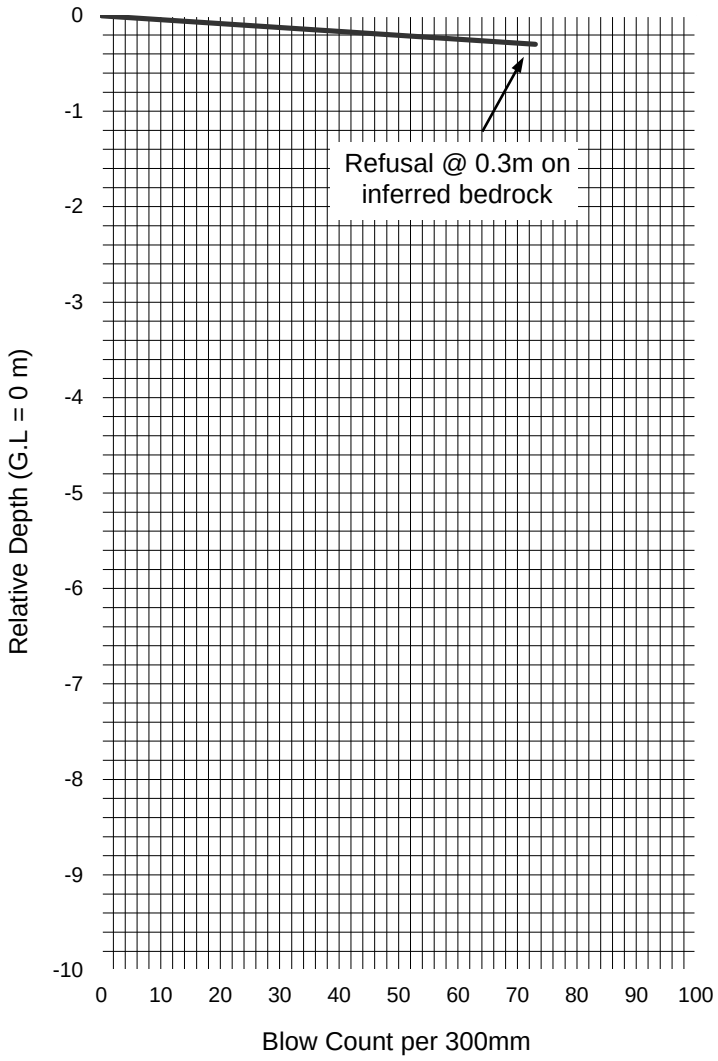
Dynamic Cone Penetrometer

Test No. : 13

Project :	**Mkuze Substation**		
Client:	**MDT Environmental**		
Date:	11/08/2017	Remarks:	-
Test Location:	Iphiva 3A		-
Date of Test:	08/08/2017	Depth Interval (m) :	0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	73

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

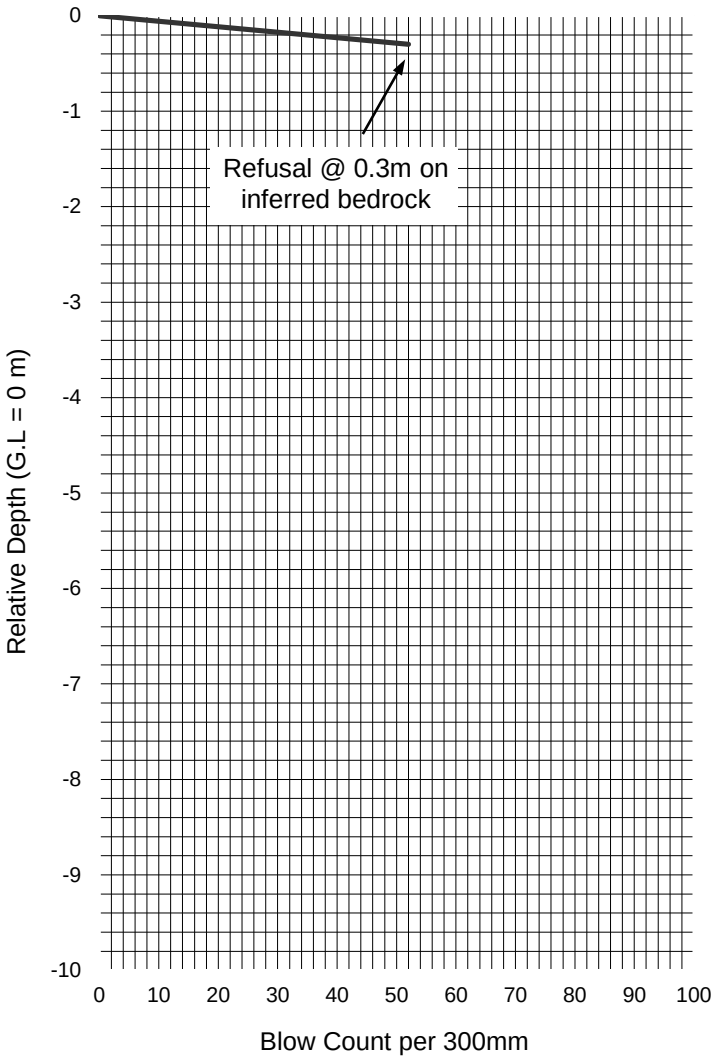
Dynamic Cone Penetrometer

Test No. : 14

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: -
Test Location: Iphiva 3A -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	52

