



Report to CK Rumboll & Partners on a Geotechnical Investigation carried out for the Louw's Bos North, RE/502, Cemetery Site, Stellenbosch, Western Cape

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1. INTRODUCTION

As requested by Ms Anelia Coetzee of CK Rumboll & Partners, Gondwana Geo Solutions (Pty) Ltd (GGS) submitted a proposal to carry out a geotechnical investigation for the proposed Louw's Bos RE/502, Cemetery Site on the 28th February 2018.

The appointment of GGS to proceed as proposed was confirmed in a signed contract with CK Rumboll and Partners on the 27th March 2018.

The Phase 1, Preliminary Site Assessment comprised a desktop study of the area with a review of available information and meeting with local land owners, mapping of all surface water bodies and conducting a borehole and spring census of the area. This information is included in this, the Phase 2 report.

The Phase 2 geotechnical investigation comprised the excavation of five trial pits at locations around the site. The trial pits were put down to obtain logging and sampling of the soils and, where possible, the depth to bedrock. Five Dynamic Cone Penetrometer Light (DPL) Tests were carried out adjacent to the inspection pits to establish the consistency of the soils with depth.

Recommendations for the suitability of the site for use as a cemetery are provided.

2. INFORMATION SUPPLIED

The following information was supplied for use in the investigation:

- Google Earth Kmz file showing the site position.
- Image IMG 20180413 WA000: Site Development Plan: Ref: STEL/9494/AC/RB
- Image IMG 20180413 WA0001
- Image IMG 20180413 WA0002

3. SITE DESCRIPTION

The area on which the geotechnical investigations were carried out consist of a site with an area of approximately 104Ha.

The site is bounded on the southern side by the Bonterivier and cultivated farm land and on the north side by municipal land in the east and cultivated farm land in the west. The eastern edge of the site abuts against the Stellenbosch aerodrome and intensive agricultural tunnels (Figures 2 and 5).

The site slopes down towards the Bonterivier in the south. The slope is gentle in the north steepening up closer to the river. Vegetation on the site consists of planted pastures or fallow agricultural land with an area of approximately 23Ha between Trial Pit TP3 and TP4 which is covered in Port Jackson Willow around the outside with indigenous protected plants toward the centre. The layout of the site is given in Figures 2 and 5.

Plates 1 and 2 below give a detailed perspective of the site.



Plate 1: Site viewed towards the east at TP3



Plate 2: Site viewed towards the south at TP4

4. FIELDWORK

The fieldwork for the investigation was conducted during April 2018 and comprised the following:

- Trial Pits, and
- Dynamic Cone Penetrometer Light (DPL) Tests

4.1 Trial Pits

The trial pits were excavated using a JCB3CX Tractor Loader Backhoe (TLB) supplied by Burcon Plant Hire from Cape Town.

Five trial pits, designated TP1 through TP5 were put down at the location as shown in Figure 2 at the site. Trial pits TP1, TP2, TP3, TP4 and TP5 were terminated in clay at a depth of 3.50m, 3.0m, 2.90m, 3.10m and 3.10m respectively, below existing ground level.

The trial holes were profiled¹ by an engineering geologist and representative soil samples recovered for laboratory testing at Geoscience Laboratories (Pty) Ltd in Cape Town. The detailed logs are provided in Appendix A.

Table 1 below indicates the locations and depths to which the trial holes were excavated.

**Table 1
Summary of Trial Pit Details**

TP No.	GPS Coordinates (WGS84)		Depth (mbegl)	Comments
	19 Y	X		
TP1	0016381	3762049	3.50	TLB Limit: No groundwater
TP2	0016770	3762438	3.00	TLB Limit: No groundwater
TP3	0017220	3761788	2.90	TLB Limit: No groundwater
TP4	0017913	3762116	3.10	TLB Limit: No groundwater
TP5	0018320	3762370	3.10	TLB Limit: No groundwater

Note: mbebl = metres below existing ground level

¹ Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

4.2 Dynamic Cone Penetrometer Light (DPL) Tests

Five Dynamic Cone Penetrometer Light, or DPL tests, designated DPL1 to DPL5 were undertaken. All tests were undertaken from surface adjacent to the corresponding trial pits. A maximum depth of 2.1m begl was achieved, in order to assess the consistency of the in-situ soils, as well as to provide an indication of the depth to bedrock where possible. DPL1, DPL3 and DPL5 were advanced to refusal depth. DPL2 and DPL4 were advanced to 2.10m and terminated.

Table 2 below indicates the depth to which the DPL tests were undertaken. The results of the DPL test, comprising plots of blow count per 300mm advance and inferred consistency against depth are provided in Appendix B.

Table 2
Summary of DPL Test Results

DPL No.	GPS Coordinates (WGS84)		Depth (mbegl)	Comments
	19 Y	X		
DPL1	0016381	3762049	0.6	Medium dense to 0.3m, dense to 0.6m. Refusal
DPL2	0016770	3762438	2.1	Medium dense to 0.3m, dense to 0.6m, stiff to 0.9m, firm to 1.2m, stiff to 1.8m, firm to 2.1m. Terminated
DPL3	0017220	3761788	0.3	Dense to 0.3m. Refusal
DPL4	0017913	3762116	2.1	Dense to 0.3m, firm to 0.6m, soft to 0.9m, firm to 1.5m, stiff to 2.1m. Terminated
DPL5	0018320	3762370	0.3	Dense to 0.3m. Refusal

5. REGIONAL GEOLOGY

The regional geology of the area is shown in the extract presented in Figure 3 and taken from the 1:250 000 Cape Town 3318 geological map prepared by the Council for Geosciences.

The regional geology consists of;

- Gravelly clay loam, Quaternary, overlying
- Granite Plutons comprising mainly coarse grained porphyritic with porphyritic biotite, fine grained leucocratic, hybridic and medium grained tourmaline-bearing variants of the Cape Granite Suite, outcrop around the site.

5.1 Site Geology

The site is underlain by a mantle of colluvial and residual soils overlying the granite of the Cape Granite Suite.

The site is underlain by a soil mantle comprising, from ground surface, light brown medium dense to dense to very dense, gravelly silty sand with abundant pebbles and cobbles. Colluvium overlying

- Yellow brown dense intact sandy silty Gravel: Colluvium overlying
- Yellow brown stiff to firm slightly shattered silty CLAY; Colluvium or
- Light grey firm to soft intact sandy CLAY; Colluvium overlying
- Cream grey stiff to firm intact gravelly CLAY: Residual Granite

6. GROUNDWATER

Groundwater was not encountered in any of the trial pits, however, water ingress into excavations may be expected if the construction takes place during the normally wet winter months after heavy rainfall.

7. LABORATORY TESTING

7.1 Materials Usage

In order to classify materials and to assess their suitability for a cemetery development the following laboratory testing was conducted on soils taken from the trial pits.

- Foundation Indicator Tests to determine Atterberg Limits, Particle Size Distribution and clay activity.
- Permeability Tests to determine soil permeability.
- In-Situ Permeability tests to determine in-situ soil permeability.

The results of the laboratory tests are provided in Appendix C and summarised in Tables 3 and 4 below.

Table 3
Summary of Results of Particle Size Distribution Analysis and Atterberg Limit Determinations

TP No.	Depth (m)	Description	Particle Size %				Atterberg Limits			GM	Classification
			Clay	Silt	Sand	Gravel	LL	PI	LS %		
TP1	1.00-3.50	Dry grey brown to grey blotched red brown stiff to firm slightly shattered CLAY. Residual Granite	24	41	34	1	32	15	7.0	0.56	A-6(7); CL; Medium heave; Type D Gravel Wearing Course
TP2	2.20-3.00	Slightly moist cream grey stiff to firm intact gravelly CLAY. Residual Granite	31	29	38	1	25	11	6.0	0.81	A-6(4); CL; Medium heave; Type D Gravel Wearing Course

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage

GM - Grading Modulus

Classification in Terms of:

USPRA²
Unified Soil Classification System³
D.H. Van Der Merwe (1964)⁴
TRH14 (1985)⁵
TRH20 (1990), Suitability for gravel wearing course⁶
Type A Erodible materials
Type B Ravels & corrugates
Type C Ravels
Type D Slippery when wet
Type E Good but may be dusty

² US Public Roads Administration Classification (Modified from Allen 1945)

³ ASTM D 2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). June 2006

⁴ D.H. Van Der Merwe (1964). The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils. The Civil Engineer, pp 103-107

⁵ TRH 14 (1985) - Guidelines for Road Construction Materials; Technical Recommendations for Highways, South African National Institute for Transport and Road Research

⁶ TRH 20 (1990) - The Structural Design, Construction and Maintenance of Unpaved Roads, Committee of State Road Authorities

Table 4
Summary of Results of Permeability Testing

TP No.	Depth (m)	Description	Test Type	Permeability k(cm/s)	Result ⁷
TP2	0.60-2.20	Dry yellow brown stiff to firm slightly shattered silty CLAY: Colluvium	Falling Head. Permeability*	1.24E-07	Impervious
	2.20-3.000	Slightly moist cream grey stiff to firm intact gravelly CLAY: Residual Granite	Falling Head. Permeability*	1.22E-06	Impervious
TP4	1.10-3.10	Dry cream grey to olive brown firm to stiff slightly shattered sandy CLAY: Residual Granite	Falling Head. Permeability*	3.42E-06	Impervious
TP5	0.25-0.35	Dry light olive brown dense intact gravelly silty sand with abundant cobbles and pebbles; Colluvium	In-situ Permeability	2.00E-02	Pervious

*Note: Test carried out on material compacted to 95%MDD

⁷ Williams 1993 in Stapelberg FDJ 2005, The Engineering Geology of Cape Town and Environs, Western Cape South Africa.

