

Appendix G-5 – Geotechnical

Appendix G-5a – Geotechnical Preferred Site



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

Project No.: 18-820R01



Date Issued: August 2018

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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 South RE/502, Cemetery Site on the 1st June 2018. The appointment of GGS to proceed as proposed was confirmed in a signed contract with CK Rumboll and Partners on the 16th July 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 eight 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. Eight 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.
- Western Cape Government Dept Agriculture Contour Plan
- Site Development Plan Louws Bos RE/502 Reference STELL/9494AC/RB
- Site Development Plan Louws Bos RE/502 Reference STELL/9494AC/RB (2)

3. SITE DESCRIPTION

The area on which the geotechnical investigations were carried out consist of a site with an area of approximately 37Ha.

The site is bounded on the northern side by Annandale Road and cultivated farm land and on the south, east and west sides side by municipal land, some of which is cultivated (Figure 2).

The site slopes down towards the Bonterivier in the north. The slope is gentle in the south steepening up closer to the river. The slope on the east side of the site slopes towards the east and includes an area which slopes at $>6^\circ$. The remainder of the site slopes at between 4.7% and 6%. (Figure 2). Vegetation on the site consists of a vineyard, planted pastures or fallow agricultural land. The fallow agricultural land is covered in weeds and small bushes.

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



Plate 1: Site viewed towards the east at TP6



Plate 2: Site viewed towards the north at TP7

4. FIELDWORK

The fieldwork for the investigation was conducted during July 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.

Eight trial pits, designated TP1 through TP8 were put down at the location as shown in Figure 2 at the site. TP1 to TP7 were terminated in clay at a depth of between 3.1m and 3.4m below existing ground level. TP8 refused on granite at a depth of 2.00m.

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	18843	3762793	3.40	TLB Limit: No water
TP2	18817	3762970	3.00	TLB Limit: No water
TP3	18852	3763126	3.20	TLB Limit: No water
TP4	18852	3763302	3.40	TLB Limit: No water
TP5	18596	3763035	3.10	TLB Limit: No water
TP6	18636	3763035	3.10	TLB Limit: No water
TP7	18312	3763213	3.10	TLB Limit: No water
TP8	18324	3762910	2.00	Refusal: Seeping water at 1.50m

Note: begl = depth below existing ground level

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

4.2 Dynamic Cone Penetrometer Light (DPL) Tests

Eight Dynamic Cone Penetrometer Light, or DPL tests, designated DPL1 to DPL8 were undertaken. All tests were undertaken from surface adjacent to the corresponding trial holes. A maximum depth of 2.7mbegl was achieved, in order to assess the consistency of the insitu soils, as well as to provide an indication of the depth to bedrock where possible. DPL8 was advanced to refusal depth of 2.0m. DPL1 to DPL7 were advanced to between 3.10m and 3.40m 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 Y00	X		
DPL1	18843	3762793	2.70	Medium dense to 0.3m, stiff to 0.6m, soft to 1.2m, firm to 2.1m and stiff to 2.47m. Terminated.
DPL2	18817	3762970	2.70	Medium dense to 0.3m, dense to 0.6m, firm to 1.2m, stiff to 1.5m, firm to 1.8m, stiff to 2.4m and very stiff to 2.7m. Terminated.
DPL3	18852	3763126	2.70	Loose to 0.3m, firm to 1.5m and stiff to 2.7m. Terminated.
DPL4	18852	3763302	2.70	Loose to 0.3m, dense to 0.6m, stiff to 0.9m, firm to 1.8m and stiff to 2.7m. Terminated.
DPL5	18596	3763035	2.70	Loose to 0.3m, medium dense to 0.9m, soft to 1.2m, firm to 2.4m and stiff to 2.7m. Terminated.
DPL6	18636	3763035	2.70	Very loose to 0.3m, medium dense to 0.6m, stiff to 0.9m, firm to 1.2m, stiff to 1.8m and very stiff to 2.7m. Terminated
DPL7	18312	3763213	2.70	Loose to 0.3m, medium dense to 0.9m, firm to 1.2m, stiff to 2.4m and very stiff to 2.7m. Terminated.
DPL8	18324	3762910	2.10	Loose to 1.2m, medium dense to 1.5m, firm to 1.8m and stiff to 2.1m. 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, grey brown medium dense, medium to coarse grained sand with small ferricrete pebbles and cobbles. Colluvium overlying

- Cream brown dense intact silty medium grained SAND with ferricrete pebbles and cobbles: Colluvium overlying
- Olive brown medium dense intact silty GRAVEL: Colluvium or
- Cream to cream brown to red brown firm to stiff to soft intact silty CLAY Residual Granite overlying
- Light cream grey completely to highly weathered widely jointed medium hard rock GRANITE.

6. GROUNDWATER

Seeping groundwater was only encountered in TP8 at a depth of 1.50m. This is consistent with the shallow bedrock in this area which was encountered at 2m and resulted in refusal of the TLB excavator. Similarly, groundwater can be expected to occur above the bedrock, however, this depth is largely well below the depth to which grave excavations will be dug.

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 %		
TP2	0.60-3.00	Slightly moist cream brown to red brown firm to very stiff intact silty CLAY. Residual Granite.	27	24	47	2	31	14	7.0	0.81	A-6(4); ML; Medium heave; Type D Gravel Wearing Course
TP3	0.30-3.20	Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.	34	30	36	0	32	14	7.0	0.56	A-6(7); ML; Medium heave; Type D Gravel Wearing Course
TP5	0.00-0.60	Slightly moist grey brown loose intact silty SAND. Colluvium.	7	3	86	4	-	NP	-	1.50	A-3(1); SW; Low heave; Type B Gravel Wearing Course
TP7	1.00-3.10	Slightly moist olive brown to red brown stiff to very stiff intact silty CLAY. Residual Granite.	26	23	50	1	32	15	7.0	0.89	A-4 (4); ML; 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
TRH20 (1990), Suitability for gravel wearing course⁵
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 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 (m/s)	Result ^{6 7}
TP3	0.30-3.20	Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.	Falling Head. Permeability*	1.71E-08	Semi-pervious to impervious
TP5	0.00-0.60	Slightly moist grey brown loose intact silty SAND. Colluvium.	Falling Head. Permeability*	1.31E-06	Semi-pervious to pervious
	1.10-3.10	Slightly moist grey brown medium dense intact silty SAND with abundant ferricrete nodules. Colluvium.	Falling Head. Permeability*	2.36E-05	Semi-pervious
TP6	0.00-0.20	Slightly moist light grey brown very loose intact silty SAND. Colluvium.	In situ Permeability	2.46E-03	Pervious
TP7	0.00-0.20	Slightly moist grey brown loose intact silty SAND. Colluvium.	In situ Permeability	3.22E-03	Pervious
	0.60-1.00	Slightly moist olive brown medium dense intact silty GRAVEL. Colluvium.	Falling Head. Permeability*	1.37E-05	Semi-pervious

*Note: Test carried out on material compacted to 92% MDD

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 gravel and silty sand in TP5 and TP7 are generally pervious to semi-pervious. The silty clay derived from residual granite in TP3 is semi-pervious to impervious. The silty sand at surface in TP6 and TP7 is found to be pervious as expected.

8. DEPARTMENT OF WATER AFFAIRS AND FORESTRY (DWAF) REQUIREMENTS

DWAF requirements with regards to the siting of cemeteries are that the following areas⁸ should be avoided. The area recommended for the siting of a cemetery is shown in Figure 2.

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

The site is above the 1:50 year flood line of the river and this requirement will be met.

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

There are seven dams around the site and the Bonterevier in the north. The proposed site boundaries as shown in Figure 2 are drawn in to exclude all the area closer than 300m from these water bodies. There are no vleis or wetlands in the area. If the above areas are avoided the proposed site will comply (Figure 2).

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

There are no areas of protected vegetation on the site.

⁶ Williams 1993 in Stapelberg FDJ 2005, The Engineering Geology of Cape Town and Environs, Western Cape South Africa.

⁷ SA National Convention on Large Dams – classification of permeability of materials

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

There are no areas of flat gradients. Most of the site slopes to the north down to Annandale Road and the Bonterivier. The average slope over most of the site is between 4.7% and 6.0%. There is an area on the east side that slopes at >6%. This has been excluded in the proposed site boundary (Figure 2). These steeper slopes are unsuitable for use as a cemetery site.

Groundwater was intersected in TP8 which falls outside the proposed site boundary (Figure 2).

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

As mentioned, the site slopes towards the north and east where the gradient is >6%. This area is unsuitable for use as a cemetery and is excluded in the proposed cemetery site boundary (Figure 2). Bedrock was intersected in TP8 at 2.0m. As mentioned this area has in any case been excluded from the proposed site.

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 depth criterion is met over the area proposed for the cemetery (Figure 2).

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

Impervious clay layers in the lower 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 2. 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	0018121	3762674	120	80 000	600	Water quality good. Bulk sales to the public
BH2	0018061	3762724	120	Domestic use	600	Water quality good
BH3	0018086	3762741	120	Domestic use	600	Water quality good

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 over the proposed site to a maximum depth of between 3.10m and 3.40m below existing ground level, as determined by trial pit excavations and DPL tests, will classify as Soft Excavation (SABS1200 DM). This of course excludes the area shown in Figure 2 in which TP8 was dug.

Furthermore, sidewall collapse was only observed in TP8 which is outside the proposed cemetery site boundary. No sidewall collapse was observed in any of the other 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 eight trial pits put down on the proposed site indicated pervious to semi pervious silty sand down to a maximum depth of 0.70mbgl overlying, in some cases, semi pervious gravel down to between 0.70mbgl and 1.0mbgl and impervious clay down to between 3.00m and 3.40mbgl.

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 on the proposed cemetery site (TP8 excluded from the proposed site). The depth to the water table on the site proposed, 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 consultants^{11,12} 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 Louws Bos South 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 proposed 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 South site.

The proposed site is underlain by a soil mantle comprising, from ground surface, loose to very loose to medium dense sands and gravel of colluvial origin overlying clays of 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 2, the DWAF requirements for the siting of cemeteries are met.

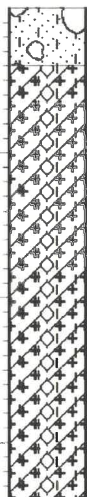
Leachate migration is unlikely as the clays in the profile are impervious.

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

Scale
1:50



0.00

Moist grey brown medium dense intact silty medium grained SAND with occasional small pebbles and cobbles over bottom 0.10m. Colluvium.

0.40

Moist cream to cream brown to red brown stiff to soft intact silty CLAY. Residual Granite.

3.40

NOTES

- 1) Final depth at 3.40m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.

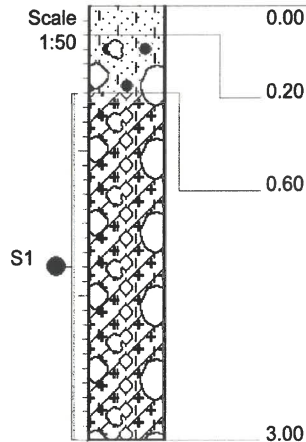


CONTRACTOR :
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DRILLED BY :
PROFILED BY : CLH
TYPE SET BY : MC
SETUP FILE : STANDARD.SET

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DIAM :
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DATE : 20/07/2018
DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3762793
Y-COORD : 19Y 0018843

HOLE No: **TP1**



Slightly moist cream brown medium dense intact silty medium grained SAND. Colluvium.

Slightly moist cream brown dense intact silty medium grained SAND with abundant ferricrete pebbles and cobbles. Colluvium.

Slightly moist cream brown to red brown firm to very stiff intact silty CLAY with occasional cobbles of completely weathered granite. 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--3.00m



CONTRACTOR :
 MACHINE : JCB 3CX
 DRILLED BY :
 PROFILED BY : CLH

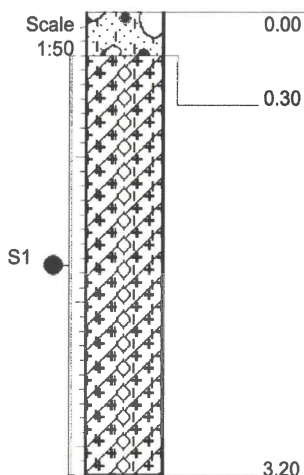
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 DIAM :
 DATE : 20/07/2018
 DATE : 20/07/2018

DATE : 25/07/2018 11:42
 TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
 X-COORD : 3762970
 Y-COORD : 19Y 0018817

HOLE No: TP2



Slightly moist grey brown loose intact silty SAND with ferricrete pebbles and cobbles. Colluvium.

Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.

NOTES

- 1) Final depth at 3.20m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
S1 0.30--3.20m



CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763126
Y-COORD : 19Y 0018852

HOLE No: **TP3**

Scale
 1:50


0.00

Moist dark grey loose intact silty SAND with ferricrete pebbles and cobbles. Colluvium.

0.70

Slightly moist cream brown to red brown firm to stiff intact silty CLAY. Residual Granite.

3.40

NOTES

- 1) Final depth at 3.40m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) No samples taken.


 CONTRACTOR :
 MACHINE : JCB 3CX
 DRILLED BY :
 PROFILED BY : CLH

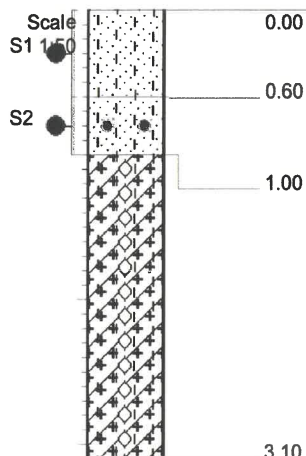
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 INCLINATION :
 DIAM :
 DATE : 20/07/2018
 DATE : 20/07/2018

 DATE : 25/07/2018 11:42
 TEXT : ..Cemetery\Logs\TP1TP8.doc

 ELEVATION :
 X-COORD : 3763302
 Y-COORD : 19Y 0018852

HOLE No: TP4



Slightly moist grey brown loose intact silty SAND. Colluvium.

Slightly moist grey brown medium dense intact silty SAND with abundant ferricrete nodules up to 30mm. Colluvium.

Slightly moist cream brown to pink brown soft to stiff intact silty CLAY. Residual Granite.

NOTES

- 1) Final depth at 3.10m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
S1 0.00--0.60m
S2 0.60--1.00m



CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

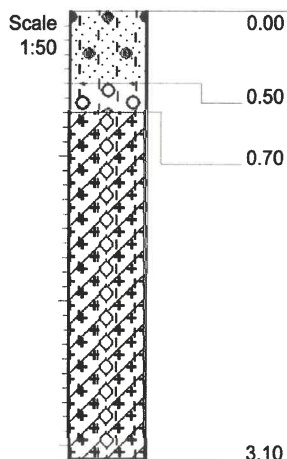
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DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763035
Y-COORD : 19Y 0018596

HOLE No: **TP5**



Slightly moist light grey brown very loose intact silty SAND with rare small ferricrete pebbles. Colluvium.

Slightly moist olive brown medium dense intact silty GRAVEL. Colluvium.