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

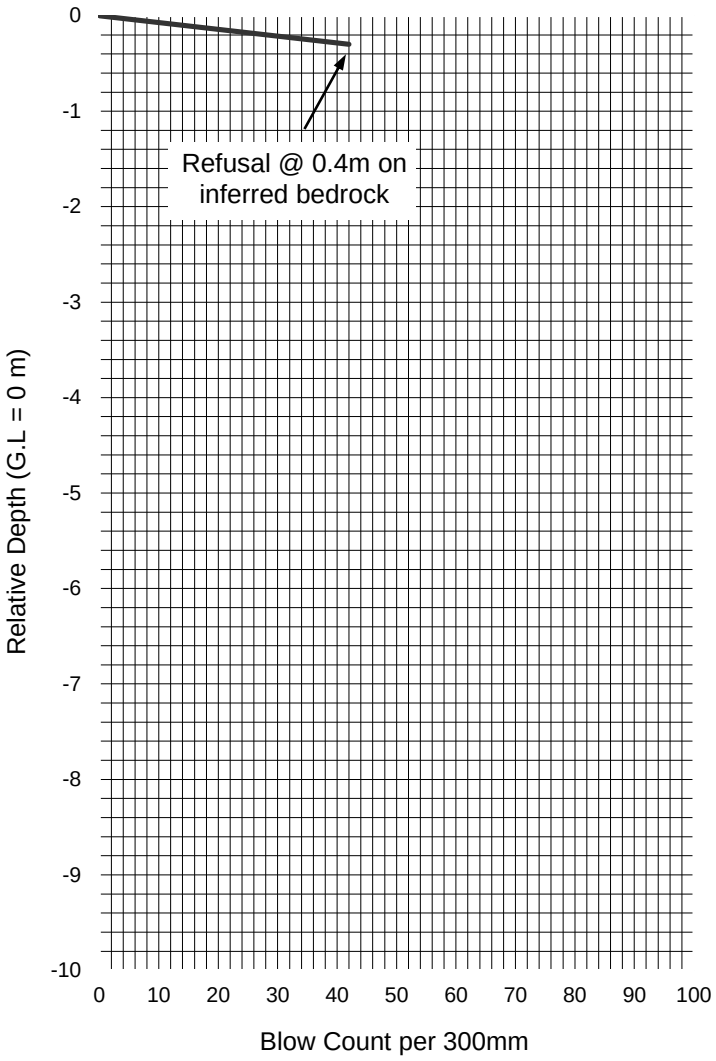
Dynamic Cone Penetrometer

Test No. : 15

Project : **Mkuze Substation**
Client: **MDT Environmental**
Date: 11/08/2017 Remarks: -
Test Location: Iphiva 3A -
Date of Test: 08/08/2017 Depth Interval (m) : 0.3

Depth (m)	Count Blows/0.3m
0	0
-0.3	42

Blow Count vs Depth



Reference No. : 31833-1

Drennan Maud & Partners.

Fig. No. -

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

APPENDIX C

LABORATORY TEST RESULTS

Laboratory Test Summary

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4860210381
68 Ridge Road, Tollgate, DURBAN Tel : (031) 201-8592
P.O. Box 30464, MAYVILLE, 4058 Fax : (031) 201-7920

Job Description: Mkhuze Substation - Ref.31833-1
Job no.: 8503
Date: 05-09-2017

Lab no.			08112	08113	08114	08115						
Location			I3A IP6	I3A IP1	I3A IP7	I3A IP10						
Depth			0.4 - 1.0m	0.5 - 1.3m	0.0 - 0.3m	0.4 - 0.9m						
Description			-	-	-	-						
			-	-	-	-						
Binder Material			-	-	-	-						
Particle Size (mm)	75	Cumulative % Passing	94	100	94	96						
	53		81	97	89	91						
	37.5		70	95	83	84						
	26.5		58	90	71	74						
	19		51	85	65	67						
	13.2		29	75	50	46						
	9.5		21	71	39	40						
	4.75		15	66	28	32						
	2		12	61	24	19						
	0.425		6	28	19	8						
	0.25		5	21	17	7						
	0.15		4	17	15	7						
	0.075		4	14	13	6						
Hydrometer	0.05	% Passing	4	12	13	5						
	0.02		3	10	10	4						
	0.005		2	8	8	3						
	0.002		2	6	7	3						
Soil Mortar	Coarse Sand <2.0 >0.425mm	% Passing	49.1	54.0	19.1	57.4						
	Fine Sand <0.425>0.05mm		49.1	40.3	70.5	40.4						
	Silt <0.05 >0.005		0.6	2.0	3.9	0.9						
	Clay <0.005		1.2	3.7	6.5	1.4						
Atterberg Limits	Liquid Limit % (m/m)		35.7	38.5	35.3	34.8						
	Plasticity Index		8.2	8.6	9.6	11.2						
	Linear Shrinkage %		6	6	4.7	6.7						
	Natural MC %		-	-	-	-						
Mod AASHTO Density	Dry Density kg/m^3		2166	1930	2044	2122						
	OMC %		10.3	12.4	10.6	10						
CBR	100% MDD		16	30	52	42						
	98%		13	2	44	40						
	95%		9	27	34	38						
	93% (Inferred) *		8	26	27	34						
	90%		6	25	20	29						
	CBR Swell (%)		0.00	0.00	0.55	0.00						
AASHTO Soil Classification *			A - 2 - 4 (0)	A - 2 - 4 (0)	A - 2 - 4 (0)	A - 2 - 6 (0)						
Grading Modulus			2.78	1.98	2.44	2.67						
TRH 14 (1985) *			G9	G6	G6	G6						

Technical Signitory: .....

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4990215961
65 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Mkhuze Substation - Ref.31833-1

Ref no.: 8503 **Lab no.:** 08112 **Borehole/Pit no.:** I3A IP6

Description: -

Depth: 0.4 - 1.0m -

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

Grading Analysis	
Grain Size (mm)	%Passing
75	94.4
53	81.2
37.5	70.0
26.5	58.1
19	51.2
13.2	29.0
9.5	21.4
4.75	15.0
2	11.8
0.425	6.0
0.25	5.1
0.15	4.5
0.075	3.9
0.05	3.5
0.02	2.9
0.005	2.4
0.002	2.1