7.2 Permeability Evaluation

The materials underlying the site have been classified in terms of their permeability characteristics the results are shown in Table 4 above.

The silty clay, gravelly clay and sandy clay in TP2 and TP4 are found to be impervious. The gravelly silty sand at surface in TP5 is found to be Porous as expected.

8. DEPARTMENT OF WATER AFFAIRS AND SANITATION (DWS) REQUIREMENTS

Department of Water Affairs and Sanitation (DWS) requirements with regards to the siting of cemeteries are that the following areas⁸ should be avoided.

The areas not recommended for the siting of cemeteries are shown in Figure 4.

8.1 Below the 1 in 50 year flood line of a river

If the area between slopes of 6% to 13.6% are avoided this requirement will be met (Figure 4)

8.2 In close proximity to water bodies such as wetlands, vleis, pans and floodplains

There is a small vlei area roughly in the centre of the site which was dry at the time of the investigation but which will become saturated in normal rainfall years. A small area in the extreme south east abuts onto the Bonterivier. If these areas are avoided the bulk of the proposed site will comply (Figure 4). The vlei area is depicted in Plate 3 below.



Plate 3: View towards the east from TP3. The brown area in the middle distance is the vlei

8.3 Situated in unstable areas

As there are no fault zones, seismic zones, dolomite or cast areas on the site, sinkholes and ground subsidence are unlikely.

8.4 Sensitive ecological areas

The area of protected vegetation is shown between trial pits TP3 and TP4 in Figure 4. If this area is avoided then this requirement will therefore be met.

⁸ National Water Act No 36 of 1998. Sections 22(3) and 22(4).

8.5 Areas with flat gradients with shallow or emergent groundwater

The site slopes to the south, gently at first and then steepening up down to the Bonterivier. The area in the north slopes at a gradient of between 2% and 6%. Further down the slope in a southerly direction, the slope increase from 6% to 9% and 9% to 13.6%. (Figure 4). These steeper slopes are unsuitable for use as a cemetery site but could be used as parks.

No groundwater was intersected in any of the trial pits.

8.6 Areas characterised by steep gradients or shallow bedrock with little soil cover

As mentioned, the site, slopes towards the river and some areas with gradients of between 6 to 13.6% are unsuitable for use as a cemetery (Figure 4). Bedrock was not intersected in any of the Trial Pits which were terminated at between 2.90m and 3.50m in clay.

The Stellenbosch Municipality Bye-Laws pertaining to Burial Parks and Cemeteries⁹ defines a grave as being 1.80m deep. Bye-Law 2.9(a) states that after a coffin is covered it rests at least 1.00m below the ground surface. This implies that the grave depth should not be shallower than 1.80m from surface. This criteria is met over the area proposed for the cemetery (Figure 4).

8.7 Areas of groundwater recharge on account of topography and/or highly permeable soils

Impervious clay layers in the upper soil profile will limit the groundwater recharge capability. These conditions may lead to a shallow perched water table in the normally wet winter months or periods of high rainfall.

8.8 Areas overlaying or adjacent to important aquifers where these are to be used for water supply purposes

The area is classified as a Minor Aquifer¹⁰ and as a result complies.

9. BOREHOLES AND DOMESTIC WATER SOURCES

There are no known boreholes on the site. The position of the boreholes on the neighbouring farms are shown in Figure 4. Table 5 summarises the details

Table 5
Summary of Borehole Details

TP No.	Approximate GPS Coordinates (WGS84)		Depth (mbegl)	Yield (litres/hr)	Approximate Distance from Suitable Site (m)	Comments
	19 Y	X				
BH1	001876	3762684	Unknown	50 000	600	Water quality good. Bulk sales to the public
BH2	0017301	3762502	Unknown	Domestic use	300	Water quality good
BH3	0016842	3762897	Unknown	Domestic use	250	Water quality good
BH4	0016334	3762048	Unknown	Domestic use	12	Water quality good. Close to the north eastern site boundary

10. DEVELOPMENT RECOMMENDATIONS

10.1 Proposed Development

The proposed development will comprise of a memorial park with cemetery areas, remembrance wall and park areas with trees and grass.

⁹ Stellenbosch Municipality, Burial Parks / Cemeteries By -Laws 2007

¹⁰ Aquifer Classification of South Africa. Department of Water Affairs 2012

10.2 Grave Excavations

As a general observation the insitu materials to a maximum depth of between 2.90m and 3.5m below existing ground level, as determined by trial pit excavations and DPL tests, will classify as Soft Excavation (SABS1200 DM).

Sidewall collapse was not observed in any of the trial pits put down and it is therefore assumed that grave excavations will stay open for a reasonable length of time. It must be noted that when the soils are wet by precipitation or otherwise, sidewall collapse is possible. The recommended stand-up time for open grave sidewalls is maximum 24 hours, however, wet periods will have a significant effect on the stability of the open graves and should be assessed individually.

10.3 Leachate Migration

All five trial pits put down on site indicated porous silty sand down to a maximum depth of 0.75mbgl overlying impervious clay down to between 2.90m and 3.50mbgl.

Leachate migration from the graves is therefore unlikely.

10.4 Basal Buffer Zone

No water was intersected in any of the trial pits put down. The depth to the water table is therefore unknown. The requirement that the basal buffer zone of 2.5m between grave and water table is met but it should be noted that this investigation was carried out during a severe drought and that in times of winter rain or heavy rain fall, the water table may be present at shallower depths.

10.5 Soil Workability

The sands in the profile will compact without difficulty on return to the grave. The clays in the profile will also compact but not as easily as the sands.

11. RATING OF CEMETERY ATTRIBUTES

Since a large degree of research was conducted by several geotechnical consultants¹¹; ¹² over the period 1990 to 2005 on the siting of cemeteries the rating of a cemetery site in terms of selected attributes is normally carried out and provides a useful guideline for planning.

The attributes used for cemetery rating are the following:

- Excavatability
- Grave stability
- Soil workability
- Groundwater
- Soil permeability, and
- Backfill Permeability

The above attributes are each further subdivided into graduations with rating values assigned to each. The site attributes are then scored against the rating values given in Tables 1 through Table 6 in Appendix D. A total rating score for the site is obtained and compared with the Site Suitability Rating in Table 6 below.

¹¹ Hall, B. & Hanbury, R (1990) Some Geotechnical Considerations in the Selection of Cemetery Sites. IMIESA March 1990.

¹² Welland, A.M and Venter, J.P (1997). Guidelines for the Investigation of Cemetery Sites: Adaptation of "Minimum Requirements for Waste Disposal by Landfill" Applicable to Cemetery Site Investigations. Prepared by BKS (Pty); Report No 108/568; project reference P412680.

Table 6
Site Suitability Rating

Rating Total Score	Site Suitability Rating
>90	Very good
75 to 90	Satisfactory
60 to 75	Poor – precautions needed
<60	Unacceptable

In terms of the ratings, the following scores are determined for the cemetery site:

Attribute	Score
Excavatability	10
Grave stability	20
Soil workability	2
Groundwater	15
Subsoil permeability	20
Backfill permeability	15
Total Score	82

Therefore, in terms of the ratings of the site attributes, the site is assessed as being **satisfactory** for use as a Cemetery site. The site is therefore considered generally suitable for its intended use as a cemetery provided the recommendations in this report are adhered to.

12. CONCLUSION

This report presents the results of the geotechnical investigation conducted for the proposed new cemetery at the Louw's Bos site.

The proposed site is underlain by a soil mantle comprising, from ground surface, dense to medium dense to very dense sands and gravel of colluvial origin overlying clays of colluvial and residual origin all of which classify as Soft Excavation (SABS1200 DM).

