

B17-04

15 August 2016

General Manager: Water and Sanitation
City of Tshwane Metropolitan Municipality
PO Box 6338
PRETORIA
0001

ATTENTION: Ms. Semakaleng Dlavani

Dear Ma'am,

WATER AND SEWER MASTER PLANS: DEVELOPMENT OF PROPOSED TOWNSHIP/REZONING – KNOPJESLAAGTE 385-JR PORTION 105, 109 AND 331

The attached request from Civilconsult (Gideon Ras) dated 30 March 2016 with regards to accommodating the proposed development in the Tshwane water and sewer systems has reference.

Although the City of Tshwane has water and sewer master plans, you requested this further analysis and report because :

- ☒ The development has large fire flow requirements (e.g. 20l/s, 25l/s or 50l/s which is usually the case for higher density cluster developments, industry, general business, shopping centres or high-rise flats ≥ 4 storeys).
- ☒ The development has a substantially higher water demand than used in the master plan.
- ☒ The reservoir which will supply the development in future will be different to the reservoir which currently supplies the development (i.e. a change in reservoir supply zones).
- ☒ The reservoir zone in which the development falls is currently experiencing inadequate bulk water system capacity.
- ☒ The drainage area in which the development falls is currently experiencing inadequate bulk sewer system capacity.

This report is a technical report stating upgrades required in the distribution networks in the vicinity of the proposed development. The City of Tshwane engineer (yourself) will accept the report or suggest changes and will make a final decision on works to be implemented by the proposed development.

This analysis and report is based on the 2010 water and sewer master plans which are updated every quarter. The latest master plans used in this analysis were the January 2016 master plans.

All costs shown in this report are year 2015/16 Rand value estimates and **include** 40% surcharge for P&Gs, contingencies and fees but **exclude** VAT.

1 WATER DISTRIBUTION NETWORK

1.1 Water Resource

The City of Tshwane (CoT) straddles two primary water catchments namely: the Crocodile River basin in the west and the Olifants River basin in the east. The dividing line between these two catchments runs in a north-south direction approximately through Cullinan. Water resources in the Crocodile River basin in the west together with imports from the Vaal River basin via the Rand Water system are sufficient to supply CoT reservoirs in this basin. However, water resources in the Olifants River basin in the east are fully committed and cannot supply **additional** water to any existing or future CoT reservoirs without additional Rand Water supply through new pipelines, especially to the Cullinan WTP and Bronkhorstspuit WTP.

The CoT Water Resources Master Plan (2014) indicates that the reservoir listed in section 1.2 below is supplied from the water source shown in the table below. From this information it can be seen that this water source is adequate to cater for the proposed development.

Catchment	Water Source	%	Comment
Vaal River basin	Rand Water	100%	The master plan calculates the water volumes required at all Rand Water connections to supply applicable reservoirs. These calculations are supplied by the CoT to Rand Water and the City obtains agreements from Rand Water for these volumes.

1.2 Distribution Zone

The proposed development was taken into consideration in the above mentioned water master plan as part of the Knopjeslaagte 385-JR Ptns 105-109-331 future development area with a landuse of low density residential.

The master plan indicates that the proposed development currently falls in no reservoir supply zone but in the future will form part of the Mnandi reservoir zone as shown in **Figure 1 (Water)**.

1.3 Revised Water Demand

The combined AADD for the proposed development as originally calculated and used in the analysis of the water distribution network in the master plan was 441 kℓ/d.

The revised AADD, peak flow and fire flow calculated for the proposed development and used in the re-analysis of the water distribution network was 906 kℓ/d calculated as follows:

Erf No.	Anticipated Landuse	New Dev. Area (ha)	Density (Units/ha)	FSR	Floor space (ha)	No. of Units	FSR Units	UWD Type	UWD (inc.UAW)	AADD (inc.UAW) (kl/d)	PDDWF incl. Infil. (kl/d)	Water / Sewer Ratio	IPDWF (l/s)	IPWWF (l/s)
NEW DEVELOPMENT														
Erven 1 & 2	Industrial (dry)	12.391	0.60	7.434		743.43	floor	0.40	kl/100m ² /d	297	211	71%	3.6	5.1
Erven 3 & 4	Industrial (dry)	16.304	0.60	9.782		978.22	floor	0.40	kl/100m ² /d	391	277	71%	4.7	6.7
Erf 5	Gate house for security villages	1.147	1			1	unit	0.60	kl/unit/d	1	0	67%	0.0	0.0
Erf 6	Private open space	0.745					area	15.00	kl/ha/d	11	0	0%	0.0	0.0
Ptn 105	Industrial (dry)	8.564	0.60	5.138		513.85	floor	0.40	kl/100m ² /d	206	146	71%	2.5	3.5
	Roads	1.717					none	0.00	kl/unit/d	0	0	0%	0.0	0.0
New Master Plan Total		40.867				1	2235			906	634		10.8	15.4

- Peak flow using zone peak hour factor of: 3.0^{\ddagger} = 31.5 ℓ/s
- Fire flow for type: Industrial/business (moderate risk) = 50 ℓ/s @ 15 m

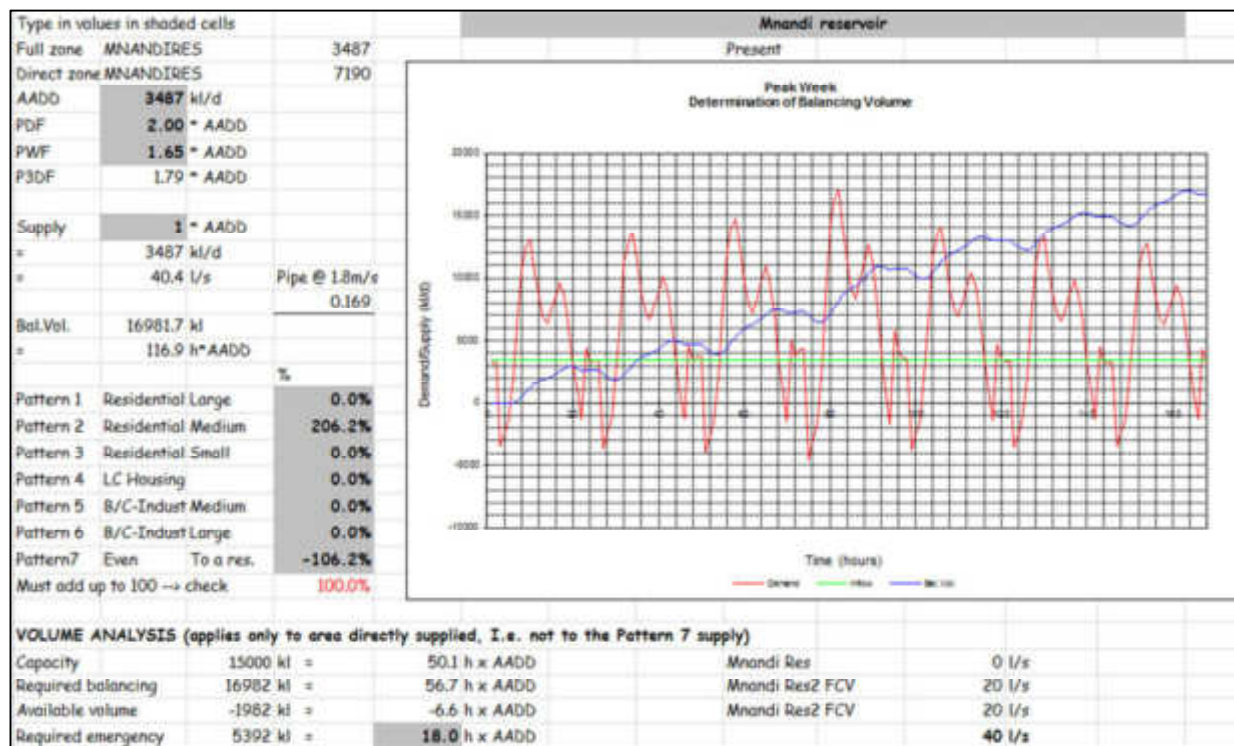
[‡] Higher peak flow factors might be applicable for internal networks.

1.4 Accommodation of Proposed Development in the Existing Water System

Accommodation of the proposed development, with its revised AADD, requires implementation of the following additions and adjustments to the *existing* water system:

1.4.1 Bulk Items

The current Mnandi reservoir zone AADD plus UAW ("scenario 2" in WADISO) in the m2016-01 Tshwane water model is 3 487 kℓ/d. The capacity of the existing Mnandi reservoir is 15 000 kℓ. The two existing FCVs can only supply 20 ℓ/s each (which is too low). Using these three input variables in a reservoir sizing spreadsheet, it shows that demand consistently exceeds supply and thus the balancing volume increases to unworkable volumes.



The Mnandi reservoir thus needs its own new RW connection to increase the supply into the Mnandi reservoir.

1.4.2 Reticulation Items

Items required to alleviate existing problems in the water distribution system:

- None

Items required to accommodate the proposed development (excluding fire flow requirements):

• MNR.6	475	m	x	600	mm Ø REPLACEMENT pipe (replacing an existing 110 mm Ø pipe)	R	3 100 000
• MNR.7	2 460	m	x	450	mm Ø main pipe	R	9 500 000
• MNR.8	710	m	x	450	mm Ø main pipe	R	2 800 00
• MNR.9 (part of)	1 045	m	x	355	mm Ø main pipe	R	1 900 000

Items required to accommodate the proposed development (including fire flow requirements):

- As above, and

• ITEM 1	580	m	x	250	mm Ø main pipe (this pipe is internal to the development)	R	-
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Should this development and the above pipe routes fall within a dolomitic area, the diameters stated above should be read as internal diameter sizes due to the wall thickness of HDPE pipes.

The proposed connection point to the existing water distribution system is shown in **Figure 1 (Water)** attached.

1.5 Internal Reticulation

The internal network design on the property of the proposed development is beyond the scope of this report. However, the consulting engineer for the development is required to allow for the fire flow demand as listed in 1.2 above on the internal networks.

For internal network design purposes the water distribution network provides the following energy gradelines (EGLs) at the proposed connection point (see **Figure 1 (Water)**):

- Static EGL = 1 542 m a.s.l. (76 m)
- Residual EGL = 1 523 m a.s.l. (57 m)
- Fire Flow EGL = 1 505 m a.s.l. (39 m)
- Ground Level = 1 466 m a.s.l.

1.6 Adjustments to the Master Plan

The revised AADD of the proposed development requires the following additions and adjustments to the *master plan* as indicated in **Figure 1 (Water)** attached:

Internal reticulation pipes to be re-rerouted according to the township layout and the water demand to be more than doubled from 441 kℓ/d to 906 kℓ/d.

2 SEWER NETWORK

2.1 Drainage Area

The proposed development was taken into consideration in the above mentioned sewer master plan as part of the Knopjeslaagte 385-JR Ptns 105-109-331 future development area with a landuse of low density residential.

The master plan indicates that the proposed development falls in the Swartspuit drainage area as shown in **Figure 2 (Sewer)** attached. This drainage area drains to the Sunderland WWTP.

2.2 Revised Sewer Flow

The combined peak day dry weather flow (PDDWF) for the proposed development as originally calculated and used in the analysis of the sewer system in the master plan was 193 kℓ/d.

The revised PDDWF calculated for the proposed development and used in the re-analysis of the sewer system was 634 kℓ/d with an instantaneous peak dry weather flow (IPDWF) of 10.8 ℓ/s. The design flow, or instantaneous peak wet weather flow (IPWWF), is 15.4 ℓ/s.

2.3 Accommodation of the Proposed Development in the Existing Sewer System

Accommodation of the proposed development, with its revised PDDWF, requires implementation of the following additions and adjustments to the *existing* sewer system as indicated in **Figure 2 (Sewer)** attached:

2.3.1 Sewer Bulk Items

- None.

2.3.2 Sewer Reticulation Items

MP Item No	MP Description	Total Length (m)	Design Flow	Design Flow Unit	Name	New Pipe ND (mm)	Total Cost
SB_F047.00	New Gravity	554	15.4	L/s		200	R 635 700
SB_F039.17	New Gravity	77	122.3	L/s		315	R 213 400
SB_F039.18	New Gravity	62	258.3	L/s		525	R 268 200
SB_F039.19	New Gravity	350	262.9	L/s		450	R 1 052 300
SB_F039.20	New Gravity	854	267.8	L/s		525	R 2 882 400
SB_F039.21	New Gravity	251	268.5	L/s		450	R 769 500
SB_F039.22	New Gravity	556	273.5	L/s		525	R 1 896 900
SB_F039.23	New Gravity	102	298.7	L/s		600	R 462 400
SB_F039.24	New Gravity	625	331.5	L/s		600	R 2 468 000
SB_F039.25	New Gravity	250	339.9	L/s		525	R 886 800
SB_F039.26	New Gravity	1455	356.4	L/s		600	R 5 644 600
SB_F103.01	New Flow Diversion	0	356.4	L/s		0	R 0
SB_F103.02	Alternative Gravity	396	0.2	L/s		600	R 1 588 400
SB_F004.02	New Gravity	759	36.8	L/s		250	R 1 217 200
SB_F004.03	New Gravity	310	37.9	L/s		250	R 519 700

MP Item No.	MP Description	Total Length (m)	Design Flow	Design Flow Unit	Name	New Pipe Size (mm)	Total Cost
01_P001.01	Alternative Gravity	29	243.0 L/s			300	R 240 800
02_P001.02	New Pump Station	0	243.0 L/s		Mickleton SA PS	0	R 5 010 000
03_P001.03	Alternative Gravity	3901	243 L/s		Mickleton SA PS	300	R 31 000 000
04_P001.04	Alternative Gravity	246	243.0 L/s			300	R 1 357 400
05_P001.05	New Gravity	800	243.0 L/s			300	R 1 857 000
06_P001.06	New Gravity	100	251.0 L/s			400	R 571 000
07_P001.07	New Gravity	330	251.0 L/s			400	R 1 210 400
08_P001.08	New Gravity	330	257.0 L/s			400	R 1 050 000
09_P001.09	New Gravity	420	262.0 L/s			400	R 1 580 000
10_P001.10	New Gravity	380	270.0 L/s			400	R 1 100 000

The proposed connection point to the existing sewer system is shown in **Figure 2 (Sewer)** attached.

In **Figure 2 (Sewer)** attached pipes in future development areas are indicated schematically.

The above Design Flows (or IPWWF) and thus pipe sizes were calculated taking cognizance of future developments upstream and downstream of the proposed development. In this regard, sewer pipes must be designed (layout and sizing) to receive design flows from all interconnecting sewer pipes as shown in **Figure 3.3 (Option 3)**.

2.4 Adjustments to the Master Plan

No adjustments to the sewer master plan are required due to the revised IPWWF of the proposed development.

Yours faithfully,



Per: Dr BF Louber
GLS Consulting

(Report done by: Adie Marings)

REQUEST FROM CONSULTANT TO GLS

From: Gideon Ras <gras@civilconsult.co.za> Sent: Wed 30/03/2016 09:51
 To: Adie Vierings
 Cc: Leon Wentzels; 'Civilconsult'; 'Damian Quedk'; 'Danie Meintjes'
 Subject: RE: Portion 109 and 331 of the Farm Knopjeslaagte 385-JR

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Hi Adie,

Thank you for the feedback.

Please include Remainder of Portion 105 in the analysis/report. The total area is thus approximately 40.8672ha.

Use Zone / Reservation	Erf No.	Area (ha)	FAR / Coverage	Floor Area(m ²)
"Special" for laboratories, service industries, computer centres, storage distribution centres, commercial uses and warehouse		8.5641	0.6	51384.6
"Special" for laboratories, service industries, computer centres, storage distribution centres, commercial uses and warehouse	3 & 4	16.3038	0.6	97820
"Special" for service industries, transport depots, warehouses, distribution centres and transport facilities	1 & 2	12.3905	0.6	74340
"special" for access & access control	5	1.1467	0.6	6880
Private Open Space	6	0.7452	0	-
Roads	N/A	1.7171	0	-

GENERAL NOTE:

1. The site is situated on the left side of the road, adjacent to the road.
2. The site is situated on the right side of the road, adjacent to the road.
3. The site is situated on the left side of the road, adjacent to the road.
4. The site is situated on the right side of the road, adjacent to the road.