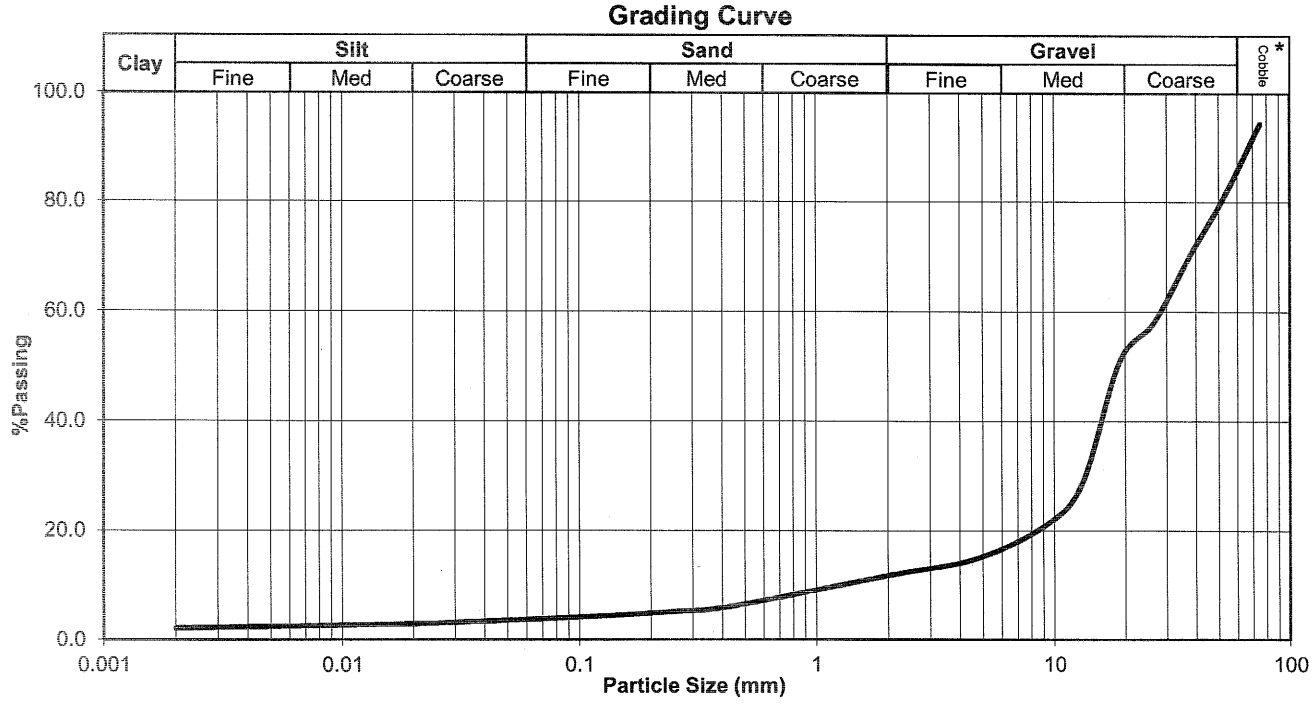
M.I.T SIZE CLASSIFICATION *	
Cobble%	14.6
Gravel%	73.6
Coarse	33.3
Medium	35.4
Fine	4.9
Sand%	8.1
Coarse	5.1
Medium	1.8
Fine	1.1
Silt%	1.6
Coarse	0.8
Medium	0.4
Fine	0.4
Clay%	2.1

PLASTICITY	
Liquid Limit, %	35.7
Plasticity Index	8.2
Linear Shrinkage, % (L/L)	6

GRADING	
D10 Size (mm)	1.2
Uniformity Coefficient	*
Grading Modulus	2.78

CLASSIFICATION	*
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 4
Unified Classification	GP

Grading Curve



Ref no.: 8503 Fig no.: -

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

The results only relate to the samples tested.

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210961
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-5992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Mkhuze Substation - Ref.31833-1

Ref no.: 8503 **Lab no.:** 08113 **Borehole/Pit no.:** I3A IP1

Description: -

Depth: 0.5 - 1.3m -

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

Grading Analysis	
Grain Size (mm)	%Passing
75	100.0
53	97.2
37.5	94.5
26.5	89.9
19	85.0
13.2	75.2
9.5	71.3
4.75	66.4
2	60.6
0.425	27.9
0.25	20.7
0.15	16.7
0.075	13.5
0.05	12.3
0.02	9.8
0.005	8.0
0.002	6.2

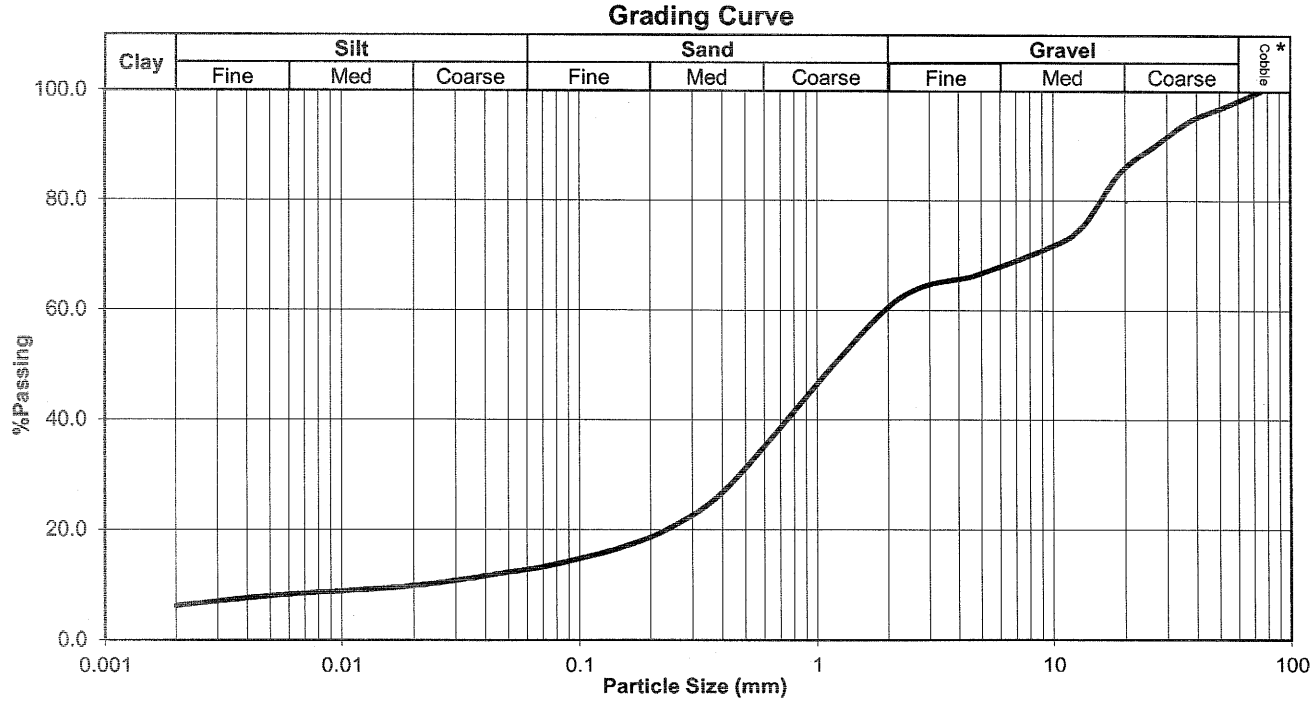
M.I.T SIZE CLASSIFICATION *	
Cobble%	1.9
Gravel%	37.5
Coarse	12.4
Medium	18.0
Fine	7.1
Sand%	47.8
Coarse	29.1
Medium	12.8
Fine	5.9
Silt%	6.6
Coarse	2.9
Medium	1.7
Fine	2.0
Clay%	6.2

PLASTICITY	
Liquid Limit	38.5
Plasticity Index	8.6
Linear Shrinkage	6

GRADING	
D10 Size (mm)	0.021
Uniformity Coefficient	91.71
Grading Modulus	1.98

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 4
Unified Classification	SM

