BOSCHENDAL FOUNDERS ESTATES:

REPORT ON THE PROVISION OF CIVIL AND ELECTRICAL ENGINEERING SERVICES

SEPTEMBER 2022

Compiled for :

BOSCHENDAL (PTY) LTD
PNIEL ROAD GROOT DRAKENSTEIN
FRANSCHHOEK
7690

Compiled by :

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Client:	Boschendal (Pty) Ltd.
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Client representative:	William George
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ANNEXURES

1. INTRODUCTION

1.1 Background

Boschendal Farm is situated south of the R45 between Stellenbosch and Franschhoek close to the townships of Lanquedoc, Johannesdal and Pniel. The Founders Estates (FE's) on the farm are situated to the west of the R310 (Helshoogte Road) between the R45 to Franschhoek and Stellenbosch. Development rights had been obtained for the development of 18 Estates of approximately 8000m², with a developable footprint varying between 1200m² and 2400m² where the houses may be built.

Existing developments on the western portion of Boschendal (west of the R310) include the following:

- Droebaan and existing laundry
- Agterdam Cottages
- Trout Cottages
- The Retreat
- Tented Camp
- Nieuwedorp
- Good Hope

Some of the FE's had already been developed and have infrastructure. These are:

- FE3: Current manager's house
- FE7: Current manager's house
- FE9: Trout Cottage
- FE11: Nieuwedorp
- FE16A: Mountain Villa
- FE16B:
- FE17: Good Hope

1.2 Climate and Topography

This area falls within the Mediterranean climatic zone with wet winters and dry summer months. The average annual rainfall for this area is approximately 903mm with temperatures ranging between 12 and 25 degrees Celsius.

The topography is generally flat on the eastern portion of the farm where the FE's are developed, with steeper slopes towards the west up the mountain slopes. The area slopes from west to east and is earmarked by several streams running from the mountains.

2. ROAD INFRASTRUCTURE

2.1 Existing Roads

Access to the FE's is from the R310 between Franschhoek and Stellenbosch. There are currently two accesses to this portion of the farm, one via a guarded security-controlled access gate to the north of the R310, and one to the south close to Pniel (access to FE17 (Good Hope). The latter is a remote-controlled security gate.

The surfacing of existing roads on the farm varies from in situ cast concrete exposed aggregate roads, precast concrete brick paved roads and gravel roads. The width of the paved roads varies between 2.5m and 3.0m with gravel shoulders of varying width. Gravel roads are wider although not provided with a gravel wearing course that is suitable for trafficking over the entire width.

There are existing roads to most of the proposed FE's.

2.2 Proposed Roads

Existing gravel roads will be upgraded to a paved standard to provide access to the new FE's. These roads are referred to as "domain roads" and will be upgraded as part of the provision of infrastructure to the FE's.

The roads to be upgraded are shown on drawing no 19111-C-FigureL in Annexure A. The details of the roads are summarized in the table below:

ROAD No	ACCESS TO FE	LENGTH (m)	WIDTH (m)	MIN GRADIENT (%)	MAX GRADIENT (%)
A	19	325	2.5	0.15	5.89
B	2, 3, 4, 5, 6, 7, 9, & 10	856	2.5 & 3.0	0.83	9.19
C	3, 4, & 5	1072	2.5	0.60	16.93
D	8, 12, 13, & 15	1105	2.5	1.39	11.76
D-1	15	207	2.5	1.64	11.31

Table 1: Founders Estate Road Details

Al roads will have a 2.5m surfaced width with a 1.25m wide cement stabilized laterite shoulder on each side. The first 400m of Road B up to Road C has a width of 3.0m.

Roads A, B, and C follow the alignments of existing roads and will be upgraded to a paved surfacing within the verges of the existing gravel roads.

The first 250m of Road D had been already upgraded to a surfaced standard. The road follows the alignment of an existing gravel road up to Stake Value (SV) 420, from where it crosses an existing stream/water course to intersect with an existing gravel road at approximately SV 520 (see drawing no C19111-C-FigureL in Annexure A). The road then follows an existing gravel road until the end.

Road D-1 follows an existing gravel road which gives access to FE15.

Private roads will be constructed from these domain roads up to each estate, and are indicated as dotted lines on drawing no 19111-C-FigureL in Annexure A. The construction of these private roads will be the responsibility of each owner of the estate.

The proposed pavement design of the domain roads are as follows:

- 80mm 35 MPa interlocking exposed aggregate paver (Between E3 concrete edgings)
- 20 mm bedding sand
- 150mm C4 (cement stabilized) subbase compacted to 97% Mod AASHTO density)
- 150 mm G7 upper selected layer compacted to 95% Mod AASHTO density (100% for sand)
- 150 mm G9 upper selected layer compacted to 93% Mod AASHTO density (100% for sand)
- 150 mm in-situ roadbed preparation compacted to 90% Mod AASHTO density (100% for sand)

Depending on the quality of the in-situ material, one or more of the abovementioned layers can be omitted.

An alternative in situ exposed aggregate concrete road finish will also be investigated before road construction commences.

A typical cross-section (drawing no 19111-C-FigureP) of the roads with pavement layers is shown in Annexure A.

Eleven trial holes were dug in the roads to be upgraded in August 2020 to a depth of approximately 1.0m. The general soil profiles are as follows:

From 0m up to 500mm or to 1 000mm: Moist, dark brown, firm intact sand and stone. Transported

From 500mm up to 1 000mm: Very moist, orange light greyish, dense, intact clay. Transported

Or

Yellow, greyish sand, slightly clayish

Some roads are located within watercourse buffer zones and botanical sensitive areas. The impact of these roads is discussed in more detail in the environmental impact assessment report.

3. STORMWATER MANAGEMENT

Graeme McGill Consulting was appointed to prepare a Stormwater Management Plan (SWMP) and Floodline Study for the proposed developments on the farm. The report and annexures are attached as Annexure B to this services report. The findings of the report are summarized as follows:

3.1 Floodline Study

Several estates are located close to streams. The 1:50 and 1:100 floodlines for 10 different streams were calculated where FE's were affected.

- Founders Estates not affected by floodlines: FE3, FE4, FE9, FE11 and FE16A.
- Floodlines just outside exclusive use areas: FE2 (southern boundary) and FE18 (northern boundary).
- Floodlines on/through Founders Estates:

  FE5: Southern boundary
  FE7 : Northwestern boundary
  FE6 : Southern boundary. Access Road B is also within the floodlines
  FE10 : Northern boundary
  FE8 : Southwestern boundary
  FE15 : Western boundary
  FE12 : Southern boundary
  FE13 : Floodline runs through the middle of the Founders Estate
  FE14 : Southern boundary
  FE19 : Northwestern boundary

Although the floodlines are encroaching on the Founders Estates, they are outside the Developable Area where houses may be built.

3.2 Culvert Crossings

Where the upgraded domain roads cross existing streams, culverts will be constructed to accommodate the stormwater. The Design Guidelines of Boschendal stipulate that these culvert crossings must be able to accommodate floods of a 1:10 year occurrence.

The following culverts are required in the domain roads:

- 2 No 0.9m high x 1.2m wide box culverts in Road C at SV 430
- 1 No 0.6m high x 0.75m wide pipe culvert in Road D at SV 470
- 5 No 1.2m high x 1.5m wide box culverts in Road D_1 at SV 20

There is an existing culvert structure in Road C which was measured on site as 1.0m x 1.0m and was constructed with stone/brick walls with a concrete slab (see photo below):

Photo 1: Outlet structure of existing culvert in Road C at SV 430

This culvert must be demolished and replaced with 2 No 0.9m high x 1.2m wide concrete box culverts.

Some private roads from the domain roads (Road A to Road D-1) cross streams and culverts need to be installed to ensure access. These culverts are listed below:

ACCESS TO	CULVERT SIZE
FE 5	3 No 0.9m wide x 1.2m high box culvert
FE9 & FE10	3 No 1.2m wide x 1.2m high box culvert
FE12	1 No 1.2m wide x 1.2m high box culvert
FE8	1 No 1.2m wide x 0.9m high box culvert
FE13	1 No 1.2m wide x 1.2m high box culvert

The culvert in Road D and all culverts in the private roads are new structures that will be required under the new roads to cross the streams.

The culvert in Road D-1 will replace a drift that currently crosses the stream.

All the proposed culverts are also indicated on drawing no 19111-C-FigureL in Annexure A.

Any new culverts or upgrading of existing structures will be subject to environmental approval.

3.3 Side Drains

Side drains along roads are designed as swales to avoid concentration or increased runoff peaks and to treat and trap any pollutants from the roads before stormwater is discharged into streams.

Multiple outlets from these swales are proposed to prevent concentrated flow.

3.4 Bioretention Basins

Each estate will be provided with a bioretention basin that will serve as a retention and treatment facility for stormwater discharged from the houses. These bioretention basins will be constructed when the houses on each estate is built.

4. WATER RETICULATION

4.1 Existing Water Reticulation

Smart Matter had been appointed to investigate the existing water sources, yield/delivery, storage, supply, and usage. The main sources are summarized below:

- Connection from the Wemmershoek bulk supply line
- Berg Fountain
- Good Hope Fountain
- Dams on the farm

There are also a few boreholes on the farm which are used to fill the dams for irrigation purposes.

The quality of the water from the two fountains had been tested and comply with the SANS 241:2015 standards for domestic use.

The existing potable and irrigation water reticulation networks are shown on drawings no 19111-C-FigureB and 19111-C-FigureC respectively in Annexure A. This information was received from the farm manager and plotted on an aerial photograph for record purposes. The exact location of these pipes still needs to be verified on site.

4.2 Water Demand

The potable/domestic water demand of the FE's is stipulated in the design guidelines and specified as 2 kl/day/FE at a pressure of 40m.The average annual daily demand (AADD) for the 19 FE's using a peak factor of 2.5 is therefore 1.10l/s. Provision is made for fire flow of 15l/s at any two fire hydrants at a time.

It is further recommended that storage for at least two days be provided, which is 76 kl. A 100kl reservoir is therefore proposed for the domestic water supply. Storage for fire water for two fire hydrants at a flow of 15l/s for a duration of one hour is also recommended. A separate 100lkl reservoir is recommended for these purposes.

4.3 Proposed Water Supply

Three alternative sources of water supply were investigated, namely:

- Two existing fountains on the farm (Berg Fountain and Good Hope Fountain).
- Supply from existing water connection on the Wemmershoek pipeline (City of Cape Town supply).
- Supply from existing water reticulation networks of Stellenbosch Municipality in Pniel.

After discussions with Stellenbosch Municipality, it was decided that the Founders Estates will be supplied with potable water from their networks in Pniel. The consulting engineers responsible for the water and sewer masterplanning of this area, Messrs. GLS Consulting, were appointed to investigate and report on the water infrastructure required to supply the Founders Estates. This report dated 20 April 2021 is included in Annexure C of this report.

This report recommends that a 250mm diameter water main (690m in length) be laid from the existing Pniel Lower Reservoir to a future 8000kl new reservoir on the boundary of Boschendal (see Figure 1 in Annexure C). A sump and booster pump will be constructed at the position of the future reservoir, which pumps water via a 90mm diameter main to the 100kℓ reservoir on Boschendal. The length of this water main is approximately 2380m and will follow existing gravel roads where possible. The sump, booster pump, rising main and reservoir will be private services and maintained by the Boschendal Utility Company (BUC).

The proposed external water main is shown on drawing no 19111-C-FigureJ in Annexure A.

4.4 Internal Water Reticulation

The internal reticulation network will consist of 110mm and 90 mm diameter PVCu water mains from the two new 100kl reservoirs at the Berg Fountain. The reticulation network will supply each FE with potable water at the specified pressure, with a metered connection point at the private access roads from the domain roads. The house connection (plus water meter) from the reticulation network to the developable area on the FE will be the responsibility of each house owner.

The proposed reticulation network from the centralized reservoir generally follows existing roads as shown on drawing no 19111-C-FigureM in Annexure A. Due to the height difference between the reservoir (421m) and lower lying FE's (229m), pressure reducing valves (PRV's) will be installed to regulate pressure in the mains and prevent the bursting of the pipes. Due to the undulating nature of the terrain, scour and air valves will be placed on low and high points in the network. Valves will also be installed in the network to isolate sections should maintenance/repairs be required.

A fire hydrant is placed on the reticulation network at the position of the house connection to each FE (at the private road to the FE). This hydrant can be used by the fire department of the local authority should it be necessary. It is further recommended that each FE be provided with two 10 kl storage tanks with a booster pump that can be used in the event of a fire at the house. This tank should not be located too close to the house and can be combined with the irrigation system of the FE as domestic water should not be used for firefighting purposes.

The maintenance of the reticulation network will be the responsibility of the Boschendal Utility Company (BUC).

4.5 Irrigation Water

The design guidelines for the FE's specify that each estate will be provided with an irrigation connection. It is recommended that two additional 10kl tanks be provided on each FE for this purpose. These tanks can be connected to the existing irrigation network (see drawing no 19111-C-FigureC in Annexure A) on the farm. A water meter will be provided on the irrigation pipe at the entrance to the FE for billing purposes.

4.6 Environmental Impact of Proposed Water Reticulation Networks

Although the proposed internal and external water reticulation networks are generally located within existing gravel roads on the farm, some mains do cross streams and are located within watercourse buffer zones and botanical sensitive areas.

The entire water reticulation network will be assessed from an environmental perspective as per 19111-C-FigureQ in Annexure A.

5. SEWER RETICULATION

5.1 Existing Sewer Reticulation Network

There is no formal sewer reticulation or treatment system on Boschendal. Developments have sewerage draining to septic tanks, where solids separate from the liquids. A natural process of anaerobic decomposition takes place in the tanks and reduces the solids and treatment of waste. The remaining wastewater infiltrates into the soil by means of soakaways. The use of septic tanks is no longer practiced or allowed by the authorities due to the risk of groundwater contamination.

Some developments have conservancy tanks which are serviced at regular intervals by private companies.

5.2 Sewer Flows

Sewer flows are usually calculated at 70 to 80% of water demands. Each FE will be provided with a separate irrigation connection, and it is estimated that sewer flows will be in the order of 90% of the water demand, equating to 1 800 l/day per FE.

5.3 Proposed Sewer Reticulation

The installation of a wastewater treatment package plant at each Founder Estate was investigated. Due to the environmental processes to authorize the package plants and the maintenance and operational requirements, GLS Consulting was requested to investigate alternatives to connect the individual Founders Estates to the municipal network by means of an underground reticulation network.

The findings of this report are attached to Annexure C of this services report. It was subsequently established that there is an existing sewer pump station (Pniel Sport Fields Pumpstation) on the Coronation Cricket Club which is on the boundary of Boschendal next to the R310.

The proposal is to connect the internal sewer reticulation network from Boschendal to this existing Pniel sewer pumpstation. This pump station pumps effluent to a manhole in Lanquedoc, from where gravity mains convey the effluent to the Pniel wastewater treatment works. The capacity and condition of the existing sewer pump station and rising main is being investigated and will be upgraded if necessary.

5.4 Proposed Internal Sewer Network

Each Founder Estate will be provided with a 110mm diameter erf sewer connection at the topographical low point of the Developable Area. This connection will link up with a 160mm diameter sewer reticulation network that will convey all effluent to the Pniel Sports Field Pump station. Sewer pipes are generally located within existing gravel roads.

There is a small internal sewer pump station that will pump effluent from FE 3, 4, 5 & 7 to the gravity main in Toad B.

The proposed internal and external sewer reticulation networks are shown on drawing no 19111-C-FigureN and drawing no 19111-C-FigureK respectively in Annexure A.

5.5 Environmental Impact of Proposed Sewer Reticulation Networks

Although the proposed internal and external sewer reticulation networks are generally located within existing gravel roads on the farm, they do cross streams and are located within watercourse buffer zones and botanical sensitive areas.

The sewer pipes highlighted on drawing 19111-C-FigureQ in Annexure A are all within environmental sensitive areas/corridors and included in the Basic Assessment Report of the environmental consultants. The impacts thereof are discussed in detail in the environmental impact study.

It is noted that the proposed sewer pipeline which will run along the eastern extent of the site within an existing roadway, past the existing Droebaan facility, existing Orchard Cottages and FE11 and FE7 which contain existing houses, northwards until FE3 (which also contains an existing house) has been excluded from the assessment.

6. SOLID WASTE DISPOSAL

Refuse is currently collected at each facility by the maintenance department on Boschendal where recycling is done, and the bins are cleaned at the Droebaan site. A private contractor collects the remainder of the waste at Droebaan and disposes it at a registered solid waste disposal site.

It is envisaged that the maintenance department will collect refuse at each FE and transport to the recycling facility. It is estimated that the 18 Founders Estate will generate approximately 9m^3 of solid waste per month.

7. TELECOMMUNICATION/FIBRE NETWORK

Sleeves and manholes for a future communication network will be installed during the installation of the civil engineering services and will generally run adjacent to existing roads. This sleeve network will provide telecommunication services to all the Founders Estates. Negotiations are underway with a service provider to provide the necessary fibre network on the farm that will be pilled through the installed sleeves.

The proposed fibre sleeve layout for telecommunication is shown on drawing number 19111-C-FigureO in Annexure A.

Although the proposed communication networks are generally located within existing gravel roads on the farm, they do cross streams and are located within watercourse buffer zones and botanical sensitive areas.

The fibre routes which will be assessed as part of the environmental process is included in drawing number 19111-C-FigureQ in Annexure A. The proposed fibre network to the east of the Founders Estate which will serve existing facilities on the estate and which would run in existing roadway have been excluded from this assessment.

8. ELECTRICITY SUPPLY

8.1 Existing Electricity Infrastructure Supply Capacity

Boschendal Farm has multiple electricity supply points from both Eskom and Stellenbosch Municipality. The existing electrical reticulation network on the farm is shown on drawing no E19111-OA in Annexure A.

The area of the Farm west of the R310 (Helshoogte Road) is supplied by Stellenbosch Municipality via two 11kV bulk supply points, Meter No. 10400029 (Goodhope) and Meter No. 17170014 (Excelsior Line). Both metering points has a notified maximum demand (NMD) of 952 kVA and is located in the positions as shown on Figure 2 below.

Two separate private 11kV overhead line networks extend into the Farm from each of the Municipal bulk supply points that supplies the various existing buildings and facilities on the Farm west of the R310.

It is the intention that the new Founders Estates (FE's) will be supplied from the existing private 11kV overhead lines on the Farm.

Figure 2: Bulk Metering Point Locality Plan

8.2 Electricity Demand

Each Founders Estate (FE) will be supplied with a 100Amp three phase (70KVA) low voltage (400 Volt) connection. The total average electricity demand for the 19 FE's using a diversity factor of 70% is therefore 931kVA.

A total of nine (9) FE's will be connected to the 11kV overhead line supplied from the Goodhope bulk meter point (Meter No. 10400029) which will add an additional diversified load of 441 kVA to this meter point.

A total of ten (10) FE's will be connected to the 11kV overhead line supplied from the Excelsior bulk meter point (Meter No. 17170014) which will add an additional diversified load of 490 kVA to this meter point.

The current peak maximum demand drawn and spare capacity available at each metering point is show in Table 2 below.

METER No.	SUPPLY TO FE	NOTIFIED MAXIMUM DEMAND (kVA)	CURRENT PEAK MAXIMUM DEMAND (kVA)	AVAILABLE SPARE CAPACITY (kVA)
Meter No. 17170014	2, 3, 4, 5, 6, 7, 9, 10 & 11	952	460	492
Meter No. 10400029	8, 12, 13, 14, 15, 16, 16b, 17, 18 & 19	952	194	758

Table 2: Available Spare Capacity

8.3 Proposed Electricity Supply

The new Founders Estates (FE's) will be supplied from the existing bulk metering points via the existing private 11kV overhead lines on the Farm.