SCALE 1:5 000

NEIGHBOURHOOD MAP

PLAN No: PEACH TREE X

LOCALITY MAP

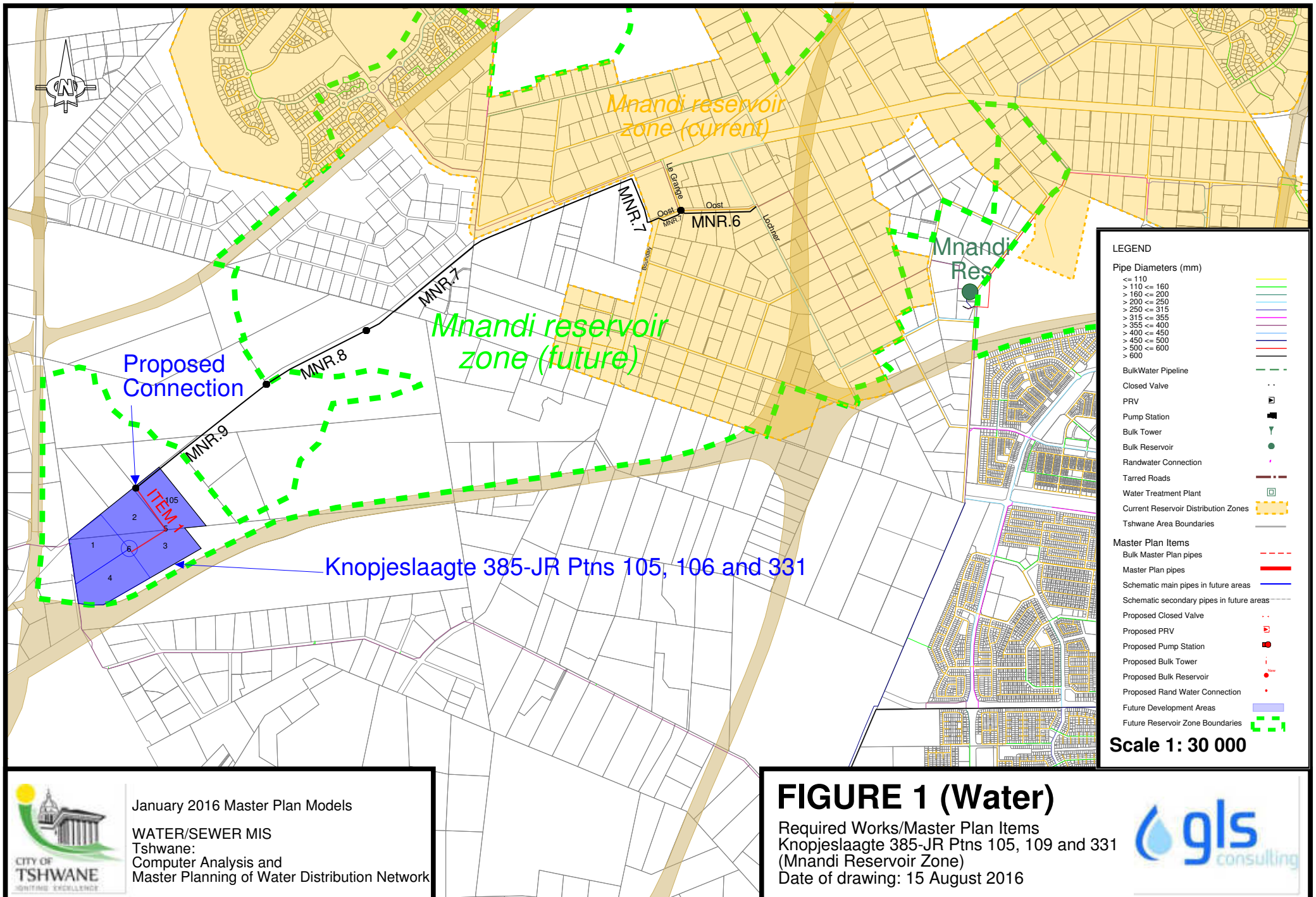
LAND USE TABLE

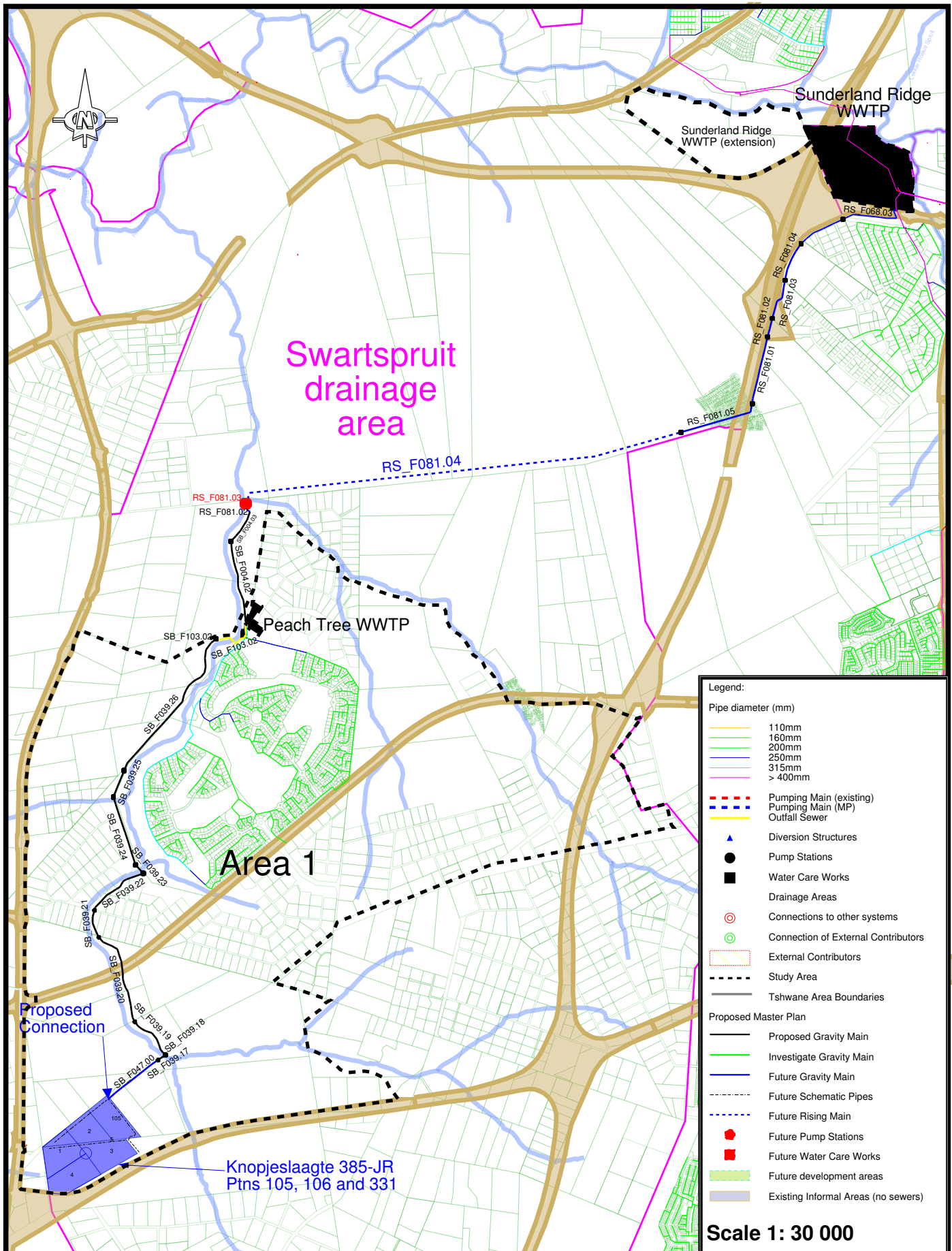
LAND USE	NO. OF PLOTS	AREA (M ²)	%
Residential (R1)	1	10 000	10.0
Residential (R2)	1	10 000	10.0
Residential (R3)	1	10 000	10.0
Residential (R4)	1	10 000	10.0
TOTAL	4	40 000	100.0

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$$\begin{array}{r} 8,944 \\ \hline 40,8612 \end{array}$$





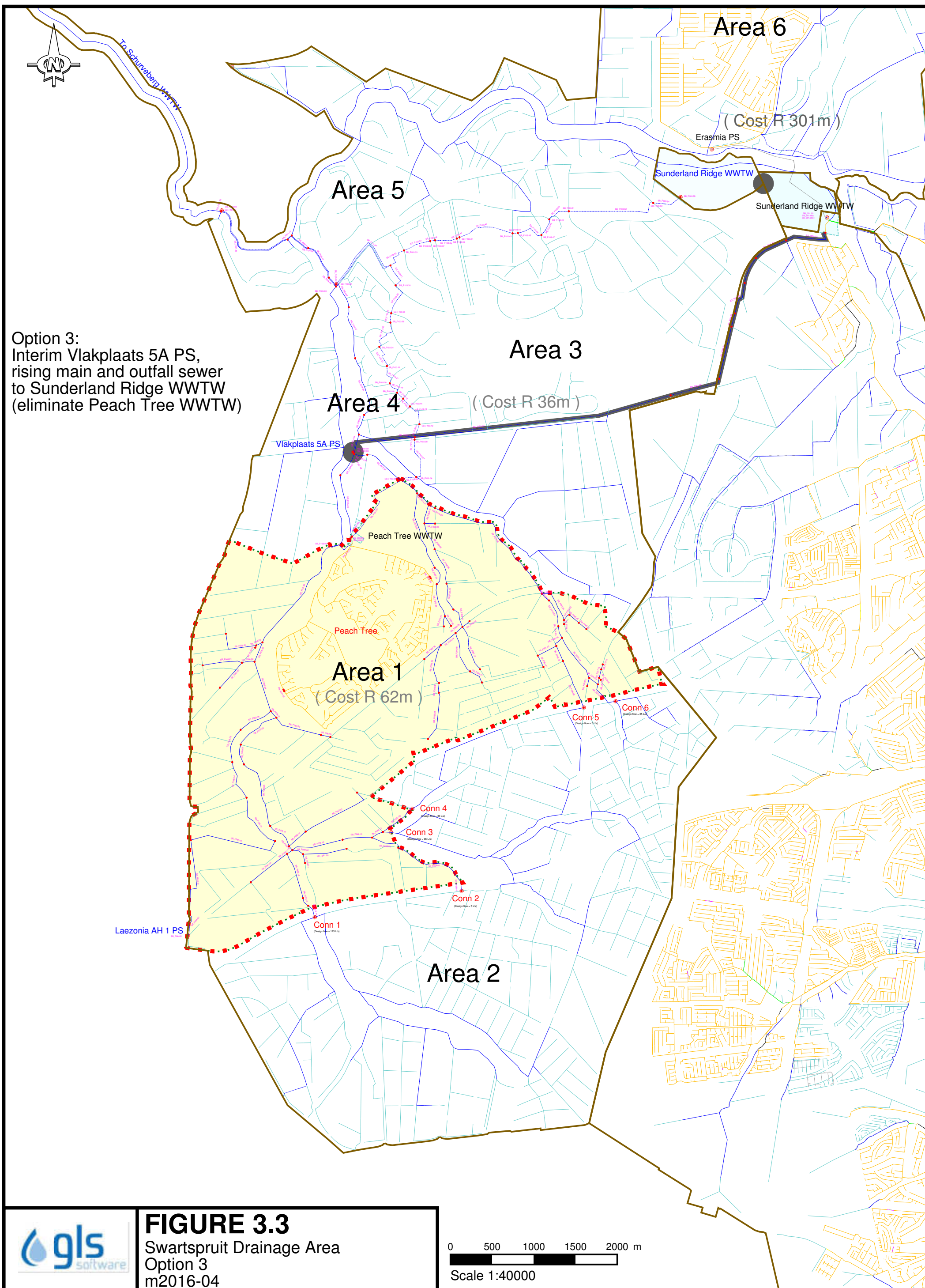
January 2016 Master Plan Models

WATER/SEWER MIS
Tshwane:
Computer Analysis and
Master Planning of Water Distribution Network

FIGURE 2 (Sewer)

Required Works/Master Plan Items
Knopjeslaagte 385JR Ptns 105, 109 and 331
(Swartspruit Drainage Area)
Date of Drawing: 15 August 2016





ADDENDUM F

GEOTECHNICAL INVESTIGATION

REPORT
ON
THE ENGINEERING GEOLOGICAL INVESTIGATION
ON
THE REMAINDER OF PORTION 105
POTION 109
PORTION 111
AND
ON
THE REMAINDER OF PORTION 331
OF
THE FARM
KNOPJESLAAGTE 385 JR.

LOUIS KRUGER GEOTECHNICS CC
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JANUARY 2016

Client

Keymacx

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION ON THE REMAINDER OF PORTION 105, PORTION 109, PORTION 111 AND ON THE REMAINDER OF PORTION 331 OF THE FARM KNOPJESLAAGTE 385 JR.

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Figure 1: Locality

Figure 2: Topography and Test pit positions

Figure 3: Engineering geological zoning

Figure 4: NHBRC zoning

Appendix A : Soil profiles

Appendix B : Laboratory test results

REPORT ON THE ENGINEERING GEOLOGICAL INVESTIGATION ON THE REMAINDER OF PORTION 105, PORTION 109, PORTION 111 AND ON THE REMAINDER OF PORTION 331 OF THE FARM KNOPJESLAAGTE 385 JR.

1. INTRODUCTION

Louis Kruger Geotechnics CC was appointed to do an engineering investigation on the Remainder of Portion 105, Portion 109, Portion 111 and on the Remainder of Portion 331 of the farm Knopjeslaagte 385 JR. The investigation was undertaken according to the normal requirements to assess the suitability of the site (SANS 634: Geotechnical Investigations For Township Development, SANS 633: Profiling, and Percussion and Core Borehole Logging In Southern Africa for Engineering Purposes, Home Building Manual Part 1 & 2", National Home Builders Registration Council, 1999) and Guidelines for Urban Engineering Geological Investigations 1997). The following aspects are addressed in this report:

- Geology and Soil profile
- Geohydrology
- Foundation conditions
- Construction material

2. TERMS OF REFERENCE

The appointment was to do an engineering investigation on the Remainder of Portion 105, Portion 109, Portion 111 and on the Remainder of Portion 331 of the farm Knopjeslaagte 385 JR. The following aspects were to be addressed:

- The geotechnical characteristics of the site
- Geotechnical constraints
- Founding conditions
- NHBRC Zoning

The locality of the site is shown on Figure 1.

3. AVAILABLE INFORMATION

The following information was available:

- 1 : 50 000 Geological Map 2528CC Lyttelton
- Cadastral map
- Colour aerial photographs, Tshwane Metropolitan Council
- Tshwane Internet Geographical information System

4. LOCALITY

The site is situated on the Remainder of Portion 105, Portion 109, Portion 111 and on the Remainder of Portion 331 of the farm Knopjeslaagte 385 JR and is bounded by the N14 Krugerdorp Highway in the south, by Fig Street in the west, by the R114 Pretoria Road in the north and by Imbovane Street in the east. The locality of the site is shown on Figure 1.

THE SITE



LOCALITY

FIGURE 1
NTS

5. **TOPOGRAPHY AND DRAINAGE**

No topographical information was available. The Tshwane Internet Geographical information System shows that the site slopes at an average of 4% towards the north-east. No drainage features are present on the site and according to the available information it is not affected by flood lines. The topography of the site is shown on Figure 2.