Slightly moist yellow brown to red brown to cream stiff to very stiff intact silty CLAY. Residual Granite.

NOTES

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



CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

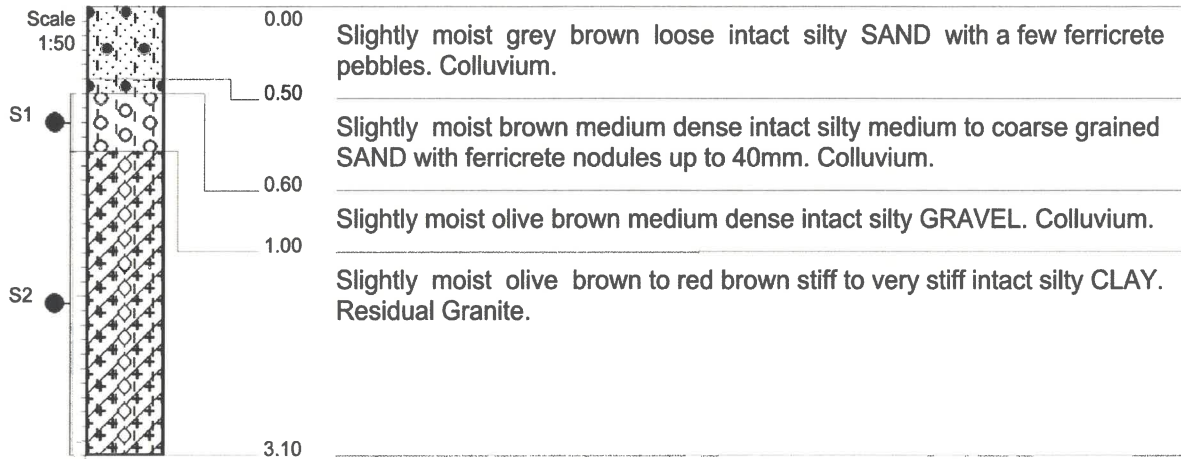
TYPE SET BY : MC
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763035
Y-COORD : 19Y 0018636

HOLE No: **TP6**



NOTES

- 1) Final depth at 3.10m. TLB limit.
- 2) No groundwater seepage.
- 3) No sidewall collapse.
- 4) Samples taken :
S1 0.60--1.00m
S2 1.00--3.10m



CONTRACTOR :
MACHINE : JCB 3CX
DRILLED BY :
PROFILED BY : CLH

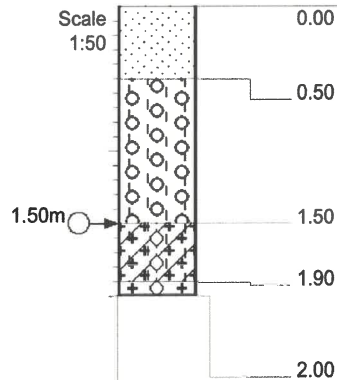
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SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE : 20/07/2018
DATE : 20/07/2018

DATE : 25/07/2018 11:42
TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
X-COORD : 3763213
Y-COORD : 19Y 0018312

HOLE No: **TP7**



Slightly moist brown loose intact medium to coarse grained SAND. Colluvium.

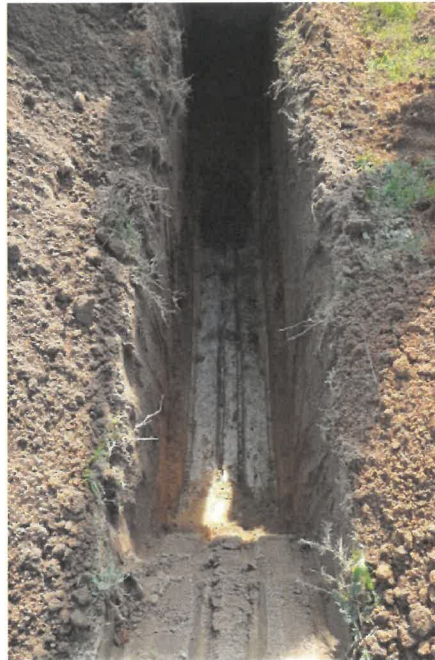
Moist olive brown loose to medium dense intact silty GRAVEL. Colluvium.

Moist cream brown stiff to firm intact silty CLAY. Residual Granite.

Light cream grey completely to highly weathered widely jointed medium hard rock GRANITE. Cape Granite Suite.

NOTES

- 1) Final depth at 2.00m. Refusal.
- 2) Groundwater seepage at 1.50m.
- 3) Sidewall collapse in gravel.
- 4) No samples taken.



CONTRACTOR :
 MACHINE : JCB 3CX
 DRILLED BY :
 PROFILED BY : CLH

TYPE SET BY : MC
 SETUP FILE : STANDARD.SET

INCLINATION :
 DIAM :
 DATE : 20/07/2018
 DATE : 20/07/2018

DATE : 25/07/2018 11:42
 TEXT : ..Cemetery\Logs\TP1TP8.doc

ELEVATION :
 X-COORD : 3762910
 Y-COORD : 19Y 0018324

HOLE No: TP8

APPENDIX B

Geotechnical Investigation carried out for the Louw's Bos South RE/502,
Cemetery Site, Stellenbosch, Western Cape

Path : C:\Users\Merrill\Desktop\Job Folders\1. Cape Town jobs\18-820 Louws Bos South Cemetery\Report\Appendix B cover page.docx





Consulting Geotechnical Engineers & Engineering Geologists

Unit 101, 1st Floor, 17 Westmead Drive, Westmead, NSW 2115, Australia
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Fax: +61 (0) 2 961 1112
Email: info@gondwana.com.au

Client: CK RUMBOLL AND PARTNERS
Project: Louw's Bos South Cemetery
Section:

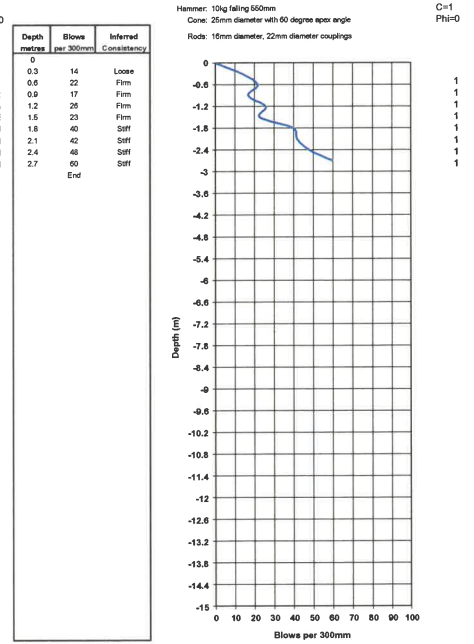
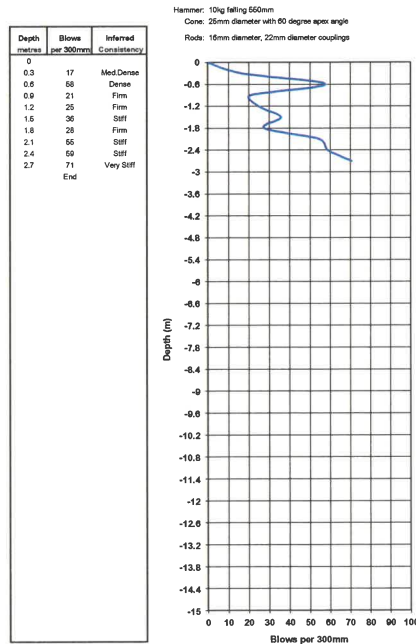
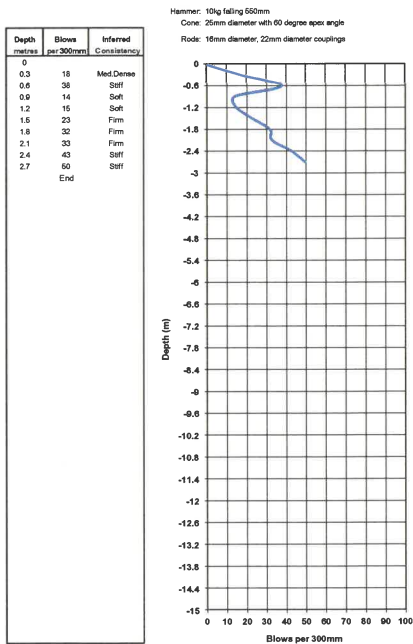
Ref.No. 18-820
Date: 20/07/2018
Operator: CLH

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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Email: info@gondwana.co.ug

Client: CK RUMBOLL AND PARTNERS
Project: Louw's Bos South Cemetery
Section:

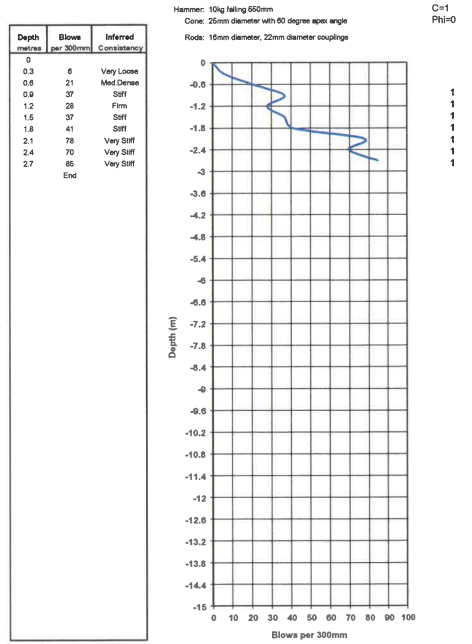
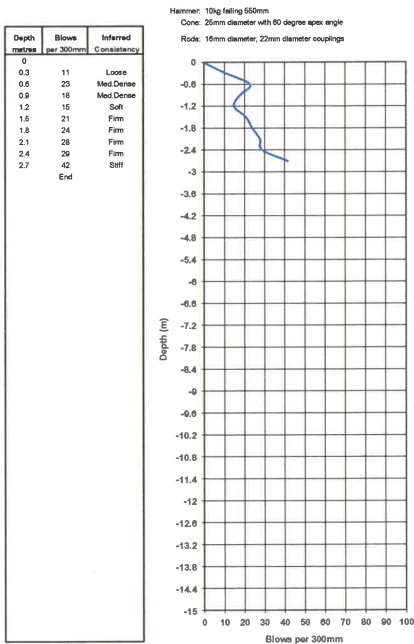
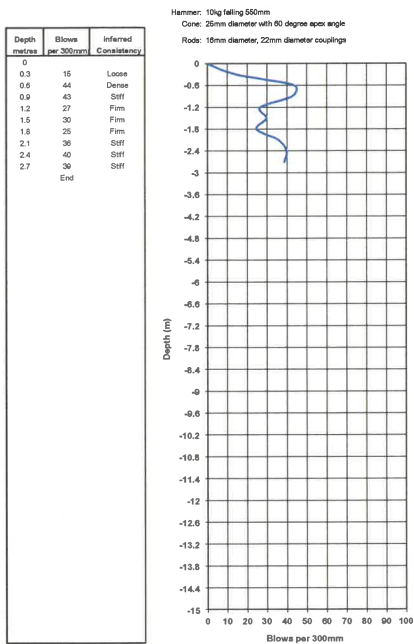
Ref.No. 18-820
Date: 20/07/2018
Operator: CLH

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

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

Light Dynamic Penetrometer Probe ——— Test No. DPL 6

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

QUALITY
MANAGEMENT
SYSTEM
REGISTERED
TO ISO 9001:2015
REGISTERED
TO ISO 45001:2018
REGISTERED
TO ISO 14001:2015

Client: CK RUMBOLL AND PARTNERS
Project: Louw's Bos South Cemetery
Section:

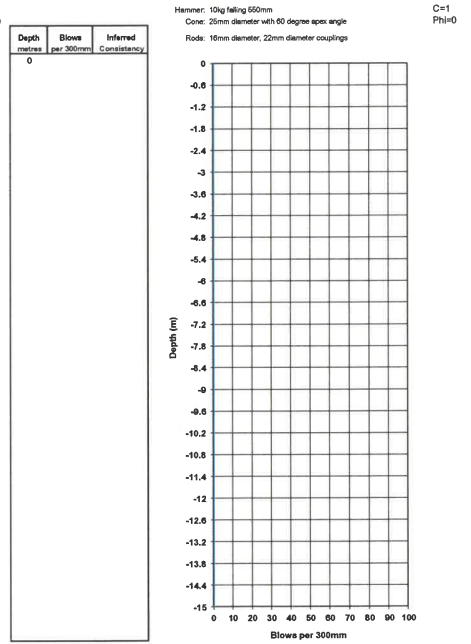
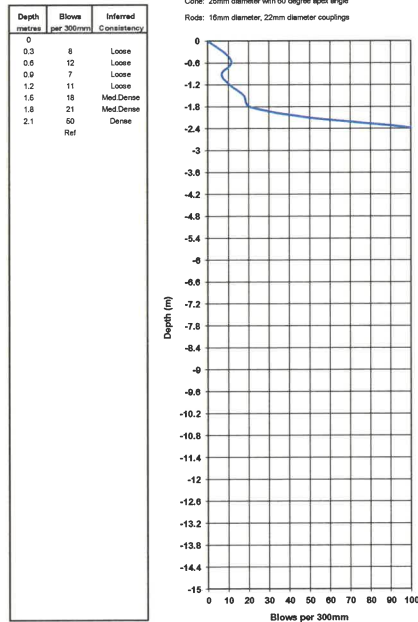
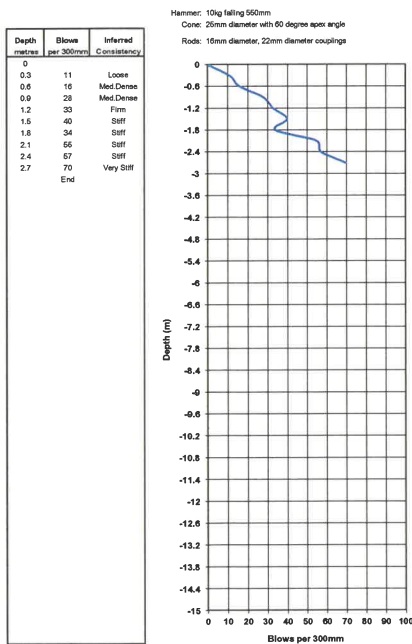
Ref.No. 18-820
Date: 20/07/2018
Operator: CLH

Light Dynamic Penetrometer Probe ——— Test No. DPL 7

Light Dynamic Penetrometer Probe ——— Test No. DPL 8

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



APPENDIX C

Geotechnical Investigation carried out for the Louw's Bos South RE/502,
Cemetery Site, Stellenbosch, Western Cape

Path : C:\Users\Merrill\Desktop\Job Folders\1. Cape Town jobs\18-820 Louws Bos South Cemetery\Report\Appendix C cover page.docx



CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550

PROJECT: Louw's Bos South Cemetry

ATT: Colin Hartley

DATE: 31-07-2018

REF: L180749

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : brown to red silty clay

SAMPLE NO. : 30710

POSITION : TP 02 @ 0.60-3.00m

CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75,00	
63,00	
53,00	
37,50	
26,50	
19,00	
13,20	
9,50	100
6,70	99
4,75	98
2,36	97
2,00	97
1,18	93
0,600	79
0,425	71
0,300	64
0,150	56
0,0750	51

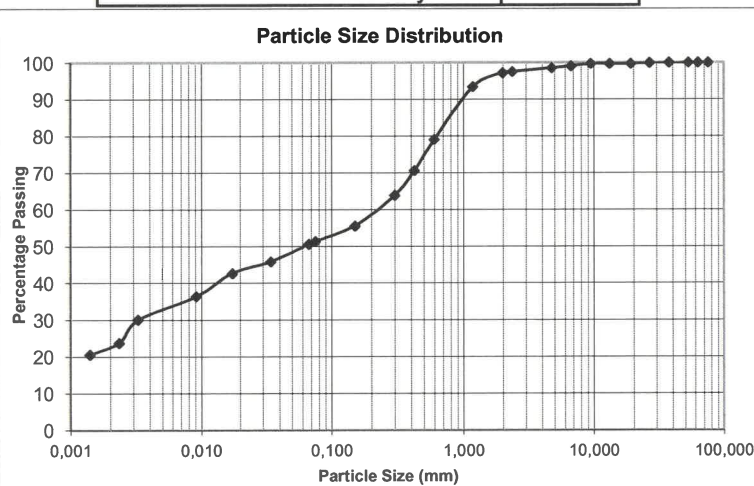
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0671	51
0,0343	46
0,0173	43
0,0091	36
0,0033	30
0,0023	24
0,0014	21

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

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

Atterberg Limits :	
Liquid Limit	31
Plastic Index	14
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	2
Sand : Percentage - 4.75mm and + 0.075mm	47
Silt : Percentage - 0.075mm and + 0.002mm	24
Clay : Percentage - 0.002mm	27

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

CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550

PROJECT: Louw's Bos South Cemetry

ATT: Colin Hartley

DATE: 31-07-2018

REF: L180749

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : brown to red silty clay

SAMPLE NO. : 30711

POSITION : TP 03 @ 0.30-3.20m

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	100
	2,36	99
	2,00	99
	1,18	95
	0,600	86
	0,425	81
	0,300	76
0,150	69	
0.0750	64	

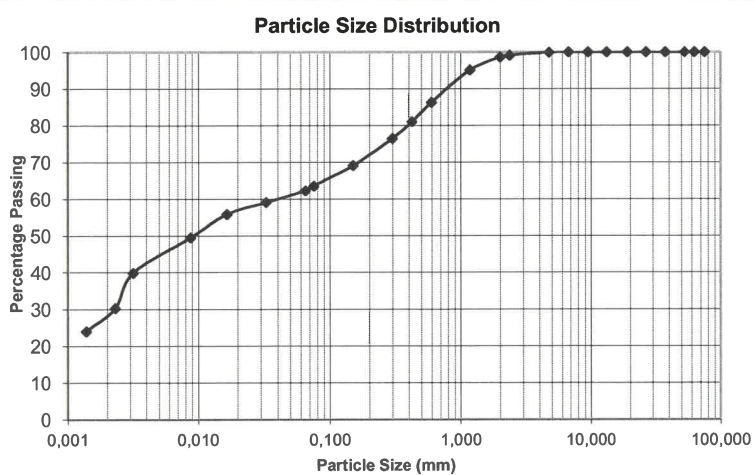
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0649	62
0,0327	59
0,0166	56
0,0087	49
0,0032	40
0,0023	30
0,0014	24

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

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

Atterberg Limits :	
Liquid Limit	32
Plastic Index	14
Linear Shrinkage	7,0

MOD AASHTO ; C.B.R. :	
MOD AASHTO (Kg/m³)	1756
O.M.C. (%)	16,2
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	0
Sand : Percentage - 4.75mm and + 0.075mm	36
Silt : Percentage - 0.075mm and + 0.002mm	30
Clay : Percentage - 0.002mm	34

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
 PROJECT NAME : Louw's Bos South Cemetry

admin only
 JOB NO: L180749
 SAMPLE NO: 30711

COMPACTION MOULD PERMEAMETER

POSITION : TP 03 @ 0,30-3,20m
 SOIL DESCRIPTION : brown to red silty clay
 PERMEANT USED : TAP WATER

SAMPLE DATA		
Standard Proctor	kg/m ³	1756
OMC	%	16,20
Percent of Proctor specified	%	92,00
Dry density of soil required	kg/m ³	1615,52
Moisture content of sample	%	16,20
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	3568,57
Mass of wet soil required	g	4146,68

ACTUAL DATA		
Mould Number		P1
Mass of Mould	g	4386
Mass of Mould and wet soil	g	8532,68
Mass of wet soil	g	4146,68
moisture content	%	16,20
Bulk Density	kg/m ³	1877,23
Dry Density	kg/m ³	1615,52
Percentage Proctor	%	92,00

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	2	46	
2	2200				2150	3	35	
3	2200				2150	1	4	
4	2200				2150	1	24	

CALCULATIONS FOR FALLING HEAD		
Log H1/H2	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
0,0100	166,00	1,08E-08
0,0100	215,00	8,34E-09
0,0100	64,00	2,80E-08
0,0100	84,00	2,14E-08

Number of tests = 4

AVERAGE =	1,71E-08	m/s
AVERAGE =	1,71E-06	cm/s

Notes :

CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550

PROJECT: Louw's Bos South Cemetry

ATT: Colin Hartley

DATE: 31-07-2018

REF: L180749

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : grey brown silty sand

SAMPLE NO. : 30712

POSITION : TP 05 @ 0.0-0.60m

CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75,00	
63,00	
53,00	
37,50	
26,50	100
19,00	99
13,20	98
9,50	97
6,70	96
4,75	96
2,36	93
2,00	92
1,18	81
0,600	60
0,425	48
0,300	37
0,150	19
0,0750	10

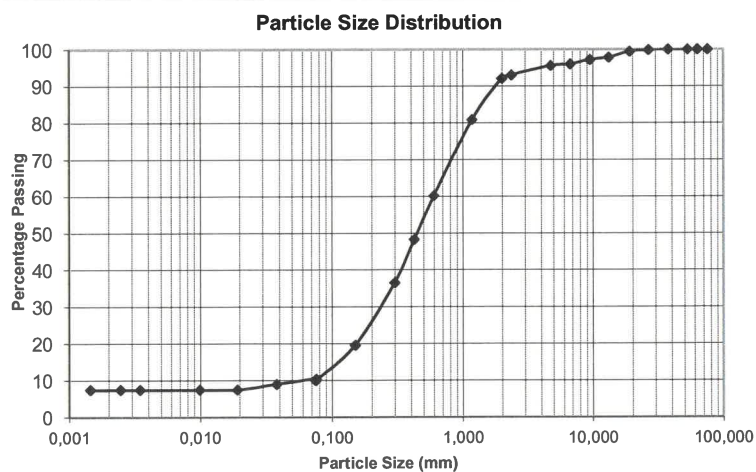
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0760	10
0,0380	9
0,0192	7
0,0099	7
0,0035	7
0,0025	7
0,0014	7

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

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

Atterberg Limits :	
Liquid Limit	
Plastic Index	N-P
Linear Shrinkage	

MOD AASHTO ; C.B.R. :	
MOD AASHTO (Kg/m ³)	1960
O.M.C. (%)	8,1
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	4
Sand : Percentage - 4.75mm and + 0.075mm	86
Silt : Percentage - 0.075mm and + 0.002mm	3
Clay : Percentage - 0.002mm	7

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
 PROJECT NAME : Louw's Bos South Cemetry

admin only
 JOB NO : L180749
 SAMPLE NO : 30712

COMPACTION MOULD PERMEAMETER

POSITION : TP 05 @ 0,0-0,60m
 SOIL DESCRIPTION : grey brown silty sand
 PERMEANT USED : TAP WATER

SAMPLE DATA		
MDD (100%)	kg/m ³	1960
MDD (100%) moisture content	%	8,1
Percent of MDD specified	%	92
Dry density of soil required	kg/m ³	1803,20
Moisture content of sample	%	8,1
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	3983,15
Mass of wet soil required	g	4305,78

ACTUAL DATA		
Mould Number		P3
Mass of Mould	g	4371
Mass of Mould and wet soil	g	8676,78
Mass of wet soil	g	4305,78
moisture content	%	8,10
Bulk Density	kg/m ³	1949,26
Dry Density	kg/m ³	1803,20
Percentage MDD	%	92,00

TEST READINGS							
		Start Test		End Test		Volume outflow	Comments
Test	Height	Time		Time			
	mm	min	sec	min	sec	ml	
1	2200			16	37	500	
2	2200			19	46	500	
3	2200			25	16	500	
4	2200			22	1	500	

CALCULATIONS FOR CONSTANT HEAD		
Hydraulic gradient	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
17,60	997,00	1,61E-06
17,60	1186,00	1,36E-06
17,60	1516,00	1,06E-06
17,60	1321,00	1,22E-06

Number of tests = 4

AVERAGE =	1,31E-06	m/s
AVERAGE =	1,31E-04	cm/s

Notes :

LABORATORY TEST RESULTS

CLIENT : Gondwana
 PROJECT NAME : Louw's Bos South Cemetry

admin only
 JOB NO : L180749
 SAMPLE NO : 30713

COMPACTION MOULD PERMEAMETER

POSITION : TP 05 @ 0,60-1,00m
 SOIL DESCRIPTION : grey brown silty sand
 PERMEANT USED : TAP WATER

SAMPLE DATA		
MDD (100%)	kg/m ³	2160
MDD (100%) moisture content	%	9,7
Percent of MDD specified	%	92
Dry density of soil required	kg/m ³	1987,20
Moisture content of sample	%	9,7
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	4389,59
Mass of wet soil required	g	4815,38

ACTUAL DATA		
Mould Number		P4
Mass of Mould	g	4724
Mass of Mould and wet soil	g	9539,38
Mass of wet soil	g	4815,38
moisture content	%	9,70
Bulk Density	kg/m ³	2179,96
Dry Density	kg/m ³	1987,20
Percentage MDD	%	92,00

TEST READINGS							
		Start Test		End Test		Volume outflow	Comments
Test	Height	Time		Time			
	mm	min	sec	min	sec	ml	
1	2200			1	1	500	
2	2200			1	7	500	
3	2200			1	10	500	
4	2200			1	16	500	

CALCULATIONS FOR CONSTANT HEAD		
Hydraulic gradient	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
17,60	61,00	2,64E-05
17,60	67,00	2,40E-05
17,60	70,00	2,30E-05
17,60	76,00	2,12E-05

Number of tests = 4

AVERAGE =	2,36E-05	m/s
AVERAGE =	2,36E-03	cm/s

Notes :

LABORATORY TEST RESULTS

CLIENT : Gondwana
PROJECT NAME : Louw's Bos South Cemetry

admin only
JOB NO : L180749
SAMPLE NO : 30714

COMPACTION MOULD PERMEAMETER

POSITION : TP 07 @ 0,60-1,00m
SOIL DESCRIPTION : olive brown silty gravel
PERMEANT USED : TAP WATER

SAMPLE DATA		
MDD (100%)	kg/m ³	2150
MDD (100%) moisture content	%	7,9
Percent of MDD specified	%	92
Dry density of soil required	kg/m ³	1978,00
Moisture content of sample	%	7,9
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	4369,27
Mass of wet soil required	g	4714,44

ACTUAL DATA		
Mould Number		P5
Mass of Mould	g	4589
Mass of Mould and wet soil	g	9303,44
Mass of wet soil	g	4714,44
moisture content	%	7,90
Bulk Density	kg/m ³	2134,26
Dry Density	kg/m ³	1978,00
Percentage MDD	%	92,00

TEST READINGS							
		Start Test		End Test		Volume outflow	Comments
Test	Height	Time		Time			
	mm	min	sec	min	sec	ml	
1	2200			1	59	500	
2	2200			1	53	500	
3	2200			1	56	500	
4	2200			2	1	500	

CALCULATIONS FOR CONSTANT HEAD		
Hydraulic gradient	Elapsed Time	COEFFICIENT OF PERMEABILITY
mm	sec	m/s
17,60	119,00	1,35E-05
17,60	113,00	1,42E-05
17,60	116,00	1,39E-05
17,60	121,00	1,33E-05

Number of tests = 4

AVERAGE =	1,37E-05	m/s
AVERAGE =	1,37E-03	cm/s

Notes :

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

PROJECT: Louw's Bos South Cemetry
DATE: 31-07-2018
REF: L180749

ASTM D422 SIEVE ANALYSIS

DESCRIPTION : olive brown to red silty clay
POSITION : TP 07 @ 1.00-3.10m

SAMPLE NO. : 30715
CLIENT SAMPLE NO. :

Sieve Analysis	Percent Passing
75,00	
63,00	
53,00	
37,50	
26,50	
19,00	
13,20	
9,50	
6,70	100
4,75	99
2,36	94
2,00	92
1,18	85
0,600	76
0,425	70
0,300	65
0,150	56
0,0750	49

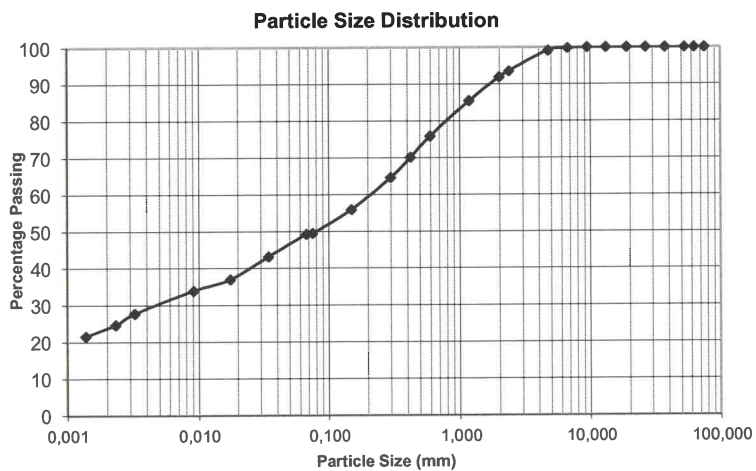
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0671	49
0,0343	43
0,0175	37
0,0091	34
0,0033	28
0,0023	25
0,0014	22

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/m³)	
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	50
Silt : Percentage - 0.075mm and + 0.002mm	23
Clay : Percentage - 0.002mm	26

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.

