APPENDIX B
Specialist Reports

GCS
Water & Environmental Consultants

APPENDIX B1
Dolomite Stability Investigation

Tel: +27(0)11 803 5726
Cell: +27(0)82 567 1561
E-Mail: ninow@gcs-sa.biz

GCS Geotechnical
(Pty) Ltd

- Dolomite Stability Investigations
- Geotechnical Monitoring
- Rockfall Protection Systems
- Rock Engineering
- Geotechnical Investigations

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Client: PHUMAF

Reference: 19-0916.047DSIR01

Dated: 29 January 2021

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

TABLE OF CONTENTS

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

EXECUTIVE SUMMARY

This report contains the results of a dolomite stability investigation (DSI) and assessment carried out for the proposed residential development at Unitas Park Ext 16 in Unitas Park, Gauteng. The purpose of this report is to assess the potential for dolomite instability and potential sinkhole formation in relation to the proposed development.

Holistically, the subsoil conditions encountered over the site generally comprise a thin cover of transported material underlain by residual chert, residual shale, residual syenite potentially shale bedrock, shale bedrock, syenite bedrock, chert bedrock, and finally underlain by weathered to fresh dolomite. The water table was measured at between 10.9 m and 20.8 m with the OWL that possibly resided at an assumed depth of around 50 m to 55 m below surface.

The drilling results of this investigation have been utilised, together with the current gravity survey and three previous drilling investigations. This data was analysed to determine the inherent hazard class (IHC) of the entire site and ascertain the sustainability of the proposed development with respect to the dolomite stability.

All of the borehole results combined have revealed that there is a low to medium risk for small to large sinkholes. The entire site can be classed as IHC 1-4//1-4 with a dolomite area designation of D2-D4. A summary is provided below:

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

This type of development can only be considered provided the water precautionary measures in Appendix C are adhered to and a D2 or D4 designation (refer to above table) implemented for water ingress prevention and foundations. The available open space has provisionally been assessed in terms of the risk of dolomite instability by using a standard gravity and drilling survey according to SANS 1936-1.

Recommendations for earthworks and drainage to promote any stable and appropriate development (especially applicable to dolomitic terrain) are given.

It is a requirement that this report be presented to the Council for Geoscience for perusal, archiving and the provision of an official Record of Decision. Furthermore, construction supervision by approved dolomite practitioners (geo-professionals and engineers) will be required and also the design and implementation of the required DRMS and DRMP in accordance with SANS 1936-4.

If a RN1 & RL1 type development is considered necessary on IHC 3-4//3-4 land, then a dolomite D4 specialist will be required to oversee the design, construction, preparation and implementation of the required DRMS and DRMP.

Finally, the ground conditions described in this report refer specifically to those encountered in the boreholes put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that ***GCS Geotechnical*** *carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense.* ***In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.***

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.047DSIR01	**Dated: 29 January 2021**

DOCUMENT ISSUE STATUS

Report Issue	Final		
GCS Reference Number	GCS Ref – 19-0916.047DSIR01		
Client Reference	Unitas Park Ext 16		
Title	Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng		
	Name	**Signature**	**Date**
Author	Dale Franklin		29 January 2021
Document Reviewer	Nino Welland		08 February 2021
Director	Nino Welland		08 February 2021

LEGAL NOTICE

This report or any proportion thereof and any associated documentation remain the property of GCS Geotechnical (Pty) Ltd until the mandator effects payment of all fees and disbursements due to GCS Geotechnical (Pty) Ltd in terms of the GCS Conditions of Contract and Project Acceptance Form. Notwithstanding the aforesaid, any reproduction, duplication, copying, adaptation, editing, change, disclosure, publication, distribution, incorporation, modification, lending, transfer, sending, delivering, serving or broadcasting must be authorised in writing by GCS Geotechnical (Pty) Ltd.

Report on a Dolomite Stability Investigation for Unitas Park Ext 16 in Unitas Park, Gauteng

Reference: 19-0916.47R01	**Dated: 29 January 2021**

1. INTRODUCTION AND SCOPE OF REPORT

At the request of Mr. Sikelela Mnguni of Phumaf (hereafter referred to as *the client*), GCS Geotechnical (hereafter referred to as GCS) was asked to provide a proposal and cost estimate for the undertaking of a dolomite stability investigation (DSI) for Unitas Park Ext 16 in Unitas Park as part of the rapid land release program (RLRP) on the 21 November 2019. The appointment was accepted and finalized on the 26 October 2020, and fieldwork was conducted on 21 January 2021 due to access issues with the landowner.

The intention of this investigation is to provide a dolomite stability evaluation across the site and to assess (in conjunction with the Council for Geoscience), the suitability of the site in terms of the proposed new development. This report attempts to provide a preliminary dolomite risk zonation for the entire site using existing information together with information gained during this investigation. The purpose of this dolomite stability report is to provide the following information:

- Establish the nature and engineering properties of the underlying soil strata for the entire site.
- Make preliminary recommendations in respect of the foundation design and construction of the proposed new pump station in terms of dolomite stability.
- Draw attention to pertinent ground water conditions.
- Provide an assessment of the dolomite stability using current percussion boreholes over the entire site.
- Finally, to comment on the suitability of the proposed new pump station as it is in relation to the dolomite stability and Inherent Hazard Class (IHC).

The proposed layout of the site is shown in Figure 1.

2. GENERAL GEOLOGY AND EXISTING INFORMATION

The following information was drawn upon for the purposes of the investigation:

- GSSA, 1986: The 1:250 000 Geological Map Series – West Rand – *2626* (1986), as compiled by the South African Geological Survey, 1986;
- DWAF, 1999: The 1:500 000 Hydrogeological Map titled “2526 Johannesburg” as compiled by DWAF, 1999.
- CGS, 2001: The 1:50 000 Geotechnical Map Series 2627DB Vereeniging.
- HDH, 2002: Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2, September 2002);
- Luxton, 1976: Report and percussion borehole logs for a project titled “*Unita Park Extension 2 Vereeniging*” written by R.F. Luxton, Hunting, and Associates, project number: 152/75, on 24 March 1976. CGS reference: F659;
- VGI, 2015: Report and percussion borehole logs for a project titled “*Unitas Park Extension 17 On Portion 224 Of The Farm Houtkop 594-IQ : Dolomite Stability Feasibility Investigation*” written by VGI Consult, project number: VGI3925, on 24 November 2015. CGS reference: F4783;
- Intraconsult, 2008: Report and percussion borehole logs for a project titled “*GFSH-2, Phase 1 Dolomite Stability Investigations: Lenong: Potion 156 and 203 of Farm Houtkop 594-IQ*” written by Intraconsult Associates, project number: IR874R, on 20 June 2008. CGS reference: F4783;
- GeoStable, 2018: Report and percussion borehole logs for a project titled “*Dolomite Stability and Geotechnical Report On A Portion Of Portion 224 Houtkop 594 IQ, To Be Known As*

Unitas Park Ext 21 Emfuleni Local Municipality" written by GeoStable SA, project number: GS0510 REV 00, in August 2018. CGS reference: F5452;

The table below shows the available published physiographical data pertaining to the site.

Table 2: Summary of Available Desk Study Information

Parameter	Value	Reference
Development	Housing	Phumaf
Site coordinates	26°35'28.47"S/ 27°53'10.80"E	Phumaf
Weinerts N-value	3 to 4	Weinert (1974)
Climatic Region	Moderate	TRH 2 (1978)
Rainfall	650 to 700 mm	2526 Johannesburg (1999) 1:500 000 scale
Temperature	0-26°C	After DWAF (1986)
Evaporation	1625 mm	After DWAF (1986)
Water Balance	Deficit	Schulze (1985)
Weathering Type	Moderate decomposition	Fookes et al (1971) & Embleton et al (1979)
General geology	Sandstone and shale of the Vryheid Formation, Ecca Group, Karoo Supergroup, and chert and dolomite of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup.	2626 West Rand (1986) 1:250 000 scale
Soil cover	-	Brink (1985) Vol 4
Origin	-	Brink (1985) Vol 4
Topography	Varying between 2% and 5% or between 1:60 and 1:20.	
Quaternary Catchment	C22F	DWAF (1999)
Hydrogeology	D3: Intergranular and Fractured (0.5-2.0 L/sec) & C5: Karst (>5.0 L/sec)	2526 Johannesburg (1999) 1:500 000 scale
Depth to groundwater	Unknown	Barnard (2000)
Erodibility Index	Low 16-20	WRC (1992)
Seismic Intensity	VI (MMS)	Fernandez et al (1972)
Liquefaction Potential	Likely (peak horizontal acceleration 100-200 cm/s2)	Welland (2002)

The site is located within the town of Unitas Park in Gauteng. The site is approximately 154 ha in size and slopes gently towards an unnamed drainage path that follows the R54 along the south western boundary. The site is covered by grass in the southern and western portion while the remainder of the site is an active maize farm.

3. FIELDWORK

The initial fieldwork **for this investigation** was carried out on 17 November 2020 and comprised a detailed gravity survey at a spacing of 30 m grid over entire site, and is included in Appendix A.

Ten rotary percussion boreholes were also drilled across the site as part of a deep geotechnical investigation. A copy of the borehole logs is included in Appendix B-1 and the positions are shown on Figure 1. The coordinates of the borehole drilled during this investigation are given in Table 3 below:

Table 3: Summary of Borehole Coordinates (WGS84)

No	S – coordinate	E – coordinate	Depth (m)
BH01	26°37'05.24"S	27°54'22.47"E	31
BH02	26°37'17.31"S	27°54'33.83"E	13
BH03	26°37'11.46"S	27°54'10.87"E	20
BH04	26°37'13.43"S	27°54'05.63"E	21
BH05	26°37'34.16"S	27°54'10.85"E	36
BH06	26°37'06.90"S	27°54'18.00"E	31
BH07	26°37'13.32"S	27°54'27.71"E	53
BH08	26°37'30.70"S	27°53'54.19"E	41
BH09	26°37'32.08"S	27°54'03.49"E	30
BH11	26°37'42.98"S	27°53'57.21"E	52

4. SITE GEOLOGY

4.1 General Geology of the Area

The site is found to be underlain by a layer of transported material which in turn is underlain by residual chert and potential residual shale. This is underlain by chert bedrock and potential shale bedrock that has been intruded by syenite. This is underlain by dolomite bedrock of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup at between 13 m and >60 m below EGL. The dolomite bedrock described above is solid with penetration rates greater than 3 min/m. There appears to be a mantle of weathered & altered dolomite (WAD) just above the dolomite bedrock.

4.2 Transported

The horizon is typically orange brown to medium brown to red brown, silty sandy gravelly clay. It is found from surface to depths of between 1 m and 3 m and is found across the site.

4.3 Residual Shale

The residual shale is typically orange brown speckled red and grey, slightly sandy gravelly clay. The residual shale is found at depths between 3 m and 5 m.

4.4 Residual Chert

The residual chert is typically red brown speckled orange, silty gravely clay. The residual chert is found at depths between 1 m and 4 m.

4.5 Residual Syenite

The residual syenite is typically orange brown speckled light and dark grey to light orange brown, clayey gravel to gravelly silt. The residual chert is found at depths between 1 m and 4 m.

4.6 Shale Bedrock

Shale bedrock comprises generally orange brown speckled red and grey to dusky light brown mottled grey and red, completely to moderately weathered rock. It is seen to overlie the dolomite and chert at depths of >20 m.

4.7 Chert Bedrock

Chert bedrock comprises generally dark grey brown to dark brown mottled orange and white to light brown to light grey, highly to slightly weathered rock. It is seen to overlie the dolomite at depths of between 6 m and >30 m.

4.8 Syenite Bedrock

Syenite bedrock comprises generally dark grey stained red to orange brown, highly to moderately weathered rock. It is seen to overlie the dolomite and chert at depths of between 5 m and 23 m as well as intruding into the chert bedrock.

4.9 WAD

The weathered and altered dolomite (WAD) is seen to occur just above the dolomite bedrock or in thin lenses within the chert bedrock and is between 1 m and 4 m thick with some penetration rates <15 min/m.

4.10 Dolomite Bedrock

Fresh dolomite bedrock comprised as dark to light grey, slightly weathered rock with penetration rates of >3min/m and is found occurring at depths of between 13 m and >60 m.

5. GROUNDWATER AND HYDROGEOLOGICAL COMPARTMENTS

The drilling results from the dolomite stability investigation indicate that a varying groundwater table is present across the site with an average resting water level of 14.1 mbgl. This is summarised below in Table 5:

Table 5: Summary of Resting Water Levels in Boreholes

No	Depth to water (mbgl)
BH01	20.8
BH02	>13.0 (dry)
BH03	>20.0 (dry)
BH04	10.9
BH05	15.7
BH06	13.2
BH07	12.5
BH08	12.3
BH09	12.1
BH11	14.9

The rest water level implies that potential receptacles or caves within the dolomite bedrock (that may receive eroded material) will be water filled and are therefore unlikely to receive eroded material to form a sinkhole. **The base level of erosion is at this water level.**

The 1:500 000 hydrogeological map series (2526 Johannesburg, dated 1999) documents that the site overlies both intergranular and fractured, and karst aquifers as having a typical borehole yield of 0.5-2.0 *l/s* and >5.0 *l/s* respectively. The quality of the groundwater is represented by the conductivity range of 0-70 mS/m. The map also shows concentrated groundwater usage for irrigation purposes.

The site resides in the Lower Klip River North dolomitic groundwater compartment and shows an average decrease in water level from 51.2 mbgl in August 1987 to 53.9 mbgl in April 2009. This is probably caused by the increase in irrigation surrounding the site.

6. SEISMICITY

The site is represented by a seismic intensity of VI (MMS) and the expected maximum peak horizontal ground acceleration is 100-200 cm/s^2, due mainly to mining activity on the Reef and a fault that runs north south through the site. This is confirmed by the updated relevant SANS seismicity code which estimates the peak ground acceleration to be 0.15g (CGS, 2003) in the area, with a 10% probability of being exceeded in the next 50 years.

7. DOLOMITE STABILITY ASSESSMENT

The site dolomite D classes are provided based on the type of structures envisaged (generally residential). The site is to include single storey structures and structures up to 3 storeys. The densities provided by the client fit into two designations of structures and are summarised below in Table 7:

Table 7: Summary of Land Use Designations

Designation	Description
RN1	Up to 60 dwelling houses per hectare with stands larger than 150 m2, and a population of < 300 people per hectare
RL1	≤ 3 storeys with 80 to 120 units per hectare and a population not exceeding 600 people per hectare

7.1 Previous Dolomite Stability Investigations

Investigations at the Council of Geological Sciences (CGS) revealed that three previous dolomite drilling investigations have been undertaken in the area. These include a report written by Intraconsult in 2008 (CGS report reference: F4783), a report written by VGI Consult in 2015 (CGS report reference: F4783, a report written by R.F Loxton, Hunting, and Associates in 1976 (CGS report reference: F659), and a report written by GeoStable SA cc in 2018 (CGS report reference: F5452). During drilling, air flush samples and penetration times were taken at intervals of 1 m and any air losses, minimal resistance to drilling and cavities were recorded where present. Water strikes were recorded during drilling when encountered. Recovered samples were logged by a registered engineering geologist.

CGS report F4783 by Intraconsult included eighteen boreholes for a potential residential development within the site. The depths of these boreholes range between 18 m and 60 m, with dolomite being encountered in BH 3540, 3621, 4037, 4325, and 4443.

CGS report F4783 by VGI Consult included four boreholes for a proposed residential development within the site. The depth of these boreholes was 60 m, with dolomite not being encountered in any of them.

CGS report reference F659 included one borehole for a proposed residential development within the site. The depth of this borehole was 22 m, with dolomite not being encountered.

CGS report reference F5452 included two boreholes for a proposed residential development within the site. The depth of these boreholes was 60 m, with dolomite not being encountered.

The existing borehole logs across the site can be found in Appendix B-2 and a summary of the boreholes drilled can be seen below in Table 7.1:

Table 7.1: Summary of Desk Study

CGS Report No	BH No	Dolomite Bedrock (mbgl)	IHC	Dolomite 'D' Designation
F4783 (Intraconsult)	2643	>60	1-4//1-4	D2-D4
	2648	>60	1-4//1-4	D2-D4
	2931	>60	1//1	D2
	2938	>60	1-4//1-4	D2-D4
	3044	>57	1//1	D2
	3426	>60	1//1	D2
	3451	>60	1-4//1-4	D2-D4
	3456	>57	4//4	D4
	3540	27-33	4//4	D4
	3621	22-28	4//4	D4
	3832	>60	1//1	D2
	3948	>60	4//4	D4
	4037	38-44	1//1	D2
	4325	34-40	4//4	D4
	4443	12-18	3//3	D4
	4655	>60	1//1	D2
	4732	>60	1//1	D2
	4750	>44	1//1	D2
F4783 (VGI)	1544/5	>60	4//4	D4
	3925/01	>60	4//4	D4
	3925/11	>60	1//1	D2
	3925/12	>60	1//1	D2
F659	BH3	>22	2//2	D2
F5452	GS03	>60	1//1	D2
	GS04	>60	1//1	D2

***Please note that Footprint Investigations (FPI's) will be required for building class RL1.**

7.2 Project Dolomite Stability Investigation

7.2.1 Project Percussion Drilling

Eleven rotary percussion boreholes were drilled during this dolomite stability investigation. During drilling, air flush samples and penetration times were taken at intervals of 1 m and any air losses, minimal resistance to drilling and cavities were recorded where present. Water strikes were recorded during drilling when encountered. Recovered samples were logged by a registered engineering geologist.

Borehole logs can be found in Appendix B-1 and a summary of the borehole logs is shown in Table 7.2.1 below:

Table 7.2.1: Summary of Borehole Data

BH No	Wad (m-m)	Chert (m-m)	Dolomite (mbgl)	Water Level (mbgl)	Gravity Signal	Penetration Rate (s/m)			Air Loss			IHC	D-Designation**	Dolomite Zone
						Cavity	0-10	10-15	Slight	Med	Total			
GCS (2021)														
01	-	2-11,27-31	>31	20.8	High	-	-	-	-	-	-	4//4	D4	C
02	-	1-6	6-13	-	High	-	-	-	-	-	-	3//3	D4	C
03	-	-	>20	-	Low	-	-	-	12-20	-	-	2//2	D2	A
04	-	-	>20	10.9	Low – Medium	-	-	-	-	-	-	2//2	D2	A
05	-	1-36	>36	15.7	Medium – High	-	-	-	-	-	-	4//4	D4	C
06	-	8-17,23-31	>31	13.2	Medium	-	-	-	-	-	-	4//4	D4	C
07	31-36	12-20	45-53	12.5	Medium	-	33-36	31	33-36,45,51-53	31-33	-	4//8	D4	C
08	-	2-18,24-41	>41	12.3	Medium	-	-	-	-	-	-	4//4	D4	C
09	-	0-6,15-30	>30	12.1	Medium – High	-	-	-	-	-	-	4//4	D4	C
11	-	0-5,20-40	40-52	14.9	Medium	-	-	-	-	-	-	4//4	D4	C
Intraconsult (2008)														
2643	-	-	>60	34	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
2648	-	-	>60	34	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
2931	-	-	>60	34	Low	-	-	-	-	-	-	1//1	D2	A
2938	-	-	>60	38	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
3044	-	29-30,40-51	>57	36	Medium – High	-	-	-	-	-	-	1//1	D2	A
3426	-	-	>60	34	Low	-	-	-	-	-	-	1//1	D2	A
3451	-	-	>60	31	Medium	-	-	-	-	-	-	1-4//1-4	D2-D4	B
3456	-	9-57	>57	29	High	-	-	-	-	-	-	4//4	D4	C
3540	-	6-27	27-33	-	Medium	-	-	-	-	-	-	4//4	D4	C
3621	-	2-21	22-28	-	High	-	-	-	-	-	-	4//4	D4	C
3832	-	-	>60	32	Low	-	-	-	-	-	-	1//1	D2	A
3948	-	7-22,30-60	>60	31	Medium	-	-	-	-	-	-	4//4	D4	C
4037	-	30-38	38-44	32	Medium	-	-	-	-	-	-	1//1	D2	A
4325	-	10-34	34-40	31	Medium – High	-	-	-	-	-	-	4//4	D4	C
4443	-	2-12	12-18	-	Medium – High	-	-	-	-	-	-	3//3	D4	C
4655	-	-	>60	27	Medium	-	-	-	-	-	-	1//1	D2	A
4732	-	-	>60	31	Low	-	-	-	-	-	-	1//1	D2	A
4750	-	-	>44	28	Low	-	-	-	-	-	-	1//1	D2	A
VGI Consult (2015)														
1544/5	-	0-60	>60	-	Medium	-	-	-	-	-	-	4//4	D4	C
3925/01	-	4-16,34-60	>60	24.0	Medium	-	-	-	-	-	-	4//4	D4	C
3925/11	-	31-60	>60	Collapse	Low	-	-	-	-	-	-	1//1	D2	A
3925/12	-	-	>60	23.0	Low	-	-	-	-	-	-	1//1	D2	A
Luxton (1976)														
BH3	-	-	>22	19.1	Low	-	-	-	-	-	-	2//2	D2	A
GeoStable (2018)														
GS03	-	-	>60	12.0	Low	-	-	-	-	-	-	1//1	D2	A
GS04	-	-	>60	16.0	Low	-	-	-	-	-	-	1//1	D2	A

Mbgl = metres below ground level
*** = water strikes measured, boreholes collapsed, and rest water levels were unable to be recorded.**
**** = FPI Required for Building Class RL1 on D2 land**

7.3 Dolomite Stability Evaluation

7.3.1 General Site Geotechnical Conditions

The following geotechnical factors determined during the investigation are considered pertinent to the evaluation of the stability of the site with respect to features associated with dolomitic terrain.

- Slightly weathered and fractured dolomite bedrock was encountered across the site at depths between 6 m and >60 m. The drilling results therefore indicate a mature karst terrain.
- Water strikes were encountered.
- Water levels across the site are anticipated to be between 10.9 m and 20.8 m and relatively shallow ground water is seen across the site. **This is considered a condition positive to stability as this water table represents the base level of potential erosion.** Caverns, if present, within the dolomite bedrock will also likely be water-filled and thus preventing the acceptance of any eroded material from above, which is a positive.
- Much of the upper soil profile above the water table is considered to possess a relatively low permeability and erosion potential and therefore a low to medium with respect to mobilisation, with a fairly steep angle of draw (60 to 80 degrees). This condition generally produces medium-sized sinkholes.
- Dolomite residuum (WAD) was identified in BH07 and is seen to over lie the dolomite bedrock. **This condition is considered negative to the stability of the profile with respect to mobilisation.**
- For the purposes of risk assessment, it has been assumed that small disseminated and interconnected openings (receptacles) occur within the dolomite residuum that was encountered across the site. Such a condition is necessary for the formation of sinkholes and dolines. Likewise, cavities must be assumed to exist within the dolomite bedrock.
- **Slight to medium air loss was encountered in BH0 & 07 just above and within the WAD-rich zones.**
- The relatively flat ground fall (1:20 to 1:60) across the site will not generally encourage the run-off of surface stormwater and is considered a negative in terms of stability but can be mitigated and engineered.
- **The water level variation over 25 years has been recorded as a 2.7 m drop and the OWL has been estimated at a depth around 40-50 m below surface.**

7.3.2 Zonal Demarcation

The site can be demarcated into three zones based on the borehole profiles. The site is underlain by deep shales as well as chert interbedded by syenite, diamictite, and dolomite. This shale unit is either part of the Malmani Subgroup, resulting in the profile being dolomitic, or part of the Karoo Supergroup, resulting in the profile being non-dolomitic.

7.3.2.1 Zone A

Zone A is represented by the following boreholes:

Borehole:		
GCS (2021)		
BH03	BH04	
Intraconsult (2008)		
2931	3823	4732
3044	4027	4750
3426	4655	
VGI (2015)		
3925/11	3925/12	
Luxton (1976)		
BH3		
GeoStable (2018)		
GS03	GS04	

Solid dolomite bedrock was encountered in this zone at a depth of between 38 m and >60 m with no WAD or low-density material greater than 2m above. This area has been classified as ***IHC1//1*** (D2) with a low risk of small sinkhole formation and low risk of subsidence.

7.3.2.2 Zone B

Zone B is represented by the following boreholes:

Borehole:		
Intraconsult (2008)		
2643	2648	2938
3451		

Solid dolomite bedrock was not encountered in this zone to a depth of >60 m with no WAD or low-density material greater than 2m above. This area has been classified as ***IHC1-4//1-4*** (IHC1=D2; IHC4=D4) with a low to medium risk of small to large sinkhole formation and low to medium risk of subsidence. This zone comprises boreholes that encountered issues with the identification of the formation or group. The shale bedrock comprises either Vryheid Formation (Karoo cover) or Malmani Subgroup (dolomitic cover). If the overlying shale is Vryheid Formation, then the zone is IHC1//1, whereas if the shale is Malmani Subgroup, the zone is IHC4//4. Previous logs identified the shale as Vryheid Formation, however the presence of chert fragments throughout the profile opposes with this classification.

7.3.2.3 Zone C

Zone C is represented by the following boreholes:

Borehole:		
GCS (2021)		
BH01	BH02	BH05
BH06	BH07	BH08
BH09	BH11	
Intraconsult (2008)		
3456	3948	4325
3540	3621	4443
VGI (2015)		
1544/5	1544/5	

Solid dolomite bedrock was encountered in this zone at a depth of between 6 m and >60 m with WAD or low-density material greater than 2m in BH07 only. This area has been classified as ***IHC3-4//3-4*** (D4) with a medium risk of small to large sinkhole formation and medium risk of subsidence.

The zones can be analysed in terms of dolomite stability in the following manner:

7.3.3 Zone A

- ***Existing Receptacle Development***

Slight airloss was recorded in BH03 only and no sample loss was not recorded in any of the boreholes. No cavities were recorded in the boreholes. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The karoo and chert cover will likely prove competent. Low-density erodible WAD was not present in any boreholes.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a low risk for a small (<2 m Ø) sinkhole. A low risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a low risk for small to large sinkholes and a low risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone A can be assigned an IHC of 1//1 and a D2 Designation (SANS 1936-1:2012). The proposed new development is therefore supported with standard precautionary measures.

7.3.4 Zone B

- ***Existing Receptacle Development***

Slight airloss and sample loss was not recorded in any of the boreholes. No cavities were recorded in the boreholes. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The potential karoo and chert cover will likely prove competent. Low-density erodible WAD was not present in any boreholes.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a medium risk for a small to large (<2 to 15m Ø) sinkhole. A medium risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The potential karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a medium risk for small to large sinkholes and a medium risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone B can be assigned an IHC of 1-4//1-4 and a D2 (IHC1//1 only) or D4 Designation (IHC4//4 only) (SANS 1936-1:2012). The proposed new development on D2 land is therefore supported with standard precautionary measures while D4 land will require **site specific precautionary measures**.

7.3.5 *Zone C*

- ***Existing Receptacle Development***

Slight to medium airloss and slight sample loss was recorded in BH07 only. No cavities were recorded in the boreholes, but low penetration rates were encountered between 33 m and 36 m. Cavities are, however, assumed to exist within the dolomite bedrock beneath the site and it is highly likely that these cavities may be water-filled due to all the boreholes recording relatively shallow resting water levels.

- ***Mobilising Agencies***

The water table has been measured to be an average of 14.1 m below surface. The original water level (OWL) has been estimated to be about 50 to 55 mbgl. Therefore, the mobilising agencies considered will be the ingress of surface water and possibly leaking services.

- ***Nature of Blanketing Layers***

The potential karoo, syenite, and chert cover will likely prove competent. Low-density erodible WAD was present in BH07 only and had penetration rates of >15 sec/min between 33 m and 36 m.

- ***Potential Development Space***

The geotechnical properties would suggest a maximum potential development space that would correspond to a medium risk for a small to large (<2 to 15m Ø) sinkhole. A medium risk is associated with subsidence.

- ***Mobilising Potential of Blanketing Layer***

The potential karoo, syenite, and chert cover found above the dolomite is considered to have a low mobilisation potential due to the moderate to high penetration rates, inherently low permeability and medium density.

- ***Risk of Sinkhole/Doline Development***

There is a medium risk for small to large sinkholes and a medium risk of subsidence.

- ***Inherent Hazard Class (IHC)***

Zone C can be assigned an IHC of 3-4//3-4 and a D4 Designation (SANS 1936-1:2012). The proposed new development is therefore supported with **site specific precautionary measures**.

7.4 Summary of Dolomite Risk Assessment

The risk assessment is based on certain assumptions, the most important of which are that the dolomite residuum contains potential receptacles and secondly, that the soil would be subjected to a mobilising agency. The most common mobilising agency is ingress of water, which causes sub-surface erosion. The water table represents the base-level of erosion and thus all the unconsolidated soil overlying the dolomite bedrock can be subjected to erosion and mobilisation and this may include a significant amount of WAD (but occurs in limited amounts on this site).

It can be possible to exercise some control over the risk of sinkhole/doline development by providing suitable (and proven) controls to prevent water ingress into the underlying soil horizons. It is essential that a high level of priority be placed on the provision of sound water management procedures in the long term. Recommendations in this regard are given in Appendix C. It is also important to ensure that the procedures adopted for the development do not interfere with the regional water table. **Thus, pumping from boreholes or otherwise lowering of the water table should be discouraged.**

All of the borehole results in each zone have revealed that there is a low to medium risk for small to large sinkholes referring to IHC 1-4//1-4 (D2-D4).

In summary, the site can be represented by IHC 1-4//1-4 (D2-D4 depending on development type). The summary can be seen below in Table 7.4:

Table 7.4: Summary of Proposed Housing Development

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

In terms of the IHC 1-4//1-4 assessment for the site, collectively, the proposed development (Building Class RL1 & RN1) is considered suitable provided the water precautionary measures listed in Appendix C are adhered to and the foundation recommendations listed below are implemented.

The following also applies:

- Structures built on dolomitic terrain of IHC 1//1 with dolomite bedrock between 38 m and >60 m with a D2 dolomite area designation (as per the above table) will require precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground.
- Structures built on dolomitic terrain of IHC 3-4//3-4 with dolomite bedrock between 6 m and >60 m with a D4 dolomite area designation (as per the above table) are unlikely to result in a tolerable hazard if the precautionary measures required in terms of SANS 1936-3 are adhered to. Site-specific precautionary measures are required. **The development is not supported as this would attract a D4 classification and the additional precautionary measures suggested for D2/3 would not reduce the risk to manageable levels. If considered necessary, then the development will require the assistance of a dolomite D4 specialist to oversee the design, construction and implementation of the DRMS and DRMP.**
- Where possible the invert excavation level to the soil mattress foundation solution should be moistened to OMC before being compacted to receive the excavated material (supplemented by a coarser fraction) in compacted layers of 150mm maximum thickness to not less than 95% MADD at approximately +/-2% of optimum moisture content. Strict compaction control should be carried out to ensure that the required density is achieved.
- It should be remembered that due to the negative bulking factor produced by compaction (typically up to 30% reduction), extra material may have to be borrowed from cut excavations elsewhere on the site to complete construction of the bedding layer and backfilling, or if not available, identified and purchased from a nearby commercial source.

In terms of the Inherent Hazard Class 1-4//1-4 for the entire site, the proposed development is considered to be suitable and appropriate provided the D2 or D4 dolomite area designation restrictions are implemented.

8. DEVELOPMENT RECOMMENDATIONS

8.1 Proposed Development and Appropriate 'D' Designations

It is understood that the proposed development will be a residential development. In view of the dolomite stability assessment (which has determined that the entire site is characterised by an IHC 1-4//1-4) the proposed development is considered suitable providing the required precautionary measures according to the dolomite D designation are employed.

In terms of the dolomite area designations (SANS 1936-1:2012), an appropriate D2 or D4 Designation should be enforced over the site as per Table 7.4.

A dolomite area designation D2 and D4 state the following:

D2 – "*General precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground, are required.*"

D4 – *"The precautionary measures required in terms of SANS 1936-3 are unlikely to result in a tolerable hazard. Site-specific precautionary measures are required."*

This report will be perused in detail by the CGS and an official Record of Decision (RoD) will be provided.

9. CONCLUSIONS

This report contains the results of a stability assessment carried out for the Unitas Park Ext 16 in Unitas Park, Gauteng. The purpose of this report is to assess the potential for dolomite instability and potential sinkhole formation.

Holistically, the subsoil conditions encountered over the site generally comprise a thin cover of transported material underlain by residual chert, residual shale, residual syenite potentially shale bedrock, shale bedrock, syenite bedrock, chert bedrock, and finally underlain by weathered to fresh dolomite. The water table was measured at between 10.9 m and 20.8 m with the OWL that possibly resided at an assumed depth of around 50 m to 55 m below surface.

The drilling results of this investigation have been utilised, together with the current gravity survey and three previous drilling investigated. This data was analysed to determine the inherent hazard class (IHC) of the entire site and ascertain the sustainability of the proposed development with respect to the dolomite stability.

All of the borehole results combined have revealed that there is a low to medium risk for small to large sinkholes. The entire site can be classed as IHC 1-4//1-4 with a dolomite area designation of D2-D4. A summary is provided below:

Zone	Sinkhole	IHC	Building Class	Designation	IHC (Zone)	Relevant Boreholes
A	Low Risk for Small	1//1	RN1	D2	1//1	GCS (2012): BH03, 04 Intraconsult (2008): 2931, 3823, 4732, 3044, 4027, 4750, 3426, 4655 VGI (2015): 3925/11, 3925/12 Luxton (1976): BH3 GeoStable (2018): GS03, GS04
			RL1	D2 + FPI		
B	Low - Medium Risk for Small-Large	1//1	RN1	D2	1-4//1-4	Intraconsult (2008): 2643, 2648, 2938, 3451
		1//1	RL1	D2 + FPI		
		4//4	RN1, RL1	D4		
C	Medium Risk for Small – Large	4//4	RN1, RL1	D4	3-4//3-4	GCS (2021): BH01, BH02, BH05, BH06, BH07, BH08, BH09, BH11 Intraconsult (2008): 3456, 3948, 4325, 3540, 3621, 4443 VGI (2015): 1544/5, 1544/5

10. RECOMMENDATIONS

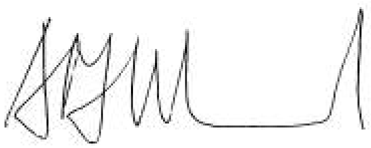
This type of development can only be considered provided the water precautionary measures in Appendix C are adhered to and a D2 or D4 designation (refer to above table) implemented for water ingress prevention and foundations. The available open space has provisionally been assessed in terms of the risk of dolomite instability by using a standard gravity and drilling survey according to SANS 1936-1.

Recommendations for earthworks and drainage to promote any stable and appropriate development (especially applicable to dolomitic terrain) are given.

It is a requirement that this report be presented to the Council for Geoscience for perusal, archiving and the provision of an official Record of Decision. Furthermore, construction supervision by approved dolomite practitioners (geo-professionals and engineers) will be required and also the design and implementation of the required DRMS and DRMP in accordance with SANS 1936-4.

If a RN1 & RL1 type development is considered necessary on IHC 3-4//3-4 land, then a dolomite D4 specialist will be required to oversee the design, construction, preparation and implementation of the required DRMS and DRMP.

Finally, the ground conditions described in this report refer specifically to those encountered in the boreholes put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that ***GCS Geotechnical*** carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense. **In this regard it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.**



Nino Welland, Pr. Eng., Pry Sci Nat
Director
For ***GCS Geotechnical***

Dale Franklin, Pr.Sci.Nat
Associate Engineering Geologist

APPENDIX A
Gravity Survey Report

APPENDIX B-1
Project Borehole Profiles

HOLE No: BH01
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

GCS Geotechnical Engineering

HOLE No: BH01
Sheet 1 of 1

JOB NUMBER: 000

Scale 1:150

Rate (min & sec)
0.22
0.38
0.29
0.38
0.18
0.22
0.27
0.29
0.31
0.46
0.56
0.59
0.37
0.41
0.22
0.29
0.44
0.55
0.49
0.56
1.04
1.05
0.51
0.39
0.34
0.59
0.36
0.31
0.46
0.51
0.44

Penetration rate (min/m): 1 2 3 4 5

Air return (%): 25 50 75

Sample return (%): 25 50 75

REDUCED LEVEL: -5, -10, -15, -20, -25, -30

20.8m

0.00

Medium brown speckled orange, sandy (10%) gravelly (20%) CLAY (70%). Interpreted as Transported.

2.00

Light grey to medium grey, gravelly (10%) clayey (15%) SILT (75%) with chert fragments, highly weathered due to penetration rates of between 0:18 and 0:56 min/m. Interpreted as CHERT. Malmani Subgroup.

11.00

Dark grey stained red, slightly gravelly (10%) clayey (25%) SILT (65%) with syenite fragments, highly to moderately weathered due to penetration rates of between 0:22 and 1:05 min/m. Interpreted as SYENITE.

27.00

Medium brown to dark grey, clayey (10%) sandy (10%) GRAVEL (80%) with chert fragments, highly weathered due to penetration rates of between 0:31 and 0:51 min/m. Interpreted as CHERT. Malmani Subgroup.

31.00

NOTES

1) Water Table at 20.8m.
2) No Groundwater Strike.
3) Final Depth at 31.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 22.47"E
Y-COORD : 26 37 05.24"S

HOLE No: BH01

HOLE No: BH02
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

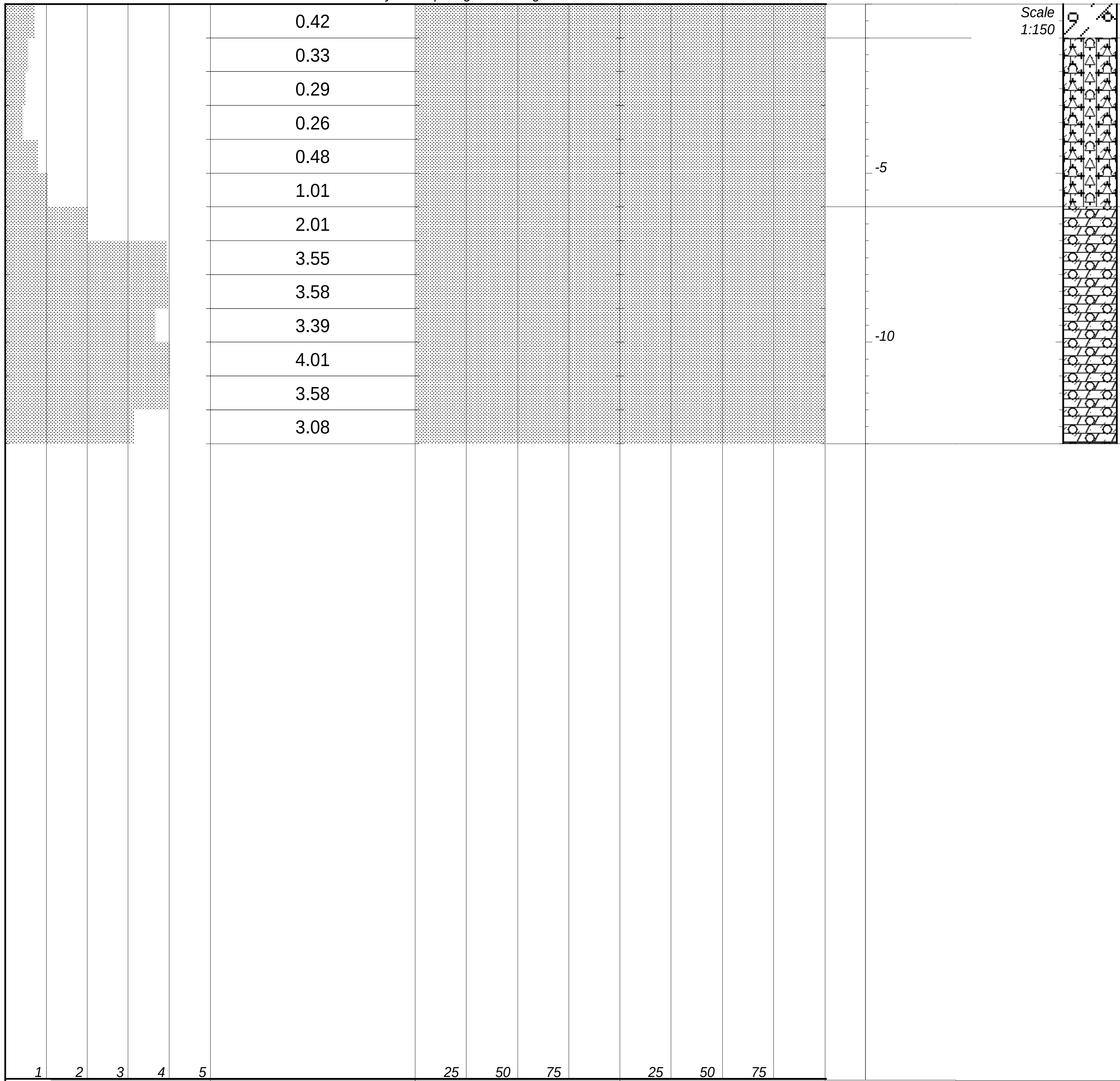
JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH02
Sheet 1 of 1

JOB NUMBER: 000



Rate (min & sec)
0.42
0.33
0.29
0.26
0.48
1.01
2.01
3.55
3.58
3.39
4.01
3.58
3.08

0.00
Orange brown, gravelly (10%) CLAY (90%). Interpreted as Transported.

1.00
Light orange, slightly gravelly (5%) clayey (20%) SILT (75%). Interpreted as Residual Chert and Syenite.

6.00
Light to dark grey, clayey (10%) sandy (10%) GRAVEL (80%) with dolomite fragments, positive HCl reaction, slightly weathered due to penetration rates of between 3:08 and 4:01 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

13.00

NOTES
1) No Water Table.
2) No Groundwater Strike.
3) Final Depth at 13.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 33.83"E
Y-COORD : 26 37 17.31"S

HOLE No: BH02

HOLE No: BH03
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

GCS Geotechnical Engineering

HOLE No: BH03
Sheet 1 of 1

JOB NUMBER: 000

Rate (min & sec):

Rate
0.26
0.31
0.32
0.36
0.41
1.11
1.24
1.02
1.40
1.34
1.46
0.22
1.03
1.10
1.33
1.24
1.39
1.59
1.22
1.54

Scale 1:150

Depth	Description
0.00 – 3.00	Red brown, silty (20%) CLAY (80%). Interpreted as Transported.
3.00 – 5.00	Orange brown speckled red and grey, slightly sandy (5%) gravelly (15%) CLAY (80%) with sale and ferricrete fragments, highly weathered due to use of clay cutter. Interpreted as SHALE. Vryheid Formation.
5.00 – 20.00	Dusky light brown mottled grey and red, slightly sandy (5%) gravelly (15%) silty (20%) CLAY (60%) with shale fragments, highly weathered due to use of clay cutter. Interpreted as SHALE. Vryheid Formation.

Reduced level: -5, -10, -15, -20

NOTES
1) No Water Table.
2) No Groundwater Strike.
3) Final Depth at 20.0m.
4) No Zone of penetration rates <15sec/m.
5) Clay cutter used between 4.0--12.0m.
6) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

Penetration rate (min/m): 1 2 3 4 5 | Rate (min & sec) | Air return (%): 25 50 75 | Sample return (%): 25 50 75 | REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 10.87"E
Y-COORD : 26 37 11.46"S

HOLE No: BH03

HOLE No: BH04
Sheet 1 of 1

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

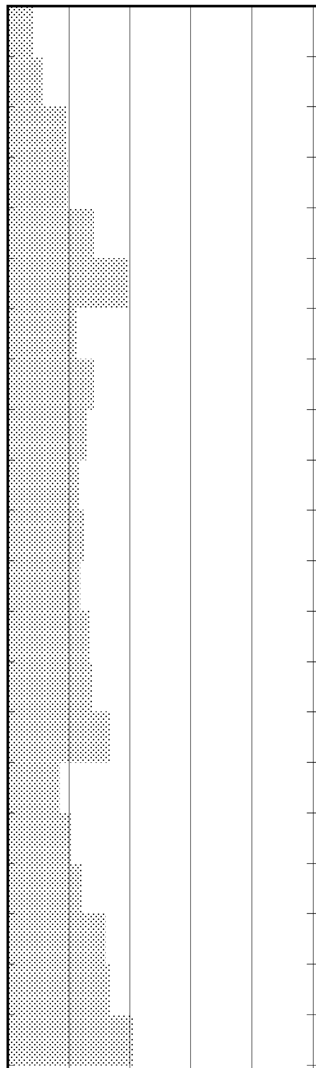
JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH04
Sheet 1 of 1

JOB NUMBER: 000



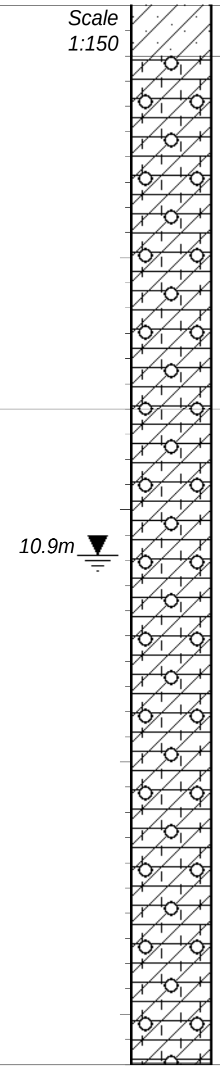
Rate (min & sec)
0.25
0.34
0.58
0.59
1.24
1.59
1.07
1.24
1.18
1.10
1.15
1.11
1.21
1.22
1.41
0.51
1.01
1.12
1.36
1.41
2.03

Air return (%): 25 50 75

Sample return (%): 25 50 75

REDUCED LEVEL: -5, -10, -15, -20

Scale 1:150



Depth (m)	Description
0.00	Dark red brown, sandy (20%) CLAY (80%). Interpreted as Transported.
1.00	Dark yellow brown, slightly gravelly (3%) silty (7%) CLAY (90%) with quartz and shale fragments, completely to highly weathered due to use of the clay cutter. Interpreted as SHALE. Vryheid Formation.
8.00	Light yellow brown, slightly gravelly (3%) silty (7%) CLAY (90%) with shale fragments, completely to highly weathered due to use of the clay cutter. Interpreted as SHALE. Vryheid Formation.
21.00	

NOTES
1) Water Table at 10.9m.
2) No Groundwater Strike.
3) Final Depth at 21.0m.
4) No Zone of penetration rates <15sec/m.
5) Clay cutter used between 7.0--16.0m.
6) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 05.63"E
Y-COORD : 26 37 13.43"S

HOLE No: BH04

HOLE No: BH05
Sheet 1 of 2
JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH05
Sheet 1 of 2
JOB NUMBER: 000

Scale 1:150

Rate (min & sec)
0.37
0.41
0.36
0.28
0.56
0.59
1.03
1.12
1.01
1.37
1.15
1.01
1.03
0.32
0.46
0.49
0.52
0.38
0.28
0.42
1.26
1.28
1.26
1.09
1.12
1.00
1.25
1.09
1.06
1.31
1.21
1.22
1.33

Penetration rate (min/m): 1 2 3 4 5

Air return (%): 25 50 75

Sample return (%): 25 50 75

REDUCED LEVEL: -5, -10, -15, -20, -25, -30

15.7m

Depth (m)	Description
0.00	Red brown, gravelly (20%) CLAY (80%). Interpreted as Transported.
1.00	Orange brown speckled medium to dark grey, gravelly (40%) CLAY (60%) with chert fragments, highly weathered due to penetration rates of between 0:28 and 0:59 min/m. Interpreted as CHERT. Malmani Subgroup.
6.00	Pale orange brown, gravelly (10%) silty (30%) CLAY (60%) with chert fragments, highly to moderately weathered due to penetration rates of between 1:01 and 1:37 min/m. Interpreted as CHERT. Malmani Subgroup.
9.00	Light and dark grey, silty (10%) sandy (15%) GRAVEL (75%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:28 and 1:28 min/m. Interpreted as CHERT. Malmani Subgroup.
27.00	Medium to dark grey, silty (5%) gravelly (30%) SAND (65%) with chert fragments, moderately weathered due to penetration rates of between 1:06 and 1:25 min/m. Interpreted as CHERT. Malmani Subgroup.
29.00	Light and dark grey, silty (10%) sandy (15%) GRAVEL (75%) with chert fragments, moderately weathered due to penetration rates of between 1:21 and 1:34 min/m. Interpreted as CHERT. Malmani Subgroup.

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH05
Sheet 2 of 2

JOB NUMBER: 000

1.24
1.28
1.34

-35

36.00

NOTES

1) Water Table at 15.7m.
2) No Groundwater Strike.
3) Final Depth at 36.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

Penetration rate (min/m) 1 2 3 4 5	Rate (min & sec)	Air return (%) 25 50 75	Sample return (%) 25 50 75	REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 10.85"E
Y-COORD : 26 37 34.16"S

HOLE No: BH05

HOLE No: BH06
Sheet 1 of 1

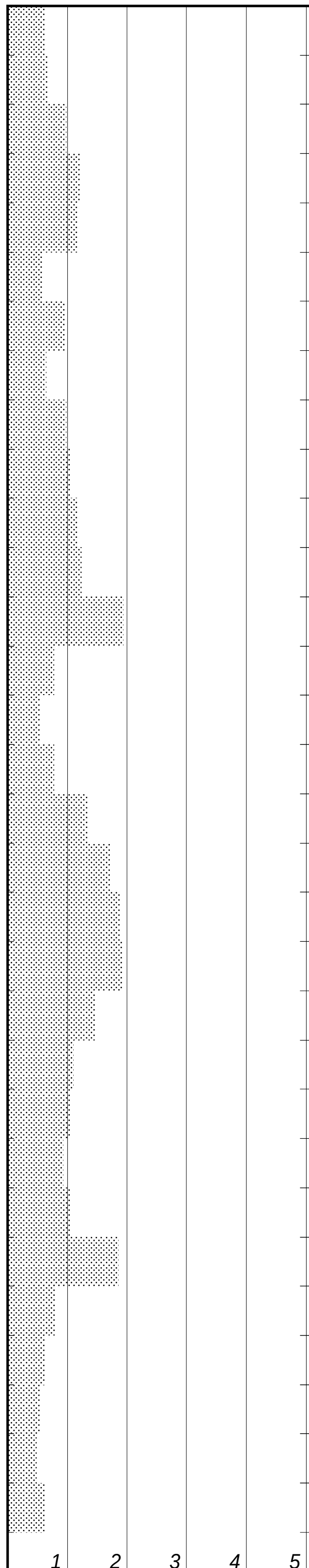
JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

GCS
Geotechnical Engineering

HOLE No: BH06
Sheet 1 of 1

JOB NUMBER: 000



Rate (min & sec)
0.38
0.41
0.59
1.12
1.10
0.35
0.58
0.39
0.59
1.03
1.10
1.14
1.56
0.46
0.32
0.46
1.21
1.43
1.53
1.55
1.27
1.06
1.03
0.56
1.03
1.51
0.48
0.37
0.32
0.29
0.37

Penetration rate (min/m): 1 2 3 4 5

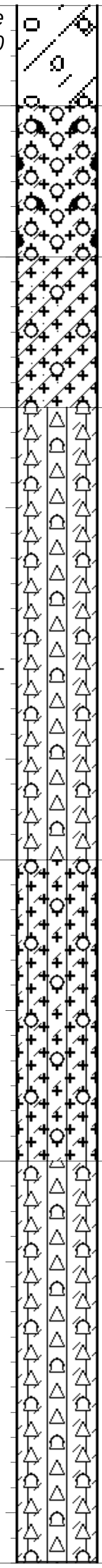
Air return (%): 25 50 75

Sample return (%): 25 50 75

REDUCED LEVEL: -5, -10, -15, -20, -25, -30

Scale 1:150

13.2m



0.00 Red brown, gravelly (5%) sandy (10%) CLAY (85%). Interpreted as Transported.

2.00 Orange brown speckled dark grey, clayey (10%) GRAVEL (90%) with ferricrete nodules. Residual Syenite.

5.00 Orange brown, sandy (15%) gravelly (25%) CLAY (65%) with syenite fragments, highly weathered due to penetration rates of between 0:35 and 0:58 min/m. Interpreted as SYENITE.

8.00 Light grey, gravelly (10%) clayey (20%) SILT (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:32 and 1:56 min/m. Interpreted as CHERT. Malmani Subgroup.

17.00 Light orange brown, gravelly (15%) clayey (20%) SILT (65%) with syenite fragments, moderately weathered due to penetration rates of between 1:03 and 1:55 min/m. Interpreted as SYENITE.

23.00 Light to medium grey, gravelly (10%) clayey (10%) SILT (80%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:51 min/m. Interpreted as CHERT. Malmani Subgroup.

31.00 NOTES

1) Water Table at 13.2m.
2) No Groundwater Strike.
3) Final Depth at 31.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 18.00"E
Y-COORD : 26 37 06.90"S

HOLE No: BH06

HOLE No: BH07
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

GCS
Geotechnical Engineering

HOLE No: BH07
Sheet 1 of 2

JOB NUMBER: 000

Scale 1:150

Rate (min & sec)
0.35
0.32
0.29
0.36
0.22
0.41
0.31
0.39
0.56
0.44
0.39
0.40
0.27
0.24
0.17
0.26
0.32
0.34
0.26
0.28
0.21
0.55
0.41
0.33
0.29
0.38
0.40
0.36
0.28
0.55
0.16
0.10
0.18

Reduced level: -5, -10, -15, -20, -25, -30

Water level: 12.5m

Depth (m)	Description
0.00 – 1.00	Dark brown speckled orange and grey, sandy (5%) clayey (20%) GRAVEL (75%). Interpreted as Transported.
1.00 – 2.00	Red brown speckled orange, silty (10%) gravelly (15%) CLAY (75%). Interpreted as Residual Chert.
2.00 – 8.00	Light grey to medium grey, sandy (5%) gravelly (20%) SILT (75%), highly weathered due to penetration rates of between 0:22 and 0:44 min/m. Interpreted as CHERT. Malmani Subgroup.
8.00 – 12.00	Light orange brown, slightly gravelly (5%) clayey (10%) SILT (85%), highly weathered due to penetration rates of between 0:39 and 0:56 min/m. Interpreted as CHERT. Malmani Subgroup.
12.00 – 20.00	Light orange with dusky red bands at 15m & 20m, slightly gravelly (5%) clayey (20%) SILT (75%) with syenite fragments, highly weathered due to penetration rates of between 0:17 and 0:34 min/m. Interpreted as SYENITE.
20.00 – 31.00	Dark orange brown, slightly gravelly (5%) clayey (30%) SILT (65%) with syenite fragments, highly weathered due to penetration rates of between 0:16 and 0:55 min/m. Interpreted as SYENITE.
31.00	

Penetration rate (min/m)	Rate (min & sec)	Air return (%)	Sample return (%)	REDUCED LEVEL
1 2 3 4 5		25 50 75	25 50 75	

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH07
Sheet 2 of 2
JOB NUMBER: 000

Rate (min & sec)
0.06
0.05
0.10
3.01
1.48
1.36
1.01
1.19
1.16
1.24
2.06
1.50
2.59
1.01
3.46
3.39
3.01
3.16
3.59
3.03

Reduced level: -35, -40, -45, -50

Dark brown, gravelly (30%) SILT (70%) with chert and dolomite fragments, very low penetration rates of between 0:05 and 0:18 min/m with a dolomite floater at 37.0m. Interpreted as WAD.

37.00

Dark brown, GRAVEL (100%) due to water washing out fines, with chert and dolomite fragments (+HCl reaction), moderately weathered due to penetration rates of between 1:01 and 2:06 min/m. Interpreted as Interbedded CHERT and DOLOMITE. Malmani Subgroup.

45.00

Dark to medium grey, GRAVEL (100%) due to water washing out fines, with dolomite fragments (+HCl reaction), moderately to slightly weathered due to penetration rates of between 1:01 and 3:59 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

53.00

NOTES

1) Water Table at 12.5m.
2) No Groundwater Strike.
3) Final Depth at 53.0m.
4) Zone of penetration rates <15sec/m at 32.0m and 34.0-- 36.0m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5 — Penetration rate (min/m)
Rate (min & sec)
25 50 75 — Air return (%)
25 50 75 — Sample return (%)
REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 27.71"E
Y-COORD : 26 37 13.32"S

HOLE No: BH07

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 000

Rate (min & sec):

0.39
0.22
0.29
0.34
0.41
0.37
0.34
0.22
0.51
0.58
1.10
0.47
0.33
0.39
0.29
0.27
0.34
0.28
0.26
0.35
0.38
0.59
0.52
0.39
1.01
1.17
1.25
1.01
0.29
0.31
0.48
0.49
0.30

Scale 1:150

12.3m

Depth (m)	Description
0.00	Red brown, gravelly (20%) silty (20%) CLAY (60%). Interpreted as Transported.
2.00	Light grey to medium brown, silty (20%) sandy (25%) GRAVEL (55%) with chert fragments, highly weathered due to penetration rates of between 0:29 and 0:34 min/m. Interpreted as CHERT. Malmani Subgroup.
4.00	Light grey brown, gravelly (15%) clayey (25%) SILT (60%) with chert fragments, highly weathered due to penetration rates of between 0:22 and 0:58 min/m. Interpreted as CHERT. Malmani Subgroup.
10.00	Pale red to pale red brown, gravelly (10%) clayey (20%) SILT (70%) with chert fragments, highly weathered due to penetration rates of between 0:227 and 0:47 min/m. Interpreted as CHERT. Malmani Subgroup.
18.00	Orange brown, slightly gravelly (5%) clayey (15%) SILT (80%) with syenite fragments, highly weathered due to penetration rates of between 0:26 and 0:59 min/m. Interpreted as SYENITE.
24.00	Medium grey brown, gravelly (20%) silty (20%) SAND (60%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:25 min/m. Interpreted as CHERT. Malmani Subgroup.

Reduced level marks: -5, -10, -15, -20, -25, -30

1 2 3 4 5
Penetration rate (min/m)

Rate (min & sec)

25 50 75
Air return (%)

25 50 75
Sample return (%)

REDUCED LEVEL

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS
Geotechnical Engineering

HOLE No: BH08
Sheet 2 of 2

JOB NUMBER: 000

Rate (min & sec)
0.38
0.41
0.31
0.50
0.41
1.09
0.52
0.48

-35
-40

34.00

Medium to dark grey, silty (10%) sandy (20%) GRAVEL (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:31 and 1:09 min/m. Interpreted as CHERT. Malmani Subgroup.

41.00

NOTES
1) Water Table at 12.3m.
2) No Groundwater Strike.
3) Final Depth at 41.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5
Penetration rate (min/m)

Rate (min & sec)

25 50 75
Air return (%)

25 50 75
Sample return (%)

REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 53 54.19"E
Y-COORD : 26 37 30.70"S

HOLE No: BH08

HOLE No: BH09	Sheet 1 of 1
JOB NUMBER: 000	

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

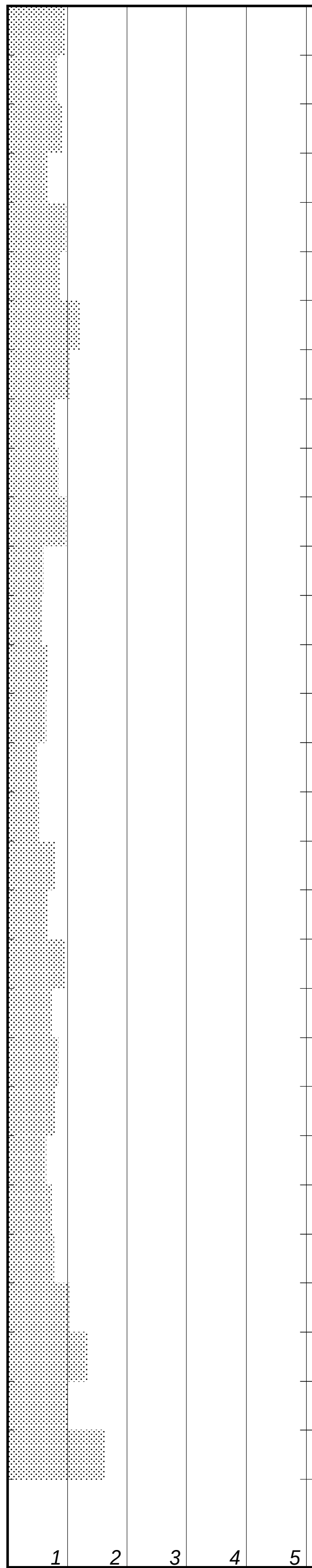
JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH09
Sheet 1 of 1
JOB NUMBER: 000



Rate (min & sec)
0.58
0.49
0.55
0.41
0.59
0.53
1.12
1.01
0.48
0.51
0.59
0.36
0.34
0.41
0.39
0.29
0.31
0.48
0.41
0.58
0.44
0.51
0.48
0.39
0.44
0.46
1.01
1.21
1.00
1.37

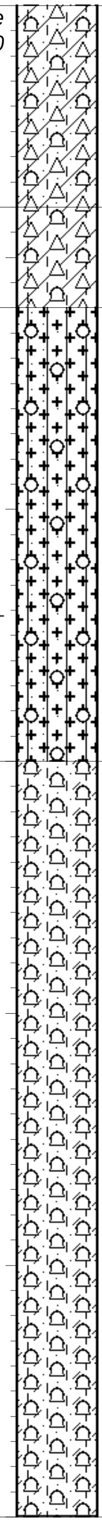
Air return (%): 25 50 75

Sample return (%): 25 50 75

REDUCED LEVEL: -5, -10, -15, -20, -25, -30

Scale 1:150

12.1m



Depth	Description
0.00	Light brown mottled light grey, gravelly (15%) sandy (15%) silty (20%) CLAY (50%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:41 and 0:58 min/m. Interpreted as CHERT. Malmani Subgroup.
4.00	Medium brown, gravelly (10%) silty (20%) CLAY (70%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:53 and 0:59 min/m. Interpreted as CHERT. Malmani Subgroup.
6.00	Orange brown, slightly gravelly (5%) sandy (30%) SILT (65%) with syenite fragments, highly to moderately weathered due to penetration rates of between 0:34 and 1:12 min/m. Interpreted as SYENITE.
15.00	Medium to light grey, silty (10%) clayey (10%) sandy (30%) GRAVEL (50%) with chert fragments, highly to moderately weathered due to penetration rates of between 0:29 and 1:37 min/m. Interpreted as CHERT. Malmani Subgroup.
30.00	

NOTES

1) Water Table at 12.1m.
2) No Groundwater Strike.
3) Final Depth at 30.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 54 03.49"E
Y-COORD : 26 37 32.08"S

HOLE No: BH09

HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 000

ROCK FABRIC	GRAIN SIZE	JOINT ROUGHNESS	ROCK HARDNESS
MF -massive	FG -fine grained	SLJ-slickensided	EHR-extremely hard rock
BF -bedded	MG -medium grain	SJ -smooth	VHR-very hard rock
FF -foliated	CG -coarse grain	RJ -rough	HR -hard rock
CF -cleaved			MHR-medium hard rock
SF -schistose	JOINT SPACING	JOINT SHAPE	SR -soft rock
GF -gneissose	VCJ-very close spacg	CUR-curvilinear	VSR-very soft rock
LF -laminated	CJ -close spacing	PLA-planar	
	MJ -medium spacing	UND-undulating	
	WJ -wide spacing	STE-stepped	
	VWJ-very wide spacng	IRR-irregular	

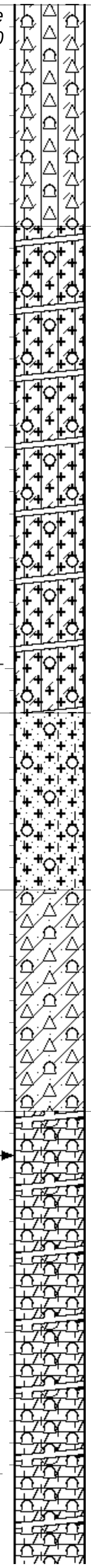
HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 000

Rate (min & sec): 0.29, 0.33, 0.25, 0.24, 0.24, 0.39, 0.27, 0.27, 0.48, 0.31, 0.43, 0.24, 0.22, 0.31, 0.29, 0.26, 0.28, 0.36, 0.24, 0.39, 0.58, 1.03, 1.10, 1.01, 1.09, 1.03, 1.16, 1.20, 1.29, 1.37, 2.49, 3.18, 1.47

Penetration rate (min/m): 1 2 3 4 5
Air return (%): 25 50 75
Sample return (%): 25 50 75
REDUCED LEVEL: -5, -10, -15, -20, -25, -30

Scale 1:150



14.9m (water level)
26.0m (water strike)

Depth (m)	Description
0.00	Light pale red, gravelly (15%) clayey (15%) SILT (70%) with chert fragments, highly weathered due to penetration rates of between 0:24 and 0:33 min/m. Interpreted as CHERT. Malmani Subgroup.
5.00	light orange brown with dusky red band at 10m, gravelly (10%) clayey (10%) SILT (80%) with syenite fragments, highly weathered due to penetration rates of between 0:22 and 0:48 min/m. Interpreted as SYENITE.
16.00	Orange brown, slightly gravelly (3%) silty (20%) SAND (77%) with syenite fragments, highly weathered due to penetration rates of between 0:24 and 0:39 min/m. Interpreted as SYENITE.
20.00	Medium brown speckled dark grey, gravelly (10%) sandy (20%) CLAY (70%) with chert fragments, moderately weathered due to penetration rates of between 0:58 and 1:10 min/m. Interpreted as CHERT. Malmani Subgroup.
25.00	Dark to medium grey, silty (5%) GRAVEL (95%), fines washed out due to water strike, with chert fragments and dolomite band at 31.0--32.0m, moderately to slightly weathered due to penetration rates of between 1:00 and 3:18 min/m. Interpreted as Interbedded CHERT and DOLOMITE. Malmani Subgroup.

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 000

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 000

Rate (min & sec)
1.29
1.48
1.49
1.31
1.09
1.00
1.35
1.26
1.55
3.16
2.46
1.49
1.46
3.22
3.46
2.59
2.58
3.01
3.09

-35
-40
-45
-50

40.00

Dark grey to medium grey, silty (5%) GRAVEL (95%), fines washed out due to water strike, with dolomite fragments, +HCl reaction, moderately to slightly weathered due to penetration rates of between 1:26 and 3:46 min/m. Interpreted as DOLOMITE. Malmani Subgroup.

52.00

NOTES
1) Water Table at 14.9m.
2) Groundwater Strike at 26.0m.
3) Final Depth at 52.0m.
4) No Zone of penetration rates <15sec/m.
5) Coordinates and elevations were recorded using a hand held GPS. Map datum is WGS84 Lo29.

1 2 3 4 5
Penetration rate (min/m)

Rate (min & sec)

25 50 75
Air return (%)

25 50 75
Sample return (%)

REDUCED LEVEL

CONTRACTOR : Hennie Erwee
MACHINE : 1900kPa 27.6m3/min
DRILLED BY : Jack
PROFILED BY : Dale Franklin
TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM : 165 mm
DATE : 21/01/2021
DATE : 21/01/2021
DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD : 27 53 57.21"E
Y-COORD : 26 37 42.98"S

HOLE No: BH11

LEGEND
Sheet 1 of 1

JOB NUMBER: 000

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAY	{SA08}
	CLAYEY	{SA09}
	SHALE	{SA12}
	DOLOMITE	{SA13}
	BANDS	{SA51}
	SYENITE	{SA17}
	CHERT	{SA21}
	WAD	{SA22}
	FERRICRETE/ferricrete nodules	{SA24}
15.5	PERMANENT WATER TABLE	{SA35}
16.5	WATER SEEPAGE/water strike	{CH50}
	BAND	{SA53}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : BH1PG-A3.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 02/02/2021 13:30
TEXT : ..nitasParkExt16BHLogs.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

APPENDIX B-2
Previous Borehole Profiles

Township UNITAS PARK

Page 1

Borehole No BH3

Date September/October, 1975

Peg No ____________ Collar Elevation ____________

Depth	Description	PLASTICITY ESTIMATE	CHIPS: FINE RATIO BY VOL. (VISUAL)	MAX CHIP SIZE	GEN CHIP SIZE RANGE (MM)	PENETRATION RATE IN MINUTES PER M
0m – 1m	Dry, brown to reddish brown, loose, medium dense, silty sand.	LP				
1m – 6m	Damp, brown, reddish brown and yellowish brown (mottled), clayey sand with ferricrete.	MP -LP				
		"				
		"				
		"				
		"				
		"				
6m – 9m	Dry to damp, light brown to yellowish olive stiff sandy/silty clay. Highly weathered Karroo.	MP				
		"				
		"				
9m – 10m	Damp to moist, light brown, light yellowish brown and light grey (mottled), stiff silty clay/clayey silt. Weathered Karroo shale/siltstone.	MP				

Remarks etc.

Township UNITAS PARK

Borehole No BH3

Date September/October, 1975

Peg No Collar Elevation

Depth	Description	PLASTICITY ESTIMATE	CHIPS: FINE RATIO BY VOL (VISUAL)	MAX CHIP SIZE	GEN CHIP SIZE RANGE (MM)	PENETRATION RATE
10m–19m	Damp to moist, light brown, light yellowish brown and light grey (mottled), stiff silty clay/clayey silt. Weathered Karroo shale/siltstone.	MP				
		"				
		"				
		"				
		"				
		"				
		"				
		"				
19m–20m	Wet, light brown to light yellowish brown, soft clayey silt/silty clay.	MP-LP				

Depth scale: 10m, 11m, 12m, 13m, 14m, 15m, 16m, 17m, 18m, 19m, 20m

Remarks etc.

Township UNITAS PARK

Borehole No BH3

Date September/October, 1975

Peg No Collar Elevation

	PLASTICITY ESTIMATE	CHIPS: FINE RATIO BY VOL (VISUAL)	MAX CHIP SIZE	MEAN CHIP SIZE (MM)	PENETRATION RATE IN METRES PER MIN
20m–21,95m: Wet, light brown to light yellowish brown, soft clayey silt/silty clay.					
End of Hole 72' (21,95 metres)					

20m 21m 22m 23m 24m 25m 26m 27m 28m 29m 30m

Remarks etc

DOLOMITE TECHNOLOGY

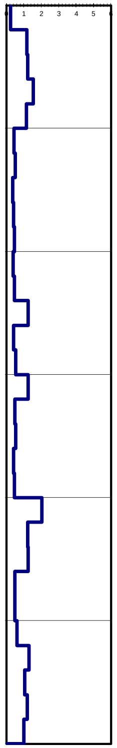
PERCUSSION BOREHOLE LOG

2015/08/14
02:39 PM
1
Profiel

X= 0.00 Y= 0.00 Z= 0.00 masl

Project no:	1544-DT	Client	**Hans van Heerden**
Project name:	Ged. 156&203 van Plaas Houtkop	Drill contractor:	JK Development
Date drilled:	20080117	Driller:	France
Date profiled:	20080122	**BH NO:**	**BH 1544/5**

Penetration rate min:s/m



Penetr rate	CAV	V SFT	SFT	FAIR H	SOLID	Air loss	DEPTH m	Symbol	Chip size mm	Depth m	DESCRIPTION
0.22		1.0				NONE	1	:|:|:|:|:|:|:	<5	1	Brown sandy clay with traces of yellow white to brown, moderately weathered sub-angular to rounded chert. Transported / Topsoil. 95% Sandy clay, 5% Chert.
1.17		0.1	0.9			NONE	2	ΔΔΔΔΔΔΔ	<10		Yellow brown sandy clay with translucent white grey, slightly weathered sub-angular chert. Residual chert. 70% Sandy clay, 30% Chert.
1.21			1.0			NONE	3	ΔΔΔΔΔΔΔ		3	
1.52			1.0			NONE	4	ΔΔΔΔΔΔΔ	<5		Greyish brown silty clay with translucent white grey, slightly weathered angular chert. Residual chert. 80% Silty clay, 20% Chert.
1.14			1.0			NONE	5	ΔΔΔΔΔΔΔ		5	
0.42		0.9	0.1			NONE	6	:|:|:|:|:|:|:			
0.49		1.0				NONE	7	:|:|:|:|:|:|:			
0.35		1.0				NONE	8	:|:|:|:|:|:|:	<5		Light pinkish grey silty clay with minor grey, highly weathered sub-rounded mudrock. Mudrock. 90% Silty clay, 10% Mudrock.
0.41		1.0				NONE	9	:|:|:|:|:|:|:			
0.45		1.0				NONE	10	:|:|:|:|:|:|:		10	
0.37		1.0				NONE	11	:|:|:|:|:|:|:			
0.46		1.0				NONE	12	:|:|:|:|:|:|:			
1.24		0.1	0.9			NONE	13	:|:|:|:|:|:|:			
0.41		1.0				NONE	14	:|:|:|:|:|:|:	<15		Light grey to grey, slightly weathered sub-angular to sub rounded mudrock. 100% Mudrock/Siltstone.
0.53		1.0				NONE	15	:|:|:|:|:|:|:			
1.24		0.9	0.1			NONE	16	:|:|:|:|:|:|:			
0.47		1.0				NONE	17	:|:|:|:|:|:|:			
0.53		1.0				NONE	18	:|:|:|:|:|:|:		18	
0.40		1.0				NONE	19	:|:|:|:|:|:|:	<5		Orange brown sandy clay with minor translucent yellow brown to grey, slightly weathered sub-angular chert. Mudrock. 90% Sandy clay, 10% Chert.
0.45		1.0				NONE	20	:|:|:|:|:|:|:		20	
2.02		0.1	0.9			NONE	21	ΔΔΔΔΔΔΔ	<10	21	Translucent light grey, unweathered angular chert. 100% Residual chert.
1.21			1.0			NONE	22	ΔΔΔΔΔΔΔ			
1.24			1.0			NONE	23	ΔΔΔΔΔΔΔ	<5		Light brown sandy clay with translucent yellow white to grey, unweathered angular chert. Residual chert. 30% Sandy clay, 70% Chert.
0.47		0.9	0.1			NONE	24	ΔΔΔΔΔΔΔ			
0.48		1.0				NONE	25	ΔΔΔΔΔΔΔ		25	
0.59		1.0				NONE	26	ΔΔΔΔΔΔΔ			
1.29		0.1	0.9			NONE	27	ΔΔΔΔΔΔΔ			
1.04			1.0			NONE	28	ΔΔΔΔΔΔΔ	<5		Translucent yellow white to grey, unweathered angular chert. 100% Residual chert.
1.18			1.0			NONE	29	ΔΔΔΔΔΔΔ			
1.00			1.0			NONE	30	ΔΔΔΔΔΔΔ		30	

Notes:

1. No water encountered. Moist between 21-30m. Dry between 0-22m and 24-30m.
2. Good sample recovery, no sample loss and no air loss.
3. No water used during drilling.
4. Hammer rate generally regular, except between 1-2m, 5-6m, 12-13m, 15-16m, 20-21m, 23-24m and 26-27m, where it was irregular.

Logged by A. Michel
Copyright DOLOMITE TECHNOLOGY

DOLOMITE TECHNOLOGY

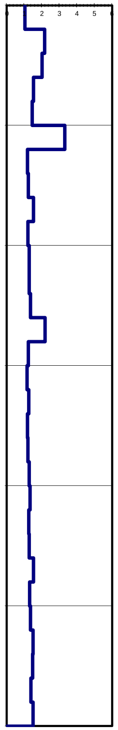
PERCUSSION BOREHOLE LOG

2015/08/14
02:39 PM
1
Profiel

X= 0.00 Y= 0.00 Z= 0.00 masl

Project no:	1544-DT	Client	**Hans van Heerden**
Project name:	Ged. 156 & 203 Plaas Houtkop	Drill contractor:	JK Development
Date drilled:	20080117	Driller:	France
Date profiled:	20080122	**BH NO:**	**BH 1544/5cont.**

Penetration rate min:s/m



Penetr rate	CAV	V SFT	SFT	FAIR H	SOLID	Air loss	DEPTH m	Symbol	Chip size mm	Depth m	DESCRIPTION
1.05			1.0			NONE	31	ΔΔΔΔΔΔΔ			
2.16				0.3	0.7	NONE	32	ΔΔΔΔΔΔΔ			
2.03				1.0		NONE	33	ΔΔΔΔΔΔΔ	<5		Light grey sandy clay with translucent light grey to grey, unweathered angular chert. Residual chert. 30% Sandy clay, 70% Chert.
1.54			0.9	0.1		NONE	34	ΔΔΔΔΔΔΔ			
1.47			1.0			NONE	35	ΔΔΔΔΔΔΔ			
3.31				0.1	0.9	NONE	36	ΔΔΔΔΔΔΔ		36	
1.19			0.9	0.1		NONE	37	ΔΔΔΔΔΔΔ			
1.24			1.0			NONE	38	ΔΔΔΔΔΔΔ			
1.54			1.0			NONE	39	ΔΔΔΔΔΔΔ			
1.22			1.0			NONE	40	ΔΔΔΔΔΔΔ			
1.28			1.0			NONE	41	ΔΔΔΔΔΔΔ			
1.30			1.0			NONE	42	ΔΔΔΔΔΔΔ			
1.36			1.0			NONE	43	ΔΔΔΔΔΔΔ			
2.19				0.5	0.5	NONE	44	ΔΔΔΔΔΔΔ			
1.24			1.0			NONE	45	ΔΔΔΔΔΔΔ			
1.16			1.0			NONE	46	ΔΔΔΔΔΔΔ			
1.26			1.0			NONE	47	ΔΔΔΔΔΔΔ			
1.19			1.0			NONE	48	ΔΔΔΔΔΔΔ	<5		Translucent light grey to grey, unweathered angular chert. 100% Residual chert.
1.23			1.0			NONE	49	ΔΔΔΔΔΔΔ			
1.29			1.0			NONE	50	ΔΔΔΔΔΔΔ			
1.33			1.0			NONE	51	ΔΔΔΔΔΔΔ			
1.26			1.0			NONE	52	ΔΔΔΔΔΔΔ			
1.29			1.0			NONE	53	ΔΔΔΔΔΔΔ			
1.53			1.0			NONE	54	ΔΔΔΔΔΔΔ			
1.32			1.0			NONE	55	ΔΔΔΔΔΔΔ			
1.36			1.0			NONE	56	ΔΔΔΔΔΔΔ			
1.51			1.0			NONE	57	ΔΔΔΔΔΔΔ			
1.49			1.0			NONE	58	ΔΔΔΔΔΔΔ			
1.40			1.0			NONE	59	ΔΔΔΔΔΔΔ			
1.52			1.0			NONE	60	ΔΔΔΔΔΔΔ		60	

Notes:

1. Water encountered between 32-33m. Wet between 32-60m. Moist between 30-32m.
2. No air loss and no sample loss, good sample recovery.
3. No water applied during drilling.
4. Hammer rate generally regular, except between 31-32m, 33-34m, 35-36m and 43-44m, where it was irregular.

Logged by A. Michel
Copyright DOLOMITE TECHNOLOGY

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/01
Sheet 1 of 2

JOB NUMBER: VGI3925

Scale 1:150

Depth (m)	Description
0.00	Brown silty SAND; COLLUVIUM
1.00	Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE
4.00	Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM
16.00	Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE
23.00	Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM
25.00	Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

Penetr time min:s/m: 0.41, 0.47, 0.43, 0.39, 0.35, 0.34, 0.38, 0.32, 0.29, 0.34, 0.37, 0.31, 0.39, 0.28, 0.33, 0.27, 0.36, 0.28, 0.25, 0.29, 0.32, 0.34, 0.39, 0.42, 0.37, 0.40, 0.48, 0.47, 0.51, 0.51, 0.39, 0.43, 0.48, 0.51

REDUCED LEVEL: 1465, 1460, 1455, 1450, 1445, 1440, 1435

Depth: 5, 10, 15, 20, 25, 30

REDUCED LEVEL	Penetr time min:s/m	Air return	Sample recov	Hammer rate

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/01
Sheet 2 of 2

JOB NUMBER: VGI3925

Depth (m)	Description
34.00	Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM
60.00	

Penetr time min:s/m: 0.51, 1.26, 1.49, 2.21, 2.14, 1.56, 2.04, 1.47, 1.50, 2.27, 2.49, 2.01, 1.56, 2.41, 2.10, 2.08, 2.27, 2.11, 2.06, 1.56, 2.24, 2.16, 1.53, 1.58, 2.18, 2.04, 2.36

REDUCED LEVEL: 1430, 1425, 1420, 1415, 1410

Depth: 35, 40, 45, 50, 55, 60

REDUCED LEVEL	Penetr time min:s/m	Air return	Sample recov	Hammer rate

NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 34 m.

3) Groundwater rest level recorded at 24 m on 2015/11/06.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Kliprivier Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/05
DATE : 2015/11/09

DATE : 01/12/15 12:43
TEXT : ..C:\DOTFILES\201512~1.TXT

ELEVATION : 1466 m AMSL
X-COORD : 2946941
Y-COORD : -89265

HOLE No: 3925/01

D055 DBB

dot.PLOT 5006 J&W

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/11
Sheet 1 of 2

JOB NUMBER: VGI3925

Scale 1:150

Penetration time (min:s/m): 0.55, 1.21, 1.17, 1.30, 2.07, 2.22, 3.48, 4.16, 3.54, 4.09, 4.24, 4.12, 3.46, 3.14, 3.21, 3.04, 2.52, 3.16, 3.02, 3.08, 2.57, 3.10, 3.29, 3.12, 3.35, 3.08, 2.49, 2.57, 2.39, 2.46, 2.09, 1.44, 1.20, 1.14

Depth (m)	Description
0.00	Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE
31.00	Angular translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM

REDUCED LEVEL | Penetr time min:s/m | Air return | Sample recov | Hammer rate

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/11
Sheet 2 of 2

JOB NUMBER: VGI3925

Penetration time (min:s/m): 1.14, 1.17, 1.01, 0.57, 0.53, 0.46, 0.49, 1.10, 1.18, 1.11, 1.41, 1.35, 1.48, 1.40, 1.53, 1.38, 1.47, 1.54, 2.07, 1.44, 2.13, 2.03, 2.27, 2.34, 2.22, 2.18, 2.29

60.00

NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 56 m.

3) No groundwater rest level recorded, hole collapsed.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Kliprivier Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

REDUCED LEVEL | Penetr time min:s/m | Air return | Sample recov | Hammer rate

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/10
DATE : 2015/11/11

DATE : 01/12/15 12:44
TEXT : ..C:\DOTFILES\201512~1.TXT

ELEVATION : 1466 m AMSL
X-COORD : 2947262
Y-COORD : -89762

HOLE No: 3925/11

D055 DBB *dot.PLOT 5006 J&W*

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/12
Sheet 1 of 2

JOB NUMBER: VGI3925

Scale 1:150

Depth (m)	Penetr time min:s/m
1	0.47
2	0.58
3	1.12
4	1.00
5	1.29
6	2.01
7	2.39
8	2.48
9	3.10
10	2.55
11	3.17
12	3.04
13	3.07
14	3.26
15	3.47
16	4.01
17	2.40
18	2.56
19	2.33
20	2.29
21	3.04
22	3.16
23	2.51
24	2.39
25	1.42
26	1.27
27	1.52
28	2.29
29	3.18
30	3.26
31	3.11
32	3.47
33	3.05
34	3.16

REDUCED LEVEL: 1465, 1460, 1455, 1450, 1445, 1440, 1435

REDUCED LEVEL | Penetr time min:s/m | Air return | Sample recov | Hammer rate

Light brown clayey SILT with minor light brown higly weathered shale fragments; RESIDUAL SHALE

SCHULDEN PROPERTIES
UNITAS PARK EXTENSION 17

HOLE No: 3925/12
Sheet 2 of 2

JOB NUMBER: VGI3925

Depth (m)	Penetr time min:s/m
35	2.47
36	2.29
37	3.46
38	4.20
39	4.39
40	1.47
41	0.49
42	0.54
43	0.40
44	0.44
45	0.41
46	0.35
47	0.39
48	0.36
49	0.43
50	0.38
51	0.30
52	0.32
53	0.26
54	0.29
55	0.27
56	0.31
57	0.30
58	0.33
59	0.29
60	0.28

REDUCED LEVEL: 1430, 1425, 1420, 1415, 1410

REDUCED LEVEL | Penetr time min:s/m | Air return | Sample recov | Hammer rate

0.00 / 34.00

Grey clayey SILT with minor grey highly weathered carbonatious shale; RESIDUAL CARBONACEOUS SHALE

40.00

Black clayey SILT with minor coal fragements; COAL

60.00

NOTES

1) Driller reports solid conditions, hole stopped at 60 m.

2) Groundwater intercepted at 51 m.

3) Groundwater rest level recorded at 23 m on 2015/11/12.

4) Original Dolomite Aquifer Groundwater Level (OWL) ?m AMSL

5) Klipriver Dolomite Groundwater Compartment

6) No water added

7) Driller reports no air or sample loss.

8) Projection Information: CM 27 degrees, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE
MACHINE : ROCK GIANT
DRILLED BY : S. MORELE
PROFILED BY : J.MEINTJES

TYPE SET BY : J.MEINTJES
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES
DIAM : 165mm
DATE : 2015/11/11
DATE : 2015/11/11

DATE : 01/12/15 12:44
TEXT : ..C:\DOTFILES\201512~1.TXT

ELEVATION : 1466 m AMSL
X-COORD : 2947153
Y-COORD : -89788

HOLE No: 3925/12

D055 DBB

dot.PLOT 5006 J&W

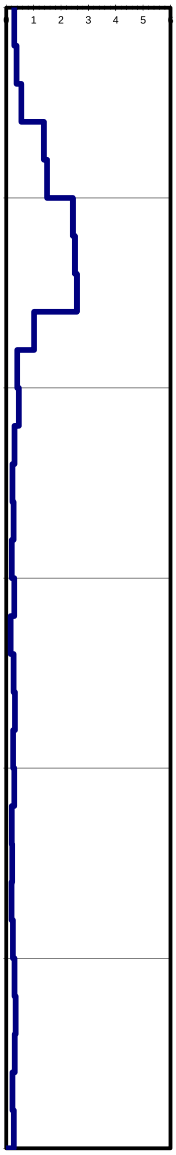
GeoStable SA cc

Percussion borehole log

Project no:	GS0510	BH NO:	**GS03**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'01,9"	X=	S 26°37'58,3"

Penetration rate

min:s/m



Penetr rate	CAVATY	V SOFT	SOFT	FAIR H	SOLID	Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,29		1,0						X	NONE	1		:|\:|\:|\:|\o		
0,38		1,0						X	NONE	2	<10	:|\:|\:|\:|\:		Reddish brown to brown sandy clayey SILT with traces of yellow brown and light brown weathered shale GRAVEL. R**ESIDUAL SHALE with traces of chert and ferricrete.**
0,55		1,0						X	NONE	3		:|o:|\:|\:|\		
1,38			1,0				X		NONE	4		:|\:|\:|\:|\:		4,0
1,49			1,0					X	NONE	5		|\\|\:|\\|\:|\		
2,43				1,0			X		NONE	6		|\\|\:|\\|\:|\		
2,51				1,0				X	NONE	7	<10	|\\|\:|\\|\:|\		Yellow brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE,STIFF CLAY**
2,58				1,0				X	NONE	8		|\\|\:|\\|\:|\		
1,02			1,0				X		NONE	9		|\\|\:|\\|\:|\		9,0
0,40		1,0					X		NONE	10				
0,46		1,0						X	NONE	11				
0,30		1,0						X	NONE	12			∇	Grey silty SAND with traces of grey highly weathered sandstone GRAVEL. **RESIDUAL SANDSTONE with traces of shale.**
0,23		1,0						X	NONE	13	<10			
0,27		1,0						X	NONE	14				
0,20		1,0						X	NONE	15				
0,29		1,0						X	NONE	16				16,0
0,16		1,0						X	NONE	17				Yellow brown sandy clayey SILT with minor yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE**
0,27		1,0						X	NONE	18	<10			
0,32		1,0						X	NONE	19				19,0
0,25		1,0						X	NONE	20				
0,29		1,0						X	NONE	21				
0,20		1,0						X	NONE	22				
0,22		1,0						X	NONE	23				
0,19		1,0						X	NONE	24				Grey moderately weathered sandstone GRAVEL with abundant grey silty SAND. S**ANDSTONE with traces of carbonaceous shale and diamictite below 27m.**
0,24		1,0						X	NONE	25				
0,30		1,0						X	NONE	26				
0,34		1,0						X	NONE	27				
0,31		1,0						X	NONE	28				
0,23		1,0						X	NONE	29				
0,28		1,0						X	NONE	30				30,0

continue ...

Notes:

1. Groundwater strike at 31m. Groundwater rest level at 12m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

Logged by Andre Fourie

Copyright **GeoStable SA cc**

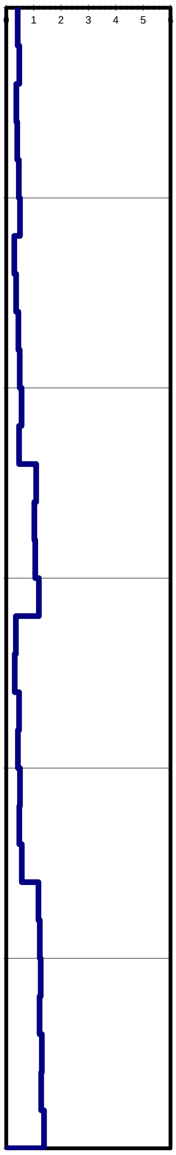
GeoStable SA cc

Percussion borehole log

Project no:	GS0510	BH NO:	**GS03 continue**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'01,9"	X=	S 26°37'58,3"

Penetration rate

min:s/m



Penetr rate	Formation: CAVATY	V SOFT	SOFT	FAIR H	SOLID	Hammer rate: Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,42		1,0						X	NONE	31		ooΔooΔoo	∇	
0,48		1,0						X	NONE	32		ooΔooΔoo		
0,37		1,0						X	NONE	33		ooΔooΔoo		
0,40		1,0						X	NONE	34		ooΔooΔoo		
0,46		1,0						X	NONE	35		ooΔooΔoo		
0,50		1,0						X	NONE	36		ooΔooΔoo		
0,29		1,0						X	NONE	37		ooΔooΔoo		
0,36		1,0						X	NONE	38		ooΔooΔoo		
0,44		1,0						X	NONE	39		ooΔooΔoo		
0,49		1,0						X	NONE	40		ooΔooΔoo		
0,56		1,0						X	NONE	41		ooΔooΔoo		
0,47		1,0						X	NONE	42		ooΔooΔoo		
1,09			1,0				X		NONE	43		ooΔooΔoo		
1,03			1,0					X	NONE	44		ooΔooΔoo		
1,06			1,0					X	NONE	45	<15	ooΔooΔoo		Dark grey and translucent, slightly weathered to unweathered diamictite GRAVEL. **DIAMICTITE**
1,19			1,0					X	NONE	46		ooΔooΔoo		
0,35		1,0					X		NONE	47		ooΔooΔoo		
0,31		1,0						X	NONE	48		ooΔooΔoo		
0,47		1,0						X	NONE	49		ooΔooΔoo		
0,43		1,0						X	NONE	50		ooΔooΔoo		
0,50		1,0						X	NONE	51		ooΔooΔoo		
0,48		1,0						X	NONE	52		ooΔooΔoo		
0,57		1,0						X	NONE	53		ooΔooΔoo		
1,18			1,0				X		NONE	54		ooΔooΔoo		
1,23			1,0					X	NONE	55		ooΔooΔoo		
1,26			1,0					X	NONE	56		ooΔooΔoo		
1,22			1,0					X	NONE	57		ooΔooΔoo		
1,30			1,0					X	NONE	58		ooΔooΔoo		
1,28			1,0					X	NONE	59		ooΔooΔoo		
1,38			1,0					X	NONE	60		ooΔooΔoo		60,0

End of hole

Notes:

1. Groundwater strike at 31m. Groundwater rest level at 12m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

Logged by Andre Fourie

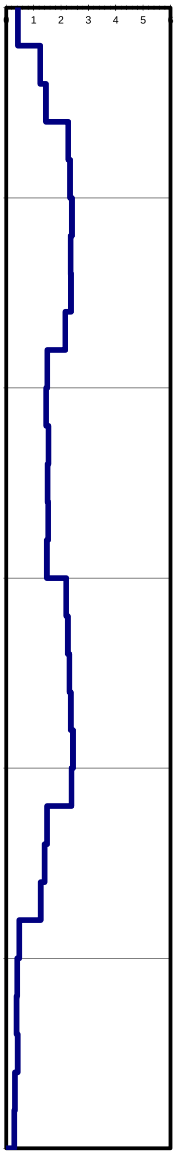
Copyright **GeoStable SA cc**

GeoStable SA cc

Percussion borehole log

Project no:	GS0510		BH NO:	**GS04**
Project name:	**Unitaspark X21**		Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018		Drill contractor:	JK Drilling
Date profiled:	24/07/2018		Driller:	Patrick
Coordinates (Lo 29 & WGS 84):		Y= E 27°54'09,4"	X=	S 26°37'54,6"

Penetration rate min:s/m



Penetr rate	CAVATY	V SOFT	SOFT	FAIR H	SOLID	Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,43		1,0						X	NONE	1				
1,24			1,0				X		NONE	2				Reddish brown to brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE** with traces of chert and ferricrete.
1,45			1,0					X	NONE	3	<10			
2,27				1,0			X		NONE	4				
2,33				1,0				X	NONE	5				
2,40				1,0				X	NONE	6				6,0
2,35				1,0				X	NONE	7				
2,37				1,0				X	NONE	8				
2,16				1,0				X	NONE	9				
1,50			1,0				X		NONE	10				
1,46			1,0					X	NONE	11				
1,54			1,0					X	NONE	12	<10		∇	Yellow brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL. **RESIDUAL SHALE and stiff clay.**
1,51			1,0					X	NONE	13				
1,53			1,0					X	NONE	14				
1,48			1,0					X	NONE	15				
2,19				1,0			X		NONE	16				
2,25				1,0				X	NONE	17				
2,31				1,0				X	NONE	18				18,0
2,36				1,0				X	NONE	19	<10			Brown sandy clayey SILT with traces of yellow brown and light brown highly weathered shale GRAVEL.
2,44				1,0				X	NONE	20				20,0 **RESIDUAL SHALE** and stiff clay.
2,38				1,0				X	NONE	21				
1,49			1,0				X		NONE	22				
1,40			1,0					X	NONE	23				
1,26			1,0					X	NONE	24				
0,48		1,0					X		NONE	25	<15			Black moderate to slightly weathered corbonaceous shale GRAVEL with minor to abundant black sandy SILT. **CARBONACEOUS SHALE**.
0,40		1,0						X	NONE	26				
0,38		1,0						X	NONE	27				
0,42		1,0						X	NONE	28				
0,32		1,0						X	NONE	29				
0,29		1,0						X	NONE	30				30,0

continue ...

Notes:

1. Groundwater strike at 47m. Groundwater rest level at 16m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

Logged by Andre Fourie

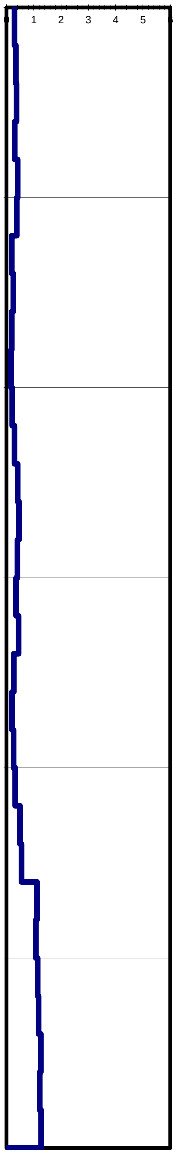
Copyright **GeoStable SA cc**

GeoStable SA cc

Percussion borehole log

Project no:	GS0510	BH NO:	**GS04 continue**
Project name:	**Unitaspark X21**	Client:	Schulden Properties (Pty) Ltd
Date drilled:	24/07/2018	Drill contractor:	JK Drilling
Date profiled:	24/07/2018	Driller:	Patrick
Coordinates (Lo 29 & WGS 84):	Y= E 27°54'09,4"	X=	S 26°37'54,6"

Penetration rate min:s/m



Penetr rate	Formation: CAVATY	V SOFT	SOFT	FAIR H	SOLID	Hammer rate: Very irregular	Irregular	Regular	Air loss	Depth m	Chip size mm	Symbol	Groundwater	DESCRIPTION
0,29		1,0						X	NONE	31				
0,34		1,0						X	NONE	32				
0,37		1,0						X	NONE	33				
0,30		1,0						X	NONE	34				
0,41		1,0						X	NONE	35				
0,38		1,0						X	NONE	36	<15			
0,19		1,0						X	NONE	37				Grey moderately weathered sandstone GRAVEL with abundant grey sitly SAND. **SANDSTONE with traces of carbonaceous shale and diamictite below 40m.**
0,25		1,0						X	NONE	38				
0,19		1,0						X	NONE	39				
0,17		1,0						X	NONE	40				
0,21		1,0						X	NONE	41				
0,29		1,0						X	NONE	42				
0,41		1,0						X	NONE	43				
0,46		1,0						X	NONE	44				44,0
0,40		1,0						X	NONE	45		ooΔooΔoo		
0,35		1,0						X	NONE	46		ooΔooΔoo		
0,44		1,0						X	NONE	47		ooΔooΔoo	▽	
0,27		1,0						X	NONE	48		ooΔooΔoo		
0,20		1,0						X	NONE	49		ooΔooΔoo		
0,26		1,0						X	NONE	50		ooΔooΔoo		
0,32		1,0						X	NONE	51		ooΔooΔoo		
0,49		1,0						X	NONE	52	<15	ooΔooΔoo		Dark grey and translucent grey, slightly weathered to unweathered dimaictite GRAVEL. **DIAMICTITE**
0,55		1,0						X	NONE	53		ooΔooΔoo		
1,12			1,0				X		NONE	54		ooΔooΔoo		
1,08			1,0					X	NONE	55		ooΔooΔoo		
1,14			1,0					X	NONE	56		ooΔooΔoo		
1,18			1,0					X	NONE	57		ooΔooΔoo		
1,26			1,0					X	NONE	58		ooΔooΔoo		
1,22			1,0					X	NONE	59		ooΔooΔoo		
1,27			1,0					X	NONE	60		ooΔooΔoo		60,0

End of hole

Notes:

1. Groundwater strike at 47m. Groundwater rest level at 16m.

2. No air or sample losses encountered during drilling.

3. No water applied during drilling.

Logged by Andre Fourie

Copyright **GeoStable SA cc**

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3832
SHEET : 2 OF 2

LOCALITY : LENONG
CO-ORDINATES : X = 2946243 Y = -090239
COLLAR ELEV : 1473m AMSL
OWL : 1440m AMSL
WGS84, Lo 27°E
CONTRACTOR : JOHAN BOTHA
DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.33		19-57m: Yellow brown mottled grey CLAYEY SILT; KAROO.
1.37		
1.42		
1.41		
1.36	45	
1.48		
1.33		
1.19		
1.14		
1.08	50	
1.21		
1.28		
1.30		
1.25		
1.13	55	
1.16		
1.09		
1.29		57-60m : Dark brown blotched yellow brown CLAYEY SILT; KAROO.
1.26		
1.35	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/DB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1400kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

REF NO. IRR74

FIG NO.

Infraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3948
SHEET : 1 OF 2

LOCALITY : LENONG	
CO-ORDINATES : X = 2946656 Y = -89652	COLLAR ELEV : 1471m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 12.06.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN.SEC/METRE)	Depth (m)
1.19	
1.02	
0.51	
0.48	
0.48	5
0.54	
0.56	
0.59	
1.12	
0.54	10
0.51	
1.17	
1.19	
1.16	
1.09	15
1.12	
1.10	
1.12	
0.59	
1.03	20
1.00	
0.56	
0.58	
1.14	
1.11	25
1.09	
1.03	
0.56	
0.58	
1.10	30
1.31	
1.24	
1.17	
1.40	
1.38	35
1.42	
1.53	
2.17	
1.56	
2.04	40

DESCRIPTION

0-2m: Orange brown CLAYEY SILTY SAND with minor angular white highly weathered CHERT; COLLUVIUM.

2-7m: Yellow brown blotched grey CLAYEY SILT; KAROO.

7-22m: Angular dark red brown and grey highly weathered and FERRUGINISED CHERT and SHALE with minor dark red brown SILTY SAND; FERRUGINISED inter-layered CHERT and SHALE.

22-30m: Angular grey khaki highly weathered soft rock SHALE with minor yellow brown CLAYEY SILT; KAROO.

30-60m: Angular dark grey brown and yellow brown highly weathered CHERT with traces of yellow brown SILTY SAND; CHERT RESIDUUM.

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3948
SHEET : 2 OF 2

LOCALITY : LENONG	
CO-ORDINATES : X = 2946656 Y = -89652	COLLAR ELEV : 1471m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 12.06.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	DEPTH (m)	DESCRIPTION
2.11		30-60m: Angular dark grey brown and yellow brown highly weathered CHERT with traces of yellow brown SILTY SAND; CHERT RESIDUUM.
2.09		
2.30		
2.23		
2.31	45	
2.19		
2.02		
1.42		
1.26		
1.31	50	
1.40		
1.38		
1.44		
1.53		
1.56	55	
1.49		
1.51		
1.28		
1.20		
1.32	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO. 18874
FIG NO

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4037
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946408 Y = -090119	COLLAR ELEV : 1472m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 29.04.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
0.45		0-3m : Reddish orange CLAYEY SILTY SAND with abundant sub-round FERRICRETE NODULES; NODULAR FERRICRETE.
1.32		
1.20		
1.51		3-6m : Reddish orange CLAYEY SILT; KAROO.
1.23	5	
1.08		
0.51		6-13m : Yellow brown mottled grey CLAYEY SILT; KAROO.
0.56		
0.49		
1.12	10	
1.03		
1.05		
0.57		
0.53		13-16m : Angular dark red brown highly weathered soft rock SHALE.
1.12	15	
1.33		
1.29		16-30m: orange brown blotched and mottled grey and dark brown CLAYEY SILT; KAROO
1.21		
1.24		
1.40	20	
1.36		
1.11		
1.04		
0.51		
1.13	25	
1.10		
1.20		
1.41		
1.29		
1.36	30	
0.50		30-38m: Dark brown CLAYEY SILT with abundant angular dark brown and grey highly and medium weathered CHERT; CHERT AND DOLOMITE RESIDUUM.
0.43		
1.38		
1.20		
1.33	35	
1.52		
1.38		
1.17		
3.51		38-44m : Dark brown CLAYEY SILT (WAD) with abundant angular dark grey medium weathered CHERT.
4.11	40	

PROFILED BY DB/RB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO.

Infraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4037
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946408 Y = -090119	COLLAR ELEV : 1472m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 29.04.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN SEC/METRE)	Depth	DESCRIPTION
4.15		38-44m :Angular grey medium weathered hard rock DOLOMITE; [samples contaminated and appear to be not representative]. DOLOMITE BEDROCK.
4.16		
4.05		
4.22		
	45	
	50	
	55	
	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel.: (011) 469-0854

REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO. 4325
SHEET: 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X – 29466232 Y =090644	COLLAR ELEV : 1471m AMSL OWL : 1440m AMSL
WGS84, Lo....27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 30.04.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.07		0-2m : Reddish orange brown CLAYEY SILTY SAND with Traces of sub-round FERRICRETE NODULES; AEOLIAN.
1.52		
2.14		2-10m : Yellow brown mottled grey and orange SANDY CLAYEY SILT; KAROO.
2.02		
1.56	5	
1.48		
1.51		
1.50		
1.33		
1.29	10	
1.41		10-30m : Angular light grey completely weathered very soft rock SHALE and translucent medium weathered CHERT; KAROO.
1.32		
1.38		
1.46		
1.29	15	
1.33		
1.27		
1.38		
1.14		
1.09	20	
1.20		
1.31		
1.25		
1.23		
1.16	25	
1.05		
1.02		
1.19		
0.54		
1.00	30	
1.06		30-33m : Dark brown SANDY CLAYEY SILT WAD with traces of grey mottled yellow CLAYEY SILT; DOLOMITE RESIDUUM transition.
1.29		
1.14		
2.38		33-34m : Angular blue grey blotched grey slightly weathered Hard rock DOLOMITE with minor light grey CLAYEY SILT and traces of angular dark grey medium weathered CHERT. DOLOMITE BEDROCK.
3.49	35	34-40m : Angular blue grey slightly weathered hard rock DOLOMITE. DOLOMITE BEDROCK.
4.00		
4.16		
4.03		
3.51		
4.14	40	

PROFILED BY DB/BB ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL 31m
3. AIR LOSSES Nil

LENONG

REF NO. IR874

FIG NO.

Infraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4443
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = -2946647 Y = 90027

COLLAR ELEV : 1469m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 27.02.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.14		0-1m : Orange brown CLAYEY SILT; RESIDUAL DIABASE.
1.29		1-2m : Orange blotched dark brown CLAYEY SILT; RESIDUAL DIABASE.
1.06		
1.32		2-12m : Dark brown CLAYEY SILT (WAD) with traces of angular grey white and brown highly weathered CHERT; CHERT AND DOLOMITE RESIDUUM.
1.48	5	
1.51		
1.42		
1.59		
2.16		
1.02	10	
1.14		
1.08		
1.53		12-13m : Angular grey and brown highly weathered and leached DOLOMITE; DOLOMITE BEDROCK.
2.51		
3.19	15	13-19m : Angular blue grey and grey slightly weathered hard rock DOLOMITE; DOLOMITE BEDROCK.
3.30		
3.14		
3.11		
3.07		
	20	
	25	
	30	
	35	
	40	

PROFILED BY DB/BB ON 27.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL -32m
3. AIR LOSSES Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

REF NO 1R874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO: 4655
SHEET: 1 OF 2

LOCALITY : LENONG
CO-ORDINATES : X = 2946939
Y = -089616
COLLAR ELEV : 1467m AMSL
OWL : 1440m AMSL
WGS84, Lo 27°E
CONTRACTOR : JOHANN BOTHA
DATE COMPLETED : 13.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1,07		0-1m : Orange brown CLAYEY SILTY SAND; HILLWASH.
1.11		1-3m : As above with traces of angular and sub-angular reddish brown highly weathered QUARTZITE and grey and white highly weathered CHERT; COLLUVIUM / KAROO.
0.56		
0.52		3-6m : Yellow brown blotched off white and grey CLAYEY SILT; KAROO.
0.53	5	
0.48		
0.46		6-21m : Angular light grey blotched pale red medium weathered soft rock SHALE with traces of angular dark grey unweathered CHERT; KAROO.
0.52		
1.10		
0.59	10	
1.02		
1.06		
1.01		
1.14		
1.21	15	
1.09		
0.56		
0.51		
1.00		
1.03	20	
0.58		
1.13		21-24m : Angular grey stained red brown highly weathered soft rock SHALE; KAROO.
1.29		
1.24		
1.30	25	24-52m : Angular dusky red speckled off white blotched dark grey completely weathered very soft rock SHALE with abundant dusky red CLAYEY SILT; KAROO.
1.25		
1.39		
1.20		
1.09		
1.05	30	
1.11		
1.06		
0.58		
0.59		
1.14	35	
1.12		
1.08		
1.20		
1.13		
1.14	40	

PROFILED BY DH/BB ON 13.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 27m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

REF NO IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4655
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946939 Y = -089616	COLLAR ELEV : 1467m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 13/06/08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.09		24-52m : Angular dusky red speckled off white blotched dark grey completely weathered very soft rock SHALE with abundant dusky red CLAYEY SILT; KAROO.
1.21		
1.20		
1.13		
1.16	45	
1.17		
1.08		
1.26		
1.21		
1.26	50	
1.19		
1.30		
1.22		
1.28		
1.35	55	
1.31		
1.24		
1.29		
1.36		
1.34	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/RB ON 13/06/08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 27m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO

Intraconsult
Consulting Engineering Geologists
Tel (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4732
SHEET : 1 OF 2

LOCALITY :

CO-ORDINATES : X = 2946489
Y = -090528

COLLAR ELEV : 1470m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 30.04.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing, Air Loss, Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.13		0-2m : Reddish orange brown mottled yellow and black CLAYEY SILTY SAND with traces of FERRICRETE NODULES; slightly ferruginised AEOLIAN.
1.41		
1.28		2-60m : Yellow brown mottled grey SANDY CLAYEY SILT, KAROO.
1.59		
3.44	5	
4.18		
6.51		
5.19		
5.52		
6.06	10	
6.29		
6.43		
6.59		
7.42		
5.25	15	
6.39		
6.38		
5.54		
5.38		
4.19	20	
5.25		
4.52		
5.17		
4.41		
3.32	25	
3.56		
4.10		
4.38		
3.49		
3.52	30	
4.04		
2.40		
2.19		
2.21		
2.45	35	
1.52		
1.43		
2.18		
2.06		
2.45	40	

PROFILED BY DB/BB ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL - 31m
3. AIR LOSSES : Nil

LENONG

REF NO IRR74

FIG NO.

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4732
SHEET : 2 OF 2

LOCALITY :	
CO-ORDINATES : X = 2946489 Y = -090528	COLLAR ELEV : 1470m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 30.04.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
2.29		2-60m . Yellow brown mottled grey SANDY CLAYEY SILT. KAROO.
2.52		
2.47		
2.20		
2.18	45	
2.32		
2.40		
2.51		
3.11		
3.29	50	
3.04		
2.48		
2.31		
2.31		
2.26	55	
2.48		
3.13		
2.19		
3.20		
3.41	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/DD ON 30.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel - (011) 469-0854

REF NO. IR874

FIG NO

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4750
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946921 Y = -89847	**COLLAR ELEV : 1468m AMSL OWL : 1440m AMSL**
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 13.06.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)

KEY REFERENCE

Casing
Air Loss
Static water level

DESCRIPTION

Penetration	Depth	Description
1.59		0-1m : Dark orange brown CLAYEY SILTY SAND; HILLWASH
3.56		1-5m : Orange brown mottled yellow brown and black CLAYEY SILTY SAND; FERRUGINISED KAROO.
5.29		
5.51		
5.56	5	
5.19		5-20m : Yellow brown CLAYEY SILT; KAROO.
5.04		
5.26		
5.43		
5.17	10	
5.20		
4.41		
5.50		
4.58		
4.16	15	
3.49		
4.10		
4.06		
4.32		
4.06	20	
3.36		20-44m : Dark brown to black CLAYEY SILT; DWYKA TILLITE
4.14		
4.07		
3.36		
3.40	25	
3.11		
2.58		
2.41		
3.16		
3.03	30	
3.14		
2.06		
1.39		
1.28		
1.04	35	
1.17		
1.32		
1.29		
1.21		
1.33	40	

PROFILED BY DB/BB ON 13.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25.4m^3/min to a 165mm button bit

2. DEPTH OWL : 28m

3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 4750
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946921
Y = -89847

COLLAR ELEV : 1468m AMSL
OWL : 1440m AMSL

WG584, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 13.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: **Casing**, **Air Loss**, Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.45		20-44m - Dark brown to black CLAYEY SILT; DWYKA TILLITE
1.39		
1.56		
1.33		
	45	
	50	
	55	
	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BR ON 13.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 28m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO.

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3044
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946271, Y = -089563 | COLLAR ELEV : 1476m AMSL | OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 28.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE: Casing, Air Loss, Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
2.02		0-3m : Reddish orange brown SANDY CLAYEY SILT with minor angular and sub-angular grey QUARTZITE AND CHERT; KAROO.
2.13		
2.34		
2.09		3-29m : Reddish orange CLAYEY SILT; RESIDUAL DIABASE.
3.12	5	
2.41		
2.08		
1.32		
1.45		
2.00	10	
1.36		
1.40		
1.52		
1.34		
1.45	15	
1.42		
1.51		
1.56		
1.40		
1.08	20	
1.21		
1.34		
1.29		
1.22		
1.03	25	
0.58		
0.51		
1.10		
0.56		
0.49	30	29-30m : Angular dark grey stained reddish brown highly weathered hard rock SLATE AND CHERT with minor orange CLAYEY SILT; KAROO.
1.04		30-40m : Olive blotched orange CLAYEY SILT; RESIDUAL DIABASE.
1.11		
0.59		
0.51		
0.52	35	
0.58		
1.02		
1.03		
0.51		
0.54	40	

PROFILED BY DB/BB ON 28.02.08

LENONG

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

Infraconsult
Consulting Engineering Geologists
Tel - (011) 469-0854

REF NO IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3044
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946271 Y = -089563	COLLAR ELEV : 1476m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 28.02.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.06		40-43m : Angular grey blotched dark grey and red brown highly weathered hard rock CHERT BAND.
1.12		
1.19		
1.14		43-45m : Angular light grey stained red brown completely weathered very soft rock SHALE.
5.00	45	
1.08		45-51m : Angular dark grey blotched dark reddish brown slightly and medium weathered hard rock CHERT BAND.
1.01		
1.06		
1.16		
1.32	50	
1.49		
3.51		51-57m : Angular dark grey unweathered hard rock DIABASE.
3.08		
3.31		
3.42	55	
3.19		
3.33		
	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

LENONG

REF NO. IRR74

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3426
SHEET : 1 OF 2

LOCALITY : LENONG	
CO-ORDINATES : X = 2945995 Y = -090331	COLLAR ELEV : 1475m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 29.04.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.02		0-6m: Reddish mottled black CLAYEY SILTY SAND with traces of sub-round FERRICRETE: FERRICRETE.
1.17		
2.48		
3.00		
3.14	5	
3.11		
2.39		6-43m : Yellow brown mottled grey CLAYEY SILT, KAROO.
2.06		
2.51		
2.32	10	
2.17		
2.12		
2.18		
2.04		
2.36	15	
2.21		
1.38		
1.41		
1.29		
1.17	20	
1.42		
1.58		
1.37		
1.28		
1.21	25	
1.20		
1.07		
1.18		
1.13		
1.20	30	
1.05		
1.21		
1.40		
1.38		
1.07	35	
1.51		
2.04		
1.37		
1.22		
1.26	40	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO IR874

FIG NO

Intraconsult
Consulting Engineering Geologists
Tel (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3426
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2945995
Y = -090331

COLLAR ELEV : 1475m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.04.08

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.41		6-43m: Yellow brown mottled grey CLAYEY SILT; KAROO.
1.37		
1.49		
1.32		43-51m : Dusky red mottled yellow CLAYEY SILT; KAROO.
1.38	45	
1.49		
1.53		
1.42		
2.03		
2.06	50	
1.52		
2.14		51-55m : Dark dusky red brown CLAYEY SILT; KAROO.
1.56		
1.29		
1.32	55	
1.08		55-60m : Angular black completely weathered very soft rock carbonaceous SHALE; KAROO.
1.13		
0.57		
0.56		
1.00	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit

2. DEPTH OWL : 34m

3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO.

Infraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3451
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946551
Y = -89432

COLLAR ELEV : 1471m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)	Depth (m)	KEY REFERENCE / DESCRIPTION
1.36		0-8m. Angular, sub-angular and sub-angular white, reddish brown and grey highly weathered CHERT, QUARTZITE and FERRUGINISED SHALE GRAVEL, with traces of reddish brown mottled yellow brown SILTY SAND; FERRUGINISED KAROO
2.11		
2.36		
2.08		
2.21	5	
2.09		
2.15		
1.51		
1.32		8-10m: Reddish brown blotched orange CLAYEY SILTY SAND with abundant angular grey and red brown highly weathered CHERT GRAVEL; KAROO.
1.09	10	
1.14		10-12m. Angular grey slightly weathered hard rock QUARTZITE with traces of the above; KAROO.
1.17		
1.44		12-20m: Reddish brown blotched orange CLAYEY SILT, KAROO.
1.52		
2.06	15	
2.23		
2.09		
2.04		
1.52		
1.34	20	
1.16		20-43m: Yellow brown speckled black CLAYEY SILT, KAROO.
1.29		
1.08		
1.13		
1.29	25	
1.24		
1.08		
1.14		
1.19		
1.29	30	
1.32		
1.20		
1.06		
1.18		
1.19	35	
1.15		
1.26		
1.26		
1.33		
1.38	40	

Casing
Air Loss
Static water level

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit

2. DEPTH OWL : 31m

3. AIR LOSSES : Nil

LENONG

REF NO IRH74

FIG NO.

intraconsult
Consulting Engineering Geologists
Tel . (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3451
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946551 Y = -89432	COLLAR ELEV : 1471m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 12.06.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.40		20-43m: Yellow brown speckled black CLAYEY SILT; KAROO.
1.31		
1.38		
1.29		43-49m. As above but with traces of angular grey and red brown highly weathered QUARTZITE and yellow brown SANDSTONE and SHALE, also translucent CHERT; KAROO.
1.41	45	
1.42		
1.50		
1.36		
1.32		
1.45	50	49-50m: Yellow brown speckled black, CLAYEY SILT; KAROO
1.39		50-53m. As above but with traces of angular grey and red brown highly weathered QUARTZITE and yellow brown SANDSTONE and SHALE, also translucent CHERT; KAROO.
1.45		
1.29		
1.38		53-60m: Yellow brown speckled black CLAYEY SILT; KAROO.
1.41	55	
1.50		
1.43		
1.58		
1.46		
1.42	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 12 06 08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 31m
3. AIR LOSSES Nil

LENONG

REF NO. IR874

FIG NO.

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3456
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946662
Y = -89253

COLLAR ELEV : 1469m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 12.06.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.30		0-9m: Orange brown CLAYEY SILT with abundant angular sub-angular and sub-round grey, white and red brown highly weathered CHERT and QUARTZITE GRAVEL; FERRUGINISED KAROO.
1.26		
1.21		
1.09		
1.14	5	
1.31		
1.00		
0.51		
0.48		
1.12	10	9-18m: Reddish orange CLAYEY SILTY SAND with minor angular orange mottled black FERRUGINISED SHALE and CHERT GRAVEL; FERRUGINISED KAROO.
0.58		
0.59		
1.17		
1.34		
1.34	15	
1.41		
1.38		
1.42		
1.30		18-47m. Angular dark grey medium weathered CHERT with traces of translucent CHERT and angular reddish brown mottled orange and black FERRUGINISED SHALE; CHERT RESIDUUM.
1.31	20	
1.29		
1.41		
1.36		
1.25		
1.29	25	
1.34		
1.36		
1.21		
1.22		
1.32	30	
1.41		
1.47		
1.50		
1.38		
1.36	35	
1.52		
1.48		
1.59		
2.02		
1.53	40	

PROFILED BY DB/BR ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 29m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel (011) 469-0854

REF NO. IR847

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3450
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946662 Y = -89253	COLLAR ELEV : 1469m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 12.06.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.54		18-47m: Angular dark grey medium weathered CHERT with traces of translucent CHERT and angular reddish brown mottled orange and black FERRUGINISED SHALE; CHERT RESIDUUM.
2.03		
2.00		
1.56		
1.51	45	
1.58		
2.16		
2.09		47-51m: Angular dark grey unweathered hard rock CHERT with traces of angular light grey highly weathered soft rock SHALE; Interlayered CHERT and SHALE.
2.31		
2.24	50	
2.19		
3.41		51-57m: Angular dark grey occasionally blotched white unweathered hard rock CHERT; CHERT.
3.38		
4.10		
4.21	55	
4.07		
4.02		
	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 12.06.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 29m
3. AIR LOSSES :

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3540
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = 2946326 Y = 089862
COLLAR ELEV : 1474m AMSL
OWL : 1440m AMSL

WGS84, Lo....27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 27.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE — **Casing**, **Air Loss**, **Static water level**

PENETRATION (MIN,SEC/METRE)	Depth (m)
1.04	
0,51	
0.38	
0,46	
1.13	5
1,21	
1.29	
1.04	
1.13	
1.21	10
1.06	
1.02	
1.01	
1.15	
1.31	15
1.24	
1.06	
1.02	
1.11	
1.19	20
1.03	
0.58	
0.52	
1.00	
1.06	25
1.32	
0.50	
3.17	
3.40	
3.31	30
3,29	
3.40	
3.31	
	35
	40

DESCRIPTION

0-1 m : Reddish orange brown CLAYEY SILTY fine SAND. AEOLIAN

1-6 m : Angular white brown and grey highly weathered CHERT and ferruginised concretions with abundant reddish brown CLAYEY SILTY SAND; KAROO.

6-23 m : Reddish brown mottled orange CLAYEY SANDY SILT with traces of angular grey and translucent medium weathered CHERT; KAROO.

23-26 m : Angular dark grey medium weathered CHERT with traces of reddish brown CLAYEY SILT; CHERT RESIDUUM.

26-27 m : Angular dark grey medium weathered CHERT and minor dark brown CLAYEY SILT WAD; CHERT AND DOLOMITE RESIDUUM.

27-33 m : Angular grey and blue grey slightly weathered hard DOLOMITE. DOLOMITE BEDROCK.

PROFILED BY DB/BB ON 27.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL 36m
3. AIR LOSSES Nil

LENONG

REF NO. IRB74

FIG NO.

Infraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3540
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES : X = 2946326 Y =-089962	**COLLAR ELEV : 1474m AMSL** **OWL : 1440m AMSL**
WGS84, Lo....27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 27.02.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing, Air Loss, Static water level

PENETRATION (MIN,SEC/METRE)	DEPTH
1.04	
0.51	
0.38	
0.46	
1.13	5
1.21	
1.29	
1.04	
1.13	
1.21	10
1.06	
1.02	
1.01	
1.15	
1.31	15
1.24	
1.06	
1.02	
1.11	
1.19	20
1.03	
0.58	
0.52	
1.00	
1.06	25
1.32	
0.50	
3.17	
3.40	
3.31	30
3.29	
3.40	
3.31	
	35
	40

DESCRIPTION

0-1 m : Reddish orange brown CLAYEY SILTY fine SAND; AEOLIAN

1-6 m : Angular white brown and grey highly weathered CHERT and ferruginised concretions with abundant reddish brown CLAYEY SILTY SAND; KAROO.

6-23 m : Reddish brown mottled orange CLAYEY SANDY SILT with traces of angular grey and translucent medium weathered CHERT; KAROO.

23-26 m : Angular dark grey medium weathered CHERT with traces of reddish brown CLAYEY SILT; CHERT RESIDUUM

26-27 m : Angular dark grey medium weathered CHERT and minor dark brown CLAYEY SILT WAD; CHERT AND DOLOMITE RESIDUUM.

27-33 m : Angular grey and blue grey slightly weathered hard DOLOMITE. DOLOMITE BEDROCK.

PROFILED BY DB/BB ON 27.02.08 LENONG

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL 36m
3. AIR LOSSES Nil

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

REF NO IR874
FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3621
SHEET : 1 OF 1

LOCALITY : LENONG

CO-ORDINATES X = 2945943 Y = -090569 WGS84, Lo....27°E

COLLAR ELEV : 1474m AMSL
OWL : 1440m AMSL

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The "Geological Column" is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Laws; Static water level

PENETRATION (MIN.SEC/METRE)	Depth (m)
0.56	
1.04	
1.28	
1.32	
1.19	5
1.08	
1.14	
1.31	
0.51	
0.58	10
1.06	
1.12	
1.09	
1.15	
1.32	15
1.29	
1.41	
2.29	
3.10	
2.41	20
0.42	
2.14	
5.16	
5.29	
4.48	25
5.11	
5.20	
5.28	
	30
	35
	40

DESCRIPTION

0-2m ; Orange brown mottled yellow, reddish brown and black SANDY CLAYEY SILT with abundant ferruginised concretions: FERRICRETE.

2-17m: Orange brown SANDY CLAYEY SILT with traces of angular grey orange and white highly weathered CHERT; KAROO.

17-21m: Dark brown CLAYEY SILT WAD with traces of the above; DOLOMITE RESIDUUM.

21-22m: As above with traces of angular grey stained yellow highly weathered soft rock DOLOMITE

22-28m ; Angular dark blue grey stained yellow and light brown highly weathered hard rock DOLOMITE. DOLOMITE BEDROCK

PROFILED BY DB/BB ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 33m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469 0854

REF NO. IR874

FIG NO

PERCUSSION DRILLING REPORT

BOREHOLE NO : 3832
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946243
Y = -090239

COLLAR ELEV : 1473m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.04.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY
REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.40		0-4m : Reddish orange mottled yellow brown and black CLAYEY SILTY SAND and abundant sub-round FERRICRETE NODULES; FERRICRETE.
2.32		
2.19		
1.58		
2.20	5	4-19m : Orange brown mottled yellow brown CLAYEY SILT; KAROO.
2.41		
3.17		
3.03		
3.12		
2.45	10	
2.29		
1.36		
2.08		
2.31		
2.19	15	
2.40		
2.10		
1.58		
2.29		
1.53	20	19-57m : Yellow brown mottled grey CLAYEY SILT, KAROO.
2.21		
1.46		
1.38		
1.21		
1.40	25	
1.47		
1.32		
1.09		
1.06		
1.24	30	
1.21		
1.02		
0.51		
0.58		
0.56	35	
1.04		
1.29		
1.18		
1.16		
1.26	40	

PROFILED BY DB/BE ON 29.04.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 32m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel - (011) 469-0854

REF NO IR874
FIG NO.

PERCUSSION DRILLING REPORT | **BOREHOLE NO : 2643**
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946139 Y = -089470	**COLLAR ELEV : 1477m AMSL OWL : 1440m AMSL**
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 28.02.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE — **Casing**, **Air Loss**, **Static water level**

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
1.02		0-1m : Angular grey, orange and white medium and highly weathered CHERT with traces of QUARTZITE and abundant orange brown CLAYEY SILTY SAND, KAROO
0.53		1-11m : Angular dark grey, grey medium weathered CHERT with abundant angular light grey completely weathered very soft rock SHALE and traces of medium weathered QUARTZITE with minor light grey CLAYEY SILT; KAROO.
0.37		
0.33		
0.41	5	
0.40		
0.49		
0.42		
0.41		
0.44	10	
0.40		
0.37		11-19m : Reddish orange brown CLAYEY SILT with minor angular dusky red highly weathered QUARTZITE AND SHALE with traces of angular grey and dusky red medium hard rock QUARTZITE, KAROO
0.43		
0.41		
0.46	15	
0.42		
0.45		
0.51		
0.56		
0.49	20	19-27m : Orange brown CLAYEY SILT with minor angular grey red brown and orange highly weathered CHERT AND QUARTZITE, KAROO
1.02		
1.10		
0.58		
0.41		
0.46	25	
1.00		
1.03		
0.59		27-39m : Angular grey blotched dusky red highly weathered soft rock SHALE; KAROO.
0.52		
0.56	30	
0.59		
1.08		
1.14		
1.21		
1.06	35	
1.10		
1.02		
0.58		
0.56		
1.15	40	39-41m : As above with minor angular black highly weathered

PROFILED BY DB/HH ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel (011) 469-0854

REF NO. IRR74

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2643
SHEET : 2 OF 2

LOCALITY : LENONG	
CO-ORDINATES : X = 2946139 Y = -089470	COLLAR ELEV : 1477m AMSL OWL :1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 28.02.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)		Depth		DESCRIPTION
1.03				soft rock SHALE; KAROO.
1.02				41-60m: Orange blotched olive CLAYEY SILT; RESIDUAL KAROO.
0.56				
1.00				
1.08		45		
1.15				
1.31				
1.39				
1.25				
1.34		50		
1.06				
0.51				
0.48				
0.42				
0.48		55		
0.49				
0.55				
0.51				
1.02				
0.51		60		
		65		
		70		
		75		
		80		

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO. IR874
FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2648
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946250 **Y = -089292**	**COLLAR ELEV : 1476m AMSL** **OWL : 1440m AMSL**
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 29.02.08	

The "Geological Column" is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)
1.21	
1.04	
0.51	
0.49	
0.52	5
0.56	
0.43	
0.40	
0.41	
0.49	10
0.58	
0.42	
0.41	
0.46	
0.39	15
0.44	
0.41	
0.40	
0.48	
0.42	20
0.49	
0.53	
0.51	
1.00	
0.59	25
1.11	
1.16	
1.02	
0.59	
0.52	30
0.46	
0.41	
1.08	
1.12	
1.36	35
1.04	
1.13	
1.06	
1.21	
1.13	40

DESCRIPTION

0-1m : Sub-angular, sub-round and angular yellow, orange and reddish brown highly weathered CHERT, SHALE AND QUARTZITE GRAVEL with abundant orange brown CLAYEY SILT, KAROO

1-31m : Angular grey, translucent and dark grey medium weathered CHERT AND QUARTZITE with traces of angular completely weathered SHALE and abundant grey brown CLAYEY SILT; KAROO.

31-46m : Angular grey, pale red and brown medium and highly weathered QUARTZITE with traces of CHERT as above and abundant light grey blotched orange brown CLAYEY SILT; KAROO.

PROFILED BY DB/BB ON 29.02.08

LENONG

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

REF NO. IR874
FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2648
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946250
Y = -089292

COLLAR ELEV : 1476m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated

KEY REFERENCE
Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.10		31-46m : Angular grey, pale red and brown medium and highly weathered QUARTZITE with traces of CHERT as above and abundant light grey blotched orange brown CLAYEY SILT; KAROO.
1.38		
1.49		
1.26		
1.32	45	
1.41		46-60m : Orange brown CLAYEY SILT with traces of angular dark brown highly weathered soft rock DIABASE.
1.30		
1.06		
1.02		
1.31	50	
1.20		
1.34		
1.38		
1.27		
1.18	55	
1.11		
1.32		
1.29		
1.40		
1.26	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BD ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO

Intraconsult
Consulting Engineering Geologists
Tel - (011) 469-0854

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2931
SHEET : 1 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2945967
Y = -089997

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHANN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing, Air Loss, Static water level

PENETRATION (MIN,SEC/METRE)	Depth (m)	DESCRIPTION
3.19		0-6m Reddish brown mottled orange and black SANDY CLAYEY SILT; FERRUGINISED HILLWASH
3.34		
3.20		
3.01		
2.48	5	
3.31		
3.29		6-28m : Orange mottled grey CLAYEY SILT; KAROO
3.02		
3.11		
3.16	10	
2.51		
2.29		
3.48		
4.14		
4.02	15	
3.50		
3.19		
3.32		
3.29		
3.14	20	
2.48		
2.56		
3.02		
3.11		
2.26	25	
2.51		
3.18		
2.39		
3.21		28-46m : Yellow brown mottled grey CLAYEY SILT; KAROO.
2.14	30	
2.51		
2.09		
2.56		
3.11		
3.28	35	
3.03		
3.16		
2.45		
2.29		
3.10	40	

PROFILED BY DU/BU ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 36m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

Intraconsult
Consulting Engineering Geologists
Tel : (011) 469-0854

FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2931
SHEET : 2 OF 2

LOCALITY : ROODTKOP

CO-ORDINATES : X = 2945967
Y = -089997

COLLAR ELEV : 1477m AMSL
OWL : 1440m AMSL

WGS84, Lo 27°E

CONTRACTOR : JOHAN BOTHA

DATE COMPLETED : 29.02.08

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
2.50		28-46m : Yellow brown mottled grey CLAYEY SILT; KAROO.
2.41		
3.10		
2.46		
2.52	45	
3.00		
3.16		46-60m : Pale dusky red blotched grey CLAYEY SILT; KAROO.
2.49		
2.21		
2.10	50	
1.40		
1.06		
1.13		
1.29		
1.04	55	
.056		
0.51		
0.59		
1.02		
1.09	60	
	65	
	70	
	75	
	80	

PROFILED BY DH/BB ON 29.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m³/min to a 165mm button bit
2. DEPTH OWL : 34m
3. AIR LOSSES Nil

LENONG

Intraconsult
Consulting Engineering Geologists
Tel. (011) 469-0854

REF NO. IR874

FIG NO.

PERCUSSION DRILLING REPORT	BOREHOLE NO : 2938 SHEET : 1 OF 2
LOCALITY : LENONG	
CO-ORDINATES : X – 29466115 Y – -089743	COLLAR ELEV : 1477m AMSL OWL : 1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHANN BOTHA	
DATE COMPLETED : 28.02.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE: Casing; Air Loss; Static water level

PENETRATION (MIN.SEC/METRE)	Depth (m)	DESCRIPTION
1.06		0-2m : Orange brown SANDY CLAYEY SILT with minor angular and sub-angular brown, grey and red brown highly weathered CHERT, SHALE AND QUARTZITE, KAROO.
1.13		
1.29		2-15m : Angular dark grey, grey and red brown medium and completely weathered SHALE and abundant orange brown highly weathered CHERT AND QUARTZITE with traces of CLAYEY SILT; KAROO.
1.22		
1.21	5	
1.04		
0.58		
0.59		
0.51		
0.56	10	
1.13		
1.19		
1.22		
1.31		
1.04	15	15-34m : Angular dusky red completely weathered medium hard rock QUARTZITE with traces of dry dark grey slightly weathered CHERT and minor pale red CLAYEY SILT; KAROO.
1.25		
1.30		
1.29		
1.20		
1.30	20	
1.14		
1.09		
1.26		
1.22		
1.28	25	
1.34		
1.33		
1.22		
1.36		
1.44	30	
1.25		
1.20		
1.13		
0.59		
0.51	35	34-41m : Angular light grey stained orange completely weathered very soft rock SHALE; KAROO
1.00		
1.26		
1.29		
1.17		
1.24	40	

PROFILED BY DB/BH ON 28.02.08 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m³/min to a 165mm button bit 2 DEPTH OWL : 38m 3. AIR LOSSES : Nil	LENONG Intraconsult Consulting Engineering Geologists Tel : (011) 469-0854	REF NO. J0874 FIG NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO : 2938
SHEET : 2 OF 2

LOCALITY : LENONG

CO-ORDINATES : X = 2946115 Y = -089743	**COLLAR ELEV** : 1477m AMSL **OWL** :1440m AMSL
WGS84, Lo 27°E	
CONTRACTOR : JOHAN BOTHA	
DATE COMPLETED : 28.02.08	

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

KEY REFERENCE

Casing
Air Loss
Static water level

PENETRATION (MIN,SEC/METRE)	Depth	DESCRIPTION
1.20		34-41m : Angular light grey stained orange completely weathered very soft rock SHALE.
1.41		
1.56		41-44m : Angular grey and dark grey completely weathered SHALE and medium weathered CHERT with minor orange brown CLAYEY SILT; KAROO.
1.48		
1.29	45	
1.52		44-51m : Angular light grey stained orange completely Weathered very soft rock SHALE.
1.38		
1.64		
1.56		
1.45	50	
1.48		
1.32		51-60m : Angular grey and dark grey completely weathered SHALE and medium weathered CHERT with minor orange brown CLAYEY SILT; KAROO.
1.52		
1.57		
1.41	55	
1.52		
2.06		
2.49		
2.23		
2.17	60	
	65	
	70	
	75	
	80	

PROFILED BY DB/BB ON 28.02.08

1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
1800kPa delivering 25,4m^3/min to a 165mm button bit
2. DEPTH OWL : 38m
3. AIR LOSSES : Nil

LENONG

REF NO. IR874

FIG NO

Intraconsult
Consulting Engineering Geologists
Tel.: (011) 469-0854

APPENDIX C
Water Precautionary Measures

WATER PRECAUTIONARY MEASURES ON DOLOMITE:

1. General measures to be implemented on all dolomite sites (minimum requirements – NHBRC Standards)

1.1 Wet-services of individual and entire development -

a. All wet-services should be of good quality in order to ensure low maintenance.

b. Piping materials selected should also be appropriate to local subsurface
conditions. If clay pipes are utilized in areas of shallow dolomite, a higher standard of pipe bedding is recommended e.g. stabilized bedding or over excavation and recompaction with an approved material (minimum specification to be G7 material) in layers of 150mm thickness, compacted to 93% mod AASHTO. Some soils may have low pH values, which will render the use of ferrous material for underground services unsuitable. Chapter II in "A Technical Guide to Good House Construction" NBRI of the CSIR (July 1984) should be consulted concerning the potential corrosion of pipes.

c. The NHBRC[1] makes the following recommendations:
Water-piping materials shall be one or more of the following:
- High-impact PVC pipes with vitualic joints
- Other flexible (as defined in SABS 0102, Part 1) water pipes with flexible, self anchoring connections.

Pipes having diameter of less than 75mm.
- HDPE type IV
- Polypropylene

Pipes should be flexible, while joints should be minimised.

d. Water pipes entering buildings should either be fitted with flexible couplings or kinked with a Z to allow opportunity for relative movement. A flexible connection at the junction with all outlet pipes should be used, which included WC pan connections.

e. Pressure-release systems tend to leak after a couple of years. This leaking water must flow directly into the storm or sewerage water system.

f. Water reticulation to houses should be kept at a minimum depth of 500mm up to the structure and above ground where possible along the structure.

g. As many services as possible should be placed within a single trench.

h. Encasement of pipes in concrete or soilcrete should be avoided. Preferably place pipes in sleeves. If this cannot be achieved, care must be taken to ensure that differential movement can still be accommodated without the pipe breaking.

[1] National Home Builders Registration Council

i. All storm-water, sewerage and water pipes and channels must be watertight. All laid wet services should be tested for leakage on installation using the air test (see NBRI Info Sheet X/BOU 2-34) for water pipes, and the water test for sewerage pipes.

j. Placement of wet-services below the footprint of structures must be avoided. No plumbing and drainage pipes should be placed under floor slabs, as far as practicable. Where this situation is unavoidable, reasons must be cited and the pipes must be placed in a sleeve to permit monitoring.

k. Where practical, pipes running parallel to structure should be kept at a distance of at least 5m from the structure.

l. Each stand should have a rodding eye or some similar access to the sewer connection in addition to the inspection eye.

m. Each stand / unit should have a water meter at a suitable location so that testing of the stand / unit specific water supply is possible. Water leakage testing must be undertaken regularly, as set out in the risk management system.

n. The roots of trees planted in close proximity to the line of water-bearing services often causes leaks in or malfunctioning of the services. Care should therefore be taken to avoid the unfortunate positioning of trees and other plants.

o. Residents should be informed of where services traverse their garden so that accidental puncturing of pipes can be avoided.

1.2 Entire Development

a. The design of wet-services should be governed by the need to create low maintenance systems. Wherever possible, keep services above ground to facilitate detection of leaks, maintenance and repair.

b. The stability of the centre line of all bulk water services should be considered.

c. Piping used in mains and communication pipes should be flexible, while joints should be minimised and, where required, self anchoring type (ie not reliant on thrust blocks for their anchorage at fittings, except at valves and end caps).

d. The relevant provision of SABS 1200 DB, L, LB, LC, LD and LE shall be observed in the installation of all underground services.

e. Water mains shall be laid only in road reserves.

f. Provision for future connections shall be made in order to minimize the cutting into pipes to provide such connections.

g. Water pipe entries into the building shall be in accordance with those of the JSD's code of practice[2].

h. The use of pre-manufactured, unjointed manholes is preferred. The manhole should be placed on a properly prepared foundation.

i. Use flexible couplings on either side of manholes.

j. Water-borne sewerage reticulation must be installed. French drains are unacceptable.

k. A detailed sanitation and water reticulation plan should be drawn up for the development according to the local geological setting and engineering geological characteristics. The plan must be incorporated into the services management system of the local authority.

1.3 Storm-water drainage

a. No accumulation of surface water is to be permitted and the <u>entire</u> development must be properly drained.

b. A minimum gradient of 1:150 should be maintained along stormwater systems.

c. Brick and precast concrete walls must be so designed as to provide drainage ports at ground level permitting passage of maximum probable quantities of water.

d. When courtyards are designed the free flow of surface water should be ensured. When gutter downpipes are to be found in such a courtyard, a lined canal should permit passage of water into a drain or onto the lawn, away from the structure. The courtyard should preferably be paved and no garden beds should be created at gutter discharge pointes. Lawns must be graded in such a way to facilitate drainage.

e. In order to deal with rainwater run-off from the roofs of structures the following is recommended:

  - If guttering is required by the local authority, then the down pipes should be discharged into a lined or precast furrow. This furrow should remove the water from the structure. The stormwater should be drained, without ponding, off the property and into the municipal stormwater system..
  - If no gutting is to be utilized, then it is recommended that a sealed surface with a width of 1,5m be cast along those walls of the structure where water will be discharged from the roof. Roof water will cascade off this sloping roof onto the apron into a lined or precast furrow. The storm-water should be drained, without ponding, off the property and into the municipal storm-water system.
  - The ground immediately against the buildings shall be shaped to fall in excess of 75mm over the first 1,5m beyond the perimeter of the building, from where it shall drain freely away from housing units. Apron slabs, where provided shall have the same fall.

---

[2] JSD Code of Practice reference

f. All ponds, watercourses and road surfaces shall be rendered impervious.

g. No trees shall be planted within 1,5 times their eventual height from the line of storm-water services.

h. The storm-water drainage system shall incorporate measures to ensure water tightness of conduits and other compartments. Whenever possible, storm-water should be channeled in lined, surface canals.

i. Concrete non-pressure pipes should be of the spigot-and-socket type with rubber ring seals. Joints in box culverts, channels, etc. should be sealed.

j. Storm-water drainage conduits shall be constructed at gradients that will not permit the deposition of silt , or sand, of the type present in the catchment area.

1.4 Trenchings

a. Trenches and excavation works should be opened and closed as rapidly as possible. Avoid leaving trenches open over weekends and holidays. A berm should be created to divert surface water away from the trenches while they are open. All trenches and excavation works must be properly backfilled and compacted according to specifications given in subclause 5.2.4 of SABS 1200 DA, but specifically to ground surface to prevent them acting as French drains. Once service / cables are installed and backfilling is completed, it must be ensured that ground surface is graded to match the slope of the surrounding area. No rocks in the top layer.

b. Berms should be constructed on the up-slope side of trenches to prevent the inflow of water during storms.

c. The fall of trenches shall be away from buildings. Wherever practical, service trenches shall not be excavated along the length of housing units within the first 3m beyond the perimeter of such units.

d. No ponding of surface water is to be permitted over, in, or in the vicinity of trenches and excavations.

1.5 Roads

a. Ensure that roadways are, in fact, placed below the site level so as to facilitate drainage. If the road network is the sole stormwater system, in a township, care must be taken that the roads are surfaced.

b. Ponding of surface water on, or next to roads that are not tarred, should be avoided.

c. Roadways which have a gradient of less than 1:80 shall be surfaced / sealed.

d. The velocity of the 1-in-20 year storm-water, flowing along unsurfaced roadways, shall not exceed 1,5m /s.

1.6 Swimming Pools

The following minimum requirements must exist:

Construction, maintenance and responsibilities for pools:

A) Construction

i) The design, construction and use of the swimming pool should at all times be to the satisfaction of the local city engineer, who should be aware of the requirements of swimming pools in dolomitic areas.

ii) The swimming pool must be designed as an *independent unit, which will not give way or distort.* The sides or floor of the pool should not crack in the event of any ground movement underneath or nearby the swimming pool.

iii) The swimming pool may be constructed from concrete, metal or any other suitable material on condition that the design conforms with conditions (Ai) above.

iv) All water pipes, pumps and connections should be installed either in the open, on the surface, or in service canals where these may be inspected or repaired without access problems.

v) **The swimming pool should be built so as to prevent any rain water into or towards the pool.**

B) Maintenance and responsibilities

i) All back wash must be discharged *directly* into main storm-water line.

ii) Any abnormal loss of water from the pool as well as any noticeable ground movements (cracks forming in the ground or in the pool) must be reported by the stand owner to the Home Owners Association or Body Corporate and the local council.

iii) It is important to note that the responsibility of checking pipes to and from the pool, the handling of run-off water from the pool as well as the repairing of cracks in the pool and replacing of leaking pipes lies solely with the stand owner. Negligence could result in the instability.

2. Additional precautionary measures for residential affordable, residential group housing (single and double story) and gentleman's estates.

a. Place bulk services in road reserves or servitudes with a minimum width of 5m. Servitudes may be utilized as parks or "bridle paths". If these services are placed mid-block, a building line restriction of a minimum width of 5 m must be imposed. Place water and sewer connections of every two units along their common property boundary. Shared sewer connections should be implemented if this arrangement leads to a reduction in the meterage of service and minimises the disturbance of the environment. Property and unit entrances should be placed at points furthest from the trenches of these water and sewer connections.

b. It is recommended that structures be placed on earth mattresses, which serve to ensure load distribution and to prevent water ingress. A continuous mattress can be considered for high density development, where it is emplaced in strips for block lengths and with widths exceeding the house footprint by at least 2 m. This exercise must be completed prior to the installation of services.

c. Water and sewer connections to households should be placed within the mattress of enhanced earth. The mattress will retard the flow of water from a leaking service but material will eventually be mobilized sufficiently for structural damage to occur. It is thus evident that testing of water-borne services on a regular basis is very important. Consideration should be given to the placement of sewer lines in inspectable canals as these are not so easy to test. If the mattress is penetrated, wet-services must be placed in sleeves for 5 m beyond the structure so that the leaking services immediately beyond the mattress cannot result in instability in close vicinity to the foundation.

d. Roadways must be sealed and be constructed below the level of stands.

e. Property and unit entrances should be placed at points away from the trenches of water and sewer connections.

f. Each stand should either have a rodding eye or some similar access to the sewer connection in addition to the inspection eyes so that sensible monitoring may be possible.

3. Additional precautionary measures for High-rise, Light Industrial and Light Commercial sites

a. It is recommended that structures be placed in stiffened rafts on earth mattresses, which serves to ensure load distribution and to prevent water ingress. The mattresses must be emplaced prior to the installation of services.

b. The principal water-bearing services must be placed either in the mattress or sleeves for a distance of at least 5m beyond the periphery of the building.

c. The surfaces around buildings should be sealed and sloped so that no surface run-off water is allowed to pond against buildings.

d. Downpipes bearing accumulated roof water can be discharged either onto the sealed surfaces to drain away from the structure, or into lined furrows and into stormwater systems.

e. Roadways should be sealed.

f. Portions should be identified at which “plugs” can be installed to stop flow in sewer and water lines at short notice in the event of rupture or sinkhole formation underneath the service. The Local Authority must ensure that contingency plans are in place to deal with such emergencies.

g. No swimming pools should be permitted in this zone.

h. Lined channels are preferred to pipes for stormwater systems in these zones.

i. Structures must be correctly and safely founded.

j. A monitoring programme must be embarked upon by either the owner of the property/buildings or the appropriate Local Council or Metropolitan Substructure to regularly check for any leaks in services, unauthorized structures which could lead to concentration of water and, where necessary, monitor the groundwater level (refer to risk management systems).

k. With respect to commercial, industrial or high rise structures, the principal water-bearing services should preferably be placed above ground or in sleeves when within 5 m of the structure.

4. Precautionary measures for sites unsuitable for development

a. No buildings should be allowed in this zone.

b. The entire site must be properly sealed.

c. No water-borne services must be allowed in this area. Ablution blocks should be avoided.

d. Surface water run-off management is critical in these areas.

APPENDIX D
Monitoring

RISK MANAGEMENT PLAN:

1. Management at Township/Development Level

1.1 Monitoring

Monitoring comprises three parts:

a. *Infrastructure monitoring:* This entails the inspection of water-bearing services, buildings, roads, etc.
b. *Ground surface monitoring:* This entails the inspection of the ground surface as it is disturbed and affected by man's activities.
c. *Groundwater monitoring:* This entails the measuring and recording of the groundwater level.

Monitoring practices will differ from site to site but also possibly from zone to zone within a site. Some zones that have more stringent precautionary measures imposed on them may need to be monitored on a more frequent basis. This could be monthly, quarterly or yearly.

A. Infrastructure Monitoring

Seasonal interval basis

1. Visual checks for debris in open storm-water channels at the start of the rainy season and after heavy storms.
2. Visual checks for water flowing out of storm-water manholes at the start of the rainy season and after heavy storms.
3. Examine buildings for cracks at the start of the rainy season.

On a short-interval basis (weekly/monthly)

1. Visual checks for outside dripping taps and pressure valves.
2. Visual checks for damp areas.
3. Visual checks for debris in storm-water channels.
4. Visual checks for water flowing out of sewer and storm-water manholes.
5. Examine buildings for cracks.
6. Visual check for over-wetting of gardens.
7. Visual check for blocked drainage ports in garden walls.

On an intermediate-interval basis (4 or 6 monthly/yearly)

In many cases, visual inspections may not be sufficient. It may be necessary to undertake regular air and water tests on wet-services. Consideration should be given to the design of the infrastructure so that these tests may be possible.

1. Close all taps in the buildings or stopcocks controlling water supply to buildings, if fitted, for one hour and monitor the water meter OR monitor the meter late at night. A slow increase in the water meter reading or continued operation of the meter will indicate that there is a leakage between the meter and the taps/stopcocks.
2. Open all manholes on the property and observe if waste water/storm-water flows normally.

On a long-interval basis (yearly)

1. Wet-services to be inspected by camera (in pipes with a diameter greater than 100mm).

B. Ground Surface Monitoring

Ground surface monitoring may be undertaken visually on a regular basis. This should be done by inspecting paved areas after rainstorms (ponding water often indicates an area of differential settlement). Inspectors should look out for ground cracks and cracks in lined and unlined channels.

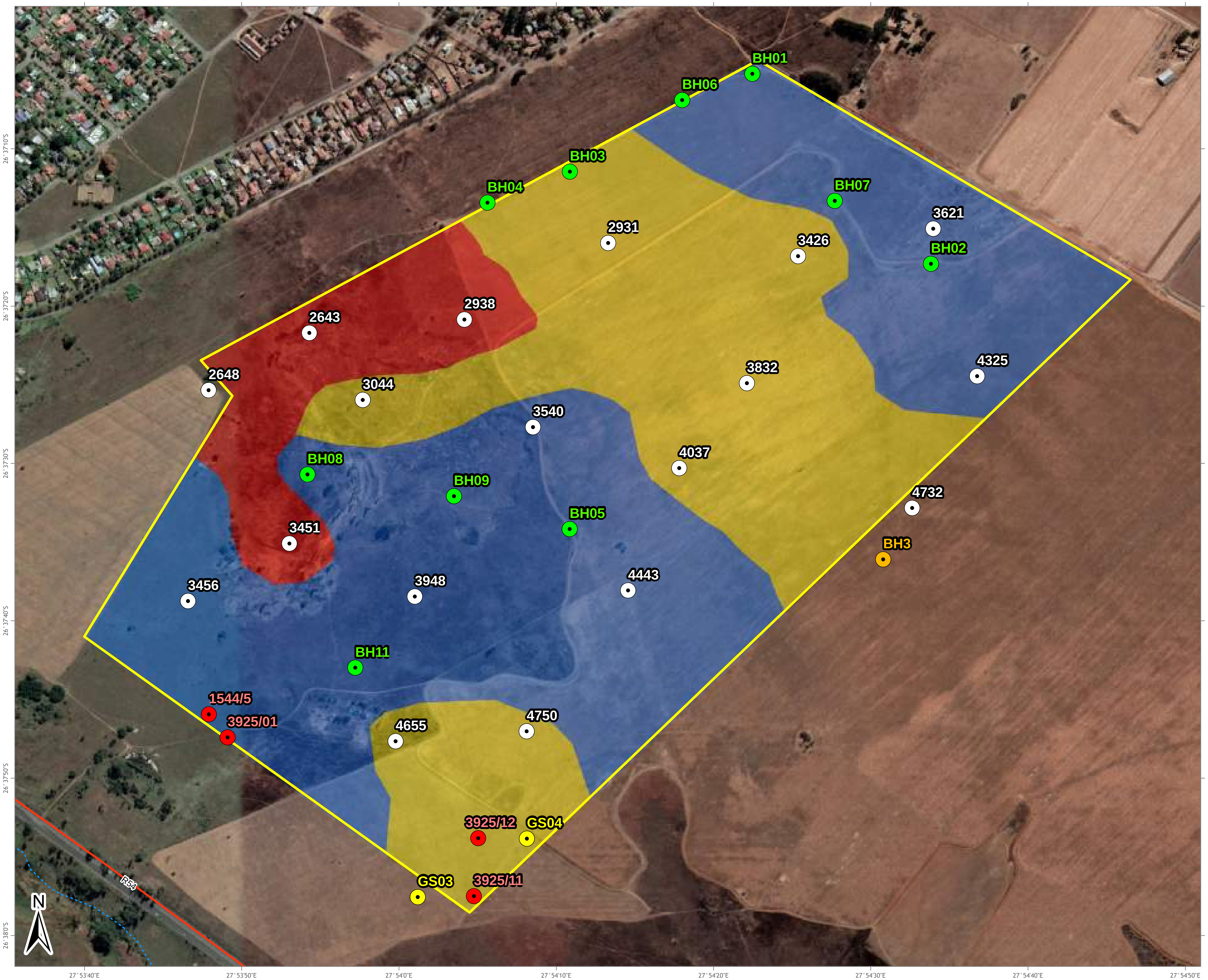
In many instances visual inspections may not be sufficient. It may be necessary to undertake precision ground surface levelling, particularly in areas that have been rehabilitated after an event. Such levelling must be undertaken by a registered land surveyor, recorded and stored in the database and appropriate actions taken when excessive settlement continues.

C. Groundwater- level Monitoring

In certain townships a recommendation will be made to fit one or more borehole(s) with the necessary equipment to measure the groundwater level. The time when the inspection is made as well as the name of the inspector must be recorded. The actual measurements should ultimately be reported to the DWAF.

FIGURES

UNITAS PARK EXT 16: DOLOMITE ZONATION MAP



LEGEND

- Project Boreholes
- GeoStable 2018 Boreholes
- Intraconsult 2008 Boreholes
- Luxton 1976 Boreholes
- VGI 2015 Boreholes

Rivers and Streams

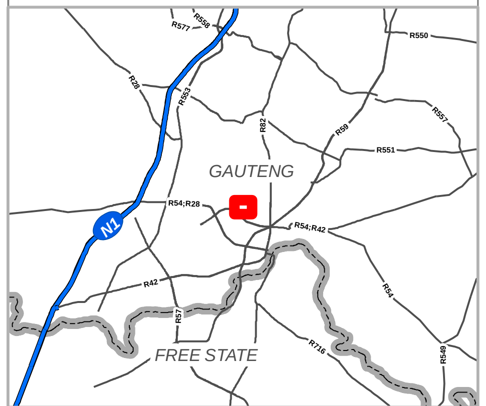
- Non-Perennial

Road Network

- Main Road
- Site Boundary

Dolomite Zone

- Zone A
- Zone B
- Zone C



Data Sources:
Google Earth™ mapping service: 2021
Imagery Date: 05/07/2019 and 07/22/2019

0 150 300 Meters

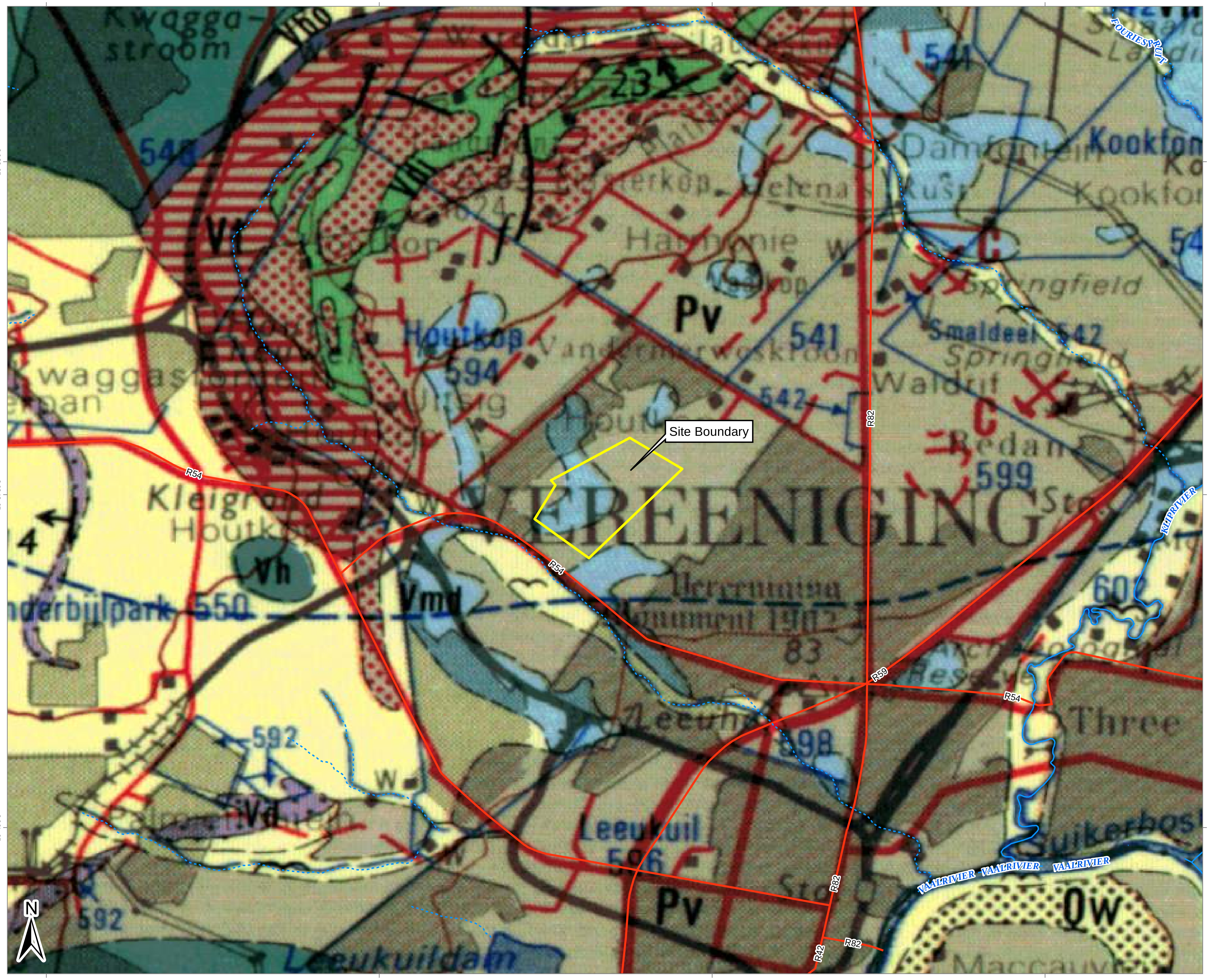
SCALE: 1:7 000

FIGURE NO.:	-	MAP NUMBER:	19-0916.047-01
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	D FRANKLIN ENGINEERING GEOLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	04 FEBRUARY 2021
PROJECT: CLIENT:	UNITAS PARK EXT 16 PHUMAF		

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

UNITAS PARK EXT 16: GEOLOGY



LEGEND

Rivers and Streams

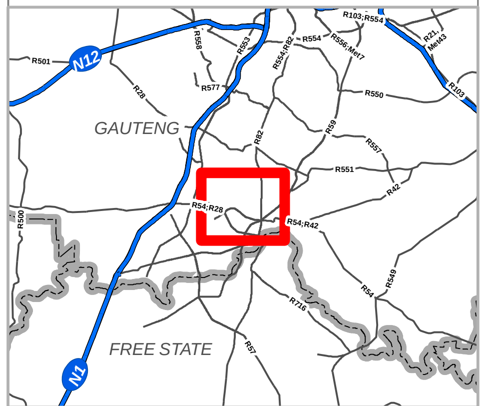
- Non-Perennial
- Perennial

Road Network

- Main Road
- Site Boundary

Lithology

Symbol	Description
	Alluvium
Qs	Soil cover
Qw	Aeolian sand
Pv	Sandstone, shale, coal
Vdi	Diabase
Vd	Quartzite and shale, ferruginous in places
Vh	Andesite, agglomerate, tuff
Vbo	Quartzite, conglomerate
Vt	Ferruginous shale, hornfels
Vt	Ferruginous quartzite
Vmd	Dolomite, chert and remnants of chert breccia of the Rooihoogte Formation



Data Sources:
Council for Geoscience
1:250 000 Geological Series: 2626

0 1 2 Kilometers

SCALE: 1:50 000

FIGURE NO.:	-	MAP NUMBER:	19-0916.047-02
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	D FRANKLIN ENGINEERING GEOLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	04 FEBRUARY 2021
PROJECT: CLIENT:	UNITAS PARK EXT 16 PHUMAF		

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

APPENDIX B2

Agricultural Agro-Ecosystem Specialist Assessment

TerraAfrica

SOIL. AGRICULTURE. ENVIRONMENT.

Agricultural Agro-Ecosystem Specialist Assessment for the proposed Residential and Mixed-Use Development in Unitas Park Extension 16

Version 1 Report

Submitted by TerraAfrica Consult cc
Mariné Pienaar
(MSc. Environmental Science)
(SACNASP Registered Agricultural Scientist)

22 October 2020

DOCUMENT AND QUALITY CONTROL

Client	GCS (Pty) Ltd
Client Project Reference Number	19-0921
Document Title	Agricultural Agro-Ecosystem Assessment for the proposed Residential and Mixed-Use Development in Unitas Park Extension 16
Document Version	Version 1

Report Version	Responsible Person	Role/Responsibility	Signed	Date
A1 – First Draft	Mariné Pienaar	Report Author		26/05/2020
Version 1	Mariné Pienaar	Report Author		22/10/2020

DECLARATION OF INDEPENCE OF THE SPECIALIST

Details of Specialist

Report author: M Pienaar
Contact number: 082 828 3587
Email address: mpienaar@terraafrica.co.za
Physical address: 7 Smuts Street, Wolmaransstad, 2630

SACNASP Registration Number: 400274/10

Fields of registration: Soil Science
Agricultural Science

Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
22 October 2020

Table of Contents

List of Figures

1. INTRODUCTION

GCS Water and Environmental Consultants (Pty) Ltd appointed TerraAfrica Consult cc to conduct the Agricultural Agro-Ecosystem Specialist Assessment as part of the Environmental Impact Assessment (EIA) process for the proposed development of residential and mixed land uses as part of the Gauteng Rapid Land Release Programme (GRLP) (from here onwards also referred to as the proposed development).

The proposed development is located on approximately 154ha of land on Portion 222 of the Farm Houtkop 594 (also referred to as Unitas Park Extension 16) (Figure 1). For the purpose of the report, this area is also referred to as the proposed development area or study area. The study area is located within the Emfuleni Local Municipality and the Sedibeng district municipalities and is part of an area that is known as Unitas Park. The town of Vereeniging is located approximately 5.1 km south-east of the site.

2. PURPOSE AND OBJECTIVES

The overarching purpose of the Agricultural Agro-Ecosystem Assessment that will be included in the Environmental Impact Assessment report, is to ensure that the sensitivity of the site to the proposed land use change (from agriculture to residential and mixed land use) is sufficiently considered. Also, that the information provided in this report, enables the Competent Authority to come to a sound conclusion on the impact of the proposed project on the food production potential of the site.

To meet this objective, site sensitivity verification must be conducted of which the results must meet the following objectives:

- It must confirm or dispute the current land use and the environmental sensitivity as was indicated by the National Environmental Screening Tool.
- It must contain proof of the current land use and environmental sensitivity pertaining to the study field.
- All data and conclusions are submitted together with the Environmental Impact Assessment report for the proposed development.

According to GN320, the Agricultural Agro-Ecosystem Assessment that is submitted must meet the following requirements:

- It must identify the extent of the impact of the proposed development on the agricultural resources.
- It has to indicate whether or not the proposed development will have an unacceptable impact on the agricultural production capability of the site, and in the event where it does, whether such a negative impact is outweighed by the positive impact of the proposed development on agricultural resources.

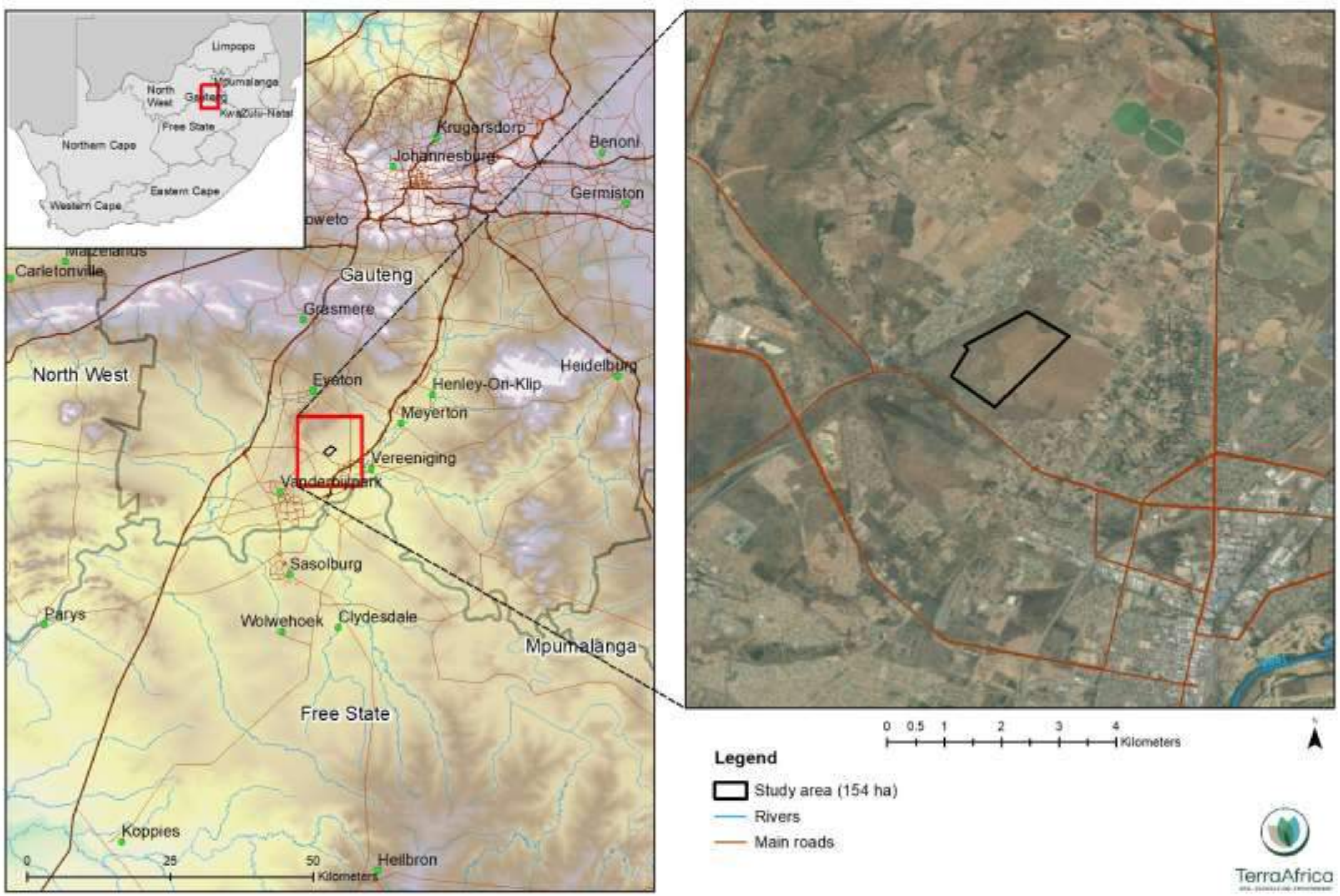


Figure 1: Locality map of the proposed Unitas Park Extension 16 development area

3. TERMS OF REFERENCE

In addition to the requirements stipulated in GN320, the following Terms of Reference as stipulated by GCS applies to the Agricultural Agro-Ecosystem Specialist Assessment:

- Consider all the baseline data that was gathered during the site survey together with all the relevant spatial data to understand the in-situ soil properties and agricultural production value of the site.
- Identify and assess potential impacts on both agricultural potential as well as soil, resulting from the proposed residential and mixed land use development.
- Identify and describe potential cumulative soil, agricultural potential and land capability impacts resulting from the proposed development in relation to proposed and existing developments in the surrounding area.
- Recommend mitigation, management and monitoring measures to minimise impacts and/or optimise benefits associated with the proposed project.

4. LEGISLATIVE FRAMEWORK FOR THE ASSESSMENT

Since the proposed development site has high sensitivity for agricultural resources, the report follows the protocols as stipulated for agricultural assessment in Government Notice 320 of 2020 (GN320). This Notice provides the procedures and minimum criteria for reporting in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (No. 107 of 1998) (from here onwards referred to as NEMA). It replaces the previous requirements of Appendix 6 of the Environmental Impact Assessment Regulations of NEMA.

In addition to the specific requirements for this study, the following South African legislation is also considered applicable to the interpretation of the data and conclusions made with regards to environmental sensitivity:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This Act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.
- Section 3 of the Subdivision of Agricultural Land Act 70 of 1970 may also relevant to the development.
- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of water resources, including wetlands. The soil assessment therefore also focused on the identification of any hydromorphic soil forms with wetland functionality that may be present in the study area.

5. SENSIVITY ANALYSIS OF THE SITE ACCORDING TO THE ENVIRONMENTAL SCREENING TOOL

The result of screening the proposed site with the Environmental Screening Tool of the Department of Environmental Affairs, showed that the area has high combined agricultural sensitivity (
Figure **2**). For sites with high agricultural sensitivity, an Agricultural Agro-Ecosystem Assessment is required.

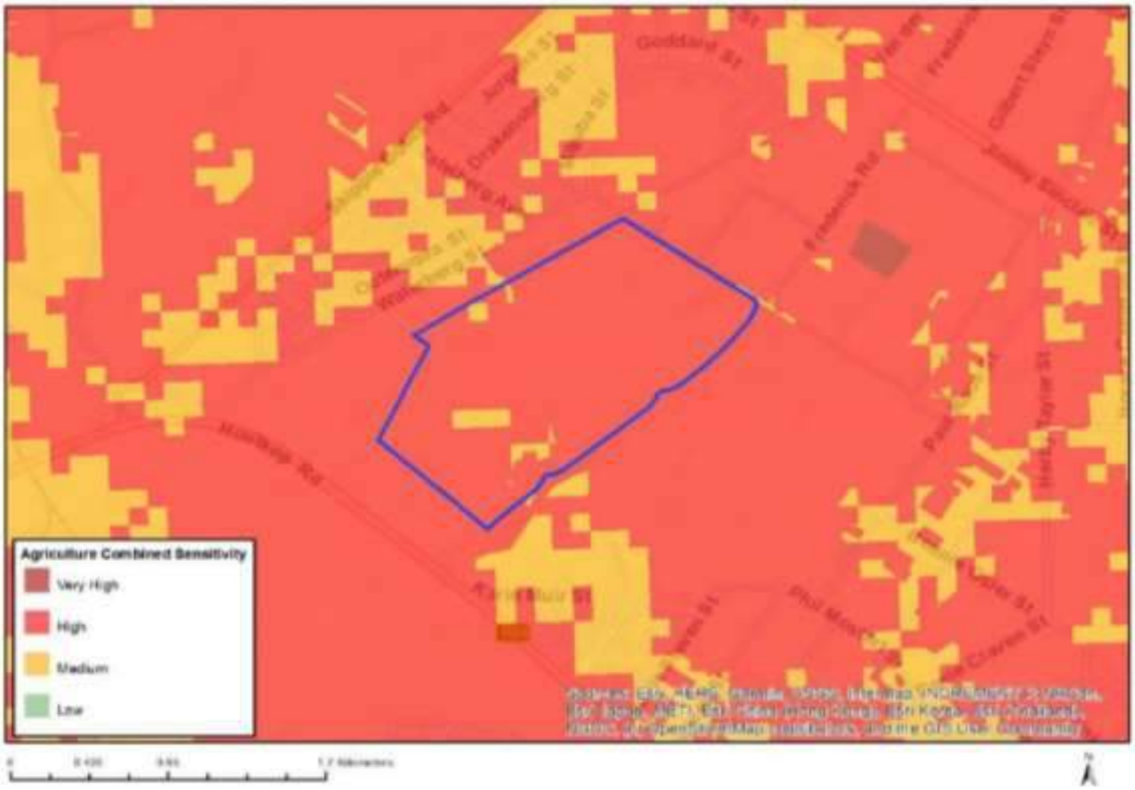


Figure 2 Visual depiction of the proposed development site's agricultural combined sensitivity

6. METHODOLOGY

6.1 Desktop analysis of aerial imagery and other spatial data

Satellite imagery accessed on Google Earth, was analysed to determine areas of existing impact and land uses within the study area as well as the larger landscape. It was also scanned for any areas where crop production and farming infrastructure may be present.

Prior to the site assessment, the study area boundary was superimposed on available spatial data layers. The following was analysed:

- The newly released National Land Capability Evaluation Raster Data Layer was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) to determine the land capability classes of the development area according to this system. The new data was developed by DAFF to address the shortcomings of the 2002 national land capability data set. The new data was developed using a spatial evaluation modelling approach (DAFF, 2017).

- The long-term grazing capacity for South Africa 2018 was also analysed for the area within which the proposed development area falls. This data set includes incorporation of the RSA grazing capacity map of 1993, the Vegetation type of SA 2006 (as published by Mucina L. & Rutherford M.C.), the Land Types of South Africa data set as well as the KZN Bioresource classification data. The values indicated for the different areas represent long term grazing capacity with the understanding that the veld is in a relatively good condition.
- The Gauteng Field Boundaries (November 2019) was analysed to determine whether the proposed Vaalbank industrial area project infrastructure falls within the boundaries of any crop production areas. The crop production areas may include rainfed annual crops, non-pivot and pivot irrigated annual crops, horticulture, old fields, smallholdings and subsistence farming. This data was also used to allocate a sensitivity rating for the proposed development area as well as a 50m buffer area around it.

6.2 Site assessment

The proposed development area was visited on 2 March 2020 (summer) for a site assessment that included a soil classification survey. The season has no effect on the outcome of the assessment. The soil profiles were examined to a maximum depth of 1.5m or the point of refusal using a hand-held soil auger. Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the S.A. Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018). For soil mapping of the areas assessed in detail, the soils were grouped into classes with relatively similar soil characteristics.

6.3 Analysis of soil samples

Eight soil samples were collected from five modal soil profiles in the study area. Soil samples were sealed in clean soil sampling plastic bags and sent to Eco Analytica Laboratory at North-West University for analyses. Samples taken to determine baseline soil fertility were analysed for electrical conductivity (EC), pH (KCl), phosphorus (Bray1), exchangeable cations (calcium, magnesium, potassium, sodium) and texture classes (relative fractions of sand, silt and clay).

6.4 Impact assessment methodology

Below are the tables with the steps followed to do the impact rating according to the method prescribed by GCS (Pty) Ltd.

Table 1 Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3

Highly significant / harmful	4
Extreme significance/ extremely harmful / within a regulated sensitive area	5

Table 2 Spatial scale

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional / neighboring areas (5km to 50km)	4
National	5

Table 3 Duration

One day to one month / immediate	1
One month to one year / Short term	2
One year to 10 years / medium term	3
Life of the activity / long term	4
Beyond life of the activity / permanent	5

Table 4 Frequency of the activity

Improbable / almost never / Annually or less	1
Low probability / Very seldom / 6 monthly	2
Medium probability / Infrequent / Temporary / Monthly	3
Highly probable / Often / semi-permanent / Weekly	4
Definite / Always / permanent / Daily	5

Table 5 Frequency of the incident/impact

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 6 Legal issues

No legislation	1
Fully covered by legislation	5

Table 7 Detection

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4

Covered	5

Table 8 Rating classes

Rating	Class
1 - 55	Low Risk (L)
56 - 169	Moderate Risk (M)
170 - 600	High Risk (H)

Table 9 Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance/Risk = Consequence X Likelihood

7. DATA LIMITATIONS, ASSUMPTIONS AND STUDY GAPS

- At the time of submission of the Version 1 report, no data has been obtained from the farmer(s) that cultivate the land on any historical production figures of the project area for the past five years. It is likely that this data will become available as the public participation process commences.
- No anticipated employment figures has yet been received from the developer and will be included in the report when available. Similarly, it is expected that the farmer who leases the land from the Gauteng Department of Human Settlements will be identified during the public participation process. He will then be asked to discuss the current employment opportunities created by his farming activities on the property.
- It was also assumed that the desktop grazing capacity and field crop boundary data obtained from DAFF, has high correlation with the actual conditions on site.
- No other uncertainties and gaps have been identified that may affect the conclusions made in this report.

8. RESPONSE TO CONCERNS RAISED BY INTERESTED AND AFFECTED PARTIES

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. Should any comment be received, it will be addressed in this report.

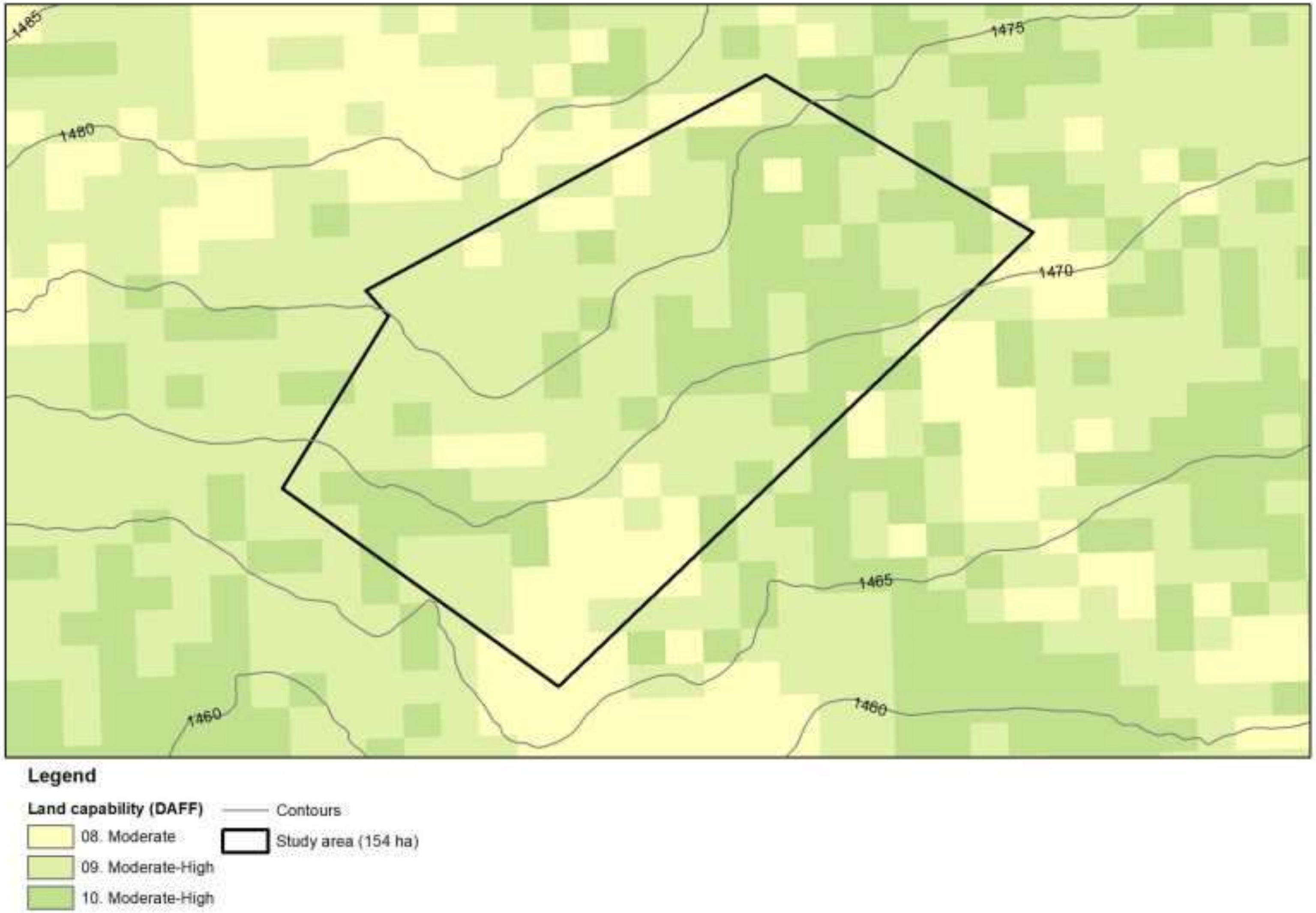


Figure 3 Land capability classification of the proposed development area and surrounding area (data source: DAFF, 2017)

Figure 4 Locality of field crop boundaries in the larger area around the proposed development area (data source: DAFF, 2019)

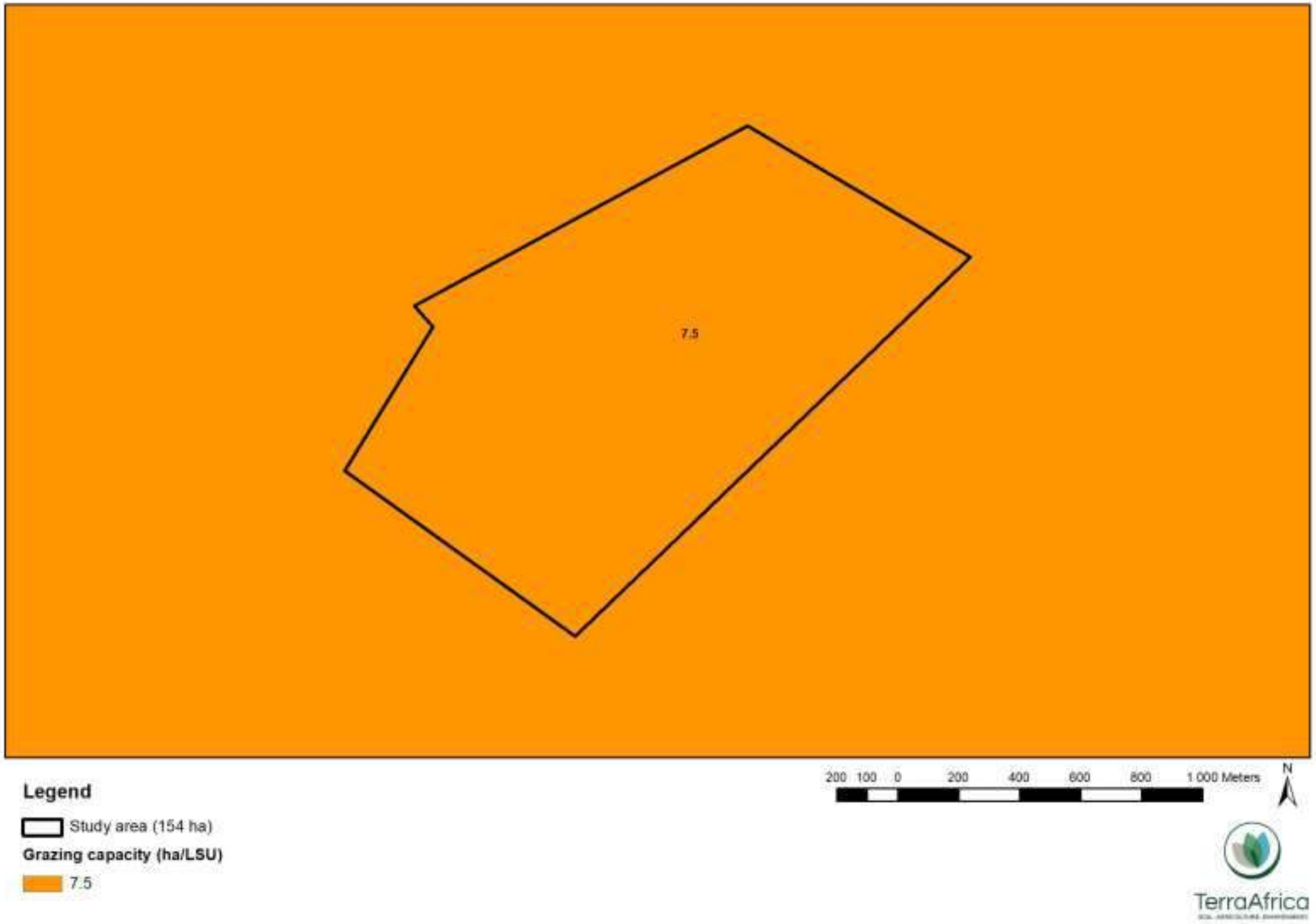


Figure 5 Long-term grazing capacity of the proposed development area and surrounding area (data source: DAFF, 2018)

9. RESULTS OF THE DESKTOP ASSESSMENT

9.1 Land capability

The proposed Unitas Park Extension 16 development area includes three different land capability classes according to the land capability raster data layer (DAFF, 2017). The three classes are Class 08 (Moderate), Class 09 (Moderate – High) and Class 10 (Moderate – High) with higher land capability located more towards the north-eastern corner of the site. Figure 3 indicates the estimated position of the different classes in the landscape.

9.2 Field crop boundaries

Following the field crop data layer for the Gauteng Province (DAFF, 2019), a large portion of the site consist of fields with rainfed annual crop cultivation and planted pastures. An area from the middle of the study area towards the north-western corner, has no field crops. Rainfed annual crop cultivation and planted pastures are also present along the north-eastern, south-eastern as well as the north-eastern and north-western boundaries of the site. Small holdings are located further away along the south-eastern and north-eastern site boundaries. Only one small area located north-east of the study area, is indicated as an area with horticultural crops. The position of field crops within and around the proposed development area is illustrated in Figure 4.

9.3 Grazing capacity

Following the metadata layer obtained from DAFF, the entire proposed development area as well as the surrounding area, has grazing capacity of 7.5 ha/LSU (Figure 5). When converting this figure to Small Stock Units (SSU), the area has grazing capacity of 1.9 ha/SSU.

10. SITE ASSESSMENT RESULTS

10.1 Soil forms

Six different soil forms (Carolina, Cullinan, Dresden, Glencoe, Lichtenburg and Mispah) were identified within the proposed development site. Both the Cullinan and Carolina soil forms are newly described soil forms of the new Natural and Anthropogenic Soil Classification System of South Africa (Soil Classification Group, 2018). The natural soil forms identified on site include soil of the Carolina, Dresden, Glencoe, Lichtenburg and Mispah forms while the Cullinan form is an anthropogenic soil form. The position of each of the soil forms as well as the average soil depth of the area, is illustrated in Figure 6 and summarised in Table 10.

Table 10 Summary of the soil classification results

Soil form/group	***Area (ha)***	***Percentage of development area (%)***	***Average soil depth (m)***
Carolina	3.9	2.53	1.2 – 1.5
Cullinan	19.0	12.34	0.15 – 0.45
Dresden	1.0	0.65	0.4 – 0.6
Glencoe	32.8	21.30	1.0 – 1.5+
Lichtenburg	58.9	38.25	1.0 – 1.5+
Mispah	38.4	24.94	0.10 – 0.35

Approximately 95.6ha of the 154ha study site consists of yellow-brown and red sandy-clay-loam soil profiles of the Carolina, Glencoe and Lichtenburg forms with soil depth of 1m or deeper than 1m. These soil profiles are located in the northern, eastern, south-eastern and centre of the study area. A small portion (1ha) of shallow Dresden soil profiles are located in the south of the study area. More than 95% of the areas of Carolina, Dresden, Glencoe and Lichtenburg soil forms have been used for maize cultivation the past growing season (2019 – 2020).

The western section of the proposed development area consist of shallow Mispah profiles with soil depth between 0.1 and 0.35m where evidence of a derelict old farmhouse was found. Two areas of previous soil excavations are present in the western section of the site (Cullinan form). The Cullinan form soil form has been described as large, exposed excavations without backfilling (Soil Classification Working Group, 2018).

Soil textural analysis of modal soil profiles indicate that soil is dominated by the sand fraction (ranging between 66.5 and 83.2% sand) with the clay fractions ranging between 8.5 and 25.1% clay particles. The silt fraction ranges between 6.0 and 19.2% clay (see Appendix 1).

10.2 Soil fertility

The purpose of establishing baseline chemical composition of soil on a site before development commences, is to determine whether there is any deterioration in soil fertility and what the nutrient status of the soil is associated with the natural vegetation. Should the chemical content of the soil be drastically different once rehabilitation commences, the chemical composition might have to be amended by the addition of fertilizers or organic matter. The analyses results obtained from the laboratory is attached as Appendix 1.

The pH levels of the analyzed soil samples in the study area ranges indicate that the soil present tend to be acidic, with all the pH(KCl) levels below 5. The lower pH range (between 3.95 and 4.86) may be a result of the continuous application of acidifying fertilizer for the purpose of crop production. For successful crop production, a pH of between 5.8 and 7.5 is optimum and crops produced in soils with lower pH may suffer aluminum (Al) toxicities if toxic levels of Al are present. The danger of Al toxicity only exists when the pH (KCl) is lower than 4.5.

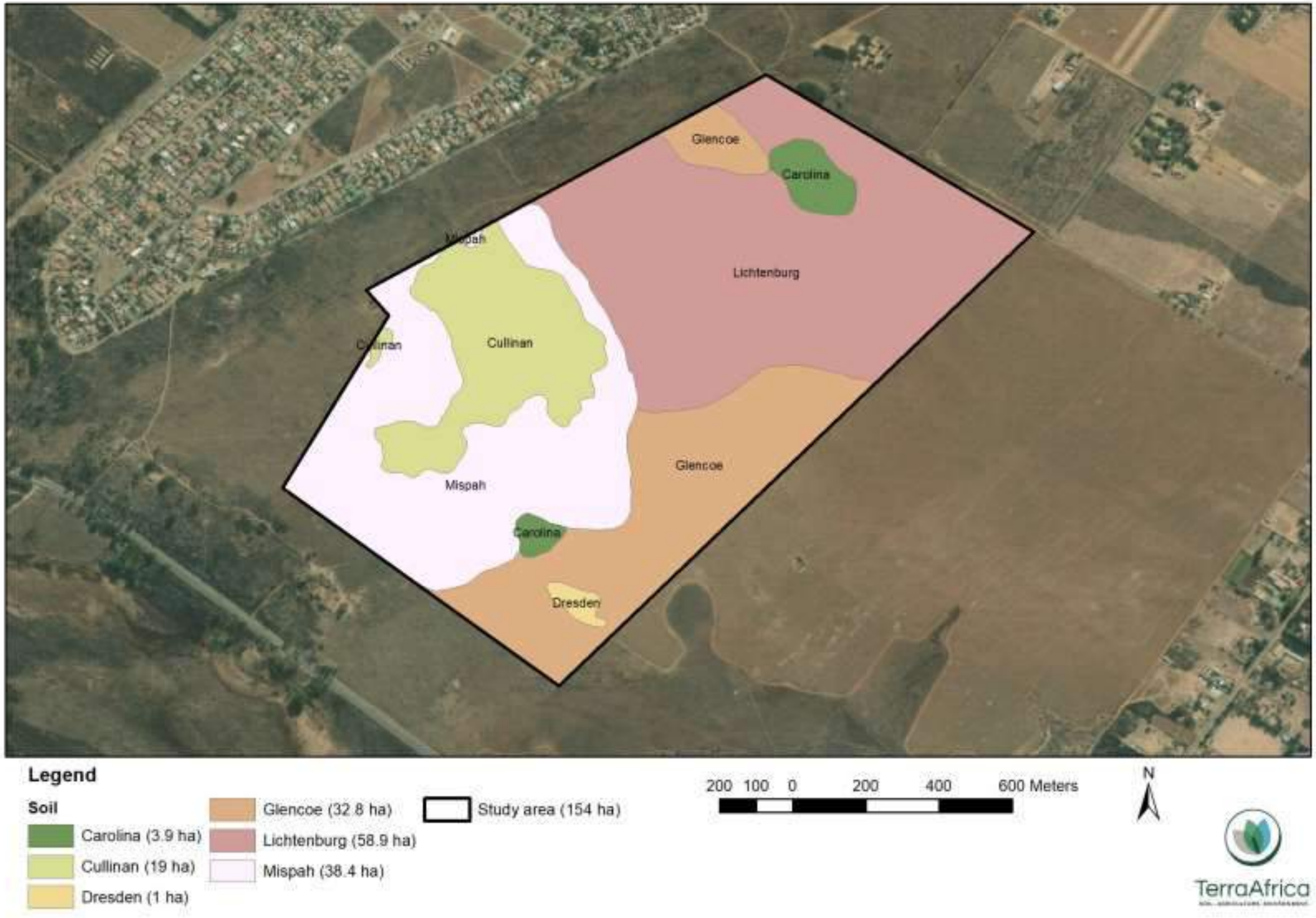


Figure 6 Soil classification map of the proposed development area

Figure 7 Land capability classification of the proposed development area

Plant-available phosphorus levels (as determined with a Bray 1 extract) range between 2.4 and 17.0 mg/kg. For the purpose of crop production, calcium and magnesium levels range between slightly deficient (115.4 mg/kg) to sufficient (507.6 mg/kg) for calcium, and between low (28.8 mg/kg) and sufficient (127.0 mg/kg) for magnesium. The potassium levels range between low (2.6 mg/kg) and high (197.3) for crop production. Of the four macro plant nutrients, the low plant-availability of phosphorus and potassium in some of the areas, may be a limiting factor to crop production. However, the nutrient deficiencies can be corrected by the precisions application of fertilizer.

The electrical conductivity (EC) of the soil samples range between 12 mS/m and 35 mS/m, indicating that the presence of any soil salinity is highly unlikely. The plant-available sodium levels range between 0.5 and 3.4 mg/kg which is low enough to assume that soil sodicity are not currently present on site.

10.3 Land capability classification

Using the soil classification data, the project site can be divided into three different land capability classes i.e. soil with either Moderate-High (Class 10), Moderate (Class 08) and Moderate-Low (Class 07) land capability. The largest portion of the proposed development area consist of soil with Moderate-High (Class 10) land capability with medium-high to high potential for rainfed crop production.

The highest land capability is 9.4 ha of land in the middle section of the site that has Moderate-High (Class 10) land capability. The shallower Glencoe profiles to the east has Class 09 land capability and the areas where the Hutton and Clovelly profiles have already been affected by anthropogenic activities, have Moderate (Class 08) land capability.

10.4 Land use and surrounding land use

During the site visit, evidence was found of a derelict farmstead surrounded by what may be the remains of a garden around the house. The current land use of the site largely consists of rainfed production of grains (maize was planted for the 2019-2020 growing season) as well natural veld that may be used for livestock production (will be confirmed when information is received from farmer who leases the property). Within the south-western section of the study site, there are evidence of two areas of previous soil excavation in where gravel and fractured rock was removed without any backfill or active rehabilitation of the area.

Land outside the proposed development site consist of a mixture of land uses, including residential areas and a school to the north-west of the site as well as rainfed crop production and farmsteads towards the north-east, east and south-east of the study site. The R54 (Houtkop Road) is located south of the study site.

10.5 Agricultural potential and activities

Following the soil and land capability classification of the site, it was found that 96.6ha of the 154ha study site, have high suitability for rainfed crop production of grains such as maize. It is estimated that the average yield in this area ranges between 6 and 9 ton/ha, therefore contributing approximately 580 to 870 tons of maize per annum to the total crop volumes of Gauteng Province.

In addition to crop production, the remaining 57.4ha that is not cultivated can be used for livestock grazing at a long-term grazing capacity of 7.5ha/LSU. This area not used for crop cultivation can therefore provide feed to approximately 8 head of cattle. Although 8 head of cattle may not be a viable production unit by itself, the crop remains after harvesting are also used as feed supplement for cattle during the winter months and may therefore allow for a larger cattle herd.

The proposed development area borders on other areas with grazing veld and grain production and may therefore be part of a larger farming unit that produces food and provide agricultural employment. This section will be updated when more information has been received.

10.6 Verified site sensitivity

Table 1 of GN 320 section 2.5 requires an assessment of change in productivity of agricultural activities based on income in the past five years, change in employment figures for the past five years and alternative development footprints within the preferred site which would have medium or low sensitivity for agricultural resources. The agricultural resources on site (soil and climate) has previously been, and are still, used for production of grain crops and to a lesser extent, livestock farming (in the most western section of the site. The area where crops are produced consist of mostly of soil with high sensitivity to any soil disturbing or soil sealing activities (associated with residential development). Therefore, 96.6ha of land has high sensitivity to the proposed and development and 57.4 ha has low sensitivity

Figure 8 Agricultural and soil sensitivity to the impacts of the proposed development

11. IMPACT ASSESSMENT

11.1 Construction phase impacts

11.1.1 Loss of current land capability

Following the site survey, it was concluded that the proposed development area consists largely of land with Moderate-High, Moderate and Moderate-Low land capability. Once construction commences and soil is stripped, the current land capability of all areas where the surface infrastructure will be constructed, will be lost. The impact will remain the same throughout the operational phase and it is not expected that the infrastructure will be decommissioned.

	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	3
Spatial Scale	2	2
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Impact rating	High (110) -	High (100) -
Mitigation:		
• The mitigation measures are limited as the project infrastructure is considered to become a permanent feature of the landscape. • The project infrastructure footprint should be kept to the project layout as provided by the client.		

11.1.2 Loss of agricultural production and agricultural-related employment

The area has been identified as having high suitability for rainfed crop production. The area with lower suitability for crop production can be used for livestock production at a stocking density of 7.5 ha/LSU. It is anticipated that the impact on the agricultural production and agricultural-related employment will be high. It is expected that the impact will remain the same during the operational phase and there will be no decommissioning.

	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	3
Spatial Scale	2	2
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Impact rating	High (110) -	High (100) -
Mitigation:		
• The mitigation measures are limited as the project infrastructure is considered to become a permanent feature of the landscape.		

• The project infrastructure footprint should be kept to the project layout as provided by the client.

11.1.3 Loss of soil ecosystem services and soil fertility in areas where topsoil are stripped

Prior to construction, the available topsoil (a combination of all soil horizons above the underlying material such as fractured rock and hard plinthite hard plinthite) will be removed and stored elsewhere. The soil in the affected area provides the following ecosystem services:

- It provide soil nutrients that supports the vegetation growth of the area;
- The hydropedology of the in situ soil profiles of the entire landscape contributes to underground water volumes of the larger area in which the project area is located.
- It provides physical support to plants, animals and microorganisms by anchoring plant roots, providing shelter for small animals and a nutrient matrix for microorganisms.

Once the soil is stripped and transported from its original position, it becomes a new matrix with different physical and biological properties as a result of mixing of the soil horizons and storing it in stockpiles.

	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	4	4
Spatial Scale	2	2
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Impact rating	High (110) -	High (110) -

Mitigation:

- The mitigation measures are limited as the topsoil will necessarily be removed for the purpose of infrastructure construction.
- The project infrastructure footprint should be kept within the site boundaries as provided by the client.
- Any topsoil stockpiles must be protected against wind and water erosion until vegetation has established on the exposed topsoil surfaces.
- If it is observed that topsoil stockpile surfaces remain bare, natural vegetation must be established on the topsoil stockpiles.

11.1.4 Soil contamination with hydrocarbons and solid waste

The following construction activities can result in the pollution of soil with hydrocarbons and/or solid waste:

- Petroleum hydrocarbon (present in oil and diesel) spills by machinery and vehicles during earthworks and the mechanical removal of vegetation during site clearing.
- Spills from vehicles transporting workers, equipment and construction material to and from the construction site.
- The generation of domestic waste by construction and operational workers.
- Spills from fuel storage tanks during construction.
- Polluted water from wash bays and workshops during the construction phase.
- Accidental spills of other hazardous chemicals used and stored on site.
- Pollution from concrete mixing.

	Without mitigation	With mitigation / enhancement
Status	Negative (-)	Negative (-)
Severity	3	2
Spatial Scale	1	1
Duration	4	2
Frequency of activity	4	4
Frequency of impact	5	3
Impact rating	Medium-low (72) -	Low (35) -

Mitigation:

- High level maintenance must be undertaken on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills;
- Impermeable and bunded surfaces must be used for storage tanks and to park vehicles on;
- Site surface water and wash water must be contained and treated before reuse or discharge from site;
- Spills of fuel and lubricants from vehicles and equipment must be contained using a drip tray with plastic sheeting filled with adsorbent material;
- Spill kits should be available on site and should be serviced regularly;
- Waste disposal at the construction site and during operation must be avoided by separating, trucking out and recycling of waste;
- Potentially contaminating fluids and other wastes must be contained in containers stored on hard surface levels in bunded locations; and
- Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately by trained staff with the correct equipment and protocols.

11.1.5 Soil compaction and surface sealing

Where houses and surface roads will be constructed, soil will become permanently sealed-off from rainwater infiltration. Soil will also be compacted as part of civil engineering procedures to ensure the stability of the infrastructure. Soil compaction affects the soil porosity, thereby decreasing the water infiltration rate of soil. Compacted soil surfaces and sealed off areas increase stormwater runoff rates and can cause soil erosion in areas outside the site boundary.

	Without mitigation	With mitigation / management
Status	Negative (-)	Negative (-)
Severity	4	4
Spatial Scale	2	2
Duration	5	5
Frequency of activity	5	5
Frequency of impact	5	5
Impact rating	High (110) -	High (110) -

Mitigation:

- Restrict traffic and vehicle movement to access roads and within the site boundaries.
- Demarcate parking areas and monitor that vehicles and equipment are not parked outside of these areas in nearby fields during the construction phase.

11.2 Operational phase impacts

During the operational phase, the impacts on land capability and physical soil properties within the site boundary, will remain unchanged. However, solid wastewater generation, surface water run-off from road surfaces and wastewater systems, can result in soil contamination outside of the site.

11.2.1 Soil pollution of soil outside the site boundaries, including agricultural fields

Solid waste generation within the residential and mixed-land use areas, can result in soil pollution of nearby fields. Stormwater run-off from surfaced roads can also contain pollutants such as petroleum hydrocarbons that spilled on sealed surfaces inside of the site. Both solid waste and stormwater run-off can result in elevated levels of soil contaminants in nearby soil, including the agricultural crop-fields.

	Without mitigation	**With mitigation / enhancement**
Status	Negative (-)	Negative (-)
Severity	3	1
Spatial Scale	2	1
Duration	4	2
Frequency of activity	4	3
Frequency of impact	4	3
Impact rating	Medium-low (72) -	Low (30) -

Mitigation:

- Soil contamination levels must be monitored annually in a zone of 500m around the site.
- High level maintenance must be undertaken on all vehicles and construction/maintenance machinery to prevent hydrocarbon spills;
- Impermeable and bunded surfaces must be used for storage tanks and to park vehicles on;
- Site surface water and wash water must be contained and treated before reuse or discharge from site;
- Spills of fuel and lubricants from vehicles and equipment must be contained using a drip tray with plastic sheeting filled with adsorbent material;
- Potentially contaminating fluids and other wastes must be contained in containers stored on hard surface levels in bunded locations; and
- Accidental spillage of potentially contaminating liquids and solids must be cleaned up immediately by trained staff with the correct equipment and protocols.

11.3. Decommissioning and closure phase

It is expected that the infrastructure will remain on site and there will be no decommissioning and closure phases.

12. CONSIDERATION OF ALTERNATIVES

No alternative layouts of the proposed development project, were provided for comparative analysis of the anticipated impacts on the soil properties and agricultural potential of the site.

13. ACCEPTABILITY STATEMENT

The proposed Unitas Park Ext 16 development site consists of 95.6ha of deep to medium-deep soil characterised by red and yellow-brown apedal B1-horizons overlying either hard plinthite or fractured rock. Only 1ha of soil consist of shallow Dresden soil where an orthic A horizon overlies hard plinthite. The soil has moderate-high to moderate potential for rainfed crop production. During the site visit, it was evident that that maize are successfully produced on 96.6ha. The remaining 57.4 is covered with a mixture of veld grass and a few trees and shrubs. This area has the potential for feeding 8 head of cattle while maintaining the long-term grazing capacity.

No agricultural production figures for the past 5 years have been made available yet but from the observations made during the site visit, the following conclusions were reached:

- Rainfed crop production is present on site with an estimated yield of 6 to 9 tons/ha, depending on largely on the rainfall pattern and volumes of a production season.
- The current number of employment opportunities generated by the farming activities on the property, is not known at the moment. Similarly, the exact yield of the crop fields as well as the density of the livestock grazing in the surrounding grassland, is not known. It is expected that this information will become available during the next four weeks as the public participation process commences.

According to the applicant, the proposed development layout went through several layout and design considerations to optimise the area to be developed and limit impact on highly sensitive areas. However, the requirements for housing and infrastructure limits the possibility to completely avoid areas with high agricultural sensitivity. It is anticipated that the impact on the agricultural production of the study site will be high with the current infrastructure layout and that the crop production within the proposed development areas as well as in a 50m buffer area around the site, will not be able to continue.

14. REFERENCE LIST

Crop Estimates Consortium, 2019. *Field crop boundary data layer (NC province)*, 2019. Pretoria. Department of Agriculture, Forestry and Fisheries.

Department of Agriculture, Forestry and Fisheries, 2017. *National land capability evaluation raster data: Land capability data layer*, 2017. Pretoria.

South Africa (Republic) 2018. *Long-term grazing capacity for South Africa*: Data layer. Government Gazette Vol. 638, No. 41870. 31 August 2018. Regulation 10 of the Conservation of Agricultural Resources Act (CARA): Act 43 of 1983. Pretoria. Government Printing Works.

The Soil Classification Working Group (2018). *Soil Classification – Taxonomic System for South Africa.* Dept. of Agric., Pretoria.

APPENDIX 1 – RESULTS OF SOIL CHEMICAL ANALYSIS

NORTH-WEST UNIVERSITY
ECO-ANALYTICA

Eco Analytica
P.O. Box 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

TERRA AFRICA (UNITAS PARK)

17/3/2020 **Nutrient Status**

Sample no.	Ca	Mg	K	Na	P	pH(KCl)	EC
	(mg/kg)						(mS/m)
1	302,1	50,7	39,8	1,8	4,9	4,63	26
2	270,5	63,7	2,6	2,5	3,5	4,50	17
3	266,7	50,5	75,5	2,9	5,8	4,73	35
4	115,4	28,8	90,7	2,0	4,8	3,95	23
5	312,6	127,0	3,7	1,2	2,4	4,86	12
6	136,0	28,7	87,4	1,1	17,0	3,92	20
7	420,6	61,8	3,2	3,4	3,3	4,76	30
8	507,6	96,5	197,3	0,5	5,0	4,66	27

Exchangeable cations

Sample no.	Ca	Mg	K	Na	S-value	pH(KCl)
	(cmol(+)/kg)					
1	1,51	0,42	0,10	0,01	2,03	4,63
2	1,35	0,52	0,01	0,01	1,89	4,50
3	1,33	0,42	0,19	0,01	1,95	4,73
4	0,58	0,24	0,23	0,01	1,05	3,95
5	1,56	1,05	0,01	0,01	2,62	4,86
6	0,68	0,24	0,22	0,00	1,14	3,92
7	2,10	0,51	0,01	0,01	2,63	4,76
8	2,53	0,79	0,51	0,00	3,84	4,66

HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSES

Exchangeable cations: 1M NH_4-Asetaat pH=7
CEC: 1 M Na-asetaat pH=7
Extractable, Exchangeable micro-elements: 0.02M $(NH_4)_2$ EDTA.H_2O
EC: Saturated Extraction
pH H_2O/KCl: 1:2.5 Extraction
Phosphorus: P-Bray 1 Extraction

17/3/2020 **Particle Size Distribution**

Sample no.	**> 2mm (%)**	**Sand**	**Silt**	**Clay**
		(% < 2mm)		
1	0,7	78,6	10,6	10,8
2	3,1	77,3	8,8	13,9
3	28,2	83,2	8,3	8,5
4	1,1	75,8	8,5	15,8
5	0,3	68,2	6,7	25,1
6	0,5	78,4	6,0	15,6
7	0,6	72,6	8,7	18,7
8	0,8	66,5	19,2	14,3

This laboratory participates in the following quality control schemes:
International Soil-Analytical Exchange (ISE), Wageningen, Nederland.
No responsibility is accepted by North-West University for any losses due to the use of this data

APPENDIX 2 - CURRICULUM VITAE OF SPECIALIST (Mariné Pienaar)

+2782-828-3587

mpienaar@terraafrica.co.za

linkedin.com/in/marinepienaar

Wolmaransstad,
South Africa

EXPERTISE

Soil Quality Assessment

Soil Policy and Guidelines

Agricultural Agro-Ecosystem Assessment

Sustainable Agriculture

Data Consolidation

Land Use Planning

Soil Pollution

Hydropedology

EDUCATION

MASTER'S DEGREE
Environmental Science
University of Witwatersrand
2010 – 2018

BACHELOR'S DEGREE
Agricultural Science
University of Pretoria
2001 – 2004

PROFESSIONAL PROFILE

I contribute specialist knowledge on agriculture and soil management to ensure long-term sustainability of projects in Africa. For the past thirteen years, it has been my calling and I have consulted on more than 200 projects. My clients include environmental and engineering companies, mining houses, and project developers. I enjoy the multi-disciplinary nature of the projects that I work on and I am fascinated by the evolving nature of my field of practice. The next section provide examples of the range of projects completed. A comprehensive project list is available on request.

PROJECT EXPERIENCE

Global Assessment on Soil Pollution
Food and Agricultural Organisation (FAO) of the United Nations (UN)

Author of the regional assessment of Soil in Sub-Saharan Africa. The report is due for release in February 2021. The different sections included:

- Analysis of soil and soil-related policies and guidelines for each of the 48 regional countries
- Description of the major sources of soil pollution in the region
- The extent of soil pollution in the region and as well as the nature and extent of soil monitoring
- Case study discussions of the impacts of soil pollution on human and environmental health in the region
- Recommendations and guidelines for policy development and capacitation to address soil pollution in Sub-Saharan Africa

Data Consolidation and Amendment
Range of projects: Mining Projects, Renewal Energy

These projects included developments where previous agricultural and soil studies are available that are not aligned with the current legal and international best practice requirements such as the IFC Principles. Other projects are expansion projects or changes in the project infrastructure layout. Tasks on such projects include the incorporation of all relevant data, site verification, updated baseline reporting and alignment of management and monitoring measures.

Project examples:

- Northam Platinum's Booysendal Mine, South Africa
- Musonoi Mine, Kolwezi District, Democratic Republic of Congo
- Polihali Reservoir and Associated Infrastructure, Lesotho
- Kaiha 2 Hydropower Project, Liberia
- Aquarius Platinum's Kroondal and Marikana Mines

PROFESSIONAL MEMBERSHIP

South African Council for Natural Scientific Professions (SACNASP)

Soil Science Society of South Africa (SSSSA)

Soil Science Society of America (SSSA)

Network for Industrially Contaminated Land in Africa (NICOLA)

LANGUAGES

English (Fluent)

Afrikaans (Native)

French (Basic)

PRESENTATIONS

There is spinach in my fish pond
TEDx Talk
Available on YouTube

♦

Soil and the Extractive Industries
Session organiser and presenter
Global Soil Week, Berlin (2015)

♦

How to dismantle an atomic bomb
Conference presentation (2014)
Environmental Law Association (SA)

PROJECT EXPERIENCE (Continued)

Agricultural Agro-Ecosystem Assessments

Range of projects: Renewable Energy, Industrial and Residential Developments, Mining, Linear Developments (railways and power lines)

The assessments were conducted as part of the Environmental and Social Impact Assessment processes. The assessment process includes the assessment of soil physical and chemical properties as well as other natural resources that contributes to the land capability of the area.

Project examples:

- Mocuba Solar PV Development, Mozambique
- Italthai Railway between Tete and Quelimane, Mozambique
- Lichtenburg PV Solar Developments, South Africa
- Manica Gold Mine Project, Mozambique
- Khunab Solar PV Developments near Upington, South Africa
- Bomi Hills and Mano River Mines, Liberia
- King City near Sekondi-Takoradi and Appolonia City near Accra, Ghana
- Limpopo-Lipadi Game Reserve, Botswana
- Namoya Gold Mine, Democratic Republic of Congo

Sustainable Agriculture

Range of projects: Policy Development for Financial Institutions, Mine Closure Planning, Agricultural Project and Business Development Planning

Each of the projects completed had a unique scope of works and the methodology was designed to answer the questions. While global indicators of sustainable agriculture are considered, the unique challenges to viable food production in Africa, especially climate change and a lack of infrastructure, in these analyses.

Project examples:

- Measurement of sustainability of agricultural practices of South African farmers – survey design and pilot testing for the LandBank of South Africa
- Analysis of the viability of avocado and mango large-scale farming developments in Angola for McKinsey & Company
- Closure options analysis for the Tshipi Borwa Mine to increase agricultural productivity in the area, consultation to SLR Consulting
- Analysis of risks and opportunities for farm feeds and supplement suppliers of the Southern African livestock and dairy farming industries
- Sustainable agricultural options development for mine closure planning of the Camutue Diamond Mine, Angola

PROFESSIONAL DEVELOPMENT

Contaminated Land Management 101 Training
Network for Industrially Contaminated Land in Africa
2020

Intensive Agriculture in Arid & Semi-Arid Environments
CINADCO/MASHAV R&D Course, Israel
2015

World Soils and their Assessment Course
ISRIC – World Soil Information Centre, Netherlands
2015

Wetland Rehabilitation Course
University of Pretoria
2010

Course in Advanced Modelling of Water Flow and Solute Transport in the Vadose Zone with Hydrus
University of Kwazulu-Natal
2010

Environmental Law for Environmental Managers
North-West University Centre for Environmental Management
2009

PROJECT EXPERIENCE (Continued)

Soil Quality Assessments

Range of projects: Rehabilitated Land Audits, Mine Closure Applications, Mineral and Ore Processing Facilities, Human Resettlement Plans

The soil quality assessments included physical and chemical analysis of soil quality parameters to determine the success of land rehabilitation towards productive landscapes. The assessments are also used to understand the suitability for areas for Human Resettlement Plans

Project examples:

- Closure Planning for Yoctolux Colliery
- Soil and vegetation monitoring at Kingston Vale Waste Facility
- Exxaro Belfast Resettlement Action Plan Soil Assessment
- Soil Quality Monitoring of Wastewater Irrigated Areas around Matimba Power Station
- Keaton Vanggatfontein Colliery Bi-Annual Soil Quality Monitoring

REFERENCES

NATALIA RODRIGUEZ EUGENIO
Soil Pollution Specialist
FAO of the UN
+3906-5705-0134
Natalia.rodriguezeugenio@fao.org

VERNON SIEMELINK
Director
Eco Elementum
+2772-196-9928
vernon@ecoe.co.za

JO-ANNE THOMAS
Director
Savannah Environmental
+2711-656-3237
joanne@savannahsa.com

RENEE JANSE VAN RENSBURG
Environmental Manager
CIGroup
+2782-496-9038
reneejvr@cigroup.za.com

APPENDIX B3

Hydrological Impact Assessment

63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Hydrological Impact Assessment

Report

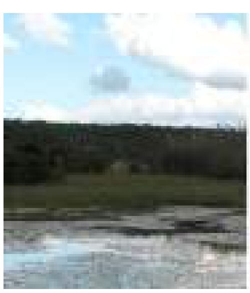
Version - A

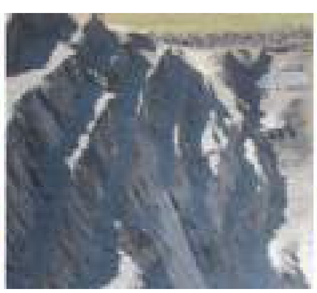
13 July 2021

Phumaf Engineering

GCS Project Number: 19-0921

Client Reference: Unitas Hydrological Impact Assessment





Report
Version - B

13 July 2021

Phumaf Engineering

19-0921

DOCUMENT ISSUE STATUS

Report Issue	Version A		
GCS Reference Number	GCS Ref - 19-0921		
Client Reference	Unitas Hydrological Impact Assessment		
Title	Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: **Hydrological Impact Assessment**		
	Name	**Signature**	**Date**
Author	Jennifer Meneghelli		12 July 2021
Director, Reviewer	Andries Wilke		13 July 2021

LEGAL NOTICE

This report or any proportion thereof and any associated documentation remain the property of GCS until the mandator effects payment of all fees and disbursements due to GCS in terms of the GCS Conditions of Contract and Project Acceptance Form. Notwithstanding the aforesaid, any reproduction, duplication, copying, adaptation, editing, change, disclosure, publication, distribution, incorporation, modification, lending, transfer, sending, delivering, serving or broadcasting must be authorised in writing by GCS.

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

APPENDICES

APPENDIX A: HYDROLOGICAL SCREENING STUDY

APPENDIX B: EFFLUENT DISCHARGE INVESTIGATION

APPENDIX C: X-LAB EARTH TEST REPORT OF WATER SAMPLES

1 INTRODUCTION

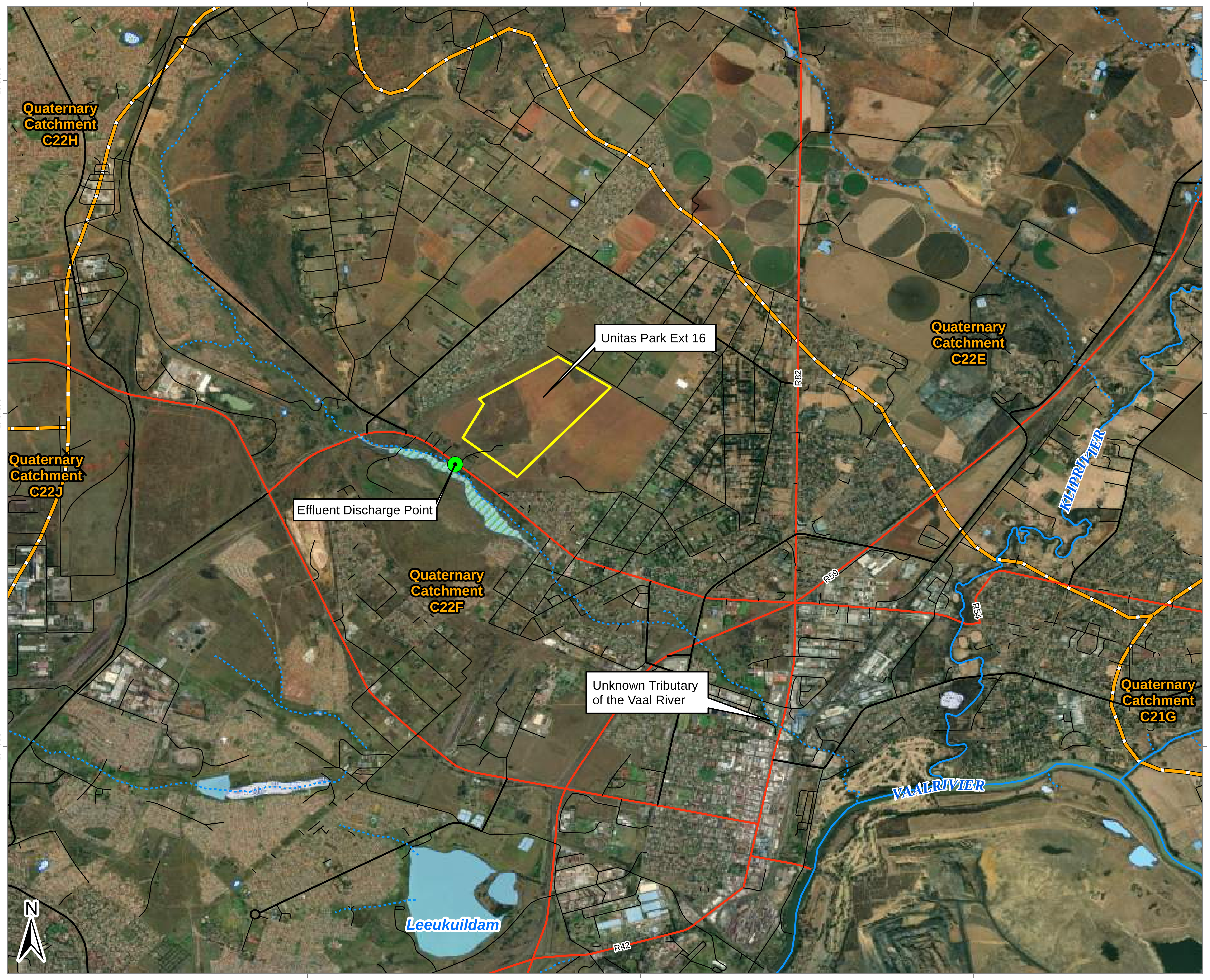
GCS Water and Environmental Consultants (Pty) Ltd (GCS) has been appointed by Phumaf Holdings (Phumaf) to carry out a hydrological impact assessment study on the proposed Unitas Extension 16 development in support of the environmental authorisation (EA) processes and associated Public Participation Processes (PPP).

The project site under investigation, Unitas Park Extension 16, is located within the Emfuleni Local Municipality, 6km northwest of the Vereeniging CBD, sandwiched between roads R54 and R42 in Gauteng province (see Figure 1-1). This development site forms part of the Gauteng Rapid Land Release Programme (GRLRP) aimed at fast-tracking the release of serviced stands from state owned land to qualifying beneficiaries. The site is approximately 149 hectares in extent is planned to have a township layout, with 2680 erven of 7 250 mixed high density units.

The site slopes to the south and surface runoff will drain to the southeast and be channelled under Houtkop Road through an existing culvert. It is proposed that the development have its own package wastewater treatment plant (WWTP) on the site, and that effluent be discharged to the downstream environment.

This study will assess the impacts of surface water runoff and effluent discharge from the development on the environment.

UNITAS PARK EXT 16: SITE MAP



LEGEND

Effluent Discharge Point

Rivers and Streams

Non-Perennial

Perennial

Road Network

Main Road

Secondary Road

Street

Unitas Park Ext 16: Site Map

Quaternary Catchments

Unchannelled Valley Bottom Wetland

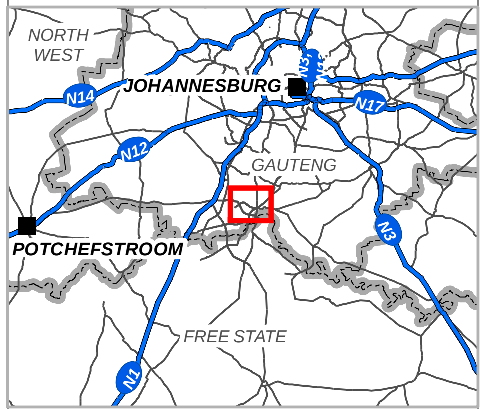
Inland Water

Dams and lakes

Reservoirs and water tanks

Marsh and swamps

Non-perennial pans



Data Sources:
Esri World Imagery Basemap
2014 DWAF Quaternary Catchments

0 1 2 Kilometers

SCALE: 1:50 000

FIGURE NO.:	-	MAP NUMBER:	19-0921-09-V3
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	J MENEGHELLI CIVIL ENGINEER
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 MAY 2021
PROJECT:	TOWNSHIP ESTABLISHMENT BRYANSTON EXT3 (JHB)		
CLIENT:	PHUMAF HOLDINGS		

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

2 SCOPE OF WORK

The scope of work to carry out the hydrological impact assessment will include the following activities:

- Assessment of background documents and pertinent literature
- Site visit
- Hydrological screening study
- Preliminary feedback
- Identify any gaps and determine any additional activities required
- Obtain Environmental Assessment Practitioner (EAP) approval for the hydrological impact assessment
- Compile and submit draft hydrological impact assessment for comment
- Public participation
- Compile and submit final hydrological impact assessment
- Project management

The hydrological impact assessment report will cover the following:

- Stormwater Management Plan for the development (developed by Phumaf)
- Floodline delineation of receiving watercourse
- Capacity of the river to handle the discharge
- Water quality assessment
- Impact assessment and mitigation measures

3 METHODOLOGY

3.1 Data gathering

The following documents were referred to as part of the literature for this assessment:

- Gauteng Rapid Land Release Civil Engineering Services Preliminary Design Report, Phumaf, 2021
- Proposed residential and mixed-use development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Ecological Impact Assessment Report, GCS, 2020
- Procedures to assess effluent discharge impacts, South African Water Quality Management Series, Department of Water Affairs and Forestry, Water Research Commission, 1995
- Proposed Reserve Determination of water Resources for the Vaal Catchment, National Water Act (Act No. 36 of 1998), GN 1419, 2018

The following national legislation was referred to guidance on best practices with regard to the hydrological assessment:

- South African Department of Water and Sanitation (formerly the department of Water Affairs and Forestry - DWAF) Best Practice Guidelines G1: Storm Water Management (DWA, 2006a) and Water and Salt Balances (DWA, 2006b).

Two site visits were carried out by the GCS hydrological team in order to examine the catchment, the wetland, the proposed development site and to collect water samples.

3.2 Hydrological screening study for effluent discharge

The objective of the preliminary study was to carry out a screening process to determine if effluent discharge by the WWTP will be acceptable based on currently available information or if a full investigation is required. During the preliminary investigation, information on the activity producing the effluent, the nature of the effluent and the surrounding catchment was gathered. The potential impacts of the proposed activity hydrologically and on the wetland were examined on a preliminary basis to estimate what further assessment would be required.

The scope of work to carry out the preliminary study is as follows:

- Field investigation
- Liaison with the GCS wetland specialist
- Determination of the potential impact of discharging effluent to the wetland may have
- Visual inspection of baseflow in the wetland / river system
- Evaluation of applicable legislation and best practices

- Proposal of alternatives to discharging into the wetland

The hydrological screening study found that a full effluent discharge investigation of the ecological and hydrological impacts to the wetland system needs to be carried out to better understand how the effluent discharge can be managed such that the development can go ahead without negatively affecting the environment and downstream communities.

This screening study is included in Appendix A.

3.3 Conceptual stormwater management plan

The conceptual stormwater management plan (SWMP) for the development was designed by Phumaf. This design was reviewed in terms of its method for managing stormwater runoff within the development and how the discharge would be integrated into the receiving environment. The basis of the assessment was *Best Practice Guideline - G1: Stormwater Management* (DWAF, 2006).

3.4 Floodline determination

A desktop climate and hydrology assessment was completed to quantify the baseline hydrology of the site.

Climate data were obtained from previous studies of the site and online sources.

Average monthly rainfall, evaporation, mean annual precipitation (MAP), mean annual evaporation (MAE) and mean annual runoff (MAR) were extracted from previous studies done on the site and the WR2012 database (WRC, 2012). Rainfall data for various sources was analysed and cross-compared to select the data estimated to be most representative of the site.

The design rainfall depths were using the Design Rainfall software for South Africa (Smithers and Schulze, 2000) for the selected rainfall station and provided input into the necessary storm event calculations for the floodline determination and conceptual SWMP.

Publicly available Advanced Land Observation Satellite data will be used to generate a digital elevation model (DEM) of the site. 1:10, 1:20, 1:50 and 1:100 return interval floodlines will then be determined:

- Catchment delineation and drainage lines will be calculated using Geographic Information Systems (GIS) software.
- Calculate peak flows:
    - Peak flood analysis (1:50 and 1:100-year flood peaks) will be undertaken for each sub-catchment contributing runoff to the rivers.

  - Peak runoff will be calculated using three of the SANRAL methods, namely the Rational Method, The Standard Design Flood and the MIPI. The most acceptable method given the catchment characteristics will be selected.
- River system modelling:
  - A steady-state backwater GeoHEC-RAS model will be constructed that accurately represents the river system and existing infrastructure.

It should be noted up-front that the flood line may not be suitable for engineering purposes and is intended for the water use authroization application process only. Should the client require engineering quality floodlines for design purposes, GCS offers this service based on obtaining high resolution survey data of the river from the Client at an additional cost, this is not included in the scope.

3.5 Effluent discharge investigation

The hydrological screening study found that it would be necessary to carry out a full effluent discharge investigation with regards to effluent generated by the WWTP. The purpose of this investigation is to predict the impacts that effluent discharge would have on the receiving watercourse in terms of water quality, ecology and hydrology and assess the watercourse's ability to handle the incoming flows. The study was complicated by the fact that the watercourse in question is a wetland and a National Freshwater Ecosystem Protection Area (NFEPA). For this reason, the effluent discharge investigation received input from GCS' ecologist.

The study determined that the wetland would be impacted by effluent discharge to it in terms of ecological function, flood mitigation ability, and water quality.

The study investigated the capacity of the downstream stormwater infrastructure that would receive the additional flows and it was found that there is adequate capacity to discharge the effluent into this system.

It was therefore recommended that in order to minimise impact to the wetland, the effluent be conveyed by pipe such that the wetland is bypassed, and the pipe discharges directly to the existing stormwater system downstream.