6. **METHOD OF INVESTIGATION**

Twenty-five test pits were dug on the site and the soil profiles were described according to the standard method proposed by Jennings, Brink and Williams (1973). Disturbed samples of the most prominent soil horizons were taken and submitted to a soils laboratory for foundation indicator tests. Due to the high gravel content and the consistency of the materials encountered on the site, no undisturbed samples were taken

7. **GEOLOGY AND SOIL PROFILE**

According to the 1: 50 000 scale geological map the site is underlain by migmatite gneiss (granite) of the Halfway House Suite. The geology of the site was confirmed during this investigation, granite bedrock was encountered in the test pits. The test pit positions are shown on Figure 2 and the soil profiles are attached as Appendix A. The following materials were encountered on the site:

7.1 **Soil profile**

The test pit positions are shown on Figure 3 and the soil profiles are attached as Appendix A. The following materials were encountered on the site:

7.1.1 *Colluvium*

Two types of colluvium were encountered on the site:

Type A: Slightly moist, dark brown, soft, shattered, silty sand with plant roots covers the eastern part of the site. This material was encountered in fourteen test pits from surface up to an average depth of 0,3 meters.

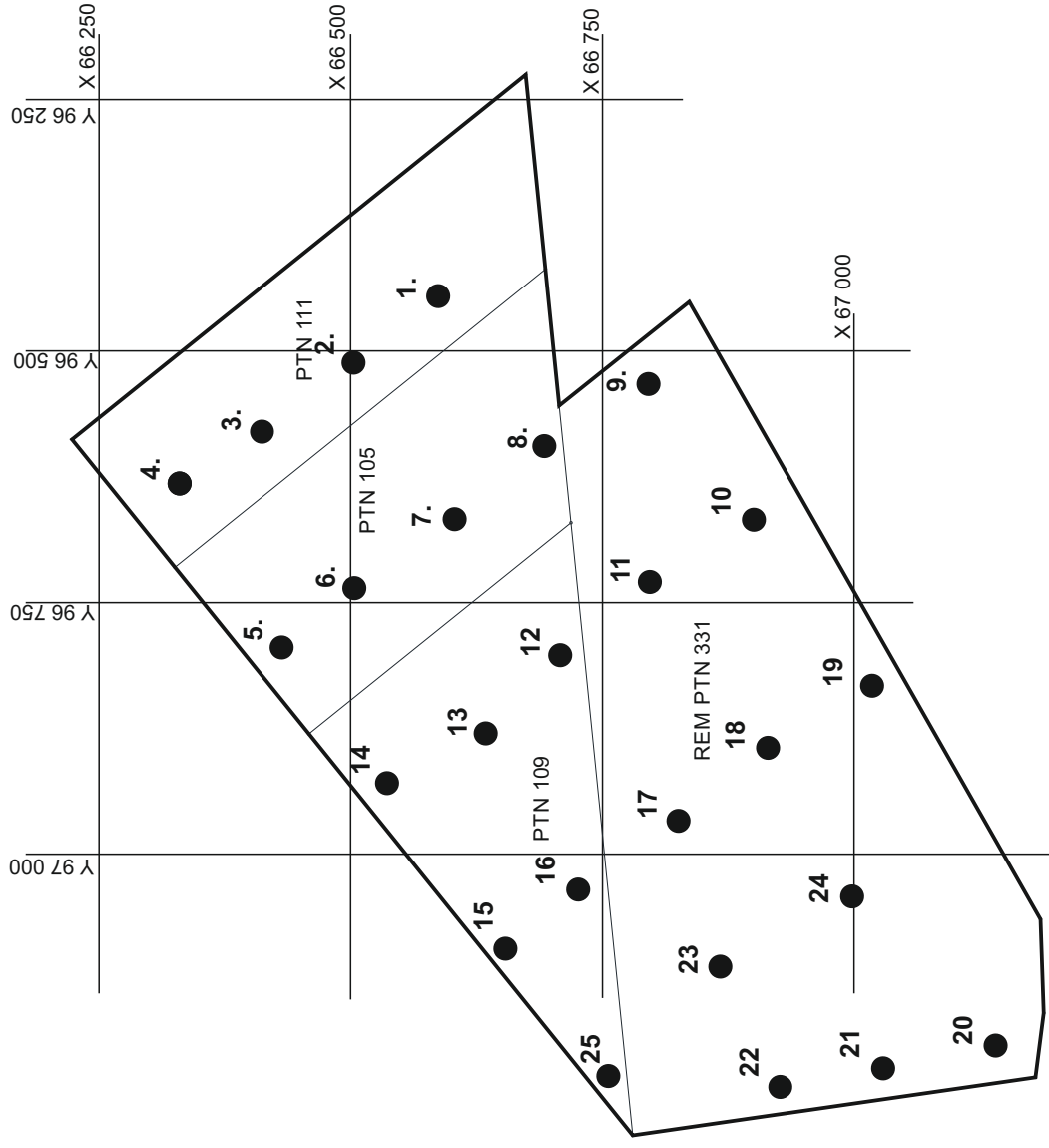
Type B: Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots was encountered on the western part of the site. This material was encountered in eight test pits from surface up to an average depth of 0,6 meters.

7.1.2 *Ferricrete*

Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles was encountered in twenty-three test pits from an average depth of 0,4 meters up to an average depth of 1,0 meters. In nine test pits the back actor refused hardpan ferricrete at an average depth of 0,7 meters.

7.1.3 *Granite*

Residual granite consisting of slightly moist, greyish white mottled orange and black, firm, intact, clayey sand with medium and large ferricrete concretions and with patches of very soft rock granite was encountered in three test pits from an average depth 0,7 meters up to an average depth of 1,3 meters and slightly moist, greyish white mottled orange, firm, intact, silty sand with very soft rock fragments was encountered in two test pits from an average depth 1,0 meters up to an average depth of 1,6 meters. Very soft rock granite was encountered in sixteen test pits from an average depth of 1,3 meters up to an average depth of 1,7 meters. The back actor refused on soft- to medium hard rock granite in sixteen test pits at an average depth of 1,4 meters.



TEST PIT POSITIONS

SCALE 1 : 7 500

FIGURE 2

8. GEOHYDROLOGY

No ground water was encountered during the investigation. The presence of pedogenic material however indicates that a perched water table could be present during and after periods of high rainfall.

9. LABORATORY TEST RESULTS

9.1 Indicator test results

The laboratory test results are attached as Appendix B and are summarized in the following table:

MATERIAL	TP	DEPTH (m)	PI	% Clay	% Silt	% Sand	% Gravel
Colluvium Type A	1	0.2	SP	3	11	85	1
Colluvium Type A	8	0.3	NP	1	11	86	2
Colluvium Type B	17	0.3	7	6	18	56	20
Colluvium Type B	20	0.3	NP	3	21	55	21
Colluvium Type B	24	0.4	7	7	14	46	33
Nodular ferricrete	1	0.8	SP	2	10	49	39
Nodular ferricrete	15	1.0	SP	4	8	45	43
Nodular ferricrete	22	1.0	SP	1	2	47	51
Residual granite Type 1	2	0.8	NP	1	13	47	39
Residual granite Type 2	21	1.3	SP	3	10	59	28

The difference between the Type A colluvium and the Type B colluvium is reflected by the higher sand- and lower gravel content of the Type A hillwash. The difference between the nodular ferricrete and the colluvium is shown by the higher gravel content and the difference between the nodular ferricrete and the residual granite is shown by the higher silt- and lower gravel content of the residual granite. The difference between the two types of residual granite is reflected by the higher gravel- and lower sand content of the Type 1 residual granite. The variation in the composition of the materials is clearly reflected by the results.

9.2 Potential expansiveness

The potential expansiveness of the materials encountered on the site was calculated according to the method proposed by Van der Merwe (1964). The following material characteristics are considered when applying this method:

- Plasticity index
- Clay fraction (< 0,002 mm)
- Thickness of expansive material
- Thickness of non - expansive material

Assuming the laboratory test results typify the material encountered on the site, the application of the method of Van der Merwe shows that all the materials classify as “Low” and is therefore considered to be non-expansive.

9.3 Collapse potential

Due to the consistency and the gravel content of the materials, no undisturbed samples were taken.

10. **ENGINEERING GEOLOGICAL ZONING**

The site was divided into the following Engineering Geological Zones:

Zone 1: Colluvium, nodular ferricrete and residual granite underlain by granite bedrock

Zone 2: Colluvium and nodular ferricrete underlain by hardpan ferricrete

The engineering geological zones are shown on Figure 3. *The boundaries between the different zones are based on field observations, aerial photographic interpretation and the interpolation of information between test pits. Therefore a conservative approach to the use of the engineering geological boundaries is recommended*

11. **GEOTECHNICAL CONSIDERATIONS**

The following geotechnical considerations, which could influence the proposed development, were identified:

11.1 Founding of structures

11.1.1 *Engineering geological zone 1: Colluvium, nodular ferricrete and residual granite underlain by granite bedrock*

- The composition and consistency of the colluvium varies considerably and the overall consistency is soft, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.
- The consistency of the nodular ferricrete with patches of honeycomb ferricrete is loose and the gravel content varies considerably, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.
- The consistency of the nodular ferricrete with patches of honeycomb ferricrete is loose and the gravel content varies considerably, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.
- The soft- to medium hard rock granite bedrock is considered suitable for the founding of structures.

11.1.2 *Engineering geological zone 2: Colluvium and nodular ferricrete underlain by hardpan ferricrete*

- The composition and consistency of the colluvium varies considerably and the overall consistency is soft, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.
- The consistency of the nodular ferricrete with patches of honeycomb ferricrete is loose and the gravel content varies considerably, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.

- The consistency of the nodular ferricrete with patches of honeycomb ferricrete is loose and the gravel content varies considerably, therefore, it is not considered suitable founding material for unadapted structures. If unadapted structures are founded on this material, and the moisture content should increase, unacceptable differential, vertical movements could occur, with resultant cracking of structures.
- Depending on the lateral and vertical continuity, the hardpan ferricrete is considered suitable for the founding of structures.

11.2 Excavatability

In engineering geological zone 1 the back actor refused at an average depth of 1,4 meters and in engineering geological zone 2 the back actor refused at an average depth of 0,7 meters.

11.3 Construction material

Both types of colluvium classify as A-2-4, the nodular ferricrete and residual granite classifies as A-1-b. The Plasticity Index and Grading Modulus were used to assess the suitability as construction material (TRH 14)

11.4 Groundwater

A perched water table, which could cause the flooding of excavations, could be present during or after periods of high rainfall. This is confirmed by the presence of pedogenic material.

11.5 Stability of excavations

Limited instability occurred in the sidewalls of the test pits.

12. GEOTECHNICAL CLASSIFICATION

The site was classified according to the Geotechnical Classification for Urban Development (after Partridge, Wood and Brink 1993). The criteria for the classification are shown in the following table:

GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

	CONSTRAINT	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness	Any collapsible horizon or consecutive horizons totalling a depth of more than 750 mm in thickness	A least favourable situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5 meters below surface	Permanent or perched water table less than 1,5 meters below surface	Swamps or marshes
C	Active soil	Low soil heave predicted	Moderate soil heave predicted	High soil heave predicted
D	Highly compressible soil	Low soil compressibility expected	Moderate soil compressibility expected	High soil compressibility expected
E	Erodibility of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume	Rock or hardpan pedocretes more than 40% of total volume
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 100 m below surface where slope closure has ceased	Mining within less than 100 m of surface or where total extraction mining has taken place
H	Instability in areas of soluble rock	Possibly unstable	Probably unstable	Known sinkholes and dolines
I	Steep slopes	Between 2 and 6 degrees (all regions)	Slopes between 6 and 18 degrees and less 2 degrees (Natal and Western Cape) Slopes between 6 and 12 degrees and less 2 degrees (all other regions)	More than 18 degrees (Natal and western Cape) More than 12 degrees (all other regions)

	CONSTRAINT	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)
J	Areas of unstable natural slopes	Low risk	Intermediate risk	High risk (especially in areas subject to seismic activity)
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s ² within 50 years	Mining induced seismic activity more than 100 cm/s ²	Natural seismic activity more than 100 cm/s ²
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas within a known drainage channel or floodplain

Based on the above, the site is classified as follows:

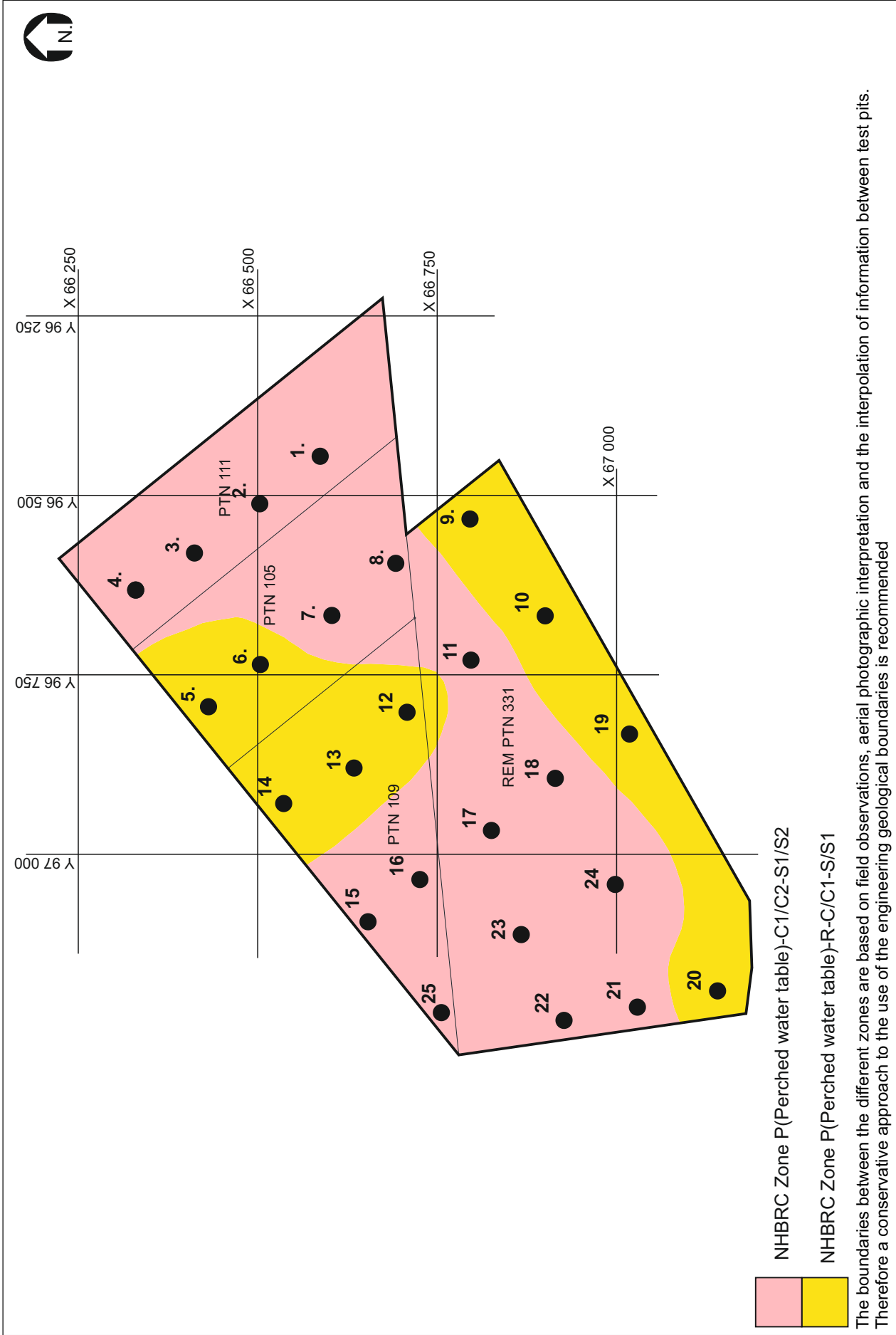
Engineering geological zone 1: 2A 1/2B 1C 2D 2E 2F 1I

Engineering geological zone 2: 1/2A 2B 1C 2D 2E 2/3F 1I

13. NHBRC CLASSIFICATION (SANS 10400-H: THE APPLICATION OF THE NATIONAL BUILDING REGULATIONS - PART H)

ZONE	NHBRC ZONE	MOTIVATION
Engineering geological zone 1 Geotechnical classification: 2A 1/2B 1C 2D 2E 2F 1I (see table)	P(Perched water table)-C1/C2-S1/S2	Due to the variation in composition, and the overall consistency, collapse is expected in the colluvium, nodular ferricrete and in the residual granite if unadapted structures are founded on it. The average thickness of the collapsible material is 1,4 meters and the thickness varies between 1,0 and 1,8 meters, therefore this part of the site is zoned as C1/C2-S1/S2. The presence of the shallow perched water table is accommodated by adding a zoning of P(Perched water table).
Engineering geological zone 2 Geotechnical classification: 1/2A 2B 1C 2D 2E 2/3F 1I (see table)	P(Perched water table)-R-C/C1-S/S1	Due to the variation in composition, and the overall consistency, collapse is expected in the colluvium and nodular ferricrete if structures are founded on it. The average thickness of the collapsible material is 0,7 meters and the thickness varies between 0,5 and 1,0 meters, therefore this part of the site is zoned as C/C1-S/S1. The presence of the shallow perched water table is accommodated by adding a zoning of P(Shallow water table),), and the presence of shallow hardpan ferricrete is accommodated by adding a zoning of R.

