ANNEXURE 19

JTEVOLVE
ACTA NON VERBA (PTY)LTD.



STORMWATER MANAGEMENT REPORT FOR THE DEVELOPMENT GARDEN ROUTE CITY

Report Number: 458_R004_Stormwater Management Report_Rev.0

Date: 2026-07-30

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253 Monument Road, Glen Marais Ext 1, Kempton Park, 1620

Dear Mam/Sir

RE: STORMWATER MANAGEMENT REPORT FOR THE PROPOSED DEVELOPMENT OF GARDEN ROUTE CITY

Kindly find enclosed our stormwater management plan for the above-mentioned project.

Should you have any further queries, please do not hesitate to contact the writer.

Yours Sincerely,



Lucricia Maleka, BSc.Eng (Civil)

PROJECT INFORMATION

REPORT NUMBER	**458_R001_Stormwater Management Report_Rev.0**	**REV**	0
LOCAL AUTHORITY	George Municipality		
DEVELOPMENT NAME	Proposed development of Garden Route City		
PROPERTY DESCRIPTION	Situated on portions 7, 8, 12 and remainder of portion 23 of the Farm Kraaibosch No. 195		
NATURE OF PROJECT	Township Establishment (Greenfield Development)		
LAND USE TYPE	Mixed land-use		

COMPILED	**NAME**	LL. Maleka	**APPROVED**	**NAME**	WF. Stoker
	QUALIFICATIONS	BSc.Eng (Civil)		**QUALIFICATIONS**	Pr.Eng (Civil)
				PR NUMBER	202101798
	SIGNATURE			**SIGNATURE**	 Digitally signed by Wynand Stoker DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng: 202101798, email=wynand@jtevolve.com, c=ZA Date: 2026.07.31 11:58:54 +02'00'

AMENDMENT HISTORY

Issue	Date	Amendment Section/Chapter/Page	Checked By
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DISTRIBUTION

Name	Copy No	Distribution Address
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1. INTRODUCTION

JT Evolve (Pty) Ltd was appointed as civil engineers for the proposed new Greenfield development of Garden Route City situated on portions 7, 8, 12 and remainder of portion 23 of the Farm Kraaibosch No. 195, hereafter referred to as "the site" or "the point of interest". Refer to the signed appointment letter in **Annexure A**. Part of the appointment includes the preparation of a stormwater management plan. This report will describe how the proposed development will install stormwater infrastructure on the development to comply with the George Municipality Stormwater By-Laws and guidelines and the City of Cape Town Stormwater Policies.

2. GENERAL INFORMATION

Table 1: General Information

	DEVELOPER/CLIENT	CONSULTING CIVIL ENGINEERS
COMPANY NAME:	Compregen Pty Ltd	JT Evolve (Pty) Ltd
REGISTRATION NO:	-	2016/132800/07
CONTACT PERSON:	Barend Greyling	Wynand Stoker
ADDRESS:	26 Whittakers Way, Bedfordview, 2007	253 Monument Road Glen Marais Kempton Park 1620
EMAIL:	barend@kironprop.co.za	wynand@jtevolve.com
CONTACT NUMBER:	011 607 8000	083 659 5766

3. SITE DESCRIPTION

3.1. Locality

The affected site is bounded by the following:

- National Road N2 to the North-West,
- Meulrivier river to the West and South-West,
- Portions 228, 413, 239, 45, 46 and 48 of the Farm Kraaibosch No. 195 to the East and
- Meulrivier river to the South

Refer to attached locality plan in **Annexure B** and the preliminary town planner layout in **Annexure C**.

3.2. Topography

The proposed development is located on a mountainous and hilly area that consists of multiple natural catchments with steep slopes that drain in multiple directions to discharge into the existing natural watercourses located within the site boundary and to the West, South and East of the site boundary. A topographical survey was conducted for the proposed development of which the slopes of the catchments were determined to vary between 3.016% to 15.659%. Refer to the attached survey drawing in **Annexure D** showing the contours of the proposed development. The site is affected by the 1:100-year floodline. Refer to the attached certified floodline plan in **Annexure E2.**

4. DETAILS OF LAND USE

4.1. Current Land-use

The site is currently zoned as "Agricultural Zone I" in terms of the George integrated zoning scheme by-law. Refer to the **Figure 1 and Figure 2** for the existing zoning of the portions of the site.

Property Information

SG 21 Digit Code	C02700000000019500007
Property Type	FARM
Property Description	195/7
Valuation	R0
Area (m^2)	686908.04
Area (ha)	68.69
Allotment	GEORGE RD
Ward Number	11
Town	GEORGE
Address	No Address to show

Zoning Information

Zoning	Agricultural Zone I
Zoning Code	AZI
Primary Use	no data

Property Information

SG 21 Digit Code	C02700000000019500008
Property Type	FARM
Property Description	195/8
Valuation	R0
Area (m^2)	403091.89
Area (ha)	40.31
Allotment	GEORGE RD
Ward Number	11
Town	GEORGE
Address	No Address to show

Zoning Information

Zoning	Agricultural Zone I Agricultural Zone I
Zoning Code	AZI AZI
Primary Use	no data Agriculture

Figure 1: Portion 7 and Portion 8 of the Farm Kraaibosch 195 - Current Zoning

Property Information

SG 21 Digit Code	C02700000000019500012
Property Type	FARM
Property Description	195/12
Valuation	R1220000 R1220000
Area (m^2)	1380784.30
Area (ha)	138.08
Allotment	GEORGE RD
Ward Number	11 13
Town	GEORGE
Address	No Address to show

Zoning Information

Zoning	Agricultural Zone I
Zoning Code	AZI
Primary Use	no data

Property Information

SG 21 Digit Code	C02700000000019500023
Property Type	FARM
Property Description	195/23
Valuation	R0
Area (m^2)	666069.01
Area (ha)	66.61
Allotment	GEORGE RD
Ward Number	11
Town	GEORGE
Address	No Address to show

Zoning Information

Zoning	Agricultural Zone I
Zoning Code	AZI
Primary Use	no data

Figure 2: Portion 12 and Portion 23 of the Farm Kraaibosch 195 - Current Zoning

4.2. Proposed Land-use

The proposed development Garden Route City is classified as a Greenfield New development in which the proposed zoning (total extent of 298.2336 ha) is mixed land-use – refer to **Table 2** below for the summary of the proposed land-use and to **Annexure C** for the draft town planner layout.

Table 2: Garden Route City - Proposed Land use

LAND-USE/ZONING	DENSITY	NO. OF ERVEN	NO. OF UNITS	TOTAL EXTENT (HA)
Residential 1	Stand sizes (700-900m²)	161	161	14.50
Residential 1	Stand sizes (500-700m²)	380	380	26.66
Residential 1	Stand sizes (400-600m²)	335	335	20.10
Medium Density Residential	40 Units per Hectare	299	299	7.48
Education	N/A	1	1	6.8404
Municipal	N/A	1	1	2.6592
Access Control Point	N/A	N/A	2	0.0725
Mixed Land Use	As per integrated zoning scheme	-	-	24.6864
Private Open Space	N/A	5	N/A	64.6216
Roads	N/A	N/A	N/A	57.9935
Future Development	As per integrated zoning scheme	5807	5807	72.62

The development will be implemented over the course of approximately 4 years. A proposed phasing schedule is provided in **Table 3** below.

Table 3: Planned Phasing of Garden Route City

PLANNED PHASING	LAND USE								
	RES 1 (700-900 m²)	RES 1 (500-700 m²)	RES 1 (400-600 m²)	MEDIUM DENSITY RESIDENTIAL (UNITS)	EDUCATION (HA)	MUNICIPAL (HA)	PRIVATE OPEN SPACE (HA)	MIXED LAND USE (HA)	ACCESS CONTROL POINT (UNIT)
Phase 1 - Year 1	161	124	0	299	0	0	16.5505	0	1
Phase 2 - Year 2	0	256	335	0	6.8404	2.6592	12.2430	0	1
Phase 3 - Year 3	0	0	0	0	0	0	3.5643	24.6864	0
Phase 4 - Year 4	0	0	0	5807	0	0	32.2638	0	0
TOTAL	**161**	**380**	**335**	**6106**	**6.8404**	**2.6592**	**64.6216**	**24.6864**	**2**

5. EXISTING CATCHMENT DESCRIPTION AND DRAINAGE CHARACTERISTICS

5.1. Existing Catchment Description

The site consists of multiple farm portions namely Portion 7, Portion 8, Portion 12 and Remainder of Portion 23 of the Farm Kraaibosch No. 195 that are currently zoned as agriculture. However, it should be noted that while Portion 8 is zoned as agricultural, the land is currently being used for mining activities with a processing plant, open excavations, compacted, disturbed soils and an approximately 5m deep mining pit. The pre-development scenario thus consists of approximately 10% impervious surfaces. The remaining portions are covered with moderate bushes, grasslands and large trees.

Currently all stormwater runoff flows on surface towards the natural flood plains located within the site boundary and the natural flood plains that border the site to the East, West and South. The natural flood plains located within the site boundary and bordering the site to the East drain into the existing mining pit which once full, overflows into the Meulrivier that eventually drains into the ocean. Refer to **Figure 1** below for the site pre-development conditions.

When designing the stormwater management plan of the site, the pre-development conditions will be considered to determine the future post-development scenario. The developer will also perform earthworks to rehabilitate the Portion which is currently being used for mining activities for future development while the existing mining pit will be analysed for use as attenuation storage for the development.

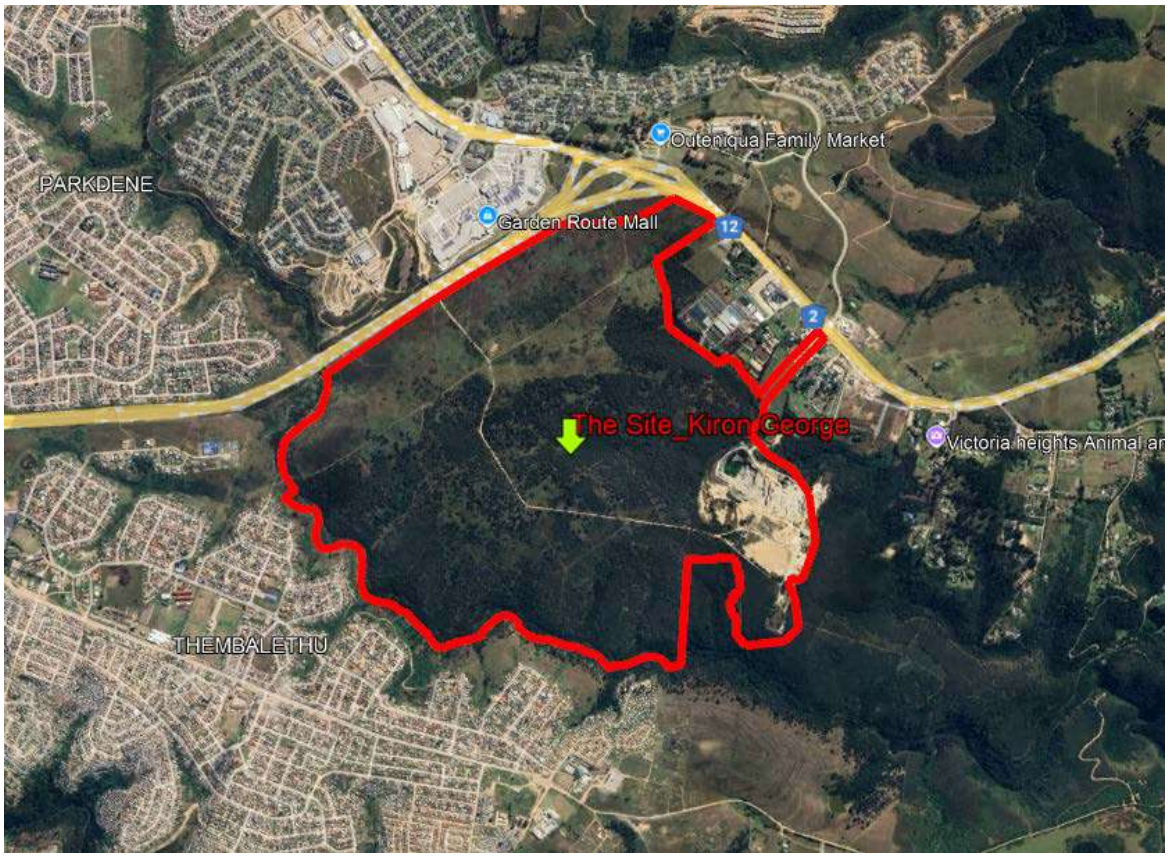


Figure 3: Site Pre-development conditions

5.2. Geotechnical considerations

A desktop study was done, and it was determined that the site and neighbouring developments are not underlain by dolomite according to the George GIS website https://experience.arcgis.com/experience/6a2aff4189d04756866bdeca87b1d145/page/Main-Map/?views=Legend.

5.3. Floodline

The site is affected by the 1:100-year floodline. A floodline determination and delineation report was compiled by JT Evolve for the 1:100-year flood peaks that affect the site. Refer to the attached floodline catchment plan in **Annexure E1** and the certified floodline plan in **Annexure E2.**

6. STORMWATER MODELLING

6.1. Guidelines

The following design standards and guidelines will be used for the stormwater modelling and designs:

1. The South African Guidelines for Sustainable Drainage Systems (WRC)
2. Guidelines for Human Settlement Planning and Design Part II (Red Book) (July 2019) Section L: Stormwater
3. George Municipality Stormwater By-Law: Province of the Western Cape: Provincial Gazette Extraordinary 8795 (14 July 2023)
2. 2013. Drainage Manual. 6th. ed. Pretoria: The South African National Roads Agency SOC Ltd.
3. City of Cape Town: Stormwater Management By-Law (Approved by Council August 2005)
4. City of Cape Town: Management of Urban Stormwater Impact Policy, version 2.1 (May 2009)
5. City of Cape Town: Stormwater Management Planning and Design Guidelines for New Developments, version 1.0 (July 2002)
6. Guidelines for the Provision of Engineering Services and Amenities in Residential township developments by the National Housing Board (Blue Book)
7. City of Cape Town: Floodplain and River Corridor Management Policy, version 2.1 (Approved by Council 27 May 2009)
8. Applicable SANS 1200 Standards

6.2. Design Principles

The objective of stormwater management is to ensure that the development's post-development peak runoff rate is less than the pre-development peak runoff rate and that the quality of the stormwater runoff is acceptable for stormwater rainfall events of the recurrence interval for the specified land-uses. The stormwater management is thus divided into two systems as per the "Red Book".

Minor System: The internal stormwater network is designed for frequent storms of a minor nature.

Major System: The internal roads, paved areas and attenuation systems designed in combination with the minor system to handle infrequent storm events that is supported by the minor system.

6.3. Stormwater Quantity

The selection of the analysis, assessment and design criteria used for the stormwater management plan are based on the guidelines given in Section 6.1 above, "*City of Cape Town: Management of Urban Stormwater Impacts Policy*, "*Stormwater Management Planning and Design Guidelines for New Developments*" and the stormwater management of the "*Guidelines for Human Settlements Planning and Design*" from the "Red Book". Both the Red Book and the City of Cape Town's Policy guidelines give the applicable standards in terms of a recurrence interval (RI) events for specified land-uses and development types using the criteria highlighted in **Table *4*** and ***Table 5*** below.

According to the tables below, the proposed development falls under the Greenfield Developments and Brownfield and Existing Development Sites located in catchments of sensitive receiving water systems. Therefore, the development is required to design and implement Sustainable Drainage Systems (SuDS) for the stormwater management of the development for the recurrence interval (RI) rainstorm of up to the 1:10-year for the minor system and the RI rainstorm of up to the 1:50-year for the major system in accordance with ***Table 5*** below.

Table 4: Interim Criteria for Achieving Sustainable Urban Drainage System Objectives in Various Developments Scenarios (Runoff Quality Improvement)

SUDS OBJECTIVES	**Greenfield Developments** ***and*** **Brownfield and Existing Development Sites located in catchments of sensitive receiving water systems**
IMPROVE QUALITY OF RUNOFF *Remove pollutants through combination of reducing and/or disconnecting impervious areas, and the use of BMPs which infiltrate or capture and treat stormwater runoff*	Design storm event for water quality treatment: 1/2-year RI, 24h storm
	Pollutant removal target: Reduction of post-development annual stormwater pollutant load discharged from development site: SS & TP – reduce to undeveloped catchment levels, or SS – 80% reduction TP – 45% reduction *Whichever requires higher level of treatment*
	All developments are required to trap litter, oil, grease at source

Table 5:Interim Criteria for Achieving Sustainable Urban Drainage System Objectives in Various Developments Scenarios (Quantity Control and Rate of Runoff)

SUDS OBJECTIVES		**Greenfield Developments *and* Brownfield and Existing Development Sites located in catchments of sensitive receiving water systems**
CONTROL QUANTITY AND RATE OF RUNOFF	Protect the stability of downstream channels	24 hour extended detention of the 1-year RI, 24h storm event
	Protect downstream properties from fairly frequent nuisance floods	Up to 10-year RI peak flow reduced to pre-development level
	Protect floodplain developments and floodplains from adverse impacts of extreme floods	Up to 50-year peak flow reduced existing development levels. Evaluate the effects of the 100-year RI storm event on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts through detention controls and/or floodplain management
		Developments adjacent to floodplains must adhere to the requirements of the Floodplain and River Corridor Management Policy
ENCOURAGE NATURAL GROUNDWATER RECHARGE		Where appropriate, site-specific requirements to be considered in consultation with Council

6.4. Existing Stormwater Infrastructure

There are several developments within the vicinity of the proposed development that drain via sheet flow into the existing natural watercourses (Meulrivier rivers) from the Northern, Western and Easternly directions that bound the development site which is defined by the 1:100-year floodline attached in **Annexure E2**. There are no existing stormwater infrastructure within the vicinity of the site that the proposed development can connect to. There are also no existing servitudes over the proposed development protecting existing municipal pipes or outlet structures.

6.5. Stormwater Master Plan

The National Highway Cape Town/ George Airport/ Mossel Bay (N2) which bounds the proposed development to the North is an existing dual carriage and is classified as class 1 road. It is therefore safe to assume that the stormwater discharging from the road surface and higher lying areas is final. With the surrounding areas already being developed and discharging into the Meulrivier, it is therefore assumed that the masterplan for said stormwater infrastructure has been completed. The proposed development therefore does not need to make provision for stormwater discharging from the N2 road surface or stormwater from higher lying properties by way of servitude areas. Please refer to the drawings in **Annexure H1** for the proposed stormwater management plan.

6.6. Description of Catchment Areas

The proposed development measures a total site area of 298.2336 ha which can be divided into multiple catchments that slope and drain towards the defined watercourse flowing within the site and bordering the site to the West, South and East of the site. The catchment plan is thus divided into 13 sub-catchment areas indicated in the key plan layout in **Annexure H2**. The identified 13 sub-catchment areas will drain to the new attenuation systems and the existing mining pit that will discharge overland above the 1:100-year floodline and eventually drain into the Meulrivier.

6.7. Stormwater Model

Simulations of the stormwater runoff and evaluation of the stormwater management system for the proposed development were performed using the United States Environmental Protection Agency Stormwater Management Model (SWMM) Version 5.2

The model was selected based on the following considerations

I. The model is widely used throughout the world for the planning analysis and design related to stormwater runoff and drainage systems in urban areas. The model provides an integrated environment for editing study area input data, running infiltration hydrologic and hydraulic simulations and viewing the results in a variety of formats.

II. The model accounts for various hydrological processes including infiltration of rainfall into unsaturated soil layers and non-linear routing of overland flow and reservoir routing of storage units and

III. The model has the capability to perform reservoir routing and applies user defined control rules to simulate the operations of orifice openings and weir crest levels.

IV. The model is the preferred stormwater modelling as recommended by The City Of Cape Town in the Stormwater Management Planning and Design Guidelines for New Developments (July 2002)

6.7.1. Runoff Calculations

The Civil Designer Software was also used to analyse the catchment using the Rational method for the sub-catchments and to determine the rainfall data for the simulation of the stormwater runoff for the 1:10-, 1:50- and 1:100-year recurrence intervals which is based on the historical and statistical data from the actual South African Weather Stations located across the different provinces. The software uses the South African Weather Services grid the required rainfall data for the specified location can be extracted from. The MAR was not considered as historical data was used in determining the attenuation volumes required for the development. The Mean Annual Precipitation (MAP) for the area was determined to be 639mm. The IDF curve was thus derived with the historical data for the location at Latitude 34°03'11", Longitude 18°49'57" and the rainfall intensity was determined for the specified recurrence interval and time of concentration of the sub-catchments. Refer to the IDF curve results for the various storm events ***Figure 4*** below. The peak rainfall intensity associated with the time of concentration for the stormwater runoff flow calculations is shown in **Table 6** below. It should be noted that the climate change uplift factor was not applied for the post-development peak rainfall intensity.

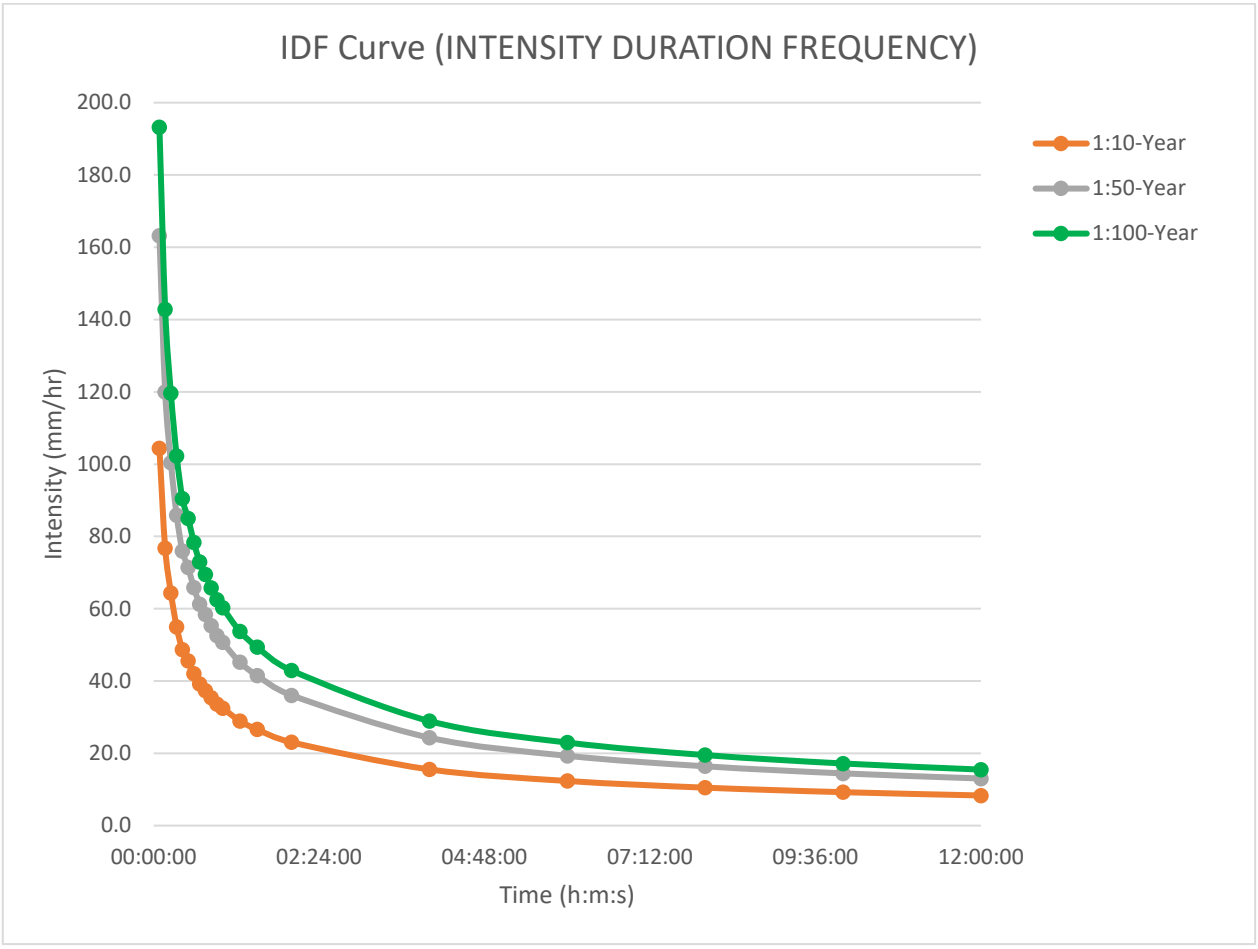


Figure 4: IDF Curve

The time of concentrations (Tc) for the post-development sub-catchments varies between 7.86 minutes to 16.32 minutes, therefore a minimum Tc of 15 minutes was used for the post-development sub-catchments (Denoted C_POST1 to C_POST13) which are predominantly zoned as residential. The Tc for the pre-development sub-catchments draining to the Eastern natural watercourse (Denoted C_PRE1 to C_PRE5) was taken to be 55 minutes and the Tc for the pre-development sub-catchments draining to the Southern natural watercourse (Denoted C_PRE6 to C_PRE13) was taken to be 50 minutes. Refer to **Table 6** below for a summary of the Tcs used for the pre- and post-development sub-catchments and to the key plan in **Annexure H2** for the details of the sub-catchments.

Table 6: Pre- and Post-Development Sub-catchments Time of Concentration and Peak Rainfall Intensity

SUB-CATCHMENTS NAME	TIME OF CONCENTRATION (MINUTES)	PEAK RAINFALL INTENSITY (MM/HR)
C_PRE1 to C_PRE5	55	33.6
C_PRE6 to C_PRE13	50	35.4
C_POST1 to C_POST13	15	64.4

6.7.2. Stormwater Model Parameters

The model parameters used for the pre-development sub-catchments runoff are shown in **Table 7** below and the parameters for the post-development sub-catchments runoff are shown in **Table 8** below. The catchment names correlate with the model representations as can be seen in **Figure 5** showing the system diagram used in modelling the pre- and post-development scenarios.

The relevant manning's n values for the impervious areas and overland flow for the existing site conditions with moderate bushes, grasslands, large trees and disturbed and compacted soils from mining activities.

The peak discharge for the pre- and post-development sub-catchments were determined using the Rational method as described in Section **6.7.1** above. The results of which are part of the software model results, are attached in **Annexure G** for the difference recurrence interval rainstorms. The runoff coefficients that were used to determine the peak discharge for the pre- and post-development sub-catchments are also provided in the stormwater model software results in **Annexure G** for the three recurrence interval storms.

The attached town planner layout plan in **Annexure C** was used to determine the total impervious and pervious areas of the 13 identified sub-catchments. Refer to the attached sheet in **Annexure F** for the total impervious and pervious areas of the 13 sub-catchments.

Table 7: Model Parameters for Pre-Development Catchments runoff simulations

PARAMETER DESCRIPTION	UNIT	PRE-DEVELOPMENT VALUE (C_PRE)												
		C_PRE1	C_PRE2	C_PRE3	C_PRE4	C_PRE5	C_PRE6	C_PRE7	C_PRE8	C_PRE9	C_PRE10	C_PRE11	C_PRE12	C_PRE13
Area	ha	35.1364	31.1068	37.8396	31.2879	22.5011	25.3325	11.9205	22.0915	17.7580	20.5894	17.08	17.0204	8.8695
Drainage path slope	%	3.016	3.033	4.528	4.715	12.941	5.947	12.582	6.163	10.264	11.865	11.086	9.507	15.659
Width	m	340.085	324.084	220.892	208.412	437.971	432.576	287.273	252.578	282.605	351.831	254.484	224.860	183.956
Percentage of impervious area	%	10	10	10	10	10	10	10	10	10	10	10	10	10
Percentage of impervious areas with no depression storage	%	50	50	50	50	50	50	50	50	50	50	50	50	50
Manning n-value impervious areas	constant	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
Manning n-value overland flow	constant	0.200	0.200	0.200	0.200	0.15	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
Depth of depression storage for impervious areas	mm	3												
Depth of depression storage for pervious areas	mm	5												
Green-Ampt infiltration parameters:														
Suction head	mm	239												
Conductivity	mm/hr	0.5												
Initial deficit	constant	0.1												

Table 8: Model Parameters for Post-Development Catchments runoff simulations

PARAMETER DESCRIPTION	UNIT	POST-DEVELOPMENT VALUE (C_POST)												
		C_POST1	C_POST2	C_POST3	C_POST4	C_POST5	C_POST6	C_POST7	C_POST8	C_POST9	C_POST10	C_POST11	C_POST12	C_POST13
Area	ha	35.1364	31.1068	37.8396	31.2879	22.5011	25.3325	11.9205	22.0915	17.7580	20.5894	17.08	17.0204	8.8695
Drainage path slope	%	1.909	2.229	2.367	4.708	12.941	4.750	7.592	4.670	6.351	6.300	9.212	7.225	6.377
Width	m	340.085	324.084	220.892	208.412	437.971	432.576	287.273	252.578	282.605	351.831	254.484	224.860	183.956
Percentage of impervious area	%	47.7	48.6	47.3	43.9	53.6	67.6	66.9	59.1	61.2	66.2	61.7	60.7	76.7
Percentage of impervious areas with no depression storage	%	66.1	64.3	73.4	78.9	75	63.1	75.0	73.6	74.5	75.4	74.7	74.3	75.0
Manning n-value impervious areas	constant	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
Manning n-value overland flow	constant	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.2
Depth of depression storage for impervious areas	mm	3												
Depth of depression storage for pervious areas	mm	5												
Green-Ampt infiltration parameters:														
Suction head	mm	239												
Conductivity	mm/hr	0.5												
Initial deficit	constant	0.1												

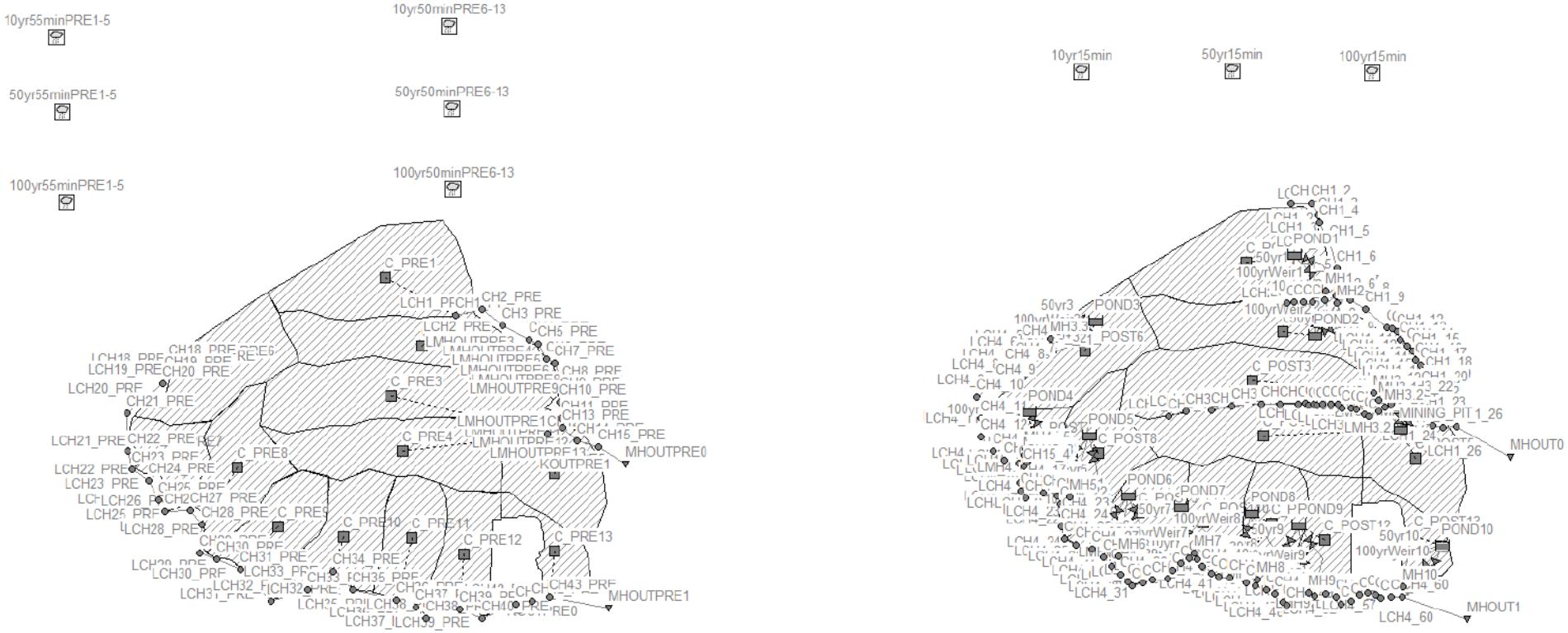


Figure 5: SWMM Model Diagrammatical Representation

6.7.3. SWMM Model Results

A hydraulic analysis was undertaken to assess the post-development effects of the proposed stormwater management system. The results indicate that, in addition to the existing mining pit, several attenuation ponds will be required to accommodate the increased stormwater runoff generated by the development. These attenuation facilities will retain and regulate runoff to ensure that discharge rates do not exceed pre-development conditions. The hydraulic analysis was run for approximately 24 hours to extend ponding and to improve the quality of stormwater runoff.

The proposed development was divided into 13 sub-catchments for both the pre- and post-development scenarios and shown in the drawing in **Annexure H2.** Of the 13 identified sub-catchments, 5 sub-catchments will drain and discharge in the Eastern floodplain of the Meulrivier natural river and the remaining 8 sub-catchments will drain and discharge into the Southern floodplains of the Meulrivier natural river.

The stormwater runoff results for the pre- and post-development scenarios are summarized in **Table 9** and **Table 10** below. **Table 9** below shows the stormwater results for the pre- and post-development sub-catchments draining to the Eastern floodplains and **Table 10** shows the stormwater results for the pre- and post-development sub-catchments draining to the Southern floodplains.

The results indicate that the additional attenuation facilities effectively reduce the post-development flood peak, ensuring that it does not exceed the pre-development flood peak.

Table 9: Stormwater runoff results – Sub-catchments draining to the East (1-5)

STORM	PRE-DEVELOPMENT RUNOFF (M^3/S)	POST-DEVELOPMENT RUNOFF WITHOUT ATTENUATION (M^3/S)	POST-DEVEVLOPMENT RUNOFF WITH ATTENUATION (M^3/S)
10 Year	3.672	6.486	3.629
50 Year	7.669	11.929	6.636
100 Year	13.762	15.021	10.778

Refer to **Figure 6**, **Figure 8** and **Figure 10** for the 10-year storm hydrograph, 50-year storm hydrograph and the 100-year storm hydrograph for the 5 sub-catchments draining to the Eastern floodplains.

Table 10: Stormwater runoff results – Sub-catchments draining to the South (6-13)

STORM	PRE-DEVELOPMENT RUNOFF (M^3/S)	POST-DEVELOPMENT RUNOFF WITHOUT ATTENUATION (M^3/S)	POST-DEVEVLOPMENT RUNOFF WITH ATTENUATION (M^3/S)
10 Year	5.105	11.789	4.580
50 Year	10.279	20.775	8.416
100 Year	13.161	25.951	13.082

Refer to **Figure 7**, **Figure 9** and **Figure 11** for the 10-year storm hydrograph, 50-year storm hydrograph and the 100-year storm hydrograph for the 8 sub-catchments draining to the Southern floodplains.

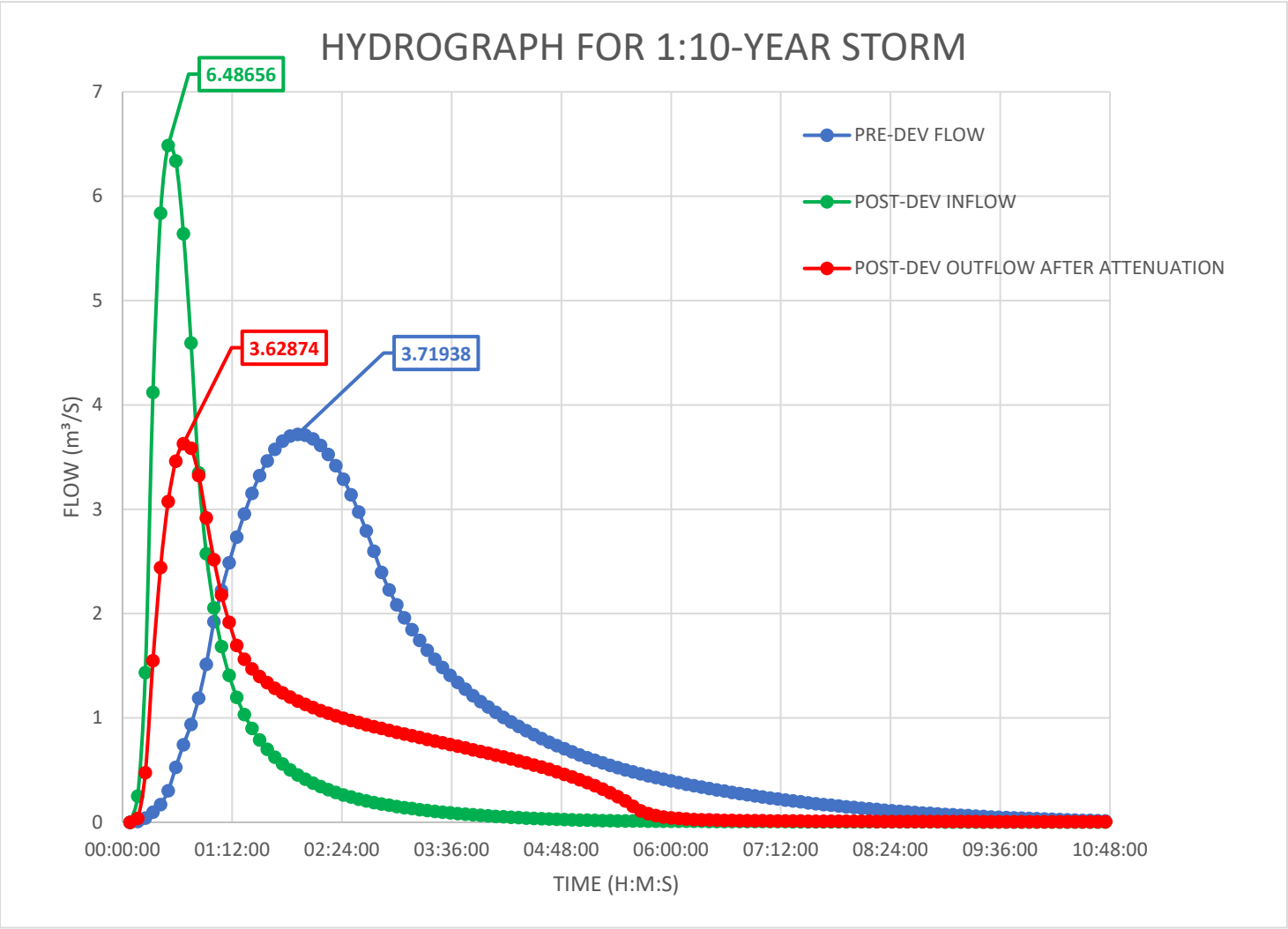


Figure 6: 10-Year RI Storm Hydrograph (Eastern floodplain Sub-catchments)

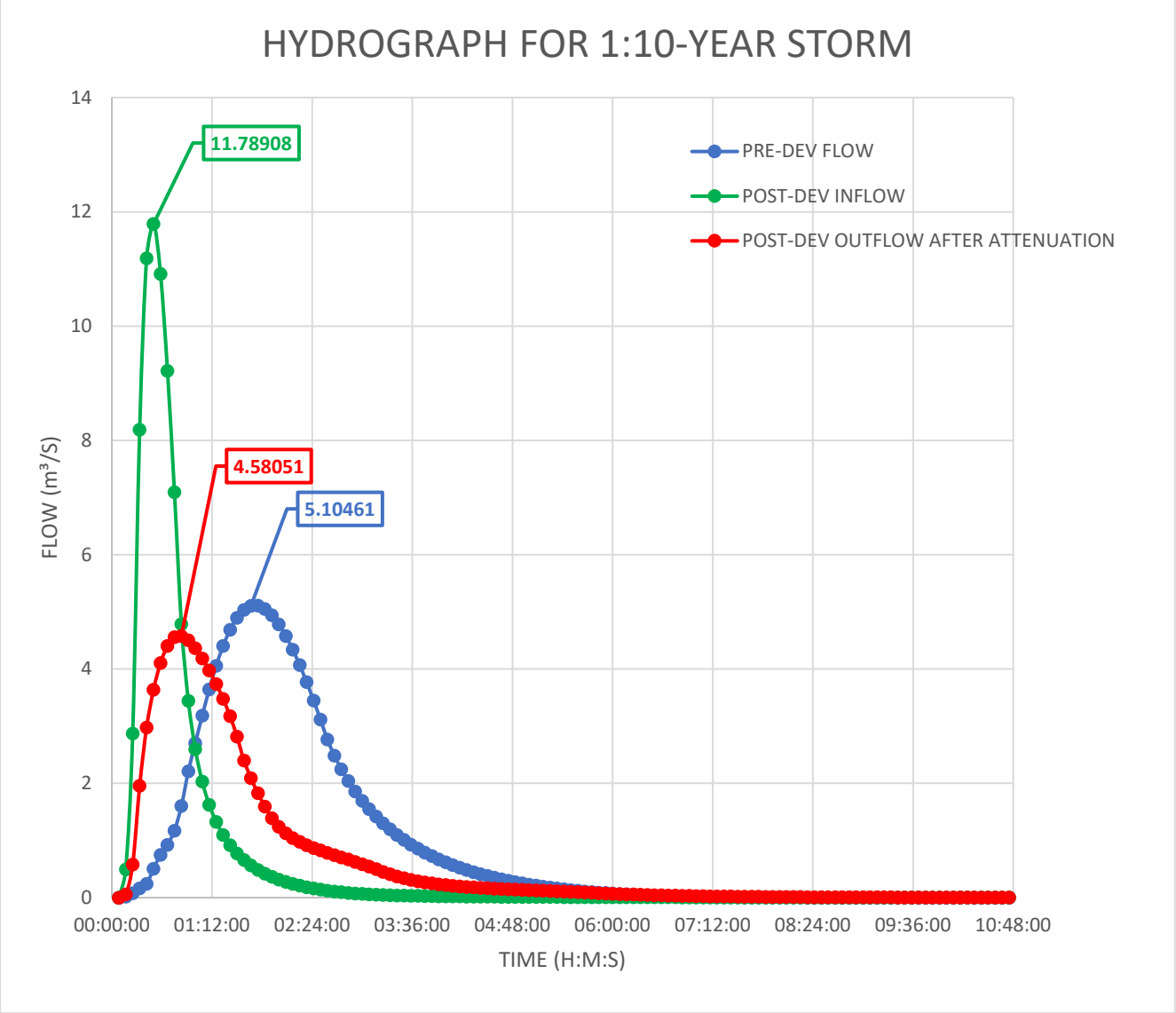


Figure 7:10-Year RI Storm Hydrograph (Southern floodplain Sub-catchments)

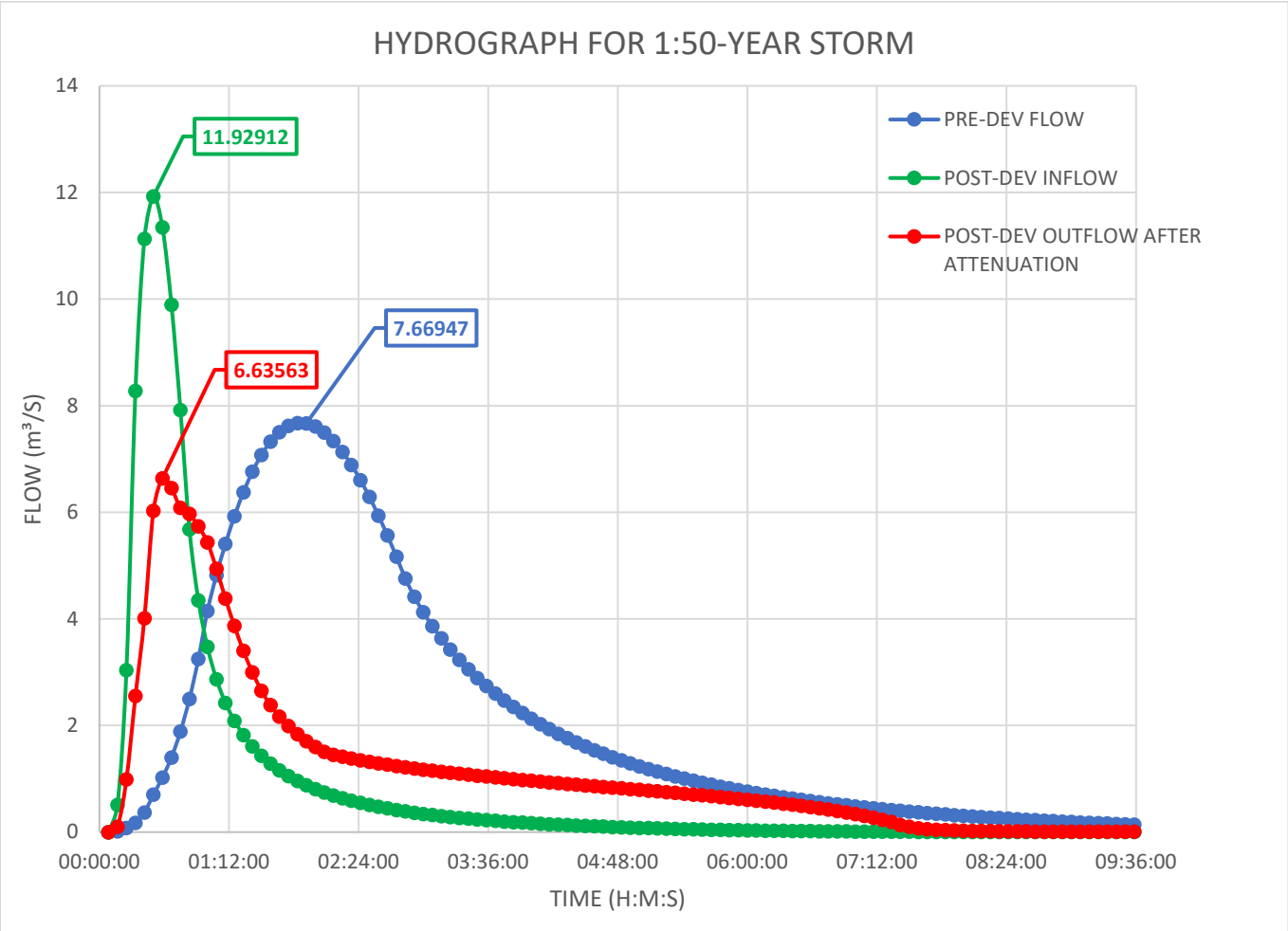


Figure 8: 50-Year RI Storm Hydrograph (Eastern floodplain Sub-catchments)

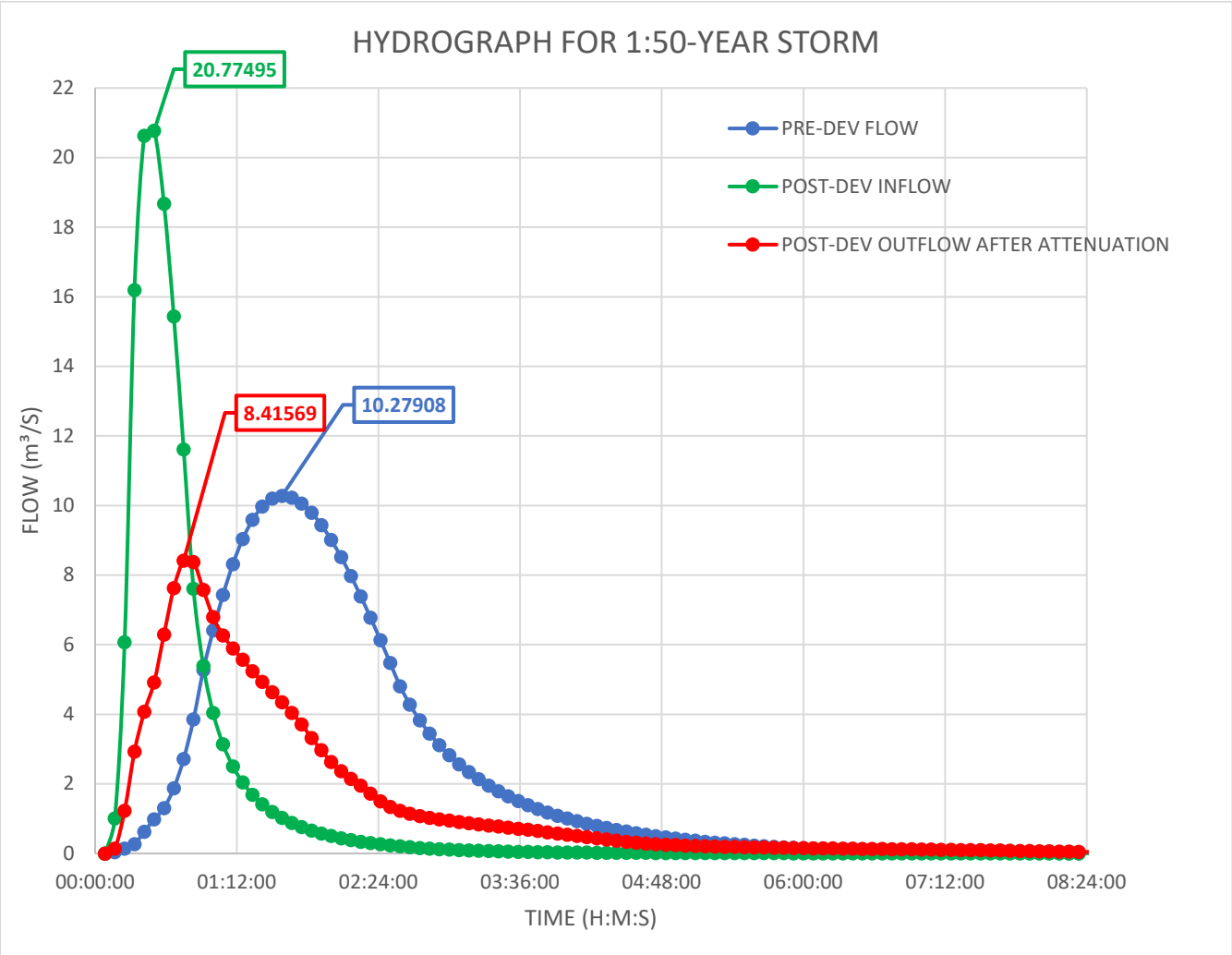


Figure 9: 50-Year RI Storm Hydrograph (Southern floodplain Sub-catchments)

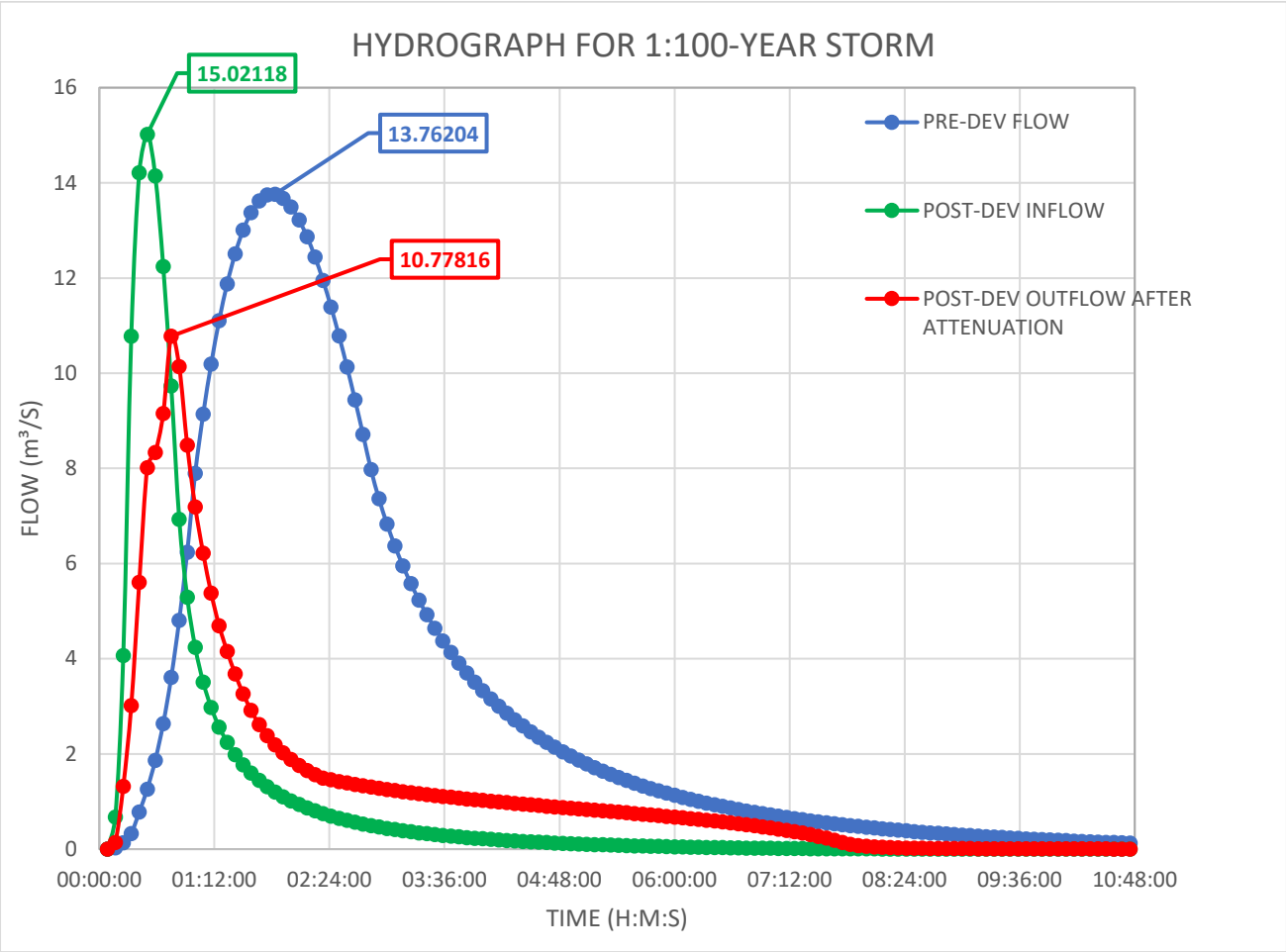


Figure 10: 100-Year RI Storm Hydrograph (Eastern floodplain Sub-catchments)

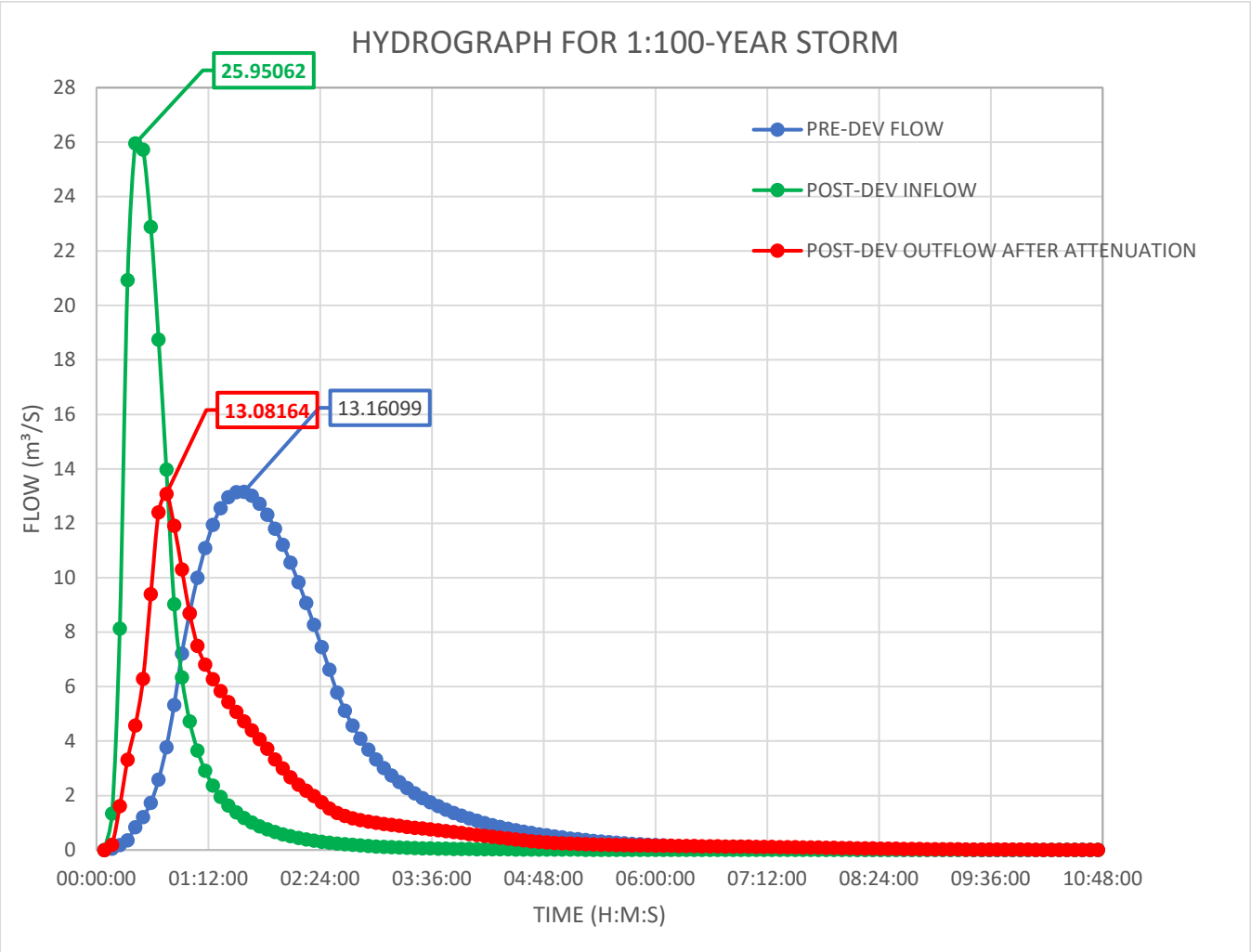


Figure 11 100-Year RI Storm Hydrograph (Southern floodplain Sub-catchments):

7. STORMWATER MANAGEMENT

It is a requirement of the George Municipality that stormwater runoff from new Greenfield developments located within catchments draining to sensitive receiving water systems must be controlled such that the post-development runoff generated by the 1:10-year and 1:50-year recurrence interval storms does not exceed the corresponding pre-development runoff rates.