The full effluent discharge study is included in Appendix B.

3.6 Water quality

Sampling of water from the wetland was carried out in order to define the baseline water quality.

3.7 Impact assessment

Surface water impacts resulting from the hydrology of the site were predicted and quantified using a modified version of the DHSW&S Risk Assessment Matrix, adjusted for hydrological assessment. The same approach used to weight the impacts and assign value to the impacts was used.

4 CONCEPTUAL STORMWATER MANAGEMENT PLAN FINDINGS

4.1 Overview

The *Gauteng Rapid Land Release Civil Engineering Services Preliminary Design Report* (Phumaf, 2021) presents the stormwater management plan proposed for the development. The topography of the site falls to the southeast, and all flow is directed to the southeast corner of the development. All stormwater is directed along roads and into kerb side inlets from where it is piped to a single discharge point for concentrated release to the environment. This discharge point is under Houtkop Road, through an existing culvert, into the wetland.

This is a conventional approach to stormwater design for paved urban spaces. This approach effectively removes and disposes of the stormwater from the development. The disadvantage of this method is that natural downstream hydrological patterns are disrupted, resulting in impacts to the receiving environment.

4.2 Impacts

The proposed development site is currently used for agriculture. Transforming the surface to an impervious urban development will substantially increase runoff volumes (by approximately 60%). This results in higher discharges and velocities occurring at higher frequencies to the receiving environment. Additionally, stormwater runoff from the urban area is of lower quality due to the presence of heavy metals, nutrients and particulates as well as macro-pollutants such as litter within the catchment from residential activities and vehicles.

It is therefore predicted that the impacts to the receiving wetland will include the following:

- Decreased water quality.
- Hydrological regime change, affecting functioning of wetland.
- Increased inundation of wetland during wet seasons.
- Erosion and sedimentation, affecting the movement of water through soils within the wetland, especially during the construction period.
- Reduction in flood mitigation capacity due to additional flow volumes from the development.
- Urban stream syndrome.

All of the above impacts negatively affect the wetland and impair its ability to provide ecological goods and services within the larger catchment. These services include biodiversity, water quality improvement, soil stabilization and flood mitigation. In terms of downstream stormwater infrastructure the wetland serves to attenuate stormwater peaks prior to them entering the system.

4.3 Mitigations

It is recommended that the stormwater management plan be modified to include sustainable urban drainage systems (SuDS). The objective of these systems is to treat runoff at source by having multiple interventions dispersed throughout the catchment. These interventions create pockets of high infiltration potential, redirecting runoff into the soils and removing pollutants by the physical, chemical and biological actions of vegetation and soil. The result is that the runoff hydrograph from the development will resemble the pre-development hydrograph - by having a longer duration, a delayed peak, and a much lower peak. The quality of the runoff will be improved and will thus have a smaller impact downstream.

Re-evaluating the stormwater management plan to make use of low impact development (LID) principles will protect the receiving wetland from degradation and enable it to continue providing essential ecosystem goods and services.

This will in turn reduce the impact of the new development on downstream existing stormwater infrastructure. The capacity of the existing stormwater system to accept the increased flows that will be generated by the development has not been calculated. If the runoff hydrograph is managed, the risk of overtopping downstream infrastructure will be removed.

As wetlands are sensitive areas and the findings of the *Ecological Impact Assessment* (GCS, 2020) was that the wetland should be demarcated as a no-go zone, it is critical that impacts to the wetland be managed and minimized.

4.4 Outlet structure

The point where the stormwater enters the environment is a critical interface and must be designed such that the flows integrate with the receiving environment. In the case of a wetland, erosion affects the flow regime causing defined channel flow rather than seepage through the soils. This has the effect of drying out the soils in the wetland and eventually destroying the wetland.

The Johannesburg Roads Agency (JRA) typical energy dissipation outlet structure has been proposed to be installed at the point where the stormwater pipe discharges into the wetland. “Double dissipation measures on a site specific basis” are specified. In this instance, as the receiving watercourse is a wetland it is recommended that gabion mattresses be installed as additional energy dissipation and scour protection.

5 FLOODLINE DETERMINATION

5.1 General climate

The climate in the Gauteng province is classified as a sub-tropical highland climate (Cwb) by the Köppen-Geiger system (Climate-Data.org, 2021). The weather is consistent and temperate, with warm wind-free days in summer and mild and dry weather in winter, with cold night temperatures. The rainfall is the region is higher than the country's average at 784 mm per annum. Rainfall occurs during the summer months as intense afternoons thunderstorms with the highest rainfall occurring in January while June and July are the driest months. Evaporation is estimated to be a mean of 2 178 mm per annum, higher than the rainfall thus indicating that the region is arid (CSIR, 2001).

5.2 Site description

The proposed development site is located in the western side of quaternary catchment C22F which drains to the Vaal River (Upper Vaal Water Management Area). The wetland forms part of the system that is the main drainage line of this side of the catchment. The nature of the flow is slow, unchannelled surface flow through reeds. The system begins close to the boundary of the catchment in Sebokeng township, where it flows through the informal area of the township. After approximately 2.1 km, the stream broadens into a wetland system located to the south of the Unitas Park proposed development site. The wetland is approximately 5.4 km in length and 400 m in width. The wetland then enters a constructed channel and flows about 6.0 km through the suburbs of Unitas Park, under a major road (the R59) to the Vaal River.

5.3 Regional hydrology

The C22F quaternary catchment has a surface area of 440 km^2, a Mean Annual Evaporation (MAE) of 1 650 mm/yr, it falls in rainfall zone C2C and has a Mean Annual Precipitation (MAP) of 655 mm/yr (Pitman & Bailey, 2015). The Mean Annual Runoff (MAR) of the entire quaternary catchment is estimated to be 9 910 000 m^3/yr and drains to the Vaal River. Rainfall data patched from multiple stations within the rainfall zone C2C was extracted from WR2012 and evaporation data for C22F was extracted from the network diagram of ternary catchment C22 from WRSM (Pitman & Bailey, 2015) and the monthly average values are shown in Figure 5-1 below. These values are determined from monthly data collected from 1920 to 2009 (89 year long record).

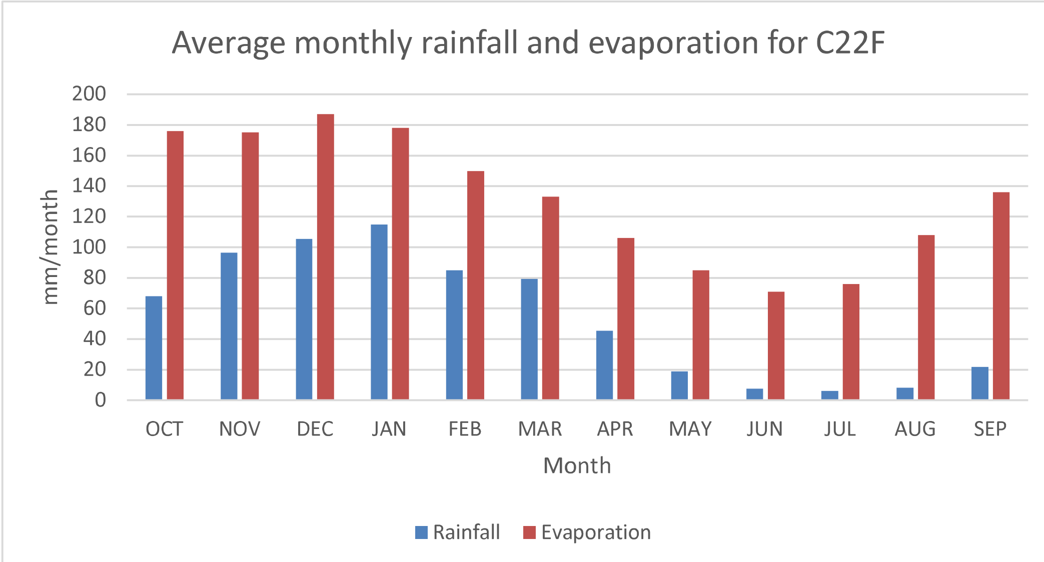


Figure 5-1 Average monthly rainfall and evaporation for C22F

5.4 Site specific rainfall and design rainfall

The closest South African Weather Service (SAWS) station that was identified in the vicinity of the site is 0438688_W Sasolburg, lying 21 km south west of the site. The daily rainfall extraction utility was used to find design rainfall depth for the area and these are shown in Table 5-1.

Table 5-1 Design Rainfall Values for 0438588_W Sasolburg

Design Rainfall Values for 0438588_W Sasolburg								
RI (yrs)		2	5	10	20	50	100	200
1	day	49.2	65.5	76.5	87.2	101.2	111.8	122.4
2	day	62.9	82.7	95.7	107.9	123.6	135.2	146.6
3	day	70	92.5	107.4	121.6	139.9	153.7	167.3
4	day	77.3	102	118.5	134.4	155.1	170.8	186.5
5	day	83.3	109.7	127.5	144.9	167.7	185.2	202.8
6	day	88.8	117.3	136.5	155.3	180.2	199.2	218.4
7	day	92.9	122.5	142.4	161.7	187.1	206.4	225.8

RI = Return Interval

5.5 Catchment delineation and characterization

The catchment gently slopes towards the stream, with a ridge to the north of the valley marking the high point of the catchment. Leeukuildam is a large pan located in the catchment but is not close to the stream and therefore is assumed not to have any direct hydrological effect on it. Land use in the catchment is a mixture of agricultural, residential and industrial and extends from Vereeniging to Vanderbijlpark.

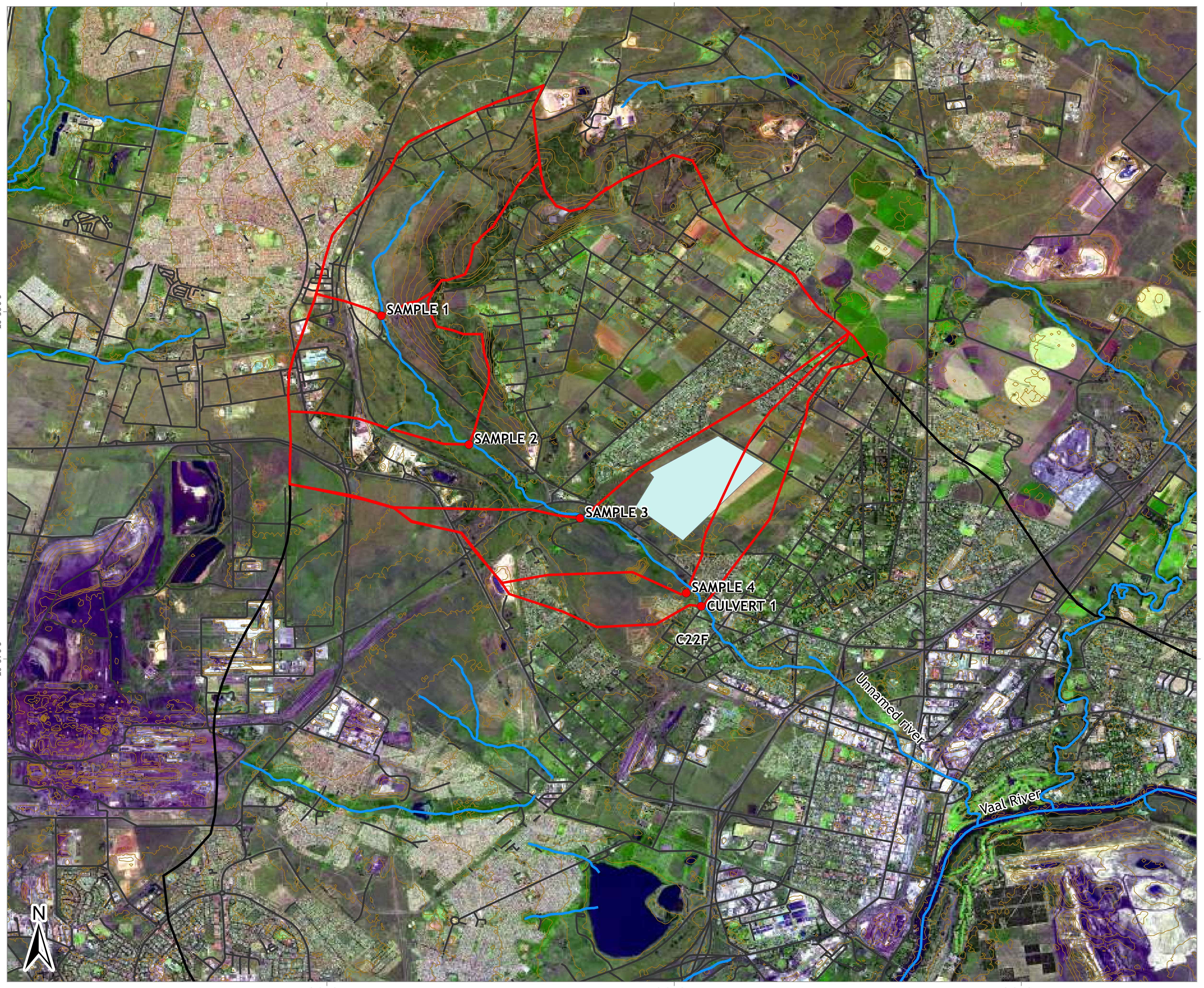
The catchment contributing directly to the wetland system was delineating using Geographical Information Systems (GIS) and Advanced Land Observation Satellite (ALOS) topography data. This is shown in Figure 5-2.

5.6 Baseline functioning of the wetland

The wetland is densely vegetated with diffuse surface flow across its width and saturated soils, typical of an unchannelled valley bottom wetland. Inflows to the wetland will include surface runoff. No direct discharges into the wetland were observed. Litter from the road is trapped by vegetation on the periphery of the wetland, with no visible litter in the wetland itself. The water is clear and odourless, indicating that the wetland is functioning to improve water quality by removing pollutants and suspended solids. As there is no defined channel, the flow is slow with no movement visible to the eye. The transect of the wetland is flat and broad, with a gentle slope. There is no defined riparian edge.

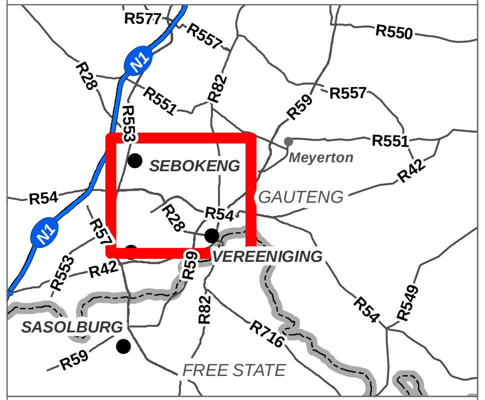
As found by the *Ecological Impact Assessment Report* (GCS, 2020) the wetland is healthy and functional. The hydrological services provided by the wetland include flood mitigation, flow attenuation and water quality improvement. This is therefore a hydrologically important asset to the local environment.

PHUMAF HOLDINGS GRLR SEDIBENG CONTRIBUTING CATCHMENTS



LEGEND

- Sample Locations
- Rivers
- Contributing Catchments
- Site Boundary
- Quaternary catchment
- Roads
- Countour



Data Sources:
SPOT satellite Imagery
2014 DWAF Quaternary Catchments
Subcatchment from specialist

0 1.25 2.5 Kilometers

SCALE: 1:58 036

FIGURE NO.: -	MAP NUMBER: 19-0921 -01
DRAWN BY: T DOMINY WATER SPECIALIST	REVIEWED BY: -
DATUM: WGS84 PROJECTION: UTM 35	DATE: 28 MAY 2021

PROJECT: PHUMAF UNITAS PARK
CLIENT: PHUMAF HOLDINGS GRLR SEDIBENG

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

5.7 Peak flows

Peak flows were calculated for the catchment of the watercourse, to the point where the wetland becomes canalized into a channel. The area up to this point is 135 km^2 and the length of the watercourse is 7.26 km. The slope of the catchment is very gentle at 0.61% and consists of the wetland or vlei along its whole length. 90% of the contributing catchment surface area is rural, and the remainder urban.

Peak flows were calculated using both the Rational Method (Alternative 3) and the Standard Design Flood method (SANRAL, 2013). The flows determined by the latter varied and were deemed to be too high to represent the catchment accurately. Therefore, the values of the Rational Method have been used to assess how the flooding of the system will impact downstream stormwater infrastructure when superimposed on the effluent discharge volumes.

The design rainfall depths for SAWS station 0438688_W Sasolburg were used in both methods.

The peak flows determined by the Rational Method are as follows:

- 2 year return interval: 79 m^3/s
- 5 year return interval: 116 m^3/s
- 10 year return interval: 147 m^3/s
- 20 year return interval: 187 m^3/s
- 50 year return interval: 270 m^3/s
- 100 year return interval: 359 m^3/s
- 200 year return interval: 441 m^3/s

5.8 Floodline

From the calculated peak flows, the 1:50 and 1:100 year floodlines were generated using GeoHECRAS modelling software to carry out a backwater analysis. The floodlines extend to the width of the wetland . Therefore, the portion of the wetland to the south of the proposed development has a wide floodplain of approximately 700 m. This indicates that this area is important for flood attenuation as it has a large volume storage capacity and slows flow by virtue of the wetland vegetation.

The post-development floodlines were not modelled but it is expected that they will have the effect of increasing the width of the floodline.

Refer to Figure 5-3 for the floodline delineation.

RATIONAL METHOD 3							
Description of catchment	Unitas Park Wetland Catchment						
River detail	Unnamed tributary of the Vaal River						
Calculated by	Jennifer Meneghelli			Date	21/06/2021		
Physical characteristics							
Size of catchment (A)	135.56	km^2		Rainfall region		C2C	
Longest watercourse (L)	7.26	km		**Area distribution factors**			
Average slope (S_{av})	0.0061	m/m		Rural (α)	Urban (β)	Lakes (γ)	
Dolomite area (D%)	0	%		0.9	0.1	0	
Mean annual precipitation (MAP)	655	mm					
Rural				**URBAN**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C2**
Vleis and pans (<3%)	90.00	0.01	0.90	**Lawns**			
Flat areas (3 - 10%)	0.00	0.06	0.00	Sandy,flat<2%	10	0.08	0.8
Hilly (10 - 30%)	0.00	0.12	0.00	Sandy,steep>7%	0	0.16	0
Steep Areas (>30%)	0.00	0.22	0.00	Heavys,flat<2%	0	0.15	0
Total	90.00	0.41	0.90	Heavys,steep>7%	0	0.3	0
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very permeable	100	0.03	3.00	Houses	0	0.5	0
Permeable	0	0.06	0.00	Flats	0	0.6	0
Semi-permeable	0	0.12	0.00	Industry			
Impermeable	0	0.21	0.00	Light industry	0	0.6	0
Total	100	0.42	3.00	Heavy industry	0	0.7	0
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush & plantation	0	0.03	0.00	City centre	0	0.8	0
Light bush & farm-lands	0	0.07	0.00	Suburban	0	0.65	0
Grasslands	100	0.17	17.00	Streets	0	0.75	0
No vegatation	0	0.26	0.00	Max flood	0	1	0
Total	100	0.53	17.00	Total (C2)	10		0.8
Time of concentration (TC)							

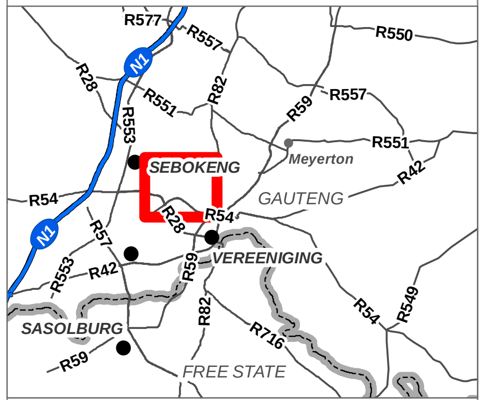
Overland flow		Defined watercourse						
$T_c = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$		$T_c = \left[\frac{0.87L^2}{1000\,S_{AV}}\right]^{0.385}$		Use Defined watercourse				
3.269	hours	2.174	hours					
Run-off coefficient								
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient, C_1		0.189	0.189	0.189	0.189	0.189	0.189	0.189
Adjusted for dolomitic areas, C_{1D}		0.189	0.189	0.189	0.189	0.189	0.189	0.189
Adj factor for initial saturation, F_t		0.50	0.55	0.60	0.67	0.83	1	1
Adjusted run - off coefficient, C_{1T}		0.094	0.104	0.113	0.127	0.157	0.189	0.189
Combined run - off coefficient, C_T		0.094	0.104	0.113	0.127	0.157	0.189	0.189
Rainfall								
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point rainfall (mm), P_T		54.12	72.05	84.15	95.92	111.32	122.98	134.6
Point Intensity (mm/h), P_{it}		24.89	33.14	38.71	44.12	51.20	56.57	61.93
Area reduction factor (%),ARF_T		0.891	0.891	1	1	1	1	1
Average intensity (mm/hour),I_T		22.192	29.544	34.506	39.332	45.647	50.428	61.928
Return Period (years)		**2**	**5**	**10**	**20**	**50**	**100**	**200**
Peak flow (m^3/s)		78.929	115.6	147.27	187.453	269.501	358.71	440.5

STANDARD DESIGN FLOOD (SDF) METHOD							
Description of catchment	Unitas Park Wetland Catchment						
River detail	Unnamed tributary of the Vaal River						
Calculated by	Jennifer Meneghelli				Date	21/06/2021	
Physical characteristics							
Size of catchment (A)	135.6	km^2		Days of thunder per year (R)	39	days	
Longest watercourse (L)	7.26	km		Time of concentration, t	130.447	minutes	
Average slope (S_{av})	0.006	m/m		Time of concentration, T_c	$T_c = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$		
SDF Basin	7						
2-year return period rainfall (M)	54.12	mm				2.174	
TR102 n-day rainfall data							
Weather Service Station	Sasolburg			MAP	655	mm	
Weather Service Station no.	0438588_W			Coordinates	26°48 S 27°48' E		
	Return Period (years)						
Duration	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Rainfall							
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point precipitation depth (mm) $P_{t,T}$	30.0084	50.6239	66.2	81.8139	102.4	118.0	133.6195
Area reduction factor (%),ARF_T	0.8915	0.8915	0.891	0.891	0.891	0.891	0.8915
Average intensity (mm/hour),I_T	12.3	20.8	27.2	33.5	42.0	48.4	54.8
Run-off coefficient							
Calibration factors	C_2 (%)	10		C_{100} (%)	50		
Return Period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Return period factors (Y_T)	0	0.84	1.28	1.64	2.05	2.33	2.58
Run-off coefficient, C_T	0.10	0.24	0.32	0.38	0.45	0.50	0.54
Peak flow (m^3/s)	46.34	190.89	327	482.00	714.8	911.21	1120.16

PHUMAF HOLDINGS GRLR SEDIBENG FLOODLINES

LEGEND

- 50yr Floodline
- 100yr Floodline
- Site Boundary
- Roads



Data Sources:
ESRI satellite Imagery
Floodlines determined by specialist

0 0.5 1 Kilometers

SCALE: 1:30 000

FIGURE NO.:	-	MAP NUMBER:	19-0921 -03
DRAWN BY:	T DOMINY WATER SPECIALIST	REVIEWED BY:	J MENEGHELLI WATER RESOURCE ENGINEER
DATUM: PROJECTION:	WGS84 UTM 35	DATE:	13 JULY 2021

PROJECT: PHUMAF UNITAS PARK
CLIENT: PHUMAF HOLDINGS GRLR SEDIBENG

GCS

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

6 WATER QUALITY

6.1 Water quality of the receiving environment

The water quality ecological requirements to protect the aquatic ecosystem for quaternary catchment C22F are EWR4 as per the *Proposed Reserve Determination of Water Resources for the Vaal Catchment* (Dept. of Water Affairs, 2018) and is shown in Table 6-1. The standard limits for discharge as set out by the DWS (Dept. of Water Affairs, 2013) are shown in Table 6-2. Where comparable, the concentrations allowed for effluent discharge are higher than the Vaal catchment targets. This indicates that in order for the system to assimilate the pollutants, there should be dilution by the natural flow of the watercourse. However, due to the watercourse being an unchanneled valley bottom wetland, flows are slow moving and the volumes of water available to dilute the effluent is much smaller than the predicted effluent volumes.

Table 6-1 EWR water quality requirements for C22F (Dept. of Water Affairs, 2018)

Category	Constituent	Percentile of data	
Inorganic salts	$MgSO_4$	95th	≤ 37 mg/L
	Na_2SO_4	95th	≤ 33 mg/L
	$MgCl_2$	95th	≤ 30 mg/L
	$CaCl_2$	95th	≤ 57 mg/L
	NaCl	95th	≤ 191 mg/L
	$CaSO_4$	95th	≤ 351 mg/L
Physical variables	EC	95th	≤ 30 mS/m
	pH	5th pc must be 6.5-8.0, 95th pc 8.0-8.8	
	DO	5th	≥ 7mg/L
Nutrients	Total Inorganic Nitrogen	50th	≤ 0.7 mg/L
	PO_4-P	50th	≤ 0.125 mg/L
Response variables	Chl-a phytoplankton	50th	≤ 10 µg/L
	Chl-a periphyton	50th	≤ 1.7 mg/m2
Toxics	Ammonia	95th	≤ 0.1 mg/L
	Fluoride	95th	≤ 1.5 mg/L

Table 6-2 DWS general discharge limits

VARIABLES AND SUBSTANCES	EXISTING SA GENERAL STANDARDS
Chemical Oxygen Demand	75 mg / l
Ionized and unionized ammonia (as N)	3.0 mg / l
Nitrate (as N)	15 mg / l
pH	Between 5.5 and 9.5
Residual Chlorine (as Cl)	0.25 mg / l
Suspended solids	25 mg / l
Phosphorous (Ortho Phosphate) (as P)	10 mg / l
Total Iron (as Fe)	0.3 mg / l
Faecal Coliforms per 100ml	1000

6.2 Baseline water quality

Four water samples were collected upstream of the proposed site, within the wetland adjacent to the site and downstream of the wetland. The location of the sample points can be seen in Figure 5-2.

It was found that all pollutants are below or within the general limits as laid out in Table 6-2 above, aside from faecal coliforms which were on average measured to be 2 500 per 100 ml of water. This indicates that the wetland is serving to purify water and that the catchment is not highly compromised. This can be attributed to the low percentage of urban or industrial development within the contributing catchments.

It is recommended that monitoring of surface water quality be carried out monthly during construction phase and every six months for the first 18 months of site establishment. Thereafter yearly monitoring should be acceptable. This is to ensure that the stormwater runoff and the effluent from the proposed development is not degrading the water quality within the wetland.

7 IMPACT ASSESSMENT

7.1 Impact assessment methodology

Due to the hydrological assessment forming part of a larger risk assessment for the study area, the potential impacts and the determination of impact significance was assessed. The process of assessing the potential impacts of the project encompasses the following four activities:

1. Identification and assessment of potential impacts;
2. Prediction of the nature, magnitude, extent and duration of potentially significant impacts;
3. Identification of mitigation measures that could be implemented to reduce the severity or significance of the impacts of the activity; and
4. Evaluation of the significance of the impact after the mitigation measures have been implemented i.e. the significance of the residual impact.

Per GNR 982 of the EIA Regulations (2014), the significance of potential impacts was assessed in terms of the following criteria:

I. Cumulative impacts;
II. Nature of the impact;
III. Extent of the impact;
IV. Probability of the impact occurring;
V. The degree to which the impact can be reversed;
VI. The degree to which the impact may cause irreplaceable loss of resources; and
VII. The degree to which the impact can be mitigated.

Table 7-1 provides a summary of the criteria used to assess the significance of the potential impacts identified. An explanation of these impact criteria is provided in Table 7-2.

The net consequence is established by the following equation:

- Consequence = (Duration + Extent + Irreplaceability of resource) x Severity

And the environmental significance of an impact was determined by multiplying consequence with probability.

Note that the DHSW&S Risk Assessment Matrix is not applicable to the hydrological study, but to the aquatic ecology and wetlands study. The matrix has been adapted in the above methodology to reflect the same approach and principles of the DHSW&S Risk Assessment Matrix such that hydrological risks can be represented.

Table 7-1: Proposed Criteria and Rating Scales to be used in the Assessment of the Potential Impacts

Criteria	Rating Scales	Notes
Nature	Positive (+)	An evaluation of the effect of the impact related to the proposed development.
	Negative (-)	
Extent	Footprint (1)	The impact only affects the area in which the proposed activity will occur.
	Site (2)	The impact will affect only the development area.
	Local (3)	The impact affects the development area and adjacent properties.
	Regional (4)	The effect of the impact extends beyond municipal boundaries.
	National (5)	The effect of the impact extends beyond more than 2 regional/ provincial boundaries.
	International (6)	The effect of the impact extends beyond country borders.
Duration	Temporary (1)	The duration of the activity associated with the impact will last 0-6 months.
	Short term (2)	The duration of the activity associated with the impact will last 6-18 months.
	Medium-term (3)	The duration of the activity associated with the impact will last 18 months-5 years.
	Long term (4)	The duration of the activity associated with the impact will last more than 5 years.
Severity	Low (-1)	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.
	Moderate (-2)	Where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected.

Criteria	Rating Scales	Notes
	High (-3)	Where natural, cultural or social functions and processes are altered to the extent that the natural process will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected.
Potential for impact on irreplaceable resources	No (0)	No irreplaceable resources will be impacted.
	Yes (1)	Irreplaceable resources will be impacted.
Consequence	Extremely detrimental (-25 to -33)	A combination of extent, duration, intensity and the potential for impact on irreplaceable resources.
	Highly detrimental (-19 to -24)	
	Moderately detrimental (-13 to -18)	
	Slightly detrimental (-7 to -12)	
	Negligible (-6 to 0)	
	Slightly beneficial (0 to 6)	
	Moderately beneficial (13 to 18)	
	Highly beneficial (19 to 24)	
	Extremely beneficial (25 to 33)	
Probability (the likelihood of the impact occurring)	Improbable (0)	It is highly unlikely or less than 50 % likely that an impact will occur.
	Probable (1)	It is between 50 and 70 % certain that the impact will occur.
	Definite (2)	It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.
Significance	Very high – negative (-49 to -66)	A function of Consequence and Probability.
	High - negative (-37 to -48)	
	Moderate – negative (-25 to -36)	
	Low - negative (-13 to -24)	
	Very low (0 to -12)	
	Low – positive (0 to 12)	
	Moderate - positive (13 to 24)	
	High - positive (37 to 48)	
	Very high - positive (49 to 66)	

Table 7-2: Explanation of Assessment Criteria

Criteria	Explanation
Nature	This is an evaluation of the type of effect the construction, operation and management of the proposed development would have on the affected environment. Will the impact change in the environment be positive, negative, or neutral?
Extent or Scale	This refers to the spatial scale at which the impact will occur. The extent of the impact is described as: footprint (affecting only the footprint of the development), site (limited to the site) and regional (limited to the immediate surroundings and closest towns to the site). Extent of scale refers to the actual physical footprint of the impact, not to the spatial significance. It is acknowledged that some impacts, even though they may be of small extent, are of very high importance, e.g. impacts on species of very restricted range. To avoid “double counting, specialists have been requested to indicate spatial significance under “intensity” or “impact on irreplaceable resources” but not under “extent” as well.
Duration	The lifespan of the impact is indicated as temporary, short, medium and long term.
Severity	This is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning, or render it slightly altered?
Impact on irreplaceable resources	This refers to the potential for an environmental resource to be replaced, should it be impacted. A resource could be replaced by natural processes (e.g. by natural colonisation from surrounding areas), through artificial means (e.g. by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providing substitute resources is usually not possible, but in social systems, substitutes are often possible (e.g. by constructing new social facilities for those that are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable e.g. red data species that are restricted to a particular site or habitat of very limited extent.
Consequence	The consequence of the potential impacts is a summation of the above criteria, namely the extent, duration, intensity and impact on irreplaceable resources.
Probability of occurrence	The probability of the impact occurring based on the professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. It is important to distinguish between the probability of the impact occurring and the probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact.

Significance	Impact significance is defined to be a combination of the consequence (as described below) and the probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluated in terms of the seriousness (consequence) of the impact, weighted by the probability of the impact occurring. In simple terms, if the consequence and probability of an impact is high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision-making.
Degree of confidence in predictions	Specialists and the EIR team were required to indicate the degree of confidence (low, medium or high) that there is in the predictions made for each impact, based on the available information and their level of knowledge and expertise. Degree of confidence is not taken into account in the determination of consequence or probability.
Mitigation measures	Mitigation measures are designed to reduce the consequence or probability of an impact, or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

7.2 Risk assessment matrix

The predicted surface water impacts are listed in the tables below, with proposed mitigation measures and estimates of risk intensity. From the assessment, it was found that during both construction and operational phases, the risk of impact to surface water from the site is negligible if appropriate mitigation measures are put in place.

The risk assessment matrix finds the proposed activities to be slightly detrimental, reduced to negligible with the inclusion of mitigation measures.

Construction

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation							Confidence
			Duration	Extent	Potential for impact on irreplaceable resources	Severity	Consequence	Probability	Significance		Duration	Extent	Severity	Potential for impact on irreplaceable resources	Consequence	Probability	Significance	
Vadose zone soils	Disturbing vadose zone during soil excavations/activities for construction of development	Earthworks, terracing	Temporary (1)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-8)	Definite (2)	Low - negative (-13 to -24) (-16)	• Only excavate areas applicable to the project area. • Cover excavated soils with a temporary liner to prevent contamination. • Keep the site clean of all general and domestic wastes. • Vegetation clearing to be limited to what is essential. • Retain as much indigenous vegetation as possible. • Exposed soils to be protected using a suitable covering. • Existing roads should be used as far as practical to gain access to the site and crossing the streams in areas where no existing crossing is apparent should be unnecessary, but if it is essential crossings should be made at right angles.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6)	Definite (2)	Negligible (0 to -12)	Medium
Wetland	Surface water contamination and sedimentation from the following activities: o Erosion and sedimentation from disturbed soils and construction materials; and o Alteration of natural drainage lines which may lead to ponding or increased runoff patterns (i.e. may cause stagnant water levels or increase erosion).	Earthworks	Temporary (1)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-8)	Definite (2)	Low - negative (-13 to -24) (-16)	• Install a temporary cut off trench to contain poor quality runoff (if observed). • Cover soil stockpiles with a temporary liner to prevent contamination. • Construct temporary silt traps at drainage points to allow sediment settlement from runoff prior to release to the environment.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6)	Definite (2)	Negligible (0 to -12)	Medium
	Water quality impacts due to: o Spillage of fuels and chemicals; and o Construction equipment and vehicles.	Plant on site during construction	Temporary (1)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-8)	Definite (2)	Low - negative (-13 to -24) (-16)	• Clean up spillages immediately. • Keep chemicals in bunded areas. • Keep vehicles and equipment clean.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6)	Probable (1)	Negligible (0 to -12)	Medium
	Increased runoff altering flow regimes of receiving watercourses due to: o Vegetation removal; and o Compacting of soil.	Site clearing and preparation	Temporary (1)	Site (2)	Yes (1)	Moderate (-2)	Slightly detrimental (-7 to -12) (-8)	Definite (2)	Low - negative (-13 to -24) (-16)	• Vegetation clearing to be limited to what is essential. • Retain as much indigenous vegetation as possible. • Compact the site footprint only, minimise working area.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6)	Probable (1)	Negligible (0 to -12)	Medium

OPERATIONAL

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation							Confidence
			Duration	Extent	Potential for impact on irreplaceable resources	Severity	Consequence	Probability	Significance		Duration	Extent	Severity	Potential for impact on irreplaceable resources	Consequence	Probability	Significance	
Primary surface water Receivers - > Non-Perennial & Perennial Streams	Increased runoff volumes due to compacted surfaces from the development may cause higher velocities and frequency of occurrence of discharge to receiving watercourses, resulting in riparian degradation (urban river syndrome). Riparian degradation leads to loss of ecosystem functioning and altering of hydrological regimes.	Stormwater runoff	Long-term (4)	Local (3)	Yes (1)	Moderate (-2)	Moderately detrimental (-13 to -18) (-16)	Definite (2)	Moderate - negative (-25 to -36) (-32)	• Release structures for stormwater runoff from the site should dissipate energy and disperse flow to ensure minimal impact to the receiving environment. • Stormwater management plan for the site should be designed such that outflow from the site is equivalent to pre-development flows in terms of magnitude and frequency of occurrence. • Sustainable urban drainage systems (SuDS) should be included in stormwater system throughout the site to counter runoff from impervious surfaces by providing infiltration capacity.	Long-term (4)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6)	Improbable (0)	Negligible (0 to -12)	Medium
	Potential sedimentation several months after the site has been constructed. It is anticipated that the sediment load will decrease with time to pre-construction levels as vegetation becomes established.	Net result of earthworks and development	Medium Term (3)	Local (3)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-7)	Definite (2)	Low (-13 to -24) (-14)	• Release structures for stormwater runoff from the site should incorporate silt traps to allow for settlement of sediments. • Silt traps to be regularly cleaned.	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (0 to -6)	Probable (1)	Negligible (0 to -12)	Medium
	Water quality deterioration due to stormwater runoff becoming contaminated with heavy metals (from vehicles, roads, and atmospheric deposition), oil and grease (from domestic and restaurant activities, leaks from vehicles), nutrients (domestic cleaning, sewage leaks) and suspended solids	Residential activities	Long-term (4)	Local (3)	Yes (1)	Moderate (-2)	Moderately detrimental (-13 to -18) (-16)	Definite (2)	Moderate - negative (-25 to -36) (-32)	• Implementation of a SWMP to keep clean water away from dirty areas. • SuDS should be implemented holistically throughout the site to intercept and treat water to remove contaminants at source. • Maintenance of SuDS. • Oil traps at restaurants, petrol stations and parking areas. • Maintenance of sewage network to prevent leaks. • Education of the community not to throw dirty water on the ground but dispose of to sewage.	Long-term (4)	Site (2)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-7)	Probable (1)	Negligible (0 to -12)	Medium

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation							Confidence
			Duration	Extent	Potential for impact on irreplaceable resources	Severity	Consequence	Probability	Significance		Duration	Extent	Severity	Potential for impact on irreplaceable resources	Consequence	Probability	Significance	
	Erosion due to change in topography, land use and vegetation removal.	Catchment modification	Long-term (4)	Local (3)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-8)	Definite (2)	Low (-13 to -24) (-16)	• Design the SWMP to ensure that the velocities of stormwater runoff flow are kept to a minimum. • Design release structures to dissipate stream power. • Include erosion protection measures such as rip rap in release structures.	Long-term (4)	Footprint (1)	Yes (1)	Low (-1)	Negligible (0 to -6) (-6)	Probable (1)	Negligible (0 to -12) (-6)	Medium
Wetland	Inundation of wetland by effluent discharge, impacting the hydrological functioning and reducing flood mitigation capacity. Water quality of the wetland will be impacted by the quality of the effluent.	Effluent discharge	Long-term (4)	Local (3)	Yes (1)	High (-3)	Highly detrimental (-19 to -24) (-24)	Definite (2)	High - negative (-37 to -48) (-48)	• Pipe the effluent from the WWTP to the stormwater system downstream of the wetland, by-passing the wetland completely. • Discharge effluent at a constant rate by including a balancing tank in the WWTP process to attenuate peaks.	Long-term (4)	Footprint (1)	Yes (1)	Low (-1)	Negligible (0 to -6) (-6)	Probable (1)	Negligible (0 to -12) (-6)	Medium

7.3 Impact assessment findings

During the construction phase of the development, the greatest impact to the environment will be the disturbance of soil and the resultant erosion and sedimentation within the site and downstream of it in the wetland. This impact is determined to be low and negative. The impact can be reduced to negligible by putting in place practices to manage the exposed soil and construction materials, as recommended in the table as mitigation measures.

During the life of the development, two main sources of hydrological impact have been identified: stormwater runoff and the effluent discharge. Both of these sources of water depend upon being disposed of to the downstream wetland. As the wetland is a sensitive area, it is vulnerable to changes in surface hydrology.

The most severe stormwater runoff impacts are predicted to be moderate and negative. This is primarily a result of the increase in surface water runoff that will be generated by creating a large impervious area where there are currently agricultural fields. It is recommended that a sustainable urban drainage system be designed that utilizes a combination of vegetation and soil infiltration to attenuate and treat at source the stormwater runoff volumes. The installation of such a mitigation would reduce the impact to negligible.

The other impact of stormwater runoff that needs to be mitigated is erosion. Erosion can have serious consequences for the functioning of the wetland as it can alter the hydrological flows of the wetland and the geomorphology. It is therefore recommended that the interface where the stormwater is released into the environment be a hydraulic structure designed to dissipate energy. Refer to Section 4.4 for more detail on this.

The discharge of sewage effluent to the wetland poses a high negative risk. All measures should be taken to avoid this impact. The recommended solution is to pipe the effluent to the downstream stormwater infrastructure and discharge directly into that canal, at a constant flow rate, bypassing the wetland completely. This intervention will reduce the impact to negligible.

8 CONCLUSIONS

A hydrological impact assessment was carried out for the proposed Unitas Extension 16 development. The development has two waste streams that will potentially have hydrological impacts: stormwater runoff and sewage effluent discharge. The scenario is further complicated because the receiving watercourse is a wetland. Wetlands are sensitive areas that are ecologically vulnerable and require protection from detrimental impacts.

The stormwater runoff impacts the downstream receiving environment as runoff volumes from an impervious urban development will be in the order of 60% higher than the current agricultural land use of the site. The proposed stormwater management plan was assessed and was found to be a typical, conventional system whereby all runoff is concentrated and released at one point.

It was found that the impacts resulting from this would include erosion, higher volumes of runoff being released at higher velocities and frequencies from the site, and decreased water quality all of which negatively impact the wetland (from low to moderately negative).

It is recommended that a sustainable urban drainage system be implemented in order to adjust the runoff hydrograph from the development to simulate that of pre-development flows. The outlet structure where the stormwater discharge enters the environment musrt be a suitably design hydraulic structure that will prevent erosion of the receiving wetland.

The effluent discharge to the environment was found to pose a high risk of negative impact. A hydrological screening study was carried out – this found that a full investigation would be required. An effluent discharge investigation ensued in order to predict the effect of the effluent discharge on the wetland. The findings of the study was that the ecological and hydrological impacts to the wetland would be severe and would compromise the healthy functioning of the system.

It is therefore recommended that the effluent be piped from the development to the existing stormwater canal, downstream of the wetland, and be discharged at a constant rate into this infrastructure. This means that the effluent bypasses the wetland, and the impact can be reduced to negligible.

REFERENCES

Climate of the Limpopo Basin. (2010). Retrieved from Limpopo River Awareness Kit: http://www.limpopo.riverawarenesskit.org/LIMPOPORAK_COM/INDEX.HTM

Climate-Data.org. (2021, April 4). Retrieved from Climate-Data.org: https://en.climate-data.org/africa/south-africa/northern-cape-470/

Dept. of Water Affairs. (2013, September 6). Revision of general authorisation in terms of Section 39 of the National Water Act, 1998 (Act no. 36 of 1998). South Africa.: Government Notice No. 36820: 665.

Dept. of Water Affairs. (2018, December 21). Proposed Reserve Determination for Water Resources for the Vaal Catachment. Government Notice No. 42127:1419.

Dept. Water and Sanitation. (2016, August 26). General authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for water uses as defined in Section 21 (c) or Section 21 (i). South Africa. : Government Notice No. 40229: 509.

DJ Ollis, J. D.-S. (2014). *WRC Report No. TT 609/14: Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition.* Water Resources Commission.

DWA. (2006a). *Best Practice Guidelines for Water Resources Protection in the South African Mining Industry. BPG G1. Stormwater Management.* Pretoria: DWA.

DWA. (2006b). *Best Practice Guidelines for Water Resources Protection in the South African Mining Industry. BPG G2: Water and Salt Balances.* Pretoria: DWA.

Phumaf. (2021). *Gauteng Rapid Land Release Civil Engineering Services Preliminary Design Report.*

Pitman, & Bailey. (2015). *WR2012*. Retrieved from https://waterresourceswr2012.co.za/resource-centre/

SANRAL. (2013). *Drainage Manual.*

SANRAL. (2013). *Drainage Manual. 6th Edition.* Pretoria: South African National Road Agency Soc Ltd (SANRAL).

Smithers and Schulze. (2000). *Design Rainfall Estimation for South Africa.* Pretoria: Water Research Commission.

WRC. (2012). *Water Resources of South Africa 2012 Study (WR2012)*. Retrieved from http://waterresourceswr2012.co.za/resource-centre/

APPENDIX A: HYDROLOGICAL SCREENING STUDY

63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Preliminary Hydrological Assessment

Report

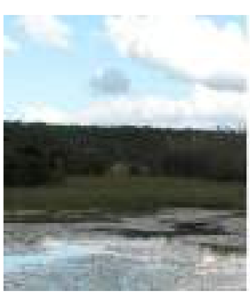
Version - B

24 May 2021

Phumaf Engineering

GCS Project Number: 19-0921

Client Reference: Unitas Effluent Discharge





Report
Version - B

24 May 2021

Phumaf Engineering

19-0921

DOCUMENT ISSUE STATUS

Report Issue	Version B		
GCS Reference Number	GCS Ref - 19-0921		
Client Reference	Unitas Effluent Discharge		
Title	Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Preliminary Hydrological Assessment		
	Name	**Signature**	**Date**
Author	Jennifer Meneghelli		24 May 2021
Author	Gareth Preen		24 May 2021
Director, Reviewer	Magnus van Rooyen		
Director, Reviewer	Andries Wilke		

LEGAL NOTICE

This report or any proportion thereof and any associated documentation remain the property of GCS until the mandator effects payment of all fees and disbursements due to GCS in terms of the GCS Conditions of Contract and Project Acceptance Form. Notwithstanding the aforesaid, any reproduction, duplication, copying, adaptation, editing, change, disclosure, publication, distribution, incorporation, modification, lending, transfer, sending, delivering, serving or broadcasting must be authorised in writing by GCS.

EXECUTIVE SUMMARY

Mixed-use residential development is planned for a site in Unitas Park, Extension 16, Vereeniging. A constraint to the development is that the local Efuleni municipality is not able to accept wastewater generated by the development as there is insufficient capacity at their wastewater treatment works. The developer has therefore proposed an on-site wastewater treatment plant (WWTP) at the development to receive and treat wastewater generated by domestic activities. The effluent generated by treatment of the wastewater will be in the order of 20 000 m^3/day and will need to be discharged to the environment as the volumes are too large to store. Discharge to the environment is the preferred means of disposal as treatment to potable standards for redistribution is not socially accepted practice. The developer has proposed discharging the effluent to the wetland located to the south of the site, beyond Houtkop road. A preliminary screening assessment was carried out to evaluate the feasibility of this activity as permission will be required from the Department of Water and Sanitation (DWS).

The wetland is part of the drainage system for the whole catchment and therefore receives large runoff flows. Disposing of 20 000 m^3/day of effluent will fundamentally alter the functioning of the wetland system and compromise its ability to provide ecosystem goods and services. In addition, the ecological baseline study carried for the wetland concluded that the wetland should be demarcated as a no-go zone and should be protected from all potential impacts of the development. It is concluded that a full investigation of the impacts to the wetland is required in order to fully understand how the proposed activity will affect the system.

Hydrologically, it is predicted that the wetland can provide storage for effluent volumes that will attenuate their flow entering the downstream system however, this will compromise the flood mitigation service provided by the wetland and will put neighbouring residential settlements at risk of flooding during storm events. The developer has not proposed any augmentation of the downstream stormwater infrastructure that would receive the effluent volumes. It is therefore proposed that a full effluent discharge investigation be carried out to quantify the hydrological impacts of the discharge on the downstream receiving system, to propose inflow hydraulic infrastructure that will protect the wetland from erosion and assess the impacts on storage in the wetland itself.

It is recommended that a full investigation be carried out to model the wetland and determine the scale of impacts to it and be submitted as part of the water use license application (WULA).

One unchannelled valley bottom wetland is located within the study area. The Present Ecological State (PES) of the wetland was determined to be Moderately Modified (Class C) (GCS, 2020). Additionally, the ecosystem goods and services provided by the wetland were determined to be low to moderate (GCS, 2020).

Based on a preliminary impact screening, it was determined that the effluent discharge will have significant implications on the health of the system. These preliminary impacts were not assessed during the initial impact assessment undertaken in 2020. Therefore, the following has been recommended:

- Undertake a detailed quantitative risk assessment of the potential impacts of the effluent discharge on the wetland;
- Undertake an assessment of the PES and Ecosystem Goods and Services in an operational phase scenario; and
- Provision of additional mitigation measures according to the mitigation hierarchy.

CONTENTS PAGE

LIST OF FIGURES

LIST OF PHOTOS

No table of figures entries found.

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

As part of the Gauteng Rapid Land Release Program, a portion 222 of the farm Houtkop 594 otherwise known as Unitas Park Extension 16 in Vereeniging has been proposed for mixed-use residential development. The local municipality (Efuleni) has insufficient treatment capacity at the municipal Wastewater Treatment Plant (WWTP) to receive sewage from the proposed development. The development has therefore allowed for its own, on-site WWTP. The WWTP would generate 20 000 m^3/day of effluent that would need to be discharged. Phumaf Holdings (Pty) Ltd (Phumaf) are the engineers designing and planning the proposed development and have appointed GCS Water and Environmental Consultants (GCS) to carry out a preliminary hydrological assessment to estimate the feasibility of discharging the treated sewage effluent from the development into the wetland to the south.

In accordance with General Authorisations, Section 39 of the National Water Act (NWA) (Dept. of Water Affairs, 2013) a person may irrigate or discharge up to 2 000 m^3 of effluent per day onto land that they own provided it complies with legislated water quality specifications amongst other criteria. The volume that is proposed to be discharged is ten times greater than the volume that would satisfy General Authorisation requirements and is proposed to be disposed on into land that does not belong to the development that is generating the effluent. Therefore, in terms of Section 21 (f) of the NWA it is necessary for Phumaf to apply for a license to discharge the effluent to a watercourse.

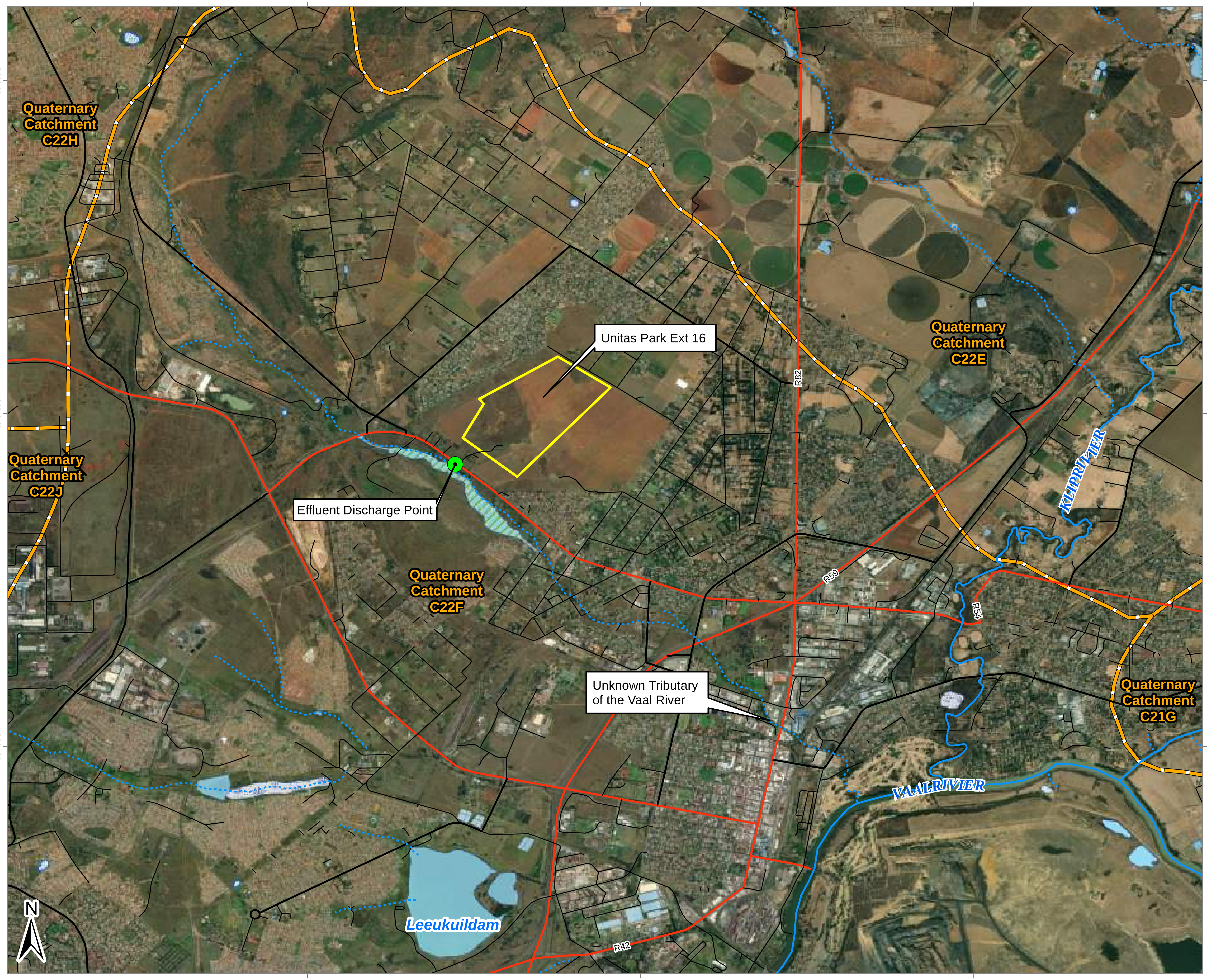
In addition, the discharge of effluent into the wetland would trigger Section 21 (i) in terms of GN 509 (Dept. Water and Sanitation, 2016) of the NWA as the fundamental, defining characteristics of the watercourse would be altered.

This activity is dependant upon the watercourse's assimilative capacity to treat and receive the effluent. As the watercourse referred to is an unchanneled valley bottom wetland, its assimilative capacity is not immediately obvious due to sporadic and seasonal surface flows being of a slow velocity as opposed to a river with a continuous baseflow. As a wetland, it is considered a sensitive area and should thus be protected as it provides ecological goods and services. The *Ecological Impact Assessment Report* (GCS, 2020) carried out for the site recommended that the wetland be demarcated as a no-go zone.

This screening exercise was therefore carried out to determine the potential of this system to receive the effluent volumes as both a hydrological system and an ecologically sensitive wetland. Based on the findings of this preliminary report, in conjunction with recommendations by the wetland specialist, it will be determined whether discharge to the wetland is possible and whether an application to DWS is likely to be successful and if not, and what alternative means of managing effluent are available.

Refer to Figure 1-1.

UNITAS PARK EXT 16: SITE MAP



LEGEND

- Effluent Discharge Point

Rivers and Streams

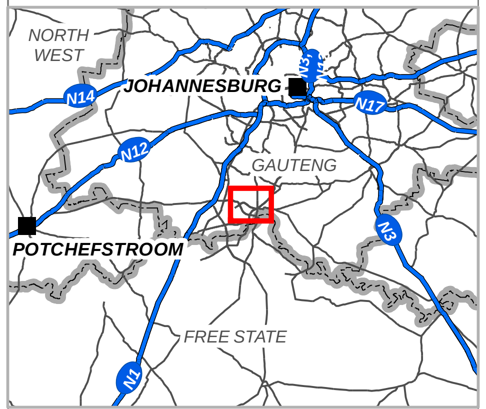
- Non-Perennial
- Perennial

Road Network

- Main Road
- Secondary Road
- Street
- Unitas Park Ext 16: Site Map
- Quaternary Catchments
- Unchannelled Valley Bottom Wetland

Inland Water

- Dams and lakes
- Reservoirs and water tanks
- Marsh and swamps
- Non-perennial pans



Data Sources:
Esri World Imagery Basemap
2014 DWAF Quaternary Catchments

0 1 2 Kilometers

SCALE: 1:50 000

FIGURE NO.:	-	MAP NUMBER:	19-0921-09-V3
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	J MENEGHELLI CIVIL ENGINEER
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 MAY 2021
PROJECT:	TOWNSHIP ESTABLISHMENT BRYANSTON EXT3 (JHB)		
CLIENT:	PHUMAF HOLDINGS		

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

2 SCOPE OF WORK

The objective of the preliminary study is to carry out a screening process to determine if discharge will be acceptable based on currently available information or if a full investigation is required. During the preliminary investigation, information on the activity producing the effluent, the nature of the effluent and the surrounding catchment will be gathered. The potential impacts of the proposed activity hydrologically and on the wetland are examined on a preliminary basis to estimate what further assessment is required.

The scope of work to carry out the preliminary study is as follows:

- Field investigation
- Liaison with the GCS wetland specialist
- Determination of the potential impact of discharging effluent to the wetland may have
- Visual inspection of baseflow in the wetland / river system
- Evaluation of applicable legislation and best practices
- Proposal of alternatives to discharging into the wetland

3 EFFLUENT INFORMATION

3.1 Generation of effluent

The housing development proposed will have 7 250 units that will be supplied with potable water. Each unit will produce domestic wastewater that must be collected and managed. The wastewater will be directed to the on-site WWTP where it will be treated. The effluent remaining after the wastewater treatment is what must be discharged.

3.2 Need for discharge

The volume of effluent generated daily by the treatment process is too large to store in conservancy tanks or trucked to an off-site facility for disposal, and therefore must be discharged. If it is not possible to discharge the effluent, then it will not be possible to go ahead with the housing development.

3.3 Measures taken to prevent and minimize waste

Measures cannot be taken to reduce or minimize the effluent without reducing the size of the proposed housing development. The only way of preventing waste is by not developing.

The option of re-using the effluent and treating to potable standards on-site has been put forward, but this has a social stigma around it and is unlikely to be accepted by residents. This is discussed further in consideration of alternatives.

4 PRELIMINARY INFORMATION

4.1 Location of the activity

The project site, Unitas Park Extension 16, is located within the Emfuleni Local Municipality, Gauteng province, 6km north-west of the Vereeniging central business district, sandwiched between roads R54 and R42. Access to the site is via Skippie Botha and Langraad. Refer to Figure 1-1.

The site is located in an area previously used for agriculture, adjacent to residential suburbs, to the north of Houtkop road. Stormwater from the site drains through a culvert under the road, into a wetland. The wetland runs through a field previously used for agriculture. It is proposed that the effluent be piped through the existing culvert and discharged into the wetland.

4.2 Nature of the effluent

The sewage received by the WWTP will consist of potable water contaminated by bath, shower, basin and domestic cleaning. There will be no industrial or chemical contamination of the sewage. The sewage will then be treated to general constituent limits for wastewater discharge to a water resource as specified by the Department of Water and Sanitation (DWS) (Dept. of Water Affairs, 2013) (see Table 4-1).

Table 4-1 DWS general discharge limits

VARIABLES AND SUBSTANCES	EXISTING SA GENERAL STANDARDS
Chemical Oxygen Demand	75 mg / l
Ionized and unionized ammonia (as N)	3.0 mg / l
Nitrate (as N)	15 mg / l
pH	Between 5.5 and 9.5
Residual Chlorine (as CI)	0.25 mg / l
Suspended solids	25 mg / l
Phosphorous (Ortho Phosphate) (as P)	10 mg / l
Total Iron (as Fe)	0.3 mg / l
Faecal Coliforms per 100ml	1000

Please refer to Appendix A for the WWTP specifications.

4.3 Type and scale of the activity

An integrated fixed film activated sludge process has been identified as the preferred technology to be used for treatment of the wastewater by the equipment suppliers, Sewtreat. The bioproducts of the treatment process will include a small amount of sludge which will be collected in bags and disposed of to landfill and 20 000 m^3 of effluent per day. The effluent will need to be discharged to the environment. At this volume, this can be considered a large-scale activity.

4.4 Water users in the catchment

The only water use registered for the quaternary catchment C22F is the abstraction of raw water from the Vaal River for Lethabo power station (urban industrial use). The power station is situated on the opposite side of the Vaal River to Unitas Park and therefore would not be impacted by a change in water quantity or quality resulting from effluent discharge.

It can therefore be assumed that all other water used in the catchment is potable Schedule 1 usage supplied by the municipality to residents. There is not evidence of farm dams of stream abstraction for agricultural use. This indicates that impacts to water users in the catchment would not be a concern as there are no direct abstractions taking place from the stream of interest.

4.5 Sensitivity of the catchment

Wetlands are considered environmentally sensitive areas in terms of the National Water Act (Act No 36 of 1998). Environmentally sensitive means that a large disturbance to functioning results from a small impact. The wetland study found that the present ecological state of the system is C: slightly modified and that it is of functional importance in terms of providing ecosystem goods and services (GCS, 2020). The report also found that there are potential direct impacts on the wetland from all phases of the life cycle of the development in addition to the proposed discharge. The cumulative impacts of the development and the discharge may result in the inability of the wetland to continue to function. It can therefore be concluded that the catchment is sensitive and an impact assessment should be carried out to better predict the full extent of the activities on it, such as habitat destruction and environmental degradation.

4.6 Water quality status of the catchment

The water quality of the catchment will not be pristine as it is a developed catchment with mixed-use of commercial agriculture and residential occupation.

- In the upper reaches of the catchment, there is an undeveloped ridge that will have clean runoff and agricultural fields that may have higher amounts of sedimentation but should not have high pollutant concentrations. However, there is an informal arm of Sebokeng township that runs immediately along the stream. It is predicted that higher concentrations of microbiological activity and sediment will be present from domestic activities and runoff from exposed soil.
- The stream then broadens into a wetland, running alongside Houtkop road. It is expected that water quality improvement by bio-remedial action would occur in this section.

- The stream is then canalized through the suburb of Unitas Park. It is likely that stormwater runoff from this area would contain higher concentrations of contaminants and that an increase in pollutants would be observed.

It is recommended that water sampling be carried out in order to better understand the catchment. This would also confirm if the wetland is performing the ecosystem service of improving water quality. Currently, only stormwater is discharged to the wetland system, no effluent. It is therefore reasonable to assume that the discharge of effluent would decrease the water quality in the catchment.

4.7 Interested and affected parties

The interested and affected parties (I&AP) include those downstream of the proposed effluent discharge outlet. This would include the residents of the suburbs Steelpark, Homer and Roods Gardens AH that lie along the southern side of the wetland and residents of Unitas and the industrial area adjacent to the Vaal River, through which the stream flows in canals. Public participation from an early stage would enable all I&AP to be identified and notified of the proposed activity allowing them to establish their concerns and become involved.

Effluent discharge of 20 000 m^3 per day into the wetland will reduce its available storage for flood mitigation. A large berm running in a north-westerly direction indicates that residents to the south of the wetland rely on it for flood mitigation. There is a risk of this protection berm overtopping during rainfall events.

In terms of pedestrians, there are footpaths across the wetland that would be inundated by the discharge of the wetland, rendering this route unusable. An alternative would need to be provided for these stakeholders.

The effluent discharge makes no allowance for the construction or augmentation of additional conveyance infrastructure downstream of the wetland. This implies that the additional volumes would be managed by the existing stormwater system. The additional volumes will reduce the available capacity to accommodate stormwater flows during rainfall events and may result in the system spilling, which would result in nuisance flows and ponding, damage to roads and stormwater infrastructure and potentially flooding of property.

All abovementioned impacts are detrimental to the I&AP. Thus, they would need to be fully informed of the proposed activity. It is recommended that a hydraulic assessment be carried out to estimate the capacity of the existing system to handle the effluent volumes.

5 JUSTIFICATION FOR DISCHARGE

5.1 Contribution to sustainable development

The housing development is significant in terms of sustainable development in that it will provide much needed housing in the Gauteng province. Sustainable development means managing the impacts to the environment to support economic and social growth. This project cannot go forward without having a means of effluent discharge so the benefit of providing housing should be offset against the environmental impacts.

5.2 Alternatives proposed

Several possible alternatives were have been proposed:

- Reduce effluent discharge to 5 000 m^3/day and gradually increase to full volume of 20 000 m^3/day once the wetland has adapted in terms of flow regime.
- Pipe effluent discharge approximately 6.12 km downstream and discharge directly into the Vaal River. This will also require a WUL, but impact to the water resource would be less as it is not an ecologically sensitive wetland, therefore the Department of Water Affairs and Sanitation (DWS) is more likely to grant permission to discharge.
- Storage of effluent is not feasible as the volumes are too large.
- Irrigation with effluent is not feasible as it would be an urban site, with no agricultural activity requiring irrigation. Also, the volumes needing to be disposed of by irrigation would exceed the limits laid out in Section 21 (c) (NWA) (Act no, 36 of 1998) General Authorisations of 2 000 m^3 per day and would therefore require a WUL.
- Treatment of effluent to potable drinking water on-site by a water treatment plant is not a preferred option due to stigma around the process and the future residents not accepting it. There is also political opposition to the treatment of effluent to potable drinking standards rather than disposal to the environment.
- Building of a formalised channel within the wetland was suggested. This would represent an impact to the wetland but may be considered based upon the ability of downstream stormwater infrastructure to receive these additional volumes (further investigation by water resources engineer to be carried out).
- Construction of an artificial wetland to attenuate and treat the effluent prior to release to the wetland was suggested. This is possible and would reduce impacts to the wetland but is costly.

6 HYDROLOGICAL PRELIMINARY ASSESSMENT

6.1 Site description

The proposed development site is located in the western side of quaternary catchment C22F which drains to the Vaal River (Upper Vaal Water Management Area). The wetland forms part of the system that is the main drainage line of this side of the catchment. The nature of the flow is slow, unchannelled surface flow through reeds. The system begins close to the boundary of the catchment in Sebokeng township, where it flows through the informal area of the township. After approximately 2.1 km, the stream broadens into a wetland system located to the south of the Unitas Park proposed development site. The wetland is approximately 5.4 km in length and 400 m in width. The wetland then enters a constructed channel and flows about 6.0 km through the suburbs of Unitas Park, under a major road (the R59) to the Vaal River.

The catchment gently slopes towards the stream, with a ridge to the north of the valley marking the high point of the catchment. Leeukuildam is a large pan located in the catchment but is not close to the stream and therefore is assumed not to have any direct hydrological effect on it. Land use in the catchment is a mixture of agricultural, residential and industrial and extends from Vereeniging to Vanderbijlpark.

6.2 Baseline functioning of the wetland

The wetland is densely vegetated with diffuse surface flow across its width and saturated soils, typical of an unchannelled valley bottom wetland. Inflows to the wetland will include surface runoff. No direct discharges into the wetland were observed. Litter from the road is trapped by vegetation on the periphery of the wetland, with no visible litter in the wetland itself. The water is clear and odourless, indicating that the wetland is functioning to improve water quality by removing pollutants and suspended solids. As there is no defined channel, the flow is slow with no movement visible to the eye. The transect of the wetland is flat and broad, with a gentle slope. There is no defined riparian edge.

As found by the *Ecological Impact Assessment Report* (GCS, 2020) the wetland is healthy and functional. The hydrological services provided by the wetland include flood mitigation, flow attenuation and water quality improvement. This is therefore a hydrologically important asset to the local environment.

6.3 Inlet hydraulic infrastructure for proposed effluent discharge

In order to discharge to the wetland, the incoming flows should simulate natural inflows as closely as possible, which would mean that they should be diffuse. It is proposed to discharge the effluent into the wetland through the existing stormwater culvert under Houtkop Road (refer to Figure 1-1). This would result in point discharge to the system. It is recommended that an inlet structure be designed to dissipate energy, allow for silt trapping, and release the flows over some distance. This is necessary to prevent erosion from the streamflow force of the discharge. Erosion in a wetland can undermine its functioning by altering the flow regime and creating a channel. This will result in the wetland drying out and its boundary contracting. This causes higher base flows downstream as attenuation capability will be lost.

The option of installing an artificial wetland upstream of the culvert in conjunction with an energy dissipating structure has been proposed so that flows be diffused prior to their entrance to the wetland. Depending on the slope and available space and associated costs, this may achieve acceptable flows to minimize impacts to the wetland.

6.4 Storage capacity

The storage capacity of the wetland is a function of the soils, vegetation and topography. In this wetland the soils are wholly saturated and there is permanent surface flow. Therefore, the available storage volume is within the vegetation and the shape of the valley. As the wetland is approximately 400 m wide and 5.4 km in length, it offers significant storage capacity. This means that there is a risk of the effluent discharge ponding within the wetland. This is not desirable as it will become a health and safety risk in term of water quality (standing water breeds pathogens) and drowning. It will also take up all available flood mitigation volume which creates a flood risk downstream. If the wetland is permanently inundated, it will fundamentally alter its hydrological functioning and will impair its ability to provide ecosystem goods and services.

It is recommended that modelling of the storage of the system be carried out to predict how efficiently the system will drain.

6.5 Outlet hydraulic infrastructure

The canal that leads from the wetland through the town has a large contributing catchment estimated to be in the order of 60 km^2. This will result in a high stormwater runoff volume in addition to the baseflow emanating from the wetland.

The proposed development does not plan to upgrade the stormwater infrastructure, but to discharge the effluent to it based on its current capacity. It can therefore be concluded that the hydraulics of the downstream stormwater system are the hydrologically constraining factors to discharging the effluent.

It is recommended that the existing and required capacity of the downstream stormwater system be analysed and compared to see if it is feasible to piggy-back the effluent discharge on the existing system.

7 WETLAND PRELIMINARY ASSESSMENT

7.1 Onsite Freshwater Resources

The Ecological Impact Assessment (GCS, 2020) identified one (1) unchanneled valley bottom wetland system. The hydrological regime of this system is driven primarily from an inlet perennial drainage line near the head of the system and overland inputs from adjacent slopes. Characteristically, the flow in an unchanneled valley bottom is diffuse and slow in nature. Infiltration and evapotranspiration from unchanneled valley bottom wetlands can be significant (Ollis *et al*, 2013).

The Present Ecological State (PES) of the onsite wetland system was determined to be Moderately Modified (Class C) (GCS, 2020). This describes a situation in which a moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact (Macfarlane *et al*, 2008). Additionally, the ecosystem goods and services provided by the wetland were determined to be low to moderate (GCS, 2020). The most significant ecosystem service provided was determined to be erosion control and phosphate trapping. In terms of natural resources, the system was determined to provide moderate service in this regard in terms of habitat availability and harvestable resources. In this regard, the wetland is an important environmental feature, as alluded to earlier in this report.

7.2 Preliminary Impact Assessment

The proposed effluent outlet is located directly downstream of an impoundment within the wetland system. Stormwater from regional road R54 enters the wetland system via an underground culvert. The impoundment, which is what appears to be an historical, informal road crossing through the wetland, makes very little provision for the movement of water. An approximately 3 m wide cut has formed in the informal crossing which allows for the movement of water to downstream areas. This impoundment has consequently had an impact on the size of the wetland. This has also had an impact on the hydrological regime of the system through reduced flow volumes and resulting in pooling water. The addition of effluent at this point is likely to have a detrimental impact on water and soil quality. The lack of flow through the system at this point will result in stagnant effluent and a breeding ground for bacteria.

The ecosystem goods and services of the wetland will also be detrimentally impacted. Additional water inputs will reduce the ability of the system to lessen the severity of localized floods. This was determined to be an important ecosystem service provided for by the wetland (GCS, 2020). Additionally, it would be important to understand the expected volume of total suspended sediments which would form part of the effluent discharge. Significant, additional sediment input would result in alterations to the geomorphological characteristics of the system.

7.3 Recommended way forward

It is suspected that the discharge of effluent into the wetland via the existing culvert will impact on the current hydrological, geomorphological and vegetative characteristics and dynamics of the system. This activity will require authorisation from the DWS in terms of Section 21 (f) of the NWA. The impacts of the proposed discharge activity were not assessed during the initial ecological assessment undertaken by GCS in 2020. Therefore, a risk assessment will need to be undertaken to determine the potential implications of the proposed discharge. Additionally, realistic mitigation measures will need to be provided to reduce the potential cumulative impacts. It is also recommended that an assessment be undertaken of the ecosystem goods and services and PES under a simulated scenario ie. assessing the wetland as if the effluent discharge point is in place and operating.

8 CONCLUSIONS

Effluent generated by the treatment of domestic wastewater from the development of 7 250 housing units needs to be discharged from the on-site WWTP. If discharge is not possible, then the housing development cannot proceed. It is not possible to eliminate the waste production as the municipal wastewater works cannot receive it. Treatment to potable standards is not a preferred solution as this is not socially accepted.

The concerns associated with the disposal of the effluent to the wetland system are how the quality and quantity will affect the wetland's functioning and ability to perform its ecosystem goods and services. Hydrologically, the reduction of flood mitigation capacity and the ability of the downstream receiving stormwater infrastructure to accommodate the increased flows are a concern.

It is recommended that a full effluent discharge investigation of the ecological and hydrological impacts to the wetland system be carried out to better understand how the proposed activity can be managed such that the development can go ahead without negatively affecting the environment and downstream communities.

A preliminary impact screening of the proposed effluent discharge into the onsite unchannelled valley bottom wetland was undertaken. It was determined that the effluent discharge will have significant implications on the health of the system. These preliminary impacts were not assessed during the initial impact assessment undertaken in 2020. Therefore, the following has been recommended:

- Undertake a detailed quantitative risk assessment of the potential impacts of the effluent discharge on the wetland;
- Undertake an assessment of the PES and Ecosystem Goods and Services in an operational phase scenario; and
- Provision of additional mitigation measures according to the mitigation hierarchy.

APPENDIX A SEWTREAT WASTEWATER TREATMENT PLANT SPECIFICATIONS

We thank you for your valued enquiry and have pleasure in submitting our quote/proposal as follows:

PROPOSAL FOR:

2x10 MLPD Aboveground Steel Tank Wastewater Treatment Facility

Mr. Sikelela Mnguni – Phumaf Holdings

Mobile: +27 72 603 6122

Email: smnguni@phumaf.com

Date: 17 August 2020

Reference Number: SSQ 3348

SECTION 1: OVERVIEW

SEWTREAT was requested to propose a steel tank aboveground biological wastewater treatment plant for Mr. Sikelela Mnguni – Phumaf Holdings, to the following specification:

Site	Midvaal Municipality
Daily Flowrate	2x10 MLPD
Discharge Limits	DWS General Discharge Limits
Final water Usage	Irrigation / Environmental discharge

SECTION 2: DESIGN OVERIEW, CONSIDERATIONS & ASSUMPTIONS

SewTreat investigated various treatment technologies and based on the requirements an ***Integrated Fixed Film Activated Sludge (IFAS)*** process was chosen as the preffered technology to satify all the legislative and site specific requirements

SECTION 3: DESIGN CRITERIA & FACTORS CONSIDERED IN THE DESIGN (Assumed)

- The effluent reporting to the treatment plant originated from a potable source before biological contamination via bath, shower, basin and cleaning operations. The Effluent has no industrial or chemical contamination.
- No toxic substances are to be forwarded to the plant.
- No storm water will be forwarded to the plant.
- Oils and fats are to be treated at the source with fat traps before entering the plant.
- Normal kitchen and bathroom detergents should not be problematic in terms of plant operation.
- For typical domestic sewage treated in aerobic/anoxic reactor with de-nitrification (MLE process low alkalinity with pH instability) is normally not a problem. In the absence of alkalinity information, it is assumed that there will be adequate alkalinity in order to maintain a pH of 6.8 to 7.2 in the reactor.
- The plant must cope with daily variation in the flow rate from a maximum during the day to nearly zero during the night
- The process design to include a 10% safety factor

3.1 Design Specifications & highlights:

The design is based on the ***WRC REPORT NO. TT 389/09***, which provide guidelines in respect to daily flow calculations, capacity and retention.

System is designed to treat to General Discharge standards with peak capacity of 2x10 MLPDduring full operational capacity.

Total Flow per Day	20 000 000	**Liter per day**
Total Flow per Day	20000	**m3 per day**
Maximum COD	1 000	**mg/l**
Air Required	35000	**m3 per hour**
Diffusers	8750	**Units**
Pall Rings	12 000 000	**Units**
Clarifier Pump	33 334	**LPM**
Disinfection Circulation	16670	**LPM**
Clarifier Up flow Velocity	266.46	**M/hour**
Feed Pump Flow rate	50 000	**LPM (Peak factor of 3)**
Discharge Pump Flow rate	50 000	**LPM**
Chlorine Dosing pump rate	10.000	**LPH**
Bacteria Dosing Pump rate	8.000	**LPH**
Qty of Sludge Bags	500	**Units**
Total Volume of plant	50 000.0	**m3**
Total retention	2.5	**Days**
Total KW Required	1 064.6	**KW Per Hour**

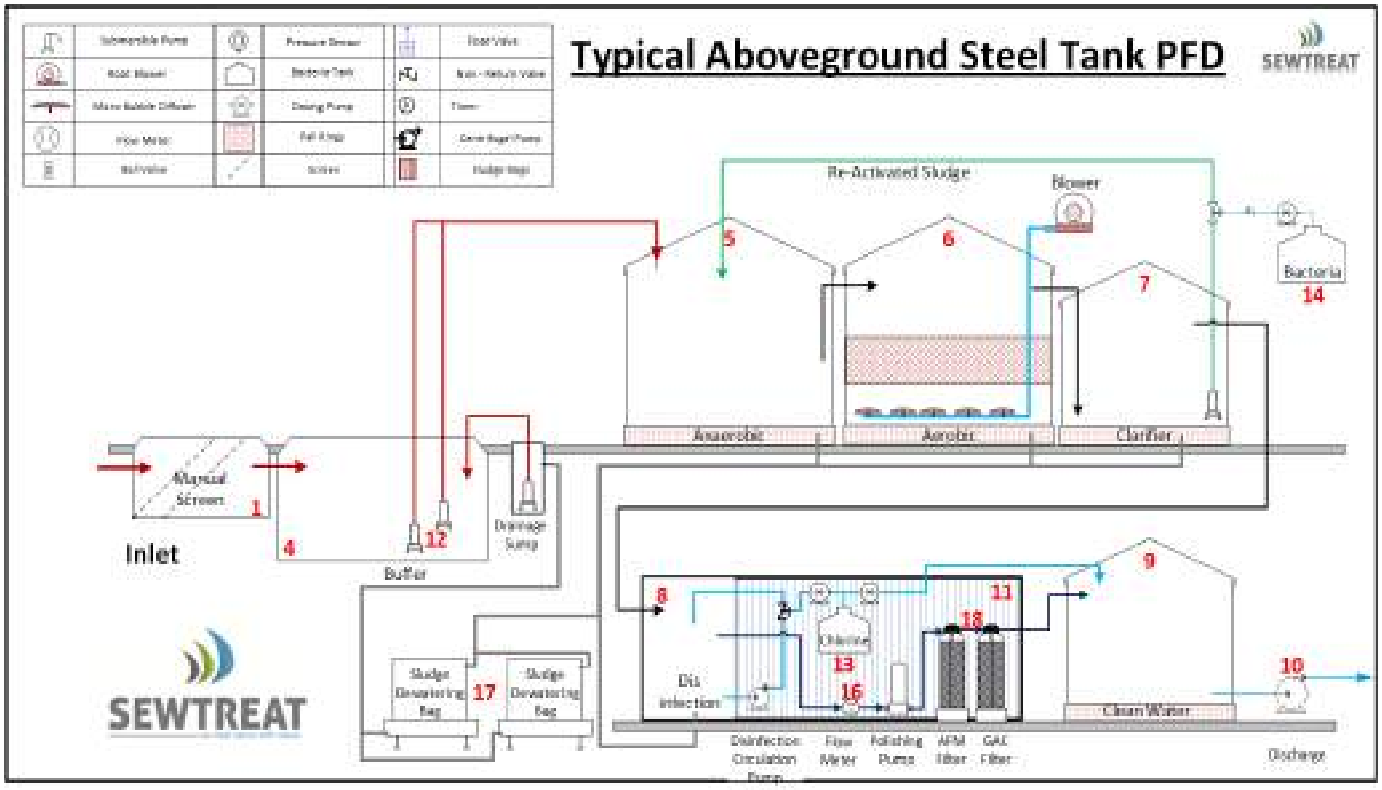
3.2 COMPLIANCE WITH SPECIFICATION AS SET OUT BY THE DEPARTMENT OF WATER AFFAIRS (DWA)

This final effluent is guaranteed to be within General limits as required from DWS, which is suitable for discharge into reservoirs and water bodies with no potential for environmental damage

VARIABLES AND SUBSTANCES	EXISTING SA GENERAL STANDARDS	EXISTING SA SPECIAL STANDARDS
Chemical Oxygen Demand	75 mg / l	30 mg /l
Ionized and unionized ammonia (as N)	3.0 mg / l	2.0 mg / l
Nitrate (as N)	15 mg / l	1.5 mg / l
pH	Between 5.5 and 9.5	Between 5.5 and 7.5
Residual Chlorine (as Cl)	0.25 mg / l	0
Suspended solids	25 mg / l	10 mg / l
Phosphorous (Ortho Phosphate) (as P)	10 mg / l	1 mg / l
Total Iron (as Fe)	0.3 mg / l	0.3 mg / l
Faecal Coliforms per 100ml	1000	0

Please Note: The plant will confirm with South Africa General standards, subject to SewTreat conditions.

SECTION 4: PROCESS OVERVIEW AND EQUIPMENT TO BE INSTALLED



The below BoQ is for 1x 10 MLpd plant.

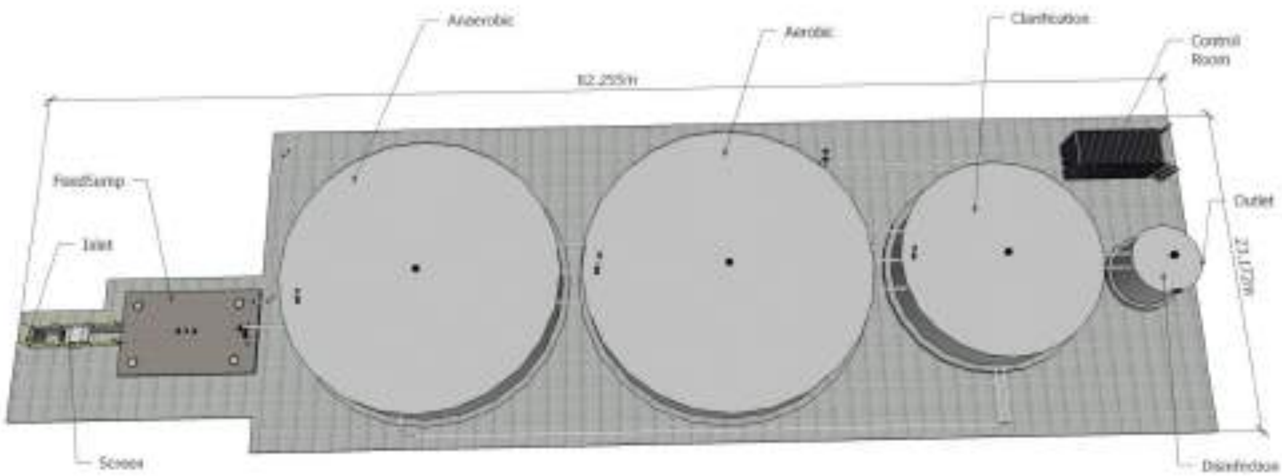
No.	Process	Included	Technical	Function
1	Screen	Included	TSF3 - M30	Screening is imperative to remove all inorganics from the incoming effluent. This can be done Manually or automatic. Screening remove the plastics, pads, condoms and all other material that cannot be digested in the biological wastewater treatment plant. Screen apertures is normally 20mm and/or 40mm
2	Inline Screen	Excluded	Not Included	Inline screen serves to remove smaller inorganic particles, this screen is normally a 3mm, 5mm or 10mm screen. Installed inline before the buffer or the anaerobic phase.
3	Lifting Station	Excluded	Not Included	if the incoming level of the effluent is deeper than 1m a lifting station is required. Pre-cast manhole rings are stacked on each other to the required depth, pumps are then installed, normally cutter type submersible pumps, these pumps pump the effluent to the inline screen, buffer or anaerobic tanks depending on the design.
4	Buffer Tank	Excluded	Not Included	Buffer tank also called the balancing tank is used in the event of high peaks during the day, if there is peak flows during for example shift changes, then the high flow is put into a buffer tank and the feed to the treatment plant is regulated at the required liter per minute. This ensures efficiency of the plant, reduces the treatment plants required capacities and ensures constant feed to the treatment plant.
5	Anaerobic Phase	Included	PHT-2200 - 4.16 - 9544m3 provided with 5 Tanks	If the client doesn't have a septic tank installed or the volume of the current septic tank is not sufficient, an Anaerobic treatment phase will need to be installed. The anaerobic treatment (Also called Septic Phase) assist in a 50% to 70% reduction of the COD and BOD. The Anaerobic phase also assist in the separation of solids from liquids

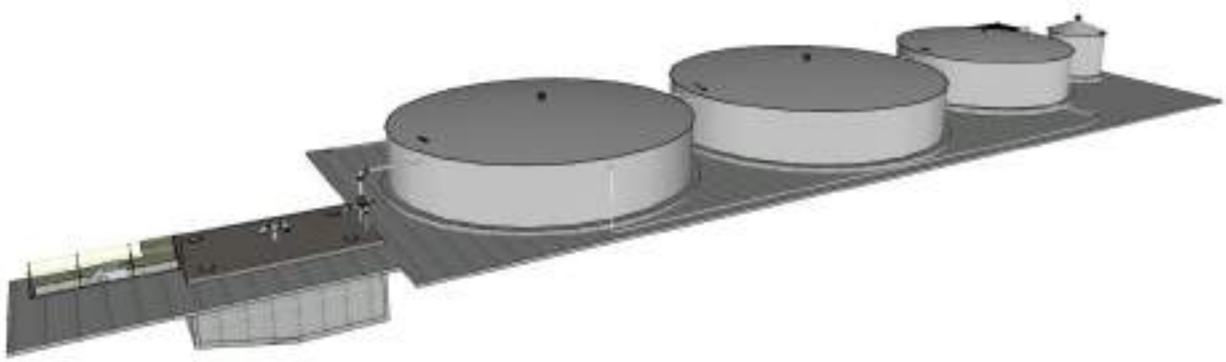
reg. num: 2016/371897/07
vat. num: 4180274930
sadc reg: 21669240
b-bbee status: level 2
procurement recognition level: 125%
email: info@sewtreat.co.za
tel: 013 690 3912
cell: 082 849 3906
fax2mail: 086 416 1349

6	Aerobic	Included	PHT-2200 - 4.16 -7636m3 provided with 4 Tanks	Aerobic phase or Bioreactor's main objective is the reduction of Ammonia through nitrification this is done by air injection via air blower through micro bubble diffusers. Nitrification is the biological process where ammonium (NH_4^+) is oxidized and converted into the nitrate (NO_3^-). PVC Pall rings to be installed in the tank to create Moving Bed Bioreactor to allow for bacterial growth at a rate of > 148m2/m3 of surface area.
7	Clarification	Included	PHT-2200 - 4.16 -5727m3 provided with 3 Tanks - Upflow rate of 133.23 - M/hour	Clarification (Also called Anoxic or Humus phase) assist with de-nitrification in anaerobic conditions. De-nitrification is biological process that involves the conversion of nitrate (NO_3^-) into nitrogen gas (N_2). The sludge that settles in this phase is called activated sludge which is then returned to the anaerobic and aerobic phase to assist in sludge breakdown. This process also reduces the quantity of sludge removed from the system significantly.
8	Disinfection	Included	Con-L&S-12M - 0m3 provided with 2 Tanks	Disinfection means the removal, deactivation or killing of pathogenic microorganisms, resulting in termination of growth and reproduction. This ensure the water is safe for re-use. There are various methodologies of disinfection, we prefer Sodium hypochlorite, although this results in a monthly consumable, it is the most effective and reliable disinfection method.
9	Final Holding tank	Excluded	Not Included	Final water holding tank, stores the water for re-use in various applications such as irrigation, fire water, general cleaning, cooling tower refill and all other non-potable applications. This is optional addition and can be provided by the client.
10	Final Discharge	Excluded	Not Included	If required, a final discharge pump can be installed to pump the water to the final water holding tanks, this is optional.
11	Control Room	Included	12m - Container c/w Steel Structure & Pool Coat	A control room serves as a clean, lockable space where the equipment and electrical panels be installed into. The control room must be well ventilated to ensure the distribution of heat from the mechanical equipment. Also serves as lockable space which offers security.
12	Feed Pumps	Included	2 x 2.2KW - Submersible Sewage Pumps - 400Lpm	Feed pumps are used in the event that the tank is above ground type, invert level is too deep, or the plant cannot be gravity fed. Pumps are selected to pump at a peak factor of 3, to ensure efficiency. We recommend that feed pumps be installed on a duty-standby assembly, which ensures availability and ensure no spillages occur.
13	Chlorine Dosing	Included	1 x Chlorine Dosing with Probe	Sodium Hypochlorite dosing pump, the pump has a sensor that automatically measures and dose the correct amount of sodium hypochlorite into the final effluent. The average dosing is 8ppm with a residual of 2ppm
14	Bacteria Dosing	Included	1 x Digital Dosing Pump	A blend of 21 species of bacteria is constantly dosed into the system to enhance the system, this is imperative in high COD applications and also where there is a lot of chemicals that is fed into the plant. By dosing the bacteria, it ensures that there is always sufficient biomass.
15	Electrical Panel	Included	Large - IP65 - Electrical panel with GSM and 29 Components	We offer 4 types: the basic panel is a wall mounted DB with no indicator lights, switches or intelligence. The Small IP65 panels is small panels with indicator light and switches and a basic GSM module. The Large IP65 panel is a complete panel with labelling, indicator lights, and full GSM integration. The PLC is the ultimate in control, intelligence and integration.
16	Flow Meter	Included	Digital Flow Meter	Flow meters are optional, we prefer to install a digital IFM type flow meter that is connected to the GSM router that delivers daily flow rates via SMS.
17	Sludge Bags	Included	400 x De-Sludge Stand 1M3	Sludge bags are used for the removal of excess sludge, this will be done periodically. The sludge bags are perforated and allows the water to drain while retaining the sludge. It is also a very cost-effective solution for sludge drying beds.
18	Final Polishing	Excluded	Not Included	If the final water is to be used for cooling towers, toilet flushing or general washing, we recommend that final water polishing be included, this entails the water being pumped through multimedia filters and activated carbon filters.

SECTION 5: TYPICAL DRAWING

The drawing for 1x 10 MLpd WWTP is indicated in this section. Two of these concepts will have to be placed in parallel from one another.





reg. num: 2016/371897/07
vat. num: 4180274930
sadc reg: 21669240

b-bbee status: level 2
procurement recognition level: 125%

email: info@sewtreat.co.za
tel: 013 690 3912
cell: 082 849 3906
fax2mail: 086 416 1349

SEWTREAT

we treat nature with nature

SECTION 6: MAINTENANCE

SewTreat will place permanent operator on-site and supply all consumables for the duration of the proposed 5 Year SLA.

6.1 Daily Maintenance

- Should there be any inorganic build-up in the in-line screen it should be removed and disposed of in the appropriate manner, in-line with hazardous waste disposal legislation.
- Check that all mechanical Equipment is operational
- Check bacteria level in bacteria holding tank and mix bacteria.
- Check that all mechanical Equipment is operational
- Check the timers to ensure that the timing has not changed due to electrical failure.
- Remove all non-organic material from manual Screen
- Ensure that flow meter is set to prescribed flow rate
- Open sludge drains valves to feed the sludge dewatering bag station

6.2 Monthly Maintenance

- ***Sampling*** – take feed sample and final treated effluent sample for SANAS accredited lab analysis
- ***Manual Screen -*** Remove all non-organic material & agitate the accumulated organic material.
- ***Blowers –*** Verify that blowers are clear of obstruction and grease mechanical components where required
- ***Clarifier Pumps -*** Verify that the submersible pumps are clear of obstructions and in good running order.
- ***Disinfection -*** Measure & record disinfection is to design specifications
- ***Dosing Equipment -*** Measure & record dosing ratio & check bacteria level in bacteria holding tank and mix bacteria.
- ***Sludge ratio's -*** Measure & record sludge levels (both top & bottom Blanket) in each tank.
- ***Flow meter & inline Screen -*** Strip & clean flow meter & in-line screen also ensure that flow meter is set to prescribed flow rate.
- ***Electrical -*** Check timers is set to correct intervals for the clarifier pumps and test & ensure time is accurate
- ***Report -*** Full independent lab analysis for discharge effluent & full fault report and corrective action requirements to be provided.

reg. num: 2016/371897/07
vat. num: 4180274930
sadc reg: 21669240

b-bbee status: level 2
procurement recognition level: 125%

email: info@sewtreat.co.za
tel: 013 690 3912
cell: 082 849 3906
fax2mail: 086 416 1349

SECTION 7: ELECTRICAL REQUIREMENTS

- We require 380V feed,
- Blower is on duty one on standby should a standby blower be purchased as critical equipment
- Timers on Blowers & Clarifier Pumps (24 hours with 15minute interval settings)
- **A GSM Unit to be installed that will report via SMS any equipment trip or malfunction, this will also provide monthly reports on the operational status of the plant.**
- Earthing, lighting protection, over/under volt protection and earth matting has been excluded
- Feed cable provision and installation excluded
- Plant lighting is excluded
- In the event that a generator will be used, we recommend that a soft Starter be incorporated, this is included

Description	Standard Issue	Technical Information	Volt	KW	Total KW	Hours per day (24)	Total KW
Blower	21	BLO-920-25	380	25.00	525.00	18	9450
Clarifier Pump	3	GQGM 6-25	220	2.00	6.00	1	6
Main Feed Pumps	2	V2200	380	2.20	4.40	12	52.8
Buffer Feed Pumps	0	Not Included	0	0.00	0.00	20	0
Disinfection Dosing	1	CHL-Probe	220	0.10	0.10	18	1.8
Disinfection Circulation	1	MFM 40-160A	380	4.00	4.00	18	72
Bacteria Dosing Pump	1	D-Dos-1	220	0.10	0.10	18	1.8
Discharge Pump	0	Gravity Discharge	0	0.00	0.00	12	0
0			0				0
Total	**29**	**Total KW**			**539.60**	**Total KW Usage per 24 Hours**	**9584.4**
						Average per hour Usage KW	**399.35**

SECTION 8: CRITICAL SPARES

Critical equipment is not included in the quoted price but a schedule is provided below.

Critical Equipment						
Description	**Technical Information**	**Qty**		**Rate**		**Total**
Blower	BLO-920-25	21	R	136 620.00	R	2 869 020.00
Clarifier Pump	GQGM 6-25	1	R	18 231.58	R	18 231.58
Main Feed Pumps	V2200	2	R	13 358.03	R	26 716.07
Buffer Feed Pumps	Not Included	0	R	-	R	-
Disinfection Dosing	CHL-Probe	1	R	20 625.00	R	20 625.00
Discharge Pump	Gravity Discharge	1	R	-	R	-
Total Excl. Vat					**R**	**2 934 592.65**

Please note: SewTreat advice at a **minimum** one of each pump be purchased as critical equipment, which will ensure the most critical functions are always operational.

reg. num: 2016/371897/07
vat. num: 4180274930
sadc reg: 21669240

b-bbee status: level 2
procurement recognition level: 125%

email: info@sewtreat.co.za
tel: 013 690 3912
cell: 082 849 3906
fax2mail: 086 416 1349

Should some of the critical equipment be procured and the client wishes to install the equipment in the control room to effectively just switch over, it can be done at additional rate as there needs to be electrical changes to effect run the critical equipment.

SECTION 9: INSTALLATION

9.1 INSTALLATION TEAM

- SEWTREAT will provide all required site installation personnel such as supervisors, team leaders, electricians, plumbers and all required personnel to ensure quality of installation
- The SewTreat will provide the following:
- All Accommodation
- All transport
- Living Out allowances
- We envisage that the installation will take approximately 32 working days

9.2 DELIVERY & OFF-LOADING

- Delivery is not included in this proposal.

9.3 HSEQ REQUIREMENTS

- All PPE, On-boarding and Medicals Included in proposal if these can be completed in 2 days, any additional days will be charged at a daily rate.
- All Contractors packs and the approval thereof and related labour and traveling cost are Excluded
- Working at heights, excavation permits, and all other site-specific requirements is excluded

SECTION 10: CUSTOMER SCOPE OF SUPPLY/RESPONSIBILITIES

- Provision of suitable access for delivery and installation of plant.
- Secured Storage on site
- Safe access for all approved SewTreat employees and contractors to the job site
- Piping, equipment or electrical to and from the defined battery limits (extraction and discharge lines)
- Security and Fire Protection systems as per local regulations
- Electrical supply from a mains breaker, with connection to our plant distribution board
- Disposal of all solid and liquid waste from the SewTreat treatment plant and other works.
- Environmental and discharge permits
- First fill of systems - we will require 500kl of clean water to fill tanks.

SECTION 11: COMMERCIAL

11.1 GUARANTEES

- ***Mechanical Guarantee:*** All Mechanical & Electronic Equipment carries a 12-month OEM guarantee
- ***Structural Guarantee:*** A Structural guarantee of 15 years is offered on the Containers and Tanks, subject to correct upkeep of the structural components, for example rust control. Please note that SewTreat uses secondhand containers, and although we endeavor to remove as much as possible dents, not all dents can be removed.
- ***Process Guarantee****:* Final Effluent is guaranteed to be in line with DWS's General standards requirements, subject to SewTreat conducting the maintenance of the plant.
- ***Start-up and commissioning****:* The plant will take between 2 – 8 weeks to reach the desired final effluent qualities
- SewTreat's liability to the client shall in any event and under all circumstances be limited to the costs of remedying any defective workmanship, repairing any defective goods or replacing any defective goods not capable of repair.
- SewTreat shall under no circumstances whatsoever be liable for any loss of profit or any damages of whatsoever nature, direct or indirect, consequential or otherwise, suffered by the client or any other person or entity, whether or not caused by the negligence of SewTreat, its agents or employees.
- The Warranty is subject to the client's compliance to service procedures and maintaining the supplied equipment as prescribed and in accordance with SewTreat's specifications and instructions. A separate maintenance service agreement may be negotiated separately based on further discussion.

11.2 INCLUSIONS

- Complete design, manufacturing, testing and installation of biological WWTP.
- All Mechanical Equipment
- Modification and retro-fitting of tanks and containers are included
- Travelling to site by the installation team
- Commissioning of plant onsite
- 1 Month's maintenance product (Bacteria)
- Operations manual with guarantee letter.

11.3 EXCLUSIONS

- Civil Slabs and groundwork with excavations and back-filling of 300mm
- Complete HSEQ
- Holding Tank
- Intermediate and hard rock excavations, subsoil drainage and excavations deeper than 300mm
- Engineering Drawings
- Pipe reticulation to Screen
- Pipe reticulation from discharge
- DO Probe, pH probe and EC Meter
- Site Lighting, Earthing and earth matting, Lightning Protection, PLC Connection & telemetry
- Sludge handling annually to be conducted by client
- No allowance was made for advance payment, retention or performance bonds; this could be supplied at an additional rate.
- Any delays on site will be charged at R 22'550.00 per day, excluding all lodging & traveling which will be billed at cost plus 15%.
- Delivery to Site – Midvaal Municipality

11.4 GENERAL TERMS & CONDITIONS

- Full terms and conditions apply and may be obtained on request.
- Our reference**SSQ 3348,** please state this number on official order.
- All prices are excluding vat, prices will remain firm for a period of 30 days.
- This design and proposal are the intellectual property of SEWTREAT, this information cannot be used for tender purposes or basis for obtaining quotations without the written consent by SEWTREAT
- SewTreat reserves the right to change technical aspects, designs, flow patterns, flow rates and equipment without prior notice to the client to ensure better performance and efficiency.
- Pricing submitted in this proposal are estimates only and will be confirmed after site visit and a clear understanding of your requirements by our engineering and design team

11.5 LEAD TIMES

• Procurement of materials	: 2 – 3 months
• Workshop Fabrication and fitment	: 1 month
• Delivery	: Client scope
• Concrete & Earth works	: Client scope
• Installation	: 2 - 3 Months
• **Projected Project Length**	**: 6 - 8 Months**

email: info@sewtreat.co.za
tel: 013 690 3912
cell: 082 849 3906
fax2mail: 086 416 1349

11.6 PAYMENT TERMS

- 50% Deposit payment with acceptance of Drawings
- 25% payment upon FAT results prior to delivery
- 20% payment upon delivery of equipment
- 5% After Installation
- All payments are strictly 7 Days from invoice.

SECTION 12: OPERATING COSTS

The monthly operating cost include the replacement of all equipment over a 60 month period, this is seen as a savings account for the plant to repair or replace any pump or mechanical equipment that may fail. This can be added to the monthly SLA, in such an event SewTreat takes full responsibility of the replacement of all equipment for the duration of the SLA term. This ensures that no additional costs are incurred over the period and makes the budgeting and future expenses fixed for the client.

Monthly Operating Cost (60 Months)				
Num	**Description**			**Monthly Rate**
1	Provision for replacement of critical equipment			R 81 516.46
2	Monthly Maintenance (Labour, travelling & Vehicles)			R 42 142.86
3	Monthly Maintenance (Plant Consumables)			R 467 142.86
4	Monthly Maintenance (Lab Analysis & Reports)			R 3 288.57
5	Electricity consumption @ R 0.65 Per KW	287 532	KW per Month	R 186 895.80
6	Disposal	-	Less than 1 ton	R -
Total Excl. Vat				**R 780 986.55**
Rate per m3 (based on monthly Volume)		**300 000**	**m3 per Month**	**R 2.60**

SECTION 13: PRICING SCHEDULE

	EWTP-BST-10000			
1	Basic System Pricing			Selling
1.1	Tanks, Liner Dome & Roofs	Qty	9	R36 270 407.24
1.2	Mechanical Equipment	Qty	29	
1.3	Disinfection System	Type	CHL-Probe	
1.4	Control Room	Type	Con-L&S-12M	
1.5	Electricals & Instrumentation	Qty	ELEC_GSM_L	
	Basic System Total - Excl Vat			**R36 270 407.24**
2	Additional Equipment			Selling
2.1	Screen	Type	SCR-AUT-75	R2 273 636.36
2.2	Anaerobic Phase	Type	PHT-2200 - 4.16	R65 887 109.55
2.3	Buffer Tank	Type	No Buffer	R0.00
2.4	Sludge Bags	Qty	400	R4 944 000.00
2.5	Lifting Station	Type	Not Provided	R0.00
2.6	Inline Screens	Type	Not Provided	R0.00
2.7	Final Water Holding Tank	Type	No Final Tank	R0.00
	Additional Equipment Total - Excl Vat			**R73 104 745.91**
3	Installation: Take-out Pricing			Selling
3.1	Civil and Groundwork	Qty	N/A	Not Included
3.2	Mechanical Installation	Qty	100	R1 032 307.69
3.3	Accommodation and Traveling	Type	100	R1 179 428.46
3.4	System Delivery	Qty	0	R0.00
3.5	Medicals and Inductions	Qty	0	R0.00
3.6	Engineering Design Drawings	Type	Signed-off	R8 203 136.49
	Installation Total - Excl Vat			**R10 414 872.64**
	Total 1x 10 MLPD WWTP - Excl Vat			**R119 790 025.79**
	Total 2x 10 MLPD WWTP - Excl Vat			**R239 580 051.58**

Our team is passionate about our designs, confident in our ability and excited to offer you a solution.

Kind Regards,
Wian Smit
Chemical Engineer
wian@sewtreat.co.za
Tel: +27 13 590 6683
Cell: +27 (72) 973 3775
Fax: 086 465 0268
Website: www.sewtreat.co.za

APPENDIX B: EFFLUENT DISCHARGE INVESTIGATION

63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Effluent Discharge Investigation

Report

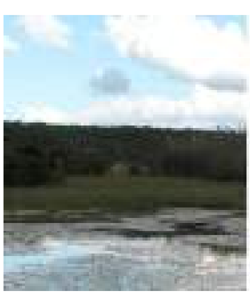
Version - B

21 June 2021

Phumaf Engineering

GCS Project Number: 19-0921

Client Reference: Unitas Effluent Discharge



Report
Version - B

21 June 2021

Phumaf Engineering

19-0921

DOCUMENT ISSUE STATUS

Report Issue	Version A issued for Client review		
GCS Reference Number	GCS Ref - 19-0921		
Client Reference	Unitas Effluent Discharge		
Title	Proposed Residential and Mixed-Use Development in Unitas Park Extension 16, Emfuleni Local Municipality Gauteng: Effluent Discharge Investigation		
	Name	**Signature**	**Date**
Author	Jennifer Meneghelli		21 June 2021
Director, Reviewer	Andries Wilke		21 June 2021

LEGAL NOTICE

This report or any proportion thereof and any associated documentation remain the property of GCS until the mandator effects payment of all fees and disbursements due to GCS in terms of the GCS Conditions of Contract and Project Acceptance Form. Notwithstanding the aforesaid, any reproduction, duplication, copying, adaptation, editing, change, disclosure, publication, distribution, incorporation, modification, lending, transfer, sending, delivering, serving or broadcasting must be authorised in writing by GCS.

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

As part of the Gauteng Rapid Land Release Program, a portion 222 of the farm Houtkop 594 otherwise known as Unitas Park Extension 16 in Vereeniging has been proposed for mixed-use residential development. The local municipality (Efuleni) has insufficient treatment capacity at the municipal Wastewater Treatment Plant (WWTP) to receive sewage from the proposed development. The development has therefore allowed for its own, on-site WWTP. The WWTP would generate 20 000 m^3/day of effluent that would need to be discharged. Phumaf Holdings (Pty) Ltd (Phumaf) are the engineers designing and planning the proposed development and have appointed GCS Water and Environmental Consultants (GCS) to carry out a preliminary hydrological assessment to estimate the feasibility of discharging the treated sewage effluent from the development into the wetland to the south.

In accordance with General Authorisations, Section 39 of the National Water Act (NWA) (Dept. of Water Affairs, 2013) a person may irrigate or discharge up to 2 000 m^3 of effluent per day onto land that they own provided it complies with legislated water quality specifications amongst other criteria. The volume that is proposed to be discharged is ten times greater than the volume that would satisfy General Authorisation requirements and is proposed to be disposed on into land that does not belong to the development that is generating the effluent. Therefore, in terms of Section 21 (f) of the NWA it is necessary for Phumaf to apply for a license to discharge the effluent to a watercourse.

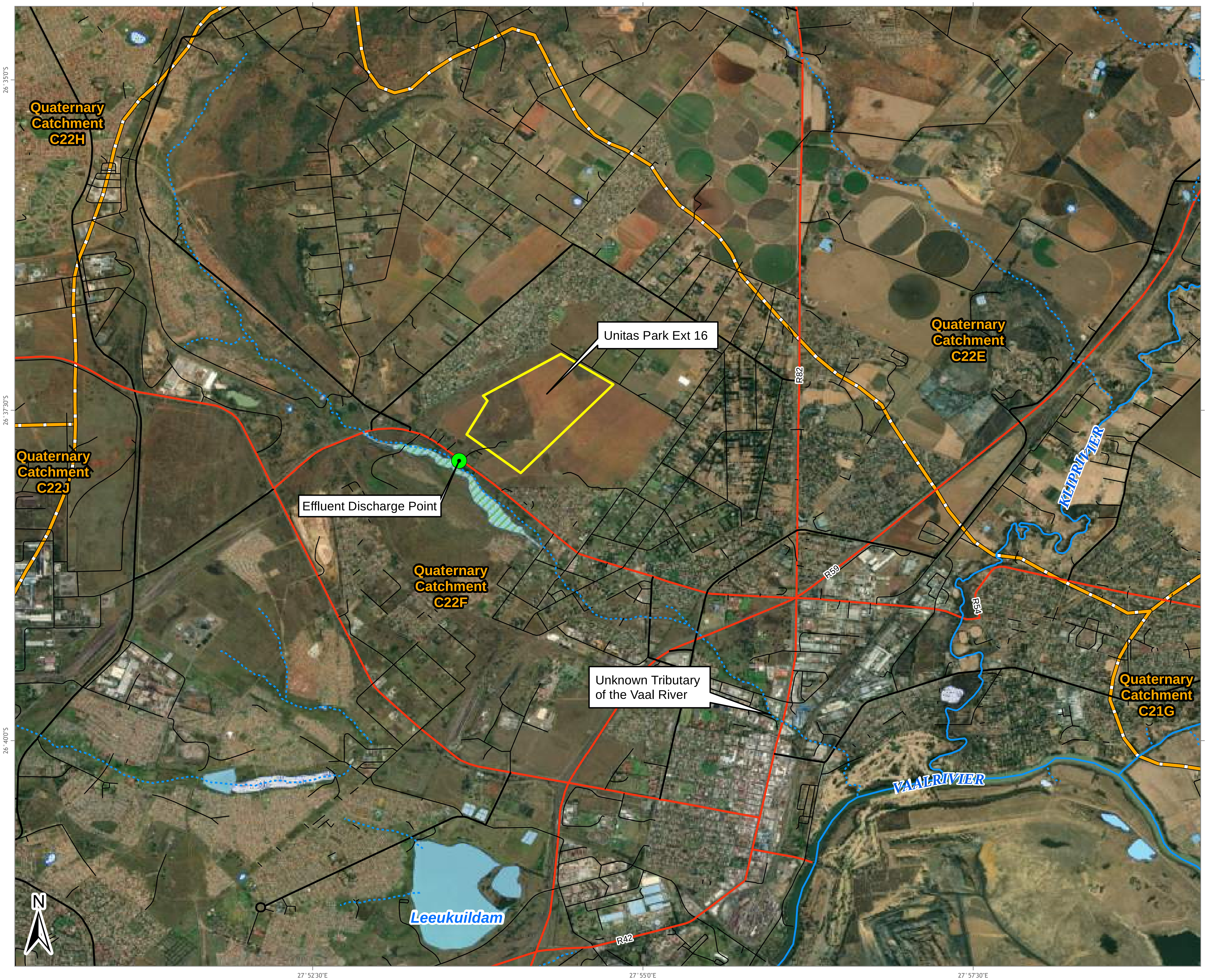
In addition, the discharge of effluent into the wetland would trigger Section 21 (i) in terms of GN 509 (Dept. Water and Sanitation, 2016) of the NWA as the fundamental, defining characteristics of the watercourse would be altered.

This activity is dependant upon the watercourse's assimilative capacity to treat and receive the effluent. As the watercourse referred to is an unchanneled valley bottom wetland, its assimilative capacity is not immediately obvious due to sporadic and seasonal surface flows being of a slow velocity as opposed to a river with a continuous baseflow. As a wetland, it is considered a sensitive area and should thus be protected as it provides ecological goods and services. The *Ecological Impact Assessment Report* (GCS, 2020) carried out for the site recommended that the wetland be demarcated as a no-go zone.

This investigation was therefore carried out to determine the potential of this system to receive the effluent volumes as both a hydrological system and an ecologically sensitive wetland.

Refer to Figure 1-1 for the project location.

UNITAS PARK EXT 16: SITE MAP



LEGEND

Effluent Discharge Point

Rivers and Streams

Non-Perennial

Perennial

Road Network

Main Road

Secondary Road

Street

Unitas Park Ext 16: Site Map

Quaternary Catchments

Unchannelled Valley Bottom Wetland

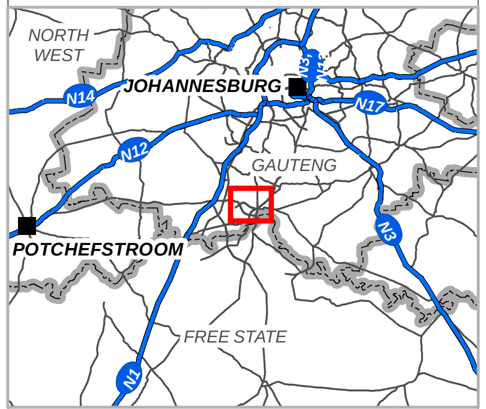
Inland Water

Dams and lakes

Reservoirs and water tanks

Marsh and swamps

Non-perennial pans



Data Sources:
Esri World Imagery Basemap
2014 DWAF Quaternary Catchments

0 1 2 Kilometers

SCALE: 1:50 000

FIGURE NO.:	-	MAP NUMBER:	19-0921-09-V3
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	J MENEGHELLI CIVIL ENGINEER
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 MAY 2021
PROJECT:	TOWNSHIP ESTABLISHMENT BRYANSTON EXT3 (JHB)		
CLIENT:	PHUMAF HOLDINGS		

GCS
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

2 SCOPE OF WORK

The scope of works is to prepare an effluent discharge investigation in accordance with the *South African Water Quality Management Series*: *Procedures to assess effluent discharge impacts* (Department of water Affairs and Forestry, Water Research Commission Report TT 64/94, 1995). This document will serve to support the WULA to discharge to a water resource in terms of Section 21 (f) of the National Water Act (Act 36 of 1998). The investigation will include the following tasks:

- Scoping module:
  - Determine the area of investigation
  - Determine sources of impact on water quality
  - Determine water uses
  - Determine water quality requirements
- Quantifying module:
  - Determine hydrological characteristics and hydraulic implications
  - Determine baseline water quality
- Decision module
  - Assessment of an application to discharge an effluent

It should be noted that the screening module (that precedes the above tasks) has been completed in the carrying out of the preliminary hydrological assessment and should be submitted with this report.

In addition to the above, as the discharge is being made to a wetland and not a river, an assessment of the impacts to the wetland will be required. This is made as an addendum to the ecological investigation of the site and is submitted separately.

The assessment of the impact of the discharge of the treated effluent into the wetland and the downstream aquatic features will be assessed based on the volumes and the treated effluent quality standards that will be achieved by the treatment.

3 AREA OF INVESTIGATION

The effluent is proposed to be discharged into a wetland that is part of an unnamed tributary of the Vaal River through quaternary catchment C22F. The tributary has no minor tributaries feeding into it that may introduce sources of contamination of dilute the flow. The entire length of this tributary will be considered as the geographic area for this investigation. Refer to Figure 1-1 for the whole length of the tributary.

