



DOORNHOEK DEVELOPMENT SERVICES REPORT

FOR THE TOWNSHIP ESTABLISHMENT ON PTN 129 OF FARM DOORNHOEK 318-KQ

JULY 2021



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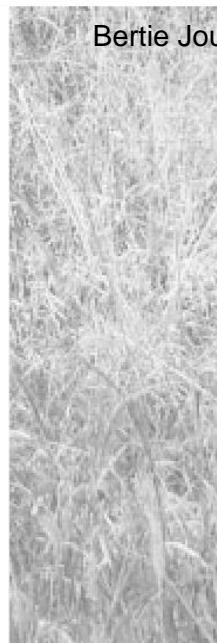


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EXECUTIVE SUMMARY

The following report will describe the civil engineering services required for the Doornhoek development situated on portion 129 of the farm Doornhoek 318 KQ.

The scope of civil services includes:

- Internal Engineering Services: Roads, Stormwater, Water and Sewer reticulation.
- Bulk Services: Sewer reticulation and pump station.

The Developer shall provide all the services necessary to create sustainable engineering services according to the Waterberg District Municipal standards.

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1. INTRODUCTION

1.1 BACKGROUND

Doornhoek development is a proposed new residential area situated on the northern outskirts of Thabazimbi, within the Waterberg District Municipal area (Refer to Locality plan in **APPENDIX A**). The development is located on farm PORTION 129 of the farm DOORNHOEK 318-LQ. The development is bound by existing civil services, such as stormwater, roads and water networks in the surrounding area.

The intended development is currently zoned as Agricultural land. A total number of 33 units is proposed on the available 2.4 ha land. The proposed development density is very low with a ratio of 13.75 units per ha.

The Services Report is required to supplement the application for the township establishment for the Doornhoek development.

As the appointed Civil Engineers, LEO Consulting is to execute the services design, which comprises of the sewerage, water, roads and stormwater services.

1.2 PURPOSE OF THIS REPORT

The report aims to:

- Summarise the shortfall analysis conducted on the existing services, caused by the interruption in development and,
- Provide the method statement for the required internal services for the Doornhoek development. This includes water, sanitation, roads and stormwater infrastructure.

1.3 SITE DESCRIPTION

1.3.1 Locality of the Site

The site is located north-east of Thabazimbi CBD along the *Thabazimbi – Marakele* road. The property is bounded by a residential development to the east, a small holding to the west and roads to the north and south. The property will gain access from the southern access road. At the time of this investigation the access road was known by the community as the *Medivet Road*. (refer to **APPENDIX A** for a locality plan of the site)

Latitude: 24°34'16.10"S

Longitude: 27°25'14.52"E

1.3.2 Regional Climate

The development is located within the summer rainfall region of the Waterberg District of South Africa.

The nearest weather station, known as the Thabazimbi station, has weather station number 0587725CX. The average yearly temperature is approximately 20.7 °C with an annual rainfall of 552 mm per year. The weather data is summarised in Figure 1-1 below.

THABAZIMBI WEATHER BY MONTH // WEATHER AVERAGES

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	24.7 °C (76.5) °F	24.6 °C (76.2) °F	23.2 °C (73.8) °F	20.2 °C (68.4) °F	17.1 °C (62.9) °F	14 °C (57.3) °F	13.6 °C (56.5) °F	17.2 °C (63) °F	21.3 °C (70.3) °F	23.9 °C (75) °F	24.3 °C (75.7) °F	24.6 °C (76.4) °F
Min. Temperature °C (°F)	19.6 °C (67.3) °F	19.5 °C (67.2) °F	18 °C (64.4) °F	14.6 °C (58.3) °F	10.4 °C (50.7) °F	6.9 °C (44.5) °F	6.1 °C (43.1) °F	9.2 °C (48.6) °F	13.3 °C (55.9) °F	16.6 °C (61.8) °F	18.2 °C (64.7) °F	19.3 °C (66.7) °F
Max. Temperature °C (°F)	29.9 °C (85.9) °F	29.7 °C (85.5) °F	28.5 °C (83.3) °F	25.8 °C (78.5) °F	23.7 °C (74.6) °F	21.1 °C (69.9) °F	21 °C (69.7) °F	24.8 °C (76.7) °F	28.9 °C (84) °F	30.8 °C (87.5) °F	30.4 °C (86.7) °F	30.1 °C (86.2) °F
Precipitation / Rainfall mm (in)	108 (4.3)	90 (3.5)	74 (2.9)	35 (1.4)	13 (0.5)	5 (0.2)	3 (0.1)	2 (0.1)	10 (0.4)	35 (1.4)	77 (3)	100 (3.9)
Humidity(%)	57%	56%	57%	57%	50%	51%	46%	37%	32%	37%	46%	56%
Rainy days (d)	9	7	7	4	2	1	1	0	1	5	8	9
avg. Sun hours (hours)	9.9	9.8	9.2	8.8	9.2	9.0	9.2	9.8	10.0	10.4	10.3	10.1

FIGURE 1-1: SUMMARISED WEATHER STATION DATA FOR THABAZIMBI

The region may be described as very dry, thus there exists limited opportunity for sustainable rainwater harvesting or similar natural development guidelines outlined in Green City design norms.

2. DETAILS OF DEVELOPER, PROPERTY OWNER AND CONSULTING ENGINEER

2.1 DEVELOPER

- Name of Developer Bertie Joubert Eiendomme Lephalale CC
- Postal Address PO Box 26072
..... Gezina
..... 0031
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- Physical Address 15 Judith Street
..... Thabazimbi
..... 0380

2.2 PROPERTY OWNER

- Name of Property Owner Bertie Joubert Eiendomme Lephalale CC
- Postal Address PO Box 26072
..... Gezina
..... 0031
- Telephone..... 082 373 8301
- Physical Address 15 Judith Street
..... Thabazimbi
..... 0380

2.3 CONSULTING ENGINEERS

- Name of Consulting Engineers LEO Consulting (Pty) Ltd
- Postal Address PO Box 32798
..... Totiusdal
..... 0135
- Telephone..... 012 333 9705
- Email..... janh@leoconsult.co.za
- Contact Person Jan Hamman

2.4 DESCRIPTION OF PROPERTY

The current zoning of the property is agricultural. Details of the proposed development on the property will be as follows:

- Units 33 units
- Total Develop Area.....2.4169 ha

Refer to **APPENDIX A** for the Layout Plan of the proposed development. The corresponding 1:50 000 Topographical map is 2427 CB. The area is not affected by existing streams or other natural elements.

An average slope of 2.5% in a South-Eastern direction can be observed, therefore sloping toward the access road known as *Medivet* road. The access road to the property is registered as a Public right of way.

From a geotechnical perspective the site is considered acceptable for township establishment. The site is blanketed by a thick layer of sandy hill wash underlined by a pebble marker of quartzite that is partly ferruginous. No rock or other geotechnically undevelopable conditions were found during the geotechnical site assessment. Soil tests were conducted that indicated a low percentage of plasticity and localised settlement may be expected. This will impact on the foundation design of the various housing structures. Further investigation and recommendations can be found in the Geotechnical Report.

3. MINIMUM DESIGN REQUIRMENTS

The following design standards will be utilised:

- UTG4 – Guidelines for Urban Stormwater Management;
- Human Settlement Planning and Design;
- Fluid Mechanics for Civil Engineers by N.B. Webber

4. ACCESS AND INTERNAL ROADS

4.1 EXISTING ROAD ACCESS

The proposed development is bordered solely on the eastern side by Zeldri Park, which can be described as a medium density development. The northern and southern edges are bordered by local roads, as can be seen from the Figure below.