FE's 2, 3, 4, 5, 6, 7, 9, 10 & 11 will be supplied from the Excelsior bulk meter point (Meter No. 17170014) and FE's 8, 12, 13, 14, 15, 16, 16b, 17, 18 & 19 will be supplied from the Goodhope bulk meter point (Meter No. 10400029).

Sufficient spare capacity is available at the exciting metering points to supply the diversified load of the FE's.

8.4 Internal Electrical Reticulation

The internal electrical reticulation infrastructure will be designed to comply with the standards and requirements of SANS 10142, and, where appropriate, generally in accordance with NRS034-1:1999 - Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks.

The private internal reticulation services will consist of an 11kV underground cable network supplied from the existing 11kV overhead lines on the Farm. Miniature substations and ground mounted transformers will be connected to the 11kV underground cable network and will in turn supply the low voltage network (underground low voltage cables and metering kiosks) to provide an individual service connection for each FE. This electrical reticulation network is shown on drawing no E19111/01-1 in Annexure A.

The internal reticulation services will generally be installed in the road reserves and the exact position of above ground equipment such as miniature substations and metering kiosks will be selected to minimize the visual impact.

The operation and maintenance of the private internal reticulation services will be the responsibility of the Boschendal Utility Company (BUC).

The BUC will receive a monthly bulk account for the electricity consumption at the two bulk supply metering points. The owners of the FE's will therefore not be able to buy electricity directly from the municipality. Each FE will therefore have a private electricity meter and will receive a monthly account from the Managing Agent.

No street and/or area lighting will be installed as part of the private reticulation network.

8.5 Environmental Impact of Proposed Electrical Reticulation Networks

Although the proposed internal electrical reticulation networks are generally located within existing gravel roads on the farm, some mains do cross streams and are located within watercourse buffer zones and botanical sensitive areas.

The electrical reticulation network highlighted on drawing 19111-C-FigureQ in Annexure A are all within environmental sensitive areas/corridors and included in the Basic Assessment Report of the environmental consultants. The impacts thereof are discussed in detail in the environmental impact study.

9. DEVELOPMENT CONTRIBUTIONS

Development Contributions (DCs) are usually payable to the local authority to provide the necessary bulk civil and electrical engineering services to accommodate the development.

DCs will be payable for each erf that is connected to the municipal civil engineering infrastructure. The contributions can be offset against the cost of certain external infrastructure and will be

concluded in a Services Agreement with Stellenbosch Municipality.

The notified maximum demand of the existing bulk electricity supply points will not be increased and therefore electrical DCs should not be payable.

10. ENVIRONMENTAL IMPACT ASSESSMENT

The FE's are located within the environmentally sensitive slopes of the farm with several water courses/streams running down the mountain. There are also archaeological sensitive areas where any excavations should be done with great caution.

Strict environmental and heritage conditions will be enforced before any construction activities for the installation of services can commence.

11. CONCLUSION

The current developments are serviced from internal networks on the farm. Civil engineering services will be installed from each FE and connected to municipal networks as described in this services report.

Electrical engineering services will be provided from existing networks on the farm and/or by on site installations.

ANNEXURE A

Drawing no	Description
19111-C-Figure L	Proposed Roads and Stormwater Layout
19111-C-Figure P	Typical Details of Road Cross-Sections
19111-C-Figure B	Existing Potable Water Network
19111-C-Figure C	Existing Irrigation Network
19111-C-Figure J	Proposed External Water
19111-C-Figure M	Proposed Internal Water
19111-C-Figure K	Proposed External Sewer
19111-C-Figure N	Proposed Internal Sewer
19111-C-Figure O	Proposed Fibre and Sleeves Layout
19111-C-Figure Q	Proposed Services Layout - BAR Scope
E19111-OA	Existing Electrical Services
E19111/01-01	Proposed Electrical Supply Layout

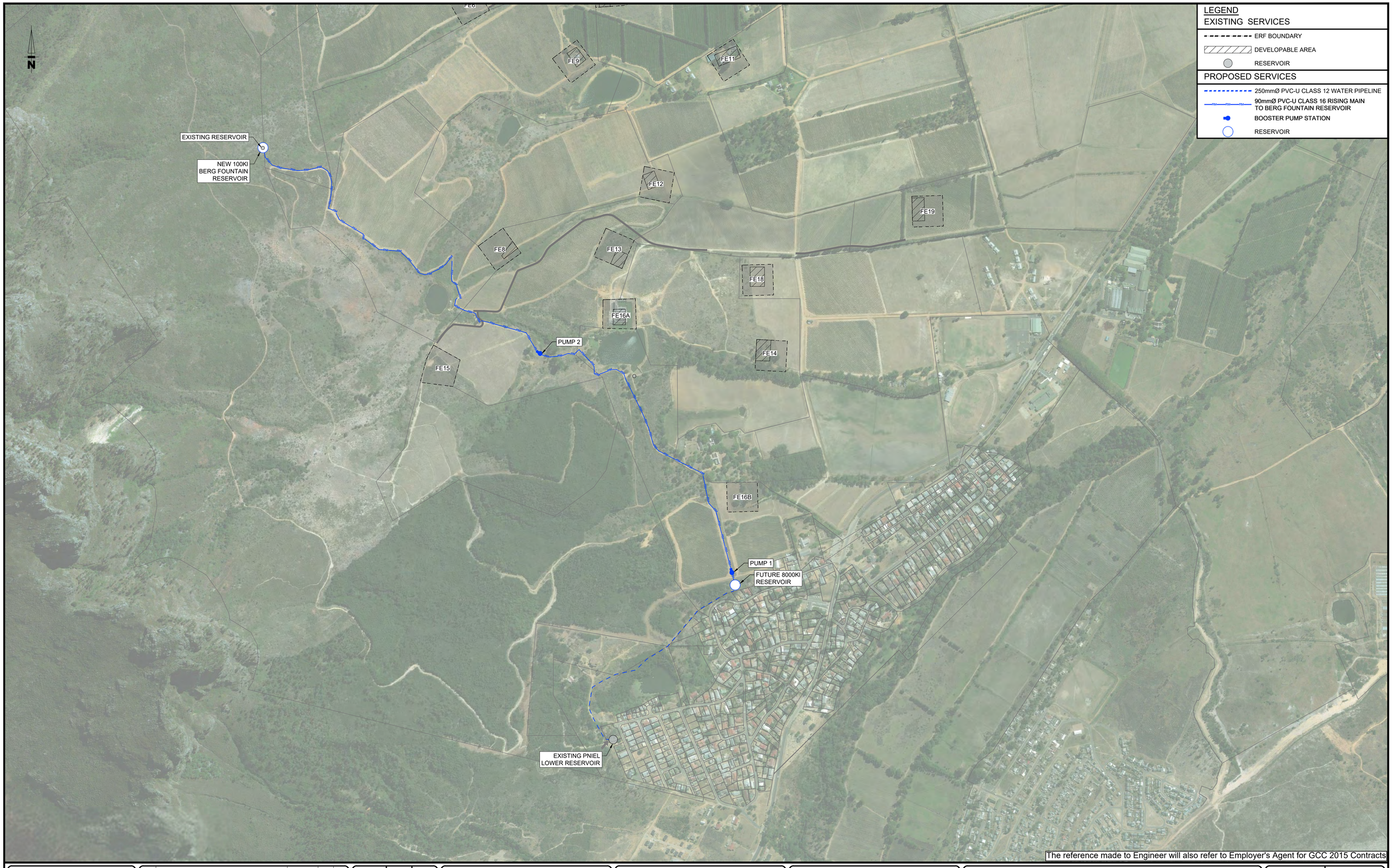
ANNEXURE B

Boschendal Founders Estate: Floodline Study & Stormwater Management Plan (Rev 2) dated 24 March 2022

Graeme McGill Consulting

ANNEXURE C

GLS Consulting Report dated 20 April 2021



The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR

0 150 300

Meters 1:5000

All dimensions must be verified on site before the works commence, Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AP	'21-09
DRAWN	AP	'21-09
CHECKED	RS	'21-09

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DATE: 2022-03-02

APPROVED

CLIENT: _____

DATE: _____

CLIENT

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PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT

BOSCHENDAL FOUNDERS ESTATE

TITLE

PROPOSED EXTERNAL WATER

SCALE	SHEET
1:5000 on A1	1 OF 1
CONTRACT No.	PROJECT No. 19111

DRAWING No. 19111-C-FigureJ REV A

COORDINATE SYSTEM: WGS84 / Lo19°

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR
0 75 150
Meters 1:2500

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
B	FOR SERVICES REPORT - AUGUST 2022	22-08-29	NL	RS
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AP	'21-09
DRAWN	AP	'21-09
CHECKED	RS	'21-09

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APPROVED
ENGINEERS: _____
DATE: 2022-08-29

APPROVED
CLIENT: _____
DATE: _____

CLIENT
BOSCHENDAL (PTY) LTD
PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT
BOSCHENDAL FOUNDERS ESTATE

TITLE
PROPOSED EXTERNAL SEWER

SCALE on A1: 1:2500	SHEET: 1 OF 1
CONTRACT No.	PROJECT No.: 19111
DRAWING No.: 19111-C-FigureK	REV: B
COORDINATE SYSTEM: WGS84 / Lo19°	

LEGEND

EXISTING SERVICES

- ERF BOUNDARY
- DEVELOPABLE AREA
- TREES
- TELEPHONE POLE
- HEADWALL
- GATE
- ROAD SIGN BOARD
- VALVE
- FENCE

PROPOSED SERVICES

- EXPOSED AGGREGATE PAVED ROAD
- PRIVATE ROAD
- SIDE DRAIN

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR

0 150 300

Meters 1:5000

REV	DESCRIPTION	DATE	REV BY	CHKD
B	FOR SERVICES REPORT - AUGUST 2022	22-08-29	NL	RS
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AL	'19-11
DRAWN	NL	'19-11
CHECKED	RS	'19-11

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APPROVED

ENGINEERS: _____

DATE: 2022-08-29

APPROVED

CLIENT: _____

DATE: _____

CLIENT

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PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT

BOSCHENDAL FOUNDERS ESTATE

TITLE

PROPOSED ROADS AND STORMWATER LAYOUT

SCALE	SHEET
1:5000 on A1	1 OF 1
CONTRACT No.	PROJECT No. 19111

DRAWING No. 19111-C-FigureL REV B

COORDINATE SYSTEM: WGS84 / Lo19°

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR
0 150 300
Meters 1:5000

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
B	FOR SERVICES REPORT - AUGUST 2022	22-08-29	NL	RS
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AP	'21-04
DRAWN	NL	'21-04
CHECKED	RS	'21-04

CONSULTING ENGINEERS
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email: bellville@lyners.co.za

APPROVED
ENGINEERS:
DATE: 2022-08-29

APPROVED
CLIENT:
DATE:

CLIENT
BOSCHENDAL (PTY) LTD
PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT
BOSCHENDAL FOUNDERS ESTATE

TITLE
PROPOSED INTERNAL WATER LAYOUT

SCALE on A1: 1:5000	SHEET: 1 OF 1
CONTRACT No.	PROJECT No.: 19111
DRAWING No.: 19111-C-FigureM	REV: B
COORDINATE SYSTEM: WGS84 / Lo19°	

LEGEND

EXISTING SERVICES

- ERF BOUNDARY
- DEVELOPABLE AREA
- TREES
- TELEPHONE POLE
- HEADWALL
- GATE
- ROAD SIGN BOARD
- VALVE
- FENCE

PROPOSED SERVICES

- 160mmØ PVC-U CLASS34 SEWER PIPELINE
- RM—RM 110mmØ PVC-U CLASS9 SEWER RISING MAIN
- SEWER MANHOLE
- SEWER PUMP STATION
- SEWER END CAP
- CONNECTION TO EXISTING SERVICES

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR

0 150 300

Meters 1:5000

REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	WN	'21-04
DRAWN	NL	'21-04
CHECKED	RS	'21-04

CONSULTING ENGINEERS

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email: bellville@lyners.co.za

APPROVED

ENGINEERS: _____

DATE: 2022-03-02

APPROVED

CLIENT: _____

DATE: _____

CLIENT

BOSCHENDAL (PTY) LTD

PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT

BOSCHENDAL FOUNDERS ESTATE

TITLE

PROPOSED INTERNAL SEWER LAYOUT

SCALE	SHEET
1:5000 on A1	1 OF 1
CONTRACT No.	PROJECT No. 19111

DRAWING No. 19111-C-FigureN REV A

COORDINATE SYSTEM: WGS84 / Lo19°

LEGEND

EXISTING SERVICES

- ERF BOUNDARY
- DEVELOPABLE AREA
- TREES
- TELEPHONE POLE
- HEADWALL
- GATE
- ROAD SIGN BOARD
- FENCE

PROPOSED SERVICES

- EXPOSED AGGREGATE PAVED ROAD
- PRIVATE ROAD
- 110mmØ PVC-U CLASS 6 FIBRE DUCT
- 32mmØ HDPE PE100 PN16 FIBRE DUCT
- FIBRE ACCESS CHAMBER
- FIBRE BOUNDARY BOX
- 110mmØ PVC-U CLASS 34 DUCT (No.)
- 160mmØ PVC-U CLASS 34 DUCT (No.)
- 110mmØ PVC-U CLASS 34 DUCT (No.) & 160mmØ PVC-U CLASS 34 DUCT (No.)

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR

0 150 300

Meters 1:5000

REV	DESCRIPTION	DATE	REV BY	CHKD
B	FOR SERVICES REPORT - AUGUST 2022	22-08-29	NL	RS
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AL	'19-11
DRAWN	NL	'19-11
CHECKED	RS	'19-11

CONSULTING ENGINEERS

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Tel: 021 914 0300/Fax: 021 914 0437
email: bellville@lyners.co.za

APPROVED

ENGINEERS: _____

DATE: 2022-08-29

APPROVED

CLIENT: _____

DATE: _____

CLIENT

BOSCHENDAL (PTY) LTD

PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT

BOSCHENDAL FOUNDERS ESTATE

TITLE

PROPOSED FIBRE AND SLEEVE LAYOUT

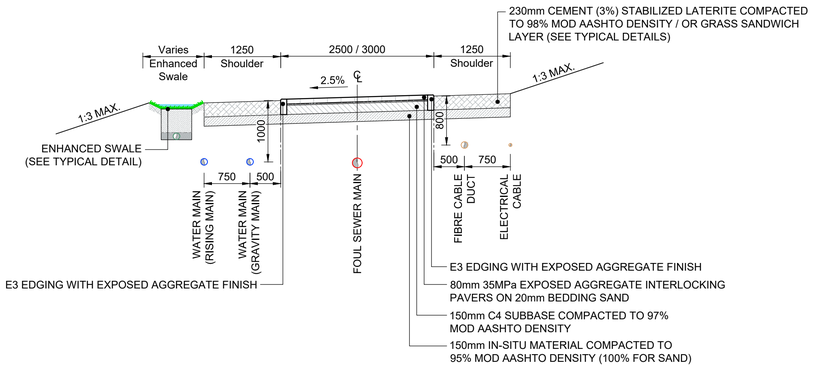
SCALE	SHEET
1:5000 on A1	1 OF 1
CONTRACT No.	PROJECT No. 19111

DRAWING No. 19111-C-Figure0 REV B

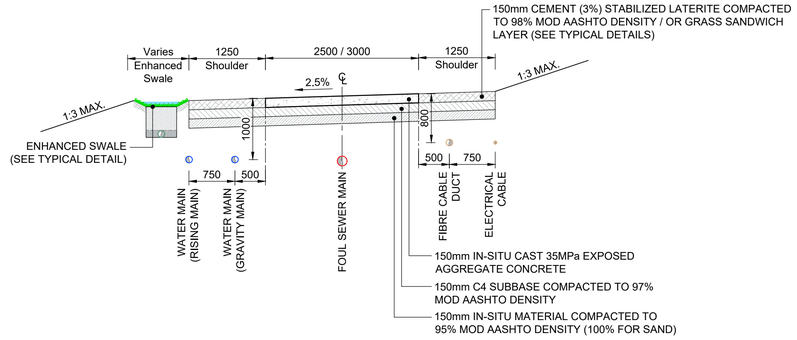
COORDINATE SYSTEM: WGS84 / Lo19°

NOTE:

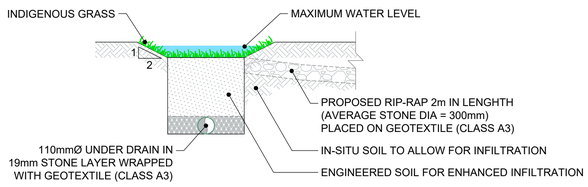
1. Construction Joints every 20m with Jointex, for In-Situ Concrete roads.
2. Saw Cut Joints every 5m, for In-Situ Concrete roads.



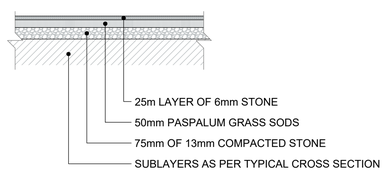
TYPICAL CROSS SECTION WITH INTERLOCKING PAVERS
SCALE 1:50



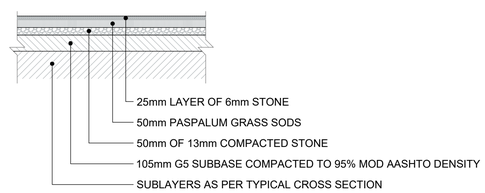
TYPICAL CROSS SECTION WITH IN-SITU CONCRETE
SCALE 1:50



TYPICAL DETAIL OF ENHANCED SWALE WITH UNDER DRAIN (GRASSED CHANNEL) WITH OUTLET TOWARDS STREAM
SCALE 1:20



GRASS SANDWICH SHOULDER FOR IN-SITU CONCRETE



GRASS SANDWICH SHOULDER FOR INTERLOCKING PAVERS

TYPICAL DETAILS FOR GRASS SANDWICH SHOULDER ALTERNATIVE
SCALE 1:20

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR
0 1.5 3
Meters 1:50

All dimensions must be verified on site before the works commence, Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR SERVICES REPORT	'22-04-14	NL	RS