Grading Curve



Ref no.: 8503 Fig no.: -

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

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210981
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4059
Fax : (031) 201-7920

Project: Mkhuze Substation - Ref.31833-1

Ref no.: 8503 **Lab no.:** 08114 **Borehole/Pit no.:** I3A IP7

Description: -

Depth: 0.0 - 0.3m -

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

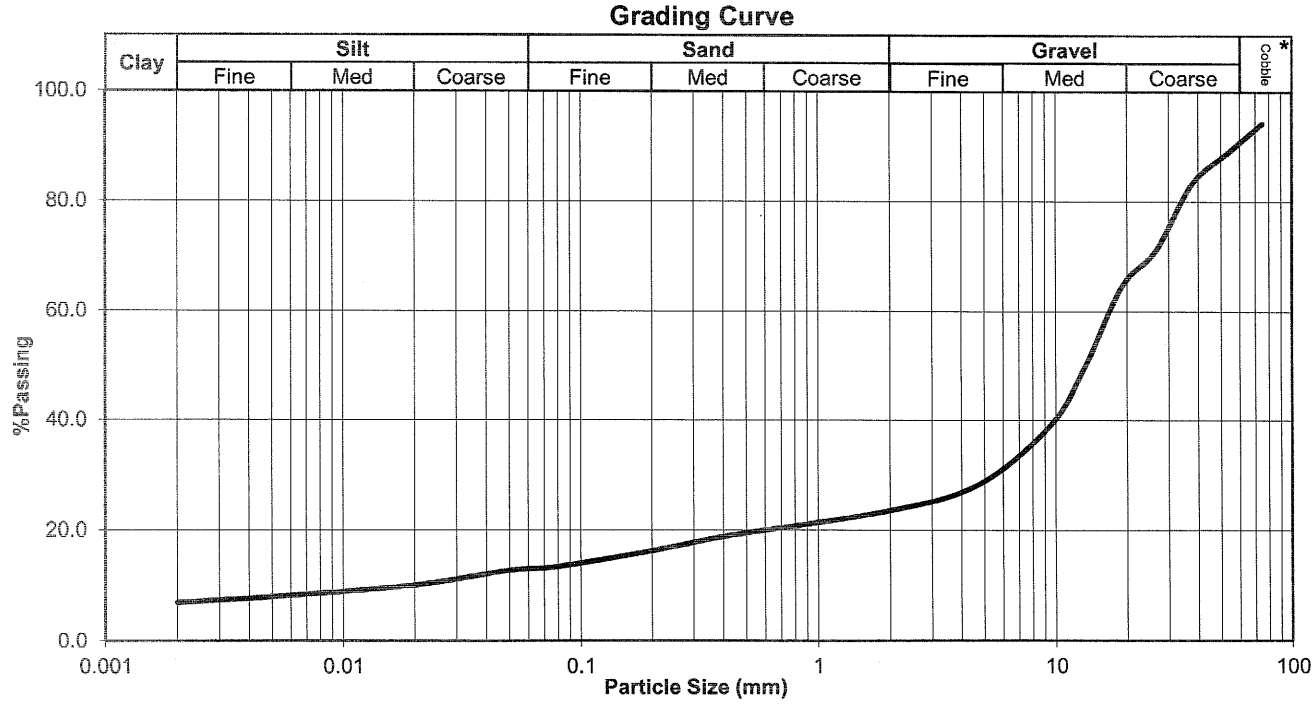
Grading Analysis	
Grain Size (mm)	%Passing
75	94.2
53	88.7
37.5	83.1
26.5	71.2
19	64.5
13.2	49.7
9.5	39.1
4.75	28.4
2	23.5
0.425	19.0
0.25	17.1
0.15	15.3
0.075	13.3
0.05	12.8
0.02	10.1
0.005	8.0
0.002	6.9

M.I.T SIZE CLASSIFICATION *	
Cobble%	9.6
Gravel%	66.9
Coarse	25.0
Medium	34.2
Fine	7.7
Sand%	10.6
Coarse	4.0
Medium	3.3
Fine	3.2
Silt%	6.0
Coarse	2.9
Medium	2.0
Fine	1.2
Clay%	6.9

PLASTICITY	
Liquid Limit	35.3
Plasticity Index	9.6
Linear Shrinkage	4.7

GRADING	
D10 Size (mm)	0.019
Uniformity Coefficient	>99
Grading Modulus	2.44

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 4
Unified Classification	GM



Ref no.: 8503 Fig no.: -

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

TEST REPORT

MATERIALS ANALYSIS

THEKWINI SOILS LAB. CC
V.A.T. REGISTRATION NO. 4590210061
68 Ridge Road, Tollgate, DURBAN
Tel : (031) 201-8992
P.O. Box 30464, MAYVILLE, 4058
Fax : (031) 201-7920