Access to and from the proposed development will be via the public access servitude running parallel to the *Thabazimbi – Marakele* road. The entrance to the proposed development can be found to the North of the site.

Figure 4-1 provides an indication of the locality of the access road in relation to the proposed new development.



FIGURE 4-1: EXISTING ACCESS ROAD

4.2 INTERNAL ROAD LAYOUT

The internal road network will be an access loop with a travelled way width of 5.0 meters within the 10-meter road reserve. The typical road cross-section is illustrated in Figure 4-2.

The access to the development shall be controlled. From a geometric point of view no significant impacts aside from minimum radii need to be designed for.

The minimum inside radius of the road will be 12.8 meters and will allow for a Single Unit (SU) vehicle movement classification.

Super-elevation of the road is unnecessary, however, the cross-fall of the road will be designed in such a way as to accommodate the stormwater on one side. This will reduce the required maintenance and the amount of silt on the road, which in turn addresses the safety of vehicle movement within the development. The design speed will be 40 km/h with a 3% cross-fall.

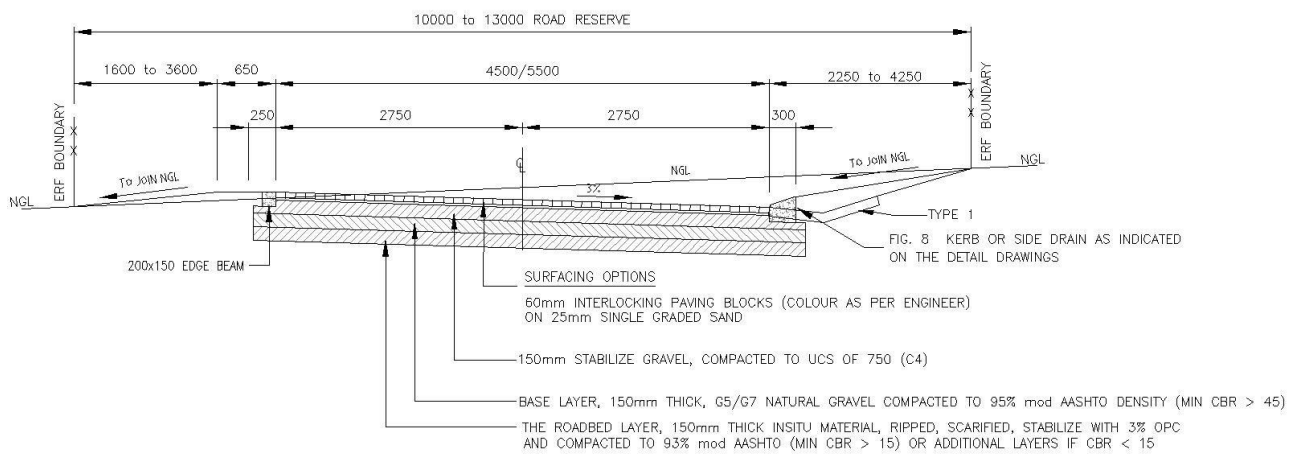


FIGURE 4-2: TYPICAL ROAD SECTION & LAYER WORKS- 4.5M/5.5M ROADS (CLASS 5B-F)

The access road is classified as a residential local/access street (also referred to as a Class 5b road or U5-D access street category), i.e. carrying mostly passenger vehicles with a light pavement structure.

5. STORMWATER MANAGEMENT PLAN

5.1 OVERVIEW

The objectives of the storm water management plan are as follows:

- To prevent the loss of life and reduce damage to properties due to runoff caused by storms.
- To prevent land and watercourse erosion.
- To protect water resources from pollution.
- To preserve natural watercourses and their erosion system.
- Not to transfer the storm water problems from one location to another.
- To achieve the foregoing objectives at optimal cost.

The stormwater system has to be designed for a flood peak with a return period of 1 in 2 years, as is required by the municipality.

The proposed development drains in the South-Easterly direction with flat slopes of approximately 2.5%. The new stormwater has to connect to the existing stormwater system located at *Medivet* road, discharging towards the airfield.

5.2 MINOR & MAJOR STORMWATER SYSTEMS

The major surface water runoff will be controlled within the road reserve prism. From Figure 5-1 below the capacity of the travelled-way prism amounts to 0,21 m³/s.

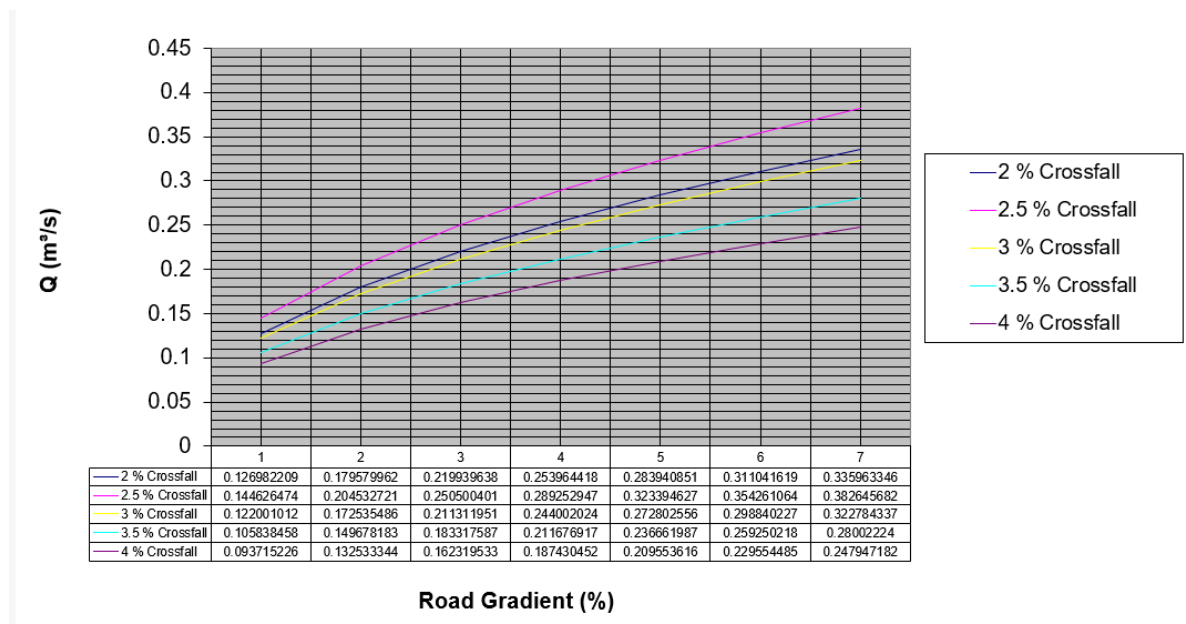


FIGURE 5-1: GRAPH DEPICTING THE WATER CARRYING ABILITY OF A 10M ROAD RESERVE

The road is under capacity for the major flood and had to be combined with a side channel. This will contribute to the road prism capacity with an additional 0,295 m³/s, as calculated and summarised in Table 5-1.