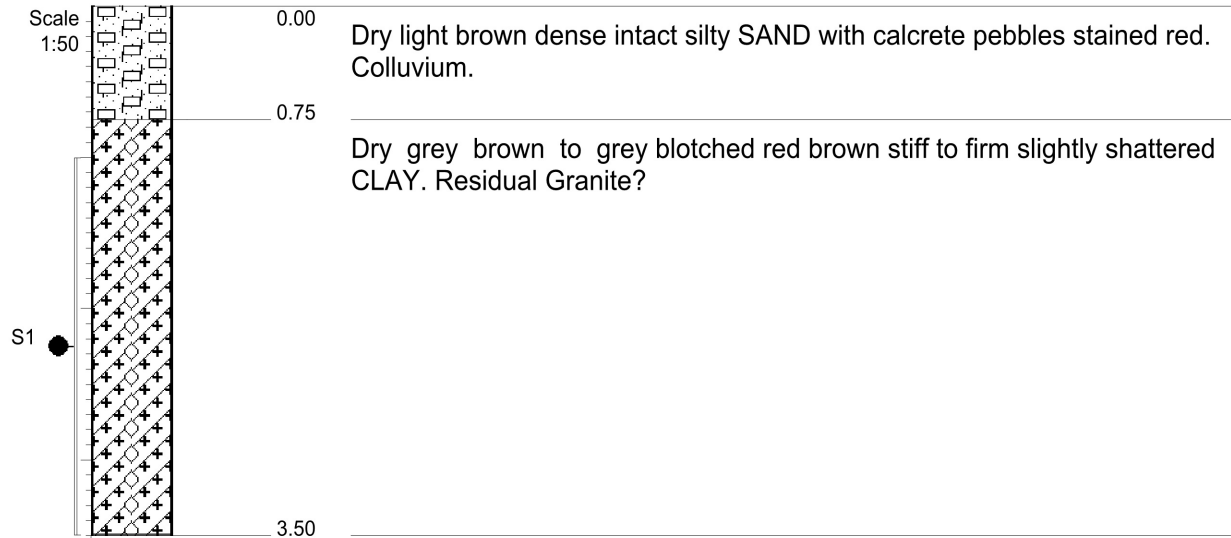
Provided that the cemetery is sited in the area proposed and shown in Figure 4, the Department of Water Affairs and Sanitation (DWS) requirements for the siting of cemeteries are met.

Leachate migration is unlikely as the clays in the profile are impervious.

The cemetery site was rated in terms of the attribute rankings and a score of 82 obtained. This indicates that in terms of the **Site Suitability Rating Index**, the site is considered **satisfactory** for development as a cemetery.

In conclusion, the information and recommendations provided in this report relates to the location of the trial holes and DPL tests put down on site. It is quite possible that variations to the ground conditions will be encountered elsewhere on the site during construction. Therefore, it is recommended that GGS be appointed to carry out periodic inspections on the earthworks and foundation excavations during construction to confirm the recommendations given in this report.

APPENDIX A


NOTES

- 1) Final depth at 3.50m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
S1 1.00--3.50m


 CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH

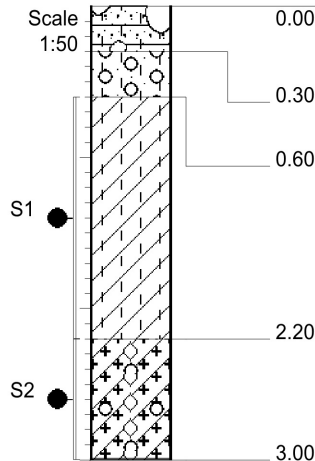
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 SETUP FILE : STANDARD.SET

 INCLINATION :
 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018

 DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

 ELEVATION :
 X-COORD : 3762049
 Y-COORD : 19Y 0016381

 HOLE No: **TP1**



Dry light brown medium dense intact silty SAND with sandstone pebbles and cobbles. Colluvium.

Dry yellow brown dense intact sandy silty GRAVEL. Colluvium.

Dry yellow brown stiff to firm slightly shattered silty CLAY. Colluvium.

Slightly moist cream grey stiff to firm intact gravelly CLAY. Residual Granite?

NOTES

- 1) Final depth at 3.00m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
 S1 0.60--2.20m
 S2 2.20--3.00m



CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH

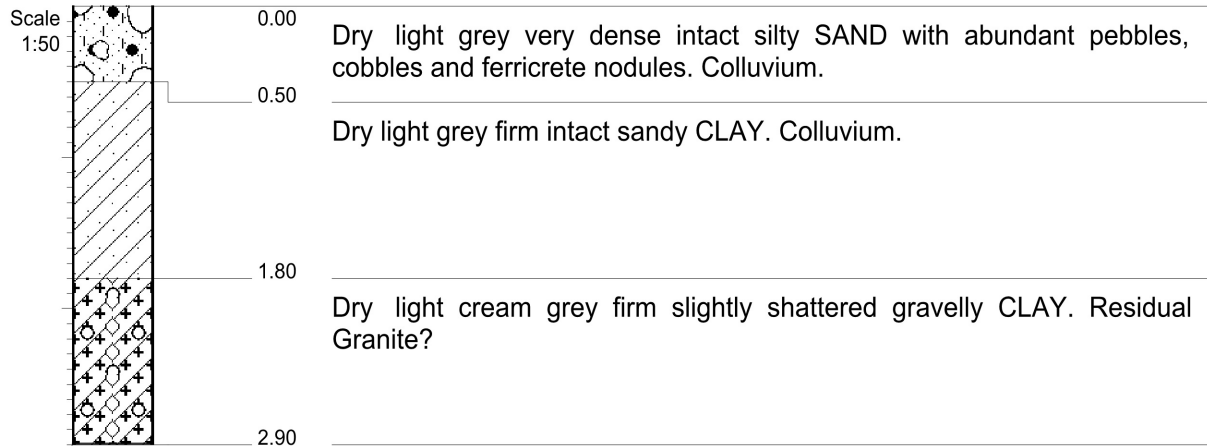
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INCLINATION :
 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018

DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

ELEVATION :
 X-COORD : 3762438
 Y-COORD : 19Y 0016770

HOLE No: **TP2**



NOTES

- 1) Final depth at 2.90m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.



CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH

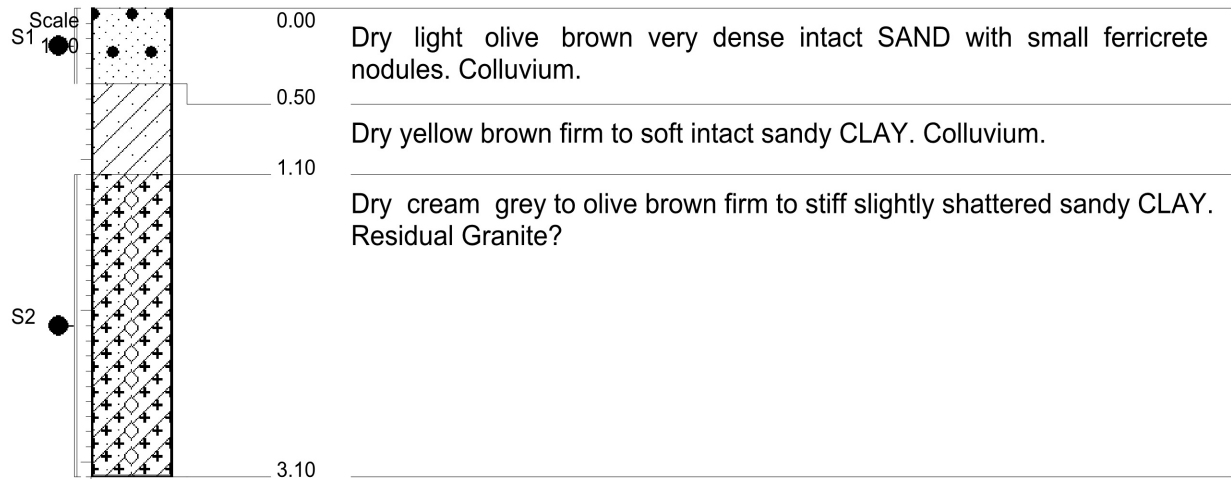
TYPE SET BY : MC
 SETUP FILE : STANDARD.SET

INCLINATION :
 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018

DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

ELEVATION :
 X-COORD : 3761788
 Y-COORD : 19Y 0017220

HOLE No: **TP3**


NOTES

- 1) Final depth at 3.10m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
 S1 0.00--0.50m
 S2 1.10--3.10m


 CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH

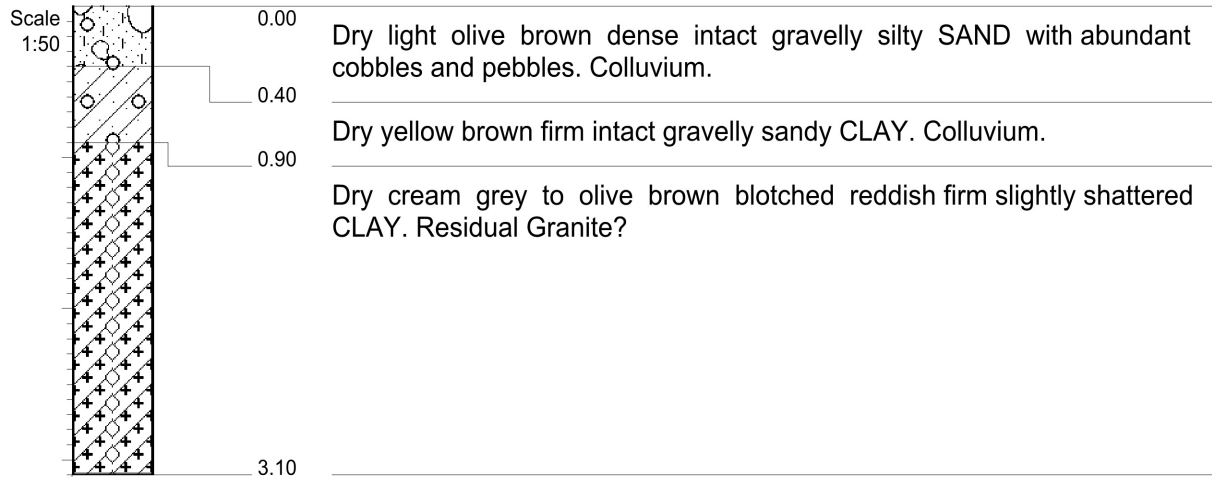
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 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018

 DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

 ELEVATION :
 X-COORD : 37612116
 Y-COORD : 19Y 0017913

 HOLE No: **TP4**


NOTES

- 1) Final depth at 3.10m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.



CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH

TYPE SET BY : MC
 SETUP FILE : STANDARD.SET

INCLINATION :
 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018

DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

ELEVATION :
 X-COORD : 3762370
 Y-COORD : 19Y 0018320

 HOLE No: **TP5**

APPENDIX B



Consulting Geotechnical Engineers & Engineering Geologists

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Project: Louws Bos Cemetery
Section:

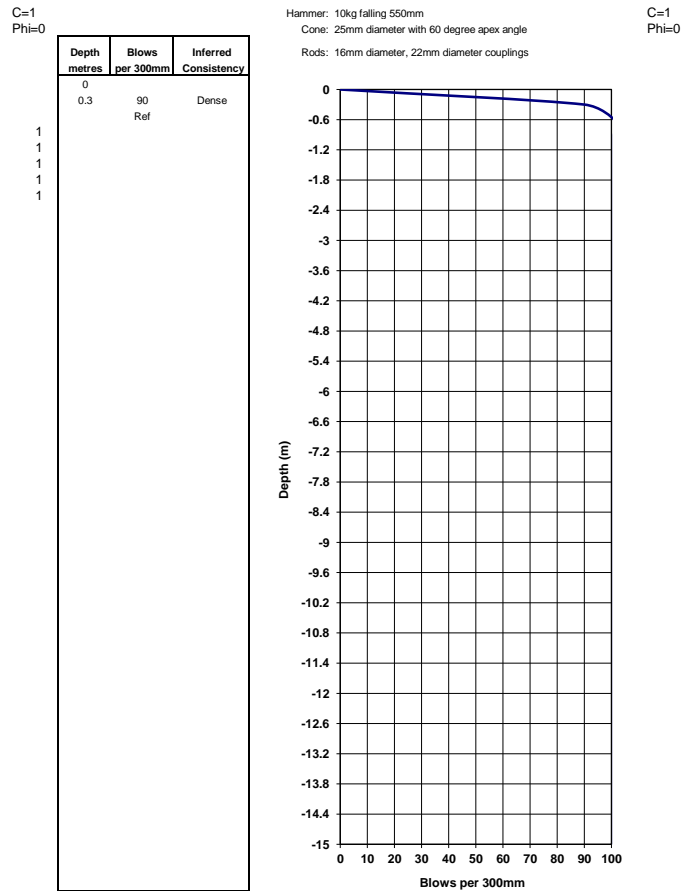
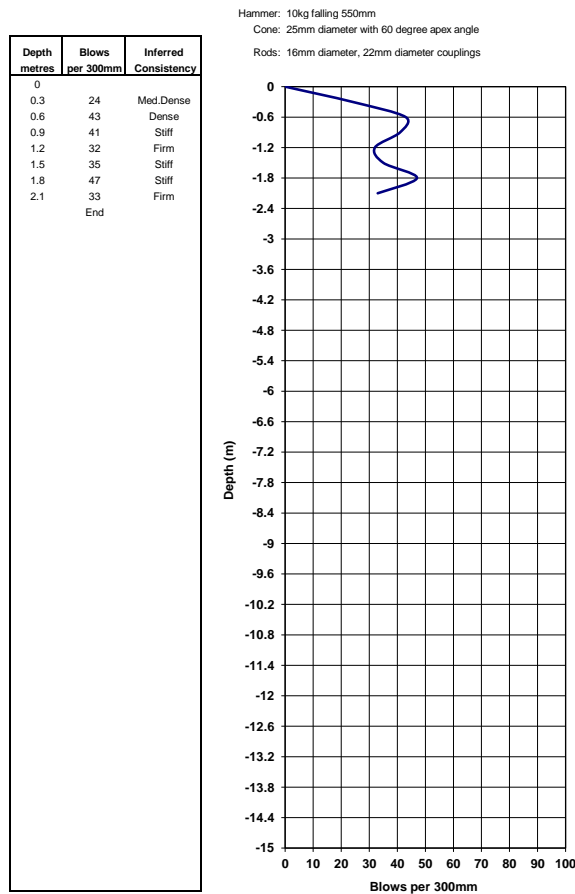
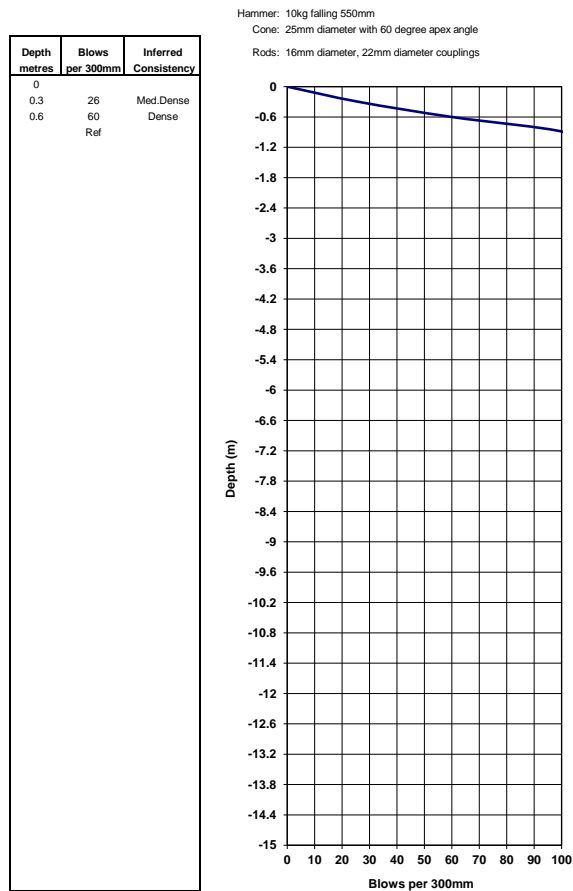
Ref.No. 18-812
Date: 12/4/2018
Operator: CH

Light Dynamic Penetrometer Probe ----- Test No. DPL 1

Light Dynamic Penetrometer Probe ----- Test No. DPL 2

Light Dynamic Penetrometer Probe ----- Test No. DPL 3

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION





Consulting Geotechnical Engineers & Engineering Geologists

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Client: CK RUMBOLL & PARTNERS
Project: Louws Bos Cemetery
Section:

Ref.No. 18-812
Date: 12/4/2018
Operator: CH

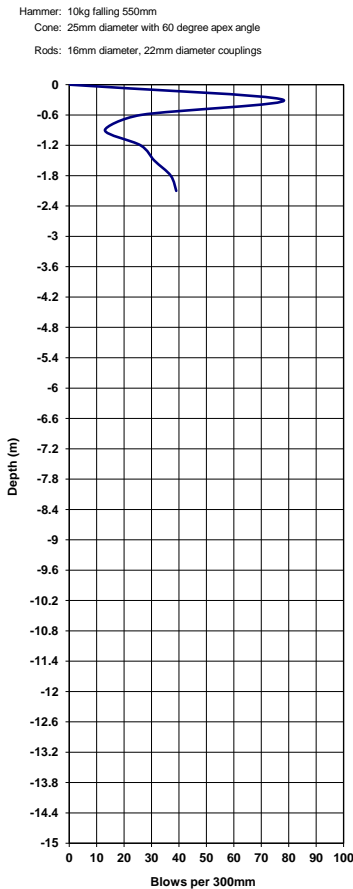
Light Dynamic Penetrometer Probe ----- Test No. DPL 4

Light Dynamic Penetrometer Probe ----- Test No. DPL 5

Light Dynamic Penetrometer Probe ----- Test No. DPL

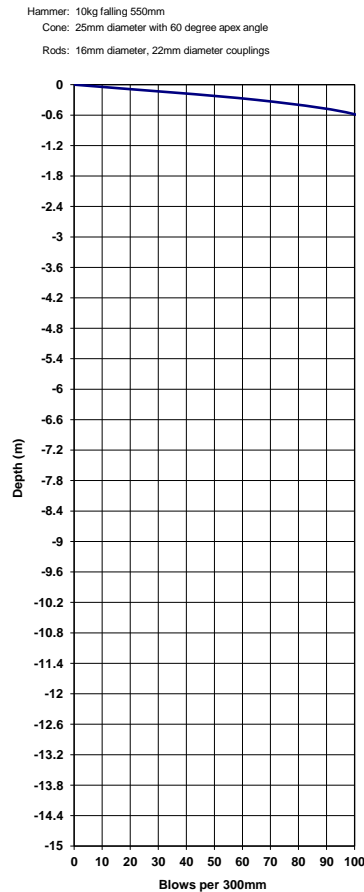
THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Depth metres	Blows per 300mm	Inferred Consistency
0		
0.3	78	Dense
0.6	26	Firm
0.9	13	Soft
1.2	26	Firm
1.5	31	Firm
1.8	37	Stiff
2.1	39	Stiff
	End	