7.1. Proposed Stormwater Management Infrastructure

The objective of this stormwater management plan is to manage and disperse stormwater through the implementation of Sustainable Urban Drainage Systems (SuDS), including attenuation/detention areas, swales and other suitable conveyance features. The primary focus is to protect the existing watercourses and wetlands and to ensure that the proposed development does not result in adverse impacts on these natural habitats. This includes the incorporation of SuDS Best Management Practices that promote infiltration where feasible and provide storages.

The proposed stormwater management infrastructure, in addition to the existing mining pit, will make use of multiple attenuation ponds in the form of swales to attenuate stormwater runoff generated by the development. These attenuation ponds will be strategically positioned throughout the site to effectively manage and attenuate post-development flows. Each attenuation pond will be provided with outlet structures to regulate discharge and ensure that stormwater is released at or below the applicable pre-development runoff rate. Refer to the stormwater management plan drawing in **Annexure H1** for the ponds' preliminary positions.

Based on the analysis and calculations undertaken, it was determined that, in addition to the storage available within the mining pit, a combined attenuation storage volume of **44,327.20 m^3** is required within the proposed attenuation ponds. Refer to **Table 11** below for the individual storage volume required for each pond. The maximum storage depth required to achieve the necessary attenuation volume differs for each pond and is also provided in **Table 11**. This volume is required to ensure that the post-development runoff rate does not exceed the pre-development runoff rate for the 1:50-year recurrence interval storm event.

To achieve the required attenuation, each pond will be constructed with outlet controls for the 1:10-year and 1:50-year recurrence interval storm events, either in the form of outlet orifice pipes or broad-crested weirs. Refer to the drawings in **Annexures H3** and **H4** for the typical details of the ponds' outlet structures. All attenuation ponds will include a minimum freeboard of 130 mm to accommodate larger-magnitude storm events. The ponds will discharge attenuated stormwater runoff overland on the surface and above the 1:100-year floodline.

Stormwater runoff will be routed to the attenuation swales via the internal stormwater infrastructure, including minor stormwater conduits, roads and open free-surface flow channels. All attenuation ponds will be constructed with overflow weirs to discharge excess floodwater during higher-order storm events, such as the 1:100-year recurrence interval storm. The overflow weirs will be constructed using stone gabions and grouted stone

pitching for energy dissipation and to protect against erosion and scour during high-flow events. Refer to the drawings in **Annexure H3** and **H4** for typical weir details.

Since the proposed development will be constructed in phases, the stormwater management infrastructure will be implemented in accordance with the phasing schedule indicated in **Table 12** below. Refer to **Annexure H2** for the stormwater catchment key plan indicating which sub-catchments fall within which phase of the development.

Phase 1, which comprises of Residential 1 erven, medium-density residential units and a mixed-use node, will require the construction of two attenuation ponds in the form of swales, associated outlet structures, and stormwater drainage infrastructure such as stormwater pipes, kerb inlets and related infrastructure. Refer to the drawing in **Annexure H5** for the stormwater infrastructure required for Phase 1 of the proposed development and to **Annexures H7 to H12** for the longitudinal sections of the stormwater infrastructure. Additionally, refer to the drawing in **Annexure H6** for the delineated sub-catchments areas used to design the stormwater pipes for phase 1 of the development.

Phase 2 of the development which consists of residential 1 erven, municipal and educational facilities will only require the construction of stormwater drainage infrastructure that will drain and discharge into the existing mining pit once it has been rehabilitated and an outlet structures have been constructed. Refer to **Table 12** for the summary of the pond and outlet structures details. The existing storage volume of the mining pit was determined to be approximately 38,729.0 m^3 with a depth of 5m. This is the maximum storage volume without any rehabilitation or earthworks being done to the mining pit. It should be noted that for the mining pit to accommodate both the 1:100-year flood peak and provide attenuation for the development, minimum earthworks will be required in the form of a berm to ensure that the mining pit can accommodate the 1:100-year flood peak without flooding the development.

The final position of the attenuation ponds for Phases 2, 3 and 4 as well as the design of the stormwater infrastructure such as pipes, catch pits and kerb inlets will be done once the town planner layout and Site Development Plan (SDP) have been finalised and approved.

Table 11: Attenuation Volume Required

POND DESCRIPTION	STORAGE CAPACITY (M^3)	CATCHMENT CONTRIBUTING	MAXIMUM POND DEPTH(M)	1:10-YEAR RI STORM OUTLET		1:50-YEAR RI STORM OUTLET	
				OUTLET SIZE	POND WATER LEVEL (M)	OUTLET SIZE	POND WATER LEVEL (M)
POND1	546.80	C_POST1	1.50	0.255m High x 2.4m Wide bottom Orifice	0.91	0.255m High x 3.5m Wide x 1.02m pond crest weir	1.33
POND2	1,179.00	C_POST2	1.50	0.255m High x 2.0m Wide bottom Orifice	0.91	0.255m High x 3.5m Wide x 1.02m pond crest weir	1.34
MINING PIT	15,740	C_POST3, C4 & C5	5.0	0.250m High x 0.7m Wide bottom Orifice	3.19	0.500m High x 2.5m Wide x 4m pond crest weir	4.48
POND3	3,286.30	C_POST6	1.50	0.255m High x 1.9m Wide bottom Orifice	0.89	0.17m High x 5m Wide x1.105m pond crest weir	1.36
POND4	3,084.80	C_POST7	1.50	Ø375mm Pipe bottom orifice	0.93	0.255m High x 0.9m Wide x 1.105m pond crest weir	1.35
POND5	3,285.00	C_POST8	1.50	0.255m High x 1.35m Wide bottom Orifice	0.77	0.17m High x 1.5m Wide x 1.19m pond crest weir	1.33
POND6	4,744.50	C_POST9	1.50	0.255m High x 0.3m Wide bottom Orifice	0.9	0.17m High x 1.5m Wide x 1.19m pond crest weir	1.34
POND7	3,699.80	C_POST10	1.50	0.255m High x 1.25m Wide bottom Orifice	0.87	0.17m High x 3.5m Wide x1.19m pond crest weir	1.36
POND8	2,768.40	C_POST11	1.80	0.255m High x 1.2m Wide bottom Orifice	0.94	0.17m High x 2.0m Wide x 1.445m pond crest weir	1.59
POND9	3,884.30	C_POST12	1.80	0.255m High x 0.5m Wide bottom Orifice	1.03	0.17m High x 2m Wide x 1.445m pond crest weir	1.59
POND10	2,108.30	C_POST13	1.50	0.255m High x 0.3m Wide bottom Orifice	0.98	0.17m High x 2m Wide x 1.105m pond crest weir	1.37
TOTAL STORAGE	**44,327.20**						

Table 12: Phased Stormwater Infrastructure Construction Schedule

CONSTRUCTION PHASE	ATTENUATION PONDS TO WHICH PHASE DRAINS TO:	REQUIRED STORMWATER INFRASTRUCTURE TO BE CONSTRUCTED:
Phase 1	Pond 1 and Pond 2	Construction of Ponds 1 and 2, outlet structures of the ponds, stormwater drainage catchpits, kerb inlets, pipes and manholes
Phase 2	Existing Mining Pit	Rehabilitation and earthworks of the mining Pit, construction of outlet structures, stormwater drainage catchpits, kerb inlets, pipes, channels and manholes
Phase 3	Pond 3	Construction of Pond 3 in the form of swales, outlet structure of the pond, stormwater drainage catchpits, kerb inlets, pipes and manholes
Phase 4	Ponds 4. 5, 6, 7, 8, 9 and 10	Construction of ponds 4 to 10 with outlet structures, stormwater drainage catchpits, kerb inlets, pipes, channels and manholes

7.2. Stormwater management during construction

The stormwater system must be managed and monitored during the construction at regular intervals by the contractor (for small sites) or the Environmental Control Officer (ECO) according to the Environmental Management Programme (EMP). The contractor or ECO is to ensure that the following are in place during construction:

- The site must be fenced off prior to construction, including the stormwater attenuation ponds, swales area to ensure that the area downstream of the site development area remains in its natural condition during the construction process.
- Implementation of temporary attenuation measures, such as earth berms to retain surface runoff until the stormwater network and attenuation areas are complete and functional.
- Runoff from the roads must be managed to avoid erosion and pollution problems both on and off the site.
- Providing a silt screen at all grid inlets to collect debris until the site is fully developed.
- The stormwater drainage network systems must be kept separate from the sewer system
- Controlling dust, especially during the construction of roads and bulk earthworks.
- Placing topsoil and grass sods onto cut/fill embankments to reduce runoff flow rates and velocities.
- The construction of the stormwater attenuation ponds it to be completed as soon as possible.
- Planting of grass and other vegetation as soon as open areas are complete to prevent scouring and erosion of the low cohesion soils found on site.
- Fencing-off the construction and keeping all construction vehicles off the undeveloped portions of vegetation and buffer areas.

7.3. Operation and Maintenance of Stormwater Infrastructure

The stormwater system is designed to be self-cleansing, but maintenance is required to ensure continual safe operation and to prevent the possibility of flooding and property damage. The developer will be responsible to monitor the internal stormwater system and attenuation facilities to identify possible improvements and / or maintenance issues. The factors to be monitored include the functionality of the internal roads, stormwater pipes and attenuations ponds. The proposed stormwater infrastructure will be constructed in road reserves and registered servitudes to ensure ease of access for maintenance. The operation and maintenance process should be done at regular intervals. The proposed interval is every 6 months which includes the following activities.

- Cleaning of kerbs and channels, catchpits, stormwater pipes and attenuation ponds.
- Removal of silt from collection points and attenuation pond.
- Plant/weed control.
- Landscaping on embankments to be trimmed.

8. ENVIRONMENTAL REQUIREMENTS

The proposed development is affected by the 1:100-year floodline with natural watercourses flowing through the site and bordering the East, West and Southern boundaries of the site. The development also consists of sensitive environmental aquatic areas and wetlands in which no construction activities should take place. Refer to the town planner layout in **Annexure C** for the sensitive areas zoned and demarcated as private open space. Additionally, the stormwater management plan proposes to discharge attenuated stormwater runoff overland to drain above the 1:100-year floodline, therefore environmental authorisation in the form of Environmental Authorisation (EA) will be required for the proposed development. Further to the above, a Water Use License Authorisation (WULA) may also be required based on the findings and requirements of the environmental authorisation. The developer is therefore required to appoint an environmental consultant to obtain this Environmental Authorisation.

9. CONCLUSION AND RECOMMENDATIONS

The design and operation of the development's stormwater management system will focus primarily on the attenuation of floods up to the 1:50-year recurrence interval rainfall events for the post-development scenario and to provide safe introduction of stormwater into the downstream stormwater system. This will be ensured by designing and building attenuation ponds or attenuation systems to attenuate a volume of at least **44,327.20 m^3.**

The proposed stormwater management system complies with the George Municipality Stormwater By-Laws and The City of Cape Town Stormwater Management Policies.

It is therefore recommended that George Municipality support this development.

ANNEXURE A: APPOINTMENT LETTER

ANNEXURE A: APPOINTMENT LETTER

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

011 391 0134 | info@jtevolve.com | www.jtevolve.co.za

Postal Address:
P.O Box 992
Kempton Park
1620
Physical Address:
253 Monument Road
Glen Marais Ext 1
Kempton Park
Gauteng
South Africa

LETTER OF APPOINTMENT

I/We hereby accept the proposal and terms and conditions as set out in the quotation submitted by JT Evolve (Pty) Ltd with reference number as stated below for the amount of **R100 000** (excluding VAT).

Project Information			
Reference:	719_OQ02_SWMP		
Appointed Services:	This fee proposal includes Stormwater Management Plan		
Property Description:	GARDEN ROUTE CITY		
Quotation Date:	2023-08-18		
Prepared By:	Wietsche Jacobs		
CUSTOMER INFORMATION			
Client Name:	Compregen (Pty) Ltd		
Company Name (if applicable)	" "	**Company VAT no.**	4870256148
Physical Address:			
		Code:	
Postal Address:			
		Code:	
Cell:	067 429 7977	**Tel:** 011	607 8000
E-mail address for accounts:	*john@p1realty.co.za | barend & jana		
E-main address for project correspondence (if not the same as above)	Barend@kironprop.co.za		
Signed in Acceptance		**Date:**	3/4/24

ANNEXURE B: LOCALITY

ANNEXURE B: LOCALITY PLAN


PARKDENE
BALLOTSVIEW
434
437
437
12
2
2
2
The Site_Kiron George
THEMBALETHU
THEMBALETHU ZONE 7
1208 m
Image © 2024 Airbus
Map Data © 2023 AND
© 2023 Google
Google Earth

ANNEXURE C: TOWN PLANNING

ANNEXURE C: TOWN PLANNER LAYOUT

GARDEN ROUTE CITY

PTN'S. 7,8 12 & REM. 23 KRAAIBOSCH No.195

USE	AREAS	No. OF ERVEN / UNITS	NOTATION
RESIDENTIAL 1 (400 - 600m²)	20,10	335	
RESIDENTIAL 1 (500 - 700m²)	26,66	380	
RESIDENTIAL 1 (700 - 900m²)	14,50	161	
MEDIUM DENSITY RESIDENTIAL 40u/ha	7,48	299 UNITS	
FUTURE DEVELOPMENT	72,62	5807 UNITS	
EDUCATION			
MIXED LAND USE			
OPEN SPACE			
PRIVATE STREETS			
PUBLIC ROADS			
ACCESS CONTROL POINT			
MIXED USE NODE			
MUNICIPAL			
SLOPES STEEPER THAN 1 : 5			

0 50 100 250 200 250 300 350 400 450 500m

PHASE 1

USE	QUANTITY	NOTATION
RESIDENTIAL 1 (700 - 900m²)	152	
RESIDENTIAL 1 (500 - 700m²)	129	
MEDIUM DENSITY RESIDENTIAL 40u/ha	299	
PRIVATE OPEN SPACE	2	
PRIVATE STREET	2	
ACCESS CONTROL POINT	1	
PUBLIC ROADS		
TOTAL	585	NOTATION

PHASE 2

USE	QUANTITY	
RESIDENTIAL 1 (500 - 700m²)	256	
RESIDENTIAL 1 (400 - 600m²)	335	
EDUCATION	1	
MUNICIPAL	1	
PRIVATE OPEN SPACE	5	
ACCESS CONTROL POINT	1	
PUBLIC ROADS		
TOTAL	599	

PHASE 3

USE	QUANTITY	NOTATION
MIXED LAND	1	
PRIVATE OPEN SPACE	2	
PUBLIC ROADS		
TOTAL	3	

PHASE 4

USE	QUANTITY	NOTATION
FUTURE DEVELOPMENT	5807	
PUBLIC ROADS		
TOTAL	5807	

DATE	AMENDMENTS

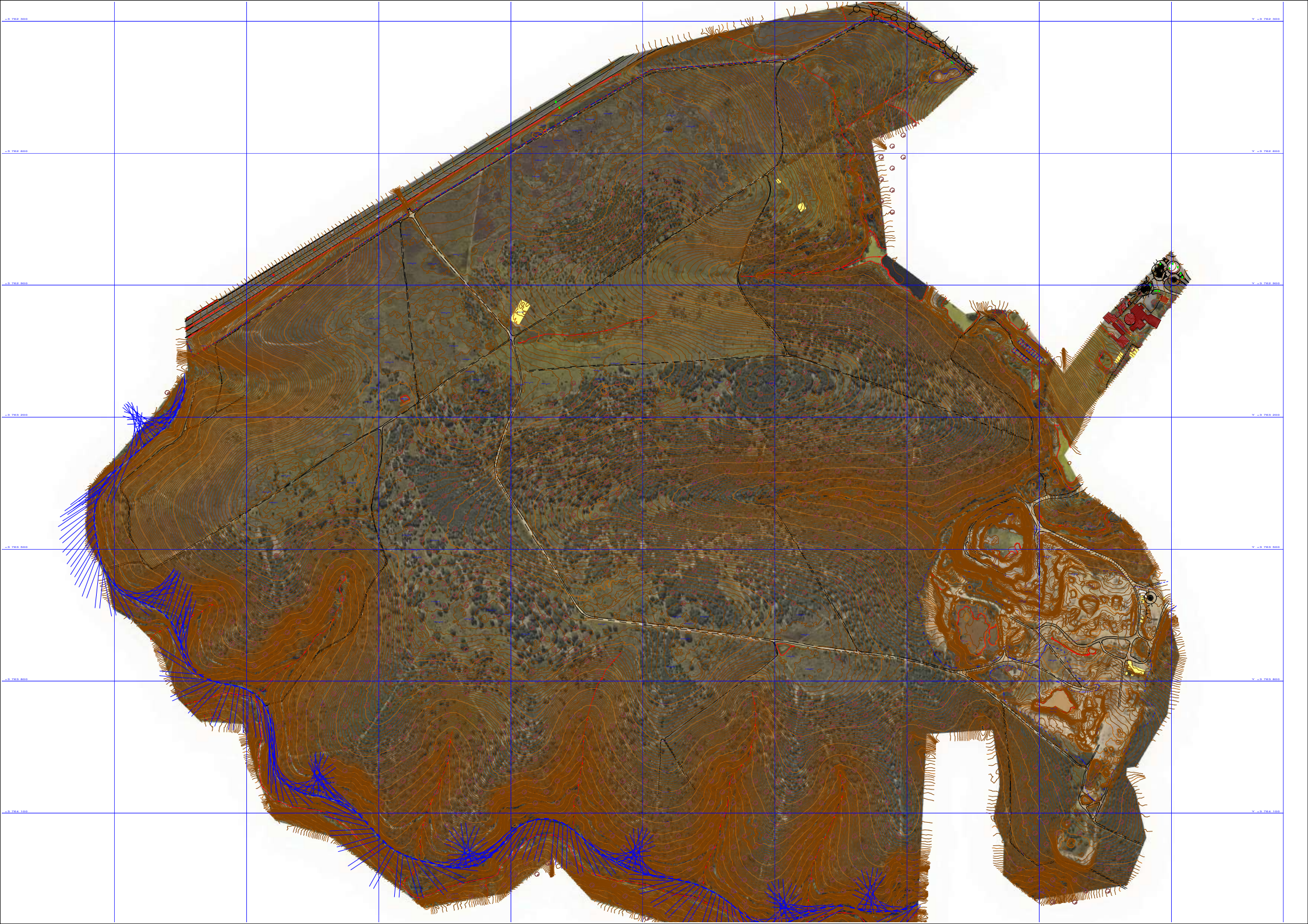
Town Planning (PTY)Ltd
AETERNO

P.O. Box 1435
Faerie Glen 0043
Tel: (012) 348 5081

Date: 27 OCTOBER 2025
Scale: 1 : 5000 (A1)
Plan No:

ANNEXURE D: TOPOGRAPHICAL SURVEY

ANNEXURE D: TOPOGRAPHICAL SURVEY

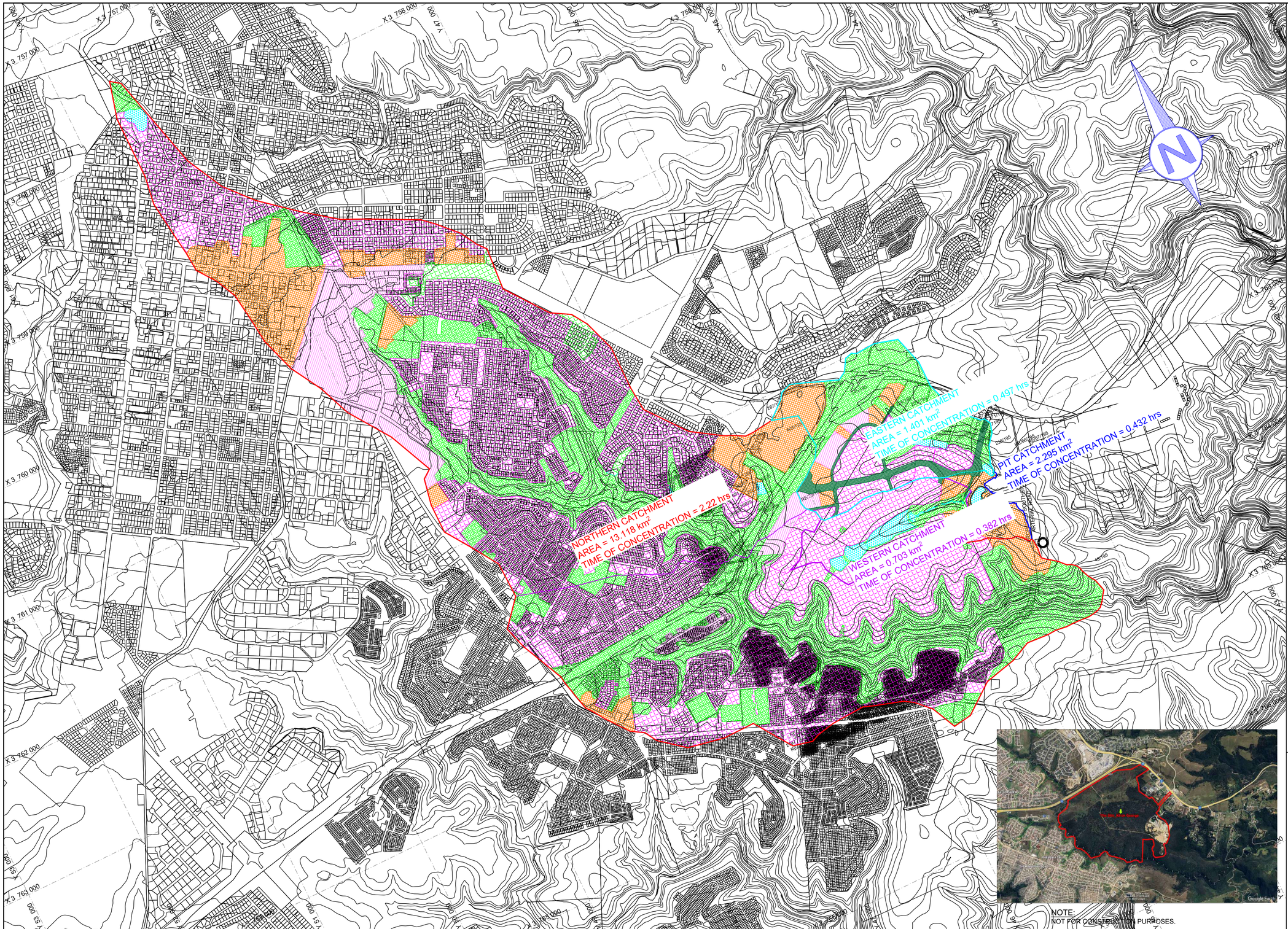


ANNEXURE E: FLOODLINE

ANNEXURE E1: FLOODLINE CATCHMENT PLAN

ANNEXURE E2: CERTIFIED FLOODLINE PLAN

ANNEXURE E1: FLOODLINE CATCHMENT PLAN



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING ROAD
- PROPOSED ROAD
- EXISTING STORMWATER
- PROPOSED STORMWATER
- NORTHERN CATCHMENT AREA = 1311.8 HA
- WESTERN CATCHMENT AREA = 70.3 HA
- EASTERN CATCHMENT AREA = 140.1 HA
- PIT CATCHMENT AREA = 229.50 HA
- RESIDENTIAL AREA = 781.779 HA
- OPEN SPACE AREA = 456.945 HA
- LAKES AND PANS AREA = 26.861 HA
- BUSINESS AREA = 156.797 HA
- LIGHT INDUSTRY AREA = 99.405 HA
- STREETS AREA = 16.664 HA

NOTE:
NOT FOR CONSTRUCTION PURPOSES.

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: LL MALEKA

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....

CONTRACT No.

PROJECT No.
458

SHEET No.
1 OF 1

PAPER SIZE
A1

SCALE
1:15 000

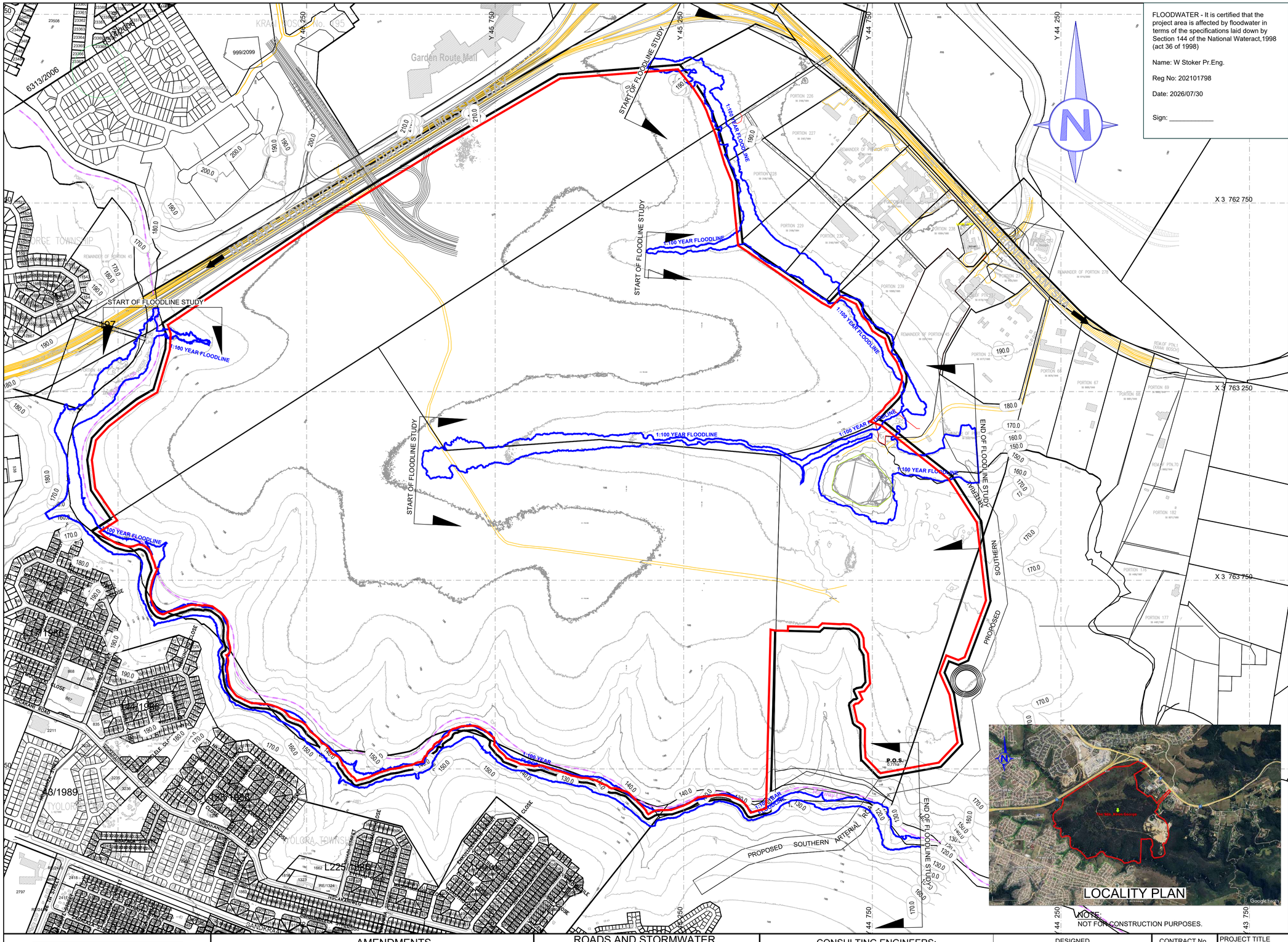
PROJECT TITLE
GARDEN ROUTE CITY
(PTNs 7, 8, 12 AND RE/23 KRAAIBOSCH NO.195)

DRAWING TITLE
STORMWATER CATCHMENT PLAN

DRAWING NUMBER
458_04A_CP1

REVISION
P0

ANNEXURE E2: CERTIFIED FLOODLINE PLAN



FLOODWATER - It is certified that the project area is affected by floodwater in terms of the specifications laid down by Section 144 of the National Wateract,1998 (act 36 of 1998)

Name: W Stoker Pr.Eng.

Reg No: 202101798

Date: 2026/07/30

Sign: _____

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

NOTE:
NOT FOR CONSTRUCTION PURPOSES.

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W STOKER

DRAWN
NAME: LLM

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....

CONTRACT No.

PROJECT No.
458

SHEET No.
1 OF 1

PAPER SIZE
A1

SCALE
1:5 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
FLOODLINE
PLAN

DRAWING NUMBER
458_04A_FP1

P0
REVISION

ANNEXURE F: IMPERVIOUS & PERVIOUS AREA CALCULATIONS

ANNEXURE F1: IMPERVIOUS AND PERVIOUS AREAS CALCULATIONS

Garden Route City	imperv	50%	50%	85%	60%	0%
	0 depression	0%	80%	75%	90%	0%
CATCHMENT		ROAD AREA (m²)	COMMUNITY FACILITY AREAA (m²)	MEDIUM DENSITY RESIDENTIAL AREA (m²)	RESIDENTIAL 1 AREA (m²)	PRIVATE OPEN SPACE AREA (m²)
C_POST1		62352.648	0	94880.014	93089.689	101041.787
C_POST2		58851.26	0	0	120355.142	73439.103
C_POST3		64365.06	0	0	239948.131	57725.217
C_POST4		28745.016	46643.224	0	166165.912	71324.925
C_POST5		0	0	141802.645	0	83208.027
C_POST6		44447.511	0	131558.153	0	33466.964
C_POST7		0	0	93877.776	0	25326.993
C_POST8		15272.265	0	114072.265	43174.015	48396.462
C_POST9		7466.323	0	106038.817	24723.9	39350.786
C_POST10		7356.329	0	127389.212	37288.433	30860.023
C_POST11		7622.008	0	99737.677	28001.438	35438.856
C_POST12		3393.431	22604.873	106225.076	0	37980.855
C_POST13		0	0	80038.805	0	8655.754
CPOST (all)		299871.851	69248.097	1095620.44	752746.66	646215.752

C_PRE1		0	0	0	0	0
C_PRE2		0	0	0	0	0
C_PRE3		0	0	0	0	0
C_PRE4		0	0	0	0	0
C_PRE5		0	0	0	0	0
C_PRE6		0	0	0	0	0
C_PRE7		0	0	0	0	0
C_PRE8		0	0	0	0	0
C_PRE9		0	0	0	0	0
C_PRE10		0	0	0	0	0
C_PRE11		0	0	0	0	0
C_PRE12		0	0	0	0	0
C_PRE13		0	0	0	0	0
CPRE (all)		0	0	0	0	0

0%	85%	10%	90%	80%			
0%	65%	50%	75%	75%			
MUNICIPAL AREA (m^2)	BUSINESS AREA (m^2)	AGRICULTURAL AREA (m^2)	HOSPITAL AREA (m^2)	LIGHT INDUSTRY AREA (m^2)	TOTAL AREA (m^2)	TOTAL AREA per model (m^2)	CHECK
0	0	0	0	0	351364.138	351364.138	0
0	58422.662	0	0	0	311068.167	311068.167	0
12984.073	3373.602	0	0	0	378396.083	378396.083	0
0	0	0	0	0	312879.077	312879.077	0
0	0	0	0	0	225010.672	225010.672	0
0	43852.718	0	0	0	253325.346	253325.346	0
0	0	0	0	0	119204.769	119204.769	0
0	0	0	0	0	220915.007	220915.007	0
0	0	0	0	0	177579.826	177579.826	0
0	0	0	0	0	202893.997	202893.997	0
0	0	0	0	0	170799.979	170799.979	0
0	0	0	0	0	170204.235	170204.235	0
0	0	0	0	0	88694.559	88694.559	0
12984.073	105648.982	0	0	0	2982335.855	2982335.855	0
					2982335.855	**2982335.855**	0
0	0	351364.138	0	0	351364.138	351364.138	0
0	0	311068.167	0	0	311068.167	311068.167	0
0	0	378396.083	0	0	378396.083	378396.083	0
0	0	312879.077	0	0	312879.077	312879.077	0
0	0	225010.672	0	0	225010.672	225010.672	0
0	0	253325.346	0	0	253325.346	253325.346	0
0	0	119204.769	0	0	119204.769	119204.769	0
0	0	220915.007	0	0	220915.007	220915.007	0
0	0	177579.826	0	0	177579.826	177579.826	0
0	0	202893.997	0	0	202893.997	202893.997	0
0	0	170799.979	0	0	170799.979	170799.979	0
0	0	170204.235	0	0	170204.235	170204.235	0
0	0	88694.559	0	0	88694.559	88694.559	0
0	0	2982335.855	0	0	2982335.855	2982335.855	0

A imper	%	A 0 depresion storage	% roof coverage	% parks/lawns	% industry	% City/res	% Streets	check
167678.1	47.7	110754.4	66.1	28.76%	0.00%	53.50%	17.75%	OK
151298.0	48.6	97270.3	64.3	23.61%	0.00%	57.47%	18.92%	OK
179019.0	47.3	131435.9	73.4	18.69%	0.00%	64.30%	17.01%	OK
137393.7	43.9	108386.9	78.9	22.80%	0.00%	68.02%	9.19%	OK
120532.2	53.6	90399.2	75.0	36.98%	0.00%	63.02%	0.00%	OK
171323.0	67.6	108096.9	63.1	13.21%	0.00%	69.24%	17.55%	OK
79796.1	66.9	59847.1	75.0	21.25%	0.00%	78.75%	0.00%	OK
130502.0	59.1	96035.0	73.6	21.91%	0.00%	71.18%	6.91%	OK
108700.5	61.2	80950.7	74.5	22.16%	0.00%	73.64%	4.20%	OK
134332.1	66.2	101346.4	75.4	15.21%	0.00%	81.16%	3.63%	OK
105388.9	61.7	78703.5	74.7	20.75%	0.00%	74.79%	4.46%	OK
103290.5	60.7	76760.4	74.3	22.31%	0.00%	75.69%	1.99%	OK
68033.0	76.7	51024.7	75.0	9.76%	0.00%	90.24%	0.00%	OK
1657287.0	55.6	1191011.5	71.9	22.10%	0.00%	67.84%	10.05%	OK
35136.4	10.0	17568.2	50.0	100.00%	0.00%	0.00%	0.00%	OK
31106.8	10.0	15553.4	50.0	100.00%	0.00%	0.00%	0.00%	OK
37839.6	10.0	18919.8	50.0	100.00%	0.00%	0.00%	0.00%	OK
31287.9	10.0	15644.0	50.0	100.00%	0.00%	0.00%	0.00%	OK
22501.1	10.0	11250.5	50.0	100.00%	0.00%	0.00%	0.00%	OK
25332.5	10.0	12666.3	50.0	100.00%	0.00%	0.00%	0.00%	OK
11920.5	10.0	5960.2	50.0	100.00%	0.00%	0.00%	0.00%	OK
22091.5	10.0	11045.8	50.0	100.00%	0.00%	0.00%	0.00%	OK
17758.0	10.0	8879.0	50.0	100.00%	0.00%	0.00%	0.00%	OK
20289.4	10.0	10144.7	50.0	100.00%	0.00%	0.00%	0.00%	OK
17080.0	10.0	8540.0	50.0	100.00%	0.00%	0.00%	0.00%	OK
17020.4	10.0	8510.2	50.0	100.00%	0.00%	0.00%	0.00%	OK
8869.5	10.0	4434.7	50.0	100.00%	0.00%	0.00%	0.00%	OK
298233.6	10.0	149116.8	50.0	100.00%	0.00%	0.00%	0.00%	OK

ANNEXURE G: RUNOFF DETERMINATION

ANNEXURE G1: RUNOFF DETERMINATION CALCULATIONS 1:10-YEAR

ANNEXURE G2: RUNOFF DETERMINATION CALCULATIONS 1:50-YEAR

ANNEXURE G3: RUNOFF DETERMINATION CALCULATIONS 1:100-YEAR

ANNEXURE G1: RUNOFF DETERMINATION CALCULATIONS 1:10-YEAR

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
--------------------------------------------------------------


****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... STEADY
Starting Date ............ 01/01/2010 00:00:00
Ending Date .............. 01/01/2010 23:55:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        20.707        34.716
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         8.400        14.084
Surface Runoff ...........        12.156        20.379
Final Storage ............         0.189         0.317
Continuity Error (%) .....        -0.184