TABLE 5-1: SUMMARY OF HYDRAULIC CALCULATIONS IN DETERMINING THE MAJOR FLOOD CAPACITY

Symmetrical Channel			
DRAIN DIMENSIONS		DRAIN CHARACTERISTICS	
BED WIDTH(M):	0.500	WET AREA(M ²):	0.19
SIDE SLOPE(H/V):	5.00	WET PERIMETER(M):	2.03
DEPTH(M):	0.150	HYDRAULIC RADIUS(M):	0.09
GRADE(M/M):	1.00%	TOP WIDTH CHANNEL(M):	2.450
MANNING N:	0.013	TOP WIDTH WATER(M):	2.000
		Water depth + Freeboard	0.195
FLOW CHARACTERISTICS			
Min required velocity (m/s)			
FLOW(M ³ /S):	0.295		
VELOCITY(M/S):	1.57	FROUDE NO:	1.64
WAVE AND SURGE ACTION			
REQ WAVE FREEBOARD:	0.045		
EXPECTED CORNER SURGE:	0.025	Corner Radius	20.00

The total major stormwater capacity will thus be 0,500 m³/s, and accommodates the 1: 50 year flood.

The minor flood recurrence for the development will amount to 0,162 m³/s. This flood projects the 1:2 year flood (Refer to Annexure B).

The minor flood system consists of the surface run-off with a side channel at the entrance of the development that connects to the stormwater of *Medivet* road.

6. WATER SERVICES

6.1 EXISTING WATER SYSTEM

Municipal water will be utilized to provide water services for the proposed development. The design of the water supply shall be done according to specifications outlined by the Department of Water and Sanitation as stated in the publication, "Guidelines for the Design and Construction of Water and Sanitation Systems," 2016.

The total average daily demand has been determined as 28.05 kL/day. The development will be supplied from the existing 160mm diameter uPVC pipe along *Medivet* Road. An existing PRV system located at the *Medivet* road intersection will regulate the water pressure for that area.

Refer to **APPENDIX C** for the water services calculations.

6.2 PROPOSED WATER RETICULATION SYSTEM FOR THE DEVELOPMENT

The internal water reticulation system for the new development will connect to the existing water reticulation system situated at the entrance of the development from *Medivet* Road.

A bulk water meter will be provided and installed in order to verify and log the water use for the development. Table 6-1 to Table 6-3 summaries the parameters required for calculation of the water demand.

TABLE 6-1: AVERAGE ANNUAL DAILY DEMAND (AADD)

Item	Zoning	Liter/Unit/Day	Total Water Consumption
1	Residential (Domestic Use)	850	28.05 kL/day
2	Residential (Garden Use)	150	4.95 kL/day

TABLE 6-2: PEAK CONSUMPTION

Predominant Land Use	Average Annual Daily Demand (l/day)	Peak Daily Factor (Equivalent Erven)
Residential	<1000	9.5

$$\text{Peak Daily Consumption} = \text{Peak Demand Factor} \times \text{Average Annual Daily Demand}$$

$$\text{Peak Daily Consumption} = \text{PDF} \times \text{AADD}$$

$$\text{Peak Daily Consumption} = 9.5 \times 28.05$$

$$\text{Peak Daily Consumption} = 266 \text{ kL/day}$$

TABLE 6-3: FIRE FLOW UNDER PEAK DEMAND CONDITIONS

Risk Classification	Total Fire Flow(l/s)	Flow at one Hydrant (l/s)	Minimum Pressure at fire Node (m)	Minimum Pressure in Rest of System (m)
Low Risk: Single residential housing	15	15	10	5

Table 6-3

Table 6-3: Fire Flow Under Peak Demand Conditions provides the associated fire risk classification as provided in the “Guidelines for Human Settlement Planning and Design”. The area is classified as “Low Risk: Single residential housing.”

Therefore, according to the “Guidelines for Human Settlement Planning and Design,” the spacing of fire hydrants shall not be more than 240 m.

The Thabazimbi Reservoir, situated at an elevation of 1094 m.a.s.l., will supply the proposed development with the required water demand. Due to the proposed development located at an elevation of 984 m.a.s.l. it is deduced that the available static pressure head is 110 m.

Two fire hydrants will be installed in the development. However, the design flow required to calculate minimum pressure is the flood peak with one operating hydrant. This value equates to 18.08 L/s (3.08 l/s+15 l/s).

6.3 WATER DESIGN ANALYSIS

The water analysis will be carried out using the computer modeling program iDAS™ based on EPANET™, in conjunction with AUTOESK™ software.

6.4 STANDARDS FOR THE CONSTRUCTION OF THE WATER RETICULATION SYSTEM

The construction of the water reticulation system will comply with the SABS standards.

All pipes shall be uPVC Class 12 pipes and will be tested to resist an operating pressure of at least 1200 kPa with a test pressure of at least 1800 kPa. The pipe network shall have a cover not less than 1.0 m below final ground level.

The following standards are applicable:

- Line valves need be installed such that not more than 30 dwellings are without water when maintenance work is necessary. Thus, the proposed development requires that a single valve be installed at the entrance.
- Fire hydrants will be placed so that no erf may be further than 240m from the nearest fire hydrant. Thus, it is recommended that two fire hydrants be installed within the proposed development.
- All pipes will be uPVC Class 12 pipes.
- Water meters to be installed at each yard connection.
- The flow rate of fire hydrants shall conform to the provisions of *Rule 4.35 Part T and Part W* of SANS 10400 of 2011, "*The Application of the National Buildings Regulations.*"

7. SEWERAGE RETICULATION

7.1 OVERVIEW

The total development sewer effluent will drain towards the South-Eastern portion of the development. The sewerage needs to be pumped to be able to connect to the existing Gravity system.

7.2 PROPOSED SEWER RETICULATION SYSTEM

The new internal sewer system will be connected to the existing rising sewer line running parallel to the *Medivet* access road. The existing sewer line along the access road to the South of the development utilizes a sewer pump to pump the effluent Westward towards the existing gravity network.

The sewer connection to the existing rising mains requires a pump station operating in parallel with the existing station. Proper process control and integration of the pump schedule will have to be implemented in order not to exceed the capacity of the rising mains.

The discharge from the development will drain towards the Waste Water Treatment Works as indicated in Figure 7-1. The Treatment Works is responsible for the entire town of Thabazimbi.