Project: Mkhuze Substation - Ref.31833-1

Ref no.: 8503 **Lab no.:** 08115 **Borehole/Pit no.:** I3A IP10

Description: -

Depth: 0.4 - 0.9m -

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

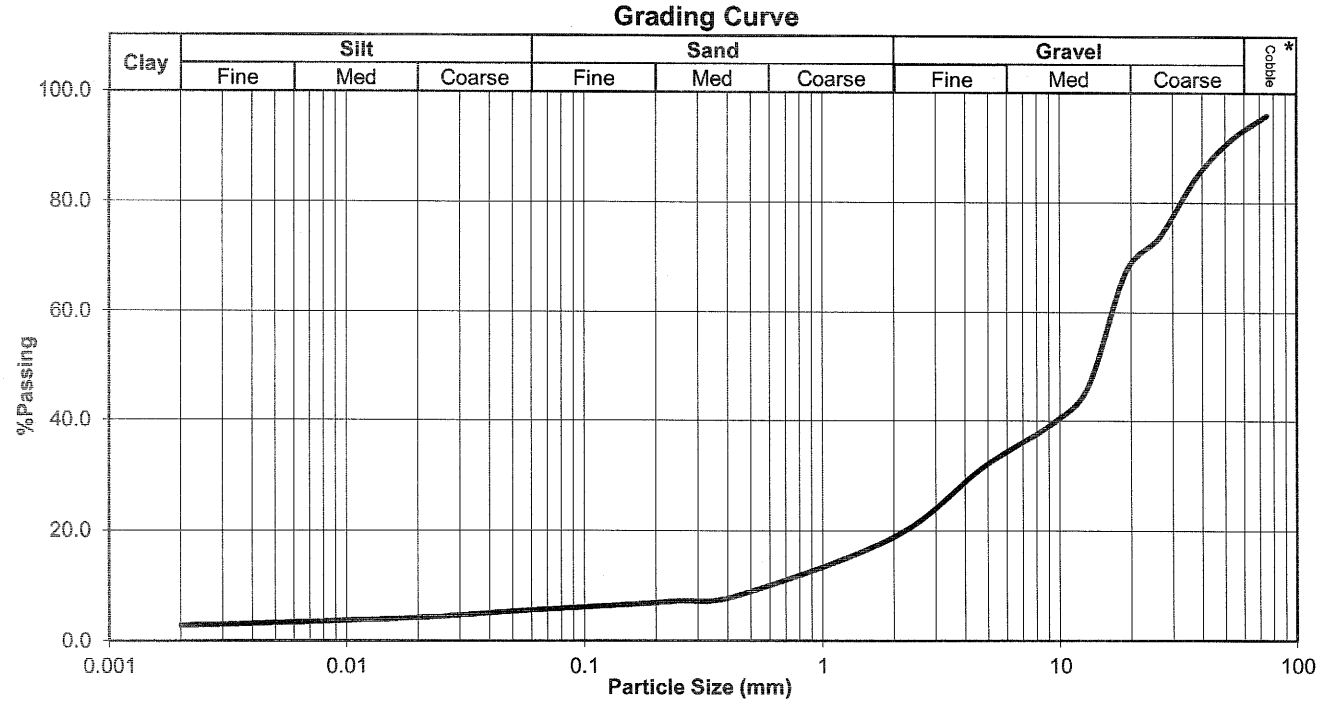
Grading Analysis	
Grain Size (mm)	%Passing
75	95.9
53	91.5
37.5	84.4
26.5	73.8
19	67.4
13.2	46.5
9.5	39.8
4.75	31.5
2	18.9
0.425	8.0
0.25	7.2
0.15	6.6
0.075	5.8
0.05	5.4
0.02	4.2
0.005	3.3
0.002	2.8

M.I.T SIZE CLASSIFICATION *	
Cobble%	7.1
Gravel%	74.0
Coarse	24.6
Medium	34.6
Fine	14.8
Sand%	13.3
Coarse	9.6
Medium	2.3
Fine	1.4
Silt%	2.7
Coarse	1.3
Medium	0.9
Fine	0.5
Clay%	2.8

PLASTICITY	
Liquid Limit	34.8
Plasticity Index	11.2
Linear Shrinkage	6.7

GRADING	
D10 Size (mm)	0.56
Uniformity Coefficient	29.69
Grading Modulus	2.67

CLASSIFICATION *	
Potential Expansiveness	Low
Group Index	0
AASHTO Soil Classification	A - 2 - 6
Unified Classification	GW - GC



Ref no.: 8503 Fig no.: -

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

Date: 11-09-2017

Ref. No. : 8508

Project : Mkuze Substation 31833-1

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

Moisture, pH and Conductivity

Lab. Number	No. BH. CH	Depth m	Moisture Content %	pH	Conductivity m s / m
08113	I3A IP1	0.5 - 1.3	-	7.2	19
08114	I3A IP7	0.0 - 0.3	-	5.9	50

WATERLAB (PTY) LTD

23B De Havilland Crescent
Persequor Techno Park,
Meiring Naudé Road, Pretoria
P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

CERTIFICATE OF ANALYSES
BASSON INDEX & BRE

Date received: 2017-08-15 | **Date completed: 2017-09-04**
Project number: 1000 | **Report number: 68767** | **Order number:**

Client name: Drennan Maud (Pty) Ltd
Address: P.O. Box 30464, Mayville, 4058
Telephone: 031 201 8992/3

Contact person: Jamie Lodge
Email: jamie@drennanmaud.com
Fax: 031 201 7920

Analyses in mg/ℓ (Unless specified otherwise)	Sample Identification: 31376 Eskom	
	I3A – IP1	I3A – IP7
Sample Number	**11043**	**11044**
Paste pH	8.1	6.6
pH Value at 25°C	7.3	6.6
pHs Value at 20°C (calc)	8.5	8.9
Electrical Conductivity in mS/m at 25°C	17.9	23.5
Total Dissolved Solids* (calc)	120	157
Total Alkalinity as $CaCO_3$	64	24
Total Hardness as $CaCO_3$ (calc)	57	99
Calcium Hardness as $CaCO_3$ (calc)	45	50
Calcium as Ca	18	20
Magnesium as Mg	3	12
Free & Saline Ammonia	<0.01	0.126
Ammonium as NH_4 (calc)	<0.3	<0.3
Acid Soluble Sulphate	UTD	UTD
Sulphate as SO_4	7.5	13
Chloride as Cl	6.9	10.8
Nitrate as N	2.3	16
Total Sulphur (Leco) %	<0.01	0.01
Langelier Index at 20°C (calc)	-1.2	-2.3
Ryznar Index at 20°C (calc)	9.8	11.3
Corrosivity Ratio (calc)	0.3	1.2
Leaching Index [LCSI] (calc)	**1303**	**2074**
Spalling Index [SCSI] (calc)	**1**	**4**
Aggressiveness Index [N_c] (calc)	**1305**	**2079**

***TDS Calculated EC X 6.7**
2:1 Distilled Water : Soil Extract
UTD = Unable to determine due to interferences

E. Botha
Geochemistry Project Manager

WATERLAB (PTY) LTD

23B De Havilland Crescent
Persequor Techno Park,
Meiring Naudé Road, Pretoria
P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

CERTIFICATE OF ANALYSES
BASSON INDEX & BRE

Date received: 2017-08-15 | **Date completed: 2017-09-04**
Project number: 1000 | **Report number: 68767** | **Order number:**

Client name: Drennan Maud (Pty) Ltd
Address: P.O. Box 30464, Mayville, 4058
Telephone: 031 201 8992/3

Contact person: Jamie Lodge
Email: jamie@drennanmaud.com
Fax: 031 201 7920

Important notes (see table for corrections on p. 4):

1. The above aggressiveness index is only applicable for conditions of laminar flow at a mean annual temperature of 20°C.
2. For stagnant/turbulent conditions the aggressiveness index must be corrected.
3. For wet/dry cycling conditions (for example in tidal zones) the aggressiveness index must be corrected.
4. For mean annual temperatures lower/higher than 20°C the aggressiveness index must be corrected.