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
```

Wet Weather Inflow	12.156	121.557
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	12.154	121.541
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.006
Continuity Error (%)	0.008	

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	5.00 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
% of Time in Steady State	:	0.00
Average Iterations per Step	:	1.00
% of Steps Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
C_POST1	24.15	0.00	0.00	9.81	11.07	2.83	13.90	4.88	1.66	0.576
C_POST2	24.15	0.00	0.00	9.40	11.26	3.02	14.28	4.44	1.57	0.591
C_POST3	24.15	0.00	0.00	10.44	11.05	2.30	13.35	5.05	1.50	0.553
C_POST4	24.15	0.00	0.00	10.51	10.36	3.05	13.41	4.20	1.46	0.555

C_POST5	24.15	0.00	0.00	6.55	12.68	4.68	17.36	3.91	1.92	0.719
C_POST6	24.15	0.00	0.00	4.79	15.69	3.06	18.75	4.75	2.16	0.776
C_POST7	24.15	0.00	0.00	4.47	15.81	3.56	19.36	2.31	1.18	0.802
C_POST8	24.15	0.00	0.00	6.71	13.88	3.18	17.05	3.77	1.52	0.706
C_POST9	24.15	0.00	0.00	5.83	14.42	3.56	17.98	3.19	1.46	0.745
C_POST10	24.15	0.00	0.00	4.90	15.62	3.28	18.90	3.84	1.80	0.783
C_POST11	24.15	0.00	0.00	5.63	14.55	3.64	18.19	3.11	1.45	0.753
C_POST12	24.15	0.00	0.00	6.04	14.29	3.47	17.76	3.02	1.34	0.735
C_POST13	24.15	0.00	0.00	3.09	18.09	2.56	20.65	1.83	0.91	0.855
C_PRE1	46.20	0.00	0.00	23.04	4.48	18.54	23.02	8.09	0.75	0.498
C_PRE2	46.20	0.00	0.00	22.68	4.48	18.91	23.39	7.28	0.69	0.506
C_PRE3	46.20	0.00	0.00	24.55	4.48	17.03	21.51	8.14	0.68	0.466
C_PRE4	46.20	0.00	0.00	23.78	4.48	17.81	22.28	6.97	0.61	0.482
C_PRE5	46.20	0.00	0.00	16.62	4.48	24.98	29.47	6.63	1.05	0.638
C_PRE6	44.25	0.00	0.00	18.85	4.28	20.99	25.27	6.40	0.86	0.571
C_PRE7	44.25	0.00	0.00	16.53	4.29	23.32	27.61	3.29	0.55	0.624
C_PRE8	44.25	0.00	0.00	20.36	4.28	19.48	23.76	5.25	0.62	0.537
C_PRE9	44.25	0.00	0.00	18.13	4.29	21.71	25.99	4.62	0.66	0.587
C_PRE10	44.25	0.00	0.00	17.61	4.29	22.24	26.52	5.38	0.81	0.599
C_PRE11	44.25	0.00	0.00	18.23	4.29	21.61	25.90	4.42	0.63	0.585
C_PRE12	44.25	0.00	0.00	18.94	4.28	20.90	25.19	4.29	0.57	0.569
C_PRE13	44.25	0.00	0.00	15.88	4.29	23.98	28.26	2.51	0.44	0.639

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	hr:min	Reported Max Depth Meters
CH12_PRE	JUNCTION	0.03	0.20	130.81	0	01:50	0.20
CH1_1	JUNCTION	0.00	0.00	192.52	0	00:00	0.00
CH1_2	JUNCTION	0.00	0.00	189.28	0	00:00	0.00
CH1_3	JUNCTION	0.00	0.00	186.99	0	00:00	0.00
CH1_4	JUNCTION	0.00	0.00	185.99	0	00:00	0.00
CH1_5	JUNCTION	0.00	0.00	182.42	0	00:00	0.00
CH1_6	JUNCTION	0.00	0.00	177.55	0	00:00	0.00
CH1_7	JUNCTION	0.02	0.37	176.48	0	00:40	0.37
CH1_8	JUNCTION	0.02	0.37	176.18	0	00:40	0.37
CH1_9	JUNCTION	0.02	0.37	175.73	0	00:40	0.37

CH1_10	JUNCTION	0.01	0.19	169.40	0	00:40	0.19
CH1_11	JUNCTION	0.01	0.21	168.31	0	00:40	0.21
CH1_12	JUNCTION	0.02	0.23	167.38	0	00:40	0.23
CH1_13	JUNCTION	0.02	0.25	166.42	0	00:40	0.25
CH1_14	JUNCTION	0.02	0.37	165.70	0	00:40	0.37
CH1_15	JUNCTION	0.02	0.37	165.51	0	00:40	0.37
CH1_16	JUNCTION	0.01	0.20	163.50	0	00:40	0.20
CH1_17	JUNCTION	0.02	0.37	162.29	0	00:40	0.37
CH1_18	JUNCTION	0.02	0.37	162.02	0	00:40	0.37
CH1_19	JUNCTION	0.02	0.37	161.75	0	00:40	0.37
CH1_20	JUNCTION	0.01	0.21	160.40	0	00:40	0.21
CH1_21	JUNCTION	0.01	0.21	158.52	0	00:40	0.21
CH1_22	JUNCTION	0.04	0.34	128.78	0	00:41	0.34
CH1_23	JUNCTION	0.05	0.42	128.23	0	00:41	0.42
CH1_24	JUNCTION	0.05	0.42	127.80	0	00:41	0.42
CH1_25	JUNCTION	0.05	0.42	127.53	0	00:41	0.42
CH1_26	JUNCTION	0.05	0.42	127.20	0	00:41	0.42
CH2_1	JUNCTION	0.00	0.00	182.61	0	00:00	0.00
CH2_2	JUNCTION	0.00	0.00	181.32	0	00:00	0.00
CH2_3	JUNCTION	0.00	0.00	180.70	0	00:00	0.00
CH2_4	JUNCTION	0.00	0.00	177.64	0	00:00	0.00
CH2_5	JUNCTION	0.00	0.00	176.79	0	00:00	0.00
CH2_6	JUNCTION	0.03	0.33	176.84	0	00:38	0.33
CH3_1	JUNCTION	0.00	0.00	197.04	0	00:00	0.00
CH3_2	JUNCTION	0.00	0.00	194.58	0	00:00	0.00
CH3_3	JUNCTION	0.00	0.00	189.61	0	00:00	0.00
CH3_4	JUNCTION	0.00	0.00	187.06	0	00:00	0.00
CH3_5	JUNCTION	0.00	0.00	182.43	0	00:00	0.00
CH3_6	JUNCTION	0.00	0.00	179.03	0	00:00	0.00
CH3_7	JUNCTION	0.00	0.00	172.87	0	00:00	0.00
CH3_8	JUNCTION	0.00	0.00	172.67	0	00:00	0.00
CH3_9	JUNCTION	0.00	0.00	172.17	0	00:00	0.00
CH3_10	JUNCTION	0.00	0.00	170.17	0	00:00	0.00
CH3_11	JUNCTION	0.00	0.00	170.09	0	00:00	0.00
CH3_12	JUNCTION	0.00	0.00	168.75	0	00:00	0.00
CH3_13	JUNCTION	0.00	0.00	167.76	0	00:00	0.00
CH3_14	JUNCTION	0.00	0.00	167.27	0	00:00	0.00
CH3_15	JUNCTION	0.00	0.00	166.71	0	00:00	0.00
CH3_16	JUNCTION	0.00	0.00	164.44	0	00:00	0.00
CH3_17	JUNCTION	0.00	0.00	164.03	0	00:00	0.00
CH3_18	JUNCTION	0.00	0.00	162.48	0	00:00	0.00
CH3_19	JUNCTION	0.00	0.00	162.35	0	00:00	0.00
CH3_20	JUNCTION	0.00	0.00	161.90	0	00:00	0.00

CH3_21	JUNCTION	0.00	0.00	160.59	0	00:00	0.00
CH3_22	JUNCTION	0.00	0.00	158.86	0	00:00	0.00
CH4_1	JUNCTION	0.03	0.33	178.73	0	00:46	0.33
CH4_2	JUNCTION	0.01	0.09	174.69	0	00:46	0.09
CH4_3	JUNCTION	0.01	0.10	170.75	0	00:46	0.10
CH4_4	JUNCTION	0.01	0.10	167.88	0	00:46	0.10
CH4_5	JUNCTION	0.01	0.09	164.56	0	00:46	0.09
CH4_6	JUNCTION	0.01	0.22	158.44	0	00:46	0.22
CH4_7	JUNCTION	0.01	0.22	157.96	0	00:46	0.22
CH4_8	JUNCTION	0.01	0.22	157.66	0	00:46	0.22
CH4_9	JUNCTION	0.01	0.22	157.22	0	00:46	0.22
CH4_10	JUNCTION	0.01	0.22	156.61	0	00:46	0.22
CH4_11	JUNCTION	0.01	0.22	155.40	0	00:46	0.22
CH4_12	JUNCTION	0.01	0.22	154.94	0	00:46	0.22
CH4_13	JUNCTION	0.01	0.22	154.09	0	00:46	0.22
CH4_14	JUNCTION	0.01	0.22	153.72	0	00:46	0.22
CH4_15	JUNCTION	0.01	0.16	152.48	0	00:46	0.16
CH4_16	JUNCTION	0.02	0.25	151.90	0	00:47	0.25
CH4_17	JUNCTION	0.02	0.25	151.63	0	00:47	0.25
CH4_18	JUNCTION	0.02	0.25	150.68	0	00:47	0.25
CH4_19	JUNCTION	0.02	0.25	150.47	0	00:47	0.25
CH4_20	JUNCTION	0.02	0.25	149.90	0	00:47	0.25
CH4_21	JUNCTION	0.02	0.25	149.55	0	00:47	0.25
CH4_22	JUNCTION	0.02	0.23	149.24	0	00:47	0.23
CH4_23	JUNCTION	0.02	0.20	147.51	0	00:47	0.20
CH4_24	JUNCTION	0.02	0.20	146.16	0	00:47	0.20
CH4_25	JUNCTION	0.02	0.19	143.09	0	00:47	0.19
CH4_26	JUNCTION	0.02	0.25	141.13	0	00:47	0.25
CH4_27	JUNCTION	0.02	0.25	140.19	0	00:47	0.25
CH4_28	JUNCTION	0.02	0.27	139.36	0	00:47	0.27
CH4_29	JUNCTION	0.04	0.27	138.84	0	00:47	0.27
CH4_30	JUNCTION	0.04	0.34	138.25	0	00:48	0.33
CH4_31	JUNCTION	0.04	0.34	138.00	0	00:48	0.33
CH4_32	JUNCTION	0.04	0.34	137.84	0	00:48	0.33
CH4_33	JUNCTION	0.04	0.34	137.55	0	00:48	0.33
CH4_34	JUNCTION	0.04	0.34	137.32	0	00:48	0.33
CH4_35	JUNCTION	0.04	0.34	136.95	0	00:48	0.33
CH4_36	JUNCTION	0.02	0.20	135.40	0	00:48	0.20
CH4_37	JUNCTION	0.03	0.25	131.90	0	00:48	0.25
CH4_38	JUNCTION	0.04	0.33	131.27	0	00:48	0.33
CH4_39	JUNCTION	0.04	0.33	131.07	0	00:48	0.33
CH4_40	JUNCTION	0.04	0.39	130.00	0	00:48	0.39
CH4_41	JUNCTION	0.04	0.39	129.70	0	00:48	0.39

CH4_42	JUNCTION	0.04	0.39	129.51	0	00:48	0.39
CH4_43	JUNCTION	0.04	0.39	129.22	0	00:48	0.39
CH4_44	JUNCTION	0.04	0.39	128.81	0	00:48	0.39
CH4_45	JUNCTION	0.04	0.45	128.16	0	00:47	0.45
CH4_46	JUNCTION	0.04	0.45	127.85	0	00:47	0.45
CH4_47	JUNCTION	0.04	0.45	127.63	0	00:47	0.45
CH4_48	JUNCTION	0.04	0.45	127.33	0	00:47	0.45
CH4_49	JUNCTION	0.04	0.45	127.21	0	00:47	0.45
CH4_50	JUNCTION	0.04	0.45	126.48	0	00:47	0.45
CH4_51	JUNCTION	0.04	0.40	123.73	0	00:48	0.40
CH4_52	JUNCTION	0.04	0.40	123.27	0	00:48	0.40
CH4_53	JUNCTION	0.03	0.32	122.32	0	00:48	0.32
CH4_54	JUNCTION	0.04	0.38	121.40	0	00:48	0.38
CH4_55	JUNCTION	0.04	0.41	120.94	0	00:48	0.41
CH4_56	JUNCTION	0.05	0.47	120.69	0	00:48	0.47
MH1	JUNCTION	0.03	0.33	184.06	0	00:38	0.33
MH2	JUNCTION	0.03	0.33	179.56	0	00:42	0.32
MH3	JUNCTION	0.03	0.27	170.59	0	00:35	0.27
MH3.1	JUNCTION	0.03	0.28	164.64	0	00:35	0.28
MH3.3	JUNCTION	0.03	0.33	181.04	0	00:46	0.33
MH4	JUNCTION	0.02	0.11	174.09	0	00:54	0.11
MH4.1	JUNCTION	0.02	0.13	162.96	0	00:54	0.13
CH15_1	JUNCTION	0.00	0.00	158.24	0	00:00	0.00
CH15_2	JUNCTION	0.00	0.00	155.91	0	00:00	0.00
CH15_3	JUNCTION	0.02	0.13	155.72	0	00:54	0.13
CH15_4	JUNCTION	0.01	0.09	155.57	0	00:54	0.09
MH5	JUNCTION	0.02	0.22	162.06	0	00:49	0.22
MH6	JUNCTION	0.03	0.09	161.06	0	01:11	0.09
MH7	JUNCTION	0.02	0.21	141.58	0	00:48	0.21
MH8	JUNCTION	0.02	0.22	135.34	0	00:45	0.22
MH9	JUNCTION	0.02	0.14	134.30	0	00:58	0.14
CH4_57	JUNCTION	0.05	0.47	120.48	0	00:48	0.47
CH4_58	JUNCTION	0.05	0.47	119.73	0	00:48	0.47
CH4_59	JUNCTION	0.05	0.47	119.49	0	00:48	0.47
CH4_60	JUNCTION	0.04	0.36	118.66	0	00:48	0.36
MH10	JUNCTION	0.02	0.10	138.14	0	00:56	0.10
MH3.2	JUNCTION	0.03	0.29	155.23	0	00:35	0.29
CH1_PRE	JUNCTION	0.03	0.15	176.44	0	02:05	0.15
CH2_PRE	JUNCTION	0.03	0.15	176.00	0	02:05	0.15
CH3_PRE	JUNCTION	0.02	0.10	171.88	0	02:05	0.10
CH4_PRE	JUNCTION	0.02	0.09	168.70	0	02:05	0.09
CH5_PRE	JUNCTION	0.02	0.10	167.00	0	02:05	0.10
CH6_PRE	JUNCTION	0.03	0.15	165.73	0	02:05	0.15

CH7_PRE	JUNCTION	0.03	0.15	165.54	0	02:05	0.15
CH8_PRE	JUNCTION	0.03	0.15	161.85	0	02:05	0.15
CH9_PRE	JUNCTION	0.03	0.15	161.60	0	02:05	0.15
CH10_PRE	JUNCTION	0.03	0.15	161.37	0	02:05	0.15
CH11_PRE	JUNCTION	0.01	0.08	158.53	0	02:05	0.08
CH13_PRE	JUNCTION	0.04	0.26	130.20	0	01:55	0.26
CH14_PRE	JUNCTION	0.04	0.26	129.67	0	01:55	0.26
CH15_PRE	JUNCTION	0.04	0.26	129.01	0	01:55	0.26
CH17_PRE	JUNCTION	0.01	0.04	173.50	0	01:45	0.04
CH18_PRE	JUNCTION	0.01	0.04	167.37	0	01:45	0.04
CH19_PRE	JUNCTION	0.01	0.06	162.46	0	01:45	0.06
CH20_PRE	JUNCTION	0.01	0.11	158.70	0	01:45	0.11
CH21_PRE	JUNCTION	0.01	0.11	157.38	0	01:45	0.11
CH22_PRE	JUNCTION	0.01	0.10	155.93	0	01:45	0.10
CH23_PRE	JUNCTION	0.01	0.11	153.79	0	01:45	0.11
CH24_PRE	JUNCTION	0.01	0.11	153.22	0	01:45	0.11
CH25_PRE	JUNCTION	0.01	0.10	151.31	0	01:40	0.10
CH26_PRE	JUNCTION	0.01	0.12	150.15	0	01:40	0.12
CH27_PRE	JUNCTION	0.02	0.15	149.01	0	01:40	0.15
CH28_PRE	JUNCTION	0.02	0.15	148.69	0	01:40	0.15
CH29_PRE	JUNCTION	0.02	0.13	143.96	0	01:45	0.13
CH30_PRE	JUNCTION	0.02	0.13	141.93	0	01:45	0.13
CH31_PRE	JUNCTION	0.02	0.19	139.09	0	01:45	0.19
CH32_PRE	JUNCTION	0.03	0.22	138.03	0	01:45	0.22
CH33_PRE	JUNCTION	0.03	0.22	137.06	0	01:45	0.22
CH34_PRE	JUNCTION	0.02	0.18	133.16	0	01:45	0.18
CH35_PRE	JUNCTION	0.03	0.25	129.79	0	01:45	0.25
CH36_PRE	JUNCTION	0.03	0.25	129.14	0	01:45	0.25
CH37_PRE	JUNCTION	0.03	0.28	127.29	0	01:45	0.28
CH38_PRE	JUNCTION	0.03	0.28	127.00	0	01:45	0.28
CH39_PRE	JUNCTION	0.03	0.28	126.25	0	01:45	0.28
CH40_PRE	JUNCTION	0.03	0.25	122.27	0	01:45	0.25
CH41_PRE	JUNCTION	0.03	0.25	120.96	0	01:45	0.25
CH42_PRE	JUNCTION	0.03	0.25	120.15	0	01:45	0.25
CH43_PRE	JUNCTION	0.03	0.25	119.16	0	01:45	0.25
MHOUTPRE0	OUTFALL	0.04	0.26	128.78	0	01:55	0.26
MHOUT0	OUTFALL	0.05	0.42	126.93	0	00:41	0.42
MHOUTPRE1	OUTFALL	0.02	0.20	117.69	0	01:45	0.20
MHOUT1	OUTFALL	0.04	0.36	118.05	0	00:48	0.36
POND1	STORAGE	0.03	0.91	187.85	0	00:38	0.91
POND2	STORAGE	0.04	0.91	183.14	0	00:42	0.90
MINING_PIT	STORAGE	0.47	3.19	132.34	0	01:16	3.19
POND3	STORAGE	0.04	0.89	185.22	0	00:46	0.89

POND4	STORAGE	0.09	0.93	184.81	0	00:54	0.93	
POND5	STORAGE	0.04	0.77	166.72	0	00:49	0.77	
POND6	STORAGE	0.16	0.90	171.06	0	01:11	0.90	
POND7	STORAGE	0.05	0.87	168.65	0	00:48	0.87	
POND8	STORAGE	0.04	0.94	147.27	0	00:45	0.94	
POND9	STORAGE	0.09	1.03	149.99	0	00:58	1.03	
POND10	STORAGE	0.10	0.98	171.30	0	00:56	0.98	

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min		Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent	
CH12_PRE	JUNCTION	2.296	2.296	0	01:50	21.7	21.7	0.000	
CH1_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_6	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_7	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_8	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_9	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_10	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_11	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_12	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_13	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_14	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_15	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_16	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_17	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_18	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_19	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_20	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_21	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH1_22	JUNCTION	0.000	3.639	0	00:41	0	22.5	0.000	
CH1_23	JUNCTION	0.000	3.639	0	00:41	0	22.5	0.000	

CH1_24	JUNCTION	0.000	3.639	0	00:41	0	22.5	0.000	
CH1_25	JUNCTION	0.000	3.639	0	00:41	0	22.5	0.000	
CH1_26	JUNCTION	0.000	3.639	0	00:41	0	22.5	0.000	
CH2_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_6	JUNCTION	0.000	2.849	0	00:40	0	9.32	0.000	
CH3_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_6	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_7	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_8	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_9	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_10	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_11	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_12	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_13	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_14	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_15	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_16	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_17	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_18	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_19	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_20	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_21	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_22	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH4_1	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_2	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_3	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_4	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_5	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_6	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_7	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_8	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_9	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_10	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_11	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
CH4_12	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	

CH4_13	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000
CH4_14	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000
CH4_15	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000
CH4_16	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_17	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_18	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_19	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_20	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_21	JUNCTION	0.000	1.480	0	00:47	0	7.05	0.000
CH4_22	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_23	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_24	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_25	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_26	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_27	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_28	JUNCTION	0.000	2.274	0	00:47	0	10.8	0.000
CH4_29	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_30	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_31	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_32	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_33	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_34	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_35	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_36	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_37	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_38	JUNCTION	0.000	2.459	0	00:48	0	14	0.000
CH4_39	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_40	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_41	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_42	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_43	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_44	JUNCTION	0.000	3.252	0	00:48	0	17.8	0.000
CH4_45	JUNCTION	0.000	4.046	0	00:47	0	21	0.000
CH4_46	JUNCTION	0.000	4.046	0	00:47	0	21	0.000
CH4_47	JUNCTION	0.000	4.046	0	00:47	0	21	0.000
CH4_48	JUNCTION	0.000	4.046	0	00:47	0	21	0.000
CH4_49	JUNCTION	0.000	4.046	0	00:47	0	21	0.000
CH4_50	JUNCTION	0.000	4.387	0	00:48	0	24	0.000
CH4_51	JUNCTION	0.000	4.387	0	00:48	0	24	0.000
CH4_52	JUNCTION	0.000	4.387	0	00:48	0	24	0.000
CH4_53	JUNCTION	0.000	4.387	0	00:48	0	24	0.000
CH4_54	JUNCTION	0.000	4.387	0	00:48	0	24	0.000
CH4_55	JUNCTION	0.000	4.387	0	00:48	0	24	0.000

CH4_56	JUNCTION	0.000	4.387	0	00:48	0	24	0.000	
MH1	JUNCTION	0.000	1.561	0	00:38	0	4.88	0.000	
MH2	JUNCTION	0.000	1.300	0	00:42	0	4.44	0.000	
MH3	JUNCTION	1.502	1.502	0	00:35	5.05	5.05	0.000	
MH3.1	JUNCTION	0.000	1.502	0	00:35	0	5.05	0.000	
MH3.3	JUNCTION	0.000	1.219	0	00:46	0	4.75	0.000	
MH4	JUNCTION	0.000	0.265	0	00:54	0	2.31	0.000	
MH4.1	JUNCTION	0.000	0.265	0	00:54	0	2.31	0.000	
CH15_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_3	JUNCTION	0.000	0.265	0	00:54	0	2.31	0.000	
CH15_4	JUNCTION	0.000	0.265	0	00:54	0	2.31	0.000	
MH5	JUNCTION	0.000	0.795	0	00:49	0	3.77	0.000	
MH6	JUNCTION	0.000	0.194	0	01:11	0	3.19	0.000	
MH7	JUNCTION	0.000	0.793	0	00:48	0	3.83	0.000	
MH8	JUNCTION	0.000	0.797	0	00:45	0	3.11	0.000	
MH9	JUNCTION	0.000	0.348	0	00:58	0	3.02	0.000	
CH4_57	JUNCTION	0.000	4.387	0	00:48	0	24	0.000	
CH4_58	JUNCTION	0.000	4.387	0	00:48	0	24	0.000	
CH4_59	JUNCTION	0.000	4.387	0	00:48	0	24	0.000	
CH4_60	JUNCTION	0.000	4.588	0	00:48	0	25.8	0.000	
MH10	JUNCTION	0.000	0.204	0	00:56	0	1.83	0.000	
MH3.2	JUNCTION	0.000	1.502	0	00:35	0	5.05	0.000	
CH1_PRE	JUNCTION	1.445	1.445	0	02:05	15.4	15.4	0.000	
CH2_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH3_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH4_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH5_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH6_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH7_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH8_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH9_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH10_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH11_PRE	JUNCTION	0.000	1.445	0	02:05	0	15.4	0.000	
CH13_PRE	JUNCTION	0.000	3.720	0	01:55	0	37.1	0.000	
CH14_PRE	JUNCTION	0.000	3.720	0	01:55	0	37.1	0.000	
CH15_PRE	JUNCTION	0.000	3.720	0	01:55	0	37.1	0.000	
CH17_PRE	JUNCTION	0.861	0.861	0	01:45	6.4	6.4	0.000	
CH18_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000	
CH19_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000	
CH20_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000	
CH21_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000	
CH22_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000	

CH23_PRE	JUNCTION	0.000	0.861	0	01:45	0	6.4	0.000
CH24_PRE	JUNCTION	0.548	1.399	0	01:40	3.29	9.69	0.000
CH25_PRE	JUNCTION	0.000	1.399	0	01:40	0	9.69	0.000
CH26_PRE	JUNCTION	0.000	1.399	0	01:40	0	9.69	0.000
CH27_PRE	JUNCTION	0.000	1.399	0	01:40	0	9.69	0.000
CH28_PRE	JUNCTION	0.618	2.012	0	01:45	5.25	14.9	0.000
CH29_PRE	JUNCTION	0.000	2.012	0	01:45	0	14.9	0.000
CH30_PRE	JUNCTION	0.000	2.012	0	01:45	0	14.9	0.000
CH31_PRE	JUNCTION	0.662	2.674	0	01:45	4.62	19.6	0.000
CH32_PRE	JUNCTION	0.000	2.674	0	01:45	0	19.6	0.000
CH33_PRE	JUNCTION	0.000	2.674	0	01:45	0	19.6	0.000
CH34_PRE	JUNCTION	0.811	3.483	0	01:45	5.38	24.9	0.000
CH35_PRE	JUNCTION	0.000	3.483	0	01:45	0	24.9	0.000
CH36_PRE	JUNCTION	0.629	4.112	0	01:45	4.42	29.4	0.000
CH37_PRE	JUNCTION	0.000	4.112	0	01:45	0	29.4	0.000
CH38_PRE	JUNCTION	0.000	4.112	0	01:45	0	29.4	0.000
CH39_PRE	JUNCTION	0.572	4.684	0	01:45	4.29	33.7	0.000
CH40_PRE	JUNCTION	0.000	4.684	0	01:45	0	33.7	0.000
CH41_PRE	JUNCTION	0.000	4.684	0	01:45	0	33.7	0.000
CH42_PRE	JUNCTION	0.000	4.684	0	01:45	0	33.7	0.000
CH43_PRE	JUNCTION	0.444	5.109	0	01:45	2.51	36.2	0.000
MHOUTPRE0	OUTFALL	0.000	3.720	0	01:55	0	37.1	0.000
MHOUT0	OUTFALL	0.000	3.639	0	00:41	0	22.5	0.000
MHOUTPRE1	OUTFALL	0.000	5.109	0	01:45	0	36.2	0.000
MHOUT1	OUTFALL	0.000	4.588	0	00:48	0	25.8	0.000
POND1	STORAGE	1.660	1.660	0	00:35	4.88	4.88	0.033
POND2	STORAGE	1.569	1.569	0	00:35	4.44	4.44	0.053
MINING_PIT	STORAGE	3.321	4.725	0	00:30	8.1	13.2	0.015
POND3	STORAGE	2.162	2.162	0	00:30	4.75	4.75	0.033
POND4	STORAGE	1.178	1.178	0	00:25	2.31	2.31	0.010
POND5	STORAGE	1.519	1.519	0	00:30	3.77	3.77	-0.000
POND6	STORAGE	1.457	1.457	0	00:30	3.19	3.19	-0.000
POND7	STORAGE	1.798	1.798	0	00:30	3.84	3.84	0.012
POND8	STORAGE	1.452	1.452	0	00:30	3.11	3.11	0.035
POND9	STORAGE	1.344	1.344	0	00:30	3.02	3.02	0.011
POND10	STORAGE	0.909	0.909	0	00:30	1.83	1.83	0.016

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Node Flooding Summary
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No nodes were flooded.

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Storage Volume Summary
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Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days	hr:min	Maximum Outflow CMS
POND1	0.008	1.5	0.0	0.0	0.275	50.2	0	00:38	1.561
POND2	0.022	1.9	0.0	0.0	0.619	52.5	0	00:42	1.300
MINING_PIT	0.903	5.7	0.0	0.0	7.632	48.5	0	01:16	0.882
POND3	0.053	1.6	0.0	0.0	1.558	47.4	0	00:46	1.219
POND4	0.111	3.6	0.0	0.0	1.507	48.8	0	00:54	0.265
POND5	0.053	1.6	0.0	0.0	1.279	38.9	0	00:49	0.795
POND6	0.312	6.6	0.0	0.0	2.289	48.3	0	01:11	0.194
POND7	0.065	1.7	0.0	0.0	1.627	44.0	0	00:48	0.793
POND8	0.035	1.2	0.0	0.0	1.063	38.4	0	00:45	0.797
POND9	0.123	3.2	0.0	0.0	1.710	44.0	0	00:58	0.348
POND10	0.103	4.9	0.0	0.0	1.194	56.7	0	00:56	0.204

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
MHOUTPRE0	70.95	0.607	3.720	37.106
MHOUT0	99.62	0.262	3.639	22.470
MHOUTPRE1	41.30	1.017	5.109	36.157
MHOUT1	99.63	0.301	4.588	25.807
System	77.87	2.187	12.490	121.540

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Link Flow Summary

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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
LCH1_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_7	CONDUIT	2.849	0	00:40	1.32	0.25	0.46
LCH1_8	CONDUIT	2.849	0	00:40	1.31	0.25	0.46
LCH1_9	CONDUIT	2.849	0	00:40	2.65	0.09	0.24
LCH1_10	CONDUIT	2.849	0	00:40	2.67	0.08	0.24
LCH1_11	CONDUIT	2.849	0	00:40	2.40	0.10	0.26
LCH1_12	CONDUIT	2.849	0	00:40	2.21	0.11	0.29
LCH1_13	CONDUIT	2.849	0	00:40	1.97	0.14	0.32
LCH1_14	CONDUIT	2.849	0	00:40	1.31	0.25	0.46
LCH1_15	CONDUIT	2.849	0	00:40	2.57	0.09	0.25
LCH1_16	CONDUIT	2.849	0	00:40	2.51	0.09	0.25
LCH1_17	CONDUIT	2.849	0	00:40	1.32	0.25	0.46
LCH1_18	CONDUIT	2.849	0	00:40	1.31	0.25	0.46
LCH1_19	CONDUIT	2.849	0	00:40	2.76	0.08	0.23
LCH1_20	CONDUIT	2.849	0	00:40	2.47	0.10	0.26
LCH1_21	CONDUIT	2.849	0	00:40	7.76	0.02	0.09
LCH1_22	CONDUIT	3.639	0	00:41	1.80	0.23	0.43
LCH1_23	CONDUIT	3.639	0	00:41	1.43	0.33	0.53
LCH1_24	CONDUIT	3.639	0	00:41	1.43	0.33	0.53
LCH1_25	CONDUIT	3.639	0	00:41	1.43	0.33	0.53
LCH1_26	CONDUIT	3.639	0	00:41	1.43	0.33	0.53
LCH2_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_6	CONDUIT	2.849	0	00:40	1.84	0.15	0.34
LCH3_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00

LCH3_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_7	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_8	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_9	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_10	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_11	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_12	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_13	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_14	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_15	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_16	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_17	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_18	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_19	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_20	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_21	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_22	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_1	CONDUIT	1.219	0	00:46	2.70	0.02	0.11
LCH4_2	CONDUIT	1.219	0	00:46	2.48	0.02	0.11
LCH4_3	CONDUIT	1.219	0	00:46	2.25	0.03	0.13
LCH4_4	CONDUIT	1.219	0	00:46	2.49	0.02	0.11
LCH4_5	CONDUIT	1.219	0	00:46	3.31	0.02	0.09
LCH4_6	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_7	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_8	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_9	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_10	CONDUIT	1.219	0	00:46	1.26	0.07	0.22
LCH4_11	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_12	CONDUIT	1.219	0	00:46	1.18	0.08	0.23
LCH4_13	CONDUIT	1.219	0	00:46	0.97	0.11	0.28
LCH4_14	CONDUIT	1.219	0	00:46	1.44	0.06	0.19
LCH4_15	CONDUIT	1.219	0	00:46	1.34	0.07	0.21
LCH4_16	CONDUIT	1.480	0	00:47	1.04	0.13	0.31
LCH4_17	CONDUIT	1.480	0	00:47	1.68	0.06	0.20
LCH4_18	CONDUIT	1.480	0	00:47	1.04	0.13	0.31
LCH4_19	CONDUIT	1.480	0	00:47	1.13	0.12	0.29
LCH4_20	CONDUIT	1.480	0	00:47	1.04	0.13	0.31
LCH4_21	CONDUIT	1.480	0	00:47	1.16	0.11	0.28
LCH4_22	CONDUIT	2.274	0	00:47	2.13	0.08	0.24
LCH4_23	CONDUIT	2.274	0	00:47	2.03	0.09	0.25
LCH4_24	CONDUIT	2.274	0	00:47	2.50	0.07	0.21
LCH4_25	CONDUIT	2.274	0	00:47	2.18	0.08	0.23
LCH4_26	CONDUIT	2.274	0	00:47	1.59	0.13	0.31

LCH4_27	CONDUIT	2.274	0	00:47	1.62	0.13	0.31
LCH4_28	CONDUIT	2.274	0	00:47	1.44	0.16	0.34
LCH4_29	CONDUIT	2.459	0	00:48	1.60	0.15	0.34
LCH4_30	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_31	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_32	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_33	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_34	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_35	CONDUIT	2.459	0	00:48	2.20	0.09	0.25
LCH4_36	CONDUIT	2.459	0	00:48	2.89	0.06	0.19
LCH4_37	CONDUIT	2.459	0	00:48	1.76	0.13	0.31
LCH4_38	CONDUIT	2.459	0	00:48	1.25	0.22	0.42
LCH4_39	CONDUIT	3.252	0	00:48	2.35	0.13	0.30
LCH4_40	CONDUIT	3.252	0	00:48	1.38	0.29	0.49
LCH4_42	CONDUIT	3.252	0	00:48	1.37	0.29	0.49
LCH4_43	CONDUIT	3.252	0	00:48	1.38	0.29	0.49
LCH4_44	CONDUIT	3.252	0	00:48	1.96	0.17	0.36
LCH4_45	CONDUIT	4.046	0	00:47	1.48	0.24	0.45
LCH4_46	CONDUIT	4.046	0	00:47	1.48	0.24	0.45
LCH4_47	CONDUIT	4.046	0	00:47	1.48	0.24	0.45
LCH4_48	CONDUIT	4.046	0	00:47	1.48	0.24	0.45
LCH4_49	CONDUIT	4.046	0	00:47	1.48	0.17	0.37
LCH4_50	CONDUIT	4.387	0	00:48	3.17	0.06	0.20
LCH4_51	CONDUIT	4.387	0	00:48	1.83	0.14	0.33
LCH4_52	CONDUIT	4.387	0	00:48	2.41	0.09	0.26
LCH4_53	CONDUIT	4.387	0	00:48	2.32	0.21	0.40
LCH4_54	CONDUIT	4.387	0	00:48	1.92	0.28	0.48
LCH4_55	CONDUIT	4.387	0	00:48	1.76	0.21	0.41
LCH4_56	CONDUIT	4.387	0	00:48	1.52	0.19	0.39
LCH3_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_41	CONDUIT	3.252	0	00:48	1.38	0.29	0.49
LMH1	CONDUIT	1.561	0	00:38	8.45	0.44	0.47
LMH2	CONDUIT	1.300	0	00:42	6.84	0.36	0.41
LMH3	CONDUIT	1.502	0	00:35	11.48	0.37	0.42
LMH3.1	CONDUIT	1.502	0	00:35	10.13	0.33	0.39
LMH3.3	CONDUIT	1.219	0	00:46	6.31	0.36	0.42
LMH4	CONDUIT	0.265	0	00:54	7.71	0.10	0.21
LCH15_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_3	CONDUIT	0.265	0	00:54	0.55	0.02	0.11
LCH15_4	CONDUIT	0.265	0	00:54	1.46	0.00	0.04
LMH4.1	CONDUIT	0.265	0	00:54	6.32	0.13	0.24
LMH5	CONDUIT	0.795	0	00:49	8.92	0.37	0.42

LMH6	CONDUIT	0.194	0	01:11	7.26	0.07	0.18
LMH7	CONDUIT	0.793	0	00:48	9.98	0.31	0.38
LMH8	CONDUIT	0.797	0	00:45	9.21	0.35	0.41
LMH9	CONDUIT	0.348	0	00:58	7.13	0.16	0.27
LCH4_57	CONDUIT	4.387	0	00:48	2.50	0.18	0.38
LCH4_58	CONDUIT	4.387	0	00:48	1.52	0.26	0.47
LCH4_59	CONDUIT	4.387	0	00:48	2.09	0.24	0.44
LCH4_60	CONDUIT	4.588	0	00:48	2.17	0.25	0.45
LMH10	CONDUIT	0.204	0	00:56	7.72	0.11	0.23
LMH3.2	CONDUIT	1.502	0	00:35	10.56	0.41	0.45
LCH1_PRE	CONDUIT	1.445	0	02:05	1.74	0.06	0.19
LCH2_PRE	CONDUIT	1.445	0	02:05	2.77	0.03	0.12
LMHOUTPRE3	CONDUIT	1.445	0	02:05	3.13	0.02	0.11
LMHOUTPRE4	CONDUIT	1.445	0	02:05	2.95	0.02	0.11
LMHOUTPRE5	CONDUIT	1.445	0	02:05	2.57	0.03	0.13
LMHOUTPRE6	CONDUIT	1.445	0	02:05	1.74	0.06	0.19
LMHOUTPRE7	CONDUIT	1.445	0	02:05	3.18	0.02	0.11
LMHOUTPRE8	CONDUIT	1.445	0	02:05	1.74	0.06	0.19
LMHOUTPRE9	CONDUIT	1.445	0	02:05	1.74	0.06	0.19
LMHOUTPRE10	CONDUIT	1.445	0	02:05	3.40	0.02	0.10
LMHOUTPRE11	CONDUIT	1.445	0	02:05	6.53	0.01	0.05
LMHOUTPRE12	CONDUIT	3.720	0	01:55	2.46	0.15	0.33
LMHOUTPRE13	CONDUIT	3.720	0	01:55	2.46	0.15	0.33
KOUTPRE1	CONDUIT	3.720	0	01:55	2.46	0.15	0.33
LMHOUTPRE16	CONDUIT	2.296	0	01:50	2.07	0.09	0.25
LCH17_PRE	CONDUIT	0.861	0	01:45	3.63	0.01	0.07
LCH18_PRE	CONDUIT	0.861	0	01:45	3.93	0.01	0.07
LCH19_PRE	CONDUIT	0.861	0	01:45	2.74	0.02	0.10
LCH20_PRE	CONDUIT	0.861	0	01:45	1.43	0.06	0.18
LCH21_PRE	CONDUIT	0.861	0	01:45	1.58	0.05	0.17
LCH22_PRE	CONDUIT	0.861	0	01:45	2.21	0.03	0.12
LCH23_PRE	CONDUIT	0.861	0	01:45	1.43	0.06	0.18
LCH24_PRE	CONDUIT	1.399	0	01:40	2.56	0.05	0.17
LCH25_PRE	CONDUIT	1.399	0	01:40	2.53	0.05	0.17
LCH26_PRE	CONDUIT	1.399	0	01:40	2.10	0.07	0.20
LCH27_PRE	CONDUIT	1.399	0	01:40	1.72	0.09	0.25
LCH28_PRE	CONDUIT	2.012	0	01:45	3.48	0.05	0.18
LCH29_PRE	CONDUIT	2.012	0	01:45	2.91	0.07	0.21
LCH30_PRE	CONDUIT	2.012	0	01:45	2.82	0.07	0.22
LCH31_PRE	CONDUIT	2.674	0	01:45	2.53	0.14	0.32
LCH32_PRE	CONDUIT	2.674	0	01:45	2.19	0.17	0.36
LCH33_PRE	CONDUIT	2.674	0	01:45	3.73	0.07	0.22
LCH34_PRE	CONDUIT	3.483	0	01:45	3.50	0.13	0.30

LCH35_PRE	CONDUIT	3.483	0	01:45	2.40	0.23	0.42
LCH36_PRE	CONDUIT	4.112	0	01:45	3.65	0.15	0.33
LCH37_PRE	CONDUIT	4.112	0	01:45	2.55	0.27	0.47
LCH38_PRE	CONDUIT	4.112	0	01:45	2.55	0.27	0.47
LCH39_PRE	CONDUIT	4.684	0	01:45	4.66	0.13	0.30
LCH40_PRE	CONDUIT	4.684	0	01:45	3.26	0.22	0.42
LCH41_PRE	CONDUIT	4.684	0	01:45	3.39	0.21	0.40
LCH42_PRE	CONDUIT	4.684	0	01:45	3.29	0.22	0.42
KOUTPRE0	CONDUIT	5.109	0	01:45	4.68	0.15	0.33
10yr1	ORIFICE	1.561	0	00:38			0.00
50yr1	ORIFICE	0.000	0	00:00			0.00
10yr2	ORIFICE	1.300	0	00:42			0.00
50yr2	ORIFICE	0.000	0	00:00			0.00
10yrMP	ORIFICE	0.882	0	01:16			0.00
50yrMP	ORIFICE	0.000	0	00:00			0.00
10yr3	ORIFICE	1.219	0	00:46			0.00
50yr3	ORIFICE	0.000	0	00:00			0.00
10yr4	ORIFICE	0.265	0	00:54			0.00
50yr4	ORIFICE	0.000	0	00:00			0.00
10yr5	ORIFICE	0.795	0	00:49			0.00
50yr5	ORIFICE	0.000	0	00:00			0.00
10yr6	ORIFICE	0.194	0	01:11			0.00
50yr6	ORIFICE	0.000	0	00:00			0.00
10yr7	ORIFICE	0.793	0	00:48			0.00
50yr7	ORIFICE	0.000	0	00:00			0.00
10yr8	ORIFICE	0.797	0	00:45			0.00
50yr8	ORIFICE	0.000	0	00:00			0.00
10yr9	ORIFICE	0.348	0	00:58			0.00
50yr9	ORIFICE	0.000	0	00:00			0.00
10yr10	ORIFICE	0.204	0	00:56			0.00
50yr10	ORIFICE	0.000	0	00:00			0.00
100yrWeir1	WEIR	0.000	0	00:00			0.00
100yrWeir2	WEIR	0.000	0	00:00			0.00
100yrWeir3	WEIR	0.000	0	00:00			0.00
100yrWeir4	WEIR	0.000	0	00:00			0.00
100yrWeir5	WEIR	0.000	0	00:00			0.00
100yrWeir6	WEIR	0.000	0	00:00			0.00
100yrWeir7	WEIR	0.000	0	00:00			0.00
100yrWeir8	WEIR	0.000	0	00:00			0.00
100yrWeir9	WEIR	0.000	0	00:00			0.00
100yrWeir10	WEIR	0.000	0	00:00			0.00
100yrWeirMP	WEIR	0.000	0	00:00			0.00

```
************************
Conduit Surcharge Summary
************************

No conduits were surcharged.


Analysis begun on:  Mon Jul 27 09:08:16 2026
Analysis ended on:  Mon Jul 27 09:08:18 2026
Total elapsed time: 00:00:02
```

ANNEXURE G2: RUNOFF DETERMINATION CALCULATIONS 1:50-YEAR

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)
--------------------------------------------------------------


****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Flow Routing Method ...... STEADY
Starting Date ............ 01/01/2010 00:00:00
Ending Date .............. 01/01/2010 23:55:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        32.349        54.234
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         9.049        15.171
Surface Runoff ...........        23.178        38.860
Final Storage ............         0.189         0.317
Continuity Error (%) .....        -0.209


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
```

Wet Weather Inflow	23.178	231.787
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	23.175	231.751
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.007
Continuity Error (%)	0.013	

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	5.00 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
% of Time in Steady State	:	0.00
Average Iterations per Step	:	1.00
% of Steps Not Converging	:	0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
C_POST1	37.65	0.00	0.00	11.25	17.56	8.45	26.01	9.14	3.06	0.691
C_POST2	37.65	0.00	0.00	10.67	17.87	8.70	26.58	8.27	2.91	0.706
C_POST3	37.65	0.00	0.00	12.36	17.47	7.49	24.96	9.45	2.80	0.663
C_POST4	37.65	0.00	0.00	12.05	16.34	9.09	25.42	7.95	2.70	0.675

C_POST5	37.65	0.00	0.00	6.88	20.00	10.65	30.65	6.90	3.44	0.814
C_POST6	37.65	0.00	0.00	5.07	24.90	7.17	32.07	8.12	3.84	0.852
C_POST7	37.65	0.00	0.00	4.65	24.94	7.87	32.80	3.91	2.10	0.871
C_POST8	37.65	0.00	0.00	7.31	21.93	8.12	30.04	6.64	2.76	0.798
C_POST9	37.65	0.00	0.00	6.20	22.77	8.45	31.21	5.54	2.57	0.829
C_POST10	37.65	0.00	0.00	5.17	24.64	7.60	32.24	6.54	3.16	0.856
C_POST11	37.65	0.00	0.00	5.96	22.97	8.51	31.47	5.38	2.58	0.836
C_POST12	37.65	0.00	0.00	6.45	22.57	8.38	30.94	5.27	2.38	0.822
C_POST13	37.65	0.00	0.00	3.21	28.55	5.61	34.16	3.03	1.60	0.907
C_PRE1	72.33	0.00	0.00	24.77	7.09	40.34	47.43	16.67	1.61	0.656
C_PRE2	72.33	0.00	0.00	24.30	7.09	40.81	47.90	14.90	1.49	0.662
C_PRE3	72.33	0.00	0.00	26.73	7.09	38.37	45.46	17.20	1.47	0.629
C_PRE4	72.33	0.00	0.00	25.72	7.09	39.38	46.48	14.54	1.32	0.643
C_PRE5	72.33	0.00	0.00	17.14	7.10	48.00	55.10	12.40	2.03	0.762
C_PRE6	69.12	0.00	0.00	19.74	6.78	42.50	49.28	12.48	1.76	0.713
C_PRE7	69.12	0.00	0.00	17.07	6.78	45.19	51.97	6.19	1.07	0.752
C_PRE8	69.12	0.00	0.00	21.54	6.78	40.69	47.47	10.49	1.30	0.687
C_PRE9	69.13	0.00	0.00	18.90	6.78	43.35	50.12	8.90	1.34	0.725
C_PRE10	69.12	0.00	0.00	18.29	6.78	43.96	50.74	10.29	1.62	0.734
C_PRE11	69.12	0.00	0.00	19.01	6.78	43.24	50.01	8.54	1.27	0.724
C_PRE12	69.13	0.00	0.00	19.84	6.78	42.40	49.18	8.37	1.17	0.711
C_PRE13	69.13	0.00	0.00	16.35	6.78	45.91	52.70	4.67	0.85	0.762

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days	hr:min	Reported Max Depth Meters
CH12_PRE	JUNCTION	0.05	0.30	130.91	0	01:45	0.30
CH1_1	JUNCTION	0.00	0.00	192.52	0	00:00	0.00
CH1_2	JUNCTION	0.00	0.00	189.28	0	00:00	0.00
CH1_3	JUNCTION	0.00	0.00	186.99	0	00:00	0.00
CH1_4	JUNCTION	0.00	0.00	185.99	0	00:00	0.00
CH1_5	JUNCTION	0.00	0.00	182.42	0	00:00	0.00
CH1_6	JUNCTION	0.00	0.00	177.55	0	00:00	0.00
CH1_7	JUNCTION	0.04	0.55	176.67	0	00:35	0.55
CH1_8	JUNCTION	0.04	0.55	176.36	0	00:35	0.55
CH1_9	JUNCTION	0.04	0.55	175.91	0	00:35	0.55

CH1_10	JUNCTION	0.02	0.29	169.50	0	00:35	0.29
CH1_11	JUNCTION	0.02	0.32	168.41	0	00:35	0.32
CH1_12	JUNCTION	0.02	0.34	167.50	0	00:35	0.34
CH1_13	JUNCTION	0.03	0.38	166.55	0	00:35	0.38
CH1_14	JUNCTION	0.04	0.55	165.88	0	00:35	0.55
CH1_15	JUNCTION	0.04	0.55	165.70	0	00:35	0.55
CH1_16	JUNCTION	0.02	0.31	163.61	0	00:35	0.31
CH1_17	JUNCTION	0.04	0.55	162.47	0	00:35	0.55
CH1_18	JUNCTION	0.04	0.55	162.20	0	00:35	0.55
CH1_19	JUNCTION	0.04	0.55	161.94	0	00:35	0.55
CH1_20	JUNCTION	0.02	0.31	160.51	0	00:35	0.31
CH1_21	JUNCTION	0.02	0.31	158.63	0	00:35	0.31
CH1_22	JUNCTION	0.06	0.49	128.92	0	00:36	0.49
CH1_23	JUNCTION	0.08	0.60	128.41	0	00:36	0.60
CH1_24	JUNCTION	0.08	0.60	127.98	0	00:36	0.60
CH1_25	JUNCTION	0.08	0.60	127.70	0	00:36	0.60
CH1_26	JUNCTION	0.08	0.60	127.38	0	00:36	0.60
CH2_1	JUNCTION	0.00	0.00	182.61	0	00:00	0.00
CH2_2	JUNCTION	0.00	0.00	181.32	0	00:00	0.00
CH2_3	JUNCTION	0.00	0.00	180.70	0	00:00	0.00
CH2_4	JUNCTION	0.00	0.00	177.64	0	00:00	0.00
CH2_5	JUNCTION	0.00	0.00	176.79	0	00:00	0.00
CH2_6	JUNCTION	0.04	0.51	177.01	0	00:34	0.51
CH3_1	JUNCTION	0.00	0.00	197.04	0	00:00	0.00
CH3_2	JUNCTION	0.00	0.00	194.58	0	00:00	0.00
CH3_3	JUNCTION	0.00	0.00	189.61	0	00:00	0.00
CH3_4	JUNCTION	0.00	0.00	187.06	0	00:00	0.00
CH3_5	JUNCTION	0.00	0.00	182.43	0	00:00	0.00
CH3_6	JUNCTION	0.00	0.00	179.03	0	00:00	0.00
CH3_7	JUNCTION	0.00	0.00	172.87	0	00:00	0.00
CH3_8	JUNCTION	0.00	0.00	172.67	0	00:00	0.00
CH3_9	JUNCTION	0.00	0.00	172.17	0	00:00	0.00
CH3_10	JUNCTION	0.00	0.00	170.17	0	00:00	0.00
CH3_11	JUNCTION	0.00	0.00	170.09	0	00:00	0.00
CH3_12	JUNCTION	0.00	0.00	168.75	0	00:00	0.00
CH3_13	JUNCTION	0.00	0.00	167.76	0	00:00	0.00
CH3_14	JUNCTION	0.00	0.00	167.27	0	00:00	0.00
CH3_15	JUNCTION	0.00	0.00	166.71	0	00:00	0.00
CH3_16	JUNCTION	0.00	0.00	164.44	0	00:00	0.00
CH3_17	JUNCTION	0.00	0.00	164.03	0	00:00	0.00
CH3_18	JUNCTION	0.00	0.00	162.48	0	00:00	0.00
CH3_19	JUNCTION	0.00	0.00	162.35	0	00:00	0.00
CH3_20	JUNCTION	0.00	0.00	161.90	0	00:00	0.00

CH3_21	JUNCTION	0.00	0.00	160.59	0	00:00	0.00
CH3_22	JUNCTION	0.00	0.00	158.86	0	00:00	0.00
CH4_1	JUNCTION	0.03	0.52	178.91	0	00:42	0.51
CH4_2	JUNCTION	0.01	0.14	174.74	0	00:42	0.14
CH4_3	JUNCTION	0.01	0.16	170.81	0	00:42	0.16
CH4_4	JUNCTION	0.01	0.16	167.94	0	00:42	0.16
CH4_5	JUNCTION	0.01	0.14	164.61	0	00:42	0.14
CH4_6	JUNCTION	0.02	0.34	158.56	0	00:42	0.34
CH4_7	JUNCTION	0.02	0.34	158.09	0	00:42	0.34
CH4_8	JUNCTION	0.02	0.34	157.78	0	00:42	0.34
CH4_9	JUNCTION	0.02	0.34	157.34	0	00:42	0.34
CH4_10	JUNCTION	0.02	0.34	156.73	0	00:42	0.34
CH4_11	JUNCTION	0.02	0.34	155.52	0	00:42	0.34
CH4_12	JUNCTION	0.02	0.34	155.06	0	00:42	0.34
CH4_13	JUNCTION	0.02	0.34	154.21	0	00:42	0.34
CH4_14	JUNCTION	0.02	0.34	153.84	0	00:42	0.34
CH4_15	JUNCTION	0.01	0.26	152.58	0	00:42	0.25
CH4_16	JUNCTION	0.03	0.38	152.03	0	00:44	0.38
CH4_17	JUNCTION	0.03	0.38	151.76	0	00:44	0.38
CH4_18	JUNCTION	0.03	0.38	150.81	0	00:44	0.38
CH4_19	JUNCTION	0.03	0.38	150.60	0	00:44	0.38
CH4_20	JUNCTION	0.03	0.38	150.03	0	00:44	0.38
CH4_21	JUNCTION	0.03	0.38	149.68	0	00:44	0.38
CH4_22	JUNCTION	0.03	0.35	149.36	0	00:44	0.35
CH4_23	JUNCTION	0.02	0.29	147.60	0	00:45	0.29
CH4_24	JUNCTION	0.02	0.29	146.24	0	00:45	0.29
CH4_25	JUNCTION	0.02	0.27	143.18	0	00:45	0.27
CH4_26	JUNCTION	0.03	0.36	141.24	0	00:45	0.36
CH4_27	JUNCTION	0.03	0.36	140.30	0	00:45	0.36
CH4_28	JUNCTION	0.03	0.39	139.48	0	00:45	0.39
CH4_29	JUNCTION	0.05	0.39	138.96	0	00:45	0.39
CH4_30	JUNCTION	0.05	0.48	138.39	0	00:46	0.48
CH4_31	JUNCTION	0.05	0.48	138.14	0	00:46	0.48
CH4_32	JUNCTION	0.05	0.48	137.98	0	00:46	0.48
CH4_33	JUNCTION	0.05	0.48	137.69	0	00:46	0.48
CH4_34	JUNCTION	0.05	0.48	137.46	0	00:46	0.48
CH4_35	JUNCTION	0.05	0.48	137.09	0	00:46	0.48
CH4_36	JUNCTION	0.03	0.29	135.48	0	00:46	0.29
CH4_37	JUNCTION	0.04	0.35	132.01	0	00:46	0.35
CH4_38	JUNCTION	0.05	0.48	131.42	0	00:46	0.48
CH4_39	JUNCTION	0.05	0.48	131.22	0	00:46	0.48
CH4_40	JUNCTION	0.06	0.56	130.17	0	00:46	0.56
CH4_41	JUNCTION	0.06	0.56	129.87	0	00:46	0.56

CH4_42	JUNCTION	0.06	0.56	129.68	0	00:46	0.56
CH4_43	JUNCTION	0.06	0.56	129.39	0	00:46	0.56
CH4_44	JUNCTION	0.06	0.56	128.98	0	00:46	0.56
CH4_45	JUNCTION	0.06	0.63	128.34	0	00:46	0.63
CH4_46	JUNCTION	0.06	0.63	128.03	0	00:46	0.63
CH4_47	JUNCTION	0.06	0.63	127.81	0	00:46	0.63
CH4_48	JUNCTION	0.06	0.63	127.52	0	00:46	0.63
CH4_49	JUNCTION	0.06	0.63	127.39	0	00:46	0.63
CH4_50	JUNCTION	0.06	0.63	126.67	0	00:46	0.63
CH4_51	JUNCTION	0.06	0.56	123.89	0	00:47	0.56
CH4_52	JUNCTION	0.06	0.56	123.43	0	00:47	0.56
CH4_53	JUNCTION	0.05	0.45	122.45	0	00:47	0.45
CH4_54	JUNCTION	0.06	0.54	121.55	0	00:47	0.53
CH4_55	JUNCTION	0.06	0.58	121.10	0	00:47	0.57
CH4_56	JUNCTION	0.07	0.66	120.88	0	00:47	0.65
MH1	JUNCTION	0.04	0.51	184.23	0	00:34	0.51
MH2	JUNCTION	0.04	0.51	179.74	0	00:36	0.51
MH3	JUNCTION	0.04	0.39	170.71	0	00:35	0.39
MH3.1	JUNCTION	0.04	0.41	164.76	0	00:35	0.41
MH3.3	JUNCTION	0.03	0.52	181.23	0	00:42	0.51
MH4	JUNCTION	0.02	0.16	174.14	0	00:50	0.16
MH4.1	JUNCTION	0.03	0.19	163.03	0	00:50	0.19
CH15_1	JUNCTION	0.00	0.00	158.24	0	00:00	0.00
CH15_2	JUNCTION	0.00	0.00	155.91	0	00:00	0.00
CH15_3	JUNCTION	0.03	0.19	155.78	0	00:50	0.19
CH15_4	JUNCTION	0.02	0.14	155.62	0	00:50	0.14
MH5	JUNCTION	0.03	0.29	162.12	0	00:50	0.29
MH6	JUNCTION	0.04	0.14	161.11	0	01:03	0.14
MH7	JUNCTION	0.02	0.30	141.67	0	00:46	0.30
MH8	JUNCTION	0.02	0.29	135.41	0	00:46	0.29
MH9	JUNCTION	0.03	0.20	134.35	0	00:55	0.20
CH4_57	JUNCTION	0.07	0.66	120.67	0	00:47	0.65
CH4_58	JUNCTION	0.07	0.66	119.92	0	00:47	0.65
CH4_59	JUNCTION	0.07	0.66	119.67	0	00:47	0.65
CH4_60	JUNCTION	0.05	0.51	118.82	0	00:47	0.51
MH10	JUNCTION	0.02	0.18	138.22	0	00:47	0.18
MH3.2	JUNCTION	0.04	0.43	155.37	0	00:35	0.43
CH1_PRE	JUNCTION	0.04	0.24	176.53	0	02:00	0.24
CH2_PRE	JUNCTION	0.04	0.24	176.09	0	02:00	0.24
CH3_PRE	JUNCTION	0.03	0.15	171.93	0	02:00	0.15
CH4_PRE	JUNCTION	0.02	0.14	168.75	0	02:00	0.14
CH5_PRE	JUNCTION	0.03	0.16	167.06	0	02:00	0.16
CH6_PRE	JUNCTION	0.04	0.24	165.82	0	02:00	0.24

CH7_PRE	JUNCTION	0.04	0.24	165.62	0	02:00	0.24
CH8_PRE	JUNCTION	0.04	0.24	161.93	0	02:00	0.24
CH9_PRE	JUNCTION	0.04	0.24	161.69	0	02:00	0.24
CH10_PRE	JUNCTION	0.04	0.24	161.46	0	02:00	0.24
CH11_PRE	JUNCTION	0.02	0.13	158.58	0	02:00	0.13
CH13_PRE	JUNCTION	0.07	0.40	130.34	0	01:50	0.40
CH14_PRE	JUNCTION	0.07	0.40	129.81	0	01:50	0.40
CH15_PRE	JUNCTION	0.07	0.40	129.15	0	01:50	0.40
CH17_PRE	JUNCTION	0.01	0.07	173.53	0	01:40	0.07
CH18_PRE	JUNCTION	0.01	0.07	167.39	0	01:40	0.07
CH19_PRE	JUNCTION	0.01	0.09	162.49	0	01:40	0.09
CH20_PRE	JUNCTION	0.02	0.17	158.76	0	01:40	0.17
CH21_PRE	JUNCTION	0.02	0.17	157.44	0	01:40	0.17
CH22_PRE	JUNCTION	0.02	0.15	155.98	0	01:40	0.15
CH23_PRE	JUNCTION	0.02	0.17	153.85	0	01:40	0.17
CH24_PRE	JUNCTION	0.02	0.17	153.28	0	01:40	0.17
CH25_PRE	JUNCTION	0.02	0.16	151.36	0	01:35	0.16
CH26_PRE	JUNCTION	0.02	0.18	150.21	0	01:35	0.18
CH27_PRE	JUNCTION	0.02	0.22	149.08	0	01:35	0.22
CH28_PRE	JUNCTION	0.02	0.22	148.77	0	01:35	0.22
CH29_PRE	JUNCTION	0.02	0.19	144.03	0	01:35	0.19
CH30_PRE	JUNCTION	0.02	0.20	142.00	0	01:35	0.20
CH31_PRE	JUNCTION	0.03	0.29	139.19	0	01:35	0.29
CH32_PRE	JUNCTION	0.04	0.33	138.14	0	01:35	0.33
CH33_PRE	JUNCTION	0.04	0.33	137.17	0	01:35	0.33
CH34_PRE	JUNCTION	0.03	0.27	133.25	0	01:35	0.27
CH35_PRE	JUNCTION	0.04	0.38	129.92	0	01:35	0.38
CH36_PRE	JUNCTION	0.04	0.38	129.27	0	01:35	0.38
CH37_PRE	JUNCTION	0.05	0.42	127.43	0	01:35	0.42
CH38_PRE	JUNCTION	0.05	0.42	127.14	0	01:35	0.42
CH39_PRE	JUNCTION	0.05	0.42	126.39	0	01:35	0.42
CH40_PRE	JUNCTION	0.04	0.38	122.40	0	01:35	0.38
CH41_PRE	JUNCTION	0.04	0.38	121.09	0	01:35	0.38
CH42_PRE	JUNCTION	0.04	0.38	120.28	0	01:35	0.38
CH43_PRE	JUNCTION	0.04	0.38	119.28	0	01:35	0.38
MHOUTPRE0	OUTFALL	0.07	0.40	128.92	0	01:50	0.40
MHOUT0	OUTFALL	0.08	0.60	127.11	0	00:36	0.60
MHOUTPRE1	OUTFALL	0.03	0.30	117.79	0	01:35	0.29
MHOUT1	OUTFALL	0.05	0.51	118.20	0	00:47	0.51
POND1	STORAGE	0.06	1.33	188.27	0	00:34	1.33
POND2	STORAGE	0.06	1.34	183.57	0	00:36	1.33
MINING_PIT	STORAGE	0.82	4.48	133.63	0	00:59	4.48
POND3	STORAGE	0.06	1.36	185.69	0	00:42	1.35

POND4	STORAGE	0.15	1.35	185.24	0	00:50	1.35	
POND5	STORAGE	0.08	1.33	167.27	0	00:50	1.33	
POND6	STORAGE	0.27	1.34	171.50	0	01:03	1.34	
POND7	STORAGE	0.08	1.36	169.14	0	00:46	1.35	
POND8	STORAGE	0.08	1.59	147.91	0	00:46	1.59	
POND9	STORAGE	0.17	1.59	150.54	0	00:55	1.59	
POND10	STORAGE	0.13	1.37	171.68	0	00:47	1.36	

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent	
CH12_PRE	JUNCTION	4.629	4.629	0	01:45	44.1	44.1	0.000	
CH1_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_6	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH1_7	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_8	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_9	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_10	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_11	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_12	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_13	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_14	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_15	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_16	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_17	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_18	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_19	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_20	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_21	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH1_22	JUNCTION	0.000	6.656	0	00:36	0	41.7	0.000	
CH1_23	JUNCTION	0.000	6.656	0	00:36	0	41.7	0.000	

CH1_24	JUNCTION	0.000	6.656	0	00:36	0	41.7	0.000	
CH1_25	JUNCTION	0.000	6.656	0	00:36	0	41.7	0.000	
CH1_26	JUNCTION	0.000	6.656	0	00:36	0	41.7	0.000	
CH2_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH2_6	JUNCTION	0.000	5.745	0	00:35	0	17.4	0.000	
CH3_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_6	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_7	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_8	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_9	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_10	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_11	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_12	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_13	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_14	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_15	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_16	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_17	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_18	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_19	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_20	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_21	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH3_22	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH4_1	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_2	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_3	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_4	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_5	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_6	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_7	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_8	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_9	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_10	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_11	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
CH4_12	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	

CH4_13	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000
CH4_14	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000
CH4_15	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000
CH4_16	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_17	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_18	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_19	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_20	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_21	JUNCTION	0.000	3.061	0	00:44	0	12	0.000
CH4_22	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_23	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_24	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_25	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_26	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_27	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_28	JUNCTION	0.000	4.237	0	00:45	0	18.7	0.000
CH4_29	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_30	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_31	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_32	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_33	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_34	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_35	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_36	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_37	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_38	JUNCTION	0.000	4.518	0	00:46	0	24.2	0.000
CH4_39	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_40	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_41	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_42	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_43	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_44	JUNCTION	0.000	6.024	0	00:46	0	30.7	0.000
CH4_45	JUNCTION	0.000	7.314	0	00:46	0	36.1	0.000
CH4_46	JUNCTION	0.000	7.314	0	00:46	0	36.1	0.000
CH4_47	JUNCTION	0.000	7.314	0	00:46	0	36.1	0.000
CH4_48	JUNCTION	0.000	7.314	0	00:46	0	36.1	0.000
CH4_49	JUNCTION	0.000	7.314	0	00:46	0	36.1	0.000
CH4_50	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000
CH4_51	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000
CH4_52	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000
CH4_53	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000
CH4_54	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000
CH4_55	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000

CH4_56	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000	
MH1	JUNCTION	0.000	3.021	0	00:34	0	9.13	0.000	
MH2	JUNCTION	0.000	2.735	0	00:36	0	8.26	0.000	
MH3	JUNCTION	2.805	2.805	0	00:35	9.45	9.45	0.000	
MH3.1	JUNCTION	0.000	2.805	0	00:35	0	9.45	0.000	
MH3.3	JUNCTION	0.000	2.566	0	00:42	0	8.12	0.000	
MH4	JUNCTION	0.000	0.560	0	00:50	0	3.91	0.000	
MH4.1	JUNCTION	0.000	0.560	0	00:50	0	3.91	0.000	
CH15_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_3	JUNCTION	0.000	0.560	0	00:50	0	3.91	0.000	
CH15_4	JUNCTION	0.000	0.560	0	00:50	0	3.91	0.000	
MH5	JUNCTION	0.000	1.237	0	00:50	0	6.63	0.000	
MH6	JUNCTION	0.000	0.426	0	01:03	0	5.54	0.000	
MH7	JUNCTION	0.000	1.507	0	00:46	0	6.54	0.000	
MH8	JUNCTION	0.000	1.291	0	00:46	0	5.37	0.000	
MH9	JUNCTION	0.000	0.657	0	00:55	0	5.27	0.000	
CH4_57	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000	
CH4_58	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000	
CH4_59	JUNCTION	0.000	7.870	0	00:47	0	41.4	0.000	
CH4_60	JUNCTION	0.000	8.524	0	00:47	0	44.4	0.000	
MH10	JUNCTION	0.000	0.655	0	00:47	0	3.03	0.000	
MH3.2	JUNCTION	0.000	2.805	0	00:35	0	9.45	0.000	
CH1_PRE	JUNCTION	3.098	3.098	0	02:00	31.6	31.6	0.000	
CH2_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH3_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH4_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH5_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH6_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH7_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH8_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH9_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH10_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH11_PRE	JUNCTION	0.000	3.098	0	02:00	0	31.6	0.000	
CH13_PRE	JUNCTION	0.000	7.676	0	01:50	0	75.7	0.000	
CH14_PRE	JUNCTION	0.000	7.676	0	01:50	0	75.7	0.000	
CH15_PRE	JUNCTION	0.000	7.676	0	01:50	0	75.7	0.000	
CH17_PRE	JUNCTION	1.760	1.760	0	01:40	12.5	12.5	0.000	
CH18_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000	
CH19_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000	
CH20_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000	
CH21_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000	
CH22_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000	

CH23_PRE	JUNCTION	0.000	1.760	0	01:40	0	12.5	0.000
CH24_PRE	JUNCTION	1.065	2.803	0	01:35	6.19	18.7	0.000
CH25_PRE	JUNCTION	0.000	2.803	0	01:35	0	18.7	0.000
CH26_PRE	JUNCTION	0.000	2.803	0	01:35	0	18.7	0.000
CH27_PRE	JUNCTION	0.000	2.803	0	01:35	0	18.7	0.000
CH28_PRE	JUNCTION	1.297	4.074	0	01:35	10.5	29.2	0.000
CH29_PRE	JUNCTION	0.000	4.074	0	01:35	0	29.2	0.000
CH30_PRE	JUNCTION	0.000	4.074	0	01:35	0	29.2	0.000
CH31_PRE	JUNCTION	1.335	5.410	0	01:35	8.9	38.1	0.000
CH32_PRE	JUNCTION	0.000	5.410	0	01:35	0	38.1	0.000
CH33_PRE	JUNCTION	0.000	5.410	0	01:35	0	38.1	0.000
CH34_PRE	JUNCTION	1.615	7.025	0	01:35	10.3	48.4	0.000
CH35_PRE	JUNCTION	0.000	7.025	0	01:35	0	48.4	0.000
CH36_PRE	JUNCTION	1.271	8.296	0	01:35	8.54	56.9	0.000
CH37_PRE	JUNCTION	0.000	8.296	0	01:35	0	56.9	0.000
CH38_PRE	JUNCTION	0.000	8.296	0	01:35	0	56.9	0.000
CH39_PRE	JUNCTION	1.172	9.463	0	01:35	8.37	65.3	0.000
CH40_PRE	JUNCTION	0.000	9.463	0	01:35	0	65.3	0.000
CH41_PRE	JUNCTION	0.000	9.463	0	01:35	0	65.3	0.000
CH42_PRE	JUNCTION	0.000	9.463	0	01:35	0	65.3	0.000
CH43_PRE	JUNCTION	0.851	10.281	0	01:35	4.67	69.9	0.000
MHOUTPRE0	OUTFALL	0.000	7.676	0	01:50	0	75.7	0.000
MHOUT0	OUTFALL	0.000	6.656	0	00:36	0	41.7	0.000
MHOUTPRE1	OUTFALL	0.000	10.281	0	01:35	0	69.9	0.000
MHOUT1	OUTFALL	0.000	8.524	0	00:47	0	44.4	0.000
POND1	STORAGE	3.058	3.058	0	00:30	9.14	9.14	0.052
POND2	STORAGE	2.909	2.909	0	00:30	8.27	8.27	0.068
MINING_PIT	STORAGE	5.977	8.695	0	00:30	14.9	24.3	0.021
POND3	STORAGE	3.840	3.840	0	00:30	8.12	8.12	0.058
POND4	STORAGE	2.099	2.099	0	00:25	3.91	3.91	0.018
POND5	STORAGE	2.755	2.755	0	00:30	6.64	6.64	0.030
POND6	STORAGE	2.566	2.566	0	00:30	5.54	5.54	0.007
POND7	STORAGE	3.164	3.164	0	00:25	6.54	6.54	0.032
POND8	STORAGE	2.576	2.576	0	00:25	5.38	5.38	0.044
POND9	STORAGE	2.382	2.382	0	00:30	5.27	5.27	0.017
POND10	STORAGE	1.601	1.601	0	00:25	3.03	3.03	0.028

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Node Flooding Summary
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No nodes were flooded.