For Geoscience:

Remarks:

ConSR22

APPENDIX D

Geotechnical Investigation carried out for the Louw's Bos South RE/502,
Cemetery Site, Stellenbosch, Western Cape

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**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

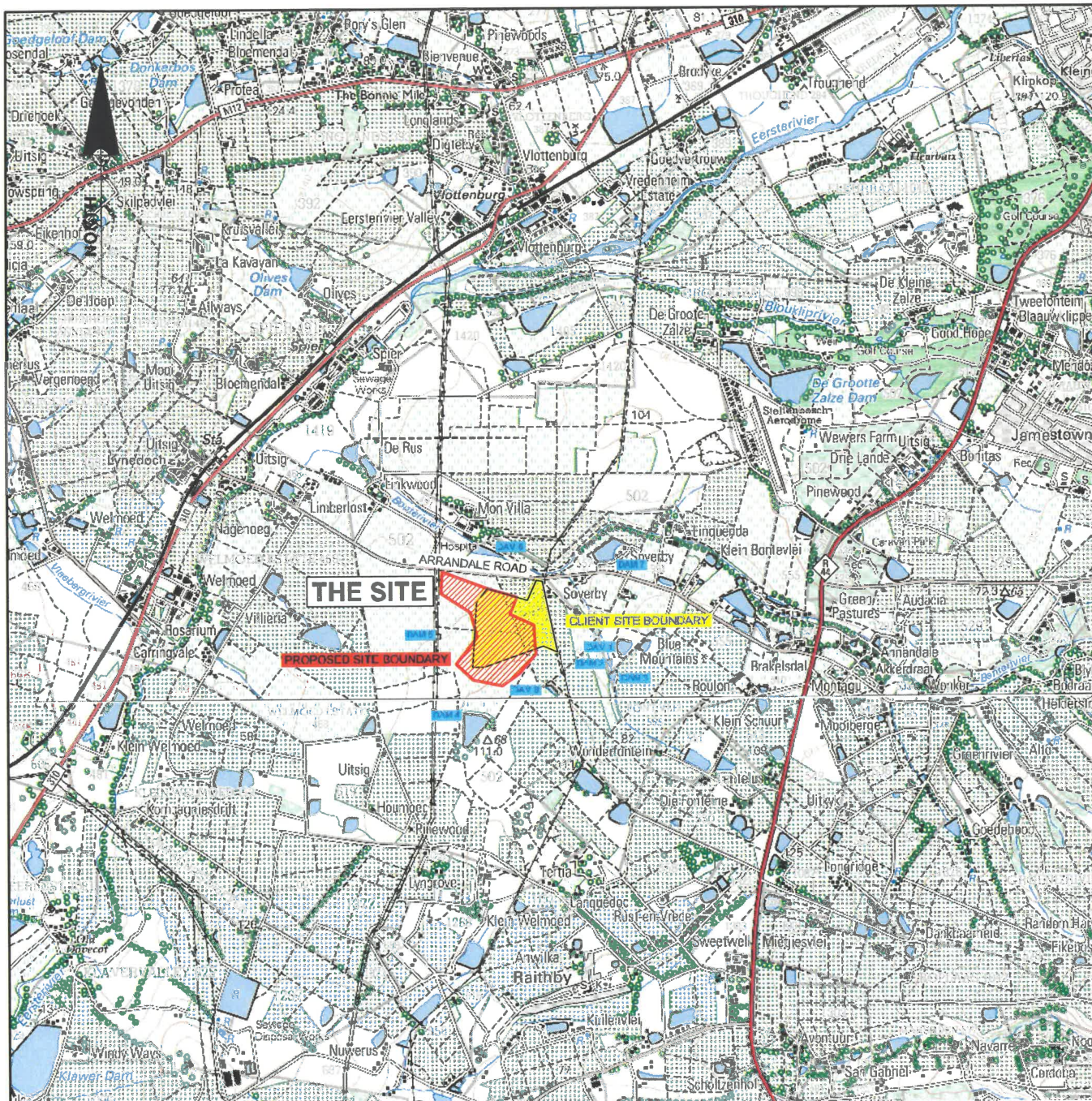
Note: * Measured from ground level

FIGURES

Geotechnical Investigation carried out for the Louw's Bos South RE/502,
Cemetery Site, Stellenbosch, Western Cape

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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

Locality Plan

Scale 1 : 50 000 (On A4 Original)

CLIENT

C.K. RUMBOLL

PROJECT

**Geotechnical Investigation for
Louws Bos South Cemetery**



DATE

26/07/2018

DRAWN

A.S.

CHECK

M.V.R.

REFERENCE NO.

18 - 820

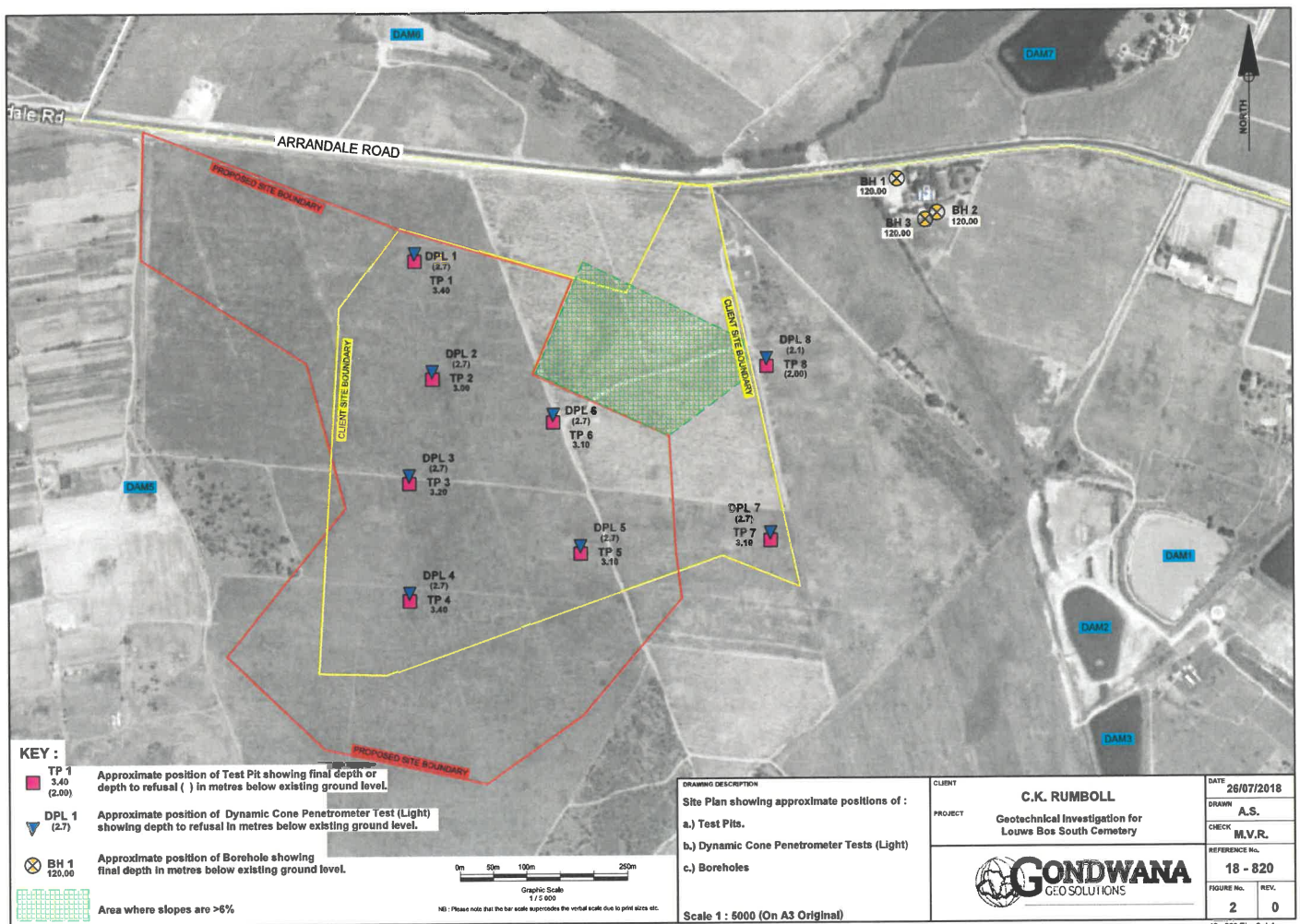
FIGURE NO.

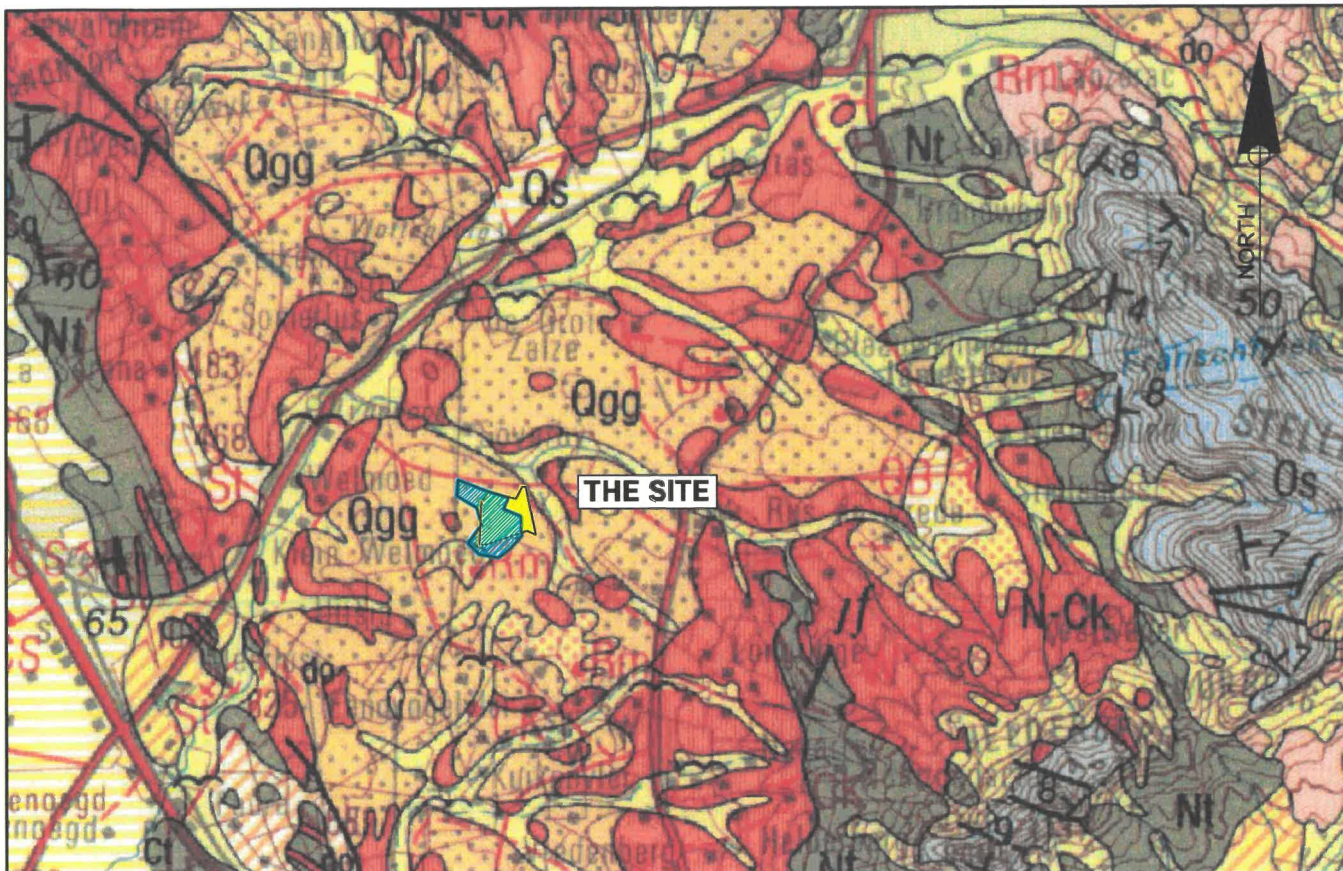
1

REV.

0

18-820 Fig 1 Locality.drw





Graphic Scale
1 / 100 000

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

LEGEND

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

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

<p>DRAWING DESCRIPTION</p> <p>Locality Plan showing Regional Geology</p> <p>Scale 1 : 100 000 (On A4 Original)</p>	CLIENT	C.K. RUMBOLL	DATE	26/07/2018
	PROJECT	Geotechnical Investigation for Louws Bos South Cemetery	DRAWN	A.S.
			CHECK	M.V.R.
			REFERENCE No.	18 - 820
			FIGURE No.	3
			REV.	0

Appendix G-5b – Geotechnical Alternate Site

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

Project No.: 18-812R01



Date Issued: May 2018

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

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Appendix A: Trial Pit Profiles
Appendix B: DPL Test Results
Appendix C: Laboratory Test Results
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Figures 1 to 4

	PREPARED:	APPROVED:
DATE:	May 2018	May 2018
NAME:	Colin Hartley	Mark Richter
SIGNATURE:		

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

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: mbegl = 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

⁷Note: 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 FORESTRY (DWAF) REQUIREMENTS

DWAF 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 consultants^{11; 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).

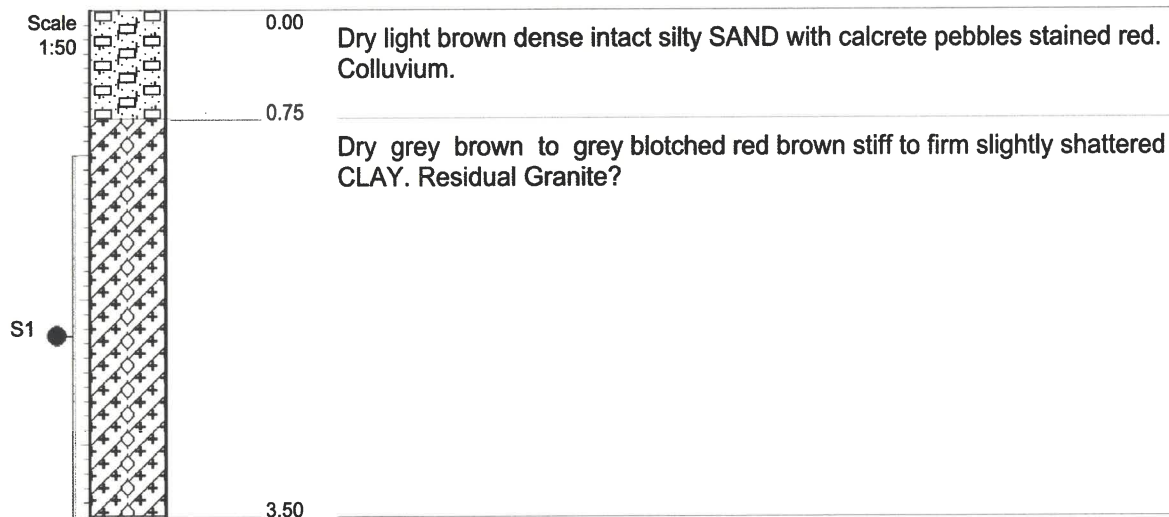
Provided that the cemetery is sited in the area proposed and shown in Figure 4, the DWAF requirements for the siting of cemeteries are met.