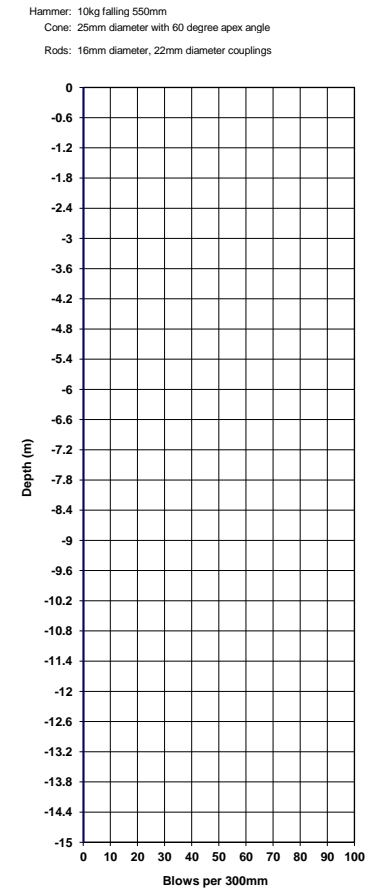
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0.3	65	Dense
	Ref	



C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		



C=1
Phi=0

APPENDIX C

CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550
ATT: Colin Hatrley

PROJECT: Louw's Bos Cemetry

DATE: 20-04-2018
REF: L180429

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : grey brown sandy clay
POSITION : TP 01 @ 1.0-3.50m

SAMPLE NO. : 30326
CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
SIEVE SIZE (mm)	75,00
	63,00
	53,00
	37,50
	26,50
	19,00
	13,20
	9,50
	6,70
	4,75
	2,36
	2,00
	1,18
	0,600
	0,425
	0,300
	0,150
	0,0750
	65

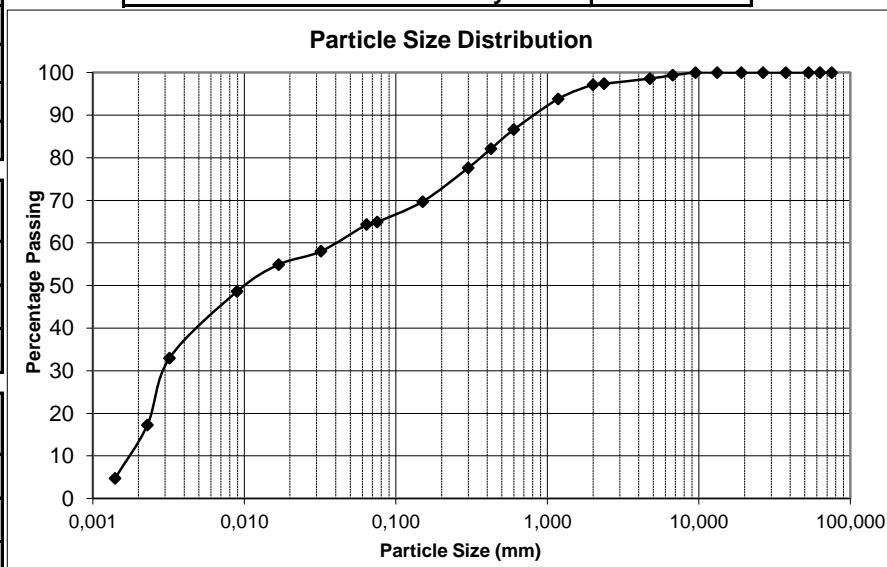
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0640	64
0,0327	58
0,0166	55
0,0087	49
0,0032	33
0,0024	17
0,0014	5

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

% SCS Dispersion:	
Initial Moisture Content (%) :	
pH:	
Conductivity mS/m:	

Atterberg Limits :	
Liquid Limit	32
Plastic Index	15
Linear Shrinkage	7,0

MOD AASHTO ; C.B.R. :	
MOD AASHTO (Kg/m ³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	1
Sand : Percentage - 4.75mm and + 0.075mm	34
Silt : Percentage - 0.075mm and + 0.002mm	41
Clay : Percentage - 0.002mm	24

The above test results are pertinent to the samples received and tested only.
While the tests are carried out according to recognized standards Geoscience shall not be liable for erroneous testing or reporting thereof. This report may not be reproduced except in full without prior consent of Geoscience.

Remarks:

ConSR22

LABORATORY TEST RESULTS

CLIENT : Gondwana Geo Solutions
 PROJECT NAME : Louw's Bos Cemetry

admin only
 JOB NO : L180429
 SAMPLE NO : 30327

COMPACTION MOULD PERMEAMETER

POSITION : TP 02 @ 0,60-2,20m
 SOIL DESCRIPTION : yellow brown sandy clay
 PERMEANT USED : TAP WATER

SAMPLE DATA		
Standard Proctor	kg/m ³	1520
OMC	%	24,50
Percent of Proctor specified	%	95,00
Dry density of soil required	kg/m ³	1444,00
Moisture content of sample	%	24,50
Length of sample	mm	125,00
Diameter of sample	mm	150,00
Area of sample	mm ²	17671,46
Volume of sample	mm ³	2208932,33
Mass of dry soil required	g	3189,70
Mass of wet soil required	g	3971,17

ACTUAL DATA		
Mould Number		P4
Mass of Mould	g	4733
Mass of Mould and wet soil	g	8704,17
Mass of wet soil	g	3971,17
moisture content	%	24,50
Bulk Density	kg/m ³	1797,78
Dry Density	kg/m ³	1444,00
Percentage Proctor	%	95,00

Standpipe dia	mm	3,75
Standpipe area	mm ²	11,04

TEST READINGS								
	Start Test			End Test			Comments	
Test	Height	Time			Height	Time		
	mm	min	sec		mm	min	sec	
1	2200				2150	21	37	
2	2200				2150	24	23	
3	2200				2150	26	5	
4	2200				2150	25	9	

CALCULATIONS FOR FALLING HEAD		
Log H1/H2	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
0,0100	1297,00	1,38E-09
0,0100	1463,00	1,23E-09
0,0100	1565,00	1,15E-09
0,0100	1509,00	1,19E-09

Number of tests = 4

AVERAGE =	1,24E-09	m/s
AVERAGE =	1,24E-07	cm/s

Notes : PROCTOR VALUE SUPPLIED

CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550

PROJECT: Louw's Bos Cemetry

DATE: 20-04-2018

ATT: Colin Hatrley

REF: L180429

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : olive brown sandy clay

SAMPLE NO. : 30328

POSITION : TP 02 @ 2.20-3.00m

CLIENT SAMPLE NO. :

Sieve Analysis		Percent Passing
SIEVE SIZE (mm)	75,00	
	63,00	
	53,00	
	37,50	
	26,50	
	19,00	
	13,20	
	9,50	
	6,70	100
	4,75	99
	2,36	89
	2,00	88
	1,18	82
	0,600	74
	0,425	71
	0,300	68
	0,150	64
	0,0750	60

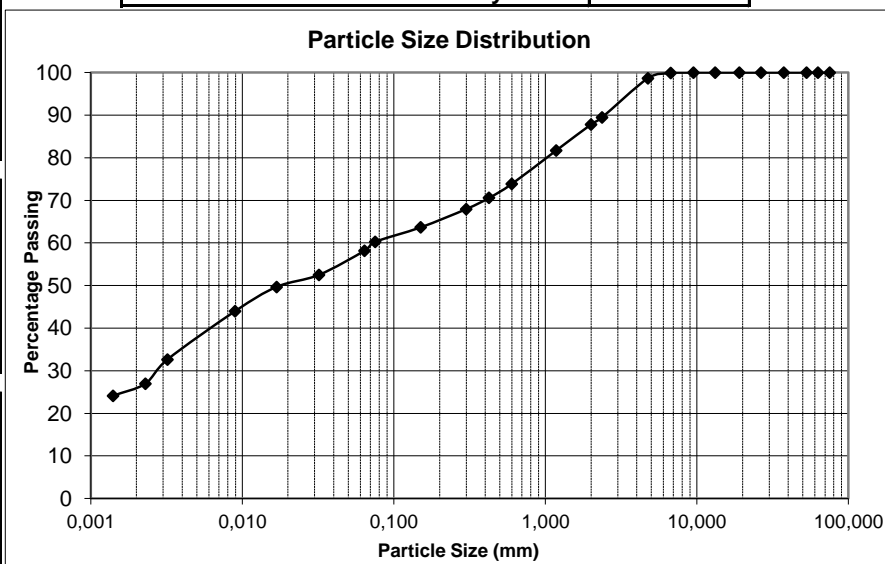
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0640	58
0,0327	53
0,0166	50
0,0087	44
0,0032	33
0,0023	27
0,0014	24

SCS Dispersion Test	
Diameter of particle (mm)	Percentage of soil suspension (%)

% SCS Dispersion:	
Initial Moisture Content (%) :	
pH:	
Conductivity mS/m:	

Atterberg Limits :	
Liquid Limit	25
Plastic Index	11
Linear Shrinkage	6,0

MOD AASHTO ; C.B.R. :	
MOD AASHTO (Kg/m ³)	
O.M.C. (%)	
C.B.R. @ 100% Comp.	
C.B.R. @ 98 % Comp.	
C.B.R. @ 95 % Comp.	
C.B.R. @ 93 % Comp.	
C.B.R. @ 90 % Comp.	
Swell (max) %	



Tabulated Summary	Percentage
Gravel : Percentage - 4.75 mm	1
Sand : Percentage - 4.75mm and + 0.075mm	38
Silt : Percentage - 0.075mm and + 0.002mm	29
Clay : Percentage - 0.002mm	31

The above test results are pertinent to the samples received and tested only.