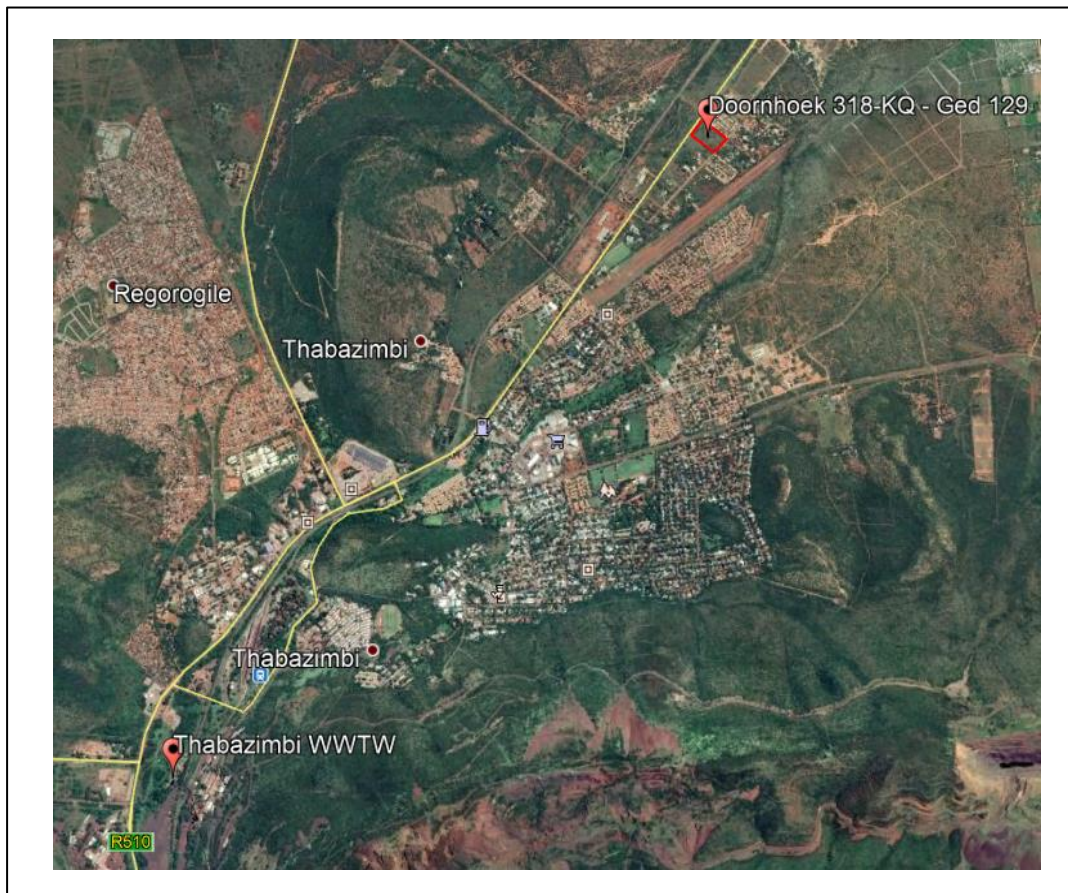


FIGURE 7-1: THABAZIMBI WASTEWATER TREATMENT WORKS

The internal network will consist of a minimum pipe diameter of 160mm diameter uPVC pipes. Refer to **APPENDIX D** for the sewerage calculations.

The following aspects for sewer design is pertinent:

- **Sewerage Outflow**

Table 7-1 reflects the daily sewerage outflow for the total development.

TABLE 7-1: TOTAL AVERAGE DAILY SEWERAGE OUTFLOW

Zoning	Unit/Day	Sewage Outflow
Residential	kL/day	24.75

- **Peak Flow per Unit**

The peak flow is calculated as follows:

$$\text{Peak Day Dry Weather Flow (PPDF)} = \text{Sewage Outflow} \times \text{Peak Factor}$$

$$PPDF = 0.75 \times 2.5$$

$$PPDF = 1.875 \text{ kL/day/unit}$$

- **Allowance for Storm Water Ingress**

In addition to the above design flow rates, the allowance for infiltration must be 15%.

- **Total Design Flows**

Pipes are designed to run at 70% total design capacity, measured in terms of flow depth. The internal pipes would thus be 160 uPVC class 34 Sewer pipes.

- **Pipe Route**

The sewer pipe will follow the natural topography. A mid-block sewer system has been adopted with sewer lines incorporated in the road reserve for the remaining erven.

- **Pump Station**

The pump station will be operated via a submersible pump system. The inflow to the sump is low, resulting in a small pump system with low risk.

The sump will consist of a square structure approximately 4 meters deep in conjunction with the relevant control valves. Figure 7-2 illustrates the general sectional layout of the proposed pump station design.

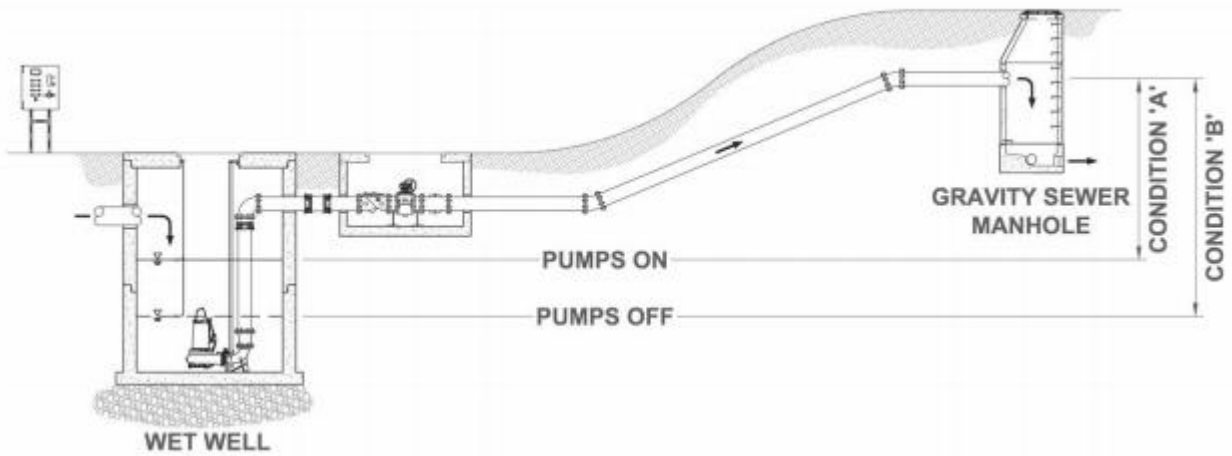


FIGURE 7-2: GENERAL SECTIONAL LAYOUT

The pumping rate of 20 m³/hour is equivalent to 5.6 L/s. This flow rate will account for the minimum flow velocity in a 110 Diameter pipe. The velocity will thus be 0.59 m/s. See Table 7-2 for the design parameters.

TABLE 7-2: DESIGN NORMS

Sewer discharge		
Middel Income group	750	l/du/day
Peak Factor	2.5	
Extraneous flow	15%	
Erven	33	
Ave Daily flow	24750	l/day
Ave Daily flow rate	0.29	l/s
Peak Daily flow rate	0.72	l/s
Peak Design Daily flow rate	0.82	l/s
Peak Design Daily flow rate	2.96	m ³ /hour
Min Pump Flow rate	20.00	m ³ /hour

The electrical motor should be between 0.8 kW and 1.2kW. Gorman-Rupp no longer supports submersible pumps, thus the available pumps include Grundfos, Flygt or KSB. The DP Grundfos has been selected as the application is suitable for Wastewater transport systems.

Figure 7-3 below shows the Pump Curve with a low Head and pump range between 3 l/s to 5 l/s.