REVISIONS

DESIGNED	RS	'20-08
DRAWN	NL	'20-08
CHECKED	RS	'20-08

CONSULTING ENGINEERS
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APPROVED
ENGINEERS: _____
DATE: 2022-04-14

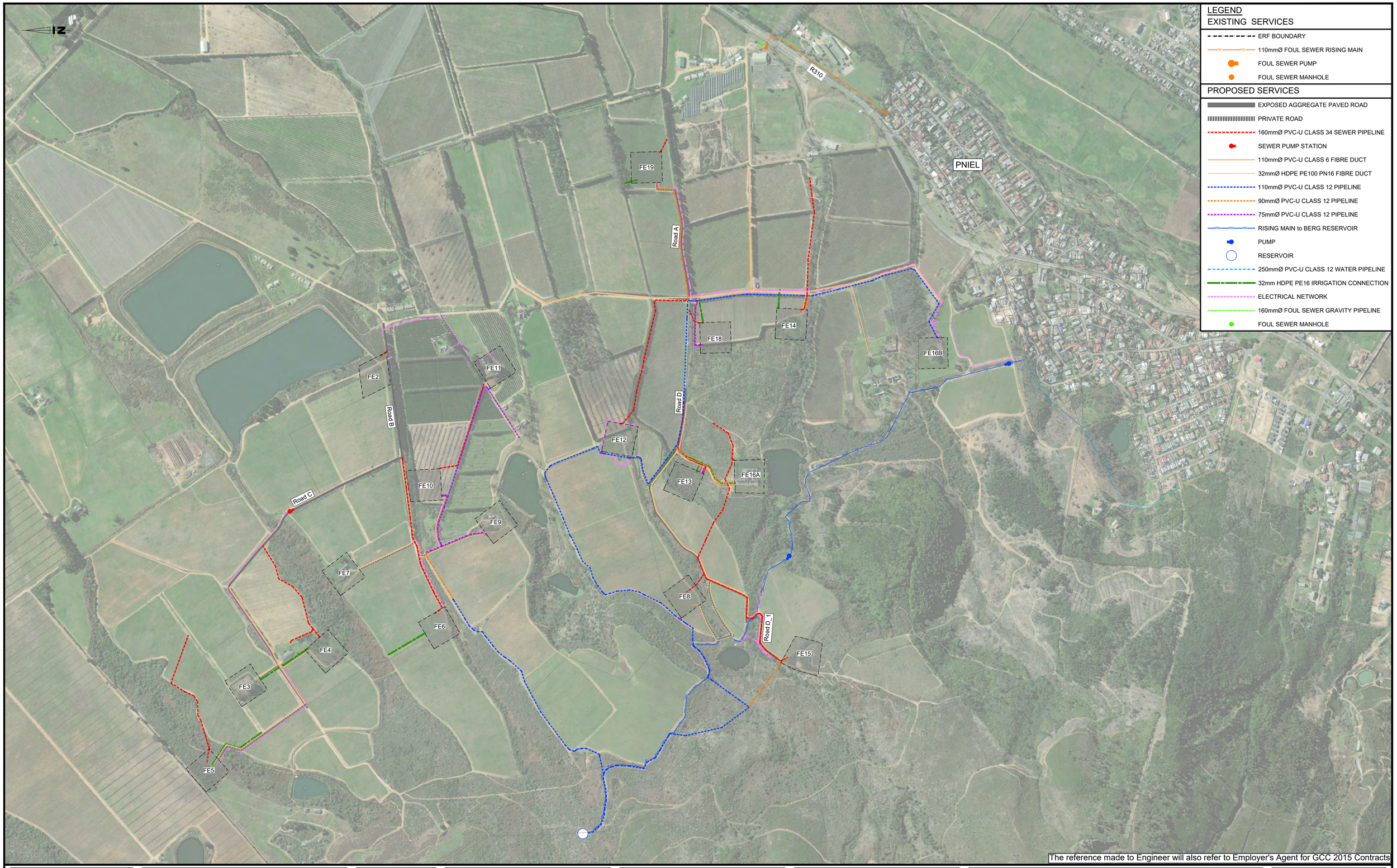
APPROVED
CLIENT: _____
DATE: _____

CLIENT
BOSCHENDAL (PTY) LTD
PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT
BOSCHENDAL FOUNDERS ESTATE

TITLE
TYPICAL DETAILS OF ROAD CROSS SECTIONS

SCALE on A1: AS SHOWN
SHEET: 1 OF 1
CONTRACT No.:
PROJECT No.: 19111
DRAWING No.: 19111-C-FigureP
REV: A
COORDINATE SYSTEM: WGS84 / Lo19°



LEGEND

EXISTING SERVICES

- ERF BOUNDARY
- 110mmØ FOUL SEWER RISING MAIN
- FOUL SEWER PUMP
- FOUL SEWER MANHOLE

PROPOSED SERVICES

- EXPOSED AGGREGATE PAVED ROAD
- PRIVATE ROAD
- 160mmØ PVC-U CLASS 34 SEWER PIPELINE
- SEWER PUMP STATION
- 110mmØ PVC-U CLASS 6 FIBRE DUCT
- 32mmØ HDPE PE100 PN16 FIBRE DUCT
- 110mmØ PVC-U CLASS 12 PIPELINE
- 90mmØ PVC-U CLASS 12 PIPELINE
- 75mmØ PVC-U CLASS 12 PIPELINE
- RISING MAIN to BERG RESERVOIR
- PUMP
- RESERVOIR
- 250mmØ PVC-U CLASS 12 WATER PIPELINE
- 32mm HDPE PE16 IRRIGATION CONNECTION
- ELECTRICAL NETWORK
- 160mmØ FOUL SEWER GRAVITY PIPELINE
- FOUL SEWER MANHOLE

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR

0 150 300

Meters 1:5000

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
B	AMENDED AS PER COMMENTS	'22-09-01	NL	RS
A	FOR SERVICES REPORT - AUGUST 2022	'22-08-29	NL	RS

REVISIONS

DESIGNED	AP	'19-11
DRAWN	NL	'19-11
CHECKED	RS	'19-11

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email: bellville@lyners.co.za

APPROVED

ENGINEERS: _____

DATE: 2022-09-01

APPROVED

CLIENT: _____

DATE: _____

CLIENT

BOSCHENDAL (PTY) LTD

PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT

BOSCHENDAL FOUNDERS ESTATE

TITLE

PROPOSED SERVICES LAYOUT BAR SCOPE

SCALE	SHEET
1:5000 on A1	1 OF 1
CONTRACT No.	PROJECT No. 19111

DRAWING No. 19111-C-FigureQ REV B

COORDINATE SYSTEM: WGS84 / Lo19°

The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR
0 300 600
Meters 1:10000

All dimensions must be verified on site before the works commence. Refer any discrepancies to the Engineer.

REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AP	'20-07
DRAWN	AP	'20-07
CHECKED	RS	'20-07

CONSULTING ENGINEERS

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APPROVED
ENGINEERS: _____
DATE: 2022-03-02

APPROVED
CLIENT: _____
DATE: _____

CLIENT
BOSCHENDAL (PTY) LTD
PNIEL ROAD
GROOT DRAKENSTEIN
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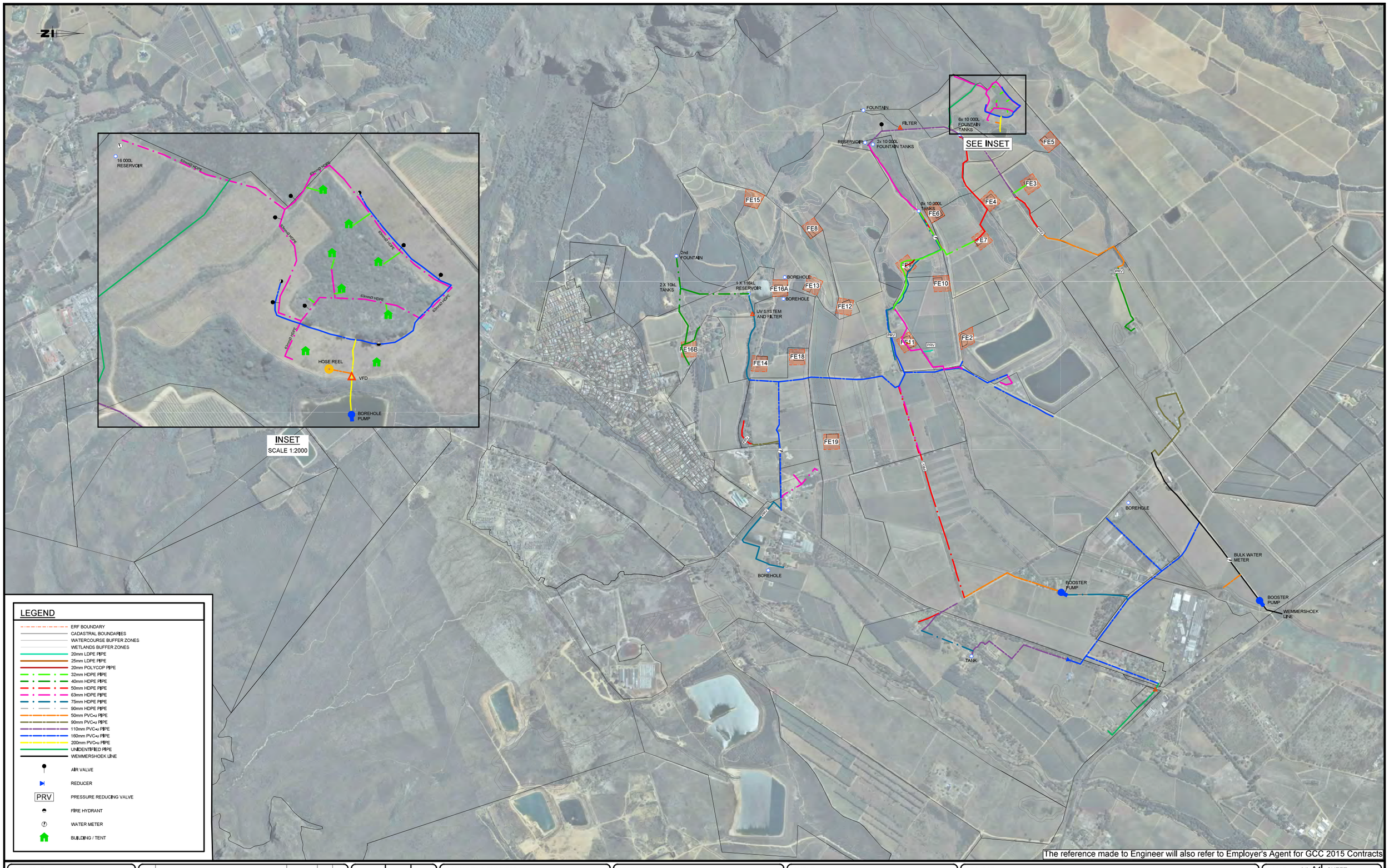
PROJECT
BOSCHENDAL FOUNDERS ESTATE

TITLE
EXISTING IRRIGATION WATER NETWORK

SCALE	on A1	SHEET
1:10 000		1 OF 1
CONTRACT No.		PROJECT No. 19111

DRAWING No. 19111-C-FigureC REV A
COORDINATE SYSTEM: WGS84 / Lo19°



The reference made to Engineer will also refer to Employer's Agent for GCC 2015 Contracts

SCALEBAR
0 300 600
Meters 1:10000

REV	DESCRIPTION	DATE	REV BY	CHKD
A	FOR SERVICES REPORT	'22-03-02	NL	RS

REVISIONS

DESIGNED	AP	'20-07
DRAWN	AP	'20-07
CHECKED	RS	'20-07

CONSULTING ENGINEERS

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email: bellville@lyners.co.za

APPROVED
ENGINEERS: _____
DATE: 2022-03-02

APPROVED
CLIENT: _____
DATE: _____

CLIENT
BOSCHENDAL (PTY) LTD
PNIEL ROAD
GROOT DRAKENSTEIN
7680

PROJECT
BOSCHENDAL FOUNDERS ESTATE

TITLE
EXISTING POTABLE WATER NETWORK

SCALE	on A1	SHEET
1:10 000		1 OF 1
CONTRACT No.		PROJECT No. 19111

DRAWING No. 19111-C-FigureB REV A
COORDINATE SYSTEM: WGS84 / Lo19°

ISO full sheet at (841.00 x 594.00 mm)
Lyners_AutoCAD.ctb
2022-03-02
U:\WERKE\1900\19111 C - BOSCHENDAL FOUNDERS ESTATE\DRAWINGS\1.2 ACTIVE\19111-C-FIGB EXIST POTABLE WATER NETWORK.DWG

Report

BOSCHENDAL FOUNDERS ESTATE:
FLOODLINE STUDY & STORMWATER MANAGEMENT PLAN

Prepared for:

BOSCHENDAL (PTY) LTD

BOSCHENDAL FARM (R310) PNIEL MAIN ROAD

P.O. BOX 35

GROOT-DRAKENSTEIN

7680

Prepared by:

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Report No.: MC378-00

Revision: Rev 3

Date: 2022-08-22

CONTENTS

DRAWINGS

MC378-C400	OVERALL ESTATE LAYOUT (REV F)
MC378-C401	STORMWATER MANAGEMENT DETAILS: SHEETS 1 & 2 OF 9 (REV C)
MC378-C402	STORMWATER MANAGEMENT DETAILS: SHEETS 3 & 4 OF 9 (REV C)
MC378-C403	STORMWATER MANAGEMENT DETAILS: SHEETS 5 & 6 OF 9 (REV E)
MC378-C404	STORMWATER MANAGEMENT DETAILS: SHEETS 7 & 8 OF 9 (REV C)
MC378-C405	STORMWATER MANAGEMENT DETAILS: SHEET 9 OF 9 (REV C)

BOSCHENDAL FOUNDERS ESTATE:

FLOODLINE STUDY AND STORMWATER MANAGEMENT PLAN

1. PROPOSED DEVELOPMENT

The Boschendal Founders' Estate is to comprise 18 individual Estates within Boschendal Estate, as a private residential development. The development is located within the Stellenbosch Municipality district. The combined site area of all the estates is 14,75 ha of which the proposed developable area will cover 3,10 ha. Access to this portion of Boschendal Estate is from Helshoogte Road (R310). Figure 1 shows the locality of all 18 estates, for which this Floodline Study and Stormwater Management Plan has been compiled.

Figure 2 shows the layout for the corresponding 18 estates and streams prepared by Lyners Consulting Engineers.

2. BRIEF

The purpose of this report is to prepare 1:50 and 1:100 year floodlines and a Stormwater Management Plan (SMP) which meets good design practice and satisfies the objectives of the Stellenbosch Municipality stormwater policies.

- *Stellenbosch Municipality Design Guidelines and Minimum Standards for Civil Engineering Services (Revision No. 0, June 2015)*
- *Stellenbosch Municipality Floodline Guide*

STORMWATER MANAGEMENT PLAN

A stormwater management plan is required to indicate how stormwater will be managed along roads. The roads are Road A, B, C, D & D-1 as shown on Figure 2. No stormwater may be diverted directly to streams, and a system of bioretention basin and swales will be introduced on each estate and at sidedrains along roads, respectively, before being discharged into the stream.

The bioretention basin and swales will serve a dual purpose:

- Any pollutants from the estates will be trapped and treated in the bioretention basin.
- Any pollutants deposited on the roads, will be trapped and treated in the swales.
- The swales will be designed to avoid concentrating or increasing runoff peaks.

The stormwater management plan would include an analysis using the SSA simulation software, the concept design of the proposed stormwater system and the preparation of a report to meet the requirements of the developer and the local authority including their stormwater policies and by-laws..

This report includes a conceptual design of the proposed stormwater system. The report and drawings are to be used to prepare the detail design and are not for construction purposes. The subject of this report is therefore the management of the quality, volume and rate of stormwater runoff from the site.

FLOODLINE STUDY

The *Floodline Guide* is applicable to a number of the estates on site because of its location relevant to the closest river/stream.

It is intended to create 18 Founders' Estates on the Boschendal farm as shown in Figure 2. Certain of these are to be located adjacent to existing streams which traverse the area. It is therefore required to determine the 1:50 and 1:100 year floodlines along 10 reaches with a total length of 4,2 km.

The 1:50 and 1:100 year flood peaks have been determined using standard methods, taking into consideration the conditions and land uses in the catchments and using the storm rainfall data set from the City of Cape Town which incorporates the anticipated effect of climate change. The attenuating effect of the dams within the catchments will be ignored as the dams have not been designed for attenuation purposes and may be full at any given time.

The software package HEC-RAS will be used to determine floodlines for the each of the river reaches. These floodlines will be presented on a drawing and described in this technical report.

FIGURE 1: LOCALITY OF THE 18 DEVELOPMENT SITES (INDIVIDUAL ESTATES): BOSCHENDAL FOUNDERS ESTATES, PNIEL

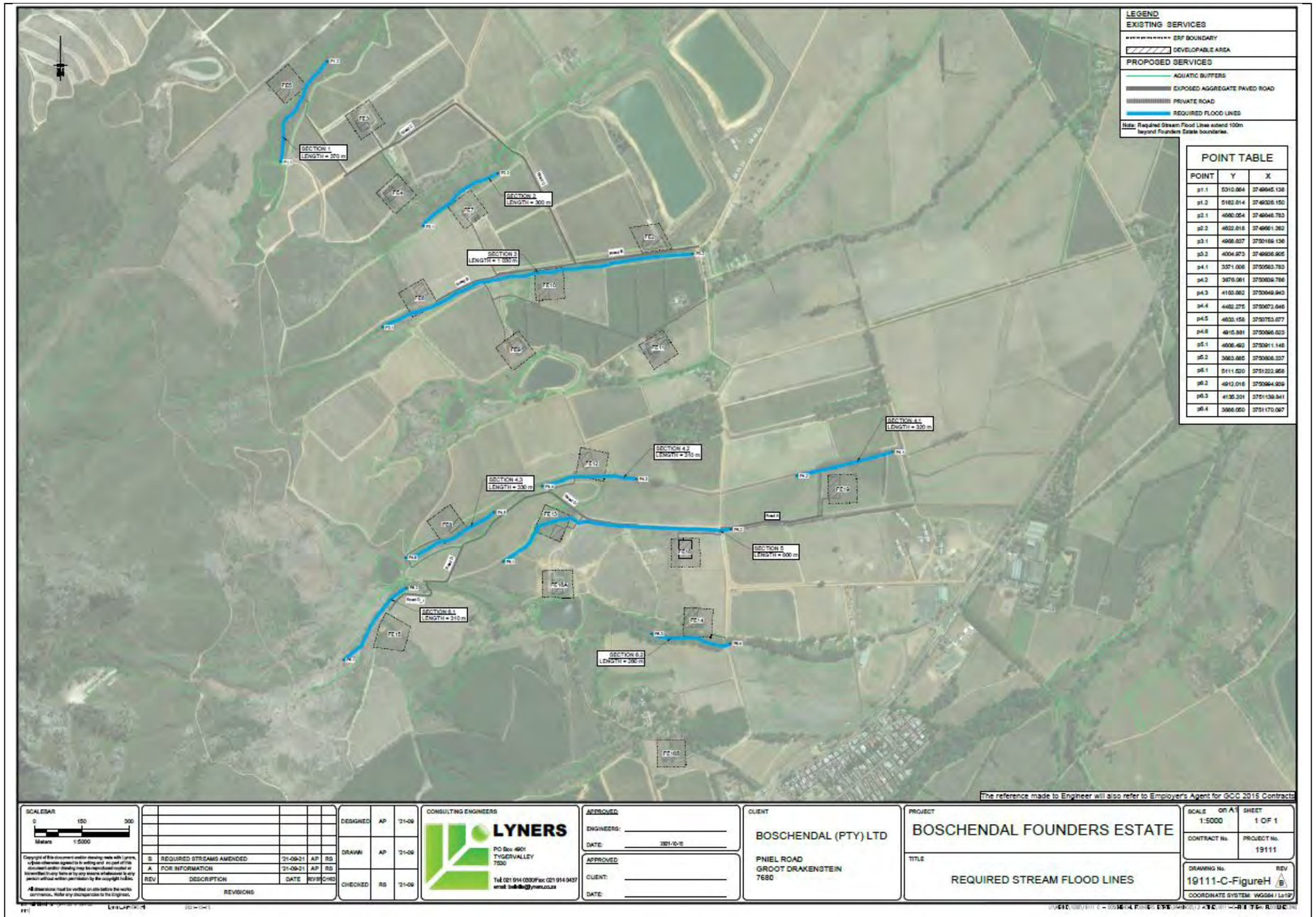

FIGURE 2: SITE LAYOUT PLAN BY LYNERS CONSULTING ENGINEERS

3. PRE-DEVELOPMENT ANALYSIS

3.1 EXISTING CONDITIONS

3.1.1 SITE CONDITIONS

18 estates are spaced apart at various locations within the Boschendal Estate.

In certain instances (FE-3, FE-7, FE-9, FE-11, FE-16A, and FE-16B) have existing houses and/or buildings on site. The remaining sites are currently undeveloped and covered by grass, shrubs, reeds and/or vineyards. The sites have steep natural slopes which vary from 2,5% up to 16,7% in various directions – dependant on the location of the estate.

The estates consist of vineyards and gravel roads throughout.

3.1.2 STORMWATER INFRASTRUCTURE AT DEVELOPMENT SITE

There is no existing stormwater infrastructure on site, besides some Ø300mm stormwater conduits within certain streams.