The upstream limit of the study shall be at the top of the sub-catchment. The tributary begins from a ridge that is mostly undeveloped and partially urbanized. This allows for the inclusion of predicting potential future upstream water impacts and including them in the study. From the upstream limit to the point of effluent discharge, inputs to the watercourse will be considered. At the upper limit, or the headwaters of the catchment, it can be assumed that water quality, hydrology and hydraulics will not be affected by the proposed discharge. This is reasonable as the beginning of the stream lies 6 km upstream of the proposed discharge point.

The downstream limit shall be defined at the point at which the unnamed tributary confluences with the Vaal River (6 km downstream), as all residents up to this point are interested and affected parties that will likely be impacted by the effluent discharge and must therefore be taken into account. Within this area, those users that are most sensitive to impacts (such as residents living along the water course or pedestrians that pass through it) will be of primary concern. It is estimated that the impacts of the effluent discharge will still be notable to this point due to the magnitude of the volumes that are to be released and their uptake of capacity within existing stormwater infrastructure. The urbanised suburbs are likely to have higher runoff volumes due to impervious surfaces and thus may also be causing impacts to the existing stormwater infrastructure and canalized stream.

For the final decision making, the wetland as delineated in Figure 1-1 will be focused on.

4 SOURCES OF IMPACT ON WATER QUALITY

Anthropogenic and natural features that could affect the quality of the water in the receiving watercourse will be identified by physical inspection (no other information sources are available). An impact on water quality is considered to be any modification to the physical, chemical or biological properties of the water and maybe beneficial or detrimental. This task will enable the impacts of the proposed effluent discharge to be contextualized appropriately.

- From the headwaters of the watercourse, the runoff from the ridge is not expected to have any impacts on the water quality as there are no geological features exposed or any areas of erosion identified, from which salts or sediments could originate.

- The stream then passes through an arm of Sebokeng township. This area was inspected during the site visit and was found to be comprised of small houses with yards used for gardening, with untarred roads. There is no natural vegetative cover. It can thus be predicted that surface runoff from the exposed earth will transport silts and small particles into the watercourse. It is also likely that microbiological components would enter the river from the domestic use of water as there is waste water reticulation serviving the houses, but rather standpipes and temporary toilets.

  This impact would be detrimental to the watercourse as is would introduce turbidity and siltation and would increase the presence of bacteria in the water.

- There are commercial farms covering approximately 1 190 ha of the sub-catchment area north of the stream, up to the ridge. Runoff from agricultural areas typically included suspended solids and nutrients – nitrates and phosphates.

  This would increase the likelihood of algal blooms and excessive growth within the watercourse due to the presence of nutrients. This would be detrimental to the watercourse as it would alter the quality of aquatic habitats.

- The land use of the contributing sub-catchment then becomes suburban. Plots are large with gardens. The impact of this runoff is estimated to primarily affect the hydrology of the watercourse by being intensified due to the reduced permeability of the surface which results in more frequent occurrences of exceedance, at sharper peaks. Pollution constituents from this area are not expected to be significant.

  This is a detrimental effect as it may result in erosion and degradation of the wetland geomorphology.

- The land use at the banks of the river as it reaches the Vaal River is commercial and industrial, comprising of shopping centres and warehouses. The area is densely developed and paved. Stormwater runoff is expected to have hydrocarbons (petrol and diesel), oil and grease from vehicles (parking lots and garages), fats (restaurants), heavy metals (copper, lead, zinc) (from petrol fumes or atmospheric fallout and roofs) and elevated nutrients all of which would be transported by suspended solids. The area appears to have waste water infrastructure, therefore the presence of microbiological pollutants is assumed to be low.

  The impact on the watercourse is detrimental as water quality will be degraded physically and chemically. Hydrologically, the watercourse will be severely impacted by the intensified flows from the developed sub-catchment.

All possible impacts to the water quality identified above are diffuse in nature. It is possible that point sources of pollution emanate from industrial discharges directly into the watercourse, but these cannot be ascertained.

5 WATER USES IN THE CATCHMENT

Water users in the affected catchment area include agricultural, domestic, industrial as human consumption and the wetland aquatic habitat as an ecological user.

- Agricultural use is assumed to be for irrigation as no stock farms have been observed. It is assumed that these users are either supplied by the municipality or by local boreholes as no abstraction points or pumphouses were observed on the watercourse.
- Domestic demand is assumed to be supplied by the Efuleni municipality where water is piped. It is likely that in the arm of Sebokeng along the watercourse, water uses may include irrigation of backyard gardens and possibly washing and cleaning by those residents that do not have water piped to their dwelling.
- Industrial demand is assumed to be supplied by the Efuleni municipality.
- Recreational, aesthetic and fishing uses have not been explicitly identified.

The Ecological Water Reserve (EWR) for the catchment was extracted from the *Proposed Reserve Determination of Water Resources for the Vaal Catchment* (Dept. of Water Affairs, 2018) and is as follows for quaternary catchment C22F:

- Present Ecological State (PES) – C: "Moderately modified. A loss and change of habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged." (DJ Ollis, 2014).
- Ecological Importance and Sensitivity (EIS) – High. This means that the habitat and biota are important and are vulnerable to modifications to flows, water levels and physico-chemical conditions.
- Target Ecological Category (TEC) – B/C. "The target is to achieve a sustainable system both ecologically and economically".
- Mean Annual Runoff (MAR) – 1 977 000 m^3/yr.
- Ecological reserve as a percentage of the natural MAR – 21.55 % = 426 000 m^3/yr.
- Basic human needs reserve as a percentage of natural MAR – 0.000 15 % = 30 m^3/yr. This is a negligible amount.

Based on the assumption that agricultural, industrial and domestic demands are met by either boreholes or municipal supply, the ecological demand on the watercourse is the highest of all users. Therefore, the impact to the natural aquatic environment should be central to the decision making with regards to the effluent discharge.

The location of the ecological water use is along the entire length of the watercourse, approximately 7.5 km, up to the end of the wetland where the stream is canalized through the suburbs.

No water uses have been omitted, based on the information available at the time of writing.

6 HYDROLOGICAL CHARACTERISTICS

The watercourse is perennial as the water table is close to the surface, the soil is saturated and there is always a base flow. This flow is predicted to be lower during the winter months. As observed, the water flows very slowly over the surface and generally forms marshy conditions.

No streamflow data has been recorded for this watercourse by the DWS so it was not possible to estimate the flow rate. The MAR of the quaternary catchment is 9 910 000 m^3/yr, meaning that for the sub-catchment contributing to the stream it would be approximately half that. This is an indication of the volume passing through the watercourse in a year. The volume may be higher due to interflow from groundwater.

The effect of the effluent discharge should be considered during the low-flow periods when the assimilative capacity of the wetland is at its lowest.

It is predicted that these volumes of effluent (20 000 m^3 per day is equivalent to 7 200 000 m^3/year) would flood the wetland system as they are approximately 78% of the volume of the MAR. This would fundamentally alter the flow characteristics of the wetland and its hydrological functioning. The impacts thereof are discussed in the addendum to the ecological investigation of the wetland.

It is recommended that the volumes of treated effluent generated by the WWTP are reassessed to obtain a more accurate volume as this volume appears to be very large for the size of the proposed development.

7 HYDRAULIC IMPLICATIONS

7.1 Existing downstream stormwater infrastructure

As the end of the field in which the wetland system is located, the stream is channeled into a formal drain with grass-lined banks. From there, several culverts allow for the flow to pass under the roads of the suburbs.

The downstream culverts were modelled to determine what their hydraulic response would be to flood events superimposed on the effluent discharge flows. Three culverts downstream of the site were investigated, all of which were concrete. Thereafter the watercourse is channeled into a concrete, parabolic canal. From the handling of the flows of these culverts, the downstream effects can be inferred.

Table 7-1 Culvert specifications

Location	Number of pipes	Shape	Dimensions (mm)
Heine Miller street	4	Pipe	1500 diameter
Doodles Tapscott street	4	Pipe	1500 diameter
Percy Sherwell street	3	Box	3000 wide by 2400 high

Figure 7-1 Heine Miller street culvert

Figure 7-2 Doodles Tapscott street culvert

Figure 7-3 Percy Sherwell street culvert

Figure 7-4 Downstream concrete, parabolic channel

7.2 Impact to downstream receiving hydraulic infrastructure

The existing stormwater infrastructure was modelled in the PCSWMM software package. The inflows to the system included the base flow of 20 000 m^3 of effluent per day and the storm event.

It was found that for all storm events, the culverts reach maximum capacity. For the 2 year event the culverts surcharge, and for all other events they are predicted to flood. It was found that this flooding pattern could be expected whether or not there was the baseflow of the effluent.

A limitation of this study is that the baseflow from the wetland itself has not been included in the model as it was not possible to measure it. There is baseflow all year found, as observed during the site visits in the dry season. However, during the wet months of October to March, it is likely that this flow will be higher.

8 RECOMMENDATIONS

It was determined that the primary user of water in the sub-catchment is the ecological requirement to maintain healthy functioning.

It is recommended that an alternative means of disposing of the effluent to the Vaal River by piping be assessed. Effluent discharge to the wetland system should not be considered for the following reasons:

- The downstream receiving stormwater infrastructure will need to be analysed for the capacity that it can handle and required augmentation of the system proposed. This will be a costly exercise and will need to be carried out for the entire length of the watercourse from where it exits to the wetland to where it enters the Vaal River, approximately 6 km with 12 river crossings.
- It is recommended that determination of the wetland baseflows be carried out in order to better understand the available capacity of the downstream stormwater infrastructure.
- It was found that the stormwater infrastructure will flood during the 2, 5, 10, 20, 50, 100 and 200 year storm events regardless of whether or not the effluent is discharged to the system.
- The wetland is likely to become inundated by the volumes of effluent discharge. This will negatively impact the habitat and biota and degrade the ecological state of the wetland. This is not in agreement with the Vaal River catchment management objectives.
- Flood mitigation capacity of the wetland will be reduced by the inundation of the wetland by effluent. This may result in flooding damaging property and causing a risk to safety.
- The water quality of the effluent is of a lower standard that the water quality guidelines proposed for the Vaal catchment management strategy. This may have detrimental effects on the ecology of the system and may pose a health risk as standing water could result in bacteriological growth.
- It is recommended that a more accurate estimate of the volumes to be discharged by the WWTP be carried out in order to better predict the impacts that the effluent will have on the inundation of the wetland.

REFERENCES

Climate of the Limpopo Basin. (2010). Retrieved from Limpopo River Awareness Kit: http://www.limpopo.riverawarenesskit.org/LIMPOPORAK_COM/INDEX.HTM

Climate-Data.org. (2021, April 4). Retrieved from Climate-Data.org: https://en.climate-data.org/africa/south-africa/northern-cape-470/

Dept. of Water Affairs. (2013, September 6). Revision of general authorisation in terms of Section 39 of the National Water Act, 1998 (Act no. 36 of 1998). South Africa.: Government Notice No. 36820: 665.

Dept. of Water Affairs. (2018, December 21). Proposed Reserve Determination for Water Resources for the Vaal Catachment. Government Notice No. 42127:1419.

Dept. Water and Sanitation. (2016, August 26). General authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for water uses as defined in Section 21 (c) or Section 21 (i). South Africa. : Government Notice No. 40229: 509.

DJ Ollis, J. D.-S. (2014). *WRC Report No. TT 609/14: Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition.* Water Resources Commission.

Pitman, & Bailey. (2015). *WR2012*. Retrieved from https://waterresourceswr2012.co.za/resource-centre/

SANRAL. (2013). *Drainage Manual.*

APPENDIX C: X-LAB EARTH TEST REPORT OF WATER SAMPLES

TEST REPORT

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Jennifer Meneghelli	Laboratory	X-Lab Earth Science
Client	GCS - GROUNDWATER CONSULTING SERVICES (PTY) LTD	Address	259 Kent Avenue Ferndale, 2194
Address	4a Old Main Road Judges Walk Kloof	Telephone	+27 (0)11 590 3000
Telephone		Laboratory Manager	Mrs Tasneem Tagari
Facsimile		Lab Reference	JBX21-8566
Email	jenniferm@gcs-sa.biz	Report Number	0000025190
		Date Received	04/05/2021 14:54
Order Number	19-0921	Date Started	5/05/2021 14:44
Samples	10	Date Reported	12/05/2021 10:12
Sample matrix	WATER		

The document is issued in accordance with SANAS's accreditation requirements.
Accredited for compliance with ISO/IEC 17025. SANAS accredited laboratory T0107.

Samples recieved Cold good condition.

T0775

SIGNATORIES

Tasneem Tagari

General Manager/Technical Signatory

Report number 0000025190

Client reference: 19-0921

TEST REPORT

Parameter	Units	LOR	JBX21-8566.001 1a	JBX21-8566.002 1b	JBX21-8566.003 2a	JBX21-8566.004 2b

Conductivity on waters Method: ME-AN-007

Parameter	Units	LOR	1a	1b	2a	2b
Conductivity in mS/m @ 25ºC	mS/m	2	43	43	42	43

Total Suspended Solids Method: ME-AN-009

Parameter	Units	LOR	1a	1b	2a	2b
TSS (0.7µm) @ 105ºC	mg/l	21	<21	28	<21	<21

Anions on Waters by Ion Chromatography Method: ME-AN-014

Parameter	Units	LOR	1a	1b	2a	2b
Nitrate	mg/l	0.1	0.4	0.3	3.9	3.7
Nitrite	mg/l	0.5	<0.5	<0.5	<0.5	<0.5

pH in water Method: ME-AN-016

Parameter	Units	LOR	1a	1b	2a	2b
pH in water at 25ºC	-	1	7.5	7.3	7.4	7.3

SUB_Chemcial Oxygen Demand in Water

Report number 0000025190
Client reference:
19-0921

TEST REPORT

Parameter	Units	LOR	JBX21-8566.001 1a	JBX21-8566.002 1b	JBX21-8566.003 2a	JBX21-8566.004 2b

Sample Number / Sample Name

SUB_Chemcial Oxygen Demand in Water

Chemical oxygen demand ^*	mg/l as O2	5.1	25.44	23.84	15.25	16.38

Ammonia on waters by Discrete Analyser Method: ME-AN-041

Ammonia	mg/l	0.012	0.16	0.14	6.4	6.4
Ammonia as N	mg/l	0.01	0.13	0.12	5.2	5.3

Microbiological parameters in Water Method: IDEXX

Faecal Coliforms *	CFU/100ml	-	66	457	10	15
Total Coliforms *	CFU/100ml	-	>2420	>2420	2420	2420

Report number 0000025190
Client reference:
19-0921

TEST REPORT

Parameter	Units	LOR	JBX21-8566.005	JBX21-8566.006	JBX21-8566.007	JBX21-8566.008
Sample Name			3a	3b	4a	4b

Conductivity on waters Method: ME-AN-007

Conductivity in mS/m @ 25ºC	mS/m	2	58	58	53	52

Total Suspended Solids Method: ME-AN-009

TSS (0.7µm) @ 105ºC	mg/l	21	<21	102	36	<21

Anions on Waters by Ion Chromatography Method: ME-AN-014

Nitrate	mg/l	0.1	<0.1	<0.1	11	11
Nitrite	mg/l	0.5	<0.5	<0.5	<0.5	<0.5

pH in water Method: ME-AN-016

pH in water at 25ºC	-	1	7.2	7.2	7.5	7.6

SUB_Chemcial Oxygen Demand in Water

Report number 0000025190

Client reference:

19-0921

TEST REPORT

Parameter	Units	LOR	JBX21-8566.005 3a	JBX21-8566.006 3b	JBX21-8566.007 4a	JBX21-8566.008 4b

Sample Number / Sample Name

SUB_Chemcial Oxygen Demand in Water

Chemical oxygen demand ^*	mg/l as O2	5.1	108.38	65.09	14.08	24.02

Ammonia on waters by Discrete Analyser Method: ME-AN-041

Ammonia	mg/l	0.012	0.021	0.027	0.021	0.016
Ammonia as N	mg/l	0.01	0.02	0.02	0.02	0.01

Microbiological parameters in Water Method: IDEXX

Faecal Coliforms *	CFU/100ml	-	411	179	5	4
Total Coliforms *	CFU/100ml	-	>2420	>2420	>2420	>2420

Report number 0000025190
Client reference:
19-0921

TEST REPORT

Parameter	Units	LOR	JBX21-8566.009 Culvert 2a	JBX21-8566.010 Culvert 2b
		Sample Number / Sample Name		

Conductivity on waters Method: ME-AN-007

Conductivity in mS/m @ 25ºC	mS/m	2	37	37

Total Suspended Solids Method: ME-AN-009

TSS (0.7µm) @ 105ºC	mg/l	21	<21	<21

Anions on Waters by Ion Chromatography Method: ME-AN-014

Nitrate	mg/l	0.1	4.3	4.1
Nitrite	mg/l	0.5	<0.5	<0.5

pH in water Method: ME-AN-016

pH in water at 25ºC	-	1	7.4	7.4

SUB_Chemcial Oxygen Demand in Water

Report number 0000025190

Client reference:

19-0921

TEST REPORT

Parameter	Units	LOR	Sample Number: JBX21-8566.009 Sample Name: Culvert 2a	Sample Number: JBX21-8566.010 Sample Name: Culvert 2b

SUB_Chemcial Oxygen Demand in Water

Chemical oxygen demand ^*	mg/l as O2	5.1	12.02	52.89

Ammonia on waters by Discrete Analyser Method: ME-AN-041

Ammonia	mg/l	0.012	0.017	0.016
Ammonia as N	mg/l	0.01	0.01	0.01

Microbiological parameters in Water Method: IDEXX

Faecal Coliforms *	CFU/100ml	-	6	11
Total Coliforms *	CFU/100ml	-	2420	>2420

METHOD SUMMARY

METHOD	METHOD SUMMARY
ME-AN-014	Inorganic anions (Br, Cl, F, NO3, NO2, SO4) are determined on aqueous samples by ion chromatography. The method is based on EPA 300.1 and APHA 4110 B.
ME-AN-016	The pH of an aliquot of aqueous sample is measured electrometrically using an electrode connected to a calibrated meter with automated temperature correction. This method is based on APHA 4500-H B.
ME-AN-007	The conductivity of an aliquot of aqueous sample is measured electrometrically using a standard cell connected to a calibrated meter with automated temperature correction. This method is based on APHA 2510.
ME-AN-041	
ME-AN-009	Total suspended solids (TSS) is determined gravimetrically by filtering an aliquot of well-shaken aqueous sample through a pre-weighed filter which is then dried at 105 deg C. The method is based on APHA 2540 D.
IDEXX	Microbiological parameters by IDEXX.

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body”.

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Unless otherwise indicated, samples were received in containers fit for purpose.

This document is issued by the Company under its General Conditions of Service.
Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.
WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) draw and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's representativity of all goods and strictly relate to the sample(s). The Company accepts no liability with regard to the origin or source from which the sample(s) is/are said to be extracted.
Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

X-Lab Earth Science is accredited by SANAS and conforms to the requirements of ISO/IEC 17025 for specific test or calibrations as indicated on the scope of accreditation to be found at http://sanas.co.za.
The document is issued in accordance with SANAS's accreditation requirements and shall not be reproduced, except in full, without written approval of the laboratory

LAB-QLT-REP-001

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

GAUTENG RAPID LAND RELEASE

CIVIL ENGINEERING SERVICES PRELIMINARY DESIGN REPORT

UNITAS PARK EXT. 16

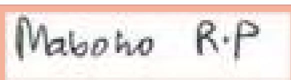
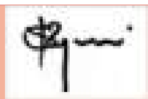
PROJECT No.: 7001

01 MARCH 2021

PHUMAF

PHUMAF HOLDINGS (PTY) LTD
P.O. BOX 4049, RANDBURG, 2125
1ST FLOOR, 24 PETER PLACE
LYME PARK
BRYANSTON,
2191

DOCUMENT CONTROL

Job Title			Job Number: 7001
Document Title	CIVIL ENGINEERING SERVICES PRELIMINARY DESIGN REPORT UNITAS PARK EXT.16		File Ref: T:\PROJECTS 2009\7000 Projects\7001 Gauteng Rapid Land Release Programme\03 CIVL\11 Design reports\Report\CIVIL ENGINEERING SERVICES PRELIMINARY DESIGN
Document Revision	Revised/ Issued By		Date
A	Sikelela Mnguni (Pr.Tech.Eng)		01 MARCH 2021
Compiled By:	Ngoako Letlalo		01 MARCH 2021
	Name & Surname	*Signature*	*Date*
Reviewed By:	Rofhiwa Maboho (Pr.Tech.Eng)		01 MARCH 2021
	Name & Surname	*Signature*	*Date*
Checked By:	Sikelela Mnguni (Pr.Tech.Eng)		01 MARCH 2021
	Name & Surname	*Signature*	*Date*
Client Approval:			
	Name & Surname	*Signature*	*Date*

CONTENTS

LIST OF ANNEXURES

ANNEXURE A: Proposed Draft Layout and Locality Plan

ANNEXURE B: 7001/S/U001 (Sheet 1 of 4)

ANNEXURE C: Traffic Impact Assessment (TIA) Report

ANNEXURE D: Map no 19-0921-09-V2

ANNEXURE E: Geotechnical Investigation Report

ANNEXURE F: Report on a Dolomite Stability Investigation

ANNEXURE G: Environmental Screening Report

ANNEXURE H: GLS Existing Water Master Plan layout

ANNEXURE I: Proposed Water reticulation Layout

ANNEXURE J: 7001/W/U005 Sheet 5 of 5

ANNEXURE K: GLS Existing Sewer Master Plan layout

ANNEXURE L: Proposed Sewer Reticulation Layout

ANNEXURE M: Proposed Roads Layout

ANNEXURE N: Proposed Stormwater reticulation Layout

ABBREVIATION / ACRONYM	TERMINOLOGY
ELM	Emfuleni Local Municipality
Ext.	Extension
WWTP	Wastewater Treatment Plant
AADD	Average Annual Daily Demand
ADWF	Average Dry Weather Flow
PWWF	Peak Wet Weather Flow
AwWF	Average Wet Weather Flow
ha	Hectare
l/s	Liters per Second
Kl/day	Kilo Litres per Day
PF	Peak Factor
Ø	Diameter
RW	Rand Water

EXECUTIVE SUMMARY

The Gauteng Rapid Land Release Programme aims to fast-track the release of serviced stands from State-owned land to qualifying beneficiaries. Phumaf Holdings (Pty) Ltd was appointed to assist the Department of Human Settlements with all preplanning, planning work, design & construction management to enable the release of the stands in question.

One of the land parcels identified for the Gauteng Rapid Land Release Programme is Unitas Park Extension 16. The site is located on portion 222 of Portion 221 of the Farm Houtkop 594IQ in the Emfuleni Local Municipality of the Sedibeng District. At the time the Feasibility Report (Stage 1) was completed, an application to establish a township of 2680 erven of between 270 – 450m2 was underway but not finalized hence the land parcel was still a farm portion. However, the client intends to withdraw the current application and develop a new township with higher densities and smaller stands in order to yield approximately 6003 housing opportunities. See Annexure A Proposed Draft Layout and Locality Plan drawing no 7001/LO/U001.

Phumaf Holdings (Pty) Ltd was appointed to undertake planning and engineering activities on various land parcels in preparation for the installation of services and/or construction of top structures.

The purpose of the report is to:

- Obtain approval from relevant authorities for the design criteria and standard for the design of water and sewer, roads, and stormwater drainage, for the proposed development
- To enable the relevant authorities to make budgetary provisions for the implementation of the proposed services where applicable.

The report proposes the following:

- The design and installation of 24km Water pipes of various pipe sizes ranging from 75mm to 250mm, Type PE 100, PN 12,5.
- The design and installation of 21km Sewer pipes of various pipe sizes ranging from 160mm to 500mm, Type PE 100 or higher, PN 10.

- The design and construction of 21km surfaced roads with widths ranging from 7.5m, 7m, 6m, and 5.5m and 2km of the proposed Future K-route (K55) which will serve as the main access route to the proposed development.
- The design and installation of 14km Stormwater pipes of various diameter pipe sizes, Concrete pipes of 75D spigot and socket in road reserves and Conrete pipes of 100D spigot and socket on road crossings.

This investigation will be based on available, local knowledge and discussions from the relevant officials.

This Civil engineering Services Preliminary Design Report is based on the Civil Engineering Services Bulk Information from Emfuleni Local Municipality (Metsi a Lekoa), Water and Sanitation GLS Master Planning Department, and Emfuleni Spatial Development Framework 2017-2025.

DESIGN NORMS AND STANDARDS

The following guidelines and standards will be used for the design of proposed Civil Engineering services for this development are as follows:

- Emfuleni Local Municipality (Metsi-A-Lekoa) Design Criteria and Internal Services Standards
- “Guidelines for Human Settlement, Planning and Design”, published by the Building and Construction Technology Division of the CSIR (also known as the Red Book)
- Department of public works “Appropriate development of infrastructure on dolomite: guidelines for consultants (PW 371 & 344)
- The Standardized Specification for Civil Engineering Construction (SANS 1200), published by the South Africa Bureau of Standards
- Development of Dolomite land (SANS 1936), published by SABS Standards Division.

ENVIRONMENTAL

Unitas Park Ext. 16 is located within Unitas Park, to the northeast of the R54 (Houtkop Road). The R82 is running north-south approximately 2.3km to the east of the site. The N1 is about 11km to the northwest of the site. Sebokeng lies to the northwest of the site, with Vereeniging to the south. The R59 runs from Vereeniging to Meyerton in the northwest of the site. The site is currently vacant, with immediate adjacent land portions also being vacant. There are existing external roads to provide access to the new proposed development however rehabilitation is needed. There is evidence of a wetland or some surface water on the site, as well as to the southeast of the site.

The layout is not proclaimed or registered due to constraints with waste-water treatment capacity and electricity upgrades required. The site is in a dolomitic zone and further tests will be undertaken to confirm the risk category. There are no environmental red flags on the site and authorization should be obtained. To achieve a higher yield, the existing layout will have to be withdrawn and a new application submitted, investigations will be undertaken to determine the impact on current environmental authorization, municipal services, etc.

WATER

The proposed development falls under the Emfuleni Local Municipality (Metsi-A-Lekoa) Water jurisdiction. Information from Emfuleni Spatial Development Framework 2017-2025, Compiled on Behalf of the Emfuleni Local Municipality by Urban Dynamics Gauteng, dated September 2017 and Project 14/2006 Civil Engineering Services Master Planning Volume 1 Water Supply, Draft report compiled in April 2009 and updated in April 2013 states that currently there is no sufficient capacity to supply the current water demand and also to accommodate future demand from future developments, therefore, new water bulk infrastructure will be required to accommodate the proposed development and other future developments.

SEWER

The proposed development falls under the Emfuleni Local Municipality (Metsi-A-Lekoa) Water jurisdiction. Information obtained from Emfuleni Spatial Development Framework 2017-2025 (ESDF), Compiled on Behalf of the Emfuleni Local Municipality by Urban Dynamics Gauteng, dated September 2017, Project SNM/2012 Civil Engineering Services Master Planning Volume 2 Sewage Disposal, first edition dated August 2013 and Southern Corridor Regional Implementation Plan indicates that the existing Bulk Sanitation Network is old, and it is overworked due to the demand for sanitation services therefore new infrastructure needs to be constructed.

Phumaf Holdings (PTY) LTD is proposing a new on-site 2x10MLPD aboveground Steel Tank Sewer Wastewater Treatment Facility (Plant) (WWTP) which will be designed and be constructed on the Erf

Reserved for engineering infrastructure on the layout, this Erf is positioned on the southwestern corner of the proposed development as shown in Annexure B drawing 7001/S/U001 (Sheet 1 of 4) proposed position of the 2 X 10MLPD aboveground steel tank waste treatment plant facility.

ROADS

The proposed development is currently used for farming purposes which means there are no roads and infrastructure within the site. There are existing road services to the north in Sonland Park and the southwestern side of the site in Unitas Park AH.

A new road network system and parking, will be constructed within the proposed site. The proposed 2km-K55 will have two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. This K-route will form the southern boundary of the proposed Unitas Park Ext.16.

The site is surrounded by classes 3, 4, and 5 roads, however, the internal main roads have a total length of approximately 24km including the proposed parking and walkways within and outside the proposed development. Information regarding bus and taxi bays planned for the development will be available in the Traffic Impact Assessment (TIA) report, see Annexure C.

STORMWATER

The proposed development of land use is agriculture and currently is being used for farming crop purposes which means there is no stormwater infrastructure within the site. There are no existing stormwater systems to the north in Sonland Park and the southwestern side of the site in Unitas Park AH.

A new stormwater pipe system will be constructed within the proposed site connecting discharging into natural watercourses nearby the proposed Unitas Park Extension 16 development. There is an existing Unknown Tribunary River running adjacent to the Houtkop (R54) to the western side of the proposed development. See Annexure D, Map no 19-0921-09-V2.

Stormwater will be discharged from the development to the nearest river which is located on the western side of the Houtkop(R54) Road by means of stormwater pipes. The proposed stormwater pipes are comprised of various pipe sizes ranging from 450mm to 1800mm in diameter. The total stormwater pipe length is approximately 14 km of Concrete pipes of 75D spigot and socket in road reserves and Conrete pipes of 100D spigot and socket on road crossings.

The new development will have internal water, sewer, road, and stormwater networks designed in accordance with Emfuleni Local Municipal standards and guidelines.

ESTIMATED PROJECT COST

The proposed Civil Engineering Infrastructure will include the following; 24 km of water pipes, 21 km of sewer pipes, 14 km of stormwater pipes, and a total road length of 24km. The estimated total construction cost for this project is R668 411 870.43 which is inclusive of 12.5% contingencies and inclusive of VAT.

1 INTRODUCTION

1.1 Project Brief and Background

The Gauteng Rapid Land Release Programme aims to fast-track the release of serviced stands from State-owned land to qualifying beneficiaries. Phumaf Holdings (Pty) Ltd was appointed to assist the Department of Human Settlements with all preplanning, planning work, design & construction management to enable the release of the stands in question.

One of the land parcels identified for the Gauteng Rapid Land Release Programme is Unitas Park Extension 16. The site is located on portion 222 of portion 221 of the farm Houtkop 594IQ in the Emfuleni Local Municipality of the Sedibeng District. At the time the Feasibility Report (Stage 1) was completed, an application to establish a township of 2680 erven of between 270 – 450m² was underway but not finalized hence the land parcel was still a farm portion. However, the client intends to withdraw the current application and develop a new township with higher densities and smaller stands in order to yield approximately 6003 housing opportunities.

The proposed development land use is shown in **Annexure A Proposed Draft Layout and Locality Plan drawing no 7001/LO/U001** as part of Unitas Park Extension 16 Urban design framework dated March 2021 prepared by Metroplan Town Planners and Urban Designers.

The purpose of the report is to:

- Obtain approval from relevant authorities for the design criteria and standard for the design of water and sewer, roads, and stormwater drainage, for the proposed development
- To enable the relevant authorities to make budgetary provisions for the implementation of the proposed services where applicable.

This Civil engineering Services Preliminary Design report is based on the Civil Engineering Services Bulk information Emfuleni Local Municipality (Metsi a Lekwa) **Water and Sanitation GLS** planning department, Geographic Information System (GIS), and Infrastructure Asset Management (IAM) IMQS Software.

2 DEVELOPMENT DETAILS

2.1 Locality

The proposed development of Unitas Park Ext 16 is located on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and the portion on which Unitas Park Ext 16 is located will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009). The other portion will be known as the Remainder of Portion 222 of the farm Houtkop 594-IQ and will contain the road reserve of the Proposed K55. A Locality Map is shown in Annexure A Proposed Draft Layout and Locality Plan drawing no 7001/LO/U001.

2.2 Proposed land – Uses and Zoning

The proposed Unitas Park Extension 16 and the extent of the proposed development area, portion 222 (a portion of portion 221) of the farm Houtkop IQ 594 IQ is 151 0900m² m² is indicated in the tables below:

LAND USE	UNITS	DENSITY
LOW DENSITY RES	214	33 du/ha
MEDIUM DENSITY RES	1234	40 du/ha
HIGH DENSITY RES	2 763	100 du/ha
MIXED USE (ONLY RESIDENTIAL)	652	100 du/ha
STUDENT VILLAGE USED AS RESIDENTIAL UNITS	1140	80 du/ha
TOTAL RESIDENTIAL	6003	
STUDENT VILLAGE	4560 STUDENTS	

LAND USE	AREA/NO OF PROPERTIES
MIXED USE (RETAIL)	65 443 sqm
PUBLIC OPEN SPACE	129 770 sqm
SOCIAL FACILITY (EG CRECHE)	5 ERVEN
SCHOOLS	2 ERVEN
SPORTS FACILITY	1 ERF
INNOVATION/INCUBATION HUB	15 382 sqm

3 SITE CONDITIONS

3.1 Topography and Vegetation

Unitas Park Extension 16 site is predominantly flat. The lowest point on the site is recorded as being approximately 1470 meters above sea level, while the highest point is outside the site to the west and is recorded at 1481 meters above sea level. The gentleness of the terrain presents a positive attribute of the site as it reduces the likelihood of intensive earthworks during construction within the area.

Unitas Park Extension 16 is in Vereeniging. The Vereeniging area normally receives about 559mm of rain per year, with most rainfall occurring during summer. It receives the lowest rainfall (0mm) in July and the highest (108mm) in January. The average midday temperatures for Vereeniging range from 17°C in June to 27.6°C in January. The region is the coldest during June when the mercury drops to 0°C on average during the night.

3.2 Geotechnical Aspects and Dolomite Stability Investigation

Geoid Geotechnical Engineers was appointed to conduct Geotechnical Site Investigations (GFSH2 Phase 1 Report) for Unitas Park Ext. 16.

This project site is characterised by four unique geotechnical zones. The bulk of the arable farmland is in **Zone 1** and is comprised of a highly compressible /potentially highly collapsible transported profile.

Zone 2 includes the south-western sector of the site and is characterized by slightly compressible colluvial deposits. **Zone 3** is incorporated in **Zone 2** but due to shallow quarrying, much of the colluvial material has been removed resulting in a large depression resulting in drainage issues.

Zone 4 is a low-lying area with poor drainage and has signs indicative of frequent shallow groundwater.

Based on an existing dolomitic stability report covering the project site, the stability of the site is described in two Dolomite Stability Zones.

Zone 1 carries a low inherent risk of sinkhole/ subsidence formation of all sizes with respect to the ingress of water and low inherent risk with respect to groundwater level drawdown.

Zone 2 carries a low inherent risk of sinkhole/ subsidence formation of all sizes with respect to the ingress of water and low inherent risk with respect to groundwater level drawdown. This project area is assigned a D3 Dolomite Area Designation.

Zone 1 will require internally reinforced high-quality engineered fill being imported from commercial sources. In this regard, crushed chert rubble or colluvial deposits.

Zone2 - provides an excellent quality material source (typically meeting G5 standards) which can be compacted to high densities in excess of 95% Mod AASHTO.

Zone 2 is well suited to earthworks solutions, subject to the material being crushed to a size that can be adequately compacted using conventional techniques.

Zone 3 will require large-scale bulk earthworks using high-quality fill to elevate the site and deal with the civil engineering drainage challenges.

Zone 4 will require upper transported soils to be removed and replaced with high-quality imported materials from commercial sources.

While this report draws on the dolomite stability classification provided by a prior feasibility-level investigation by others, a footprint-level investigation will need to be completed under a separate mandate to satisfy the minimum requirements of SANS 1936:2012, which will govern the unsupported spans required for the foundations of the proposed structures.

Further detailed information and recommendations can be found in the Geotechnical Investigation Report located in Annexure E.

Dolomite Stability Investigation

GCS Geotechnical (hereafter referred to as GCS) was appointed to undertake a dolomite stability investigation (DSI) for Unitas Park Ext 16 in Unitas Park as part of the rapid land release program. The purpose of this report is to assess the potential for dolomite instability and potential sinkhole formation.

General Geology of the Area

The site is found to be underlain by a layer of transported material which in turn is underlain by residual chert and potential residual shale. This is underlain by chert bedrock and potential shale bedrock that has been intruded by syenite. This is underlain by the dolomite bedrock of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup at between 13 m and >60 m below EGL. The dolomite bedrock described above is solid with penetration rates greater than 3 min/m. There appears to be a mantle of weathered & altered dolomite (WAD) just above the dolomite bedrock.

Summary of Dolomite Risk Assessment

The risk assessment is based on certain assumptions, the most important of which are that the dolomite residuum contains potential receptacles and secondly, that the soil would be subjected to a mobilising agency. The most common mobilising agency is the ingress of water, which causes sub-surface erosion. The water table represents the base-level of erosion and thus all the unconsolidated soil overlying the dolomite bedrock can be subjected to erosion and mobilisation and this may include a significant amount of weathered & altered dolomite (WAD) (but occurs in limited amounts on this site).

It can be possible to exercise some control over the risk of sinkhole/doline development by providing suitable (and proven) controls to prevent water ingress into the underlying soil horizons. It is essential that a high level of priority be placed on the provision of sound water management procedures in the long term. It is also important to ensure that the procedures adopted for the development do not interfere with the regional water table. Thus, pumping from boreholes or otherwise lowering of the water table should be discouraged.

Conclusions

Holistically, the subsoil conditions encountered over the site generally comprise a thin cover of transported material underlain by residual chert, residual shale, residual syenite potentially shale bedrock, shale bedrock, syenite bedrock, chert bedrock, and finally underlain by weathered to fresh dolomite. The water table was measured at between 10.9 m and 20.8 m with the original water level (OWL) that possibly resided at an assumed depth of around 50 m to 55 m below the surface.
The drilling results of this investigation have been utilised, together with the current gravity survey and three previous drillings investigated. This data was analysed to determine the inherent hazard class (IHC) of the entire site and ascertain the sustainability of the proposed development with respect to the dolomite stability.

Recommendations

It is a requirement that this report is presented to the Council for Geoscience for perusal, archiving, and the provision of an official Record of Decision. Furthermore, construction supervision by approved dolomite practitioners (geo-professionals and engineers) will be required, and also the design and implementation of the required DRMS and DRMP in accordance with SANS 1936-4.

Finally, the ground conditions described in this report refer specifically to those encountered in the boreholes put down on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important that GCS Geotechnical carry out periodic inspections of the open excavations. Any change from the anticipated ground conditions could then be taken into account to avoid unnecessary expense. In this regard, it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.

Further information and recommendations and conclusion can be found in the Report on a Dolomite Stability Investigation located in Annexure F.

3.3 Environmental Aspects

GCS Water and Environmental consultants were appointed to undertake the environmental assessment for the proposed Unitas Park Extension 16 Project and the Environmental Screening report was prepared.

The above-mentioned report was undertaken for environmental authorization processes required for the stands in order for compliance with the National Environmental Management Act (Act 107 of 1998, as amended). The report provides details of an Environmental Screening exercise undertaken in order to confirm the required authorization process and to identify risks associated with the process.

The information below was extracted from the report under the heading Additional recommendations:

From the findings of this environmental screening process, it is evident that potential environmental and social impacts may be of moderate to high consequence. Therefore, the required processes, EIA and WULA, have been triggered. Several supporting assessments, processes, and reports are recommended and should be carried out in tandem with the licensing and authorisation processes.

- Environmental Management Plan (EMP) is compiled and implemented during the construction phase.
- An ecological and wetland assessment is carried out to confirm the sensitivity of the wetland and watercourse, to input recommendations to the EMP.
- An Environmental Control Officer (ECO) is employed by the client during the construction phase to audit the site on a regular basis and ensure compliance with the EMP.
- A Notice of Intent to Develop (NID) should be sent to the South African Heritage Resources Agency (SAHRA) to indicate the proposed development.

Further information and recommendations and conclusion can be found in the environmental screening report located in **Annexure G.**

4 BULK WATER SUPPLY

4.1 Authority and Provider Arrangements

The proposed development area falls within the Emfuleni Local Municipality (Metsi-A-Lekoa) Water jurisdiction and the municipality serves as both the Water Service Authority as well as the Water Service Provider.

The content of this section is based on information obtained from Emfuleni Spatial Development Framework 2017-2025, Compiled on Behalf of the Emfuleni Local Municipality by Urban Dynamics Gauteng, dated September 2017 and Project 14/2006 Civil Engineering Services Master Planning Volume 1 Water Supply, Draft report compiled in April 2009 and updated in April 2013.

4.2 Bulk Services and Bulk Supply Services

The content in this section below is based on the information extracted from Emfuleni Spatial Development Framework 2017-2025 report under the Municipal Services section.

This section gives an insight on the conditions and status of the existing Bulk Water Infrastructure in Emfuleni, and the plans that Emfuleni Local Municipality has with regards to solving the problems they are currently facing regarding their old overworked bulk water infrastructure which does not have sufficient capacity to supply the current demand and also to accommodate future demand from future developments.

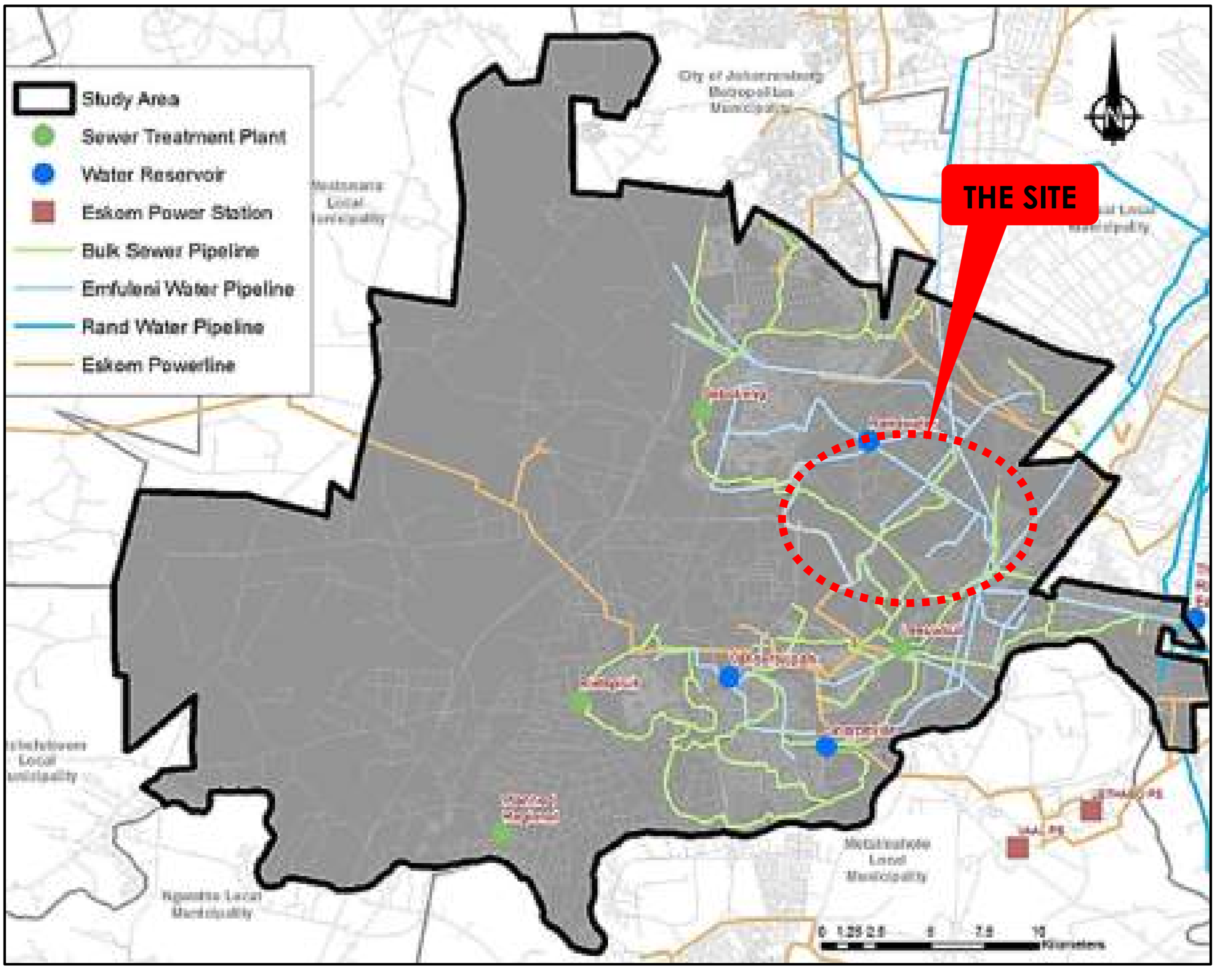


FIGURE 4. 1: BULK SERVICES

(EMFULENI SPATIAL DEVELOPMENT FRAMEWORK 2017-2025)

The water system consists of pipe networks, 9 reservoirs, and a small portable water treatment plant. Emfuleni borders the Vaal River and therefore extracts water from the river for consumption within Emfuleni. However, only a small amount of the required quantity is extracted from the Vaal River and purified at 0.2 Ml/day. Most potable water required by Emfuleni is supplied by Rand Water (205 Ml/day). The bulk water network is illustrated in Figure 4.1.

The bulk water network is old, and it is overworked due to the demand for potable water. Additional water connections have largely been provided to informal settlement households to cope with the growth of those settlements. In addition, water connections are continuously being provided to new housing development within Emfuleni.

Unitas Park is supplied from the Helenasrust Rand Water connection via Rand Water's Langerand reservoir. The pressures in the Rand Water pipes are limited (± 1550 m), the Rand Water connection is sufficient, but the network pipes must be augmented. No balancing and storage facilities are provided. A water line connects to Rand Water at Langerand and feeds a new reservoir north-west of Unitas Park extension. A 500mm Ø distribution line runs from the new reservoir site to Tshepiso.

Unitas Park township and densification areas can connect to the existing pipelines and no additional bulk water infrastructure was required in the short to medium term. Currently, there is no spare capacity at the Langerand but the introduction of a new supply zone with reservoir TWL 1570 m will remove all pressure on the system. The Langerand reservoir will provide storage for the 1570 m supply zone.

Emfuleni Local Municipality GLS Water Master Plan will be required to determine the impact the proposed development's water demand will have on the existing bulk infrastructure and confirm if the bulk infrastructure solutions, upgrades, and reinforcements have been implemented.

4.3 Design norms and standards

The design norms and standards that have been utilized for internal water reticulation for this report are the following:

- Emfuleni Local Municipality (Metsi-A-Lekoa) Design Criteria and Internal Services Standards
- "Guidelines for Human Settlement, Planning and Design", published by the Building and Construction Technology Division of the CSIR (also known as the Red Book)
- Department of public works "Appropriate development of infrastructure on dolomite: guidelines for consultants (PW 371 & 344)

- The Standardized Specification for Civil Engineering Construction (SANS 1200), published by the South Africa Bureau of Standards
- Development of Dolomite land (SANS 1936), published by SABS Standards Division.

The design parameters utilised to calculate the demand and requirements for civil services for this report are in accordance with the Guidelines for Human Settlement Planning and Design compiled by the Department of Housing and Construction Technology (2000) and other approved design specifications.

TABLE 4.1 DESIGN PARAMETERS AND DESIGN STANDARDS FOR WATER SUPPLY		
PARAMETER	DETAIL	SPECIFICATION
Pressure	Maximum (Static)	90m
	Minimum (at peak flow)	24m
AADD	High rise flats according to FSR	0.4 km per unit/100m2/day
Peak Factor	Entire Development	4.0
Flow Velocity	Supply mains (max)	1,5 - 2,5 m/s
	Supply mains (recommended)	1,0 m/s
	Network pipe maximum	1,2 m/s
	Network pipe recommended	0,6 m/s
	At fire flow	3,5 m/s *
Piping	Sizes Material	Min – 75mm dia ND HDPE, uPVC class 9 / 12 SABS 966 approved No solvent welding will be allowed
Connections	Residential connections	HDPE class 12 50mm single connections – small stands 100mm single connections – larger stand Connection installed & tested up to 1m outside erf boundary
Valves	Spacing	Maximum 600m AVK Waterworks type, Cast Iron, anticlockwise closing, opposite splay pegs, Aqua-loc mono box type – blue lid color
ydrant Spacing	Maximum Spacing	120m apart Underground Byonette type opposite splay pegs, Aqua-loc mono box type – red lid color
Fire flow:	Flow per hydrant (High Risk) Minimum pressure: Maximum Spacing:	25 ℓ/s 15 m 120m apart
Cover to Pipes	Minimum Cover	1 000mm

It must be noted that these standards have been utilised to obtain an indication of the size of the services only and they must, therefore, be confirmed through a final design process.

4.4 Water Demands

The summarised AADD and peak flows calculated during the preliminary designs are summarised in Tables 4.2 to 4.7 below.

TABLE 4.2: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 1

Zoning	No of Stands	No of Dwellings	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
250sqm Erven	360	360	9	900	Kℓ per Erf	324000	3.75	4	15.000
Mixed-Use: Walk-Up Units		158		900	Kℓ per Unit	142200	1.65	4	6.583
Mixed-Use			0.6348	400	Kl per 100m²	25392	0.29	4	1.176
Social Facility	1		0.4256	400	Kl per 100m²	17024	0.20	1	0.197
Public Open Space	1		0.4286						
TOTAL									22.956
SUB-TOTAL									22955.926 kl/day
PLUS UAW (15% OF TOTAL AADD)									4051.406 kl/day
TOTAL AVERAGE DEMAND (AADD)									27006.972 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4									312.581 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk									15 l/s & 25 l/s

TABLE 4.3: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 2

Zoning	No of Stands	No of Dwellings	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
250sqm Erven	477	477	11.925	900	Kℓ per Erf	429300	4.97	4	19.875
Walk-Up Units		730		900	Kℓ per Unit	657000	7.60	4	30.417
Mixed-Use: Walk-Up Units		148		900	Kℓ per Unit	133200	1.54	4	6.167
Mixed-Use			0.5928	400	Kl per 100m²	23712	0.27	4	1.098
Social Facility	1		0.3915	400	Kl per 100m²	15660	0.18	1	0.181
Public Open Space	1		0.46						
TOTAL									57.737
SUB-TOTAL									57737.361 kl/day
PLUS UAW (15% OF TOTAL AADD)									10188.946 kl/day
TOTAL AVERAGE DEMAND (AADD)									67926.307 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4									786.184 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk									15 l/s & 25 l/s

TABLE 4.4: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 3									
Zoning	No of Stands	No of Dwellings /pupil	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
250sqm Erven	1	42	1.05	900	Kℓ per Erf	37800	0.44	4	1.750
300sqm Erven	1	80	2.4	900	Kℓ per Erf	72000	0.83	5	4.167
Walk-Up Units		522		900	Kℓ per Unit	469800	5.44	5	27.188
Mixed-Use: Walk-Up Units		110		900	Kℓ per Unit	99000	1.15	4	4.583
Mixed-Use			0.4428	400	Kl per 100m²	17712	0.21	4	0.820
Social Facility	1		0.4715	400	Kl per 100m²	18860	0.22	1	0.218
Public Open Space	1		0.4927						
Sports Field	1			50	Kl per day	50	0.00		0.000
Primary School	1	400		20	Kℓ per Pupil	8000	0.09	1	0.093
Secondary School	1	800		20	Kℓ per Pupil	16000	0.19	1	0.185
TOTAL									32.733
SUB-TOTAL									32732.731 kl/day
PLUS UAW (15% OF TOTAL AADD)									5776.364 kl/day
TOTAL AVERAGE DEMAND (AADD)									38509.096 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4									445.707 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk									15 l/s & 25 l/s

TABLE 4.5: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 4								
Zoning	No of Dwellings	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
Student Village (Residential Units)	1140		700	Kℓ per Unit	798000	9.24	4	36.944
Innovation/Incubation Hub		1.5382	400	Kl per 100m²	61528	0.71	4	2.849
Public Open Space		10.7953						
TOTAL								39.793
SUB-TOTAL								39792,963 kl/day
PLUS UAW (15% OF TOTAL AADD)								7022,288 kl/day
TOTAL AVERAGE DEMAND (AADD)								46815,251 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4								541,843 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk								25 l/s

TABLE 4.6: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 5									
Zoning	No of Stands	No of Dwellings	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
250sqm Erven	291	291	7.275	900	Kℓ per Erf	261900	3.03	4	12.125
Walk-Up Units		747		900	Kℓ per Unit	672300	7.78	5	38.906
Mixed-Use: Walk-Up Units		132		900	Kℓ per Unit	118800	1.38	4	5.500
Mixed-Use			0.5302	400	Kl per 100m^2	21208	0.25	4	0.982
Social Facility	1		0.2864	400	Kl per 100m^2	11456	0.13	1	0.133
Public Open Space	1		0.3079						
TOTAL									49.864
SUB-TOTAL									49864.444 kl/day
PLUS UAW (15% OF TOTAL AADD)									8799.608 kl/day
TOTAL AVERAGE DEMAND (AADD)									58664.052 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4									678.982 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk									15 l/s & 25 l/s

TABLE 4.7: WATER DEMAND (ANNUAL AVERAGE DAILY DEMAND) PHASE 6									
Zoning	No of Stands	No of Dwellings	Area (ha)	AADD per Unit (l/day)	Unit	Average Water Demand (l/day)	Average Water Demand (l/s)	Peak Factor	Peak Demand (l/s)
250sqm Erven	44	44	1.1	900	Kℓ per Erf	39600	0.46	4	1.833
300sqm Erven	134	134	4.02	900	Kℓ per Erf	120600	1.40	5	6.979
Walk-Up Units		764		900	Kℓ per Unit	687600	7.96	5	39.792
Mixed-Use: Walk-Up Units		104		900	Kℓ per Unit	93600	1.08	4	4.333
Mixed-Use			0.4168	400	Kl per 100m^2	16672	0.19	4	0.772
Social Facility	1		0.9896	400	Kl per 100m^2	39584	0.46	1	0.458
Public Open Space	1		0.4927						
TOTAL									44.813
SUB-TOTAL									44813.333 kl/day
PLUS UAW (15% OF TOTAL AADD)									7908.235 kl/day
TOTAL AVERAGE DEMAND (AADD)									52721.569 kl/day
PEAK DEMAND (exc. Fire flow) PF = 4									610.203 l/s
FIRE FLOW PER HYDRANT (X4) - Low Risk and High risk									15 l/s & 25 l/s

Total Instantaneous Peak Demand = Average Daily Demand X Instantaneous Peak = 247.8968 l/s.

Instantaneous Peak Factor = 4 (Reference 1 & 2)

Limited calculations to determine the demand for the various services were prepared to obtain an indication of the size of the services. The actual sizes of the services will have to be determined through a final design process after the relevant details (final site layout plan, number of units, size and coverage of the various land uses, etc.) have been finalised.

4.5 Existing Water Pipe Networks

Information received from the Emfuleni Local Municipality (Metsi-A-Lekwa), GLS Water Master planning, and the topographical survey for this site indicates that there are no existing water Services within the proposed site but there are existing water services in the neighbouring areas Sonland Park located in the northern direction and Unitas Park AH located on the southern direction of the proposed development.
As attached in Annexure H Emfuleni Water Master Plan Layout Layout-South-Base Pipes-drawing number S12-012-315 indicates that there is an existing water network which comprises of various pipe sizes in Sonland Park located to the north of the proposed site and in Unitas Park AH located to the southwest of the proposed site. The Master plan layout shows that the existing water system pipe diameters vary from 75mm diameter to 160mm diameter. However, the proposed layout plan is currently being prepared in order to establish the suitability and capacity of the services for the connection point.

Emfuleni Local Municipality revised GLS Water Master Plan will be required to determine the impact the proposed development's water demand will have on the existing bulk infrastructure and confirm if the bulk infrastructure solutions, upgrades, and reinforcements have been implemented as yet.

4.6 Capacity analysis of Network pipes

The topographical survey done shows no signs of existing water pipes within the proposed site. According to Emfuleni Local Municipality, there are no records of any internal water network for the proposed development since is currently vacant land being used for crop plantation.
GLS Water Masterplan report has confirmed the Rand Water connection Unitas Park township is sufficient, but the network pipes must be augmented.

Unitas Park township and densification areas can connect to the existing pipelines and no additional bulk water infrastructure was required in the short to medium term. Currently, there is no spare capacity at the Langerand but the introduction of a new supply zone with reservoir TWL 1570 m will remove all pressure on the system.

4.7 Proposed Water Network

The current proposed layout for the proposed development will only allow us to provide the total length of proposed water reticulation within road reserves because the proposed SDP's within the erfs provided for walk-ups units are not yet finalised. The proposed internal water reticulation network for the Proposed Unitas Park Ext 16 is shown in Annexure I.

The Emfuleni Local Municipality and Red book design norms were considered in the design and placement for the reticulation network of the internal Water layout.

The pipe sizes, material, and class will be Type PE 100, PN 12,5. The water mains will be installed 1.5m from the erf boundary forming a loop. Isolating valves will be placed at the reticulation nodes to provide effective isolation of loops.

The total length of internal water pipelines that will be installed inside road reserves for this development is approximately 24km. The proposed designs were done according to the yield provided from the current proposed draft layout.

The water connection point is located at the intersection of Tafelberg Avenue and Waterberg Street. At the moment we assume that an upgrade will be needed on that link connection pipe since the existing pipe diameter is smaller than that of the proposed link connection pipe from the new Unitas Park Ext 16 development. We have requested Emfuleni Local Municipality (Metsi A Lekoa) to confirm the diameter of the existing link connection pipe and to also give an indication of the approximate length of the existing pipe that will need to be upgraded. We still await the above-mentioned information from Metsi A Lekoa.

4.8 Pipe materials

A Criterion for the selection of pipeline material was based on geotechnical constraints. The National Department of Public Works' PW344 and 371 design manual "Appropriate development of infrastructure on dolomite: Guidelines for consultants" were used for the selection of pipeline material.

- The piping used in bulk supply, ring mains, and secondary reticulation should be flexible. Joints should be minimal in number and of the flexible, self-anchoring type, i.e. not reliant on thrust blocks or friction for their anchorage.
- Subsurface pipe materials should be one or more of the following:

TABLE 4.3: PIPE MATERIALS SPECIFICATIONS

MATERIAL	REQUIREMENTS
Pipe Material	Pipes of 75 mm and larger diameter: HDPE: Type PE 100, PN 12,5 (or higher-pressure class if required) to SANS 4427.
Joint, fitting and welding Requirements	Butt-welded joints (SANS 10268-Part 2) in general. Electro-fusion welding (SANS 10268-Part 2) must be approved by Departmental Engineer, where butt welding is impossible. <u>Fittings</u>: Manufactured from HDPE: Type PE 100, PN 12,5 (or higher) to SANS 4427. Moulded not machined fittings are preferred. No manufactured extrusion welded fittings <u>Welding</u>: All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655, and SANS 1671 codes.
Supply lengths	Supply pipe in 12 m (minimum) lengths.
Alternative pipe material	<u>Alternative</u>: High impact PVC pipes: modified poly (vinyl chloride) (PVC-M) pipes that comply with the requirements of SANS 966-2 or SANS 1283 with a pressure of not less than 12, **only if approved by the departmental engineer.** Supply length: 6m or 9m Joints: Pressed on Spheroidal Graphite Cast Iron (SG) iron or stainless-steel Victaulic shoulders. Alternatively, pipes with spigot and socket end provided with an additional metal locking ring (stainless-steel).

- Piping from the main reticulation to the building is unjointed HDPE: Type PE 100, PN 16 (or higher class if required) pipes to SANS 4427.
- Underground valves are to be placed in watertight concrete or HDPE manholes. HDPE manholes are to be manufactured to the same standard as sewer manholes Concrete manholes for the valve are to be designed as water retaining structures.
- No high-pressure compression connections are to be allowed below ground level. All such connections are to be placed in watertight manholes.
- Shut-off valves and water meters shall be supplied at the main supply with a permanently fixed pressure gauge on the building side of the main shut-off valve (for regular systems testing).
- All site services to be tested to zero percent leakage.

4.9 Standard Details

SANS 1200 (together with other applicable details) details will be used to prepare project-specific details and be submitted to Emfuleni Local Municipality (Metsi-A-Lekoa) for their approval.

The provision of SANS 1936 is also applicable to this project.

4.10 Proposed link upgrades

Land use was changed from “agricultural” to “residential” therefore upgrading of link infrastructure will be required for this project. See **Annexure J drawing no 7001/W/U005 Sheet 5 of 5.**

5 BULK SANITATION

5.1 Authority and Provider Arrangements

The proposed development area falls within the Emfuleni Local Municipality (Metsi-A-Lekoa) Water jurisdiction and the Municipality serves as both the Sanitation Service Authority as well as the Sewer Service Provider.

The content of this section is based on information obtained from Emfuleni Spatial Development Framework 2017-2025 (ESDF), Compiled on Behalf of the Emfuleni Local Municipality by Urban Dynamics Gauteng, dated September 2017, Project SNM/2012 Civil Engineering Services Master Planning Volume 2 Sewage Disposal, first edition dated August 2013 and Southern Corridor Regional Implementation Plan.

5.2 Bulk Sewer Systems

The content in this section below is based on the information extracted from Emfuleni Spatial Development Framework 2017-2025 report under the Municipal Services section.

The sanitation system consists of gravity pipelines and, due to the flat terrain; it also consists of 49 sewage pump stations. The wastewater system consists of 3 wastewater treatment works. The Sebokeng wastewater treatment works, located in Sebokeng next to the Rietspruit, is the largest wastewater treatment works within Emfuleni. The Emfuleni Local Municipality sewage drain to four (4) wastewater treatment works, viz. Leeuwkuil WWTW`s, Rietspruit WWTW`s, Sebokeng WWTW`s, and the Midvaal WWTW`s. The Leeuwkuil WWTW`s drainage area has 34 sub-drainage areas, the Rietspruit WWTW`s has 3 sub-drainage areas, the Sebokeng WWTW`s has 6 sub-drainage areas and the Midvaal WWTW`s drainage area has 1 sub-drainage area inside the Emfuleni Local Municipality area, which either drain to a pump station or the water treatment works directly. Risiville, a portion of Duncanville and Lakeside Estates, which is located inside the Midvaal Municipal Area, Lenasia, Orange Farm, and Savanna City, located in the Johannesburg Municipal area, also drain to the Emfuleni sewer system.

The bulk sanitation network is old, and it is overworked due to the demand for sanitation services. The age of the networks varies between 60 -70 years across the Municipal area. The short-term sanitation infrastructure plans involve the rehabilitation of existing infrastructure, including sewer pump stations to minimize sewer spills. Existing sanitation infrastructure has reached the end of its lifespan and can only be kept operational with a high risk of sewer spills. New infrastructure needs to be constructed to prevent future sewer spills.

The Unitas Park Area has been identified as a high-priority development area for housing, and the number of potential equivalent stands in this area is 8000 with an average daily dry weather flow of 6.4Mℓ/day. Bulk sewer lines have recently been installed, and the Quaggasfontein outfall sewer line runs from Quaggasfontein past Unitaspark extension up to the Leeuwkuil works.

This wastewater treatment facility has a capacity of 119 Ml/day. Significant parts of the sanitation system infrastructure, including the Rietspruit and Leeuwkuil wastewater treatment works, need to be upgraded and rehabilitated.

Emfuleni Metsi-A-Lekoa GLS Sewer Master Plan Report has confirmed that the existing Sewer Wastewater treatment plants in the Emfuleni Local Municipality are overwhelmed and do not have sufficient capacity to accommodate any future proposed developments and they need to be upgraded and Rehabilitated.

5.3 Design norms and standards

The design norms and standards that have been utilized for this report are the:

- "Guidelines for Human Settlement, Planning and Design", published by the Building and Construction Technology Division of the CSIR (also known as the Red Book).
- Any relevant published SANS documents.
- Emfuleni Local Municipality (Metsi-A-Lekoa) Design Criteria and Internal Services Standards

The design parameters utilised to calculate the demand and requirements for civil services for this report are in accordance with the Guidelines for Human Settlement Planning and Design compiled by the Department of Housing and Construction Technology (2000) and other approved design specifications.

It must be noted that these standards have been utilised to obtain an indication of the size of the services only and they must, therefore, be confirmed through the final design process.

Criteria:

A full waterborne sewerage system is proposed, with individual connections to all erven.

Elements:

- SABS approved piping with a minimum size of 160mm diameter.
- Concrete manholes with a spacing of not more than 80mm, installed at all direction changes and mains intersections
- 160mm dia. connection to all erven with a depth to ensure drainage of 100% of the stand.
- Erf connections end 1m inside the Erf

TABLE 5.1: DESIGN STANDARDS AND DESIGN PARAMETERS FOR SEWERAGE RETICULATION DESIGN		
PARAMETER	ELEMENT	GUIDELINES
Average dry weather Flow (ADWF)	High rise flats according to FSR	0.3/kl/erf/day
Minimum Pipe diameter	Gravity sewers	160 mm
Minimum Velocity at full flow	Gravity sewers	0,7 m/s at half full
Peak Factor	Entire Development	2.5 maximum
Minimum Slopes for Pipes Diameters		1:80 at head
	100 mm	1: 120
	150 mm	1: 200
	200 mm	1: 300
	225 mm	1: 350
	250 mm	1: 400
	300 mm	1: 500
Pipe Material	Underground	Any SABS approved piping
Location of Sewers	In road reserves Midblock	2,5 m from erf boundaries in a road reserve 1,3 m from erf boundaries or where possible
Manholes	Spacing Material	80 m maximum HDPE manhole /Pre-cast concrete rings Concrete pre-heavy-duty cast-in-situ, with step Irons and heavy-duty type concrete cover Piping inside manhole Clay/Fibre Concrete
Pipe Covers		1.0m generally 1.4 under streets

Manhole sizes		0m to 1.2m deep: 0.9m inside diameter chamber, no shaft; 1.21m to 3.5m deep: 1.25 inside dia. chamber, no shaft; deeper than 3,5m: 1,5m inside dia chamber, no shaft Erf connections 160mm dia minimum, SABS approved piping
Erf connections		160mm dia minimum, SABS approved piping
Erf connections slope		1.60 minimum
Erf connections depths		500mm minimum cover at buildings

It must be noted that these standards have been utilised to obtain an indication of the size of the services only and they must, therefore, be confirmed through a final design stage.

5.4 Sewage Flows

The following are assumed:

1. Demand rates are according to the Guidelines for Human Settlement.
2. Emfuleni Local Municipality Metsi-A-Lekoa Design Criteria and Internal Services Standards

TABLE 5.2: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 1									
Zoning	No of Stands	No of Dwellings	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
250sqm Erven	360	360	9	900	Kℓ per Erf	324000	3.750	2.5	9.375
Mixed-Use: Walk-Up Units		158		900	Kℓ per Unit	142200	1.646	2.5	4.115
Mixed-Use			0.6348	300	Kl per $100m^2$	19044	0.220	2.5	0.551
Social Facility	1		0.4256	300	Kl per $100m^2$	12768	0.148	1	0.148
Public Open Space	1		0.4286						
TOTAL									14.188
						Total incl.15% Extraneous flow			16.317

TABLE 5.3: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 2									
Zoning	No of Stands	No of Dwellings	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
250sqm Erven	477	477	11.925	900	Kℓ per Erf	429300	4.969	2.5	12.422
Walk-Up Units		730		900	Kℓ per Unit	657000	7.604	2.5	26.615
Mixed-Use: Walk-Up Units		148	0	900	Kℓ per Unit	133200	1.542	2.5	3.854
Mixed-Use			0.5928	300	Kl per $100m^2$	17784	0.206	2.5	0.515
Social Facility	1		0.3915	300	Kl per $100m^2$	11745	0.136	1	0.136
Public Open Space	1		0.46						
TOTAL									43.541
						Total incl.15% Extraneous flow			50.072

TABLE 5.4: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 3									
Zoning	No of Stands	No of Dwellings /pupil	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
250sqm Erven		42	1.05	900	Kℓ per Erf	37800	0.438	2.5	1.094
300sqm Erven		80	2.4	900	Kℓ per Erf	72000	0.833	2.5	2.917
Walk-Up Units		522		900	Kℓ per Unit	469800	5.438	2.5	19.031
Mixed-Use: Walk-Up Units		110		900	Kℓ per Unit	99000	1.146	2.5	2.865
Mixed-Use			0.4428	300	Kl per 100m²	13284	0.154	2.5	0.384
Social Facility	1		0.4715	300	Kl per 100m²	14145	0.164	1	0.164
Sports Field	1								
Primary School	1	400		15	Kℓ per Pupil	6000	0.07	1	0.069
Secondary School	1	800		15	Kℓ per Pupil	12000	0.14	1	0.139
Public Open Space	1		0.4927				0.00		
TOTAL									26.663
						Total incl.15% Extraneous flow			30.662

TABLE 5.5: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 4								
Zoning	No of Dwellings	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
Student Village (Residential Units)	1140	0	700	Kℓ per Unit	798000	9.236	2.5	23.090
Innovation/Incubation Hub		1.5382	300	Kl per 100m²	46146	0.534	2.5	1.335
Public Open Space		10.7953						
TOTAL								24.426
					Total incl.15% Extraneous flow			28.089

TABLE 5.6: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 5									
Zoning	No of Stands	No of Dwellings	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
250sqm Erven	291	291	7.275	900	Kℓ per Erf	261900	3.031	2.5	7.578
Walk-Up Units		747		900	Kℓ per Unit	672300	7.781	2.5	27.234
Mixed-Use: Walk-Up Units		132		900	Kℓ per Unit	118800	1.375	2.5	3.438
Mixed-Use			0.5302	300	Kl per 100m²	15906	0.184	2.5	0.460
Social Facility	1		0.2864	300	Kl per 100m²	8592	0.099	1	0.099
Public Open Space	1		0.3079						
TOTAL									38.810
						Total incl.15% Extraneous flow			44.631

TABLE 5.7: SEWER OUTFLOW (ANNUAL AVERAGE DAILY DISCHARGE) PHASE 6									
Zoning	No of Stands	No of Dwellings	Area (ha)	ADWF per Unit (l/day)	Unit	Average Sewage Outflow (l/day)	Average Sewage Outflow (ADWF)(l/s)	Peak Factor	PWWF (l/s)
250sqm Erven	44	44	1.1	900	Kℓ per Erf	39600	0.458	2.5	1.146
250sqm Erven	134	134	4.02	900	Kℓ per Erf	120600	1.396	2.5	4.885
Walk-Up Units		764		900	Kℓ per Unit	687600	7.958	2.5	27.854
Mixed-Use: Walk-Up Units		104	0	900	Kℓ per Unit	93600	1.083	2.5	2.708
Mixed-Use			0.4168	300	Kl per 100m²	12504	0.145	2.5	0.362
Social Facility	1		0.9896	300	Kl per 100m²	29688	0.344	1	0.344
Public Open Space	1		0.4927						
TOTAL									37.299
						Total incl.15% Extraneous flow			42.894

Sewer design flow is estimated at approximately 80% of the water consumption plus 15% Stormwater infiltration.

The total sanitation demand calculated for the proposed development is approximately 212.6656 l/s

The chosen design standards used for the calculations above are:

Peak Flow Rate = Average Daily Flow Rate X Peak Factor

Peak Factor = 2.5

Limited calculations to determine the demand for the various services were prepared to obtain an indication of the size of the services. The actual sizes of the services will have to be determined through a final design process after the relevant details (final site layout plan, number of units, size and coverage of the various land uses, etc.) have been finalised.

5.5 Existing Sewer Pipe Networks

Information received from Emfuleni Local Municipality (Metsi -A-Lekoa)/ GLS Sewer Master planning and the topographical survey indicates that there are existing sewer services in the nearby townships to the north in Sonland Park and the southwestern side of the proposed site in Unitas Park but there are no existing services within the proposed site. New sewer reticulation design within the erfs and in the road, reserves will be constructed for this proposed development. As attached in Annexure K, Emfuleni Local Municipality Sewer Master Plan SMN 2012 drawing number SMN-2012-01-04.

The existing sewer masterplan drawings show that there are existing Sewer pipes with various pipe sizes in Sonland Park located to the north and Unitas Park located to the southern side of the proposed development.

5.6 Capacity analysis of Network pipes

The topographical survey done shows no signs of existing sewer pipes within the proposed site. According to Emfuleni Local Municipality, there are no records of any internal sewer network for the proposed development since is currently vacant land being used for crop plantation.

The Unitas Park Area has been identified as a high-priority development area for housing, and the number of potential equivalent stands in this area is 8000 with an average daily dry weather flow of 6.4Mℓ/day. Bulk sewer lines have recently been installed, and the Quaggasfontein outfall sewer line runs from Quaggasfontein past Unitaspark extension up to the Leeuwkuil works.

This wastewater treatment facility has a capacity of 119 Ml/day. Significant parts of the sanitation system infrastructure, including the Rietspruit and Leeuwkuil wastewater treatment works, need to be upgraded and rehabilitated.

The current Emfuleni Metsi-A-Lekoa GLS Sewer Master Plan Report has confirmed that the existing Sewer Wastewater treatment plants in the Emfuleni Local Municipality are overwhelmed and do not have sufficient capacity to accommodate any future proposed developments and they need to be upgraded and Rehabilitated.

5.7 Proposed Sewer Network

The current proposed layout for the proposed development allows us to provide the total length of proposed water reticulation within road reserves because the proposed SDP's within the erfs provided for walk-ups units are not yet finalised. The proposed internal sewer reticulation network proposed Unitas Park Ext 16 is shown in Annexure L.

Emfuleni Local Municipality (Metsi-a-Lekoa) and Red book design guidelines and norms were considered in the design and placement of the proposed sewer reticulation.

The total length of internal sewer pipelines that will be installed inside road reserves for this development is approximately 21km. The proposed designs were done according to the yield provided from the current proposed draft layout.

The pipes material will be Type PE 100 or higher, PN 10, SDR but the pipe sizes will be confirmed during the final detailed design stages when the proposed layout is completed and approved, and the manholes will be 1 000mm to 1500mm diameter HDPE manhole /Pre-cast concrete rings with concrete covers.

Phumaf is proposing a new on-site 2x10MLPD aboveground Steel Tank Sewer Wastewater Treatment Facility (Plant) (WWTP) which if Emfuleni agrees and permit will be designed and be constructed on the erf reserved for engineering infrastructure on the layout, this erf is positioned on the southwestern corner of the proposed development.

The sewer from the aboveground Steel Tank Sewer Wastewater Treatment Facility will be treated to potable water standards however will be conveyed by means of a sewer outfall 500mm Ø concrete pipe to the nearest wetland which is located on the western side of the Houtkop(R54) Road.

5.8 Pipe Materials

A criterion for the selection of pipeline material was based on geotechnical constraints. The National Department of Public Works' PW344 and 371 design manual "Appropriate development of infrastructure on dolomite: Guidelines for consultants" were used for the design of pipeline material.

- Sanitation systems shall not incorporate soakaways.
- Subsurface pipe materials should be as follows:

TABLE 5.4: PIPE MATERIALS SPECIFICATIONS	
MATERIAL	REQUIREMENTS
Application	Dolomite area designation (D1, D2, D3, and D4)
Pipe Material	HDPE: Type PE 100 or higher, PN 10, SDR to SANS 4427
Joint, fitting and welding Requirements	Butt-welded joints (SANS 10268-Part 1) in general. Electro-fusion welding (SANS 10268-Part 2) must be approved by Departmental Engineer, where butt welding is impossible. Fittings: Manufactured from HDPE: Type PE 100, PN 10 (or higher) to SANS 4427 Welding: All welding to relevant SANS 10268, SANS 10269, SANS 10270, SANS 1655, and SANS 1671 codes.
Supply lengths	Supply pipe in 12 m (minimum) lengths.
Alternative pipe material	**Only to be used beyond 15 m from structures.** PVC Pipe: SANS 791 Heavy-duty - Class 34 (solid wall). **Use of PVC to be approved by the departmental engineer.**
Manholes	The use of pre-manufactured HDPE manholes is advised. Alternatively use concrete manholes, designed as water retaining structures, **if approved by the departmental engineer.** HDPE manholes: All material for HDPE manholes to conform to HDPE: Type PE 100 or higher, SANS 4427 specifications, and all welding to SANS 10268, SANS 10269, SABS SANS 1655, and SANS 1671. Manufacturing: HDPE structured wall pipes used as manhole shafts shall be manufactured according to SANS 21138 to SANS 674 in terms of profile, pipe, fittings, and pipe endings, but with stainless steel stiffness and 5mm minimum wall thickness. HDPE solid wall pipes used as manhole shafts shall be manufactured according to SANS 4427. Ring Stiffness: Ring Stiffness shall be tested according to ISO 9969 i. 8,0 kN/m^2 ring stiffness for all depth ii. 4,0 kN/m^2 ring stiffness for depth not exceeding 1.5m and approved by the department Joints to pipes: HDPE pipes to be extrusion welded to manhole. Benching: HDPE (PE 100 to SANS 4427) flat sheet and pipe of minimum 12mm thickness.

	Cover Slab: the installation of the cover slab must form an integral part of the structure by means of attaching it to the shoulder ring beam with an approved epoxy. Concrete manholes: Design as water retaining Structures **if departmental engineer approves use.** Inlet pipes to be provided with puddle flange or key joint (detail TYPE NO DT 12/W) to ensure watertight fixing into walls or construct the structure with flexible watertight inlets.

- All connections to manholes shall be flexible and watertight.
- All sewerage pipes and fittings must be watertight. All laid drainage and sanitary sewer pipes should be tested for leakage using the standard SANS water test on installation. Welded HDPE pipe systems to be pressure tested to relevant pipe pressure class and manufacturer's specification.
- All sewers and structures to be tested to zero percent leakage for water tests.
- Avoid using rodding and cleaning eyes and rather use small HDPE manholes (multi-directional collecting pots) that are pre-manufactured small size (300, 500- and 700-mm diameter) manholes with factory fitted HDPE benching. Piping from the manhole to surface level shall consist of HDPE pipes and long radius bends with electrofusion/butt welded connections. All HDPE material to be Type PE 100 as per SANS 4427 and all welding to conform to SANS 10268, SANS 10269, SANS method1269, SANS 0270, SANS 1655, and SANS 1671. Manhole shafts to be structured or solid wall HDPE pipes with 8,0 kN/m² ring stiffness or alternatively manufactured to the same standard.
- The planting of trees or general gardening within 5 meters of sewer lines should be avoided.

5.9 Standard Details

SANS 1200 (together with other applicable details) details will be used to prepare project-specific details and be submitted to Emfuleni Local Municipality (Metsi-A–Lekoa) for their approval.

The provision of SANS 1936 is also applicable to this project.

5.10 Proposed link Upgrades

Land use was changed from “agricultural” to “residential” but since Phumaf Holdings (PTY) LTD is proposing an on-site Sewer WWTP, there will not be any need to upgrade the link infrastructure for this project.

6 ROADS

6.1 Authority and Provider Arrangements

The Emfuleni Local Municipality is responsible for the provision and maintenance of roads and stormwater infrastructure in its area of jurisdiction.

6.2 Traffic Impact Study

A traffic impact assessment (TIA) was conducted and took into cognisance the existing 2020 scenario, the future 2025 scenario on the existing geometry and the 2025 future scenario on the upgraded geometry were analyzed.

The purpose of the Traffic Impact Assessment (TIA) report is to assess the traffic impact at the intersections surrounding the development, due to the additional traffic that the development will generate together with measures to mitigate the impact. See **Annexure C** for the TIA report.

6.3 Site Access

The existing and future proposed road networks in close proximity to the proposed development are summarized below and attached in **Annexure A** as Locality Map for Existing Major Road Networks.

Access to the site is problematic as there are currently no constructed roads linking the site to the surrounding road network. See **Figure 6.1** Below for proposed site accesses.

The following are potential access points:

POTENTIAL ACCESS 1: There are two potential access points to the K55. Provision is made for these entrances in the subdivision of Portion 222 of the farm Houtkop 594-IQ. The southern entrance is 700m from Houtkop Road. In order to obtain access, the 700m portion of the road from Houtkop Road must first be constructed. The K55 is a provincial road and there is no indication when this road will be constructed. The onus of constructing the road will thus fall on the developer.

POTENTIAL ACCESS 2: The northern potential access point to the K55, is 1.4km from Houtkop Road and 700m from Frederik Road. Frederik Road is a small dirt road providing access to agricultural holdings. It links to Jimmy Sinclair Street in the north. The distance from the site to Jimmy Sinclair Street is approximately 1.4km. This road will have to be upgraded to accommodate the additional traffic generated by the proposed development. This road also forms part of the K55 and will have to be upgraded to provincial standards at least from Frederik Road to the potential access point which is 700m and ideally up to Jimmy Sinclair Road which is almost 2.1km.

There is a Right of way servitude that links potential access point 2 to Bennie Osler Street in the east. Bennie Osler is a small street providing access to agricultural holdings. The servitude is over private land and is approximately 800m in length. The developer will have to construct the road linking the site to Bennie Osler Street and Bennie Osler Street will have to be upgraded. This is not regarded as a viable option.

POTENTIAL ACCESS 3: There is potential access to the north/ north-east of the site to an un-named street (possibly an extension of Max Shapiro Street). As stated for Access 2, Frederik Road extends to the north and links up with Jimmy Sinclair. It is currently a dirt road and only provides access to agricultural holdings. The link is approximately 1.4km in length and will have to be upgraded by the developer.

POTENTIAL ACCESS 4: There is potential access in the north-west of the site to Sonland Park and Skippie Botha Road. This access road will necessitate the construction of a road across Sonland Park Ext. 6. Provision is made for such a road in the layout of Sonland Park Ext 6. The township has been approved, but however not yet proclaimed. Should the township not be proclaimed before the inception of this development a servitude will have to be registered over private land and a road constructed. The length of the road is approximately 200m.

POTENTIAL ACCESS 5: There is potential access in the south-west of the site to Houtkop Road. This access road will necessitate the construction of a road across Sonland Park Ext. 4. Provision is made for such a road in the layout of Sonland Park Ext 4. The township has been approved, but however not yet proclaimed. Should the township not be proclaimed before the inception of this development a servitude will have to be registered over private land and a road constructed. The length of the road is approximately 800m.

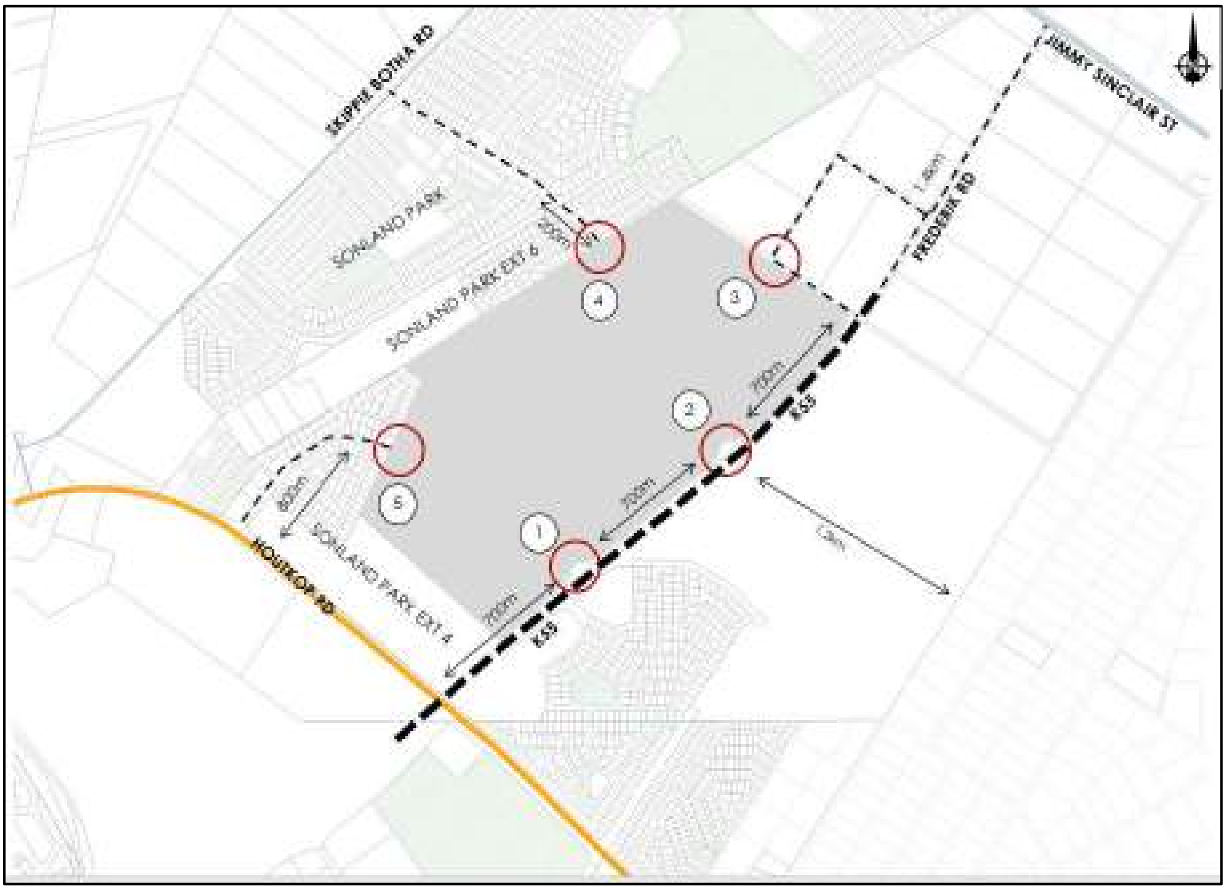


Figure 6.1: PROPOSED SITE ACCESS

(EMFULENI SPATIAL DEVELOPMENT FRAMEWORK 2017-2025)

6.4 Design Standards

The design norms and standards that have been utilized for this report are the:

- Guidelines for Human Settlement Planning and Design, CSIR (Redbook) (Reference 1)
- Roads and Stormwater standard details, Emfuleni Local Municipality (Reference 2)
- Any relevant published SANS documents.

The design parameters that will be utilized for geometric design and pavement structures and requirements for civil services for this report are in accordance with the Guidelines for Human Settlement Planning and Design compiled by the Department of Housing and Construction Technology (2000) and other approved design specifications.

It must be noted that these standards have been utilised to obtain an indication of the size of the services only and they must, therefore, be confirmed through the final design process.

TABLE 6.2: DESIGN PARAMETERS AND DESIGN STANDARDS FOR ROADS	
Class	4a, 4b, 5a, 5b and 5c
Road Width	7.5m, 7m, 6m, 5.5m, and 5m
Road Reserve	22m, 20m,16m,13m, and 10.5m
Pavement Layers	No layer within the pavement structure shall be less than 125mm
Cross fall/Camber	Single cross fall (3%)
Longitudinal Slope	Minimum:0.5%
Kerbing	Fig 3 barrier or type Fig 8b Mountable
Pedestrian Walkways	No pedestrian walkway shall be less than 1.2m when paved
Verges	The minimum verge width shall be 2.7m
Access to Erven	Minimum stacking distance at entrances is to be between 4.5m edge of road and gate

The classification of roads for the proposed development is shown in the table below:

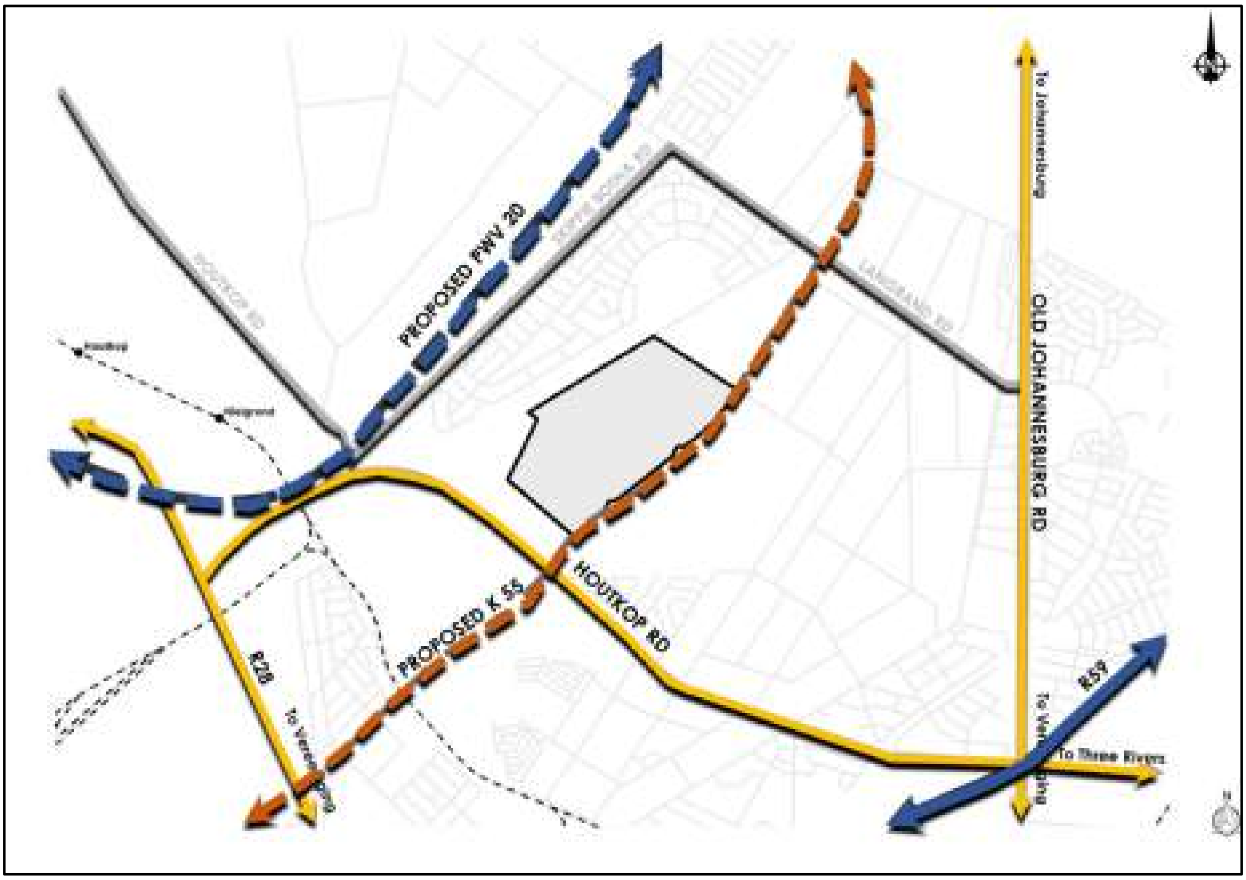
TABLE 6.3: CLASSIFICATION OF ROAD		
CLASS NAME	DESIGN TYPOLOGY	CLASS NO.
Minor Arterial	Major	3
Collector Street, commercial	Commercial Major Collector	4a
Collector Street, Residential	Residential Minor Collector	4b
Local Street, Commercial	Commercial access Street	5a
Local Street, Residential	Local Residential Street	5b
Walkway Non-Motorised Priority	Pedestrian only	6a and 6b

6.5 External Road and Intersection Upgrades Required

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59/ Old Johannesburg Road. The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, Houtkop Road, Skippie Botha Road, and Langrand Road provide connectivity to the north, east, and west.

See Locality Map for external roads in **Annexure A** and for possible intersection upgrades required See **attached** Traffic Impact Assessment (TIA) report in **Annexure C.**



*Fig*ure 6.2: ROAD NETWORK

(EMFULENI SPATIAL DEVELOPMENT FRAMEWORK 2017-2025)

6.6 Internal Roads

The proposed development is currently used for farming purposes which means there are no roads and infrastructure within the site. There are existing road services to the north in Sonland Park and the southwestern side of the site in Unitas Park AH.

A new road network system and parking, will be constructed within the proposed site. The proposed 2km-K55 will have two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. This K-route will form the southern boundary of the proposed Unitas Park Ext.16.

The site is surrounded by classes 3, 4, and 5 roads, however, the internal main roads have a total length of approximately 24km including the proposed parking and walkways within and outside the proposed development. Information regarding bus and taxi bays planned for the development will be available in the Traffic Impact Assessment (TIA) report.

See Annexure M for the proposed Roads layout for the proposed development.

7 Public Transport & Non-motorised Transport (NMT)

Existing Public Transport and NMT Facilities

Public Transport

There are several bus and taxi routes around the site: on Houtkop Road, Old Johannesburg Road, Langrand Road, and Skippie Botha Road.

These routes are between 1 and 3 km from the site and there are currently no direct linkages between these routes and the site.

The Vereeniging-Johannesburg commuter railway line passes to the south-west of the site. There are two stations, Houtkop Station and Kleigrond Station. These are more than 3km from the site and as with the bus and taxi routes, there are no direct linkages from the site to these stations.

THUS: Regional accessibility via private and public transport is good but not local accessibility.

Information regarding Existing Public Transport and NMT Facilities will be detailed in the Traffic Impact Assessment (TIA) report Attached is **Annexure M** of this report.

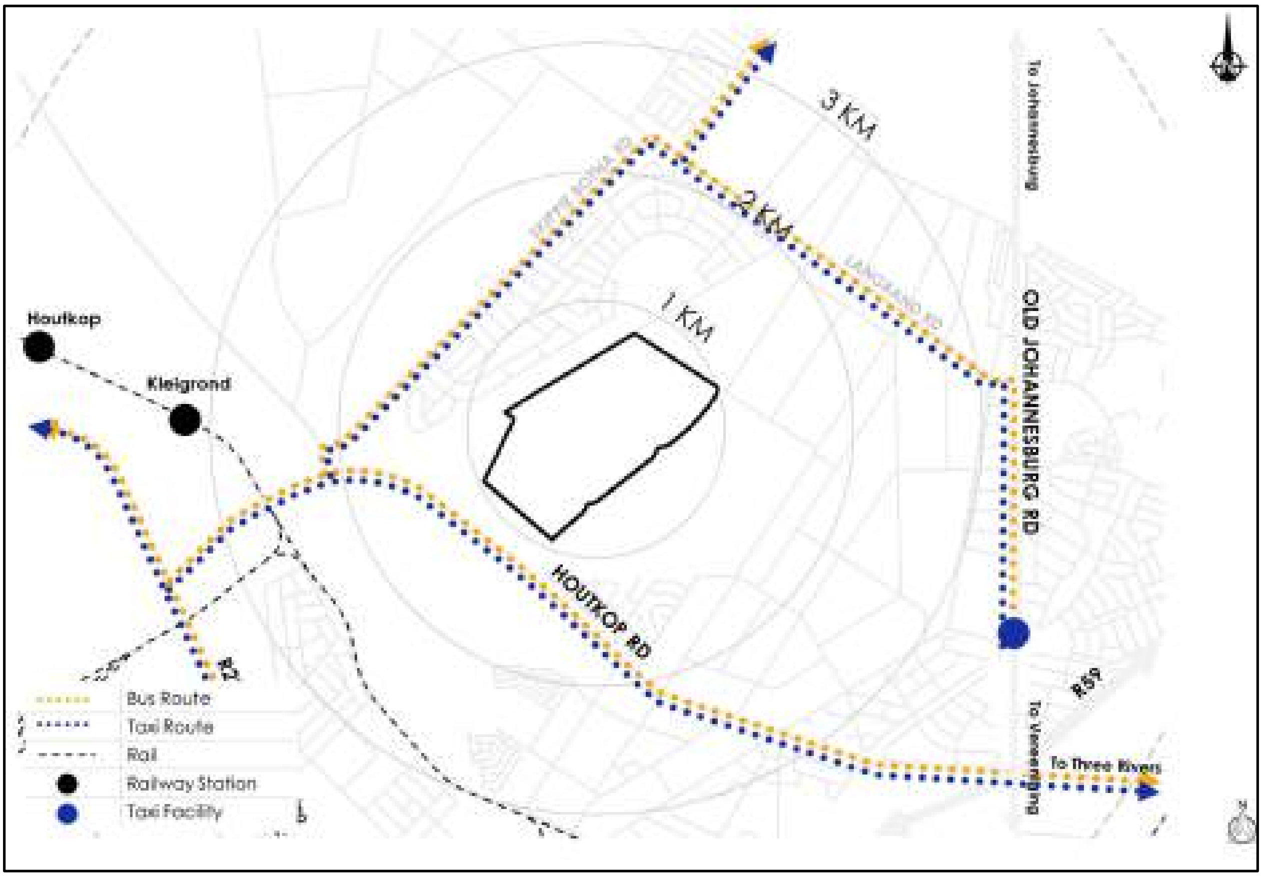


Figure 7.1: PUBLIC TRANSPORT

(EMFULENI SPATIAL DEVELOPMENT FRAMEWORK 2017-2025)

8 BULK EARTHWORKS

Geoid Geotechnical Engineers was appointed to conduct Geotechnical Site Investigations (GFSH2 Phase 1 Report) for Unitas Park Ext. 16.

The information below is the findings and recommendations from the Geotechnical Site Investigations (GFSH2 Phase 1 Report) conducted and the existing dolomitic stability report available.

Based on an existing dolomitic stability report covering the project site, the stability of the site is described in two Dolomite Stability Zones.

Zone 1 carries a low inherent risk of sinkhole/ subsidence formation of all sizes with respect to the ingress of water and low inherent risk with respect to groundwater level drawdown.

Zone 2 carries a low inherent risk of sinkhole/ subsidence formation of all sizes with respect to the ingress of water and low inherent risk with respect to groundwater level drawdown. This project area is assigned a D3 Dolomite Area Designation.

Zone 1 will require internally reinforced high-quality engineered fill being imported from commercial sources. In this regard, crushed chert rubble or colluvial deposits.

Zone2 - provides an excellent quality material source (typically meeting G5 standards) which can be compacted to high densities in excess of 95% Mod AASHTO.

Zone 2 is well suited to earthworks solutions, subject to the material being crushed to a size that can be adequately compacted using conventional techniques.

Zone 3 will require large-scale bulk earthworks using high-quality fill to elevate the site and deal with the civil engineering drainage challenges.

Zone 4 will require upper transported soils to be removed and replaced with high-quality imported materials from commercial sources.

While this report draws on the dolomite stability classification provided by a prior feasibility-level investigation by others, a footprint-level investigation will need to be completed under a separate mandate to satisfy the minimum requirements of SANS 1936:2012, which will govern the unsupported spans required for the foundations of the proposed structures.

Further detailed information and recommendations can be found in the geotechnical investigation report located in Annexure E.

9 STORMWATER MANAGEMENT

9.1 Authority and Provider Arrangements

The Emfuleni Local Municipality (ELM) is responsible for the provision and maintenance of roads and stormwater infrastructure in its area of jurisdiction.

9.2 Design Norms and Standards

The design criteria will be derived from the following:

- The Guidelines for Human Settlement Planning and Design (Red Book) and
- SANRAL Drainage Manual 5th Edition.

The Rational Method will be used to calculate the stormwater runoff for this site. The stormwater will be drained along the road reserve, mainly in kerbs, with underground piped.

Designs will be such that the 1:5-year minor storm and the 1:25 year major storm are accommodated in the canals and the road structure without overtopping.

TABLE 9.1: DESIGN PARAMETERS AND DESIGN STANDARDS FOR STORMWATER	
Stormwater Recurrence Interval	1:10 years, 1:5 years and 1:2 years
Minimum Pipe size within road reserves	450mm diameter
Maximum manhole spacing	80m
Minimum pipe class for 450mm and 525mm diameter	75D
Minimum velocity to be not more than	0.8m/s in pipes
Maximum velocity to be not more than	3m/s in road
Slope to be not less than	1% in order to self-clean
No hidden junction box will be allowed	
Pipe Material	Concrete interlocking

9.3 Existing Stormwater Drainage Zones

There is no information available regarding existing stormwater infrastructure on existing areas adjacent to the planned developments, in Sonland Park located to the north, Unitas Park AH, and Unitas Park located to the southwestern side of the site.

The proposed development's current land use is agriculture and is being used for farming crop plantation purposes. The available survey information available also shows that there is no existing stormwater infrastructure within the proposed development

A new stormwater pipe system will be constructed within the proposed site connecting discharging into natural watercourses nearby the proposed Unitas Park Extension 16 development. There is an existing River running adjacent to the Houtkop (R54) to the western side of the proposed development in which the proposed stormwater runoff from Unitas will discharge into.

9.4 Proposed Internal Stormwater

No existing stormwater exists within the proposed development areas. The proposed stormwater will be designed in accordance with the design criteria as described in Section 9.1.

The proposed development of land use is agriculture and currently is being used for farming crop purposes which means there is no stormwater infrastructure within the site. There are no existing stormwater systems to the north in Sonland Park and the southwestern side of the site in Unitas Park AH.

A new stormwater pipe system will be constructed within the proposed site connecting discharging into natural watercourses nearby the proposed Unitas Park Extension 16 development. There is an existing River running adjacent to the Houtkop (R54) to the western side of the proposed development.

Stormwater runoff is discharged from the development to the nearest river which is located on the western side of the Houtkop(R54) Road by means of stormwater pipes. The stormwater comprises various pipe sizes ranging from 450mm to 1800 in diameter. The pipes material will be Concrete pipes of 75D spigot and socket in road reserves and Conrete pipes of 100D spigot and socket on road crossings . The total stormwater pipe length is approximately 14 km.

See Annexure O for the proposed stormwater reticulation layout.

10 PROJECT ESTIMATES AND BUDGET

The estimated total construction cost for this project is **R668 411 870.43** which is inclusive of 12.5% contingencies and inclusive of VAT.

The payment of the Works would be re-measurable and would be done on a monthly basis during construction. A detailed bill of quantities would be included in the detailed design report. The table below indicates the preliminary cost estimates:

TABLE 10.1: SUMMARY OF PRICING SCHEDULE		
SECTION	DESCRIPTION	AMOUNT
1	Water Network (Internal Reticulation)	R24 853 080.33
2	Sewer Network (Internal Reticulation)	R43 284 091.23
3	Roads	R141 494 311.80
4	Stormwater Network	R24 935 321.43
5	External and Site Works	R17 500 000.00
6	Proposed K55 cost estimate	R25 000 000.00
7	Proposed 2x 10 MLPD WWTP	R239 580 051.58
	Total Schedule of Prices	**R516 646 856.37**
	12,5% Contingencies	R64 580 857.05
	Subtotal	**R581 227 713.42**
	15% VAT	R87 184 157.01
	Estimated Order Magnitude	**R668 411 870.43**

11 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

- All internal water, sewer, roads, and stormwater will have to be designed in accordance with Emfuleni Local Municipality guidelines and standards.
- The Langerand Reservoir will supply the newly proposed development. Currently, there is no spare capacity at the Langerand but the introduction of a new supply zone with reservoir TWL 1570 m will remove all pressure on the system.
- The Leeuwkuil wastewater treatment works, need to be upgraded and rehabilitated. The impact in which this new development will have on the existing infrastructure will have to be addressed in a detailed GLS report.
- Additional capacity analysis of the existing link network pipes in Sonland Park and Unitas Park AH will be required with a GLS report to determine if and any upgrades are required on the network pipes for both the water pipes. at the time of this report, the time and budget did not allow for this level of investigation.
- Additional services (Roads and stormwater, Water, and Sewer) would need to be installed to accommodate the new proposed development layout.

11.2 Recommendations

- Significant parts of the sanitation system infrastructure, including Leeuwkuil wastewater treatment works, need to be upgraded and rehabilitated.
- A new water supply zone with reservoir TWL 1570 will need to be introduced to increase the capacity of the Langerand Reservoir.
- Phumaf is proposing a new on-site 2x10MLPD aboveground Steel Tank Sewer Wastewater Treatment Facility (Plant) (WWTP) which if Emfuleni agrees and permit will be designed and be constructed on the erf reserved for engineering infrastructure on the layout, this erf is positioned on the southwestern corner of the proposed development.
- The proposal report for this Steel Tank Above Ground Biological Wastewater Treatment Plant is prepared by SEWTREAT and is attached in this report as Annexure K.

It is recommended that this report be approved to enable us to proceed to the next stage of Detailed Design.

ANNEXURE A

PROPOSED DRAFT LAYOUT AND LOCALITY PLAN

PROPOSED LAYOUT: UNITAS EXTENSION 16

BAR SCALE: 1: 7000	200m	200m	200m	200m	200m	200m	200m	200m	200m	200m

SITUATED ON: PORTION 22 OF THE FARM HOUTKOP 594 IQ

LOCAL AUTHORITY: EMFULENI LM

PROVINCE: GAUTENG

SCALE: 1: 7000

LOCALITY

NORTH

NOTES

1. FIGURE **A,B,C,D,E,F,G,H,J,K,L,M,N,P,Q,R,S,T,U,V, W,X,Y,Z,1A,1B,A** REPRESENTS A PORTION OF PORTION 22 OF THE FARM HOUTKOP 594 IQ, MEASURING **151Ha** IN EXTENT.
2. COORDINATE SYSTEM: WG 27
3. ALL AREAS AND DIMENSIONS ARE APPROXIMATE AND SUBJECT TO FINAL SURVEY.