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

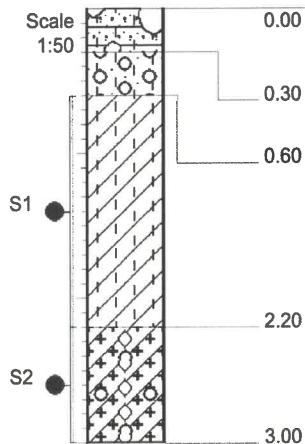


CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH
 TYPE SET BY : MC
 SETUP FILE : STANDARD.SET

INCLINATION :
 DIAM :
 DATE : 13/04/2018
 DATE : 13/04/2018
 DATE : 30/04/2018 08:01
 TEXT : ..Cemetery\Logs\TP1TP5.doc

ELEVATION :
 X-COORD : 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

TYPE SET BY : MC
SETUP FILE : STANDARD.SET

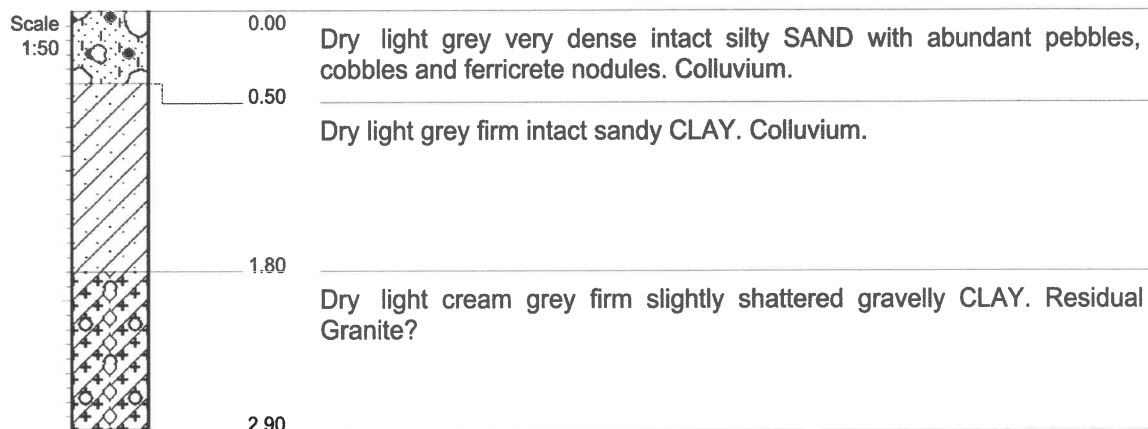
INCLINATION :

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

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

ELEVATION :
X-COORD : 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.

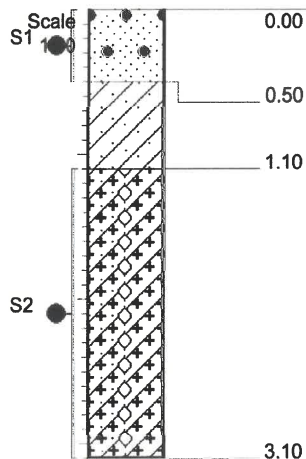


CONTRACTOR :
 MACHINE : JCB3CX
 DRILLED BY :
 PROFILED BY : CLH
 TYPE SET BY : MC
 SETUP FILE : STANDARD.SET

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**



Dry light olive brown very dense intact SAND with small ferricrete nodules. Colluvium.

Dry yellow brown firm to soft intact sandy CLAY. Colluvium.

Dry cream grey to olive brown firm to stiff slightly shattered sandy CLAY. Residual Granite?

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

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 : 37612116
 Y-COORD : 19Y 0017913

HOLE No: TP4

Scale
 1:50


0.00

Dry light olive brown dense intact gravelly silty SAND with abundant cobbles and pebbles. Colluvium.

0.40

Dry yellow brown firm intact gravelly sandy CLAY. Colluvium.

0.90

Dry cream grey to olive brown blotched reddish firm slightly shattered CLAY. Residual Granite?

3.10

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

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

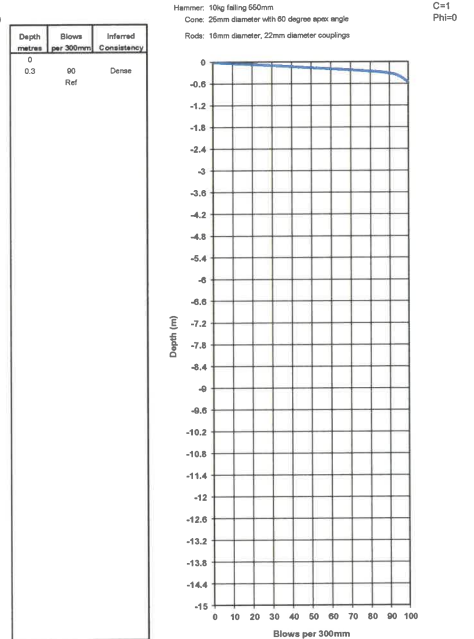
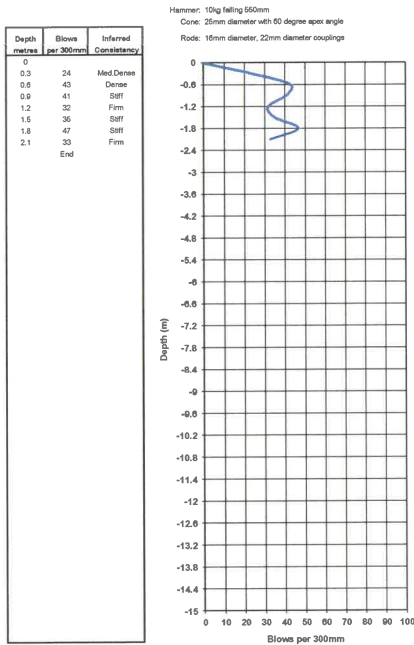
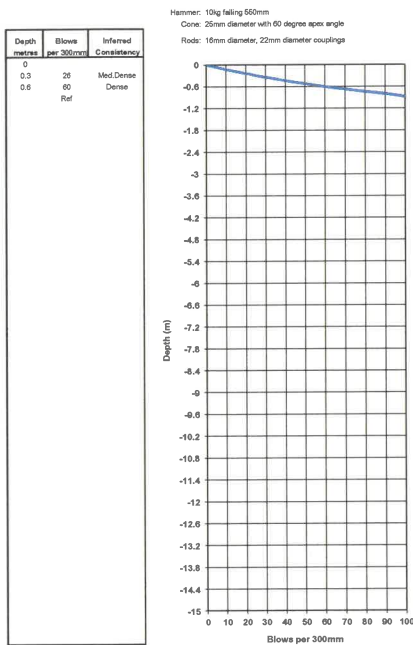
Ref.No. 18-812
Date: 12/4/2018
Operator: CH

Light Dynamic Penetrometer Probe ——— Test No. DPL 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



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

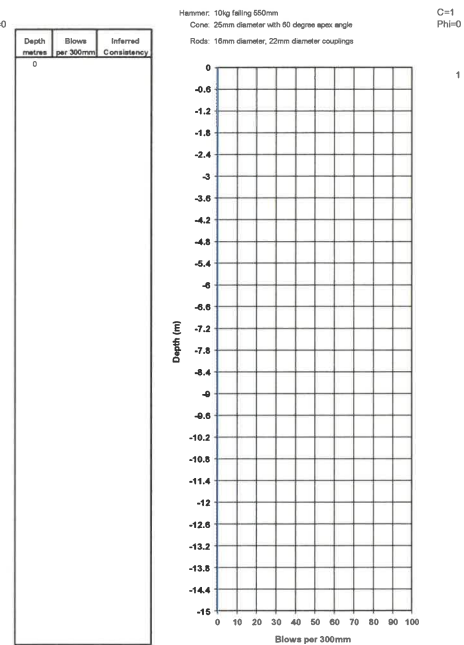
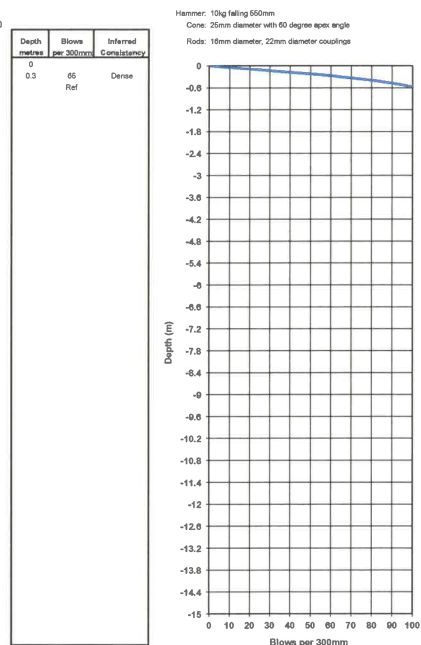
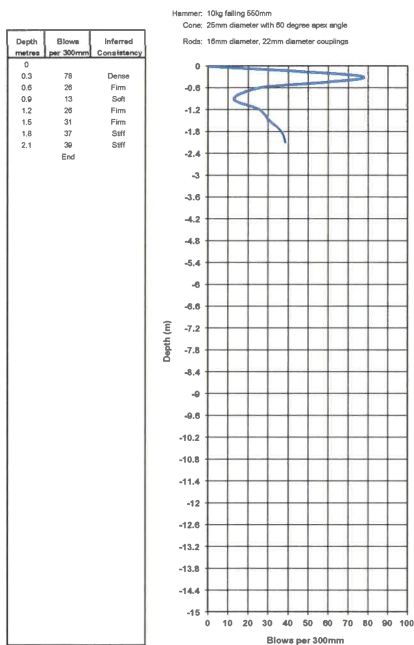
Ref.No. 18-812
Date: 12/4/2018
Operator: CH

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



APPENDIX C

Geotechnical Investigation for the Louw's Bos Cemetery Site, Stellenbosch,
Western Cape.

Path : C:\Users\Merril\Desktop\Job Folders\1. Cape Town jobs\18-812 Louws Bos Cemetery\Report\Appendix C cover page.docx



CLIENT: Gondwana Geo Solutions
108 Upper Kenridge Avenue
Durbanville
7550

PROJECT: Louw's Bos Cemetry

ATT: Colin Hatrley

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
75,00	
63,00	
53,00	
37,50	
26,50	
19,00	
13,20	
9,50	100
6,70	99
4,75	99
2,36	97
2,00	97
1,18	94
0,600	87
0,425	82
0,300	78
0,150	70
0,0750	65

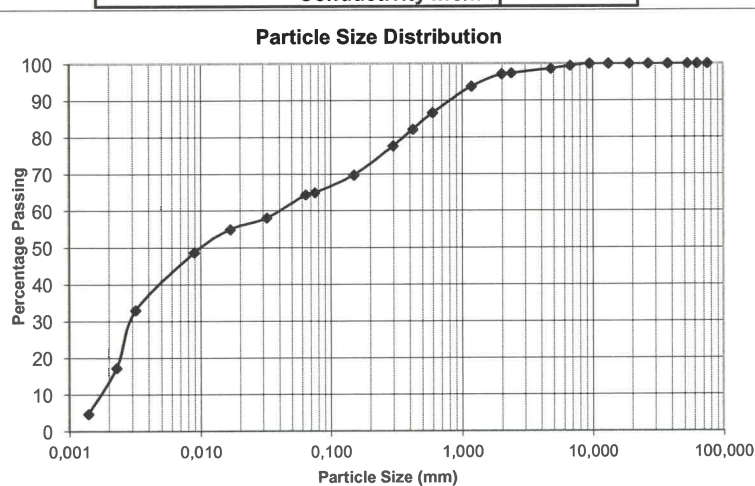
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0640	64
0,0327	58
0,0166	55
0,0087	49
0,0032	33
0,0024	17
0,0014	5

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.

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 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 Cemetery

ATT: Colin Hatrley

DATE: 20-04-2018

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
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

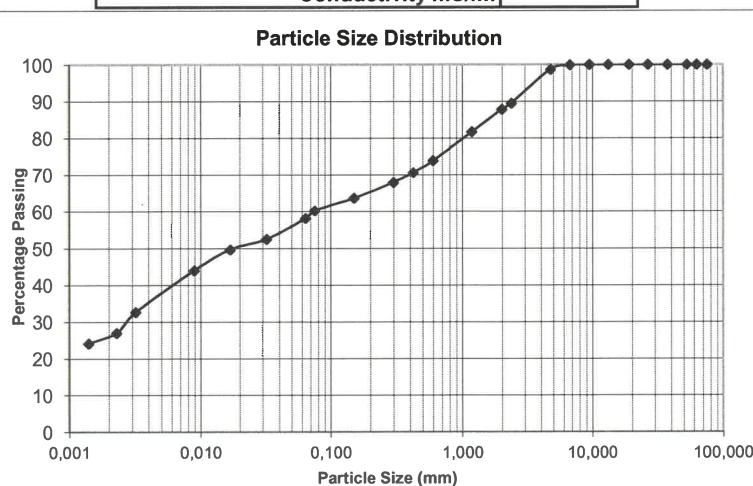
Hydrometer Analysis	
Diameter of particle (mm)	Percentage of soil suspension (%)
0,0640	58
0,0327	53
0,0166	50
0,0087	44
0,0032	33
0,0023	27
0,0014	24

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/m³)	
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 Cemetry

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**

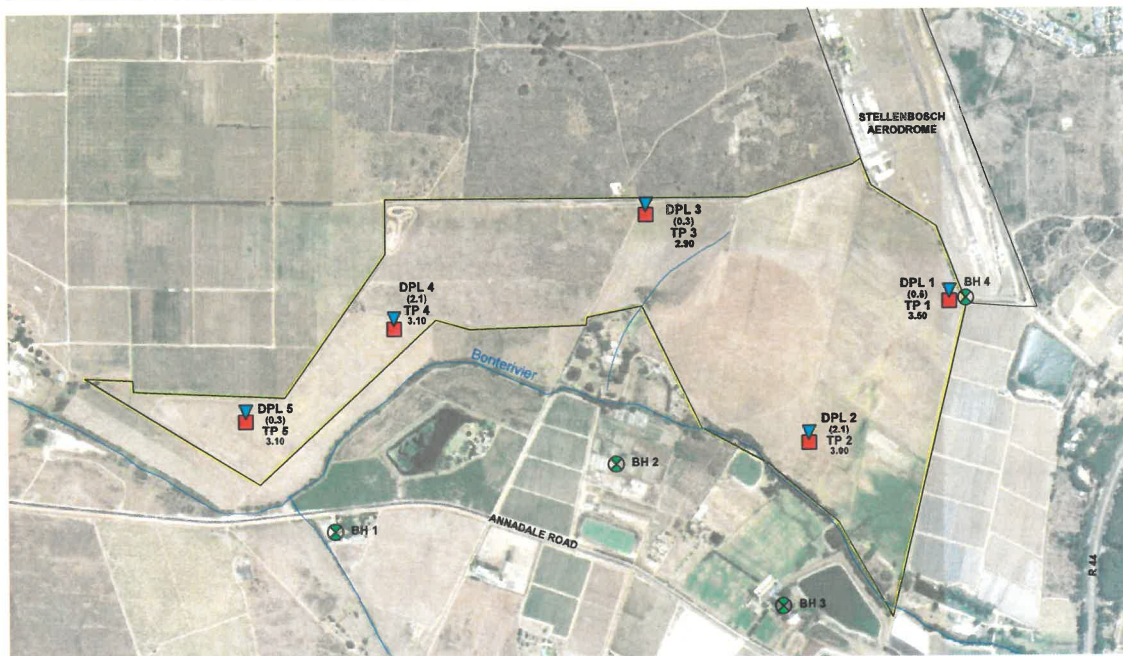
DESCRIPTION	PERCOLATION RATE (mm/hr)	APPROX. PERMEABILITY (cm/sec)	RATING
Impermeable	Not measurable	<10 ⁻⁵	15
Relatively impermeable	10 - 15	10 ⁻⁴ to 10 ⁻⁵	20
Relatively permeable	15 - 50	10 ⁻³ to 10 ⁻⁴	10
Permeable	50 - 1000	>10 ⁻³	0