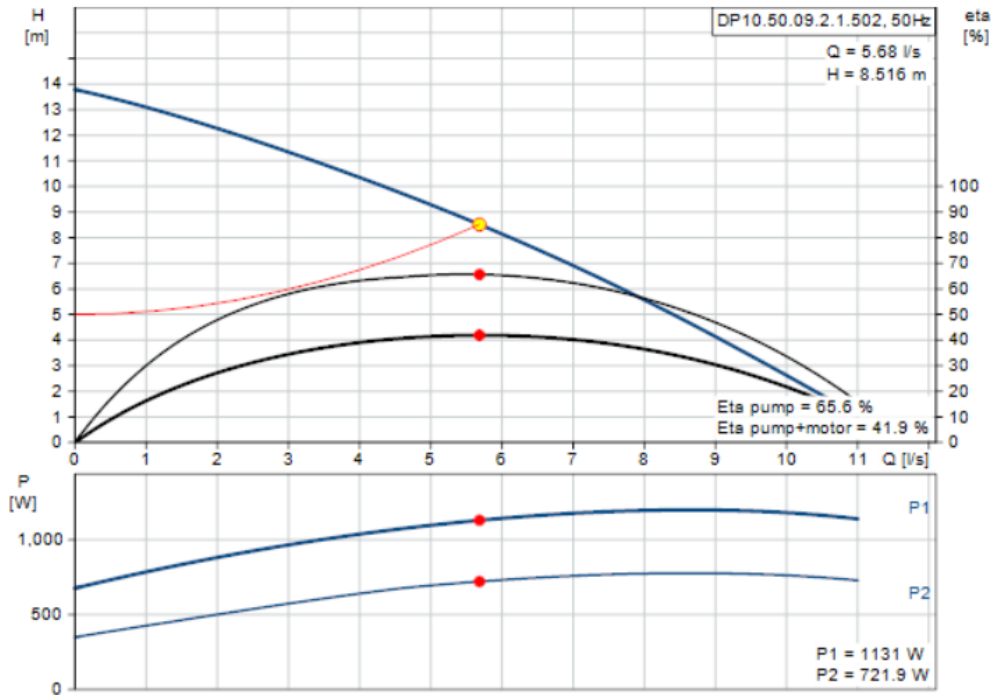


FIGURE 7-3: DP GRUNDFOS PUMP CURVE

TABLE 7-3: SUMMARY OF SUMP DESIGN PARAMETERS

Sump Design			
Pump Rate	Qp	20.0	m ³ /hour
Inflow Rate	Qf	1.0	m ³ /hour
Cycle time Between Starts	T	1.0	
Volume	V	6.0	m ³
Net flow when pumping	Qp-Qf	19.0	m ³ /hour
Time to fill	V/Qf	6.0	hours
Time to Empty	V/(Qp-Qf)	0.3	hours
Time for Complete Cycle	T	6.32	hours
T Min	Tmin	1.2	hours

8. PRELIMINARY COST ESTIMATE

Table 8-1 provides a summary of the different schedules applicable to the development and provides an indication of the cost per stand for the various services. Refer to **APPENDIX E** for the preliminary cost estimate of the project.

TABLE 8-1: SUMMARY OF SCHEDULES

1.	SCHEDULE 1: PRELIMINARY AND GENERAL	359 536.55
2.	SCHEDULE 2 : DAYWORKS	35 953.65
3.	SCHEDULE 3 : SEWER PIPE TRENCHES	203 600.12
4.	SCHEDULE 4 : WATER TRENCHES	52 818.75
5.	SCHEDULE 5: STORMWATER EARTHWORKS	2 524.00
6.	SCHEDULE 6 : EARTHWORKS (ROADS, SUBGRADE)	77 715.38
7.	SCHEDULE 7 : WATER NETWORK	188 962.82
8.	SCHEDULE 8 : SEWER NETWORK	265 130.00
9.	SCHEDULE 9 : CABLE DUCT	3 200.00
10.	SCHEDULE 10 : SUBBASE AND BASE	213 041.25
11.	SCHEDULE 11 : ASPHALT SURFACING	614 900.00
12.	SECTION 12 : STORMWATER AND KERBING	173 732.42
13.	SCHEDULE 13 : ANCILLORY ROAD SIGNS	2 057.99
	SUB-TOTAL ALL SECTIONS	2 193 172.93
	ALLOW 25% FOR CONTINGENCIES	548 293.23
	SUB TOTAL	2 741 466.16
	VAT @ 14%	383 805.26
	CONSTRUCTION TOTAL	3 125 271.42

		Stands	33
A	WATER SUPPLY	368 717	11 173
B	SEWERAGE	714 813	21 661
C	ROADS	1 389 145	42 095
D	STORMWATER DRAINAGE	268 791	8 145
		2 741 466	83 075

cost of water supply / m length of pipe	983.25
cost of sewerage / m length of pipe	1 374.64
cost of roads and stormwater / m ² of road	753.61

9. CONCLUSIONS AND RECOMMENDATIONS

All the Civil Engineering aspects have been accounted for in terms of sustainable development. The only constraint is the sewer pump station which would require maintenance. All the services are available and shall be provided by the Local Municipality.

The development has a borehole that can contribute to the township and garden water supply.

The *Medivet* road is in poor condition and will need to be upgraded. The design of this road needs to make provision for the bulk stormwater system.

All services will be installed to the specifications and standards of Civil Engineering guidelines and to the SANS specifications.

APPENDICES

APPENDIX A: LOCALITY PLAN

APPENDIX B: HYDROLOGIC CALCULATIONS

APPENDIX C: WATER SERVICES CALCULATIONS

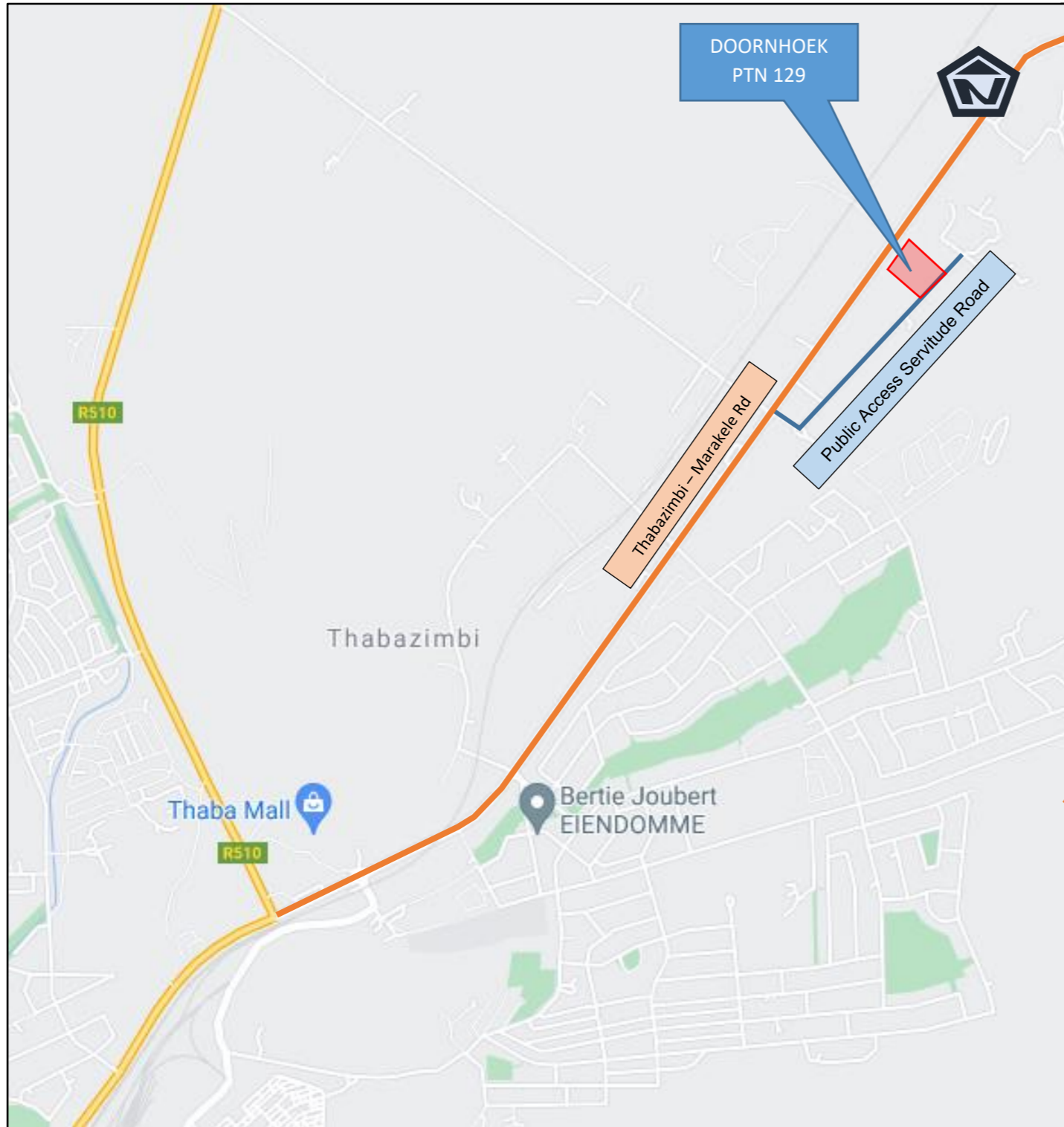
APPENDIX D: SEWERAGE CALCULATIONS

APPENDIX E: PRELIMINARY COST ESTIMATE

ANNEXURES

ANNEXURE A: PROPOSED ESTABLISHMENT CONDITIONS

**APPENDIX A
LOCALITY PLAN**



APPENDIX B
HYDROLOGY CALCULATIONS

BESKRYWING VAN OPVANGGEBIED :	Doornhoek Ontwikkeling	BEREKEN DEUR :	Jan Hamman
DUIKER :	Algemeen Ontwikkelde Vloed	DATUM :	07/09/21