For Geoscience:

While the tests are carried out according to recognized standards Geoscience shall not

be liable for erroneous testing or reporting thereof. This report may not be reproduced except in full without prior consent of Geoscience.

Remarks:

ConSR22

LABORATORY TEST RESULTS

CLIENT : Gondwana Geo Solutions
 PROJECT NAME : Louw's Bos Cemetery

admin only
 JOB NO : L180429
 SAMPLE NO : 30328

COMPACTION MOULD PERMEAMETER

POSITION : TP 02 @ 2,20-3,00m
 SOIL DESCRIPTION : olive brown sandy clay
 PERMEANT USED : TAP WATER

SAMPLE DATA		
Standard Proctor	kg/m ³	1490
OMC	%	25,70
Percent of Proctor specified	%	95,00
Dry density of soil required	kg/m ³	1415,50
Moisture content of sample	%	25,70
Length of sample	mm	125,00
Diameter of sample	mm	150,00
Area of sample	mm ²	17671,46
Volume of sample	mm ³	2208932,33
Mass of dry soil required	g	3126,74
Mass of wet soil required	g	3930,32

ACTUAL DATA		
Mould Number		P5
Mass of Mould	g	4598
Mass of Mould and wet soil	g	8528,32
Mass of wet soil	g	3930,32
moisture content	%	25,70
Bulk Density	kg/m ³	1779,28
Dry Density	kg/m ³	1415,50
Percentage Proctor	%	95,00

Standpipe dia	mm	3,75
Standpipe area	mm ²	11,04

TEST READINGS								
	Start Test			End Test			Comments	
Test	Height	Time			Height	Time		
	mm	min	sec		mm	min	sec	
1	2200				2150	3	28	
2	2200				2150	2	14	
3	2200				2150	2	2	
4	2200				2150	2	27	

CALCULATIONS FOR FALLING HEAD		
Log H1/H2	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
0,0100	208,00	8,63E-09
0,0100	134,00	1,34E-08
0,0100	122,00	1,47E-08
0,0100	147,00	1,22E-08

Number of tests = 4

AVERAGE =	1,22E-08	m/s
AVERAGE =	1,22E-06	cm/s

Notes :

LABORATORY TEST RESULTS

CLIENT : Gondwana Geo Solutions
 PROJECT NAME : Louw's Bos Cemetery

admin only
 JOB NO : L180429
 SAMPLE NO : 30329

COMPACTION MOULD PERMEAMETER

POSITION : TP 04 @ 1,10-3,10m
 SOIL DESCRIPTION : olive brown sandy clay
 PERMEANT USED : TAP WATER

SAMPLE DATA		
Standard Proctor	kg/m ³	1675
OMC	%	15,40
Percent of Proctor specified	%	95,00
Dry density of soil required	kg/m ³	1591,25
Moisture content of sample	%	15,40
Length of sample	mm	125,00
Diameter of sample	mm	150,00
Area of sample	mm ²	17671,46
Volume of sample	mm ³	2208932,33
Mass of dry soil required	g	3514,96
Mass of wet soil required	g	4056,27

ACTUAL DATA		
Mould Number		P6
Mass of Mould	g	4677
Mass of Mould and wet soil	g	8733,27
Mass of wet soil	g	4056,27
moisture content	%	15,40
Bulk Density	kg/m ³	1836,30
Dry Density	kg/m ³	1591,25
Percentage Proctor	%	95,00

Standpipe dia	mm	3,75
Standpipe area	mm ²	11,04

TEST READINGS								
	Start Test			End Test			Comments	
Test	Height	Time			Height	Time		
	mm	min	sec		mm	min	sec	
1	2200				2150	0	46	
2	2200				2150	0	43	
3	2200				2150	0	53	
4	2200				2150	1	21	

CALCULATIONS FOR FALLING HEAD		
Log H1/H2	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
0,0100	46,00	3,90E-08
0,0100	43,00	4,17E-08
0,0100	53,00	3,38E-08
0,0100	81,00	2,21E-08

Number of tests = 4

AVERAGE =	3,42E-08	m/s
AVERAGE =	3,42E-06	cm/s

Notes :

APPENDIX D

**TABLE 1
EXCAVATABILITY RATINGS**

DESCRIPTION	ASSESSMENT	RATING
Easy Spade	Pick point to 50mm	15
Pick and Spade	Slight indentation	10
Machine	Firm blows (1-3mm)	5
Blasting	Backactor refusal	0

**TABLE 2
STABILITY RATINGS**

DESCRIPTION	ASSESSMENT	RATING
Stable	Excavation can be profiled safely	20
Overbreak	Excavation stable: Overbreak 1.3 - 1.8 *	15
Slightly unstable	Minor falls of material	8
Unstable	Collapse of hole likely	F

Note: Overbreak = Ratio of widths top of trench to base
F = Fatal flaw

**TABLE 3
WORKABILITY RATINGS**

DESCRIPTION	UNIFIED CLASS	MDD (kg/m ³)	RATING
Excellent / Good	GW / SW / GP	+1800	10
Fair	SP / SM	<1800	5
Poor	OL / CL / ML	<1700	2
Very poor	OH / CH / MH	>1800	0

**TABLE 4
WATER TABLE RATINGS**

DESCRIPTION	WATER TABLE DEPTH (m) *	RATING
Deep water table	+8	25
Intermediate	4 - 8	15
Possible perched water	0 - 4	5
Water logged soil	0 - 4	F

**TABLE 5
SUBSOIL PERMEABILITY RATINGS**

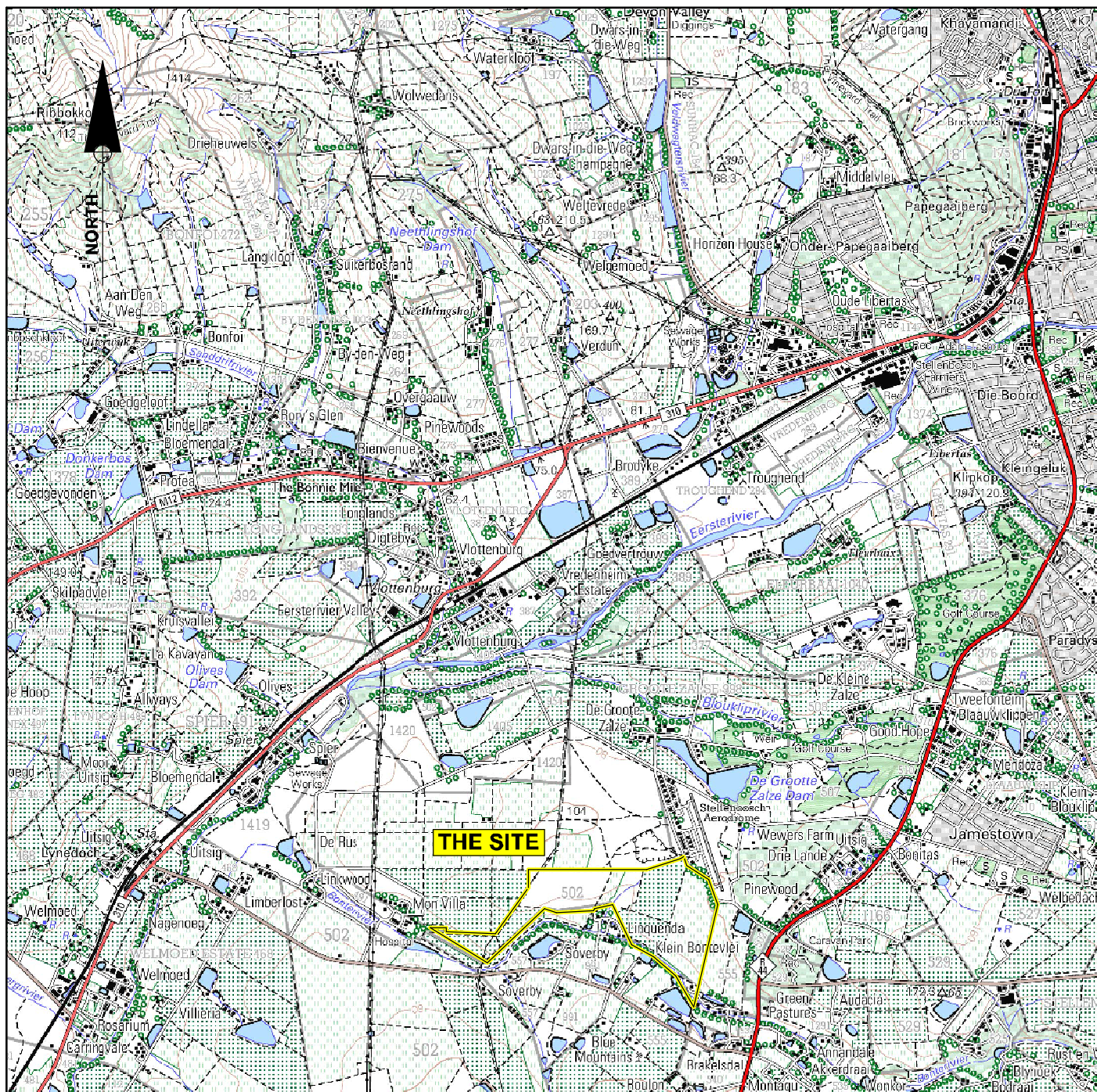
DESCRIPTION	PERCOLATION RATE (mm/hr)	APPROX. PERMEABILITY (cm/sec)	RATING
Impermeable	Not measurable	<10 ⁻⁵	15
Relatively impermeable	10 - 15	10 ⁻⁴ to 10 ⁻⁵	20
Relatively permeable	15 - 50	10 ⁻³ to 10 ⁻⁴	10
Permeable	50 - 1000	>10 ⁻³	0