**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

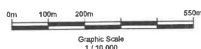
Note: * Measured from ground level

FIGURES



KEY :

- TP 1 (5.50) 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)



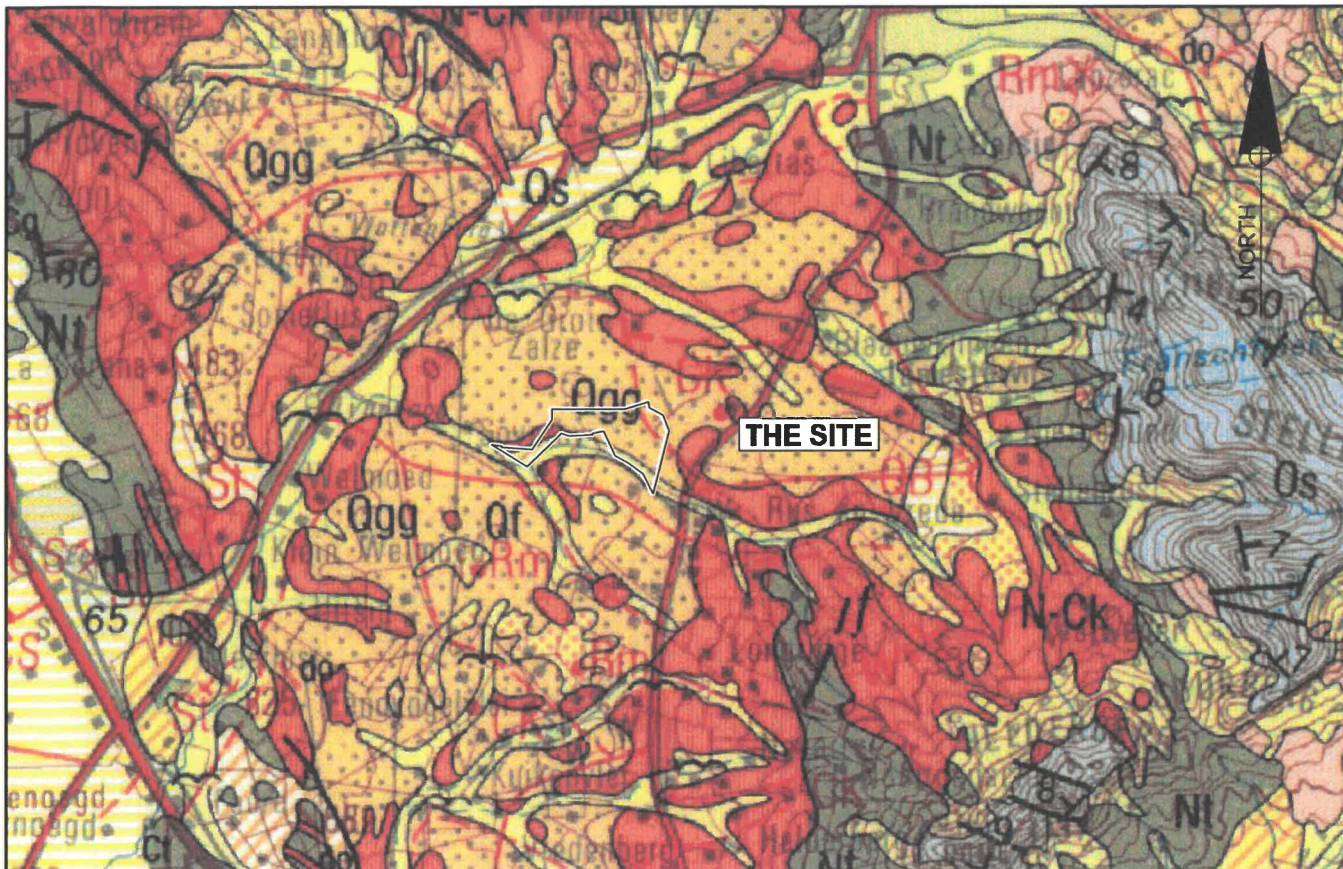
ND : Please note that the bar scale supercedes the verbal scale due to print sizes etc.

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	02/06/2018
PROJECT	Louws Bos Cemetery	DRAWN	A.S.
		CHECK	M.V.R.
		REFERENCE No.	18 - 812
		FIGURE No.	2
		REV.	0





LEGEND


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



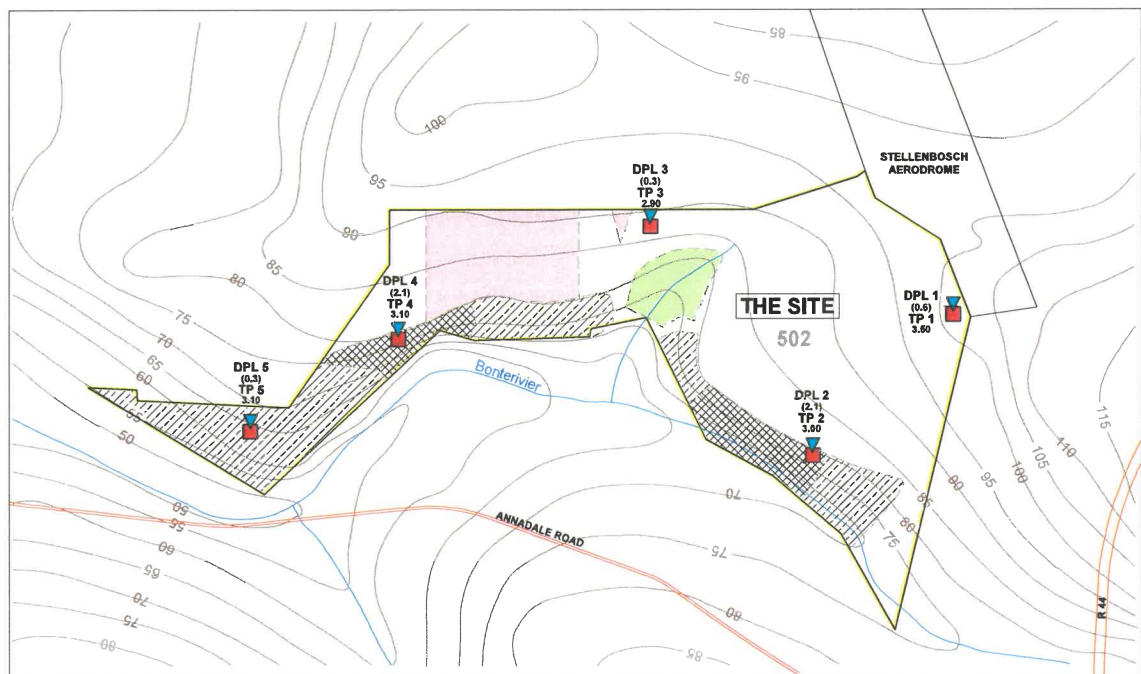
Graphic Scale
1 / 100 000

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

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

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



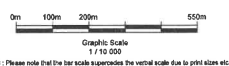


KEY :

- 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.

Approximate Slope

- 2% to 6%
- 6% to 9%
- 9% to 13.6%



NB : Please note that the bar scale exaggerates the vertical scale due to print size 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
02/06/2018
DRAWN
A.S.
CHECK
M.V.R.
REFERENCE NO.
18 - 812
FIGURE NO.
4
REV.
0

18 - 812 Fig. 4.d4

Appendix G-6 – Archaeological

ARCHAEOLOGICAL IMPACT ASSESSMENT

PROPOSED NEW MUNICIPAL CEMETERY: LOUW'S BOS NORTH AND LOUW'S BOS SOUTH, REMAINDER FARM 502, STELLENBOSCH, WESTERN CAPE

Assessment conducted under Section 38 (3) of the National Heritage Resource
Act (No. 25 of 1999)

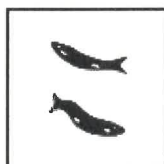
Prepared for:

CKR & Partners
16 Rainier Street, Malmesbury
Att: Ms Anelia Coetzee
Email: leap@rumboll.co.za

Applicant:

STELLENBOSCH MUNICIPALITY

By



Jonathan Kaplan
Agency for Cultural Resource Management
5 Stuart Road, Rondebosch, 7700
Cellular: 082 321 0172
Email: acrm@wcaccres.co.za

**NOVEMBER
2018**

Executive summary

1. Introduction

ACRM was appointed to conduct an Archaeological Impact Assessment (AIA) for a proposed new municipal cemetery on Remainder Farm No. 502 near Stellenbosch in the Western Cape.

Two proposed, alternative cemetery sites are under consideration; namely Louw's Bos North and Low's Bos South. Both sites are located alongside Annandale Road, off the R44 north between Somerset West and Stellenbosch.

The proposed cemetery will occupy a footprint area of about 30ha and will include a memorial park, perimeter fencing, parking, a memorial wall, and ablution facilities. Existing access roads will be upgraded.

2. Aim of the study

The aim of the study is to assess the sensitivity of archaeological resources in the two proposed alternative cemetery sites, to determine the potential impacts on such resources, and to avoid and/or minimise such impacts by means of management and/or mitigation measures.

The AIA forms part of a wider Heritage Impact Assessment (HIA) that will be conducted by Bruce Eitzen of New World Associates.

3. Results of the study

A field assessment of the proposed Louw's Bos North cemetery site was undertaken on the 18th October 2018, and an assessment of the proposed Louw's Bos South cemetery site was undertaken on the 13th November, 2018.

The following observations were made:

3.1 Louw's Bos North

No archaeological remains were recorded in the footprint area of the proposed cemetery site, which comprises old agricultural land covered in grazing grass and weeds. There is barely any surface stone covering the proposed development site.

Relatively large numbers of Early Stone Age (ESA) resources were, however, recorded on a portion of Rem. Farm 502, on deeply ploughed agricultural land alongside Annandale Road and the floodplain of the Bonterivier, that included chunks, cores, flakes, cleavers and several bifaces/handaxes, struck from round quartzite river cobbles. The remains all occur in a highly transformed context.

3.2 Louw's Bos South

A small number of ESA implements including chunks, cores and flakes were recorded in a large block of wheat fields on the upper slopes of the proposed cemetery site. No archaeological resources were recorded on the remainder of the proposed development

AIA proposed Louw's Bos Cemetery near Stellenbosch

site, which comprises old, unused agricultural land covered in very dense grass, weeds, and large patches of recovering veld. The receiving environment has historically been totally transformed by agriculture.

The small numbers and highly transformed context (i. e. wheat fields) in which they were found, mean that the remains have been graded as having *low* (Grade IIIC) archaeological significance.

4. Impact statement

The results of the study indicate that the proposed development of a new municipal cemetery on Remainder Farm No. 502 near Stellenbosch, will not impact of important pre-colonial archaeological heritage. ESA resources in a highly transformed context were documented on the farm, but have been graded as having *low* (Grade IIIC) archaeological significance.

5. Conclusion

The study has identified no significant impacts to pre-colonial archaeological heritage that will need to be mitigated prior to the proposed development commencing. The receiving environment (i. e. transformed agricultural land) is not a sensitive or threatened archaeological landscape.

Insofar as a comparative study of the two proposed development sites is concerned, no one site is preferred over the other.

6. Recommendations

The following recommendations are made:

6.1 Louw's Bos North

1. No archaeological mitigation is required prior to construction activities commencing.
2. The property is suitable for development.

6.2 Louw's Bos South

1. No archaeological mitigation is required prior to construction activities commencing
2. The property is suitable for development

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1. INTRODUCTION

ACRM was appointed by CKR & Partners, on behalf of the Stellenbosch Municipality, to conduct an Archaeological Impact Assessment (AIA) for a proposed new municipal cemetery on Remainder Farm No. 502 near Stellenbosch in the Western Cape (Figures 1-2).

Two proposed, alternative cemetery sites are under consideration; namely Louw's Bos North and Low's Bos South. Both sites are located alongside Annandale Road, off the R44 north between Somerset West and Stellenbosch.

The proposed cemetery will occupy a footprint area of about 30ha and will include a memorial park, perimeter fencing, parking, a memorial wall, and ablution facilities. Existing access roads will be upgraded.

The AIA forms part of a wider Heritage Impact Assessment (HIA) that will be conducted by Bruce Eitzen of New World Associates.

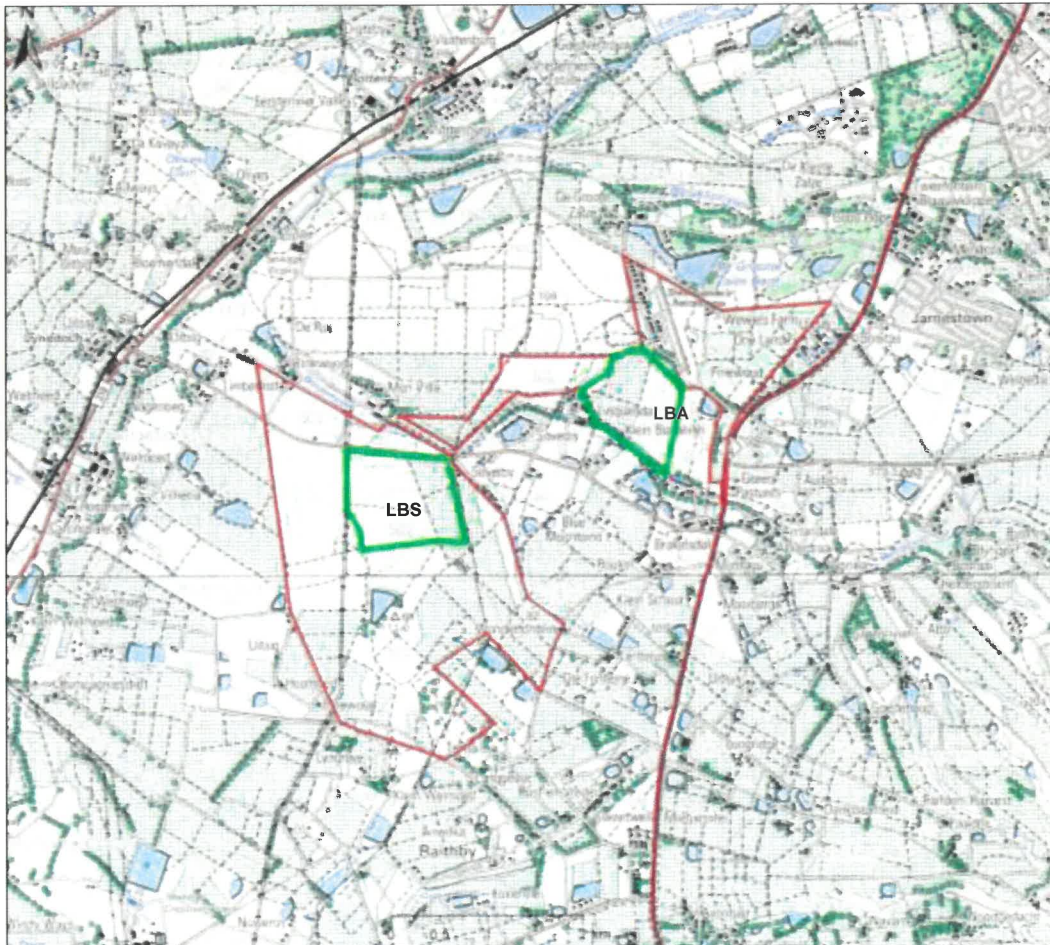


Figure 1. 1:50 000 locality map (3318DD Stellenbosch). The green polygons indicate the location of the proposed, and proposed alternative cemetery sites; namely Louw's Bos North (LBA) and Louw's Bos South (LBS)

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 2. Google satellite map of the proposed, and proposed alternative cemetery sites on Remainder of Farm 502 near Stellenbosch

2. HERITAGE LEGISLATION

The National Heritage Resources Act (Act No. 25 of 1999) makes provision for a compulsory Heritage Impact Assessment (HIA) when an area exceeding 5000 m² is being developed. This is to determine if the area contains heritage sites and to take the necessary steps to ensure that they are not damaged or destroyed during development.