Within the development precinct there are a numerous lengths of stream, some of which flow adjacent to certain estates. The streams vary widely in slope and dimension.

FIGURE 3: TYPICAL EXISTING SITE CONDITIONS

FIGURE 4: EXAMPLE OF ONE OF THE STREAMS

3.1.3 ADJACENT CATCHMENT RUN-ON

Based on the natural slopes, adjacent run-on can be expected but with no adverse effects on the development.

3.2 FLOODLINE STUDY

3.2.1 INTRODUCTION

Refer to Drawing MC378-C401/2/3/4/5.

The floodline study requires the determination of the 1:50 and1:100 year floodlines for 10 different streams located within the Boschendal Founders Estate.

This section of the report serves to describe the computation of the floodlines for the different streams.

3.2.2 SCOPE

The study comprises of the following:

- FLOOD HYDROLOGY:
  - Determination of flow peaks for return periods of 1:50 and 1:100 year, calculated using a range of standard hydrological methods.

- RIVER HYDRAULICS:
  - Acquisition of survey of the development site
  - Modelling the streams using the water surface profile software package HEC-RAS 5.0.7. The required inputs are from the field observations, the survey data, any constraints, and the peak flows for floods of 1:50 and the 1:100 year return intervals.
  - Computation of water surface profiles, energy grades and flow velocities.
  - Determination of floodlines and demarcating these in plan on drawings.

3.2.3 FLOOD PEAK FLOWS

- CATCHMENTS:

The catchments which drain to the various streams are depicted in Figure 5 below. The overall catchment has been sub-divided in order to determine the flood peaks at 10 difference locations.

In Table 1 below a matrix of the stream and the corresponding Estate affected.

TABLE 1: AFFECTED ESTATE AND STREAM MATRIX

ESTATE NUMBER	STREAMS									
	1	**2**	**3**	**4.1**	**4.2**	**4.3**	**5**	**6.1**	**6.2**	**7**
FE-2			X							
FE-3(1)										
FE-4(1)										
FE-5	X									
FE-6			X							
FE-7		X								
FE-8						X				
FE-9										
FE-10		X								
FE-11(1)										
FE-12					X					
FE-13							X			
FE-14									X	
FE-15								X		
FE-16A(1)										
FE-16B										X
FE-18							X			
FE-19				X						

Note:
(1) Estates FE-3, FE-4, FE-11 and FE-16A are not in close proximity of any streams. Therefore the floodline study is not applicable.

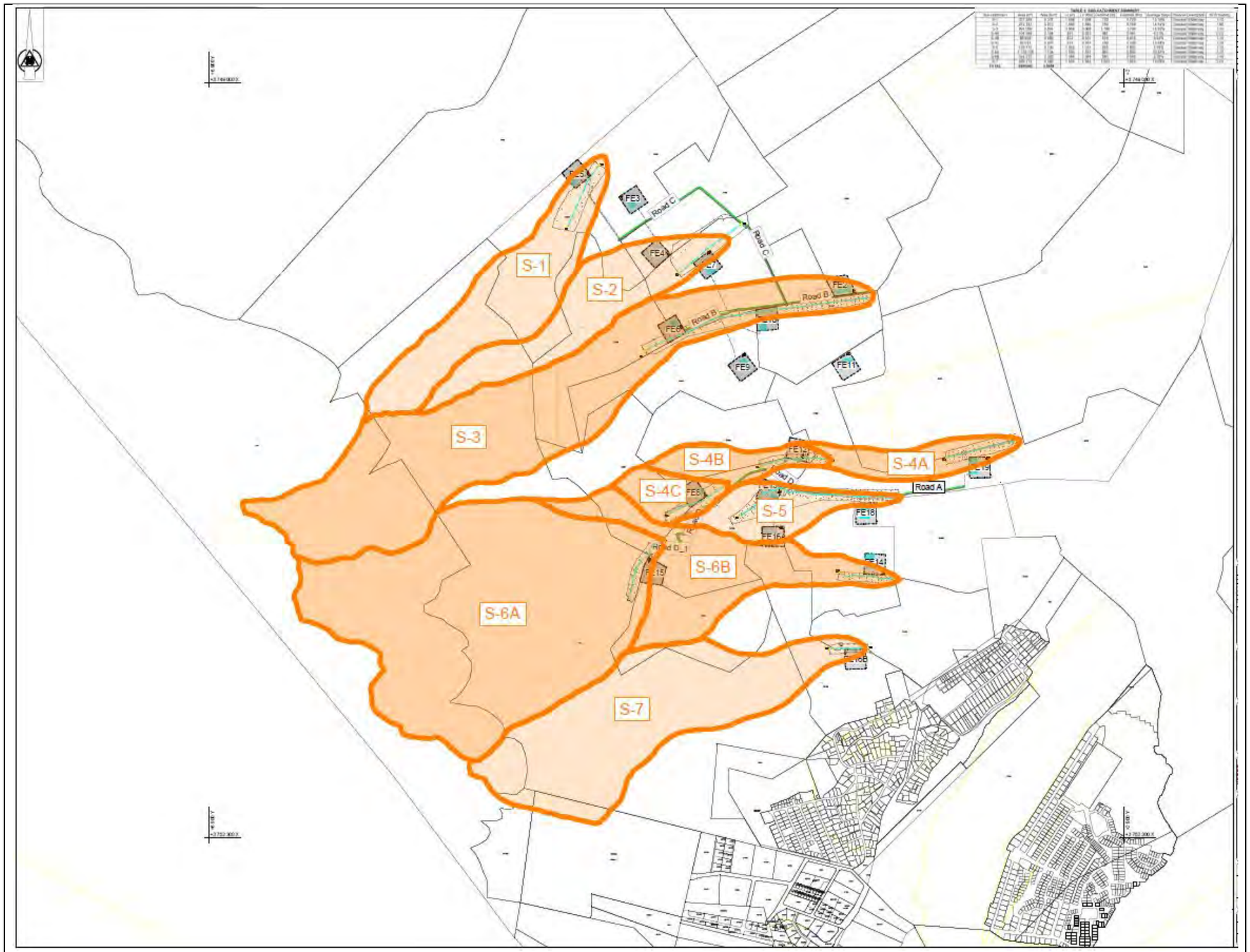

FIGURE 5: SUB-CATCHMENT LAYOUT

The parameters for these sub-catchments are summarised in Table 2 below.

TABLE 2: SUB-CATCHMENT SUMMARY

Sub-catchment	Area (m^2)	Area (km^2)	Lc (m)	Lc (Km)	Centroid (m)	Centroid (Km)	Average Slope
S-1	337 289	0.34	1 658	1.658	720	0.720	15.15%
S-2	272 757	0.27	1 589	1.589	769	0.769	14.14%
S-3	891 059	0.89	3 068	3.068	1 786	1.786	18.35%
S-4A	104 269	0.10	831	0.831	461	0.461	4.21%
S-4B	88 925	0.09	822	0.822	516	0.516	9.24%
S-4C	76 037	0.08	537	0.537	256	0.256	15.34%
S-5	129 770	0.13	1 045	1.045	622	0.622	7.26%
S-6A	1 134 138	1.13	1 833	1.833	962	0.962	30.32%
S-6B	324 975	0.32	1 384	1.384	583	0.583	9.70%
S-7	596 173	0.60	1 884	1.884	1 265	1.265	19.09%
TOTAL	**3 955 392**	**3.96**					

3.2.4 STORM DATA

The City of Cape Town commissioned the University of Kwa-Zulu Natal to investigate the likely effect of climate change on storm intensities in the Western Cape. The recommendation from this investigation was that an increase of approximately 15% over the existing IDF curves be allowed for. This was accepted by the City and a set of point storm rainfall depths has been prepared for a one minute by one-minute grid covering the Western Cape.

The point rainfall figures applicable to the development site have been extracted from the Western Cape design rainfall database. The site is located near grid points 33°53'S 18°56'E and 33°53'S 18°57'E. The average rainfall from the two grid points were calculated and used for the design. The rainfall figures used for the design is given in Table 3.

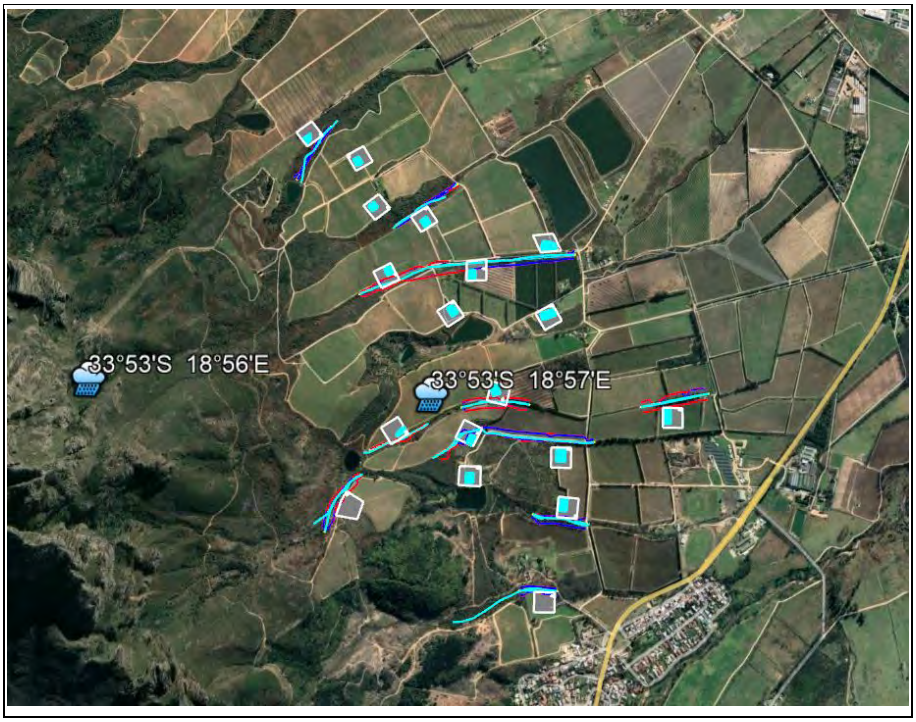

FIGURE 6: RAINFALL DATABASE GRID POINTS NEAR DEVELOPMENT SITE

TABLE 3: FINAL SELECTED GRID POINT STORM RAINFALL DEPTHS FOR THE DEVELOPMENT SITE EXTRACTED FROM CITY OF CAPE TOWN DESIGN GRID INCORPORATING A CLIMATE CHANGE FACTOR

RETURN PERIOD (YR)	POINT STORM RAINFALL DEPTHS (mm) FOR EVENT DURATIONS (MINUTES) OF:							
	10	30	60	120	240	360	720	1440
0.5	4.8	8.5	12.3	17.9	23.9	28.2	37.6	50.1
1	7.1	12.6	18.2	26.4	35.2	41.6	55.4	73.8
2	9.5	16.6	24.0	34.8	46.3	54.7	72.8	96.9
5	12.7	22.3	32.2	46.6	62.0	73.3	97.5	129.7
10	14.9	26.2	37.9	54.9	73.1	86.3	114.8	152.7
20	17.2	30.1	43.6	63.2	84.1	99.3	132.1	175.6
50	20.3	35.6	51.5	74.5	99.1	117.0	155.6	206.9
100	22.8	39.8	57.7	83.5	110.9	131.0	174.1	231.4

NOTES:

1. These data are from the averages from positions: 33°53'S 18°56'E and 33°53'S 18°57'E.
2. The 1:0.5 year and 1:1 year return period rainfall depths have been extrapolated.

3.2.5 FLOOD PEAKS

- METHODOLOGY:

The flood peak flows have been computed using five methods appropriate for these type of sub-catchments, viz. the HEC-HMS using SCS Runoff Method, Rational Method 3, Standard Design Flood (SDF), Midgley and Pitman method, and the Regional Maximum Flood (RMF) ratio method.

For the final peak flows used for the floodline study, the results obtained from the HEC-HMS using SCS Runoff Method was used for the flood determination.

Below in Table 4 is a summary of the peak flows for each stream.

TABLE 4: PEAK FLOW SUMMARY

Stream No.	Peak Flow (m^3/s)	
	1:50YR	**1:100YR**
1	7.5	8.5
2	6.0	7.0
3	15.8	18.3
4.1	6.8	7.8
4.2	4.8	5.5
4.3	2.6	3.0
5	3.1	3.6
6.1	29.0	33.4
6.2	33.9	39.1
7	13.6	15.7

3.2.6 FLOOD DETERMINATION

The software package HEC-RAS (Ver 5.0.7) was used to compute the water surface profiles for the 1:50 and 1:100 year recurrence intervals as follows, using cross-sections from the survey and the previously determined flood peak flows.

Based on field observations, the upstream and downstream boundary conditions were deemed to be the normal depth as defined by the river grade at the upper and lower cross-sections respectively.

The stream channels are mostly rocky (refer to Figure 4 above) with the embankments being overgrown and Manning n roughness coefficients were selected accordingly (Main channel n=0,04; Left and right banks 0,5).

The results of the water surface profiles analyses are contained in Annexure D.

From these results the floodline levels have been plotted on the accompanying drawings MC378-C401/2/3/4/5, where the floodlines are defined as the energy grade levels.

3.3 STORM RUNOFF MODEL

3.3.1 METHODOLOGY

The pre-development and post-development runoff was calculated using the Storm and Sanitary Analysis (SSA) software package using the EPA SWMM hydrology method. SWMM is a dynamic hydrology-hydraulic water quality simulation model. It is used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. The runoff component operates on a collection of sub-catchment areas that receive precipitation and generate runoff and pollutant loads. The routing portion transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff made within each sub catchment. It tracks the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period made up of multiple time steps.

3.4 PRE-DEVELOPMENT RUNOFF PEAKS

The pre-development parameters and CN values are shown in Table 5. The pre-development model represents the current Greenfields status of each Estate (grassed area and scattered shrubs).

The total development site pre-development peak runoff flows are given in Table 6.

TABLE 5: PRE-DEVELOPMENT SUB-CATCHMENT SUMMARY

Sub-Catchment	Area (ha)	Width (m)	% Slope	n-Perv	D-store Perv	SOIL	LAND USE	CN
FE-2	0.81	56	7.55	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-3	0.81	65	5.70	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-4	0.81	64	13.08	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-5	0.81	65	7.84	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-6	0.80	70	9.07	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-7	0.81	62	8.75	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-8	0.81	64	15.03	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-9	0.81	70	4.91	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-10	0.88	78	5.74	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-11	0.81	63	4.93	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-12	0.81	75	5.45	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-13	0.81	90	13.01	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-14	0.81	67	5.10	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-15	0.93	82	16.63	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-16A	0.84	74	8.18	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-16B	0.78	75	8.91	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-18	0.81	74	5.15	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
FE-19	0.81	75	2.72	0.15	2	B/C	Open Space/Parks (Urban/Suburban)	68
Total	**14.75**							

Notes:
1). “Width” is a SWMM catchment parameter computed as Area/Longest Collector.
2). Parameter % Imperv was not used – set to zero.
3.) Infiltration is controlled by the SCS runoff factor CN, which was set to 68 – representative of the current condition.

TABLE 6: PEAK PRE-DEVELOPMENT RUNOFF SUMMARY

SUB CATCHMENT	Q_{PEAK} (l/s)							
	0.5YR	1YR	2YR	5YR	10YR	20YR	50YR	100YR
FE-2	3.0	14.7	33.5	61.4	83.2	106.9	141.4	170.2
FE-3	3.0	14.9	33.8	61.8	83.6	107.5	142.1	170.9
FE-4	3.5	19.5	40.3	71.0	95.0	121.1	158.4	189.3
FE-5	3.2	16.6	36.3	65.3	88.0	112.7	148.4	178.0
FE-6	3.4	18.3	38.6	68.5	92.0	117.3	153.9	184.1
FE-7	3.2	16.8	36.6	65.8	88.6	113.4	149.3	179.1
FE-8	3.6	20.3	41.3	72.4	96.7	123.0	160.7	191.9
FE-9	3.0	14.9	33.7	61.6	83.5	107.3	141.9	170.7
FE-10	3.4	17.3	38.4	69.5	93.9	120.4	158.7	190.7
FE-11	2.9	13.9	32.2	59.5	80.8	104.1	137.9	166.2
FE-12	3.2	16.1	35.6	64.4	86.9	111.4	146.9	176.4
FE-13	3.9	23.5	45.4	78.1	103.6	131.1	170.1	202.3
FE-14	3.0	14.6	33.3	61.2	82.9	106.6	141.0	169.7
FE-15	4.3	25.5	50.3	87.2	115.9	146.9	191.2	227.7
FE-16A	3.5	18.6	39.5	70.4	94.5	120.7	158.4	189.8
FE-16B	3.4	18.8	38.7	68.2	91.3	116.2	152.1	181.7
FE-18	3.1	15.7	34.9	63.5	85.7	110.0	145.2	174.4
FE-19	2.8	12.6	30.1	56.5	77.1	99.6	132.3	159.8

4. POST-DEVELOPMENT STORMWATER MANAGEMENT – QUANTITY AND RATE OF RUNOFF

4.1 STELLENBOSCH MUNICIPALITY DESIGN GUIDELINES

In Section 2 the conditions set out in the Stellenbosch Municipality Design Guidelines and Minimum Standards for Civil Engineering Services, Revision No: 0, June 2015 applies to this development.

Section D – Design Guidelines and Minimum Standards For Stormwater Drainage, contains the following:

i) The minor system (underground piped system) should have the capacity to accommodate the 1:2 year runoff peak flows
ii) The major system (underground and overland) should have the capacity to accommodate the 1:50 year peak flows without damage to properties, injuries or loss of life.
iii) Systems draining trapped lows should accommodate the 1:100 year storm.

If the full carrying capacity of the roads are utilised then:

i) No inundation beyond the road reserves are permitted
ii) The maximum allowable inundation above the road crown during major storm events is 150mm.

4.2 RUNOFF ANALYSIS

4.2.1 PROPOSED ON-SITE STORMWATER CONFIGURATION

Due to the size and type of the proposed development on each estate, no adverse post-development runoff is expected. Attenuation of roof and paving runoff will be provided by the bioretention basin and the swales will provide attenuation of the roadway runoff.

In order to achieve the required runoff treatment on site, it is proposed to use bioretention basin. These will act as both a sediment traps, filters and in addition attenuation.

The runoff from the development site will flow on to the bioretention basin either directly or as overland flow.

In the bio-retention bed the runoff will enter the 1,2m deep bio-infiltration media. The runoff will seep through the bio-infiltration media.

4.3 MODEL LAYOUT AND PARAMETERS

4.3.1 MODEL LAYOUT

The post-development model parameters are shown in Table 7. The post-development model represents the proposed development layout which consists of residential properties, road areas and open spaces.

TABLE 7: POST-DEVELOPMENT SUB-CATCHMENT SUMMARY

Sub-Catchment	Area (ha)	Width (m)	% Slope	n-Perv	D-store Perv	SOIL	LAND USE	Weighted CN
FE-2	0.81	56	7.55	0.15	2	B/C	Partially Residential	72
FE-3	0.81	65	5.70	0.15	2	B/C	Partially Residential	70
FE-4	0.81	64	13.08	0.15	2	B/C	Partially Residential	70
FE-5	0.81	65	7.84	0.15	2	B/C	Partially Residential	70
FE-6	0.80	70	9.07	0.15	2	B/C	Partially Residential	70
FE-7	0.81	62	8.75	0.15	2	B/C	Partially Residential	70
FE-8	0.81	64	15.03	0.15	2	B/C	Partially Residential	69
FE-9	0.81	70	4.91	0.15	2	B/C	Partially Residential	70
FE-10	0.88	78	5.74	0.15	2	B/C	Partially Residential	70
FE-11	0.81	63	4.93	0.15	2	B/C	Partially Residential	72
FE-12	0.81	75	5.45	0.15	2	B/C	Partially Residential	70
FE-13	0.81	90	13.01	0.15	2	B/C	Partially Residential	70
FE-14	0.81	67	5.10	0.15	2	B/C	Partially Residential	72
FE-15	0.93	82	16.63	0.15	2	B/C	Partially Residential	71
FE-16A	0.84	74	8.18	0.15	2	B/C	Partially Residential	70
FE-16B	0.78	75	8.91	0.15	2	B/C	Partially Residential	71
FE-18	0.81	74	5.15	0.15	2	B/C	Partially Residential	72
FE-19	0.81	75	2.72	0.15	2	B/C	Partially Residential	70
Total	**14.75**							

Notes:
1). “Width” is a SWMM catchment parameter computed as Area/Longest Collector.
2). Parameter % Imperv was not used – set to zero.
3.) Infiltration is controlled by the SCS runoff factor CN, which was set to between 69 and 72 – representative of the proposed condition.