It is important to note that the zoning is based on the profiling of test pits and the interpolation of information between test pits; therefore it is possible that variations from the expected conditions can occur. The zoning is shown on Figure 4.



<p>NHBRC ZONING</p>	<p>SCALE 1 : 7 500</p>	<p>FIGURE 4</p>
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14. CONCLUSIONS AND RECOMMENDATIONS

It is important to note that the recommendations are based on the profiling of test pits and the interpolation of information. It is therefore possible that variations from the expected conditions can occur.

14.1 Foundations for light structures

14.1.1 *NHBRC Zone P(Perched water table)-C1/C2-S1/S2*

The colluvium, nodular ferricrete and the residual granite are expected to be potentially collapsible / compressible. Therefore this material is considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

If granite bedrock is present at shallow depth:

- *Deep strip footings:*
Found structures below the potentially collapsible material. Structures should be provided with vertical movement joints, light reinforcement in the masonry and floor slabs should be provided with fabric reinforcement.

If the depth to granite bedrock becomes too deep to found economically:

- *Modified normal:*
Found structures on reinforced strip footings, the foundation pressure should not exceed 50 kPa and structures should be provided with light reinforcement in the masonry and articulation joints at internal and external doors.
- *Stiffened strip footings, stiffened or cellular raft:*
Found structures on stiffened strip footings or a stiffened or cellular raft with lightly reinforced masonry. The bearing pressure should not exceed 50 kPa and floor slabs should be reinforced.
- *Compaction of insitu soil below footings:*
Remove unsuitable material up to a depth and width of 1,5 times the foundation width, below normal founding depth. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with suitable material, compacted in 150 mm layers to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal reinforced strip footings on the backfill and should be provided with vertical movement joints, light reinforcement in the masonry and floor slabs should be provided with fabric reinforcement.
- *Soil raft:*
Remove the collapsible material to 1,0 meters beyond the perimeter of the structure to at least a depth of 1,5 times the width of the widest foundation. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with suitable material, compacted in 150 mm layers to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal reinforced strip footings on the backfill and should be provided with vertical movement joints and light reinforcement in the masonry.
- *Piled or pier foundations:*
Found structures on piled or pier foundations with reinforced ground beams or solid slabs on piled or pier foundations

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is furthermore recommended that the trenches for services be profiled***

and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.

14.1.2 NHBRC Zone P(Perched water table)-R-C/C1-S/S1

The colluvium and nodular ferricrete are considered to be potentially collapsible. Therefore these materials are considered unsuitable in its natural state to act as a founding medium. This even applies for light structures with a foundation pressure of less than 100kPa. From the discussion foundation improvement and imparting flexibility in the brickwork are clearly required. The following alternatives are recommended:

If hardpan ferricrete is present at shallow depth and the lateral and vertical continuity is confirmed:

- *Deep strip footings:*
Found structures below the potentially collapsible material. Structures should be provided with vertical movement joints, light reinforcement in the masonry and floor slabs should be provided with fabric reinforcement.

If the depth to hardpan ferricrete becomes too deep to found economically:

- *Modified normal:*
Found structures on reinforced strip footings, the foundation pressure should not exceed 50 kPa and structures should be provided with light reinforcement in the masonry and articulation joints at internal and external doors.
- *Compaction of insitu soil below footings:*
Remove unsuitable material up to a depth and width of 1,5 times the foundation width, below normal founding depth. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with suitable material, compacted in 150 mm layers to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal reinforced strip footings on the backfill and should be provided with vertical movement joints and light reinforcement in the masonry.
- *Soil raft:*
Remove the collapsible material to 1,0 meters beyond the perimeter of the structure to at least a depth of 1,5 times the width of the widest foundation. The loose material in the bottom of excavations should be compacted, and the excavations backfilled with suitable material, compacted in 150 mm layers to at least 93% of Mod AASHTO density at -1% to +2% of optimum moisture content. Structures can be founded on normal reinforced strip footings on the backfill and should be provided with vertical movement joints and light reinforcement in the masonry.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. **It is furthermore recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.**

14.1.3 Recommendations that apply to the entire site

Due to the slope of the site, it is envisaged that a level platform for the structure will be created by way of a balanced cut to fill operation. This means that on the cut end of the platform, excavations may have proceeded to the level of the hardpan ferricrete or granite bedrock, depending on the depth of cut and the thickness of the transported material at the cut end. When building platforms are constructed, the soil profile should be investigated to establish the approximate thickness of the various horizons within the platform area. The following guidelines should be followed:

- In cut sections, the alternatives listed in the previous section apply. Should the cut extend up to competent founding material, only loose material at founding level has to be removed or must be compacted
- On the fill end, the founding alternatives listed in the previous section apply. If the entire fill section is constructed by compacting a competent material, founding at shallow depth is possible.

It is important though that in spite of the guidelines given above, inspection of foundation excavations and the involvement of a competent engineer familiar with structural founding are necessary. ***It is furthermore recommended that the trenches for services be profiled and that a construction report be compiled for the development. The purpose of the construction report is to confirm or adapt the zoning of the site, and to provide more accurate information regarding the founding conditions.***

14.2 Foundations for large structures

Detailed foundation investigations should be done on the footprints of large structures.

14.3 Excavatability

The excavatability of the materials encountered on the site was evaluated according to the South African Bureau of Standards Standardized Specification for Civil Engineering Construction DB: Earthworks (Pipe Trenches. In NHBRC Zone P(Perched water table)-C1/C2-S1/S2 the excavatability is considered to classify as “soft to intermediate” up to an **average** depth of one meter. In NHBRC Zone P(Perched water table)-R-C/C1-S/S1 the excavatability is considered to classify as “soft to intermediate” up to an **average** depth of 0,5. *It is important to note that the evaluation is based primarily on the profiling of test pits and the interpolation of information between test pits. It is therefore possible that variations from the expected conditions can occur.*

14.4 Geohydrology

All excavations should be provided with adequate drainage. Structures should be provided with damp proofing and provision should be made to prevent the ingress of water into– and below foundations.

14.5 Construction material

Both types of hillwash could be suitable as fill and selected sub-grade, the nodular ferricrete and the residual granite could be suitable as fill, selected sub-grade and sub-base. *It is recommended that the suitability of material that is to be used, be confirmed by detailed laboratory testing.*

14.5 Services

Due to the expected corrosivity, it is recommended that all services be protected.

14.7 Stability of excavations

It is recommended that all excavations be cut back or shored.

14.8 General recommendations

- Water has a significant influence on the behaviour of the in-situ material. To reduce differential movements of structures it is necessary to maintain moisture equilibrium under the structures. Therefore it is recommended that the following measures regarding drainage around structures be implemented:

- No accumulation of surface water must be allowed around the perimeter of the structures and the entire development must be properly drained.
- Down pipes should discharge into a lined or precast furrow. This furrow should discharge the water 1,5 meters away from the foundation onto a paved or grassed surface sloping away from the building.
- Preferably, if no gutters or paving is to be provided around structures, a 1,5 meter wide sealed concrete apron should be cast along the perimeter of the structures the water must be channeled away from the foundation.
- Leaks in water bearing services should be attended to without undue delay.
- No large shrubs or trees should be planted closer to structures than the distances provided in the following Table:

DESCRIPTION	MATURE HEIGHT OF TREE		
	Up to 8m	8m tot 15m	Over 15m
Buildings other than single storey buildings of lightweight construction	-	0,5	1,2
Single storey buildings of lightweight construction (e.g. timber framed)	-	0,7	1,5
Free standing masonry walls	-	1,0 ¹ 0,5 ²	2,0 ¹ 1,0 ²
Drains and underground services <ul style="list-style-type: none"> • less than 1 meter deep • more than 1 meter deep 	0,5 -	1,5 1,0	3,0 2,0

Note:

1) These distances will generally avoid all direct damage

2) These distances assume that some movement and minor damage, which may be tolerated, might occur.

This table provides guidance on the acceptable proximity of young trees or new planting to allow for future growth. This table should not be taken to imply that construction work can occur at the specified distances from existing trees; as such work might damage the tree, or render it dangerous, but refers to the potential for future growth, either of a young tree or of planting, occurring subsequent to construction



L.J Kruger Pr. Sci. Nat.

15. **REFERENCES**

- "Guidelines for Urban Engineering Geological Investigations", SAIEG & SAICE, 1995
- "Home Building Manual Part 1 & 2", National Home Builders Registration Council, 1999
- "Revised Guide to Soil Profiling for Civil Engineering Purposes in Southern Africa", Jennings Brink and Williams, The Civil Engineer in SA, 1973
- "The Prediction of Soil Heave from the Plasticity Index and Percentage Clay Fraction of Soils", D.H van der Merwe, The Civil Engineer in South Africa, 1964
- "A Guide to Construction on or with Materials Exhibiting Additional Settlement due to Collapse of Grain Structure", Jennings and Knight 1975
- "A Short Workshop on Suggested Interpretation Techniques of Soil Movement with Emphasis on Heave and Collapse Conditions": SAIEG, 1999
- "The Engineering Geology of Southern Africa", Volumes 1, 2 , 3 and 4, A.B.A Brink
- "Soil Survey for Engineering", Brink, Partridge & Williams
- South African Bureau of Standards Standardized Specification for Civil Engineering Construction DB: Earthworks (Pipe Trenches) SABS 1200 DB-1982
- Technical Recommendations for Highways, TRH 14 of 1985

APPENDIX A

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPIESLAAGTE 385 JR


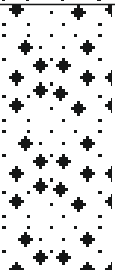
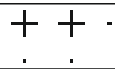
CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 1.

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
		0,3	
			Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,5	
			Slightly moist, orange speckled white with black stained joints, very soft rock granite
		1,8	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR





CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 2.

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
			0,3
			Slightly moist, greyish white mottled orange and black, firm, intact, clayey sand with medium and large ferricrete concretions and with patches of very soft rock granite - Reworked residual granite
			1,3
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

CLIENT: Keymacx

MACHINE: TLB	LOGGED BY: LJK
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TEST PIT: 3. DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
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			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
	0,5		Slightly moist, dark brown becoming yellow mottled orange and black, loose, \silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
	1,2		Slightly moist, orange speckled white with black stained joints, very soft rock granite
	1,5		Refusal on soft rock granite
			No ground water

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SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

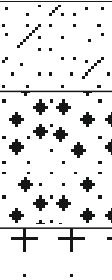
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MACHINE: TLB

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TEST PIT: 4.

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			<p>Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium</p> <p>0,4</p> <p>Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles</p> <p>1,0</p> <p>Slightly moist, orange speckled white with black stained joints, very soft rock granite</p> <p>1,3</p> <p>Refusal on soft rock granite</p> <p>No ground water</p>

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR


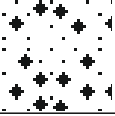
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MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 5.

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
			0,3 Slightly moist, dark brown becoming yellow mottled orange and black, loose, \silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
			0,8 Refusal on hardpan ferricrete
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR


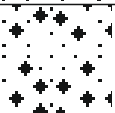


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MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 7

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
		0,3 	Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		0,8 	Slightly moist, greyish white mottled orange and black, firm, intact, clayey sand with medium and large ferricrete concretions and with patches of very soft rock
		1,2 	granite - Reworked residual granite
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

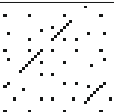
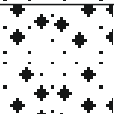
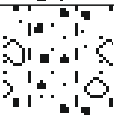
PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

CLIENT: Keymacx

MACHINE: TLB	LOGGED BY: LJK
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TEST PIT: 8. DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
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			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
	0,5		Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
	1,0		Slightly moist, greyish white mottled orange and black, firm, intact, clayey sand with medium and large ferricrete concretions and with patches of very soft rock granite - Reworked residual granite
	1,5		Refusal on soft rock granite
			No ground water

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SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR



CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 9

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
			0,3 Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
			0,8 Refusal on hardpan ferricrete
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPIESLAAGTE 385 JR

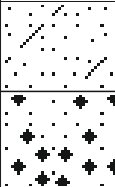
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TEST PIT: 10

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			<p>Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium</p> <p>0,4 Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles</p> <p>0,8</p> <p>Refusal on hardpan ferricrete</p> <p>No ground water</p>

SOIL PROFILE



PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

CLIENT: Keymacx

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TEST PIT: 12 DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
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			0,2	Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
			0,5	Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
				Refusal on hardpan ferricrete
				No ground water

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SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPIESLAAGTE 385 JR


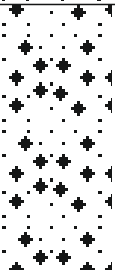
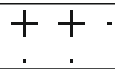
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TEST PIT: 15

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
		0,3	
			Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,5	
			Slightly moist, orange speckled white with black stained joints, very soft rock granite
		1,8	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPIESLAAGTE 385 JR


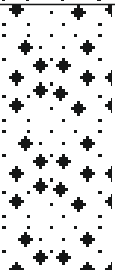
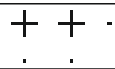
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MACHINE: TLB

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TEST PIT: 16

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, dark brown, soft, shattered, silty sand with plant roots - Colluvium
		0,3	
			Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,5	
			Slightly moist, orange speckled white with black stained joints, very soft rock granite
		1,8	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR



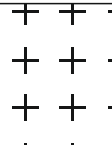
CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 17

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium
			0,5 Slightly moist, dark brown becoming yellow mottled orange and black, loose, \silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
			1,2 Slightly moist, orange speckled white with black stained joints, very soft rock granite
			1,8 Refusal on soft rock granite
			No ground water

SOIL PROFILE

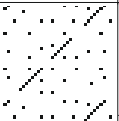
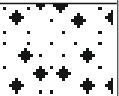
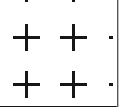
PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

CLIENT: Keymacx

MACHINE: TLB	LOGGED BY: LJK
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TEST PIT: 18 DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
------------------	-----------------	--------	-------------

			<p>Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium</p>
	0,6		<p>Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles</p>
	1,0		<p>Slightly moist, orange speckled white with black stained joints, very soft rock granite</p>
	1,5		<p>Refusal on soft rock granite</p> <p>No ground water</p>

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SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPIESLAAGTE 385 JR


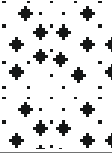
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MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 19

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium
		0,3 	Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,0	Refusal on hardpan ferricrete
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

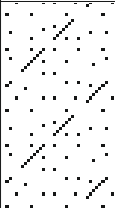
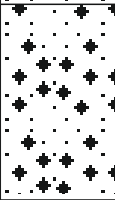
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MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 21

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium
		0,9	
			Slightly moist, greyish white mottled orange, firm, intact, silty sand with very soft rock fragments - Residual granite
		1,8	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR


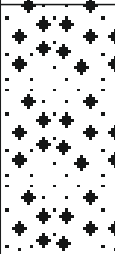
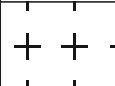
CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 22