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Storage Volume Summary
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Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days	hr:min	Maximum Outflow CMS
POND1	0.016	2.9	0.0	0.0	0.459	84.0	0	00:34	3.021
POND2	0.040	3.4	0.0	0.0	1.012	85.8	0	00:36	2.735
MINING_PIT	1.953	12.4	0.0	0.0	13.218	84.0	0	00:59	2.750
POND3	0.106	3.2	0.0	0.0	2.862	87.1	0	00:42	2.566
POND4	0.221	7.1	0.0	0.0	2.649	85.9	0	00:50	0.560
POND5	0.137	4.2	0.0	0.0	2.758	84.0	0	00:50	1.237
POND6	0.664	14.0	0.0	0.0	4.057	85.5	0	01:03	0.426
POND7	0.151	4.1	0.0	0.0	3.182	86.0	0	00:46	1.507
POND8	0.091	3.3	0.0	0.0	2.300	83.1	0	00:46	1.291
POND9	0.289	7.4	0.0	0.0	3.226	83.1	0	00:55	0.657
POND10	0.152	7.2	0.0	0.0	1.851	87.8	0	00:47	0.655

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
MHOUTPRE0	71.21	1.235	7.676	75.707
MHOUT0	99.63	0.486	6.656	41.685
MHOUTPRE1	41.46	1.960	10.281	69.947
MHOUT1	99.63	0.518	8.524	44.410
System	77.98	4.198	24.668	231.750

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Link Flow Summary

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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
LCH1_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_7	CONDUIT	5.745	0	00:35	1.66	0.51	0.69
LCH1_8	CONDUIT	5.745	0	00:35	1.66	0.51	0.69
LCH1_9	CONDUIT	5.745	0	00:35	3.41	0.17	0.36
LCH1_10	CONDUIT	5.745	0	00:35	3.44	0.17	0.36
LCH1_11	CONDUIT	5.745	0	00:35	3.08	0.20	0.40
LCH1_12	CONDUIT	5.745	0	00:35	2.83	0.23	0.43
LCH1_13	CONDUIT	5.745	0	00:35	2.51	0.28	0.48
LCH1_14	CONDUIT	5.745	0	00:35	1.66	0.51	0.69
LCH1_15	CONDUIT	5.745	0	00:35	3.30	0.18	0.37
LCH1_16	CONDUIT	5.745	0	00:35	3.23	0.19	0.38
LCH1_17	CONDUIT	5.745	0	00:35	1.66	0.51	0.69
LCH1_18	CONDUIT	5.745	0	00:35	1.66	0.51	0.69
LCH1_19	CONDUIT	5.745	0	00:35	3.55	0.16	0.35
LCH1_20	CONDUIT	5.745	0	00:35	3.17	0.19	0.39
LCH1_21	CONDUIT	5.745	0	00:35	10.15	0.03	0.13
LCH1_22	CONDUIT	6.656	0	00:36	2.20	0.42	0.61
LCH1_23	CONDUIT	6.656	0	00:36	1.75	0.59	0.75
LCH1_24	CONDUIT	6.656	0	00:36	1.74	0.60	0.75
LCH1_25	CONDUIT	6.656	0	00:36	1.75	0.59	0.75
LCH1_26	CONDUIT	6.656	0	00:36	1.75	0.60	0.75
LCH2_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_6	CONDUIT	5.745	0	00:35	2.34	0.31	0.51
LCH3_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00

LCH3_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_7	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_8	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_9	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_10	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_11	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_12	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_13	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_14	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_15	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_16	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_17	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_18	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_19	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_20	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_21	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_22	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_1	CONDUIT	2.566	0	00:42	3.58	0.04	0.16
LCH4_2	CONDUIT	2.566	0	00:42	3.29	0.05	0.18
LCH4_3	CONDUIT	2.566	0	00:42	2.98	0.06	0.20
LCH4_4	CONDUIT	2.566	0	00:42	3.30	0.05	0.18
LCH4_5	CONDUIT	2.566	0	00:42	4.41	0.03	0.13
LCH4_6	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_7	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_8	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_9	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_10	CONDUIT	2.566	0	00:42	1.65	0.15	0.34
LCH4_11	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_12	CONDUIT	2.566	0	00:42	1.54	0.17	0.36
LCH4_13	CONDUIT	2.566	0	00:42	1.27	0.23	0.43
LCH4_14	CONDUIT	2.566	0	00:42	1.89	0.12	0.30
LCH4_15	CONDUIT	2.566	0	00:42	1.75	0.14	0.32
LCH4_16	CONDUIT	3.061	0	00:44	1.35	0.27	0.48
LCH4_17	CONDUIT	3.061	0	00:44	2.20	0.13	0.31
LCH4_18	CONDUIT	3.061	0	00:44	1.35	0.27	0.48
LCH4_19	CONDUIT	3.061	0	00:44	1.46	0.24	0.44
LCH4_20	CONDUIT	3.061	0	00:44	1.35	0.27	0.48
LCH4_21	CONDUIT	3.061	0	00:44	1.50	0.23	0.43
LCH4_22	CONDUIT	4.237	0	00:45	2.67	0.16	0.34
LCH4_23	CONDUIT	4.237	0	00:45	2.54	0.17	0.36
LCH4_24	CONDUIT	4.237	0	00:45	3.14	0.12	0.30
LCH4_25	CONDUIT	4.237	0	00:45	2.73	0.15	0.34
LCH4_26	CONDUIT	4.237	0	00:45	1.98	0.25	0.45

LCH4_27	CONDUIT	4.237	0	00:45	2.02	0.24	0.44
LCH4_28	CONDUIT	4.237	0	00:45	1.79	0.29	0.49
LCH4_29	CONDUIT	4.518	0	00:46	1.98	0.28	0.48
LCH4_30	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_31	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_32	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_33	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_34	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_35	CONDUIT	4.518	0	00:46	2.73	0.17	0.36
LCH4_36	CONDUIT	4.518	0	00:46	3.61	0.11	0.28
LCH4_37	CONDUIT	4.518	0	00:46	2.18	0.24	0.44
LCH4_38	CONDUIT	4.518	0	00:46	1.54	0.40	0.60
LCH4_39	CONDUIT	6.024	0	00:46	2.93	0.24	0.44
LCH4_40	CONDUIT	6.024	0	00:46	1.69	0.54	0.70
LCH4_42	CONDUIT	6.024	0	00:46	1.69	0.54	0.70
LCH4_43	CONDUIT	6.024	0	00:46	1.69	0.54	0.70
LCH4_44	CONDUIT	6.024	0	00:46	2.43	0.31	0.51
LCH4_45	CONDUIT	7.314	0	00:46	1.80	0.44	0.63
LCH4_46	CONDUIT	7.314	0	00:46	1.80	0.44	0.63
LCH4_47	CONDUIT	7.314	0	00:46	1.80	0.44	0.63
LCH4_48	CONDUIT	7.314	0	00:46	1.80	0.44	0.63
LCH4_49	CONDUIT	7.314	0	00:46	1.80	0.31	0.52
LCH4_50	CONDUIT	7.870	0	00:47	3.90	0.11	0.29
LCH4_51	CONDUIT	7.870	0	00:47	2.22	0.25	0.47
LCH4_52	CONDUIT	7.870	0	00:47	2.95	0.17	0.37
LCH4_53	CONDUIT	7.870	0	00:47	2.84	0.37	0.57
LCH4_54	CONDUIT	7.870	0	00:47	2.33	0.50	0.67
LCH4_55	CONDUIT	7.870	0	00:47	2.14	0.38	0.58
LCH4_56	CONDUIT	7.870	0	00:47	1.84	0.34	0.55
LCH3_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_41	CONDUIT	6.024	0	00:46	1.69	0.54	0.70
LMH1	CONDUIT	3.021	0	00:34	9.79	0.86	0.71
LMH2	CONDUIT	2.735	0	00:36	8.21	0.75	0.65
LMH3	CONDUIT	2.805	0	00:35	13.40	0.69	0.61
LMH3.1	CONDUIT	2.805	0	00:35	11.88	0.61	0.57
LMH3.3	CONDUIT	2.566	0	00:42	7.55	0.77	0.66
LMH4	CONDUIT	0.560	0	00:50	9.54	0.21	0.31
LCH15_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_3	CONDUIT	0.560	0	00:50	0.73	0.05	0.17
LCH15_4	CONDUIT	0.560	0	00:50	1.96	0.01	0.07
LMH4.1	CONDUIT	0.560	0	00:50	7.80	0.27	0.36
LMH5	CONDUIT	1.237	0	00:50	9.99	0.57	0.54

LMH6	CONDUIT	0.426	0	01:03	9.14	0.15	0.26
LMH7	CONDUIT	1.507	0	00:46	11.76	0.60	0.56
LMH8	CONDUIT	1.291	0	00:46	10.43	0.57	0.54
LMH9	CONDUIT	0.657	0	00:55	8.53	0.30	0.38
LCH4_57	CONDUIT	7.870	0	00:47	3.06	0.33	0.53
LCH4_58	CONDUIT	7.870	0	00:47	1.84	0.47	0.66
LCH4_59	CONDUIT	7.870	0	00:47	2.55	0.44	0.62
LCH4_60	CONDUIT	8.524	0	00:47	2.67	0.46	0.64
LMH10	CONDUIT	0.655	0	00:47	10.71	0.36	0.42
LMH3.2	CONDUIT	2.805	0	00:35	12.24	0.77	0.66
LCH1_PRE	CONDUIT	3.098	0	02:00	2.30	0.12	0.30
LCH2_PRE	CONDUIT	3.098	0	02:00	3.69	0.06	0.19
LMHOUTPRE3	CONDUIT	3.098	0	02:00	4.18	0.05	0.17
LMHOUTPRE4	CONDUIT	3.098	0	02:00	3.94	0.05	0.18
LMHOUTPRE5	CONDUIT	3.098	0	02:00	3.42	0.07	0.20
LMHOUTPRE6	CONDUIT	3.098	0	02:00	2.30	0.12	0.30
LMHOUTPRE7	CONDUIT	3.098	0	02:00	4.25	0.05	0.17
LMHOUTPRE8	CONDUIT	3.098	0	02:00	2.30	0.12	0.30
LMHOUTPRE9	CONDUIT	3.098	0	02:00	2.31	0.12	0.30
LMHOUTPRE10	CONDUIT	3.098	0	02:00	4.55	0.04	0.16
LMHOUTPRE11	CONDUIT	3.098	0	02:00	8.79	0.01	0.08
LMHOUTPRE12	CONDUIT	7.676	0	01:50	3.17	0.30	0.50
LMHOUTPRE13	CONDUIT	7.676	0	01:50	3.17	0.30	0.50
KOUTPRE1	CONDUIT	7.676	0	01:50	3.17	0.30	0.50
LMHOUTPRE16	CONDUIT	4.629	0	01:45	2.66	0.18	0.38
LCH17_PRE	CONDUIT	1.760	0	01:40	4.80	0.03	0.11
LCH18_PRE	CONDUIT	1.760	0	01:40	5.20	0.02	0.11
LCH19_PRE	CONDUIT	1.760	0	01:40	3.61	0.04	0.15
LCH20_PRE	CONDUIT	1.760	0	01:40	1.87	0.12	0.28
LCH21_PRE	CONDUIT	1.760	0	01:40	2.07	0.10	0.26
LCH22_PRE	CONDUIT	1.760	0	01:40	2.91	0.06	0.19
LCH23_PRE	CONDUIT	1.760	0	01:40	1.87	0.12	0.28
LCH24_PRE	CONDUIT	2.803	0	01:35	3.33	0.10	0.25
LCH25_PRE	CONDUIT	2.803	0	01:35	3.28	0.10	0.26
LCH26_PRE	CONDUIT	2.803	0	01:35	2.72	0.13	0.31
LCH27_PRE	CONDUIT	2.803	0	01:35	2.22	0.18	0.37
LCH28_PRE	CONDUIT	4.074	0	01:35	4.54	0.11	0.27
LCH29_PRE	CONDUIT	4.074	0	01:35	3.78	0.14	0.32
LCH30_PRE	CONDUIT	4.074	0	01:35	3.66	0.15	0.33
LCH31_PRE	CONDUIT	5.410	0	01:35	3.26	0.28	0.48
LCH32_PRE	CONDUIT	5.410	0	01:35	2.81	0.35	0.55
LCH33_PRE	CONDUIT	5.410	0	01:35	4.85	0.15	0.33
LCH34_PRE	CONDUIT	7.025	0	01:35	4.51	0.25	0.45

LCH35_PRE	CONDUIT	7.025	0	01:35	3.07	0.46	0.64
LCH36_PRE	CONDUIT	8.296	0	01:35	4.70	0.31	0.51
LCH37_PRE	CONDUIT	8.296	0	01:35	3.25	0.54	0.70
LCH38_PRE	CONDUIT	8.296	0	01:35	3.25	0.54	0.70
LCH39_PRE	CONDUIT	9.463	0	01:35	6.00	0.26	0.46
LCH40_PRE	CONDUIT	9.463	0	01:35	4.17	0.45	0.63
LCH41_PRE	CONDUIT	9.463	0	01:35	4.34	0.43	0.61
LCH42_PRE	CONDUIT	9.463	0	01:35	4.21	0.45	0.63
KOUTPRE0	CONDUIT	10.281	0	01:35	6.02	0.29	0.49
10yr1	ORIFICE	1.931	0	00:34			0.00
50yr1	ORIFICE	1.091	0	00:34			0.00
10yr2	ORIFICE	1.615	0	00:36			0.00
50yr2	ORIFICE	1.119	0	00:36			0.00
10yrMP	ORIFICE	1.052	0	00:59			0.00
50yrMP	ORIFICE	1.697	0	00:59			0.00
10yr3	ORIFICE	1.550	0	00:42			0.00
50yr3	ORIFICE	1.015	0	00:42			0.00
10yr4	ORIFICE	0.333	0	00:50			0.00
50yr4	ORIFICE	0.227	0	00:50			0.00
10yr5	ORIFICE	1.085	0	00:50			0.00
50yr5	ORIFICE	0.152	0	00:50			0.00
10yr6	ORIFICE	0.243	0	01:03			0.00
50yr6	ORIFICE	0.183	0	01:03			0.00
10yr7	ORIFICE	1.018	0	00:46			0.00
50yr7	ORIFICE	0.488	0	00:46			0.00
10yr8	ORIFICE	1.066	0	00:46			0.00
50yr8	ORIFICE	0.225	0	00:46			0.00
10yr9	ORIFICE	0.443	0	00:55			0.00
50yr9	ORIFICE	0.214	0	00:55			0.00
10yr10	ORIFICE	0.245	0	00:47			0.00
50yr10	ORIFICE	0.410	0	00:47			0.00
100yrWeir1	WEIR	0.000	0	00:00			0.00
100yrWeir2	WEIR	0.000	0	00:00			0.00
100yrWeir3	WEIR	0.000	0	00:00			0.00
100yrWeir4	WEIR	0.000	0	00:00			0.00
100yrWeir5	WEIR	0.000	0	00:00			0.00
100yrWeir6	WEIR	0.000	0	00:00			0.00
100yrWeir7	WEIR	0.000	0	00:00			0.00
100yrWeir8	WEIR	0.000	0	00:00			0.00
100yrWeir9	WEIR	0.000	0	00:00			0.00
100yrWeir10	WEIR	0.000	0	00:00			0.00
100yrWeirMP	WEIR	0.000	0	00:59			0.00

```
************************
Conduit Surcharge Summary
************************

No conduits were surcharged.


Analysis begun on:  Mon Jul 27 09:17:25 2026
Analysis ended on:  Mon Jul 27 09:17:26 2026
Total elapsed time: 00:00:01
```

ANNEXURE G3: RUNOFF DETERMINATION CALCULATIONS 1:100-YEAR

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)

****
Analysis Options
****
Flow Units ..... CMS
Process Models:
  Rainfall/Runoff ..... YES
  RDII ..... NO
  Snowmelt ..... NO
  Groundwater ..... NO
  Flow Routing ..... YES
  Ponding Allowed ..... NO
  Water Quality ..... NO
Infiltration Method ..... GREEN_AMPT
Flow Routing Method ..... STEADY
Starting Date 01/01/2010 00:00:00
Ending Date 01/01/2010 23:55:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Wet Time Step 00:05:00
Dry Time Step 00:05:00
Routing Time Step ..... 5.00 sec

********** Volume Depth
Runoff Quantity Continuity hectare-m mm
********** --------- -------
Total Precipitation 41.917 70.276
Evaporation Loss 0.000 0.000
Infiltration Loss 9.332 15.645
Surface Runoff 32.482 54.457

Final Storage	0.189	0.317
Continuity Error (%)	-0.203	

**************************	Volume	Volume
Flow Routing Continuity	hectare-m	10^6 ltr
**************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	32.482	324.820
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	32.476	324.765
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.001	0.007
Continuity Error (%)	0.015	

****
Highest Flow Instability Indexes
****
All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step	:	5.00 sec
Average Time Step	:	5.00 sec
Maximum Time Step	:	5.00 sec
% of Time in Steady State	:	0.00
Average Iterations per Step	:	1.00

% of Steps Not Converging : 0.00

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
C_POST1	44.85	0.00	0.00	11.67	21.02	11.81	32.82	11.53	3.88	0.732
C_POST2	44.85	0.00	0.00	11.02	21.40	12.05	33.45	10.41	3.68	0.746
C_POST3	44.85	0.00	0.00	12.93	20.90	10.72	31.62	11.97	3.55	0.705
C_POST4	44.85	0.00	0.00	12.49	19.52	12.69	32.21	10.08	3.40	0.718
C_POST5	44.85	0.00	0.00	6.97	23.90	13.93	37.83	8.51	4.29	0.843
C_POST6	44.85	0.00	0.00	5.15	29.82	9.44	39.25	9.94	4.76	0.875
C_POST7	44.85	0.00	0.00	4.71	29.80	10.22	40.02	4.77	2.61	0.892
C_POST8	44.85	0.00	0.00	7.47	26.22	10.91	37.12	8.20	3.45	0.828
C_POST9	44.85	0.00	0.00	6.30	27.22	11.16	38.37	6.81	3.22	0.856
C_POST10	44.85	0.00	0.00	5.24	29.46	9.97	39.43	8.00	3.97	0.879
C_POST11	44.85	0.00	0.00	6.05	27.45	11.19	38.64	6.60	3.23	0.862
C_POST12	44.85	0.00	0.00	6.57	26.98	11.11	38.09	6.48	2.96	0.849
C_POST13	44.85	0.00	0.00	3.24	34.13	7.27	41.39	3.67	2.00	0.923
C_PRE1	107.66	0.00	0.00	25.86	10.63	71.06	81.69	28.70	2.96	0.759
C_PRE2	107.66	0.00	0.00	25.34	10.63	71.59	82.22	25.58	2.72	0.764
C_PRE3	107.66	0.00	0.00	28.12	10.63	68.80	79.42	30.05	2.74	0.738
C_PRE4	107.66	0.00	0.00	26.95	10.63	69.97	80.60	25.22	2.45	0.749
C_PRE5	107.66	0.00	0.00	17.52	10.63	79.45	90.08	20.27	3.41	0.837
C_PRE6	82.25	0.00	0.00	20.02	8.09	54.05	62.13	15.74	2.27	0.755
C_PRE7	82.25	0.00	0.00	17.25	8.09	56.83	64.92	7.74	1.35	0.789
C_PRE8	82.25	0.00	0.00	21.90	8.09	52.15	60.24	13.31	1.69	0.732
C_PRE9	82.25	0.00	0.00	19.14	8.09	54.93	63.02	11.19	1.71	0.766
C_PRE10	82.25	0.00	0.00	18.51	8.09	55.56	63.65	12.91	2.07	0.774

C_PRE11	82.25	0.00	0.00	19.25	8.09	54.81	62.90	10.74	1.63	0.765
C_PRE12	82.25	0.00	0.00	20.12	8.09	53.94	62.03	10.56	1.51	0.754
C_PRE13	82.25	0.00	0.00	16.51	8.09	57.58	65.67	5.82	1.07	0.798

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
CH12_PRE	JUNCTION	0.07	0.42	131.03	0 01:45	0.42
CH1_1	JUNCTION	0.00	0.00	192.52	0 00:00	0.00
CH1_2	JUNCTION	0.00	0.00	189.28	0 00:00	0.00
CH1_3	JUNCTION	0.00	0.00	186.99	0 00:00	0.00
CH1_4	JUNCTION	0.00	0.00	185.99	0 00:00	0.00
CH1_5	JUNCTION	0.00	0.00	182.42	0 00:00	0.00
CH1_6	JUNCTION	0.00	0.00	177.55	0 00:00	0.00
CH1_7	JUNCTION	0.04	0.63	176.75	0 00:32	0.63
CH1_8	JUNCTION	0.04	0.63	176.45	0 00:32	0.63
CH1_9	JUNCTION	0.04	0.63	176.00	0 00:32	0.63
CH1_10	JUNCTION	0.02	0.34	169.55	0 00:32	0.34
CH1_11	JUNCTION	0.02	0.37	168.47	0 00:32	0.37
CH1_12	JUNCTION	0.03	0.40	167.55	0 00:32	0.40
CH1_13	JUNCTION	0.03	0.44	166.61	0 00:32	0.44
CH1_14	JUNCTION	0.04	0.63	165.97	0 00:32	0.63
CH1_15	JUNCTION	0.04	0.63	165.78	0 00:32	0.63
CH1_16	JUNCTION	0.02	0.36	163.66	0 00:32	0.35
CH1_17	JUNCTION	0.04	0.63	162.56	0 00:32	0.63
CH1_18	JUNCTION	0.04	0.63	162.29	0 00:32	0.63
CH1_19	JUNCTION	0.04	0.63	162.02	0 00:32	0.63
CH1_20	JUNCTION	0.02	0.36	160.56	0 00:32	0.36

CH1_21	JUNCTION	0.02	0.36	158.68	0	00:32	0.36
CH1_22	JUNCTION	0.07	0.65	129.08	0	00:46	0.64
CH1_23	JUNCTION	0.09	0.79	128.60	0	00:46	0.78
CH1_24	JUNCTION	0.09	0.79	128.17	0	00:46	0.78
CH1_25	JUNCTION	0.09	0.79	127.89	0	00:46	0.78
CH1_26	JUNCTION	0.09	0.79	127.57	0	00:46	0.78
CH2_1	JUNCTION	0.00	0.00	182.61	0	00:00	0.00
CH2_2	JUNCTION	0.00	0.00	181.32	0	00:00	0.00
CH2_3	JUNCTION	0.00	0.00	180.70	0	00:00	0.00
CH2_4	JUNCTION	0.00	0.00	177.64	0	00:00	0.00
CH2_5	JUNCTION	0.00	0.00	176.79	0	00:00	0.00
CH2_6	JUNCTION	0.05	0.56	177.06	0	00:31	0.56
CH3_1	JUNCTION	0.00	0.00	197.04	0	00:00	0.00
CH3_2	JUNCTION	0.00	0.00	194.58	0	00:00	0.00
CH3_3	JUNCTION	0.00	0.00	189.61	0	00:00	0.00
CH3_4	JUNCTION	0.00	0.00	187.06	0	00:00	0.00
CH3_5	JUNCTION	0.00	0.00	182.43	0	00:00	0.00
CH3_6	JUNCTION	0.00	0.00	179.03	0	00:00	0.00
CH3_7	JUNCTION	0.00	0.00	172.87	0	00:00	0.00
CH3_8	JUNCTION	0.00	0.00	172.67	0	00:00	0.00
CH3_9	JUNCTION	0.00	0.00	172.17	0	00:00	0.00
CH3_10	JUNCTION	0.00	0.00	170.17	0	00:00	0.00
CH3_11	JUNCTION	0.00	0.00	170.09	0	00:00	0.00
CH3_12	JUNCTION	0.00	0.00	168.75	0	00:00	0.00
CH3_13	JUNCTION	0.00	0.00	167.76	0	00:00	0.00
CH3_14	JUNCTION	0.00	0.00	167.27	0	00:00	0.00
CH3_15	JUNCTION	0.00	0.00	166.71	0	00:00	0.00
CH3_16	JUNCTION	0.00	0.00	164.44	0	00:00	0.00
CH3_17	JUNCTION	0.00	0.00	164.03	0	00:00	0.00
CH3_18	JUNCTION	0.00	0.00	162.48	0	00:00	0.00
CH3_19	JUNCTION	0.00	0.00	162.35	0	00:00	0.00
CH3_20	JUNCTION	0.00	0.00	161.90	0	00:00	0.00
CH3_21	JUNCTION	0.00	0.00	160.59	0	00:00	0.00
CH3_22	JUNCTION	0.00	0.00	158.86	0	00:00	0.00
CH4_1	JUNCTION	0.04	0.58	178.97	0	00:38	0.58

CH4_2	JUNCTION	0.01	0.18	174.78	0	00:38	0.18
CH4_3	JUNCTION	0.01	0.19	170.85	0	00:38	0.19
CH4_4	JUNCTION	0.01	0.19	167.97	0	00:38	0.19
CH4_5	JUNCTION	0.01	0.18	164.65	0	00:38	0.18
CH4_6	JUNCTION	0.02	0.43	158.65	0	00:38	0.42
CH4_7	JUNCTION	0.02	0.43	158.17	0	00:38	0.42
CH4_8	JUNCTION	0.02	0.43	157.86	0	00:38	0.42
CH4_9	JUNCTION	0.02	0.43	157.42	0	00:38	0.42
CH4_10	JUNCTION	0.02	0.43	156.82	0	00:38	0.42
CH4_11	JUNCTION	0.02	0.43	155.60	0	00:38	0.42
CH4_12	JUNCTION	0.02	0.43	155.14	0	00:38	0.42
CH4_13	JUNCTION	0.02	0.43	154.29	0	00:38	0.42
CH4_14	JUNCTION	0.02	0.43	153.93	0	00:38	0.42
CH4_15	JUNCTION	0.02	0.32	152.64	0	00:38	0.32
CH4_16	JUNCTION	0.03	0.47	152.13	0	00:40	0.47
CH4_17	JUNCTION	0.03	0.47	151.86	0	00:40	0.47
CH4_18	JUNCTION	0.03	0.47	150.90	0	00:40	0.47
CH4_19	JUNCTION	0.03	0.47	150.69	0	00:40	0.47
CH4_20	JUNCTION	0.03	0.47	150.12	0	00:40	0.47
CH4_21	JUNCTION	0.03	0.47	149.77	0	00:40	0.47
CH4_22	JUNCTION	0.04	0.43	149.45	0	00:40	0.43
CH4_23	JUNCTION	0.03	0.36	147.68	0	00:42	0.36
CH4_24	JUNCTION	0.03	0.36	146.32	0	00:42	0.36
CH4_25	JUNCTION	0.02	0.34	143.25	0	00:42	0.34
CH4_26	JUNCTION	0.03	0.45	141.33	0	00:42	0.45
CH4_27	JUNCTION	0.03	0.45	140.39	0	00:42	0.45
CH4_28	JUNCTION	0.04	0.50	139.58	0	00:42	0.49
CH4_29	JUNCTION	0.05	0.50	139.06	0	00:42	0.49
CH4_30	JUNCTION	0.06	0.61	138.52	0	00:43	0.60
CH4_31	JUNCTION	0.06	0.61	138.27	0	00:43	0.60
CH4_32	JUNCTION	0.06	0.61	138.11	0	00:43	0.60
CH4_33	JUNCTION	0.06	0.61	137.82	0	00:43	0.60
CH4_34	JUNCTION	0.06	0.60	137.59	0	00:43	0.60
CH4_35	JUNCTION	0.06	0.60	137.22	0	00:43	0.60
CH4_36	JUNCTION	0.03	0.36	135.56	0	00:43	0.36

CH4_37	JUNCTION	0.04	0.45	132.10	0	00:43	0.45
CH4_38	JUNCTION	0.06	0.60	131.54	0	00:43	0.60
CH4_39	JUNCTION	0.06	0.60	131.34	0	00:43	0.60
CH4_40	JUNCTION	0.06	0.72	130.32	0	00:43	0.71
CH4_41	JUNCTION	0.06	0.72	130.02	0	00:43	0.71
CH4_42	JUNCTION	0.06	0.72	129.83	0	00:43	0.71
CH4_43	JUNCTION	0.06	0.72	129.54	0	00:43	0.71
CH4_44	JUNCTION	0.06	0.72	129.13	0	00:43	0.71
CH4_45	JUNCTION	0.07	0.80	128.51	0	00:43	0.79
CH4_46	JUNCTION	0.07	0.80	128.20	0	00:43	0.79
CH4_47	JUNCTION	0.07	0.80	127.98	0	00:43	0.79
CH4_48	JUNCTION	0.07	0.80	127.68	0	00:43	0.79
CH4_49	JUNCTION	0.07	0.80	127.56	0	00:43	0.79
CH4_50	JUNCTION	0.07	0.80	126.83	0	00:43	0.79
CH4_51	JUNCTION	0.06	0.71	124.05	0	00:44	0.71
CH4_52	JUNCTION	0.06	0.71	123.59	0	00:44	0.71
CH4_53	JUNCTION	0.05	0.58	122.58	0	00:44	0.58
CH4_54	JUNCTION	0.06	0.69	121.70	0	00:44	0.69
CH4_55	JUNCTION	0.07	0.74	121.26	0	00:44	0.74
CH4_56	JUNCTION	0.08	0.84	121.06	0	00:44	0.83
MH1	JUNCTION	0.04	0.56	184.28	0	00:31	0.56
MH2	JUNCTION	0.04	0.55	179.79	0	00:33	0.55
MH3	JUNCTION	0.04	0.47	170.78	0	00:35	0.47
MH3.1	JUNCTION	0.04	0.47	164.83	0	00:35	0.47
MH3.3	JUNCTION	0.04	0.58	181.28	0	00:38	0.58
MH4	JUNCTION	0.02	0.18	174.16	0	00:46	0.18
MH4.1	JUNCTION	0.03	0.26	163.09	0	00:46	0.26
CH15_1	JUNCTION	0.00	0.00	158.24	0	00:00	0.00
CH15_2	JUNCTION	0.00	0.00	155.91	0	00:00	0.00
CH15_3	JUNCTION	0.03	0.26	155.85	0	00:46	0.26
CH15_4	JUNCTION	0.02	0.19	155.68	0	00:46	0.19
MH5	JUNCTION	0.03	0.33	162.16	0	00:46	0.33
MH6	JUNCTION	0.04	0.17	161.13	0	00:54	0.17
MH7	JUNCTION	0.03	0.34	141.71	0	00:42	0.34
MH8	JUNCTION	0.02	0.33	135.46	0	00:42	0.33

MH9	JUNCTION	0.03	0.25	134.40	0	00:49	0.25
CH4_57	JUNCTION	0.08	0.84	120.85	0	00:44	0.83
CH4_58	JUNCTION	0.08	0.84	120.10	0	00:44	0.83
CH4_59	JUNCTION	0.08	0.84	119.85	0	00:44	0.83
CH4_60	JUNCTION	0.06	0.66	118.96	0	00:44	0.65
MH10	JUNCTION	0.02	0.21	138.24	0	00:43	0.20
MH3.2	JUNCTION	0.04	0.52	155.46	0	00:35	0.52
CH1_PRE	JUNCTION	0.06	0.34	176.63	0	01:55	0.34
CH2_PRE	JUNCTION	0.06	0.34	176.19	0	01:55	0.34
CH3_PRE	JUNCTION	0.04	0.22	172.00	0	01:55	0.22
CH4_PRE	JUNCTION	0.03	0.21	168.82	0	01:55	0.21
CH5_PRE	JUNCTION	0.04	0.23	167.13	0	01:55	0.23
CH6_PRE	JUNCTION	0.06	0.34	165.92	0	01:55	0.34
CH7_PRE	JUNCTION	0.06	0.34	165.73	0	01:55	0.34
CH8_PRE	JUNCTION	0.06	0.34	162.04	0	01:55	0.34
CH9_PRE	JUNCTION	0.06	0.34	161.79	0	01:55	0.34
CH10_PRE	JUNCTION	0.06	0.34	161.56	0	01:55	0.34
CH11_PRE	JUNCTION	0.03	0.18	158.63	0	01:55	0.18
CH13_PRE	JUNCTION	0.09	0.57	130.50	0	01:50	0.57
CH14_PRE	JUNCTION	0.09	0.57	129.97	0	01:50	0.57
CH15_PRE	JUNCTION	0.09	0.57	129.31	0	01:50	0.57
CH17_PRE	JUNCTION	0.01	0.08	173.54	0	01:35	0.08
CH18_PRE	JUNCTION	0.01	0.08	167.40	0	01:35	0.08
CH19_PRE	JUNCTION	0.01	0.11	162.51	0	01:35	0.11
CH20_PRE	JUNCTION	0.02	0.20	158.79	0	01:35	0.20
CH21_PRE	JUNCTION	0.02	0.20	157.47	0	01:35	0.20
CH22_PRE	JUNCTION	0.02	0.18	156.01	0	01:35	0.18
CH23_PRE	JUNCTION	0.02	0.20	153.87	0	01:35	0.20
CH24_PRE	JUNCTION	0.02	0.20	153.31	0	01:35	0.20
CH25_PRE	JUNCTION	0.02	0.18	151.39	0	01:30	0.18
CH26_PRE	JUNCTION	0.02	0.21	150.24	0	01:30	0.21
CH27_PRE	JUNCTION	0.03	0.26	149.12	0	01:30	0.26
CH28_PRE	JUNCTION	0.03	0.26	148.80	0	01:30	0.26
CH29_PRE	JUNCTION	0.03	0.22	144.06	0	01:35	0.22
CH30_PRE	JUNCTION	0.03	0.23	142.03	0	01:35	0.23

CH31_PRE	JUNCTION	0.04	0.33	139.24	0	01:35	0.33
CH32_PRE	JUNCTION	0.04	0.38	138.19	0	01:35	0.38
CH33_PRE	JUNCTION	0.04	0.38	137.22	0	01:35	0.38
CH34_PRE	JUNCTION	0.03	0.31	133.29	0	01:35	0.31
CH35_PRE	JUNCTION	0.05	0.44	129.98	0	01:35	0.44
CH36_PRE	JUNCTION	0.05	0.44	129.32	0	01:35	0.44
CH37_PRE	JUNCTION	0.05	0.49	127.50	0	01:35	0.49
CH38_PRE	JUNCTION	0.05	0.49	127.20	0	01:35	0.49
CH39_PRE	JUNCTION	0.05	0.49	126.46	0	01:35	0.49
CH40_PRE	JUNCTION	0.05	0.44	122.46	0	01:35	0.44
CH41_PRE	JUNCTION	0.05	0.44	121.15	0	01:35	0.44
CH42_PRE	JUNCTION	0.05	0.44	120.34	0	01:35	0.44
CH43_PRE	JUNCTION	0.05	0.44	119.34	0	01:35	0.44
MHOUTPRE0	OUTFALL	0.09	0.57	129.08	0	01:50	0.57
MHOUT0	OUTFALL	0.09	0.79	127.30	0	00:46	0.78
MHOUTPRE1	OUTFALL	0.04	0.34	117.83	0	01:35	0.34
MHOUT1	OUTFALL	0.06	0.66	118.35	0	00:44	0.65
POND1	STORAGE	0.07	1.43	188.37	0	00:31	1.42
POND2	STORAGE	0.07	1.44	183.67	0	00:33	1.44
MINING_PIT	STORAGE	0.89	4.75	133.90	0	00:48	4.74
POND3	STORAGE	0.07	1.48	185.82	0	00:38	1.48
POND4	STORAGE	0.16	1.50	185.39	0	00:46	1.49
POND5	STORAGE	0.09	1.50	167.44	0	00:46	1.50
POND6	STORAGE	0.29	1.48	171.64	0	00:54	1.48
POND7	STORAGE	0.09	1.48	169.26	0	00:42	1.48
POND8	STORAGE	0.09	1.78	148.10	0	00:42	1.77
POND9	STORAGE	0.19	1.76	150.72	0	00:49	1.76
POND10	STORAGE	0.14	1.48	171.80	0	00:43	1.48

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
CH12_PRE	JUNCTION	8.160	8.160	0 01:45	75.5	75.5	0.000
CH1_1	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_2	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_3	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_4	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_5	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_6	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH1_7	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_8	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_9	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_10	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_11	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_12	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_13	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_14	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_15	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_16	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_17	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_18	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_19	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_20	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_21	JUNCTION	0.000	7.418	0 00:32	0	21.9	0.000
CH1_22	JUNCTION	0.000	10.922	0 00:46	0	52.5	0.000
CH1_23	JUNCTION	0.000	10.922	0 00:46	0	52.5	0.000
CH1_24	JUNCTION	0.000	10.922	0 00:46	0	52.5	0.000
CH1_25	JUNCTION	0.000	10.922	0 00:46	0	52.5	0.000
CH1_26	JUNCTION	0.000	10.922	0 00:46	0	52.5	0.000
CH2_1	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH2_2	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
CH2_3	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr

CH2_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH2_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH2_6	JUNCTION	0.000	7.418	0	00:32	0	21.9	0.000
CH3_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_4	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_5	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_6	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_7	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_8	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_9	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_10	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_11	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_12	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_13	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_14	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_15	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_16	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_17	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_18	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_19	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_20	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_21	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH3_22	JUNCTION	0.000	0.000	0	00:00	0	0	0.000 ltr
CH4_1	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_2	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_3	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_4	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_5	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_6	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_7	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_8	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_9	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_10	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000

CH4_11	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_12	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_13	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_14	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_15	JUNCTION	0.000	3.713	0	00:38	0	9.94	0.000
CH4_16	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_17	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_18	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_19	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_20	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_21	JUNCTION	0.000	4.466	0	00:40	0	14.7	0.000
CH4_22	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_23	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_24	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_25	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_26	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_27	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_28	JUNCTION	0.000	6.264	0	00:42	0	22.9	0.000
CH4_29	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_30	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_31	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_32	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_33	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_34	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_35	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_36	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_37	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_38	JUNCTION	0.000	6.826	0	00:43	0	29.7	0.000
CH4_39	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_40	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_41	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_42	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_43	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_44	JUNCTION	0.000	9.179	0	00:43	0	37.7	0.000
CH4_45	JUNCTION	0.000	11.115	0	00:43	0	44.3	0.000

CH4_46	JUNCTION	0.000	11.115	0	00:43	0	44.3	0.000	
CH4_47	JUNCTION	0.000	11.115	0	00:43	0	44.3	0.000	
CH4_48	JUNCTION	0.000	11.115	0	00:43	0	44.3	0.000	
CH4_49	JUNCTION	0.000	11.115	0	00:43	0	44.3	0.000	
CH4_50	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_51	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_52	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_53	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_54	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_55	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_56	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
MH1	JUNCTION	0.000	3.364	0	00:31	0	11.2	0.000	
MH2	JUNCTION	0.000	3.068	0	00:33	0	10.1	0.000	
MH3	JUNCTION	3.550	3.550	0	00:35	12	12	0.000	
MH3.1	JUNCTION	0.000	3.550	0	00:35	0	12	0.000	
MH3.3	JUNCTION	0.000	2.955	0	00:38	0	9.45	0.000	
MH4	JUNCTION	0.000	0.692	0	00:46	0	4.5	0.000	
MH4.1	JUNCTION	0.000	0.977	0	00:46	0	4.77	0.000	
CH15_1	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_2	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CH15_3	JUNCTION	0.000	0.977	0	00:46	0	4.77	0.000	
CH15_4	JUNCTION	0.000	0.977	0	00:46	0	4.77	0.000	
MH5	JUNCTION	0.000	1.509	0	00:46	0	7.78	0.000	
MH6	JUNCTION	0.000	0.593	0	00:54	0	6.4	0.000	
MH7	JUNCTION	0.000	1.852	0	00:42	0	7.62	0.000	
MH8	JUNCTION	0.000	1.624	0	00:42	0	6.39	0.000	
MH9	JUNCTION	0.000	0.942	0	00:49	0	6.31	0.000	
CH4_57	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_58	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_59	JUNCTION	0.000	12.084	0	00:44	0	50.8	0.000	
CH4_60	JUNCTION	0.000	13.125	0	00:44	0	54.5	0.000	
MH10	JUNCTION	0.000	0.788	0	00:43	0	3.48	0.000	
MH3.2	JUNCTION	0.000	3.550	0	00:35	0	12	0.000	
CH1_PRE	JUNCTION	5.678	5.678	0	01:55	54.3	54.3	0.000	
CH2_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000	

CH3_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH4_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH5_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH6_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH7_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH8_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH9_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH10_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH11_PRE	JUNCTION	0.000	5.678	0	01:55	0	54.3	0.000
CH13_PRE	JUNCTION	0.000	13.764	0	01:50	0	130	0.000
CH14_PRE	JUNCTION	0.000	13.764	0	01:50	0	130	0.000
CH15_PRE	JUNCTION	0.000	13.764	0	01:50	0	130	0.000
CH17_PRE	JUNCTION	2.268	2.268	0	01:35	15.7	15.7	0.000
CH18_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH19_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH20_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH21_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH22_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH23_PRE	JUNCTION	0.000	2.268	0	01:35	0	15.7	0.000
CH24_PRE	JUNCTION	1.352	3.586	0	01:30	7.74	23.5	0.000
CH25_PRE	JUNCTION	0.000	3.586	0	01:30	0	23.5	0.000
CH26_PRE	JUNCTION	0.000	3.586	0	01:30	0	23.5	0.000
CH27_PRE	JUNCTION	0.000	3.586	0	01:30	0	23.5	0.000
CH28_PRE	JUNCTION	1.686	5.247	0	01:35	13.3	36.8	0.000
CH29_PRE	JUNCTION	0.000	5.247	0	01:35	0	36.8	0.000
CH30_PRE	JUNCTION	0.000	5.247	0	01:35	0	36.8	0.000
CH31_PRE	JUNCTION	1.711	6.958	0	01:35	11.2	48	0.000
CH32_PRE	JUNCTION	0.000	6.958	0	01:35	0	48	0.000
CH33_PRE	JUNCTION	0.000	6.958	0	01:35	0	48	0.000
CH34_PRE	JUNCTION	2.065	9.011	0	01:35	12.9	60.9	0.000
CH35_PRE	JUNCTION	0.000	9.011	0	01:35	0	60.9	0.000
CH36_PRE	JUNCTION	1.631	10.642	0	01:35	10.7	71.6	0.000
CH37_PRE	JUNCTION	0.000	10.642	0	01:35	0	71.6	0.000
CH38_PRE	JUNCTION	0.000	10.642	0	01:35	0	71.6	0.000
CH39_PRE	JUNCTION	1.510	12.153	0	01:35	10.6	82.2	0.000

CH40_PRE	JUNCTION	0.000	12.153	0	01:35	0	82.2	0.000
CH41_PRE	JUNCTION	0.000	12.153	0	01:35	0	82.2	0.000
CH42_PRE	JUNCTION	0.000	12.153	0	01:35	0	82.2	0.000
CH43_PRE	JUNCTION	1.073	13.163	0	01:35	5.82	88	0.000
MHOUTPRE0	OUTFALL	0.000	13.764	0	01:50	0	130	0.000
MHOUT0	OUTFALL	0.000	10.922	0	00:46	0	52.5	0.000
MHOUTPRE1	OUTFALL	0.000	13.163	0	01:35	0	88	0.000
MHOUT1	OUTFALL	0.000	13.125	0	00:44	0	54.5	0.000
POND1	STORAGE	3.883	3.883	0	00:30	11.5	11.5	0.059
POND2	STORAGE	3.680	3.680	0	00:30	10.4	10.4	0.072
MINING_PIT	STORAGE	7.473	10.963	0	00:30	18.6	30.6	0.039
POND3	STORAGE	4.761	4.761	0	00:30	9.94	9.94	0.069
POND4	STORAGE	2.608	2.608	0	00:25	4.77	4.77	0.025
POND5	STORAGE	3.448	3.448	0	00:30	8.2	8.2	0.039
POND6	STORAGE	3.225	3.225	0	00:25	6.81	6.81	0.009
POND7	STORAGE	3.969	3.969	0	00:25	8	8	0.045
POND8	STORAGE	3.228	3.228	0	00:25	6.6	6.6	0.054
POND9	STORAGE	2.958	2.958	0	00:25	6.48	6.48	0.025
POND10	STORAGE	1.997	1.997	0	00:25	3.67	3.67	0.042

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Node Flooding Summary
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No nodes were flooded.