**TABLE 6
BACKFILL PERMEABILITY RATINGS**

DESCRIPTION	ASSESSMENT	RATING
Impermeable	OH / CI / CH	5
Relatively impermeable	GC / SC / MH	10
Relatively permeable	GP / SP / GW	7
Very permeable	SW / SP	0

Note: * Measured from ground level


FIGURES



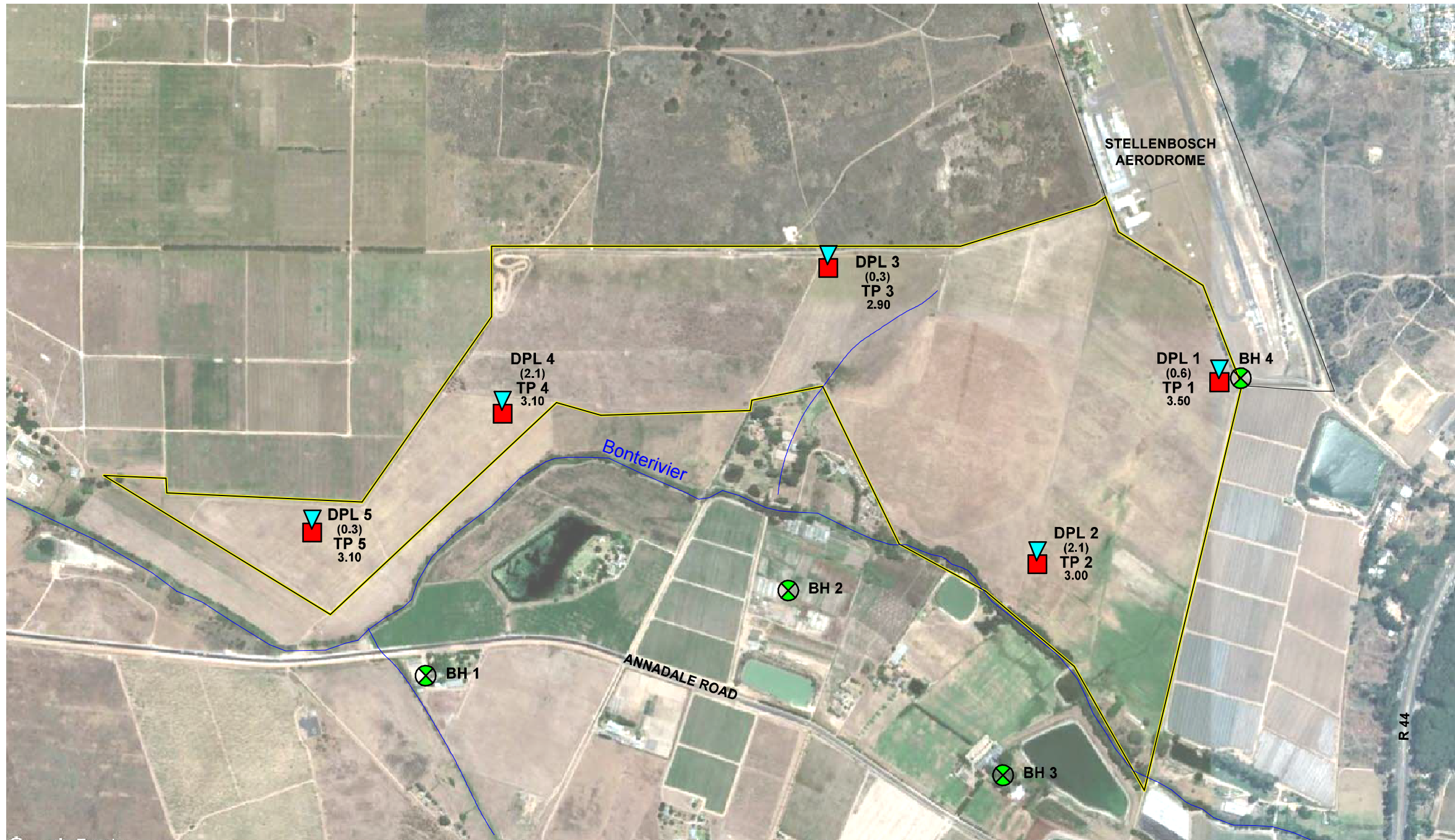
Graphic Scale
1 / 50 000

NB : Please note that the bar scale supersedes the verbal scale due to print sizes etc.

Drawing prepared from 1 / 50 000 TOPOGRAPHICAL SERIES : 3318 DD

DRAWING DESCRIPTION	CLIENT	DATE 02/05/2017	
	PROJECT	DRAWN A.S.	
		CHECK M.V.R.	
		REFERENCE No. 18 - 812	
		FIGURE No. 1	REV. 0
Locality Plan	<div><div></div><div>CK RUMBOLL & PARTNERS Geotechnical Investigation for Louw's Bos Cemetery</div></div>		
Scale 1 : 50 000 (On A4 Original)			



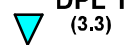


KEY :



TP 1
1.50

Approximate position of Test Pit showing final depth or depth to refusal () in metres below existing ground level.



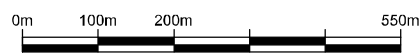
DPL 1
(3.3)

Approximate position of Dynamic Cone Penetrometer Test (Light) showing depth to refusal in metres below existing ground level.



BH 1

Approximate position of Borehole (Depth Unknown - Domestic)