FISIESE EIENSKAPPE :		OORLANDVLOEI	STROOMBAAN	AREA VERDELINGSFAKTORE SOM =1		
GROOTTE VAN OPVANG GEBIED	A =	0.0228 km ²	0 km ²	LANDELIK	STEDELIK	MERE
LANGSTE STROOMBAAN	L =	0.040 km	0.130 km	0.2	0.8	0
GEMIDDELDE HELLING	S =	0.01 m/m	0.025 m/m			
AREA DOLOMIET	=	0 %	0 %			
WAARDE VIR r	=	0.3	0			

LANDELIK			STEDELIK		
OPPERVLAKTE HELLING (%)	DEURLAATBAARHEID (%)	PLANTEGROEI (%)	OPPERVLAKTE HELLING (%)	DEURLAATBAARHEID (%)	PLANTEGROEI (%)
VLEIE EN PANNE	0	0	DIGTE BOS EN PLANTASIES	0	GRASPERKE EN PARKE
PLAT GEBIED	100	70	LIGTE BOS EN LANDERYE	10	NYWERHEIDSGEBIEDE
HEUWELAGTIG	0	30	GRASVELD	80	STAD/WOON
STEIL GEBIEDE	0	0	GEEN PLANTEGROEI	10	STRATE
TOTAAL	100	TOTAAL	100	TOTAAL	100

REENVAL		WAARDES VAN r	
Tc (OORLANDVLOEI) = 0.604(r/L*S ^{0.5})*0.467 =	0.224 UUR	13.46 MIN	SKOON GROND
Tc (WATERBAAN) = (0.87L ² /1000S)*0.385 =	0.057 UUR	3.42 MIN	GEPLAVEIDE AREA
GEMIDDELDE JAARLIKSE REENVAL	500 mm	16.89 TOT MIN	YL GRAS
REENVAL STREEK : WINTER	DEUR JAAR	SOMER	MATIGE GRAS
		552	DIGTE BOS

HERHALINGSPERIODE (JAAR)	2	5	10	20	50	100
PUNTREENVAL (mm)	23.58	31.39	37.30	43.20	51.01	56.92
PUNT-ITENSITEIT I (mm/UUR)	83.78	111.53	132.51	153.50	181.25	202.23
AREA REDUKSIEFAKTOR	0.75	0.8	0.85	0.9	0.95	1
GEMIDDELDE ITENSITEIT (mm/UUR)	62.84	89.22	112.64	138.15	172.18	202.23

AFLOOPFAKTOR		HERHALINGSPERIODE T (JAAR)					
		2	5	10	20	50	100
LANDELIK C1		0.391	0.391	0.391	0.391	0.45	0.45
STEDELIK C2		0.580	0.580	0.580	0.580	0.600	0.600
MERE C3		0	0	0	0	0	0
SAAM GESTEL C= aC1 + bC2 + cC3		0.542	0.542	0.542	0.542	0.570	0.570

PIEKVLOEI		HERHALINGSPERIODE T (JAAR)					
		2	5	10	20	50	100
PIEKVLOEI Q = CIA/3.6 (M ³ /S)		0.216	0.306	0.387	0.474	0.622	0.730
AANGEPASTE PIEK (M ³ /S) (Ft*Q)		0.162	0.245	0.329	0.427	0.591	0.730

AANBEVOLE WAARDES VIR AFLOOPFAKTOR C

LANDELIK C1		STEDELIK C2						
KOMPONENT	KLASSIFIKASIE	GEMIDDELDE JAARLIKSE REENVAL (mm)			GEBRUIK	FAKTOR		
		<600	600-900	>900				
OPPERVLAKTE	VLEIE EN PANNE (<3%)	0.01	0.03	0.05	GRASPERKE	0.05-0.10		
	PLAT GEBIED (3% TOT 10%)	0.06	0.08	0.11	SANDERIG, PLAT (<2%)			
	HEUWELAGTIG (10 TOT 30%)	0.12	0.16	0.20	SANDERIG, STEIL (>7%)			
	STEIL GEBIEDE (>30%)	0.22	0.26	0.30	SWAAR GROND, PLAT (<2%)			
DEURLAATBAARHEID Cd	BAIE DEURLAATBAAR	0.03	0.04	0.05	SWAAR GROND, STEIL (>7%)	0.25-0.35		
	DEURLAATBAAR	0.06	0.08	0.10	WOONGEBIEDE			
	SEMI-DEURLAATBAAR	0.12	0.16	0.20	HUISE			
	ONDEURLAATBAAR	0.21	0.26	0.30	WOONSTELLE			
PLANTEGROEI Rd	DIGTE BOS EN PLANTASIES	0.03	0.04	0.05	NYWERHEID	0.50-0.80		
	LIGTE BOS EN PLANTASIES	0.07	0.11	0.15	LIGTE NYWERHEID			
	GRASVELD	0.17	0.21	0.25	SWAAR NYWERHEID			
	GEEN PLANTEGROEI	0.26	0.28	0.30	BESIGHEID			
HERHALINGSPERIODE (J)	100	50	20	10	5	2	MAKSIMUM VLOED	1.00
AANPASSINGSFAKTOR Ft	1.00	0.95	0.90	0.85	0.80	0.75		