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Storage Volume Summary
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	Average Volume	Avg Pcnt	Evap Pcnt	Exfil Pcnt	Maximum Volume	Max Pcnt	Time of Max Occurrence	Maximum Outflow

Storage Unit	1000 m³	Full	Loss	Loss	1000 m³	Full	days	hr:min	CMS
POND1	0.019	3.5	0.0	0.0	0.508	93.0	0	00:31	3.858
POND2	0.047	4.0	0.0	0.0	1.115	94.5	0	00:33	3.582
MINING_PIT	2.153	13.7	0.0	0.0	14.489	92.0	0	00:48	5.681
POND3	0.121	3.7	0.0	0.0	3.238	98.5	0	00:38	3.713
POND4	0.247	8.0	0.0	0.0	3.073	99.6	0	00:46	0.977
POND5	0.165	5.0	0.0	0.0	3.282	99.9	0	00:46	1.971
POND6	0.724	15.3	0.0	0.0	4.677	98.6	0	00:54	0.855
POND7	0.173	4.7	0.0	0.0	3.639	98.3	0	00:42	2.358
POND8	0.110	4.0	0.0	0.0	2.725	98.4	0	00:42	1.939
POND9	0.328	8.4	0.0	0.0	3.767	97.0	0	00:49	1.131
POND10	0.163	7.7	0.0	0.0	2.077	98.5	0	00:43	1.044

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
MHOUTPRE0	71.41	2.112	13.764	129.819
MHOUT0	99.63	0.612	10.922	52.467
MHOUTPRE1	41.52	2.462	13.163	88.019
MHOUT1	99.63	0.635	13.125	54.459
System	78.05	5.820	34.595	324.763

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Link Flow Summary
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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
LCH1_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH1_7	CONDUIT	7.418	0	00:32	1.81	0.66	0.79
LCH1_8	CONDUIT	7.418	0	00:32	1.81	0.66	0.79
LCH1_9	CONDUIT	7.418	0	00:32	3.73	0.22	0.42
LCH1_10	CONDUIT	7.418	0	00:32	3.77	0.22	0.42
LCH1_11	CONDUIT	7.418	0	00:32	3.37	0.26	0.46
LCH1_12	CONDUIT	7.418	0	00:32	3.09	0.30	0.50
LCH1_13	CONDUIT	7.418	0	00:32	2.74	0.36	0.56
LCH1_14	CONDUIT	7.418	0	00:32	1.81	0.66	0.79
LCH1_15	CONDUIT	7.418	0	00:32	3.61	0.23	0.44
LCH1_16	CONDUIT	7.418	0	00:32	3.53	0.24	0.44
LCH1_17	CONDUIT	7.418	0	00:32	1.81	0.66	0.79
LCH1_18	CONDUIT	7.418	0	00:32	1.81	0.66	0.79
LCH1_19	CONDUIT	7.418	0	00:32	3.89	0.21	0.41
LCH1_20	CONDUIT	7.418	0	00:32	3.46	0.25	0.45
LCH1_21	CONDUIT	7.418	0	00:32	11.19	0.04	0.15
LCH1_22	CONDUIT	10.922	0	00:46	2.59	0.69	0.81
LCH1_23	CONDUIT	10.922	0	00:46	2.04	0.98	0.99
LCH1_24	CONDUIT	10.922	0	00:46	2.04	0.98	0.99
LCH1_25	CONDUIT	10.922	0	00:46	2.04	0.98	0.99
LCH1_26	CONDUIT	10.922	0	00:46	2.04	0.98	0.99
LCH2_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00

LCH2_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH2_6	CONDUIT	7.418	0	00:32	2.55	0.40	0.59
LCH3_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_4	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_5	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_6	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_7	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_8	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_9	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_10	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_11	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_12	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_13	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_14	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_15	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_16	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_17	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_18	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_19	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_20	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_21	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH3_22	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_1	CONDUIT	3.713	0	00:38	4.11	0.07	0.20
LCH4_2	CONDUIT	3.713	0	00:38	3.78	0.07	0.22
LCH4_3	CONDUIT	3.713	0	00:38	3.41	0.09	0.24
LCH4_4	CONDUIT	3.713	0	00:38	3.79	0.07	0.22
LCH4_5	CONDUIT	3.713	0	00:38	5.07	0.05	0.17
LCH4_6	CONDUIT	3.713	0	00:38	1.44	0.33	0.53
LCH4_7	CONDUIT	3.713	0	00:38	1.44	0.33	0.53
LCH4_8	CONDUIT	3.713	0	00:38	1.44	0.33	0.53
LCH4_9	CONDUIT	3.713	0	00:38	1.44	0.33	0.53
LCH4_10	CONDUIT	3.713	0	00:38	1.88	0.22	0.42
LCH4_11	CONDUIT	3.713	0	00:38	1.44	0.33	0.53

LCH4_12	CONDUIT	3.713	0	00:38	1.75	0.25	0.45
LCH4_13	CONDUIT	3.713	0	00:38	1.44	0.33	0.53
LCH4_14	CONDUIT	3.713	0	00:38	2.15	0.18	0.37
LCH4_15	CONDUIT	3.713	0	00:38	2.00	0.20	0.40
LCH4_16	CONDUIT	4.466	0	00:40	1.53	0.40	0.59
LCH4_17	CONDUIT	4.466	0	00:40	2.51	0.19	0.38
LCH4_18	CONDUIT	4.466	0	00:40	1.53	0.40	0.59
LCH4_19	CONDUIT	4.466	0	00:40	1.66	0.35	0.55
LCH4_20	CONDUIT	4.466	0	00:40	1.53	0.40	0.59
LCH4_21	CONDUIT	4.466	0	00:40	1.70	0.34	0.54
LCH4_22	CONDUIT	6.264	0	00:42	3.06	0.23	0.43
LCH4_23	CONDUIT	6.264	0	00:42	2.92	0.25	0.45
LCH4_24	CONDUIT	6.264	0	00:42	3.61	0.18	0.37
LCH4_25	CONDUIT	6.264	0	00:42	3.14	0.22	0.42
LCH4_26	CONDUIT	6.264	0	00:42	2.26	0.37	0.57
LCH4_27	CONDUIT	6.264	0	00:42	2.31	0.36	0.56
LCH4_28	CONDUIT	6.264	0	00:42	2.04	0.43	0.62
LCH4_29	CONDUIT	6.826	0	00:43	2.27	0.42	0.61
LCH4_30	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_31	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_32	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_33	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_34	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_35	CONDUIT	6.826	0	00:43	3.16	0.25	0.46
LCH4_36	CONDUIT	6.826	0	00:43	4.18	0.16	0.35
LCH4_37	CONDUIT	6.826	0	00:43	2.51	0.36	0.56
LCH4_38	CONDUIT	6.826	0	00:43	1.76	0.61	0.76
LCH4_39	CONDUIT	9.179	0	00:43	3.38	0.36	0.56
LCH4_40	CONDUIT	9.179	0	00:43	1.93	0.82	0.89
LCH4_42	CONDUIT	9.179	0	00:43	1.93	0.82	0.90
LCH4_43	CONDUIT	9.179	0	00:43	1.93	0.82	0.89
LCH4_44	CONDUIT	9.179	0	00:43	2.80	0.48	0.66
LCH4_45	CONDUIT	11.115	0	00:43	2.05	0.66	0.80
LCH4_46	CONDUIT	11.115	0	00:43	2.05	0.67	0.80
LCH4_47	CONDUIT	11.115	0	00:43	2.05	0.66	0.80

LCH4_48	CONDUIT	11.115	0	00:43	2.05	0.66	0.80
LCH4_49	CONDUIT	11.115	0	00:43	2.05	0.48	0.66
LCH4_50	CONDUIT	12.084	0	00:44	4.51	0.17	0.37
LCH4_51	CONDUIT	12.084	0	00:44	2.55	0.39	0.60
LCH4_52	CONDUIT	12.084	0	00:44	3.40	0.26	0.47
LCH4_53	CONDUIT	12.084	0	00:44	3.27	0.57	0.73
LCH4_54	CONDUIT	12.084	0	00:44	2.68	0.76	0.86
LCH4_55	CONDUIT	12.084	0	00:44	2.46	0.58	0.74
LCH4_56	CONDUIT	12.084	0	00:44	2.11	0.52	0.70
LCH3_3	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH4_41	CONDUIT	9.179	0	00:43	1.93	0.82	0.89
LMH1	CONDUIT	3.364	0	00:31	9.92	0.95	0.78
LMH2	CONDUIT	3.068	0	00:33	8.37	0.84	0.70
LMH3	CONDUIT	3.550	0	00:35	14.00	0.87	0.72
LMH3.1	CONDUIT	3.550	0	00:35	12.50	0.77	0.66
LMH3.3	CONDUIT	2.955	0	00:38	7.73	0.88	0.73
LMH4	CONDUIT	0.692	0	00:46	10.13	0.25	0.34
LCH15_1	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
LCH15_3	CONDUIT	0.977	0	00:46	0.90	0.09	0.24
LCH15_4	CONDUIT	0.977	0	00:46	2.43	0.02	0.09
LMH4.1	CONDUIT	0.977	0	00:46	9.05	0.48	0.49
LMH5	CONDUIT	1.509	0	00:46	10.45	0.70	0.61
LMH6	CONDUIT	0.593	0	00:54	10.04	0.21	0.31
LMH7	CONDUIT	1.852	0	00:42	12.32	0.73	0.64
LMH8	CONDUIT	1.624	0	00:42	10.98	0.72	0.63
LMH9	CONDUIT	0.942	0	00:49	9.39	0.43	0.46
LCH4_57	CONDUIT	12.084	0	00:44	3.53	0.51	0.68
LCH4_58	CONDUIT	12.084	0	00:44	2.11	0.72	0.84
LCH4_59	CONDUIT	12.084	0	00:44	2.93	0.67	0.80
LCH4_60	CONDUIT	13.125	0	00:44	3.07	0.70	0.82
LMH10	CONDUIT	0.788	0	00:43	11.25	0.43	0.46
LMH3.2	CONDUIT	3.550	0	00:35	12.64	0.97	0.80
LCH1_PRE	CONDUIT	5.678	0	01:55	2.86	0.22	0.42
LCH2_PRE	CONDUIT	5.678	0	01:55	4.61	0.11	0.27

LMHOUTPRE3	CONDUIT	5.678	0	01:55	5.24	0.09	0.24
LMHOUTPRE4	CONDUIT	5.678	0	01:55	4.92	0.10	0.26
LMHOUTPRE5	CONDUIT	5.678	0	01:55	4.26	0.12	0.29
LMHOUTPRE6	CONDUIT	5.678	0	01:55	2.86	0.22	0.42
LMHOUTPRE7	CONDUIT	5.678	0	01:55	5.32	0.08	0.24
LMHOUTPRE8	CONDUIT	5.678	0	01:55	2.85	0.22	0.42
LMHOUTPRE9	CONDUIT	5.678	0	01:55	2.86	0.22	0.42
LMHOUTPRE10	CONDUIT	5.678	0	01:55	5.70	0.08	0.22
LMHOUTPRE11	CONDUIT	5.678	0	01:55	11.10	0.03	0.12
LMHOUTPRE12	CONDUIT	13.764	0	01:50	3.85	0.54	0.71
LMHOUTPRE13	CONDUIT	13.764	0	01:50	3.85	0.54	0.71
KOUTPRE1	CONDUIT	13.764	0	01:50	3.85	0.54	0.71
LMHOUTPRE16	CONDUIT	8.160	0	01:45	3.23	0.32	0.52
LCH17_PRE	CONDUIT	2.268	0	01:35	5.29	0.03	0.13
LCH18_PRE	CONDUIT	2.268	0	01:35	5.73	0.03	0.12
LCH19_PRE	CONDUIT	2.268	0	01:35	3.98	0.05	0.18
LCH20_PRE	CONDUIT	2.268	0	01:35	2.06	0.15	0.33
LCH21_PRE	CONDUIT	2.268	0	01:35	2.27	0.13	0.30
LCH22_PRE	CONDUIT	2.268	0	01:35	3.20	0.07	0.22
LCH23_PRE	CONDUIT	2.268	0	01:35	2.06	0.15	0.33
LCH24_PRE	CONDUIT	3.586	0	01:30	3.65	0.12	0.29
LCH25_PRE	CONDUIT	3.586	0	01:30	3.59	0.13	0.30
LCH26_PRE	CONDUIT	3.586	0	01:30	2.98	0.17	0.36
LCH27_PRE	CONDUIT	3.586	0	01:30	2.43	0.23	0.43
LCH28_PRE	CONDUIT	5.247	0	01:35	4.98	0.14	0.31
LCH29_PRE	CONDUIT	5.247	0	01:35	4.15	0.18	0.37
LCH30_PRE	CONDUIT	5.247	0	01:35	4.01	0.19	0.38
LCH31_PRE	CONDUIT	6.958	0	01:35	3.56	0.36	0.55
LCH32_PRE	CONDUIT	6.958	0	01:35	3.06	0.46	0.63
LCH33_PRE	CONDUIT	6.958	0	01:35	5.31	0.19	0.39
LCH34_PRE	CONDUIT	9.011	0	01:35	4.93	0.33	0.52
LCH35_PRE	CONDUIT	9.011	0	01:35	3.34	0.59	0.74
LCH36_PRE	CONDUIT	10.642	0	01:35	5.13	0.40	0.59
LCH37_PRE	CONDUIT	10.642	0	01:35	3.54	0.70	0.81
LCH38_PRE	CONDUIT	10.642	0	01:35	3.54	0.70	0.81

LCH39_PRE	CONDUIT	12.153	0	01:35	6.56	0.33	0.53
LCH40_PRE	CONDUIT	12.153	0	01:35	4.54	0.58	0.73
LCH41_PRE	CONDUIT	12.153	0	01:35	4.73	0.55	0.71
LCH42_PRE	CONDUIT	12.153	0	01:35	4.58	0.58	0.73
KOUTPRE0	CONDUIT	13.163	0	01:35	6.56	0.38	0.57
10yr1	ORIFICE	2.008	0	00:31		0.00	
50yr1	ORIFICE	1.356	0	00:31		0.00	
10yr2	ORIFICE	1.682	0	00:33		0.00	
50yr2	ORIFICE	1.386	0	00:33		0.00	
10yrMP	ORIFICE	1.084	0	00:48		0.00	
50yrMP	ORIFICE	2.537	0	00:48		0.00	
10yr3	ORIFICE	1.626	0	00:38		0.00	
50yr3	ORIFICE	1.329	0	00:38		0.00	
10yr4	ORIFICE	0.353	0	00:46		0.00	
50yr4	ORIFICE	0.339	0	00:46		0.00	
10yr5	ORIFICE	1.161	0	00:46		0.00	
50yr5	ORIFICE	0.348	0	00:46		0.00	
10yr6	ORIFICE	0.257	0	00:54		0.00	
50yr6	ORIFICE	0.337	0	00:54		0.00	
10yr7	ORIFICE	1.069	0	00:42		0.00	
50yr7	ORIFICE	0.783	0	00:42		0.00	
10yr8	ORIFICE	1.133	0	00:42		0.00	
50yr8	ORIFICE	0.491	0	00:42		0.00	
10yr9	ORIFICE	0.470	0	00:49		0.00	
50yr9	ORIFICE	0.472	0	00:49		0.00	
10yr10	ORIFICE	0.257	0	00:43		0.00	
50yr10	ORIFICE	0.531	0	00:43		0.00	
100yrWeir1	WEIR	0.494	0	00:31		0.00	
100yrWeir2	WEIR	0.514	0	00:33		0.00	
100yrWeir3	WEIR	0.758	0	00:38		0.00	
100yrWeir4	WEIR	0.284	0	00:46		0.00	
100yrWeir5	WEIR	0.462	0	00:46		0.00	
100yrWeir6	WEIR	0.262	0	00:54		0.00	
100yrWeir7	WEIR	0.506	0	00:42		0.00	
100yrWeir8	WEIR	0.316	0	00:42		0.00	

100yrWeir9	WEIR	0.189	0	00:49	0.00
100yrWeir10	WEIR	0.257	0	00:43	0.00
100yrWeirMP	WEIR	2.061	0	00:48	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Jul 27 09:43:16 2026
Analysis ended on: Mon Jul 27 09:43:17 2026
Total elapsed time: 00:00:01

ANNEXURE H: STORMWATER DRAWINGS

ANNEXURE H1: STORMWATER MANAGEMENT PLAN: 458_04A_SWMP1_REV.P1

ANNEXURE H2: STORMWATER KEY PLAN: 458_04A_K1_REV.P1

ANNEXURE H3: STORMWATER TYPICAL DETAILS: 458_04A_D1_REV.P1

ANNEXURE H4: STORMWATER TYPICAL DETAILS: 458_04A_D2_REV.P1

ANNEXURE H5: STORMWATER GENERAL LAYOUT PLAN: 458_04A_GL1_REV.P3

ANNEXURE H6: STORMWATER GENERAL LAYOUT PLAN: 458_04A_GL2_REV.P1

ANNEXURE H7: STORMWATER LONG SECTIONS: 458_04A_L1_REV.P1

ANNEXURE H8: STORMWATER LONG SECTIONS: 458_04A_L2_REV.P1

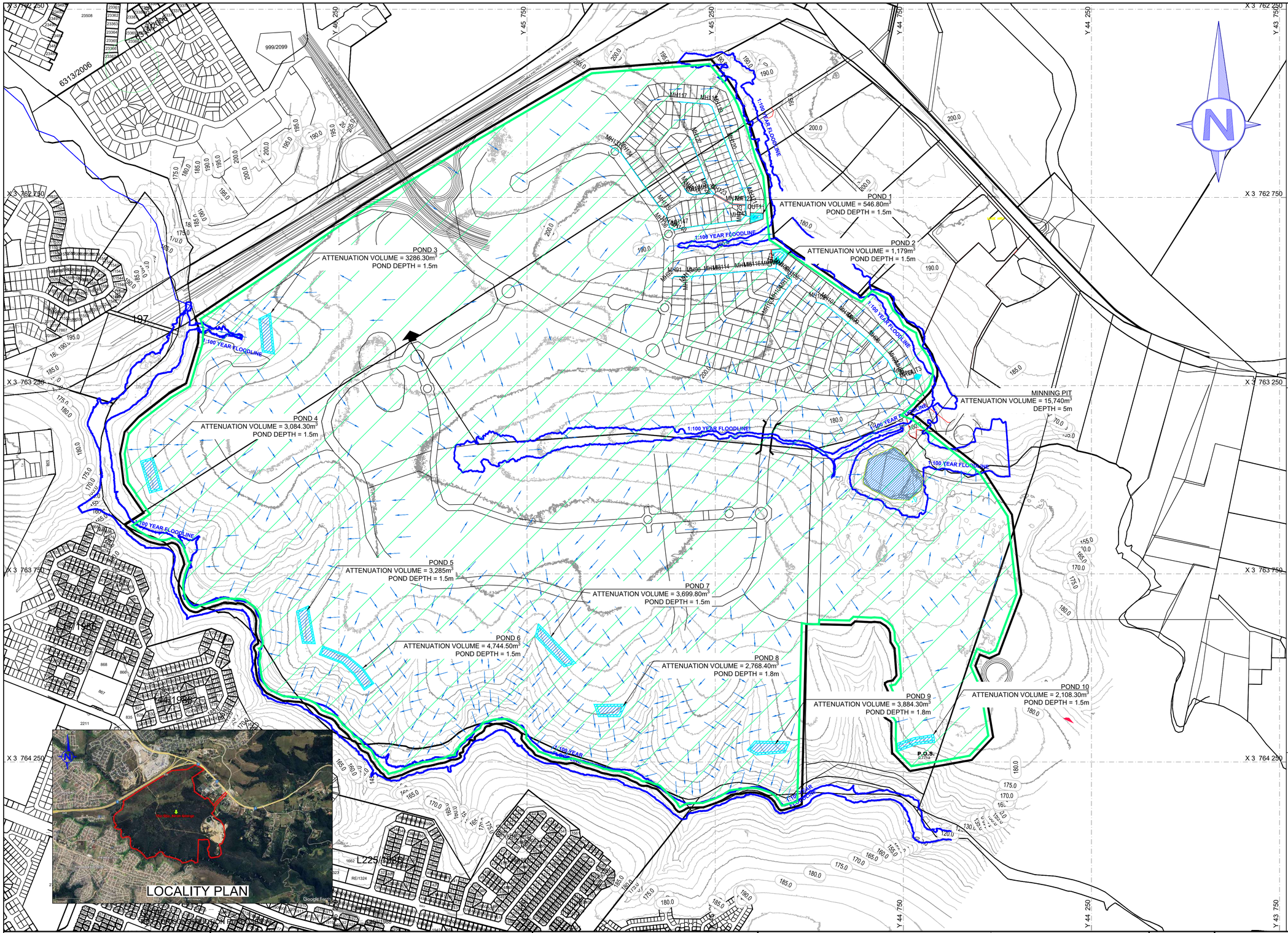
ANNEXURE H9: STORMWATER LONG SECTIONS: 458_04A_L3_REV.P1

ANNEXURE H10: STORMWATER LONG SECTIONS: 458_04A_L4_REV.P1

ANNEXURE H11: STORMWATER LONG SECTIONS: 458_04A_L5_REV.P1

ANNEXURE H12: STORMWATER LONG SECTIONS: 458_04A_L6_REV.P1

ANNEXURE H1: STORMWATER MANAGEMENT PLAN: 458_04A_SWMP1_REV.P1



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
3. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
4. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
5. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
6. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
7. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED.

LEGEND:

- EXISTING ROAD
- PROPOSED ROAD
- EXISTING STORMWATER
- PROPOSED STORMWATER
- STORMWATER RUNOFF FLOW ARROWS
- USABLE SITE AREA 2 ,982,336 m²

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2026-07-12	LLM	PRELIMINARY POND SIZES AND LOCATION FOR NEW TOWN PLANNER LAYOUT
P1	2026-07-27	LLM	PONDS AND PIPES SIZING CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: WF STOKER

DRAWN
NAME: LLM

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, ou=JT Evolve (Pty) Ltd, ou=Pr Eng, 202101798, email=wynand@jtevolve.com, c=ZA
Date: 2026.07.31 11:57:44 +02'00'

CONTRACT No.

PROJECT No. 458

SHEET No. 1 OF 1

PAPER SIZE A1

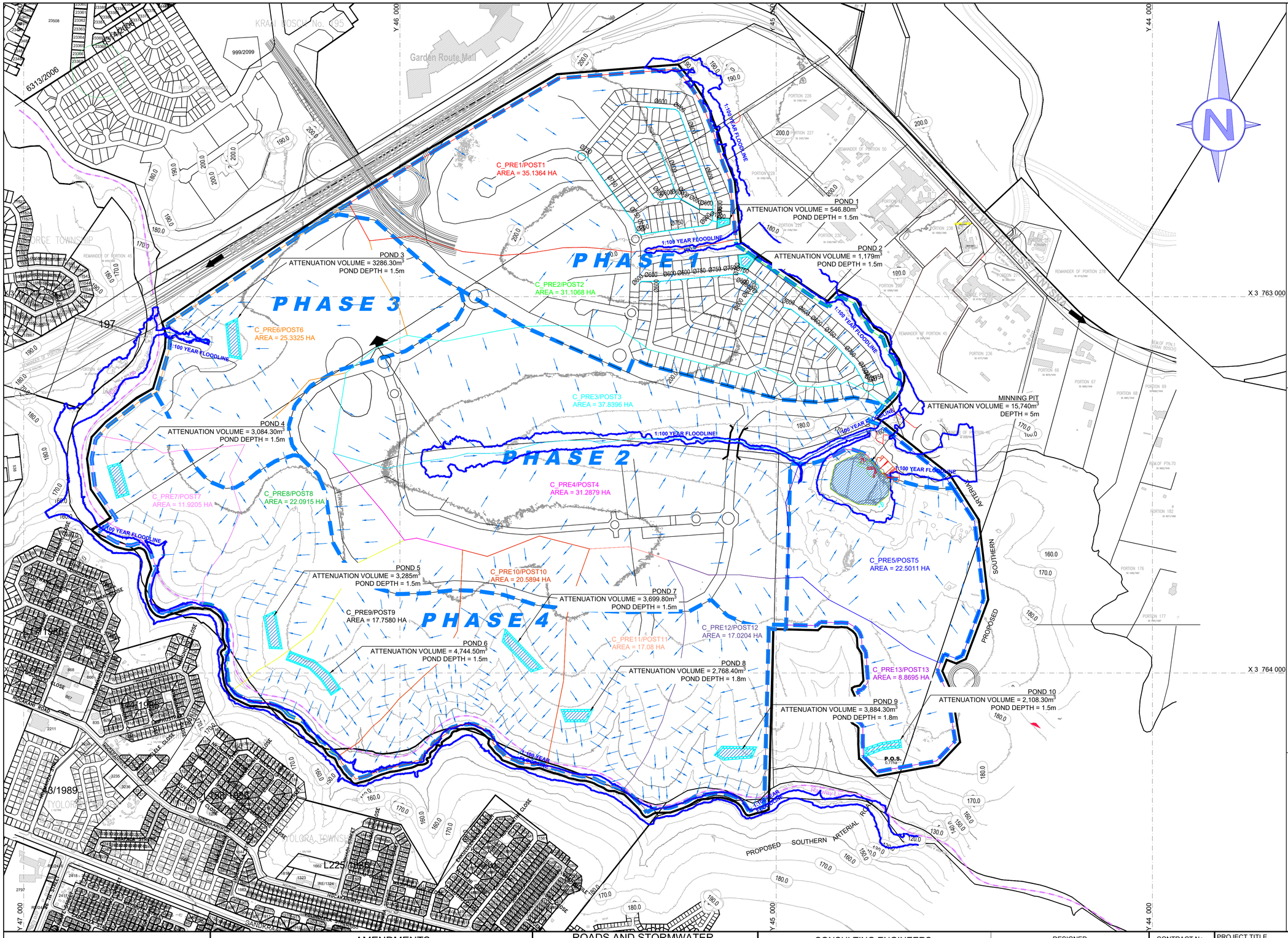
SCALE 1:5 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER MANAGEMENT PLAN

DRAWING NUMBER 458_04A_SWMP1 P1 REVISION

ANNEXURE H2: STORMWATER KEY PLAN: 458_04A_K1_REV.P1



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
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6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026-07-28	LLM	TOWNPLANNER LAYOUT CHANGED

ROADS AND STORMWATER

APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng:, 202101798, email=wynand@jtevolve.co.za, c=ZA
Date: 2026.07.31 11:57:10 +02'00'

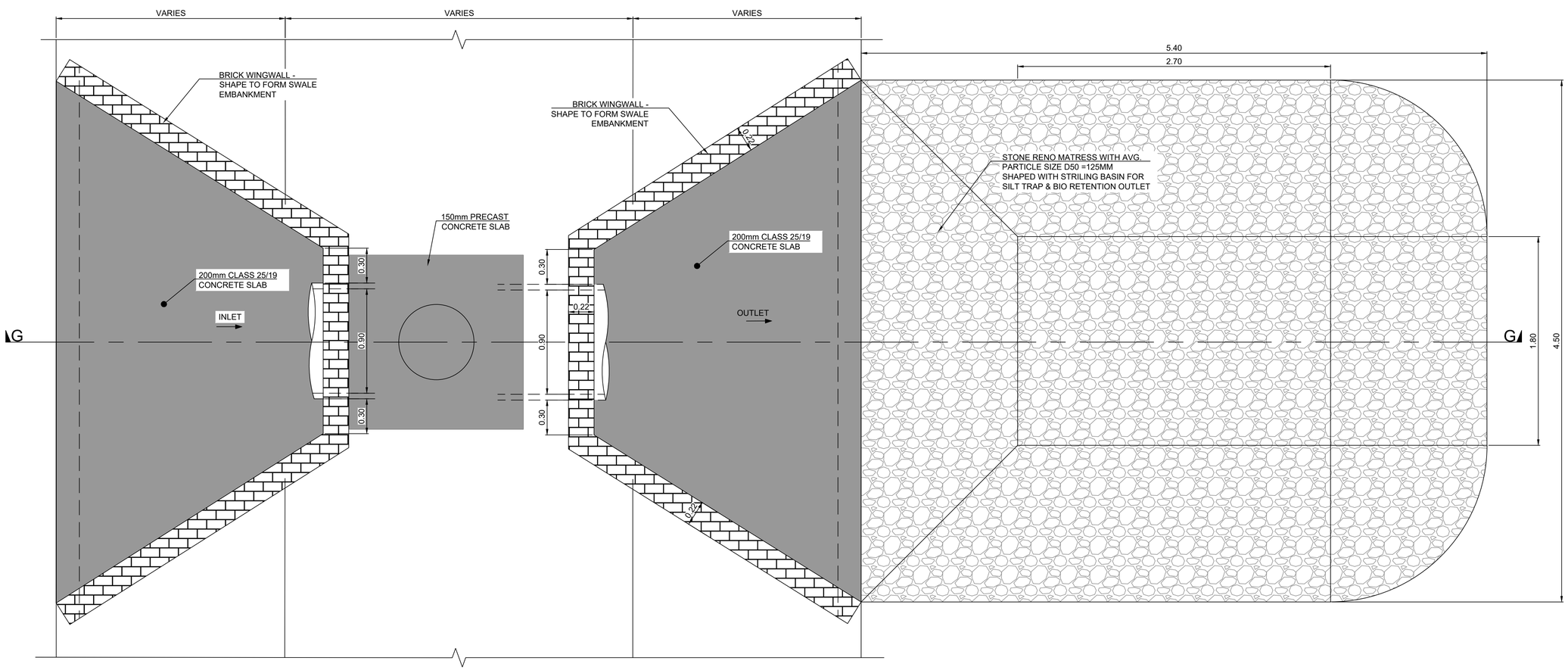
CONTRACT No.	
PROJECT No.	458
SHEET No.	1 OF 1
PAPER SIZE	A1
SCALE	1:5 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
CATCHMENTS
KEY PLAN

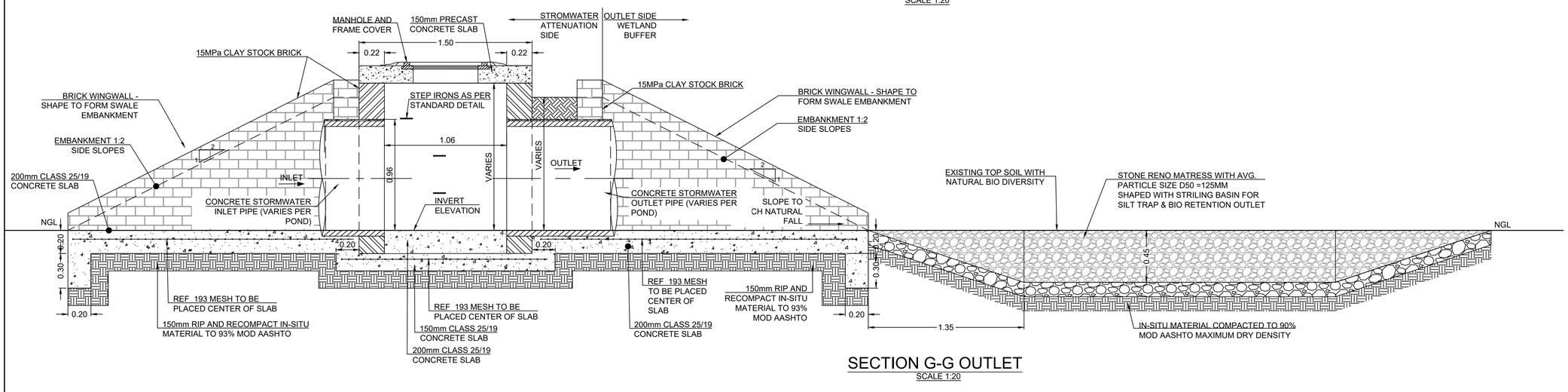
DRAWING NUMBER 458_04A_K1 P1 REVISION

ANNEXURE H3: STORMWATER TYPICAL DETAILS: 458_04A_D1_REV.P1



TOP VIEW OF POND OUTLET STRUCTURE

SCALE 1:20



SECTION G-G OUTLET

SCALE 1:20

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
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3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
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7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
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9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
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13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P1	2026-07-28	LLM	ISSUED FOR COMMENTS AND APPROVAL

ROADS AND STORMWATER

APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W STOKER

DRAWN
NAME: LLM

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:..... Digitally signed by Wynand Stoker DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng, 202101798, email=wynandj@jtevolve.com, c=ZA Date: 2026.07.31 11:56:01 +02'00'

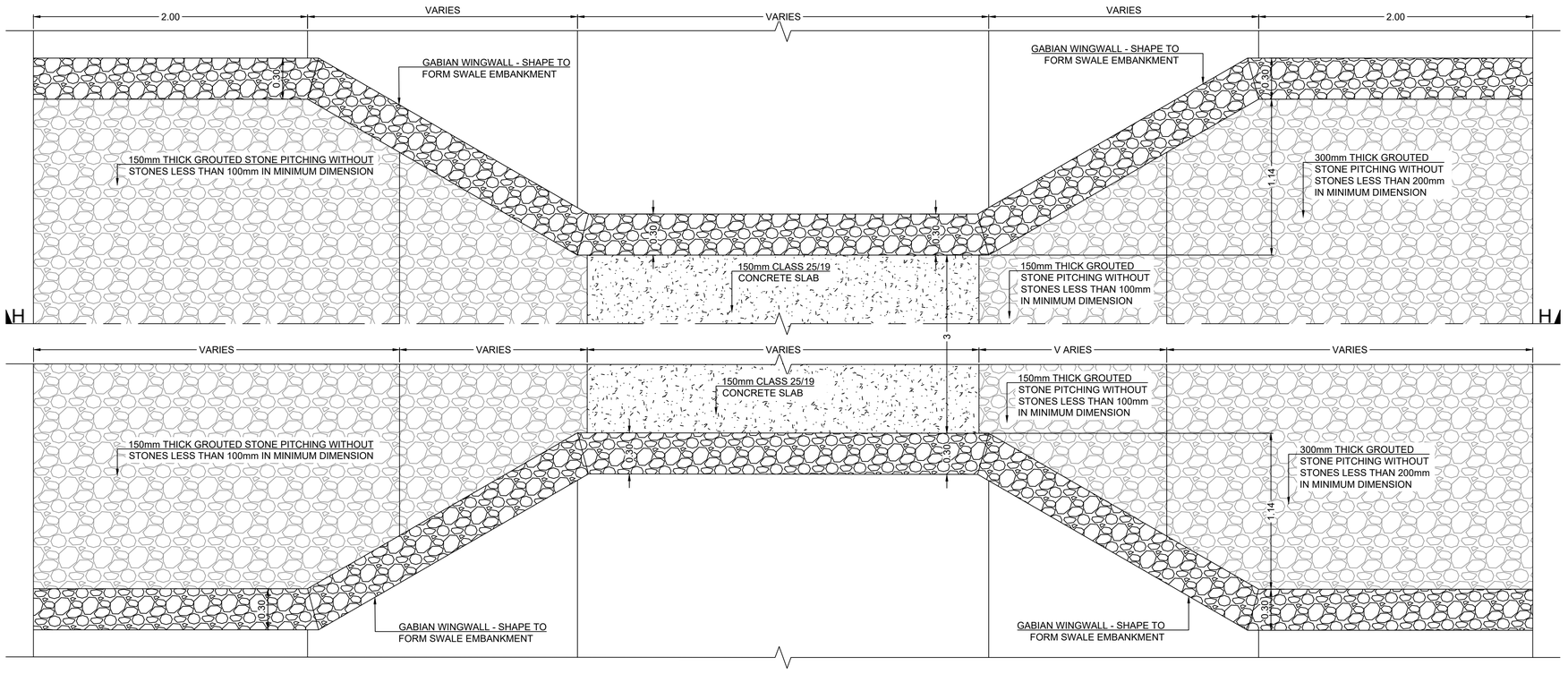
CONTRACT No.	
PROJECT No.	458
SHEET No.	1 OF 2
PAPER SIZE	A1
SCALE	1:20

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7,8,12 & RE/23 KRAAIBOSCH NO.195)

DRAWING TITLE
STORMWATER TYPICAL DETAIL

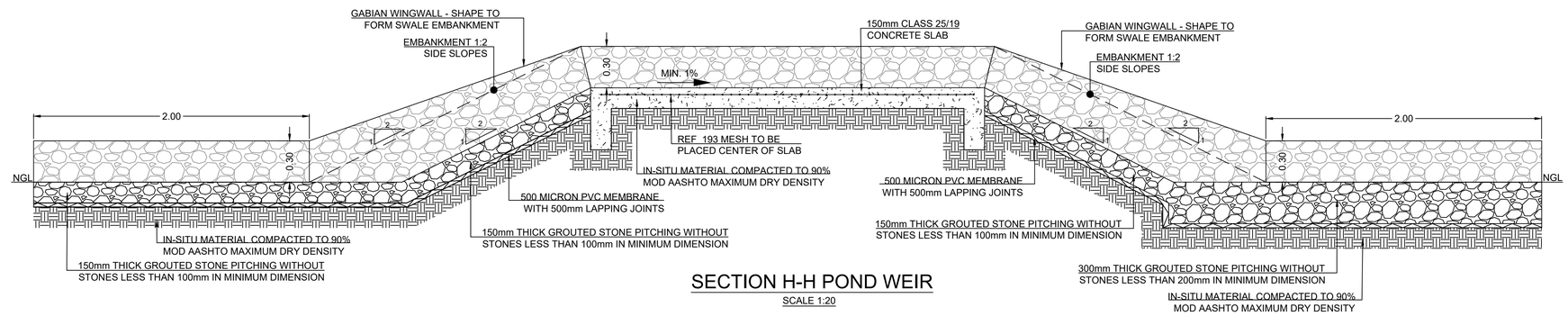
DRAWING NUMBER 458_04A_D1 P1 REVISION

ANNEXURE H4: STORMWATER TYPICAL DETAILS: 458_04A_D2_REV.P1



TOP VIEW OF A POND WEIR

SCALE 1:20



SECTION H-H POND WEIR

SCALE 1:20

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
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8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
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15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
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13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P1	2026-07-28	LLM	ISSUED FOR COMMENTS AND APPROVAL

ROADS AND STORMWATER

APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W STOKER

DRAWN
NAME: LLM

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng, email=wstoker83@mweb.com, c=ZA
Date: 2026.07.31 11:54:39 +02'00'

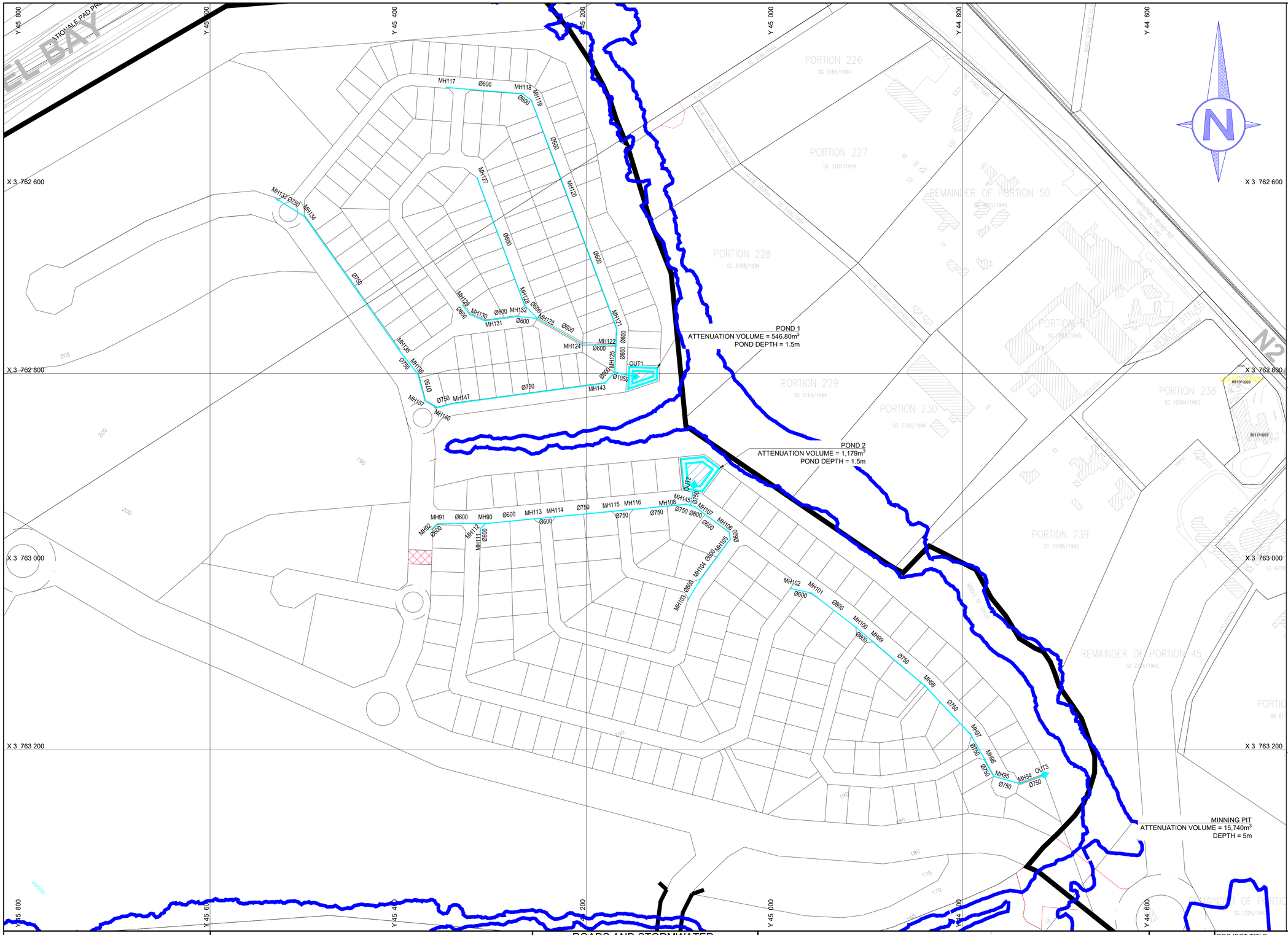
CONTRACT No.	
PROJECT No.	458
SHEET No.	2 OF 2
PAPER SIZE	A1
SCALE	1:20

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7,8,12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
TYPICAL
DETAIL

DRAWING NUMBER 458_04A_D2 P1 REVISION

ANNEXURE H5: STORMWATER GENERAL LAYOUT PLAN: 458_04A_GL1_REV.P3



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
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6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
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SPECIFIC NOTES:

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13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- PROPOSED WETLAND BUFFER

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026-07-09	MGP	TOWNPLANNER LAYOUT CHANGED
P2	2026-07-27	MGP	PIPE SIZE CHANGED
P3	2026/07/29	MGP	STRUCTURE NAME ADDED

ROADS AND STORMWATER

APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W STOKER

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng., 202101796, email=wynand@jtevolve.co.za, c=ZA
Date: 2026.07.31 11:54:14 +02'00'

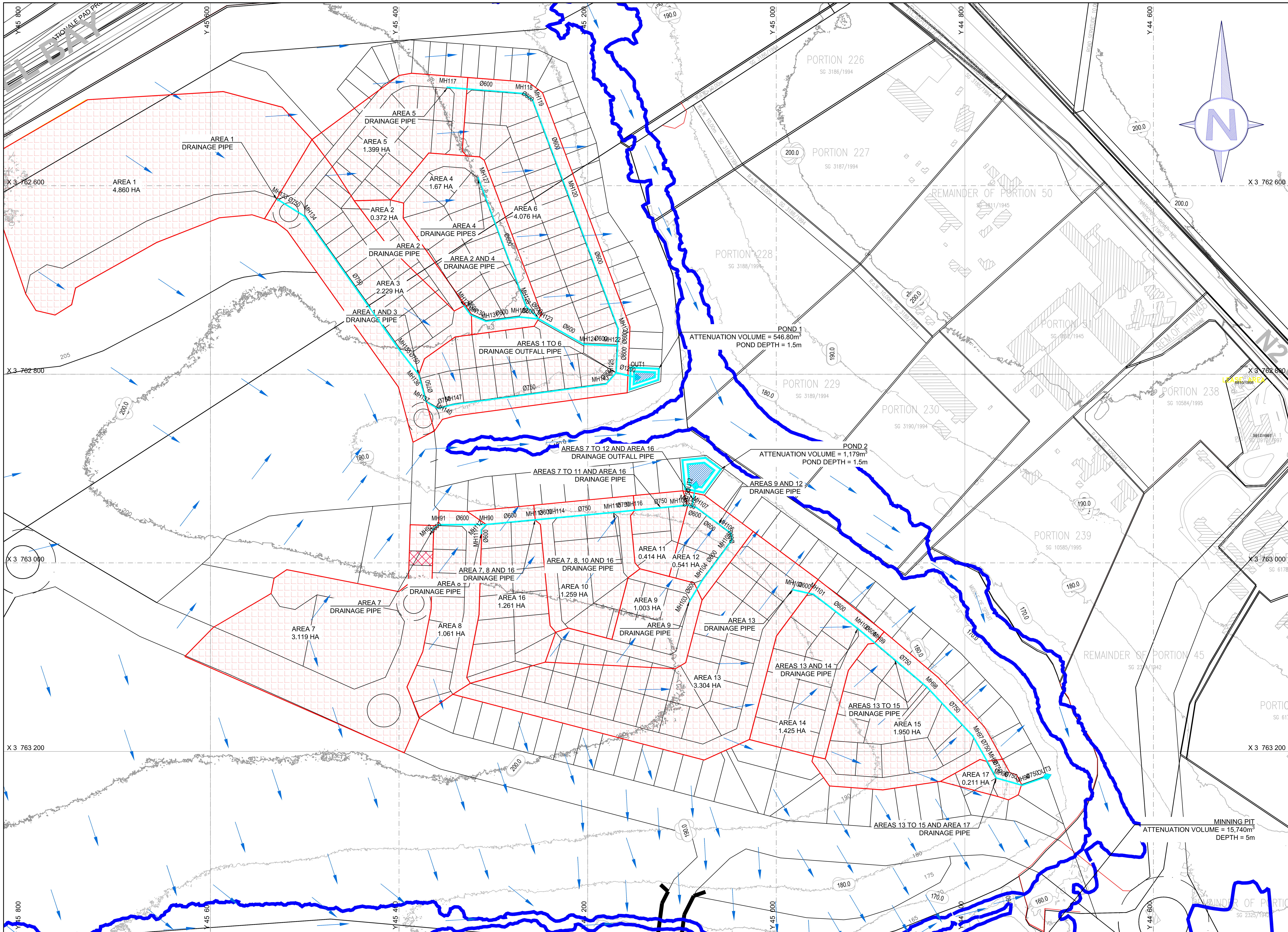
CONTRACT No.	
PROJECT No.	458
SHEET No.	1 OF 2
PAPER SIZE	A1
SCALE	1:2 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
GENERAL LAYOUT
PLAN

DRAWING NUMBER 458_04A_GL1 P3 REVISION

ANNEXURE H6: STORMWATER GENERAL LAYOUT PLAN: 458_04A_GL2_REV.P1



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED.

LEGEND:

- ROAD
- EXISTING STORMWATER LINE
- EXISTING CONNECTION POINTS
- PROPOSED STORMWATER PIPE
- PROPOSED STORMWATER MANHOLE
- PROPOSED STORMWATER KI's
- PROPOSED STORMWATER INLET
- PROPOSED STORMWATER OUTLET
- STORMWATER RUNOFF FLOW ARROWS
- 100 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026-07-30	LLM	PIPES SUB CATCHMENT AREAS SHOWN

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:............................ PROF REG No:....................
SIGNATURE:............................ DATE:....................

PROJECTS DIVISION
NAME:............................ PROF REG No:....................
SIGNATURE:............................ DATE:....................

PLANNING DIVISION
NAME:............................ PROF REG No:....................
SIGNATURE:............................ DATE:....................

CONSULTING ENGINEERS:

JT | EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W STOKER DATE:
PROF REG No: 202101798
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng.: 202101798, email=wynand@jtevolve.com, c=ZA
Date: 2026.07.31 11:53:48 +02'00'
SIGNATURE:

CONTRACT No.

PROJECT No.
458

SHEET No.
2 OF 2

PAPER SIZE
A1

SCALE
1:1 000

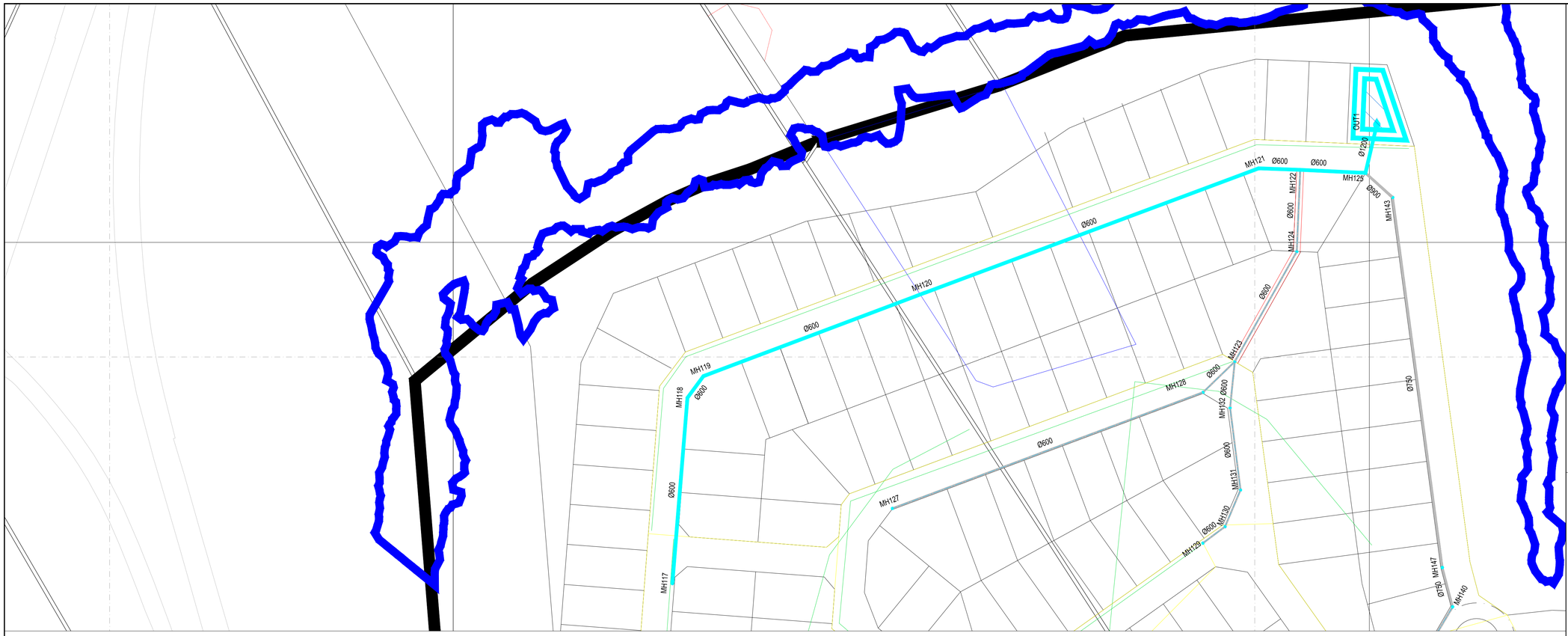
PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

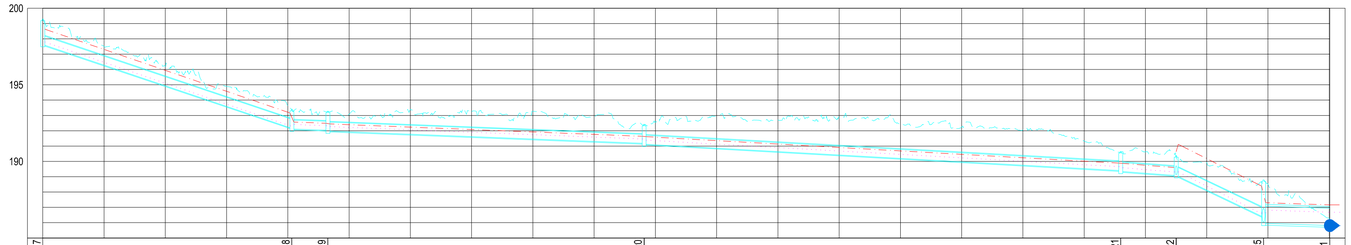
DRAWING TITLE
STORMWATER
GENERAL LAYOUT
PLAN

DRAWING NUMBER
458_04A_GL2

P1
REVISION

ANNEXURE H7: STORMWATER LONG SECTIONS: 458_04A_L1_REV.P1





SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 185.000

			MH117	MH118	MH119	MH120	MH121	MH122	MH125	OUT1
REFERENCE				Ø600 75D	Ø600 75D	Ø600 75D	Ø600 75D	Ø600 75D	Ø600 75D	Ø1200 100D
DISTANCE (m)			0.000	81.325	93.083	196.324	351.921	370.032	398.550	420.189
GROUND LEVEL			199.232	193.346	193.221	192.361	190.565	190.311	188.732	186.238
PIPE INVERT LEVEL			197.630	192.161	192.111 / 192.032	191.176	191.126	189.400	189.350 / 189.076	186.354 / 185.957	185.812
SLOPE / LENGTH				6.73% 1:14.9 81.33m	0.67% 1:149.9 11.76m	0.78% 1:128.1 103.24m	1.11% 1:90.1 155.60m	1.51% 1:66.1 18.11m	9.54% 1:10.5 28.52m	0.67% 1:149.3 21.64m
HYDRAULICS	DESIGN	Q(m3/s)		0.24	0.24	0.24	0.24	0.24	0.59	2.52
		V(m/s)		4.1	1.8	1.9	2.1	2.4	6.0	3.1
	MAX. (0.8D)	Q(m3/s)		1.46	0.46	0.50	0.59	0.69	1.73	2.64
		V(m/s)		6.3	2.0	2.2	2.6	3.0	7.5	3.1

LONGSECTION MH117 - MH126
FROM 0.000 TO 420.189

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED.

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026/07/29	MGP	TOWNPLANER LAYOUT CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:..... Digitally signed by Wynand Stoker DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng 20210107006, email=wynand@jtevolve.co.za, c=ZA Date: 2026.07.31 11:53:20 +02'00'

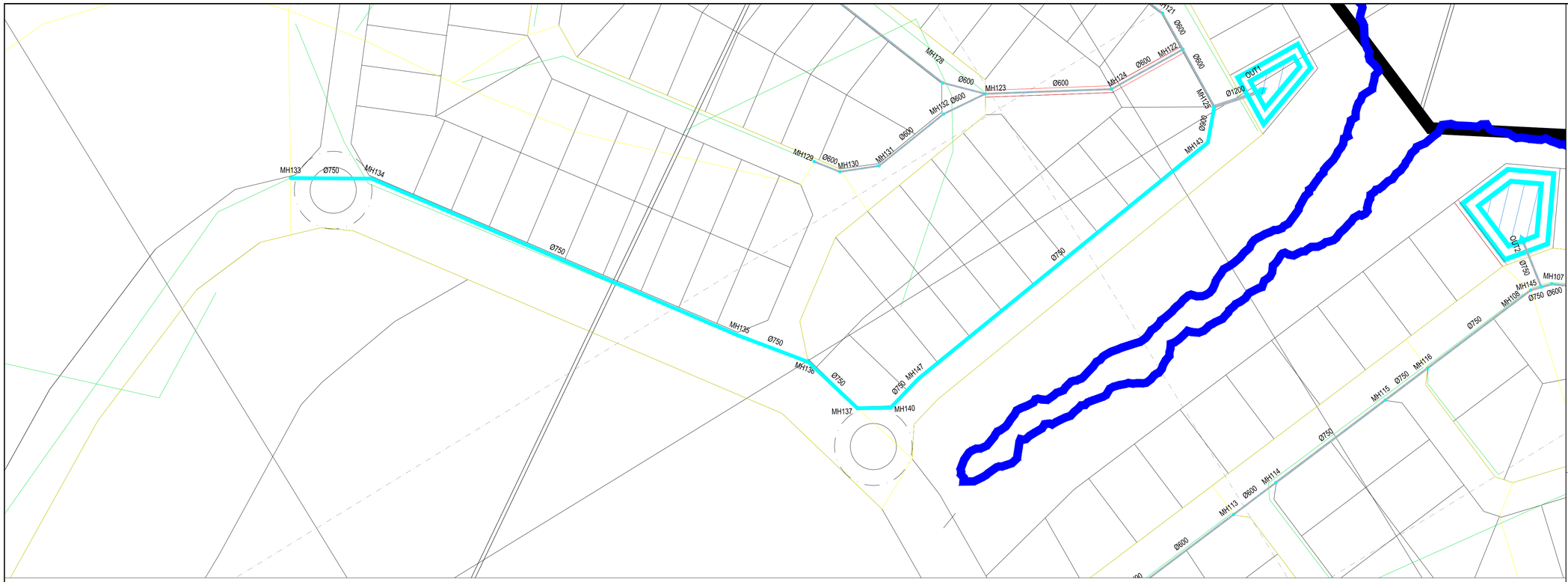
CONTRACT No.	
PROJECT No.	458
SHEET No.	1 OF 6
PAPER SIZE	A1
SCALE	1:1000

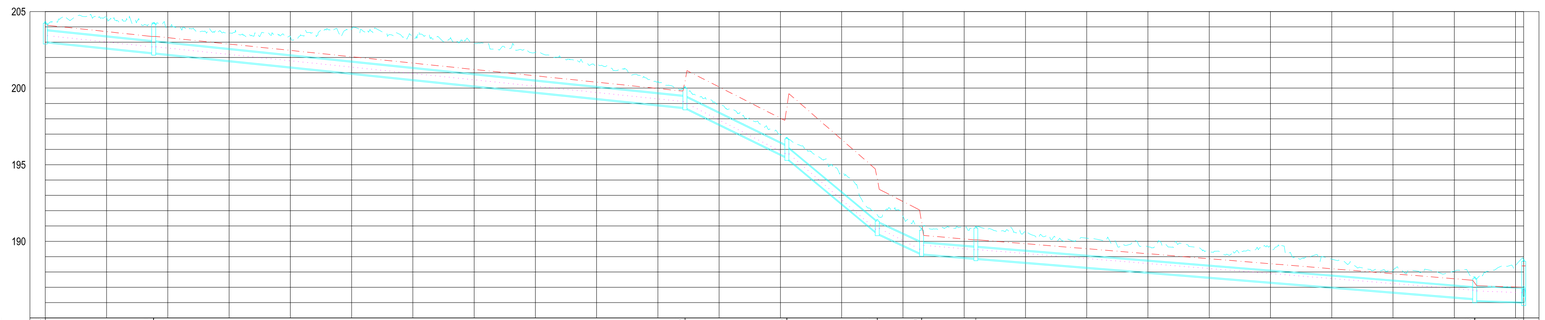
PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
LONGITUDINAL
SECTION

DRAWING NUMBER 458_04A_L1 P1 REVISION

ANNEXURE H8: STORMWATER LONG SECTIONS: 458_04A_L2_REV.P1



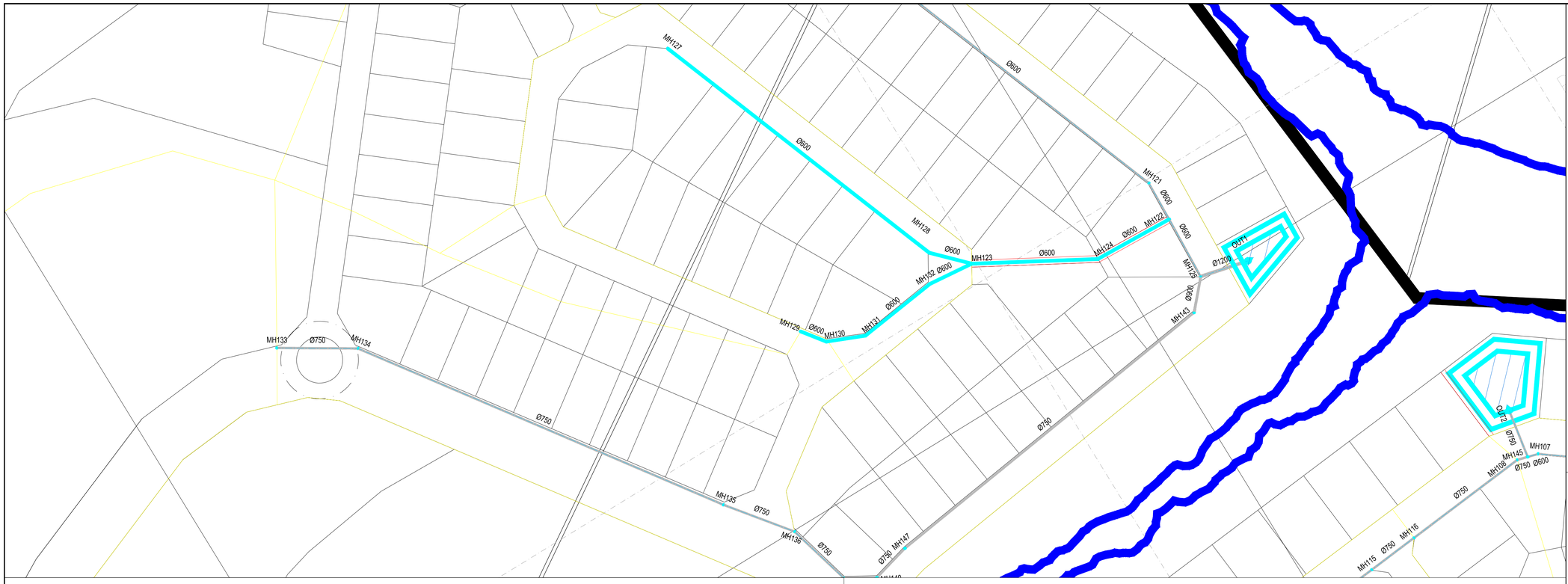


SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 185.000

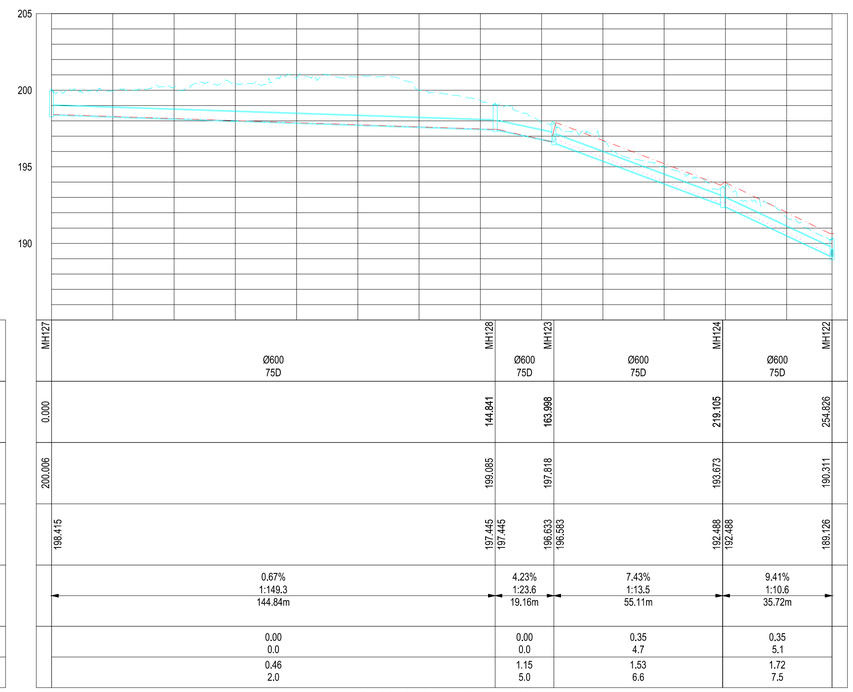
| | | |

ANNEXURE H9: STORMWATER LONG SECTIONS: 458_04A_L3_REV.P1



SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 185.000

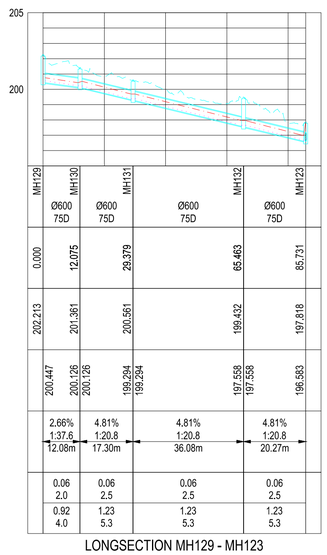


REFERENCE		MH127	Ø600 75D		MH128	Ø600 75D	MH123	Ø600 75D		MH124	Ø600 75D	MH122
DISTANCE (m)		0.000			144.841		163.998			219.105		254.826
GROUND LEVEL		200.006			199.085		197.618			193.673		190.311
PIPE INVERT LEVEL		198.415			197.445	197.445	196.633	196.583		192.488	192.488	189.126
SLOPE / LENGTH			0.67% 1:149.3 144.84m			4.23% 1:23.6 19.16m		7.43% 1:13.5 55.11m			9.41% 1:10.6 35.72m	
HYDRAULICS	DESIGN Q(m3/s) V(m/s)		0.00 0.0			0.00 0.0		0.35 4.7			0.35 5.1	
	MAX. (0.8D) Q(m3/s) V(m/s)		0.46 2.0			1.15 5.0		1.53 6.6			1.72 7.5	

LONGSECTION MH127 - MH122
FROM 0.000 TO 254.826

SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 195.000



REFERENCE		MH129	Ø600 75D		MH130	Ø600 75D	MH131	Ø600 75D		MH132	Ø600 75D	MH123
DISTANCE (m)		0.000			12.075		29.379			65.463		85.731
GROUND LEVEL		202.213			201.361		200.561			199.432		197.818
PIPE INVERT LEVEL		200.447			200.126	200.126	199.294	199.294		197.558	197.558	196.583
SLOPE / LENGTH			2.66% 1:37.6 12.08m			4.81% 1:20.8 17.30m		4.81% 1:20.8 36.08m			4.81% 1:20.8 20.27m	
HYDRAULICS	DESIGN Q(m3/s) V(m/s)		0.06 2.0			0.06 2.5		0.06 2.5			0.06 2.5	
	MAX. (0.8D) Q(m3/s) V(m/s)		0.92 4.0			1.23 5.3		1.23 5.3			1.23 5.3	

LONGSECTION MH129 - MH123
FROM 0.000 TO 85.731

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026/07/29	MGP	TOWNPLANER LAYOUT CHANGED

ROADS AND STORMWATER

APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:

JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:.....

Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=IT Engineering(168.isu.ff-Eng-3021017), email=wynand@jtevolve.com, c=ZA
Date: 2026.07.31 11:52:40 +02'00'

CONTRACT No.

PROJECT No. 458

SHEET No. 3 OF 6

PAPER SIZE A1

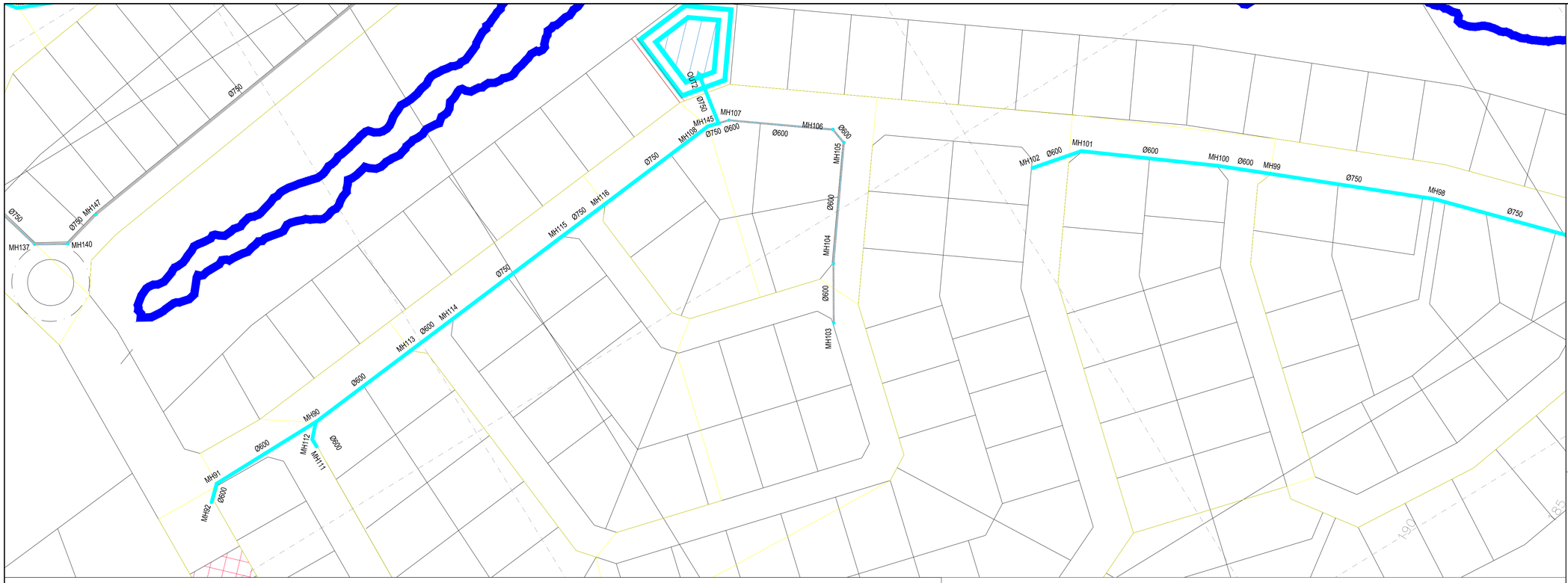
SCALE 1:1000

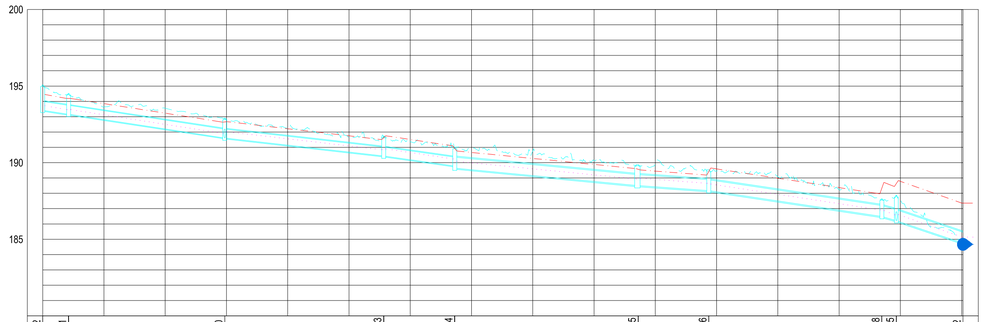
PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
LONGITUDINAL
SECTION

DRAWING NUMBER 458_04A_L3 P1 REVISION

ANNEXURE H10: STORMWATER LONG SECTIONS: 458_04A_L4_REV.P1



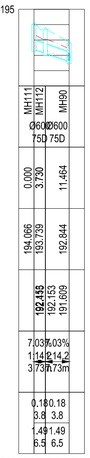


SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 180.000

			MH92	MH91		MH90		MH113		MH114		MH115		MH116		MH108	MH145	OUT2
REFERENCE				Ø600 75D		Ø600 75D		Ø600 75D		Ø750 100D		Ø750 100D		Ø750 100D		Ø750 100D	Ø750 100D	
DISTANCE (m)			0.000	8.464		59.449		111.322		134.516		194.399		217.466		273.950	278.685	300.431
GROUND LEVEL			195.017	194.467		192.844		191.669		190.947		189.805		189.473		187.581	187.855	184.747
PIPE INVERT LEVEL			193.415	193.158		191.609		190.434		190.434		188.497		188.304		188.172	188.172	184.747
SLOPE / LENGTH				3.04% 1:32.9 8.46m		3.04% 1:32.9 50.99m		2.26% 1:44.2 51.88m		2.83% 1:35.3 23.18m		1.92% 1:52.1 59.88m		1.44% 1:69.5 23.07m		2.98% 1:33.5 56.48m	5.75% 1:17.4 4.74m	6.75% 1:14.8 21.75m
HYDRAULICS	DESIGN	Q(m3/s)		0.54		0.54		0.72		0.94		0.94		0.94		1.16	1.32	1.50
		V(m/s)		3.8		3.8		3.6		4.1		3.6		3.2		4.5	6.0	6.6
	MAX. (0.8D)	Q(m3/s)		0.98		0.98		0.84		0.94		1.34		1.16		1.67	2.32	2.52
		V(m/s)		4.2		4.2		3.7		4.1		3.9		3.3		4.8	6.7	7.2

LONGSECTION MH92 - MH110
FROM 0.000 TO 300.431



SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 190.000

			MH111	MH112	MH90
REFERENCE			Ø600 75D	Ø600 75D	
DISTANCE (m)			0.000	3.750	11.464
GROUND LEVEL			194.066	193.739	192.844
PIPE INVERT LEVEL			192.145	192.145	191.609
SLOPE / LENGTH			7.03% 1:14.2 3.75m	3.03% 1:33.0 7.71m	
HYDRAULICS	DESIGN	Q(m3/s)	0.18	0.18	
		V(m/s)	3.8	3.8	
	MAX. (0.8D)	Q(m3/s)	1.49	1.49	
		V(m/s)	6.5	6.5	

LONGSECTION MH111 - MH90
FROM 0.000 TO 11.464

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026/07/29	MGP	TOWNPLANER LAYOUT CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng | 2021017 98, email=wynand@jtevolve.com, c=ZA
Date: 2026.07.31 11:52:21 +02'00'

CONTRACT No.

PROJECT No. 458

SHEET No. 4 OF 6

PAPER SIZE A1

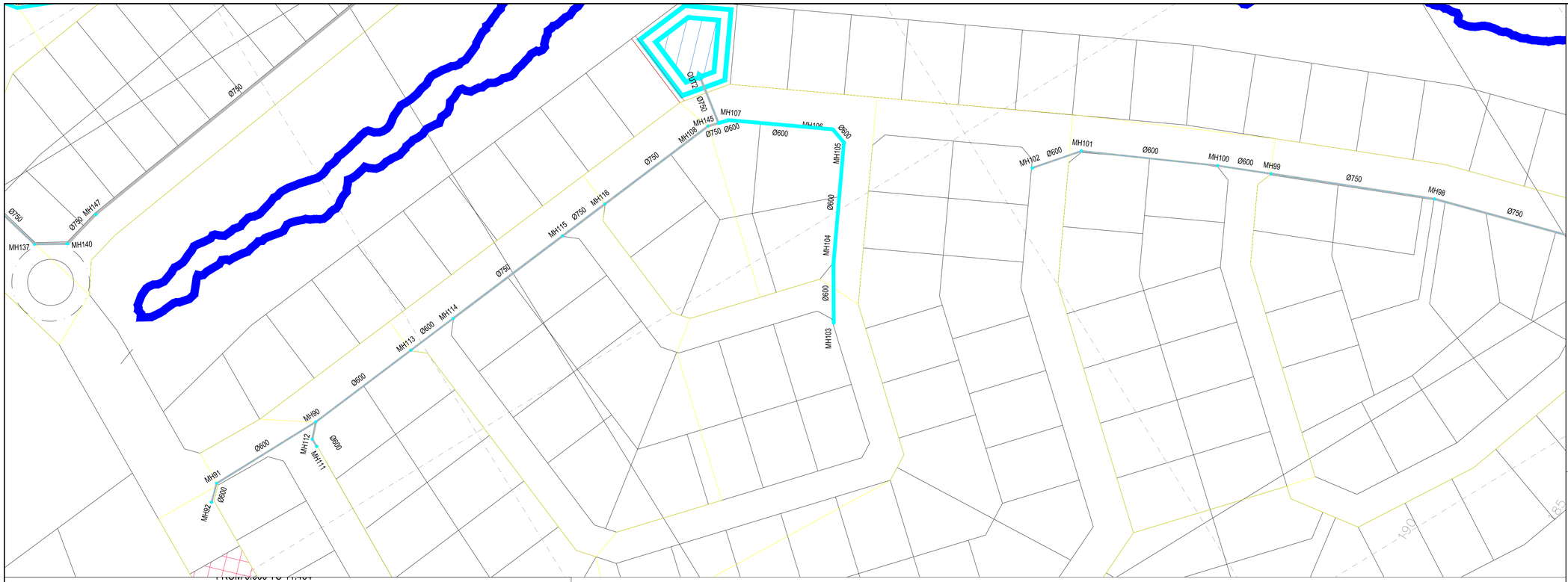
SCALE 1:1000

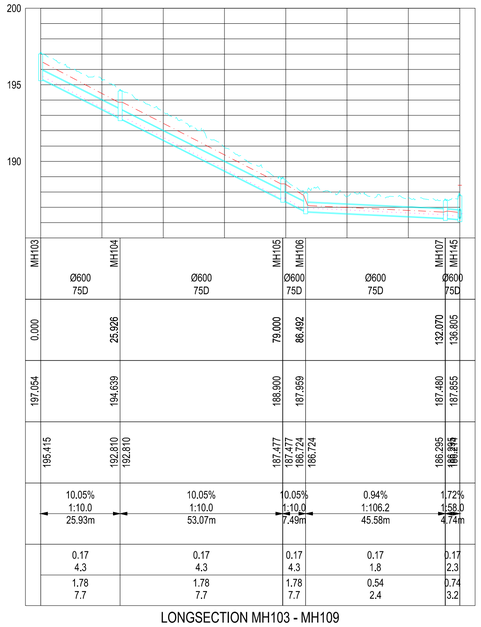
PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
LONGITUDINAL
SECTION

DRAWING NUMBER 458_04A_L4 P1 REVISION

ANNEXURE H11: STORMWATER LONG SECTIONS: 458_04A_L5_REV.P11





SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 185.000

REFERENCE		
DISTANCE (m)		
GROUND LEVEL		
PIPE INVERT LEVEL		
SLOPE / LENGTH		
HYDRAULICS	DESIGN	Q(m3/s) V(m/s)
	MAX. (0.8D)	Q(m3/s) V(m/s)

LONGSECTION MH103 - MH109
FROM 0.000 TO 136.805

GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. DO NOT SCALE FROM THESE DRAWINGS.
3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
4. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICCIPAL CIVIL ENGINEERING WORKS,THIRD EDITION 2005 AND STANDARD COE DETAIL DRAWINGS.
5. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS.(IF APPLICABLE)
6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
10. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- 50 YEAR FLOODLINE

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026/07/29	MGP	TOWNPLANER LAYOUT CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W JACOBS

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:.....
Digitally signed by Wynand Stoker
DN: cn=Wynand Stoker, o=JT Evolve (Pty) Ltd, ou=Pr Eng.: 20210179B, email=wynand@jtevolve.com, c=ZA
Date: 2026.07.31 11:51:48 +02'00'

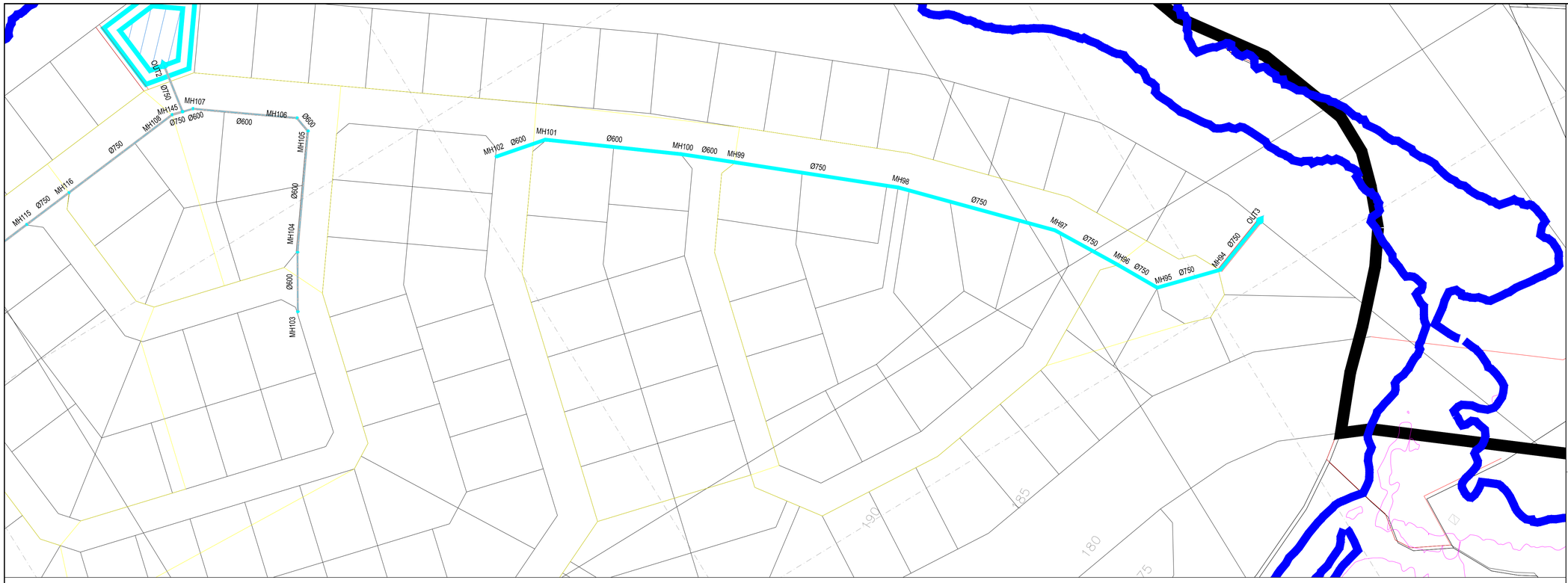
CONTRACT No.	
PROJECT No.	458
SHEET No.	5 OF 6
PAPER SIZE	A1
SCALE	1:1000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
LONGITUDINAL
SECTION

DRAWING NUMBER 458_04A_L5 P1 REVISION

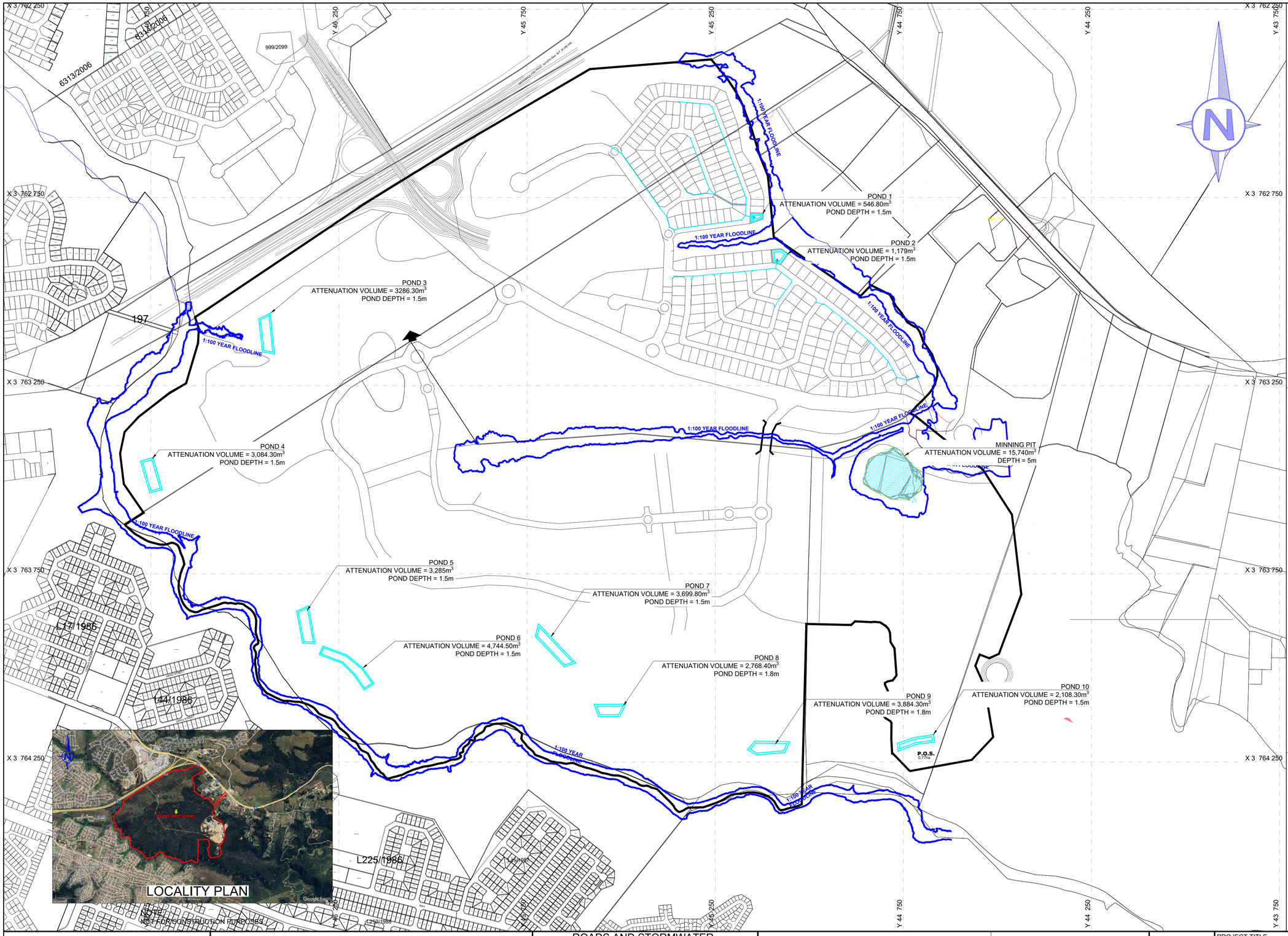
ANNEXURE H12: STORMWATER LONG SECTIONS: 458_04A_L6_REV.P1



SCALES:
Horizontal 1:1000
Vertical 1:200

DATUM 170.000

| | | |



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
3. UNLESS OTHERWISE SHOWN ALL CONCRETE SHALL BE CLASS 25MPa/19mm.
4. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
5. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
6. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
7. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED.

LEGEND:

- EXISTING ROAD
- PROPOSED ROAD
- EXISTING STORMWATER
- PROPOSED STORMWATER
- USABLE SITE AREA 2 ,982,336 m²

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2026-07-12	LLM	PRELIMINARY POND SIZES AND LOCATION FOR NEW TOWN PLANNER LAYOUT
P1	2026-07-27	LLM	PONDS AND PIPES SIZING CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: WF STOKER

DRAWN
NAME: LLM

APPROVED
NAME: W STOKER DATE:.....
PROF REG No: 202101798
SIGNATURE:.....

CONTRACT No.

PROJECT No. 458

SHEET No. 1 OF 1

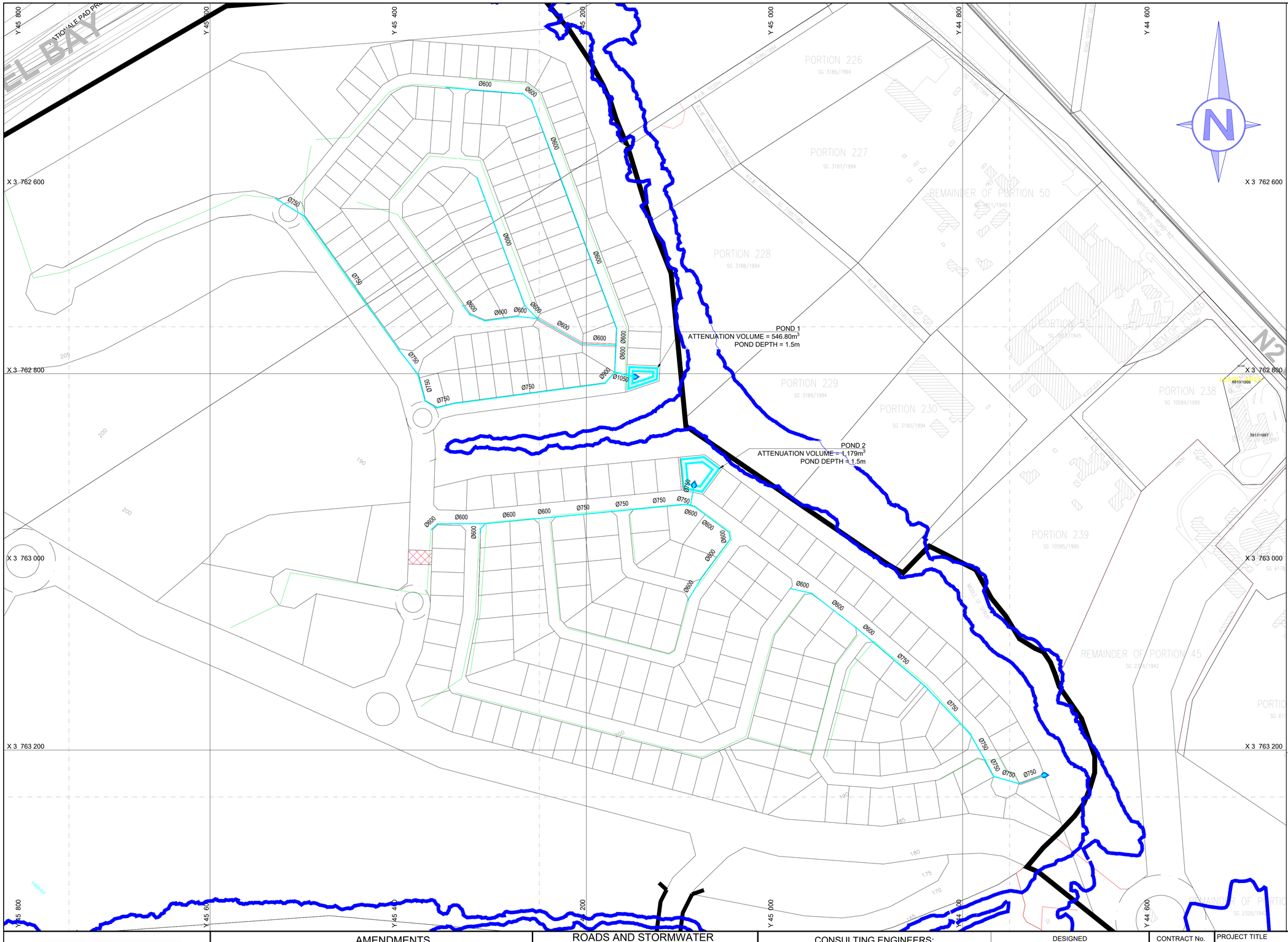
PAPER SIZE A1

SCALE 1:5 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER MANAGEMENT PLAN

DRAWING NUMBER 458_04A_SWMP1 P1 REVISION



GENERAL NOTES:

1. MINIMUM REQUIREMENTS ARE INDICATED ON THE DRAWING. THE CONSULTANT / DESIGNER IS RESPONSIBLE AND LIABLE FOR FURTHER DETAILS AND TO ENSURE EFFECTIVE OPERATION AND MAINTENANCE OF THE INSTALLATION.
2. THE SIGNATURE OR INITIALS ON THIS DRAWING OF COE OFFICIAL DOES NOT REMOVE ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT / DESIGNER.
3. THE CONSULTANT / DESIGNER REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARD DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE WATER AND SANITATION DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH IN THE DESIGN.
4. ALL MATERIAL AND WORKMANSHIP MUST COMPLY WITH THE REQUIREMENTS OF THE LATEST RELEVANT SANS STANDARD.
5. FINAL POSITION OF SERVICES TO BE DETERMINED ON SITE.
6. ALL DIMENSIONS TO BE CHECKED AND APPROVED ON SITE.
7. ALL DIMENSIONS ARE IN m (UNLESS OTHERWISE SPECIFIED).
8. DO NOT SCALE FROM THESE DRAWINGS.
9. CLASS OF CONCRETE UNLESS OTHERWISE SPECIFIED ON DRAWING DETAILS:

REINFORCED	CLASS 30/19
THRUST BLOCKS	CLASS 20/19
BLINDING	CLASS 15/19
FLOOR SCREED	SAND : CEMENT = 3 : 1

10. PRE-CAST CONCRETE RINGS AND COVER SLABS TO COMPLY WITH SANS 1294.
11. JOINTS BETWEEN CONCRETE RINGS AND BETWEEN COVER SLABS AND BETWEEN RINGS AND FLOORS TO BE SEALED WITH BITUMEN SEALANT(APPROVED BY THE DESIGNER).
12. SEWER INSTALLED WITHIN ROAD RESERVE BOUNDARIES MUST BE POSITIONED IN ACCORDANCE WITH THE APPLICABLE SERVICES LAYOUT DRAWINGS.
13. ALL CONSTRUCTION TO BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, THIRD EDITION 2005 AND THE STANDARD COE DETAIL DRAWINGS.
14. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE ARCHITECTS DRAWINGS (IF APPLICABLE)
15. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATIONS FOR MUNICIPAL CIVIL ENGINEERING WORKS, SERIES 4.

SPECIFIC NOTES:

1. ALL PIPES TO BE CONCRETE SPIGOT AND SOCKET WITH ROLLING RUBBERRINGS OR SLIDING RUBBER JOINTS OF PIPE CLASS SPECIFIED IN ACCORDANCE WITH SANS 677 LAYED IN CLASS B BEDDING UNDER ROAD SURFACES OR CLASS C BEDDING ELSEWHERE.
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3. ALL DIMENSIONS MUST BE CHECKED AND APPROVED ON SITE.
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6. THESE DRAWINGS MUST BE READ IN CONJUNCTION WITH THE STANDARD SPECIFICATION FOR MUNICIPAL CIVIL ENGINEERING WORKS.
7. THE SIGNATURE OR INITIALS ON THIS DRAWING OF ANY MANAGER OF THE TRANSPORT DEPARTMENT, IN NO WAY REMOVES ANY RESPONSIBILITY WHATSOEVER FROM THE CONSULTANT.
8. THE CONSULTANT REMAINS RESPONSIBLE TO ENSURE THAT ALL THE GUIDELINES, STANDARDS DRAWINGS, STANDARDS AND SPECIFICATIONS OF THE TRANSPORT DEPARTMENT HAVE BEEN MET AND ARE COMPLIED WITH.
9. FINAL POSITION OF SERVICE TO BE DETERMINED ON SITE
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11. CONCRETE FOR BENCHING SHALL BE CLASS 15MPa/38mm OR CLASS 15MPa/19mm.
12. UNLESS OTHERWISE SHOWN OR SPECIFIED ALL EXPOSED CONCRETE SURFACES SHALL HAVE A WOOD FLOAT SURFACE FINISH AND SHALL BE COVERED WITH AN APPROVED CURING COMPOUND WITHIN 24 HOURS OF CASTING
13. ALL CONCRETE EDGES SHALL BE CHAMFERRED 20mm.
14. EXISTING SERVICES THAT ARE INDICATED TO BE "REMOVED" AND ARE SITUATED UNDER FLOOR SLABS SHALL BE DISCONNECTED AND ABANDONED

LEGEND:

- EXISTING STORMWATER
- PROPOSED STORMWATER
- 100 YEAR FLOODLINE
- PROPOSED WETLAND BUFFER

GEORGE
THE CITY FOR ALL REASONS

ROADS AND STORMWATER
DEPARTMENT

AMENDMENTS

REV	DATE	BY	DESCRIPTION
P0	2024-12-04	MGP	ISSUED FOR COMMENTS / APPROVAL
P1	2026-07-09	MGP	TOWNPLANNER LAYOUT CHANGED
P2	2026-07-27	MGP	PIPE SIZE CHANGED

ROADS AND STORMWATER
APPROVED ON BEHALF OF:

OPERATIONS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PROJECTS DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

PLANNING DIVISION
NAME:..... PROF REG No:.....
SIGNATURE:..... DATE:.....

CONSULTING ENGINEERS:
JT EVOLVE
ACTA NON VERBA (PTY) LTD.

DESIGNED
NAME: W STOKER

DRAWN
NAME: MGP

APPROVED
NAME: W JACOBS DATE:.....
PROF REG No: 202403261
SIGNATURE:.....

CONTRACT No.

PROJECT No.
458

SHEET No.
1 OF 8

PAPER SIZE
A1

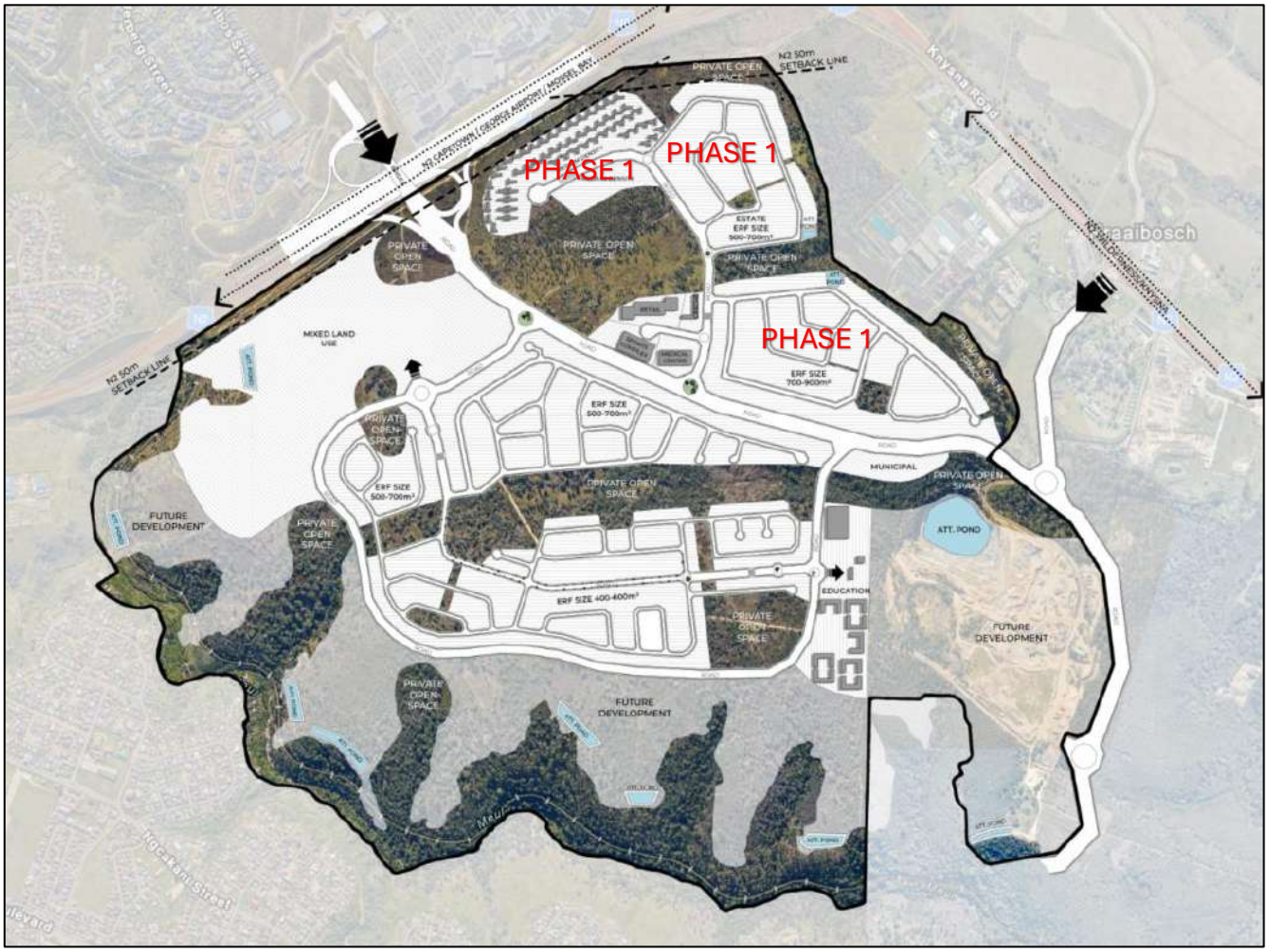
SCALE
1:2 000

PROJECT TITLE
GARDEN ROUTE CITY
(PTNS 7, 8, 12 & RE/23 KRAAIBOSCH NO. 195)

DRAWING TITLE
STORMWATER
GENERAL LAYOUT
PLAN

DRAWING NUMBER
458_04A_GL1
P2
REVISION

ANNEXURE 20



GRG 432

GARDEN ROUTE CITY – PHASE 1

ELECTROTECHNICAL REPORT

OCTOBER 2026

EMPLOYER/CLIENT:

KIRON PROPERTIES

26 WHITTAKERS WAY, BEDFORDVIEW

GERMISTON

ENGINEER:

BDE CONSULTING ENGINEERS

73 MEADE STREET

GEORGE

BDE CONSULTING ENGINEERS

TEMPLATE REFERENCE

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BDE CONSULTING ENGINEERS

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1 INTRODUCTION

This electrical engineering services report covers the electrical network required to provide an adequate electricity supply for the initial Phase A of the envisaged Garden Route City development, as well as the network development required to accommodate the longer-term requirements of the complete Garden Route City development.

The envisaged Garden Route City development will be established on the open municipal area adjacent to the N2, as presented in Figure 1. The two closest 66/11 kV municipal substations, namely SS Thembalethu and SS Glenwood, are also indicated.

Figure 1: Geographical area Garden Route City development.



2 EXISTING ELECTRICAL INFRASTRUCTURE

There are no 11 kV (MV) networks crossing the development area. The nearby MV networks do not have sufficient spare network capacity to accommodate any phase of the envisaged development.

The 66 kV Electrical Master Plan, prepared by BDE Consulting Engineers, took the Garden Route City development area into account and provides for a dedicated 66/11 kV substation (see Annexure A).

The adjacent Thembalethu 66/11 kV substation, comprising two 20 MVA transformers and designed by BDE Consulting Engineers, has been constructed and was recently energised. According to the 66 kV Electrical Master Plan, a dedicated 66/11 kV substation will be required north of the existing SS Thembalethu to supply the Garden Route City area and to strengthen the existing MV networks surrounding the N2 and the Sasol/Victoria Bay supply area.

3 EXPECTED DEMAND & DESIGN CRITERIA

3.1 LOAD ESTIMATE

The load estimation presented in the table below is based on the Master Plan Garden Route City, done by Aeterno Town Planning (Pty) Ltd and dated 20 September 2026. A diversified factor of 0.9 was used to calculate a realistic load estimate of **~1.1 MVA** for Phase 1 of the development.

Table 2: Load estimate Garden Route City - Phase 1

Phase No	Name	Zoning	Comments	Units	ADMD (kVA)	Total kVA
1	Phase 1 development area	Res 1	Estate Housing	144	2.5	355.0
		Res 1	Estate Housing	127	2.5	317.5
		Res 3	Group Housing	290	1.8	522.0
	Private Road Streetlights (External)		37W Ledlume Mini	x 10	0.04	0.4
	Private Road Streetlights (Internal)		37W Ledlume Mini	x 50	0.04	2.0
	Private Road Streetlights (Main external)		LEDlume XP 2 30 LED 96W OPTIC 5307.ldt. streetlights	x 50	0.1	5.0
	General supplies (pump stations, etc.)					30.0
Total load estimate:						**1232**
Total load estimate (diversified - DF=0.9) (MVA):						**1.11**

3.2 RETICULATION DESIGN CRITERIA

The complete internal electrically network of the development is designed for after diversified maximum demands (ADMD) between 4.0 kVA and 4.5 kVA per supply connection, as required by regulation for the various type of loads to be supplied within the development.

The natural loading of the internal network is expected to be closer to ADMD's of approximately 1.8 kVA to 2.5 kVA per supply connection at transformer level, which correlate to a before diversified maximum demands (BDMD) of 6.4 kVA and 8.5 kVA per supply connection for the various type of loads to be supplied within the development (according to the Herman-Beta probabilistic load flow algorithm).

4 PROPOSED ELECTRICAL DISTRIBUTION NETWORK

4.1 POINT OF SUPPLY

The point of supply for the Garden Route City Phase 1 development will be at two 11 kV circuit breakers in the new SS Garden Route substation to be established, supplied from the existing SS Thembalethu substation. Should the Municipality prefer to take over the internal MV network between the development zones, the points of supply will instead be at the three Bulk Metering Units (BMUs) to be established at the entrances to the three housing developments.

The internal MV networks of the development zones will be supplied from the 4-way bulk-metered RMU (BMU) to be established adjacent to each development.

4.2 CONSUMPTION METERING

The Garden Route City development will be bulk-metered at 11 kV at the new SS Garden Route substation, or alternatively at the three BMUs.

In each development zone, strategically positioned 11/0.42 kV mini-substations will supply low-voltage (LV) distribution feeders via several distribution kiosks to the end customers. Individual LV metering of all residential units will be provided by means of a private prepayment metering system.

4.3 PROPOSED NEW SUBSTATION

The new SS Garden Route 66/11 kV substation will be strategically established in an area designated for municipal services within the development. The proposal is to establish the substation in phases. During Phase 1, the substation yard and control and switching buildings will be established. All 66 kV switchgear, as well as the 66/11 kV transformers, will be installed at a later stage when the development or area load requirements necessitate their installation.

66 kV overhead line servitudes will be registered from SS Thembalethu to SS Garden Route. The 66 kV overhead lines to be established will initially, during Phase 1, be operated at 11 kV from SS Thembalethu.

4.4 PROPOSED MEDIUM VOLTAGE (MV) NETWORK

As mentioned, the supply to the new SS Garden Route substation will initially be operated at 11 kV from SS Thembalethu via two single-circuit 66 kV isolated overhead lines to the new SS Garden Route 11 kV switching building (see Annexure B for the anticipated 66 kV tower configurations).

An 11 kV internal MV ring network will be established from the SS Garden Route 11 kV switching building, passing through each development zone and connecting to the BMU at each development. Each development will further have its own internal MV network from the BMU supplying the strategically positioned mini-substations.

Figures 2 and 3 present the geographical layout of the MV network integration from SS Thembalethu to the Garden Route City development. See Annexure A for the complete geographical drawing.

Figure 2: Geographical Phase 1 MV network from SS Thembalethu to Garden Route City – Thembalethu side.

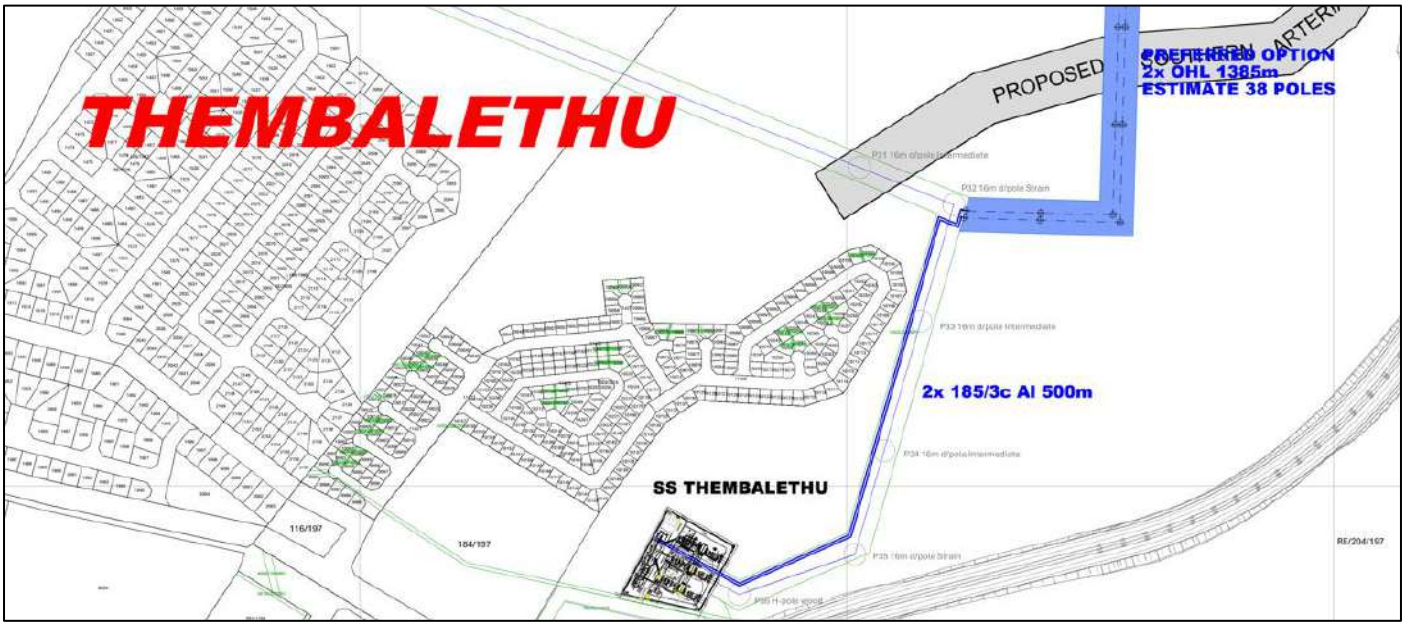
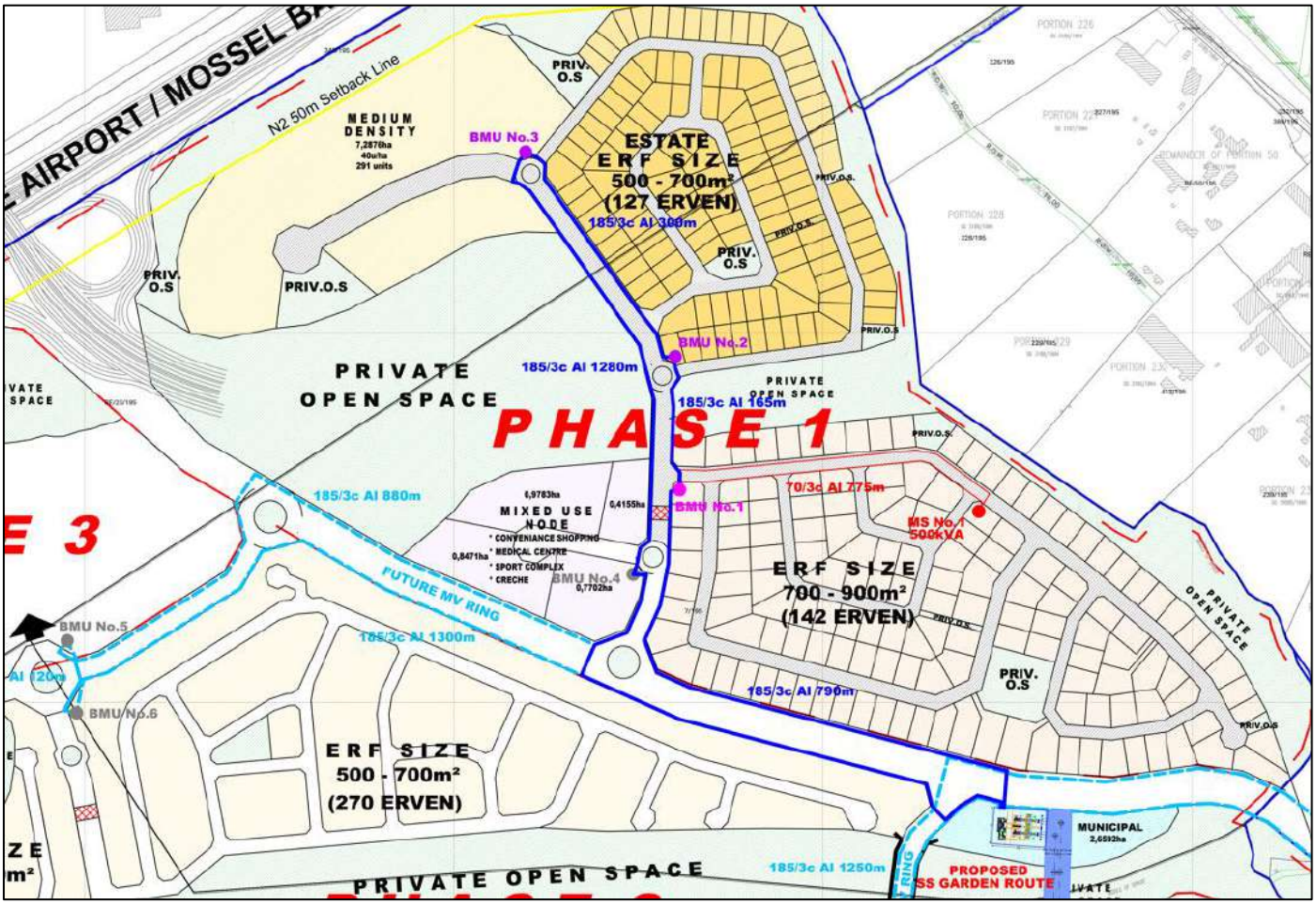


Figure 3: Geographical Phase 1 MV network from SS Thembalethu to Garden Route City – Development side.



There will be two dedicated MV bulk feeder bays supplying the internal MV ring network from the new proposed SS Garden Route throughout the Phase 1 development, as indicated in Figure 3.

Figures 4 and 5 present the plan view and the 11kV switchgear schematic layout of the new proposed SS Garden Route substation respectively.

Figure 4: SS Garden Route– Plan view.