LEGEND

1. PROPOSED LAND USES

- RESIDENTIAL LOWER DENSITY
- RESIDENTIAL MEDIUM DENSITY
- RESIDENTIAL HIGHER DENSITY
- MIXED USE
- STUDENT VILLAGE
- INNOVATION/INCUBATION HUB
- SOCIAL
- EDUCATIONAL
- PUBLIC OPEN SPACE
- SPORTS FACILITY
- INFRASTRUCTURE

DETAILS

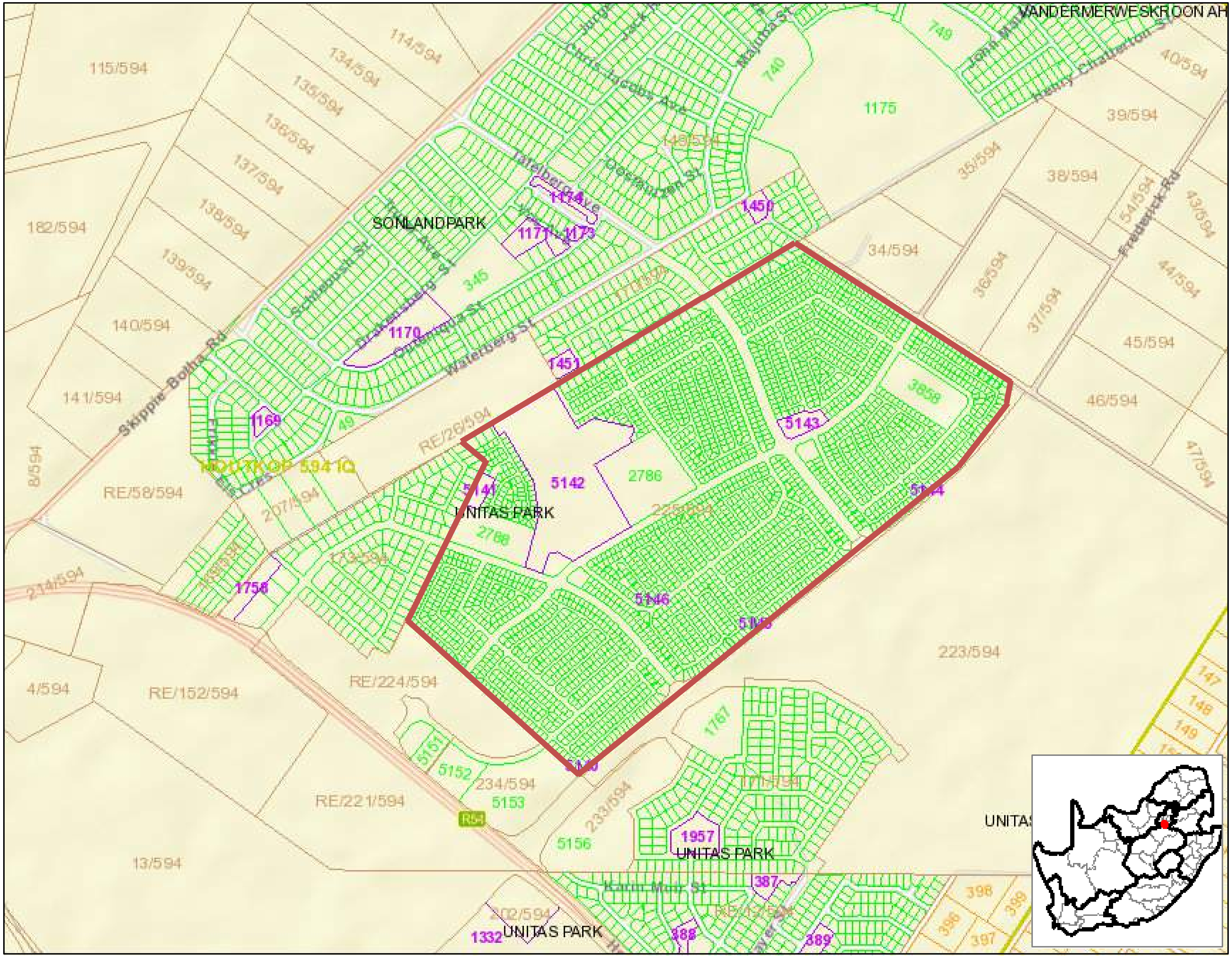
DATE: 2021-02-22
DRAWN: RF MENTZ
SCALE: 1: 7000 (A3)
DRAWING NO: N/A

METROPLAN

PROJECT NUMBER: MP- 1367

PLAN NO 1

ArcGIS Web Map



Scale 1:18 056

0 0,225 0,45 0,9 km

Department of Rural development and land reforrm

Chief Surveyor General Property Search (April 2018 Version)

May 11, 2020

Legend

- Provinces
- Parent Farm
- Farm Portion
- Allotment Township
- Holding
- Public Place
- Erven

N

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Web AppBuilder for ArcGIS

Esri South Africa, Esri, HERE, Garmin, NGA, USGS |

ENGINEER:	CLIENT	PROJECT TITLE	DRAWING TITLE:
PHUMAF P.O. BOX 4049 RANDBURG-2125 FIRST FLOOR 24 PETER PLACE LYME PARK BRAYNSTON 2191 TEL (011)326-0741/90	GAUTENG PROVINCE HUMAN SETTLEMENTS REPUBLIC OF SOUTH AFRICA	RAPID LAND RELEASE PROGRAMME UNITAS PARK EXT.16	LOCALITY MAP SHOWING MAJOR ROAD NETWORK

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

NO.	DATE	REVISION	BY
A	10/2019	BULK INVESTIGATION	
B	03/2021	PDR	

SCALE	DATE	DESIGNED	DRAWN	CHECKED
NTS.	03/2021			Maboho R-P

DRAWING NO. 7001/L0/U001

REVISION B

ANNEXURE B

7001/S/U001 (SHEET 1 OF 4)

COORDINATE LIST

WG 27

Unitas Sewer Network 2

MH No.	YLo	XLo
Constant:		
MH1	−89467.598	2946318.317
MH2	−89477.390	2946389.588
MH3	−89480.772	2946428.446
MH4	−89467.328	2946477.122
MH5	−89453.867	2946525.855
MH6	−89441.146	2946571.914
MH7	−89438.464	2946573.900
MH8	−89371.513	2946550.188
MH9	−89363.169	2946573.754
MH10	−89370.175	2946590.232
MH11	−89355.288	2946632.215
MH12	−89335.991	2946686.633
MH13	−89370.519	2946716.747
MH14	−89405.048	2946746.860
MH15	−89360.054	2946798.451
MH16	−89315.061	2946850.041
MH17	−89270.067	2946901.632
MH18	−89328.517	2946953.253
MH19	−89386.967	2947004.875
MH20	−89445.416	2947056.497
MH21	−89503.866	2947108.119
MH22	−89562.315	2947159.742
MH23	−89581.193	2947175.560
MH24	−89252.396	2946508.000
MH25	−89298.942	2946524.485
MH26	−89345.487	2946540.970
MH27	−89452.524	2946692.423
MH28	−89080.486	2946734.209
MH29	−89127.881	2946776.065
MH30	−89175.277	2946817.920
MH31	−89222.672	2946859.776
MH32	−89440.247	2946765.075
MH33	−89492.341	2946811.081
MH34	−89544.436	2946857.088
MH35	−89596.530	2946903.095
MH36	−89606.406	2946919.157
MH37	−89622.896	2946933.720
MH38	−89588.746	2946972.878
MH39	−89602.311	2946984.709
MH40	−89613.420	2946991.750
MH41	−89629.906	2947006.318
MH42	−89588.259	2947054.071
MH43	−89546.612	2947101.825
MH44	−89560.682	2947114.251
MH45	−89568.160	2947123.546
MH46	−89582.826	2947136.499
MH47	−89629.726	2946720.283
MH48	−89665.382	2946751.773
MH49	−89701.039	2946783.262
MH50	−89666.203	2946823.207
MH51	−89631.366	2946863.151
MH52	−89604.266	2946768.507
MH53	−89635.234	2946795.857
MH54	−89606.909	2946725.481
MH55	−89578.114	2946758.086
MH56	−89549.319	2946790.691
MH57	−89590.343	2946826.921
MH58	−89666.906	2946883.258
MH59	−89401.494	2946809.571
MH60	−89445.070	2946847.574
MH61	−89488.646	2946885.578
MH62	−89532.222	2946923.582
MH63	−89706.632	2946918.342
MH64	−89668.269	2946962.330
MH65	−89366.410	2946849.298
MH66	−89406.803	2946884.525
MH67	−89447.196	2946919.753
MH68	−89487.589	2946954.981
MH69	−89452.754	2946994.923
MH70	−89458.556	2947008.049
MH71	−89475.136	2947022.509
MH72	−89467.102	2947031.606
MH73	−89493.080	2947054.548
MH74	−89506.453	2947066.359
MH75	−89532.806	2947089.632
MH76	−89331.662	2946888.650
MH77	−89372.026	2946924.074
MH78	−89412.390	2946959.499
MH79	−89519.221	2946971.961
MH80	−89558.845	2947006.953
MH81	−89625.834	2947087.761

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 2	(m)	(mm)
MH1 – MH2	71.940	160mm HDPE–PE100 Class PN10
MH2 – MH3	39.005	160mm HDPE–PE100 Class PN10
MH3 – MH4	50.498	160mm HDPE–PE100 Class PN10
MH4 – MH5	50.558	160mm HDPE–PE100 Class PN10
MH5 – MH6	47.783	160mm HDPE–PE100 Class PN10
MH6 – MH7	3.337	160mm HDPE–PE100 Class PN10
MH7 – MH8	71.026	160mm HDPE–PE100 Class PN10
MH8 – MH9	25.000	160mm HDPE–PE100 Class PN10
MH9 – MH10	17.905	160mm HDPE–PE100 Class PN10
MH10 – MH11	44.544	160mm HDPE–PE100 Class PN10
MH11 – MH12	57.739	160mm HDPE–PE100 Class PN10
MH12 – MH13	45.815	160mm HDPE–PE100 Class PN10
MH13 – MH14	45.815	160mm HDPE–PE100 Class PN10
MH14 – MH15	68.454	160mm HDPE–PE100 Class PN10
MH15 – MH16	68.454	160mm HDPE–PE100 Class PN10
MH16 – MH17	68.454	160mm HDPE–PE100 Class PN10
MH17 – MH18	77.982	160mm HDPE–PE100 Class PN10
MH18 – MH19	77.982	160mm HDPE–PE100 Class PN10
MH19 – MH20	77.982	160mm HDPE–PE100 Class PN10
MH20 – MH21	77.982	160mm HDPE–PE100 Class PN10
MH21 – MH22	77.982	160mm HDPE–PE100 Class PN10
MH22 – MH23	24.629	250mm HDPE–PE100 Class PN10
MH24 – MH25	49.378	160mm HDPE–PE100 Class PN10
MH25 – MH26	49.378	160mm HDPE–PE100 Class PN10
MH26 – MH9	37.248	160mm HDPE–PE100 Class PN10
MH27 – MH14	72.231	160mm HDPE–PE100 Class PN10
MH28 – MH29	63.232	160mm HDPE–PE100 Class PN10
MH29 – MH30	63.232	160mm HDPE–PE100 Class PN10
MH30 – MH31	63.232	160mm HDPE–PE100 Class PN10
MH31 – MH17	63.232	160mm HDPE–PE100 Class PN10
MH32 – MH33	69.501	160mm HDPE–PE100 Class PN10
MH33 – MH34	69.501	160mm HDPE–PE100 Class PN10
MH34 – MH35	69.501	160mm HDPE–PE100 Class PN10
MH35 – MH36	18.855	160mm HDPE–PE100 Class PN10
MH36 – MH37	22.000	160mm HDPE–PE100 Class PN10
MH37 – MH38	51.958	160mm HDPE–PE100 Class PN10
MH38 – MH39	18.000	200mm HDPE–PE100 Class PN10
MH39 – MH40	13.152	200mm HDPE–PE100 Class PN10
MH40 – MH41	22.001	200mm HDPE–PE100 Class PN10
MH41 – MH42	63.363	200mm HDPE–PE100 Class PN10
MH42 – MH43	63.363	200mm HDPE–PE100 Class PN10
MH43 – MH44	18.771	200mm HDPE–PE100 Class PN10
MH44 – MH45	11.930	200mm HDPE–PE100 Class PN10
MH45 – MH46	19.567	200mm HDPE–PE100 Class PN10
MH46 – MH22	30.999	200mm HDPE–PE100 Class PN10
MH47 – MH48	47.571	160mm HDPE–PE100 Class PN10
MH48 – MH49	47.571	160mm HDPE–PE100 Class PN10
MH49 – MH50	53.001	160mm HDPE–PE100 Class PN10
MH50 – MH51	53.001	160mm HDPE–PE100 Class PN10
MH51 – MH35	53.001	160mm HDPE–PE100 Class PN10
MH52 – MH53	41.317	160mm HDPE–PE100 Class PN10
MH53 – MH50	41.316	160mm HDPE–PE100 Class PN10
MH54 – MH55	43.500	160mm HDPE–PE100 Class PN10
MH55 – MH56	43.500	160mm HDPE–PE100 Class PN10
MH56 – MH57	54.732	160mm HDPE–PE100 Class PN10
MH57 – MH51	54.731	160mm HDPE–PE100 Class PN10
MH58 – MH37	66.957	160mm HDPE–PE100 Class PN10
MH59 – MH60	57.820	160mm HDPE–PE100 Class PN10
MH60 – MH61	57.820	160mm HDPE–PE100 Class PN10
MH61 – MH62	57.820	160mm HDPE–PE100 Class PN10
MH62 – MH38	75.000	160mm HDPE–PE100 Class PN10
MH63 – MH64	58.367	160mm HDPE–PE100 Class PN10
MH64 – MH41	58.367	160mm HDPE–PE100 Class PN10
MH65 – MH66	53.596	160mm HDPE–PE100 Class PN10
MH66 – MH67	53.596	160mm HDPE–PE100 Class PN10
MH67 – MH68	53.596	160mm HDPE–PE100 Class PN10
MH68 – MH69	52.998	160mm HDPE–PE100 Class PN10
MH69 – MH70	14.351	160mm HDPE–PE100 Class PN10
MH70 – MH71	22.000	160mm HDPE–PE100 Class PN10
MH71 – MH72	12.137	160mm HDPE–PE100 Class PN10
MH72 – MH73	34.658	160mm HDPE–PE100 Class PN10
MH73 – MH74	17.842	160mm HDPE–PE100 Class PN10
MH74 – MH75	35.159	160mm HDPE–PE100 Class PN10
MH75 – MH43	18.419	160mm HDPE–PE100 Class PN10
MH76 – MH77	53.704	160mm HDPE–PE100 Class PN10
MH77 – MH78	53.704	160mm HDPE–PE100 Class PN10
MH78 – MH69	53.704	160mm HDPE–PE100 Class PN10
MH79 – MH71	67.071	160mm HDPE–PE100 Class PN10
MH80 – MH74	79.208	160mm HDPE–PE100 Class PN10
MH81 – MH46	65.000	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
250mm HDPE–PE100 Class PN10	24.63
200mm HDPE–PE100 Class PN10	261.15
160mm HDPE–PE100 Class PN10	3634.85
Total :	3920.63

COORDINATE LIST

WG 27

Unitas Sewer Network 1

MH No.	YLo	XLo
Constant:		
MH82	−90255.747	2945635.826
MH83	−90203.796	2945665.804
MH84	−90151.846	2945695.782
MH85	−90099.895	2945725.759
MH86	−90132.715	2945791.098
MH87	−90165.536	2945856.436
MH88	−90198.356	2945921.775
MH89	−90234.566	2945993.807
MH90	−90259.624	2946043.656
MH91	−90258.031	2946048.470
MH92	−90269.582	2946063.466
MH93	−90303.383	2946130.705
MH94	−90323.547	2946157.033
MH95	−90337.790	2946183.854
MH96	−90376.263	2946234.089
MH97	−90414.736	2946284.324
MH98	−90457.693	2946340.850
MH99	−90481.749	2946372.661
MH100	−90513.795	2946415.036
MH101	−90532.496	2946439.765
MH102	−90540.213	2946449.970
MH103	−90525.604	2946461.160
MH104	−90473.669	2946483.173
MH105	−90413.928	2946528.923
MH106	−90379.136	2946573.315
MH107	−90365.543	2946583.724
MH108	−90356.167	2946571.480
MH109	−90294.316	2946616.812
MH110	−90232.465	2946662.144
MH111	−90170.614	2946707.476
MH112	−90108.763	2946752.807
MH113	−90046.913	2946798.139
MH114	−89984.573	2946843.830
MH115	−89923.211	2946888.803
MH116	−89920.105	2946884.566
MH117	−89902.408	2946897.537
MH118	−89865.967	2946924.245
MH119	−89863.059	2946950.784
MH120	−89828.351	2946995.069
MH121	−89808.209	2947010.317
MH122	−89765.527	2947044.396
MH123	−89722.846	2947078.475
MH124	−89677.875	2947117.712
MH125	−89660.404	2947102.282
MH126	−89655.441	2947107.901
MH127	−90119.507	2945961.411
MH128	−90158.597	2945941.763
MH129	−90142.366	2945736.921
MH130	−90173.552	2945798.960
MH131	−90204.738	2945860.998
MH132	−90235.924	2945923.036
MH133	−90262.161	2945975.229
MH134	−90288.399	2946027.423
MH135	−90182.541	2946086.419
MH136	−90219.951	2946067.613
MH137	−90272.264	2945631.747
MH138	−90333.127	2945672.315
MH139	−90393.991	2945712.883
MH140	−90370.287	2945748.446
MH141	−90346.583	2945784.008
MH142	−90344.829	2945800.368
MH143	−90366.784	2945815.003
MH144	−90403.396	2945839.407
MH145	−90447.150	2945868.571
MH146	−90456.443	2945874.767
MH147	−90458.217	2945883.656
MH148	−90428.106	2945928.720
MH149	−90410.843	2945942.606
MH150	−90454.714	2945990.012
MH151	−90485.797	2946023.600
MH152	−90485.068	2946032.126
MH153	−90435.533	2946070.063
MH154	−90385.997	2946108.000
MH155	−90336.462	2946145.937
MH156	−90364.870	2945729.527
MH157	−90335.440	2945773.680
MH158	−90447.380	2945773.419
MH159	−90473.417	2945765.828
MH160	−90502.694	2945785.341

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 1	(m)	(mm)
MH82 – MH83	59.979	160mm HDPE–PE100 Class PN10
MH83 – MH84	59.979	160mm HDPE–PE100 Class PN10
MH84 – MH85	59.979	160mm HDPE–PE100 Class PN10
MH85 – MH86	73.118	160mm HDPE–PE100 Class PN10
MH86 – MH87	73.118	160mm HDPE–PE100 Class PN10
MH87 – MH88	73.118	160mm HDPE–PE100 Class PN10
MH88 – MH89	80.621	160mm HDPE–PE100 Class PN10
MH89 – MH90	55.793	160mm HDPE–PE100 Class PN10
MH90 – MH91	5.071	200mm HDPE–PE100 Class PN10
MH91 – MH92	18.929	250mm HDPE–PE100 Class PN10
MH92 – MH93	75.257	250mm HDPE–PE100 Class PN10
MH93 – MH94	33.163	250mm HDPE–PE100 Class PN10
MH94 – MH95	30.368	315mm HDPE–PE100 Class PN10
MH95 – MH96	63.275	315mm HDPE–PE100 Class PN10
MH96 – MH97	63.275	315mm HDPE–PE100 Class PN10
MH97 – MH98	70.997	315mm HDPE–PE100 Class PN10
MH98 – MH99	39.883	400mm HDPE–PE100 Class PN10
MH99 – MH100	53.128	400mm HDPE–PE100 Class PN10
MH100 – MH101	31.004	400mm HDPE–PE100 Class PN10
MH101 – MH102	12.795	450mm HDPE–PE100 Class PN10
MH102 – MH103	18.402	450mm HDPE–PE100 Class PN10
MH103 – MH104	56.408	450mm HDPE–PE100 Class PN10
MH104 – MH105	75.247	450mm HDPE–PE100 Class PN10
MH105 – MH106	56.401	450mm HDPE–PE100 Class PN10
MH106 – MH107	17.121	450mm HDPE–PE100 Class PN10
MH107 – MH108	15.422	450mm HDPE–PE100 Class PN10
MH108 – MH109	76.684	450mm HDPE–PE100 Class PN10
MH109 – MH110	76.684	450mm HDPE–PE100 Class PN10
MH110 – MH111	76.684	450mm HDPE–PE100 Class PN10
MH111 – MH112	76.684	450mm HDPE–PE100 Class PN10
MH112 – MH113	76.684	450mm HDPE–PE100 Class PN10
MH113 – MH114	77.291	450mm HDPE–PE100 Class PN10
MH114 – MH115	76.078	450mm HDPE–PE100 Class PN10
MH115 – MH116	5.254	450mm HDPE–PE100 Class PN10
MH116 – MH117	21.942	500mm HDPE–PE100 Class PN10
MH117 – MH118	45.181	500mm HDPE–PE100 Class PN10
MH118 – MH119	26.697	500mm HDPE–PE100 Class PN10
MH119 – MH120	56.266	500mm HDPE–PE100 Class PN10
MH120 – MH121	25.263	500mm HDPE–PE100 Class PN10
MH121 – MH122	54.618	500mm HDPE–PE100 Class PN10
MH122 – MH123	54.618	500mm HDPE–PE100 Class PN10
MH123 – MH124	59.682	500mm HDPE–PE100 Class PN10
MH124 – MH125	23.309	500mm HDPE–PE100 Class PN10
MH125 – MH126	7.497	500mm HDPE–PE100 Class PN10
MH127 – MH128	43.750	160mm HDPE–PE100 Class PN10
MH128 – MH88	44.500	160mm HDPE–PE100 Class PN10
MH129 – MH130	69.436	160mm HDPE–PE100 Class PN10
MH130 – MH131	69.436	160mm HDPE–PE100 Class PN10
MH131 – MH132	69.436	160mm HDPE–PE100 Class PN10
MH132 – MH133	58.417	160mm HDPE–PE100 Class PN10
MH133 – MH134	58.417	160mm HDPE–PE100 Class PN10
MH134 – MH90	33.038	160mm HDPE–PE100 Class PN10
MH135 – MH136	41.871	160mm HDPE–PE100 Class PN10
MH136 – MH91	42.621	160mm HDPE–PE100 Class PN10
MH137 – MH138	73.145	160mm HDPE–PE100 Class PN10
MH138 – MH139	73.145	160mm HDPE–PE100 Class PN10
MH139 – MH140	42.739	160mm HDPE–PE100 Class PN10
MH140 – MH141	42.738	160mm HDPE–PE100 Class PN10
MH141 – MH142	16.454	160mm HDPE–PE100 Class PN10
MH142 – MH143	26.386	160mm HDPE–PE100 Class PN10
MH143 – MH144	44.000	160mm HDPE–PE100 Class PN10
MH144 – MH145	52.583	160mm HDPE–PE100 Class PN10
MH145 – MH146	11.169	160mm HDPE–PE100 Class PN10
MH146 – MH147	9.065	160mm HDPE–PE100 Class PN10
MH147 – MH148	54.198	160mm HDPE–PE100 Class PN10
MH148 – MH149	22.154	160mm HDPE–PE100 Class PN10
MH149 – MH150	64.591	160mm HDPE–PE100 Class PN10
MH150 – MH151	45.764	160mm HDPE–PE100 Class PN10
MH151 – MH152	8.556	160mm HDPE–PE100 Class PN10
MH152 – MH153	62.394	200mm HDPE–PE100 Class PN10
MH153 – MH154	62.394	200mm HDPE–PE100 Class PN10
MH154 – MH155	62.394	250mm HDPE–PE100 Class PN10
MH155 – MH94	17.027	250mm HDPE–PE100 Class PN10
MH156 – MH157	53.062	160mm HDPE–PE100 Class PN10
MH157 – MH141	15.193	160mm HDPE–PE100 Class PN10
MH158 – MH144	79.303	160mm HDPE–PE100 Class PN10
MH159 – MH160	35.184	160mm HDPE–PE100 Class PN10
MH160 – MH161	50.031	160mm HDPE–PE100 Class PN10
MH161 – MH145	50.031	160mm HDPE–PE100 Class PN10
MH162 – MH160	19.566	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
COORDINATE LIST AND PIPE DATA LIST
SHEET 1 OF 3

REF. NO. –	DESIGNER R. MABOHO
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/A001

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

MH No.	Unitas Sewer Network 1 YLo	XLo
Constant:		
MH162	−90518.975	2945796.193
MH163	−90233.950	2945683.100
MH164	−90241.588	2945698.294
MH165	−90274.372	2945763.512
MH166	−90293.015	2945800.597
MH167	−90322.547	2945859.345
MH168	−90326.118	2945857.550
MH169	−90328.316	2945861.921
MH170	−90346.626	2945873.213
MH171	−90378.735	2945907.910
MH172	−90264.860	2945671.114
MH173	−90271.152	2945683.631
MH174	−90294.307	2945686.669
MH175	−90327.307	2945722.605
MH176	−90292.242	2945754.529
MH177	−90189.720	2945713.117
MH178	−90218.211	2945769.794
MH179	−90246.365	2945825.802
MH180	−90275.193	2945883.149
MH181	−90339.969	2945850.587
MH182	−90314.780	2945995.701
MH183	−90362.484	2945969.335
MH184	−90582.385	2945887.767
MH185	−90549.946	2945935.887
MH186	−90517.507	2945984.006
MH187	−90227.604	2946186.631
MH188	−90247.853	2946193.520
MH189	−90285.362	2946175.439
MH190	−90727.836	2945935.402
MH191	−90780.200	2945970.304
MH192	−90831.940	2946004.789
MH193	−90885.521	2946040.502
MH194	−90883.474	2946043.573
MH195	−90868.150	2946080.096
MH196	−90851.373	2946120.085
MH197	−90809.731	2946170.178
MH198	−90768.089	2946220.271
MH199	−90726.447	2946270.364
MH200	−90681.064	2946312.709
MH201	−90635.682	2946355.054
MH202	−90590.299	2946397.399
MH203	−90706.620	2945944.696
MH204	−90676.916	2945989.262
MH205	−90647.212	2946033.827
MH206	−90609.792	2946068.743
MH207	−90572.372	2946103.658
MH208	−90574.937	2946107.007
MH209	−90621.653	2946157.075
MH210	−90638.657	2946175.298
MH211	−90640.505	2946179.774
MH212	−90612.869	2946206.271
MH213	−90574.340	2946242.695
MH214	−90549.401	2946265.987
MH215	−90532.446	2946281.784
MH216	−90517.991	2946295.272
MH217	−90501.794	2946308.528
MH218	−90486.949	2946319.408
MH219	−90635.526	2946142.613
MH220	−90687.460	2946021.941
MH221	−90738.761	2946061.577
MH222	−90713.527	2946091.931
MH223	−90694.370	2946114.977
MH224	−90665.533	2946149.665
MH225	−90646.985	2946070.967
MH226	−90657.614	2946082.271
MH227	−90667.710	2946092.585
MH228	−90680.568	2946103.415
MH229	−90602.392	2946195.042
MH230	−90520.964	2946185.483
MH231	−90477.402	2946217.789
MH232	−90504.924	2946249.786
MH233	−90526.898	2946141.902
MH234	−90486.030	2946175.283
MH235	−90433.710	2946215.353
MH236	−90417.037	2946228.122
MH237	−90451.993	2946273.765
MH238	−90720.490	2945972.568
MH239	−90766.052	2946002.936
MH240	−90802.640	2946019.522
MH241	−90780.235	2946074.521
MH242	−90743.019	2946119.849
MH243	−90705.828	2946164.184
MH244	−90669.112	2946207.939
MH245	−90656.444	2946220.746
MH246	−90623.503	2946251.482

PIPE DATA LIST

MH – MH Unitas Sewer Network 1	Distance (m)	Diam. (mm)
MH163 – MH164	17.005	160mm HDPE–PE100 Class PN10
MH164 – MH165	72.995	160mm HDPE–PE100 Class PN10
MH165 – MH166	41.507	160mm HDPE–PE100 Class PN10
MH166 – MH167	65.753	160mm HDPE–PE100 Class PN10
MH167 – MH168	3.997	160mm HDPE–PE100 Class PN10
MH168 – MH169	4.893	160mm HDPE–PE100 Class PN10
MH169 – MH170	21.513	160mm HDPE–PE100 Class PN10
MH170 – MH171	47.274	160mm HDPE–PE100 Class PN10
MH171 – MH149	47.273	160mm HDPE–PE100 Class PN10
MH172 – MH173	14.009	160mm HDPE–PE100 Class PN10
MH173 – MH164	33.001	160mm HDPE–PE100 Class PN10
MH174 – MH175	48.790	160mm HDPE–PE100 Class PN10
MH175 – MH176	47.421	160mm HDPE–PE100 Class PN10
MH176 – MH165	20.000	160mm HDPE–PE100 Class PN10
MH177 – MH178	63.436	160mm HDPE–PE100 Class PN10
MH178 – MH179	62.686	160mm HDPE–PE100 Class PN10
MH179 – MH180	64.186	160mm HDPE–PE100 Class PN10
MH180 – MH167	53.000	160mm HDPE–PE100 Class PN10
MH181 – MH168	15.503	160mm HDPE–PE100 Class PN10
MH182 – MH183	54.505	160mm HDPE–PE100 Class PN10
MH183 – MH149	55.255	160mm HDPE–PE100 Class PN10
MH184 – MH185	58.033	160mm HDPE–PE100 Class PN10
MH185 – MH186	58.033	160mm HDPE–PE100 Class PN10
MH186 – MH152	58.033	160mm HDPE–PE100 Class PN10
MH187 – MH188	21.389	160mm HDPE–PE100 Class PN10
MH188 – MH189	41.640	160mm HDPE–PE100 Class PN10
MH189 – MH94	42.389	160mm HDPE–PE100 Class PN10
MH190 – MH191	62.929	160mm HDPE–PE100 Class PN10
MH191 – MH192	62.179	160mm HDPE–PE100 Class PN10
MH192 – MH193	64.391	160mm HDPE–PE100 Class PN10
MH193 – MH194	3.691	160mm HDPE–PE100 Class PN10
MH194 – MH195	39.607	160mm HDPE–PE100 Class PN10
MH195 – MH196	43.366	160mm HDPE–PE100 Class PN10
MH196 – MH197	65.141	160mm HDPE–PE100 Class PN10
MH197 – MH198	65.141	160mm HDPE–PE100 Class PN10
MH198 – MH199	65.141	160mm HDPE–PE100 Class PN10
MH199 – MH200	62.070	160mm HDPE–PE100 Class PN10
MH200 – MH201	62.070	160mm HDPE–PE100 Class PN10
MH201 – MH202	62.070	160mm HDPE–PE100 Class PN10
MH202 – MH101	71.667	160mm HDPE–PE100 Class PN10
MH203 – MH204	53.558	160mm HDPE–PE100 Class PN10
MH204 – MH205	53.558	160mm HDPE–PE100 Class PN10
MH205 – MH206	51.180	160mm HDPE–PE100 Class PN10
MH206 – MH207	51.180	160mm HDPE–PE100 Class PN10
MH207 – MH208	4.218	160mm HDPE–PE100 Class PN10
MH208 – MH209	68.478	160mm HDPE–PE100 Class PN10
MH209 – MH210	24.924	200mm HDPE–PE100 Class PN10
MH210 – MH211	4.842	200mm HDPE–PE100 Class PN10
MH211 – MH212	38.286	200mm HDPE–PE100 Class PN10
MH212 – MH213	53.021	200mm HDPE–PE100 Class PN10
MH213 – MH214	34.125	200mm HDPE–PE100 Class PN10
MH214 – MH215	23.174	200mm HDPE–PE100 Class PN10
MH215 – MH216	19.770	200mm HDPE–PE100 Class PN10
MH216 – MH217	20.931	200mm HDPE–PE100 Class PN10
MH217 – MH218	18.404	200mm HDPE–PE100 Class PN10
MH218 – MH98	36.273	250mm HDPE–PE100 Class PN10
MH219 – MH209	20.040	160mm HDPE–PE100 Class PN10
MH220 – MH221	64.828	160mm HDPE–PE100 Class PN10
MH221 – MH222	39.473	160mm HDPE–PE100 Class PN10
MH222 – MH223	29.968	160mm HDPE–PE100 Class PN10
MH223 – MH224	45.109	160mm HDPE–PE100 Class PN10
MH224 – MH211	39.153	160mm HDPE–PE100 Class PN10
MH225 – MH226	15.516	160mm HDPE–PE100 Class PN10
MH226 – MH227	14.433	160mm HDPE–PE100 Class PN10
MH227 – MH228	16.812	160mm HDPE–PE100 Class PN10
MH228 – MH223	18.004	160mm HDPE–PE100 Class PN10
MH229 – MH212	15.358	160mm HDPE–PE100 Class PN10
MH230 – MH213	78.244	160mm HDPE–PE100 Class PN10
MH231 – MH232	42.206	160mm HDPE–PE100 Class PN10
MH232 – MH215	42.206	160mm HDPE–PE100 Class PN10
MH233 – MH234	52.767	160mm HDPE–PE100 Class PN10
MH234 – MH235	65.902	160mm HDPE–PE100 Class PN10
MH235 – MH236	21.000	160mm HDPE–PE100 Class PN10
MH236 – MH237	57.491	160mm HDPE–PE100 Class PN10
MH237 – MH218	57.491	160mm HDPE–PE100 Class PN10
MH238 – MH239	54.754	160mm HDPE–PE100 Class PN10
MH239 – MH240	40.172	160mm HDPE–PE100 Class PN10
MH240 – MH241	59.388	160mm HDPE–PE100 Class PN10
MH241 – MH242	58.648	160mm HDPE–PE100 Class PN10
MH242 – MH243	57.869	160mm HDPE–PE100 Class PN10
MH243 – MH244	57.119	160mm HDPE–PE100 Class PN10
MH244 – MH245	18.015	160mm HDPE–PE100 Class PN10
MH245 – MH246	45.054	160mm HDPE–PE100 Class PN10
MH246 – MH247	59.734	160mm HDPE–PE100 Class PN10
MH247 – MH248	58.987	160mm HDPE–PE100 Class PN10
MH248 – MH99	68.085	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST

WG 27

MH No. Constant:	Unitas Sewer Network 1 YLo	XLo
MH247	−90579.828	2946292.233
MH248	−90536.750	2946332.529
MH249	−90847.425	2946049.367
MH250	−90824.577	2946103.826
MH251	−90784.129	2946152.468
MH252	−90743.681	2946201.110
MH253	−90703.234	2946249.752
MH254	−90658.987	2946290.995
MH255	−90614.740	2946332.238
MH256	−90570.493	2946373.481
MH257	−89915.560	2945871.305
MH258	−89950.027	2945939.872
MH259	−89970.452	2945980.502
MH260	−89990.876	2946021.132
MH261	−89996.803	2946023.094
MH262	−90005.786	2946040.963
MH263	−90003.824	2946046.890
MH264	−90028.790	2946096.554
MH265	−90053.755	2946146.217
MH266	−90059.988	2946148.280
MH267	−90059.907	2946162.886
MH268	−90083.275	2946211.391
MH269	−90106.642	2946259.895
MH270	−90123.298	2946288.908
MH271	−90162.346	2946341.343
MH272	−90161.032	2946350.319
MH273	−90109.864	2946388.422
MH274	−90056.428	2946428.215
MH275	−90087.092	2946470.052
MH276	−90117.755	2946511.889
MH277	−90087.284	2946534.223
MH278	−90069.539	2946547.228
MH279	−90026.784	2946578.564
MH280	−90015.345	2946586.637
MH281	−90001.804	2946596.932
MH282	−89983.829	2946609.616
MH283	−90020.450	2946661.513
MH284	−89977.603	2946692.719
MH285	−89975.523	2946720.990
MH286	−89986.149	2946736.049
MH287	−89996.721	2946751.198
MH288	−90005.114	2946760.584
MH289	−90018.120	2946778.328
MH290	−89971.390	2946812.577
MH291	−89914.188	2946854.502
MH292	−89922.465	2946865.794
MH293	−90078.631	2945981.959
MH294	−90037.717	2946002.527
MH295	−90141.510	2946107.044
MH296	−90100.749	2946127.662
MH297	−90187.156	2946221.110
MH298	−90146.899	2946240.503
MH299	−89972.416	2946324.556
MH300	−90039.529	2946292.226
MH301	−90296.454	2946282.804
MH302	−90334.100	2946331.976
MH303	−90304.508	2946353.667
MH304	−90301.647	2946374.173
MH305	−90265.490	2946401.052
MH306	−90245.720	2946415.775
MH307	−90239.543	2946414.871
MH308	−90227.742	2946429.161
MH309	−90208.337	2946443.612
MH310	−90246.875	2946495.364
MH311	−90270.767	2946527.446
MH312	−90215.318	2946568.086
MH313	−90159.868	2946608.726
MH314	−90104.419	2946649.366
MH315	−90050.405	2946688.955
MH316	−90382.501	2946312.130
MH317	−90353.276	2946334.559
MH318	−90189.910	2946348.221
MH319	−90162.898	2946382.593
MH320	−90283.022	2946518.464
MH321	−90116.869	2946416.870
MH322	−90158.727	2946473.080
MH323	−90200.586	2946529.290
MH324	−90141.713	2946572.446
MH325	−90081.186	2946616.902
MH326	−90291.955	2946485.824
MH327	−90324.061	2946528.652
MH328	−90314.347	2946561.216
MH329	−90254.815	2946604.849
MH330	−90195.282	2946648.481
MH331	−90135.750	2946692.114

PIPE DATA LIST

MH – MH Unitas Sewer Network 1	Distance (m)	Diam. (mm)
MH249 – MH250	59.058	160mm HDPE–PE100 Class PN10
MH250 – MH251	63.262	160mm HDPE–PE100 Class PN10
MH251 – MH252	63.262	160mm HDPE–PE100 Class PN10
MH252 – MH253	63.262	160mm HDPE–PE100 Class PN10
MH253 – MH254	60.488	160mm HDPE–PE100 Class PN10
MH254 – MH255	60.488	160mm HDPE–PE100 Class PN10
MH255 – MH256	60.488	160mm HDPE–PE100 Class PN10
MH256 – MH100	70.296	160mm HDPE–PE100 Class PN10
MH257 – MH258	76.742	160mm HDPE–PE100 Class PN10
MH258 – MH259	45.475	160mm HDPE–PE100 Class PN10
MH259 – MH260	45.475	160mm HDPE–PE100 Class PN10
MH260 – MH261	6.243	160mm HDPE–PE100 Class PN10
MH261 – MH262	20.000	160mm HDPE–PE100 Class PN10
MH262 – MH263	6.243	160mm HDPE–PE100 Class PN10
MH263 – MH264	55.586	160mm HDPE–PE100 Class PN10
MH264 – MH265	55.586	160mm HDPE–PE100 Class PN10
MH265 – MH266	6.565	160mm HDPE–PE100 Class PN10
MH266 – MH267	14.607	200mm HDPE–PE100 Class PN10
MH267 – MH268	53.840	200mm HDPE–PE100 Class PN10
MH268 – MH269	53.840	200mm HDPE–PE100 Class PN10
MH269 – MH270	33.453	250mm HDPE–PE100 Class PN10
MH270 – MH271	65.377	250mm HDPE–PE100 Class PN10
MH271 – MH272	9.071	250mm HDPE–PE100 Class PN10
MH272 – MH273	63.797	250mm HDPE–PE100 Class PN10
MH273 – MH274	66.625	250mm HDPE–PE100 Class PN10
MH274 – MH275	51.871	250mm HDPE–PE100 Class PN10
MH275 – MH276	51.871	250mm HDPE–PE100 Class PN10
MH276 – MH277	37.779	250mm HDPE–PE100 Class PN10
MH277 – MH278	22.001	315mm HDPE–PE100 Class PN10
MH278 – MH279	53.009	315mm HDPE–PE100 Class PN10
MH279 – MH280	14.001	315mm HDPE–PE100 Class PN10
MH280 – MH281	17.010	315mm HDPE–PE100 Class PN10
MH281 – MH282	22.000	315mm HDPE–PE100 Class PN10
MH282 – MH283	63.516	315mm HDPE–PE100 Class PN10
MH283 – MH284	53.006	315mm HDPE–PE100 Class PN10
MH284 – MH285	28.348	315mm HDPE–PE100 Class PN10
MH285 – MH286	18.431	315mm HDPE–PE100 Class PN10
MH286 – MH287	18.473	355mm HDPE–PE100 Class PN10
MH287 – MH288	12.592	355mm HDPE–PE100 Class PN10
MH288 – MH289	22.000	355mm HDPE–PE100 Class PN10
MH289 – MH290	57.936	355mm HDPE–PE100 Class PN10
MH290 – MH291	70.921	400mm HDPE–PE100 Class PN10
MH291 – MH292	14.000	400mm HDPE–PE100 Class PN10
MH292 – MH116	18.920	400mm HDPE–PE100 Class PN10
MH293 – MH294	45.793	160mm HDPE–PE100 Class PN10
MH294 – MH261	45.793	160mm HDPE–PE100 Class PN10
MH295 – MH296	45.679	160mm HDPE–PE100 Class PN10
MH296 – MH266	45.679	160mm HDPE–PE100 Class PN10
MH297 – MH298	44.684	160mm HDPE–PE100 Class PN10
MH298 – MH269	44.685	160mm HDPE–PE100 Class PN10
MH299 – MH300	74.495	160mm HDPE–PE100 Class PN10
MH300 – MH269	74.494	160mm HDPE–PE100 Class PN10
MH301 – MH302	61.928	160mm HDPE–PE100 Class PN10
MH302 – MH303	36.690	160mm HDPE–PE100 Class PN10
MH303 – MH304	20.705	160mm HDPE–PE100 Class PN10
MH304 – MH305	45.053	160mm HDPE–PE100 Class PN10
MH305 – MH306	24.651	160mm HDPE–PE100 Class PN10
MH306 – MH307	6.243	160mm HDPE–PE100 Class PN10
MH307 – MH308	18.533	200mm HDPE–PE100 Class PN10
MH308 – MH309	24.195	200mm HDPE–PE100 Class PN10
MH309 – MH310	64.525	200mm HDPE–PE100 Class PN10
MH310 – MH311	40.001	200mm HDPE–PE100 Class PN10
MH311 – MH312	68.747	200mm HDPE–PE100 Class PN10
MH312 – MH313	68.748	200mm HDPE–PE100 Class PN10
MH313 – MH314	68.748	200mm HDPE–PE100 Class PN10
MH314 – MH315	66.969	200mm HDPE–PE100 Class PN10
MH315 – MH286	79.666	200mm HDPE–PE100 Class PN10
MH316 – MH317	36.840	160mm HDPE–PE100 Class PN10
MH317 – MH302	19.350	160mm HDPE–PE100 Class PN10
MH318 – MH307	83.100	160mm HDPE–PE100 Class PN10
MH319 – MH309	76.079	160mm HDPE–PE100 Class PN10
MH320 – MH311	15.195	160mm HDPE–PE100 Class PN10
MH321 – MH322	70.084	160mm HDPE–PE100 Class PN10
MH322 – MH323	70.084	160mm HDPE–PE100 Class PN10
MH323 – MH324	72.996	160mm HDPE–PE100 Class PN10
MH324 – MH325	75.099	160mm HDPE–PE100 Class PN10
MH325 – MH283	75.359	160mm HDPE–PE100 Class PN10
MH326 – MH327	53.526	160mm HDPE–PE100 Class PN10
MH327 – MH108	53.526	160mm HDPE–PE100 Class PN10
MH328 – MH329	73.810	160mm HDPE–PE100 Class PN10
MH329 – MH330	73.810	160mm HDPE–PE100 Class PN10
MH330 – MH331	73.810	160mm HDPE–PE100 Class PN10
MH331 – MH332	66.187	160mm HDPE–PE100 Class PN10
MH332 – MH289	79.655	160mm HDPE–PE100 Class PN10
MH333 – MH334	62.287	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre

Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 2 OF 3

REF. NO.	—	DESIGNER	R. MABOHO	Maboho R.P
SCALE	1:1500	DRAWING	F. MAZIBUKO	
DATE	03/2021	CHECKED	S. MNGUNI	

TYPE NUMBER

DRAWING NUMBER

7001/S/A002

A1

100mm ON ORIGINAL DRAWING

COORDINATE LIST

WG 27

MH No.	Unitas Sewer Network 1	
Constant:	YLo	XLo
MH332	−90082.366	2946731.240
MH333	−89997.716	2946445.445
MH334	−90033.627	2946496.337
MH335	−89886.170	2945849.462
MH336	−89841.506	2945875.398
MH337	−89796.842	2945901.333
MH338	−89824.297	2945949.029
MH339	−89851.752	2945996.726
MH340	−89879.207	2946044.422
MH341	−89906.662	2946092.119
MH342	−89934.102	2946139.631
MH343	−89881.474	2946170.075
MH344	−89923.211	2946235.852
MH345	−89892.190	2946257.742
MH346	−89917.320	2946293.356
MH347	−89942.451	2946328.970
MH348	−89970.138	2946368.206
MH349	−89996.426	2946405.459
MH350	−89994.883	2946414.398
MH351	−89938.845	2946453.942
MH352	−89982.814	2946516.253
MH353	−89779.292	2945911.524
MH354	−89871.713	2945892.548
MH355	−89901.985	2945948.782
MH356	−89932.037	2946004.606
MH357	−89962.200	2946060.635
MH358	−89990.726	2946114.770
MH359	−90019.252	2946168.905
MH360	−90011.479	2946173.566
MH361	−89985.404	2946191.966
MH362	−89970.282	2946202.637
MH363	−89947.306	2946218.849
MH364	−89948.020	2946163.963
MH365	−89748.322	2945935.287
MH366	−89771.328	2945975.121
MH367	−89794.333	2946014.954
MH368	−89820.590	2946060.416
MH369	−89846.846	2946105.879
MH370	−89809.214	2946127.613
MH371	−89848.793	2946196.243
MH372	−89685.376	2946110.315
MH373	−89728.087	2946085.656
MH374	−89770.797	2946060.996
MH375	−89911.107	2946506.560
MH376	−89939.156	2946546.309
MH377	−89967.205	2946586.057
MH378	−89900.556	2946480.960
MH379	−89852.237	2946515.057
MH380	−89886.415	2946563.493
MH381	−89920.594	2946611.929
MH382	−89949.099	2946652.324
MH383	−89564.028	2946097.717
MH384	−89599.824	2946159.709
MH385	−89629.743	2946211.522
MH386	−89659.662	2946263.335
MH387	−89691.582	2946318.613
MH388	−89723.502	2946373.892
MH389	−89755.422	2946429.170
MH390	−89768.447	2946454.217
MH391	−89775.513	2946456.689
MH392	−89793.851	2946494.756
MH393	−89830.600	2946546.835
MH394	−89812.625	2946559.519
MH395	−89845.289	2946605.808
MH396	−89877.952	2946652.097
MH397	−89921.107	2946713.253
MH398	−89964.261	2946774.408
MH399	−89952.952	2946782.697
MH400	−89905.372	2946817.569
MH401	−89895.115	2946825.087
MH402	−89903.303	2946839.649
MH403	−89868.747	2946374.527
MH404	−89812.085	2946401.849
MH405	−89840.503	2946725.640
MH406	−89868.182	2946764.865
MH407	−89761.526	2946579.030
MH408	−89792.682	2946623.182
MH409	−89824.270	2946667.948
MH410	−89780.890	2946698.559
MH411	−89770.887	2946705.618
MH412	−89754.275	2946722.220
MH413	−89743.763	2946734.274

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 1	(m)	(mm)
MH334 – MH278	62.286	160mm HDPE–PE100 Class PN10
MH335 – MH336	51.648	160mm HDPE–PE100 Class PN10
MH336 – MH337	51.648	160mm HDPE–PE100 Class PN10
MH337 – MH338	55.034	160mm HDPE–PE100 Class PN10
MH338 – MH339	55.034	160mm HDPE–PE100 Class PN10
MH339 – MH340	55.034	160mm HDPE–PE100 Class PN10
MH340 – MH341	55.034	160mm HDPE–PE100 Class PN10
MH341 – MH342	54.867	160mm HDPE–PE100 Class PN10
MH342 – MH343	60.799	160mm HDPE–PE100 Class PN10
MH343 – MH344	77.902	160mm HDPE–PE100 Class PN10
MH344 – MH345	37.967	160mm HDPE–PE100 Class PN10
MH345 – MH346	43.588	160mm HDPE–PE100 Class PN10
MH346 – MH347	43.588	160mm HDPE–PE100 Class PN10
MH347 – MH348	48.022	160mm HDPE–PE100 Class PN10
MH348 – MH349	45.594	160mm HDPE–PE100 Class PN10
MH349 – MH350	9.071	160mm HDPE–PE100 Class PN10
MH350 – MH351	68.586	160mm HDPE–PE100 Class PN10
MH351 – MH352	76.263	160mm HDPE–PE100 Class PN10
MH352 – MH279	76.263	160mm HDPE–PE100 Class PN10
MH353 – MH337	20.294	160mm HDPE–PE100 Class PN10
MH354 – MH355	63.864	160mm HDPE–PE100 Class PN10
MH355 – MH356	63.399	160mm HDPE–PE100 Class PN10
MH356 – MH357	63.632	160mm HDPE–PE100 Class PN10
MH357 – MH358	61.191	160mm HDPE–PE100 Class PN10
MH358 – MH359	61.191	160mm HDPE–PE100 Class PN10
MH359 – MH360	9.063	160mm HDPE–PE100 Class PN10
MH360 – MH361	31.913	160mm HDPE–PE100 Class PN10
MH361 – MH362	18.508	160mm HDPE–PE100 Class PN10
MH362 – MH363	28.119	160mm HDPE–PE100 Class PN10
MH363 – MH344	29.491	160mm HDPE–PE100 Class PN10
MH364 – MH362	44.623	160mm HDPE–PE100 Class PN10
MH365 – MH366	46.000	160mm HDPE–PE100 Class PN10
MH366 – MH367	45.999	160mm HDPE–PE100 Class PN10
MH367 – MH368	52.500	160mm HDPE–PE100 Class PN10
MH368 – MH369	52.500	160mm HDPE–PE100 Class PN10
MH369 – MH370	43.457	160mm HDPE–PE100 Class PN10
MH370 – MH371	79.225	160mm HDPE–PE100 Class PN10
MH371 – MH345	75.269	160mm HDPE–PE100 Class PN10
MH372 – MH373	49.318	160mm HDPE–PE100 Class PN10
MH373 – MH374	49.318	160mm HDPE–PE100 Class PN10
MH374 – MH370	76.900	160mm HDPE–PE100 Class PN10
MH375 – MH376	48.649	160mm HDPE–PE100 Class PN10
MH376 – MH377	48.649	160mm HDPE–PE100 Class PN10
MH377 – MH282	28.834	160mm HDPE–PE100 Class PN10
MH378 – MH379	59.138	160mm HDPE–PE100 Class PN10
MH379 – MH380	59.281	160mm HDPE–PE100 Class PN10
MH380 – MH381	59.281	160mm HDPE–PE100 Class PN10
MH381 – MH382	49.440	160mm HDPE–PE100 Class PN10
MH382 – MH284	49.440	160mm HDPE–PE100 Class PN10
MH383 – MH384	71.585	160mm HDPE–PE100 Class PN10
MH384 – MH385	59.831	160mm HDPE–PE100 Class PN10
MH385 – MH386	59.831	160mm HDPE–PE100 Class PN10
MH386 – MH387	63.832	160mm HDPE–PE100 Class PN10
MH387 – MH388	63.832	160mm HDPE–PE100 Class PN10
MH388 – MH389	63.833	160mm HDPE–PE100 Class PN10
MH389 – MH390	28.232	160mm HDPE–PE100 Class PN10
MH390 – MH391	7.485	160mm HDPE–PE100 Class PN10
MH391 – MH392	42.254	160mm HDPE–PE100 Class PN10
MH392 – MH393	63.739	160mm HDPE–PE100 Class PN10
MH393 – MH394	22.000	160mm HDPE–PE100 Class PN10
MH394 – MH395	56.654	160mm HDPE–PE100 Class PN10
MH395 – MH396	56.654	160mm HDPE–PE100 Class PN10
MH396 – MH397	74.849	160mm HDPE–PE100 Class PN10
MH397 – MH398	74.848	160mm HDPE–PE100 Class PN10
MH398 – MH399	14.021	160mm HDPE–PE100 Class PN10
MH399 – MH400	58.991	160mm HDPE–PE100 Class PN10
MH400 – MH401	12.717	160mm HDPE–PE100 Class PN10
MH401 – MH402	16.707	160mm HDPE–PE100 Class PN10
MH402 – MH291	18.414	160mm HDPE–PE100 Class PN10
MH403 – MH404	62.906	160mm HDPE–PE100 Class PN10
MH404 – MH389	62.906	160mm HDPE–PE100 Class PN10
MH405 – MH406	48.008	160mm HDPE–PE100 Class PN10
MH406 – MH400	64.505	160mm HDPE–PE100 Class PN10
MH407 – MH408	54.038	160mm HDPE–PE100 Class PN10
MH408 – MH409	54.789	160mm HDPE–PE100 Class PN10
MH409 – MH410	53.093	160mm HDPE–PE100 Class PN10
MH410 – MH411	12.244	160mm HDPE–PE100 Class PN10
MH411 – MH412	23.486	160mm HDPE–PE100 Class PN10
MH412 – MH413	15.994	160mm HDPE–PE100 Class PN10
MH413 – MH414	44.501	160mm HDPE–PE100 Class PN10
MH414 – MH415	50.000	160mm HDPE–PE100 Class PN10
MH415 – MH416	52.478	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre	
Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST

WG 27

MH No.	Unitas Sewer Network 1	
Constant:	YLo	XLo
MH414	−89777.118	2946763.732
MH415	−89814.595	2946796.830
MH416	−89853.929	2946831.568
MH417	−89880.453	2946867.673
MH418	−89743.802	2946631.962
MH419	−89730.089	2946641.638
MH420	−89717.746	2946650.348
MH421	−89723.596	2946605.780
MH422	−89673.986	2946640.768
MH423	−89676.970	2946645.539
MH424	−89662.210	2946662.252
MH425	−89702.986	2946698.263
MH426	−89852.716	2946694.384
MH427	−89795.188	2946734.978
MH428	−89791.579	2946747.151
MH429	−89788.953	2946869.803
MH430	−89830.825	2946906.782
MH431	−89787.846	2946956.086
MH432	−89745.615	2947004.532
MH433	−89703.009	2947053.407
MH434	−89704.128	2946880.323
MH435	−89734.046	2946906.416
MH436	−89740.301	2946906.009
MH437	−89747.058	2946919.259
MH438	−89763.496	2946933.777
MH439	−89725.637	2946977.187
MH440	−89687.778	2947020.596
MH441	−89645.483	2947069.093
MH442	−89656.036	2947078.292
MH443	−89768.964	2946873.553
MH444	−89788.343	2946905.286

PIPE DATA LIST

MH – MH	Distance	Diam.
Unitas Sewer Network 1	(m)	(mm)
MH416 – MH417	44.801	160mm HDPE–PE100 Class PN10
MH417 – MH117	37.066	160mm HDPE–PE100 Class PN10
MH418 – MH419	16.783	160mm HDPE–PE100 Class PN10
MH419 – MH410	76.294	160mm HDPE–PE100 Class PN10
MH420 – MH419	15.106	160mm HDPE–PE100 Class PN10
MH421 – MH422	60.707	160mm HDPE–PE100 Class PN10
MH422 – MH423	5.628	160mm HDPE–PE100 Class PN10
MH423 – MH424	22.297	160mm HDPE–PE100 Class PN10
MH424 – MH425	54.402	160mm HDPE–PE100 Class PN10
MH425 – MH413	54.402	160mm HDPE–PE100 Class PN10
MH426 – MH427	70.409	160mm HDPE–PE100 Class PN10
MH427 – MH428	12.697	160mm HDPE–PE100 Class PN10
MH428 – MH414	22.000	160mm HDPE–PE100 Class PN10
MH429 – MH430	55.864	160mm HDPE–PE100 Class PN10
MH430 – MH431	65.408	160mm HDPE–PE100 Class PN10
MH431 – MH432	64.269	160mm HDPE–PE100 Class PN10
MH432 – MH433	64.838	160mm HDPE–PE100 Class PN10
MH433 – MH125	64.838	160mm HDPE–PE100 Class PN10
MH434 – MH435	39.699	160mm HDPE–PE100 Class PN10
MH435 – MH436	6.268	160mm HDPE–PE100 Class PN10
MH436 – MH437	14.874	160mm HDPE–PE100 Class PN10
MH437 – MH438	21.931	160mm HDPE–PE100 Class PN10
MH438 – MH439	57.600	160mm HDPE–PE100 Class PN10
MH439 – MH440	57.600	160mm HDPE–PE100 Class PN10
MH440 – MH441	64.349	160mm HDPE–PE100 Class PN10
MH441 – MH442	14.000	160mm HDPE–PE100 Class PN10
MH442 – MH125	24.384	160mm HDPE–PE100 Class PN10
MH443 – MH436	43.301	160mm HDPE–PE100 Class PN10
MH444 – MH438	37.804	160mm HDPE–PE100 Class PN10

TOTAL LENGTHS OF PIPING

MH Centre to MH Centre	
Diameter (mm)	Length (m)
500mm HDPE–PE100 Class PN10	353.13
500mm HDPE–PE100 Class PN10	21.94
450mm HDPE–PE100 Class PN10	793.84
400mm HDPE–PE100 Class PN10	227.85
355mm HDPE–PE100 Class PN10	111.00
315mm HDPE–PE100 Class PN10	519.24
250mm HDPE–PE100 Class PN10	622.89
200mm HDPE–PE100 Class PN10	989.75
160mm HDPE–PE100 Class PN10	13196.12
Total :	16835.76

COORDINATE LIST

WG 27

Unitas Sewer Outlet Network		
MH No.	YLo	XLo
Constant:		
OUT439	−89644.485	2947099.778
OUT440	−89659.990	2947116.716
MH441	−89670.565	2947128.172
MH442	−89658.487	2947140.327
MH443	−89606.492	2947185.274
MH444	−89590.363	2947193.298
MH445	−89535.473	2947251.497
MH446	−89480.583	2947309.695
MH447	−89425.692	2947367.894
MH448	−89370.802	2947426.092
MH449	−89315.912	2947484.291
OUT450	−89301.071	2947492.935

PIPE DATA LIST

MH – MH	Distance
Unitas Sewer Outlet Network	(m)
OUT439 – OUT440	22.963
OUT440 – MH441	15.591
MH441 – MH442	17.135
MH442 – MH443	68.730
MH443 – MH444	18.015
MH444 – MH445	80.000
MH445 – MH446	80.000
MH446 – MH447	80.000
MH447 – MH448	80.000
MH448 – MH449	80.000
MH449 – OUT450	17.175

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE

CIVIL ENGINEERING

PROJECT TITLE

UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE

COORDINATE LIST AND PIPE DATA LIST

SHEET 3 OF 3

REF. NO.	–	DESIGNER	R. MABOHO
SCALE	1:1500	DRAWING	F. MAZIBUKO
DATE	03/2021	CHECKED	S. MNGUNI

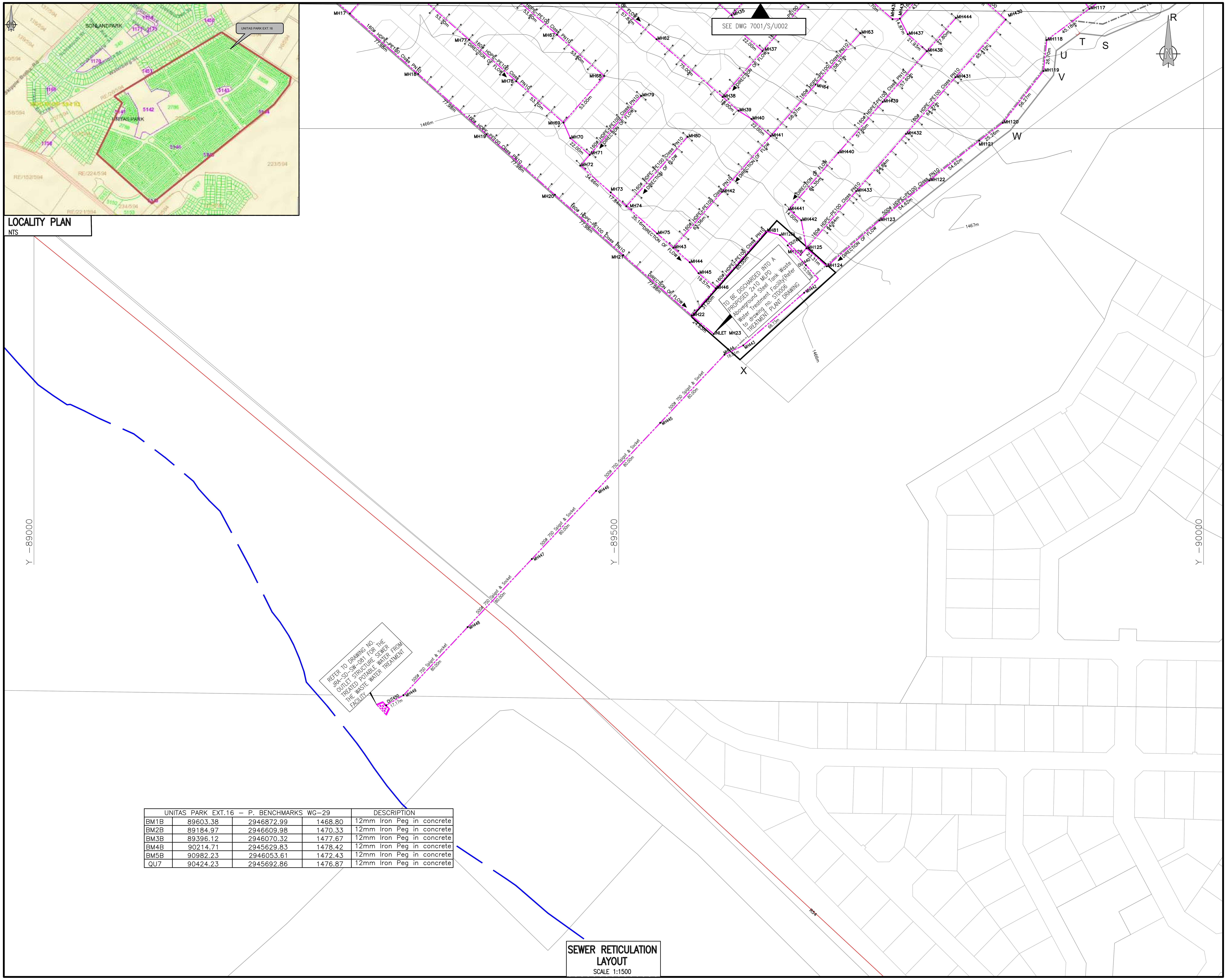
TYPE NUMBER

DRAWING NUMBER

7001/S/A003

A1

100mm ON ORIGINAL DRAWING



UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
10. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
11. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
12. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 — PIPE DIAMETER
- 17.31m — DISTANCE BETWEEN MH
- HOUSE CONNECTION
- 1.20 — CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF
CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS
P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

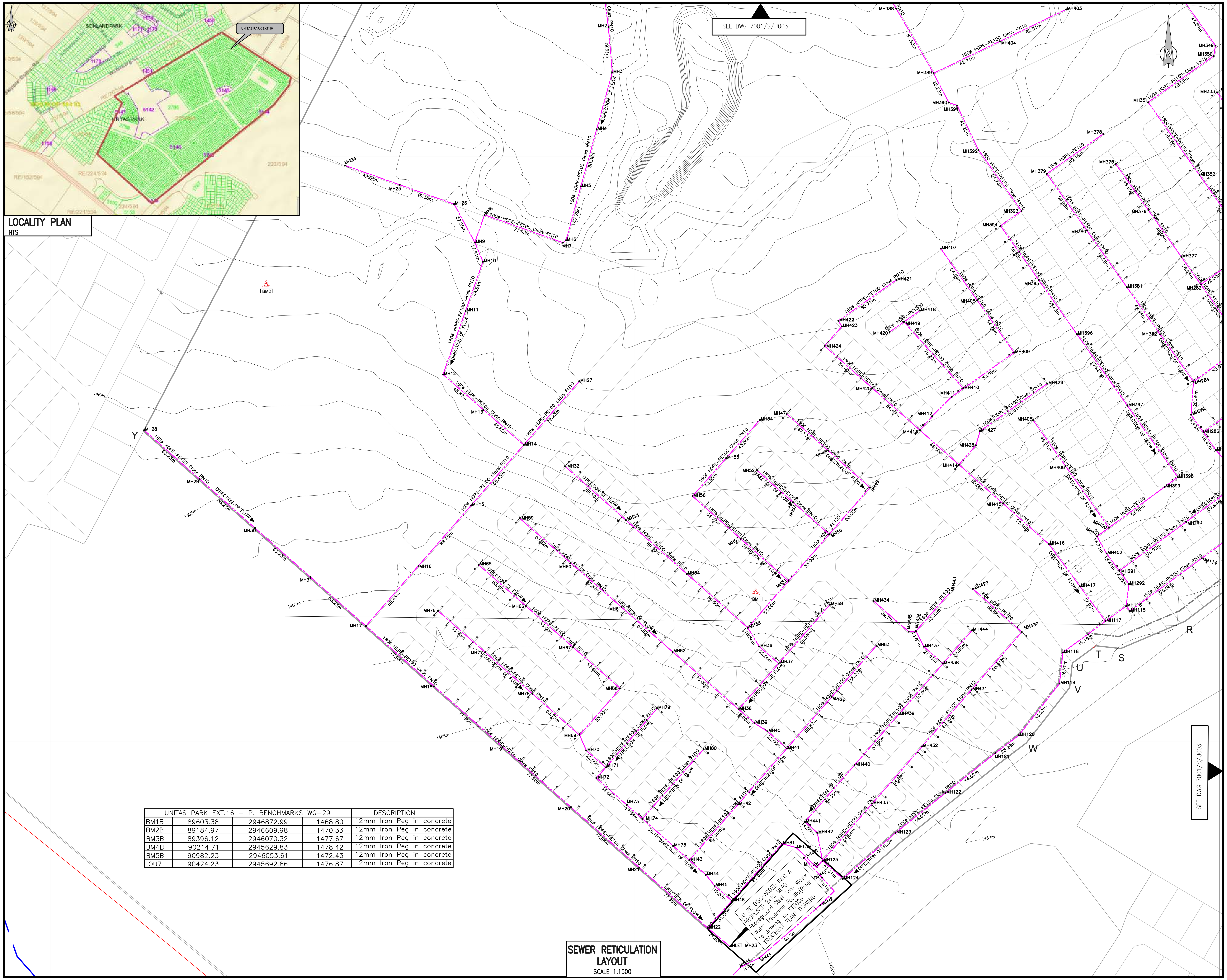
DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 1 OF 5

REF. NO.	–	DESIGNER	R. MABOHO
SCALE	1:1500	DRAWING	F. MAZIBUKO
DATE	03/2021	CHECKED	S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U001

A1
100mm ON ORIGINAL DRAWING



UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
10. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
11. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
12. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 — PIPE DIAMETER
- 17.31m — DISTANCE BETWEEN MH
- HOUSE CONNECTION
- 1.20 — CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

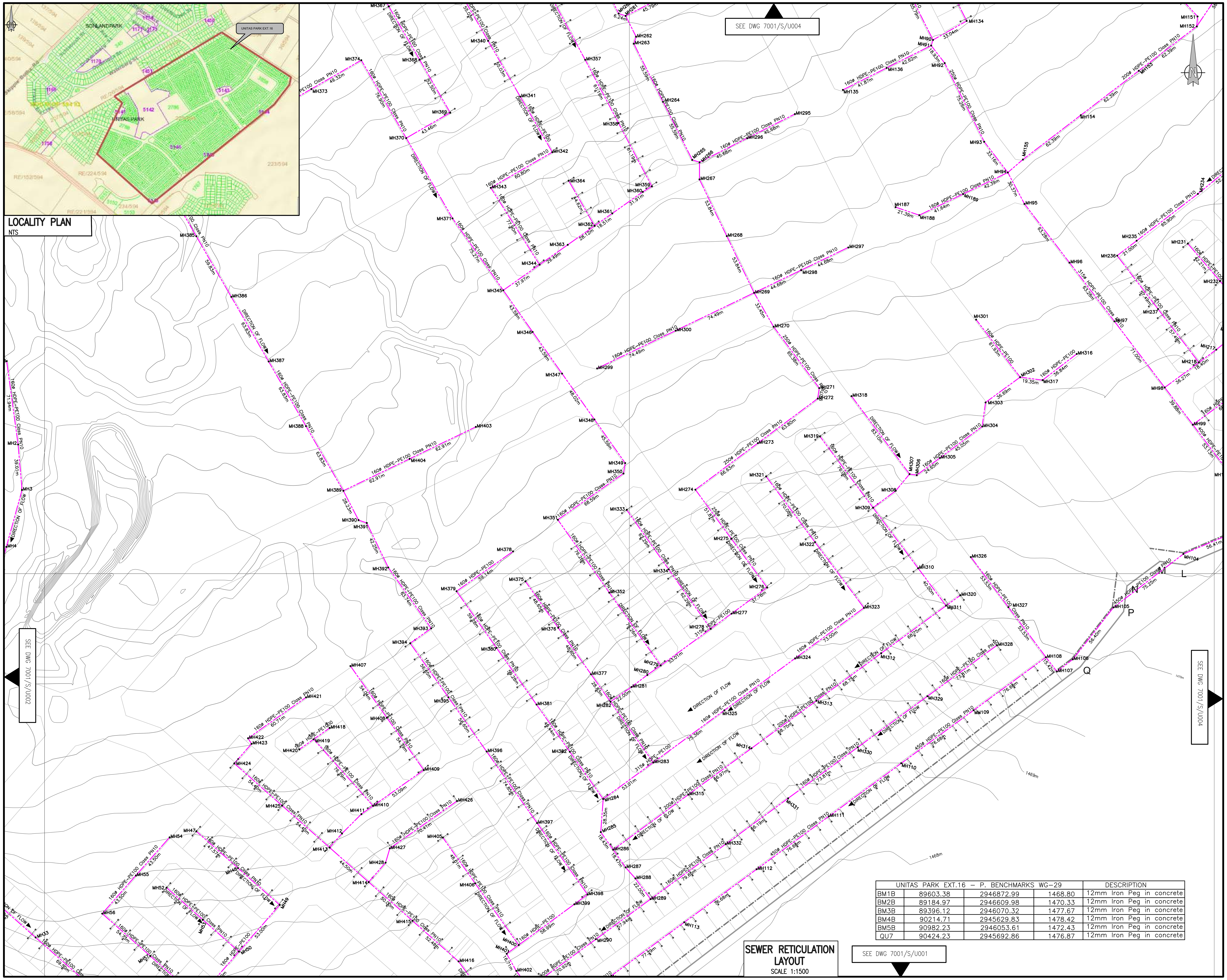
DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 2 OF 5

REF. NO.	–	DESIGNER	R. MABOHO
SCALE	1:1500	DRAWING	F. MAZIBUKO
DATE	03/2021	CHECKED	S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U002

A1
100mm ON ORIGINAL DRAWING



UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
10. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
11. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
12. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 / 17.31m — PIPE DIAMETER / DISTANCE BETWEEN MH
- HOUSE CONNECTION
- 1.20 — CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

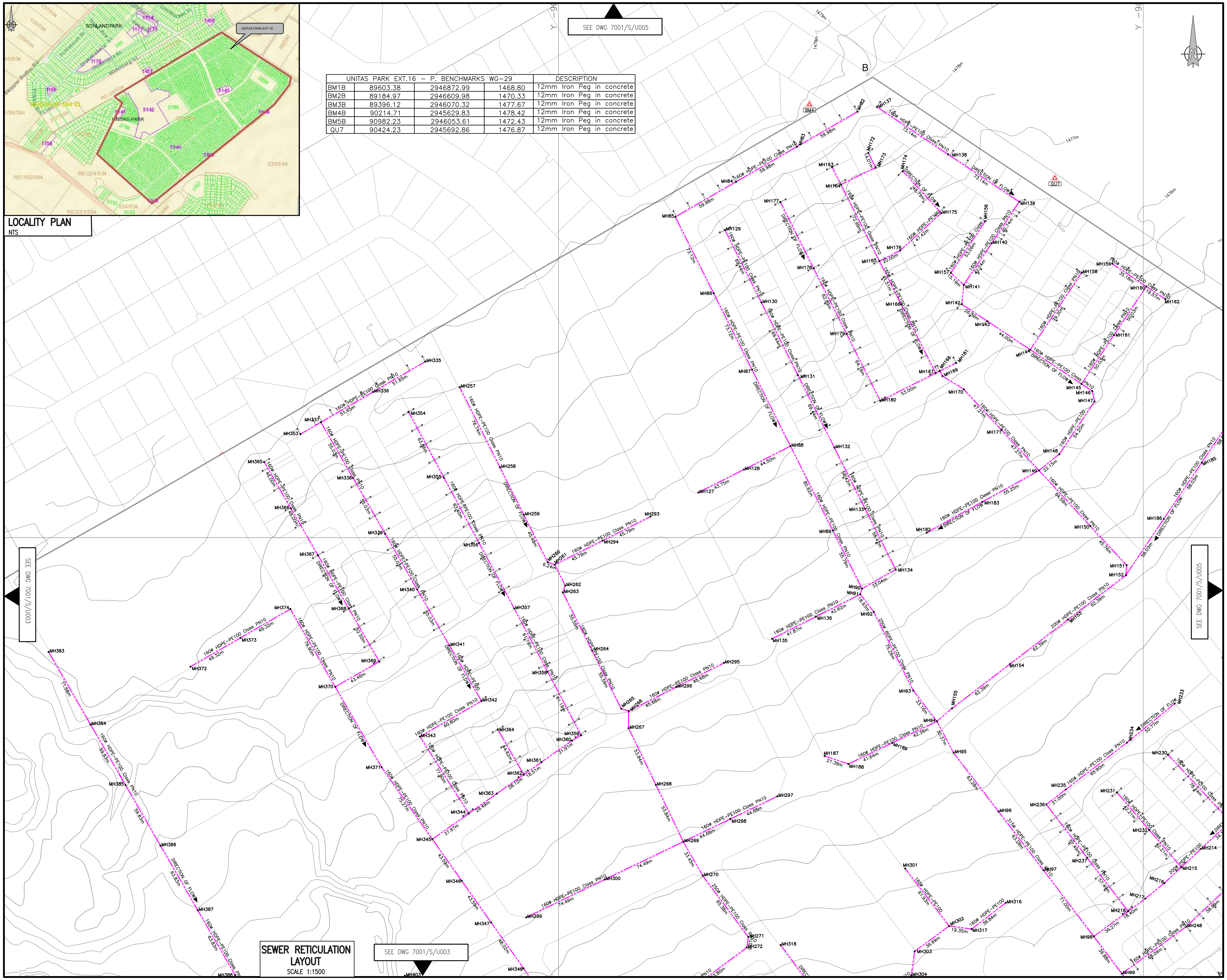
DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 3 OF 5

REF. NO. –	DESIGNER R. MABOHO Maboho RF
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U003

A1
100mm ON ORIGINAL DRAWING



UNITAS PARK EXT.16 – P. BENCHMARKS WG-29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
10. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
11. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
12. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

PROPOSED SEWER
NEW MANHOLE
MH10 — SEWER MANHOLE NO
160ø HDPE–PE100 Class PN10 — PIPE DIAMETER
17.31m — DISTANCE BETWEEN MH
HOUSE CONNECTION
1.20 — CONNECTION DEPTH
EXISTING RIVER
DIRECTION OF FLOW
BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

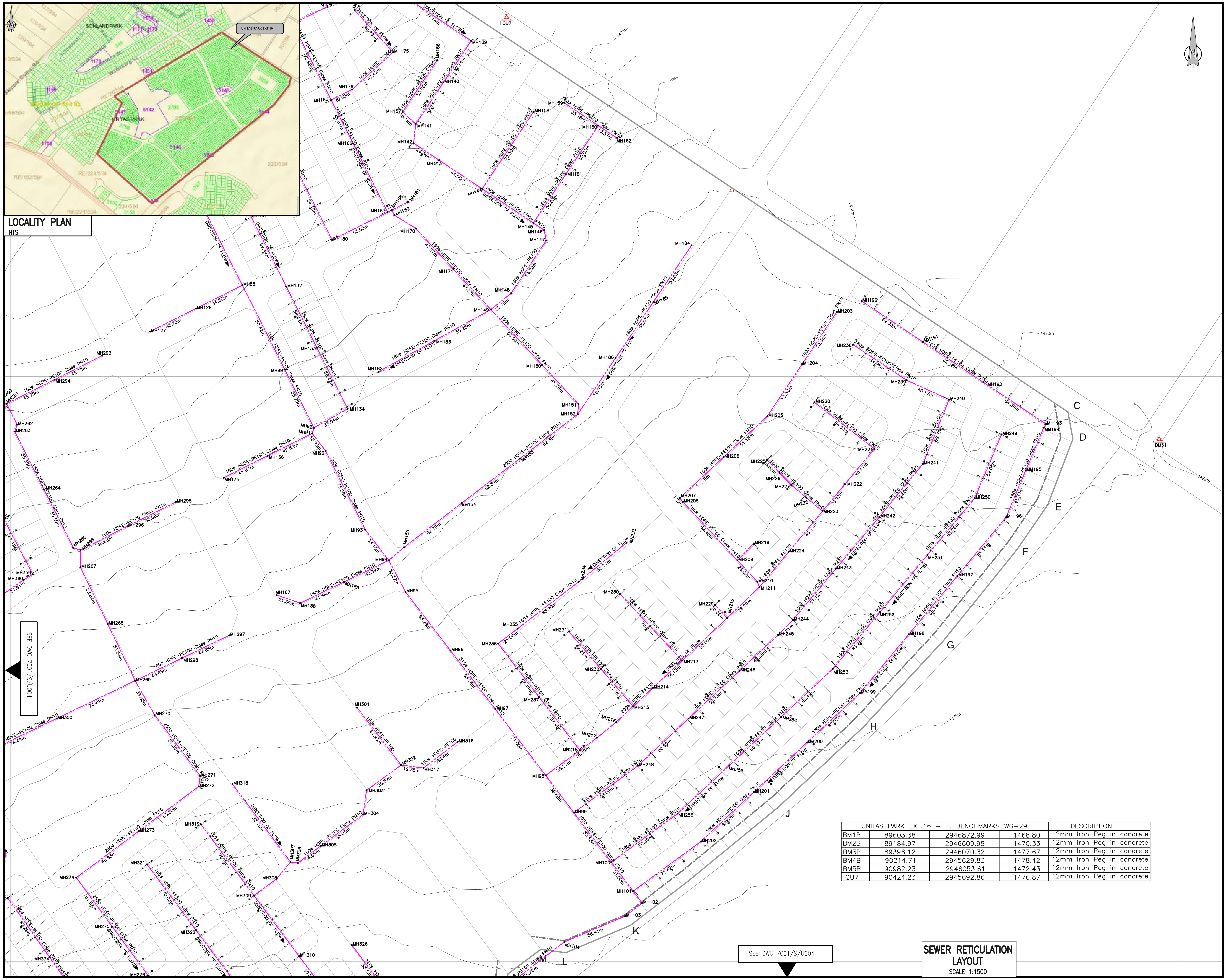
DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 4 OF 5

REF. NO.	–	DESIGNER	R. MABOHO
SCALE	1:1500	DRAWING	F. MAZIBUKO
DATE	03/2021	CHECKED	S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U004

A1
100mm ON ORIGINAL DRAWING



UNITAS PARK EXT.16 – P. BENCHMARKS WG–29				DESCRIPTION
BM1B	89603.38	2946872.99	1468.80	12mm Iron Peg in concrete
BM2B	89184.97	2946609.98	1470.33	12mm Iron Peg in concrete
BM3B	89396.12	2946070.32	1477.67	12mm Iron Peg in concrete
BM4B	90214.71	2945629.83	1478.42	12mm Iron Peg in concrete
BM5B	90982.23	2946053.61	1472.43	12mm Iron Peg in concrete
QU7	90424.23	2945692.86	1476.87	12mm Iron Peg in concrete

NOTES AND SPECIFICATIONS GENERAL

1. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SABS REQUIREMENTS.
2. ALL DIMENSIONS ARE IN MILLIMETRES.(UNLESS OTHERWISE SPECIFIED).
3. DO NOT SCALE FROM THESE DRAWINGS.
4. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
5. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COT DETAIL DRAWINGS.
6. THIS DRAWING MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING, OF ANY DIRECTOR OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE PUBLIC WORKS AND INFRASTRUCTURE DEVELOPMENT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
10. THE CONTRACTOR SHALL WHERE NECESSARY DETERMINE THE EXACT LOCATION OF EXISTING SERVICES AND PROTECT THEM FROM DAMAGE THROUGHOUT THE DURATION OF THE WORKS.
11. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER WITH REGARDS TO STANDARD AND SPECIFICATION BEFORE ORDERING ANY MATERIAL.
12. ONLY STAFF FROM LOCAL AUTHORITY WILL HANDLE ON EXISTING SERVICES UNLESS PERMISSION GRANTED TO THE CONTRACTOR IN WRITING BY THE LOCAL AUTHORITY.
13. THE LOCAL AUTHORITY'S STAFF WILL BE NOTIFIED WELL IN ADVANCE TO ATTEND SITE INSPECTIONS AND MEETINGS.
14. SEWER PIPELINES SHALL BE 160mmø HDPE–PE100 Class PN10 SEWER PIPES IN ERVEN MUST BE 1.0m FROM BOUNDARY IN ROAD RESERVE < 10m SEWER PIPE MUST BE LAID 1.0m INSIDE ERF BOUNDARY IN 13m ROAD RESERVE AND MORE WIDER ROAD RESERVE SEWER PIPES MUST BE LAID 1m FROM THE ERF BOUNDARY

LEGEND:

- PROPOSED SEWER
- NEW MANHOLE
- MH10 — SEWER MANHOLE NO
- 160ø HDPE–PE100 Class PN10 — PIPE DIAMETER
- 17.31m — DISTANCE BETWEEN MH
- HOUSE CONNECTION
- 1.20 — CONNECTION DEPTH
- EXISTING RIVER
- DIRECTION OF FLOW
- BM3 — BENCHMARK

NO.	DATE	AMENDMENT	APPROVED
A	05/2020	ISSUED FOR OUTLINE SCHEME	
B	03/2021	ISSUED FOR PDR	

CLIENT:

GAUTENG PROVINCE
HUMAN SETTLEMENTS
REPUBLIC OF SOUTH AFRICA

ENGINEER:

PHUMAF

CIVIL, STRUCTURAL ENGINEERS & PROJECT MANAGERS

P.O. BOX 4049
RANDBURG-2125
FIRST FLOOR 24 PETER PLACE
LYME PARK BRYANSTON 2191
TEL (011)326-0741/90

© COPYRIGHT PHUMAF HOLDINGS (PTY) LTD NOT TO BE REPRODUCED WITHOUT PERMISSION OF THE COPYRIGHT HOLDER.

DISCIPLINE
CIVIL ENGINEERING

PROJECT TITLE
UNITAS PARK EXT.16

WCS NO.

DRAWING TITLE
SEWER RETICULATION LAYOUT
SHEET 5 OF 5

REF. NO. –	DESIGNER R. MABOHO Maboho RP
SCALE 1:1500	DRAWING F. MAZIBUKO
DATE 03/2021	CHECKED S. MNGUNI

TYPE NUMBER

DRAWING NUMBER
7001/S/U005

A1
100mm ON ORIGINAL DRAWING

ANNEXURE C

TRAFFIC IMPACT ASSESSMENT (TIA) REPORT

TRAFFIC IMPACT & ACCESS STUDY REPORT
UNITAS PARK EXTENSION 16- FINAL REPORT

PREPARED BY

PHUMAF HOLDINGS
P.O. BOX 4049,
RANDBURG
2125

Cell: +27 (0)72 603 6122
Tel: +27 (0)11 326 0741/90
Email: smnguni@phumaf.com
Contact Person: Sikelela Mnguni (Pr.Tech.Eng)

PREPARED FOR:

GAUTENG PROVINCE HUMAN SETTLEMENT
37 Sauer Street
Marshalltown
JOHANNESBURG
2001

Tel: +27 (0)11 355 6000
Fax: +27 (0)11 355 6211

CONFIGURATION CONTROL

Project: Proposed Mixed Use Unitas Park Extension 16

Title: Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

Created by: Sikelela Mnguni *(Pr.Tech.Eng)*

REVISION RECORD

Revision	Date	Compiled	Saved as	Project Minutes
A0	07 July 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None
A1	02 November 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None

---

DECLARATION

It is herewith certified that this Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality has been prepared according to requirements of the South African Traffic Impact and Site Traffic Assessment Manual.

Prepared : Sikelela. Mnguni (*Pr.Tech. Eng-201170212*)

Signed: 

Date: 02 November 2020

Clients Approval :

Signed:

Date:

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON PORTION 222 OF THE FARM HOUTKOP 594-IQ (SG DIAGRAM 7423/2008). PORTION 222 OF THE FARM HOUTKOP 594-IQ IS IN THE PROCESS OF SUBDIVISION AND WILL BE KNOWN AS PORTION 225 (A PORTION OF 222) OF THE FARM HOUTKOP 594-IQ (SUBDIVISION DIAGRAM 4362/2009) IN THE EMFULENI LOCAL MUNICIPALITY

TABLE OF CONTENTS

LIST OF ANNEXURES

ANNEXURE A

- TRIP GENERATIONS

ANNEXURE B: BOOK OF DRAWINGS

- LOCALITY MAP-FIGURE PH_001
- PROPOSED DRAFT LAYOUT OF THE DEVELOPMENT-FIGURE PH_002
- FUTURE K-ROUTE AND PWV ROUTE MASTER PLAN-FIGURE PH_003
- PUBLIC TRANSPORTATION AND PROPOSED IRPTN ROUTES-FIGURE PH_004 & FIGURE PH_004a
- ACCESS POINTS TO THE DEVELOPMENT & COUNTING STATIONS -FIGURE PH_005
- 2020 AM & PM PEAK BACKGROUND VOLUMES -FIGURE PH_006
- 2025 AM & PM PEAK BACKGROUND + DEVELOPMENT VOLUMES -FIGURE PH_007

1 INTRODUCTION

1.1 Background

Phumaf Holdings (Pty) Ltd has been appointed by Gauteng Province Human Settlement to complete the Traffic Impact & Access Study for Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, the extension of Houtkop Road, Skippie Botha Road, and Langrand Road provides connectivity to the north, east, and west. As shown in the locality plan indicated in Figure PH_001 as shown in the book of drawings.

The development consists of the following land use:

- Proposed Mixed Use Residential Development

The purpose of this report is to assess the traffic impact at surrounding intersections, due to the additional traffic that the development will generate together with measures to mitigate the impact.

1.2 Approval of Submission

This report will be subject to approval from the relevant roads authorities. This report will be submitted to the following roads authorities for approval:

- Emfuleni Local Municipality (ELM)
- Gauteng Department of Roads and Transport (GDRT)

2 DEVELOPMENT DETAILS

2.1 Locality

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, the extension of Houtkop Road, Skippie Botha Road, and Langrand Road provides connectivity to the north, east, and west. As shown in the locality plan indicated in Figure PH_001 as shown in the book of drawings.

2.2 Development and Property Particulars

The development particulars of the Proposed Mixed Use Residential Development Unitas Park Ext. 16 are summarized in Table 1.

TABLE 1: PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON PORTION 222 OF THE FARM HOUTKOP 594-IQ (SG DIAGRAM 7423/2008). PORTION 222 OF THE FARM HOUTKOP 594-IQ IS IN THE PROCESS OF SUBDIVISION AND WILL BE KNOWN AS PORTION 225 (A PORTION OF 222) OF THE FARM HOUTKOP 594-IQ (SUBDIVISION DIAGRAM 4362/2009) IN THE EMFULENI LOCAL MUNICIPALITY	
Name of the Applicant	GAUTENG PROVINCE HUMAN SETTLEMENT 37 Sauer Street Marshalltown JOHANNESBURG 2001 Tel: +27 (0)11 355 6000 Fax: +27 (0)11 355 6211
Name of the Development	Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality

The proposed layout of the development for Proposed Mixed Uses Residential Development Unitas Park Ext. 16 is shown in (Figure PH_002 as shown in the book of drawings).

3 STUDY AREA

3.1 The extent of the Study Area

The extent of the study area is determined by the extent of the expected additional traffic that may be generated by the proposed development.

The guideline document "Manual for Traffic Impact Studies" of the Department of Transport was used to determine the different scenarios and the extent of the study area.

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

On a more local level, the extension of Houtkop Road, Skippie Botha Road, and Langrand Road provides connectivity to the north, east, and west. As shown in the locality plan indicated in Figure PH_001 as shown in the book of drawings.

3.2 The planned or proposed major development

Planned or proposed major developments and land-uses in the area have been taken into consideration and these include the following:

a) Approved but not yet implemented developments;
b) Land with potential or latent lands that have been taken into account.

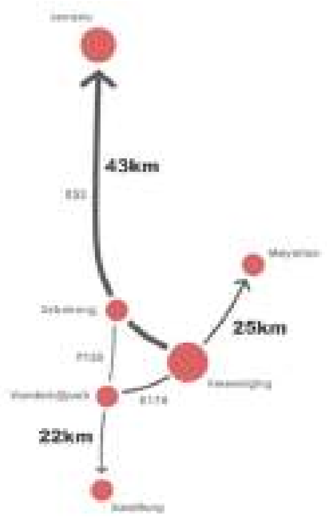
At the time of doing this study, no latent development rights were received from the Emfuleni Local Municipality Planning Department.

4 PLANNED FUTURE ROADS, RAIL NETWORK & PUBLIC TRANSPORT

4.1 Planned future roads

Movement patterns provide an understanding of how an area functions because it illustrates the spatial relationships between settlements and core areas (employment and shopping areas) and the linkages that exist between such spatial entities.

The Schematic PH_001 shows the movement of people within Emfuleni and between Emfuleni and the neighbouring municipal areas. Six primary core areas are located within and close to Emfuleni. Movement within Emfuleni largely occurs within a triangle, anchored by the core areas of Vanderbijlpark, Vereeniging, and Sebokeng. Movements between Emfuleni and neighbouring municipal areas occur along three axes. The first axis is located between Vereeniging and Sebokeng towards Lenasia and Johannesburg. The second axis is located between Vanderbijlpark, Vereeniging, and Meyerton towards Ekurhuleni. The third axis is located between Sebokeng, Vanderbijlpark, and Sasolburg.



Schematic PH_001 MOVEMENT AXIS

A strong movement of people occurs between Vanderbijlpark, Vereeniging, and Meyerton towards Johannesburg along the P156 freeway. A strong movement also occurs between Sebokeng and Johannesburg, especially during morning and afternoon peak hours, as commuter access employment opportunities in Johannesburg and surrounding areas. A strengthening of movement in the future can be expected between Vereeniging and Sebokeng, as urban development and densification occur along this corridor. Movement along the corridor between Vereeniging, Sebokeng, and Johannesburg is supported by the existing commuter railway line

The South African Road Classification and Access Management Manual is an official road planning document supported by SANRAL and the National Department of Transport (NDOT). According to the South African Road Classification and Access Management Manual, the road hierarchy within South Africa functions on 5 levels. The first level contains freeways, consisting of national freeways and provincial PWV roads and these are classified as Class 1 roads. These roads provide regional access, connecting an area to neighbouring cities and towns. The second and third levels comprise major and minor arterials (or K-routes), which aim to provide better intra-urban access between suburbs and activity areas. These are classified as Class 2 and 3 roads. The fourth level comprises collector roads, which are classified as Class 4 roads. These roads connect residential areas to the mentioned arterial network. On the fifth level, local streets provide direct access to land uses and link these land uses to the mentioned collector roads. These are classified as Class 5 roads.

In essence, freeways and arterials are highly mobile and therefore aim to connect people over large distances to activity areas and neighbouring settlements. Collector roads and local streets provide good accessibility and therefore aim to connect people and land use to more mobile roads. Road-based public transport systems (minibus taxis and busses) mostly use arterials and collector roads, because these provide an efficient balance between mobility and land use accessibility.

Figure PH_004 & 004a in the book of drawings depicts the road network serving Emfuleni area. The N1 freeway passes through the centre of Emfuleni, linking Emfuleni to Johannesburg and Soweto. The primary role of this freeway is to link Gauteng Province to the Free State Province and the Western Province and therefore fulfills a through-traffic function, rather than serving Emfuleni specifically. The P156 freeway, on the other hand, primarily serves Emfuleni, linking Vanderbijlpark and Vereeniging to Ekurhuleni and the OR Tambo International Airport. Due to its function, corridor development is increasingly occurring along the P156 freeway, especially in the Vereeniging and Meyerton areas. The P156 freeway is located on the eastern boundary of Emfuleni.

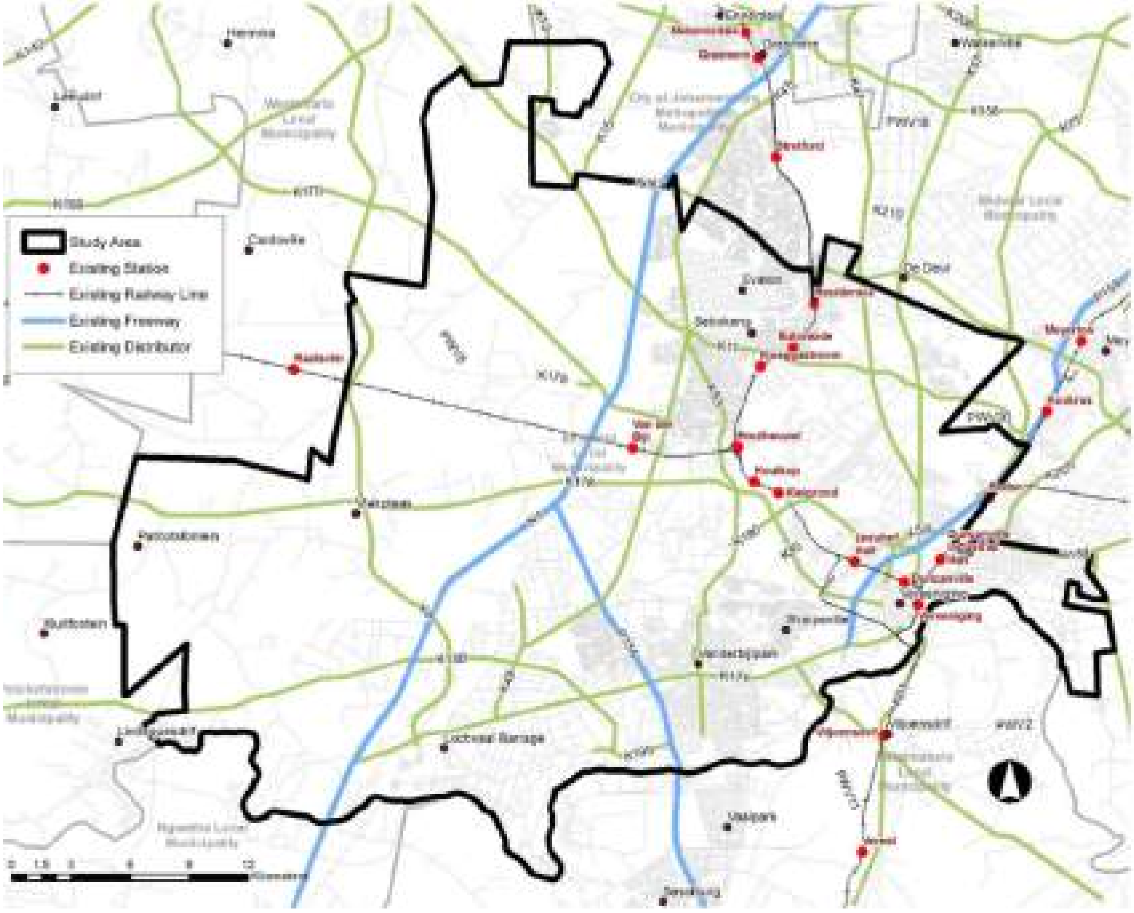
Most of Emfuleni's planned K-route network has been developed, although not all the K-routes have been developed to a dual carriageway level. Many of the K-routes are also in need of rehabilitation, especially K-routes such as the K174 (Barrage Road). Despite this, the complete K-route network allows urban infill and expansion to take place in almost any part of Emfuleni, providing the access infrastructure needed for urban development. Four K-routes can be highlighted as prominent K-routes serving Emfuleni. The first is the K53 (Moshoeshoe Road that becomes the Golden Highway), which runs between Vanderbijlpark and Sebokeng. This is an important commuter spine serving Emfuleni. The second K-route worth mentioning is the K174 (Barrage Road), linking Vanderbijlpark to Vereeniging. This road is a gateway route into Emfuleni and the Municipality is thus concerned over the type of development that take place along this route. The K178 links Sebokeng to Vereeniging and the shopping and employment opportunities found within Vereeniging. This K-route is expected to become a major commuter spine, as urban development intensifies along this route. The fourth K-route is the K164, which links Evaton to Meyerton. Savanna City (a 14000-residential unit development) will be situated on and have access from the K164, which will increase the prominence of this K-route.

Figure PH_003 in the book of drawings depicts The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

4.2 Rail Network

Emfuleni is served by a rail network that connects Emfuleni to neighbouring areas in Gauteng and the Free State. As depicted in Schematic PH_002, this rail network consists of 3 lines. The first rail line stretches along with the P156 (R59) freeway and links Sasolburg to Vereeniging, Meyerton, and Germiston. This rail line is primarily a freight line but does contain commuter railway stations along the line. The second railway line stretches from Sasolburg, via Vereeniging towards Sebokeng, Orange Farm, and Johannesburg.

This railway line also functions as a freight railway line, although it also fulfills a significant commuter railway line function. The third railway line stretches from Sebokeng towards Westonaria. This railway line is exclusively used for rail freight purposes.



Schematic PH_002: RAIL NETWORK

Emfuleni is served by a commuter rail network that connects Emfuleni to neighbouring areas in Gauteng. This commuter rail network consists of 2 lines. The first rail line stretches from Vereeniging to Meyerton towards Germiston. This commuter railway line contains commuter railway stations, with prominent stations being the Vereeniging Station, the Duncanville Industrial Halt Station, and the Meyerton Station. The use of this railway line as a commuter railway line is limited due to fragmented urban development and low residential densities along this railway line. The second commuter railway line stretches from Vereeniging towards Sebokeng, Orange Farm, and Johannesburg. Prominent stations along this line are Houtheuwel Station, Residentia Station, and Stretford Station. This railway line traverses densely built-up urban areas, as is found in Sebokeng and Orange Farm, and it, therefore, fulfills a significant commuter railway line function.

4.3 Public Transportation

Emfuleni comprises an extensive bus network that serves the municipal area. A prominent bus route is the bus route linking Vereeniging to Sebokeng along with the K53 (Moshoeshoe Road) and the K45 (Golden Highway). This bus route links Evaton and Sebokeng to the Vereeniging CBD and the industrial areas located within Vereeniging. Other bus routes worth mentioning are the bus route linking Vereeniging to Meyerton, the bus route linking Vereeniging to Residentia Station, and the Bus route linking Evaton to Meyerton. Linking the bus network to the commuter rail network will enable the bus network to act as a feeder system to the commuter rail network. This will give Emfuleni access to an integrated hierarchy of public transport modes servicing different parts of the municipal are and it will greatly improve the current public transport network serving Emfuleni.

Emfuleni comprises an extensive minibus taxi network. This network largely uses the same routes and serves the same areas within the municipal area that the bus network does. The only significant exception is that a minibus taxi route links the Vanderbijlpark CBD to Sebokeng via Mittal Steel; a route that the bus network does not serve. A disadvantage of the minibus taxi network is that the routes of this network are not fixed and can, therefore, change in the future. Therefore, the minibus taxi route does not indicate fixed locations where Emfuleni can develop. Bus routes and in particular commuter railway lines provide a much better indication of where to densify Emfuleni.

Developing Emfuleni's transportation infrastructure is dealt with in terms of the road network and public transport network. Whereas the road network primarily refers to provincial and metropolitan roads, the public transport network refers to the public transport routes and stations that make up the transportation network. Figure PH_005 in the book of drawings illustrates the transportation infrastructure development proposals made for Emfuleni.

Emfuleni is a municipality with a population nearing 1 million people. In other words, Emfuleni is becoming a metropolitan area. It is, therefore, necessary that Emfuleni starts positioning itself for this responsibility. A key function of a metropolitan area is to provide public transport of a high standard to support its metropolitan population. Emfuleni thus needs to start identifying its public transport routes, so that it can start shaping its land-use structure (which takes time) to serve this public transport network. To this end, Emfuleni can proactively promote public transport by (a) engaging with PRASA to further develop the Vereeniging-Johannesburg commuter railway line (especially concerning station development) and (b) identify and develop a Strategic Public Transport Network (SPTN) to serve urban areas within Emfuleni that are not served by the Vereeniging-Johannesburg commuter railway line.

Emfuleni is served by a commuter rail network that connects Emfuleni to neighbouring areas in Gauteng. Prominent station along this line is Houtheuwel Station, Residentia Station, and Stretford Station. Currently, the use of this railway line as a commuter railway line is limited due to fragmented urban development and low residential densities along this railway line. Urban development along the Vereeniging-Sebokeng-Orange Farm commuter railway line will provide the necessary commuter thresholds needed to ensure the viable operation and expansion of this commuter railway line.

Concerning further developing the Vereeniging-Johannesburg commuter railway line, it is proposed the 2 new stations are developed along this line to better serve envisaged urban expansion areas within Emfuleni. The first proposed station is located at the proposed Sonlandpark Regional Node and will serve the Sonlandpark and Boipatong areas. The second proposed station is located north of Houtheuwel Station and will better serve the envisaged Lethabong extensions. The additional stations along this commuter rail line will provide opportunities for Transit-Oriented Development (TOD). This will involve focusing on new higher density, mixed-use development around these commuter rail stations. The layout of the land uses concerning the stations are of critical importance, because it will determine the level of access that commuters will have to these stations. It should be noted that the station proposals above area Emfuleni SDF proposals and not PRASA proposals at this stage.

In addition to the above, a Strategic Public Transport Network (SPTN) is proposed by the Emfuleni SDF that will serve urban areas within Emfuleni that are not served by the Vereeniging-Johannesburg commuter railway line. Two SPTN routes have been identified. The first route links Vereeniging to Sebokeng along the K53 (Moshoeshoe Road) and the K45 (Golden Highway), and then turns eastward at Evaton towards Residentia Station. This SPTN route links Evaton and the Sebokeng CBD to the Vereeniging CBD. This route can be extended southwards across the Vaal River up to Sasolburg. The second SPTN route utilizes Barrage Road (K147) and links the Vanderbijlpark CBD, the Bedworthpark Regional Node, the proposed River City Node, the Vereeniging CBD, and the Three Rivers Node. This route can be extended northeastwards up to Meyerton.

It is important to note that where an SPTN route utilizes a K-route (arterial), flexible, public transport oriented design parameters will be required, especially where this route traverses or abut an activity node. For example, pedestrian crossing and accesses will have to be addressed differently within such sections of the SPTN route. Also, the development of the SPTN route can already at this stage be planned to accommodate higher-order road-based public transport systems in the future, such as the Bus Rapid Transit (BRT) system. The implementation of a BRT system can then be phased over time. The following phasing will most probably be logical:

- Phase 1: Design SPTN routes to allow the long-term implementation of the BRT system
- Phase 2: Start operating municipal system on SPTN route
- Phase 3: Construct major BRT stations at regional nodes
- Phase 4: Start operating BRT system
- Phase 5: Construct minor BRT stations at other locations along SPTN route
- Phase 6: Construct dedicated BRT lanes

Having a longer-term view of public transport network development will enable municipal planners to develop a land-use structure that can support the envisaged public transport network in the future. Municipal planners can promote the development of activity nodes at commuter railway stations and envisaged SPTN/BRT stations that would (a) apply higher land use densities, (b) a greater land use mix and (c) a pedestrian-oriented structure. These are all critical elements needed to support the viable operation of a public transport system and station.

TABLE 2: PROPOSED PUBLIC TRANSPORT ROUTES, STATIONS, AND LAND USE INTEGRATION

SPTN Route/ railway line	Nodal Area	Station or Rank or Stop	Integration Principles
Proposed Barrage Road SPTN route	Vanderbijlpark CBD	▪ Proposed bus station and minibus taxi rank within CBD	▪ Design and locate mixed land uses at commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Vereeniging CBD	▪ Existing Vereeniging commuter railway station ○ Proposed bus station and minibus taxi rank at commuter railway station	▪ Design and locate mixed land uses at commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to a commuter railway station
Proposed Barrage Road SPTN route	River City Node (part of Vanderbijlpark CBD)	▪ Proposed bus station and minibus taxi rank within Node	▪ Develop higher-density residential uses to support proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Sebokeng CBD	○ Existing Houtheuwel commuter railway station ○ Existing bus station and minibus taxi rank within CBD	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers ▪ Design and construct pedestrian walkways to facilitate access to commuter railway station
Proposed Barrage Road SPTN route	Bedworthpark Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank

SPTN Route/ railway line	Nodal Area	Station or Rank or Stop	Integration Principles
Proposed Golden Highway SPTN route	Evaton Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Develop higher-density residential uses to support proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Proposed Barrage Road SPTN route	Three River Regional Node	▪ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Sonlandpark Regional Node	▪ Proposed Sonlandpark commuter railway station ▪ Proposed bus station and minibus taxi rank at commuter railway station	▪ Design and locate mixed land uses at proposed commuter railway station ▪ Design and construct pedestrian walkways to facilitate access to the proposed commuter railway station
Proposed Golden Highway SPTN route	Boitumelo Community Node	○ Proposed bus station and minibus taxi rank within node	▪ Design and locate mixed land uses at proposed bus station and minibus taxi rank ▪ Design and construct pedestrian walkways to facilitate access to proposed bus station and minibus taxi rank
Vereeniging-Johannesburg commuter railway line	Kwaggastroom Community Node	○ Existing Kwaggastroom commuter railway station	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers
Vereeniging-Johannesburg commuter railway line	Residensia Community Node	▪ Existing Residensia commuter railway station	▪ Develop higher-density residential uses to support a commuter railway station with required commuter numbers

As alluded to above, the efficient functioning of the public transport system within Emfuleni will not only require a well-developed public transport network but will also require well-developed public transit stations and stops that are strategically located along the public transport routes. The major public transit stations and stops should preferably be located within the nodal areas. Many of the existing, planned, and proposed nodes will be served by the existing and proposed commuter railway stations of the Vereeniging-Johannesburg commuter railway line. These include, amongst others, the Residensia Station, Houtheuwel Station, Vereeniging Station, and the proposed Sonlandpark Station. Where nodal areas are served by a road-based public transport network (SPTN), such as the Vanderbijlpark CBD, the Bedworthpark Regional Node, and the Evaton Regional Node, a bus station, and minibus taxi rank should make up the public transit station serving such a node. It is proposed that major transit stations and stops within Emfuleni be located at localities set out in Table 2 above, which correspond with the Transit-Oriented Developments (TODs) proposed for Emfuleni. Pick-up and drop-off stops can be places at 400-600m intervals along the SPTN routes.

To ensure the optimal use of each public transit station and stop, it will have to be integrated through a competent design with surrounding land uses. This design will need to focus on pedestrian movement and how pedestrians exchange between the transit facility and the surrounding land uses. The competent building design is also necessary to ensure land use and transportation integration and will have to be applied to buildings (e.g. retail centers and walk-ups) bordering these transit stations.

5 EXISTING AND PROPOSED ACCESS TO THE DEVELOPMENT

5.1 Existing Major Access

Access to the site is problematic as there are currently no constructed roads linking to the site. The following are potential connections:

Schematic PH_003: MOVEMENT AXIS

- The proposed K55 has two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. There is no indication as to when this will be done.
- There are three access points across the adjacent unproclaimed townships (Sonlandpark Ext 4, Unitas Park Ext 4, and Unitas Park Ext 2) based on their approved layouts. These townships must first be proclaimed and developed before such access can be obtained. To get access in the interim a right-of-way servitude will have to be registered on private property and the roads constructed.
- There is a registered right of way servitude that links to Bennie Osler Street in the Unitas Park Agricultural Holdings. This road must still be constructed.
- Frederik Road in the Unitas Park Agricultural Holdings is constructed up to the north-eastern edge of the site. Thereafter it becomes a dirt road that borders a portion of the site. It continues north from the edge of the site as a dirt road that links up with Langrand Road. These roads will have to be upgraded to accommodate the increase in vehicular traffic anticipated by the development of the site.
- The currently approved layout allows for an access road to the south to connect to Houtkop Road. This connection will necessitate a right of way servitude over privately owned land and will not be allowed once the K55 is constructed due to the distance from the intersection of the K55 and Houtkop Road.

The only current feasible options to obtain access to the site is the construction of the southern portion of the K55 up to the boundary of the site. Another option will be the upgrade of Frederik Road. This in itself will not be sufficient as Frederik Road will not be able to cope with the increase in traffic.

Access to the development is also (indicated in Figure PH_005 as shown in the book of drawings).

5.2 Proposed Access

The concession to grant access to Proposed Mixed Use Residential Development Unitas Park Ext.16 from Municipality Road is the Emfuleni Local Municipality and Gauteng Department of Roads and Transport.

The only current feasible options to obtain access to the site is the construction of the southern portion of the K55 up to the boundary of the site.

6 TRAFFIC FLOWS & DEVELOPMENT TRIPS

6.1 Existing Traffic Flows

Detailed traffic surveys (traffic counts) were carried out at the following intersections :

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection; indicated in Figure PH_007 as shown in the book of drawings). The surveys were conducted for 13 hours (06:00-18:30) during the weekday on Thursday, 05 March 2020.

From the traffic counts a common peak hour was determined (the busiest hour) for each counted period and was found to be as follows:

- Morning peak 06:30-07:30
- Afternoon peak 16:00-17:00

6.2 Traffic Evaluation

The traffic impact of the proposed development has been assessed by examining the intersections in the area of influence. These intersections include:

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

The performance of each of the above intersections has been assessed by comparing the traffic flows (demand) with the estimated capacity (supply) for the critical movements at each intersection to obtain a Level of Service (LOS) for each movement and delays experienced.

Sidra Intersection 8.0, simulation software was used to evaluate the intersections.

The following parameters were used to evaluate capacity analysis:

The following definitions from the 2000 Highway Capacity Manual are used in this report:

- Capacity - The maximum hourly rate at which vehicles can reasonably be expected to traverse a lane or roadway during a given period under prevailing traffic and control conditions.
- Volume - The hourly rate of vehicle arrivals at an intersection.
- Volume to capacity ratio (v/c) - Is the ratio of volume to capacity.

Level of service (LOS) - Level of service is defined in terms of delay. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. The levels of service for signalized and un-signalized intersections as defined in the 2000 Highway Capacity Manual are shown in Table 3 below.

TABLE 3: LEVEL OF SERVICE DEFINITIONS

Level of Service	Signalized intersections Stopped delay (seconds)	Unsignalized intersections Total delay (seconds)
A	< 10	< 10
B	> 10 and < 20	> 10 and < 15
C	> 20 and < 35	> 15 and < 25
D	> 35 and < 55	> 25 and < 35
E	> 55 and < 80	> 35 and < 50
F	> 80	> 50

An intersection is deemed to be operating acceptably at levels of service A to D. If an intersection operates at a level of service E or F or has a volume to a capacity ratio higher than 0.95 the intersection is considered to be operating at capacity.

6.3 Development Trip Generation and Traffic Volume Scenario-Adjusted Factors

Various trip adjustment factors have been introduced into the COTO document to allow for trip reductions. These adjustment factors are discussed briefly below.

6.4 Mixed-use Developments (MUD)

According to the COTO manual "mixed-use developments are defined as developments in an area that consist of two or more single-use developments between which trips can be made utilizing non-motorized modes of transport (such as walking). This has the net effect of reducing the vehicle trip generation in the area."

Since this development will consist of mixed land use, the reduction factors which have been applied are listed in Table 4 below. Note, Pm = Reduction factor for mixed-use development.

6.5 LOW VEHICLE OWNERSHIP (LVO) & VERY LOW VEHICLE OWNERSHIP (VLVO)

According to COTO "the vehicle ownership in areas with high levels of vehicle ownership varies between one or two per household. In areas with a low level of vehicle ownership, the majority of households (more than 50%) do not own a vehicle and rely on public transport for transportation.

In areas with a very low level of vehicle ownership, nearly all households (more than 90%) do not own a vehicle and rely on public transportation."

This study considered low to very low vehicle ownership and the reduction factors which have been applied are listed in Table 4 below. Note, Pv = Reduction factor for vehicle ownership.

6.6 TRANSIT NODE OR CORRIDORS

According to COTO “the transit reduction factors apply to developments that are located within a reasonable walking distance from a major transit node or stops on a major transit corridor.”

This study considered transit nodes and a 15% reduction factor has been applied for all land uses as recommended in the COTO manual. See Table 4 below. Note, Pt = Reduction factor for transit nodes or corridors.

Table 4: Adjustment Factors Applied for Trip Reductions			
Trip Code	Pm	Pv	Pt
Single Dwelling Units	30%	80%	15%
Townhouses (Simplexes and Duplexes)	30%	80%	15%
Apartments and Flats	30%	80%	15%

6.7 TRIP SUMMARY

The detailed trip generation calculations are included in Annexure A. Using the COTO document the expected peak hour trip generation for the proposed development was calculated and indicated in Table 5 below.

Table 5: EXPECTED PEAK HOUR TRIP GENERATION (veh/h)					
WEEKDAY AM			WEEKDAY PM		
IN	OUT	TOTAL	IN	OUT	TOTAL
141	424	566	396	170	566

Table 5 shows that the proposed development will generate 566 trips during the weekday AM and weekday PM peak periods, respectively.

From Table 5 it can be seen that the development will generate a maximum of 566 trips during the weekday PM peak period. The Manual for Traffic Impact Studies requires that a traffic impact statement be done for developments that generate more than 50 but less than 150 peak hour trips as indicated in Table 6 below.

Table 6: Assessment Years for Traffic Studies (from Manual for Traffic Impact Studies)	
Type of Study	Assessment years to consider
Traffic Impact Statement (50-150 peak hour trips)	• Base year; • Any other year at the discretion of responsible road authority.
Traffic Impact Study (150-2000 peak hour trips)	• Base year; • Five years after the base year; • Any other year at the discretion of responsible road authority.
Traffic Impact Study (> 2000 peak hour trips)	• Base year; • Ten years after the base year; • Any other year at the discretion of responsible road authority.
Multiphase developments	• Base year; • Five years after the base year for developments < 2000 peak hour trips; • Ten years after the base year for developments > 2000 peak hour trips; • Any other year at the discretion of responsible road authority.

6.8 GROWTH RATE

TMH 16 South African Traffic Impact and Site Traffic Assessment Manual Volume 1 requires that a five-year horizon be considered for developments that generate more than 50 trips. TMH 17 South African Trip Data Manual recommends growth rates for developments as shown in Table 7.

Table 7: Typical Traffic Growth Rates	
Development Area	Growth Rates
Low Growth Area	• 0-3%
Average Growth Area	• 3-4%
Above-average growth areas	• 4-6%
Fast-growing areas	• 6-8%
Exceptionally high growth areas	• >8%

A growth rate of 3% was considered appropriate for this study

6.9 Total Future Traffic Flows with Development

The existing 2020 peak hour traffic volumes (see Figure PH_006 as shown in the book of drawings) were thus subjected to a 3% growth rate over five years; this is in line with an above-average growth rate as given in Table 7 above. The 2025 background plus development peak hour traffic volumes are presented in Figure PH_007 as shown in the book of drawings.

6.10 Trip Distribution and Assignment

Assumptions concerning the expected trip distribution were based on the location of the site access about the surrounding road network; the existing traffic volumes, travel patterns as well as the land use nature of the proposed development.

The expected trip distribution and development generated traffic of the proposed development can be seen in Figure PH_007 as shown in the book of drawings.

7 TRAFFIC IMPACT AND CAPACITY ANALYSIS

7.1 General

The AM and PM peak hour trip generation of the development was analysed. The critical peak hour analysis was considered for the following scenarios:

- 2020 without development scenario;
- 2025 with a development scenario.

2020 without development scenario demonstrates the existing intersection's operation. 2025 with a development scenario is the worst-case scenario and would indicate all the intersection upgrading the developer would be responsible for.

This analysis aims to ensure that the intersection of:

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

This analysis aims to ensure that the intersections and proposed accesses operate at an acceptable level of service. If the intersection should operate poorly the aim will be to at least improve the overall performance of the intersection.

7.2 2020 Background Scenario Without Development

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Gary Player Street are shown in Table 8 & Table 9 for 2020 without development scenario.

Table 8 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

Table 9 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Houtkop Road and Gary Player Street currently operates at LOS F on the North approach during the PM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Laurie Stevens Street are shown in Table 10 & Table 11 for 2020 without development scenario.

Table 10 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

Table 11 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Houtkop Road and Laurie Stevens Street currently operates at LOS E on the North approach during the PM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Percy Sherwell Street are shown in Table 12 & Table 13 for 2020 without development scenario.

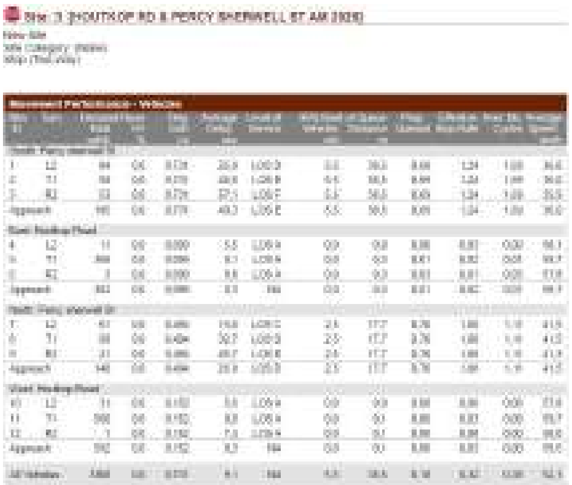


Table 12 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

Table 13 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Houtkop Road and Percy Sherwell Street currently operates at LOS F on the South approach during the PM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Japie Krige Street are shown in Table 14 & Table 15 for 2020 without development scenario.

Table 14 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

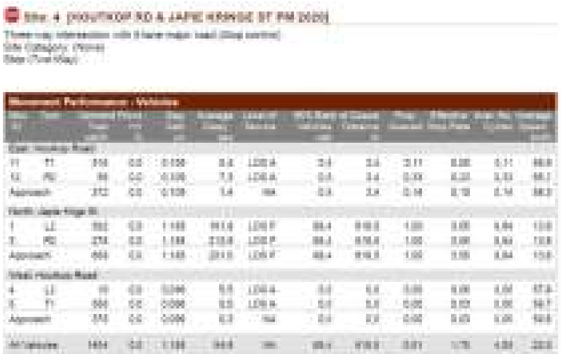


Table 15 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Houtkop Road and Japie Krige Street currently operates at LOS F on the North approach during the AM & PM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Senator/Sprinkbok Street are shown in Table 16 & Table 17 for 2020 without development scenario.

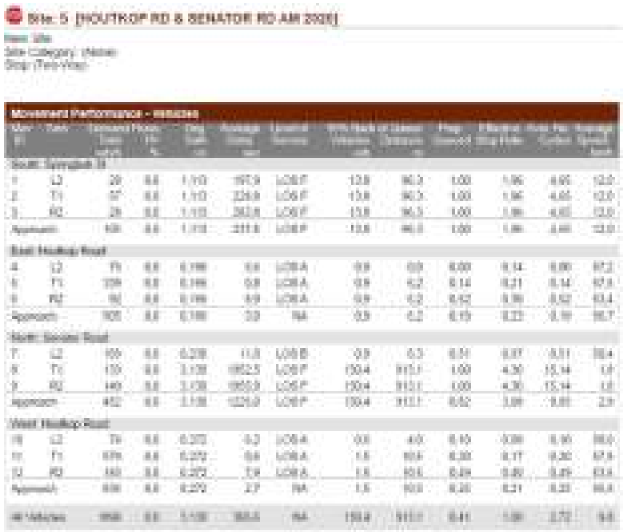


Table 16 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

Table 17 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of Houtkop Road and Senator/Sprinkbok Street currently operates at LOS F on the South & North approach during the AM & PM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street are shown in Table 18 & Table 19 for 2020 without development scenario.

Table 18 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

Table 19 SUMMARY OF 2020 PM-PEAK CAPACITY ANALYSIS RESULTS
WITHOUT DEVELOPMENT

The capacity analysis indicates that the intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street currently operates at LOS F on the South & West approach during the AM peak, an intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Poole Street are shown in Table 20 & Table 21 for 2020 without development scenario

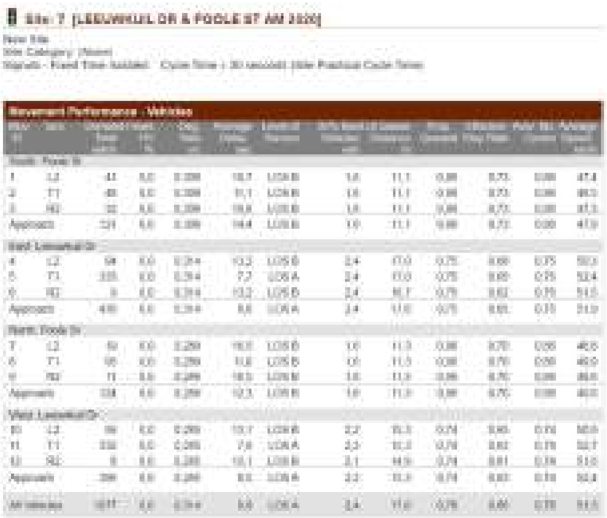

Site: 7 [LEEUWKUIL DR & POOLE ST AM 2020]

Table 20 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

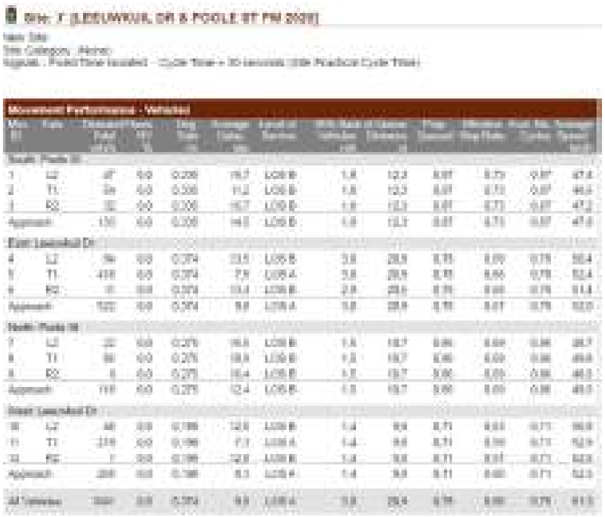

Site: 7 [LEEUWKUIL DR & POOLE ST PM 2020]

Table 21 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Leeuwkrol Drive and Poole Street currently operates at LOS A during both the AM & PM peak, an NO intersection upgrade required.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Johannesburg Road are shown in Table 22 & Table 23 for 2020 without development scenario

Table 22 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

Table 23 SUMMARY OF 2020 AM-PEAK CAPACITY ANALYSIS RESULTS *WITHOUT DEVELOPMENT*

The capacity analysis indicates that the intersection of Leeuwkrol Drive and Johannesburg Road currently operates at LOS F during the AM & PM peak, an intersection upgrade required.