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium
		0,5	
			Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,6	
			Slightly moist, orange speckled white with black stained joints, very soft rock granite
		2,0	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

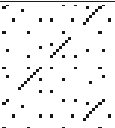
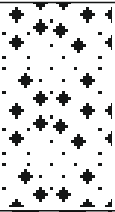
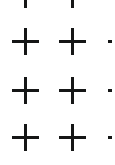
CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 23

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Slightly moist, brown, soft, shattered, silty, gravelly, sand with plant roots - Colluvium
		0,6	
			Slightly moist, dark brown becoming yellow mottled orange and black, loose, \silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,5	
			Slightly moist, orange speckled white with black stained joints, very soft rock granite
		2,3	
			Refusal on soft rock granite
			No ground water

SOIL PROFILE

PROJECT: Ptn 105 Ptn 109 Rem Ptn 133 SITE: KNOPJESLAAGTE 385 JR

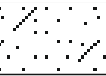

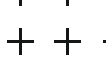
CLIENT: Keymacx

MACHINE: TLB

LOGGED BY: LJK

TEST PIT: 25

DATE: 18/11/2015

SAMPLE / TEST	GROUND WATER	LEGEND	DESCRIPTION
			Fill, consisting of dark brown, soft, clayey sand with plant roots
		0,3 	Slightly moist, dark brown becoming yellow mottled orange and black, loose, silty, sandy, fine and medium gravel consisting of hard, round, intact, nodular ferricrete and medium ferricrete concretions and with scattered medium sized quartz cobbles
		1,0 	Slightly moist, orange speckled white with black stained joints, very soft rock granite
		1,4	Refusal on soft rock granite
			No ground water

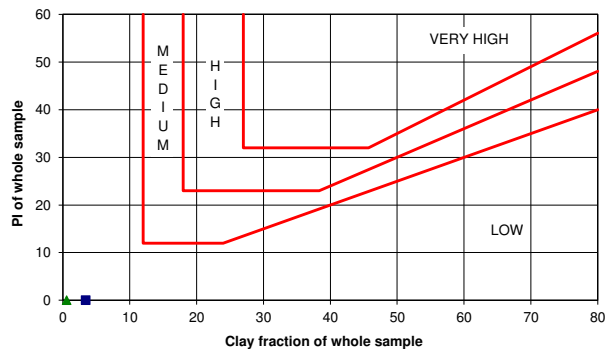
APPENDIX B

PARTICLE SIZE ANALYSIS

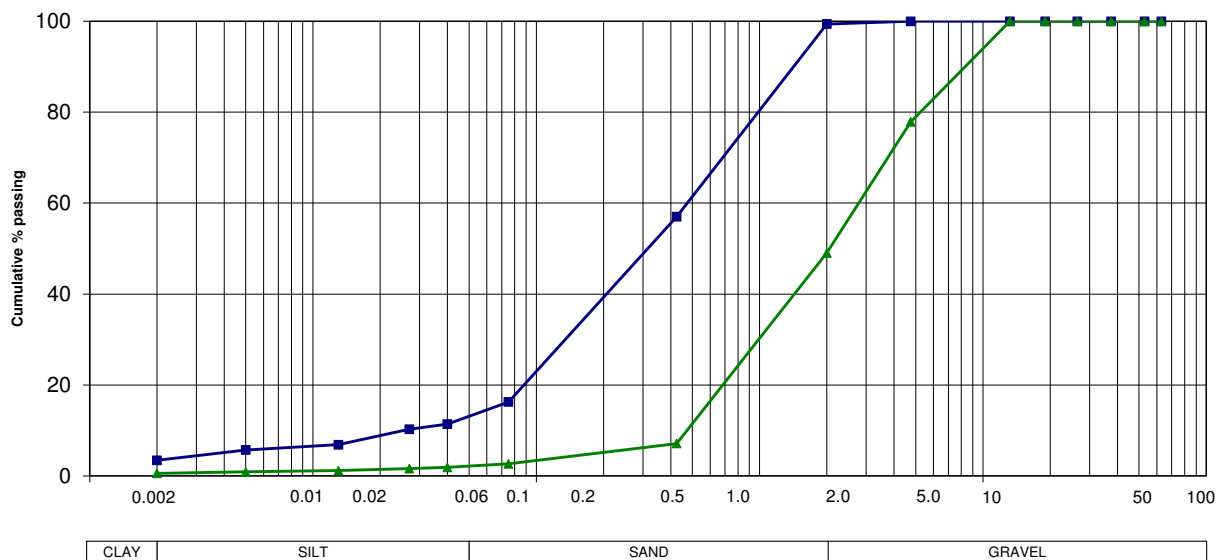
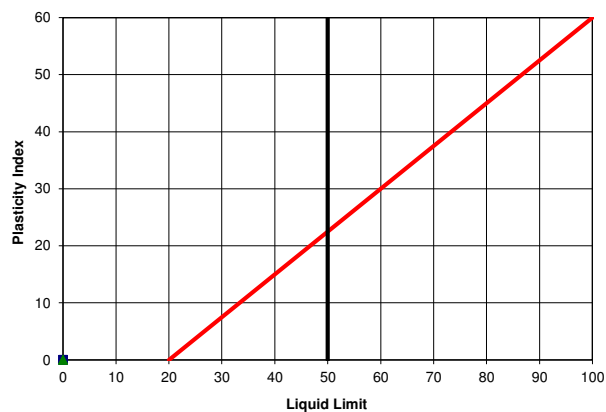
Sample No.	1	2
Soillab Sample No.	2015-S-1607-01	2015-S-1607-02
Depth (m)		
Position	SAMPLE 1	SAMPLE 2
Material Description	DARK GREY SILTY SAND	DARK GREY FERRICRETE W/ GRANITE SANDY GRAVEL
Organic Material	YES	YES
Moisture (%) / Dispersion (%)		
SCREEN ANALYSIS (% PASSING) (TMH 1 A1(a) & A5)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	100	78
2.00 mm	99	49
0.425 mm	57	7
0.075 mm	16	3
HYDROMETER ANALYSIS (% PASSING) (TMH 1 A6)		
0.040 mm	11	2
0.027 mm	10	2
0.013 mm	7	1
0.005 mm	6	1
0.002 mm	3	1
% Clay	3	1
% Silt	11	2
% Sand	85	47
% Gravel	1	51
ATTERBERG LIMITS (TMH 1 A2 - A4)		
Liquid Limit		
Plasticity Index	SP	SP
Linear Shrinkage (%)	0.5	1.0
Grading Modulus	1.27	2.41
Uniformity coefficient	19	6
Coefficient of curvature	1.5	0.7
Classification	A-2-4 (0)	A-1-a (0)
Unified Classification	SM	SP
Chart Reference		

PROJECT : KNOPJESFONTEIN X2
 JOB No. : 2015-S-1607
 DATE : 18-11-2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



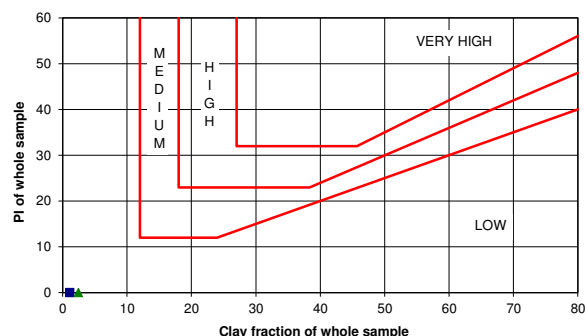
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PARTICLE SIZE ANALYSIS

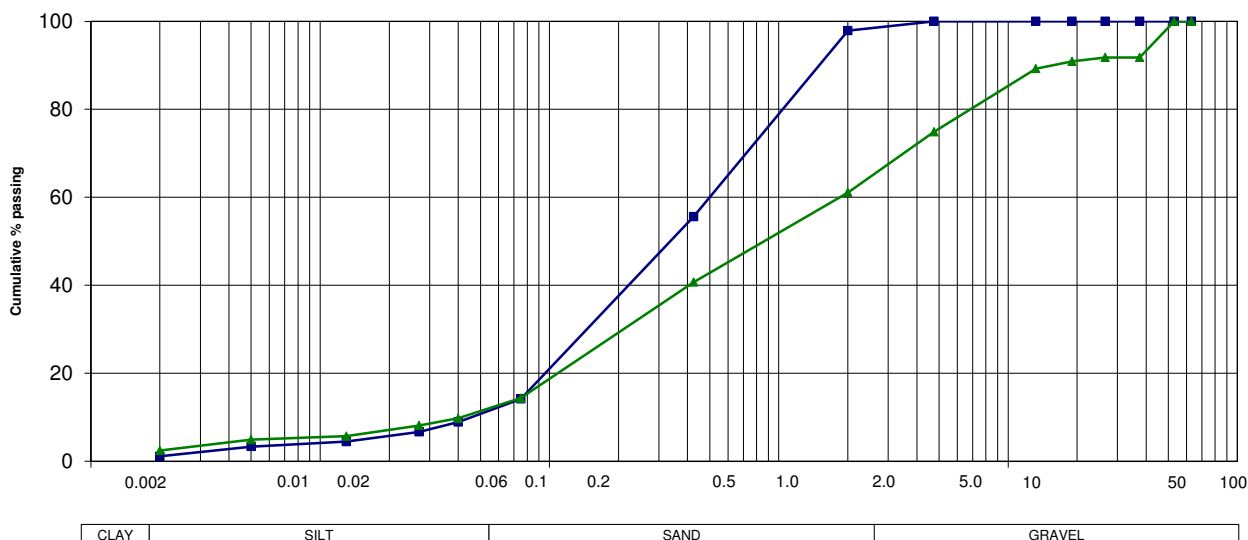
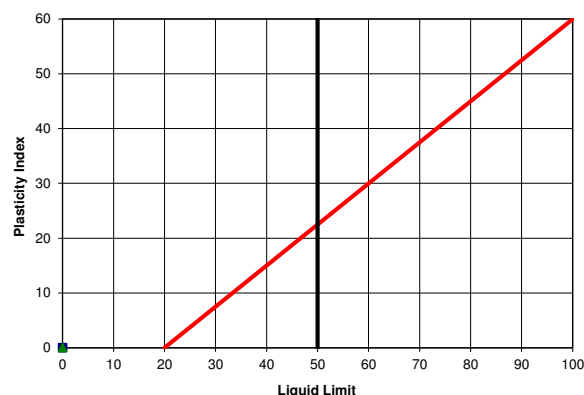
Sample No.	3	4
Soillab Sample No.	2015-S-1607-03	2015-S-1607-04
Depth (m)		
Position	SAMPLE 3	SAMPLE 4
Material Description	LIGHT GREY SILTY SAND YES	DARK GREY FERRICRETE QUARTZ GRAVELLY SAND YES
Organic Material		
Moisture (%) / Dispersion (%)		
SCREEN ANALYSIS (% PASSING) (TMH 1 A1(a) & A5)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	92
26.5 mm	100	92
19.0 mm	100	91
13.2 mm	100	89
4.75 mm	100	75
2.00 mm	98	61
0.425 mm	56	41
0.075 mm	14	14
HYDROMETER ANALYSIS (% PASSING) (TMH 1 A6)		
0.040 mm	9	10
0.027 mm	7	8
0.013 mm	4	6
0.005 mm	3	5
0.002 mm	1	2
% Clay	1	2
% Silt	11	10
% Sand	86	49
% Gravel	2	39
ATTERBERG LIMITS (TMH 1 A2 - A4)		
Liquid Limit		
Plasticity Index	NP	SP
Linear Shrinkage (%)	0.0	0.5
Grading Modulus	1.32	1.84
Uniformity coefficient	11	45
Coefficient of curvature	0.9	0.6
Classification	A-2-4 (0)	A-1-b (0)
Unified Classification	SM	SM
Chart Reference		

PROJECT : KNOPJESFONTEIN X2
JOB No. : 2015-S-1607
DATE : 18-11-2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART

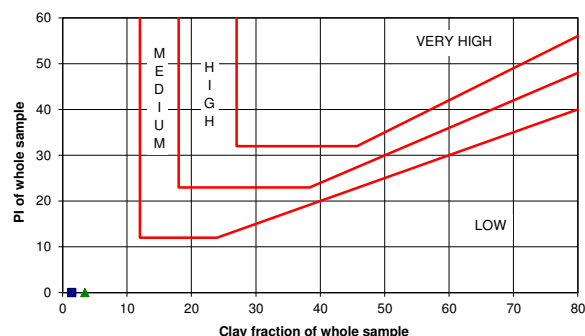


PARTICLE SIZE ANALYSIS

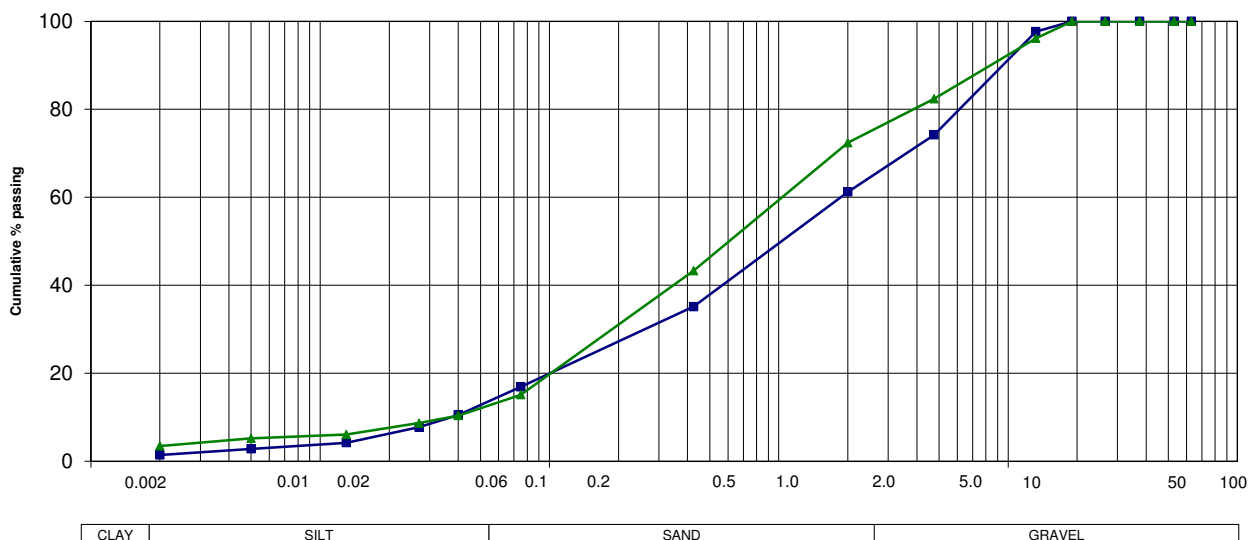
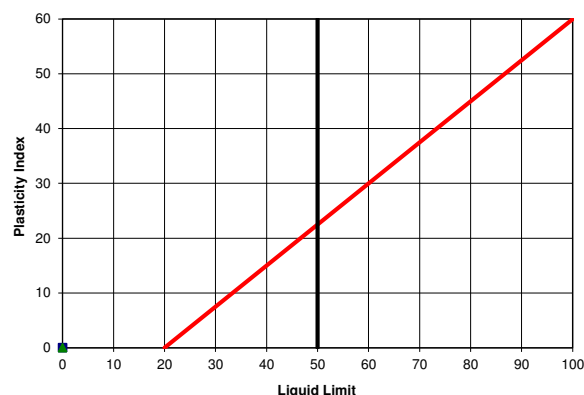
Sample No.	5	6
Soillab Sample No.	2015-S-1607-05	2015-S-1607-06
Depth (m)		
Position	SAMPLE 5	SAMPLE 6
Material Description	DARK REDDISH BROWN FERRICRETE QUARTZ GRAVELLY SAND	DARK GREY FERRICRETE QUARTZ GRAVELLY SAND
Organic Material		YES
Moisture (%) / Dispersion (%)		
SCREEN ANALYSIS (% PASSING) (TMH 1 A1(a) & A5)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	96
4.75 mm	74	82
2.00 mm	61	72
0.425 mm	35	43
0.075 mm	17	15
HYDROMETER ANALYSIS (% PASSING) (TMH 1 A6)		
0.040 mm	11	10
0.027 mm	8	9
0.013 mm	4	6
0.005 mm	3	5
0.002 mm	1	3
% Clay	1	3
% Silt	13	10
% Sand	47	59
% Gravel	39	28
ATTERBERG LIMITS (TMH 1 A2 - A4)		
Liquid Limit		
Plasticity Index	NP	SP
Linear Shrinkage (%)	0.0	1.0
Grading Modulus	1.87	1.69
Uniformity coefficient	50	28
Coefficient of curvature	1.0	0.9
Classification	A-1-b (0)	A-1-b (0)
Unified Classification	SM	SM
Chart Reference		