Note that the purpose of the post-development SSA model was to determine the effect of the proposed development, in order to determine the Water Quality Volume for each estate.

5. POST-DEVELOPMENT STORMWATER MANAGEMENT - QUALITY TREATMENT

5.1 OBJECTIVES

It is required by the selected SuDS objective, to treat the stormwater runoff so that the total phosphorus concentration is reduced by 45%. This treatment is to be applied to the 24-hr duration 1:0,5-year storm Water Quality Volume (WQv).

The required objective for this site for stormwater quality is:

- Suspended solids (SS): 80% reduction
- Total phosphorous (TP): 45% reduction

Total phosphorous is contributed by the runoff from roadways within the development. Runoff from the parking and roadways will be treated by the bioretention basin and swales, respectively.

Suspended solids are primarily generated by runoff from roofs and landscaping areas. The runoff from the building therefore only requires sediment removal. The sediment will be intercepted and trapped in the bioretention basin.

The water treatment design is applied to the water quality volume (WQv), which is the runoff from the 24-hr duration 1:0,5 year storm. This will be treated by the bioretention basin. Refer to Table 8.

Note that these requirements can be scaled according to the size of dwelling and surrounding impervious area.

TABLE 8: WATER QUALITY VOLUME SUMMARY

Estate	Runoff (mm)	Developable Area (m²)	WQv (m³)	Bioretention Basin (m²)
FE-2	11.1	8 103	90.2	69
FE-3	10.1	8 100	81.6	19
FE-4	10.2	8 100	82.9	19
FE-5	10.1	8 077	81.9	22
FE-6	10.2	8 033	82.0	18
FE-7	10.2	8 100	82.2	35
FE-9	10.1	8 100	81.6	40
FE-10	10.1	8 792	89.0	40
FE-11	11.1	8 100	89.8	73
FE-12	10.1	8 098	81.9	39
FE-14	11.1	8 100	90.2	74
FE-16A	10.2	8 360	85.2	40
FE-16B	10.8	7 761	83.6	39
FE-18	11.2	8 100	90.5	67
FE-19	10.0	8 100	80.7	34
TOTAL	**156.6**	**147 506**	**1 273.2**	**629**

Note:
1. The area is listed for each founder's estate are based on the assumption that the full developable area will be hardened.
2. Should the hardened area be less than the developable area, the area of the required bioretention basin can be scaled on a pro-rata basis.
3. Estates FE-8, FE-13, and FE-15 were excluded on purpose from this table. No bioretention basins were required.

5.2 BIORETENTION BASIN

It should be noted that the bioretention basins are proposed for the individual FE's and that these relate to the stormwater management of the individual FE homesteads. The infrastructure for the overall development will therefore not included the bioretention basins.

A 1,2m deep bioretention basin will be provided at each estate. The bioretention basins will have a surface area sized for the incoming WQv, as per the Georgia Stormwater Management Manual Volume 2 Technical Handbook, Section 3.2.3.The WQv represents the runoff volume from the 24-hour duration, 1:0,5-year storm.

Table 9 contains the soil grading summary required for the bioretention basins.

TABLE 9: BIORETENTION BASINS SPECIFICATIONS

Sieve size (mm)	Soil Type	% Passing
6	Fine Gravel	100
2	Coarse sand	90-100
0.6	Medium sand	40-70
0.2	Fine Sand	5-20
0.063	Clay/silt	<5

Notes:
1. Depth as per stormwater management plan.
2. Add 3-5% organic material by weight.
3. Ph 5.5-8.5
4. Underdrain porosity >30%
5. Electrical Conductivity, Salinity <3300 µS/cm
6. Minimum infiltration rate: 600mm/day

References:
- CIRIA Report C753 The SuDS Manual
- Georgia Stormwater Management Manual. Vol 2 Technical Manual

Below in Tables 10.1 to 10.3 is summary of the parameter for each bioretention basin.

TABLE 10.1: BIORETENTION BASINS SUMMARY

ESTATE	FE-2	FE-3	FE-4	FE-5	FE-6
TOB (RLm)	252.11	326.82	312.11	320.72	309.85
IL (RLm)	251.81	326.52	311.81	320.42	309.55
Total Depth (m)	0.30	0.30	0.30	0.30	0.30
Bioretention basin (m²)	69	19	19	22	18
Internal Side Slope (1:V)	3	3	3	3	3

TABLE 10.2: BIORETENTION BASINS SUMMARY

ESTATE	FE-7	FE-9	FE-10	FE-11	FE-12
TOB (RLm)	288.49	287.29	275.15	255.34	269.04
IL (RLm)	288.19	286.99	274.85	255.04	268.74
Total Depth (m)	0.30	0.30	0.30	0.30	0.30
Bioretention basin (m²)	35	40	40	73	39
Internal Side Slope (1:V)	3	3	3	3	3

TABLE 10.3: BIORETENTION BASINS SUMMARY

ESTATE	FE-14	FE-16A	FE-16B	FE-18	FE-19
TOB (RLm)	244.29	281.06	250.15	249.53	255.81
IL (RLm)	243.99	280.76	249.85	249.23	255.51
Total Depth (m)	0.30	0.30	0.30	0.30	0.30
Bioretention basin (m²)	74	40	39	67	34
Internal Side Slope (1:V)	3	3	3	3	3

5.3 PROPOSED ENCHANCED SWALES

Refer to Detail 2 on drawings MC378-C401/2/3/4/5.

As part of the proposed development, stormwater swales were designed with the purpose of:

- To trap any pollutants deposited from the road and be treated in the swale
- To avoid concentrating or increasing runoff peaks

The proposed stormwater swales are located along the proposed roadways namely Road A, Road B, Road C, Road D and Road D_1. The purpose of the swale is to allow any overland runoff from the proposed roadway to be treated, attenuated and discharged into the nearest stream.

Where possible, multiple outlets will be provided to prevent concentrated flow. It is proposed to construct the outflows with 2 dry-stone layers (open joints, no mortar) with rip-rap at the base of the outlet lined with geotextile (Class A3). The runoff will spill out via this outlet towards the nearest stream. The proposed outlets are to be constructed at 20m-25m intervals.

Below in Table 11 is a summary of the enhanced swale parameters.

TABLE 11: STORMWATER SWALE PARAMETERS

Swale No.	Swale Location	Design flow (m^3/s)	Swale dimensions (m)				
			Base width	Flow depth	Total depth	Top width	Average Slope
Swale C-1	Road C	0.051	0.50	0.05	0.07	0.78	10.64%
Swale C-2	Road C	0.067	0.50	0.06	0.08	0.80	13.73%
Swale C-3	Road C	0.060	0.50	0.06	0.07	0.79	12.63%
Swale C-4 (north)	Road C to Stream 2	0.047	0.50	0.06	0.08	0.84	4.76%
Swale C-4 (south)	Road C to Road B	0.049	0.50	0.05	0.06	0.76	12.91%
Swale B-1	Road B at FE6	0.062	0.50	0.06	0.08	0.84	8.28%
Swale B-2	From FE10 to FE2	0.064	0.50	0.07	0.09	0.87	6.10%
Swale-D1-1	At FE15	0.038	0.50	0.05	0.06	0.75	8.27%
Swale-D1-2	From Road D to Road D_1	0.044	0.50	0.05	0.07	0.78	8.27%
Swale-D1	From Road D_1 to FE8	0.064	0.50	0.07	0.08	0.84	8.73%
Swale-D2	From Swale D-1 to FE12	0.050	0.50	0.06	0.07	0.79	8.73%
Swale-D3	From Swale-D2 to FE18	0.055	0.50	0.07	0.09	0.85	5.48%
Swale-A1	Along Road A	0.052	0.50	0.07	0.09	0.85	4.67%

For swales that have an average slope of more than 6% to have half-stone gabions placed at a minimum of every 30m to reduce flow velocity and prevent erosion.

6. PROPOSED CROSSING OF STREAMS

6.1 OBJECTIVE

The objective of the proposed crossing at streams is allow for access roads to the estates.

Using "*The South African National Roads Agency SOC Limited: Drainage Manual (6th Edition, September 2013)"* the roads have been classified as a Class 4 or 5 road, suggesting that the roads can be designed for the peak 1:10 year recurrence interval. Refer to Figure 7 below.

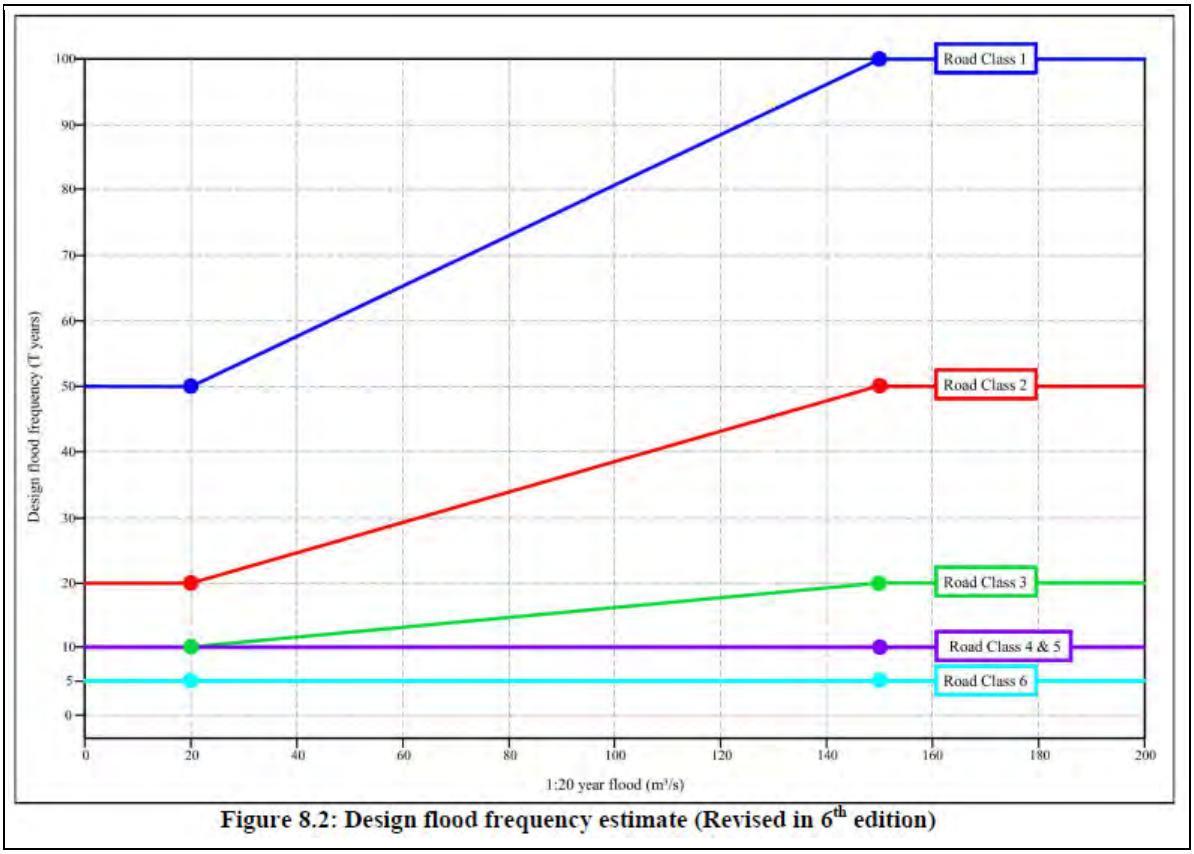

Figure 8.2: Design flood frequency estimate (Revised in 6th edition)

FIGURE 7: EXTRACT FROM THE ROAD DRAINAGE MANUAL, EDITION 6 (SEP 2013)

6.2 CULVERT SIZING

Refer to Drawing MC378-C400 for positions of proposed culverts.

The culverts have been designed with the upstream of 1,2 x H. The inlet should be rounded as per the Drainage Manual specifications so as to give an inlet coefficient of 1. In total seven (7) stream crossings were identified.

Below in Table 12 is summary of the culvert sizing parameters.

TABLE 12: CULVERT SIZING SUMMARY

Culvert Name	Stream No.	Catchment	1:10yr Peak flow (m^3/s)	Approx. Length of crossing (m)	Approx. depth of stream (m)	Proposed culvert size (m)	Capacity of proposed culverts (m^3/s)
1A	1	S-1	5.0	17.3	0.81	3No. 0.9m(H) x 1.20m(W)	6.20
2A	2	S-2	4.0	18.0	0.86	2No. 0.9m(H) x 1.20m(W)	4.13
3A	3	S-3	10.5	9.6	1.10	3No. 1.20m(H) x 1.20m(W)	11.93
4.2A	4.2	S-4B	3.2	12.5	0.41	1No. 1.20m(H) x 1.50m(W)	3.98
4.3A	4.3	S-4C	1.7	13.6	1.28	1No. 1.20m(H) x 0.90m(W)	2.39
5A	5	S-5	2.0	11.4	1.50	1No. 1.20m(H) x 1.20m(W)	3.18
6.1A	6.1	S-6A	19.2	12.0	1.02	5No. 1.20m(H) x 1.50m(W)	19.89
ADD. CULVERT	-	S-5	0.6	5.0	0.50	1No. 0.60m(H) x 0.75m(W)	0.70

7. MAINTENANCE OF THE STORMWATER SYSTEM

7.1 SCOPE OF MAINTENANCE

The ongoing sustainability of the stormwater system is linked to its effective maintenance of all its components. These include downpipes, gutters, channels, bioretention basins, and swales.

7.2 RESPONSIBILITY FOR MAINTENANCE

The maintenance responsibility of the connector roads and swales will be that of registered Home Owners' Association of the Boschendal Estate, whereas the private access roads and bioretention basins will be the responsibility of the individual Estate Owners. The HOA and the individual Estate Owners will be required to ensure that the stormwater systems are in good repair, in a healthy state and regularly serviced as described in this section the report. Records should be kept of these maintenance activities. A maintenance schedule is included as Annexure B. This should be used as a checklist and for record purposes.

7.3 MAINTENANCE REQUIREMENTS OF THE DIFFERENT ELEMENTS

(i) Roof Gutters

These must be kept in good functional condition and free from debris. This will require regular inspections and repairs as may be necessary.

(ii) Downpipes and Delivery Pipes

These must be kept in good functional condition and free from debris. This will require regular inspections of all visible sections and repairs as may be necessary.

(iii) Bioretention Basins

The depth of the bioretention beds should be kept well-vegetated while maintaining the volume required for attenuation by removal of sediment from time to time.

(iv) Swales

Swales should be kept clear of all obstructions so as to maintain adequate flow capacity. The banks should be kept clear of obstructions so as to maintain flow capacity and the banks should be vegetated to a height of approximately 200mm or shorter.

The condition of the outlets and half-gabions should be maintained so as to avoid erosion.

8. MASTER LANDSCAPING PLAN

All planting and landscaping should be compliant with the “Landscape Guidelines, Landscape Plan and Implementation Programme”, dated November 2020 (or final edition), compiled by Boschendal Estate.

9. SEDIMENT, LITTER AND DEBRIS CONTROL: OPERATIONS AND SERVICES

Addressing sediment, litter and debris control for a development of this size requires that the construction work, operational activities and transportation activities work in unison to achieve a successful reduction in all three pollutants types.

10. DEVELOPMENT PHASING

The development is to constructed as individual phases. The bioretention basin and all its components allocated to a development catchment need to be constructed in conjunction with the construction on each estate. The swales must form part of the road construction.

11. CONCLUSIONS

11.1 PROPOSED DEVELOPMENT

It is proposed to develop various estates on the Boschendal Estate region which is currently undeveloped, for residential use. The development will be comprised residential units of various sizes, internal roadways and landscaping areas.

Access to Boschendal Estate is from Helshoogte Road (R310).

11.2 STELLENBOSCH MUNICIPALITY GUIDELINES

In Section 2 the conditions set out in the Stellenbosch Municipality Design Guidelines and Minimum Standards for Civil Engineering Services, Revision No: 0, June 2015 applies to this development.

The objectives include attenuation of peak runoff and water quality treatment. The objectives to be met by this stormwater management plan are listed in Table 1.

The building runoff generates mainly suspended solids (SS) which is to be trapped and removed, while the remainder must be treated for SS as well as total phosphorous (TP) removal.

11.3 EXISTING CONDITIONS

The sites are undeveloped (greenfield) except where houses and other buildings are located on certain Founders' Estates, and slopes in various directions, based on the location of the estate. The average slopes varies between 2,5% and 16,6%. The soil has a low permeability with much dense grass and shrub cover.

11.4 RUNOFF PEAK ATTENUATION

There is no adverse peak runoff from the development site. Therefore the bioretention basin and swales will act as partial attenuation of the development site and roadways, respectively.

11.5 RUNOFF WATER QUALITY TREATMENT

Runoff water quality standards are achieved with the use of bioretention basin and swales.

It should be noted that the bioretention basins are proposed for the individual FE's and that these relate to the stormwater management of the individual FE

homesteads. The installation of stormwater infrastructure for the overall FE development will therefore not include the bioretention basins.

The bioretention basins would be constructed when individual FE homesteads are developed.

11.6 MAINTENANCE

Maintenance forms an integral part of the sustainability of the stormwater management plan. A plan is presented in Section 7 and Annexure B. The implementation of the plan will be the responsibility of the HOA and the individual Estate Owners as described in section 7.

G A McGILL Pr Eng

2022-08-22

ANNEXURE A: STELLENBOSCH MUNICIPALITY DESIGN GUIDELINES AND STANDARDS FOR CIVIL ENGINEERING SERVICES

EXTRACT: SECTION D – DESIGN GUIDELINES AND MINIMUM STANDARDS FOR STORMWATER DRAINAGE

(BOUND SEPARATELY)

ANNEXURE B: MAINTENANCE SCHEDULES

TABLE B1: BIORETENTION BASINS MAINTENANCE SCHEDULE

PROPOSED BIO-RETENTION AREAS																								
COMPONENT	NO.	INSPECTIONS [I]		NO.	ROUTINE MAINTENANCE [R]		NO.	CORRECTIVE AND IRREGULAR MAINTENANCE			ANNUAL SPREAD OF MAINTENANCE ACTIVITIES (I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		J	F	M	A	M	J	J	A	S	O	N	D
Overland inlet strip	1.1	Inspect inlet strip for any obstructions	3	1.1	If the overland inlet strip has any obstructions, it has to be removed	3	1.1	If overland inlet strip is damaged, it needs to be repaired.	As required		I, R			I, R			I, R			I, R		
Filterbed	2.1	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess stating water levels in underdrain (if applicable) to determine if maintenance is necessary	3	2.1	Remove litter and surface debris and weeds	3	2.1	Infill any holes in the filter medium, improve erosion protection if required	As required		I, R			I, R			I, R			I, R		
	2.2	Check operation of underdrains by inspection of flows after rain	3	2.2	Replace any plants, to maintain planting density	As required	2.2	Repair minor accumulation of silt by raking away surface mulch, scarifying surface of medium and replace mulch	As required		I			I			I			I		
	2.3	Assess plants for diseases infection, poor growth, invasive species and replace as necessary	3	2.3	Remove sediment and debris build up from around inlets and forebays	3	2.3	Remove and replace filter medium and vegetation above	As required but likely to be > 20 years		I, R			I, R			I, R			I, R		
	2.4	Inspect inlets and outlets for any blockages	3																				
Catch pit/ kerb inlets/ stormwater pipes	3.1	Ensure catch pit inlets are free of obstructions	6	3.1	Remove any obstructions from inlets	6					I,R							I,R					
	3.2	Remove sediment at sediment trap	6	3.2	Remove any obstructions from inlets	6					I,R							I,R					

Reference:

The South African Guidelines for Sustainable Drainage Systems. N Armitage, M Vice, L Fisher-Jeffes, K Winter, A Spiegel, J Dunstan. Water Research Commission report TT558/13, May 2013.