7.3 2025 With Development Scenario

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Gary Player Street are shown in Table 24 & Table 25 for 2025 with a development scenario.


Site: 1v [GARY PLAYER STR & HOUTKOP RD AM 2025 PLUS DEVELOPMENT - SIGNAL UPGRADE]

Movement Performance - Vehicles

Table 24 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*


Site: 1v [GARY PLAYER STR & HOUTKOP RD PM 2025 PLUS DEVELOPMENT - SIGNAL UPGRADE]

Movement Performance - Vehicles

Table 25 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Gary Player Street currently operates at LOS B for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Laurie Stevens Street are shown in Table 26 & Table 27 for 2025 with a development scenario.


Site: 2v [LAURIE STEVENS & HOUTKOP RD AM 2025 PLUS DEVELOPMENT - SIGNAL UPGRADE]

Movement Performance - Vehicles

Table 26 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*


Site: 2v [LAURIE STEVENS & HOUTKOP RD PM 2025 PLUS DEVELOPMENT - SIGNAL UPGRADE]

Movement Performance - Vehicles

Table 27 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Laurie Stevens Street currently operates at LOS A for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Percy Sherwell Street are shown in Table 28 & Table 29 for 2025 with a development scenario.

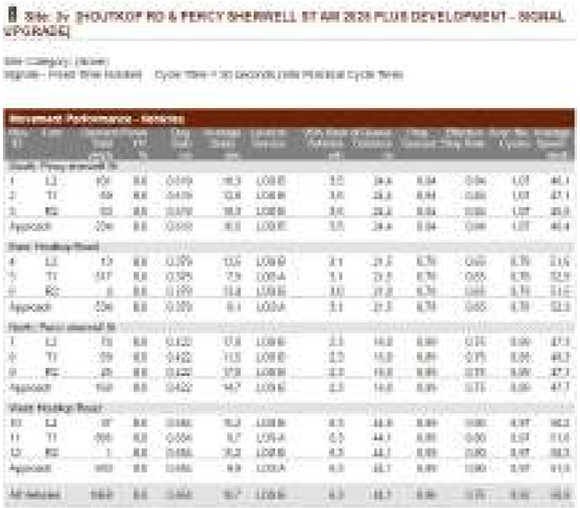


Table 28 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

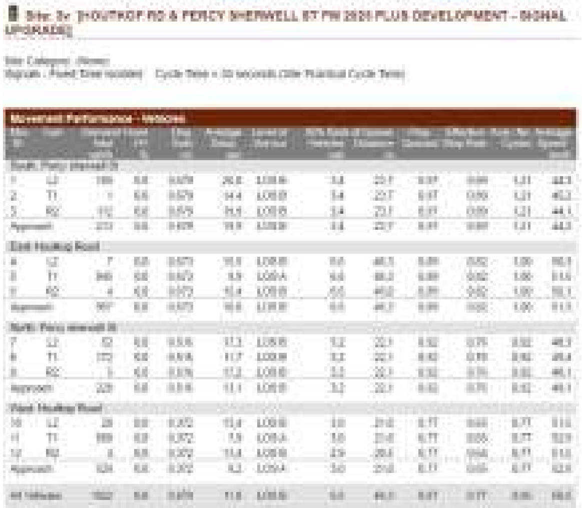


Table 29 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Percy Sherwell Street currently operates at LOS A for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Japie Krige Street are shown in Table 30 & Table 31 for 2025 with a development scenario.

Table 30 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Table 31 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Japie Krige Street currently operates at LOS C for both the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Senator/Sprinkbok Street are shown in Table 32 & Table 33 for 2025 with a development scenario.

Site: 5v [HOUTKOP RD & SENATOR RD AM 2025 PLUS DEVELOPMENT - SINAL UPGRADE]

New Site
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = [illegible] seconds (Site Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Sprinkbok St												
1	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
East: Houtkop Road												
4	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
North: Senator Road												
7	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
West: Houtkop Road												
10	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
All Vehicles		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 32 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

Site: 5v [HOUTKOP RD & SENATOR RD PM 2025 PLUS DEVELOPMENT - SIGNAL UPGRADE]

New Site
Site Category: (None)
Signals - Fixed Time Isolated   Cycle Time = [illegible] seconds (Site Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Sprinkbok St												
1	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
East: Houtkop Road												
4	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
North: Senator Road												
7	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
West: Houtkop Road												
10	L2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	T1	[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12	R2	[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Approach		[illegible]	[illegible]	[illegible]	[illegible]	LOS C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
All Vehicles		[illegible]	[illegible]	[illegible]	[illegible]	LOS B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 33 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Houtkop Road and Senator/Sprinkbok Street currently operates at LOS C & B for the AM & PM peak, with the intersection signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street are shown in Table 34 & Table 35 for 2025 with a development scenario.

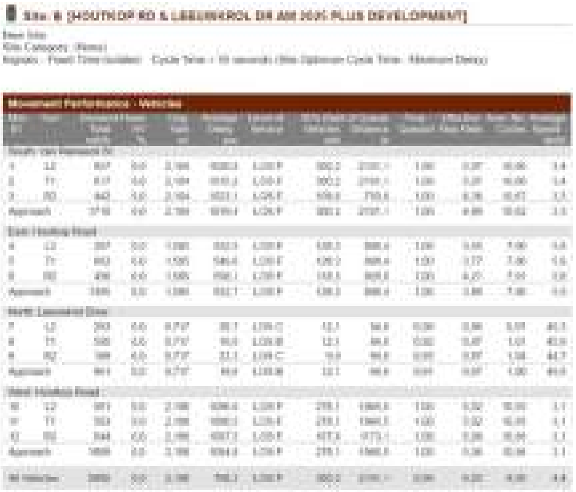


Table 34 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS _WITH DEVELOPMENT & INTERSECTION UPGRADES_

Table 35 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS _WITH DEVELOPMENT & INTERSECTION UPGRADES_

The capacity analysis indicates that the intersection of Houtkop Road and Leeuwkrol Drive/Van Riebeek Street currently operates at LOS F for the AM & PM peak, with the intersection signalisation has to be synchronized with the new signals.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Poole Street are shown in Table 36 & Table 37 for 2025 with a development scenario

Table 36 SUMMARY OF 2025 AM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

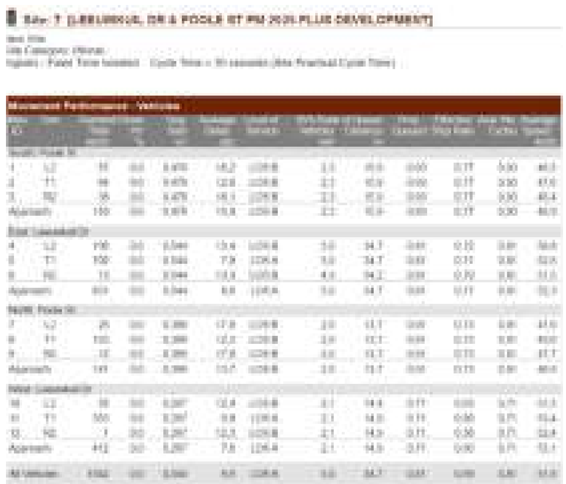
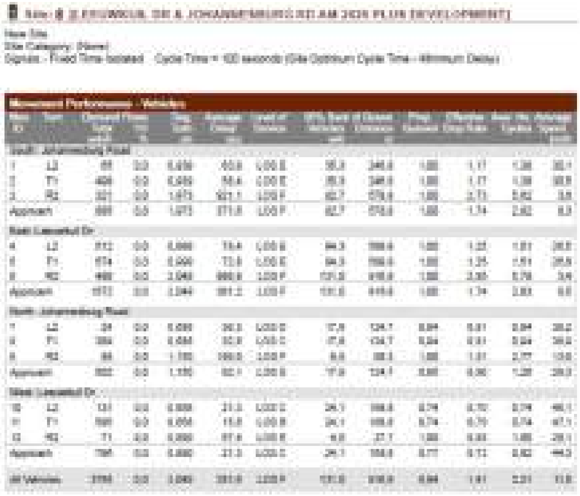
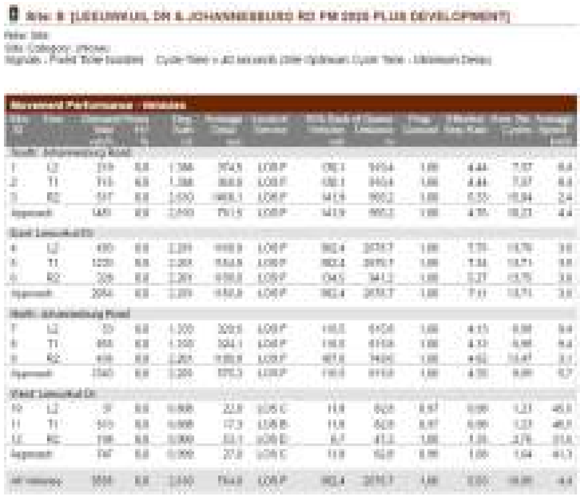


Table 37 SUMMARY OF 2025 PM-PEAK CAPACITY ANALYSIS RESULTS *WITH DEVELOPMENT & INTERSECTION UPGRADES*

The capacity analysis indicates that the intersection of Leeuwkrol Drive and Poole Street currently operates at LOS A for the AM & PM peak, with the existing signalisation.

The results of Sidra Intersection Capacity Analyses at the existing intersection of Leeuwkrol Drive and Johannesburg Road are shown in Table 38 & Table 39 for 2025 with a development scenario



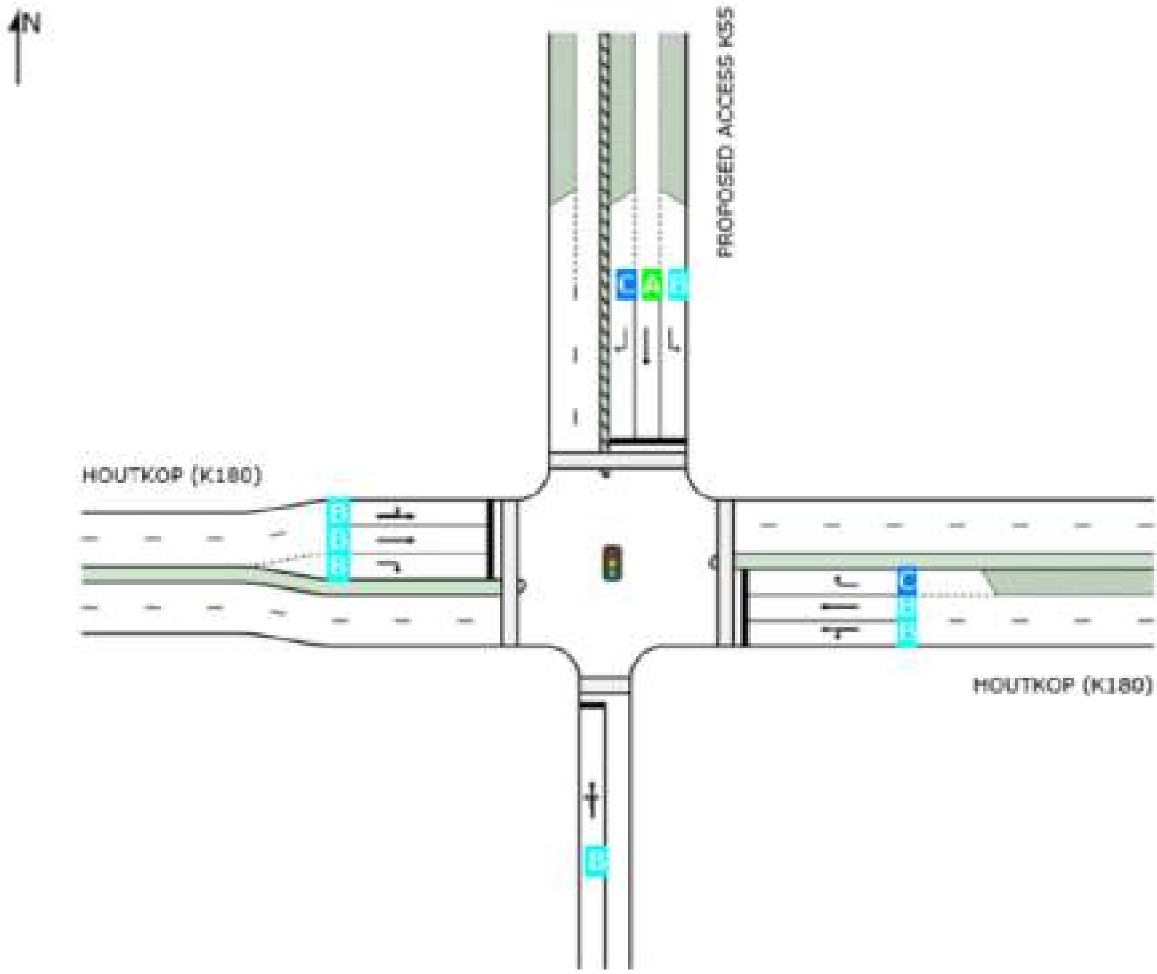


The capacity analysis indicates that the intersection of Leeuwkrol Drive and Johannesburg Road currently operates at LOS F for the AM & PM peak, with the intersection signalisation has to be synchronized with the new signals.

8 ACCESS

8.1 General

Access will be provided off Proposed K55 and K180 this intersection will to Gautrans Standards, and as per PRS 78/197/4Bp (refer below for the access layout configuration).



Schematic PH_004: PROPOSED SIGNALISED ACCESS

9 PARKING PROVISION

Parking will be provided within the site as required by the Emfuleni Local Municipality Town Planning Scheme.

10 NON-MOTORISED & PUBLIC TRANSPORT FACILITIES

10.1 Pedestrian Facilities

Pedestrian walkways have been provided along the site frontage of the proposed development as per the Emfuleni Local Municipality requirements or standards.

It is a requirement that pedestrian access must be provided to and from the development, particularly from public transport facilities. Currently, they are formal transport facilities in the vicinity of the development exist.

The planning of the development will however take into consideration possible future road-based public transport infrastructure along various provincial routes (existing or planned).

The conflict between vehicular and pedestrian/bicycle traffic must be minimised. As part of the development, pedestrian crossings would be provided at all major intersections and access points. Bicycle access and crossings, shared with pedestrians or otherwise, would be provided where appropriate.

The minimum footpath or cycleway and clear widths indicated in Table 40 must be provided along the perimeter of the development. The clear width is measured between the side of the road (outer edge of the kerb or shoulder) and the road reserve boundary.

Table 40 : Minimum Sidewalk, Walkway and Cycle Track Width*

Descriptions	Minimum Width
Sidewalks/ Walkways with Buffer Strip • Minimum Width • Desirable Width • Buffer Strip Width	 1.5m 1.8m 0.6m
Sidewalks/Walkways without Buffer Strip	1.8m
Sidewalks in Business Areas	2.5-3.5m
Cycle Track	2.0m
Shared Cycle Track/Walkway	2.4m

*Reference COTO TMH16 Volume 2

Table 41: Desirable Pedestrian Buffer Strips*

Road Class	Desirable Buffer Width (m)
Class 2	6.0
Class 3	4.5
Class 4a	3.0
Class 4b	2.5
Class 5a	0.6-2.5
Class 5b	0.6-1.5

*Reference COTO TMH16 Volume 2

10.2 General

In terms of the National Land Transport Transition Act (NLTTA) 22 of 2000, section 29, it is a requirement that an assessment of public transport is included in a traffic impact assessment.

The following comments are made regarding public transport:

It is recommended that road K180 be provided with a pair of public transport lay-bys in the form of bus and taxi stops at each access point where access to the township is gained. It is further recommended that the proposed lay-bys be constructed to the appropriate design standards of the relevant roads authority (See Schematic PH_005 below).

Schematic PH_005: Typical Public Transport lay-bys

11 ROAD UPGRADES HIGH-LEVEL COST ESTIMATES

TABLE 42: SUMMARY OF PRICING SCHEDULE		
SECTION	DESCRIPTION	AMOUNT
1	Houtkop Road and Gary Player Street intersection-Proposed Traffic Signal	R795 000,00
2	Houtkop Road and Laurie Stevens Street -Proposed Traffic Signal	R795 000,00
3	Houtkop Road and Percy Sherwell Street -Proposed Traffic Signal	R795 000,00
4	Houtkop Road and Japie Krige Street -Proposed Traffic Signal	R795 000,00
5	Houtkop Road and Senator/Sprinkbok Street -Proposed Traffic Signal	R795 000,00
6	Access on K55 & K180-Proposed Traffic Signal	R795 000,00
7	Proposed Bus-Laybys	R3 500 000,00
8	The proposed K55 has two access points that have been provided for in the erf subdivision.	R24 000 000,00
9	External and Site Works	R750 000,00
	Total Schedule of Prices	R33 020 000,00
	10% Contingencies	R3 302 000,00
	Subtotal	R36 322 000,00
	15% VAT	R5 448 300,00
	Estimated Order Magnitude	R41 770 300,00

12 CONCLUSION AND RECOMMENDATION

Based on the assessment of the existing and planned future road network, traffic counts, a traffic analysis and capacity analysis of road links in the study area, the following concluding remarks are relevant.

This Traffic Impact (TIA) & Access Study pertains for the establishment of a Proposed Mixed Use Residential development Unitas Park Extension 16 Situated on Portion 222 of the farm Houtkop 594-IQ (SG Diagram 7423/2008). Portion 222 of the farm Houtkop 594-IQ is in the process of subdivision and will be known as Portion 225 (a portion of 222) of the farm Houtkop 594-IQ (Subdivision Diagram 4362/2009) in the Emfuleni Local Municipality.

The site is currently undeveloped. The township locality and the surrounding road network are indicated on FIGURE PH_001 , 002 & 003.

The development consists of the following land use:

- Proposed Mixed Use Residential Development

Detailed traffic surveys (traffic counts) were carried out at the following intersections :

- Houtkop Road and Gary Player Street intersection;
- Houtkop Road and Laurie Stevens Street intersection;
- Houtkop Road and Percy Sherwell Street intersection;
- Houtkop Road and Japie Krige Street intersection;
- Houtkop Road and Senator/Sprinkbok Street intersection;
- Houtkop Road and Leeuwkrol Drive/Van Riebeek Street intersection;
- Leeuwkrol Drive and Poole Street intersection;
- Leeuwkrol Drive and Johannesburg Road intersection.

The proposed development will generate 566 trips during the weekday AM and weekday PM peak periods, respectively.

The site is well-connected on a regional scale. To the south is Houtkop Road (R54), to the south-west is the R28 and to the east is the R59 (Old Johannesburg Road). The proposed PWV 20 runs to the west of the site and the proposed K55 abuts the site on its eastern boundary.

The proposed K55 has two access points that have been provided for in the erf subdivision. This road, or a portion of it, must first be constructed before access to the site can be obtained. There is no indication as to when this will be done.

From the analysis performed, it was found that the impact of the proposed developments can be mitigated by means of several road and intersection improvements as shown in Section 7.3

The 2020 background traffic & future 2025 traffic show that there is an existing capacity constraint. Therefore the developers of the latent rights developments are required to contribute towards roads and intersection upgrades. The upgrading will be as per the requirements of ELM and GDRT.

Pedestrian walkways have been provided along the site frontage of the proposed development as per the Emfuleni Local Municipality requirements or standards.

It is a requirement that pedestrian access must be provided to and from the development, particularly from public transport facilities. Currently, they are no formal transport facilities in the vicinity of the development exist.

The planning of the development will however take into consideration possible future road-based public transport infrastructure along various provincial routes (existing or planned).

The conflict between vehicular and pedestrian/bicycle traffic must be minimised. As part of the development, pedestrian crossings would be provided at all major intersections and access points. Bicycle access and crossings, shared with pedestrians or otherwise, would be provided where appropriate.

The minimum footpath or cycleway and clear widths indicated in Table 40 must be provided along the perimeter of the development. The clear width is measured between the side of the road (outer edge of the kerb or shoulder) and the road reserve boundary.

In terms of the National Land Transport Transition Act (NLTTA) 22 of 2000, section 29, it is a requirement that an assessment of public transport is included in a traffic impact assessment.

The following comments are made regarding public transport:

It is recommended that road K180 be provided with a pair of public transport lay-bys in the form of bus and taxi stops at each access point where access to the township is gained. It is further recommended that the proposed lay-bys be constructed to the appropriate design standards of the relevant roads authority (See Schematic PH_005)

13 REFERENCES

- TMH 16 Volume 2, South African Traffic Impact and Site Traffic Assessment Standards and Requirements Manual, Version 1.0, Committee of Transport Officials (COTO) August 2012
- TMH 17 Volume 1, South African Trip Data Manual, Version 1.0, Committee of Transport Officials (COTO) September 2012
- Highway Capacity Manual, Transportation Research Board, National Research Council Washington D.C., 2010
- Manual for Traffic Impact Studies, Department of Transport (DOT), October 1995
- The Development of an Operations Plan for an IRPTN North/South Corridor,City of Ekurhuleni, 2012.

ANNEXURE A-TRIP GENERATION

UNITAS PARK EXTENSION 16- FINAL REPORT

PREPARED BY

PHUMAF HOLDINGS
P.O. BOX 4049,
RANDBURG
2125

Cell: +27 (0)72 603 6122
Tel: +27 (0)11 326 0741/90
Email: smnguni@phumaf.com
Contact Person: Sikelela Mnguni (Pr.Tech.Eng)

PREPARED FOR:

GAUTENG PROVINCE HUMAN SETTLEMENT
37 Sauer Street
Marshalltown
JOHANNESBURG
2001

Tel: +27 (0)11 355 6000
Fax: +27 (0)11 355 6211

CONFIGURATION CONTROL

Project: Proposed Mixed Use Unitas Park Extension 16

Title: Annexure A-Trip Generation

Created by: Sikelela Mnguni *(Pr.Tech.Eng)*

REVISION RECORD

Revision	Date	Compiled	Saved as	Project Minutes
A0	07 July 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None
A1	02 November 2020	Sikelela Mnguni *(Pr.Tech.Eng*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None

Prepared : Sikelela. Mnguni (*Pr.Tech. Eng-201170212*)

Signed:

Date: 02 November 2020

Clients Approval :

Signed:

TRAFFIC COUNTS
UNITAS PARK EXTENSION 16- FINAL REPORT

PREPARED BY

PHUMAF HOLDINGS
P.O. BOX 4049,
RANDBURG
2125

Cell: +27 (0)72 603 6122
Tel: +27 (0)11 326 0741/90
Email: smnguni@phumaf.com
Contact Person: Sikelela Mnguni (Pr.Tech.Eng)

PREPARED FOR:

GAUTENG PROVINCE HUMAN SETTLEMENT
37 Sauer Street
Marshalltown
JOHANNESBURG
2001

Tel: +27 (0)11 355 6000
Fax: +27 (0)11 355 6211

CONFIGURATION CONTROL

Project: Proposed Mixed Use Unitas Park Extension 16

Title: Traffic Counts

Created by: Sikelela Mnguni *(Pr.Tech.Eng)*

REVISION RECORD

Revision	Date	Compiled	Saved as	Project Minutes
A0	07 July 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None
A1	02 November 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None

Prepared : Sikelela. Mnguni (*Pr.Tech. Eng-201170212*)

Signed:

Date: 02 November 2020

Clients Approval :

Signed:

DEVELOPMENT	LAND USE	UNIT OF MEASUREMENT (ha)	COTO TRIP DATA MANUAL (TMH17)											ADJUSTED PEAK TRIP RATE (veh/h)		EXPECTED PEAK HOUR TRIP GENERATION (veh/h)					
			TRIP CODE	PEAK HOUR BASE TRIP GENERATION RATES (veh/h)						TRIP REDUCTION FACTORS (%)						WEEKDAY AM			WEEKDAY PM		
				WEEKDAY AM	SPLIT		WEEKDAY PM	SPLIT													
					IN	OUT		IN	OUT	MIXED-USE (Pm)	VEHICLES OWNERSHIP (Pv)	TRANSIT NODES OR CORRIDORS (Pt)	TOTAL (Pc)	WEEKDAY AM	WEEKDAY PM	IN	OUT	TOTAL	IN	OUT	TOTAL
UNITAS PARK	LOW DENSITY RES	1354	210-SINGLE DWELLING UNITS	1	25%	75%	1	70%	30%	30%	80%	15%	**88,1%**	0,119	0,119	40	121	**161**	113	48	**161**
UNITAS PARK	MEDIUM DENSITY RES	1886	231-TOWNHOUSES (SIMPLEXES AND DUPLEXES)	0,85	25%	75%	0,85	70%	30%	30%	80%	15%	**88,1%**	0,101	0,101	48	143	**191**	134	57	**191**
UNITAS PARK	HIGH DENSITY RES	2763	220-APARTMENTS AND FLATS	0,65	25%	75%	0,65	70%	30%	30%	80%	15%	**88,1%**	0,077	0,077	53	160	**214**	150	64	**214**
																141	424	566	396	170	566

ANNEXURE B-BOOK OF DRAWINGS

UNITAS PARK EXTENSION 16- FINAL REPORT

PREPARED BY

PHUMAF HOLDINGS
P.O. BOX 4049,
RANDBURG
2125

Cell: +27 (0)72 603 6122
Tel: +27 (0)11 326 0741/90
Email: smnguni@phumaf.com
Contact Person: Sikelela Mnguni (Pr.Tech.Eng)

PREPARED FOR:

GAUTENG PROVINCE HUMAN SETTLEMENT
37 Sauer Street
Marshalltown
JOHANNESBURG
2001

Tel: +27 (0)11 355 6000
Fax: +27 (0)11 355 6211

CONFIGURATION CONTROL

Project: Proposed Mixed Use Unitas Park Extension 16

Title: Annexure B-Book Of Drawings

Created by: Sikelela Mnguni *(Pr.Tech.Eng)*

REVISION RECORD

Revision	Date	Compiled	Saved as	Project Minutes
A0	07 July 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None
A1	02 Novemeber 2020	Sikelela Mnguni *(Pr.Tech.Eng)*	Proposed Unitas Park Extension 16 *TIA RT. A1*	None

Prepared : Sikelela. Mnguni (*Pr.Tech. Eng-201170212*)

Signed:

Date: 02 November 2020

Clients Approval :

Signed:

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY

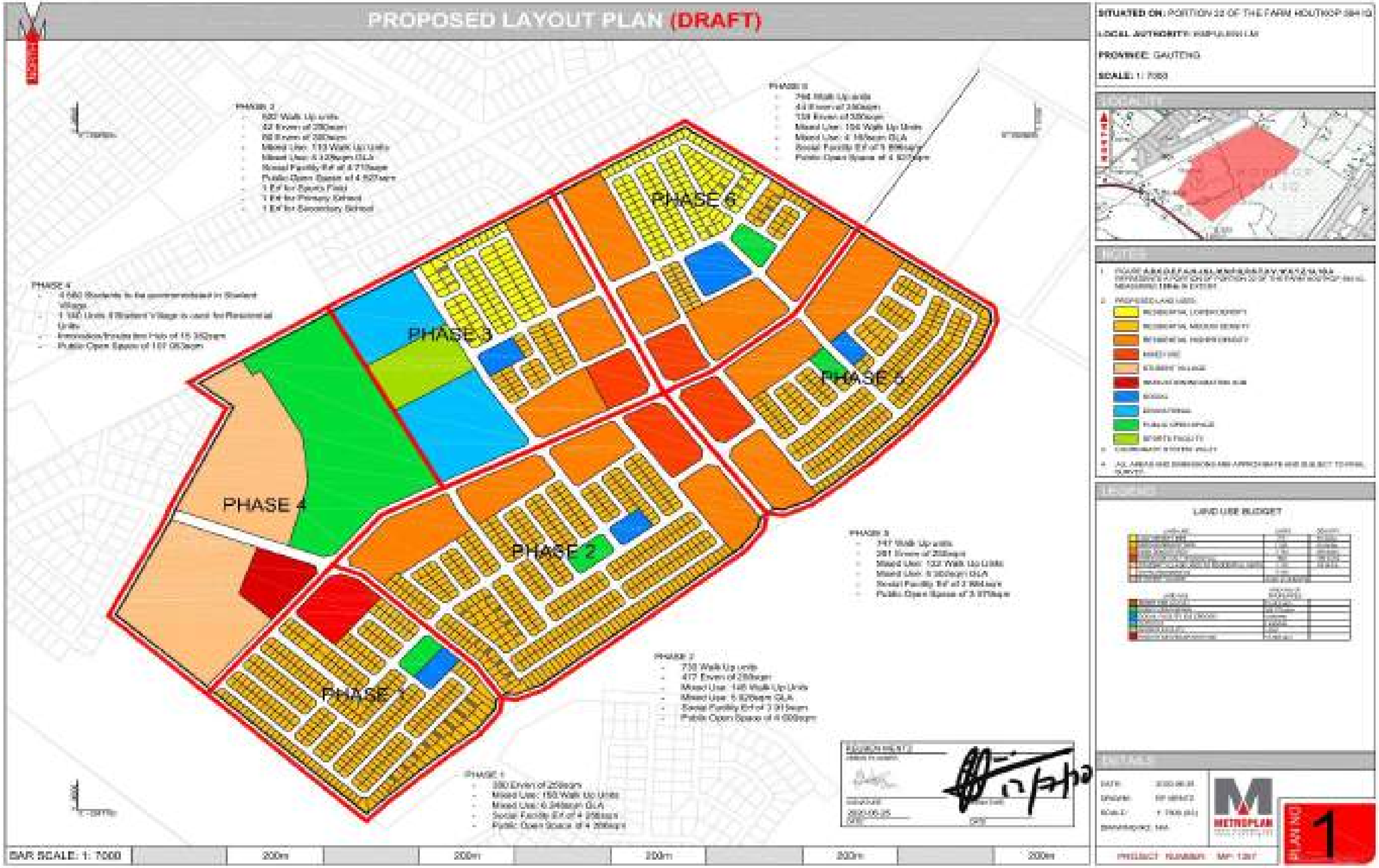
LOCALITY PLAN

FIGURE PH_001

PHUMAF

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY

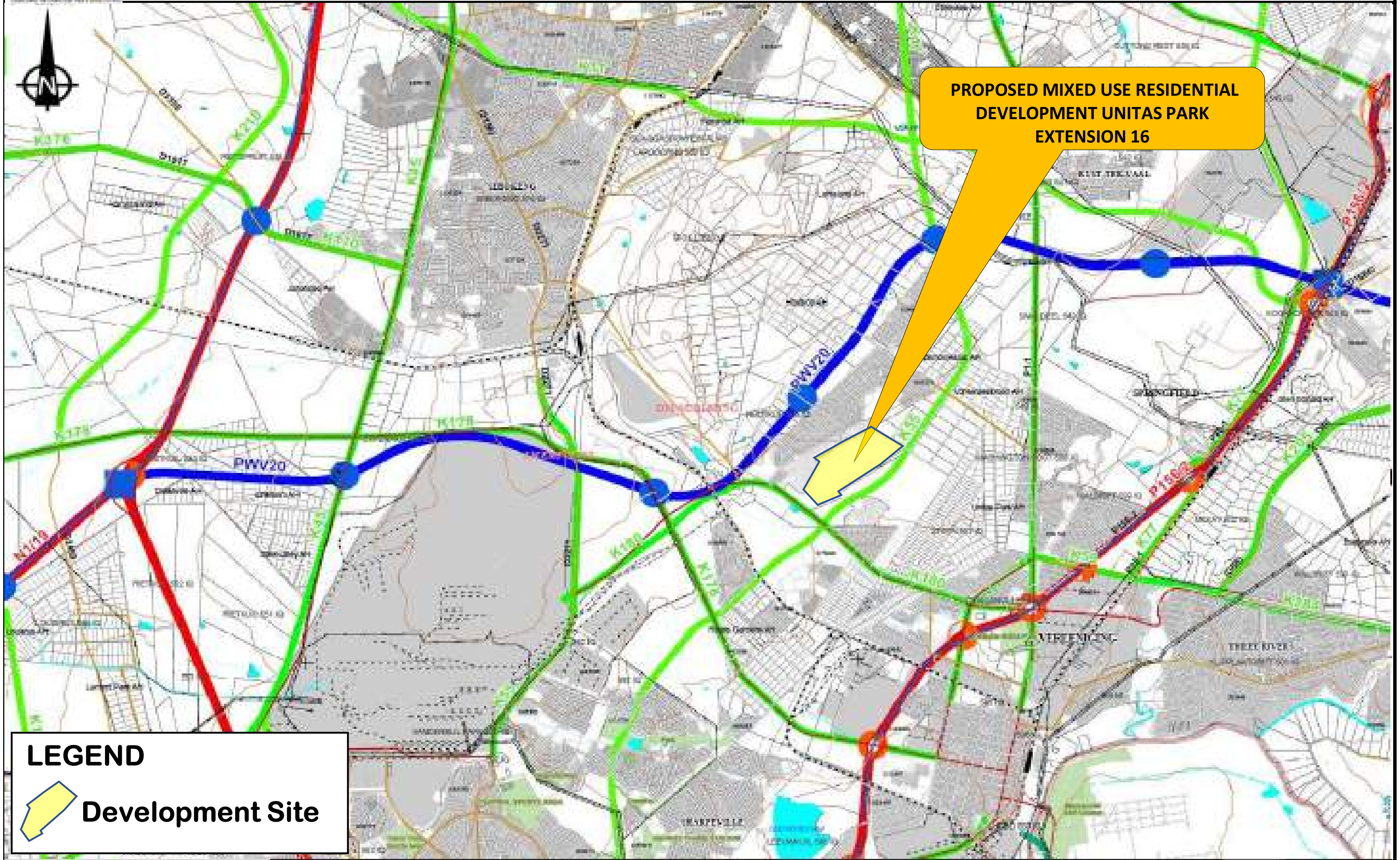
GAUTENG PROVINCE



PROPOSED DRAFT LAYOUT OF THE DEVELOPMENT

FIGURE PH_002

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY



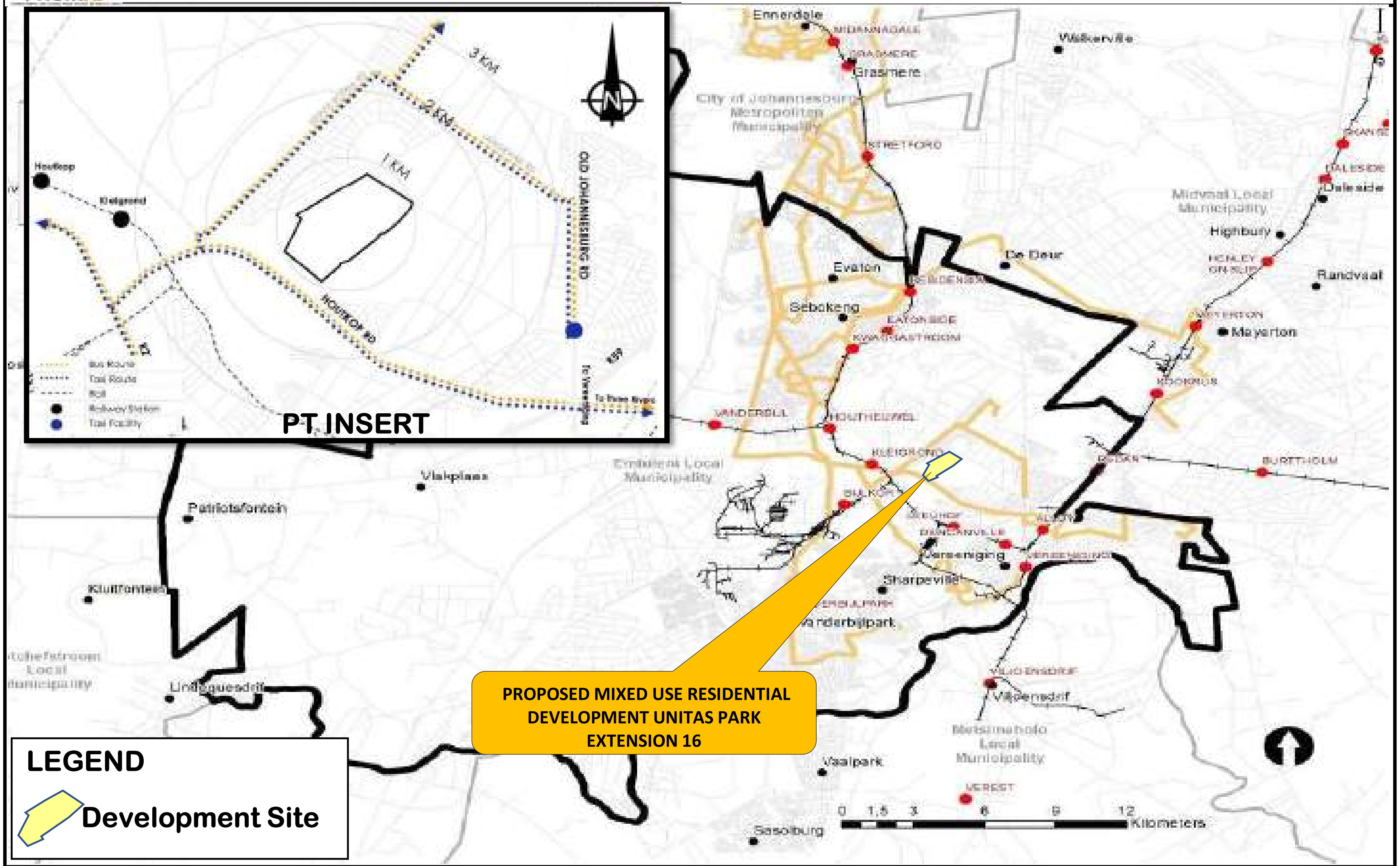
FUTURE K-ROUTES AND PWV ROUTE MASTER PLAN

FIGURE PH_003

PHUMAF

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY

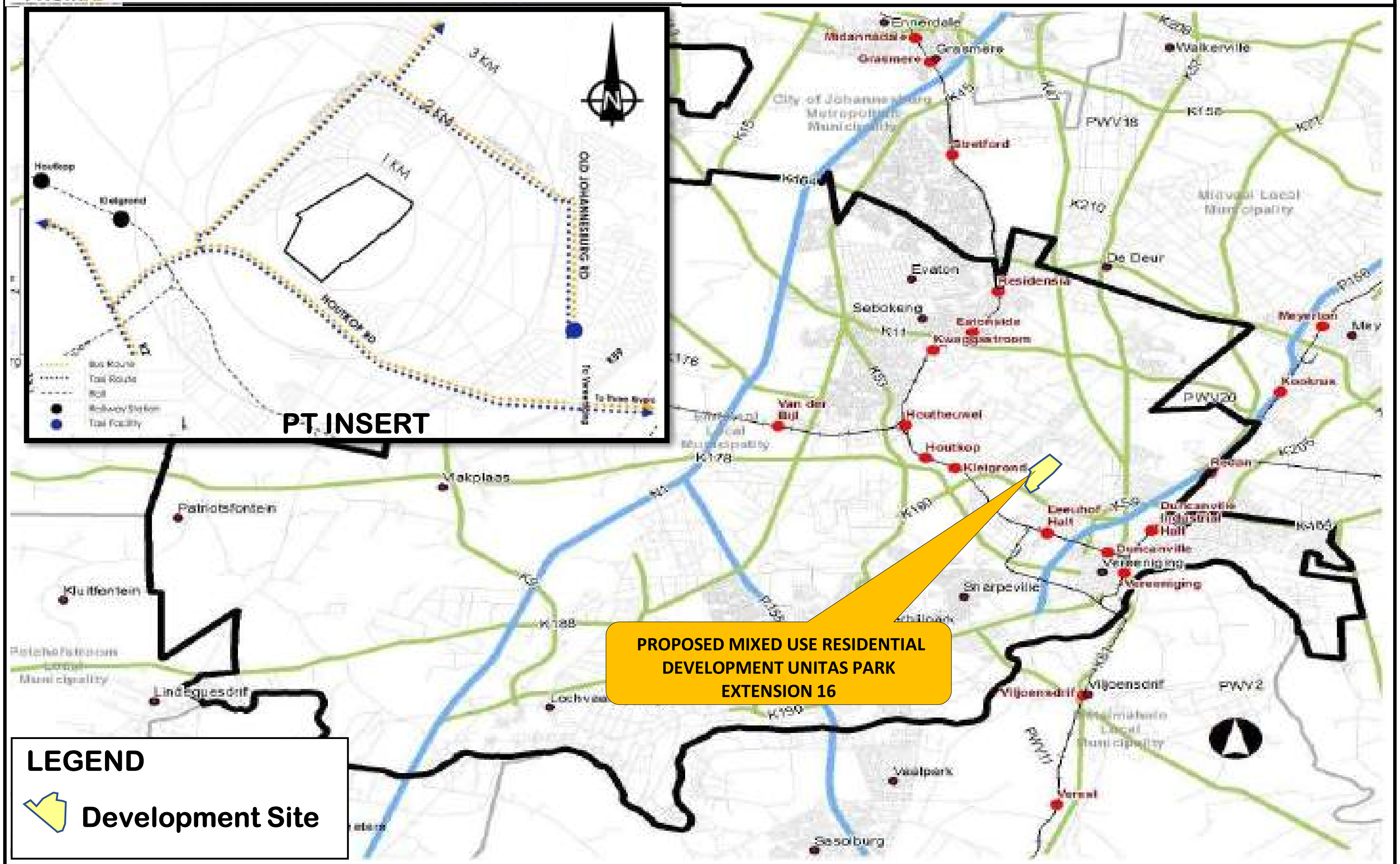
GAUTENG PROVINCE



EMFULENI LOCAL M EXISTING PT ROUTES

FIGURE PH_004

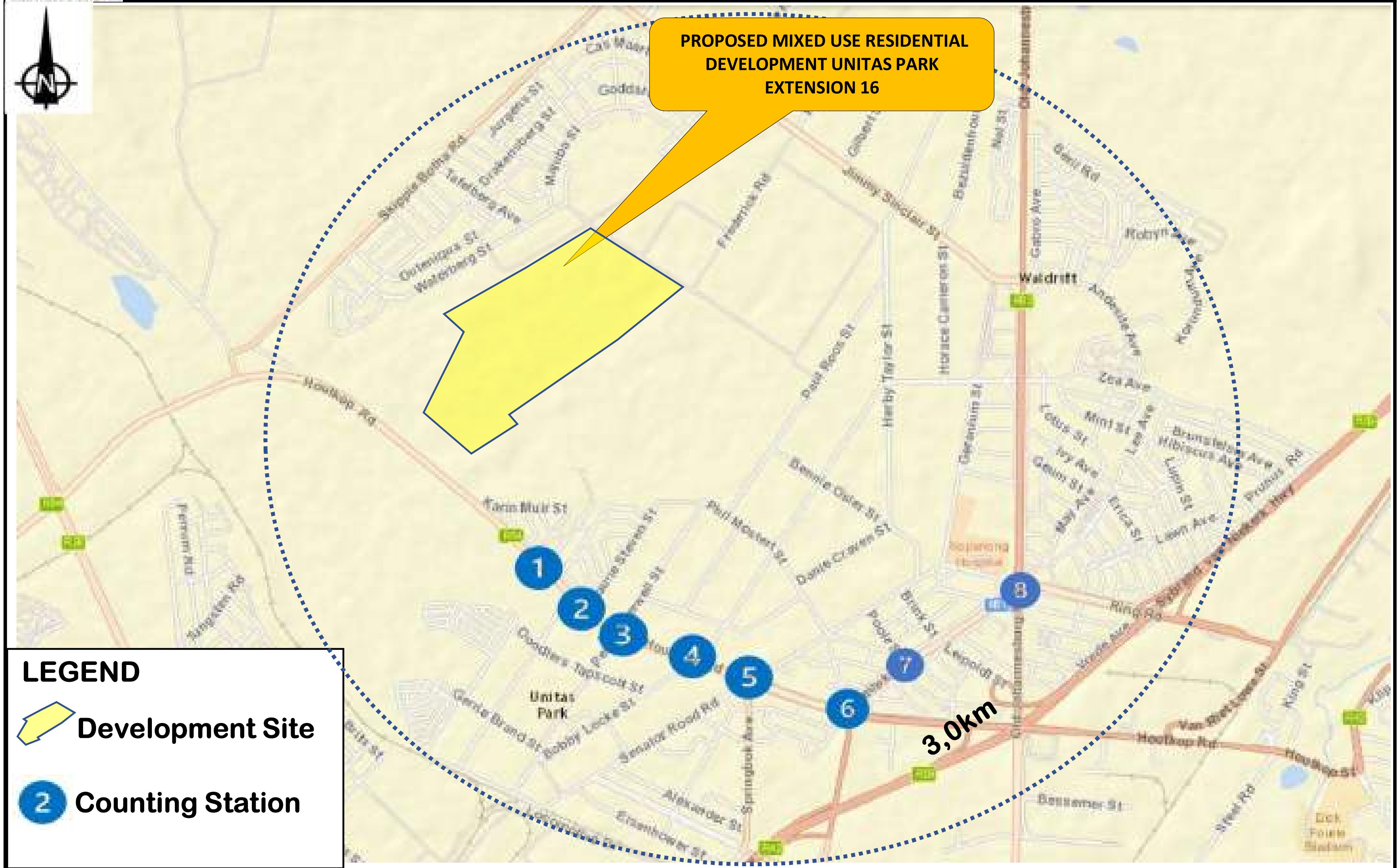
TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY



EMFULENI LM EXISTING TRANSPORT NETWORKS

FIGURE PH_004a

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY



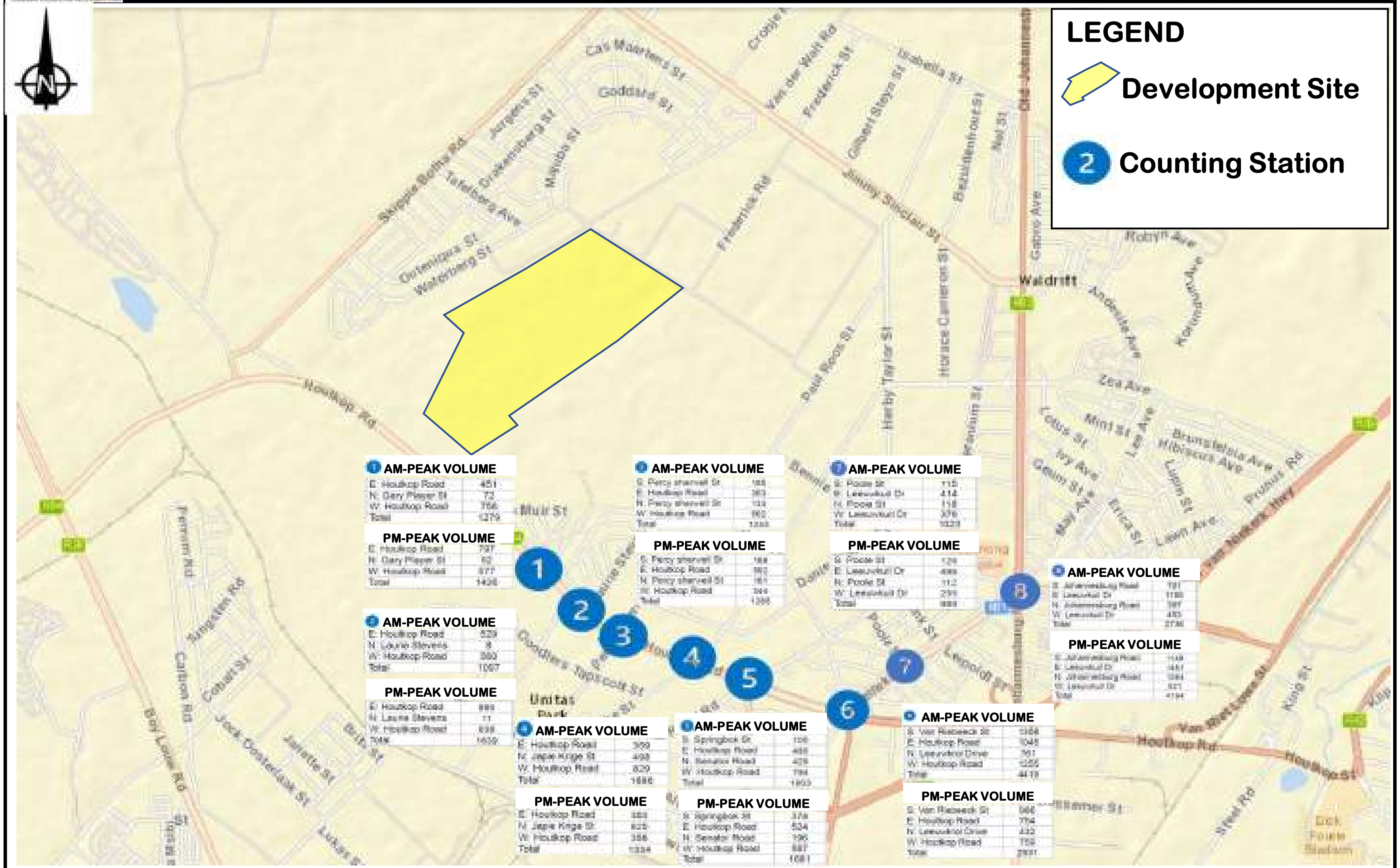
ACCESS POINTS AND COUNTING STATIONS

FIGURE PH_005

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY

PHUMAF

GAUTENG PROVINCE



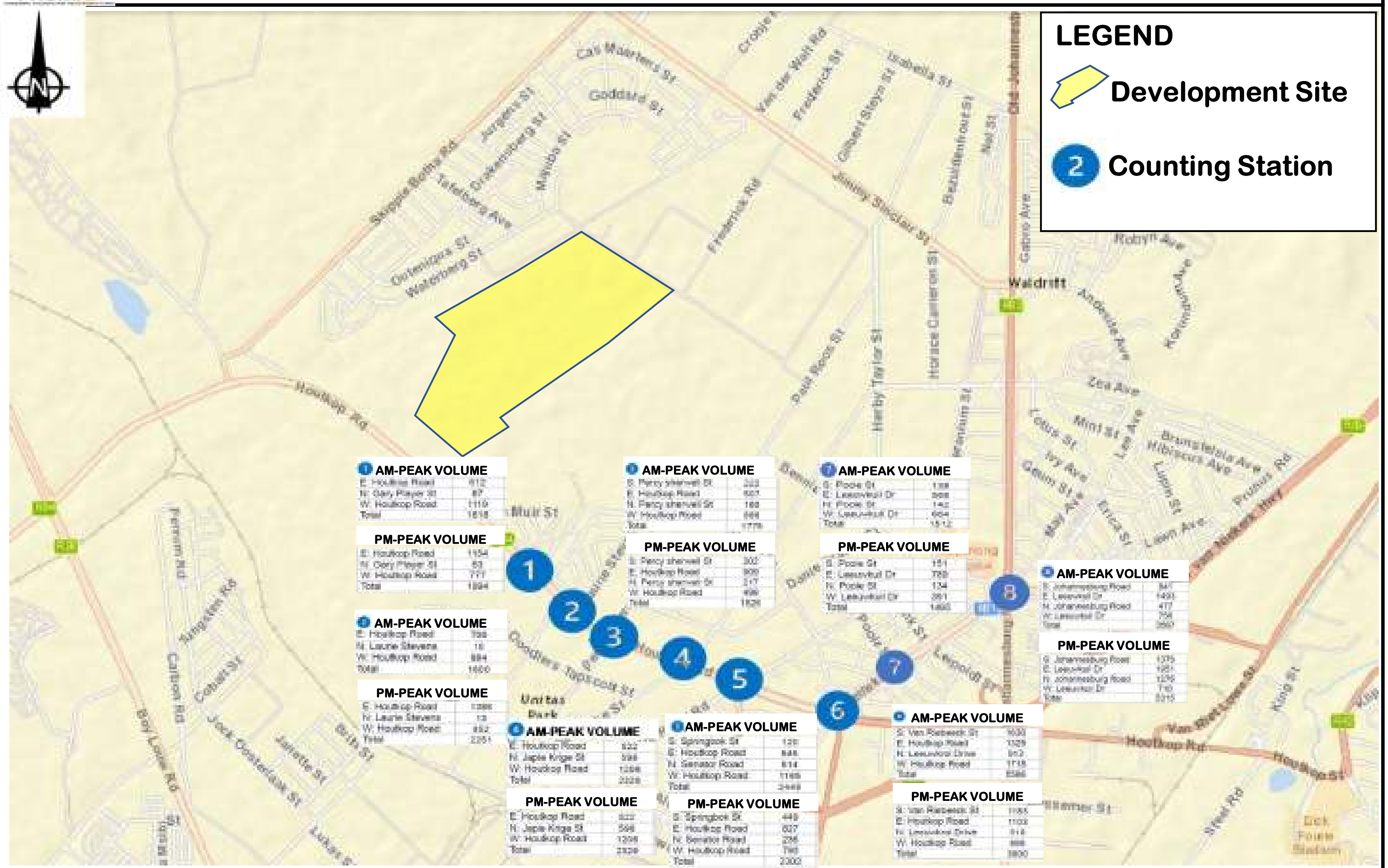
2020 AM & PM PEAK BACKGROUND VOLUMES

FIGURE PH_006

TRAFFIC IMPACT & ACCESS STUDY FOR PROPOSED MIXED USE RESIDENTIAL DEVELOPMENT UNITAS PARK EXTENSION 16 SITUATED ON REMAINING EXTENT OF PORTION 222 (A PORTION OF PORTION 221) OF THE FARM HOUTKOP 594 IQ (UNITAS PARK EXTENSION 16) IN THE EMFULENI LOCAL MUNICIPALITY

PHUMAF

GAUTENG PROVINCE



AM-PEAK VOLUME

E. Houtkop Road	612
N. Gary Player St	87
W. Houtkop Road	1119
Total	1818

PM-PEAK VOLUME

E. Houtkop Road	1154
N. Gary Player St	63
W. Houtkop Road	777
Total	1994

AM-PEAK VOLUME

E. Houtkop Road	798
N. Laurie Stevens	18
W. Houtkop Road	884
Total	1600

PM-PEAK VOLUME

E. Houtkop Road	1386
N. Laurie Stevens	13
W. Houtkop Road	852
Total	2251

AM-PEAK VOLUME

S. Percy sherwell St	323
E. Houtkop Road	527
N. Percy sherwell St	160
W. Houtkop Road	666
Total	1776

PM-PEAK VOLUME

S. Percy sherwell St	302
E. Houtkop Road	809
N. Percy sherwell St	217
W. Houtkop Road	498
Total	1826

AM-PEAK VOLUME

S. Poole St	138
E. Leeuwkuil Dr	568
N. Poole St	142
W. Leeuwkuil Dr	664
Total	1512

PM-PEAK VOLUME

S. Poole St	151
E. Leeuwkuil Dr	769
N. Poole St	134
W. Leeuwkuil Dr	261
Total	1460

AM-PEAK VOLUME

S. Johannesburg Road	847
E. Leeuwkuil Dr	1493
N. Johannesburg Road	477
W. Leeuwkuil Dr	758
Total	3560

PM-PEAK VOLUME

S. Johannesburg Road	1375
E. Leeuwkuil Dr	1951
N. Johannesburg Road	1270
W. Leeuwkuil Dr	710
Total	5315

AM-PEAK VOLUME

E. Houtkop Road	822
N. Japie Krige St	398
W. Houtkop Road	1208
Total	2328

PM-PEAK VOLUME

E. Houtkop Road	822
N. Japie Krige St	596
W. Houtkop Road	1208
Total	2329

AM-PEAK VOLUME

S. Springbok St	120
E. Houtkop Road	848
N. Senator Road	614
W. Houtkop Road	1165
Total	2449

PM-PEAK VOLUME

S. Springbok St	449
E. Houtkop Road	827
N. Senator Road	236
W. Houtkop Road	790
Total	2302

AM-PEAK VOLUME

S. Van Riebeeck St	1630
E. Houtkop Road	1129
N. Leeuwkuil Drive	912
W. Houtkop Road	1718
Total	5386

PM-PEAK VOLUME

S. Van Riebeeck St	1165
E. Houtkop Road	1103
N. Leeuwkuil Drive	914
W. Houtkop Road	868
Total	3800

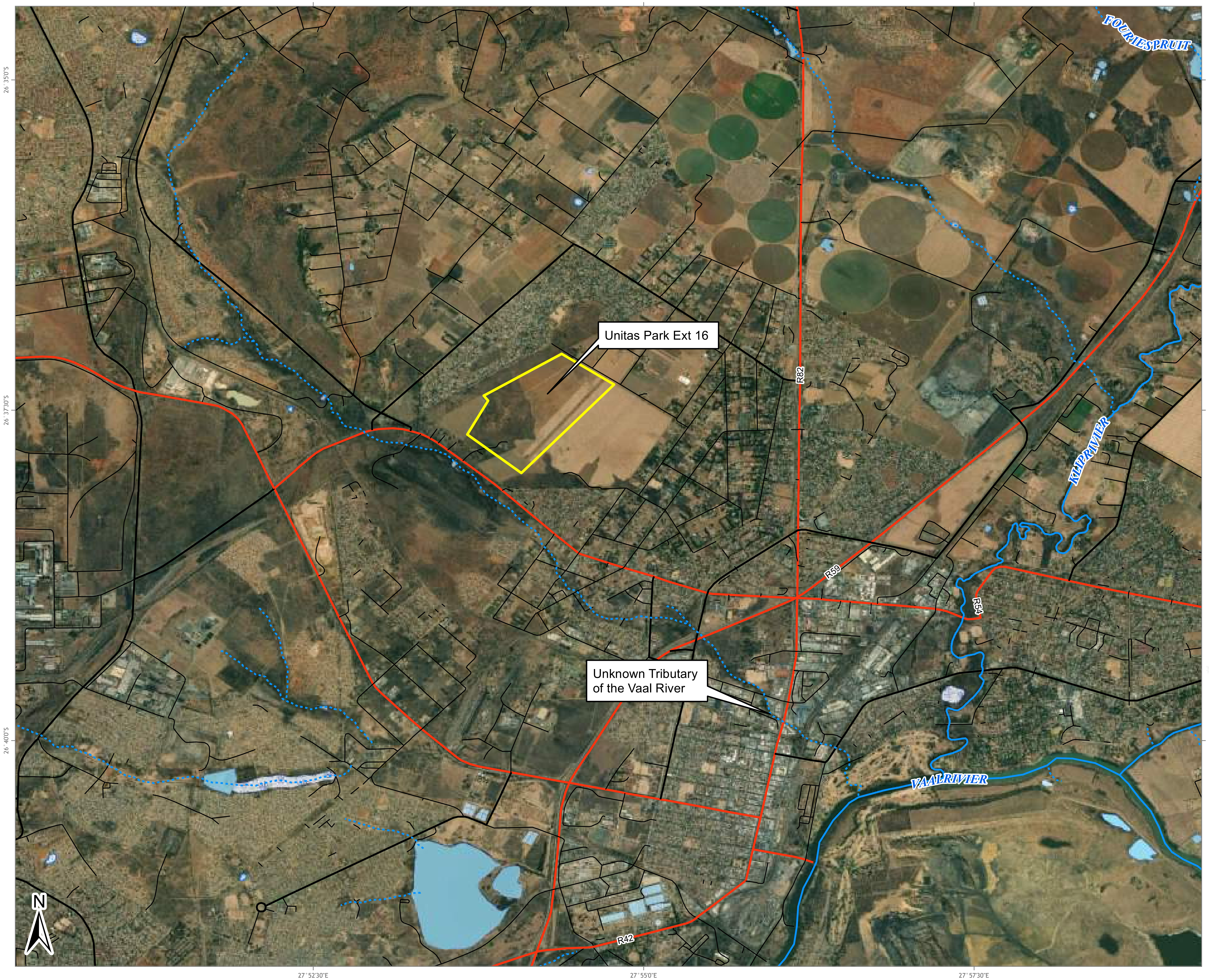
2025 AM & PM PEAK BACKGROUND + DEVELOPMENT VOLUMES

FIGURE PH_007

ANNEXURE D

MAP NO 19-0921-09-V2

UNITAS PARK EXT 16: SITE MAP



LEGEND

Rivers and Streams

Non-Perennial

Perennial

Road Network

Main Road

Secondary Road

Street

Unitas Park Ext 16: Site Map

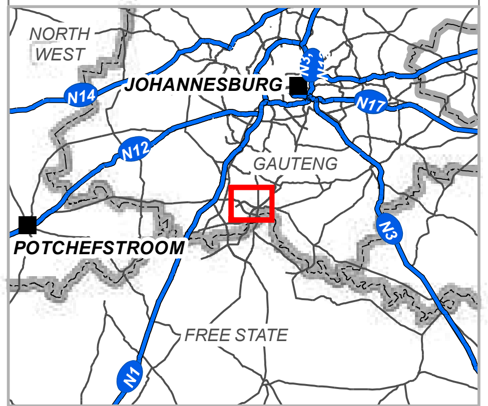
Inland Water

Dams and lakes

Reservoirs and water tanks

Marsh and swamps

Non-perennial pans



Data Sources:
Esri World Imagery Basemap

0 1 2 Kilometers

SCALE: 1:50 000

FIGURE NO.:	-	MAP NUMBER:	19-0921-09-V2
DRAWN BY:	N NAIDOO GIS TECHNICIAN	REVIEWED BY:	J MENEGHELLI CIVIL ENGINEER
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	18 FEBRUARY 2021

PROJECT: TOWNSHIP ESTABLISHMENT BRYANSTON EXT3 (JHB)
CLIENT: PHUMAF HOLDINGS

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

ANNEXURE E

GEOTECHNICAL INVESTIGATION REPORT, ENGEODE DATA REQUEST

UNITAS PARK X16
PROJECT B

GEOTECHNICAL INVESTIGATION REPORT
GFSH2-PHASE 1

REPORT NO: GGE/19034

February 2020

Prepared By:

Geoid Geotechnical Engineers (Pty) Ltd
21 Glenluce Drive
Douglasdale
Sandton
2191

Tel: 011-704-3131
Enquiries: Mr Stuart Morgan
Email: mail@geoid.co.za

Prepared For:

Phumaf Holdings (Pty) Ltd
356 Pretoria Avenue Street
Randburg
2194

Tel: 011-326-0741
Enquiries: Mr Ngoni Gandiwa
Email: ngandiwa@phumaf.com

Table of Contents

Appendices

List of Figures

List of Tables

List of Abbreviations

BGL -	Below ground level
BH -	Borehole (& No)
COP -	Code of Practice = SANS 1936 : 2012
DAD -	Dolomite Area Designation
DC -	Dynamic Compaction
DR -	Dynamic Replacement
DRMP -	Dolomite Risk Management Plan
DWAF -	Department of Water Affairs & Forestry
IHC -	Inherent Hazard (Risk) Class
NGL -	Natural ground level
RIC -	Rapid Impact Compaction
SANS -	South African National Standard - SANS 1936 : 2012 - Development of Dolomite Land
SDP -	Site Development Plan
TPB -	Test Pit (& No)

GEOID Geotechnical Engineers

+27-11-704-3131
+27-86-503-8371
+27-83-326-5395
21 Glenluce Drive, Douglasdale
Sandton, 2191, South Africa
mail@geoid.co.za
www.geoid.co.za

Project Title	GFSH2-Phase 1 Geotechnical Investigation for Unitas Park X16 - Project B		
Client	Phumaf Holdings (Pty) Ltd c/o Ngoni Gandiwa	Contact Details	ngandiwa@phumaf.com
Project Number	GGE/19034	Date	2 February 2020

1. Introduction and Terms of Reference

Geoid Geotechnical Engineers (GGE) have been appointed by Mr Kenneth Chitenhe, on behalf of Phumaf Holdings (Pty) Ltd, to carry out a *near-surface GFSH2-Phase 1 Geotechnical Investigation* for Unitas Park X16 - Project B. The approved cost proposal 047RFP/7001/2019 of September 2019, and subsequent Professional Services Agreement, dated 17th October 2019 have reference.

The work has been carried out in accordance with the requirements set out in the Guidelines for Urban Engineering Geological Investigations, as published by the *South African Institute of Engineering Geologists* and *South African Institution of Civil Engineers*.

2. Scope of Work

The scope of work undertaken in this near-surface geotechnical investigation includes the following:

(a) to determine the nature, distribution and engineering properties of the near-surface soils and rocks influencing the proposed development;

(b) to classify the site into similar geotechnical zones according to the guidelines referred to above;

(c) to give general foundation recommendations for the proposed development in each geotechnical zone;

(d) to classify the excavation characteristics for terracing and the installation of buried services;

(e) to highlight areas of the site affected by shallow groundwater;

(f) to assess the slope stability of the project site;

(g) to comment provisionally on the properties of available soils for construction of roads and terraces;

(h) to comment on any other general geotechnical issues which warrant attention.

3. Site Location and Description

The project site is a 151ha near-rectangular property, situated in the existing farmland of Houtkop 594-IQ, midway between Sonlandpark in the north and Unitas Park in the south. The site boundaries are not clearly defined on the ground, given its setting within an existing operational farm (see Figure 1 - Appendix A).

Regional topographic contours show the site dipping very gently south-eastwards at a gradient of 1:75 (0.8° or 1.3%), with surface drainage essentially taking the form sheetwash towards a canal, south of the R54 (see Figure 1). Whilst no natural drainage lines were noted on the property at the time of the investigation, a zone of vlei grass was noted in the southern sector, indicative of a masked or palaeo drainage line. In addition, the very presence of the canal confirms that the natural drainage pattern has been artificially altered, potentially intercepting the natural drainage of this property, which is now masked by the ploughed farmlands.

Other than a large quarry zone in the western sector and patches of rocky outcrop which preclude farming activities - these being colonised by veldgrass and scattered trees - vegetation is dominated by juvenile cultivated corn lands illustrated in the photos below.

Relatively small, but significant, boulder outcrop was observed in the non-arable zones of the site at the time of the investigation.

4. Information Supplied

4.1 Proposed Development

The project summary specification for this site indicates that 7250 number, mixed high density Res 4, BNG Walk-up units are proposed, the suggested concept of which is illustrated in the image adjacent.

4.2 Base Data

The base data consulted for this investigation comprises the following information, which has been sequentially overlaid on the drawings using ArcGIS - spatial database modelling software:

Data	Scale	Sheet Name	Reference	Source
Topographic	1:50,000	Vereeniging	2627DB	Surveys and Mapping
Geological	1:250,000	West Rand	2626	Council for Geoscience
Geotechnical	1:50,000	Vereeniging	2627DB	Council for Geoscience
Hydrogeological	1:500,000	Johannesburg	2526	Department of Water Affairs
Dolomite Compartments	1:50,000	Klipriver - Natalspruit	A1	Department of Water Affairs
SRTM 90m Digital Elevation Model	-	-	-	ESRI
ArcGIS imagery / LIDAR Survey	-	-	-	City of Joburg e-Services

5. Investigation Methodology

This investigation is based on a desk study of the available information on file and dolomite stability reports purchased from the Council for Geoscience, followed by in situ, visual and tactile profiling of a grid of test pits, supplemented with soil laboratory tests, all in accordance with industry norms and the GFSH2-Phase 1 specifications.

5.1 Test Pit Profiling

The near-surface fieldwork component of this investigation was undertaken between 12th December 2019 and 15th January 2020 and comprised 62 test pits (numbered TPB01 - TPB62) set out using a hand-held GPS on a pre-planned, triangulated grid, covering the full extent of the site at an acceptable resolution, in order to satisfy the requirements of the GFSH2-Phase 1 investigation (see Figure 4, Appendix A).

Test pits were excavated by means of a Cat 428E TLB, supplied by VV Plant Hire CC, to maximum reach or nominal refusal. Pits were, then, formally profiled in situ by a professional geotechnical engineer, using industry-standard profiling techniques[1], during which time soil samples were retrieved for analysis.

Profile plots, which graphically represent the soil profile encountered in the test pits, are presented in Appendix C.

5.2 Laboratory Testing

Selected soil samples retrieved at the time of profiling were submitted for laboratory testing, focussing on foundation analysis alone. The tests undertaken include:

(i) Grading and Atterberg limit tests to determine the basic engineering properties of the in situ soils for classification purposes.

(ii) Natural moisture content tests to determine the in situ moisture regime.

(iii) Collapse potential test, soaked at 200kPa, to model the combined effect of foundation loading and ingress moisture, and to provide a collapse index for site classification purposes.

(iv) One-dimensional consolidometer and double oedometer tests to assess the stress-strain behaviour of the soils under both NMC and saturated conditions, from which to predict the settlement and allowable bearing pressures for foundations placed on the soil horizons tested.

(v) Basic chemistry tests in the form of pH and Conductivity (Resistivity) to assess the aggressiveness of the soil moisture towards buried concrete and steel.

(vi) No moisture-density tests at Mod-AASHTO compactive effort and California Bearing Ratio (CBR) tests were undertaken at this stage, as these fall outside of the scope GFSH2-Phase 1 feasibility investigations, and are only required for more detailed design of earth terrace / soil mattresses once conceptual layouts and site development plans have been determined.

Copies of laboratory tests are found in Appendix D with a summary presented in Table 1 (Appendix B).

[1] Brink, ABA, and Bruin, RMH (2002) ***Guidelines for Soil and Rock Logging in South Africa,*** Proceedings, Geotermininology Workshop organized by AEG, SAICE, and SAIEG, 1990.

6. Geology and Soil Profile

6.1 Regional Geology

Available regional geological[2] and geotechnical[3] mapping indicates that the area of investigation is largely underlain by Karoo deposits which host an inlier[4] of Malmani Subgroup dolomite (Chuniespoort Group, Transvaal Supergroup) in the central-south-western sector, where the ground instability mitigation impact provided by Karoo deposits appears to be absent - see Figures 2-3, Appendix A.

Records from the associated dolomite stability assessment should be consulted to determine the thickness of the Karoo cover soils/rocks and the overall stability of the profile, as these are not discussed within the scope of the present near-surface geotechnical report.

6.2 Local Soil Profile

Two broad characteristic profiles - detailed below - are representative of this site, which largely confirm the regional geology (see Figures 2, 3 - Appendix A), the boundaries of which are presented in Figure 5 (Appendix A), and inferred from a combination of the test pit profiles and the remote interpretation of aerial photographs and satellite imagery.

These include the following broad zones, represented visually in the images below, with a summary presented in Table 2 (Appendix B) for ease of reference:

6.2.1 Aeolian Zone

(i) **Aeolian / Hillwash**
Dry through moist, reddish-brown, loose through medium dense, porous, silty through clayey fine sand.

(ii) **Ferruginous Aeolian / Hillwash** (locally serving as the Pebble Marker)
Trace sub-rounded quartzite cobbles in a matrix of dry to slightly moist, reddish-brown through khaki mottled dusky-red spotted black, loose through medium dense to dense, variably cemented, clayey fine sand with abundant discrete, rounded ferricrete nodules, locally improving to hardpan quality.

(iii) **Ferruginous Reworked Residual Karoo Deposits**
Slightly moist through moist, mustard-yellow mottled reddish-brown spotted black, firm through stiff, clayey silt with abundant discrete ferricrete nodules. These Karoo deposits are observed to be a combination of residual shale, subordinate sandstone and minor traces of conglomerate.

---

2 Department of Mineral and Energy Affairs (1986), 1:250,000 Geological Series, ***2626 West Rand,*** Geological Survey.

3 Council for Geoscience (2003), 1:50,000 Geotechnical Series, ***2627DB Vereeniging.***

4 An ***inlier*** is an area of older rocks surrounded by younger rocks. Conversely an ***outlier*** is an area of younger rock completely surrounded by older rocks

6.2.2 Colluvial Zone

(i) **Colluvium**

Scattered through abundant sub-rounded gravel, cobbles and small boulders in a matrix of slightly moist, brown, loose to medium, porous, silty fine sand.

(ii) **Ferruginous Alluvial Pebble Marker**

Abundant sub-rounded cobbles and heavy ferricrete in a matrix of slightly moist, mustard-orange blotched brown, dusky-red and black, firm to stiff, slightly shattered, clayey silt.

(iii) **Alluvial Pebble Marker**

Slightly moist, mustard-yellow mottled pale grey, firm to stiff, fissured, silty clay with pockets of boulders.

(iv) **Ferricrete**

Slightly moist, reddish-brown blotched mustard-yellow and off-white, dense to very dense, clayey fine sand with scattered sub-rounded cobbles in well-developed honeycomb ferricrete through hardpan ferricrete.

6.3 Rock Profile

While no rock outcrop / sub-outcrop was generally encountered within the *aeolian zone* of the site, the *colluvial zone,* in contrast, is characterised by extensive *boulder outcrop / sub-outcrop*, which has evidently been the material of quarrying interest in the past.

While not strictly a bedrock, the ferricrete is, moreover, frequently well developed to a hardpan consistency, which would classify as *soft rock quality*, from an excavation perspective.

6.4 Groundwater

Although groundwater is generally absent from the upper 3m of the profile, a single test pit in the southern sector exposed bouldery alluvial material beneath the aeolian deposits where strong groundwater inflows were encountered at depth. Above the seepage zone, the profile exhibits highly leached soils, indicative of periodic shallow groundwater activity.

Moreover, virtually all of the test pits exhibit ubiquitous evidence of variably developed ferricrete at depth, which is, similarly, indirectly indicative of an historic, fluctuating water table (well within the soil profile) beneath most of the site in the distant past.

It is possible that the drainage canal straddling the southern boundary the site, just south of the R54 arterial road, may have intercepted and rerouted the headwaters of a significant watercourse which, at one time, appears to have passed directly through this site - evidenced by the alluvial boulder remnants of a palaeo drainage line encountered in several of the test pits.

Moreover, although not specifically deemed to be groundwater, significant ponding of surface water was observed in the lower-lying depressions of the quarry (Zone 3), in the absence of surface drainage opportunity and the underlying, relatively impervious soil profile.

7. Geotechnical Assessment

This GFSH2-Phase 1 geotechnical assessment represents a *professional interpretation of the factual information* collated from site investigation, which comprises a regular triangulated grid of discrete test pit profiles, supplemented with the interpretation of remotely sensed aerial imagery. The comments are intended to guide the design and costing of an appropriate founding solution for structures within each geotechnical zone, as well as the bulk excavation and stability of any cut slopes, ground improvements using the available materials, and are subject to consideration of the final site development plan and/or bulk excavation levels which are yet to be finalised.

Given the general coverage of this site in the absence of a formal site development plan - as is the norm for a GFSH2-Phase 1 investigation - it must be appreciated that normal ground profile variations imply that, while the soil profiles presented in this report provide an *initial guide* to the expected ground conditions, notable changes may be encountered between these test positions, which should, in fact, be anticipated, particularly where geological interfaces occur between proposed zone boundaries.

As such, these provisionally inferred zone boundaries (Figure 5, Appendix A) must be confirmed / otherwise by means of formal trench inspections by a Geotechnical Specialist - as mandated in the GFSH2-Phase 2 investigation process - so that individual structures are provided with a *site-specific geotechnical classification* in order for appropriate foundation solutions to be applied.

It is, therefore, considered sound engineering practice that the Geotechnical Specialist should have further input - and be given opportunity to review final development plans and design details in regard to all the ground-related issues covered in this report - to verify the appropriateness of decision-making on the construction methodology and specifications, and to provide important continuity from investigation / initial interpretation phase through to construction.

7.1 Near-Surface Geotechnical Classification

The geotechnical classification which follows provides a first-order appraisal of the project site from a ground engineering perspective, illustrating the impact of the ground on a characteristic light masonry structure. The classification and geotechnical data appraisal are further expounded to guide the optimal development of the site.

On the basis of our field profiling and laboratory testing, we are of the opinion that the project site is characterised by four unique geotechnical zones (Figure 5), assigned the following geotechnical designations (defined in Appendix E):

7.1.1 Zone 1: 2 [C2 / H1-H2]

This zone - which incorporates the bulk of the arable farmland - comprises a characteristic *highly compressible / potentially highly collapsible* transported profile (either hillwash / aeolian deposits), overlying loose, nodular ferricrete of marginally better densities, generally overlying a potentially *moderately expansive* residual Karoo profile.

7.1.2 Zone 2: 2 [S1 / H1 / R (boulder outcrop)]

The soil profile on this zone - which comprises the south-western sector of the site - is characterised by *slightly compressible* colluvial deposits, frequently underlain by bouldery alluvial deposits with a *slightly expansive* clayey matrix, where with large tracts of this zone have been well *cemented* through pedogenic action.

7.1.3 Zone 3: 2-3 [P (excavation)]

A large enclave, fully incorporated within Zone 2, has been subjected to large-scale, but relatively shallow quarrying activity (possibly less than about 3m) which has removed much of the colluvial material, resulting in a large depression which will exhibit significant surface drainage challenges. While it is evident that the existing site development plan recognises the flaw, the areal extent of the quarry appears to extend beyond the limits previously anticipated. In order to avoid development complications, the land surveyor's contours should be used as the definitive basis to delineate this zone more conclusively.

7.1.4 Zone 4: 2-3 [C2 / H1-H2 / W (waterlogged)]

This zone comprises a low-lying area of poor drainage - possibly associated with a palaeo drainage line - characterised by potentially waterlogged, highly collapsible hillwash/aeolian soils overlying potentially moderately expansive alluvial soils. The zone is mapped on the basis of vlei vegetation, which is indicative of frequent shallow groundwater

7.2 Inherent Dolomitic Hazard Classification

On the basis of an existing dolomite stability report[5] covering this project site, the stability of the site is described in terms of two Dolomite Stability Zones, namely:

7.2.1 Zone 1: IHC 1//1(8)

This zone is characterised by a low inherent risk of sinkhole / subsidence formation of all sizes with respect to ingress of water and a low (with sub-areas of high) inherent risk with respect to groundwater level draw-down.

7.2.2 Zone 2: IHC 3/4//1(8)

This zone is characterised by a medium inherent risk of sinkhole / subsidence formation of all sizes with respect to ingress of water and a low (with sub-areas of high) inherent risk with respect to groundwater level draw-down.

7.3 Dolomite Area Designation

Under the present code of practice governing developments on dolomitic land, SANS 1936:2012, ground earmarked for the proposed residential 4 development, allocated an IHC5 or less is assigned a D3 Dolomite Area Designation, and is *not precluded from development,* subject to the Footprint Level Investigation densities being met, and the necessary drainage and wet services applied which meet the required engineering standards.

7.4 Material Properties

Our provisional materials assessment - in terms of TRH14[6] - of the soil profile is based on our visual-tactile profiling, prior experience and interpretation of a limited laboratory index tests, and is broadly summarised in Table 3 below:

Table 3: Materials Assessment

Horizon	Estimated TRH14	Quality for earthworks	Typical Application
Hillwash / Aeolian	G8	Fair to poor	Low quality selected materials
Ferruginous Hillwash / Aeolian	G7-G8	Fair to poor	Medium to low quality selected materials
Colluvium	G5*-G7	Good to fair	Suitable for earthworks * subject to on site crushing and screening.
Alluvium	G6-G9	Fair to very poor	Generally unsuitable for earthworks applications
Residual Karoo	G8-G10	Poor to very poor	Not suitable for earthworks applications

7.5 Groundwater Occurrences

Despite the general absence of groundwater in the test pits - with only a single test pit (TPB55) encountering any direct evidence of groundwater - the profiles exhibit near-ubiquitous presence of variably developed ferricrete, which is indirectly indicative of an historic, fluctuating water table beneath most of the site in the past. Moreover, as numerous test pits exposed alluvial material - which is indicative of a palaeo drainage line passing beneath the site - shallow groundwater should be anticipated in the wet season, and provision made for dewatering measures during construction.

7.6 Corrosiveness

A set basic chemistry tests (pH and conductivity) tests conducted on the representative soil horizons most likely to interact with buried concrete and ferrous services (see Table 1, Appendix B) show the soils to exhibit a combination of *moderately low pH* (moderately acidic) and *low through high electrical resistivity*, indicating that these soils are relatively benign in the higher lying ground, but become ***highly* corrosive** towards concrete and buried ferrous (steel) in the lower-lying southern half of the site, particularly in the vicinity of the quarry and palaeo drainage line.

In view of this, specialist advice should be sought regarding appropriate mitigating measures.

5 Intraconsult Associates (2008), ***GFSH-2: Phase 1 Dolomite Stability Investigations: Portion 156 and 203 of Farm Houtkop 594-IQ***, Report IR874R.

6 TRH14 *(1985)*, ***Guidelines for Road Construction Materials,*** Technical Recommendations for Highways, CSIR, Pretoria.

7.7 Excavation

The excavation assessment of the soil/rock profile - in terms of *COLTO - Earthworks* [7] specification - is presented in Table 2 (Appendix B) and summarised in Table 4 below:

Table 4: Excavation Assessment

<table>
<tr><th>Excavation Class</th><th>Broad SANS1200D Engineering Definition</th><th>Zone 1:
2 [C2 / H1-H2]</th><th>Zone 2:
2 [S1 / H1 / R (boulder outcrop)]</th><th>Zone 3:
2-3
[P (excavation)]</th><th>Zone 4:
2-3 [C2 / H1-H2 / W (waterlogged)]</th></tr>
<tr><td>Soft Excavation [8]</td><td>Generally possible by hand or conventional light earth-moving equipment (TLB)</td><td>Generally accounts for the upper 2.0m-2.5m of the profile in this zone.</td><td>Very limited to the merely the loose, upper colluvial deposits, although this may also classify as Boulder Class A.</td><td>Similarly absent from this zone given that much of the transported material has been removed during the quarrying operations.</td><td>Appears to be limited to the upper 1.2m of the profile in view of the stiff underlying alluvial deposits which classify as intermediate excavation.</td></tr>
<tr><td>Intermediate Excavation [9]</td><td>Necessitates the use of heavier plant (tracked excavator) and/or pneumatic ground-engaging-tools for economic excavation</td><td>Limited to Isolated areas below 1.1m depth where the ferricrete is well developed, massive and approaches hardpan consistency.</td><td>Frequently present near-surface, well within the upper 1m of the profile, where competent hardpan ferricrete has developed.</td><td>Highly variable in this zone. Periodically arising at shallow depths where ferricrete is present, while completely absent in areas directly underlain by Karoo deposits.</td><td>Present from below 1.2m, with the base depth not proven.</td></tr>
<tr><td>Hard Excavation [10]</td><td>Requiring drill-and-blast operations</td><td colspan="4">Not proved in this zone within test pit depth.</td></tr>
<tr><td>Boulder Class A [11] Excavation</td><td>All material that, in the opinion of the Engineer, can be removed by any means other than explosives, including dump-rock and boulders not exceeding 0.5m³ in volume</td><td rowspan="2">Generally not encountered within the upper 1.5m of the profile, with very localised evidence of Class A boulders arising in the alluvial boulder bed which generally arises below these depths.</td><td colspan="2" rowspan="2">Prolifically present throughout this zone, both above surface and below surface.

While the coarse fraction typically exceeds 40%, the particle size is generally such that it can be routinely accommodated by TLB / excavators and transported by ADT without prior fragmentation.</td><td rowspan="2">Not proved in this zone.</td></tr>
<tr><td>Boulder Class B [12] Excavation</td><td>Rock occurring in bulk or in bands or ledges, the practicable excavation of which, in the opinion of the Engineer, will necessitate the use of explosives, as well as boulders exceeding 0.5m³ in volume (whether or not blasting is required for their removal) and which will necessitate the use of heavier plant (tracked excavator) and/or fragmentation prior to transport</td></tr>
</table>

7 COLTO (1998), *Standardized Specification for Road and Bridge Works for State Road Authorities*, SAICE.

8 Excavation in material which can be efficiently removed or loaded by any of the following plant without prior ripping:

- A bulldozer with a mass of at least 22 tons, (which Includes the mass of a ripper if fitted) and an engine developing approximately 145 kW at the flywheel, or
- A tractor-scraper unit with a mass of at least 28 tons and an engine developing approximately 245 kW at the flywheel, pushed during loading by a bulldozer as specified below, or
- A track-type front-end loader with a mass of at least 22 tons and an engine developing approximately 140 kW at the flywheel.

9 Excavation (excluding soft excavation) in material which can be efficiently ripped by a bulldozer with a mass of at least 35 tons when fitted with a single tine ripper and an engine developing approximately 220 kW at the flywheel.

10 Excavation (excluding boulder excavation) in material which cannot be efficiently ripped by a bulldozer with properties above. This type of excavation generally includes excavation in material such as formations of unweathered rock, which can be removed only after blasting.

11 Excavation in material containing *more than 40% by volume* of boulders of size in the range $0.03m^3$ - $20m^3$, in a matrix of soft material or smaller boulders.

12 Where material contains *40% or less by volume* of boulders or lumps of hard dolomite ranging from $0.03m^3$ - $20m^3$ in size, in a matrix of soft material or smaller boulders or lumps of hard dolomite, then those boulders or lumps of hard dolomite between $0.03m^3$ - 20m3 and require individual drilling and blasting in order to be loaded by a track type front-end loader or back-acting excavator.

7.8 Foundation Assessment

The foundation assessment for the anticipated four-storey walk-up structures is as follows:

(i) The uppermost aeolian / hillwash horizon is *highly compressible,* and *potentially highly collapsible* and not suitable for use as a founding horizon.

(ii) These aeolian deposits show a low suitability for conventional compaction, negating an earthworks solution other than minor improvement through a combination of hydraulic pre-collapsing and impact rolling.

(iii) The underlying pedogenic horizon is highly erratic, ranging from nodular ferricrete in Zone 1 to competent hardpan in Zone 2, necessitating more detailed, site-specific investigation to confirm its suitability for founding purposes.

(iv) These ferruginous materials exhibits better compaction characteristics than the overlying aeolian deposits, but lie deeply buried in most instances, making its reworking / improvement an onerous proposition.

(v) While the rocky colluvial deposits of Zone 2 are *not unsuitable* for founding purposes, this would necessitate stripping the surface boulders to render this zone suitable for development. Stiffened footings placed in the colluvium are appropriate given the propensity for compressibility and the risk of moderately expansive alluvial and Karoo clays underlying these materials.

(vi) The sump formed by the excavations in Zone 3 presents a near-fatal flaw from a civil engineering perspective. These ground levels would need to be essentially reinstated to render this zone suitable for development, making this an extremely onerous proposition.

(vii) The potential for water-logging in Zone 4 necessitates further investigation to deal with this inherent problem, which may necessitate soil drainage measures needing to be employed.

7.9 Slope Stability

Given the relatively flat and featureless site, there is no apparent need for terracing of individual structures, nor any need for significant cut and fill operations to render it suitable for development - other than large scale bulk earthworks to reinstate the original ground levels of Zone 3, to deal with the inherent drainage challenges.

7.10 Dolomite Stability

Issues of dolomite stability are not covered in this report, and must be formally addressed under a separate appointment. On the basis of the present feasibility level report, the site is deemed to be a D3 zone, which will support the proposed Res 4 scheme.

One of the major outcomes of the footprint level dolomite stability investigation is to finalise the hazard class and determine the loss of support required for the structural design of all foundations. This tends to have a superordinate impact on the foundation design, and limits the appropriate solutions which can be employed. It is through this lens that the foundation recommendations which follow are provided.

8. Recommendations

8.1 Foundation Recommendations

Foundation solutions in dolomitic terrain are essentially dictated by the inherent hazard class determined by the dolomite stability assessment. A full *footprint-level dolomite stability investigation* is, therefore, a necessary precursor prior to finalising the foundation design(s), as these parameters generally have an overriding impact on the minimum requirements for development.

Notwithstanding this, Table 5 below provides guidance on the appropriate foundation solution - or combination solution - likely to be required, based on the observations of the near-surface geotechnical investigation and the *anticipated* IHC3/4 classification presented in the *feasibility level investigation* for this farm:

Table 5: Suitable Foundation Solutions for the Proposed Structures

	Foundation Solution	Suitability	Notes on the Application of Foundation Solution
	Normal (Strip footing / slab on the ground)	✗	Inappropriate for this full site.
Structural Solutions	Modified Normal (Reinforced Strip Footing)	✗	Inappropriate for this full site.
Structural Solutions	Grillage of Ground Beams or Cellular Raft	✔	Unsupported spans to accommodate random loss of support to be determined from the formal footprint-level dolomite stability investigation - but provisionally set at 2m, based on the existing feasability-level dolomite stability report. Beams / rafts should be taken through the loose aeolian deposits, and placed on compacted ferricrete / colluvium, failing which these soils should be pre-collapsed or improved through impact rolling as a minimum to improve the overall bearing capacity, which is presently extremely low in the case of the aeolian deposits.
Structural Solutions	Pad and pier foundations	✗	Inappropriate for this full site in view of the dolomite stability requirements. .
Geotechnical Soil Solutions	Compaction of Soil Below Individual Footings	✗	Inappropriate for this full site.
Geotechnical Soil Solutions	Deep Strip Foundations	✘	No advantage gained in any of the zones, other than, perhaps, Zone 4. Strip footings to be replaced with *ground beams* to meet the requisite loss of support criterion.
Geotechnical Soil Solutions	Engineered Soil Raft / Soil Mattress (By an earthworks specialist)	✓/✘	Zone 1: In the absence of any high quality material, this is not a suitable option. Zone 2: Well suited, subject to screening and on site crushing of oversized rock. Zone 3: A necessary requirement to render this zone suitable for development, with a very large cost implication, which is, perhaps, prohibitive. Zone 4: In the absence of any high quality material, this is not a suitable option. Where poor quality materials dominate the profile (viz Zone1, 3 and 4), this would involve a deep box cut to 1.5B depth (or the surface of any hardpan pedogenic horizon) to fully remove these weak transported soils. These would need to be replaced with imported engineered fill material - of nominally G5/G6 standards - compacted in 150mm layers to no less than 95% Mod AASHTO. Given the dolomite stability requirements, the net structural solution would still be required to span the requisite loss of support - anticipated to be up to 2m - anywhere beneath the structures, rendering the earthworks solution essentially superfluous and unviable.

KEY	
✔	Appropriate foundation solution.
✓	Appropriate but insufficient in isolation, necessitating additional structural solutions.
✘	Not incorrect, but poorly suited to this application due to inherent problems, with high cost implications.
✗	Foundation solution is either not appropriate for this geotechnical site class or not recommended given the observed conditions on site.

8.2 Material Usage

8.2.1 Zone 1

In view of the generally poor quality soil profile in this zone, in situ densification through conventional compaction is likely to be *unsuccessful in improving the soils to a sufficient standard for reuse* in soil mattress construction.

Any ground improvements contemplated for this site to mitigate the dolomite risk profile and reduce the structural spans required will mandate high quality engineered fill being imported from commercial sources, which is appropriately internally reinforced. In this regard, crushed chert rubble or colluvial deposits - which are commonly available in Zone 2 - provides an excellent quality material source (typically meeting G5 standards) which can be compacted to high densities in excess of 95% Mod AASHTO.

8.2.2 Zone 2

Well suited to earthworks solutions, subject to the material being crushed to a size which can be adequately compacted using conventional techniques.

8.2.3 Zone 3

Depressions in the ground surface necessitate large-scale bulk earthworks to elevate the site and deal with the civil engineering drainage challenges. Should this be a viable solution, the use of high-quality fill would beneficiate this zone to developable status.

8.2.4 Zone 4

In view of the generally poor quality soil profile on this site, in situ densification through conventional compaction is likely to be unsuccessful in improving the soils to a sufficient standard for reuse in soil mattress construction. As such, these upper transported soils would need to be removed and replaced with high quality imported materials from commercial sources.

8.3 Surface Beds

Surface beds should be constructed on no less than 450mm of granular fill, of nominally G5/G6 quality - crushed colluvium / chert being well suited - compacted to 95% Mod AASHTO density to provide adequate and consistent support, failing which floor slabs should be reinforced but discontinuous with the walls of the structure and allowed to move independently to avoid cracking.

8.4 Slope Stability

In general, other than Zone 3 (and its perimeter, in particular) which necessitates large-scale rehabilitation, the site does not warrant any special attention to slopes, other than those artificially induced in deep services trenches. These should be formed no steeper than 1V:1H to lower the risk of sidewall collapse, or alternatively fully supported during construction.

Moreover, the surcharging of cut sidewalls by way of spoil heaps, construction materials and equipment (including those with outrigger jacks) should be strictly avoided as being highly-detrimental to cut stability, particularly when workers are present in trenches / box excavations in excess of 1.5m deep.

8.5 Drainage Precautions

As the site is relatively flat, high priority needs to be placed on inducing adequate surface drainage to promote runoff of surface water, as uncontrolled ponding represents a near-surface and overall stability risk to the development.

Given the dolomitic nature of the site, SANS 1936:2012 Code of Practice dictates the minimum standards that services must comply with in order to mitigate the risk of sinkhole development. These standards are mandatory and must be enforced by the appointed professional team.

9. General Notes

(a) Given the general coverage of this site in the absence of a formal site development plan – as is the norm for GFSH2-Phase 1 investigations – test pits are present which may impact on individual structures. Where present, these should be re-opened and suitably rehabilitated as part of the bulk earthworks operations, or accommodated in the overall foundation solution so that individual structures are not compromised.

(b) It must be appreciated that normal ground profile variations imply that, while the soil profiles presented in this report provide an *initial guide* to the expected ground conditions, notable changes may be encountered between these test positions, which should, in fact, be anticipated, particularly where geological interfaces occur.

(c) The broad zonation provided in this report, determined by means of a grid of discrete test pit profiles, must be confirmed / otherwise and the boundaries refined by means of formal trench inspections by a Geotechnical Specialist – as mandated in the GFSH2-Phase 2 investigation process – so that individual structures are provided with a site-specific classification and foundation solution appropriate to its geotechnical classification.

(d) Zone 3, in particular, should be refined using the contours produced by the land surveyor, which will more accurately define the zone boundary, which is a function of ground elevation.

(e) Additional work arising from this investigation, which will be required to provide the rational basis for the foundation design, including any ground improvement measures for final design and tender evaluation stage, are expected to include:

(i) **Feasibility- and footprint-level dolomite stability assessment** to confirm the anticipated IHC3/4 conditions and the **assumed D3 designation**;

(ii) Professional design input, by the Geotechnical Specialist, for the ground improvement solutions;

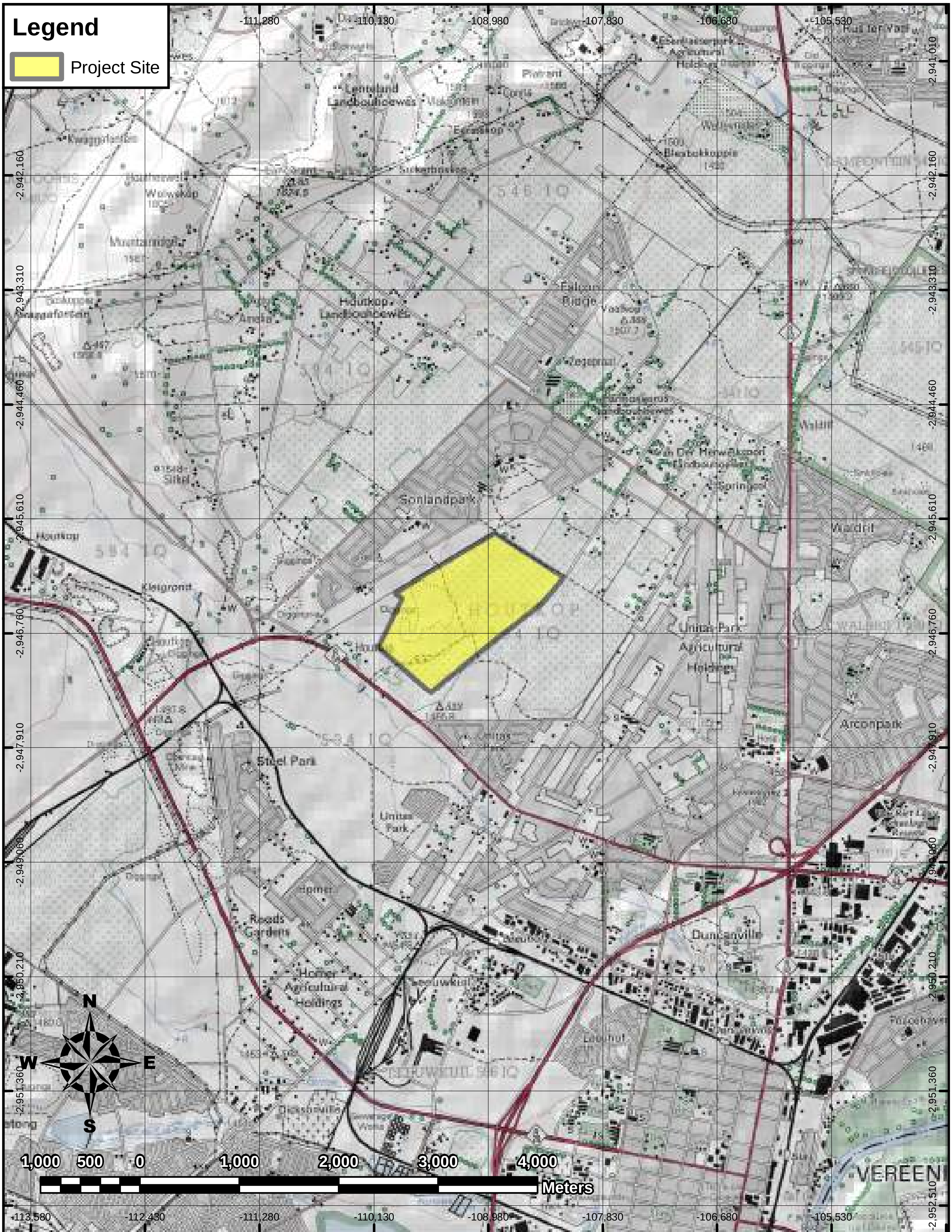
(iii) Inspection of earthworks, excavations and foundation trenches to verify these investigation findings, allowable bearing pressures and compliance with design recommendations.

(f) While this report draws on the dolomite stability classification provided by a prior feasibility-level investigation by others, a footprint-level investigation will need to be completed under a separate mandate to satisfy the minimum requirements of SANS 1936:2012, which will govern the unsupported spans required for the foundations of the proposed structures.

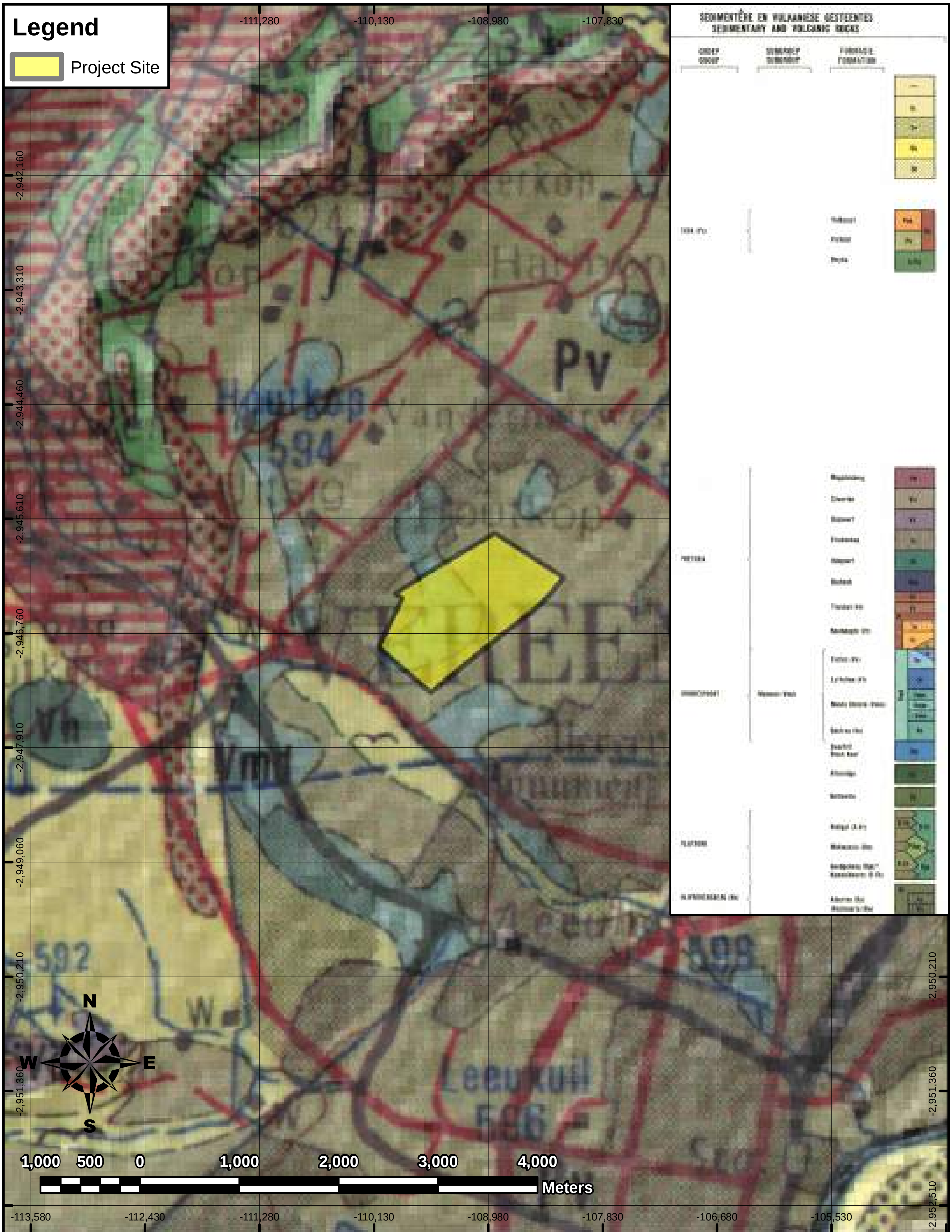
CS MORGAN Pr Eng | Director
Geoid Geotechnical Engineers

APPENDIX A

Figures



21 Glenluce Drive Douglasdale Sandton, 2191 Tel: 011-704-3131 Fax: 086-503-8371 mail@geoid.co.za	TITLE: **Unitas Park Extension 16 Regional Topographic Setting**	PROJECT NUMBER: DRAWING NUMBER: REVISION: DATE:	**GGE/19034** **Figure 1** **0** **21/10/2019**
	CLIENT: **Phumaf Consulting Engineers**	ENGINEER: SCALE: DATUM:	**CS Morgan** **1:50,000** **WG29**

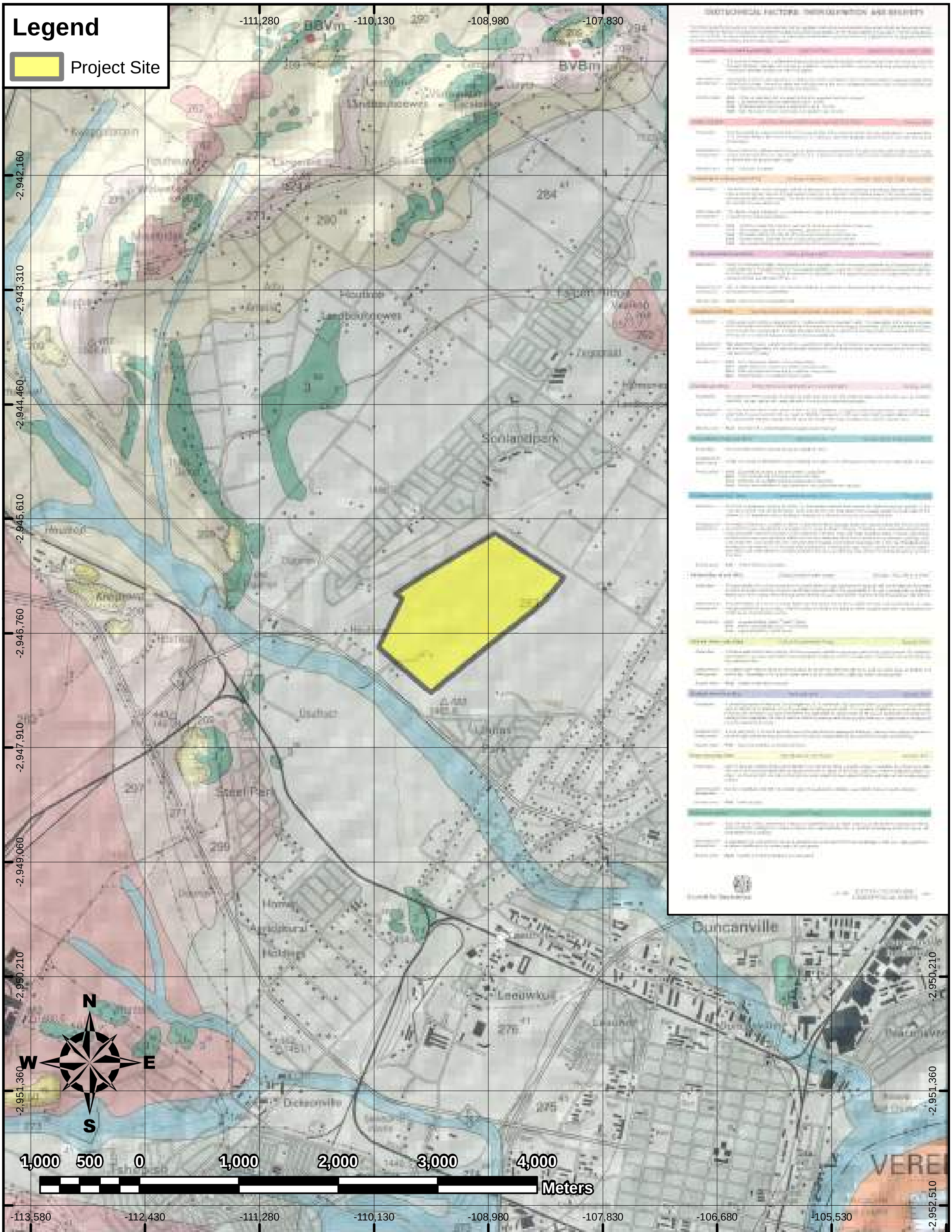


GEOiD Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
Tel: 011-704-3131
Fax: 086-503-8371
mail@geoid.co.za

TITLE:
Unitas Park Extension 16
Regional Geological Setting

CLIENT:
Phumaf Consulting Engineers

PROJECT NUMBER:	GGE/19034
DRAWING NUMBER:	Figure 2
REVISION:	0
DATE:	21/10/2019
ENGINEER:	CS Morgan
SCALE:	1:50,000
DATUM:	WG29



GEOiD Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
Tel: 011-704-3131
Fax: 086-503-8371
mail@geoid.co.za

TITLE:
Unitas Park Extension 16
Regional Geotechnical Setting

CLIENT:
Phumaf Consulting Engineers

PROJECT NUMBER:	GGE/19034
DRAWING NUMBER:	Figure 3
REVISION:	0
DATE:	21/10/2019
ENGINEER:	CS Morgan
SCALE:	1:50,000
DATUM:	WG29

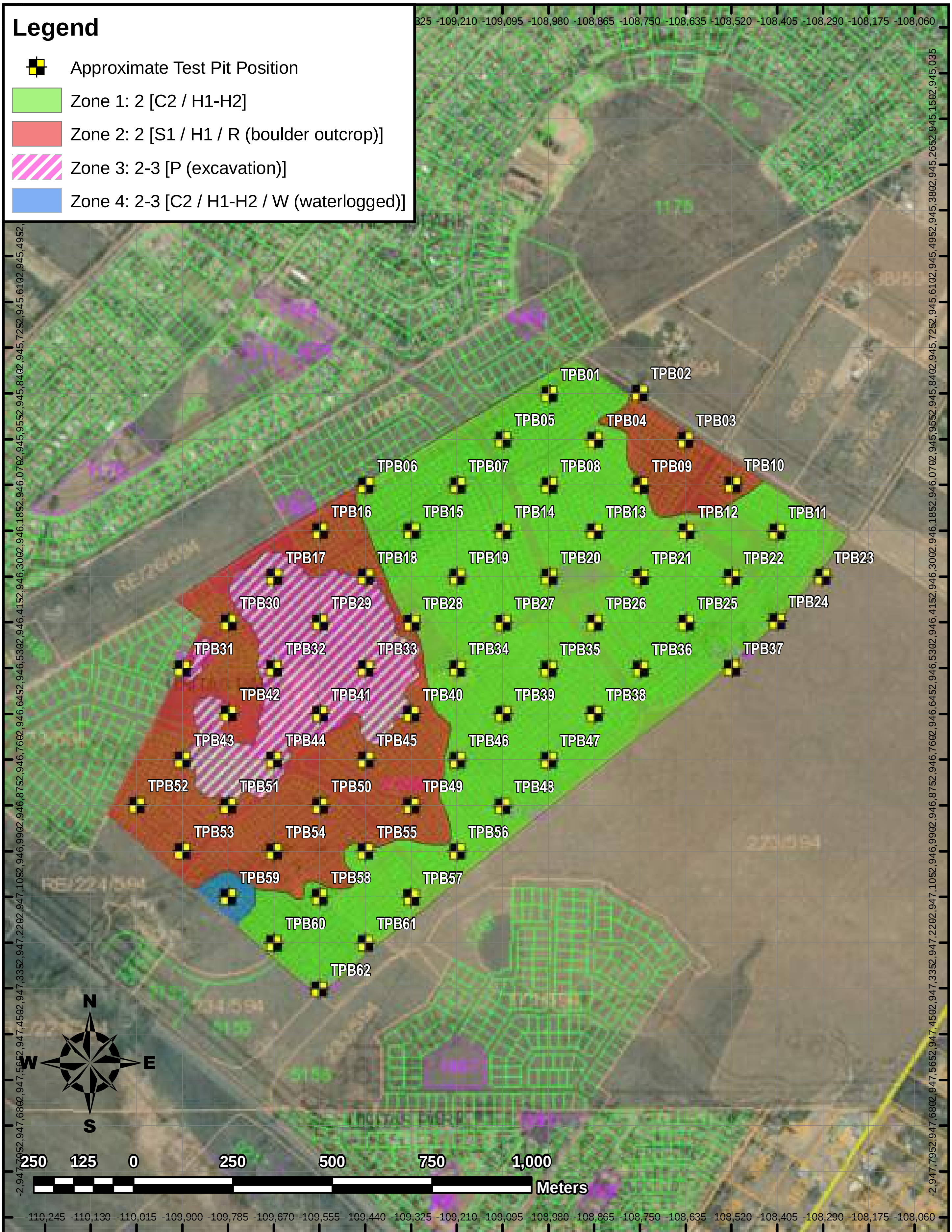
GEOiD Geotechnical Engineers

21 Glenluce Drive
Douglasdale
Sandton, 2191
Tel: 011-704-3131
Fax: 086-503-8371
mail@geoid.co.za

TITLE:
Unitas Park Extension 16
Approximate Test Pit Positions

CLIENT:
Phumaf Consulting Engineers

PROJECT NUMBER:	GGE/19034
DRAWING NUMBER:	Figure 4
REVISION:	0
DATE:	20/01/2020
ENGINEER:	CS Morgan
SCALE:	1:12,500
DATUM:	WG29



21 Glenluce Drive
Douglasdale
Sandton, 2191
Tel: 011-704-3131
Fax: 086-503-8371
mail@geoid.co.za

TITLE:
Unitas Park Extension 16
Inferred Geotechnical Zonation

CLIENT:
Phumaf Consulting Engineers

PROJECT NUMBER:	GGE/19034
DRAWING NUMBER:	Figure 5
REVISION:	0
DATE:	20/01/2020
ENGINEER:	CS Morgan
SCALE:	1:12,500
DATUM:	WG29

APPENDIX B

Tables

Table 1: Summary of Soil Index and Material Properties

Hole No	Material	Depth (m)	LL	PI (425)	LS	GM	NMC	PI (w)	425	075	002	DD	e_0	P_c / CP / Swell	pH	Resist	Conduct	PRA	USC	TRH14 *
TPB11	Ferruginous Reworked Shale	2.0-2.2	42	17	9	0.49	12	15	86	70	18	1,388	0.88	0.4%	-	-	-	A.7.6	CL	sub-G8
TPB15	Aeolian / Hillwash	0.8-1.0	22	7	3	0.59	11	6	87	54	9	1,209	1.17	70kPa	6.3	6,993	143	A.4	CL-ML	sub-G7
TPB15	Ferruginous Aeolian / Hillwash	1.6-2.0	21	11	5	0.80	13	8	79	50	9	-	-	-	5.1	4,255	235	A.6	SC	G7
TPB15	Reworked Residual Shale	2.0-2.5	24	11	6	0.74	15	9	82	51	10	-	-	-	5.2	5,003	200	A.6	CL	sub-G7
TPB16	Colluvium	1.0-1.8	NP	NP	0	1.90	8	NP	35	22	5	-	-	-	3.9	8,929	112	A.1.b	SM	G6
TPB16	Colluvium	1.0-1.8	NP	NP	0	1.96	8	NP	34	21	4	-	-	-	-	-	-	A.1.b	SM	G6
TPB16	Reworked Residual Shale	1.8-2.4	33	11	6	0.94	11	8	73	50	9	-	-	-	4.2	14,706	68	A.6	SC	G7
TPB17	Alluvial Pebble Marker	1.3-2.0	28	9	5	0.81	12	7	79	52	9	-	-	-	-	-	-	A.4	SC	G7
TPB23	Aeolian / Hillwash	0.6-0.8	24	7	3	0.44	1695	7	93	59	9	1,215	1.16	-	-	-	-	A.4	CL	sub-G7
TPB23	Ferruginous Aeolian / Hillwash	1.5-2.0	27	15	7	0.78	22	12	80	52	13	-	-	-	-	-	-	A.6	CL	sub-G7
TPB23	Ferruginous Reworked Shale	2.1-2.4	33	18	9	1.05	13	12	69	50	13	-	-	-	-	-	-	A.6	SC	sub-G7
TPB26	Aeolian / Hillwash	0.8-1.0	23	9	5	0.49	16	8	92	52	9	1,231	1.19	1.4%	-	-	-	A.4	CL	sub-G7
TPB26	Ferruginous Alluvium	2.4-2.8	28	14	7	1.29	15	8	61	39	9	-	-	-	-	-	-	A.6	SC	sub-G7
TPB44	Residual Syenite	1.8-2.0	38	13	7	0.44	15	12	95	59	13	1,477	0.82	200kPa	5.3	2,809	356	A.6	CL/ML	sub-G7
TPB47	Aeolian / Hillwash	0.8-1.0	28	14	7	0.44	22	13	89	61	13	1,072	1.43	200kPa	-	-	-	A.6	CL	sub-G7
TPB52	Aeolian / Hillwash	1.0-1.2	32	14	6	0.42	12	13	93	62	15	1,141	1.28	1.3%	5.3	5,000	200	A.6	CL	sub-G7
TPB56	Ferruginous Alluvial Pebble Marker	1.0-1.2	29	13	7	2.24	8	3	27	19	2	-	-		-	-	-	A.2.6	GC	G6
TPB57	Aeolian / Hillwash	0.8-1.0	29	11	5	0.45	17	10	93	58	11	1,215	1.18	6.2%	5.0	1,206	829	A.6	CL	sub-G7
TPB58	Ferruginous Alluvial Pebble Marker	1.1-1.5	31	13	7	2.43	3	2	19	11	1	-	-		5.2	1,730	578	A.2.6	GP-GC	G6
TPB58	Reworked Residual Shale	2.0-2.5	45	24	12	0.23	16	23	96	81	26	-	-		5.4	4,464	224	A.7.6	CL	sub-G9

KEY

LL: Liquid limit
PI (425): Plasticity index of sample fines portion
LS: Linear shrinkage
GM: Grading modulus
ε: Material strain (%) at given load in kPa
NMC: Natural moisture content
pH: Acidity / Alkalinity Index
Resist: Resistivity (Ω/cm)
425: Percentage passing 425 μm sieve
075: Percentage passing 75 μm sieve
002: Percentage passing 2 μm sieve
DD: Dry density (kg/m^3)
e_0: Initial Void Ratio
P_c: Estimated pre-consolidation pressure (kPa)
Conduct: Conductivity (μS/cm)
PI (w): Plasticity index of whole sample
CBR: California Bearing Ratio at Mod AASHTO compaction
OMC: Optimum moisture content at Mod AASHTO compaction (%)
MDD: Maximum dry density at Mod AASHTO compaction (kg/m^3)
PRA: AASHTO Soil Classification
USC: Unified Soil Classification
TRH14: Road Construction Material Classification
*: Estimate only, to be confirmed by CBR tests

Table 2: Depth and Inferred Thicknesses of the Soils / Rocks Underlying the Site; Excavation Classification According to *SANS 1200D: Earthworks*

Hole No.	Hole Depth (m)	Depth to the Base of Horizon (m)							Depth to Top of Rock (m)	Depth (m) to Base of		Hard Rock Excavation From (m)	Boulder Excavation Class A (<0.8m)	Depth to Ground Water (m)
		Aeolian / Hillwash	Ferruginous Hillwash / Aeolian (Nodular Ferricrete)	Colluvium	Alluvium	Alluvial Pebble Marker	Honeycomb / Hardpan Ferricrete	Reworked / Residual Karoo		Soft Excavation	Intermediate Excavation			
TPB01	1.40	0.30	1.10	-	-	-	1.40+	-	NP	1.10	1.40+	NP	NP	NE
TPB02	2.00	-	-	2.00[1]+	-	-	-	-	NP	2.00	2.00+	NP	small	NE
TPB03	1.60	0.50	-	0.80 [1]	-	-	1.60+	-	NP	1.00	1.60+	NP	NP	NE
TPB04	1.40	0.30	1.10	-	-	-	1.40+	-	NP	1.10	1.40+	NP	NP	NE
TPB05	2.30	0.70	1.70	-	-	-	-	2.30+	NP	2.30	2.30+	NP	NP	NE
TPB06	2.60	2.20	2.60 [1]+	-	-	-	-	-	NP	2.60+	NP	NP	NP	NE
TPB07	2.30	1.40	1.70	-	-	-	-	2.30+	NP	2.30+	NP	NP	NP	NE
TPB08	2.10	1.30	1.90	-	-	-	2.10+	-	NP	1.90	2.10+	NP	NP	NE
TPB09	0.15	-	-	-	-	-	0.15+	-	NP	NE	0.15+	NP	NP	NE
TPB10	2.30	0.80	2.00	-	-	-	-	2.30+	NP	2.00	2.30+	NP	NP	NE
TPB11	2.80	1.20	1.60	-	-	-	-	2.80+	NP	2.50	2.80+	NP	NP	NE
TPB12	2.30	0.45	-	-	-	2.10	-	2.30+	NP	2.30+	NP	NP	NP	NE
TPB13	2.40	1.10	1.90	-	-	-	2.40+	-	NP	2.40	2.40+	NP	NP	NE
TPB14	2.50	1.80	2.00	-	-	-	2.50+	-	NP	2.50+	NP	NP	NP	NE
TPB15	2.50	1.60	2.00	-	-	-	-	2.50[1]+	NP	2.50+	NP	NP	NP	NE
TPB16	1.80	-	-	1.80	-	-	-	2.70+	NP	2.70+	NP	NP	small	NE
TPB17	2.40	-	-	0.75	1.30	2.40+	-	-	NP	2.40	2.40+	NP	NP	NE
TPB18	2.20	-	-	1.20		2.30+	-	-	NP	1.20	2.20+	NP	small	NE
TPB19	2.30	1.70	2.10	-	-	-	2.30+	-	NP	2.10	2.30+	NP	NP	NE
TPB20	2.50	1.70	2.30	-	-	-	2.50+	-	NP	2.50	2.50+	NP	NP	NE
TPB21	2.60	1.10	2.00	-	-	2.60+ [1]	-	-	NP	2.60+	-	NP	NP	NE
TPB22	2.80	0.80	1.60	-	-	-	-	2.80+[1]	NP	2.80+	-	NP	NP	NE
TPB23	2.40	1.50	2.10	-	-	-	2.40+	2.40 [1]	NP	2.40	2.40+	NP	NP	NE
TPB24	2.80	1.30	2.00	-	-	-	-	2.80+ [1]	NP	2.80+	-	NP	NP	NE
TPB25	2.80	1.20	1.70	-	-	-	-	2.80+[1]	NP	2.80+	-	NP	NP	NE

Hole No.	Hole Depth (m)	Depth to the Base of Horizon (m)							Depth to Top of Rock (m)	Depth (m) to Base of		Hard Rock Excavation From (m)	Boulder Excavation Class A (<0.8m)	Depth to Ground Water (m)
		Aeolian / Hillwash	Ferruginous Hillwash / Aeolian (Nodular Ferricrete)	Colluvium	Alluvium	Alluvial Pebble Marker	Honeycomb / Hardpan Ferricrete	Reworked / Residual Karoo		Soft Excavation	Intermediate Excavation			
TPB26	2.80	1.30	2.40	-	2.80+[1]	-	-	-	NP	2.40	2.80+	NP	NP	NE
TPB27	1.90	0.60	0.90	-			1.90+		NP	1.60	1.90+	NP	small	NE
TPB28	0.85	0.45	0.85	-	-	-	0.85+	-	NP	0.85	0.85+	NP	NP	NE
TPB29	1.20	0.40	1.20	-	-	-	1.20+	-	NP	1.20	1.20+	NP	NP	NE
TPB30	2.00	1.00	2.00	-	-	-	2.00+	-	NP	2.00	2.00+	NP	NP	NE
TPB31	1.50	0.70	1.10	-	-	-	1.50+	-	NP	1.10	1.50+	NP	NP	NE
TPB32	1.60	-	-	0.60	-	1.60[1]+	-	-	1.60	0.60	1.60+	NP	small	NE
TPB33	1.50	-	-	-	-	1.50+	-	-	NP	1.50	1.50+	NP	small	NE
TPB34	0.75	0.40	0.75	-	-	-	0.75+	-	NP	0.75	0.75+	NP	NP	NE
TPB35	2.60	-	1.50	-	-	2.60+[1]	-	-	NP	1.50	2.60+	NP	NP	NE
TPB36	2.80	1.05	2.00	-	-	-	-	2.80+[1]	NP	2.80+	NP	NP	NP	NE
TPB37	2.80	1.20	2.00	-	-	-	-	2.80+[1]	NP	2.80+	NP	NP	NP	NE
TPB38	2.90	0.90	1.60	-	2.90+	-	-	-	NP	2.90+	NP	NP	NP	NE
TPB39	2.70	1.70	2.70	-	-	-	-	-	NP	2.70+	NP	NP	NP	NE
TPB40	0.35	-	-	0.35	-	-	0.35+	-	NP	0.35	0.35+	NP	NP	NE
TPB41	1.90	-	-	0.65	-	-	-	1.90+	NP	1.90+	NP	NP	small	NE
TPB42	1.20	-	-	0.70	-	-	-	1.20+	NP	0.70	1.20+	NP	small	NE
TPB43	1.10	-	-	0.75	-	1.10[1]+	-	-	NP	1.10	NP	NP	medium	NE
TPB44	2.50	-	-	1.70 [2]				2.50[3]+	NP	2.50+	NP	NP	NP	NE
TPB45	1.40	-	-	0.60	-	-	1.40+		NP	1.00	1.40+	NP	NP	NE
TPB46	2.10	1.60	2.10+						NP	2.10+		NP	NP	NE
TPB47	2.70	1.15	1.70	-	-	2.70+[1]			NP	1.70	2.70+	NP	NP	NE
TPB48	2.80	1.50	2.20	-	2.80+[1]				NP	2.80+		NP	NP	NE
TPB49	0.60	-	-	0.45	-	-	0.60+		NP	0.45	0.60+	NP	NP	NE
TPB50	2.40	-	-	-	-	1.10	-	2.40	2.40	2.40	2.40+	NP	NP	NE
TPB51	2.30	-	-	0.90	-	2.20	-	2.30+	NP	2.20	2.30+	NP	NP	NP

Hole No.	Hole Depth (m)	Depth to the Base of Horizon (m)							Depth to Top of Rock (m)	Depth (m) to Base of		Hard Rock Excavation From (m)	Boulder Excavation Class A (<0.8m)	Depth to Ground Water (m)
		Aeolian / Hillwash	Ferruginous Hillwash / Aeolian (Nodular Ferricrete)	Colluvium	Alluvium	Alluvial Pebble Marker	Honeycomb / Hardpan Ferricrete	Reworked / Residual Karoo		Soft Excavation	Intermediate Excavation			
TPB52	2.00	1.25	2.00	-	-	-	2.00+	-	NP	2.00	2.00+	NP	NP	NE
TPB53	1.40	0.70	0.90	1.40[1]	-	-	1.40+	-	NP	1.20	1.40+	NP	small	NE
TPB54	2.30	-	-	-	-	1.60	-	2.30	2.30	2.00	2.30+	NP	NP	NE
TPB55	2.60	0.45	-	1.30	-	2.60+[1]	-	-	NP	2.60+	NP	NP	NP	2.4
TPB56	2.80	0.45	-	-	-	2.20[1]	-	2.80+	NP	2.80+	NP	NP	NP	NE
TPB57	2.60	1.30	2.10	-	2.60+[1]	-	-	-	NP	2.60+	NP	NP	NP	NE
TPB58	2.70	0.60	-	1.10	-	2.00+[1]	-	2.70+	NP	2.70+	NP	NP	NP	NE
TPB59	1.20	0.50	-	-	1.20+	-	-	-	NP	0.80	1.20+	NP	NP	NE
TPB60	2.20	0.70	-	-	2.20+[1]	-	-	-	NP	2.20+	NP	NP	NP	NE
TPB61	2.50	0.45	1.30	-	-	2.50+[1]	-	-	NP	2.50+	NP	NP	NP	NE
TPB62	2.50	0.90	1.70	-	2.50+	-	-	-	NP	1.70	2.50+	NP	NP	NE

KEY:

NP: Not proven
NE: Not encountered
[1]: Ferruginous
[2]: Colluvial fill deposits
[3]: Residual intrusive soils (possibly syenite)

<u>**Excavation Classification System:**</u>

Soft excavation - generally possible by hand or using conventional light earth-moving equipment (**TLB** and the like).
Intermediate excavation - necessitates the use of heavier plant (**tracked excavator**) and/or pneumatic ground-engaging-tools for economic excavation.
Hard excavation - requires **drill-and-blast** operations.
Boulder excavation - which may require **large plant** and/or **pneumatic fragmentation** of large particulate material for the practicable transportation thereof.