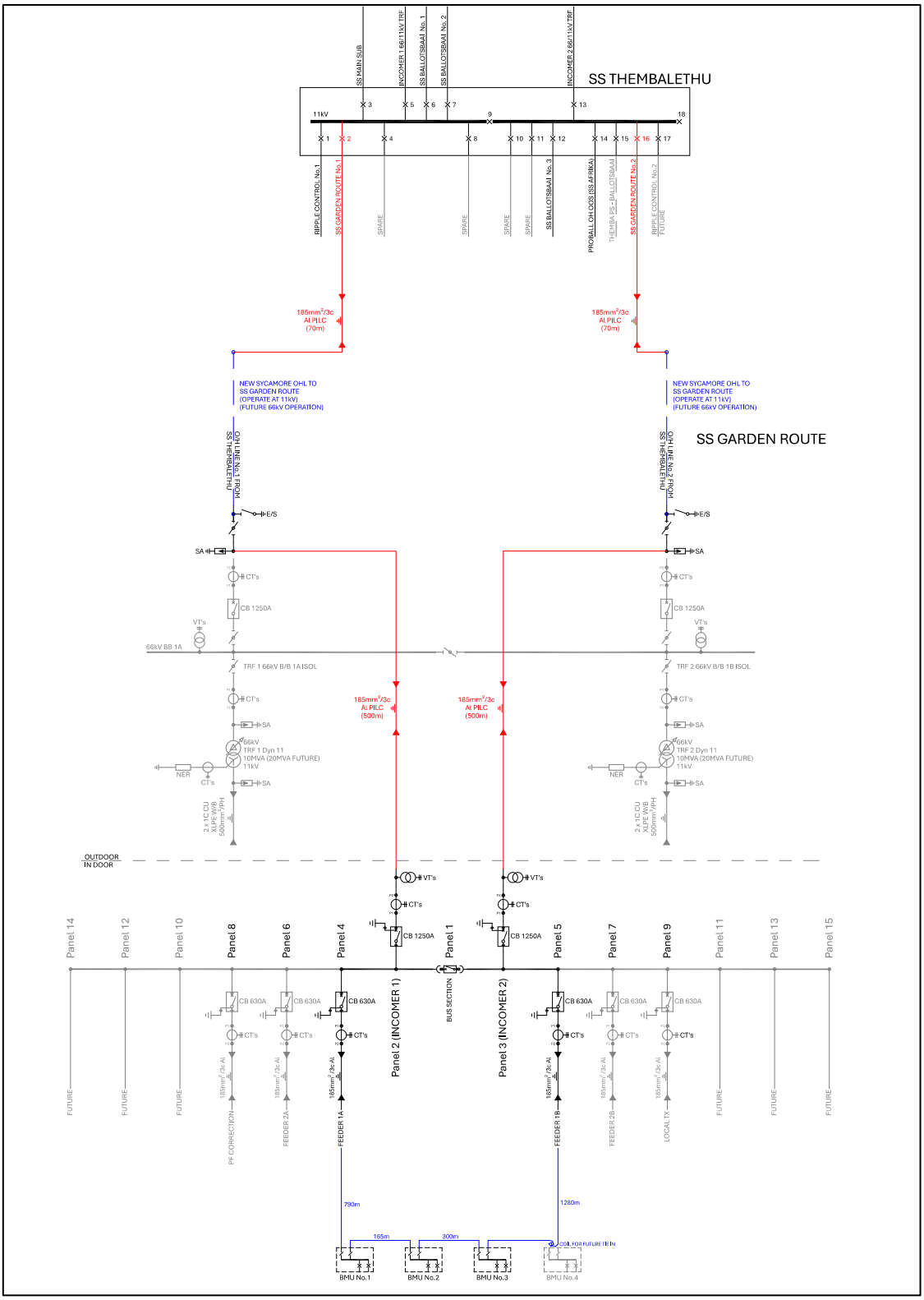
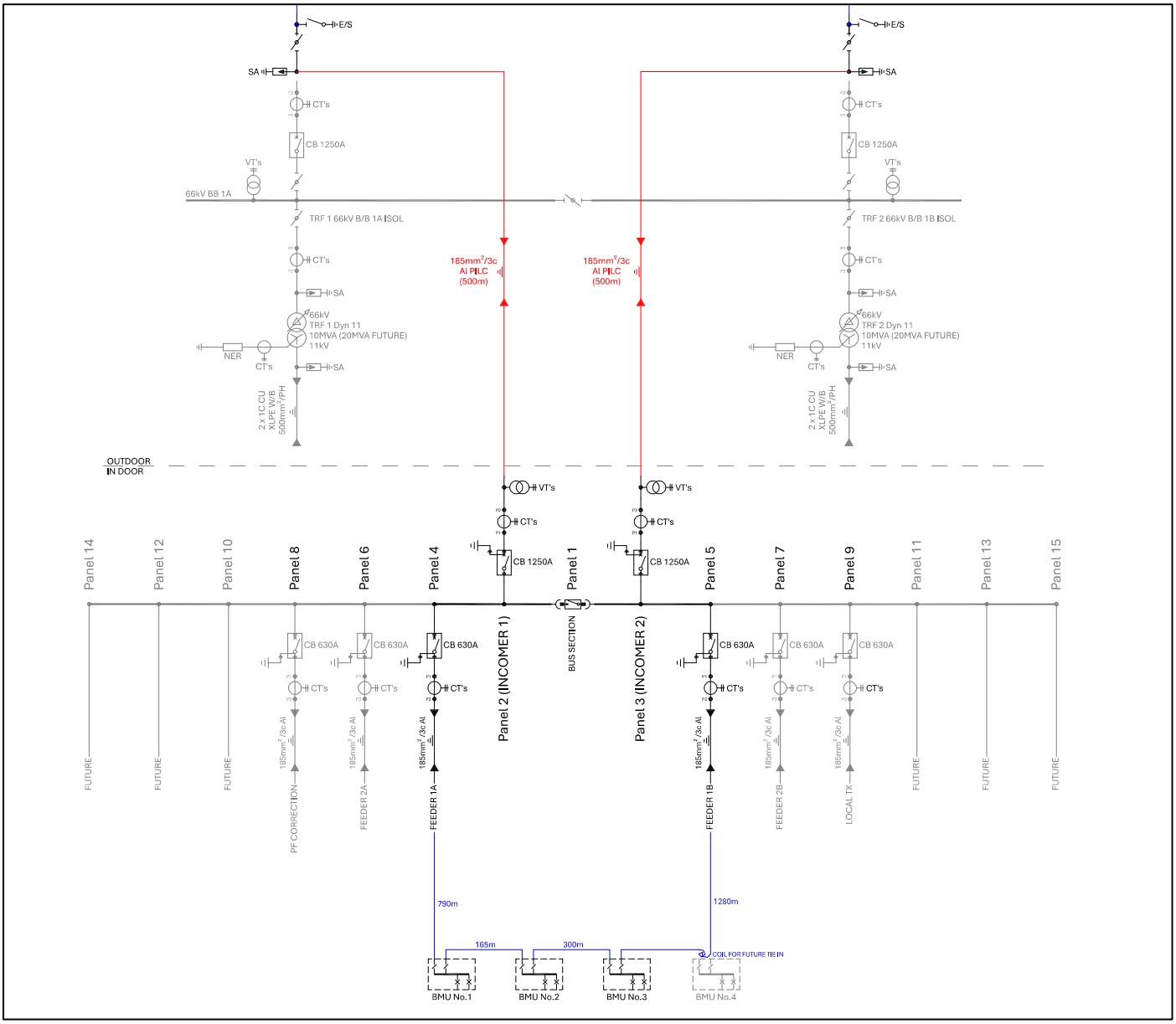


Figure 5: SS Garden Route– 11kV switchgear schematic layout.



4.5 STREET LIGHTING

The installation, electricity consumption, operation and maintenance of the internal street lighting within the development zones shall be the responsibility of the Homeowners Association (HOA). These streetlight circuits will be supplied from two general supply circuits from the Guard House at the entrance to each development.

Depending on the Municipality's preference, the street lighting along the other main roads through the development may, following installation, be operated and maintained by the Municipality. If the Municipality does not take over the other main roads within the development, the electricity consumption, operation and maintenance of the associated street lighting will remain the responsibility of the overall HOA of the Garden Route City development.

5 NETWORK ANALYSES

The industry-leading software package DIgSILENT PowerFactory was used to develop a realistic model of the proposed MV network supplying the initial Phase 1 development.

The load flow results of the proposed MV network are presented in Annexure B. The new MV ring network supplied from SS Thembalethu via the partially constructed SS Garden Route provides approximately 4 MVA of additional spare network capacity, over and above the approximately 1.1 MVA expected demand for Phase 1.

The two worst-case N-1 network contingencies were simulated and are presented in Annexure B. The load flow results show that the voltages and thermal loading of the network remain within the applicable operating limits under both normal and contingency conditions. See Annexure C for the complete network analysis results.

6 CONCLUSION

6.1 LIMITATIONS AND ASSUMPTIONS

- This report identifies and proposes a technically feasible network for integrating Phase 1 of the envisaged Garden Route City development.
- The estimated diversified demand, as presented in Table 1, is based on rational assumptions and appropriate diversification.

6.2 GENERAL

- The proposed network from SS Thembalethu with two 11kV feeders initially, consisting of 11kV cables and 66kV overhead lines, will create the optimal feasible network for supplying the initial load requirement of the Phase 1 development.
- Based on rational design principles and appropriate diversification, network capacity of ~5.1 MVA (1.1 MVA + 4 MVA) will be created in the Garden Route City supply area.

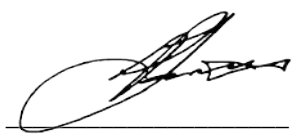
7 ANNEXURES

7.1 Annexure A – PROPOSED ELECTRICAL NETWORK – PHASE 1

7.2 Annexure B – 66KV TOWER CONFIGURATIONS (OPERATE AT 11kV INITIALLY) - PHASE 1

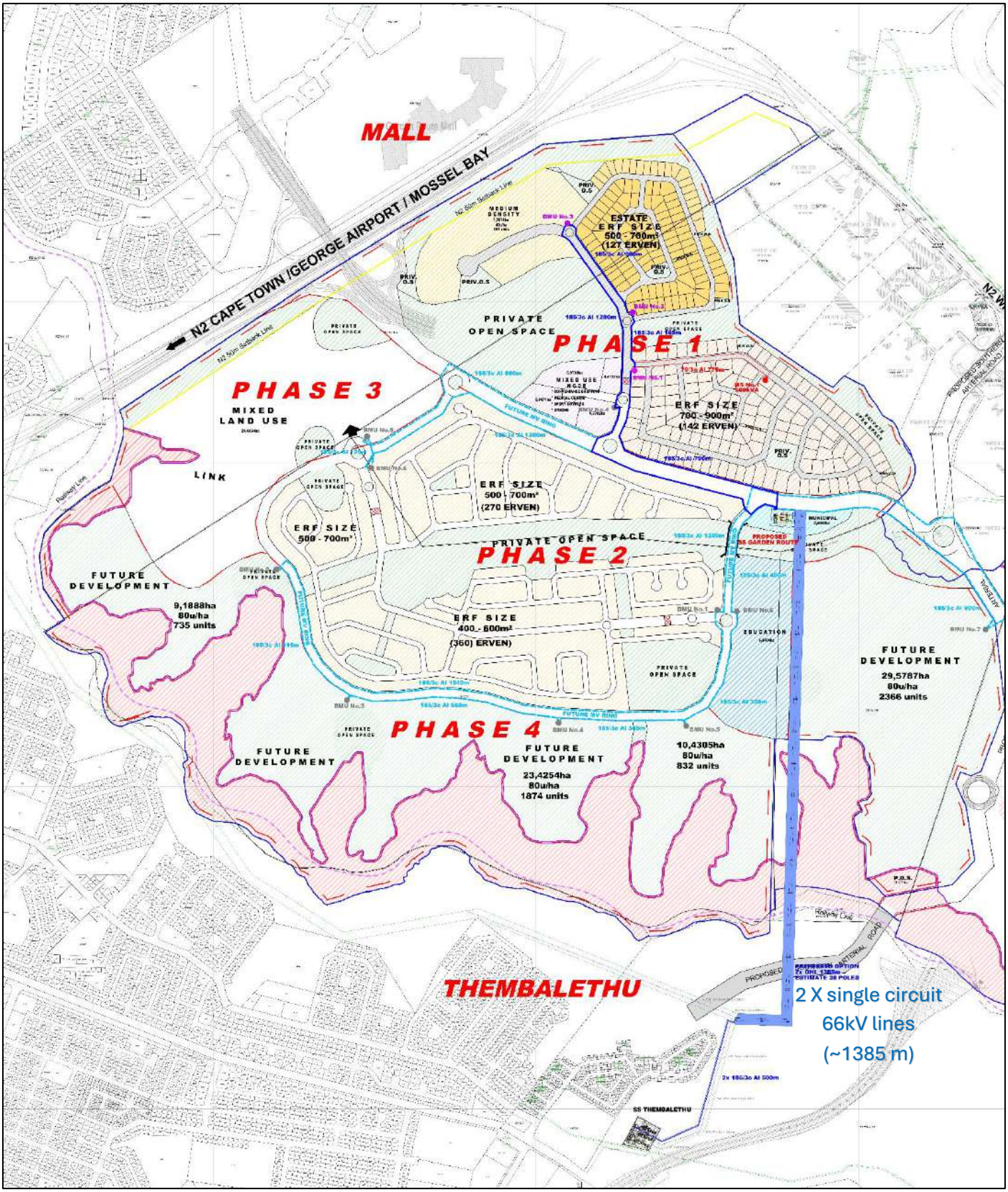
7.3 Annexure C – NETWORK ANALYSES RESULTS

For and on behalf of BDE Consulting Engineers,

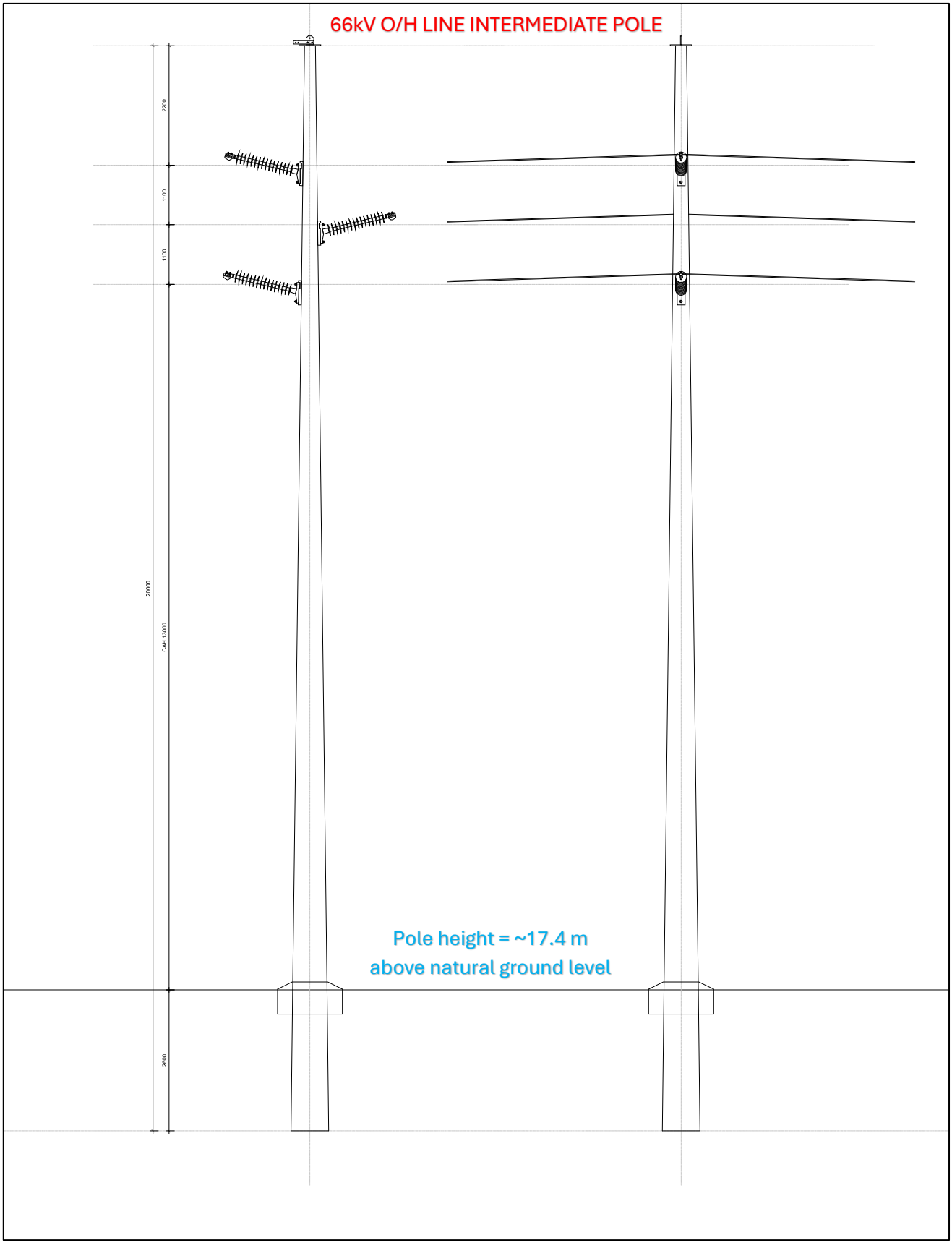


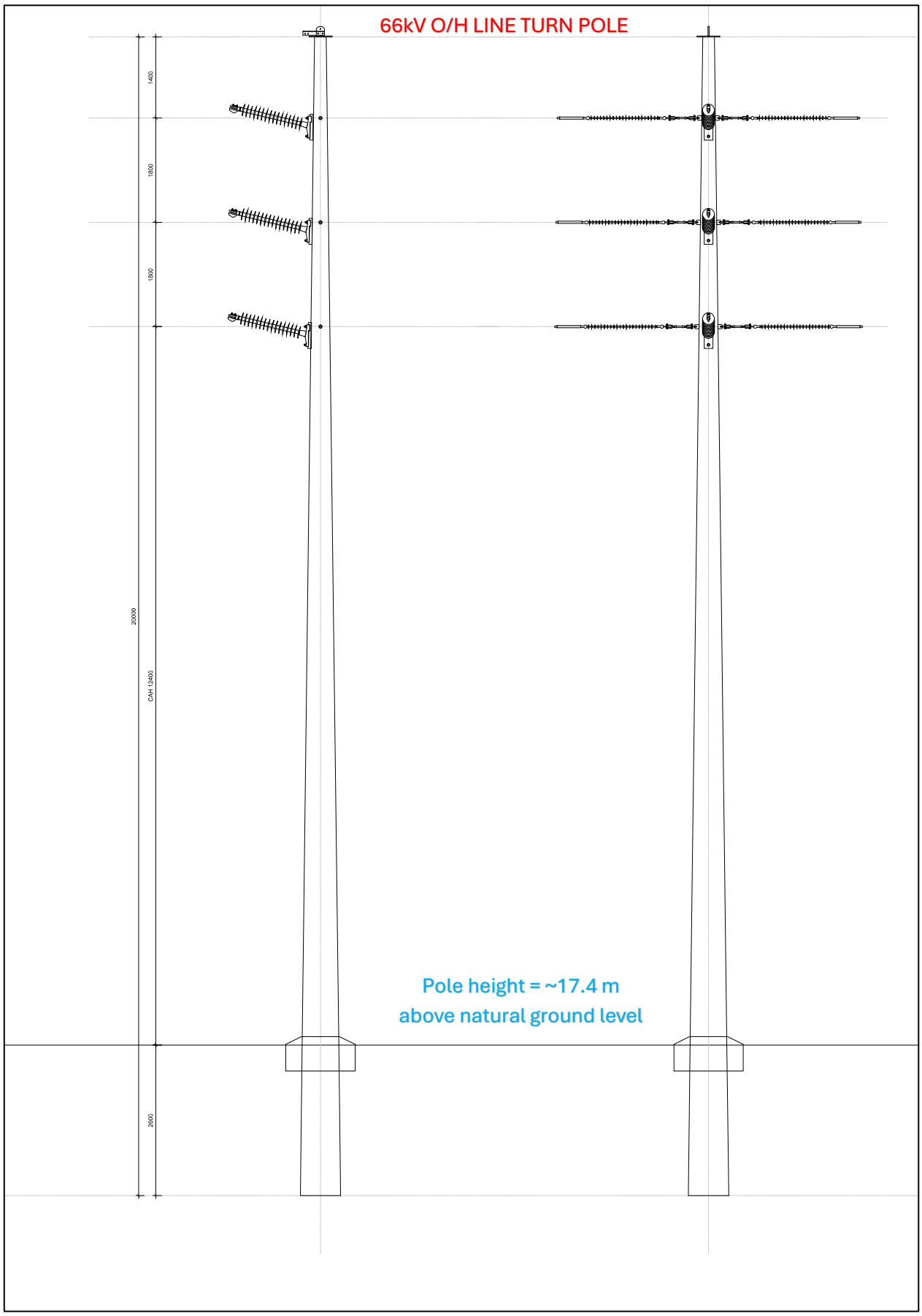
P Lambrechts, Pr.Eng.
BDE CONSULTING ENGINEERS

7.1 ANNEXURE A – GEOGRAPHICAL NETWORK DIAGRAM - PHASE 1

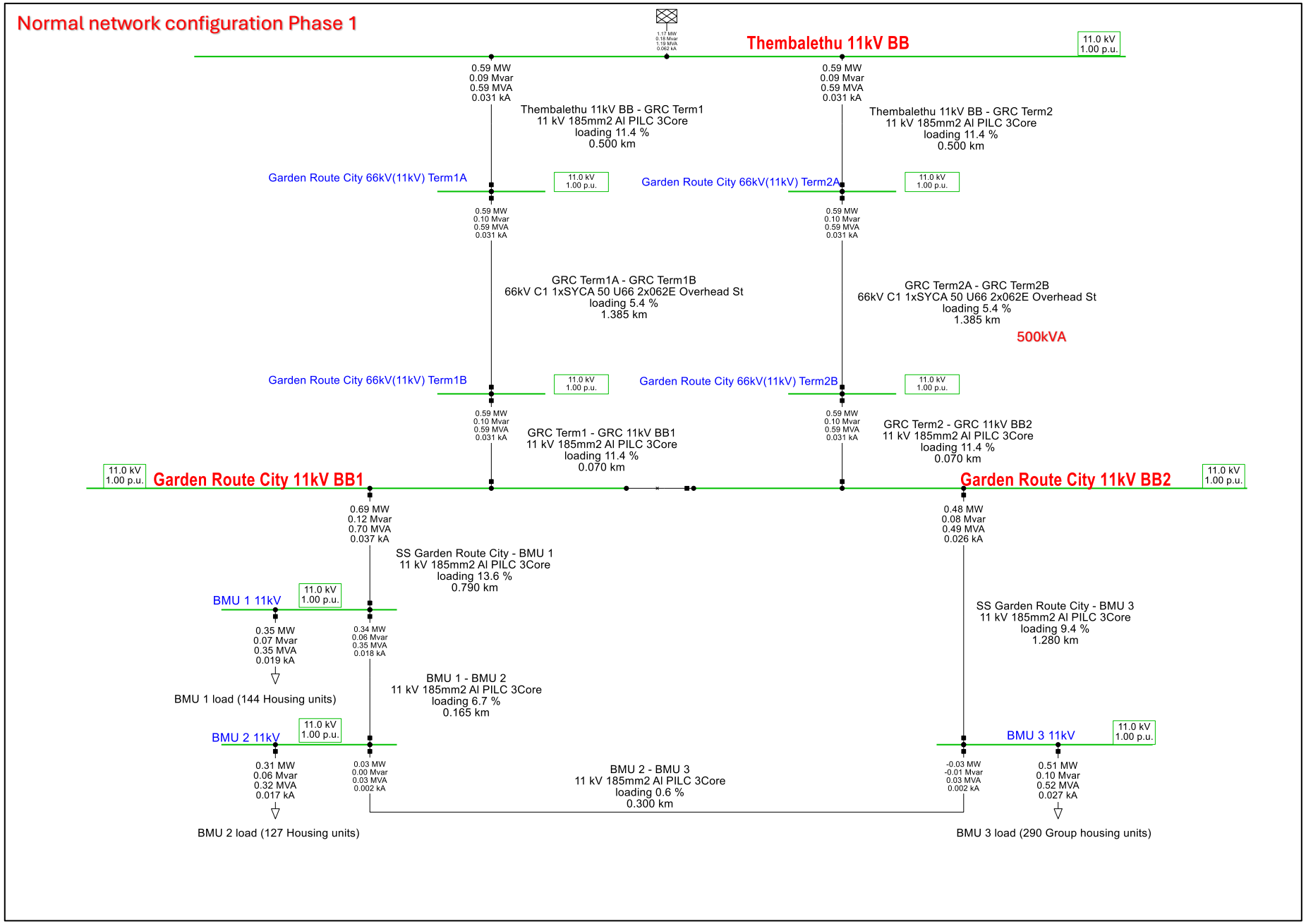


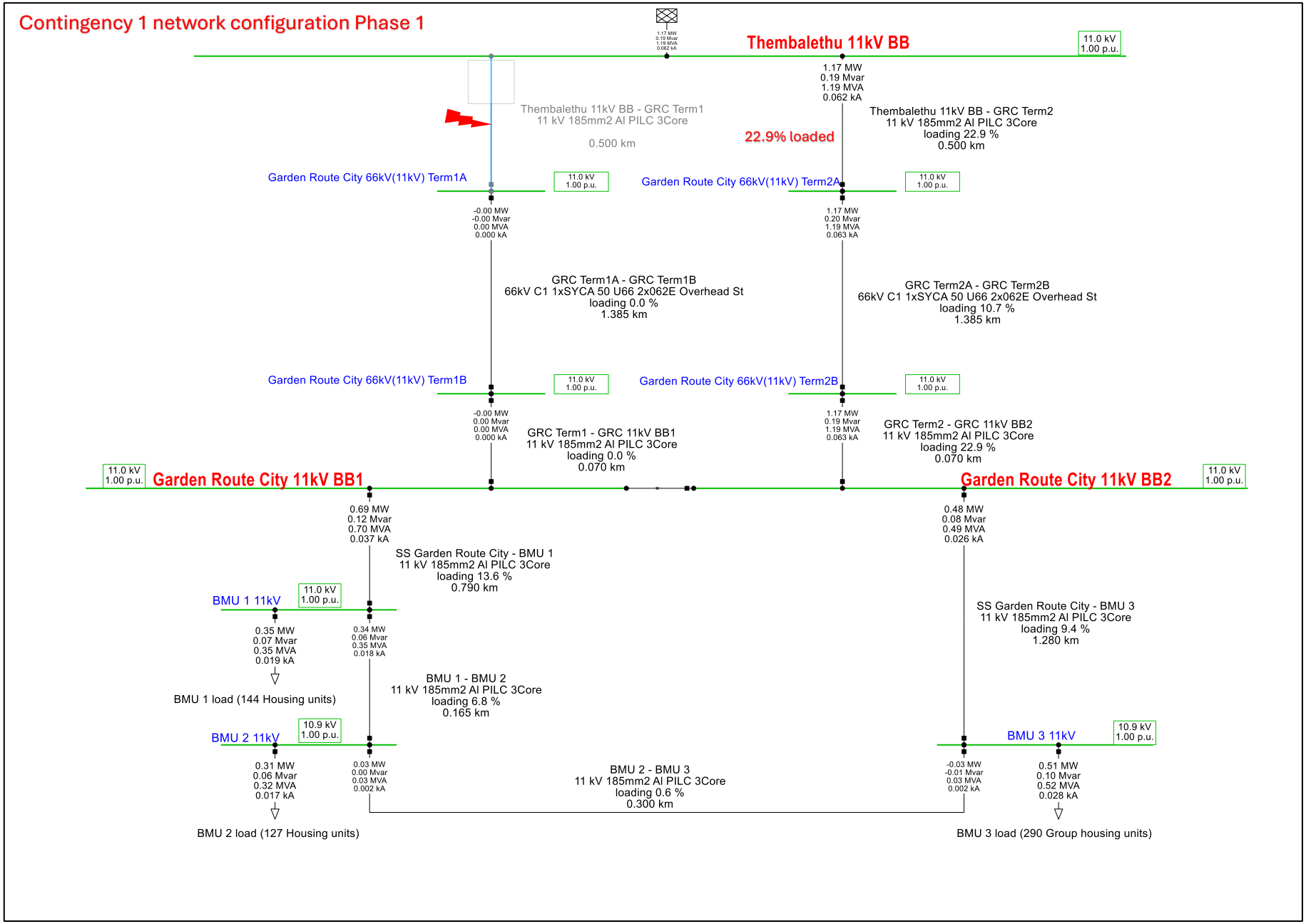
7.2 ANNEXURE B – 66KV TOWER CONFIGURATIONS (OPERATE AT 11KV INITIALLY) - PHASE 1

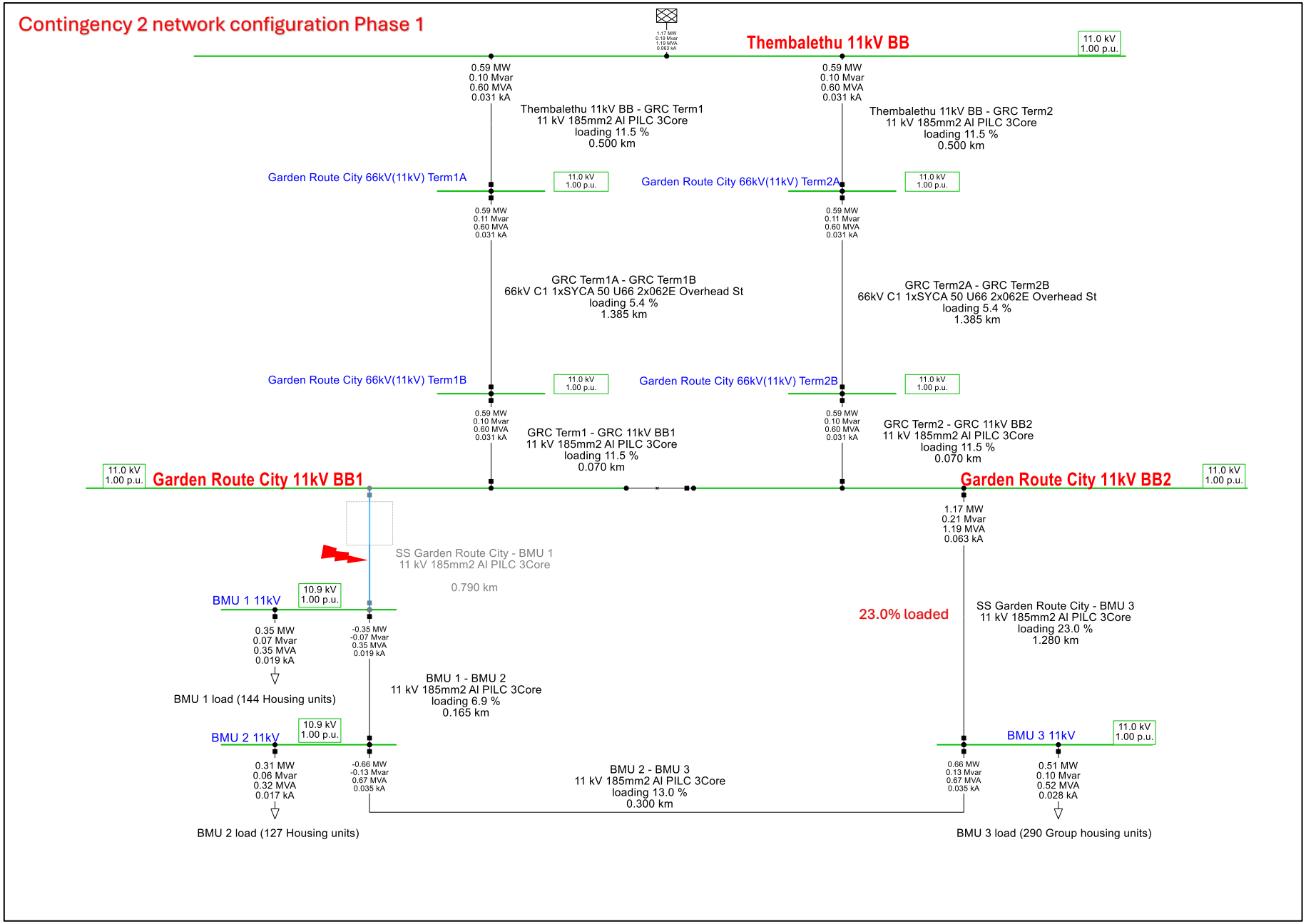



66kV O/H LINE TURN POLE
1400
1800
1800
20000
CAH 12400
2600
Pole height = ~17.4 m
above natural ground level

7.3 ANNEXURE C – NETWORK ANALYSES RESULTS




Contingency 1 network configuration Phase 1
1.17 MW
0.19 Mvar
1.19 MVA
0.062 kA
Thembalethu 11kV BB
11.0 kV
1.00 p.u.
1.17 MW
0.19 Mvar
1.19 MVA
0.062 kA
Thembalethu 11kV BB - GRC Term1
11 kV 185mm2 Al PILC 3Core
0.500 km
22.9% loaded
Thembalethu 11kV BB - GRC Term2
11 kV 185mm2 Al PILC 3Core
loading 22.9 %
0.500 km
Garden Route City 66kV(11kV) Term1A
11.0 kV
1.00 p.u.
Garden Route City 66kV(11kV) Term2A
11.0 kV
1.00 p.u.
-0.00 MW
-0.00 Mvar
0.00 MVA
0.000 kA
1.17 MW
0.20 Mvar
1.19 MVA
0.063 kA
GRC Term1A - GRC Term1B
66kV C1 1xSYCA 50 U66 2x062E Overhead St
loading 0.0 %
1.385 km
GRC Term2A - GRC Term2B
66kV C1 1xSYCA 50 U66 2x062E Overhead St
loading 10.7 %
1.385 km
Garden Route City 66kV(11kV) Term1B
11.0 kV
1.00 p.u.
Garden Route City 66kV(11kV) Term2B
11.0 kV
1.00 p.u.
-0.00 MW
0.00 Mvar
0.00 MVA
0.000 kA
1.17 MW
0.19 Mvar
1.19 MVA
0.063 kA
GRC Term1 - GRC 11kV BB1
11 kV 185mm2 Al PILC 3Core
loading 0.0 %
0.070 km
GRC Term2 - GRC 11kV BB2
11 kV 185mm2 Al PILC 3Core
loading 22.9 %
0.070 km
11.0 kV
1.00 p.u.
Garden Route City 11kV BB1
Garden Route City 11kV BB2
11.0 kV
1.00 p.u.
0.69 MW
0.12 Mvar
0.70 MVA
0.037 kA
0.48 MW
0.08 Mvar
0.49 MVA
0.026 kA
SS Garden Route City - BMU 1
11 kV 185mm2 Al PILC 3Core
loading 13.6 %
0.790 km
SS Garden Route City - BMU 3
11 kV 185mm2 Al PILC 3Core
loading 9.4 %
1.280 km
BMU 1 11kV
11.0 kV
1.00 p.u.
0.35 MW
0.07 Mvar
0.35 MVA
0.019 kA
0.34 MW
0.06 Mvar
0.35 MVA
0.018 kA
BMU 1 load (144 Housing units)
BMU 1 - BMU 2
11 kV 185mm2 Al PILC 3Core
loading 6.8 %
0.165 km
BMU 2 11kV
10.9 kV
1.00 p.u.
BMU 3 11kV
10.9 kV
1.00 p.u.
0.31 MW
0.06 Mvar
0.32 MVA
0.017 kA
0.03 MW
0.00 Mvar
0.03 MVA
0.002 kA
BMU 2 - BMU 3
11 kV 185mm2 Al PILC 3Core
loading 0.6 %
0.300 km
-0.03 MW
-0.01 Mvar
0.03 MVA
0.002 kA
0.51 MW
0.10 Mvar
0.52 MVA
0.028 kA
BMU 2 load (127 Housing units)
BMU 3 load (290 Group housing units)


Contingency 2 network configuration Phase 1
1.17 MW
0.19 Mvar
1.19 MVA
0.063 kA
Thembalethu 11kV BB
11.0 kV
1.00 p.u.
0.59 MW
0.10 Mvar
0.60 MVA
0.031 kA
Thembalethu 11kV BB - GRC Term1
11 kV 185mm2 Al PILC 3Core
loading 11.5 %
0.500 km
0.59 MW
0.10 Mvar
0.60 MVA
0.031 kA
Thembalethu 11kV BB - GRC Term2
11 kV 185mm2 Al PILC 3Core
loading 11.5 %
0.500 km
Garden Route City 66kV(11kV) Term1A
11.0 kV
1.00 p.u.
Garden Route City 66kV(11kV) Term2A
11.0 kV
1.00 p.u.
0.59 MW
0.11 Mvar
0.60 MVA
0.031 kA
0.59 MW
0.11 Mvar
0.60 MVA
0.031 kA
GRC Term1A - GRC Term1B
66kV C1 1xSYCA 50 U66 2x062E Overhead St
loading 5.4 %
1.385 km
GRC Term2A - GRC Term2B
66kV C1 1xSYCA 50 U66 2x062E Overhead St
loading 5.4 %
1.385 km
Garden Route City 66kV(11kV) Term1B
11.0 kV
1.00 p.u.
Garden Route City 66kV(11kV) Term2B
11.0 kV
1.00 p.u.
0.59 MW
0.10 Mvar
0.60 MVA
0.031 kA
0.59 MW
0.10 Mvar
0.60 MVA
0.031 kA
GRC Term1 - GRC 11kV BB1
11 kV 185mm2 Al PILC 3Core
loading 11.5 %
0.070 km
GRC Term2 - GRC 11kV BB2
11 kV 185mm2 Al PILC 3Core
loading 11.5 %
0.070 km
11.0 kV
1.00 p.u.
Garden Route City 11kV BB1
Garden Route City 11kV BB2
11.0 kV
1.00 p.u.
1.17 MW
0.21 Mvar
1.19 MVA
0.063 kA
SS Garden Route City - BMU 1
11 kV 185mm2 Al PILC 3Core
0.790 km
BMU 1 11kV
10.9 kV
1.00 p.u.
23.0% loaded
SS Garden Route City - BMU 3
11 kV 185mm2 Al PILC 3Core
loading 23.0 %
1.280 km
0.35 MW
0.07 Mvar
0.35 MVA
0.019 kA
-0.35 MW
-0.07 Mvar
0.35 MVA
0.019 kA
BMU 1 load (144 Housing units)
BMU 1 - BMU 2
11 kV 185mm2 Al PILC 3Core
loading 6.9 %
0.165 km
BMU 2 11kV
10.9 kV
1.00 p.u.
BMU 3 11kV
11.0 kV
1.00 p.u.
0.31 MW
0.06 Mvar
0.32 MVA
0.017 kA
-0.66 MW
-0.13 Mvar
0.67 MVA
0.035 kA
BMU 2 - BMU 3
11 kV 185mm2 Al PILC 3Core
loading 13.0 %
0.300 km
0.66 MW
0.13 Mvar
0.67 MVA
0.035 kA
0.51 MW
0.10 Mvar
0.52 MVA
0.028 kA
BMU 2 load (127 Housing units)
BMU 3 load (290 Group housing units)

ANNEXURE 21

Proposed Mixed Use Garden Route City Development, George, Western Cape.

Aquatic Biodiversity Site Sensitivity Verification



Prepared For: Hilland Environmental
Author: Dr. J.M. Dabrowski (PhD)
Confluent Environmental Pty (Ltd)
7 St. Johns Street,
Dormehls Drift,
George, 6529
SACNASP: Pr. Sci. Nat. (Water Resources – 114084)

Date: 12 January 2024
Version: Draft Final

confluent

DECLARATION OF SPECIALIST INDEPENDENCE

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant;
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.



Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

December 2024

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GLOSSARY

Aquatic Biodiversity	The variety of plant and animal life in water ecosystems, relevant to the study due to the site's proximity to potential water bodies.
Desktop Review	Preliminary assessment based on existing data and information, conducted prior to on-site investigations.
Erosion Control Methods	Techniques employed to prevent or minimize soil erosion, such as haybale check dams or silt fencing, crucial in areas with high inherent erosion potential.
Freshwater Ecosystem Priority Area (FEPA)	Designated areas of high importance for freshwater ecosystem conservation, identified as a sensitivity feature in the DFFE screening tool.
Site Assessment	Comprehensive evaluation of the proposed development site, including the identification of wetlands, watercourses, and soil characteristics.
Sensitivity	The degree to which a particular area or ecosystem is susceptible to disturbance or impact, crucial in determining potential environmental consequences.
Terrestrial Critical Biodiversity Area (CBA1)	A designation indicating the significance of the area's biodiversity on land.
Topography	The physical features of the land surface, considered for its potential influence on drainage and ecological features.
Wetland	An area where water covers the soil, or is present either at or near the surface, contributing to biodiversity and ecological significance.
Western Cape Biodiversity Spatial Plan (WCBSP)	A plan indicating categorized areas based on their ecological importance in the Western Cape region.

ABBREVIATIONS

CBA:	Critical Biodiversity Area
CD:NGI:	Chief Directorate: National Geo-spatial Information
DFFE:	Department of Environment, Forestry and Fisheries
DWAF:	Department of Water Affairs and Forestry
DWS:	Department of Water & Sanitation
EIS:	Ecological Importance and Sensitivity
ESA:	Ecological Support Area
FEPA:	Freshwater Ecosystem Priority Area
GA:	General Authorisation
GPS:	Global Positioning System
NEMA:	National Environmental Management Act
NFEPA:	National Freshwater Ecosystem Priority Areas
NWA:	National Water Act
NWM5:	National Wetland Map 5
SACNASP:	South African Council for Natural Scientific Professions
WCBSP:	Western Cape Biodiversity Spatial Plan
WUL:	Water Use License

1. INTRODUCTION

Confluent Environmental was appointed by HilLand Environmental on behalf of the applicant to provide Aquatic Biodiversity specialist inputs for a proposed mixed-use development on five portions of Farm 195 Kraaibosch (Figure 1). These properties include the following:

- RE/8/195, which covers 40.82 ha
- RE/23/195, which covers 66.6 ha
- 7/195, which covers 68.69 ha
- 12/195, which covers 139.18 ha
- 48/195, which covers 103.7 ha

This amounts to a total area of ca. 419 ha. The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA) as well as the National Water Act (NWA).

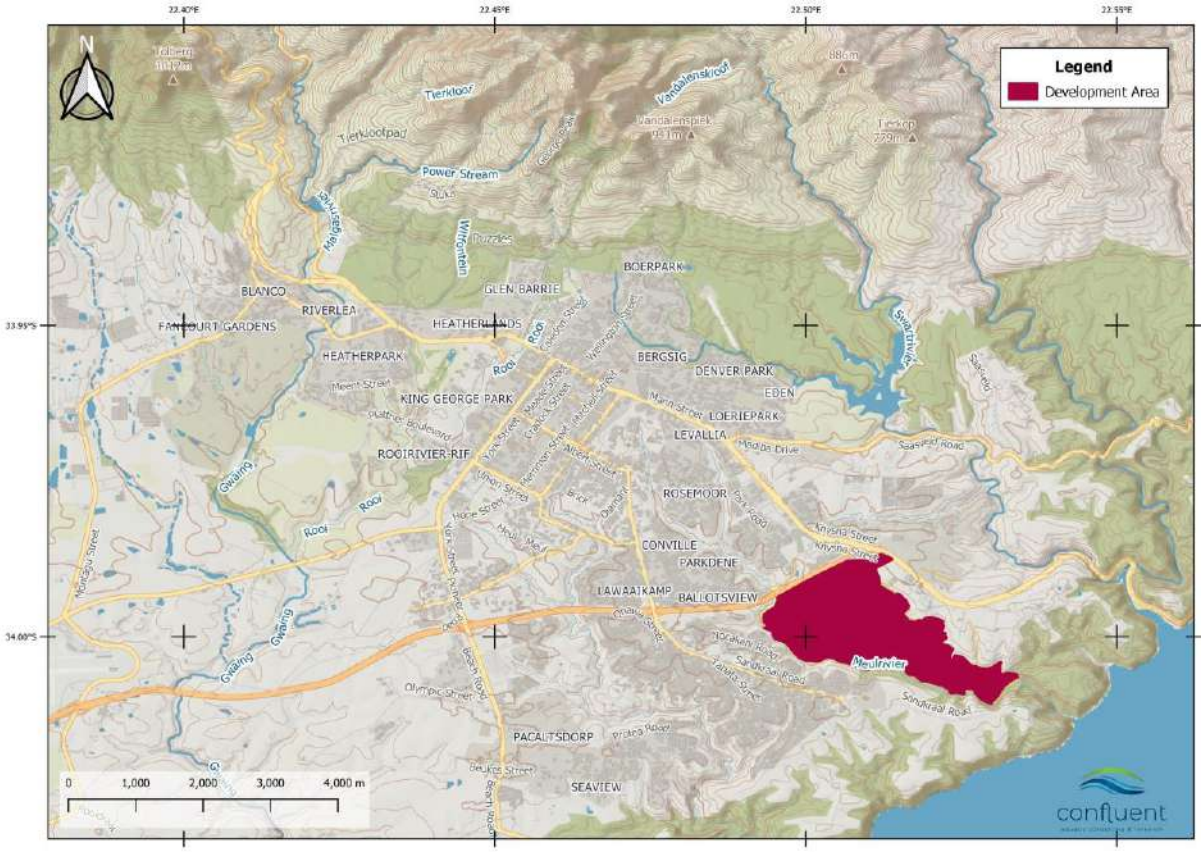

Figure 1. Location of properties comprising the proposed development area.

1.1 Key Legislative Requirements

1.1.1 National Environmental Management Act

According to the protocols specified in GN 1540 (Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national

web-based environmental screening tool. An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

- **Very High** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Specialist Assessment; or
- **Low** sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement.

According to the DFFE Screening Tool, the sensitivity of aquatic biodiversity is **Very High** (Figure 2) for the following reasons:

- The properties fall within a Strategic Water Source Area (SWSA).
- One or more aquatic Critical Biodiversity Areas (CBAs) are mapped to occur within the property boundaries.

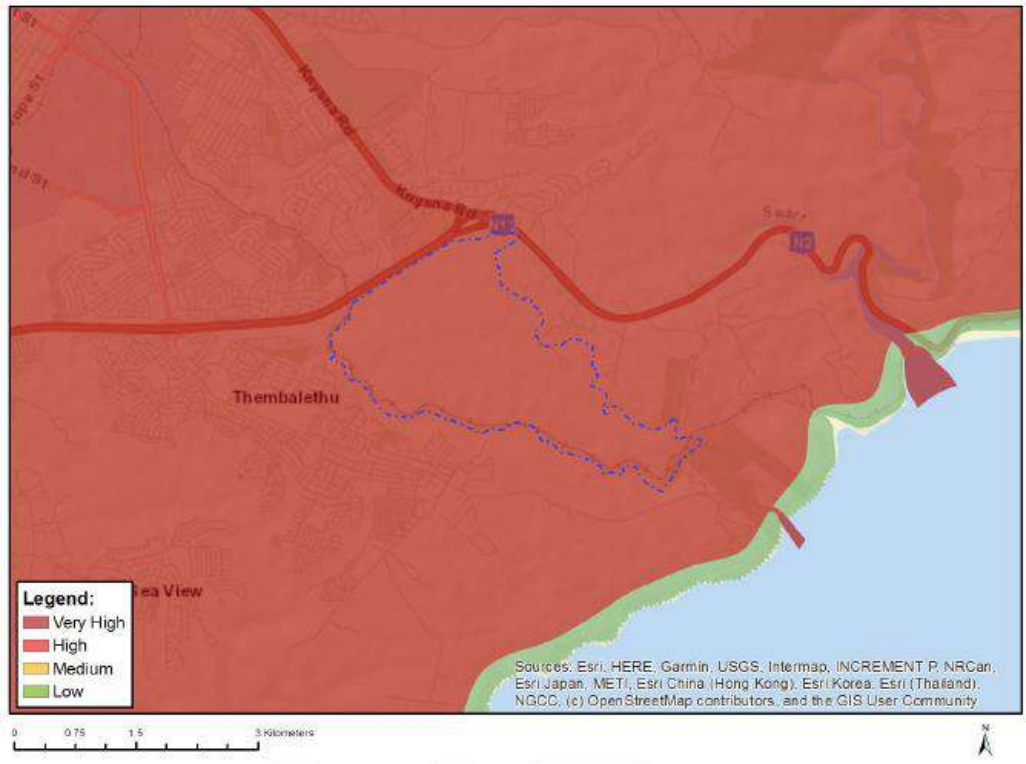

Figure 2: Results of the DFFE Screening Tool which indicate Very High Sensitivity for the Aquatic Biodiversity theme for the proposed development area.

1.1.2 National Water Act

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, or aquifers. A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be watercourse, and

For the purposes of this assessment, a wetland area is defined according to the NWA (Act No. 36 of 1998):

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

Wetlands must therefore have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

No activity may take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). According to Section 21 (c) and (i) of the National Water Act, an authorization (Water Use License or General Authorisation) is required for any activities that impede or divert the flow of water in a watercourse or alter the bed, banks, course or characteristics of a watercourse. The regulated area of a watercourse for section 21(c) or (i) of the Act water uses means:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;

b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or

c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

According to Section 21 (c) and (i) of the NWA, any water use activities that do occur within the regulated area of a watercourse must be assessed using the DWS Risk Assessment Matrix (GN4167) to determine the impact of construction and operational activities on the flow, water quality, habitat and biotic characteristics of the watercourse. Low-Risk activities require a General Authorisation (GA), while Medium or High-Risk activities require a Water Use License (WUL).

1.2 Assumptions and Exclusions

- A series of site visits were conducted in November and December 2024 which fell over a relatively wet summer period. While this represented an ideal time of year to identify wetland habitats, it is possible that, given the cumulative size of the properties, some smaller wetland features may not have been detected. Historical satellite imagery was used to help in the identification of possible wetland areas that were then validated during site visits.

1.3 The Proposed Development

The current proposal is for a large-scale mixed-use development in the five portions included in this assessment (Figure 3). In addition to the planning on-site, there will also need to be additional upgrades to infrastructure that fall outside of the cadastral boundaries of this proposed development. The botanical sensitivity of these required upgrade areas required and routes for linear infrastructure have not been determined in this report. Therefore, a detailed assessment must take place for these areas during the impact assessment phase.

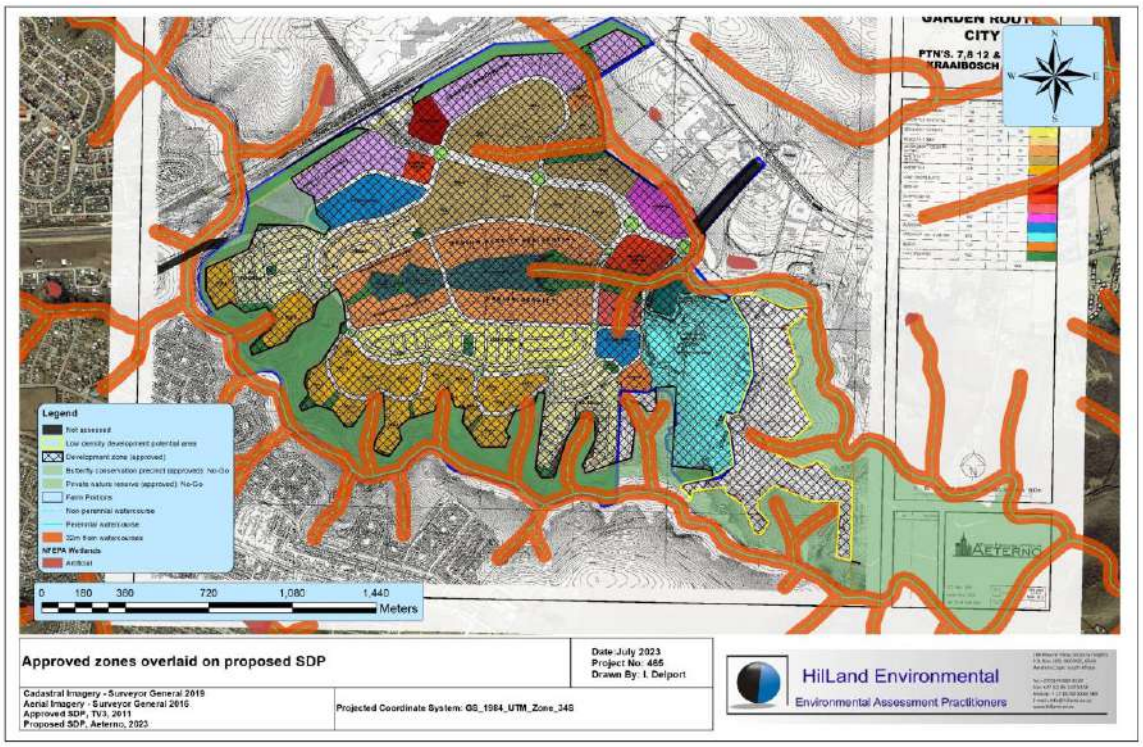

Figure 3: Preliminary SDP provided by Hilland Environmental for the proposed development.

2. METHODS

2.1 Watercourse Classification

Classification of watercourses is important as this determines the assessment methodologies that can be applied. Furthermore, classification of the watercourse provides a fundamental understanding of the hydrological and geomorphic drivers that characterise the watercourse and therefore assists in the interpretation of impacts to the watercourse. Watercourses were categorised into discrete hydrogeomorphic units (HGMs) based on their geomorphic characteristics, source of water and pattern of water flow through the watercourse. These HGMs were then classified according to Ollis et al. (2013).

2.2 Wetland Delineation

Wetlands are described by the National Water Act (Act 36 of 1998) as:

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which

land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

According to DWAF (2005) wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of plants that grow in water saturated conditions (hyrdophytes or obligate wetland plants);
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.

The boundary of the wetland was delineated in accordance with DWAF (2005) guidelines which considers the following four specific indicators:

- The Terrain Unit Indicator: Identifies those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator: Identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation;
- The Soil Wetness Indicator: Identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation (i.e. mottling and gleying within 50 cm of the soil surface); and
- The Vegetation Indicator: Identifies hydrophilic vegetation associated with frequently saturated soils.

The boundary of the wetland was determined by identifying the presence or absence of the combination of indicators mentioned above at selected points in the field. The location of soil augering points used to assess soil wetness were marked on a hand-held GPS and saturation zones were classified according to the soil wetness indicators as follows:

- Temporary Zone: Short periods of saturation (less than three months per annum) characterised by few high chroma mottles and minimal grey matrix (< 10 %).
- Seasonal Zone: Significant periods of wetness (at least three months per annum) characterised by many low chroma mottles and a grey matrix.
- Permanent Zone: Wetness all year round characterised by a prominent grey matrix and few to no high chroma mottles.

Auger points that showed no sign of saturation were classified as 'Dry'. All augering points were imported into GIS software and, in combination with aerial imagery and other site observations of vegetation indicators, were used to plot the boundary of the wetland.

2.3 Present Ecological State (PES)

2.3.1 Wetlands

WET-Health 2.0 is designed to assess the PES of a wetland by scoring the perceived deviation from a theoretical reference condition, where the reference condition is defined as the un-impacted condition in which ecosystems show little or no influence of human actions. Whilst wetland features vary considerably from one wetland to the next, wetlands are all broadly influenced/ by their climatic and geological setting and by three core inter-related drivers,

namely hydrology, geomorphology and water quality. The biology of the wetland (in which vegetation generally plays a central role) responds to changes in these drivers, and to activities within and around the wetland. The interrelatedness of these four components is forms the basis of the modular-based approach adopted in WET-Health Version 2. Desktop and field data were captured in GIS software and used to populate the Level 1 WET-Health tool (Macfarlane et al., 2020) which was used to derive the PES of the wetland HGM units. The magnitude of observed impacts on the hydrological, geomorphological, water quality and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall condition of the wetland on a scale from 1-10. Resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 1 below.

Table 1: Wetland Present Ecological State (PES) categories and impact descriptions.

ECOLOGICAL CATEGORY	DESCRIPTION	IMPACT SCORE*	PES SCORE (%)*
A	Unmodified, natural.	0-0.9	90-00
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	80-89
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	60-79
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	40-59
E	Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	20-39
F	Critically modified. Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	0-19

2.3.2 Rivers & Drainage Lines

The Index of Habitat Integrity (IHI; Kleynhans, 1996) is widely regarded as the most appropriate method for assessing riverine habitats as it is not dependent on flow in the watercourse and, therefore, produces results that are directly comparable across perennial and non-perennial systems. The IHI was developed as a rapid assessment of the severity of impacts on criteria affecting habitat integrity within a river reach. Instream (water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; rubbish dumping) and riparian (vegetation removal, invasive vegetation, bank erosion, channel modification, water abstraction, inundation, flow modification, physico-chemistry) criteria are assessed as part of the index. Each of the criteria are given a score (from 0 to 25, corresponding to no and very high impact, respectively – Table 2) based on their degree of modification, along with a confidence rating based on the level of confidence in the score. Weighting scores are used to assess the extent of modification for each criterion (*x*):

$$Weighted\ Score = \frac{IHI_x}{25} \times Weight_x$$

Where;

- IHI = rating score for the criteria (Table 2);
- 25 = maximum possible score for a criterion; and
- Weight = Weighting score for the criteria (Table 3).

Table 2: Descriptive classes for the assessment of habitat modifications (Kleynhans, 1996)

Impact Class	Description	Score
None	No discernible impact, or the modification is located in a way that has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not affected.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 3: Criteria and weights used for the assessment of instream and riparian zone habitat integrity

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**		**100**

The estimated impacts of all criteria calculated this way are summed, expressed as a percentage and subtracted from 100 to arrive at an assessment of habitat integrity for the instream and riparian components, respectively. An IHI class indicating the present ecological state of the river reach is then determined based on the resulting score (ranging from Natural to Critically Modified – Table 4).