PROJECT : KNOPJESFONTEIN X2
JOB No. : 2015-S-1607
DATE : 18-11-2015



POTENTIAL EXPANSIVENESS



PLASTICITY CHART

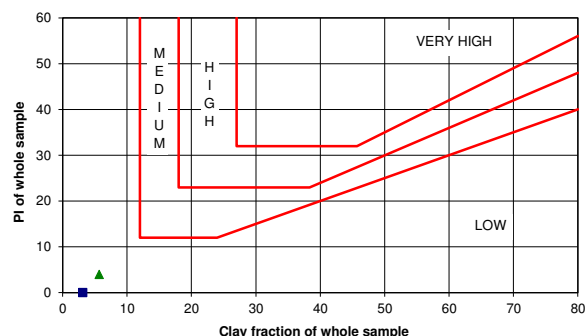


PARTICLE SIZE ANALYSIS

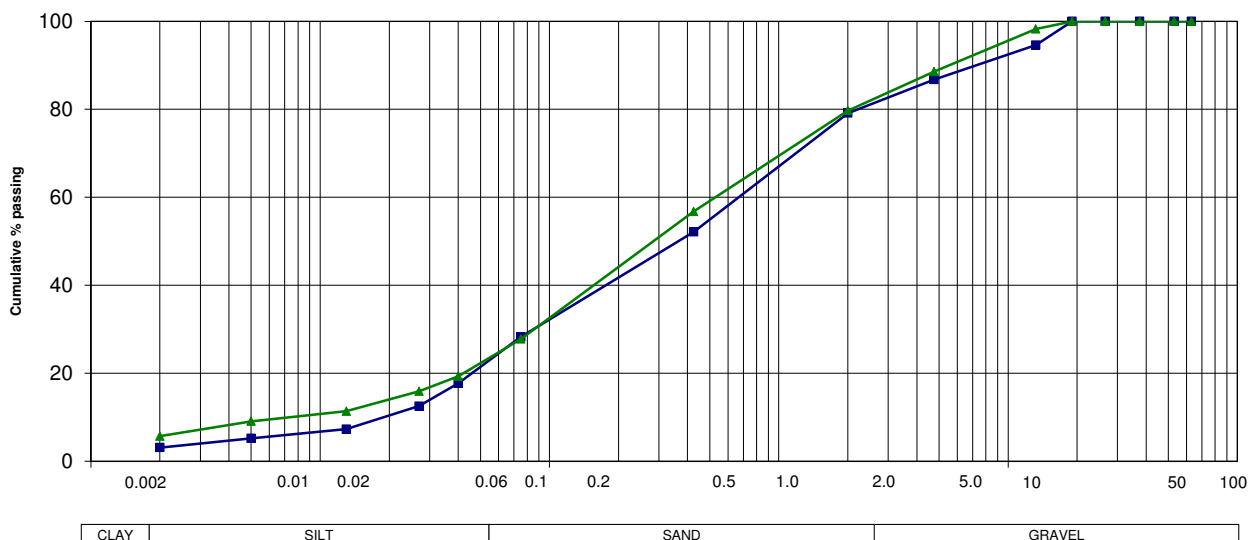
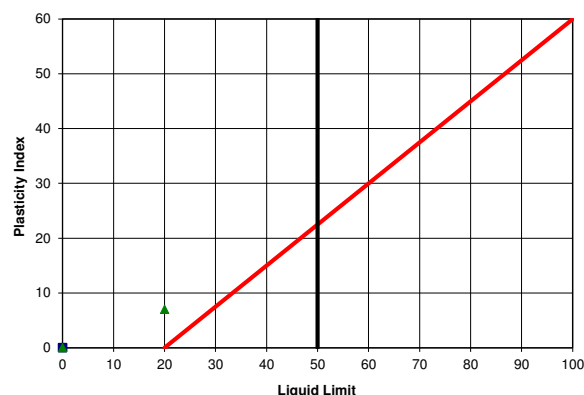
Sample No.	7	8
Soillab Sample No.	2015-S-1607-07	2015-S-1607-08
Depth (m)		
Position	SAMPLE 7	SAMPLE 8
Material Description	LIGHT BROWN FERRICRETE W/ GRANITE GRAVELLY SAND	DARK GREY FERRICRETE W/ GRANITE GRAVELLY SAND
Organic Material		YES
Moisture (%) / Dispersion (%)		
SCREEN ANALYSIS (% PASSING) (TMH 1 A1(a) & A5)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	95	98
4.75 mm	87	89
2.00 mm	79	80
0.425 mm	52	57
0.075 mm	28	28
HYDROMETER ANALYSIS (% PASSING) (TMH 1 A6)		
0.040 mm	18	19
0.027 mm	13	16
0.013 mm	7	11
0.005 mm	5	9
0.002 mm	3	6
% Clay	3	6
% Silt	21	18
% Sand	55	56
% Gravel	21	20
ATTERBERG LIMITS (TMH 1 A2 - A4)		
Liquid Limit		20
Plasticity Index	NP	7
Linear Shrinkage (%)	0.0	3.0
Grading Modulus	1.40	1.36
Uniformity coefficient	35	72
Coefficient of curvature	0.6	1.9
Classification	A-2-4 (0)	A-2-4 (0)
Unified Classification	SM	SM & SC
Chart Reference		

PROJECT : KNOPJESFONTEIN X2
 JOB No. : 2015-S-1607
 DATE : 18-11-2015



POTENTIAL EXPANSIVENESS



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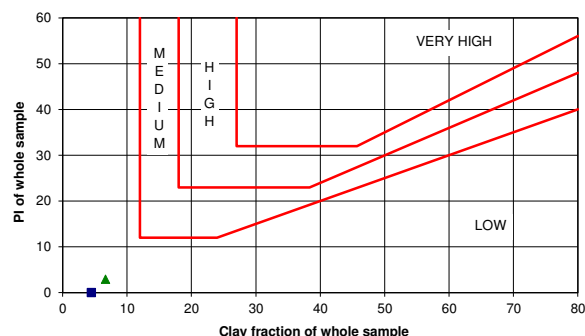


PARTICLE SIZE ANALYSIS

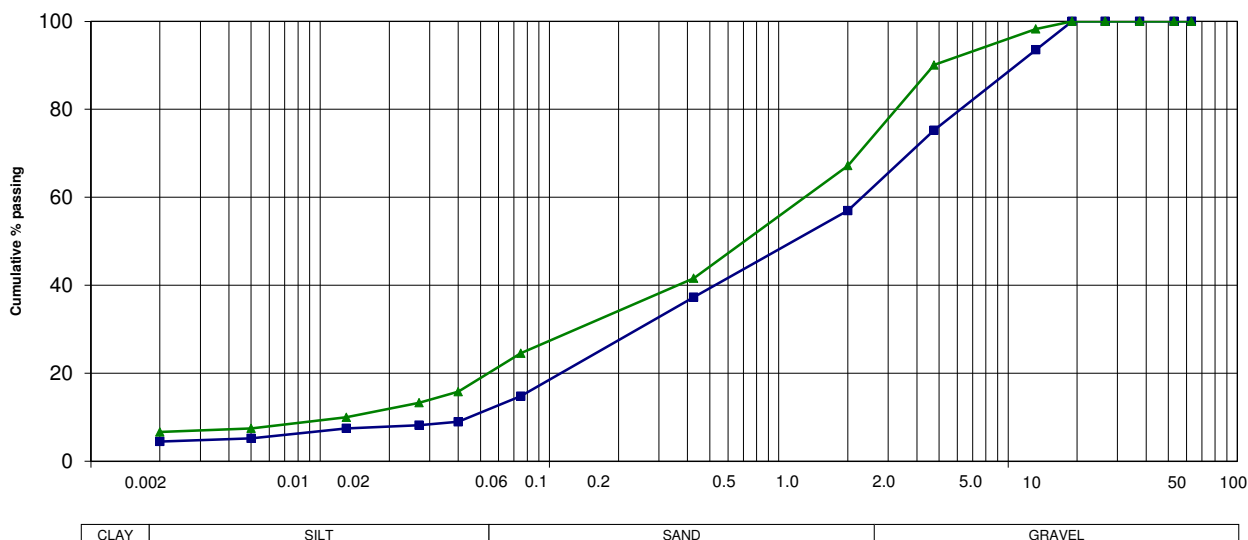
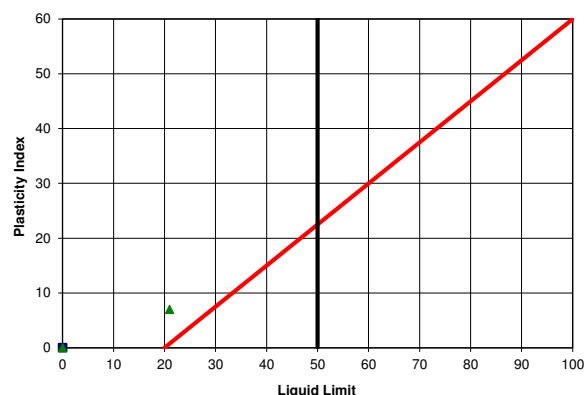
Sample No.	9	10
Soillab Sample No.	2015-S-1607-09	2015-S-1607-10
Depth (m)		
Position	SAMPLE 9	SAMPLE 10
Material Description	DARK BROWN QUARTZ FERRICRETE GRAVELLY SAND	LIGHT BROWN FERRICRETE W/ GRANITE GRAVELLY SAND
Organic Material		
Moisture (%) / Dispersion (%)		
SCREEN ANALYSIS (% PASSING) (TMH 1 A1(a) & A5)		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	94	98
4.75 mm	75	90
2.00 mm	57	67
0.425 mm	37	42
0.075 mm	15	25
HYDROMETER ANALYSIS (% PASSING) (TMH 1 A6)		
0.040 mm	9	16
0.027 mm	8	13
0.013 mm	7	10
0.005 mm	5	7
0.002 mm	4	7
% Clay	4	7
% Silt	8	14
% Sand	45	46
% Gravel	43	33
ATTERBERG LIMITS (TMH 1 A2 - A4)		
Liquid Limit		21
Plasticity Index	SP	7
Linear Shrinkage (%)	1.0	3.0
Grading Modulus	1.91	1.67
Uniformity coefficient	52	99
Coefficient of curvature	0.6	1.0
Classification	A-1-b (0)	A-2-4 (0)
Unified Classification	SM	SM & SC
Chart Reference		

PROJECT : KNOPJESFONTEIN X2
 JOB No. : 2015-S-1607
 DATE : 18-11-2015

POTENTIAL EXPANSIVENESS



PLASTICITY CHART



ADDENDUM G

TRAFFIC IMPACT STUDY

TRAFFIC IMPACT STUDY

**Portions 105, 109 & 331 of the
Farm Knopjeslaagte 385 JR**

May 2016



route ²
transport strategies

po box 67823 highveld 0169
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cell: +27 (82) 814 2230
jac.botha@route2.co.za

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FIGURES

Figure 1	Locality Plan
Figure 2	Existing 2016 Peak Hour Traffic volumes
Figure 3	Trip Distribution & Assignment
Figure 4	Base 2017 with Development Traffic
Figure 5	Gautrans Map D5
Figure 6	Road Reserves
Figure 7	Aerial Locality

ANNEXURES

Annexure A	Outputs of aaSIDRA Intersection Analyses
Annexure B	Aerial Photo
Annexure C	Proposed Site Layout

1 INTRODUCTION

Route² – Transport Strategies have been appointed to undertake a Traffic Impact Study for the proposed Commercial and Light Industrial development on Portions 105, 109 & 331 of the Farm Knopjeslaagte 385 JR. The site located to the north of the N14 and south of the R114 (M34).



The Site

2 SCOPE OF THE REPORT

The purpose of this report is to identify the traffic impact that would be generated by the proposed development on the surrounding road network. The study area, development trip generation, trip distribution, capacity analysis and site access requirements are assessed in the report. Recommendations are also made in terms of public transport.

2.1 Study Area

The extent of the study area is driven by an estimation of the traffic generated by the proposed development and the intersections likely to be affected by the additional traffic. The development is expected to generate +/- **840** peak hour trips, therefore a traffic impact study is required.

The study includes the intersections of:

1. R511 and R114 (M34) – priority controlled.
2. R114 and Access Road – proposed signals.

2.2 Roads Affected

R511 (P39-1)

The R511 is a Class 2 road and was recently upgraded all the way to Erasmia. This road is also the future K46 with intersection spacing of 600m.



R114 (P102-1)

The R114 (M34) is a Class 2 road. This road is a normal provincial road and should have intersection spacing of 600m.



2.3 Peak Hours Analysed

Peak morning and afternoon traffic counts were conducted on Tuesday 24 May 2016 at the intersections mentioned above.

The existing weekday AM (07:00 – 08:00) and PM (16:00 – 17:00) peak hour traffic volumes are summarised in **Figure 2**.

2.4 Assessment Scenarios

To determine the likely impact of the additional traffic on the network the following three scenarios were analysed:

- **Existing 2016** AM and PM peak hour flows;
- **Base 2017** AM and PM peak hour flows with development traffic; and
- **Future 2021** traffic.

3 PROPOSED DEVELOPMENT

This traffic impact study is in support of the Rezoning Application for Commercial and Light Industrial use. The following development controls are applied for as per **Table 1** below.

Table 1: Development Controls

Township	Land Use	Potential Size
Portions 105, 109 & 331 Farm Knopjeslaagte	Commercial & Light Industrial (36 hectares @ FAR 0.5)	140 000m ² GLA

4 DEVELOPMENT TRAFFIC

4.1 Trip Generation

The trip generation for the development was derived using the new COTO trip Manual for Manufacturing.

The predicted peak hour traffic to and from the site is summarised in **Table 2** below.

Table 2: Peak Hour Trip Generation

Peak Hour	Land Use	Trip Rate	Split	New Trips	
				IN	OUT
Weekday AM	Manufacturing (140 000m ²)	0.6	80:20	672	168
Weekday PM	Manufacturing (140 000m ²)	0.6	80:20	168	672

4.2 Trip Distribution

The following distribution was used as summarised in **Figure 3**:

- 20% from the north along the R511.
- 40% from the south along the R511.
- 40% from the east along R114 (M34).

Figure 3 illustrates the assumed trip distribution for the development traffic while **Figure 4** illustrates the **Base 2017** traffic with the additional development traffic and an expected 5% growth in background traffic.

5 TRAFFIC IMPACT & CAPACITY ANALYSES

5.1 Assessment Criteria

The intersections have been analysed using aaSIDRA traffic analysis software. SIDRA is a computer program that provides a number of performance measures including v/c ratios, delays, level of service (LOS), etc.

When elements of a road network such as intersections are analyzed, their operating conditions are described in terms of LOS. The six letters from A to F are used to indicate different LOS. LOS A indicates very light traffic with correspondingly low delays. LOS E reflects capacity conditions, with high delays and unstable flow. LOS F reflects conditions where traffic demand exceeds capacity and traffic experiences congestion and delays. Generally LOS A to D is considered acceptable in accordance with international standards. LOS E and F on the other hand are deemed unacceptable.