3. DESCRIPTION OF THE RECEIVING ENVIRONMENT

3.1 Louw's Bos North

The proposed development site is located to the north of Annandale Road, about 10kms south west of Stellenbosch (Figure 3). Access to the site is via the R44 between Somerset West and Stellenbosch. The proposed cemetery site comprises old agricultural land. There is barely any visible surface stone covering the site. Historically, for many years, vegetables such as broccoli and cauliflower were grown on the farm to supply large retailers such as Pick & Pay (Wrench Louw pers. comm. October, 2018). For the last 15 years or so, the land has been used for grazing and centre pivot farming. The site has been divided into several large grazing camps where cattle are rotated between camps. The receiving environment has therefore been totally transformed by agriculture (Figures 4-6). There are no significant landscape features on the proposed development site, although the Bonterivier runs just below the southern boundary of the proposed development site. Surrounding land use is agriculture (grazing, vineyards & strawberry farming), farm dams, guest accommodation, and the Stellenbosch North to the north east.



Figure 3. Google satellite map indicating the footprint area (red polygon) for the proposed Louw's Bos North Cemetery on Rem. Farm 502, Stellenbosch

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 4. View of the proposed cemetery site facing west



Figure 5. View of the proposed cemetery site facing south east with the Simonsig in the distance

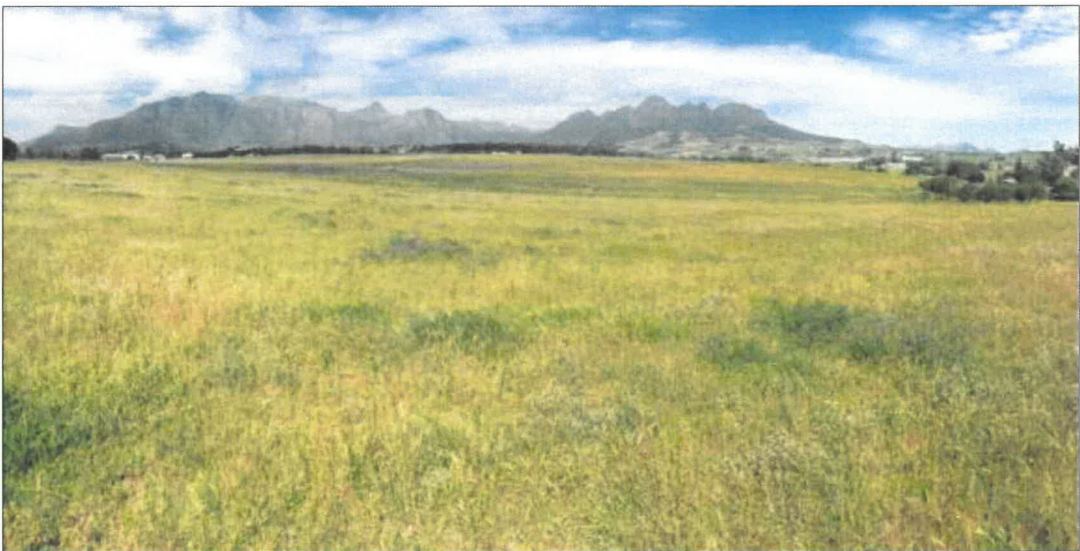


Figure 6. View of the cemetery site facing east

3.2 Louw's Bos South

The proposed cemetery site is located directly alongside (i.e. south of) Annandale Road (Figure 7). The eastern sector of the proposed development site comprises a large block of vineyards and wheat fields (Figures 8 & 9). The remainder of the site (i. e. the western sector) comprises old agricultural lands that have not been worked for more than 10 years and are covered in a mix of extremely dense Kikuyu grass, weeds such as Lupens, natural grasses, and large patches of recovering veld, on a substrate of loose, weathered quartzitic sands (Figures 10-13). Some gravel and Koffieklip was also noted. Existing infrastructure comprises gravel farm roads, barely visible twee-spoor tracks, some farm fencing and poles. There is barely any surface stone covering the western portion of the proposed site, even alongside Annandale road, where visibility is still fairly good. There are no significant landscape features on the proposed site, and no springs, pans or sources of natural water. Surrounding land use is agriculture (vineyards, vacant agricultural lands & vegetable farming to the west), roads and farm dams.

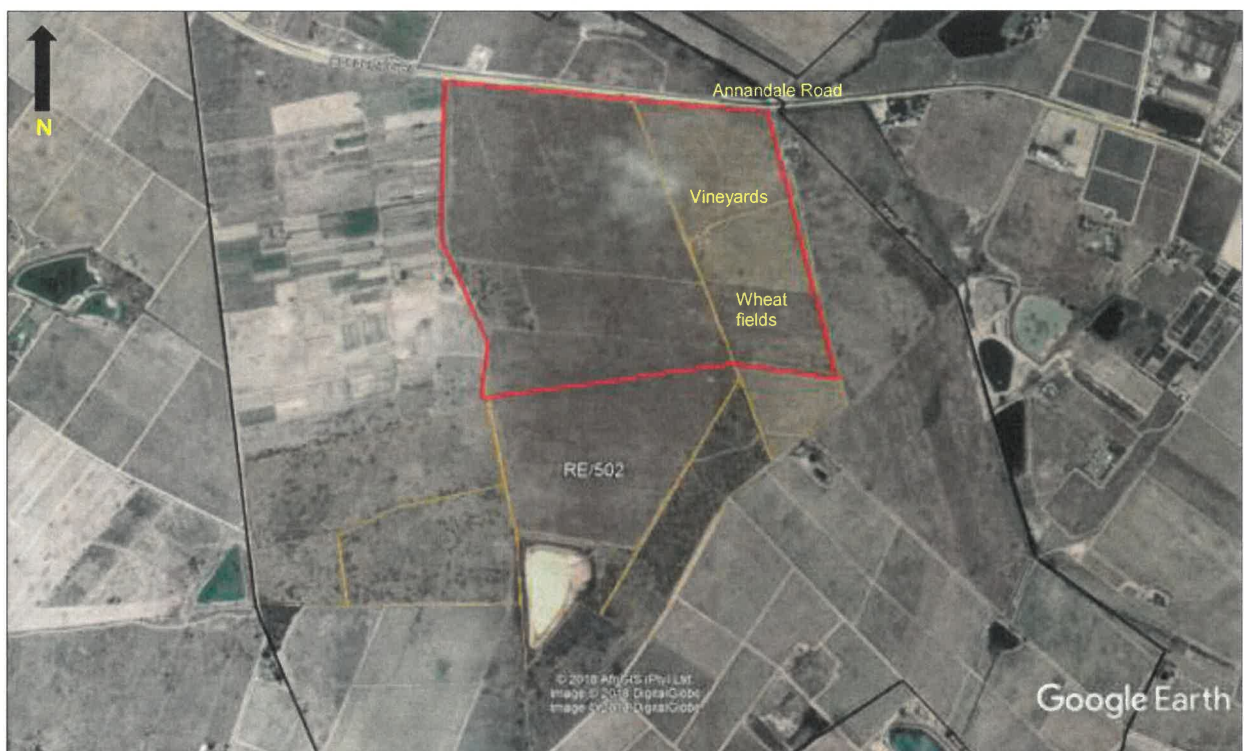


Figure 7. Close up Google satellite map indicating the footprint area of the proposed Louw's Bos South Cemetery site (red polygon) on Rem. Farm 502, Stellenbosch

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 8. Vineyards in the eastern sector of the proposed cemetery site. View facing north east



Figure 9. Wheat fields in the eastern sector of the proposed cemetery site. View facing north



Figure 10. Western sector of the proposed cemetery site. View facing north east

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 11. Western sector of the proposed cemetery site. View facing east



Figure 12. Western sector of the proposed cemetery site. View facing west



Figure 13. Western sector of the proposed cemetery site alongside Annandale Road. View east

4. STUDY APPROACH

4.1 Method

The overall purpose of the study is to assess the sensitivity of archaeological resources in the proposed two cemetery sites, to determine the potential impacts on such resources, and to avoid and/or minimise such impacts by means of management and/or mitigation measures.

The significance of archaeological resources was assessed in terms of their content and context. Attributes considered in determining significance include artefact and/or ecofact types, rarity of finds, exceptional items, organic preservation, potential for future research, density of finds and the context in which archaeological traces occur.

A field assessment of the proposed development sites was undertaken on 18th October (Louw's Bos North) and 14th November (Louw's Bos South), 2018.

A track path of both surveys was captured.

A desktop study was also carried out to assess the heritage context surrounding the proposed development sites.

4.2 Constraints and limitations

There were no constraints or limitations associated with the study, although visibility was very poor across both proposed development sites, due to dense vegetation cover. Access to both sites was unrestricted and mobility was unhindered.

4.3 Identification of potential risks

The results of the study have shown that there are no archaeological risks associated with the proposed development. Limited numbers of ESA resources were identified on the proposed Louw's Bos South site, but these occur in a highly transformed context (wheat fields).

4.4 Archaeology of the study area

Early Stone Age (ESA) implements were first discovered by the French entomologist Dr Louis Peringuey in 1899 at Bosman's Crossing at the foot of the Papagaaiberg alongside the Eerste River in Stellenbosch (Peringuey 1902, 1911; Seddon 1966). The artefacts, exposed in the railway cutting, are associated with the younger gravels of the course alluvial fan on which much of Stellenbosch is situated, and are dated to the earlier part of the Middle Pleistocene, between 700 000 and 300 000 years ago (Deacon & Goosen 1997). Among these tools was an artefact type of great antiquity recognized as an early handaxe. For many years after this, the ESA of South Africa was referred to as the 'Stellenbosch Culture' until the term was re-defined in the 1960s (Goodwin & Van Riet Lowe 1929). A large sandstone boulder marks the location of the Bosman's Crossing Provincial Heritage Site (PHS) which was declared a National Monument in 1962.

Today the ESA is divided into the 'Olduvian' period, which is up to 1.7 million years old. This industry is associated with the oldest and most simple human-made artefacts. This was followed by the 'Acheleun' Tradition, a more developed stone artefact industry, characterised by the presence of specific types of stone tools such as handaxes, choppers and cleavers. Acheleun sites have been recorded throughout the country and are especially associated with river terraces, streams, and certain types of rock outcrops. Acheleun tools are also commonly found on mountain slopes, and in degraded and transformed areas such as slope washes, cuttings, excavations, and in vineyards.

ESA artefacts have been documented at numerous locations in the Stellenbosch area, on the farms Spier, Meerust, Lynedoch, Hartlands, Vlottenberg and De Wijnlanden (Kaplan 2002), and on several farms to the east of the R310, at Croyden (Kaplan 2005, 2004) and Faure (Kaplan 2006). Large numbers of tools including handaxes, cleavers, cores, and flakes have also been documented in agricultural lands and vineyards during an investigation of the De Zalze Golf Estate (Kaplan 2009), directly north of the proposed Louw's Bos North cemetery site, while a rich Acheleun site occurs on the Farm Blaauklippen, on the upper slopes of the Helderberg to the east of the R44 (Deacon and Goosen 1997). ESA flakes and angular chunks have also found on the lower slopes of the Papagaaiberg near the cemetery (Kaplan 2010). ESA tools were also recently encountered alongside Adam Tas Road, and in Devon Road, Stellenbosch during a Heritage Impact Assessment (HIA) for the proposed Plankenbrug sewer pipeline (Kaplan 2015a), and at Vlottenburg Hamlet inside the urban edge (Kaplan 2015b).

5. RESULTS OF THE STUDY

5.1 Louw's Bos North

No archaeological remains were recorded in the proposed ± 30 ha footprint area of the proposed Louw's Bos North Cemetery north of Allandale Road (Figure 14). The receiving environment is quite waterlogged across the lower slopes and covered in very thick grass. A large centre pivot field (much of it covered in Lupens) also covers a large portion of the proposed development site. There is barely any surface stone on the site, apart from a few large pieces of Koffieklip.

Relatively large numbers of ESA resources were, however, recorded in heavily ploughed fields in the south western portion of Farm 502 alongside Allandale Road, where these tools have been brought to the surface by ploughing activities (Figure 14 & Table 1). The majority of the finds comprise chunks, flaked chunks, round cores, partially modified flakes, and several cleavers. Three pear-shaped, Acheleun bifacial handaxes were also recorded. All the artefacts have been struck from round quartzite river cobbles, and occur in a highly transformed context. A number of tools were also found embedded in the gravel farm roads that ring the fields, and among large piles of quartzite cobbles and Koffieklip that have been removed from the surrounding fields. It is interesting to note that the lithics in this area are located close to the banks/floodplain of the Bonterivier, where quartzite river cobbles would have been readily available to early ESA hominins as a source material for making tools. The surrounding fields also contain many unworked cobbles of varying sizes.

A collection of tools and the context in which they were found study is illustrated in Figures 14-26.

5.1.1 Grading

The highly transformed context, in which they were found, means that the remains have been graded as having *low* (Grade IIIC) archaeological significance.