The SuDs Manual, B Woods Ballard, S Wilson, H Udale-Clarke, S-Illman, T Scott, R Ashely, R Kellaher. Department for Environment Food & Rural Affairs, ISBN 978-0-86017-760-9, 2015

TABLE B2: MAINTENANCE SCHEDULE FOR SWALES

PROPOSED SWALES																								
COMPONENT	NO.	INSPECTIONS (I)		NO.	ROUTINE MAINTENANCE (R)		NO.	CORRECTIVE AND IRREGULAR MAINTENANCE		NO.	ANNUAL SPREAD OF MAINTENANCE ACTIVITIES (I=INSPECTION; R=ROUTINE; OTHER AS SPECIFIED)											
		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		ACTIVITY	FREQUENCY (months)		J	F	M	A	M	J	J	A	S	O	N	D
Canal Liner block (or equivalent)	1.1	Inspect sides and base	1	1.1	Remove litter and debris	1	1.1	Repair erosion or other damage	As required		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
				1.2	Inspect uneven surfaces	4	1.2	Relevel uneven surfaces and reinstate design levels	As required			I,R				I,R				I,R		
				1.3	Manage other vegetation and remove nuisance plants	1	1.3	Remove vegitation	As required		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
				1.4	Inspect inlets and outlets for blockages, and clear if required	1	1.4	Remove build-up of sediment	As required		I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R	I,R
				1.5	Inspect vegetation coverage	4	1.6					I,R				I,R				I,R		
Spillway	2.1	Keep hinged grid free of obstruction	6	2.1	Remove any obstruction from hinged grid	6					I,R							I,R				

Reference:

The South African Guidelines for Sustainable Drainage Systems. N Armitage, M Vice, L Fisher-Jeffes, K Winter, A Spiegel, J Dunstan. Water Research Commission report TT558/13, May 2013.

The SuDs Manual, B Woods Ballard, S Wilson, H Udale-Clarke, S-Illman, T Scott, R Ashely, R Kellaher. Department for Environment Food & Rural Affairs, ISBN 978-0-86017-760-9, 2015

ANNEXURE C: SEDIMENT, LITTER, DEBRIS CONTROL – OPERATIONS AND SERVICES

TABLE C1: SEDIMENT, LITTER AND DEBRIS CONTROL

1. CONSTRUCTION WORKS		2. Operational Activities		3. Transportation Activities	
1.1 GENERAL	• Ensure that the least amount of land is exposed to the risk of erosion for the shortest period. • Effectively control surface runoff entering and leaving the site. • Effectively control the generation of dust, litter and debris within the site. • Install erosion control works and measures to minimise the amount of site erosion. • Install sediment collection devices to prevent the export of sediment from the site • Rehabilitate all disturbed areas as soon as possible. • Maintain the erosion control and sediment collection devices. • Limit site access to nominated and controlled areas. • Locate and secure all stockpiles away from concentrated water flow paths. • Ensure that erosion control and sediment collection structures are in place before site clearing work begins. • Locate sediment traps and basins in locations that will not create adverse flood risks to adjoining properties.	2.1 Refuelling Facilities	• Temporary fuel dispensing areas should be covered. • These areas must be isolated from surface runoff generated elsewhere on-site by utilising surface grades and/or diversion drains. • Cleaning or wash waters generated from fuel dispensing areas must not be discharged directly or indirectly to stormwater. • All runoff generated from fuel dispensing areas should discharge into a well-maintained separate system, with the necessary pre-treatment facilities for discharge to sewer or a temporary storage facility.	3.1 General	• The transportation of all goods and materials by the building and construction industry and/or its nominated contractors must be carried out in such a manner to prevent accidental spills and leakage. • Loads that may be subject to loss through wind erosion or accidental spillage must be totally and securely covered or sealed. Loose material should be cleaned from trucks before they leave the site. • When loading, and unloading, prevent spillage of materials on to the road. Any accidental spills must be cleaned up immediately so as to prevent the material from entering the stormwater system.
1.2 SERVICES INSTALLATION	• Install water and sewer services as part of the road construction works. • Avoid works in areas of likely concentrated runoff. • Divert runoff away from all trench lines with temporary banks constructed from trenching spoil or sandbags. • Properly compact soil used for trench backfill and rehabilitate the road surface as soon as practicable. • Locate stockpiles of bedding and backfill material away from concentrated drainage paths, including road gutters. • Protect the toe of all stockpiles retained for more than one day with an appropriate silt barrier. • Services installed by the direct ploughing method need special consideration if their alignment is across the natural surface contours. Under this method, the trench is not compacted and may be subject to severe erosion from runoff entering the trench and washing the compacted material along the trench line. • Techniques should be used that minimise this risk, such as direct grout injection at regular intervals along the trench line to create effective barriers and force any soakage water back to the surface and away from the trench.	2.2 Workshops	• The floor drainage of covered work areas must be isolated from the stormwater system by utilising surface grades, and/or diversion drains. When floor areas are cleaned, dry absorbents and dry sweeping should be used to minimise the generation of wastewater.		

TABLE C1 CONTINUED: SEDIMENT, LITTER AND DEBRIS CONTROL

1.3 BUILDING CONSTRUCTION WORKS	• All building construction works must be conducted in such a manner so as to minimise the entry of pollutants into the stormwater system. This includes, but is not necessarily limited to, the following building activities and trades. Hard waste • All hard waste must be stored on-site in such a manner so as to prevent any materials from entering the stormwater system either by wind or water action. They must be disposed of to a waste depot, licensed to receive that waste. • Smaller items should be kept in covered bins. They must be disposed of to a waste depot, licensed to receive that waste. • Consideration should be given to recycling waste wherever facilities for receipt of items are available. Concrete works • Where possible, all residues and wastes generated by concrete works must be prevented from entering the stormwater system. Where this is not possible, such as in concrete pavement cutting works, the amount of waste that can enter the stormwater system must be minimised. • On-site mixing of concrete, either by hand or by mechanical means, should be carried out in a designated area of the site which can contain all excess water, residues and waste. • Where site conditions require the use of concrete pumps from public roadways, temporary bunds must be provided across all downslope gutters to trap any spilt material. All spilt material must be removed from the roadway and gutter before the temporary bunds are removed. • Concrete mix trucks, pumps and equipment must not be washed down in roadways, footpaths or reserves. These vehicles and equipment should be washed down either within a designated contained area within the site or at a suitably designed and operated depot wash-down facility. • Waste concrete slurry should be allowed to dry and either be disposed of on-site or taken to a licensed waste depot. Brick work and Cutting • Mortar must not be mixed in gutters or any other location, which will drain to the stormwater system. • All wastewater from brick cutting activities must be prevented from entering the stormwater system. • Brick cutting activities that generate surplus wastewater should not be carried out on public roads, footpaths or reserves. Painting • Paint waste and wash waters must not be discharged to the stormwater system. • Water-based paint cleaning water should be disposed of to sewer or diverted into a contained area lined with newspaper on-site. When it is dry, place the newspaper with paint residue in a solid waste bin. • Oil-based clean up material should be filtered for reuse of the solvent or taken to a waste depot that is licensed to accept these wastes. Place the paint residue after filtering in a solid waste bin. • Unused paint should be kept in the tin or other sealed container and disposed of to a waste depot licensed to receive this waste. Plastering • Plastering waste and wash waters must not be discharged to the stormwater system. • All residues and wastes from plastering activities should be allowed to dry within a designated contained area of the site. Solid waste should be disposed of either on-site or taken to a licensed waste depot. • Alternatively, solid wastes from plastering activities such as calcium sulphate may be used as a clay modifier in gardens.	2.3 Uncovered Work Area	• Work activities that involve potentially polluting materials such as fuel, oil, grease, coolant, chemicals, solvents and/or cleaning agents that could drain, leak or spill should be relocated to undercover areas which contain pre-treatment devices connected to sewer. • If this is not possible, uncovered work areas must be maintained in a manner that minimises the entry of pollutants from premises into the stormwater system. For example, regularly cleaned and maintained drip pads or containers must be used under vehicles being repaired. Spilt material that could pollute stormwater must not be left unattended but should be cleaned using dry absorbents and dry sweeping wherever possible. Storage, Loading and Unloading Areas • All hard materials should be stored and handled to avoid contamination of stormwater. Stormwater drainage must be directed around or away from all stockpiles that could potentially cause pollution of stormwater. Hard stockpile areas should either be covered or located in such a manner so as to prevent erosion of the stored material and subsequent pollution of stormwater. • All liquid materials that are potentially hazardous to the environment must be stored and handled carefully to avoid leaks and spills. For large quantities, such materials should be located within a bunded compound. The bund should be impervious to infiltration, able to safely contain at least 120% of the volume of the largest container located within the bund, roofed to minimise the collection of rainwater inside the bunded compound. • Liquid handling facilities should be covered and bunded to prevent possible stormwater contamination as well as to assist in the control of any spills. Vehicle, Plant and Equipment Cleaning Areas • Waste or wash-down water from the cleaning of vehicles, plant and/or equipment must not be allowed to discharge to the stormwater system.		

			• These activities should be carried out in a covered area that discharges all wastewater to sewer.		

1. SEDIMENT, LITTER AND DEBRIS CONTROL: SOIL EROSION AND SEDIMENT CONTROL STRUCTURES

Together with the operations and service described above physical soil erosion and sediment control structures need to be put in place to reduce the sediment, litter and debris during construction. This stormwater management plan prescribes the use of 1) Erosion Control Measure and 2) Sediment Collection Structure to achieve silt and litter regulation set by the City of Cape Town.

1. Erosion Control Measures

Measures described in this section are source controls that limit the amount of site erosion. The measures rely on the principles of limiting runoff velocities and stabilising disturbed surfaces to limit erosion.

1.1 Diversion Drains

Diversion drains are channels constructed across a slope to convey runoff at a non-erosive velocity. Diversion drains are used to direct flow from upslope catchments around disturbed areas. The drains may also be used where long cut or fill slopes need to be reduced into shorter non-erodible sections, by intercepting sheet runoff and directing it across the slope to discharge on to a stabilised area. The channels require construction on a relatively flat grade to minimise velocities and prevent scour. Diversions of runoff around disturbed areas will minimise the quantity of runoff requiring treatment for the removal of sediment. Figure 4 is a cross-section of a typical diversion drain.

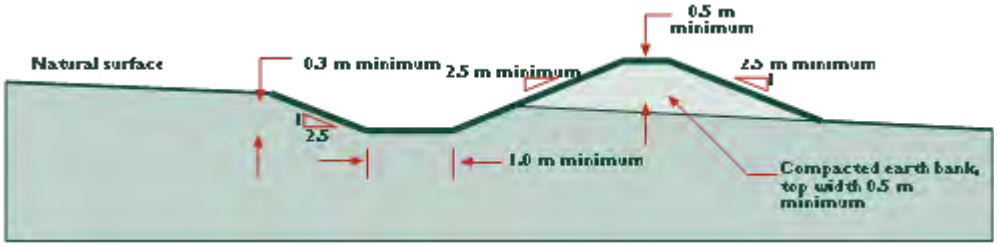

FIGURE 1: TYPCIAL DIVERSION DRAIN SECTION

1.2 Revegetation

Revegetation, by providing a dense groundcover to reducing soil erosion from disturbed sites. The methods function by protecting the soil surface from rain impact, increasing infiltration, reducing runoff velocity, binding the soil and filtering runoff. Revegetation should not be expected to provide complete erosion protection for a soil that is not stable due to its inherent structure, texture or excessive slope. Erosion control matting should be used on all revegetation areas on excessive slopes to provide interim protection until the vegetation cover can be fully established.

Revegetation of all disturbed areas should be carried out as soon as is practicable following the completion of earthworks. The measures may be applied on a broad scale to control

erosion from a large area, or they may be applied to a more localised extent to protect newly constructed formations against scouring effects. All revegetation areas should be adequately fenced to prevent damage from adjacent activities.

1.3 Level Spreaders

A level spreader is a structure built across the slope at the outlet of a channel or drain, which has a wide level overflow sill discharging on to an undisturbed area stabilised by vegetation cover. The purpose of the level spreader is to convert a concentrated, potentially erosive outflow from a drain or channel into non-erosive sheet flow. Level spreaders to be placed at the outlet of diversion channels. The spreaders require careful construction to ensure that the outlet sill is level over its entire length. They can only be used in locations where the overflow sill can be constructed on undisturbed soil. The level spreader needs to be constructed such that the sill is parallel to the slope and discharges on to a stabilised vegetated area. Discharge from the sill should only be allowed as shallow, slow moving sheet flows. Level spreaders should not be used in potential flow path areas. Care should be taken to ensure that the discharge does not become concentrated into rivulets across unstable areas. Figure 5 shows a typical design that can be used.

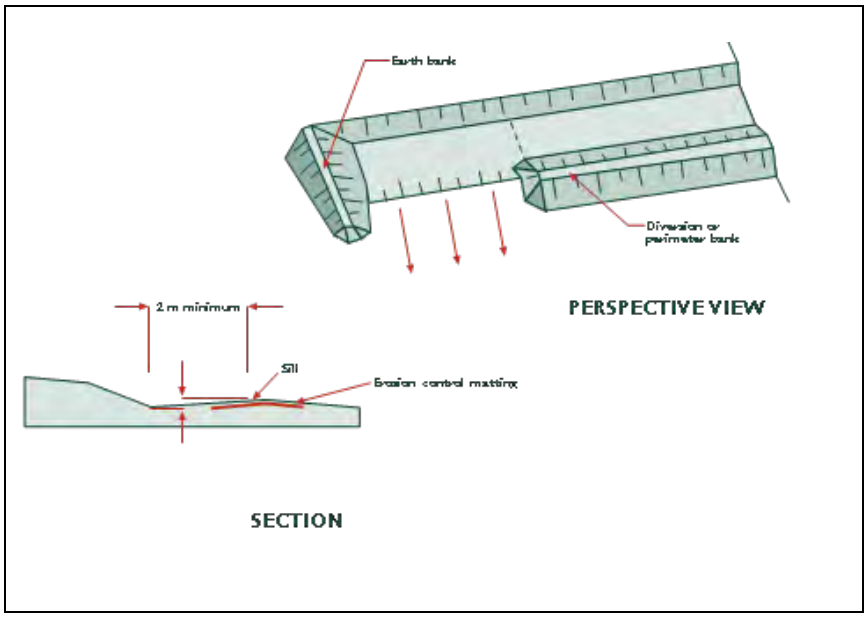

FIGURE 2: LEVEL SPREADER

2. SEDIMENT CONTROL STRUCTURE

Measures described in this section are small scale devices used for the removal of sediment. Most of the measures would normally be temporary in nature, being required only until the disturbed surfaces in the catchment they serve have become permanently stabilised, usually by revegetation. All sediment control structures will require regular inspection and periodic maintenance and/or replacement. Care must be exercised to ensure that the sediment removed from the structures during maintenance operations is not allowed to be remobilised and exported from the site.

2.1 Hale bale barriers

Hay bale barriers will be a temporary sediment control device. They are constructed from bales of hay positioned to intercept sediment laden runoff and retain the sediment. The primary purpose of a hay bale barrier is to reduce runoff velocities and filter runoff, thus causing the deposition and removal of silt. Hay bale barriers may be placed across minor drainage lines to filter runoff from small catchment areas of up to 0.5 ha in size.

Hay bales may also be used as a temporary perimeter bank around disturbed areas preventing runoff from leaving the disturbed area without being treated. The barriers may also be placed around stormwater inlet pits, to prevent sediment entering the underground drainage system. Hay bale barriers are relatively inexpensive and are easy to install. However, the bales only have a three-month life span and therefore require regular inspection and repair or replacement. It is important to ensure that the hay bales do not contain any potential pest plants.

Hay bale barriers should be inspected after each rain event for displacement, undercutting and overtopping, and repaired immediately. Experience has shown that most hay bale barrier failures are related to the following installation and related problems:

- bales not staked firmly into the ground
- bales not embedded into the ground
- bales not butted tightly end-to-end
- insufficient space provided for sediment entrapment
- access for cleaning not provided
- bales displaced by site operations or equipment and not restored to their original position at the end of the working day
- barrier not located in the centre of, and perpendicular to, the flow path
- bales providing habitats for vermin
- care should be taken when using hay bale barriers on sites prone to vandalism as they may be subject to arson attacks.

Figure 3 shows a cross-section of how a hay bale should be embed and staked into the ground.

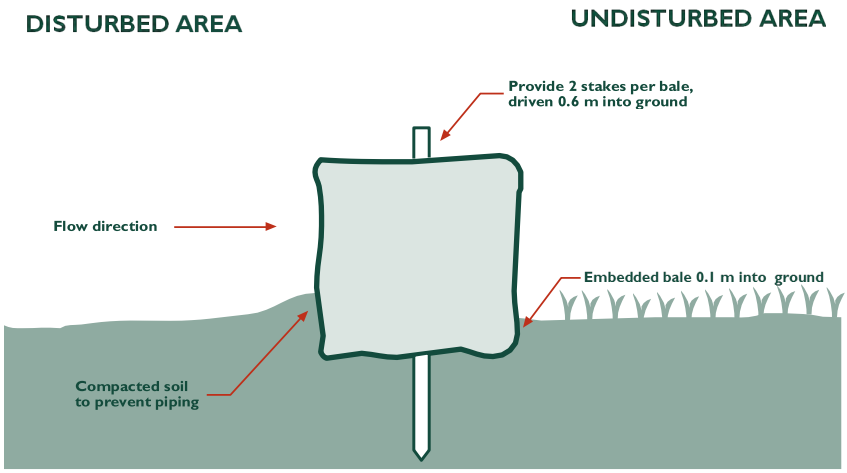

FIGURE 3: PROPER METHOD FOR STAKIGN AND EMBEDDING HAY BALE

2.2 Silt Fences

Silt fences can be used if hay bales are not available (drought). Silt fences are a temporary sediment control measure constructed from woven wire fencing mesh and filter fabric to intercept sediment laden runoff and retain sediment. Note: If good quality heavy duty geofabric is used, the layer of wire mesh is not required.

The main purpose of a silt fence is to reduce runoff velocities and cause the deposition of silt.

Silt fences are usually placed to intercept sheet flow from disturbed areas. They may also be used around the toe of stockpiles to prevent the unwanted migration of material from the stockpile. In some instances, silt fences may also be placed across minor drainage lines to act as a sediment trap. Under these conditions, the total catchment area draining to the fence should be less than 0.5 ha. The fences are relatively quick and easy to install. They may also be moved from location to location as required. The design life of the silt fence is governed by the ultra-violet stability of the fabric, which is generally about 6 months.

Figure 4 shows a cross-section of a typical silt fence.