APPENDIX C

Test Pit Profiles

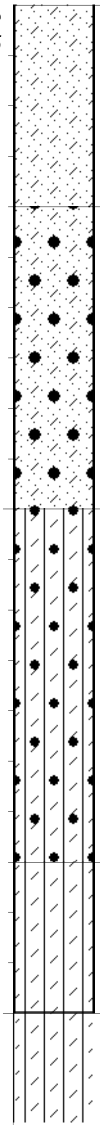
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB01
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown, loose, porous, slightly clayey fine sand.

AEOLIAN / HILLWASH

0.40

Moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand with abundant rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

1.00

Moist, brown blotched mustard-yellow and black, soft to firm, porous, clayey silt with ferricrete nodules and shale fragments.

FERRUGINOUS REWORKED RESIDUAL SHALE

1.70

Slightly moist, pale brown blotched pale grey and black, stiff, slightly shattered clayey silt.

REWORKED RESIDUAL SHALE

2.00

End of hole at nominal TLB refusal on stiff, REWORKED RESIDUAL SHALE

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB01

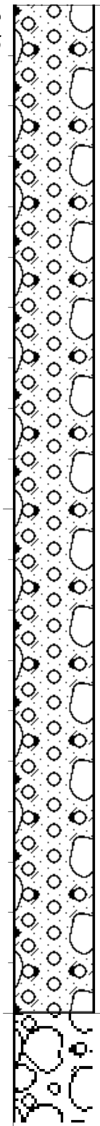
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB02
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-rounded quartz gravel and scattered chert and medium quartzite boulders in a matrix of moist, brown blotched black and off-white, loose to medium dense, porous, clayey fine sand with pockets off ferricrete.

FERRUGINOUS COLLUVIUM

2.00

End of hole at partial refusal on large boulders in matrix as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB02

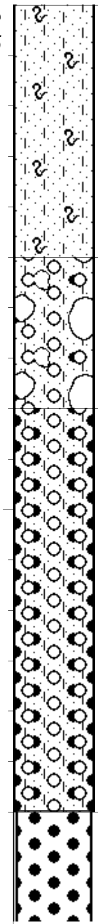
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB03
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown, loose, porous, silty fine sand; roots.

AEOLIAN / HILLWASH

0.50

Abundant sub-rounded cobbles and gravel clast-supported in a matrix of slightly moist to moist, brown spotted black, pale loose to medium dense, well cemented, silty fine sand.

FERRUGINOUS COLLUVIUM

0.80

Slightly moist, brown blotched black and mustard-yellow, dense to very dense, well cemented, silty sand and gravel in honeycomb ferricrete.

FERRICRETE

1.60

End of hole at TLB refusal on very dense, HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB03

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

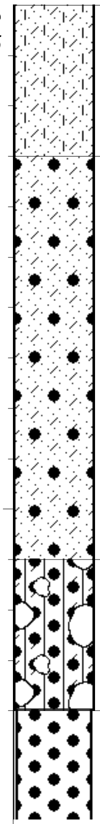
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB04

JOB NUMBER: GGE/19034

Scale
1:15



Depth (m)	Description
0.00	Moist, brown, loose, porous, slightly clayey silty sand. AEOLIAN / HILLWASH
0.30	Abundant discrete ferricrete nodules becoming concretions in a matrix of moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand. FERRUGINOUS AEOLIAN / HILLWASH
1.10	Abundant sub-rounded quartzite and chert cobbles in a matrix of slightly moist to moist, mustard-yellow, very dense, well cemented, clayey silt. FERRICRETE
1.40	End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB04

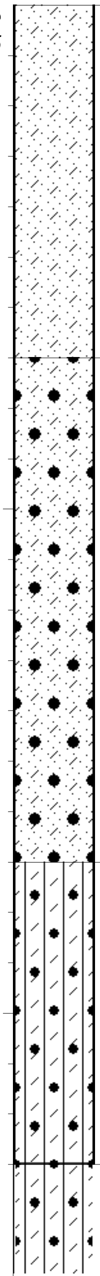
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB05
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown, loose, porous, slightly clayey fine sand.

AEOLIAN / HILLWASH

0.70

Moist, brown spotted black, loose, porous, clayey fine sand with abundant rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

1.70

Slightly moist to moist, mustard-yellow blotched pale grey and black, firm to stiff, shattered, clayey silt with abundant ferricrete and shale fragments.

REWORKED RESIDUAL SHALE

2.30

End of hole at nominal TLB refusal on stiff, REWORKED RESIDUAL SHALE

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB05

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB06
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15

Depth (m)	Description
0.00	Moist becoming slightly moist, reddish-brown, loose through medium dense, porous, slightly clayey fine sand. AEOLIAN / HILLWASH
2.20	Slightly moist, reddish-brown spotted black, medium dense, porous, clayey fine sand with abundant ferricrete nodules and trace gravels. FERRUGINOUS AEOLIAN / HILLWASH (PEBBLE MARKER)
2.60	End of hole not at refusal - continues as above.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB06

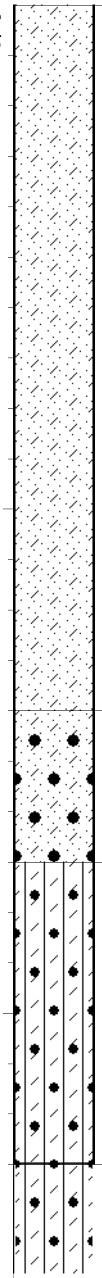
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB07
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown, loose, porous, slightly clayey fine sand.

AEOLIAN / HILLWASH

1.40

Moist, brown spotted black, loose, porous, clayey fine sand with abundant rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

1.70

Slightly moist to moist, mustard-yellow blotched beige and black, possibly firm, clayey silt with abundant ferricrete and shale fragments.

REWORKED RESIDUAL SHALE

2.30

End of hole at nominal TLB refusal on stiff, REWORKED RESIDUAL SHALE

NOTES

1) Unstable test pit sidewalls - possible former test pit.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB07

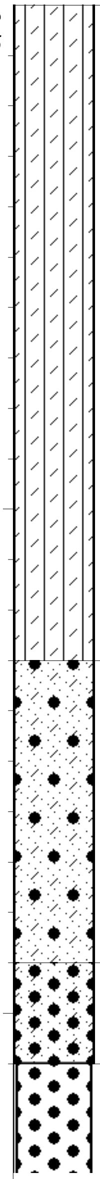
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB08
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Moist to very moist, brown becoming brownish-orange, soft, clayey silt.

AEOLIAN / HILLWASH

1.30

Abundant discrete ferricrete nodules in a matrix of moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand.

FERRUGINOUS AEOLIAN / HILLWASH

1.90

Slightly moist to moist, brown blotched mustard-yellow and black, dense to very dense, well cemented, clayey fine sand in hardpan ferricrete.

FERRICRETE

2.10

End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB08

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB09
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale *1:15*

0.00

Slightly moist, brown blotched dusky-red, mustard-orange, pale yellow and black, very dense, well cemented, silty sand in honeycomb ferricrete.

FERRICRETE

0.15

End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Abundant chert and quartzite boulders at ground surface.
2) Stable test pit sidewalls.
3) No groundwater encountered.
4) No samples taken.

CONTRACTOR : VV PLANT HIRE CC	*INCLINATION :* Vertical	*ELEVATION :*
MACHINE : Cat 428E	*DIAM :* 0.75m	*X-COORD :*
DRILLED BY : John	*DATE :* 13 December 2019	*Y-COORD :*
PROFILED BY : CS Morgan	*DATE :* 13 December 2019	*HOLE No:* TPB09
TYPE SET BY : CSM	*DATE : 03/02/2020 11:21*	
SETUP FILE : STANDARD.SET	*TEXT : ..nitasParkX16ProjectB.txt*	

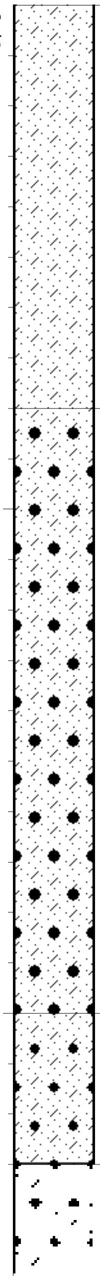
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB10
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, orange-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.80

Moist becoming slightly moist, brownish-orange blotched mustard-yellow and black, loose through dense, variably ferruginised, clayey fine sand approaching hardpan.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Dry to slightly moist, pale brown blotched brownish-orange and black, stiff, leached, clayey sand with ferricrete.

FERRUGINOUS REWORKED RESIDUAL SANDSTONE ?

2.30

End of hole at refusal on stiff FERRUGINOUS REWORKED RESIDUAL SANDSTONE?.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

HOLE No: TPB10

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB11
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15

Depth	Description
0.00	Moist, brown becoming reddish-brown, loose, porous, clayey fine sand. AEOLIAN / HILLWASH
1.20	Slightly moist to moist, reddish-brown through orange-brown spotted black, medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered chert cobbles. FERRUGINOUS AEOLIAN / HILLWASH
1.60	Moist, mustard-yellow mottled and blotched brownish-orange, pale grey spotted black, firm to stiff, micro-shattered and slickensided on joints, clayey silt with abundant weak ferricrete nodules. FERRUGINOUS REWORKED RESIDUAL SHALE?
2.80	End of hole not at refusal - continues as above.

UB11/1

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Undisturbed sample UB11/1 taken from 2.0m--2.2m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB11

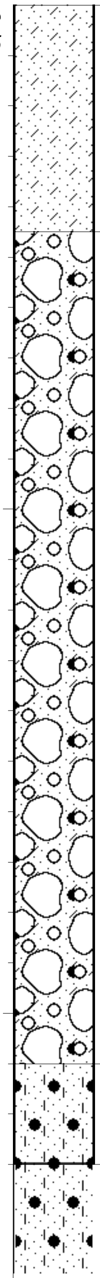
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB12
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.45

Moist, reddish-brown spotted black and dusky-red, medium dense, mass ferruginised, clayey fine sand with abundant sub-angular through sub-rounded quartzite gravel and small boulders.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.10

Slightly moist to moist, pale yellowish-orange through pale pink, medium dense, partially intact and relict-structured, silty fine sand.

REWORKED RESIDUAL SANDSTONE?

2.30

End of hole at nominal TLB refusal on stiff, FERRICRETE.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB12

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB13
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15

Depth (m)	Description
0.00 – 1.10	Moist, brown becoming reddish-brown, loose, porous, clayey fine sand. AEOLIAN / HILLWASH
1.10 – 1.90	Abundant discrete ferricrete nodules in a matrix of slightly moist to moist, brownish-orange through yellowish-brown blotched black, medium dense, porous, clayey fine sand. FERRUGINOUS AEOLIAN / HILLWASH
1.90 – 2.40	Slightly moist to moist, light brown blotched dusky-red, mustard-orange, pale yellow and black, dense, porous, clayey fine sand in honeycomb ferricrete. FERRICRETE
2.40	End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB13

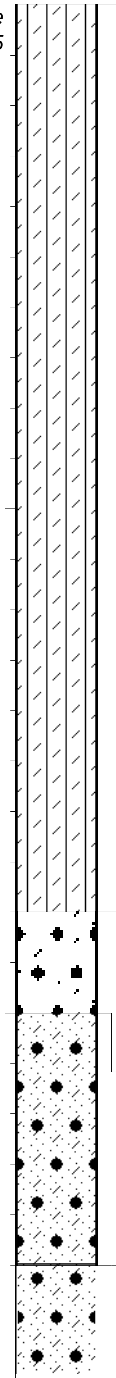
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB14
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, soft, clayey silt.

AEOLIAN / HILLWASH

1.80

Abundant discrete ferricrete nodules in a matrix of moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Moist, light brown mottled reddish-brown blotched black, firm, porous, clayey fine sand with abundant ferricrete nodules.

FERRICRETE

2.50

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB14

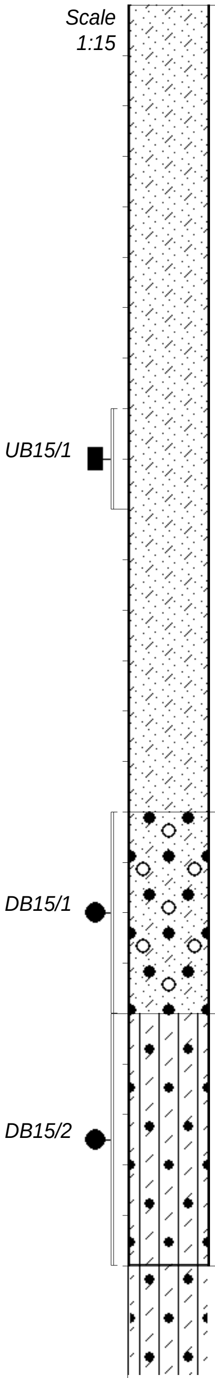
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: **TPB15**
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Moist, reddish-brown, loose, porous, slightly clayey fine sand.

AEOLIAN / HILLWASH

1.60

Moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand with abundant rounded ferricrete nodules and trace gravels.

FERRUGINOUS AEOLIAN / HILLWASH (PEBBLE MARKER)

2.00

Slightly moist to moist, yellowish-brown blotched pale grey, firm, slightly shattered and weakly ferruginised, clayey silt.

REWORKED RESIDUAL SHALE

2.50

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) Undisturbed sample UB15/1 taken from 0.8m--1.0m.
4) Disturbed sample DB15/1 taken from 1.6m--2.0m.
5) Disturbed sample DB15/2 taken from 2.0m--2.5m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TPB15**

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

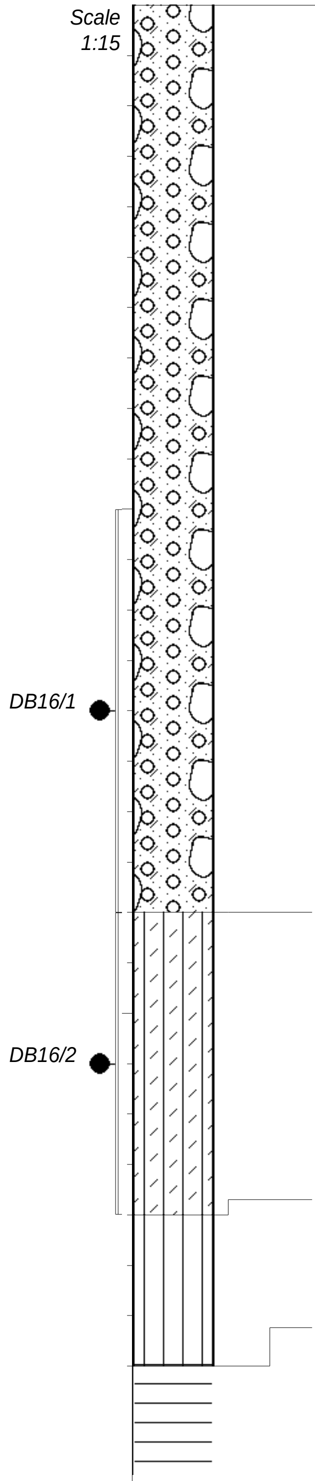
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB16
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-angular quartz gravel and small sub-rounded boulders in a matrix of moist, brown blotched black and off-white, loose to medium dense, porous, clayey fine sand.

COLLUVIUM

1.80

Slightly moist, brown mottled beige, firm, fragmented, clayey silt with shale fragments.

REWORKED RESIDUAL SHALE

2.40

Slightly moist, khaki stained red, firm to stiff, moderately bedded, silt through very soft rock.

RESIDUAL SHALE

2.70

End of hole at TLB refusal on very soft rock, SHALE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Disturbed sample DB16/1 taken from 1.0m--1.8m.

4) Disturbed sample DB16/2 taken from 1.8m--2.4m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB16

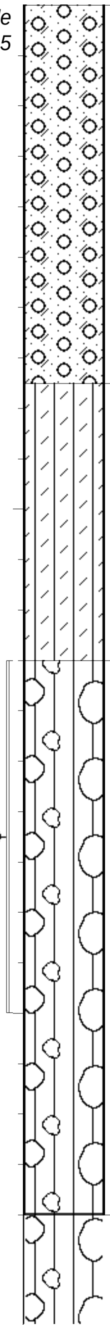
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB17
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



DB17/1

0.00

Abundant sub-rounded quartz gravel in a matrix of moist, brown, loose, porous, clayey fine sand.

COLLUVIUM

0.75

Slightly moist, pale grey blotched pale yellow , brown and red, firm, slightly fissured, slightly clayey silt.

ALLUVIUM?

1.30

Scattered sub-rounded and rounded cobbles in a matrix of slightly moist, mustard-yellow blotched red, stiff, largely intact, silt.

ALLUVIAL PEBBLE MARKER?

2.40

End of hole at nominal TLB refusal on stiff, ALLUVIAL PEBBLE MARKER?

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) Disturbed sample DB17/1 taken from 1.3m--2.0m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB17

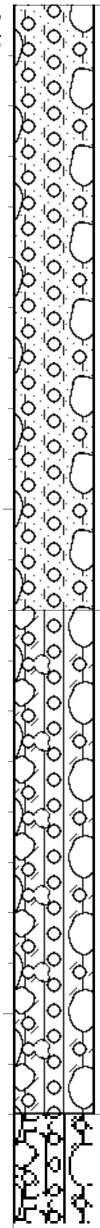
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB18
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-rounded quartz gravel and rounded boulders clast-supported in a matrix of moist, brown, loose, porous, silty sand.

COLLUVIUM

1.20

Abundant conglomerate, sandstone and chert gravels, cobbles and small boulders in a matrix of slightly moist to moist, brown through beige, stiff, slightly shattered, clayey silt.

ALLUVIAL PEBBLE MARKER

2.20

End of hole at nominal refusal on stiff ALLUVIAL PEBBLE MARKER.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB18

21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: **TPB19**
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15

0.00
Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.70
Abundant discrete ferricrete nodules in a matrix of moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand.

FERRUGINOUS AEOLIAN / HILLWASH

2.10
Slightly moist to moist, light brown blotched pale grey, dusky-red and black, stiff, cemented, clayey sand.

FERRICRETE

2.30
End of hole at nominal refusal of stiff FERRICRETE.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TPB19**

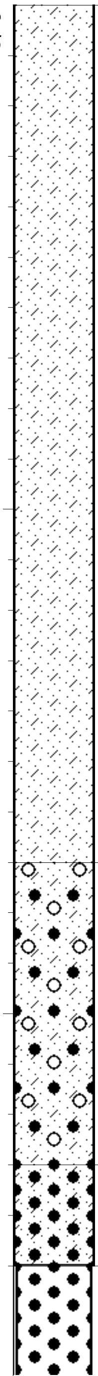
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB20
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



Depth (m)	Description
0.00	Moist, brown becoming reddish-brown, soft, porous, clayey fine sand. AEOLIAN / HILLWASH
1.70	Scattered chert fragments and abundant discrete ferricrete nodules in a matrix of moist, reddish-brown through yellowish-brown, loose, porous, clayey fine sand. FERRUGINOUS COLLUVIUM
2.30	Moist, brown mottled mustard-yellow blotched black, medium dense to dense, porous, clayey fine sand in honeycomb ferricrete. FERRICRETE
2.50	End of hole at refusal on HARDPAN FERRICRETE.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB20

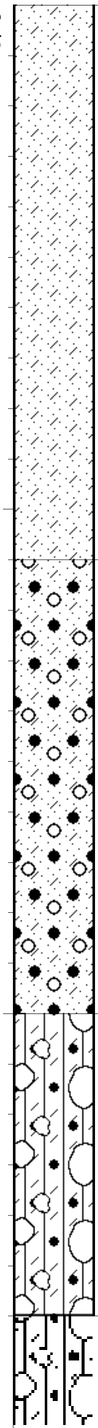
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB21
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist to very moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.10

Slightly moist to moist, light brownish-orange spotted black, medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered sub-rounded gravel.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Slightly moist to moist, khaki mottled brownish-orange spotted black, firm, shattered, clayey silt with weak ferricrete nodules and scattered sub-rounded cobbles.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.60

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB21

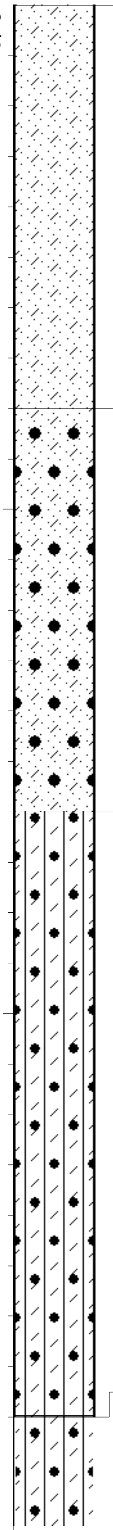
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB22
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.80

Slightly moist to moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

1.60

Slightly moist to moist, khaki mottled reddish-brown and pale grey spotted black, firm to stiff, shattered and slickensided on joints, clayey silt with weak ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.80

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB22

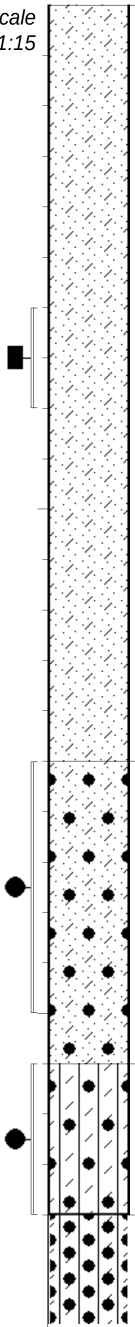
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB23
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



UB23/1

DB23/1

DB23/2

0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.50

Slightly moist to moist, reddish-brown spotted black, medium dense, porous, clayey fine sand with abundant ferricrete nodules, scattered chert and quartzite cobbles.

FERRUGINOUS AEOLIAN / HILLWASH

2.10

Slightly moist to moist, mustard-yellow mottled reddish-brown spotted black, firm to stiff, clayey silt with abundant discrete ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.40

End of hole at nominal TLB refusal on stiff, FERRUGINOUS REWORKED RESIDUAL SHALE?

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Undisturbed sample UB23/1 taken from 0.6m--0.8m.

4) Disturbed sample DB23/1 taken from 1.5m--2.0m.

5) Disturbed sample DB23/2 taken from 2.1m--2.4m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB23

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

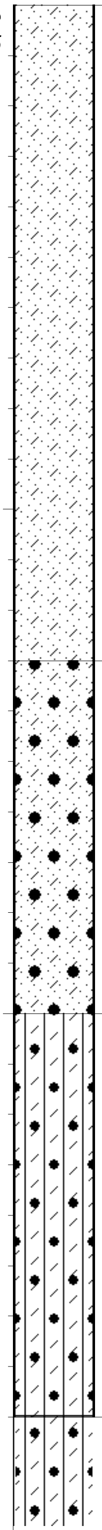
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB24
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.30

Slightly moist to moist, reddish-brown through orange-brown spotted black, medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered chert cobbles.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Slightly moist to moist, mustard-yellow mottled and blotched dull brown, grey and reddish-brown spotted black, firm, slickensided on joints, clayey silt with trace ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.80

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB24

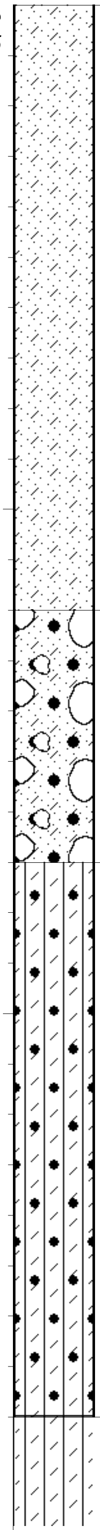
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB25
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.20

Slightly moist to moist, reddish-brown spotted black, loose to medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered sub-rounded cobbles.

FERRUGINOUS AEOLIAN / HILLWASH

1.70

Slightly moist to moist, khaki mottled reddish-brown and pale grey spotted black, firm to stiff becoming stiff, shattered and slickensided on joints, clayey silt with weak ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.80

End of hole not at refusal on khaki streaked grey stained black and red, slightly slickensided and shattered clayey silt - REWORKED RESIDUAL SHALE?

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB25

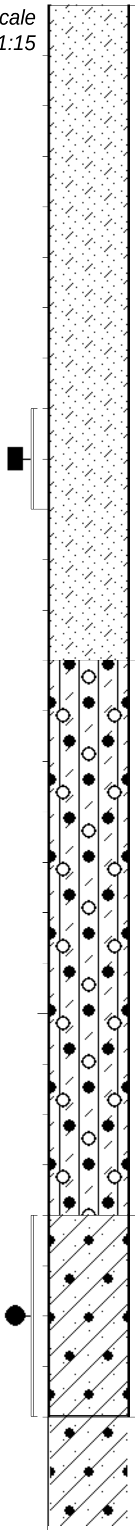
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB26
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



UB26/1

DB26/1

0.00

Moist to very moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.30

Moist, brownish-orange through brownish-yellow spotted black, loose to medium dense, porous, clayey fine silt with abundant discrete rounded ferricrete nodules and scattered sub-rounded gravel.

FERRUGINOUS AEOLIAN / HILLWASH

2.40

Slightly moist, khaki mottled grey, mustard-yellow spotted black, stiff, shattered and slickensided, sandy clay and weak ferricrete nodules.

FERRUGINOUS ALLUVIUM

2.80

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Undisturbed sample UB26/1 taken from 0.8m--1.0m.

4) Disturbed sample DB26/1 taken from 2.4m--2.8m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB26

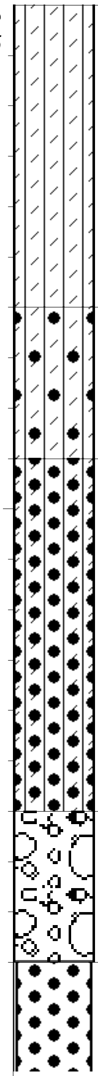
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB27
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, soft, porous, clayey silt.

AEOLIAN / HILLWASH

0.60

Moist, brownish-orange through brownish-yellow spotted black, soft, porous, clayey silt with abundant discrete rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

0.90

Slightly moist to moist, mustard-yellow blotched black, firm to stiff, porous, clayey silt in honeycomb ferricrete.

FERRICRETE

1.60

Dry to slightly moist, mustard-yellow blotched grey and black, well cemented, clayey fine sand with trace chert gravel and cobbles.

FERRUGINISED COLLUVIUM

1.90

End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB27

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB28
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15

Depth (m)	Description
0.00	Slightly moist to moist, reddish-brown, loose, porous, clayey fine sand; roots. AEOLIAN / HILLWASH
0.45	Slightly moist to moist, brown spotted black, dense, porous, clayey fine sand with abundant ferricrete nodules and scattered sub-angular gravel. FERRUGINOUS PEBBLE MARKER
0.85	End of hole at abrupt TLB refusal on chert gravel in very dense, HARDPAN FERRICRETE.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB28

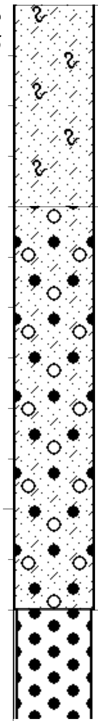
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB29
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Slightly moist to moist, reddish-brown, loose, porous, clayey fine sand; roots.

AEOLIAN / HILLWASH

0.40

Abundant ferricrete nodules clast-supported in a matrix of slightly moist, brown blotched back, loose to medium dense, porous, clayey fine sand with scattered chert gravel.

FERRUGINOUS PEBBLE MARKER

1.20

End of hole at abrupt TLB refusal on reddish-brown blotched black, dense, HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB29

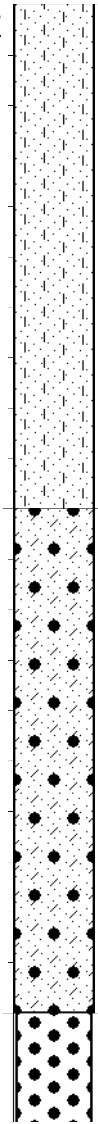
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB30
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Slightly moist, brown, loose, porous, slightly silty sand.

AEOLIAN / HILLWASH

1.00

Abundant ferricrete nodules clast-supported in a sparse matrix of slightly moist, pale brown, medium dense to dense, clayey fine sand.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

End of hole at TLB refusal on pale brown blotched mustard-orange and black, very dense, HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC	*INCLINATION :* Vertical	*ELEVATION :*
MACHINE : Cat 428E	*DIAM :* 0.75m	*X-COORD :*
DRILLED BY : Moses	*DATE :* 14 January 2020	*Y-COORD :*
PROFILED BY : CS Morgan	*DATE :* 14 January 2020	*HOLE No:* TPB30
TYPE SET BY : CSM	*DATE : 03/02/2020 11:21*	
SETUP FILE : STANDARD.SET	*TEXT : ..nitasParkX16ProjectB.txt*	

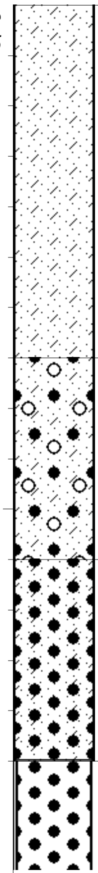
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB31
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Slightly moist to moist, dark brown through medium brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.70

Scattered sub-rounded gravel and abundant ferricrete nodules and concretions in a matrix of slightly moist, brown blotched back, medium dense through dense, clayey fine sand.

FERRUGINOUS PEBBLE MARKER

1.10

Slightly moist, brown blotched black and red, very dense, mass ferruginised clayey sand with scattered sub-rounded gravel.

HONEYCOMB FERRICRETE

1.50

End of hole at TLB refusal on very dense, HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB31

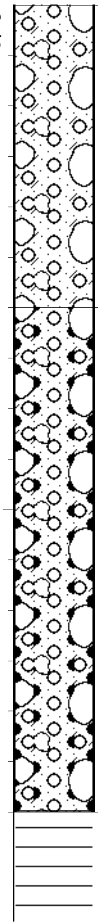
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB32
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant shale, chert and quartzite cobbles and gravel in a matrix of slightly moist, orange-brown, loose, porous, clayey fine sand.

COLLUVIUM

0.60

Abundant shale, chert and quartzite cobbles and gravel and pockets of low-grade coal mass ferruginised in a matrix of slightly moist, orange-brown, very dense, clayey fine sand.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

1.60

End of hole at nominal TLB refusal on mustard-yellow, moderately weathered, soft rock, SHALE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB32

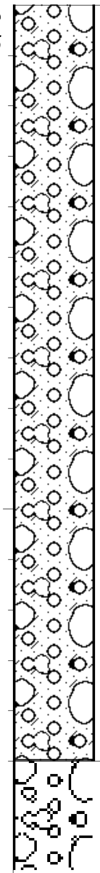
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB33
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-angular chert gravel and cobbles in a matrix of slightly moist to moist, dusky-red mottled mustard-yellow and black, firm becoming stiff, evidently cemented, clayey sand.

FERRUGINOUS COLLUVIUM

1.50

End of hole not at nominal TLB refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB33

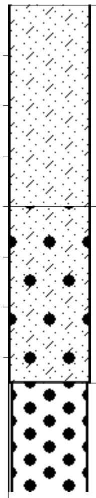
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB34
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



Depth (m)	Description
0.00	Moist, brown becoming reddish-brown, loose, porous, clayey fine sand. AEOLIAN / HILLWASH
0.40	Abundant black ferricrete nodules in a matrix of very moist, reddish-brown, medium dense, porous, clayey fine sand. FERRUGINOUS AEOLIAN / HILLWASH
0.75	End of hole at refusal on mustard-orange blotched dusky-red and black, very dense, HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB34

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB35
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale *1:15*

0.00

Moist, reddish-brown spotted black, medium dense, porous, clayey fine sand with abundant ferricrete nodules becoming honeycomb with depth.

FERRUGINOUS AEOLIAN / HILLWASH

1.50

Slightly moist, khaki mottled grey, reddish-pink spotted black, stiff, slightly shattered, ferruginous sandy clay with scattered sub-rounded boulders.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.60

End of hole not at nominal refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB35

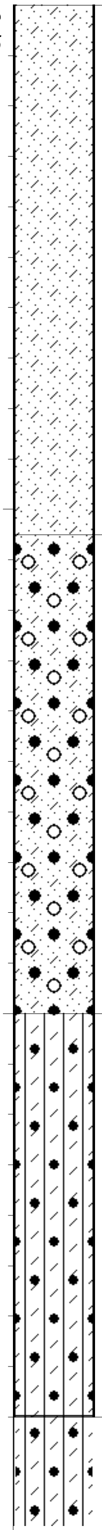
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB36
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist to very moist, reddish-brown becoming brownish-orange, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.05

Slightly moist to moist, brownish-orange through mustard-yellow spotted black, loose through medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered sub-rounded cobbles.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Slightly moist to moist, khaki mottled pinkish-red nd grey spotted black, firm to stiff, shattered and slickensided, clayey silt with weak ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.80

End of hole not at refusal - continues as above.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB36

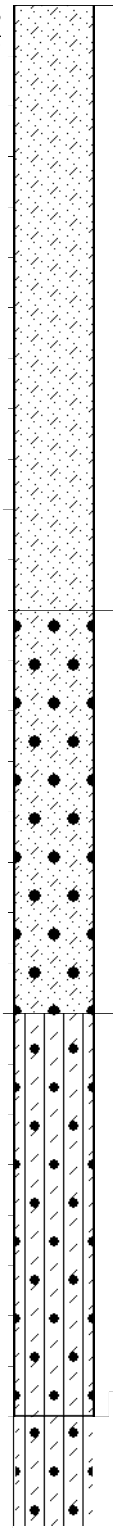
Geoid Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB37
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown becoming reddish-brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.20

Slightly moist to moist, reddish-brown through orange-brown spotted black, medium dense, porous, clayey fine sand with abundant discrete rounded ferricrete nodules and scattered chert cobbles.

FERRUGINOUS AEOLIAN / HILLWASH

2.00

Moist, mustard-yellow mottled and blotched grey, reddish-brown spotted black, firm to stiff, slickensided on joints, clayey silt with weak ferricrete nodules.

FERRUGINOUS REWORKED RESIDUAL SHALE?

2.80

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB37

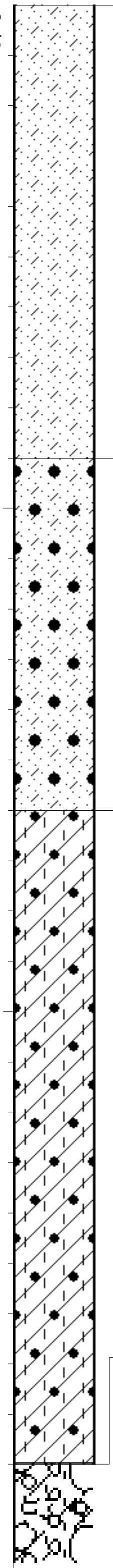
Geoid Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB38
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



Depth (m)	Description
0.00	Moist to very moist, brown through brownish-orange, loose, porous, clayey fine sand. AEOLIAN / HILLWASH
0.90	Moist, mustard-yellow spotted black, loose, porous, clayey fine sand with abundant discrete rounded ferricrete nodules. FERRUGINOUS AEOLIAN / HILLWASH
1.60	Slightly moist to moist, khaki mottled pinkish-red and grey spotted black, firm to stiff, shattered and slickensided, silty clay. ALLUVIUM?
2.90	End of hole not at partial refusal on sub-rounded quartzite and chert cobbles gravel in a matrix as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB38

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB39
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15

Depth (m)	Description
0.00	Moist, brown becoming brownish-orange, loose, porous, clayey fine sand. AEOLIAN / HILLWASH
1.70	Slightly moist to moist, brownish-yellow mottled mustard-orange spotted black, loose to medium dense, porous, clayey fine sand with moderately abundant weak ferricrete nodules. FERRUGINOUS AEOLIAN / HILLWASH
2.70	End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB39

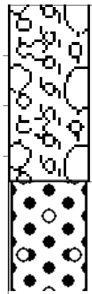
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB40
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Abundant chert <u>gravels</u> and <u>cobbles</u> in a matrix of slightly moist, reddish-brown, <u>loose to medium</u>, porous, <u>silty fine sand</u>.

COLLUVIUM

0.35

End of hole at refusal on dusky-red mottled mustard-yellow and black, <u>very dense, gravelly</u> HARDPAN FERRICRETE.

NOTES

1) Chert boulders at surface.
2) Stable test pit sidewalls.
3) No groundwater encountered.
4) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB40

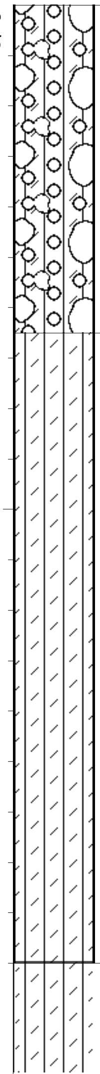
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB41
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Abundant sub-rounded chert and quartzite gravel, cobbles and small sub-rounded boulders in a matrix of slightly moist to moist, brown blotched mustard-yellow and black, loose to medium dense, porous becoming slightly shattered, clayey silt.

COLLUVIUM

0.65

Slightly moist to moist, reddish-brown blotched greyish-brown and pale yellow, firm, slightly shattered, clayey silt with abundant rock fragments.

REWORKED RESIDUAL SHALE

1.90

End of hole at nominal TLB refusal as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB41

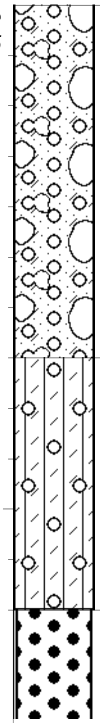
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB42
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



Depth	Description
0.00	Abundant chert and quartzite cobbles and gravel in a matrix of slightly moist to moist, reddish-brown blotched off-white, loose to medium dense, porous, clayey fine sand. COLLUVIUM
0.70	Slightly moist to moist, red blotched black, stiff, clayey silt with chert cobbles and pockets of low-grade coal. REWORKED RESIDUAL KAROO
1.20	End of hole at nominal TLB refusal HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB42

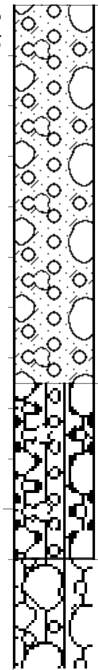
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB43
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-rounded gravel, cobbles and scattered sub-rounded boulders in a matrix of slightly moist to moist, brown blotched off-white and dusty-pink, loose to medium dense, porous, clayey fine sand.

COLLUVIUM

0.75

Abundant sub-rounded gravel and chert cobbles in a matrix of slightly moist to moist, khaki blotched reddish-orange, dense, sandy clayey silt.

FERRUGINOUS COLLUVIUM

1.10

End of hole at nominal TLB refusal boulders in a matrix as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB43

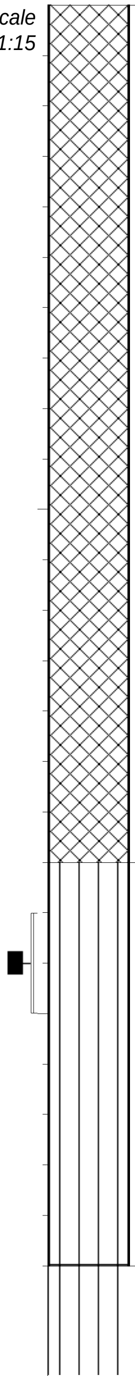
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB44
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Slightly moist, brown mottled pink and yellow, very loose, unconsolidated, mixed clayey silt and gravel.

FILL (QUARRY OPERATIONS)

1.70

Slightly moist, reddish-orange streaked black, firm to stiff, intact, relict-structured but slightly fissured, silt.

RESIDUAL SYENITE?

2.50

End of hole not at TLB refusal - continues as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) Undisturbed sample UB44/1 taken from 1.8m--2.0m.

CONTRACTOR : VV PLANT HIRE CC	*INCLINATION :* Vertical	*ELEVATION :*
MACHINE : Cat 428E	*DIAM :* 0.75m	*X-COORD :*
DRILLED BY : Moses	*DATE :* 14 January 2020	*Y-COORD :*
PROFILED BY : CS Morgan	*DATE :* 14 January 2020	*HOLE No:* TPB44
TYPE SET BY : CSM	*DATE : 03/02/2020 11:21*	
SETUP FILE : STANDARD.SET	*TEXT : ..nitasParkX16ProjectB.txt*	

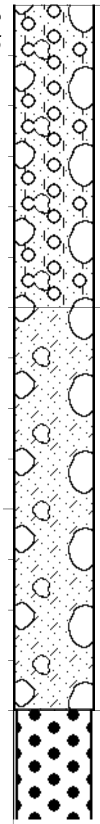
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB45
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Scattered sub-rounded cobbles and abundant gravel and in a matrix of slightly moist, brown, loose to medium, porous, silty fine sand.

COLLUVIUM

0.60

Slightly moist, reddish-brown blotched mustard-yellow and off-white, dense to very dense, clayey fine sand with scattered sub-rounded cobbles in well-developed honeycomb ferricrete.

FERRICRETE

1.40

End of hole at refusal on very dense, HARDPAN FERRICRETE.

NOTES

1) Chert boulders at surface.
2) Stable test pit sidewalls.
3) No groundwater encountered.
4) No samples taken.

CONTRACTOR : VV PLANT HIRE CC	*INCLINATION :* Vertical	*ELEVATION :*
MACHINE : Cat 428E	*DIAM :* 0.75m	*X-COORD :*
DRILLED BY : John	*DATE :* 13 December 2019	*Y-COORD :*
PROFILED BY : CS Morgan	*DATE :* 13 December 2019	*HOLE No:* TPB45
TYPE SET BY : CSM	*DATE : 03/02/2020 11:21*	
SETUP FILE : STANDARD.SET	*TEXT : ..nitasParkX16ProjectB.txt*	

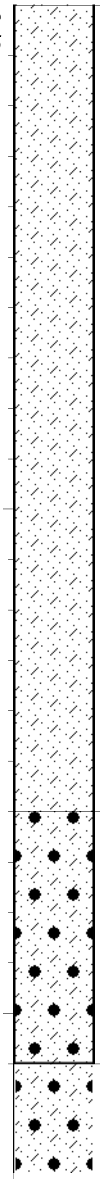
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB46

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Moist, brown becoming brownish-orange, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

1.60

Slightly moist to moist, yellowish-brown spotted black, evidently dense, relatively massive ferricrete concretions in clayey fine sand.

FERRUGINOUS AEOLIAN / HILLWASH

2.10

End of hole not at refusal - continues as above.

NOTES

1) Unstable test pit sidewalls - hole profiled from surface.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

HOLE No: TPB46

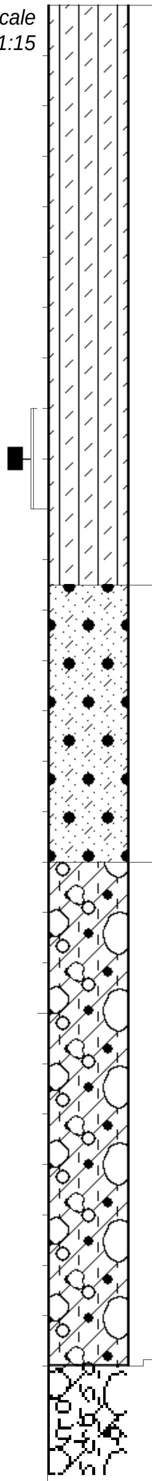
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB47
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00
Moist to very moist, brown becoming mustard-yellow, soft, porous, clayey silt.

AEOLIAN / HILLWASH

1.15
Moist, mustard-yellow spotted black, loose, porous, clayey fine sand with abundant discrete rounded ferricrete nodules.

FERRUGINOUS AEOLIAN / HILLWASH

1.70
Slightly moist to moist, khaki mottled pinkish-red and grey spotted black, stiff to very stiff, shattered and slickensided, silty clay with ferricrete nodules and sub-rounded quartzite gravel and cobbles.

ALLUVIAL PEBBLE MARKER

2.70
End of hole at partial refusal on sub-rounded quartzite and chert cobbles gravel in a matrix as above.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) Undisturbed sample UB47/1 taken from 0.8m--1.0m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB47

GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB48
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15

Depth (m)	Description
0.00 – 1.50	Moist to very moist, brown becoming mustard-yellow mottled reddish-orange, soft, porous, clayey silt. AEOLIAN / HILLWASH
1.50 – 2.20	Moist, khaki blotched black, loose, porous, clayey fine sand with moderately abundant discrete rounded ferricrete nodules. FERRUGINOUS AEOLIAN / HILLWASH
2.20 – 2.80	Moist, khaki mottled yellowish-brown and grey spotted black, firm to stiff, shattered and slickensided, clayey silt with ferricrete nodules. ALLUVIUM
2.80	End of hole not at refusal - continues as above.

NOTES
1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB48

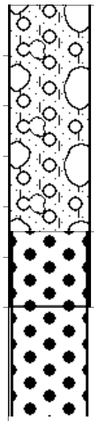
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB49
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



Depth (m)	Description
0.00	Abundant sub-rounded gravel and cobbles in a matrix of slightly moist to moist, brown, loose to medium dense, porous, silty sand. COLLUVIUM
0.45	Dusky-red blotched mustard-yellow, very dense, well cemented hardpan ferricrete. FERRICRETE
0.60	End of hole at refusal on HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB49

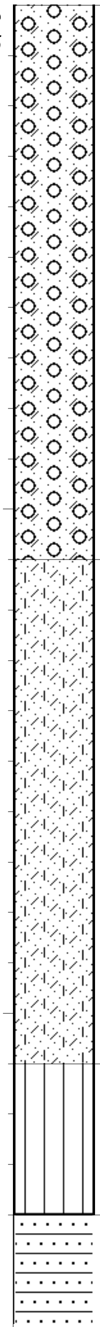
Geoid Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB50
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Abundant sub-rounded gravel in a matrix of moist, reddish-brown blotched black, loose to medium, porous, clayey fine sand.

ALLUVIAL PEBBLE MARKER

1.10

Slightly moist, brown mottled black and mustard-yellow, soft to firm, friable, slightly clayey silty fine sand with shale fragments.

REWORKED RESIDUAL SANDSTONE

2.10

Slightly moist, pale yellow stained black, firm, partially intact and relict-structured, silt.

RESIDUAL SANDSTONE

2.40

End of hole at refusal on medium hard rock, SANDSTONE.

NOTES

1) Chert boulders at surface.
2) Stable test pit sidewalls.
3) No groundwater encountered.
4) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB50

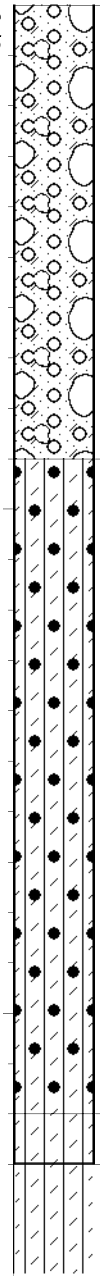
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB51
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Abundant sub-rounded chert and quartzite gravel, cobbles and small sub-rounded boulders in a matrix of slightly moist, brown, loose to medium dense, porous, clayey fine sand.

COLLUVIUM

0.90

Chert, quartzite and coal cobbles in a matrix of slightly moist, reddish-brown blotched dusky-red and black, firm to stiff, cemented, clayey silt.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.20

Slightly moist, red blotched khaki and yellow, stiff, porous, clayey silt with trace shale.

REWORKED RESIDUAL SHALE

2.30

End of hole at nominal TLB refusal as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB51

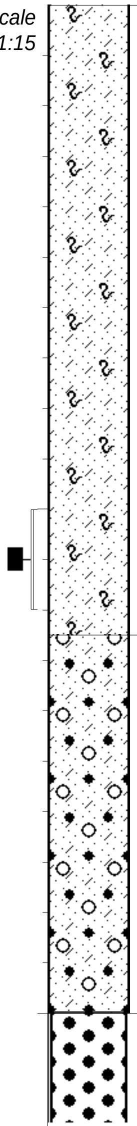
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB52
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



UB52/1

0.00

Slightly moist, brown becoming yellowish-brown, firm, porous, clayey fine sand; tree roots.

AEOLIAN / HILLWASH

1.25

Slightly moist, pale brown blotched orange and dusky-red, firm becoming stiff, clayey fine sand ferricrete nodules.

FERRUGINOUS HILLWASH

2.00

End of hole at nominal TLB refusal on stiff NEAR- HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Undisturbed sample UB52/1 taken from 1.0m--1.2m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB52

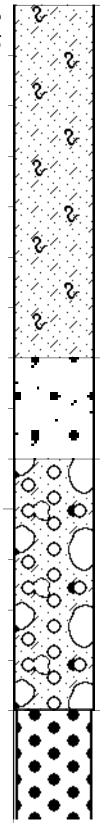
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB53
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



Depth	Description
0.00	Slightly moist to moist, dark brown becoming medium brown, firm, porous, clayey fine sand; roots. AEOLIAN / HILLWASH
0.70	Slightly moist to moist, light brown mottled orange, firm becoming stiff, slightly ferruginous, clayey fine sand. FERRUGINOUS HILLWASH
0.90	Abundant sub-rounded cobbles and gravel clast-supported in a matrix of slightly moist, pale grey blotched orange, dense to very dense, well cemented, clayey fine sand. FERRUGINOUS COLLUVIUM
1.40	End of hole at nominal TLB refusal on stiff NEAR- HARDPAN FERRICRETE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : Moses
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 14 January 2020
DATE : 14 January 2020

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB53

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

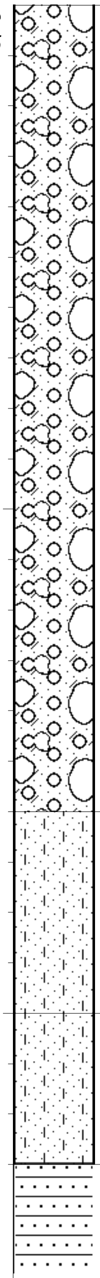
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB54

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Abundant sub-rounded cobbles and gravel in a matrix of slightly moist to moist, brown, loose to medium, porous, clayey fine sand.

ALLUVIAL PEBBLE MARKER

1.60

Slightly moist, dusty-pink blotched mustard-orange and pale grey, firm to stiff, silty fine sand.

REWORKED RESIDUAL SANDSTONE

2.00

Slightly moist, dusty-pink mottled pale grey, stiff, intact and relict-structured, silty fine sand.

RESIDUAL SANDSTONE

2.30

End of hole at refusal on very soft rock, SANDSTONE.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan
TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019
DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB54

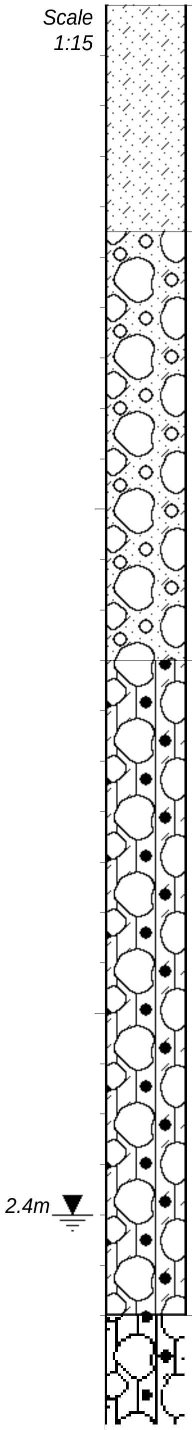
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB55

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Moist, brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.45

Abundant sub-rounded gravel, cobbles and small boulders in a matrix of moist, mustard-orange blotched brown, medium dense, porous, clayey fine sand.

COLLUVIUM

1.30

Moist becoming wet, mustard-yellow blotched pale grey, reddish-brown and black, soft, porous, clayey silt with large ferricrete concretions and small sub-rounded boulders.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.60

End of hole under water, so refusal not proven - continues as above.

NOTES

1) Unstable test pit sidewalls.

2) Standing water at 2.4m.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB55

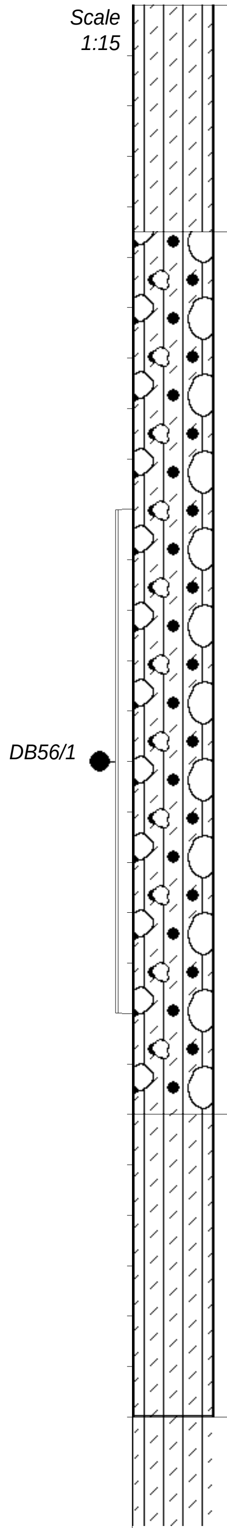
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB56
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown, soft, porous, clayey silt.

AEOLIAN / HILLWASH

0.45

Scattered sub-rounded and rounded cobbles and small boulders and hardpan ferricrete concretions in a matrix of moist to very moist, light brown through reddish-orange blotched black, medium dense, porous, clayey silt.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.20

Slightly moist to moist, mustard-yellow blotched grey, reddish-orange and black, firm, slightly fissile, clayey silt through very sot rock.

REWORKED RESIDUAL SHALE

2.80

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Disturbed sample DB56/1 taken from 1.0m--2.0m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB56

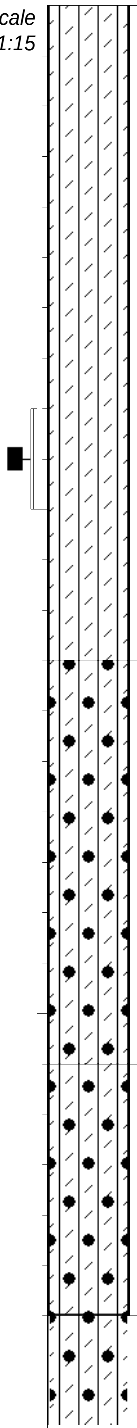
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB57
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



UB57/1

0.00

Moist to very moist, brown through brownish-orange, soft to firm, porous, clayey silt.

AEOLIAN / HILLWASH

1.30

Slightly moist to moist, yellowish-brown blotched black, firm, porous, clayey silt with abundant discrete ferricrete nodules.

FERRUGINOUS HILLWASH

2.10

Slightly moist to moist, mustard-yellow blotched pale grey spotted black, firm to stiff, shattered and slickensided clayey silt with weak ferricrete.

FERRUGINOUS ALLUVIUM

2.60

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) Undisturbed sample UB57/1 taken from 0.8m--1.0m.

CONTRACTOR : VV PLANT HIRE CC	*INCLINATION :* Vertical	*ELEVATION :*
MACHINE : Cat 428E	*DIAM :* 0.75m	*X-COORD :*
DRILLED BY : John	*DATE :* 12 December 2019	*Y-COORD :*
PROFILED BY : CS Morgan	*DATE :* 12 December 2019	*HOLE No:* TPB57
TYPE SET BY : CSM	*DATE : 03/02/2020 11:21*	
SETUP FILE : STANDARD.SET	*TEXT : ..nitasParkX16ProjectB.txt*	

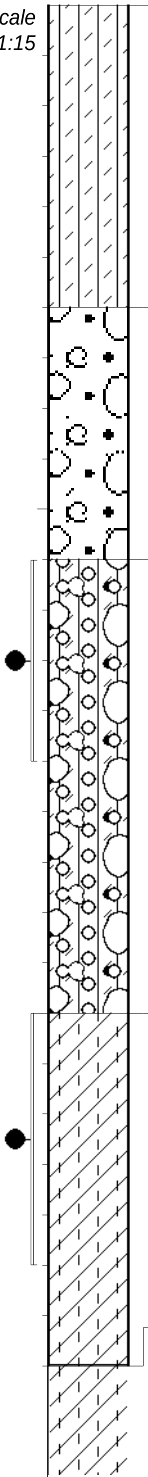
Geoid Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB58
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale 1:15



0.00

Moist, brown becoming yellowish-brown, loose, porous, clayey silt.

AEOLIAN / HILLWASH

0.60

Abundant nodular ferricrete and scattered sub-rounded cobbles in a matrix of moist, khaki, loose to medium dense, porous, clayey fine sand.

FERRUGINOUS COLLUVIUM

1.10

Abundant sub-rounded cobbles and gravel in a matrix of slightly moist, mustard-orange blotched pale grey, stiff to very stiff, slightly shattered, clayey silt with ferricrete.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.00

Slightly moist to moist, mustard-yellow mottled pale grey and dusty-pink, firm, shattered, silty clay.

REWORKED RESIDUAL SHALE

2.70

End of hole not at refusal - continues as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) Disturbed sample DB58/1 taken from 1.1m--1.5m.
4) Disturbed sample DB58/2 taken from 2.0m--2.5m.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB58

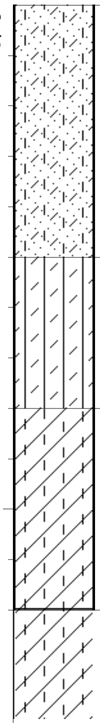
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB59
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



Depth	Description
0.00	Moist, brown, loose, porous, clayey silty sand. AEOLIAN / HILLWASH
0.50	Moist, grey blotched mustard-orange, firm, shattered, clayey silt. ALLUVIUM
0.80	Dry to slightly moist, grey blotched mustard-orange, stiff to very stiff, shattered, silty clay. ALLUVIUM
1.20	End of hole at refusal on very stiff ALLUVIUM.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB59

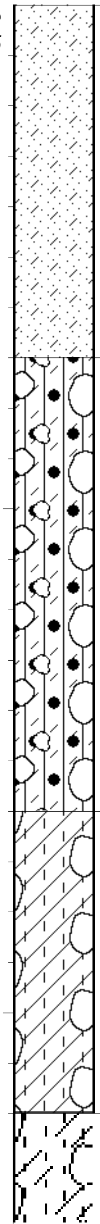
GEOID Geotechnical Engineers
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB60
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale *1:15*



0.00

Moist, brown, loose, porous, clayey fine sand.

AEOLIAN / HILLWASH

0.70

Abundant sub-rounded cobbles and heavy ferricrete in a matrix of slightly moist, mustard-orange blotched brown, dusky-red and black, firm to stiff, slightly shattered, clayey silt.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

1.60

Slightly moist, mustard-yellow mottled pale grey, firm to stiff, fissured, silty clay with pockets of boulders.

ALLUVIAL PEBBLE MARKER

2.20

End of hole at refusal on ALLUVIAL BOULDERS.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

INCLINATION : Vertical
DIAM : 0.75m
DATE : 13 December 2019
DATE : 13 December 2019

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

HOLE No: TPB60

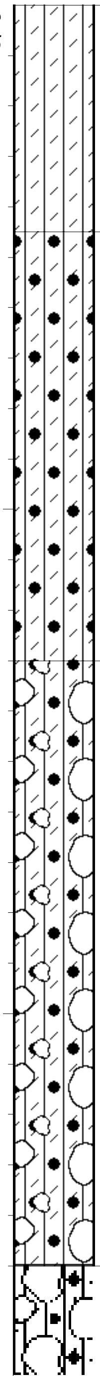
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB61
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown through brownish-orange, soft, porous, clayey silt.

AEOLIAN / HILLWASH

0.45

Moist, mustard-yellow blotched black and dusky-red, firm, porous, clayey silt with abundant discrete ferricrete nodules.

FERRUGINOUS HILLWASH

1.30

Slightly moist to moist, mustard-yellow blotched pale grey spotted black and reddish-orange, firm, fissured, clayey silt with abundant sub-rounded quartzite cobbles and small boulders.

FERRUGINOUS ALLUVIAL PEBBLE MARKER

2.50

End of hole at refusal on boulders - continues as above.

NOTES

1) Stable test pit sidewalls.
2) No groundwater encountered.
3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB61

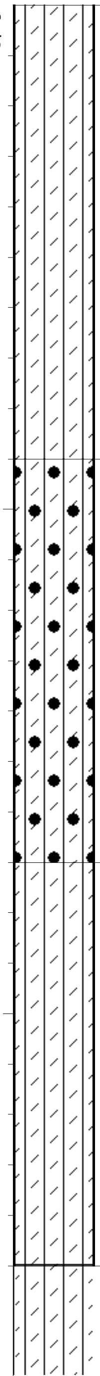
21 Glenluce Drive
Douglasdale
Sandton, 2191
South Africa
T: +27-11-704-3131
F: +27-86-503-8312
mail@geoid.co.za

UNITAS PARK EXTENSION 16 - PROJECT B
PHUMAF CONSULTING ENGINEERS

HOLE No: TPB62
Sheet 1 of 1

JOB NUMBER: GGE/19034

Scale
1:15



0.00

Moist, brown through mustard-yellow mottled red spotted black, soft to firm, porous, clayey silt.

AEOLIAN / HILLWASH

0.90

Moist, mustard-yellow blotched pinkish-red and black, firm, porous, clayey silt with abundant discrete ferricrete nodules.

FERRUGINOUS HILLWASH

1.70

Slightly moist to moist, pale grey blotched mustard-yellow, stiff, shattered and slickensided clayey silt.

ALLUVIUM

2.50

End of hole at refusal on stiff ALLUVIUM.

NOTES

1) Stable test pit sidewalls.

2) No groundwater encountered.

3) No samples taken.

CONTRACTOR : VV PLANT HIRE CC
MACHINE : Cat 428E
DRILLED BY : John
PROFILED BY : CS Morgan

TYPE SET BY : CSM
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM : 0.75m
DATE : 12 December 2019
DATE : 12 December 2019

DATE : 03/02/2020 11:21
TEXT : ..nitasParkX16ProjectB.txt

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: TPB62

APPENDIX D

Laboratory Test Results

Geopractica

SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700

TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

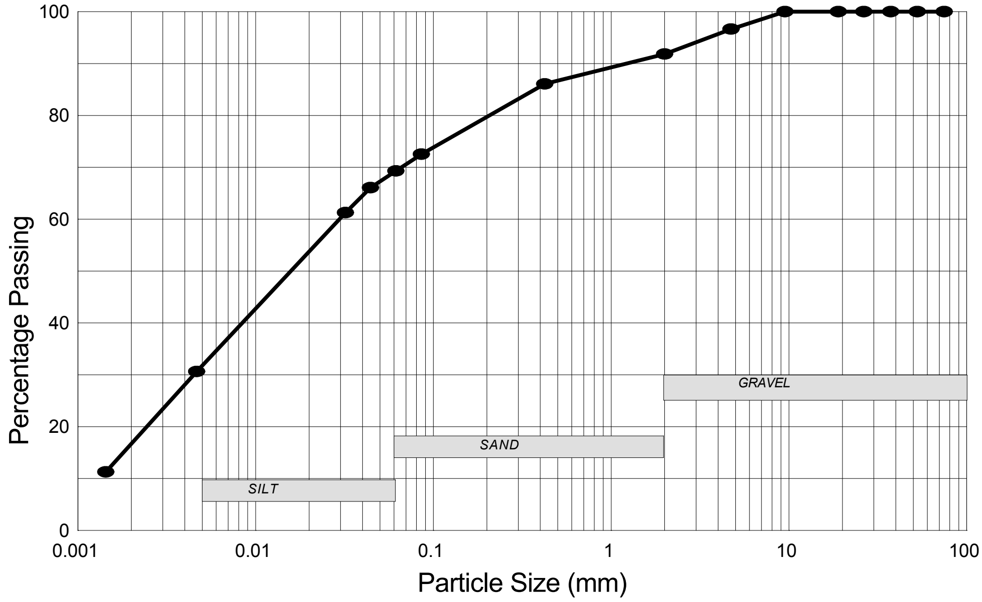
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 11 / 1 @ 2,0 - 2,2m	
Date	20 JANUARY 2020	Test No	203
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	96.68
2.00	91.84
0.425	86.12

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0861	72.58
0.0618	69.35
0.0444	66.13
0.0321	61.29
0.0047	30.64
0.0014	11.29

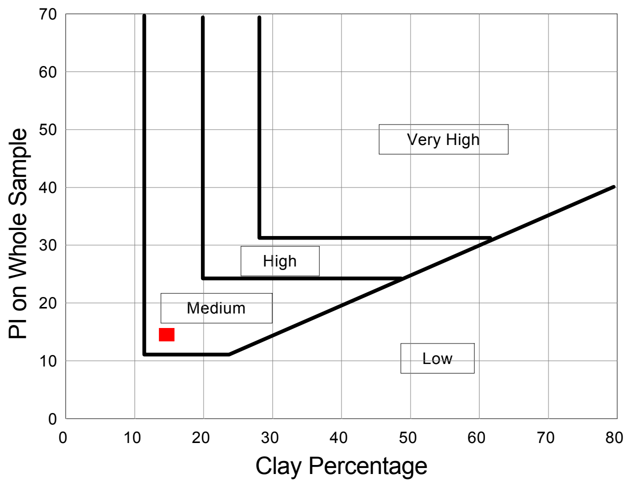
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	42
Plastic Limit	25
Plastic Index	17
Linear Shrinkage	9
Grading Modulus	0.49
Moisture Content	12.26
PI on Whole Sample	15
PRA Classification	A.7.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

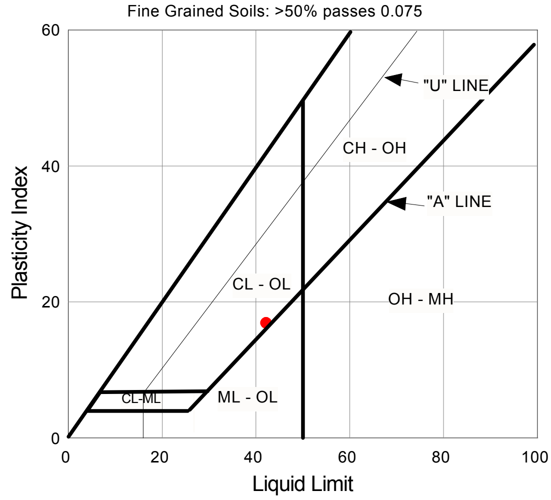
Clay (<0.002)	14.64
0.002 < Silt < 0.06	54.38
0.06 < Sand < 2.0	22.82
Gravel > 2.0	8.16
% less than 0.075	71.11

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

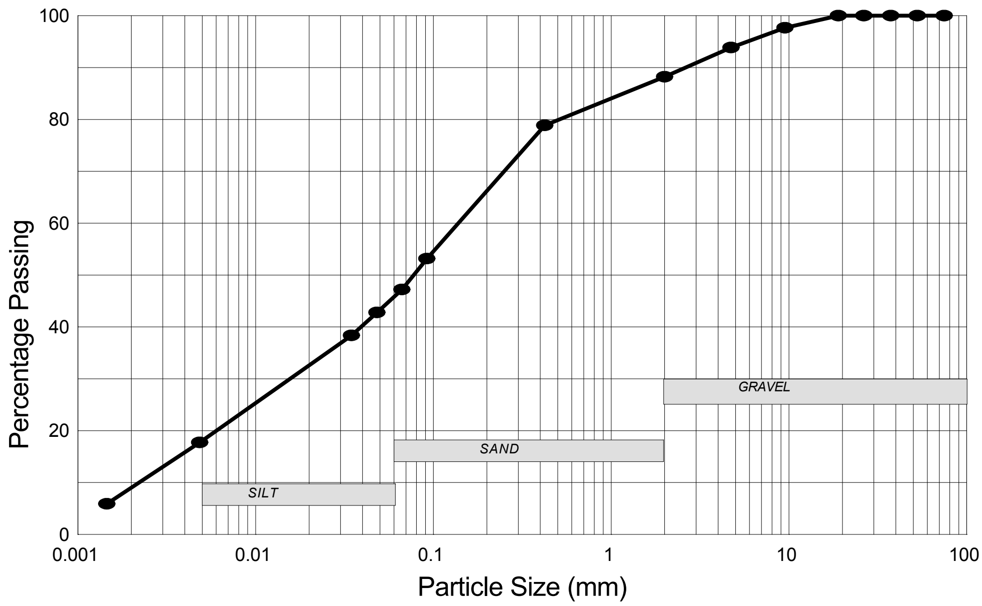
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 15 / 1 @ 1,6 - 2,0m	
Date	20 JANUARY 2020	Test No	219
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	97.68
4.75	93.89
2.00	88.29
0.425	78.86

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	53.17
0.0669	47.26
0.0482	42.83
0.0348	38.40
0.0049	17.72
0.0015	5.91

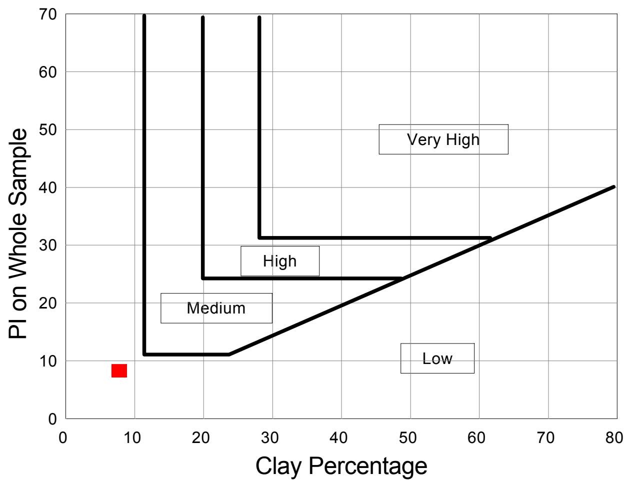
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	21
Plastic Limit	10
Plastic Index	11
Linear Shrinkage	5
Grading Modulus	0.80
Moisture Content	12.51
PI on Whole Sample	8
PRA Classification	A.6
Unified Classification	SC

ESTIMATED COMPOSITION (As BS 1377)

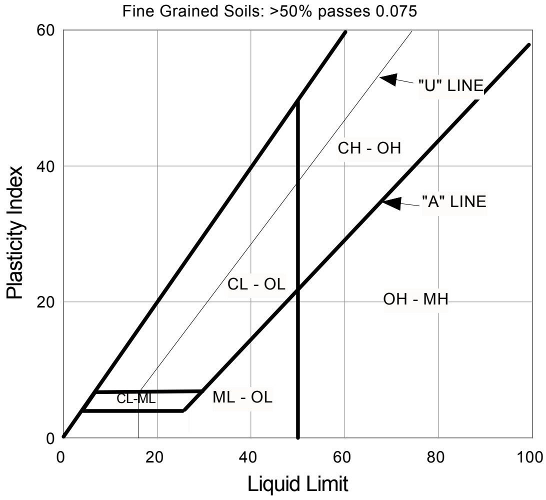
Clay (<0.002)	7.78
0.002 < Silt < 0.06	37.84
0.06 < Sand < 2.0	42.67
Gravel > 2.0	11.71
% less than 0.075	49.16

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

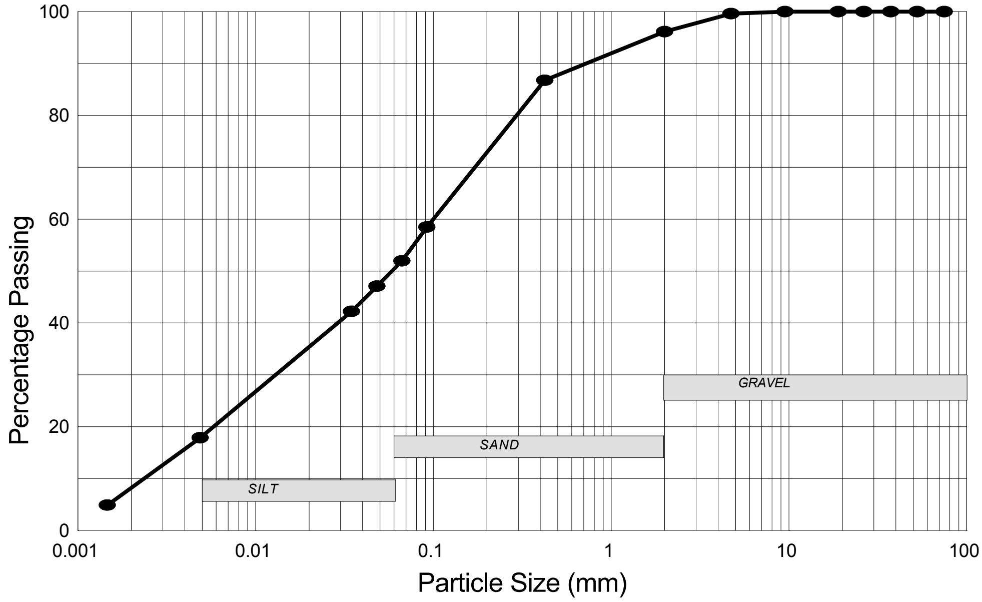
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 15 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2020	Test No	205
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.66
2.00	96.16
0.425	86.81

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	58.52
0.0669	52.02
0.0482	47.14
0.0348	42.27
0.0049	17.88
0.0015	4.88

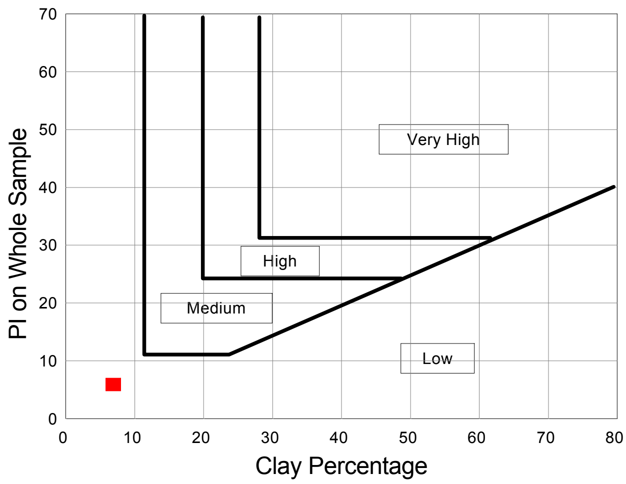
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	22
Plastic Limit	15
Plastic Index	7
Linear Shrinkage	3
Grading Modulus	0.59
Moisture Content	11.12
PI on Whole Sample	6
PRA Classification	A.4
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

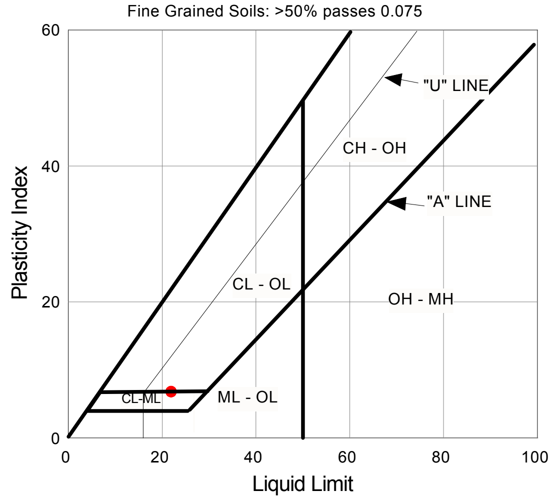
Clay (<0.002)	6.89
0.002 < Silt < 0.06	43.32
0.06 < Sand < 2.0	45.94
Gravel > 2.0	3.84
% less than 0.075	54.11

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

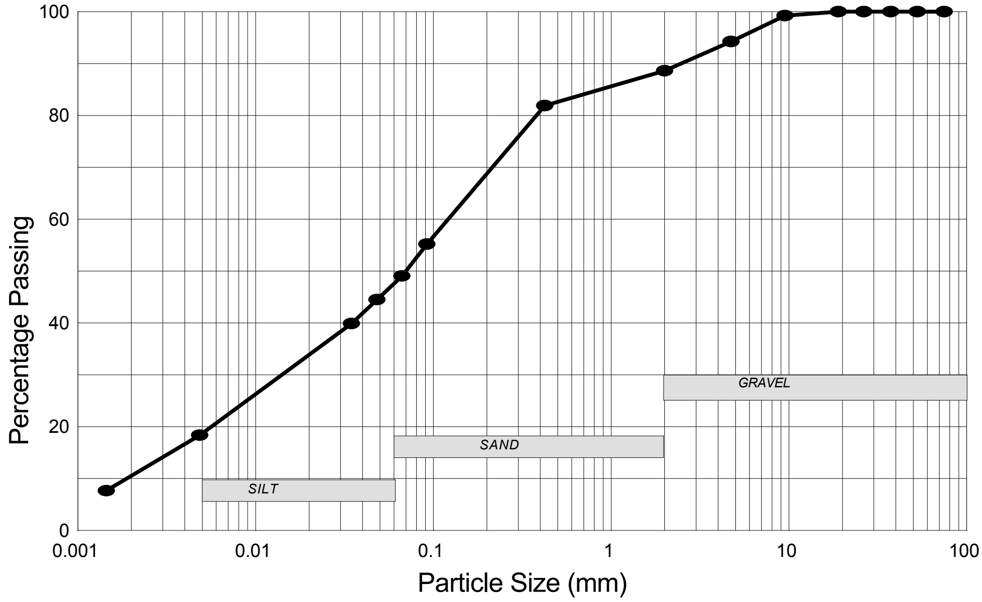
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 15 / 2 @ 2,0 - 2,5m	
Date	20 JANUARY 2020	Test No	220
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	99.26
4.75	94.28
2.00	88.61
0.425	81.94

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	55.25
0.0669	49.11
0.0482	44.50
0.0348	39.90
0.0049	18.42
0.0015	7.67

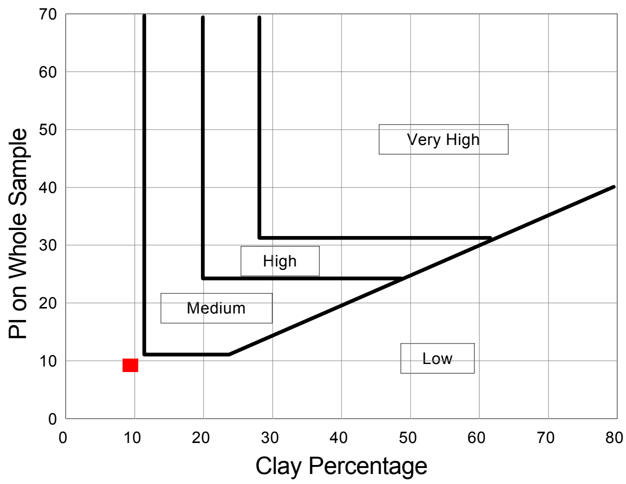
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	24
Plastic Limit	12
Plastic Index	11
Linear Shrinkage	6
Grading Modulus	0.74
Moisture Content	14.74
PI on Whole Sample	9
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

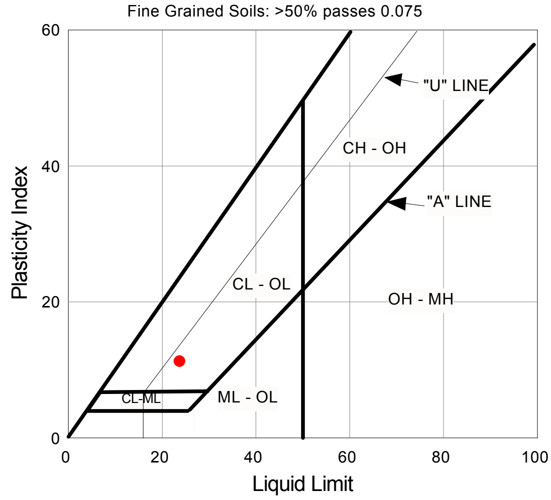
Clay (<0.002)	9.41
0.002 < Silt < 0.06	38.00
0.06 < Sand < 2.0	41.21
Gravel > 2.0	11.39
% less than 0.075	51.08

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075

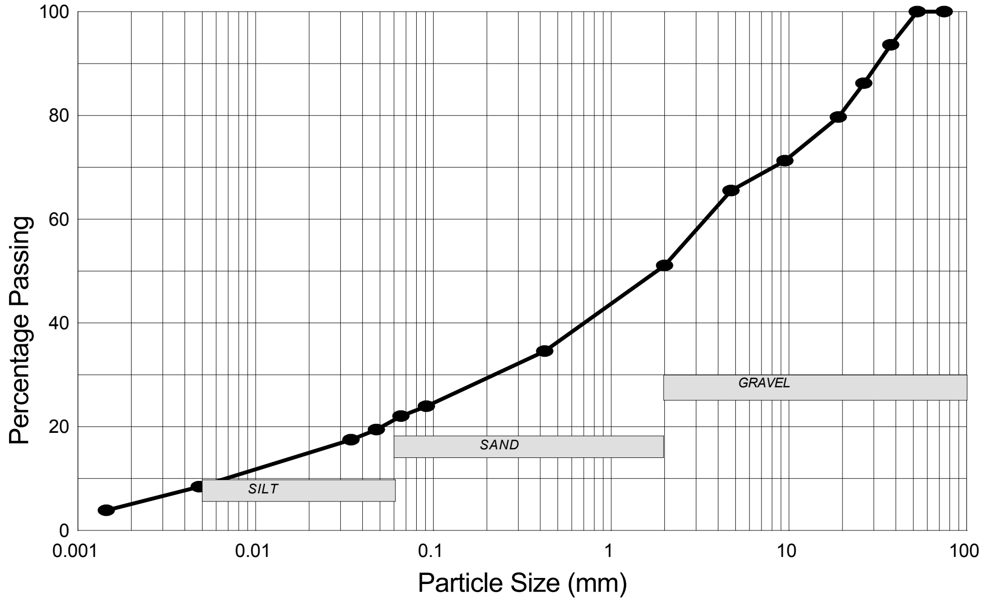


Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	DB 16 / 1 @ 1,0 - 1,8m	
Date	20 JANUARY 2020	Test No	230
Job No	20021	Checked By	EB

GRADING ANALYSIS



SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	93.63
26.50	86.23
19.00	79.74
9.50	71.31
4.75	65.51
2.00	51.09
0.425	34.61

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0914	23.98
0.0660	22.04
0.0479	19.44
0.0346	17.50
0.0048	8.43
0.0014	3.89

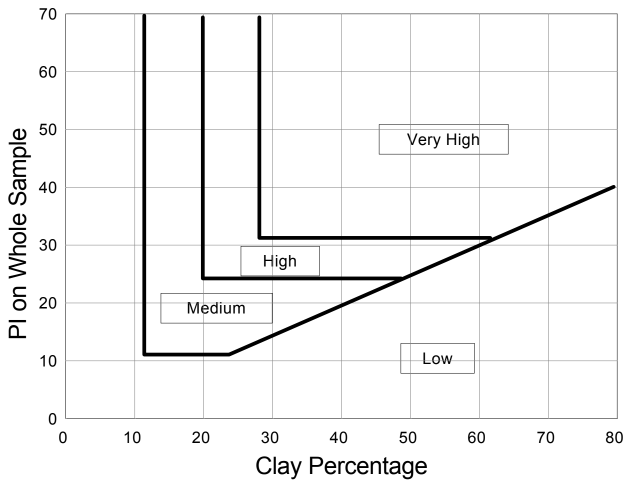
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	Non Plastic
Plastic Limit	Non Plastic
Plastic Index	Non Plastic
Linear Shrinkage	0
Grading Modulus	1.90
Moisture Content	7.78
PI on Whole Sample	Non Plastic
PRA Classification	A.1.b
Unified Classification	SM

ESTIMATED COMPOSITION (As BS 1377)

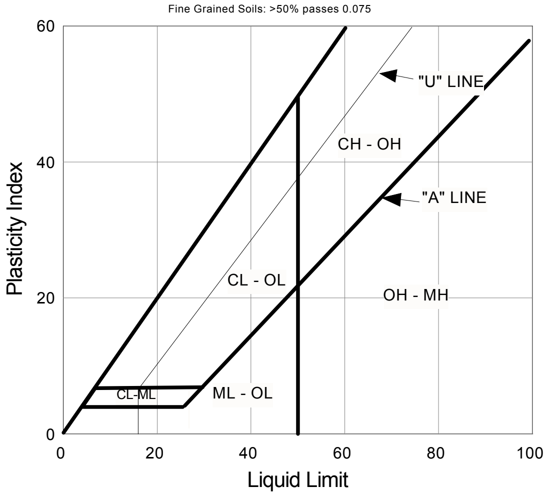
Clay (<0.002)	4.63
0.002 < Silt < 0.06	16.55
0.06 < Sand < 2.0	29.92
Gravel > 2.0	48.91
% less than 0.075	22.72

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

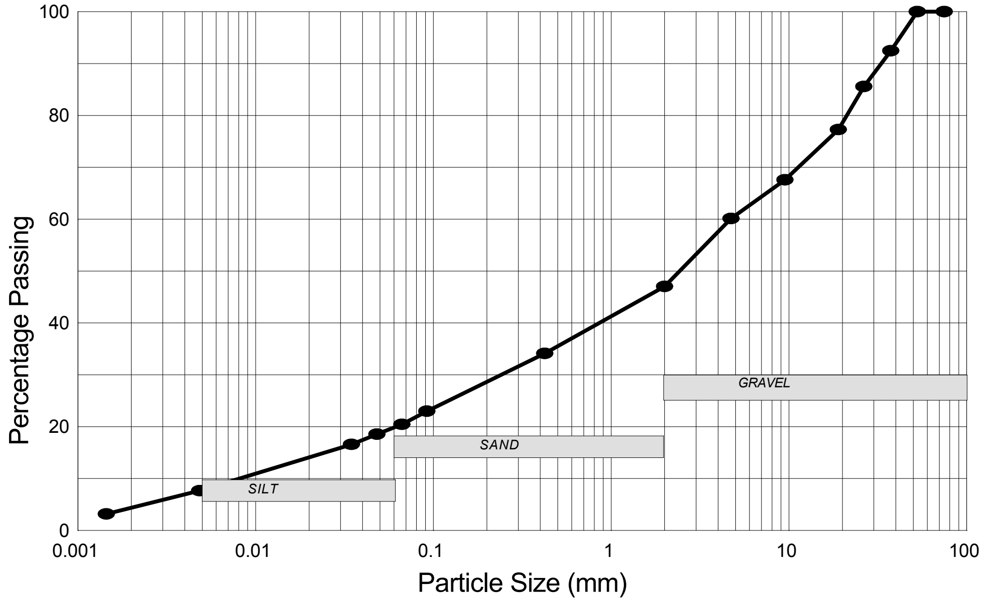
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16 DB 16 / 1 @ 1,0 - 1,8m		
Date	20 JANUARY 2020	Test No	221
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	92.51
26.50	85.60
19.00	77.29
9.50	67.60
4.75	60.18
2.00	47.05
0.425	34.15

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	23.02
0.0669	20.47
0.0482	18.55
0.0348	16.63
0.0049	7.67
0.0015	3.20

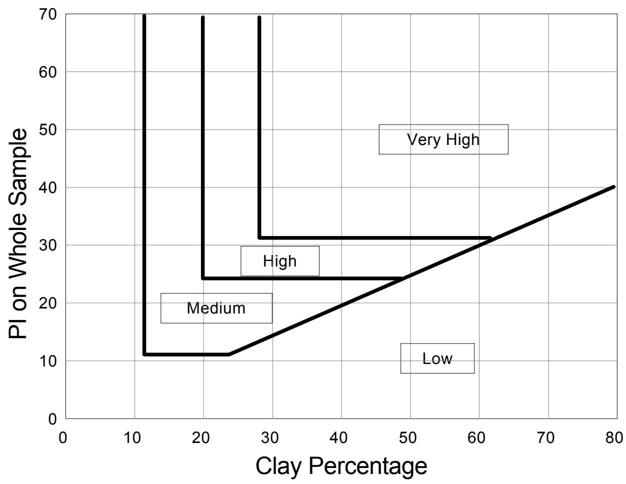
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	Non Plastic
Plastic Limit	Non Plastic
Plastic Index	Non Plastic
Linear Shrinkage	0
Grading Modulus	1.96
Moisture Content	7.84
PI on Whole Sample	Non Plastic
PRA Classification	A.1.b
Unified Classification	SM

ESTIMATED COMPOSITION (As BS 1377)

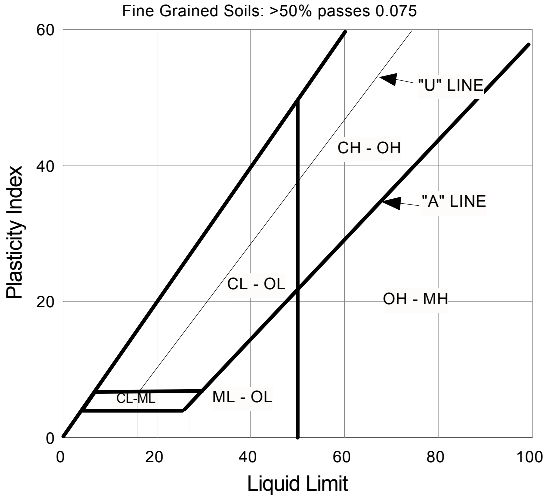
Clay (<0.002)	3.92
0.002 < Silt < 0.06	15.84
0.06 < Sand < 2.0	27.29
Gravel > 2.0	52.95
% less than 0.075	21.29

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

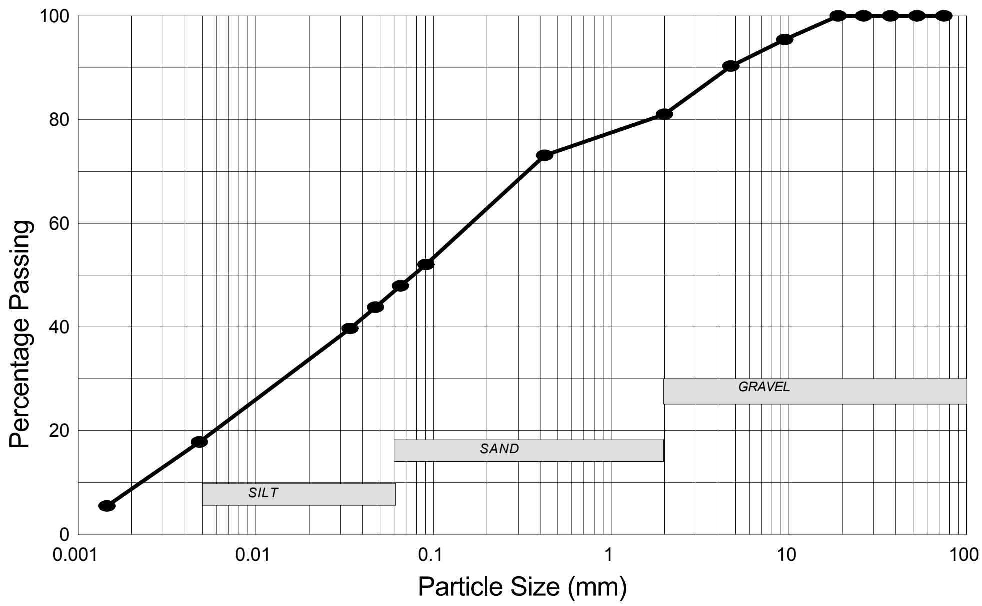
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 16 / 2 @ 1,8 - 2,4m	
Date	20 JANUARY 2020	Test No	222
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	95.49
4.75	90.37
2.00	81.07
0.425	73.13

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0908	52.04
0.0656	47.93
0.0473	43.82
0.0341	39.72
0.0048	17.80
0.0015	5.48

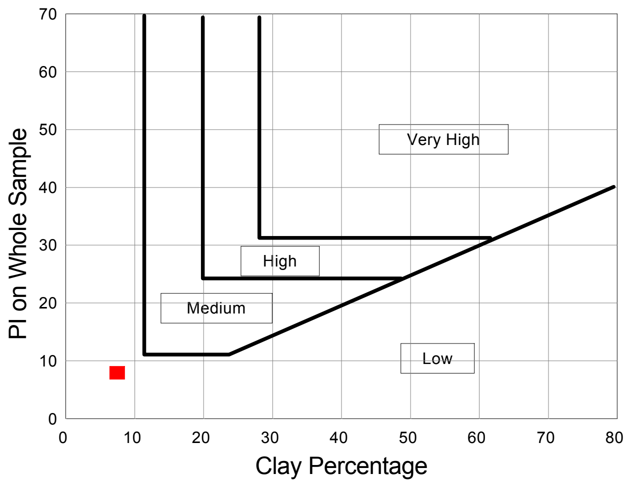
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	33
Plastic Limit	22
Plastic Index	11
Linear Shrinkage	6
Grading Modulus	0.94
Moisture Content	11.20
PI on Whole Sample	8
PRA Classification	A.6
Unified Classification	SC

ESTIMATED COMPOSITION (As BS 1377)

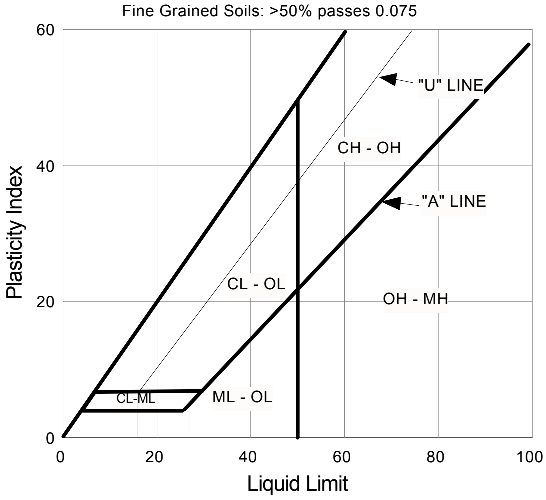
Clay (<0.002)	7.45
0.002 < Silt < 0.06	39.23
0.06 < Sand < 2.0	34.39
Gravel > 2.0	18.93
% less than 0.075	49.47

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Revision No 5 (06/07/2016)

Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

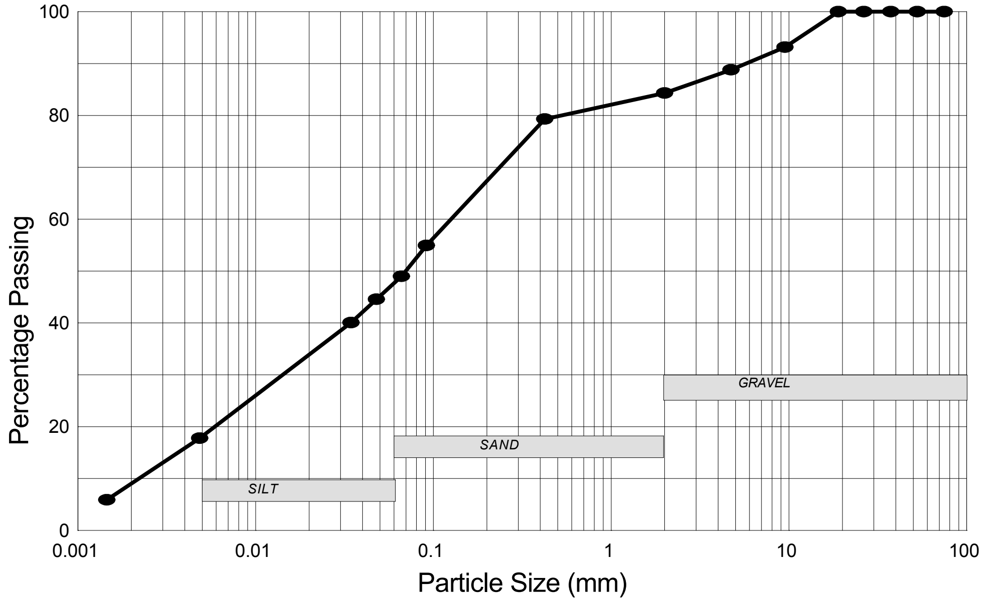
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 17 / 1 @ 1,3 - 2,0m	
Date	20 JANUARY 2020	Test No	223
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	93.22
4.75	88.80
2.00	84.32
0.425	79.35

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0914	54.98
0.0665	49.04
0.0479	44.58
0.0346	40.12
0.0049	17.83
0.0015	5.94

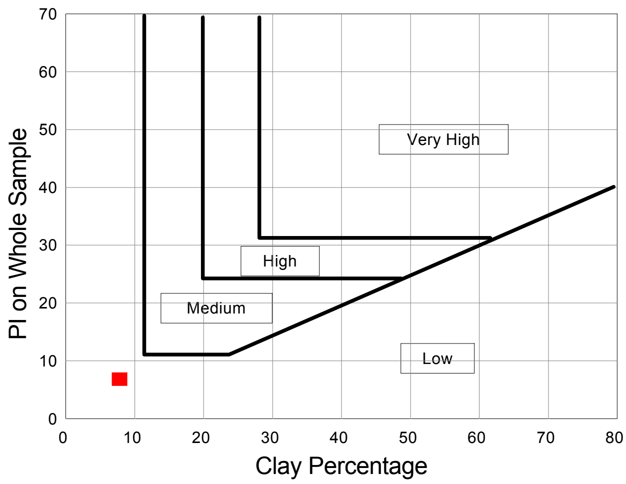
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	28
Plastic Limit	19
Plastic Index	9
Linear Shrinkage	5
Grading Modulus	0.81
Moisture Content	12.36
PI on Whole Sample	7
PRA Classification	A.4
Unified Classification	SC

ESTIMATED COMPOSITION (As BS 1377)

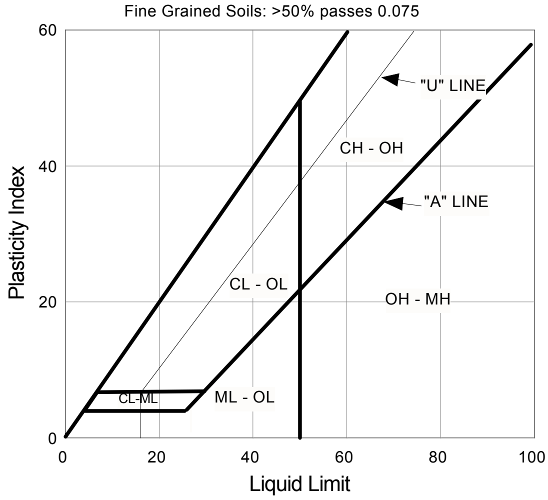
Clay (<0.002)	7.83
0.002 < Silt < 0.06	39.65
0.06 < Sand < 2.0	36.84
Gravel > 2.0	15.68
% less than 0.075	51.07

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

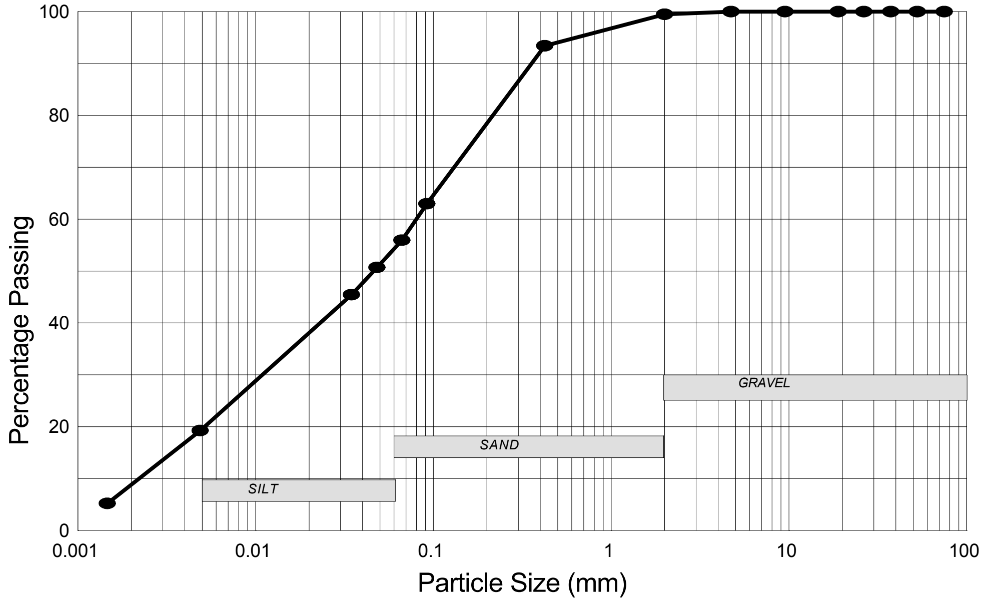
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16 UB 23 / 1 @ 0,6 - 0,8m		
Date	20 JANUARY 2020	Test No	207
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	100.00
2.00	99.53
0.425	93.45

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	63.00
0.0669	56.00
0.0482	50.75
0.0348	45.50
0.0049	19.25
0.0015	5.25

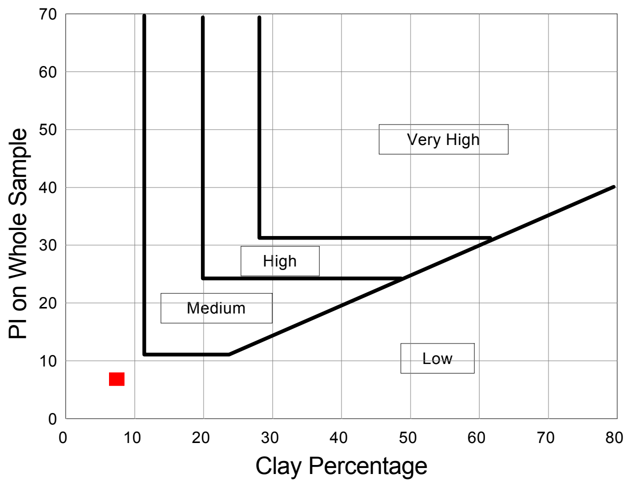
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	24
Plastic Limit	17
Plastic Index	7
Linear Shrinkage	3
Grading Modulus	0.44
Moisture Content	16.95
PI on Whole Sample	7
PRA Classification	A.4
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