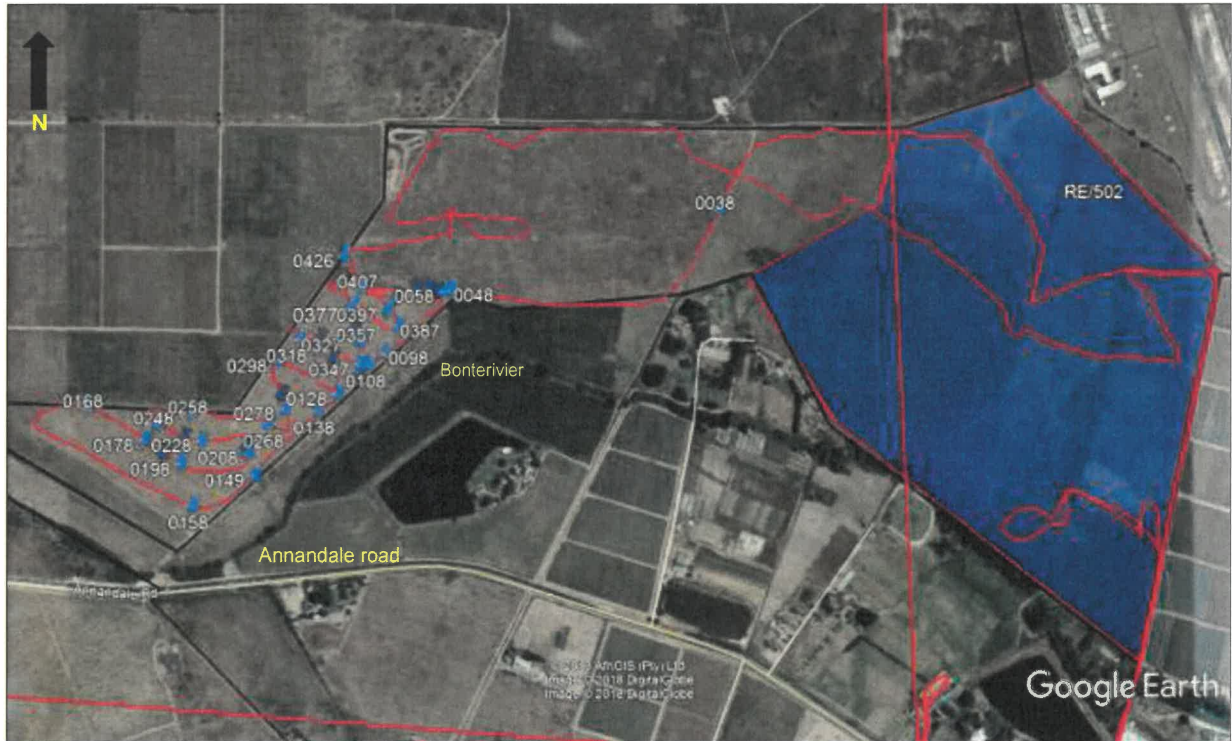


Figure 14. Trackpaths in red and waypoints of archaeological finds. The proposed cemetery site is the blue shaded area



Figure 15 Collection of tools (Points 048-068). Scale is cm.



Figure 16. Collection of tools. Scale is in cm

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 17. Context in which the remains were found



Figure 20. Cleaver (Point 0218) among stones in road



Figure 18. Context in which the remains were found

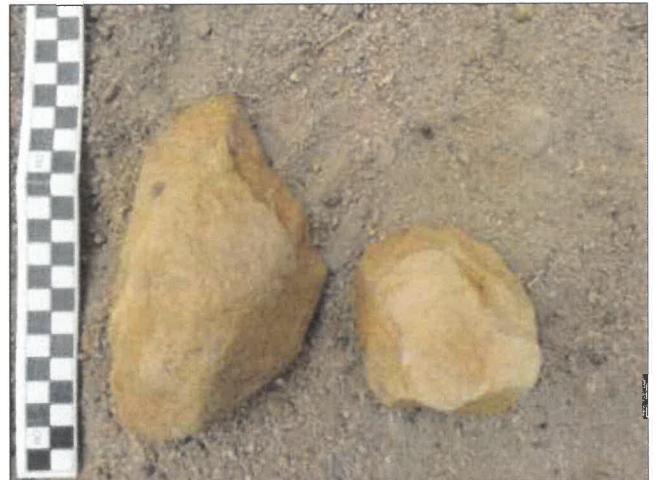


Figure 21. Collection of tools. Scale is in cm



Figure 19. Collection of tools. Scale is in cm



Figure 22. Collection of tools. Scale is in cm

AIA proposed Louw's Bos Cemetery near Stellenbosch



Figure 23. Handaxe & flake. Scale is in cm



Figure 24. Biface on pile of Koffieklip (0426).



Figure 25. Classic Acheulean handaxe (0397). Scale in cm



Figure 26. 0426. Context in which the remains were found

Point	Name of farm	Lat/long	Description	Mitigation
	Rem. Farm 502, Stellenbosch		All ESA All in quartzite unless otherwise indicated	
0038		S33° 59.056' E18° 48.765'	Retouched chunk in road	None required
0048		S33° 59.139' E18° 48.436'	Retouched flake in road	None required
0058		S33° 59.140' E18° 48.427'	Round core in road	None required
0068		S33° 59.137' E18° 48.407'	Round core in fields	None required
0078		S33° 59.137' E18° 48.392'	Chunk in fields	None required
0088		S33° 59.142' E18° 48.414'	Cleaver	None required
0098		S33° 59.203' E18° 48.356'	Biface on cortex flake in ploughed fields alongside gravel road	None required
0108		S33° 59.215' E18° 48.335'	Chunks and unworked cobbles in ploughed field	None required

AIA proposed Louw's Bos Cemetery near Stellenbosch

0118		S33° 59.226' E18° 48.322'	Same as above	None required
0128		S33° 59.245' E18° 48.295'	Same as above	None required
0138		S33° 59.262' E18° 48.272'	Same as above	None required
0149		S33° 59.329' E18° 48.195'	Chunk and flake among pile of cobbles alongside gravel ring road	None required
0158		S33° 59.359' E18° 48.118'	Core	None required
0168		S33° 59.259' E18° 47.988'	Chunk	None required
0178		S33° 59.292' E18° 48.058'	Several chunks and flakes on large patch/scatter of stone in fields.	None required
0189		S33° 59.306' E18° 48.081'	Same as above	None required
0198		S33° 59.316' E18° 48.103'	Same as above	
0208		S33° 59.306' E18° 48.187'	Core in gravel road	None required
0218		S33° 59.299' E18° 48.183'	Cleaver & core in packed cobble bed in gravel road	None required
0228		S33° 59.293' E18° 48.130'	Chunks and several flakes among scatter of river stone in ploughed fields	None required
0238		S33° 59.290' E18° 48.107'	Same as above	None required
0248		S33° 59.276' E18° 48.075'	Chunk	None required
0258		S33° 59.265' E18° 48.117'	Pointed flake/biface in gravel farm road	None required
0268		S33° 59.276' E18° 48.211'	Core, x 2 chunks in fields	None required
0278		S33° 59.260' E18° 48.231'	Core in fields	None required
0288		S33° 59.246' E18° 48.226'	Several chunk, flake in fields – lots of surface river stone	None required
0298		S33° 59.211' E18° 48.223'	Core	None required
0308		S33° 59.208' E18° 48.288'	2 chunks, flaked chunk in fields	None required
0318		S33° 59.201' E18° 48.271'	Incomplete core	None required
0327		S33° 59.189' E18° 48.249'	Chunk	None required
0337		S33° 59.189' E18° 48.274'	Large Cutting Tool (LCT), 3 chunks, core – scatter of stone in fields	None required
0347		S33° 59.214' E18° 48.323'	Core/flaked chunk	None required
0357		S33° 59.191' E18° 48.324'	Core	None required
0367		S33° 59.177' E18° 48.318'	Pointed flake/biface	None required
0377		S33° 59.158' E18° 48.311'	X 2 chunks and flake	None required
0387		S33° 59.176' E18° 48.370'	Retouched flake/LCT	None required
0397		S33° 59.159' E18° 48.357'	Handaxe	None required
0407		S33° 59.137' E18° 48.325'	Small core	None required
0417		S33° 59.146' E18° 48.366'	Handaxe	None required
0426		S33° 59.104' E18° 48.303'	Biface/core among pile of Koffiekop and cobbles removed from fields	None required

Table 1. Spreadsheet of waypoints and description of archaeological finds

5.2 Louw's Bos South

A small number of ESA implements including chunks, cores and modified flakes were recorded in the highly transformed wheat fields on the upper slopes of Farm No. 502 (Figure 27 & Table 2). A few tools were also recorded embedded in the gravel farm roads as well.

No archaeological remains were recorded in the western sector of the proposed Louw's Bos site, which comprise old agricultural land covered in very dense grasses, weeds, and large patches of recovering natural veld.

A collection of tools recorded during the study is illustrated in Figures 28 and 29.

5.2.1 Grading

The limited numbers and highly transformed context in which they were found mean that the remains have been graded as having *low* (Grade IIIC) archaeological significance.

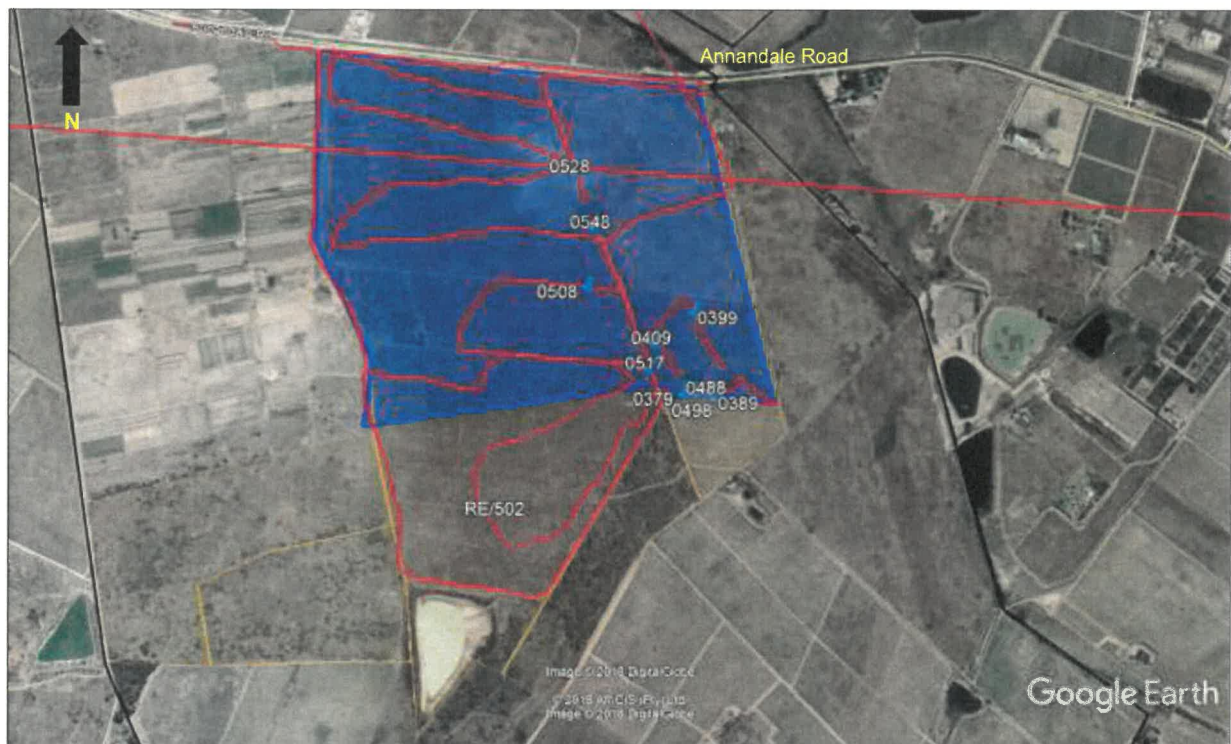


Figure 27. trackpaths (in red) and waypoints of archaeological finds

AIA proposed Louw's Bos Cemetery near Stellenbosch

Point	Name of farm	Lat/long	Description	Mitigation
	Rem. Farm 502, Stellenbosch		All ESA All in quartzite unless otherwise indicated	
				None required
0369		S33° 59.830' E18° 48.017'	Retouched flake/biface in gravel farm road	None required
0379		S33° 59.832' E18° 48.028'	Small, thin snapped cortex flake	None required
0389		S33° 59.837' E18° 48.076'	MSA flake/prepared platform in gravel farm road	None required
0399		S33° 59.731' E18° 48.046'	Heavy chunk/core in wheat fields	None required
0409		S33° 59.770' E18° 47.987'	Flaked chunk	None required
0419		S33° 59.815' E18° 48.030'	Core	None required
0428		S33° 59.817' E18° 48.035'	Chunk	None required
0438		S33° 59.817' E18° 48.039'	Chunk/core	None required
0448		S33° 59.820' E18° 48.045'	Chunk	None required
0458		S33° 59.820' E18° 48.045'	Flake	None required
0468		S33° 59.815' E18° 48.091'	Flake/biface	None required
0478		S33° 59.831' E18° 48.078'	Chunk	None required
0488		S33° 59.831' E18° 48.068'	Broken flake	None required
0498		S33° 59.831' E18° 48.047'	Flake	None required
0508		S33° 59.700' E18° 47.886'	Chunk embedded in road	None required
0517		S33° 59.801' E18° 47.977'	Chunk embedded in road	None required
0528		S33° 59.560' E18° 47.866'	Flake embedded in road	None required
0538		S33° 59.607' E18° 47.887'	Chunk	None required
0548		S33° 59.628' E18° 47.896'	chunk	None required

Table 2. Spreadsheet of waypoints and description of archaeological finds



Figure 28. ESA tools. Scale is in cm



Figure 29. ESA tools. Scale is in cm

6. IMPACT STATEMENT

The results of the study indicate that a proposed new municipal cemetery on Remainder Farm No. 502 will not have an impact of great significance on pre-colonial archaeological heritage.

In the case of the proposed Louw's Bos North cemetery north of Allandale Road, relatively large numbers of ESA implements were recorded outside the proposed cemetery footprint area alongside Annandale Road, while limited numbers of similar types of tools were recorded in transformed wheat fields in the footprint on the proposed Louw's Bos South cemetery site, south of Allandale Road.

The overall impact significance of the proposed development on archaeological resources is therefore rated as being LOW, and indications are that the receiving environment is not a sensitive or threatened archaeological landscape.

7. CONCLUSION

The study has identified no significant impacts to pre-colonial archaeological heritage that will need to be mitigated prior to the proposed development commencing.

The receiving environment (transformed agricultural land) is not a threatened archaeological landscape.

Insofar as a comparative study of the two proposed development sites is concerned, no one site is preferred over the other.

8. RECOMMENDATIONS

With regard to the proposed establishment of a proposed and proposed alternative municipal cemetery on Remainder Farm 502 near Stellenbosch, the following recommendations are made:

8.1 Louw's Bos North

1. No mitigation is required prior to construction activities commencing.
2. The site is suitable for development.

8.2 Louw's Bos South

1. No mitigation is required prior to construction activities commencing.
2. The site is suitable for development.

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