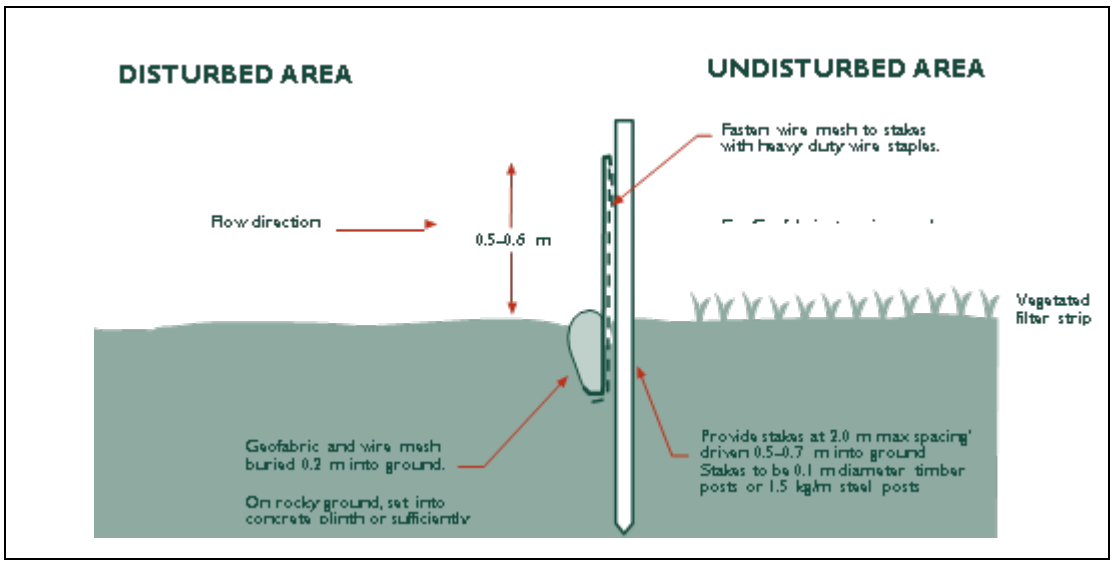

FIGURE 4: TYPICAL SILT FENCE CROSS-SECTION

2.3 Temporary Construction Exit

Temporary construction exits should be installed at any point where traffic will be leaving a construction site. The function of the construction exits is to minimise the transportation of sediment from construction sites on to public roads or adjacent properties via the wheels, chassis and sides of vehicles. Temporary construction exits consist of an elevated pad of coarse gravel overlaying a geotextile fabric. A timber or metal shaker ramp is often located on top of the gravel pad.

Facilities should be provided for vehicles to be washed down on the pad prior to leaving the site. This will be a necessary practice in muddy conditions where the shaking action of the pad is not sufficient to dislodge material attached to the outside of the vehicles.

All drainage from the exit pad must be directed to a sediment trap or sedimentation basin. A mountable berm, immediately adjacent to the site boundary, may be necessary to prevent drainage from the pad discharging on to the exit road.

The exit pad should have a minimum width of 3 metres but may not be less than the maximum available width at the site exit. The minimum length of the exit pad should be 15 metres, except for single residential allotments where a 6 metres minimum length applies.

The gravel pad, constructed from 75 mm aggregate, should have a minimum thickness of 150–200 mm. It may require periodic topping up. For building sites with only small areas of disturbed soil that are not accessible to construction traffic, temporary construction exits may not be required

Figure 5 shows a typical section through a temporary construction exit.

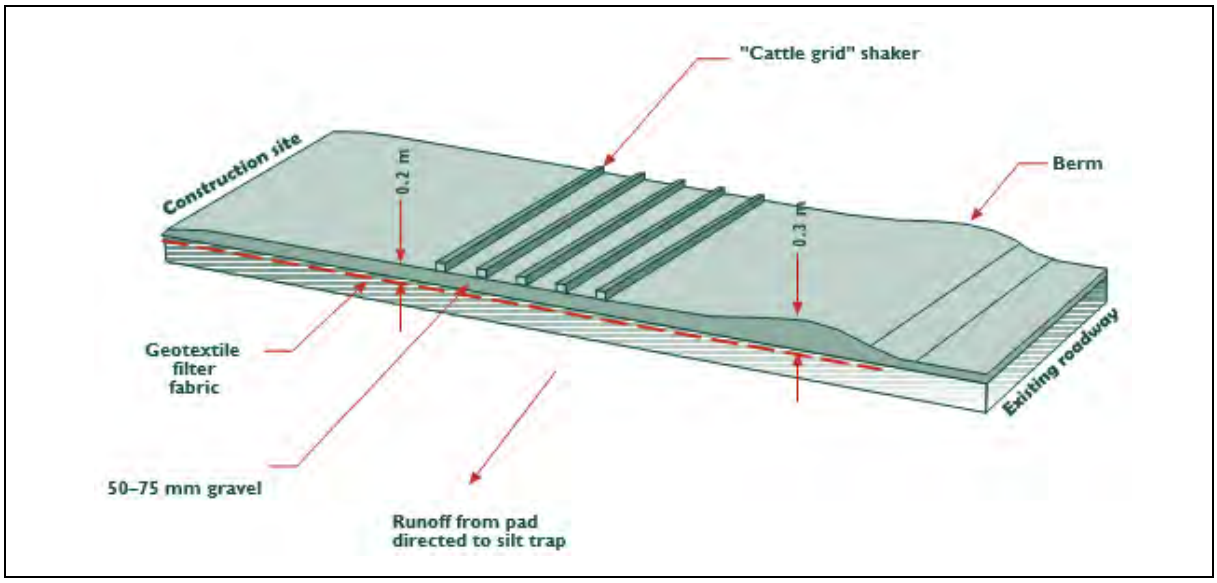

FIGURE 5 TEMPORARY CONSTRUCTION EXIT

2.4 Sediment Traps

Sediment traps are temporary structures used to intercept runoff and capture silt. The trap requires the excavation of a small basin and the creation of an embankment along its downhill side. The primary function of the sediment trap is to capture a concentrated sediment laden flow and store it under quiescent (still) conditions. This allows the silt to be deposited in the bottom of the trap.

Sediment traps are located on drainage lines downstream of small catchment areas where a high sediment load is expected to be generated. (For low sediment load cases, hay bale barriers or silt fences may be more suitable.) The traps must be installed before any land clearing operations.

Figure 6 shows a representations of how all the flow sediment collection structures will work in unison to achieve the required sediment, litter and debris requirements for the City of Cape Town by becoming.

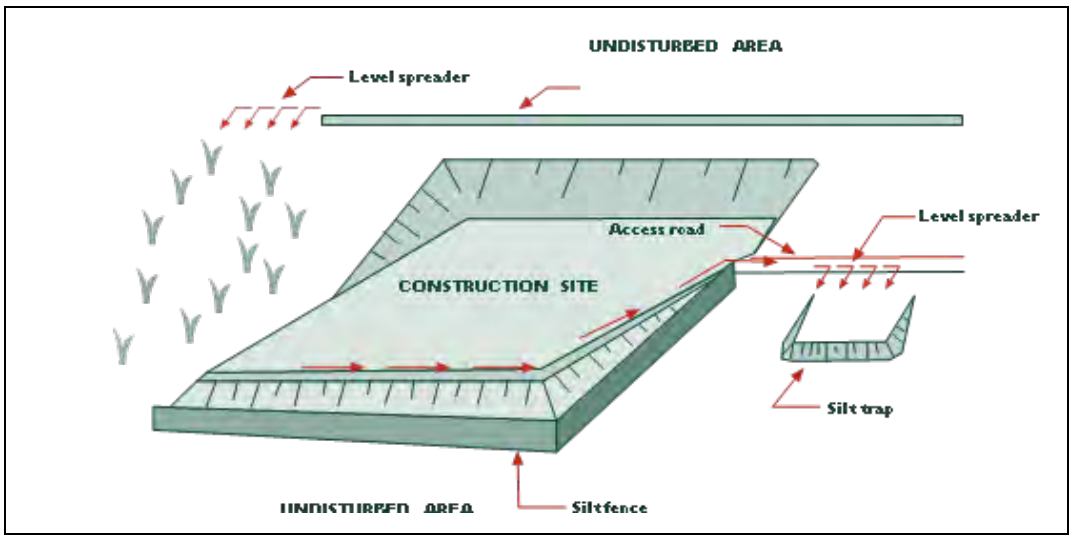

FIGURE 6 SITE DEVELOPMENT MEASURE USING SEDIMENT COLLECTION STRUCTRES

ANNEXURE D: HEC-RAS OUTPUT DATA FOR 1:50 AND 1:100 YEAR FLOODS

TABLE D.1: STREAM 1 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
305	7.5	337.85	338.16	8.7	337.88	338.23
300	7.5	335.54	337.4	8.7	335.56	337.47
275	7.5	331.24	331.97	8.7	331.27	332.08
250	7.5	330.22	330.53	8.7	330.27	330.6
225	7.5	328.92	329.43	8.7	328.97	329.51
200	7.5	327.79	328.16	8.7	327.83	328.24
175	7.5	326.55	327.01	8.7	326.6	327.08
150	7.5	325.4	325.79	8.7	325.44	325.87
125	7.5	324.05	324.49	8.7	324.08	324.56
100	7.5	322.68	323.02	8.7	322.71	323.09
75	7.5	320.9	321.35	8.7	320.93	321.41
50	7.5	319.04	319.42	8.7	319.07	319.49
25	7.5	317.12	317.59	8.7	317.15	317.66
2	7.5	315.45	315.88	8.7	315.48	315.95

TABLE D.2: STREAM 2 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
346	6	300.41	300.93	7	300.44	301
325	6	298.68	299.17	7	298.71	299.25
300	6	296.47	297.07	7	296.51	297.15
275	6	294.2	294.87	7	294.24	294.96
250	6	292.06	292.69	7	292.1	292.79
225	6	290.03	290.63	7	290.07	290.72
200	6	288.06	288.68	7	288.11	288.77
175	6	286.08	286.76	7	286.12	286.88
150	6	284.08	284.73	7	284.12	284.83
125	6	282.1	282.72	7	282.15	282.8
100	6	280.09	280.75	7	280.13	280.85
75	6	278.11	278.74	7	278.16	278.83
50	6	276.11	276.77	7	276.15	276.87
25	6	274.19	274.85	7	274.25	274.94
0	6	272.2	272.93	7	272.25	273.05

TABEL D.3: STREAM 3 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
1025	15.8	326.44	327.56	18.3	326.5	327.7
1000	15.8	324.21	325.29	18.3	324.27	325.43
975	15.8	321.95	323.07	18.3	322	323.2
950	15.8	319.81	320.79	18.3	319.86	320.91
925	15.8	317.57	318.58	18.3	317.62	318.73
900	15.8	315.19	316.27	18.3	315.24	316.41
875	15.8	312.5	313.72	18.3	312.56	313.86
850	15.8	309.91	311.17	18.3	309.97	311.34
825	15.8	307.44	308.75	18.3	307.5	308.92
800	15.8	305.52	306.54	18.3	305.58	306.69
775	15.8	302.73	304.24	18.3	302.8	304.4
750	15.8	300.59	301.8	18.3	300.66	301.98
725	15.8	298.49	299.66	18.3	298.53	299.76
700	15.8	296.39	297.04	18.3	296.42	297.07
675	15.8	294.89	295.42	18.3	294.92	295.44
650	15.8	292.83	293.93	18.3	292.88	293.99
625	15.8	290.83	291.87	18.3	290.86	291.96
600	15.8	288.53	289.73	18.3	288.61	289.84
575	15.8	286.36	287.37	18.3	286.41	287.52
550	15.8	284.3	285.19	18.3	284.35	285.31
525	15.8	282.27	283.27	18.3	282.33	283.41
500	15.8	280.43	281.48	18.3	280.5	281.63
475	15.8	278.21	279.5	18.3	278.29	279.66
450	15.8	276.03	277.28	18.3	276.1	277.45
425	15.8	273.92	275.11	18.3	273.99	275.27
400	15.8	271.96	273.1	18.3	272.03	273.27
375	15.8	270.14	271.23	18.3	270.21	271.4
350	15.8	269.21	269.78	18.3	269.25	269.87
325	15.8	266.81	268.26	18.3	266.92	268.34
300	15.8	265.63	266.4	18.3	265.66	266.5
275	15.8	264.02	264.99	18.3	264.06	265.02
250	15.8	262.02	263	18.3	262.05	263.03
225	15.8	260.59	261.19	18.3	260.63	261.23
200	15.8	258.47	259.68	18.3	258.59	259.78
175	15.8	256.83	257.94	18.3	256.9	258.12
150	15.8	255.55	256.47	18.3	255.63	256.61
125	15.8	254.28	255.05	18.3	254.33	255.14
100	15.8	253.07	253.63	18.3	253.13	253.71
75	15.8	250.87	251.54	18.3	250.89	251.63
50	15.8	249.3	249.62	18.3	249.34	249.68
25	15.8	247.48	248.08	18.3	247.51	248.13
0	15.8	246.31	246.68	18.3	246.34	246.73

TABLE D.4: STREAM 4.1 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
312	6.8	233.47	233.58	7.8	233.48	233.6
300	6.8	232.97	233.06	7.8	232.98	233.08
275	6.8	231.88	232.01	7.8	231.9	232.03
250	6.8	230.72	230.83	7.8	230.74	230.86
225	6.8	229.51	229.79	7.8	229.55	229.85
200	6.8	228.73	229	7.8	228.75	229.05
175	6.8	227.37	228.04	7.8	227.48	228.12
150	6.8	226.77	227.09	7.8	226.79	227.17
125	6.8	225.14	226.03	7.8	225.23	226.06
100	6.8	224.25	224.62	7.8	224.29	224.71
75	6.8	223.53	223.81	7.8	223.55	223.84
50	6.8	222.65	222.92	7.8	222.66	222.92
25	6.8	221.7	221.86	7.8	221.72	221.88
5	6.8	221.29	221.38	7.8	221.31	221.41

TABLE D.5: STREAM 4.2 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
308	4.8	282.25	282.86	5.5	282.3	282.94
300	4.8	281.64	282.26	5.5	281.68	282.34
275	4.8	279.88	280.47	5.5	279.92	280.56
250	4.8	278.07	278.71	5.5	278.11	278.8
225	4.8	276.11	276.82	5.5	276.16	276.91
200	4.8	274.55	274.67	5.5	274.56	274.69
175	4.8	272.78	273.18	5.5	272.83	273.22
150	4.8	271.07	271.54	5.5	271.08	271.6
125	4.8	269.27	269.65	5.5	269.29	269.66
100	4.8	267.58	267.84	5.5	267.6	267.88
75	4.8	265.84	266.2	5.5	265.88	266.26
50	4.8	264.45	264.83	5.5	264.48	264.89
25	4.8	262.91	263.34	5.5	262.95	263.35
4	4.8	261.33	261.68	5.5	261.36	261.7

TABLE D.6: STREAM 4.3 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
275	2.6	323.72	324.13	3	323.74	324.18
250	2.6	321.07	321.46	3	321.09	321.51
225	2.6	318.53	318.91	3	318.55	318.96
200	2.6	316.09	316.52	3	316.12	316.57
175	2.6	313.7	314.16	3	313.73	314.22
150	2.6	311.29	311.78	3	311.32	311.84
125	2.6	308.87	309.28	3	308.9	309.33
100	2.6	306.44	306.96	3	306.48	307.03
75	2.6	303.98	304.6	3	304.02	304.68
50	2.6	301.55	302.11	3	301.59	302.19
25	2.6	299.11	299.7	3	299.15	299.78
0	2.6	296.65	297.22	3	296.69	297.3

TABLE D.7: STREAM 5						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
758	3.1	297.58	297.84	3.6	297.61	297.88
750	3.1	296.79	297.1	3.6	296.82	297.13
725	3.1	293.77	294.65	3.6	293.85	294.74
700	3.1	291.32	291.91	3.6	291.35	292.02
675	3.1	289.18	289.8	3.6	289.26	289.89
650	3.1	287.25	287.78	3.6	287.28	287.86
625	3.1	284.96	284.97	3.6	284.96	284.98
600	3.1	282.46	284.44	3.6	282.49	284.35
575	3.1	279.81	280.1	3.6	279.84	280.16
550	3.1	276.78	277.5	3.6	276.81	277.55
525	3.1	274.18	274.65	3.6	274.22	274.73
500	3.1	272.32	272.52	3.6	272.34	272.56
475	3.1	271.43	271.68	3.6	271.49	271.76
450	3.1	268.95	270.13	3.6	269	270.24
425	3.1	267.76	268.02	3.6	267.78	268.06
400	3.1	265.72	266.48	3.6	265.8	266.55
375	3.1	263.96	264.45	3.6	264	264.57
350	3.1	261.58	262.36	3.6	261.63	262.44
325	3.1	260.76	261.02	3.6	260.87	261.08
300	3.1	258.67	259.46	3.6	258.68	259.69
275	3.1	257.93	258.09	3.6	257.94	258.11
250	3.1	256.09	256.84	3.6	256.15	256.87
225	3.1	254.5	254.92	3.6	254.55	255.02
200	3.1	252.98	253.49	3.6	253.04	253.58
175	3.1	252.17	252.31	3.6	252.18	252.34
150	3.1	250.45	251.07	3.6	250.52	251.11

125	3.1	249.66	249.85	3.6	249.68	249.9
100	3.1	247.51	248.47	3.6	247.57	248.47
75	3.1	246.73	246.99	3.6	246.79	247.06
50	3.1	246.17	246.31	3.6	246.18	246.35
25	3.1	244.37	245.06	3.6	244.42	245.05
0	3.1	243.64	243.86	3.6	243.7	243.93

TABLE D.8: STREAM 6.1 RESULTS

RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
300	29	372.26	374.53	33.4	372.34	374.74
275	29	369.24	371.32	33.4	369.29	371.52
250	29	365.66	367.93	33.4	365.71	368.16
225	29	361.69	363.68	33.4	361.74	363.9
200	29	358.15	359.88	33.4	358.21	360.03
175	29	355.54	357.13	33.4	355.59	357.33
150	29	352.93	354.84	33.4	352.98	355.04
125	29	350.34	352.38	33.4	350.43	352.58
100	29	347.37	349.06	33.4	347.41	349.31
75	29	345.16	346.26	33.4	345.22	346.42
50	29	342.03	343.44	33.4	342.07	343.61
25	29	339.56	340.77	33.4	339.64	340.91
0	29	336.77	338.39	33.4	336.83	338.53

TABLE D.9: STREAM 6.2 RESULTS

RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
250	33.9	252.22	253.16	39.1	252.31	253.3
225	33.9	251.03	252.01	39.1	251.12	252.16
200	33.9	249.51	250.67	39.1	249.55	250.82
175	33.9	248.28	249.38	39.1	248.38	249.55
150	33.9	247.13	248.3	39.1	247.22	248.5
125	33.9	246.04	247.17	39.1	246.12	247.38
100	33.9	244.78	245.87	39.1	244.83	246.06
75	33.9	243.96	244.71	39.1	244.05	244.87
50	33.9	242.72	243.77	39.1	242.78	243.92
25	33.9	241.64	242.47	39.1	241.69	242.61
6	33.9	241.08	241.78	39.1	241.16	241.91

TABLE D.10: STREAM 7 RESULTS						
RIVER STATION	1:50 YEAR			1:100 YEAR		
	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)	FLOW (m^3/s)	W.S. ELEV. (RLm)	E.G. ELEV. (RLm)
165	13.6	261.84	262.89	15.7	261.88	262.93
150	13.6	260.49	261.57	15.7	260.52	261.61
125	13.6	258.07	258.7	15.7	258.09	258.74
100	13.6	256.03	256.35	15.7	256.06	256.41
75	13.6	254.34	254.66	15.7	254.37	254.71
50	13.6	252.67	252.94	15.7	252.69	252.98
25	13.6	250.7	251.19	15.7	250.72	251.23
0	13.6	248.76	249.42	15.7	248.8	249.49

20 April 2021

Lyners and Associates (Pty) Ltd
South Gate Building
Carl Cronjé Drive
Tyger Valley Waterfront
BELLVILLE
PO Box 4901
7530

Attention: Mr Rudolph Schoonwinkel

Dear Sir,

PROPOSED RESIDENTIAL DEVELOPMENT ON PORTIONS 2 - 19 OF FARM 1685 (FOUNDERS ESTATE) AND AGRICULTURAL DEVELOPMENT ON PORTION 4 OF FARM 1674 (THE PACKSHED), BOSCHENDAL FARM - DWARS RIVER: CAPACITY ANALYSIS OF THE BULK WATER AND SEWER SERVICES

Your request regarding comments on the bulk water and sewer supply to the proposed development (proposed residential development on Portions 2 to 19 of Farm 1685 and agricultural development on Portion 4 of Farm 1674, Dwars River), refers.