APPENDIX C
PRELIMINARY COST ESTIMATE

Doornhoek

Item	Description	Unit	Qty	Rate (R)	Amount (R)
1.	SCHEDULE 1: PRELIMINARY AND GENERAL				
1.1	FIXED-CHARGE ITEMS				
1.1.1	Contractual Requirements	sum	33		21 572.19
1.1.2	Establish Facilities on Site	sum			86 288.77
1.1.3	Remove Contractor's site establishment on completion	sum			5 393.05
1.2	TIME-RELATED ITEMS				
1.2.1	Contractual requirements	sum			46 739.75
1.2.2	Operate and maintain facilities on the site:	sum			186 959.00
1.3	LOCATION AND PROTECTION OF EXISTING SERVICES				12 583.78
TOTAL : SCHEDULE 1					359 536.53
2.	SCHEDULE 2 : DAYWORKS				
2.1	LABOUR	sum			7 909.80
2.2	PLANT	sum			15 819.61
2.3	MATERIALS	sum			12 224.24
TOTAL : SCHEDULE 2					35 953.65
3.	SCHEDULE 3 : SEWER PIPE TRENCHES				
3.1	SITE CLEARANCE				
3.1.1	Clear, 3m wide, vegetation and trees of girth up to 1,0 m	m	520	28.00	14 560.00
3.2	EXCAVATION				
	Excavate in all materials, backfill, compact and dispose of up to 1,5 m in depth	m³	171	105.00	17 915.63
3.2.1	up to 1,5 m in depth	m³	68	115.00	7 848.75
3.2.2	deeper than 1,5 m but not deeper than 2,0m	m³	123	115.00	14 127.75
3.2.3	deeper than 2,0 m but not deeper than 2,5 m	m³	107	185.00	19 841.25
3.2.4	deeper than 2,5 m but not deeper than 3,0 m	m³	338	185.00	62 530.00
	deeper than 3,0 m but not deeper than 3,5 m	m³	215	200.00	42 900.00
	deeper than 3,5 m but not deeper than 4,0 m	m³			
3.2.5	Extra over items 3.2.1 to 3.2.3 for : Intermediate excavation	m³	10	150.00	1 532.21
3.2.6	Hard rock excavation	m³	10	350.00	3 575.16
3.2.7	Excavate unsuitable material from the trench bottom and dispose of within the freehaul distance	m³	1	33.30	25.97
3.3	BEDDING				
	Provision of bedding material from trench excavations				
3.3.1	Selected granular material	m³	39	85.00	3 315.00
3.3.2	Selected fill material	m³	176	80.00	14 040.00
	Provision of bedding material by importation from other				
3.3.3	Selected granular material	m³	3	85.00	265.20
3.3.4	Selected fill material	m³	14	80.00	1 123.20
TOTAL : SCHEDULE 3					203 600.12

Item	Description	Unit	Qty	Rate (R)	Amount (R)
4.	SCHEDULE 4 : WATER TRENCHES				
4.1	EXCAVATION				
4.1.1	Excavate in all materials for trenches 0-1 m wide, backfill, 1,2 m nominal depth	m	375	105.00	39 375.00
	Extra over item 4.1.1 for:				
4.1.2	Intermediate excavation	m³	3	150.00	506.25
4.1.3	Hard rock excavation	m³	3	350.00	1 181.25
4.1.4	Excavate unsuitable material from the trench bottom and dispose of within the freehaul distance	m³	1	150.00	84.38
4.2	BEDDING				
	Provision of bedding material from trench excavations				
4.2.1	Selected granular material	m³	83	85.00	7 028.44
4.2.2	Selected fill material	m³	55	80.00	4 410.00
	Provision of bedding material by importation from other necessary excavations				
4.2.3	Selected granular material	m³	2	85.00	143.44
4.2.4	Selected fill material	m³	1	80.00	90.00
TOTAL : SCHEDULE 4					52 818.75
5.	SCHEDULE 5: STORMWATER EARTHWORKS				
5.1	SITE CLEARANCE				
5.1.1	Clear and grub canal and pipeline routes, 3 m wide, outside road reserves	m	5	5.00	25.00
5.2	EARTHWORKS FOR STORMWATER DRAINAGE				
	Excavate in all materials, backfill, compact and dispose	m³	60	35.00	2 100.00
	Extra-over for excavation in:				
5.2.5	Intermediate material	m³	0	150.00	0.00
5.2.6	Hard material	m³	0	350.00	0.00
5.3	BEDDING				
	Provision of bedding materials from trench excavations				
5.3.1	Selected granular material	m³	2	85.00	178.50
5.3.2	Selected fill material	m³	2	105.00	220.50
	Provision of bedding material by importation from other necessary excavations				
5.3.3	Selected granular material	m³	0	85.00	0.00
5.3.4	Selected fill material	m³	0	105.00	0.00
TOTAL SCHEDULE 5					2 524.00
6.	SCHEDULE 6 : EARTHWORKS (ROADS, SUBGRADE)				
6.2	SITE CLEARANCE				
6.2.1	Clear and grub road and street reserves	ha	1	6 500.00	3 650.01
6.3	PREPARATION AND STRIPPING OF SITE				
6.3.1	Remove topsoil from areas designated for roads and streets to a depth of 150mm and spoil within the township boundaries	m³	450	7.22	3 250.42
6.4	TREATMENT OF ROADBED				
6.4.1	Roadbed preparation and compaction of in-situ material Minimum of 90% of mod AASHTO density	m³	390	80.00	31 213.20
6.5	EARTHWORKS				
6.5.1	Cut to fill compacted to 90% of mod AASHTO density	m³	78	60.00	4 681.98
6.5.2	Selected layer from borrow (G7 material minimum):				
	a. Compacted to 93% of mod AASHTO density	m³	390	85.00	33 164.03
6.5.3	Cut to spoil at a suitable spoil area arranged by the Contractor from:				
	a. Soft excavation	m³	20	85.00	1 658.20
	b. Intermediate excavation	m³	0	150.00	29.26
	c. Hard rock excavation	m³	0	350.00	68.28
TOTAL SCHEDULE 6					77 715.38

Item	Description	Unit	Qty	Rate (R)	Amount (R)
7.	SCHEDULE 7 : WATER NETWORK				
7.1	PIPEWORK				
	Supply, lay, joint, bed and test water supply mains:				
7.1.1	uPVC class 12, 63 mm dia	m	0	90.00	0.00
7.1.2	uPVC class 12, 75 mm dia	m	0	170.00	0.00
7.1.3	uPVC class 12, 90 mm dia	m	0	160.00	0.00
7.1.4	uPVC class 12, 110 mm dia	m	365	210.00	76 650.00
7.1.5	uPVC class 12, 160 mm dia	m	10	240.00	2 400.00
7.1.6	uPVC class 12, 200 mm dia	m	0	0.00	0.00
7.1.7	uPVC class 12, 250 mm dia	m	0	0.00	0.00
7.1.8	uPVC class 12, 315 mm dia	m	0	0.00	0.00
7.1.9	Steel Grade B, 350 mm dia	m	0	0.00	0.00
7.1.10	Steel Grade B, 400 mm dia	m	0	0.00	0.00
7.1.11	Steel Grade B, 450 mm dia	m	0	0.00	0.00
7.1.12	Steel Grade B, 500 mm dia	m	0	0.00	0.00
7.1.13	Steel Grade B, 550 mm dia	m	0	0.00	0.00
7.1.14	Steel Grade B, 600 mm dia	m	0	0.00	0.00
7.2	Disinfect all reticulation mains	m	375	5.00	1 875.00
7.3	VALVES				
7.3.1	Gate Valves	No	1	5 500.00	5 500.00
7.3.2	Valve chamber for valves up to 100 mm dia complete	No	1	2 000.00	2 000.00
7.4	FITTINGS AND SPECIALS	Sum			15 810.00
7.5	FIRE HYDRANT ASSEMBLIES				
7.5.1	On 75 mm dia main	No	2	4 500.00	9 000.00
7.6	MAINS CONNECTIONS				
7.6.1	Excavation to expose existing dia waterline, cut into existing pipeline and install T-piece	No	1	5 000.00	5 000.00
7.7	SUNDRIES				
7.7.1	Anchor and thrust blocks in class 20 MPa/19 mm concrete	m³	1	1 200.00	1 350.00
7.7.2	Marking on kerbing as per standard drawing T/SW 2-7	No	15	23.00	345.00
7.8	DOUBLE HOUSE CONNECTIONS				
7.8.1	Across road reserve	No	36	660.74	23 786.82
7.8.2	Pipe side of road reserve	No	36	569.33	20 496.00
7.9	WATERMETERS				
7.9.1	Supply and install water meters	No	33	750.00	24 750.00
	TOTAL SCHEDULE 7				188 962.82
8.	SCHEDULE 8 : SEWER NETWORK				
8.1	PIPEWORK				
	Supply, lay, and test uPVC sewers	160mm m	520	240.00	124 800.00
8.2	MANHOLES				
	Manholes as per Drawing LD-5, complete with Type 4 cast iron cover and frame				
8.2.1	up to 1,5 m in depth	No	8	6 000.00	48 000.00
8.2.2	deeper than 1,5 m but not deeper than 2,0m	No	2	6 500.00	13 000.00
8.2.3	deeper than 2,0 m but not deeper than 2,5 m	No	4	7 500.00	30 000.00
8.2.4	deeper than 2,5 m but not deeper than 3,0 m	No	1	8 500.00	8 500.00
8.2.4	deeper than 3,0 m but not deeper than 3,5 m	No	0	9 500.00	0.00
8.2.4	deeper than 3,5 m but not deeper than 4,0 m	No	0	11 500.00	0.00
8.4	HOUSE CONNECTIONS				
	House connections complete				
8.4.1	a. Type 1 (pipe side erf)	No	17	750.00	12 750.00
8.4.2	b. Type 2 (erf other side of fence)	No	16	1 750.00	28 000.00
8.5	SUNDRIES				
8.5.1	Painted marking on kerbing	No	1	80.00	80.00
	TOTAL SCHEDULE 8				265 130.00