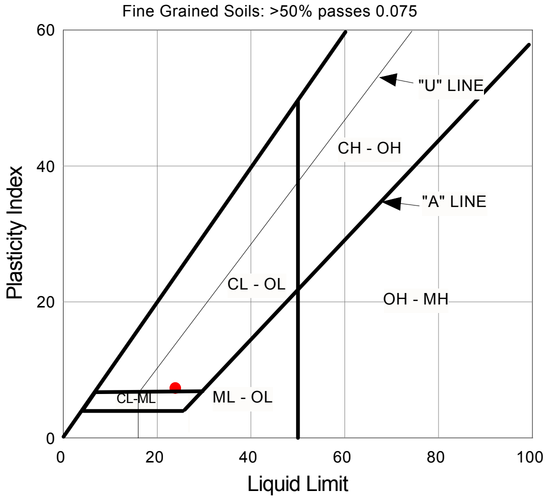
Clay (<0.002)	7.42
0.002 < Silt < 0.06	46.64
0.06 < Sand < 2.0	45.48
Gravel > 2.0	0.47
% less than 0.075	58.25

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075

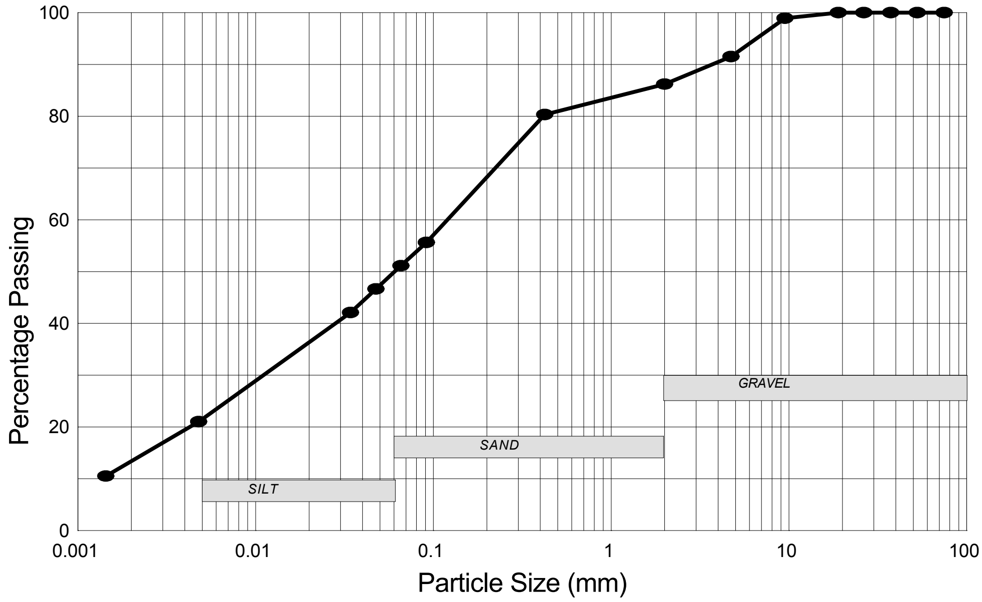


SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 23 / 1 @ 1,5 - 2,0m	
Date	20 JANUARY 2020	Test No	224
Job No	20021	Checked By	EB

GRADING ANALYSIS



SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	98.94
4.75	91.52
2.00	86.25
0.425	80.38

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0914	55.69
0.0660	51.18
0.0476	46.66
0.0343	42.15
0.0048	21.07
0.0014	10.54

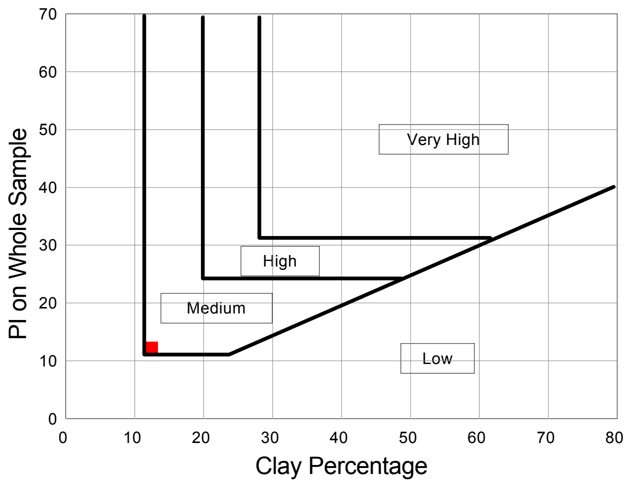
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	27
Plastic Limit	11
Plastic Index	15
Linear Shrinkage	7
Grading Modulus	0.78
Moisture Content	21.50
PI on Whole Sample	12
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

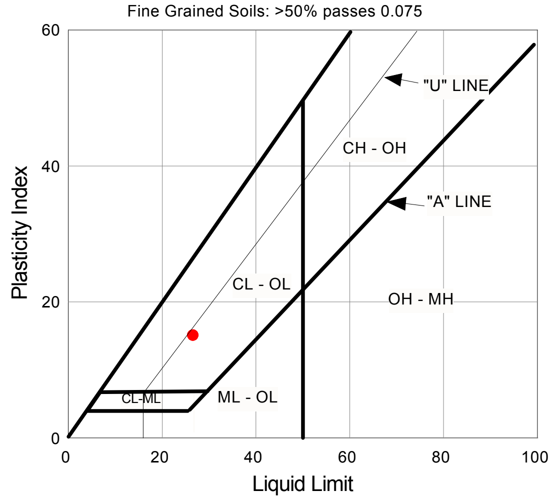
Clay (<0.002)	12.29
0.002 < Silt < 0.06	37.41
0.06 < Sand < 2.0	36.55
Gravel > 2.0	13.75
% less than 0.075	52.77

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica

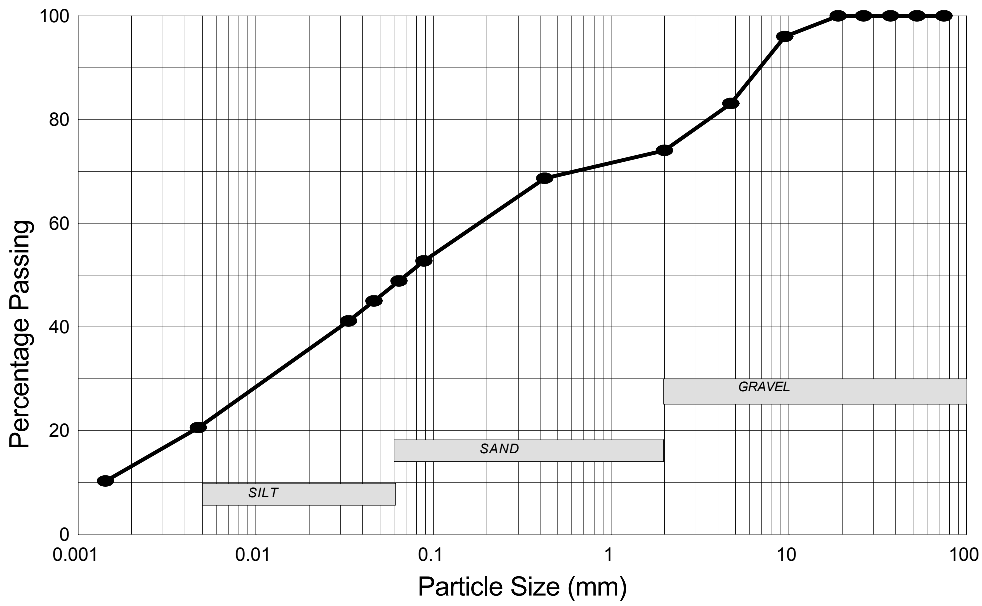
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700

TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 23 / 2 @ 2,1 - 2,4m	
Date	20 JANUARY 2020	Test No	225
Job No	20021	Checked By	EB

GRADING ANALYSIS



SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	96.06
4.75	83.16
2.00	74.07
0.425	68.68

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0888	52.74
0.0642	48.88
0.0464	45.02
0.0335	41.16
0.0048	20.58
0.0014	10.29

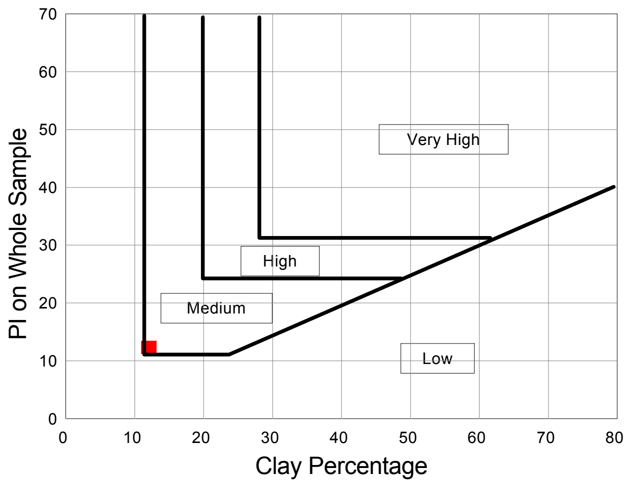
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	33
Plastic Limit	15
Plastic Index	18
Linear Shrinkage	9
Grading Modulus	1.05
Moisture Content	13.10
PI on Whole Sample	12
PRA Classification	A.6
Unified Classification	SC

ESTIMATED COMPOSITION (As BS 1377)

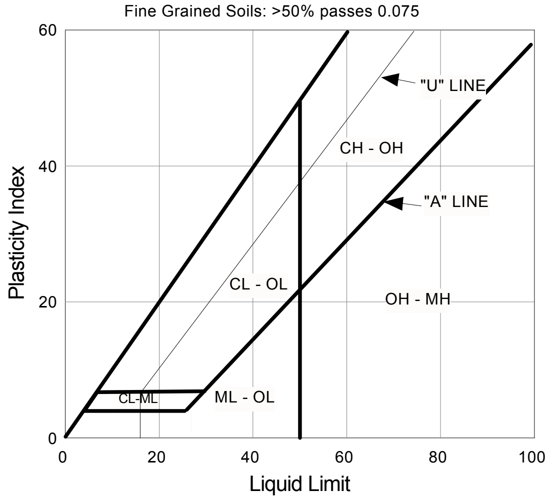
Clay (<0.002)	12.05
0.002 < Silt < 0.06	35.92
0.06 < Sand < 2.0	26.10
Gravel > 2.0	25.93
% less than 0.075	50.57

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

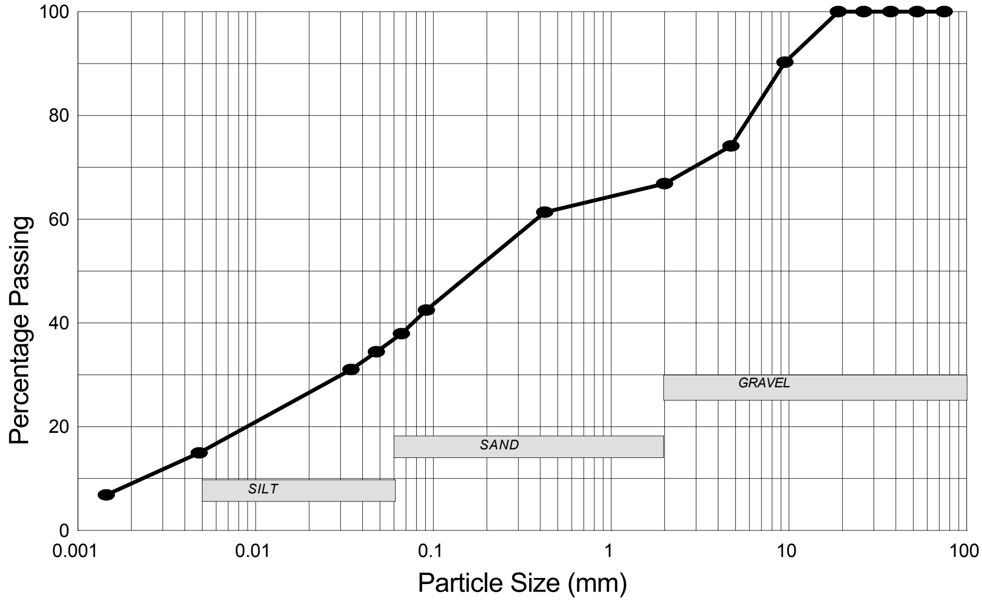
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 26 / 1 @ 2,4 - 2,8m	
Date	20 JANUARY 2020	Test No	226
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	90.28
4.75	74.14
2.00	66.86
0.425	61.36

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0914	42.51
0.0665	37.92
0.0479	34.47
0.0346	31.02
0.0048	14.94
0.0014	6.89

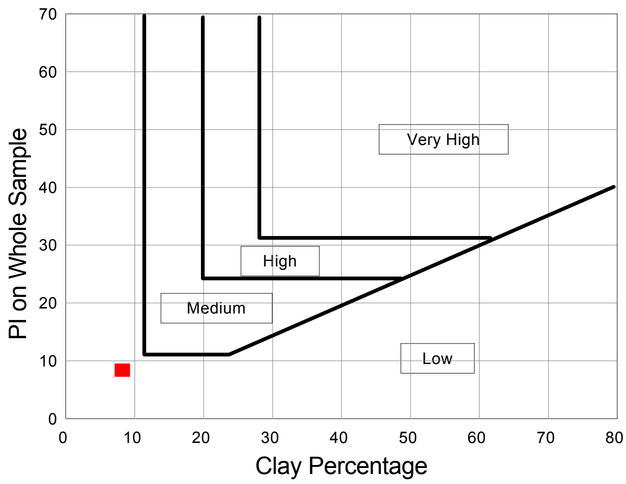
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	28
Plastic Limit	14
Plastic Index	14
Linear Shrinkage	7
Grading Modulus	1.29
Moisture Content	14.57
PI on Whole Sample	8
PRA Classification	A.6
Unified Classification	SC

ESTIMATED COMPOSITION (As BS 1377)

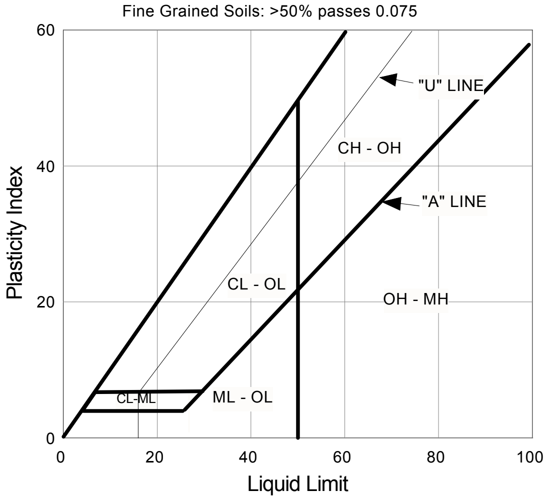
Clay (<0.002)	8.20
0.002 < Silt < 0.06	28.51
0.06 < Sand < 2.0	30.14
Gravel > 2.0	33.14
% less than 0.075	39.49

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075

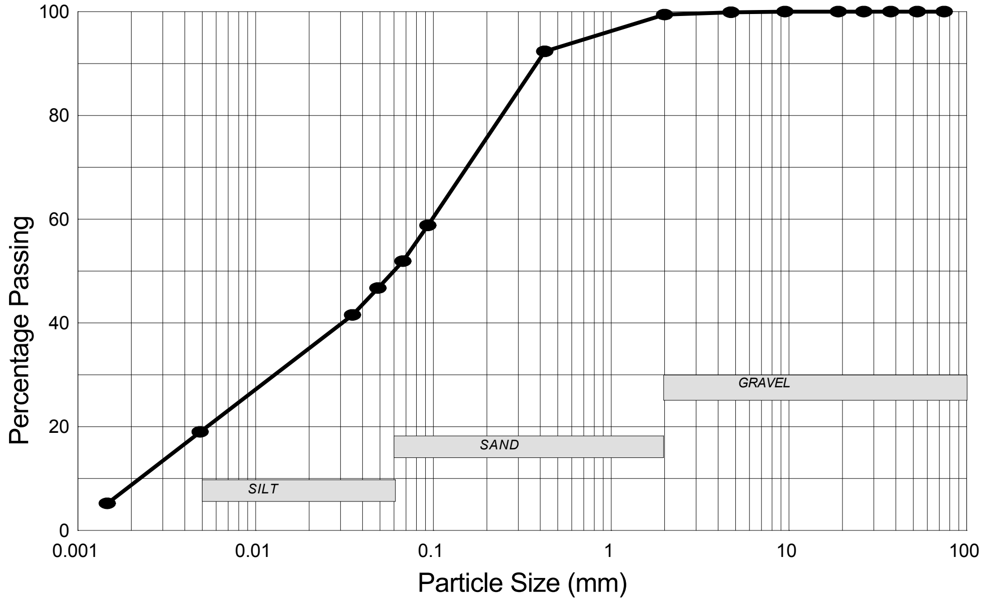


Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB26 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2020	Test No	209
Job No	20021	Checked By	EB

GRADING ANALYSIS



SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.89
2.00	99.48
0.425	92.38

HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0934	58.82
0.0678	51.90
0.0489	46.71
0.0352	41.52
0.0049	19.03
0.0015	5.19

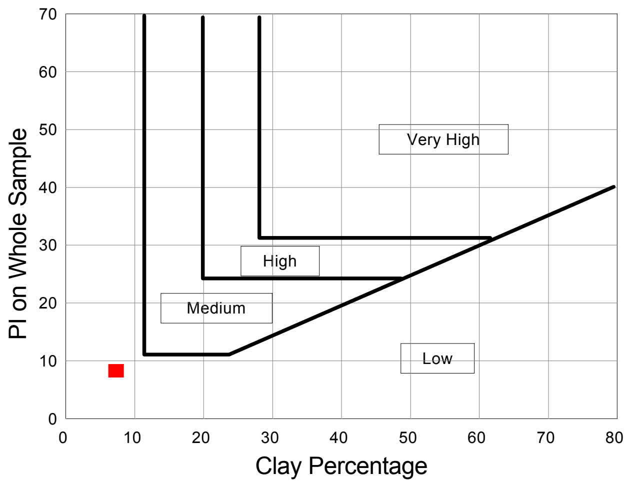
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	23
Plastic Limit	14
Plastic Index	9
Linear Shrinkage	5
Grading Modulus	0.49
Moisture Content	16.47
PI on Whole Sample	8
PRA Classification	A.4
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

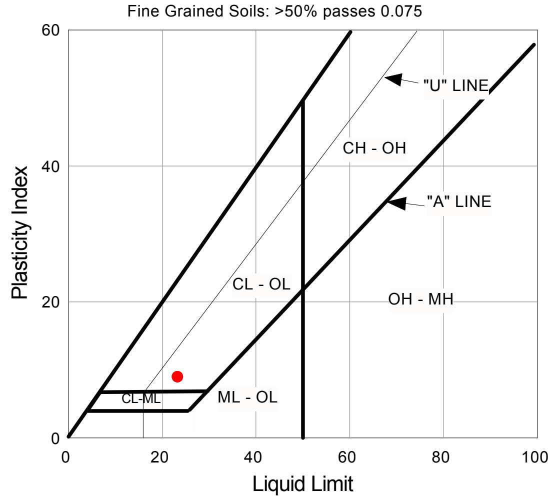
Clay (<0.002)	7.33
0.002 < Silt < 0.06	42.43
0.06 < Sand < 2.0	49.72
Gravel > 2.0	0.52
% less than 0.075	53.85

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

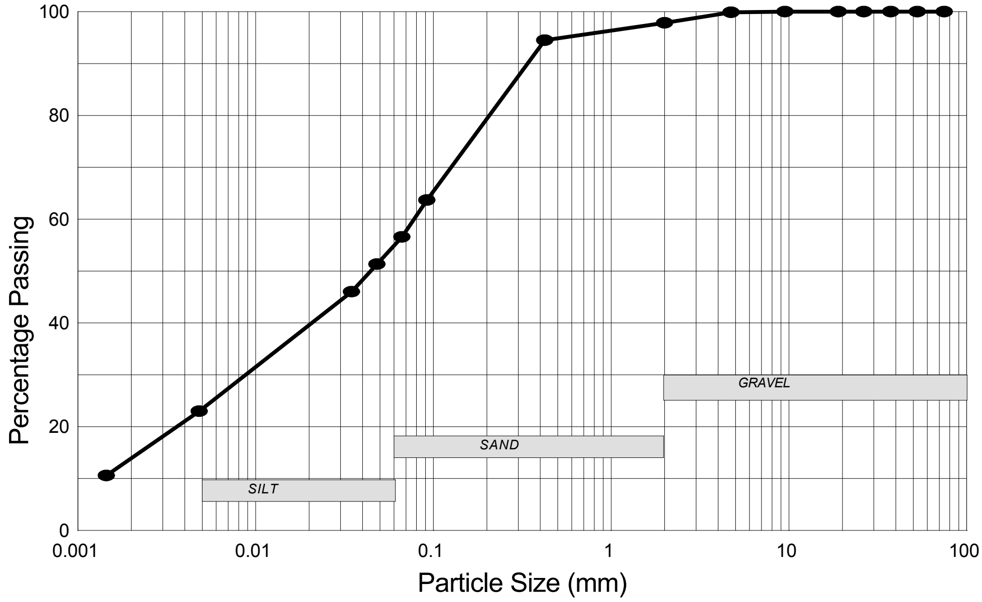
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 44 / 1 @ 1,8 - 2,0m	
Date	20 JANUARY 2020	Test No	211
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.88
2.00	97.87
0.425	94.52

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	63.72
0.0669	56.64
0.0482	51.33
0.0348	46.02
0.0048	23.01
0.0014	10.62

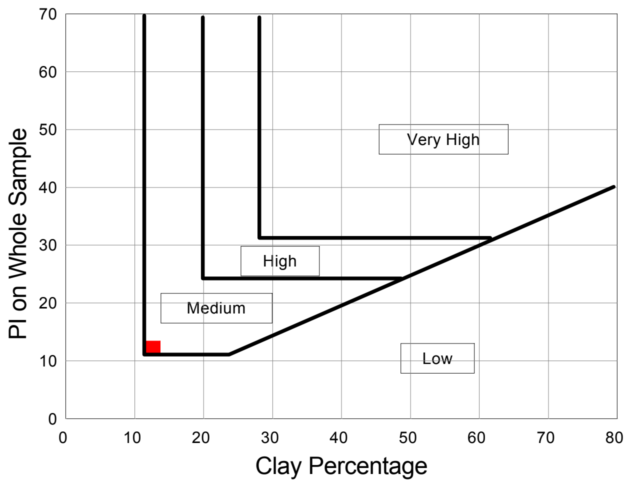
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	38
Plastic Limit	25
Plastic Index	13
Linear Shrinkage	7
Grading Modulus	0.44
Moisture Content	15.07
PI on Whole Sample	12
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

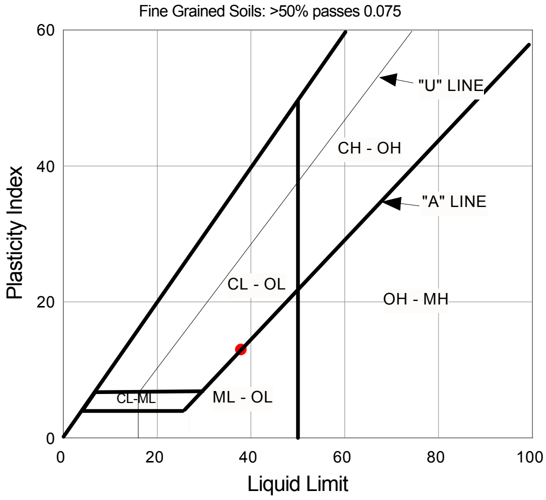
Clay (<0.002)	12.64
0.002 < Silt < 0.06	42.04
0.06 < Sand < 2.0	43.20
Gravel > 2.0	2.13
% less than 0.075	58.92

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

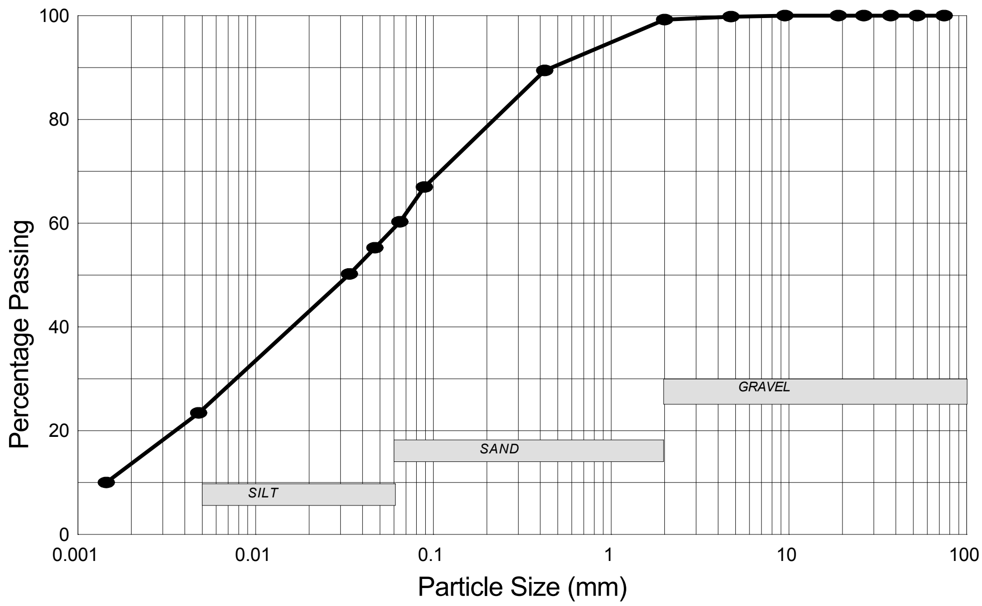
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 47 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2020	Test No	213
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.85
2.00	99.28
0.425	89.43

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0895	66.99
0.0651	60.29
0.0470	55.27
0.0339	50.24
0.0048	23.45
0.0014	10.05

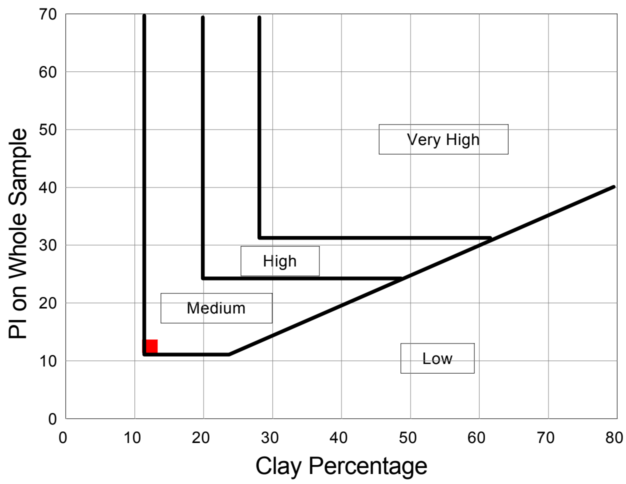
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	28
Plastic Limit	14
Plastic Index	14
Linear Shrinkage	7
Grading Modulus	0.44
Moisture Content	21.65
PI on Whole Sample	13
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

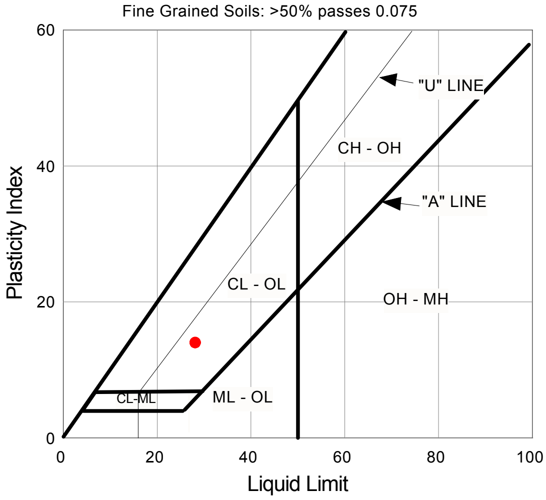
Clay (<0.002)	12.24
0.002 < Silt < 0.06	46.63
0.06 < Sand < 2.0	40.41
Gravel > 2.0	0.72
% less than 0.075	63.02

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

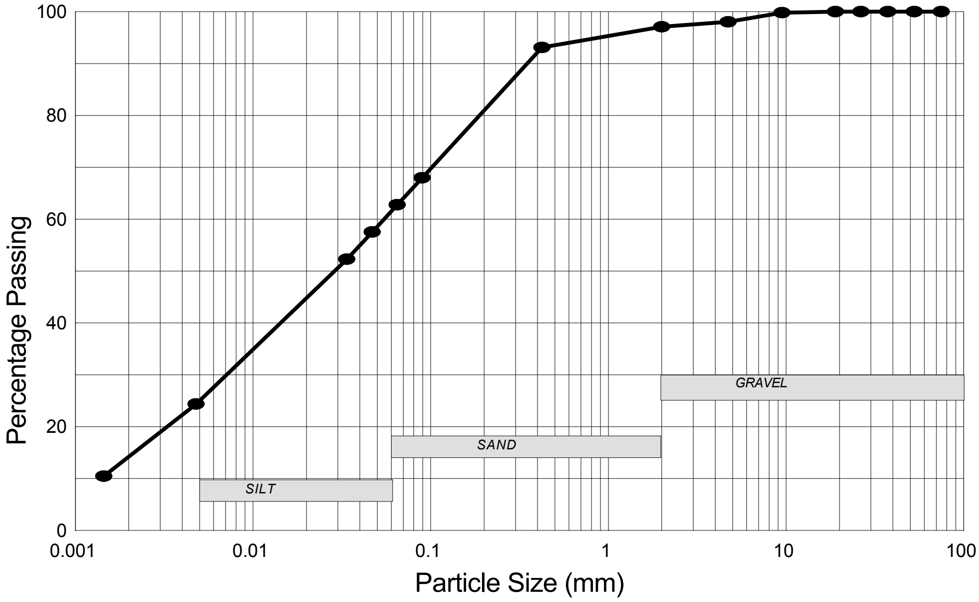
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 52 / 1 @ 1,0 - 1,2m	
Date	20 JANUARY 2020	Test No	215
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	99.85
4.75	98.04
2.00	97.11
0.425	93.13

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0901	68.02
0.0651	62.79
0.0470	57.55
0.0339	52.32
0.0048	24.42
0.0014	10.46

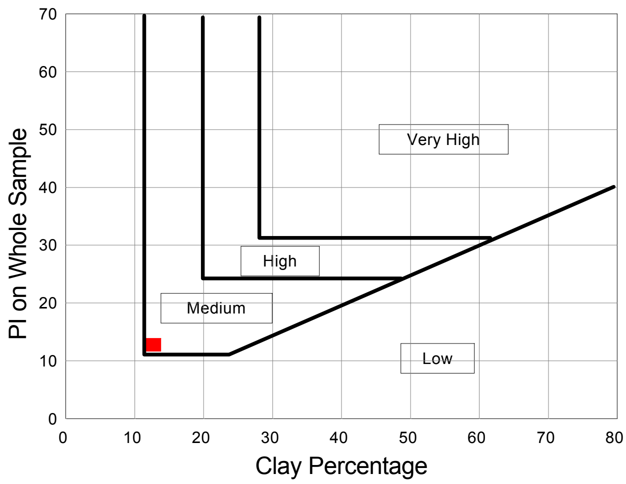
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	32
Plastic Limit	18
Plastic Index	14
Linear Shrinkage	6
Grading Modulus	0.42
Moisture Content	11.56
PI on Whole Sample	13
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

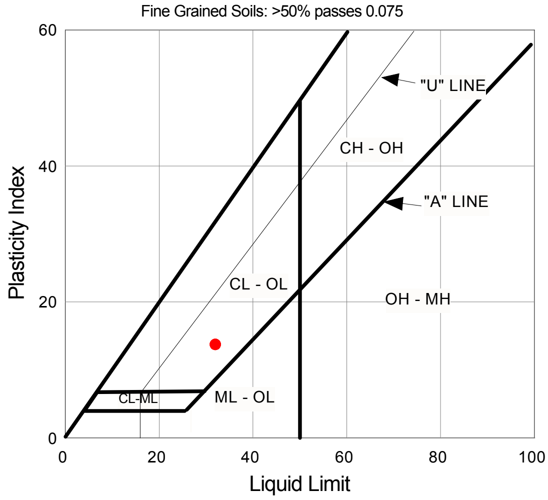
Clay (<0.002)	12.75
0.002 < Silt < 0.06	48.56
0.06 < Sand < 2.0	35.80
Gravel > 2.0	2.89
% less than 0.075	64.86

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

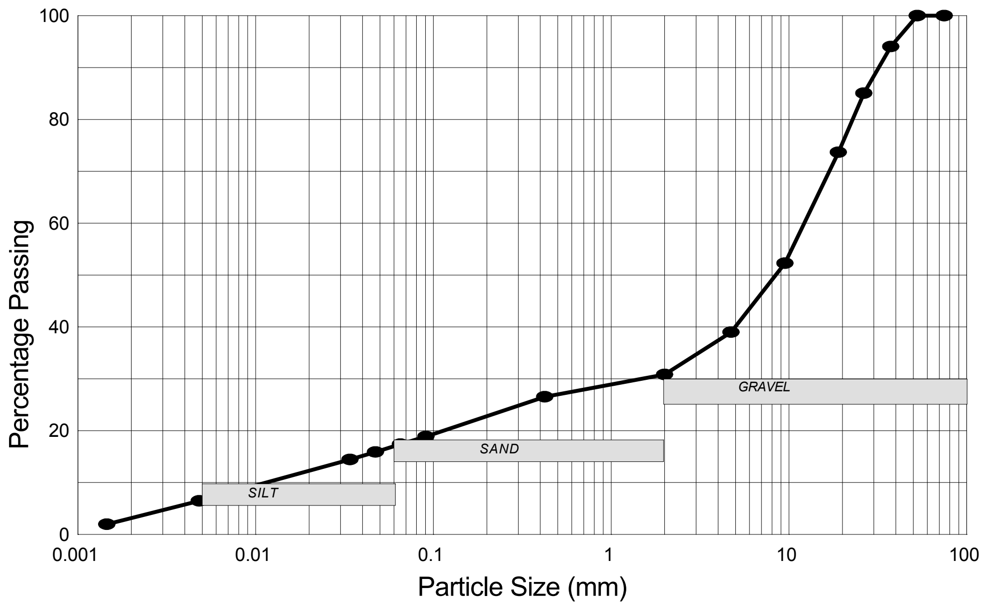
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16 UB 56 / 1 @ 1,0 - 2,0m		
Date	20 JANUARY 2020	Test No	227
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	94.11
26.50	85.11
19.00	73.70
9.50	52.30
4.75	39.04
2.00	30.84
0.425	26.57

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0908	18.91
0.0656	17.42
0.0473	15.92
0.0341	14.43
0.0048	6.47
0.0015	1.99

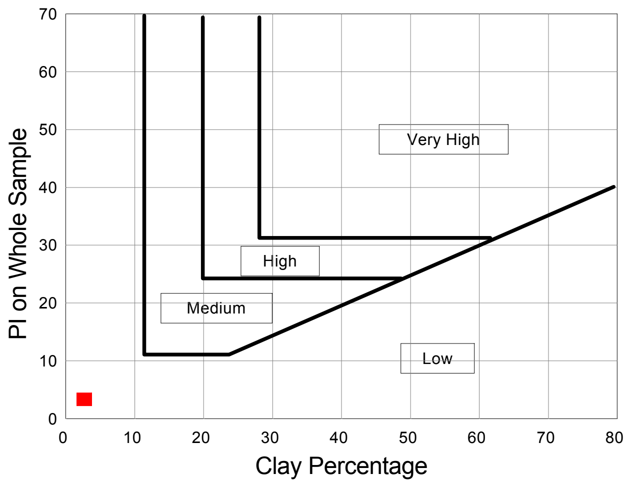
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	29
Plastic Limit	16
Plastic Index	13
Linear Shrinkage	7
Grading Modulus	2.24
Moisture Content	8.08
PI on Whole Sample	3
PRA Classification	A.2.6
Unified Classification	GC

ESTIMATED COMPOSITION (As BS 1377)

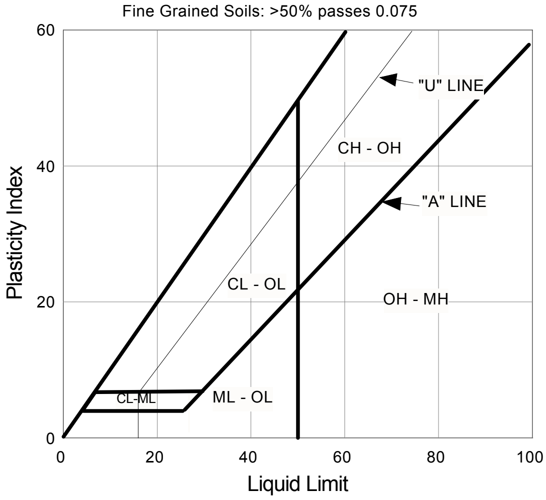
Clay (<0.002)	2.71
0.002 < Silt < 0.06	14.25
0.06 < Sand < 2.0	13.88
Gravel > 2.0	69.16
% less than 0.075	17.98

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

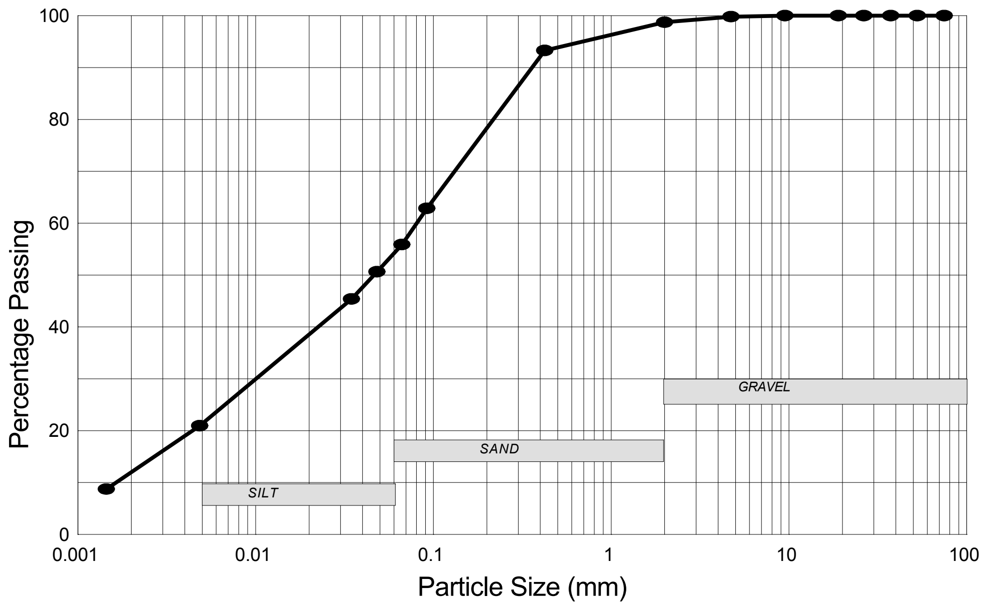
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 57 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2020	Test No	217
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.83
2.00	98.76
0.425	93.30

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0921	62.90
0.0669	55.91
0.0482	50.67
0.0348	45.43
0.0049	20.97
0.0015	8.74

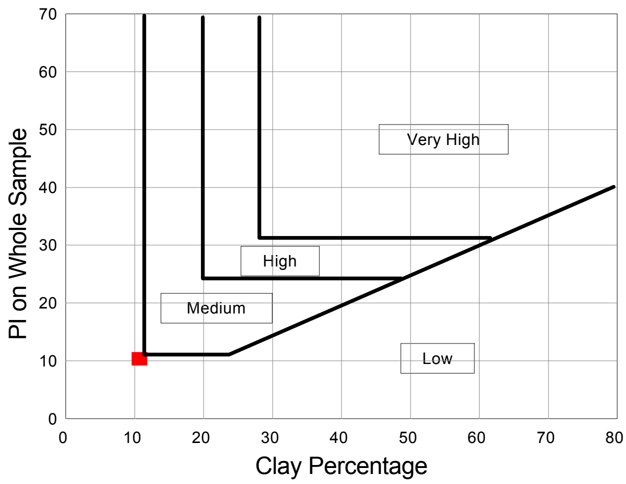
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	29
Plastic Limit	18
Plastic Index	11
Linear Shrinkage	5
Grading Modulus	0.45
Moisture Content	17.01
PI on Whole Sample	10
PRA Classification	A.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

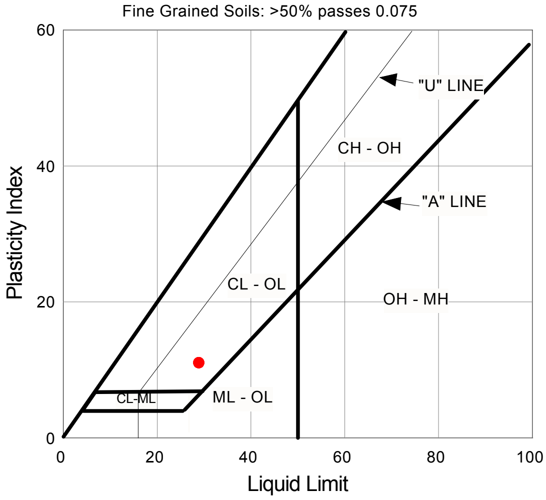
Clay (<0.002)	10.71
0.002 < Silt < 0.06	43.26
0.06 < Sand < 2.0	44.79
Gravel > 2.0	1.24
% less than 0.075	58.16

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Revision No 5 (06/07/2016)

Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

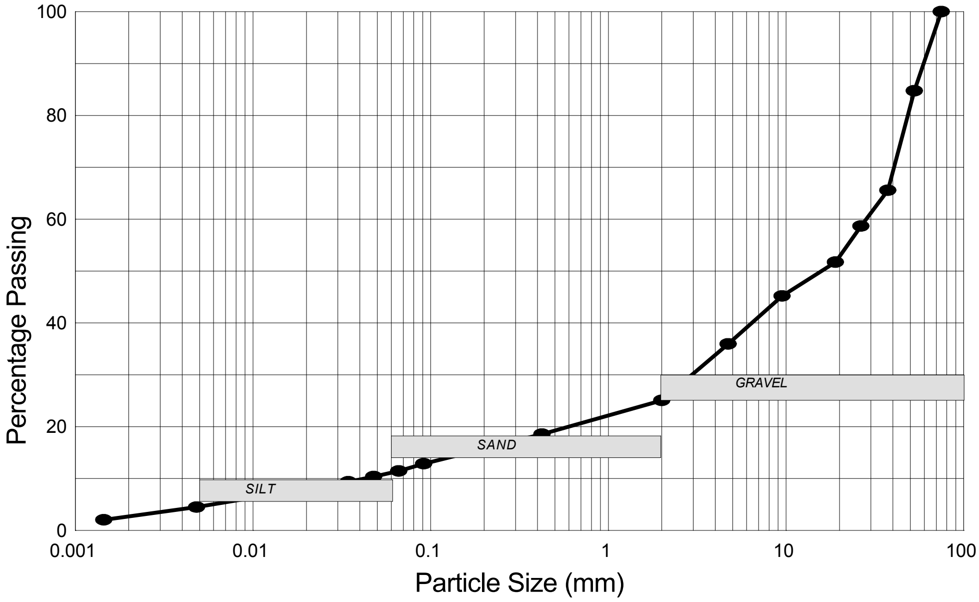
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 58 / 1 @ 1,1 - 1,5m	
Date	20 JANUARY 2020	Test No	228
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	84.78
37.50	65.61
26.50	58.69
19.00	51.75
9.50	45.21
4.75	35.97
2.00	25.12
0.425	18.57

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0914	12.87
0.0665	11.48
0.0479	10.44
0.0346	9.39
0.0048	4.52
0.0014	2.09

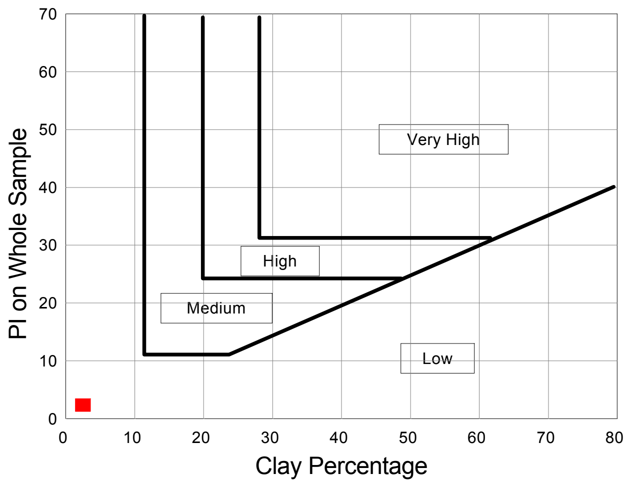
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	31
Plastic Limit	18
Plastic Index	13
Linear Shrinkage	7
Grading Modulus	2.43
Moisture Content	2.77
PI on Whole Sample	2
PRA Classification	A.2.6
Unified Classification	GP - GC

ESTIMATED COMPOSITION (As BS 1377)

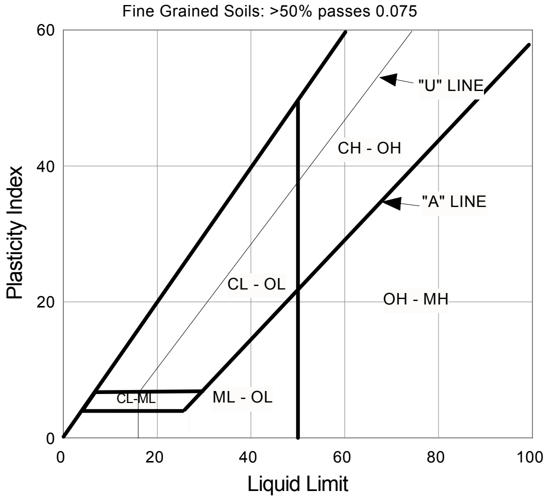
Clay (<0.002)	2.48
0.002 < Silt < 0.06	8.63
0.06 < Sand < 2.0	14.00
Gravel > 2.0	74.88
% less than 0.075	11.95

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

FOUNDATION INDICATOR

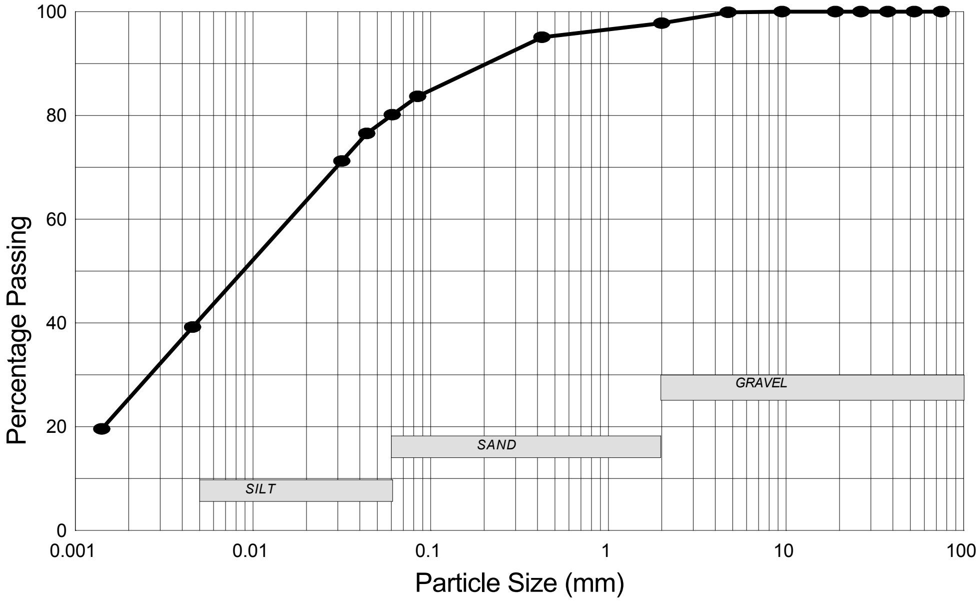
Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 58 / 2 @ 2,0 - 2,5m	
Date	20 JANUARY 2020	Test No	229
Job No	20021	Checked By	EB

SIEVE ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
75.00	100.00
53.00	100.00
37.50	100.00
26.50	100.00
19.00	100.00
9.50	100.00
4.75	99.89
2.00	97.79
0.425	95.10

GRADING ANALYSIS



HYDROMETER ANALYSIS

Values are expressed as a percentage of total sample

Sieve Size (mm)	Total Passing (%)
0.0847	83.71
0.0609	80.14
0.0437	76.58
0.0316	71.24
0.0046	39.18
0.0014	19.59

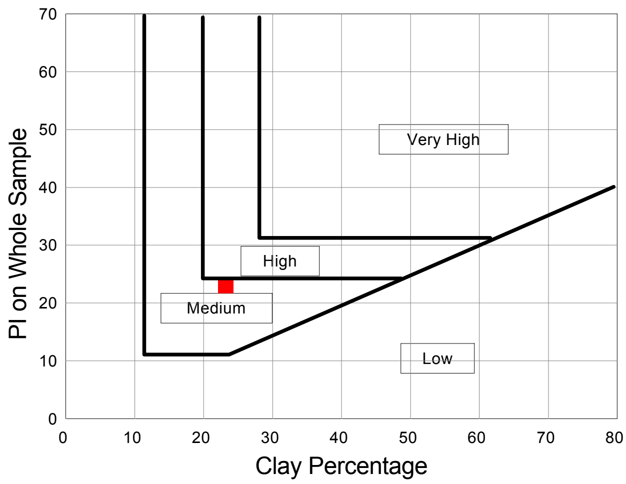
ATTERBERG LIMITS & OTHER VALUES

Liquid Limit	45
Plastic Limit	21
Plastic Index	24
Linear Shrinkage	12
Grading Modulus	0.23
Moisture Content	16.22
PI on Whole Sample	23
PRA Classification	A.7.6
Unified Classification	See Plasticity Chart

ESTIMATED COMPOSITION (As BS 1377)

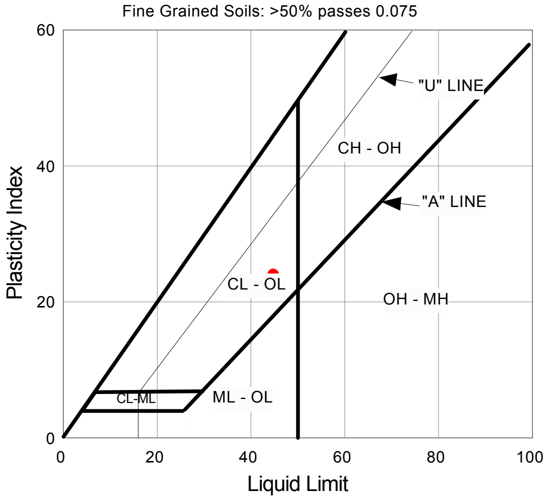
Clay (<0.002)	23.21
0.002 < Silt < 0.06	56.75
0.06 < Sand < 2.0	17.82
Gravel > 2.0	2.21
% less than 0.075	82.26

ACTIVITY CHART



PLASTICITY CHART

Fine Grained Soils: >50% passes 0.075



Revision No 5 (06/07/2016)

Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

COLLAPSE POTENTIAL at 200 kPa

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 11 / 1 @ 2,0 - 2,2m	
Date	20 JANUARY 2019	Test No	204
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.615

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	153	0.884	0.00
10	90	154	0.883	0.05
33	130	156	0.881	0.15
65	190	159	0.878	0.30
127	310	163	0.875	0.50
200	1750	165	0.873	0.60
200	3190	172	0.866	0.95
498	3430	196	0.844	2.15
993	3670	217	0.824	3.20
1868	5110	258	0.785	5.25
743	5230	250	0.793	4.85
118	5350	239	0.803	4.30
10	5470	228	0.813	3.75

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	311.80
Mass wet sample plus ring after test (gms)	312.80
Mass dry sample plus ring (gms)	300.50
Mass ring (gms)	211.20
Moisture content before test (%)	**12.65**
Moisture content after test (%)	**13.77**

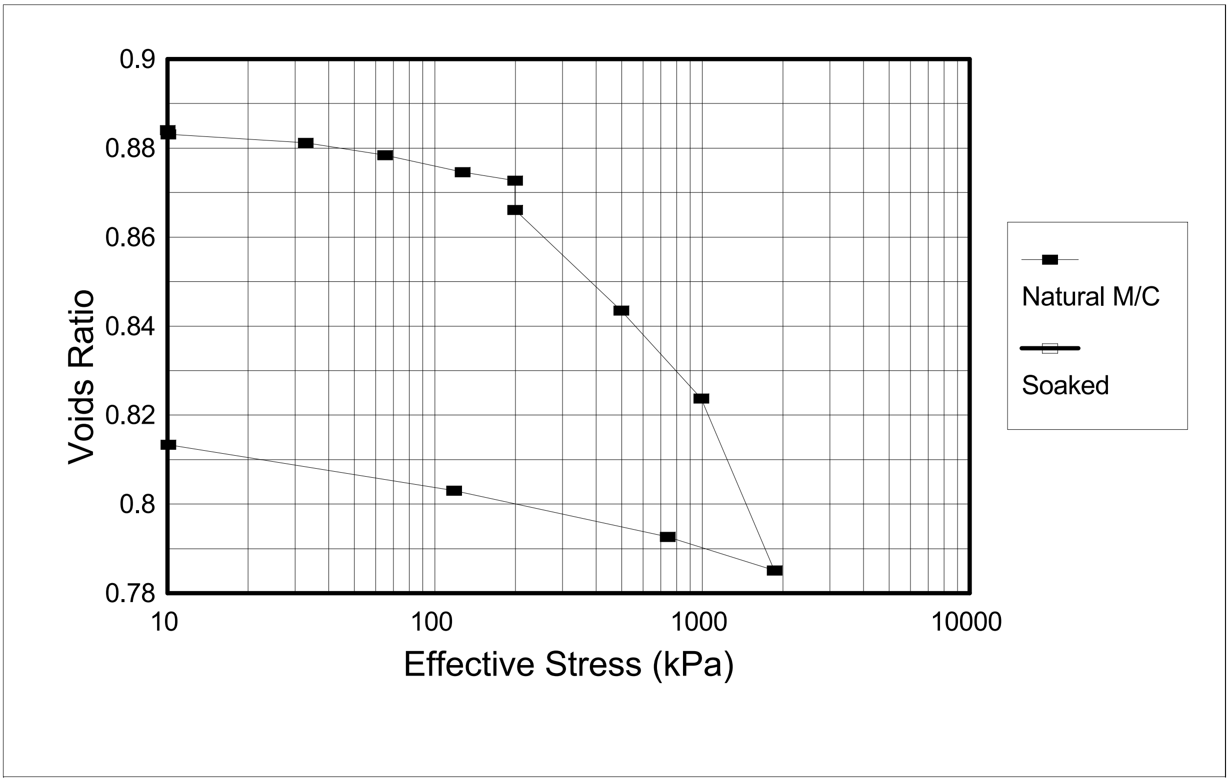
Other Data

Initial Dry Density (kg/m3)	**1388**
Initial Void Ratio	**0.88**

Programe Data
Revision No 2 (19/03/2001)

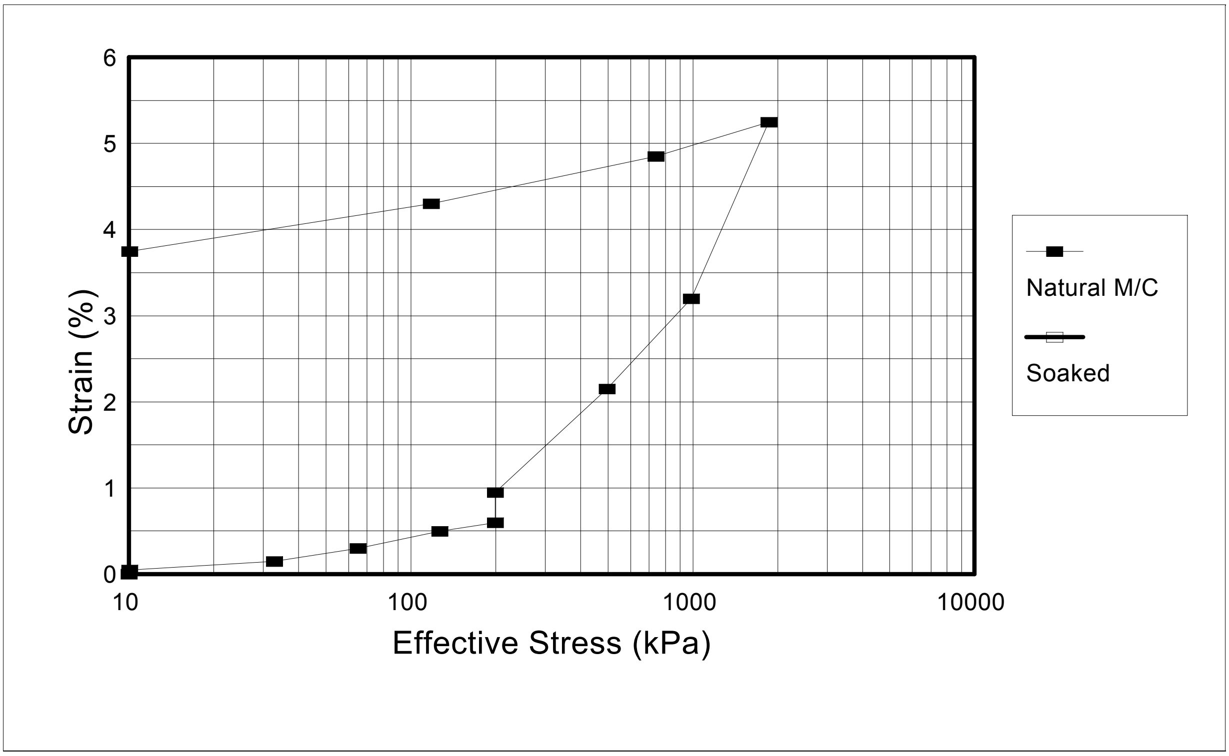
VOIDS RATIO v EFFECTIVE STRESS

Test No: 204



STRAIN v EFFECTIVE STRESS

Test No: 204



Geopractica

SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700

TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

DOUBLE OEDOMETER

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB15 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2020	Test No	206
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.63

Sample at NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	120	1405	1.175	0.00
10	1440	1406	1.174	0.05
33	1500	1412	1.167	0.35
65	1560	1431	1.147	1.30
127	1620	1488	1.085	4.15
251	1680	1570	0.996	8.25
498	1740	1650	0.909	12.25
993	1800	1733	0.818	16.40
1868	3240	1794	0.752	19.45
743	3360	1788	0.758	19.15
118	3480	1780	0.767	18.75
10	3600	1765	0.783	18.00

Sample Soaked

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	120	797	1.178	0.00
10	1440	794	1.181	-0.15
33	1500	805	1.169	0.40
65	1560	831	1.141	1.70
127	1620	866	1.103	3.45
251	1680	915	1.049	5.90
498	1740	974	0.985	8.85
993	1800	1017	0.938	11.00
1868	3240	1059	0.892	13.10
743	3360	1056	0.896	12.95
118	3480	1053	0.899	12.80
10	3600	1048	0.904	12.55

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	299.00
Mass wet sample plus ring after test (gms)	298.20
Mass dry sample plus ring (gms)	289.40
Mass ring (gms)	211.60
Moisture content before test (%)	**12.34**
Moisture content after test (%)	**11.31**

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	302.00
Mass wet sample plus ring after test (gms)	306.80
Mass dry sample plus ring (gms)	292.50
Mass ring (gms)	214.80
Moisture content before test (%)	**12.23**
Moisture content after test (%)	**18.40**

Other Data

Initial Dry Density (kg/m3)	**1209**
Initial Void Ratio	**1.17**

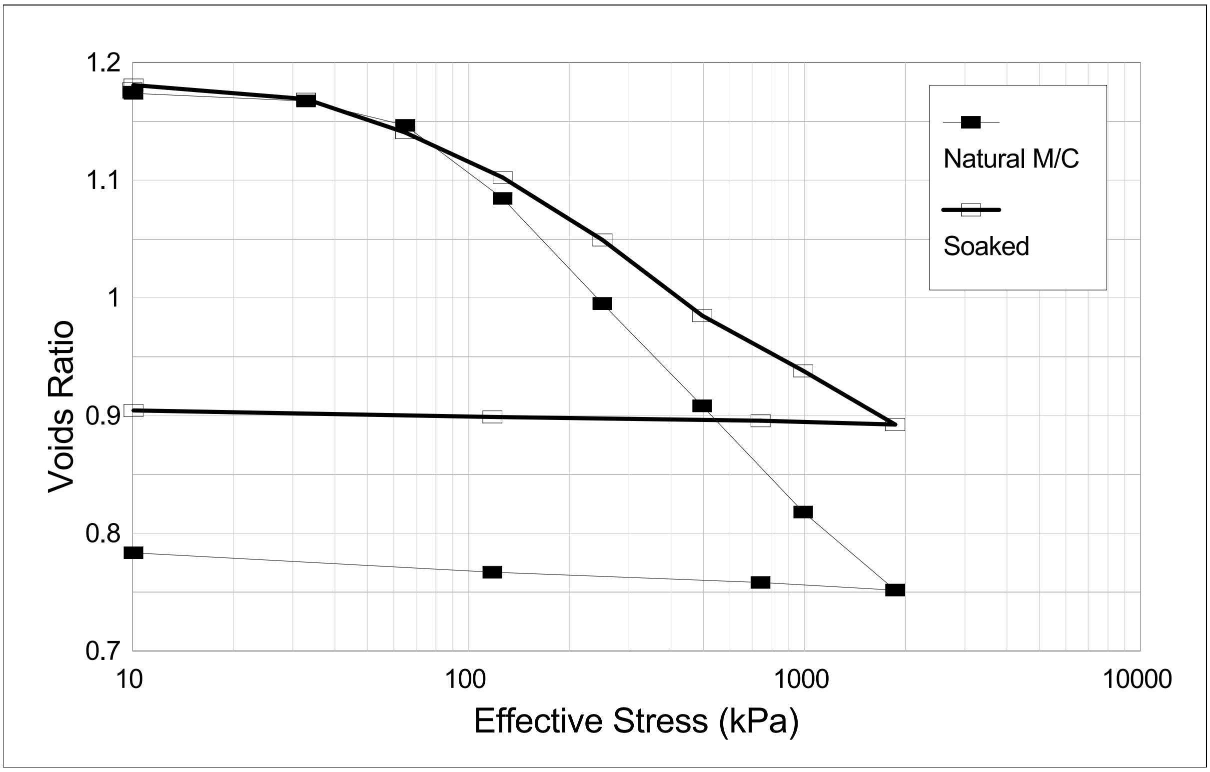
Other Data

Initial Dry Density (kg/m3)	**1208**
Initial Void Ratio	**1.18**

Programe Data
Revision No 3 (04/04/2001)

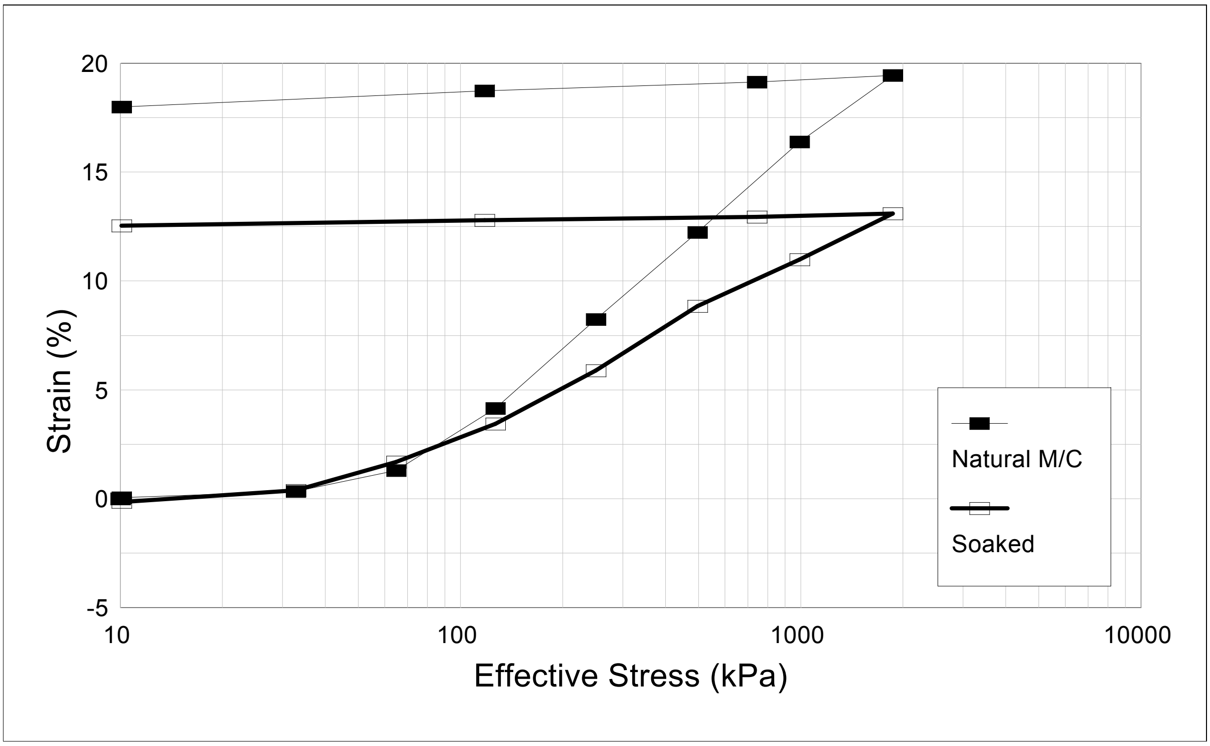
VOIDS RATIO v EFFECTIVE STRESS

Test No: 206



STRAIN v EFFECTIVE STRESS

Test No: 206



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

SINGLE OEDOMETER CONSOLIDATION

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16 UB 23/1 @ 0,6 - 0,8m		
Date	20 JANUARY 2020	Test No	208
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.626

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	480	1324	1.161	0.000
10	1920	1325	1.159	0.050
33	2040	1334	1.150	0.500
65	2160	1358	1.124	1.700
127	2280	1404	1.074	4.000
251	2400	1493	0.978	8.450
498	3840	1599	0.863	13.750
993	4320	1772	0.677	22.400
1868	5760	1867	0.574	27.150
743	6880	1852	0.590	26.400
118	7000	1837	0.606	25.650
10	7120	1826	0.618	25.100

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	301.80
Mass wet sample plus ring after test (gms)	301.40
Mass dry sample plus ring (gms)	289.80
Mass ring (gms)	211.60
Moisture content before test (%)	**15.35**
Moisture content after test (%)	**14.83**

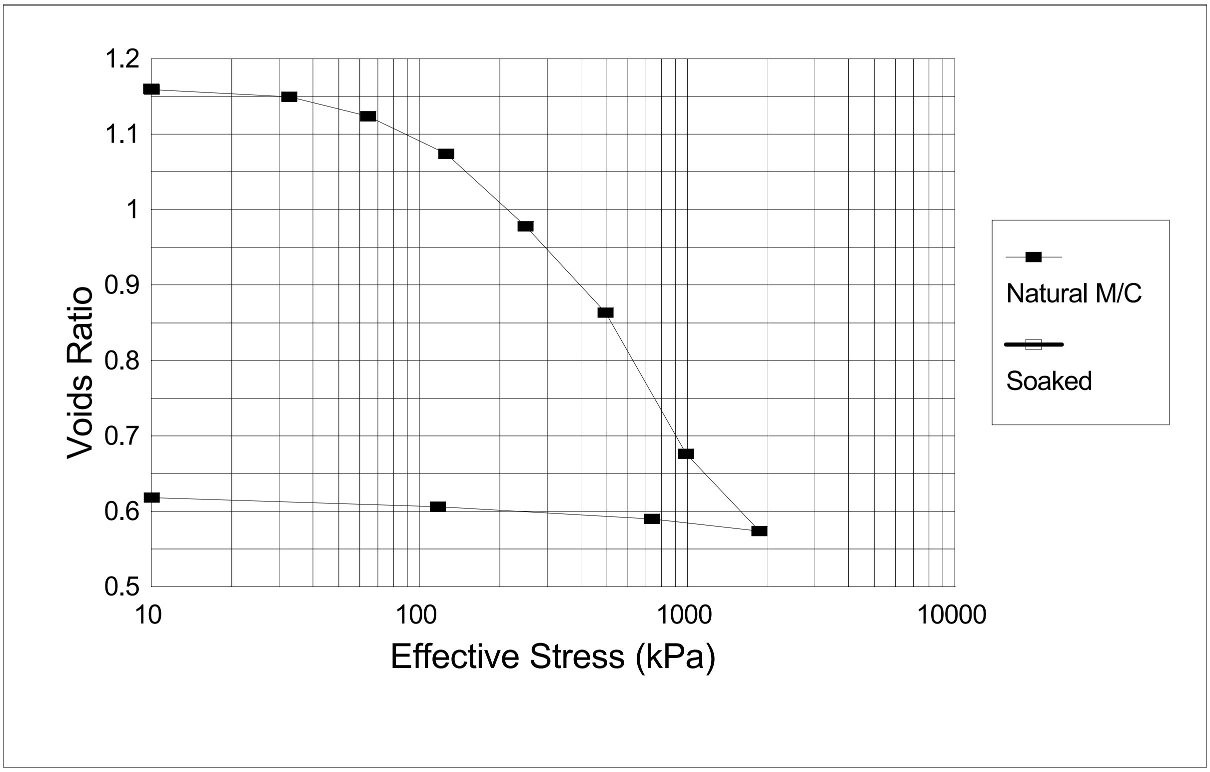
Other Data

Initial Dry Density (kg/m3)	**1215**
Initial Void Ratio	**1.16**

Programe Data
Revision No 2 (19/03/2001)

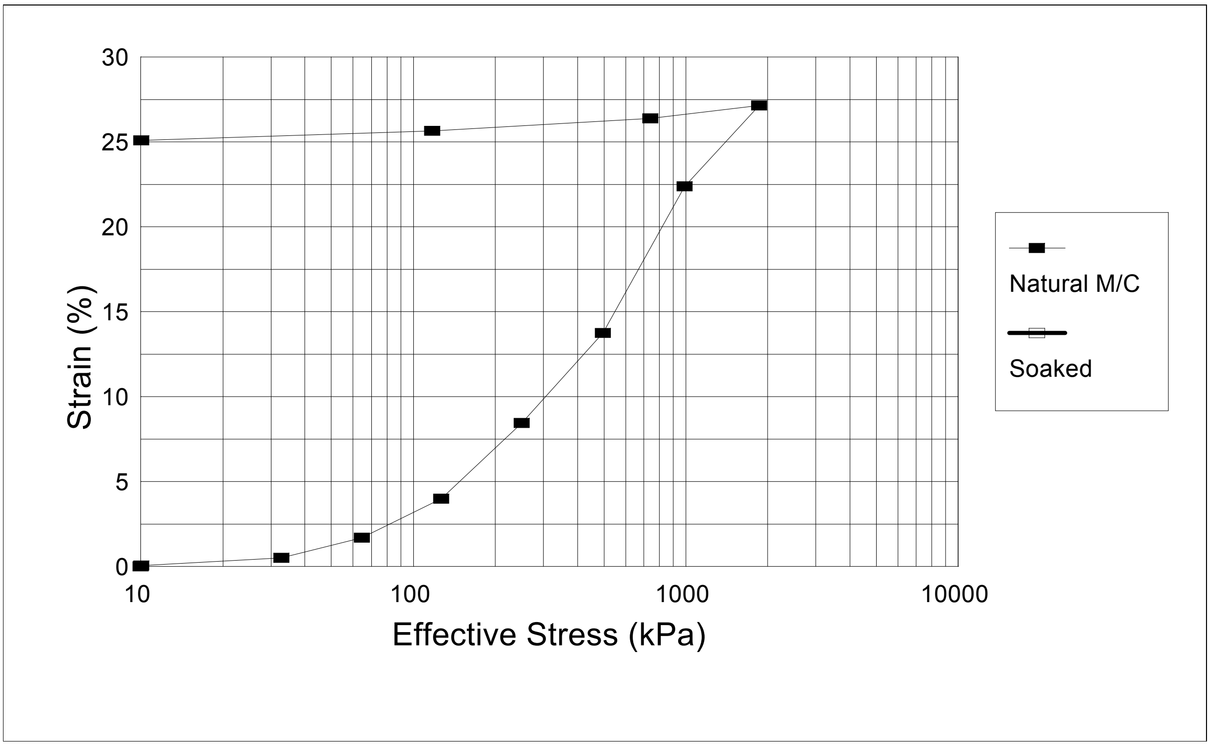
VOIDS RATIO v EFFECTIVE STRESS

Test No: 208



STRAIN v EFFECTIVE STRESS

Test No: 208



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

COLLAPSE POTENTIAL at 200 kPa

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 26 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2019	Test No	210
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.694

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	1048	1.189	0.00
10	90	1050	1.186	0.10
33	130	1055	1.181	0.35
65	190	1080	1.154	1.60
127	310	1139	1.089	4.55
200	1750	1188	1.035	7.00
200	3190	1217	1.004	8.45
498	3430	1286	0.928	11.90
993	3670	1388	0.816	17.00
1868	5110	1492	0.703	22.20
743	5230	1485	0.710	21.85
118	5350	1465	0.732	20.85
10	5470	1454	0.744	20.30

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	303.60
Mass wet sample plus ring after test (gms)	305.80
Mass dry sample plus ring (gms)	290.40
Mass ring (gms)	211.20
Moisture content before test (%)	**16.67**
Moisture content after test (%)	**19.44**

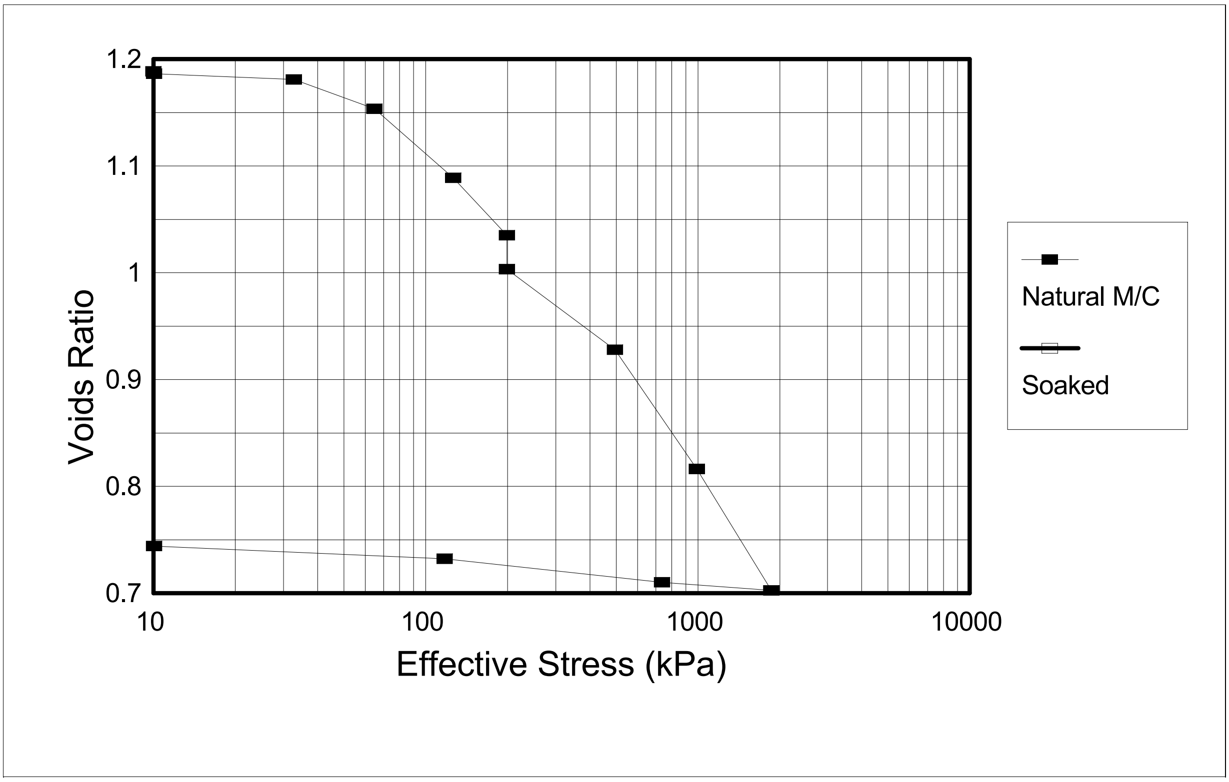
Other Data

Initial Dry Density (kg/m3)	**1231**
Initial Void Ratio	**1.19**

Programe Data
Revision No 2 (19/03/2001)

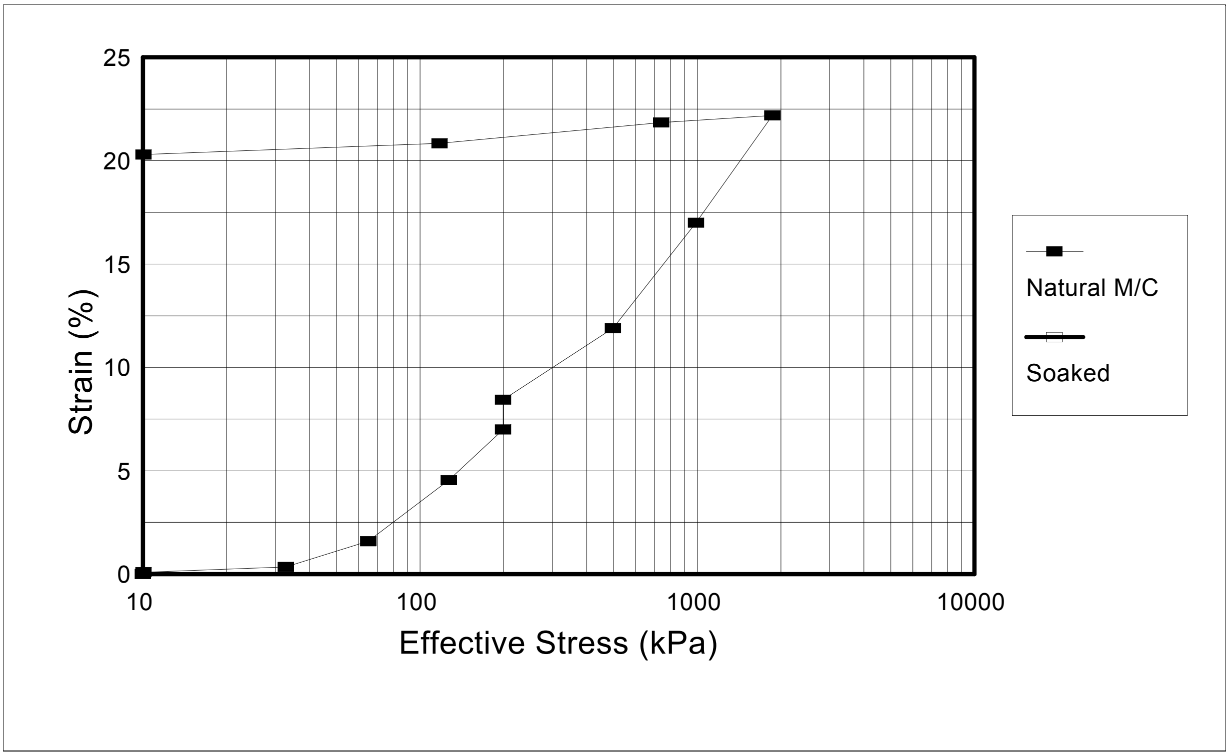
VOIDS RATIO v EFFECTIVE STRESS

Test No: 210



STRAIN v EFFECTIVE STRESS

Test No: 210



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

DOUBLE OEDOMETER

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB44 / 1 @ 1,8 - 2,0m	
Date	20 JANUARY 2020	Test No	212
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.728

Sample at NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	120	936	0.848	0.00
10	1440	937	0.847	0.05
33	1500	940	0.844	0.20
65	1560	950	0.835	0.70
127	1620	959	0.826	1.15
251	1680	970	0.816	1.70
498	1740	992	0.796	2.80
993	1800	1024	0.766	4.40
1868	3240	1085	0.710	7.45
743	3360	1071	0.723	6.75
118	3480	1053	0.739	5.85
10	3600	1043	0.749	5.35

Sample Soaked

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	120	306	0.883	0.00
10	1440	305	0.884	-0.05
33	1500	307	0.882	0.05
65	1560	318	0.872	0.60
127	1620	339	0.852	1.65
251	1680	366	0.827	3.00
498	1740	408	0.787	5.10
993	1800	464	0.734	7.90
1868	3240	519	0.683	10.65
743	3360	506	0.695	10.00
118	3480	486	0.714	9.00
10	3600	444	0.753	6.90

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	319.80
Mass wet sample plus ring after test (gms)	318.00
Mass dry sample plus ring (gms)	305.80
Mass ring (gms)	210.80
Moisture content before test (%)	**14.74**
Moisture content after test (%)	**12.84**

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	318.00
Mass wet sample plus ring after test (gms)	322.60
Mass dry sample plus ring (gms)	304.40
Mass ring (gms)	211.20
Moisture content before test (%)	**14.59**
Moisture content after test (%)	**19.53**

Other Data

Initial Dry Density (kg/m3)	**1477**
Initial Void Ratio	**0.85**

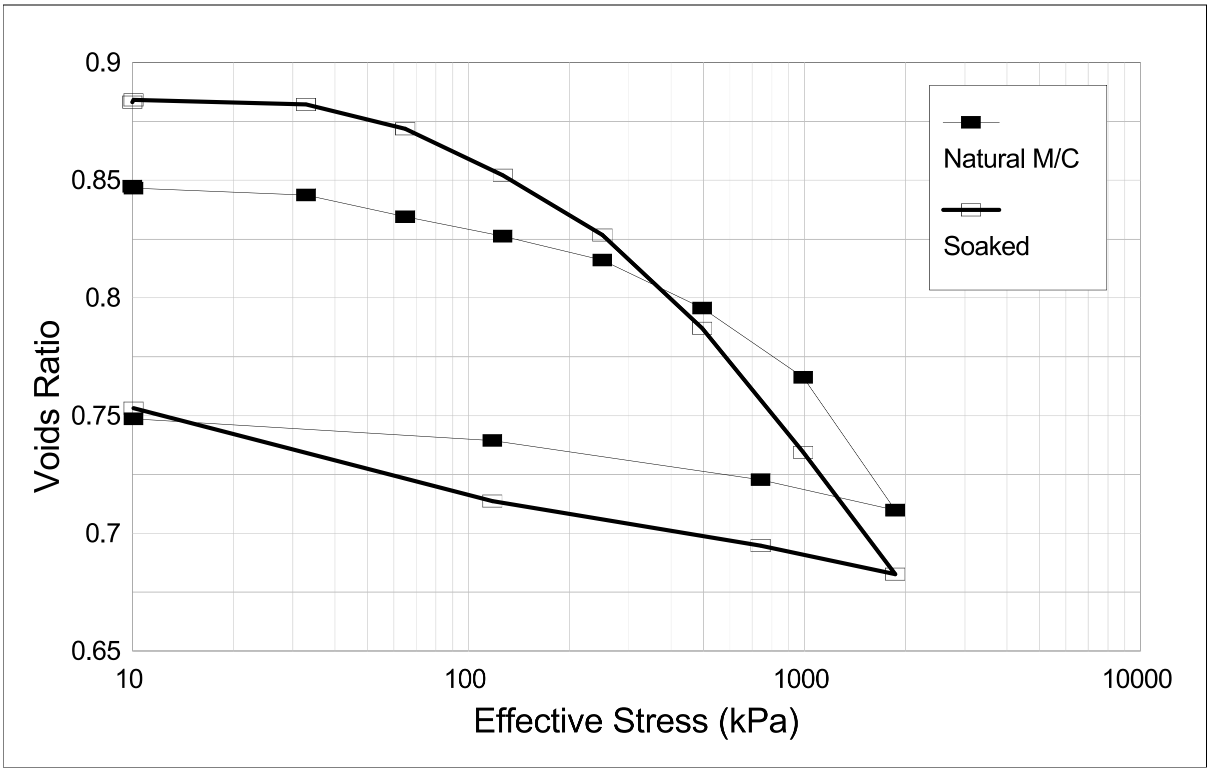
Other Data

Initial Dry Density (kg/m3)	**1449**
Initial Void Ratio	**0.88**

Programe Data
Revision No 3 (04/04/2001)

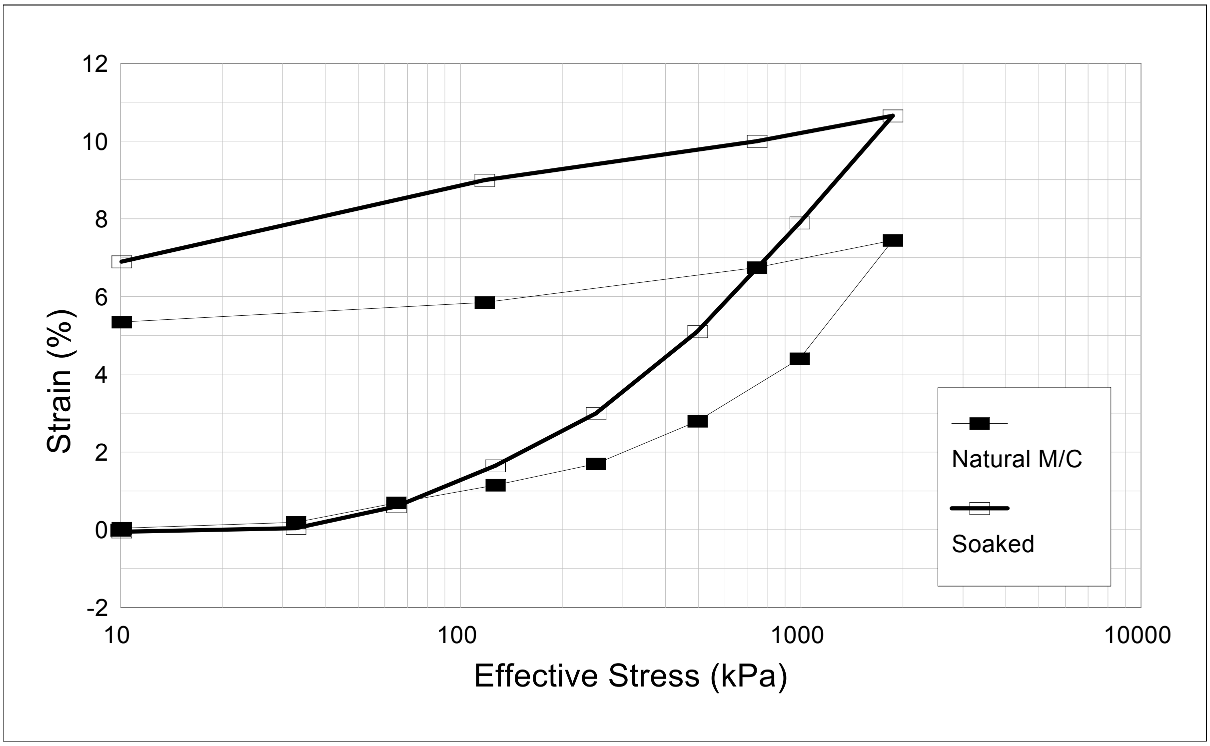
VOIDS RATIO v EFFECTIVE STRESS

Test No: 212



STRAIN v EFFECTIVE STRESS

Test No: 212



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

COLLAPSE POTENTIAL at 200 kPa

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 47 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2019	Test No	214
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.604

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	345	1.428	0.00
10	90	348	1.424	0.15
33	130	355	1.416	0.50
65	190	376	1.390	1.55
127	310	444	1.308	4.95
200	1750	512	1.225	8.35
200	3190	538	1.194	9.65
498	3430	656	1.051	15.55
993	3670	739	0.950	19.70
1868	5110	804	0.871	22.95
743	5230	791	0.887	22.30
118	5350	772	0.910	21.35
10	5470	759	0.926	20.70

Moisture Content Calculations

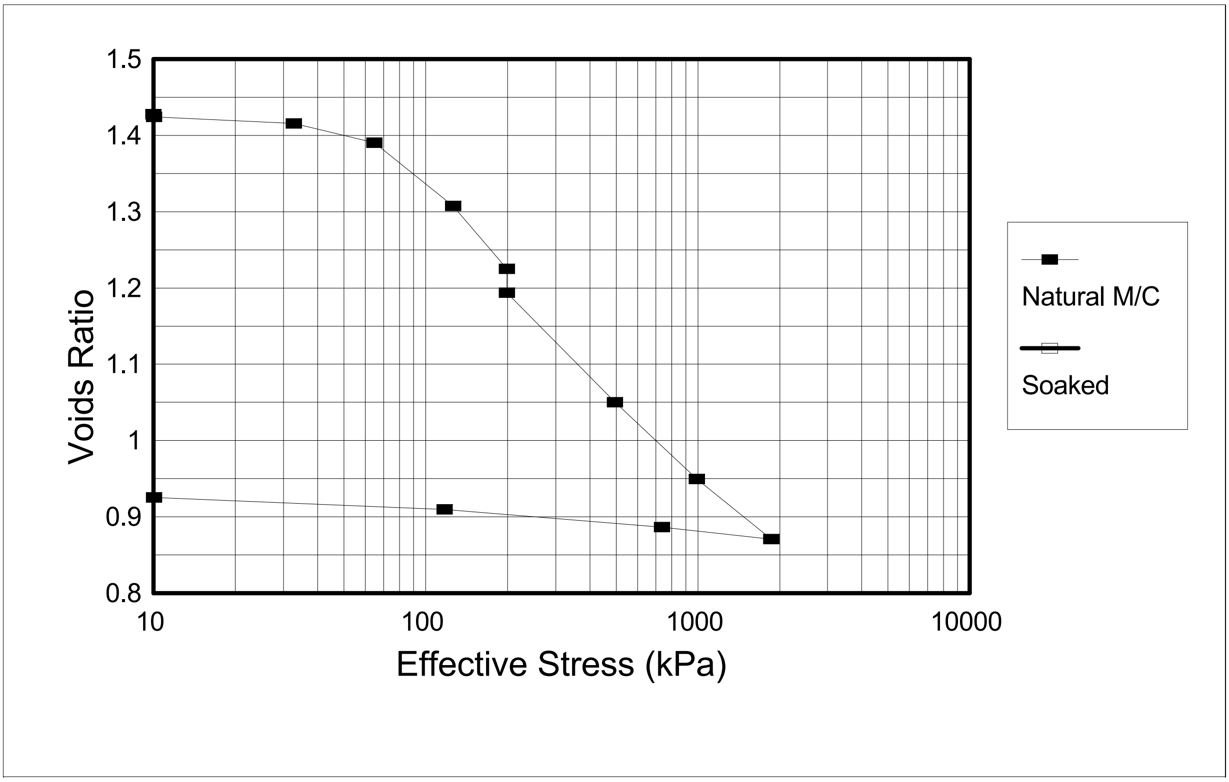
Mass wet sample plus ring before test (gms)	297.20
Mass wet sample plus ring after test (gms)	298.40
Mass dry sample plus ring (gms)	281.00
Mass ring (gms)	212.00
Moisture content before test (%)	**23.48**
Moisture content after test (%)	**25.22**

Other Data

Initial Dry Density (kg/m3)	**1072**
Initial Void Ratio	**1.43**

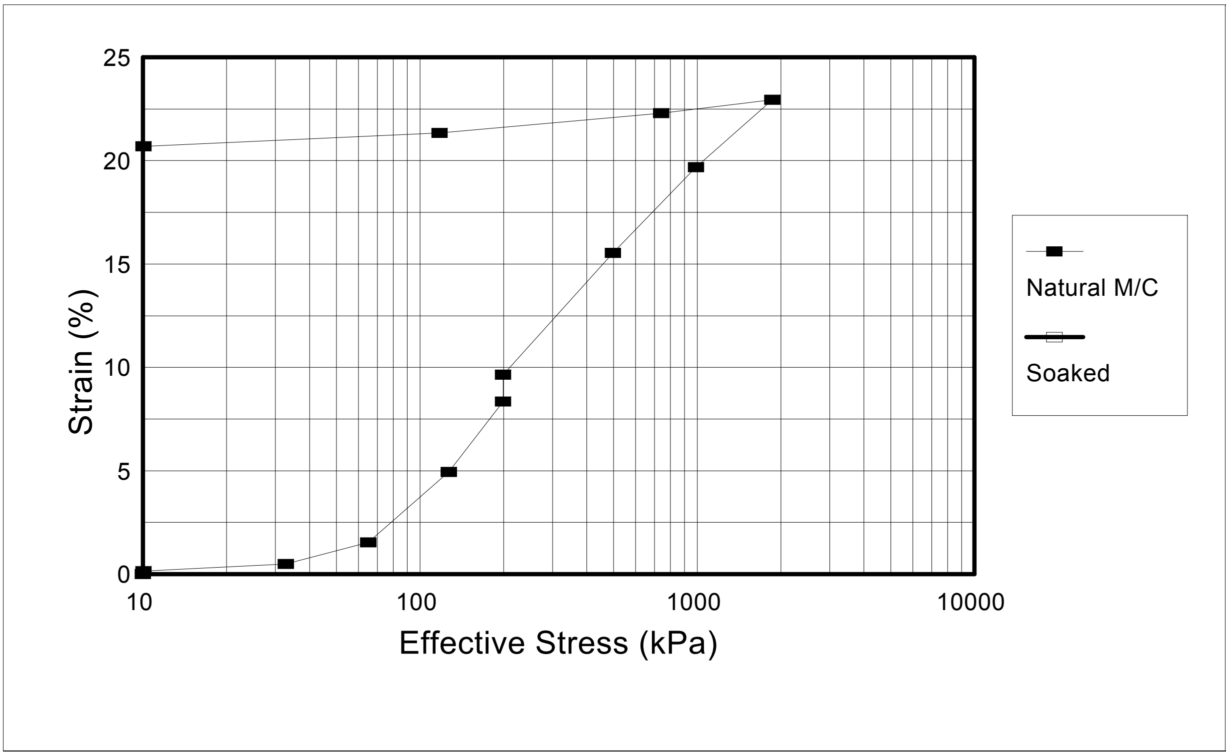
VOIDS RATIO v EFFECTIVE STRESS

Test No: 214



STRAIN v EFFECTIVE STRESS

Test No: 214



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

COLLAPSE POTENTIAL at 200 kPa

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 52 / 1 @ 1,0 - 1,2m	
Date	20 JANUARY 2019	Test No	216
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.598

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	290	1.277	0.00
10	90	292	1.275	0.10
33	130	296	1.270	0.30
65	190	308	1.257	0.90
127	310	338	1.223	2.40
200	1750	356	1.202	3.30
200	3190	481	1.060	9.55
498	3430	592	0.933	15.10
993	3670	674	0.840	19.20
1868	5110	741	0.764	22.55
743	5230	735	0.771	22.25
118	5350	723	0.784	21.65
10	5470	708	0.801	20.90

Moisture Content Calculations

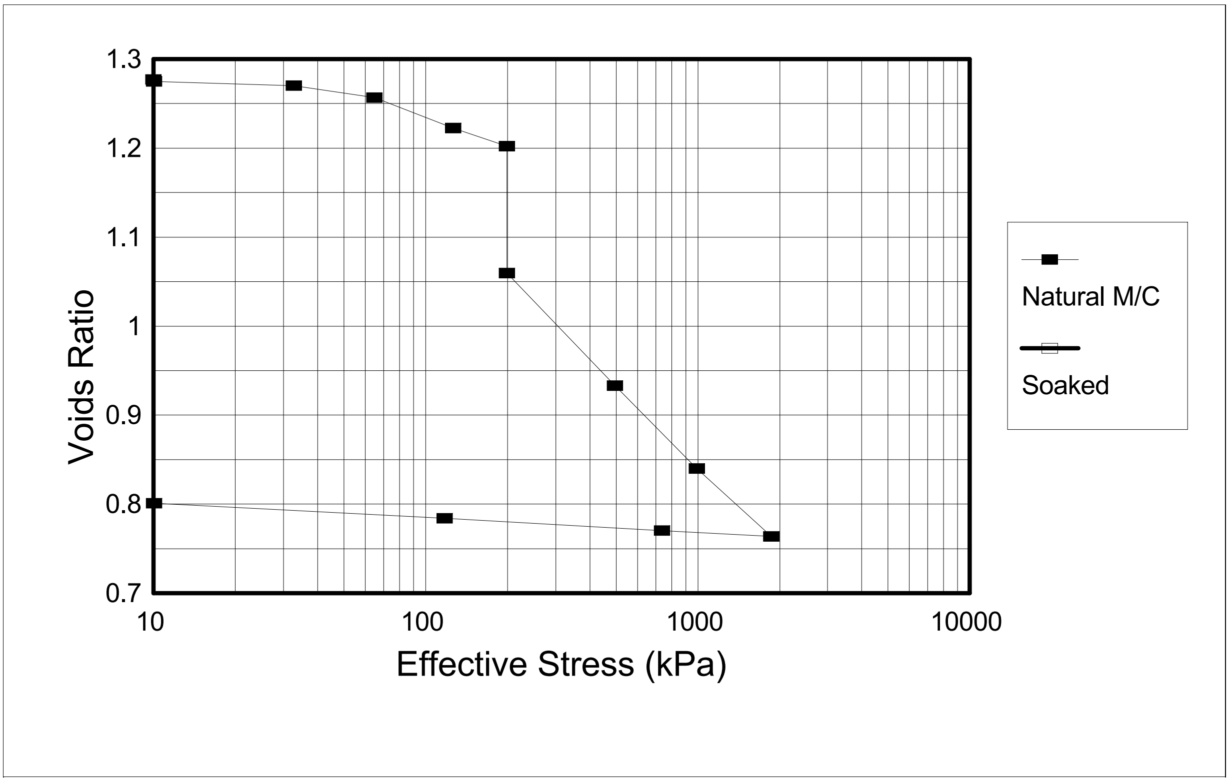
Mass wet sample plus ring before test (gms)	299.00
Mass wet sample plus ring after test (gms)	304.00
Mass dry sample plus ring (gms)	288.80
Mass ring (gms)	215.40
Moisture content before test (%)	**13.90**
Moisture content after test (%)	**20.71**

Other Data

Initial Dry Density (kg/m3)	**1141**
Initial Void Ratio	**1.28**

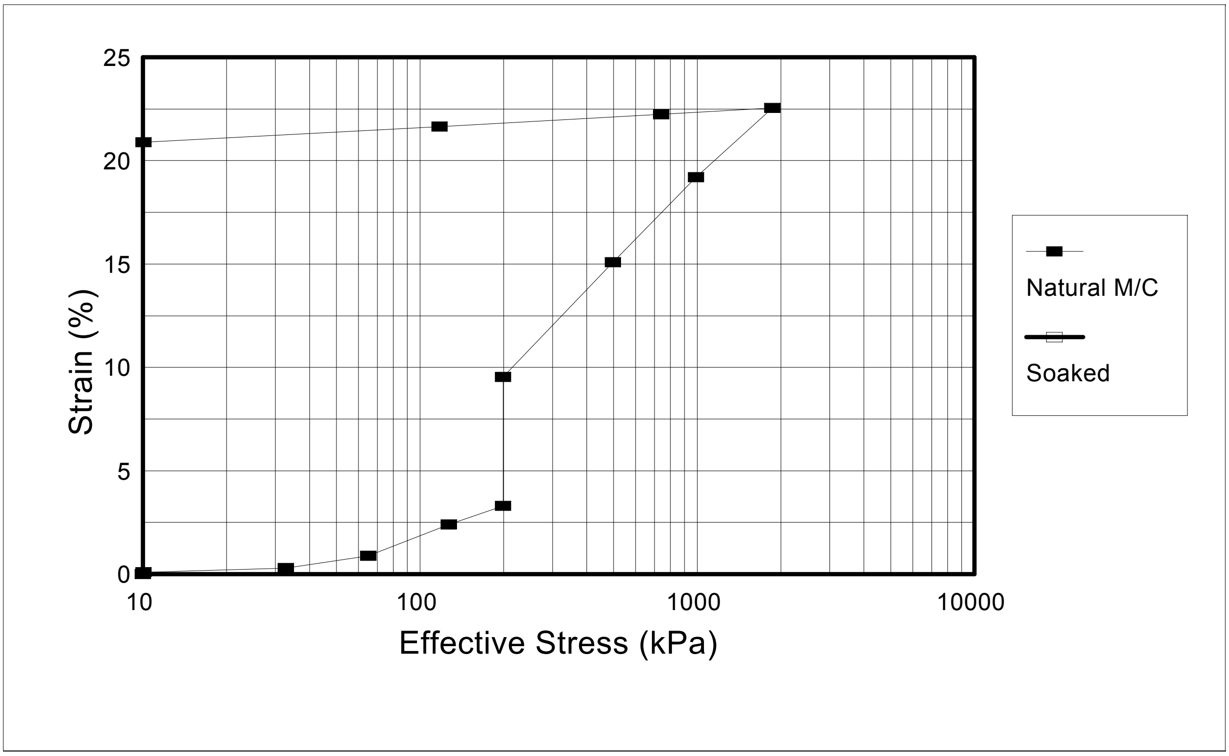
VOIDS RATIO v EFFECTIVE STRESS

Test No: 216



STRAIN v EFFECTIVE STRESS

Test No: 216



Geopractica
SOILS & MATERIALS TESTING
P.O.BOX 227, MARAISBURG, 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: lab@geopractica.co.za

COLLAPSE POTENTIAL at 200 kPa

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16	UB 57 / 1 @ 0,8 - 1,0m	
Date	20 JANUARY 2019	Test No	218
Job No	20021	Checked By	EB

Sample Height (mm)	20	Sample Diameter (mm)	64	Sample Specific Gravity	2.65

Sample Preparation	NMC

Effective Stress (kPa)	Time (mins)	Consolidation Reading	Voids Ratio	Strain (%)
10	60	629	1.180	0.00
10	90	630	1.179	0.05
33	130	656	1.151	1.35
65	190	682	1.123	2.65
127	310	715	1.087	4.30
200	1750	745	1.054	5.80
200	3190	766	1.031	6.85
498	3430	856	0.933	11.35
993	3670	917	0.866	14.40
1868	5110	972	0.806	17.15
743	5230	969	0.810	17.00
118	5350	956	0.824	16.35
10	5470	929	0.853	15.00

Moisture Content Calculations

Mass wet sample plus ring before test (gms)	307.60
Mass wet sample plus ring after test (gms)	308.40
Mass dry sample plus ring (gms)	293.40
Mass ring (gms)	215.20
Moisture content before test (%)	**18.16**
Moisture content after test (%)	**19.18**

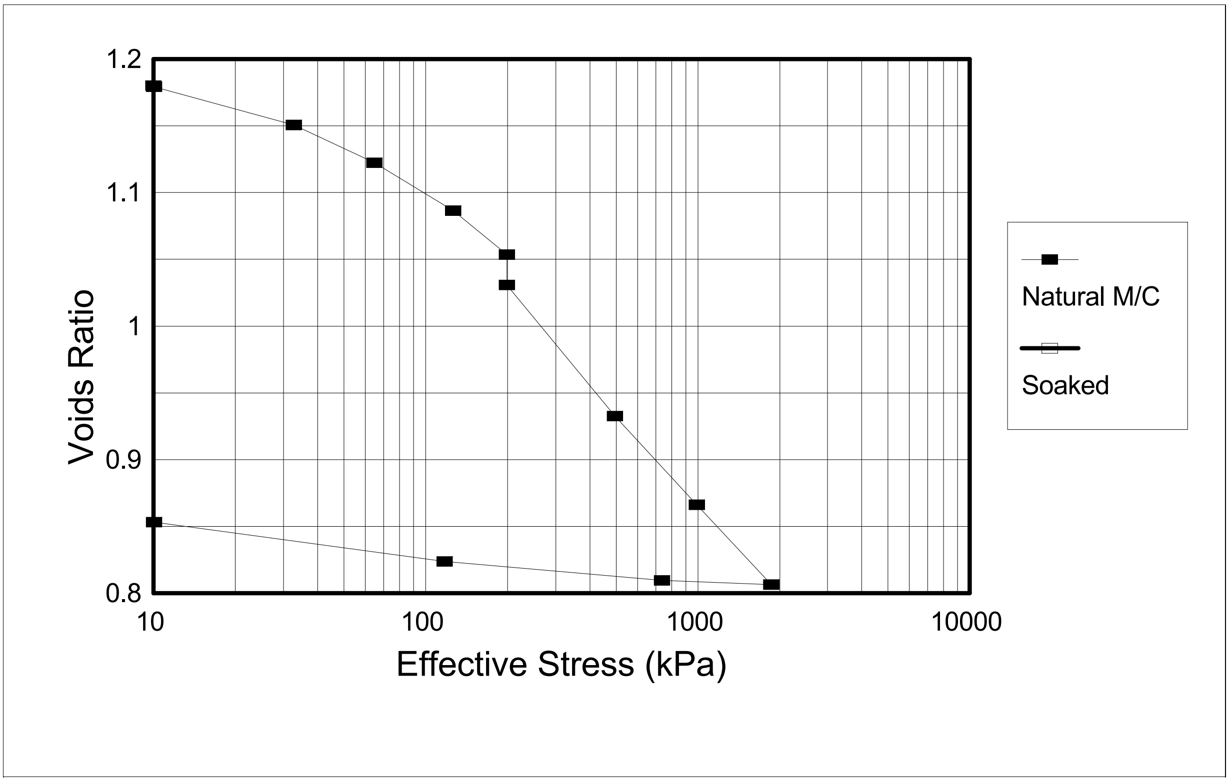
Other Data

Initial Dry Density (kg/m3)	**1215**
Initial Void Ratio	**1.18**

Programe Data
Revision No 2 (19/03/2001)

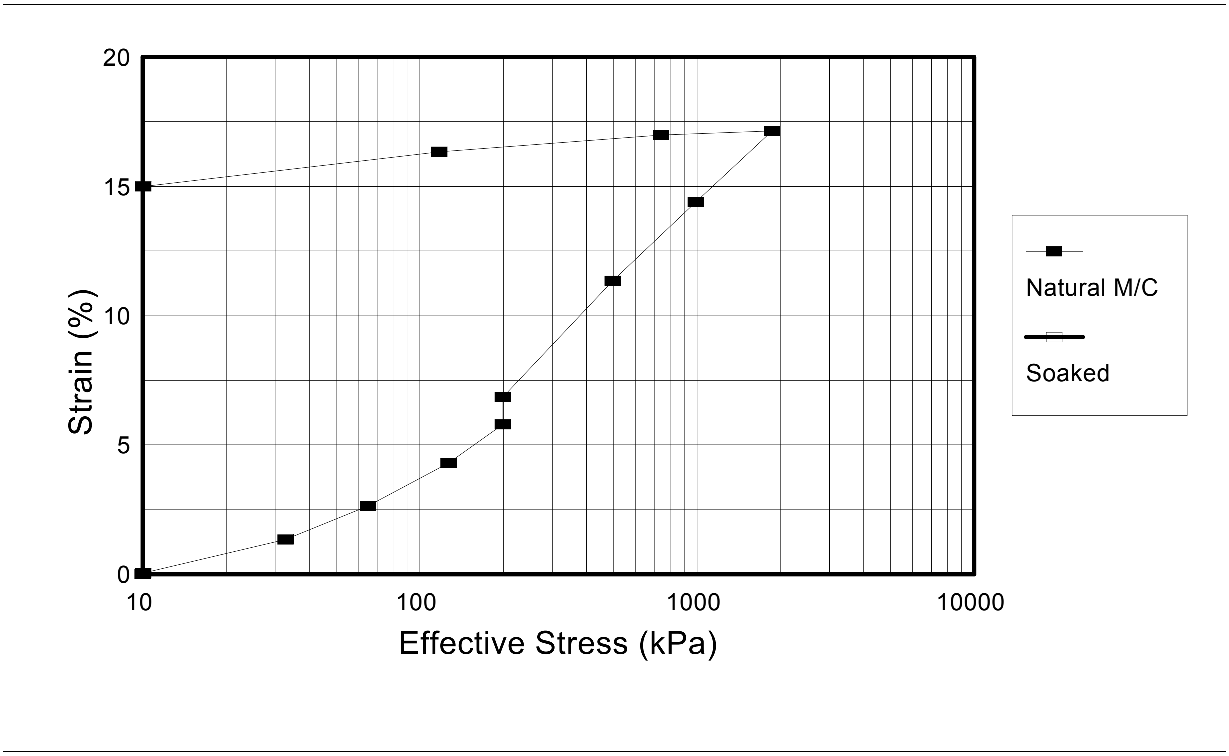
VOIDS RATIO v EFFECTIVE STRESS

Test No: 218



STRAIN v EFFECTIVE STRESS

Test No: 218



Geopractica
SOIL and MATERIAL TESTING
P.O. BOX 227
MARAISBURG 1700
TEL: (011) 674 1325
FAX: (011) 674 4513
e mail: satisfied@geopractica.co.za

SOIL pH and CONDUCTIVITY TEST RESULT

Client	GEOID GEOTECHNICAL ENGINEERS		
Location	UNITAS PARK X16		
Date	20 JANUARY 2020	Test No	
Job No	20021	Checked By	MAX

Sample Description	pH	Electrical Conductivity EC (µS/cm)	Total Dissolved Salts TDS (ppm)	Resistivity R (Ohms/cm)
UB15 / 1 @ 0,8 - 1,0m	6.3	143	72	6993
UB44 / 1 @ 1,8 - 2,0m	5.3	356	178	2809
UB52 / 1 @ 1,0 - 1,2m	5.3	200	100	5000
UB57 / 1 @ 0,8 - 1,0m	5.0	829	415	1206
DB15 / 1 @ 1,6 - 2,0m	5.1	235	117	4255
DB15 / 2 @ 2,0 - 2,5m	5.2	200	100	5003
DB16 / 1 @ 1,0 - 1,8m	3.9	112	56	8929
DB16 / 2 @ 1,8 - 2,4m	4.2	68	34	14706
DB58 / 1 @ 1,1 - 1,5m	5.2	578	289	1730
DB58 / 2 @ 2,0 - 2,5m	5.4	224	112	4464

pH	Degree of Acidity
<4	Extremely Acidic
4.0 - 5.4	Strongly Acidic
5.5 - 6.4	Moderately Acidic
6.5 - 7.0	Slightly Acidic
7.1 - 7.4	Slightly Alkaline
7.5 - 8.4	Moderately Alkaline
>8.4	Strongly Alkaline

Resistivity (Ohmn/cm)	Degree of Corrosivity
0 - 2 000	Extremely Corrosive
2 000 - 4 000	Very Corrosive
4 000 - 5 000	Corrosive
5 000 - 6 000	Mildly Corrosive
>10 000	Not Generally Corrosive

Programed Data
Revision No 1 (28/02/2001)

APPENDIX E

Site Classification Rationale

Site Classification Rationale

In terms of the investigation guidelines, it is necessary to classify the proposed township into Site Classes according to the requirements of the NHBRC Building Manual and the Code of Practice (COP) for Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction compiled by the Joint Structural Division of the SAICE and the IStructE.

According to the GFSH-2 *Guidelines for Urban Engineering Geological Investigation*, any site can be divided into one of three primary Geotechnical Sub-Areas which indicate the **general development potential** of an area, as summarised in Table 1. The first objective is thus to classify the site in terms of its development potential according to geotechnical, geo-hydrological and environmental considerations highlighted in the study.

The second objective is then met by applying the COP to categorise areas with **common site / founding characteristics** and **potential foundation movements**, giving recommendations for typical founding options for single-storey building of masonry construction. The assumptions on which these recommendations are based include a maximum foundation bearing pressure of 50kPa applied through minimum 0.6m wide strip foundations installed at approximately 0.4m below natural ground surface. A summary of the various Site Classes for which a site may be classified, is contained in Table 2.

As an example, a site class of 2/C/H/R(locally) as defined in accordance with Tables 1 and 2 is thus associated with a developable site (with precautions) (2), with collapse and/or consolidation settlement potential of less than 5mm (C), heave/shrinkage potential of less than 7.5mm (H) and (local) occurrences of rock outcrop or shallow sub-outcrop (R).

Table 1: Geotechnical Constraints on Planned Development

Prefix	Development Potential	Impact of Geotechnical Character of Area on Construction Measures
1	The geotechnical conditions are such that urban development can take place without any special precautionary/remedial measures for geotechnical conditions.	- None - Normal building construction
2	Geotechnical conditions are such that the area may be developed for urban use, but appropriate remedial measures and/or precautionary measures are required in the context of the geotechnical constraints.	- Problem Soils - Special foundation and top structure requirements
3	Geotechnical conditions are such that urban development is not recommended.	- Severe Geotechnical or Environmental Constraints - Development not recommended / permitted

Table 2: Typical Residential Site Class Designations

Site Class	Typical Founding Material	Character of Founding Material	Expected Range of Total Soil Movements (mm)	Assumed Differential Movement (% of Total)
R	Rock (excluding mud rocks which may exhibit swelling to some depth)	Stable	Negligible	-
H H1 H2 H3	Fine grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	Expansive Soils	<7.5 7.5 - 15 15 - 30 >30	50% 50% 50% 50%
C C1 C2	Silty sands, sands, sandy and gravelly soils	Compressible and Potentially Collapsible Soils	<5.0 5.0 - 10 >10	75% 75% 75%
S S1 S2	Fine grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	Compressible Soil	<10 10 - 20 >20	50% 50% 50%
P	Contaminated soils Controlled fill Uncontrolled fill Land fill Mine waste fill Mining subsidence Dolomitic areas Marshy areas Reclaimed areas Very soft silt/silty clays Landslip	Variable	Variable	
W	Development probably controlled by floodline considerations	N/A	N/A	N/A

ANNEXURE F

REPORT ON A DOLOMITE STABILITY INVESTIGATION