This document should inter alia be read in conjunction with the Water Master Plan (performed for the Stellenbosch Municipality) dated June 2019 and the Sewer Master Plan dated June 2019 for the Stellenbosch Municipality.

The proposed Founders Estate development was conceptually taken into consideration for the June 2019 master plans for the water and sewer networks as future development area DR10. The Packshed was however not taken into consideration in the June 2019 master plans.

1. WATER DISTRIBUTION SYSTEM

1.1 *Distribution zone*

Ultimate solution

Refer to master plan items SDW.B1 to SDW.B7 and SDW.B17 to SDW.B19 on Figure SW6.5b in the June 2019 Dwars River Water Master Plan:

The master plan indicated that the proposed residential development area should be accommodated in the future Boschendal Upper reservoir water distribution zone. It is proposed that the Boschendal Upper reservoir be supplied from a proposed Boschendal Lower reservoir via the proposed Boschendal PS no. 2.

A second bulk connection to the City of Cape Town's (CCT) Wemmershoek bulk supply pipeline is proposed for the Dwars River area (on the western side of the Dwars River) that gravitates to a proposed sump, from where water should be pumped to the proposed Dwars River Lower reservoir.

From the Dwars River Lower reservoir bulk water should then be pumped to the new Boschendal Upper reservoir (via the proposed Boschendal PS no. 2) and to the existing Pniel Lower reservoir (via the proposed Boschendal PS no. 1), as indicated on Figure 6.5b in the June 2019 Stellenbosch Water Master Plan.

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Directors: MS Mokgosi, AG Hingeston, JJ Streicher, HA Baartman

Interim solution

In the interim (before the proposed Boschendal Lower reservoir is implemented) the proposed development can be accommodated with the implementation of a dedicated bulk pipeline from the Pniel Lower reservoir to the proposed Boschendal PS no. 2.

From the Boschendal PS no. 2 water should be pumped through a 75 mm diameter pipe to the proposed Boschendal Upper reservoir (Top Water Level (TWL) of approximately 428 metres above mean sea level (m a.s.l.)), from where water should be supplied under gravity to the Founders Estate development.

The proposed booster PS, bulk pipeline from the PS to the reservoir and the reservoir should be private infrastructure owned by the developer. The proposed bulk pipeline from the Pniel Lower reservoir to the Boschendal PS no. 2 should be Municipal infrastructure as it will form a link between the existing Pniel Lower reservoir and the proposed Boschendal Lower reservoir in future.

The Packshed development has existing water supply rights from the CCT bulk supply line to the north and will therefore be supplied directly from CCT.

The proposed development is situated inside the water priority area.

1.2 *Water demand*

The original water analysis for the master plan was performed with a total annual average daily demand (AADD) for the proposed development area (future development areas DR10 in the June 2019 water master plan) of 47,5 kL/d (excluding Packshed).

For this re-analysis of the water master plan the AADD and fire flow for the proposed development was calculated as follows:

- 18 Founders Estates @ 2,0 kL/d
  (as indicated by Lyners and Associates (Pty) Ltd) = 36,0 kL/d
- Fire flow criteria (Low risk) = 15 L/s @ 10 m

1.3 Present situation

1.3.1 Network capacity

There is currently no water network infrastructure located within close proximity of the proposed development. New water infrastructure will therefore have to be implemented to accommodate the proposed development in the existing water system.

It is proposed that the connection to the existing Dwars River system is made through a connection at the existing Pniel Lower reservoir.

The existing Dwars River bulk infrastructure system has sufficient capacity to accommodate the proposed development via the proposed connection to the existing Pniel Lower reservoir.

1.3.2 Reservoir capacity

The criteria for total reservoir volume used in the Stellenbosch Water Master Plan for the Dwars River area is 72 hours of the AADD (of the reservoir supply zone).

The developers of the Founders Estate have indicated that a 100 kL reservoir at a TWL of approximately 428 m a.s.l. will be provided for the development.

1.4 Implementation of the master plan

The following master plan item will be required to connect the proposed private infrastructure of the proposed development to the existing Pniel Lower reservoir, as shown on Figure 1:

Bulk supply upgrades

- SDW.B7 : 690 m x 250 mm Ø supply pipeline R 1 730 000 *

The following link services items will be required to supply water from master plan item SDW.B7 to the proposed Boschendal Upper reservoir site and to provide sufficient reservoir storage capacity for the proposed development, as shown on Figure 1.

- SDW.B17 : New Boschendal PS no. 2 (2 L/s @ 205m)
- SDW.B18 : 2 380 m x 75 mm Ø supply pipeline
- SDW.B19 : New 100 kL Boschendal Upper reservoir

(cost not included, private infrastructure to be provided by the developer)

- (* Including P & G, Contingencies and Fees, but excluding VAT - Year 2020/21 Rand Value. This is a rough estimate, which does not include major unforeseen costs).

- The routes of the proposed pipelines and positions of the proposed reservoir and pump station are schematically shown on Figure 1, but have to be finalised subsequent to detail pipeline route and reservoir and pump station position investigations.

- Master plan item SDW.B7 was sized according to the Water Master Plan to supply water via the proposed 250 mm Ø pipe from the proposed new Boschendal Lower reservoir (master plan item SDW.B5) to the existing Pniel Lower reservoir for further distribution to the Pniel, Johannesdal, Lanquedoc and Kylemore in future.

1.6 *Minimum items required*

The minimum requirements to connect the proposed development to the existing Pniel Lower reservoir are master plan item SDW.B7 and link services items SDW.B17, SDW.B18 & SDW.B19.

2. SEWER NETWORK

2.1 *Drainage area*

There is currently no sewer infrastructure located within close proximity of the proposed developments.

The proposed developments can however be accommodated within the existing Pniel PS sewer drainage area. Sewage is pumped from the Pniel PS directly to the existing Dwars River Wastewater Treatment Works (WWTW).

The developments are inside the sewer priority area.

2.2 *Sewer flow*

The original sewer analysis for the master plan was performed with a total peak day dry weather flow (PDDWF) for the proposed Founders Estate (future development area DR10 in the June 2019 sewer master plan) of 33,3 kL/d.

The Packshed was however not taken into consideration in the June 2019 master plan.

For this re-analysis, the total PDDWF for the proposed developments was calculated as follows:

- 18 Founders Estates @ 2 kL/d/estate with 90% sewage portion (as indicated by Lyners and Associates (Pty) Ltd) = 32,4 kL/d

- Packshed @ 15 kL/d with 90% sewage portion (as indicated by Lyners and Associates (Pty) Ltd) = 13,5 kL/d

Total PDDWF = 45,9 kL/d

2.3 Present situation

There is currently no sewer infrastructure located within close proximity of the proposed developments.

New sewer infrastructure will therefore be required to connect the proposed developments to the existing Dwars River sewer system. The existing sewer reticulation network downstream of the proposed connection point has sufficient capacity to accommodate the proposed developments in the existing sewer system.

The Pniel PS was analysed with a capacity of 15 L/s and accompanying 200 mm Ø rising main in the Sewer Master Plan. The capacity of 15 L/s was however assumed and is the minimum flow rate in order to achieve scouring velocity through the downstream rising main. The capacity of the Pniel PS and size of the accompanying rising main should however be verified by SM.

The assumed capacity of 15 L/s is sufficient to accommodate the proposed Founders Estate and Packshed developments.

It is however recommended that flow measurements be taken at the Pniel PS to verify that the capacity of the PS is at least 15 L/s.

If the PS capacity does not exceed 15 L/s, we recommend that the PS be upgraded to a capacity of 25 to 30 L/s (no upgrading required of the existing 200 mm Ø rising main).

2.4 *Link services*

The following link services items will be required to connect the proposed developments to the existing Pniel sewer system:

New sewer infrastructure

• Item 1	: New pump station (cost based on 4 L/s)	R 1 940 000 *
• Item 2	: 3 535 m New rising main (cost based on 90 mm Ø)	R 3 140 000 *
• Item 3	: 1 825 m x 160 mm Ø New gravity outfall	R 3 093 000 *
• Item 4	: New pump station (cost based on 4 L/s)	R 1 940 000 *
• Item 5	: 430 m New rising main (cost based on 90 mm Ø)	R 394 000 *
	Total	R 10 507 000 *

Notes:

- (* Including P & G, Contingencies and Fees, but excluding VAT – Year 2020/21 Rand Value. This is a rough estimate, which does not include major unforeseen costs).
- In the Sewer Master Plan for Dwars River it is proposed that sewage should gravitate from the proposed Founders Estate directly towards the existing Pniel PS drainage area if the topography of the area permits it. A detailed survey of the area has however showed that it is not possible to gravitate from the lowest point on the Founders Estate (see position of item 4 on Figure 2) along the Helshoogte Road towards the existing Pniel PS drainage area. A new internal PS and accompanying rising main (items 4 and 5) have therefore been proposed to connect the internal sewage system of the Founders Estate to the existing Pniel sewer network.
- An alternative option to connect the Founders Estate to the existing Pniel network is to gravitate from the position of the proposed PS (item 4) directly to the existing Pniel PS (if the topography of the area permits it).

- The routes of the proposed pipelines and positions of the proposed pump stations are schematically shown on Figure 2 attached, but have to be finalised subsequent to detail pipeline route and pump station position investigations.

2.5 *Minimum items required*

The minimum requirements to connect the proposed developments to the existing Pniel sewer system are link services items 1 to 5.

3. CONCLUSION

The developer of Portions 2 to 19 of Farm 1685 and Portion 4 of Farm 1674 in the Dwars River area may be liable for the payment of a Development Contribution (as calculated by Stellenbosch Municipality) for bulk water and sewer infrastructure as per Council Policy.

There is currently no water network infrastructure located within close proximity of the proposed Founders Estate development. New water infrastructure will therefore have to be implemented to accommodate the proposed Founders Estate development in the existing water system.

The Packshed development has existing water supply rights from the CCT bulk supply line and will be supplied directly from the CCT system.

It is proposed that the connection to the existing Dwars River system in order to accommodate the proposed Founders Estate development is made through a connection at the existing Pniel Lower reservoir.

The existing Dwars River bulk water system has sufficient capacity to accommodate the proposed development via the proposed connection to the Pniel Lower reservoir.

The minimum requirements to connect the proposed development to the existing Pniel Lower reservoir are master plan item SDW.B7 and link services items SDW.B17, SDW.B18 & SDW.B19.

There is currently no sewer infrastructure located within close proximity of the proposed Founders Estate and Packshed developments.

New sewer infrastructure will therefore be required to connect the proposed developments to the existing Dwars River sewer system. The existing sewer reticulation network downstream of the proposed connection point has sufficient capacity to accommodate the proposed developments in the existing sewer system.

The minimum requirements to connect the proposed developments to the existing Pniel sewer system are link services items 1 to 5.

We trust you find this of value.

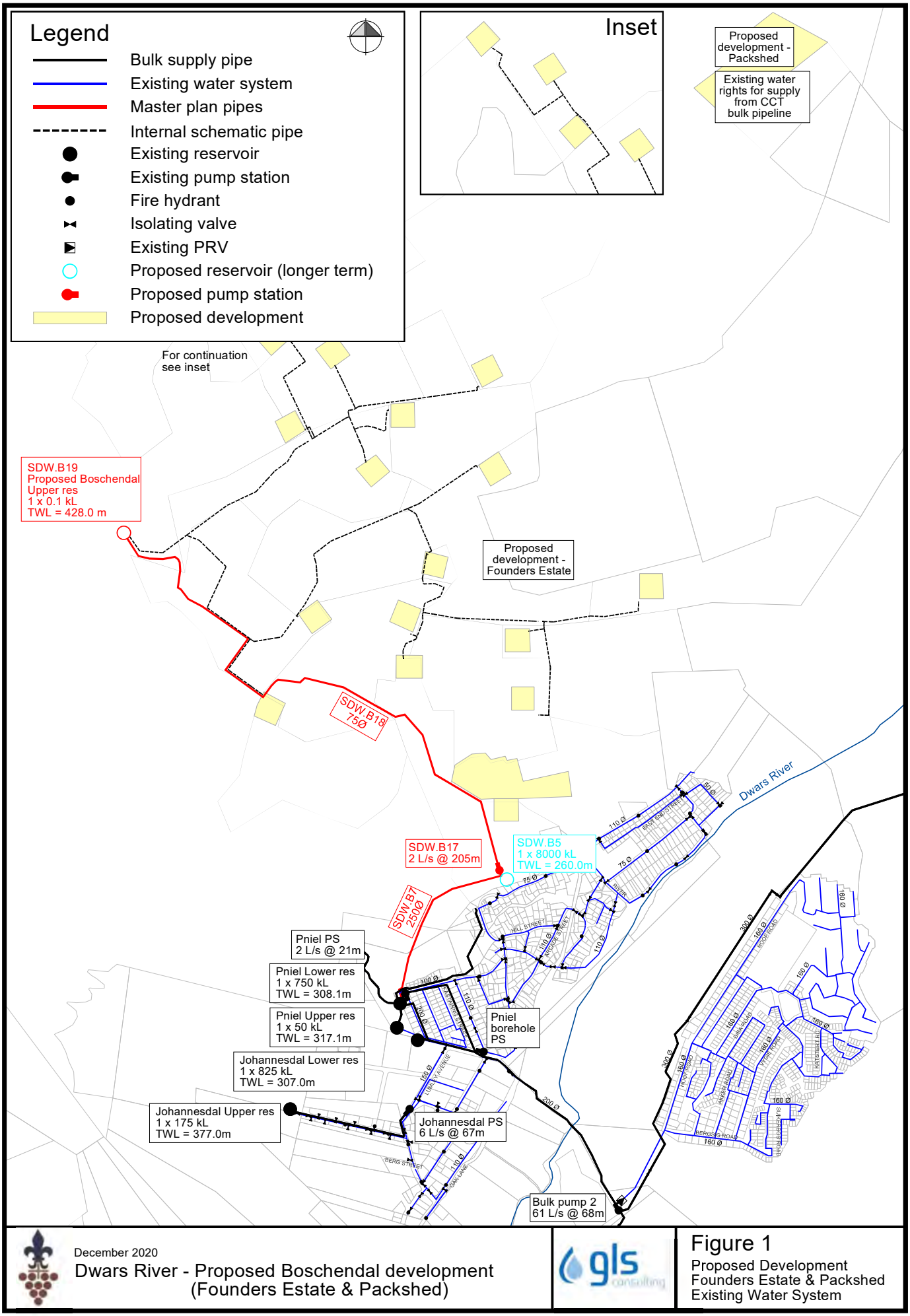
Yours sincerely,

GLS CONSULTING (PTY) LTD
REG. NO.: 2007/003039/07

_____
Per: PC DU PLESSIS

cc. The Director
Directorate: Public Works
Stellenbosch Municipality
P. O. Box 17
STELLENBOSCH
7599

Attention: Mr Adriaan Kurtz



December 2020

Dwars River - Proposed Boschendal development
(Founders Estate & Packshed)

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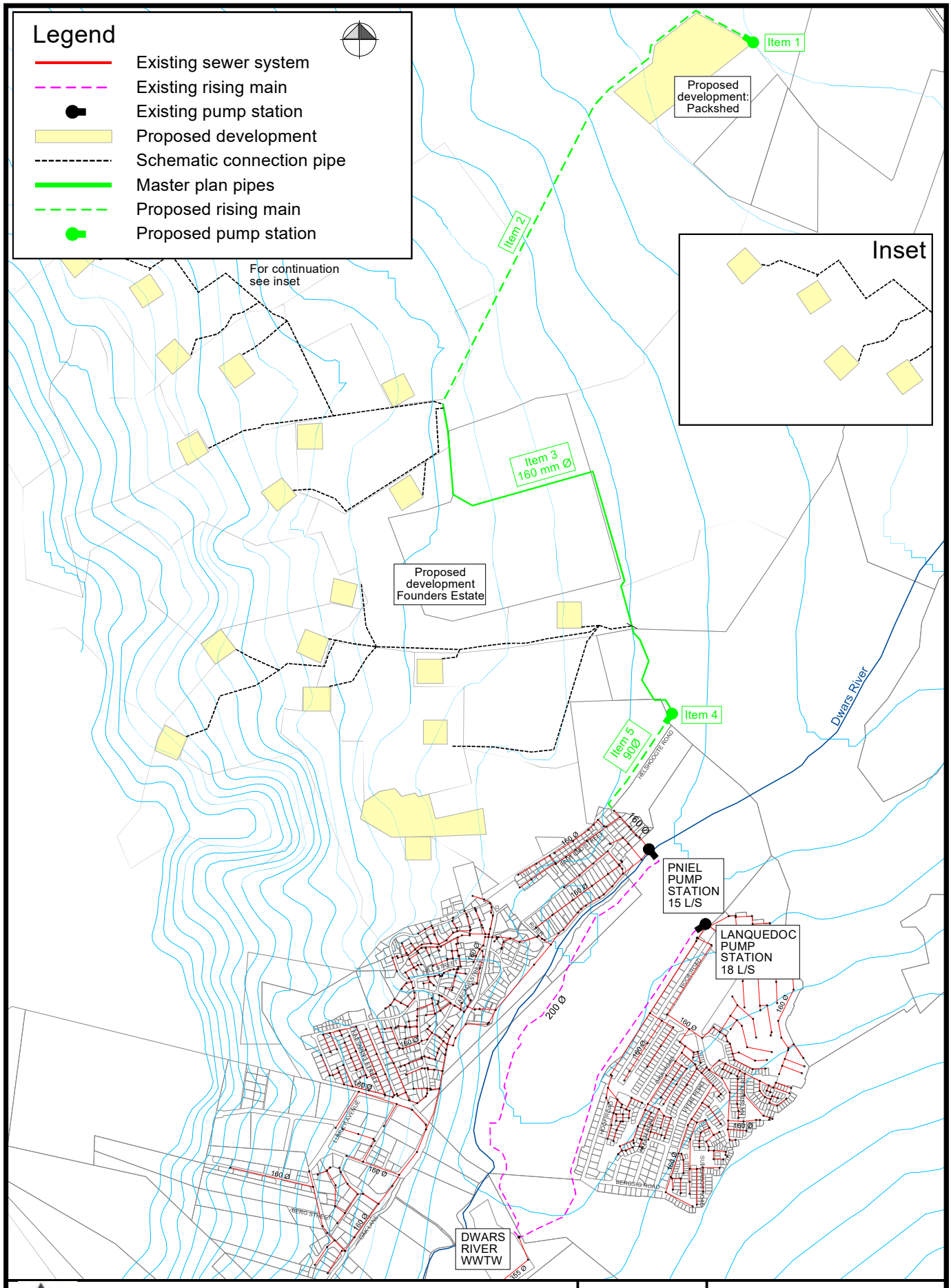
Figure 1

Proposed Development
Founders Estate & Packshed
Existing Water System



April 2021

Dwars River - Proposed Boschendal development
(Founders Estate & Packshed)

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Figure 2 (Rev 1)
Proposed Development
Founders Estate & Packshed
Existing Sewer System