Guidelines for assessing overall aggressiveness (N_c):

N_c	Aggressiveness
Not greater than 300	None to mild
400-700	Mild to moderate
800-1000	High
= or > 1 100	Very high

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	6-7	<6

Corrosiveness Towards metals	
Corrosivity	>0.2

Sample Name	Sample Number	Corrosivity Indices	Basson Index
I3A – IP1	11043	Corrosive	Aggressive
I3A – IP7	11044	Corrosive	Aggressive

E. Botha
Geochemistry Project Manager

WATERLAB (PTY) LTD

23B De Havilland Crescent
Persequor Techno Park,
Meiring Naudé Road, Pretoria
P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

CERTIFICATE OF ANALYSES
BASSON INDEX & BRE

Date received: 2017-08-15 | **Date completed: 2017-09-04**
Project number: 1000 | **Report number: 68767** | **Order number:**

Client name: Drennan Maud (Pty) Ltd
Address: P.O. Box 30464, Mayville, 4058
Telephone: 031 201 8992/3

Contact person: Jamie Lodge
Email: jamie@drennanmaud.com
Fax: 031 201 7920

To correct for:	Multiply	By: (see Notes 2 to 5 below)
Turbulence	LCSI	1.75
Stagnance	LCSI	0.5
Temperature	LCSI, SCSI, N7 Where N7=0.2 x Cl in mg/l	(1+ [0.05 x (T-20)])
Wet-dry cycles	SCSI	0.23×10^{-6} x TDS x DTF x CPA Where: DTF = Dry Time Fraction CPA = wet-dry cycles per annum

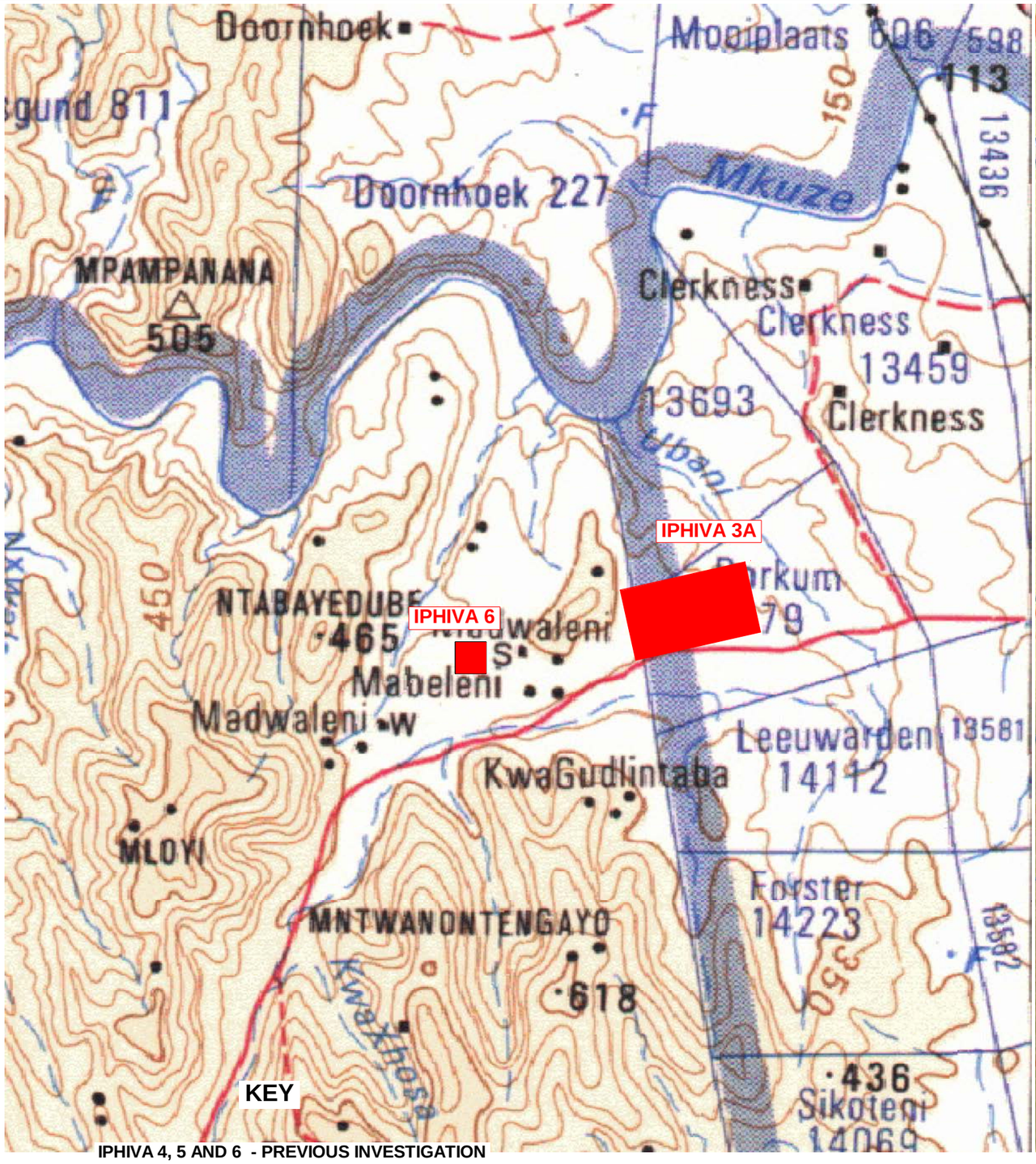
Note 1: Only if the concrete contains embedded steel.
Note 2: To preserve the correct logical relationships when dealing with the negative sub indices (ie LCSI or SCSI having minus values) they should be multiplied by the reciprocal of the relevant factor indicated in this column
Note 3: If more than one correction is required, multiply by the product of the individual correction factors
Note 4: Use subscript c to indicate that the index has been corrected, eg for turbulent conditions $LCSI_c$ = LCSI x 1.75
Note 5: Round off corrected indices to the nearest 100.