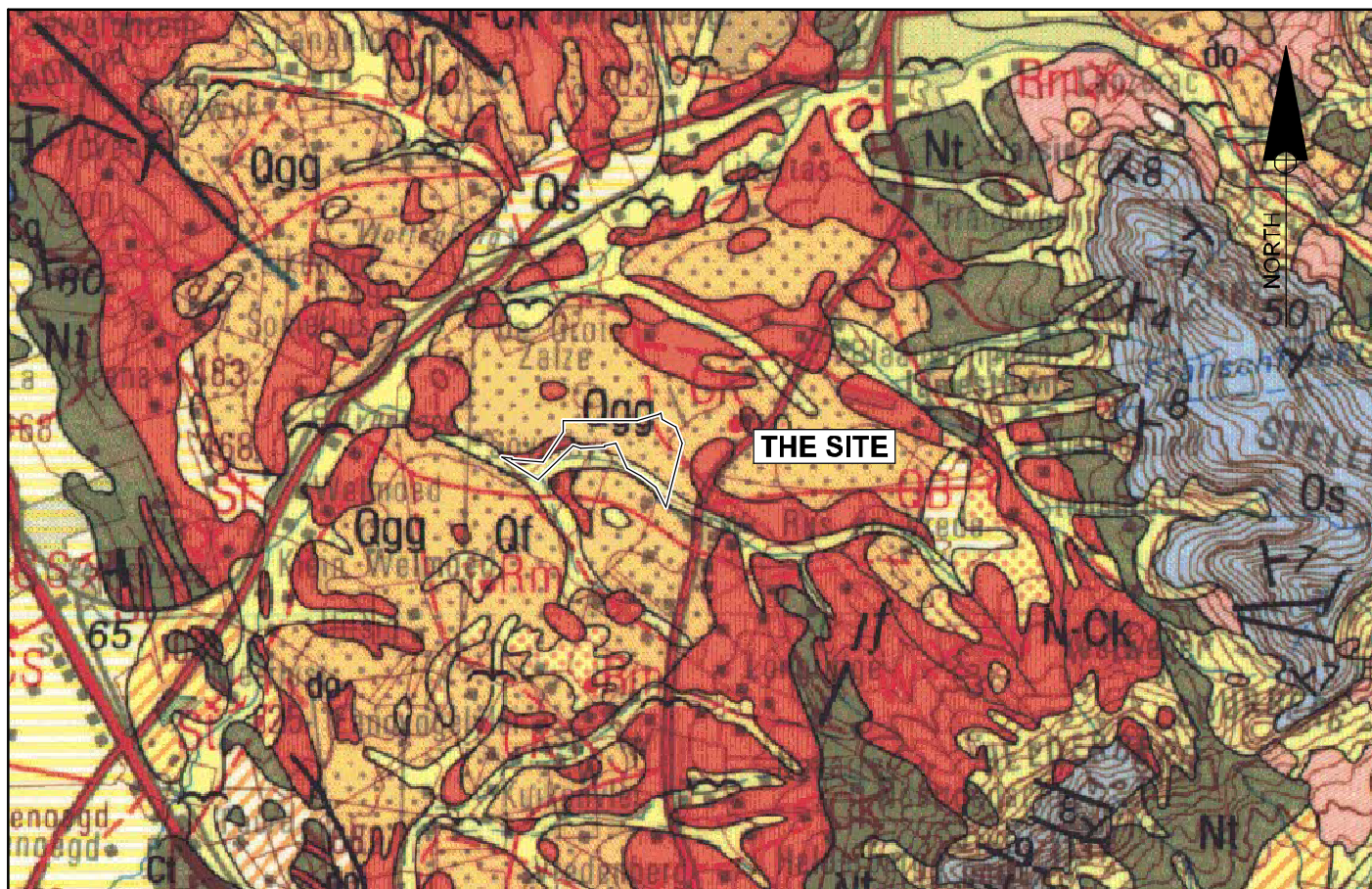
Graphic Scale
1 / 10 000

NB : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

DRAWING DESCRIPTION
Site Plan showing approximate positions of :
a.) Test Pits.
b.) Dynamic Cone Penetrometer Tests (Light)
c.) Boreholes
Scale 1 : 10 000 (On A3 Original)

CLIENT	CK RUMBOLL & PARTNERS	DATE	02/05/2018
PROJECT	Louws Bos Cemetery	DRAWN	A.S.
		CHECK	M.V.R.
		REFERENCE No.	18 - 812
		FIGURE No.	2
		REV.	0





Graphic Scale
1 / 100 000

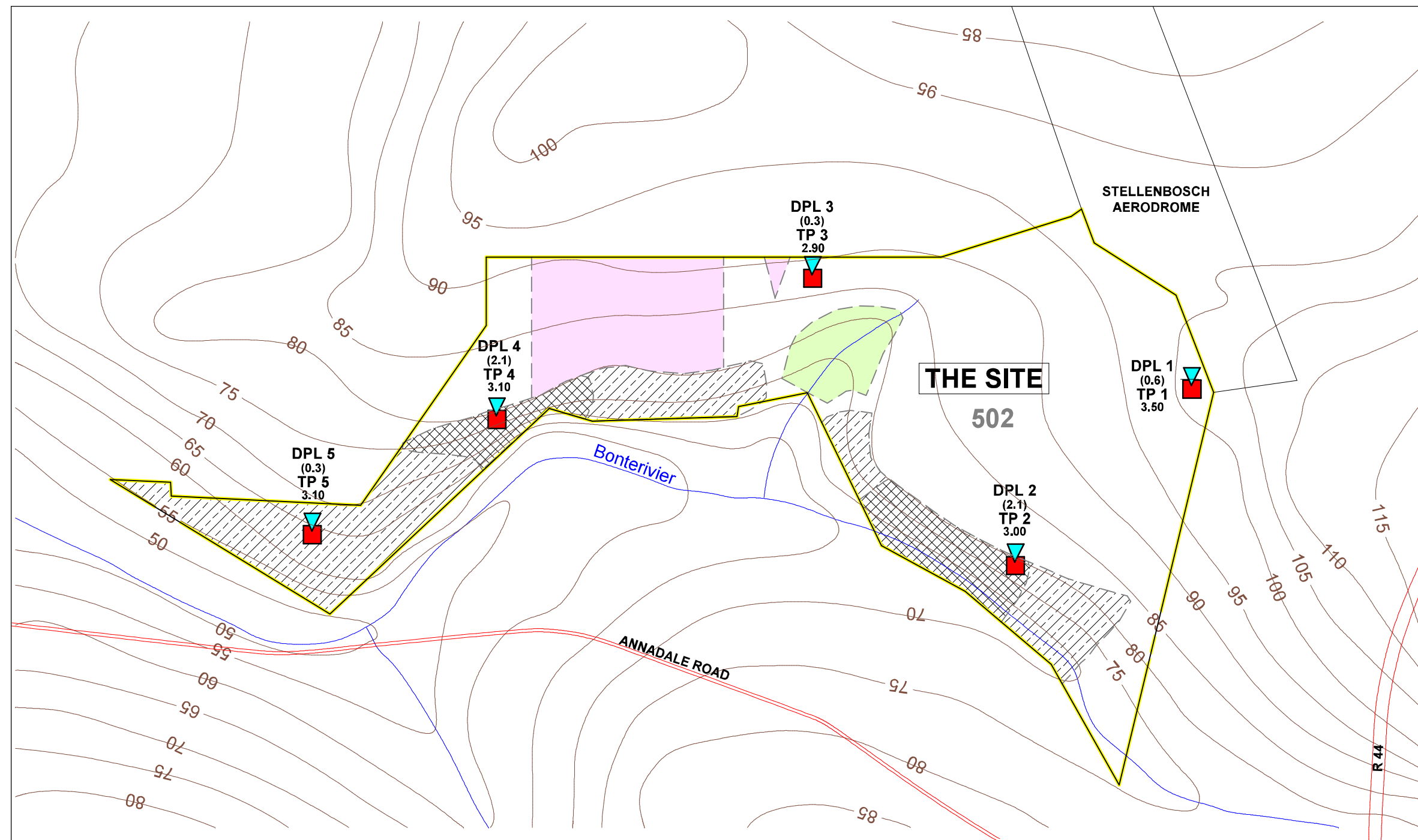
NU : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

LEGEND

	Alluvium
	Qgg Gravelly clay/loam soil
	Qg Loam and sandy loam
	Qs Sandy soil - Springfontyn Formation
	Qq/Qf Silcrete (Qq) and ferricrete (Qf)
	do Dolerite - Intrusive rock
	Os Quartzitic sandstone with thin siltstone/ shale - Peninsula Formation
	N-Ck Granite - porphyritic, biotitic, with tourmaline-bearing variants. CAPE GRANITE SUITE
	N-Cs Granite - porphyritic with leucocratic, hybridic, biotitic variants. CAPE GRANITE SUITE
	Nt Greywacke, phyllite and quartzitic sandstone - interbedded lava and tuff - Tygerberg Formation. MALMESBURY GROUP

Drawing prepared from 1 / 250 000 GEOLOGICAL SERIES : CAPE TOWN 3318

DRAWING DESCRIPTION <p style="text-align: center;">Locality Plan showing Regional Geology</p> <p>Scale 1 : 100 000 (On A4 Original)</p>	CLIENT <p style="text-align: center;">CK RUMBOLL & PARTNERS</p>	DATE <p style="text-align: center;">02/05/2018</p>
	PROJECT <p style="text-align: center;">Geotechnical Investigation for Louw's Bos Cemetery</p>	DRAWN <p style="text-align: center;">A.S.</p>
		CHECK <p style="text-align: center;">M.V.R.</p>
		REFERENCE No. <p style="text-align: center;">18 - 812</p>
		FIGURE No. <p style="text-align: center;">3</p>
		REV. <p style="text-align: center;">0</p>



KEY :

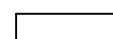


Approximate position of Test Pit showing final depth or depth to refusal () in metres below existing ground level.

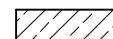


Approximate position of Dynamic Cone Penetrometer Test (Light) showing depth to refusal in metres below existing ground level.

Approximate Slope



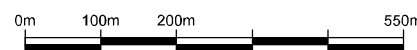
2% to 6%



6% to 9%



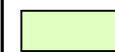
9% to 13.6%



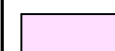
Graphic Scale
1 / 10 000

NB : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

DRAWING DESCRIPTION
Site Plan showing Topography of the Site



Vlei



Approximate area of Protected Vegetation

Scale 1 : 10 000 (On A3 Original)

CLIENT
CK RUMBOLL & PARTNERS
PROJECT
Louws Bos Cemetery



DATE
02/05/2018

DRAWN
A.S.

CHECK
M.V.R.

REFERENCE No.
18 - 812

FIGURE No.
4

REV.
0