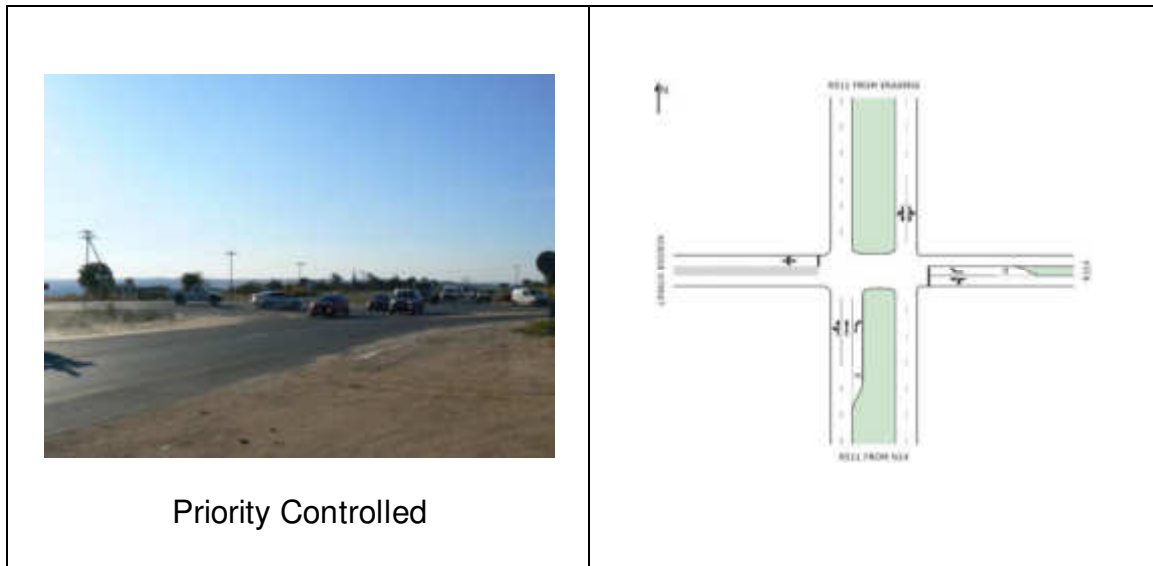
A further measure of the operating conditions prevailing at any one point in a road network is the volume to capacity ratio (v/c). As the name implies it is the traffic demand volume divided by the available capacity of the roadway element. Generally ratios of up to approximately 0.9 are internationally deemed acceptable.

Results of the aaSIDRA capacity analyses at the intersections are discussed in the following sub sections, with details of the outputs enclosed in **Annexure A**.

5.2 Background Traffic

The analysis results of the background traffic with development traffic includes a 5% growth per annum. At this stage there is no approved latent rights in the area.

5.3 R511 and R114

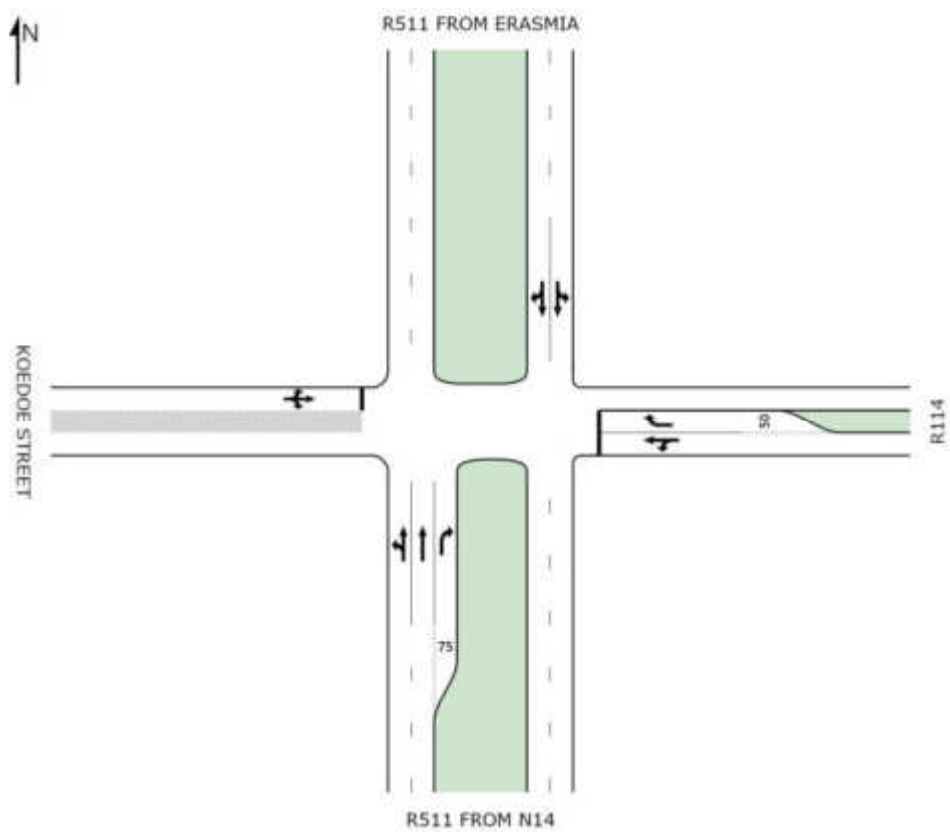


Results of Analysis:

Scenario	AM Peak Hour					PM Peak Hour				
	NB	WB	SB	EB	TOTAL	NB	WB	SB	EB	TOTAL
Existing 2015	N/A (34.2) {>1.0} [>120]	F (>120) {>1.0} [>120]	N/A (1.0) {0.36} [0.00]	F (>120) {>1.0} [66.1]	N/A (>120) {>1.0} [>120]	N/A (2.7) {0.23} [6.4]	F (92.1) {>1.0} [>120]	N/A (1.9) {0.15} [0.00]	E (40.8) {0.09} [1.6]	N/A (21.2) {>1.0} [>120]
Base 2017 + Development + Signals + Upgrades	C (20.4) {0.81} [108.8]	C (22.3) {0.85} [81.6]	C (26.5) {0.85} [114.3]	C (29.7) {0.17} [13.2]	C (23.1) {0.85} [114.3]	C (29.0) {0.69} [73.9]	B (12.8) {0.65} [45.8]	B (19.1) {0.43} [46.1]	B (12.0) {0.01} [1.1]	C (20.7) {0.69} [73.9]
Future 2021	C (22.3) {0.96} [>120]	C (25.8) {0.96} [82.2]	D (38.8) {0.94} [>120]	C (33.4) {0.20} [14.7]	C (29.8) {0.96} [>120]	C (26.6) {0.66} [86.2]	B (14.3) {0.69} [52.9]	B (18.0) {0.44} [53.2]	B (13.5) {0.01} [1.3]	C (20.2) {0.69} [86.2]
Legend										
A	Level of Service									
(12.7)	Delay in Seconds									
{0.95}	Volume / Capacity									
[20]	Longest Average Queue in meters									

For the **Existing 2016** scenario the analysis indicates that the intersection operates with major delays along the R114 approaches. To mitigate this traffic signals are proposed which has being proposed and is Warranted as per Warrant 1 of SARTSM. The signals are proposed since it is a direct result of the existing traffic volumes and not the additional development traffic.

With including the development traffic by **2017 & 2021** the intersection operation will improve considerably with the proposed traffic signals. The proposed layout is shown below with an additional northbound right turning lane.



5.4 R114 and New Access Road

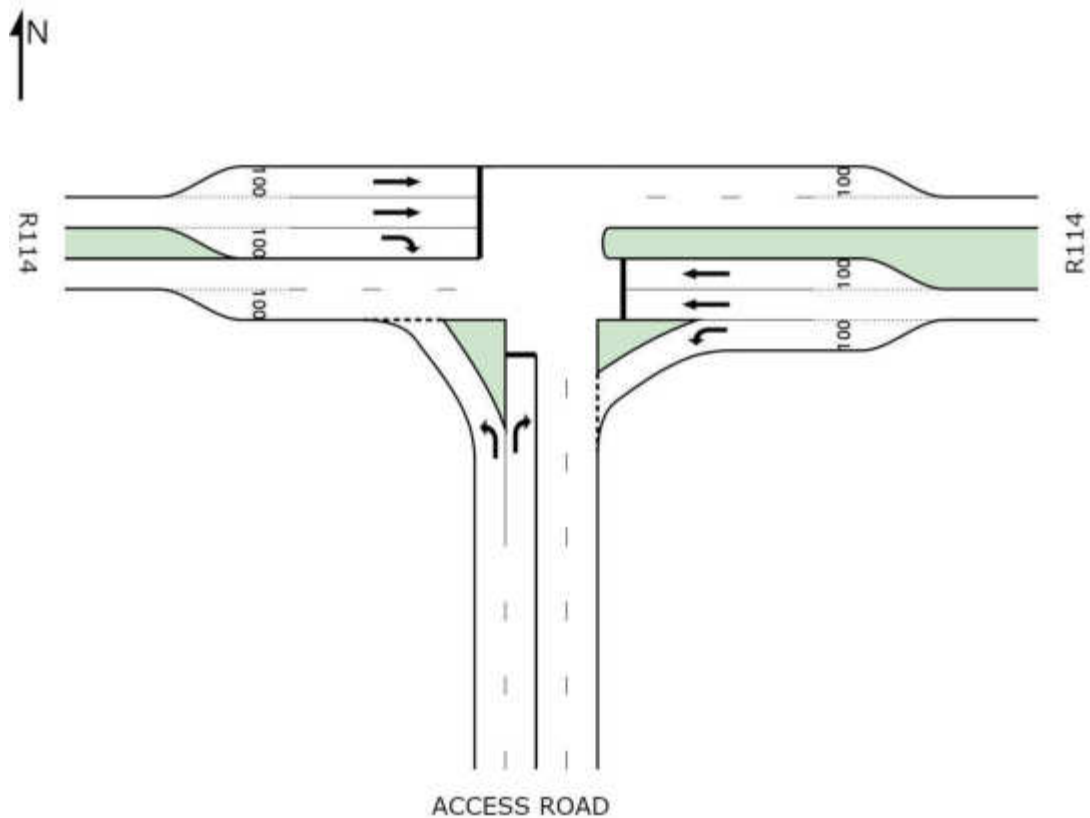


Proposed Signals

Results of Analysis:

Scenario	AM Peak Hour					PM Peak Hour				
	NB	WB	SB	EB	TOTAL	NB	WB	SB	EB	TOTAL
Base 2017 + Development + Signals	C (33.9) {0.74} [31.5]	B (12.6) {0.75} [111.7]		B (13.8) {0.75} [>120]	B (14.6) {0.75} [>120]	B (17.2) {0.46} [57.8]	B (19.4) {0.47} [55.6]		B (15.3) {0.28} [38.2]	B (17.3) {0.47} [57.8]
Future 2021	D (45.6) {0.71} [29.9]	A (4.8) {0.55} [83.1]		A (11.6) {0.72} [50.7]	A (10.3) {0.72} [83.1]	C (21.3) {0.51} [76.1]	B (17.9) {0.49} [64.4]		C (22.0) {0.43} [55.4]	C (20.4) {0.51} [76.1]
Legend										
A					Level of Service					
(12.7)					Delay in Seconds					
{0.95}					Volume / Capacity					
[20]					Longest Average Queue in meters					

For the **Base 2017** and **Future 2021** scenarios the analysis indicates that the intersection operates with an acceptable LOS during the peak hours analysed if signalised. The proposed layout is illustrated below:



5.5 Concluding Remarks

Based on our site observations, the existing and base traffic volumes shown in the figures, as well as the above capacity analyses, it is concluded that the proposed development traffic will have some impact on the weekday AM and PM peak hour intersection capacities and therefore it is proposed that the R114 and Access Road to the development is signalised.

6 ACCESS REQUIREMENTS

6.1 Access Location

Access to the proposed development will be from a 25m wide road linking from the R114. The access road should have two lanes in and two lanes out.

6.2 Sight Distance & Intersection Spacing

The proposed access road will be located 600m from the R511 and R114 intersection which is in line with the Gautrans spacing requirements.

7 ACCESS TO PUBLIC TRANSPORT

7.1 Background

In terms of the “National Land Transport Act” (NLTA) (Act No.5 of 2009), it is required that an assessment of public transport be included in traffic impact studies. The following comments are relevant.

7.2 Public Transport

The following public transport facilities are recommended:

- ***The implementation of bus and minibus-taxi lay-bys on both sides of the R114 at the Access Road intersection.***

The following is proposed for pedestrians:

- ***Construction of a 1,5m wide sidewalk along the Access Road from the R114.***

8 CONCLUSION

Route 2 – Transport Strategies was appointed to prepare a Traffic Impact Study in support of the development of Portions 105, 109 & 331 Farm Knopjeslaagte Township.

The development is expected to generate 840 peak hour trips during the peak hours. The capacity analysis indicates that the intersection of the R511 and R114 needs to be signalised as a result of background traffic and the intersection of the R114 and Access Road should be signalised with the necessary turning lanes being constructed to Gautrans Standards.

The following is proposed and can be concluded:

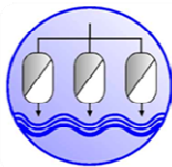
- ***Provision of 1,5m wide sidewalk along the Access Road from the R114.***
- ***The access road should have two lanes in and two lanes out.***
- ***The implementation of bus and minibus-taxi lay-bys on both sides of the R114 and Access Road intersection.***
- ***Upgrading of the R511 and R114 intersection with signals, an additional northbound right turning lane, a southbound left turning slip lane and additional westbound turning lanes.***

Figures

- Figure 1 Locality Plan**
- Figure 2 Existing 2016 Peak Hour Traffic volumes**
- Figure 3 Trip Distribution and Assignment**
- Figure 4 Base 2017 with Development Traffic**
- Figure 5 Gautrans Map D5**
- Figure 6 Road Reserves**
- Figure 7 Aerial Locality**

ADDENDUM H

PREVIOUS APPROVALS - SEWAGE TREATMENT WITH PACKAGE PLANT



PROPOSAL

600m³/day Waste Water Treatment Plant

E/4998/16-01

Client : GFC Consulting
Contact Person : Gawie Combrinck
Tel No. : 012 347 6299
E-Mail : gawiecombrinck@gfc-holdings.co.za
Date : 14 October 2016
No of Pages : 14

REVISION SCHEDULE

REV	DATE	DESCRIPTION	ORIGINATOR
A	2016-09-16	Issued for Approval	Taigrine Jones
00	2016-10-14	Issued to Client	Taigrine Jones
01	2016-09-19	Issued to Client	Johan Bieseman



1 INFORMATION FROM THE CLIENT

The client requested a quote for a 600m³/day sewage treatment plant.

2 PROCESS DESCRIPTION

AquaPlan MBBR:

The AquaPlan MBBR (Moving bed, biofilm reactor) process uses two reactors in series with a final clarification stage to lower the incoming effluent BOD and COD. This is mainly an aeration process during which nitrification occurs. The MBBR process is an excellent process solution that provides excellent BOD reduction, Nitrification, and total reduction of nitrogen removal processes.

The main advantage of this process is the floating media in the reactors which aids the attached growth of micro-organisms. This in turn increases the concentration of MLVSS. Unlike many other sewage treatment systems where the micro-organisms is continually removed from the reactor, the MBBR system is used to retain these organisms, cultivate and grow them to a point where more efficient sewage treatment can be established.

The micro-organisms will be cultivated on AquaPlan special floating media, which provides an excellent substrate for media growth while still ensuring a maintenance free, self-cleansing system.

To further aid in treatment efficiency, all AquaPlan reactors will be fitted with micro bubble or fine bubble aeration to increase oxygen transfer efficiency (SOTE) which in turn saves energy on the blower units.

The process will start with the raw effluent entering into a sump, from which it will be pumped at a continuous rate of 26m³/h into the MBBR system. Therefore the level inside the inlet sump will fluctuate, but will serve as flow equalisation unit. The raw sewage will enter into the first MBBR in which breakdown of the sewage water will start. All the liquid from this sump, including settleable solids will overflow into the second reactor for further treatment and reduction of BOD and COD. Finally, all liquid and settleable solids will overflow into a clarifier unit. The solids will then sink to the bottom of the clarifier to form a sludge blanket while the product water will overflow from the top of the clarifier.