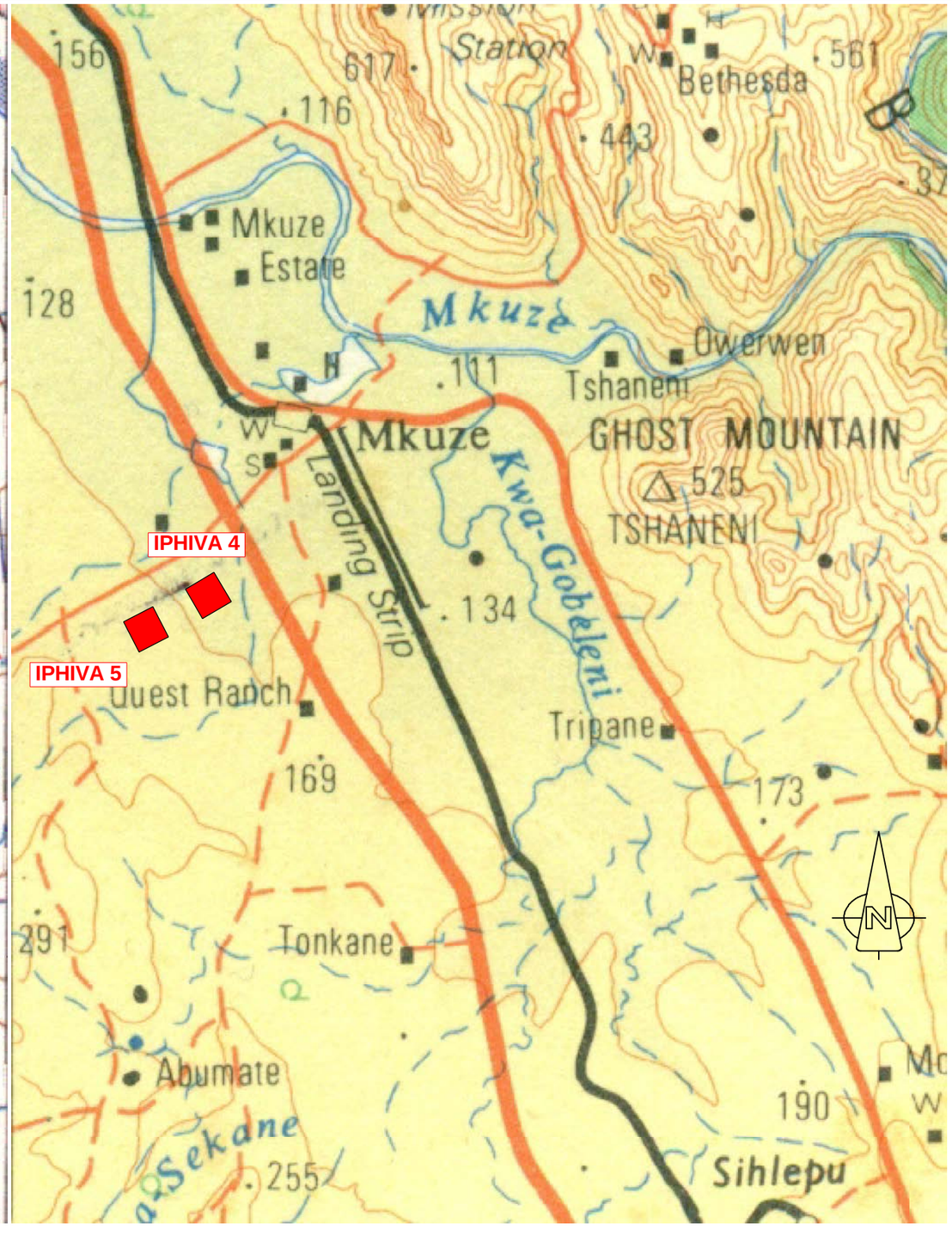
E. Botha
Geochemistry Project Manager

DRAWING № 31833-1/01 - LOCALITY PLAN

DRAWING № 31833-1/02 - SITE PLAN

DRAWING № 31833-1/03 - GEOLOGICAL PLAN





IPHIVA 4, 5 AND 6 - PREVIOUS INVESTIGATION

IPIVIA 3A - CURRENT INVESTIGATION

DRENNAN MAUD (PTY) LTD
Geotechnical Engineers & Engineering Geologists

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

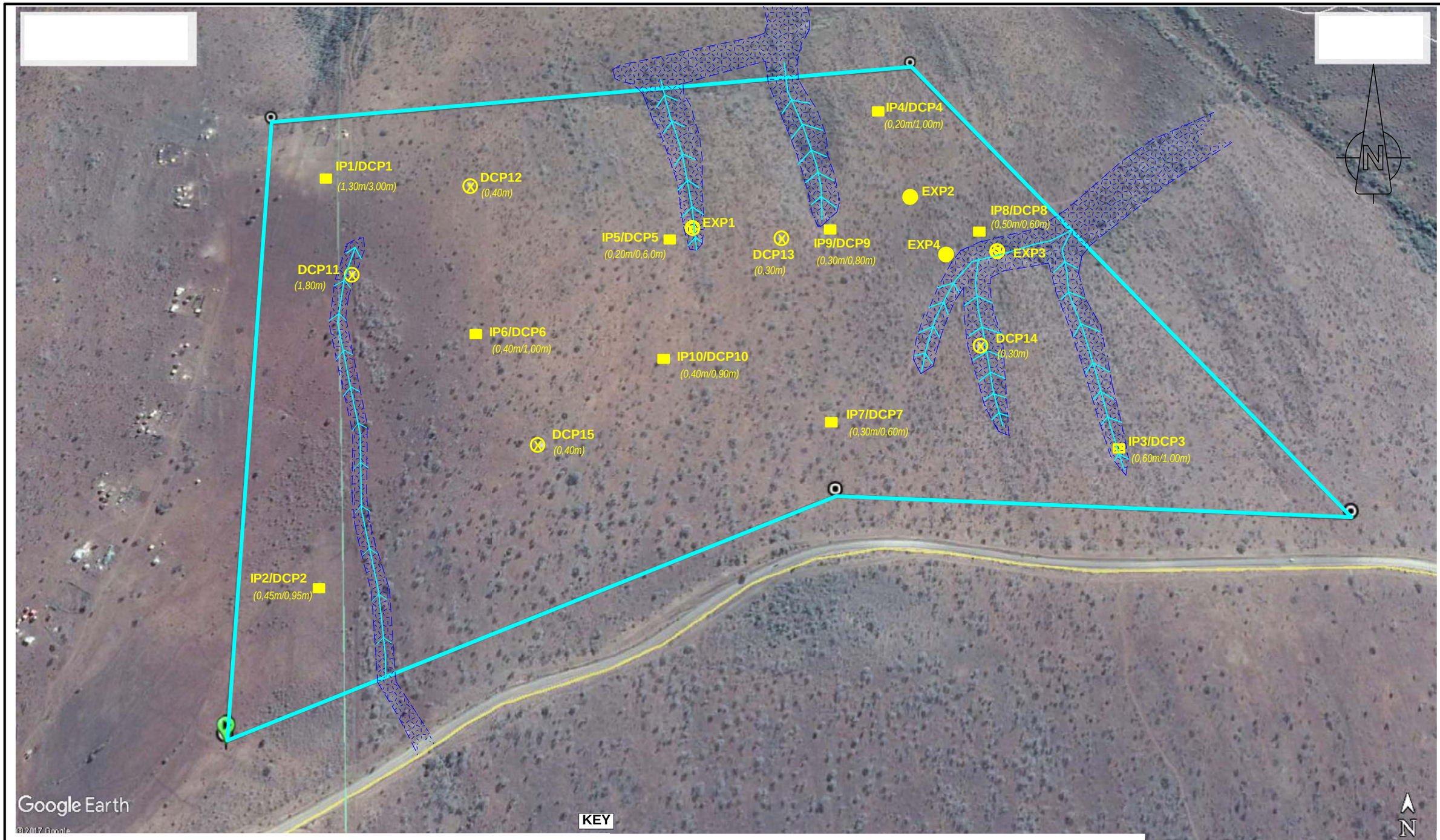
P.O. Box 30464
MAYVILLE
4058
Telefax 031-201-7920
e-mail:info@drennanmaud.com