Item	Description	Unit	Qty	Rate (R)	Amount (R)
9.	SCHEDULE 9 : CABLE DUCT				
9.1	Supply, lay, bed and prove uPVC class 6 cable ducts a. 110 mm dia	No	8	120.00	960.00
9.2	Supply and install paper plugs and draw wiring	No	8	120.00	960.00
9.3	Painted service marking on kerbing	No	16	80.00	1 280.00
TOTAL SCHEDULE 9					3 200.00
10.	SCHEDULE 10 : SUBBASE AND BASE				
10.1	SUBBASE				
10.1.1	Construct the subbase course with material from borrow areas, compacted to 95% of mod AASHTO density C4 or G6 material from borrowpit identified by Contractor	m³	390	250.00	97 541.25
10.2	BASE				
10.2.1	Construct base with G4 material obtained from borrowpit identified by Contractor, compacted to 98% of mod AASHTO density	m³	330	350.00	115 500.00
TOTAL SCHEDULE 10					213 041.25
11.	SCHEDULE 11 : ASPHALT SURFACING				
11.1	Prime coat :				
11.1.1	MC30 cut-back bitumen	litre	1 540	17.00	26 180.00
11.2	Tack coat:				
	30 % cationic stable grade emulsion	litre	2 420	16.00	38 720.00
11.3	ASPHALT SURFACING, CONTINUOUSLY GRADED - MEDIUM				
11.3.1	25 mm thick with 80/100 penetration grade bitumen binder	m²	2 200	250.00	550 000.00
TOTAL SCHEDULE 11					614 900.00

Item	Description	Unit	Qty	Rate (R)	Amount (R)
12.	SECTION 12 : STORMWATER AND KERBING				
12.1	Kerb Inlet Structures 3,6m average length including transitions	No	0	9 100.00	0.00
12.2	Junction Box Structures				
12.2.1	Junction box at direction change	No	0	5 100.00	0.00
12.2.3	Break into existing stormwater pipe and construct junction box	No	0	7 100.00	0.00
12.3	KERBING				
	Cast in situ class 30/13 concrete kerbing				
12.3.1	Straight sections: mountable 300mm wide	m	350	210.00	73 500.00
12.3.1	Straight sections: mountable 400mm wide	m	15	260.00	3 900.00
12.3.3	Curved sections, radius 12 m: semi mountable kerbs	m	24	230.00	5 520.00
12.3.4	Edging size 125 X 200	m	300	170.00	51 000.00
12.4	CULVERTS				
12.4.1	Supply, handle, lay and bed concrete pipe culverts				
	450mm	m	0	800.00	0.00
	600mm	m	0	1 050.00	0.00
	750mm	m	0		0.00
	900mm	m	0		0.00
	1050mm	m	0		0.00
12.4.2	Supply, handle, and install concrete box culverts				
	600 x 450	m	0	893.42	0.00
	600 x 600	m	0	912.39	0.00
	600 x 900	m	0	1 303.09	0.00
	600 x 1200	m	0	1 663.18	0.00
	900 x 900	m	0	1 585.67	0.00
	900 x 1200	m	0	1 963.72	0.00
	900 x 1500	m	0	2 359.94	0.00
12.5	Gravel trapezoidal channel (Finishing)	m	0	13.16	0.00
12.6	Concrete trapezoidal channel (Concrete work)	m	50	796.25	39 812.37
12.7	Rectangular channel (Concrete and brickwork)	m	0	535.30	0.00
TOTAL SCHEDULE 12					173 732.37
13.	SCHEDULE 13 : ANCILLORY ROAD SIGNS				
13.1	TRAFFIC SIGNS				
13.1.1	Provision and erection of regulatory signs, for 60km/h design standard, complete :				
	a. Stop sign (R1)	No	1	1 025.28	1 025.28
13.1.3	Provision and erection of information signs, complete :				
	a. Road name signs	No	1	1 032.70	1 032.70
13.2	ROADMARKINGS				
13.2.1	Roadmarkings : Non reflectorised paint applied at a nominal rate of 0.42 litre / m ²				
	a. White lines (broken or unbroken) 100mm wide	m	0	7.60	0.00
	b. White lines (broken or unbroken) 300mm wide	m	0	17.04	0.00
	d. White characters and symbols	m ²	0	73.95	0.00
13.2.2	Setting out and pre-marking of lines	km	0	865.09	0.00
TOTAL SCHEDULE 13					2 057.99

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SUMMARY OF SCHEDULES :

1.	SCHEDULE 1: PRELIMINARY AND GENERAL	359 536.53
2.	SCHEDULE 2 : DAYWORKS	35 953.65
3.	SCHEDULE 3 : SEWER PIPE TRENCHES	203 600.12
4.	SCHEDULE 4 : WATER TRENCHES	52 818.75
5.	SCHEDULE 5: STORMWATER EARTHWORKS	2 524.00
6.	SCHEDULE 6 : EARTHWORKS (ROADS, SUBGRADE)	77 715.38
7.	SCHEDULE 7 : WATER NETWORK	188 962.82
8.	SCHEDULE 8 : SEWER NETWORK	265 130.00
9.	SCHEDULE 9 : CABLE DUCT	3 200.00
10.	SCHEDULE 10 : SUBBASE AND BASE	213 041.25
11.	SCHEDULE 11 : ASPHALT SURFACING	614 900.00
12.	SECTION 12 : STORMWATER AND KERBING	173 732.37
13.	SCHEDULE 13 : ANCILLORY ROAD SIGNS	2 057.99
	SUB-TOTAL ALL SECTIONS	2 193 172.86
	ALLOW 25% FOR CONTINGENCIES	548 293.22
	SUB TOTAL	2 741 466.08
	VAT @ 14%	383 805.25
	CONSTRUCTION TOTAL	3 125 271.33

		Stands	33
A	WATER SUPPLY	368 717	11 173
B	SEWERAGE	714 813	21 661
C	ROADS	1 389 145	42 095
D	STORMWATER DRAINAGE	268 791	8 145
		2 741 466	83 075

cost of water supply / m length of pipe	983.25
cost of sewerage / m length of pipe	1 374.64
cost of roads and stormwater / m ² of road	753.61

**ANNEXURE A
PROPOSED CONDITIONS OF
ESTABLISHMENT**