From the clarifier the water will be pumped into a multimedia sand filter for further polishing and reduction of suspended solids at a rate of 26m³/h. Thus the flow through the entire process will be kept constant. After filtration the water will be dosed with sodium hypochlorite for disinfection and will flow into the client storage tank or downstream water system.



Sludge will be drawn from the bottom of the clarifier and a portion of the sludge will be recycled back to the 1st reactor to aid in biological efficiency due to the increased concentration of micro-organism. The remainder of the sludge will be pumped to a sludge collection tank or can be treated with drying beds.

3 TECHNICAL SPECIFICATION AND SCOPE OF SUPPLY:

3.1 INLET CONDITIONS OF DOMESTIC RAW SEWAGE:

bCOD / BOD (ratio)	1.6
BOD ₅	240 mg/L
sBOD	80 mg/L
COD	600 mg/L
sCOD	160 mg/L
VSS	200 mg/L
TSS	240 mg/L
Temperature	> 12 °C

3.2 OUTLET CONDITIONS OF TREATED WATER

COD	< 75 mg/L
NH ₄	< 10 mg/L
TSS	< 25
Nitrate (NO ₃)	10 – 20 mg/L

Flow	
Flow rate	600 m ³ /day
Treatment duration	24 hours/day
Average flow	25 m ³ /h
Flow per reactor	12,5 m ³ /h
Design aeration	4 hours contact time
Reactor volume	51,6 m ³
Settling velocity	1,5 m/h
Physical Dimensions:	
Total reactor & clarifier length	12 m
Total reactor & clarifier width	2,4 m
Total reactor & clarifier height	2,8 m
Reactor length	8,3 m



Clarifier length	3,7 m
Total fill volume	74 m ³
Internal	
Floating media	0,15 m ³ fill / m ³ reactor volume
Total fill	8 m ³
Clarifier lamella packs	28 packs
Fine bubble aeration	16 per reactor
Equipment	
Blower	Ecotao
Blower capacity	320 Nm ³ /h
Blower pressure	400 mbar
Power usage	5,5 Kw
Submersible pump	Cyclone Industries / Grundfos
Pump capacity	26 m ³ /h
Pump pressure	1 bar
Pump rpm	2,400
Pump power usage	2 Kw
Sludge recycle pump	Cyclone Industries / Grundfos
Pump capacity	5 m ³ /h
Pump pressure	0,8 bar
Pump rpm	2,400
Pump power usage	0,75 Kw
Product pump	Cyclone Industries / Grundfos
Pump capacity	26 m ³ /h
Pump pressure	1,5 bar
Pump rpm	2,400
Pump power usage	1,4 Kw
Electrical	
PLC	Delta



4 SCOPE OF SUPPLY

- 2 off AquaPlan MBBR Unit with air diffuser:
 - Flow rate (combined): 600 m³/day
 - 12m x 2,4m x 2,8m
 - Includes necessary valves
 - Includes 1 x ultrasonic level detector
 - Fitted with walk way and safety railing
 - Includes 1 x SS304 Aqua Drum (drum screen)
 - Note that the detail design of the exact size of the reactors (size and volume) rests with Aquaplan
- 1 off Auxiliary Skid
 - Control Panel:
 - Delta PLC
 - Delta colour HMI
 - Push button interface for manual override
 - PLC programming
 - Chlorine Disinfection tank (carbon steel)
 - Residence time of 30 minutes
 - Fitted with under draining system for maintenance and sludge removal
 - Includes positive displacement pump to dose the disinfectant
 - Pipework as part of skid:
 - Galvanised mild steel

4.1 COMMISSIONING AND TRAINING:

All Equipment installed on site by AquaPlan will tested for functionality at our workshop. Operators can also be trained as the testing of equipment takes place.

4.2 TREATED EFFLUENT QUALITY

Considering that the raw sewage would be of a domestic nature (not industrial), the following effluent quality, in line with the General standard for Sewage effluent, can be expected:

pH:	5.5 to 9.5
Oxygen absorbed:	< 10
Chemical oxygen demand mg/l:	< 75
Free and saline ammonia (mg/l):	< 10
Suspended solids m/l:	< 25
Soap, oil, grease (with input limit of 40 mg/l)	<2.5 mg/l



Residual chlorine (after 1 hour)	0.1 mg/l
Nitrate (mg/l)	10 – 20 mg/l
E-coli count:	0 per 100ml
Temperature:	below 30°C

Treated effluent can be used for non-crop irrigation purposes or for release into a maturation pond followed by a natural water cycle such as a river.

4.3 ENGINEERING AND STANDARDS:

The Engineering and fabrication of the items supplied under this proposal will be in accordance with all the relevant SABS Specifications and manufactured in strict accordance with the AquaPlan quality management system.

4.4 BATTERY LIMITS

4.4.1 START LOCATION

The start location of the battery limit is at the Inlet pipework to the rotating drum screen. The feed pressure required is 2 bar. The client will be required to supply the main incomer cable that will supply power to our centralized control panel. From this point all electrical and instrumentation cable will be supplied by AquaPlan. The piping required up to the flange connection is for the clients account.

4.4.2 END LOCATION

The end location of the battery limit is at the discharge flange of the chlorine contact tank. The handling and disposal of the dried sludge will be for the clients account.

4.4.3 CONCLUSION

All equipment within this location (as described in the start and end location) will be subjected to the scope of works as described in the scope of supply section.

4.5 EXCLUSIONS:

- Installation – AquaPlan has excluded installation from the scope of work. The AquaPlan team will however advise the client if there are any problems or enquiries during installation. Installation will strictly be done by the client.
- Scaffolding – AquaPlan will not be responsible for the set-up or removal of any scaffolding.
- Craneage – AquaPlan will not arrange or pay for hire or use of a crane for transport purposes our premises. If craneage is required, it will be to the cost of the client.

- d) Rigging – Rigging has not been included in the quote.
- e) Arranging work permits – Transportation of units and on site team is a battery limit, obtaining any work permits, access cards, or vehicle permits required to bring a truck or employees on to site will be the responsibility of the client.
- f) Clearance of site – AquaPlan will not do any site work relating to clearing of site so that work can commence.
- g) Any civil works – No repair work or construction activities related to the foundation or plinths will be done by AquaPlan on site. All plinths to be provided by the client.
- h) Electric components – AquaPlan will not provide any electric cables to supply power to the centralized panel or control system.
- i) Operation and maintenance of the plant – AquaPlan will not operate the plant or maintain any part of the plant or clarifiers. If the client required plant operators to be trained on the process and separate quote will be provided.
- j) Supply of standby equipment – AquaPlan will not supply any standby pumps or units.
- k) Supply and installation of any storage tanks – AquaPlan will not supply any storage tanks other than what is specified in the inclusions.
- l) Chemicals – AquaPlan will not provide any chemicals needed for the process.
- m) Supply of any spare parts – spare parts such as pumps and plates will not be provided.
- n) Supply, installation and testing of all piping.
- o) Supply of spare parts list – to be finalised on detailed design.
- p) Export documentation – AquaPlan will not provide a cost for export documentation as this quote is bas ex-works.
- q) Off-loading and storage from transport.
- r) Any item not explicitly mentioned.
- s) The inlet raw sewage screen has not been included in our supply. It is however critical that the client considers that this is included, however has not been included in this supply.
- t) The inlet balancing tank /or sump has also not been included in this scope of supply.

- u) Our supply is a fully functional containerised system that is put down on a concrete plinth system. We have included the complete process as needed- excluding the two points s, and t, above.
- v) The excavation and raw sewerage supply into an inlet sump is to be done by the client. The raw sewerage needs to be supplied into the reactor by the client. Once the raw sewerage has been supplied into the reactor, will the Aquaplan system take care of the screened sewage to be treated. Kindly note that a raw sewerage rotating screen is required at the sump, but has not been priced at this point.
- w) The client is to provide a disposal point for the treated effluent.
- x) The sludge removed periodically from the reactors needs to be Taken away by the client- a sludge tank will be provided- (5000 l)



4.6 DOCUMENT DELIVERABLE LIST:

Documents that will be supplied to the client at project design phase:

A) Project Initiation Documents

A1 Vendor Document Register	(Client)
A2 Tender / Formal Quote and Proposal	(AquaPlan)
A3 Official Order	(Client)
A4 Formal Contract	(AquaPlan / Client)
A5 Proposed Fabrication and Project Schedule	(AquaPlan)
A7 Payment Schedule	(AquaPlan / Client)
A8 Work Breakdown Structure	(AquaPlan)

B) Project Progress Documents

B1 Monthly Progress Reports	(AquaPlan)
B2 Monthly Updated Fabricated and Project Schedule	(AquaPlan)

C) Process Design Documents

C1 Process Flow Diagram	(AquaPlan)
C2 Battery Limit Schedule	(AquaPlan)
C3 Piping and Instrumentation Diagram	(AquaPlan)
C4 Functional Design Specifications	(AquaPlan / Client)
C5 Operating and Maintenance Manual	(AquaPlan)

D) Mechanical Design Documents

D1 Drawing Register (3D & Manufacturing)	(AquaPlan)
D2 Lubrication Schedule	(AquaPlan)
D3 Spare Part / Critical Schedule	(AquaPlan)
D4 Installation and Assembly Procedure	(AquaPlan)
D5 Technical Specification(s)	(AquaPlan)
D6 Engineering Data Book	(AquaPlan)
D7 Inspection Reports	(AquaPlan)

E) Electrical Design Documents

E1 Electrical Load Schedules	(AquaPlan)
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E2	Electrical Equipment Schedule	(AquaPlan)
G) Manufacturing Documents		
G1	Equipment and Bill of Materials Schedule	(AquaPlan)
G2	Manufacturing Procedures	(AquaPlan)
G3	Welding Documentation	(AquaPlan)
G4	Manufacturing QC Plan	(AquaPlan)
H) Project Completion Documents		
H1	Final Release and handover certificate (C1-C6)	(AquaPlan / Client)
H2	Client Hand Over Documentation	(AquaPlan / Client)



5 PROJECT COSTING

5.1 COST BREAKDOWN

Item	Description	Qty	Unit	Amount Ea	Total
1	Engineering & Design	1	Sum	R 72 000,00	R 72 000,00
2	Inlet Works and connecting pipeworkEquipment – part of the reactors	1	Sum	R 320 000,00	R 320 000,00
3	600m ³ /day MBBR System (2 off reactor containerised)	1	Sum	R 3 685 000,00	R 3 685 000,00
4	Auxiliary Skid & Electrical	1	Sum	R 530 700,00	R 530 700,00
5	Transport to site	1	Ea.	R 69 450,00	R 69 450,00
6	Commissioning	1	Sum	R 21 500,00	R 21 500,00
Sub Total A (Ex-Works and Excl. Vat)					R 4 698 650,00
7	Project Management, Quality Assurance and Control	4,00%	% of Sub Total A	R 187 946,00	R 187 946,00
8	Health and Safety Overheads	3,00%	% of Sub Total A	R 140 959,50	R 140 959,50
9	Data Books Cost	1,20%	% of Sub Total A	R 56 383,80	R 56 383,80
10	P&G's, Head Office Overheads and Engineering Cost	6,80%	% of Sub Total A	R 319 508,20	R 319 508,20
Total (excl. VAT)					R 5 350 447,50

5.2 TERMS OF PAYMENT:

The following terms will be adhered to:

- 30% of total contract value upon confirmation of order.
- 20% upon verification of cast numbers/MTC's or material delivery to site.
- 30% upon mechanical completion (before shipping).
- 15% upon delivery to site.
- 5% on completion of commissioning.
- All invoices to be settled within 7 day from invoice date.



6 COMMERCIAL CONDITIONS

6.1 CONDITIONS OF PROPOSAL:

This proposal is based on AquaPlan's Standard Conditions of Contract and Sale, which are described below.

6.2 PROJECT COST AND PRICE BASIS:

The Project Cost will be fixed and firm for an order placed within the validity period, to the amount in the ZAR currency.

Prices are comprehensive and cross-subsidised; no take out prices accepted.

6.3 VALIDITY:

This proposal remains valid for a period of thirty (30) days from date hereof, after which it will become subject to confirmation or re-negotiation.

6.4 WARRANTY:

All equipment supplied by AquaPlan in terms of this offer, will be fully guaranteed against faulty design or defective workmanship.

The guarantee will be for a period of thirteen (13) months from date of delivery of such equipment, or twelve (12) months from the date of commissioning of the complete system, whichever occurs first.

AquaPlan will not be held responsible to comply with the above stated guarantee in the event where equipment has been altered, or repaired, without our knowledge, or any damage caused by others to our equipment, or system, by improper operation, misuse, abuse, negligence, accidents. This will also apply in the event where the plant is expected to perform outside of the original design specification

6.5 PROJECT PROGRAM:

The Project will be executed in accordance with the current Project Program. We will require approximately **fourteen (14) to sixteen (16) weeks (depending on material availability and workshop load)** at receipt of official order, to complete the work.



6.6 TERMINATION OF CONTRACT:

Should the Contract be terminated by the Purchaser after placement of an official order, for any reasons that are not the responsibility of AquaPlan, damages that may be suffered arising out of such termination, will be charged to the Purchaser.

6.7 RATES OF EXCHANGE VALUES:

1 US\$ - R 14.00 (ZAR)

6.8 LAW OF COUNTRY:

South African Law to apply for this Contract

6.9 OUT OF SCOPE COST

Delayed or Additional Time:

The client bill for days exceeding the contract will be charged at the individual daily rate for those required to stay onsite until project completion as outlined in table below:

Discipline	Rate ZAR/hr	Discipline	Rate ZAR/hr
Design engineer	R 785,00	Senior Draughtsman	R 525,00
Project consultant	R 635,00	Drawing office administration	R 285,00
Project manager	R 785,00	Snr design draftsman - civil	R 635,00
Project Assistant / technician	R 277,00	Checker civil	R 285,00
Project Engineer	R 525,00	Commissioning manager	R 785,00
Engineering manager	R 785,00	Workshop Manager	R 635,00
Packager engineer	R 525,00	Quality Engineer	R 525,00
Lead process Engineer - design	R 785,00	Safety officer	R 285,00
Senior process engineer	R 635,00	Housekeeping superintendent	R 264,00
Process engineer	R 525,00	Planner	R 396,00
Lead Mechanical Engineer - design	R 785,00	Store manager	R 525,00
Senior Mechanical engineer	R 635,00	Store officer	R 285,00
Mechanical engineer	R 525,00	Procurement officer	R 330,00
Lead Electrical Engineer - design	R 785,00	Driver - LDV	R 158,00
Senior Electrical engineer	R 635,00	Driver - code 18	R 285,00
Electrical engineer	R 525,00	Welder	R 180,00
Lead Civil Engineer - design	R 785,00	Welder - coded	R 285,00
Senior Civil engineer	R 635,00	Boilermaker	R 285,00
Civil engineer	R 525,00	Assistant	R 95,00
Lead C&I Engineer - design	R 785,00	Semi-skilled	R 120,00
Senior C&I engineer	R 635,00	Pipe fitter	R 285,00
C&I engineer	R 525,00	Electrician (Gov. ticket)	R 397,00
Lead Piping Engineer - design	R 785,00	Electrical assistant	R 195,00
Senior Piping engineer	R 635,00	Machine operator	R 285,00
Piping engineer	R 525,00	Forklift driver	R 145,00
Departmental manager - Process	R 785,00	Painter	R 105,00
Departmental manager - Mechanical	R 785,00	Labourer	R 85,00
Departmental manager - Piping	R 785,00	Brick-layer	R 85,00
Departmental manager - Civil/structural	R 785,00	Plasterer	R 85,00



Departmental manager - C&I	R 785,00	Concrete technologist	R 285,00
Departmental manager - Electrical	R 785,00	Tiler	R 120,00
Departmental drawing office manager	R 635,00	Site Supervisor	R 525,00
All subsistence will be reimbursed per person per day spent on site			R 450,00