DESIGNED :	J.L.
DRAWN :	S.P.
DATE :	11/08/2017
SCALE :	N.T.S.
CHECKED :	

PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED MKUZE SUBSTATION
LOCALITY PLAN

DRAWING NO.

31833-1/01



KEY

IP1/DCP1 (1,3m/3,0m) — APPROX. POSITION OF INSPECTION PITS/ DYNAMIC CONE PENETROMETER TESTS (INFERRED BEDROCK DEPTH / FINAL DEPTH)	EXP4 — APPROX. POSITION OF EXPOSURES	SEEPAGE AREAS
	DCP15 (0,40m) — APPROX. DYNAMIC CONE PENETROMETER TESTS (FINAL DEPTH)	RECOMMENDED HERRINGBONE SUBSOIL DRAINAGEBENEATH FILLS

DRENNAN MAUD (PTY) LTD
Geotechnical Engineers & Engineering Geologists

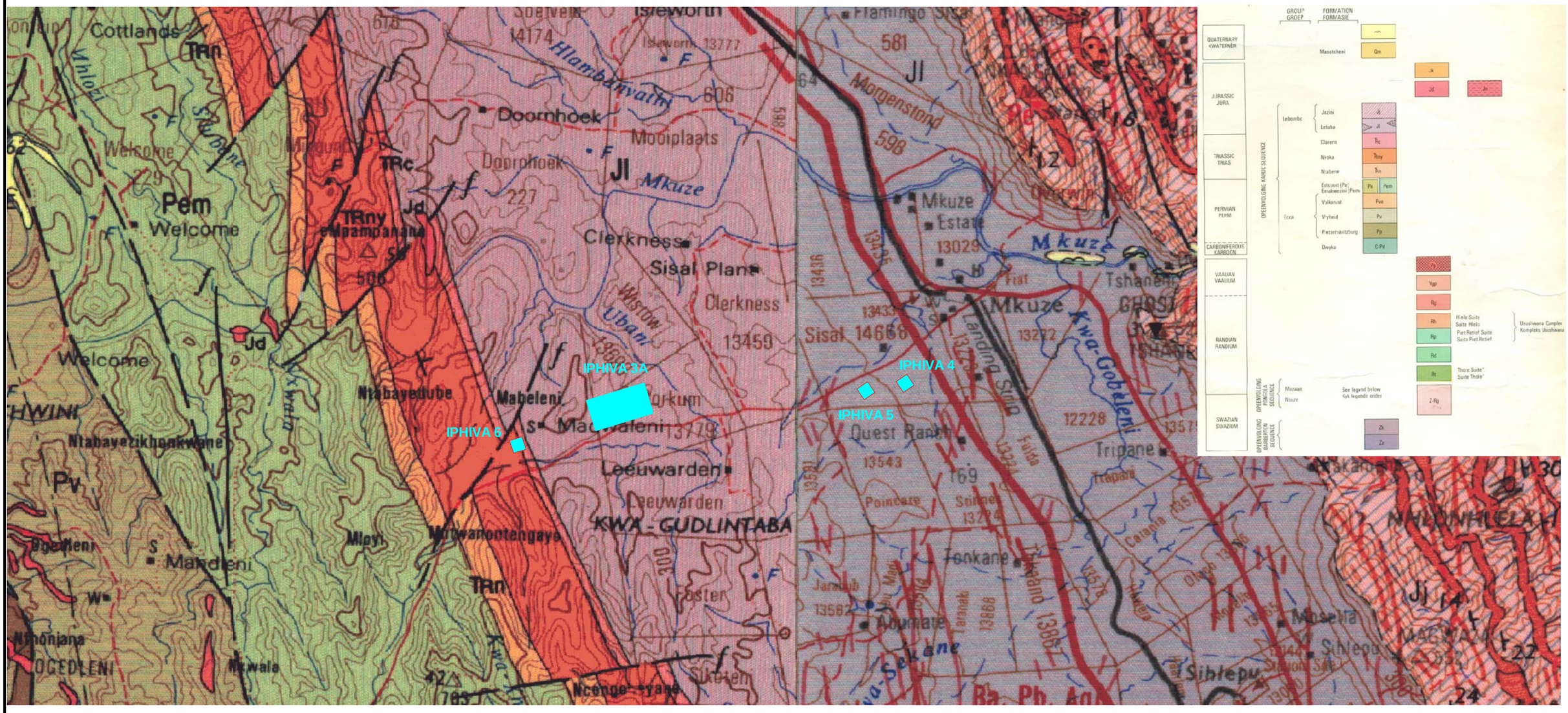
68 Peter Mokaba Ridge
Tollgate
DURBAN
4001
Telephone 031-201-8992

P.O. Box 30464
MAYVILLE
4058
Telefax 031-201-7920
e-mail:info@drennanmaud.com

DESIGNED : J.L.
DRAWN : S.P.
DATE : 11/8/2017
SCALE : AS SHOWN
CHECKED :

PRELIMINARY GEOTECHNICAL INVESTIGATION
MKUZE SUBSTATION
IPHIVA 3A

DRAWING NO.
31833-1/02



KEY

IPHIVA 4, 5 AND 6 - PREVIOUS INVESTIGATION

IPIVIA 3A - CURRENT INVESTIGATION

DRENNAN MAUD (PTY) LTD
Geotechnical Engineers & Engineering Geologists

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

P.O. Box 30464
MAYVILLE
4058
Telefax 031-201-7920
e-mail:info@drennanmaud.com

DESIGNED :	J.L.
DRAWN :	S.P.
DATE :	11/08/2017
SCALE :	N.T.S.
CHECKED :	

PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED MKUZE SUBSTATION
GEOLOGICAL PLAN

DRAWING NO.

31833-1/03