Table 4: Index of habitat integrity (IHI) classes and descriptions

Integrity Class	Description	IHI Score (%)
A	Unmodified, natural.	> 90
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 – 90
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 – 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 – 19

2.4 Ecological Importance and Sensitivity

2.4.1 Wetlands

The ecological importance of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales (Duthie, 1999). Ecological sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Duthie, 1999). The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC). The revised method for the determination of the EIS of a wetland considers the three following ecological aspects (Rountree et al., 2013):

- **Ecological importance and sensitivity**
  - Biodiversity support including rare species and feeding/breeding/migration;
  - Protection status, size and rarity in the landscape context;
  - Sensitivity of the wetland to floods, droughts and water quality fluctuations.
- **Hydro-functional importance**
  - Flood attenuation;
  - Streamflow regulation;
  - Water quality enhance through sediment trapping and nutrient assimilation;
  - Carbon storage
- **Direct human benefits**
  - Water for human use and harvestable resources;
  - Cultivated foods;
  - Cultural heritage;
  - Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system (Table 5).

Table 5: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

2.4.2 Rivers & Drainage Lines

The EIS of watercourses was assessed using a method developed by Kleynhans (1999). In summary, several biological and aquatic habitat determinants are assigned a score ranging from 1 (low importance or sensitivity) to 4 (high importance or sensitivity). These determinants include the following:

- **Biodiversity support:**
  - Presence of Red Data species;
  - Presence of unique instream and riparian biota;
  - Use of the ecosystem for migration, breeding or feeding.
- **Importance in the larger landscape:**
  - Protection status of the watercourse;
  - Protection status of the vegetation type;
  - Regional context regarding ecological integrity;
  - Size and rarity of the wetland types present;
  - Diversity of habitat types within the wetland.
- **Sensitivity of the watercourse:**
  - Sensitivity of watercourse to changes in flooding regime;
  - Sensitivity of watercourse to changes in low flow regime, and

- Sensitivity to water quality changes.

The median value of the scores for all determinants is used to assign an EIS category according to Table 6.

Table 6: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Quaternaries/delineations that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3 and <=4	A
High: Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use.	>2 and <=3	B
Moderate: Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use	>1 and <=2	C
Low/marginal: Quaternaries/delineations that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.	>0 and <=1	D

2.5 Wetland and Buffer Determination

Buffer zones have been defined as a strip of land with a use, function or zoning specifically designed to act as barriers between human activities and sensitive water resources with the aim of protecting these water resources them from adverse negative impacts. Appropriate buffers were estimated based on buffer zone guidelines developed by Macfarlane and Bredin (2017). These guidelines estimate required buffer zone widths based on a combination of input parameters which include, *inter alia*, the nature of the activity and associated impacts, basic climatic and soil conditions, the PES and EIS of potentially affected watercourses and the implementation of appropriate mitigation measures.

3. CATCHMENT CONTEXT

3.1 Catchment Features

The properties are located in the quaternary catchment K30C in the catchment of the Swart River (Figure 4). The main rivers draining this catchment are the Swart and Kaaimans, both of which originate in the Outeniqua Mountains to the north. The Swart River feeds the Garden Route Dam and terminates in the Kaaimans River Estuary. Two smaller coastal rivers – the Skaapkop and Meul - also drain the catchment. The non-perennial Meul River runs along the western boundary of the development area and discharges into the sea at Ballots Bays (Figure 5). A smaller non-perennial tributary of the Meul River (named as Meul East for the purposes of this report) drains the eastern boundary of development area. According to the latest

national wetlands geospatial database (CSIR, 2018) no wetlands are mapped to occur within or adjacent to the property boundaries.

The project area falls within the South-Eastern Coastal Belt (20) Level 1 ecoregion (20.02 Level 2 Ecoregion), which is characterized by moderately undulating plains and low mountains with altitude ranging from 0 to 1 300 m above mean sea level. Watercourses are typically located at the base of relatively steep slopes. Mean annual precipitation for the catchment area is approximately 800 mm per year and occurs all year-round, with peaks in October to November and March to April. Dominant natural vegetation in the vegetation comprises broadly of fynbos, renosterveld, dune thicket, and afro-montane forest.

Soils in the catchment area are relatively shallow consisting of a diagnostic pedocutanic duplex soil, with a clear textural contrast between the A and B horizon. The B horizon is however heavily enriched with clay, which serves as a barrier to both root growth and water movement. Sub-surface water therefore tends to flow laterally over the top of the B horizon, through the more coarsely textured A horizon. In addition, the area falls within a very high rainfall and high rainfall intensity zone, which, in urban areas with a high proportion of impervious surfaces, results in the production of very large volumes of high energy stormwater (Table 7). For these reasons, soils are highly erodible and is undoubtedly the main cause of relatively widespread bank erosion and channel incision of urban watercourses in and around George.

Table 7. Summary of relevant catchment features for the proposed development area.

Feature	Description
Quaternary catchment	K30C
Mean Annual Runoff	186.61 mm
Mean Annual Precipitation	834.00 mm
Inherent erosion potential of soils (K-factor)	0.74, Very High
Rainfall intensity	Very High
Ecoregion Level II	20.02, Southeastern coastal belt
Geomorphological Zone	Upper Foothill
NFEPA area	Sub-quaternary reach 9093 and 9144, no FEPA.
Mapped Vegetation Type	FFg 5: Garden Route Granite Fynbos (CR: Critically Endangered)
Conservation	None

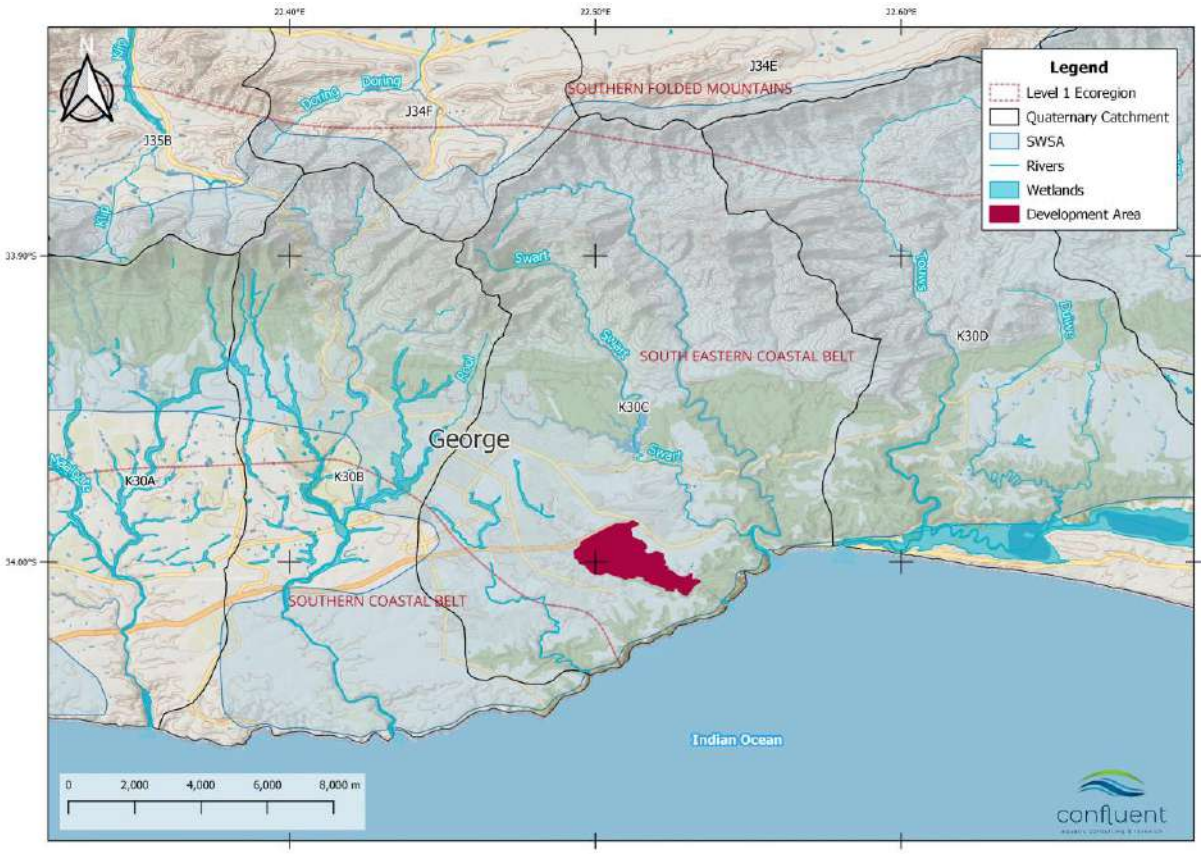

Figure 4. Map indicating the proposed development area in quaternary catchment K30C.



Figure 5: The proposed development area in relation to mapped watercourses.

3.2 Conservation and Catchment Management

3.2.1 Western Cape Biodiversity Spatial Plan

The main purpose of a biodiversity spatial plan is to ensure that the most recent and best quality spatial biodiversity information can be accessed and used to inform land use and development planning, environmental assessments and authorisations, natural resource management and other multi-sectoral planning processes. The WCBSP plan achieves this by providing a map of terrestrial and freshwater areas that are important for conserving biodiversity pattern and ecological processes – these areas are called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs).

The Meul River has been largely designated as an aquatic CBA1, while the upper reaches of the Meul East River and the smaller intermittent drainage lines feeding these two larger systems have been designated as ESA2 (Figure 6). The Meul River is therefore considered to be in a natural condition and is important for meeting biodiversity targets and no further loss of aquatic habitat is recommended. The Meul East and smaller drainage lines are not important for meeting biodiversity targets but do provide an important hydrological function in terms of delivering surface water flows to larger more important systems and are also important from the perspective of providing corridors for faunal movement. Management objectives associated with these biodiversity categories are provided in Table 8.

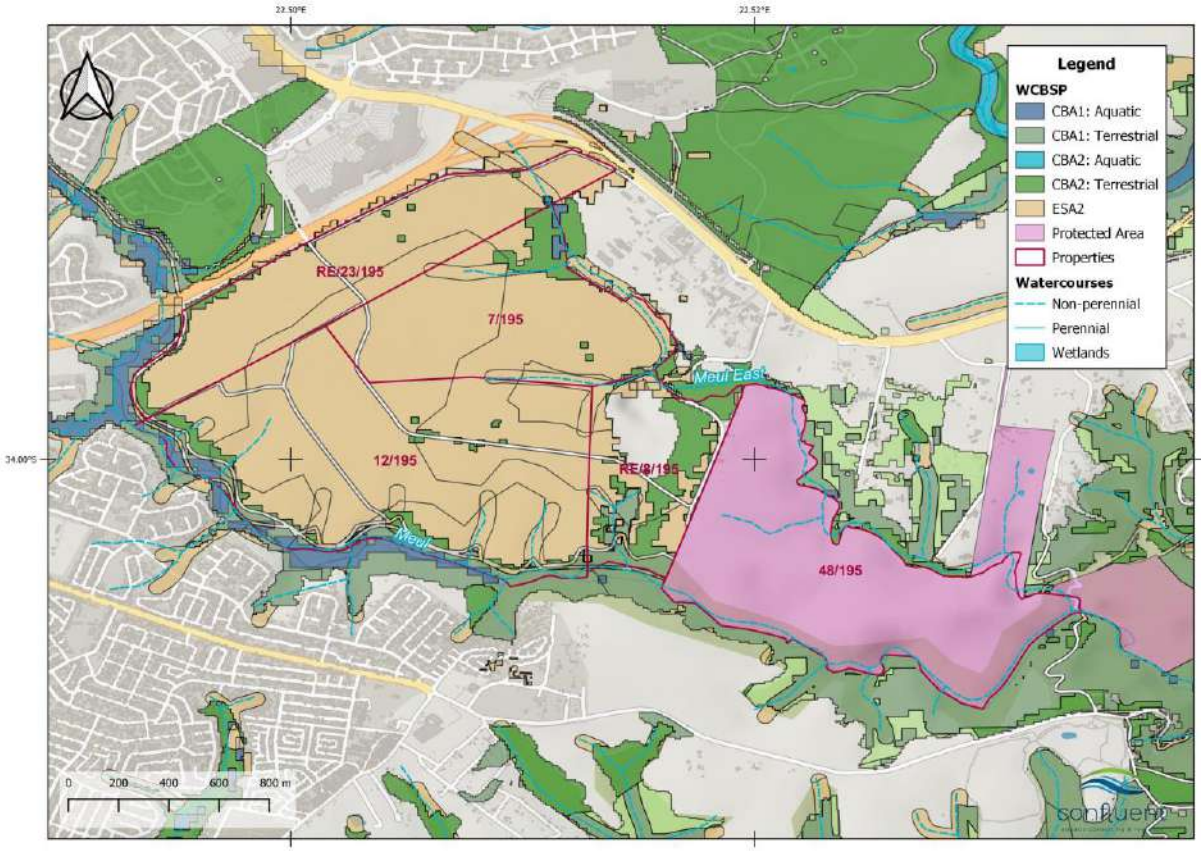

Figure 6. The proposed development area to mapped conservation features of the Western Cape Biodiversity Spatial Plan (2017).

Table 8. Definitions and objectives for conservation categories identified in the Western Cape Biodiversity Spatial Plan (WCBSP, 2017).

WCBSP Category	Definition	Management Objective
Critical Biodiversity Area 1 (CBA1)	Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.
Ecological Support Area 2 (ESA2)	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

2.3.3 Strategic Water Source Area

The project area falls within the Outeniqua Strategic Water Source Area (SWSA) (Figure 4), which is considered to be of national importance. SWSAs are defined as areas of land that either:

a) Supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or

b) Have high groundwater recharge and where the groundwater forms a nationally important resource; or

c) Areas that meet both criteria (a) and (b).

SWSAs are vital for water and food security in South Africa and also provide the water used to sustain the economy. Given this context, management and implementation guidelines have been developed with the objective of facilitating and supporting well-informed and proactive land management, land-use and development planning in these nationally important and critical areas (Le Maitre, et al., 2018). The primary principle behind this objective is to protect the quantity and quality of the water they produce by maintaining or improving their condition. The proposed development footprint falls within an urban 'working landscape' and in this context the management objectives are:

- To maintain at least the present condition and ecological functioning of these landscapes;
- To restore where necessary; and
- To limit or avoid further adverse impacts on the sustained production of high-quality water.

A key objective in the management of SWSAs is to ensure the quantity and quality of water within and flowing from SWSAs is protected from developments that cause unacceptable and irreparable impacts. Development of roads, parking areas and other impervious surfaces, along with wetland draining or infilling has the potential to change quantities of water in watercourses by intercepting, increasing, reducing or diverting flows from their normal path. Water quality can be impacted by flow-related alterations, particularly increased flows as this usually results in altered sediment transport causing scouring, sedimentation and increased turbidity due to suspended sediments. Especially during the construction phase. The operational phase of urban developments increases the risk of toxic hydrocarbons and other

road-based pollutants as well as sewage from leaking or blocked drains or pump stations impacting on water quality.

3.3 Desktop Present Ecological State

4. SITE ASSESSMENT

Given the large size of the development area, several site visits were conducted over a period extending from 7 November 2024 to 5 December 2024. These site visits coincided with a relatively wet period, which was ideal for identifying wetland areas (Figure 7).

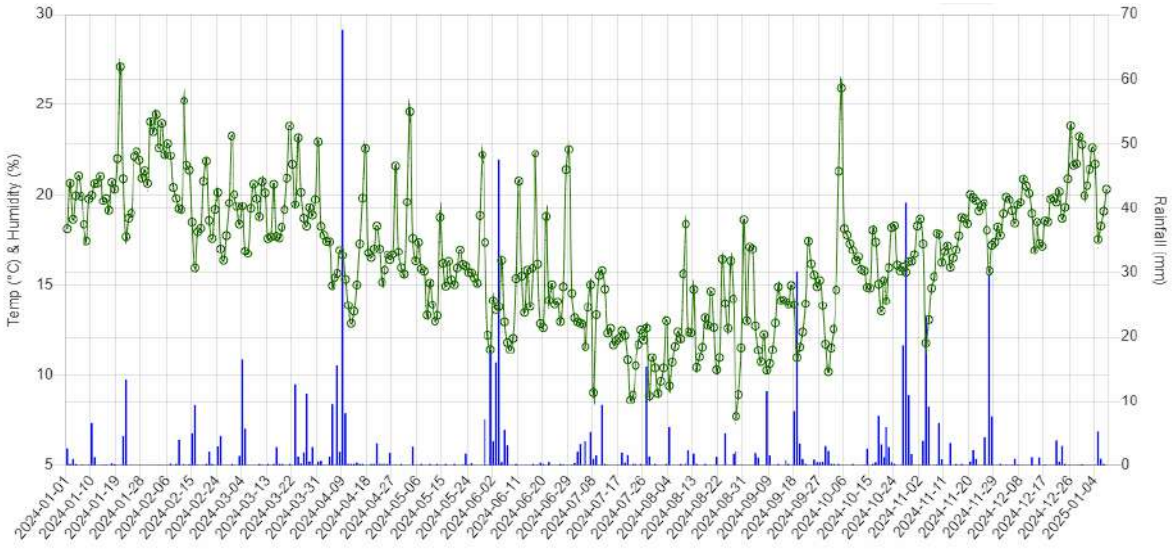

Figure 7: Graph illustrating rainfall and temperature recorded in George for the year 2024 (

4.1 Wetlands

In contrast to the National Wetlands Map (CSIR,2018), several wetlands were identified throughout the study area and are indicated in Figure 8. All of these wetlands were delineated and classified according to the methodologies described in Section 2.2. A description of each the wetlands is provided in the section below.



Figure 8: Map indicating delineated wetlands in the development area.

4.1.1 GRC1

Classification: Hillslope Seep Wetland

Hydroperiod: Seasonal inundation and saturation.

- Fed primarily by stormwater discharge from the N2 highway to the north.
- Dominated by mesic natural fynbos vegetation that included a diversity of wetland plant species including *Cliffortia odorata, Cliffortia strobilifera, Helichrysum cymosum* and *Caryx aethiopica.*



Figure 9: GRC1 – hillslope seep wetland augmented by stormwater runoff from culverts draining the N2 highway to the north.

4.1.2 GRC2

Classification: Unchanneled Valley Bottom Wetland.

Hydroperiod: Seasonally inundated and permanently saturated.

- Located in the upper-most reaches of the Meul East River.
- Confined to a natural valley floor with no distinct open water channel.
- Valley bottom is well vegetated and is dominated robust wetland vegetation that include *Phragmites australis, Typha capensis* and *Odorata strobilifera.*
- Flows in the upper most section of the wetland are concentrated by a road crossing and associated culvert, however, this has not affected the hydrogeomorphological characteristics of the wetland.
- Some minor invasion by *Acacia mearnsii* and *Rubus sp.* along the less saturated outer margins of the wetland.
- Lower reaches of wetland have been impounded to create a series of dams.



Figure 10: Photographs illustrating well vegetated unchanneled valley bottom wetland GRC2, dominated by tall, robust wetland plant species.

4.1.3 GRC3

Classification: Hillslope Seep Wetland.

Hydroperiod: Seasonally inundated saturated.

- Seasonal wetland characterised by *Carex sp.* and *Nidorella ivifolia* along the outer margins. Visible standing and flowing water following the wet season.



Figure 11: GRC3 dominated by Carex sp.

4.1.4 GRC4

Classification: Depression Wetland.

Hydroperiod: Seasonally inundated and saturated.

- Seasonal wetland system that was completely inundated at the time of the site visit.
- Characterised by a diversity of obligate wetland plant species that include *Juncus effusus, Laurembergia repens, Wimmerella arabidea, Carex xp., Isolepis diabolica, Ficinia marginata* and *Fuirena hirsuta.*
- Two roads crossing the wetland cause more pronounced inundation (depth and extent).



Figure 12: Photographs of the GRC4 depression wetland, including a road crossing through the wetland (right).

4.1.5 GRC5

Classification: Hillslope Seep Wetland.

Hydroperiod: Permanently to seasonally inundated and saturated.

- Large seasonal wetland that extends from GRC4 depression down towards a heavily incised drainage line that feeds the Meul East River.

- Northern section of the wetland is covered by a *Eucalyptus* plantation, but wetland characteristics were confirmed through soil augering, which at the time demonstrated a completely saturated, clay dominated soil matrix, showing clear signs of gleying and mottling. Wetland plant species observed included *F. marginata, J. effusus and Centellas p.* (which were particularly abundant).
- A road crosses through the wetland, however water was actively seeping across the road.
- The area south of the road is more seasonal in nature and is characterised by patches of *Juncus effusus, J. capensis, F. marginata,* and a variety of wetland grasses (e.g. *Carex sp*.), with some invasion by *Acacia mearnsii* and *Cortaderia selloana* around the margins.



Figure 13: Photographs illustrating J. effusus in the foreground and the Eucalyptus plantation in the background (left), and saturated soil augered within the Eucalyptus plantation (right).

4.1.6 GRC6

Classification: Depression Wetland.

Hydroperiod: Permanently inundated and saturated (artificial).

- Artificial depression created as a result of localised excavations.
- Dominated by *J. effusus* and *Zantedeschia aethiopica*.



Figure 14: Photographs of GRC6 dominated by J. effusus.

4.1.7 GRC7

Classification: Depression Wetland.

Hydroperiod: Seasonally inundated and saturated

- Seasonal wetland dominated by *Carex clavata*.
- Partially invaded by bottle-brush *(Callistemon rigidis)* and *A. mearnsii* around the margins.



Figure 15: Photographs of GRC7 dominated by C. clavata.

4.1.8 GRC8

Classification: Hillslope Seep Wetland

Hydroperiod: Temporarily to seasonally saturated

- Temporary to seasonal draining down towards the Meul River. Dominated by mesic grasses including *Caryx sp*.



Figure 16: Photographs showing GRC8 (left) and mottled soil profile typical of a temporarily to seasonally saturated wetland (right).

4.1.9 GRC9

Classification: Unchanneled Valley Bottom Wetland.

Hydroperiod: Seasonally saturated.

- Road crossing and associated constriction of flows at the lower end of the wetland has resulted in a heavily incised channel downstream of the road.
- Mid to lower reaches of the wetland are heavily invaded by *A. mearnsii*.
- Road crossing the upper reaches impedes surface flows creating an inundated area upstream of the road and reduced surface flows downstream of the road.



Figure 17: Photographs illustrating heavy invasion by A. mearnsii (left) and inundated portion of the wetland above the road (right).

4.1.10 GRC10

Classification: Hillslope Seep Wetland.

Hydroperiod: Seasonally saturated

- Seasonal wetland showing clear signs of mottling and gleying in the soil profile. Feeds into the Meaul River
- Dominated by mesic fynbos vegetation that includes water-loving species such as *C. odorata, Watsonia angusta, H. cymosum* and *Berzelia sp.*



Figure 18: Photographs illustrating a stand of C. odorata (left) and mottling and gleying in the soil profile (right).

4.1.11 GRC11

Classification: Depression Wetland.

Hydroperiod: Seasonally saturated and inundated.

- Seasonal wetland partially bisected by a road.
- Dominated by *J. effusus.*
- A small dam has been excavated into the wetland south of the road.



Figure 19: Photographs illustrating the inundated wetland depression (left) and the small dam excavated into the wetland (right).

4.1.12 GRC12

Classification: Depression Wetland (artificial).

Hydroperiod: Seasonally saturated and inundated.

- Artificial depression created as a result of localised excavations.



Figure 20: Photograph of GRC12 dominated by J. effusus.

4.2 Meul River

The Meul River is a non-perennial river that originates entirely within the urban and industrial area of George and is heavily impacted by formalized and unformalized development (Figure 21). Frequent sewage spills occur along the river, leading to severe water quality problems all the way down to Ballots Bay. Erosion along unprotected banks at stormwater outlets is a relatively widespread problem that has required upgrades to stormwater infrastructure (i.e. construction of headwall outlets and erosion protection below the outlets). Solid waste pollution and littering is widespread. The hydrology of the river and its tributaries has been modified by increased inputs of stormwater discharge which has led to channelisation of wetland systems and erosion of the bed and banks and in parts, a heavily incised channel – particularly the smaller tributaries. The riparian zone is heavily invaded by alien invasive species, the most common of which are *A. mearnsii*, *S. mauritanium* and *Rubus sp*.

The most significant impacts are associated with point source inputs of stormwater and wastewater (untreated raw sewage from leaking/blocked pipelines and manholes) and solid waste and litter from poorly serviced formal and informal settlements. Well-established buffers along the majority of the length of the river offers little protection against these point source impacts and water quality is poor from the source all the way to the sea. Stormwater outlets are targeted as informal dumping areas, resulting in blockage of outlets which exacerbates erosion problems.



Figure 21: Photograph of the Meul River running along the western boundary of the development area.

4.3 Meul East River

The Meul East River is non-perennial and is confined to a very narrow steep valley. A series of small dams are located in the upper reaches (below GRC2) which regulate flows along the length of the stream. The entire length of the stream (up until the confluence with the Meul River) is heavily invaded by a variety of alien tree species, including *A. mearnsii, S. mauritanium, Pinus sp.* and *Eucalyptus sp.*



Figure 22: Photograph showing the steep valley and high levels of alien tree invasion associated with the Meul East River.

4.4 Minor Drainage Lines

Several non-perennial, drainage lines drain the development area. Flow in these systems is intermittent (i.e. a few hours to a few days) following heavy rainfall. The primary function of these systems is for delivery of surface flows to larger downstream systems (i.e. Meul and Meul East Rivers) and they provide limited habitat for aquatic biota. All of these streams are heavily invaded by alien tree species (predominantly *A. mearnsii*). The streams below wetland GRC5 and GRC9 have been severely impacted by road crossings which have constricted flows originating from the upstream wetland areas, leading to more concentrated flows downstream, which have caused serious erosion of the bed and banks and the formation of a deep, incised channel (Figure 23).



Figure 23: Heavily eroded channel below GRC5 (left) and GRC9 (right).

5. AQUATIC ASSESSMENT

5.1 Present Ecological State

5.1.1 Wetlands

Existing impacts to wetlands have been described above and are largely related to invasion by alien plant species (most notably *A. mearnsii* and *Eucalyptus sp.*) and infilling by roads crossing wetlands. These impacts affect hydrology through affecting water distribution within the wetland, leading to localised areas of inundation and/or water loss from the system. Apart from GRC1 and GRC2, which receive stormwater runoff from the N2 highway, existing land use/cover has a negligible impact on water quality in all wetlands which is considered to be relatively natural. While invasion by *A. mearnsii* is pervasive in the surrounding landscape, many of the wetlands experience relatively low levels of invasion within the delineated area and vegetation is often representative of mesic fynbos vegetation interspersed with wetland plant species (particularly in the seasonal seeps) or obligate wetland plant species in the case of more permanently saturated wetlands (i.e. GRC2 and GRC4). GRC5 and GRC9 are heavily invaded by *Eucalyptus* and *A. mearnsii*, respectively. Overall, the PES of each wetland ranges from B (largely natural with only minor impacts) to C (moderately modified) (Table 9).

Table 9: Table of PES assessments conducted for each the wetlands identified in the development area.

Wetland	Hydrology	Geomorphology	Water Quality	Vegetation	Overall PES
GRC1	C	B	C	B	**B**
GRC2	C	A	C	C	**C**
GRC3	C	C	A	B	**B**
GRC4	B	B	A	B	**B**
GRC5	C	B	A	D	**C**
GRC6	Artificial				
GRC7	C	A	A	B	**B**
GRC8	C	A	A	B	**B**
GRC9	D	C	A	D	**C**
GRC10	D	B	A	C	**C**
GRC11	C	B	B	B	**B**
GRC12	Artificial				

5.1.2 Rivers & Drainage Lines

The PES of all rives and drainage lines is assessed in Table 10 and is summarised as follows:

- The PES of the Meul and Meul East rivers is determined as D – Largely Modified – a large loss of natural habitat, biota and basic ecosystem functions has occurred.
- The PES of GRC5 and GRC9 stream is C – Moderately Modified – while loss of habitat has occurred basic ecosystem function remains unchanged.
- The PES of the minor drainage lines is B – Largely Natural (i.e. few modifications related to invasion by alien tree species).

Table 10: PES of rivers and streams occurring within the development area.

Modification	Meul	GRC5 & GRC9	Meul East	Minor Drainage Line
Instream Habitat				
Water abstraction	0 - None.	0 - None	15 – Relatively high considering the size of the stream.	0 - None
Flow modification	10 - A few small dams in upper reaches of catchment area.	0 - None	15 – Several instream dams in upper reaches.	0 - None
Bed modification	15 - High rates of erosion in the catchment area, leading to increased sediment accumulation	5 - Minor	10 – Moderate sediment input from quarry	5 - Minor
Channel modification	15 - Peak flows have increased substantially due to increased stormwater runoff, leading to channel incision and bank erosion.	20 – Road crossings concentrate flow leading to heavily incised and eroded channel	15 - Peak flows have increased substantially due to increased stormwater runoff, leading to channel incision and bank erosion	10 – Minor to moderate channel erosion caused by invasion by alien tree species (most notable *A. mearnsii*)
Physico-chemical modification	16 - Water quality heavily impacted by urban stormwater runoff, leaking sewage infrastructure, poorly serviced informal settlements	5 - Minor	10 – Nursery and quaary operations runoff	5 - Minor
Inundation	1 - Very few impoundments – negligible impact on instream habitat.	0 - None	10 – Upper reaches inundated by dams.	0 - None
Alien macrophytes	0 - None	0 - None	0 - None	0 - None
Alien aquatic fauna	0 - None	0 - None	0 - None	0 - None
Rubbish dumping	15 - High loads of litter and solid waste in lower reaches.	5 - Minor	5 - Minor	5 - Minor
Instream IHI score	**52**	**76**	**52**	**88**
Riparian Habitat				
Vegetation removal	3 - Minimal vegetation removal.	5 - Minor	5 - Minor	5 - Minor
Invasive vegetation	18 - High rates of invasion by *A. mearnsii, S. mauritianum* and *Rubus sp.*	20 – Heavily invaded by *A. mearnsii*	20 - High rates of invasion by *A. mearnsii, S. mauritianum* and *Eucalyptus.*	15 – Moderate to heavy invasion by *A. mearnsii*
Bank erosion	10 - Serious bank erosion at informal crossings	20 – Serious bank erosion	10 – Moderate bank erosion	10 – Moderate bank erosion
Channel modification	15 – Eroded channel affects riparian habitat quality	15 – Eroded channel affects riparian habitat quality.	15 – Eroded channel affects riparian habitat quality.	5 – Minor impacts on riparian vegetation.
Water abstraction	0 - Riparian vegetation not affected by water abstraction.	0 - Riparian vegetation not affected by water abstraction	0 - Riparian vegetation not affected by water abstraction	0 - Riparian vegetation not affected by water abstraction
Inundation	1 - Very few impoundments – negligible impact on riparian habitat.	0 - None	10 – Upper reaches inundated by dams.	0 - None
Flow modification	0 - Riparian vegetation not affected by flow modification.	0 - None	0 - Riparian vegetation not affected by flow modification.	0 - None
Physico-chemical modification	0 - Riparian vegetation not affected by water quality.	0 - Riparian vegetation not affected by water quality.	0 - Riparian vegetation not affected by water quality.	0 - Riparian vegetation not affected by water quality.
Riparian IHI Score	**55**	**48**	**50**	**73**
Combined Score	**53 – Largely Modified**	**62 – Moderately Modified**	**51 – Largely Modified**	**81 – B (Largely Natural)**

5.2 Ecological Importance & Sensitivity

5.2.1 Wetlands

- Of all the wetlands GRC2 and GRC4 are notable for their potential to support biodiversity (Moderate). This is attributed mainly to the diversity of habitat types and wetland plant species in these wetlands. All other wetlands are of Low biodiversity importance (Table 11).
- All wetlands are of low importance at a landscape scale, but are considered important at a local scale (Table 11).
- Most wetlands (seeps and depressions) are not particularly sensitive to changes in surface flows, flood and water quality. GRC2 is moderately sensitive (Table 11).
- The larger wetlands - GRC1-5 and GRC9 - offer important ecosystem services in terms of assimilating pollutants and regulating streamflow (i.e. providing a source of water during drier periods) (Table 12).
- None of the wetlands offer important direct human benefits (Table 13). The diversity of habitats and wetland plants and the scenic beauty of GRC2 and GRC4 provide moderately important benefits from a recreational perspective (e.g. birdwatching). Overall, the importance of all wetland is however Low.

Table 11. Ecological Importance and Sensitivity importance criteria for the wetland.

Ecological Importance and Sensitivity	GRC1	GRC2	GRC3	GRC4	GRC5	GRC6	GRC7	GRC8	GRC9	GRC10	GRC11
Biodiversity Support											
Presence of Red Data species	1	2	1	2	1	1	1	1	1	1	1
Populations of unique species	0	2	0	2	0	0	0	0	0	0	0
Migration/feeding/breeding sites	1	2	1	2	1	1	1	1	1	1	1
Average	**0.66**	**2**	**0.66**	**2**	**0.66**	**0.66**	**0.66**	**0.66**	**0.66**	**0.66**	**0.66**
Landscape Support											
Protection status of wetland	0	0	0	0	0	0	0	0	0	0	0
Protection status of vegetation type	0	0	0	0	0	0	0	0	0	0	0
Regional context of the ecological integrity	1	1	2	2	1	1	2	2	1	2	1
Size and rarity of the wetland types present	1	1	1	1	2	1	1	1	1	1	1
Diversity of habitat types	1	2	1	2	1	1	1	1	1	1	1
Average	**0.6**	**0.8**	**0.8**	**1**	**0.8**	**0.6**	**0.8**	**0.8**	**0.6**	**0.8**	**0.6**
Sensitivity to changes in floods	1	2	1	1	1	1	1	1	1	1	1
Sensitivity to changes in low flows	1	2	1	1	1	1	1	1	3	1	1
Sensitivity to changes in water quality	1	2	1	1	1	1	1	1	1	1	1
Average	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1.66**	**1**	**1**
ECOLOGICAL IMPORTANCE AND SENSITIVITY	**L**	**M**	**L**	**L**	**L**	**L**	**L**	**L**	**M**	**L**	**L**

Table 12: Hydro-functional importance of the wetland.

Hydro-functional Importance			GRC1	GRC2	GRC3	GRC4	GRC5	GRC6	GRC7	GRC8	GRC9	GRC10	GRC11
Regulating & supporting benefits	Flood attenuation		2	2	1	2	1	1	1	1	2	1	1
	Streamflow regulation		2	2	1	1	2	0	1	1	1	1	0
	Water quality enhancement	Sediment trapping	2	2	2	2	2	1	1	1	2	1	1
		Phosphate assimilation	2	2	2	2	2	1	1	1	2	1	1
		Nitrate assimilation	2	2	2	2	2	1	1	1	2	1	1
		Toxicant assimilation	2	2	2	2	2	1	1	1	2	1	1
		Erosion control	2	2	2	2	2	0	1	1	2	0	0
	Carbon storage		2	2	1	2	2	1	1	1	1	1	1
Average			**2**	**2**	**1.6**	**1.9**	**1.9**	**0.8**	**1**	**1**	**1.8**	**0.9**	**0.8**
HYDRO-FUNCTIONAL IMPORTANCE			**M**	**M**	**M**	**M**	**M**	**L**	**L**	**L**	**M**	**L**	**L**

Table 13: Direct human benefit importance of the wetland.

Direct Human Benefits		GRC1	GRC2	GRC3	GRC4	GRC5	GRC6	GRC7	GRC8	GRC9	GRC10	GRC11
Subsistence benefits	Water for human use	0	1	0	1	0	1	0	0	0	1	1
	Harvestable resources/cultivated foods	0	1	0	0	0	1	0	0	0	0	1
Cultural benefits	Cultural heritage	0	0	0	0	0	0	0	0	0	0	0
	Tourism and recreation Education and research	1	2	1	2	1	1	1	1	1	1	1
		0.25	**1**	**0.25**	**0.75**	**0.25**	**0.75**	**0.25**	**0.25**	**0.25**	**0.5**	**0.75**
DIRECT HUMAN BENEFITS		**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**

6. BUFFER

Buffer determination considered the soil and climatic characteristics of the catchment, the nature of the development (mixed use commercial/retail/residential) and general characteristics of potential buffers (as observed in the field). Given the high quantity and intensity of rainfall and the highly erodible soils a preliminary buffer of 30 m has been determined for all watercourses within the development footprint (Table 14). A 50 m buffer has been implemented for the main Meul and Meul East Rivers to account for the very steep slopes along these watercourses. Figure 24 shows recommended buffers for all watercourses.

Table 14: Selected input parameters used to determine buffer widths.

MAP	>800 mm
Rainfall Intensity	70.9 – Zone 4 (Very High)
Soil SCS	A/B
Slope of Catchment	Gentle (2 – 10 %)
Slope of Buffer	Gentle (2 – 10 %)
Soil erosion potential	0.74 (Very High)
Vegetation Characteristics	Fair - Moderately robust vegetation with fair interception (e.g. tufted grass stands but with lowered basal cover)
Soil Permeability	Moderately Low - Deep moderately fine textured soils (e.g. loam & sandy clay loam)
Buffer Width	30 m

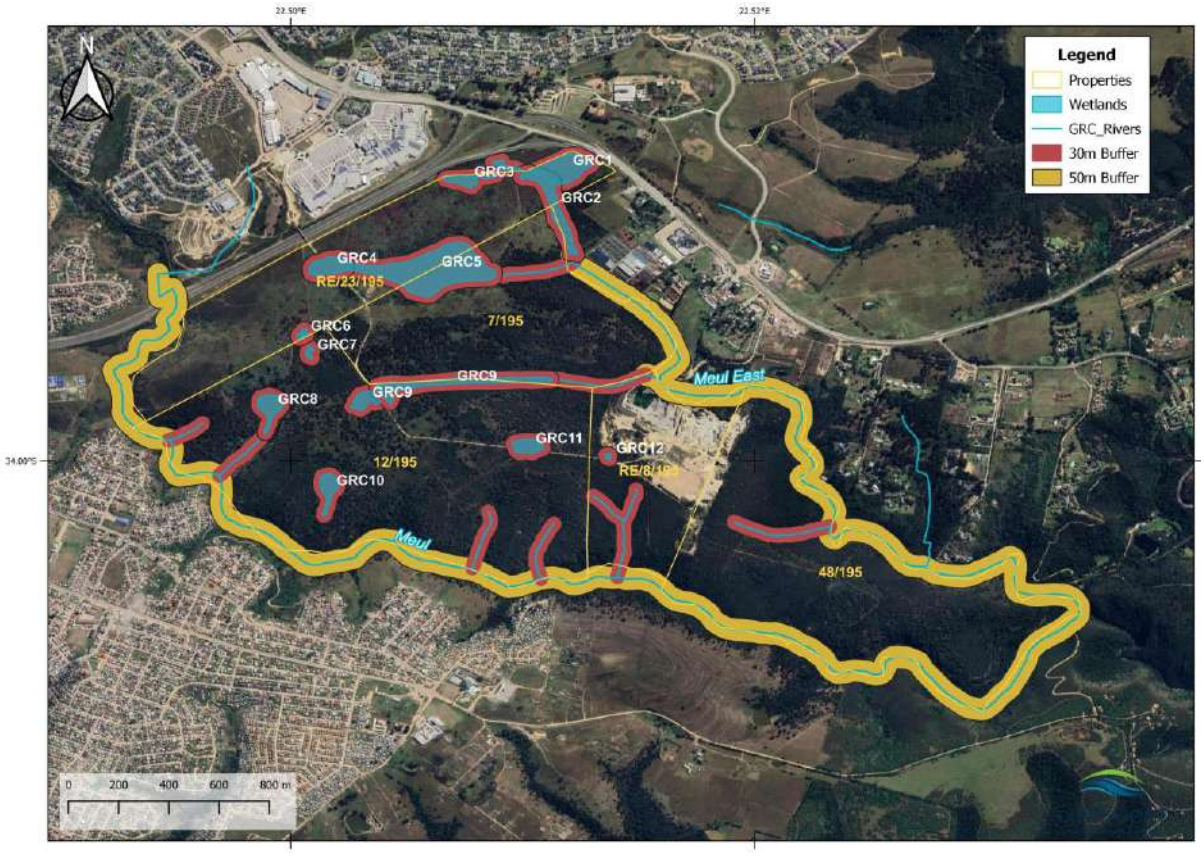

Figure 24: Map showing recommended buffers for watercourses.

7. CONCLUSION

In contrast to geospatial databases, several wetlands were confirmed as being present within the development area. The SDP will therefore need to be adjusted to take these wetlands into account. The sensitivity of the site is therefore considered to be Very High and a specialist assessment will need to be compiled in order to assess and mitigate impacts associated with the development.

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ANNEXURE 22

Proposed Development of Garden Route City, George, Western Cape

Terrestrial Animal Species Specialist Assessment:

Site Sensitivity Verification Report



Prepared For:	Hilland Environmental
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SACNASP:	Professional Natural Scientist (Ecological Sciences), 162841 (Application status-Pending)
Reviewer:	Dr. J.M. Dabrowski (Pr. Sci. Nat. Water Resources and Ecology; 115166)
Date:	December 2024
Version:	Draft pending SDP

DECLARATION OF SPECIALIST INDEPENDENCE

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant;
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.



Kim Daniels (MSc)

December 2024

SUMMARY OF EXPERIENCE AND ABRIDGED CV
- KIM DANIELS

Core skills

- MSc. Biodiversity and Conservation Biology (University of Cape Town.) and 3 years of work experience (research assistance and education) for research projects aimed at investigating invertebrate diversity, plant diversity, insect ecology, disease ecology, invasive species, plant systematics, herpetology, and climate change impacts on a variety of taxa.
- Ecological and field work experience before, during, and after postgraduate degrees across a range of environments (mesic savanna, arid savanna, fynbos, succulent karoo, and Nama karoo) and taxa (plants, invertebrates, avifauna, amphibians, and small mammals).
- My postgraduate studies have been focused on vegetation change in the fynbos and parasitic plants as thermal refugia for savanna birds.

Work experience

- Teaching assistant at the Organization of Tropical Studies and Roots & Shoots
- Internships in Entomology, Horticulture, and Plant Conservation
- Research assistant at the Centre for Invasion Biology
- Field assistant at Valuing Orchard and Integrated Crop Ecosystem Services Project

Qualifications

- BSc. Biodiversity and Conservation Biology (2018, University of the Western Cape)
- BSc. Hons. Biodiversity and Conservation Biology (2021, University of the Western Cape)
- MSc. Conservation Biology (2023, University of Cape Town)

References

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- Ms. Paula Strauss – Previous employer

  Research co-ordinator; Grootbos Nature Reserve

  E-mail: paula@grootbosfoundation.org; Tel: 072 611 7971

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ABBREVIATIONS AND ACCRONYMS

CBA	Critical Biodiversity Area
CD:NGI	Chief Directorate: National Geo-spatial Information
DFFE	Department of Forestry, Fisheries, and the Environment
ESA	Ecological Support Area
EWT	Endangered Wildlife Trust
NEMA	National Environmental Management Act
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SDP	Site Development Plan
SSVR	Site Sensitivity Verification Report
WCBSP	Western Cape Biodiversity Spatial Plan

1. INTRODUCTION

Confluent Environmental Pty (Ltd) was appointed by Hilland Environmental to provide Terrestrial Animal Specialist inputs for the proposed development of Garden Route City, a mixed-use complex (residential, education, hotel, waterfront park, business, church, hospital, butterfly park, and others are approved zones at the site) on Portion 7, 12, and 48 of Kraaibosh Farm 195, (7/195. 12/195, and 48/195) and the Remainder of Portion 8 and Portion 23 of Kraaibosch Farm 195 (RE/8/195 and RE/23/195) in George, Western Cape. The site development plan (SDP) is informed by several preliminary assessments including one focused on butterfly diversity.

1.1 General Site Location

The development area is ca. 417 hectares in extent and located west of Victoria Bay with tributaries to the Meul River running along its western, eastern, and southern extent meeting in the west of the area (Figure. 1). The N2 runs along its northern edge. A quarry is situated in RE/8/195. The site is accessible via roads leading to the quarry and more disused roads across the site. The landscape is heavily developed west of the site, with densely populated Thembalethu, Conville, and Blue Mountain just outside of its boundary and medium density Kraaibosch located in the north-east. The property falls within the larger Garden Route Biosphere Reserve. George (or Blydskap) Private Nature Reserve forms part of the eastern extent of the site.

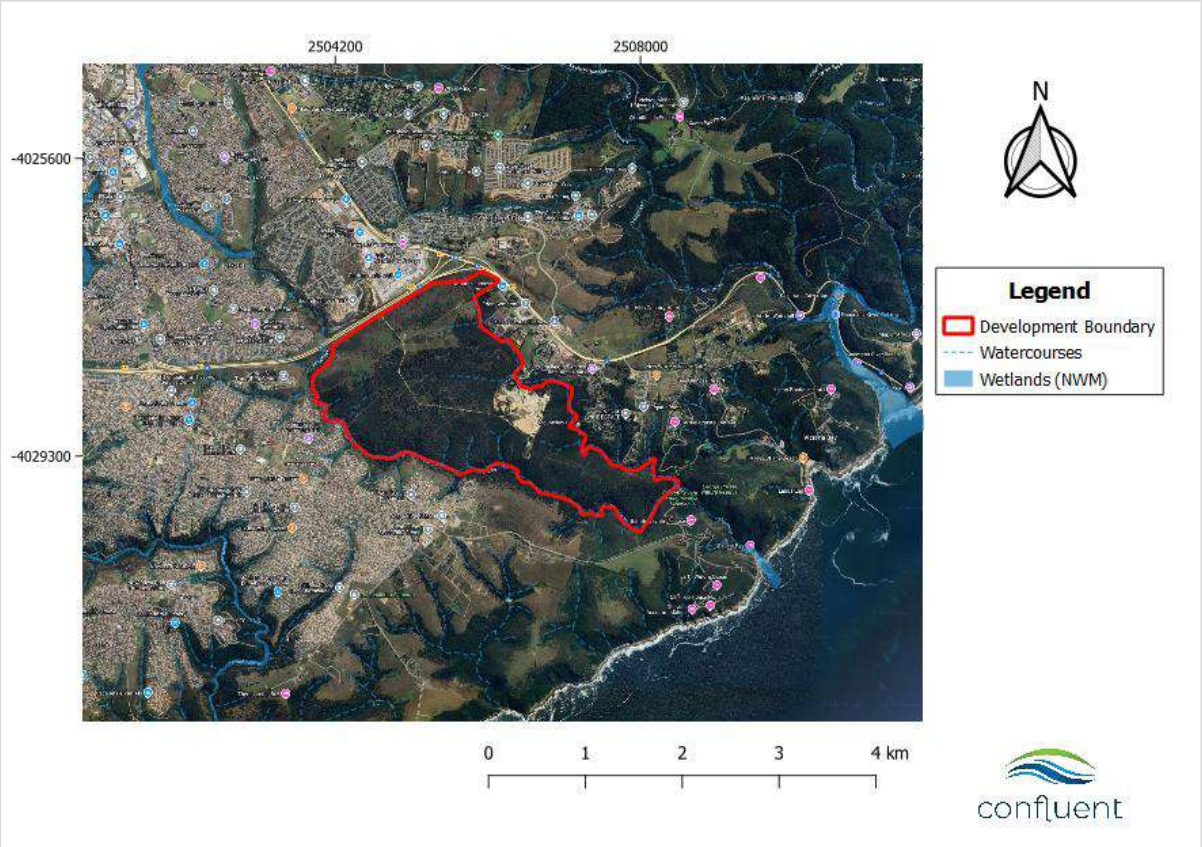

Figure 1. The proposed site for the development of Garden Route City in George, Western Cape.

1.2 Development Layout

At the time of writing this report the site development plan (SDP) included an approved butterfly conservation precinct and private nature reserve. The development area is divided by its zoning and some proposed roads are already outlined (Figure. 2). There is no indication of the proposed sewer system and electricity supply but it is assumed that these connections would be municipal.

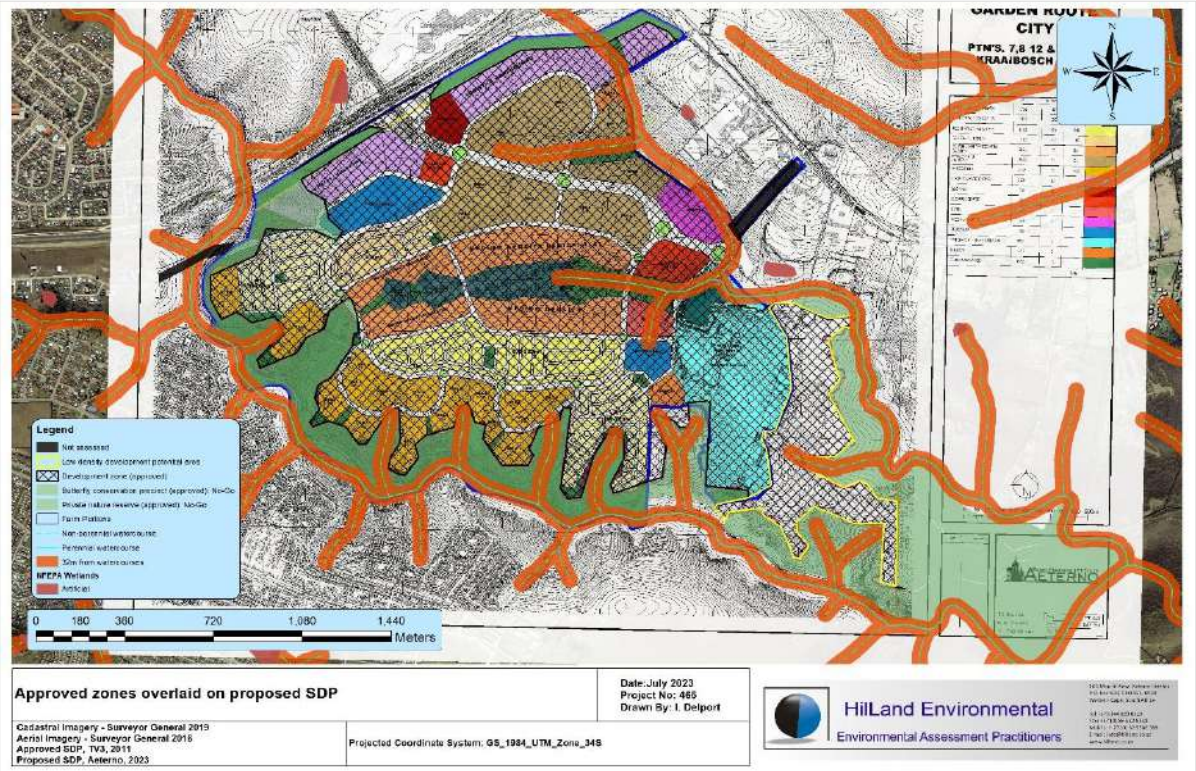

Figure 2. Zoning map for the proposed development of Garden Route City

2. TERMS OF REFERENCE

2.1 Online Screening Tool

The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA; Act 107 of 1998).

The Department of Forestry, Fisheries and the Environment (DFFE) Screening Tool determined a MEDIUM and HIGH sensitivity for the terrestrial animal species theme across the proposed development site (Figure 3), with several animal Species of Conservation Concern (SCC) potentially present (Table 1).

As per Published Government Notice No. 1150 of the Government Gazette 43855 (30 October 2020):

A **HIGH** sensitivity rating indicates:

1. Confirmed habitat for SCC.

2. SCC, listed on the IUCN Red List of Threatened Species or South Africa's National Red List website as Critically Endangered, Endangered or Vulnerable, according to the IUCN Red List 3.1. Categories and Criteria and under the national category of Rare.

These areas are unsuitable for development due to a very likely impact on SCC.

A **MEDIUM** sensitivity rating indicates:

1. Suspected habitat for SCC based either on historical records (prior to 2002) or being a natural area included in a habitat suitability model for this species.

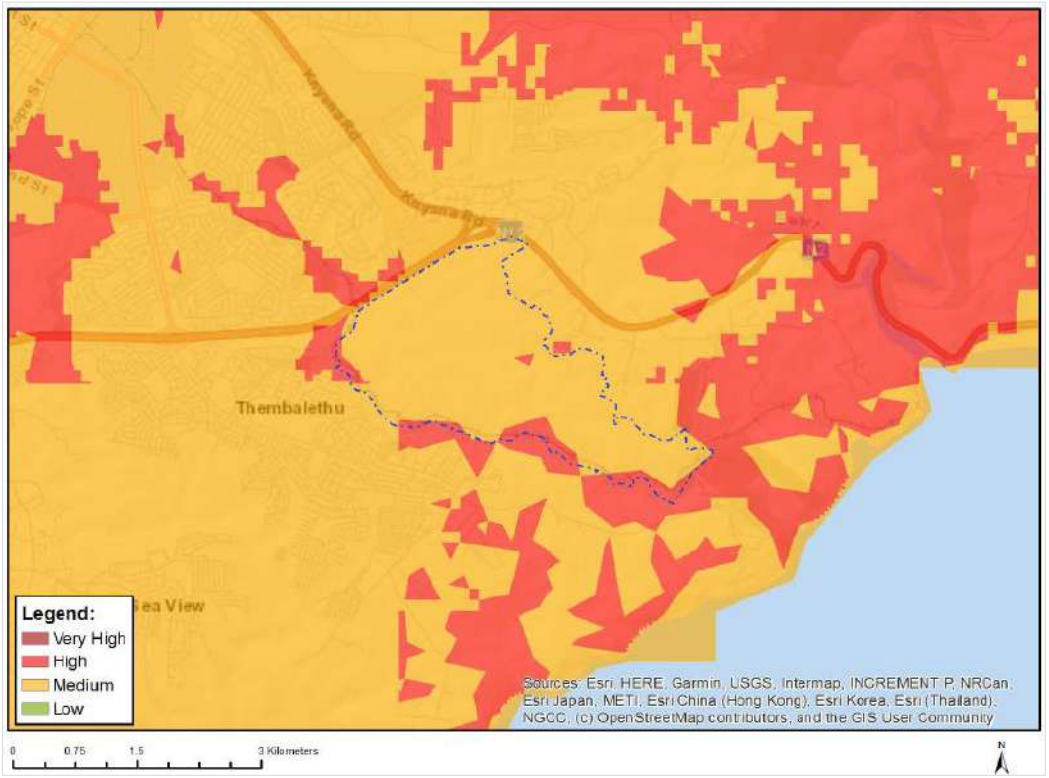

Figure 3. DFFE Online Screening Tool outcome for the terrestrial animal species theme. The development boundary is indicated by the blue dashed line.

Table 1. Species of Conservation Concern highlighted by the DFFE Online Screening Tool for the development area.

Sensitivity	Taxon	Species	Common name	Red list status
Medium	Amphibian	*Afrixalus knysnae*	Knysna Leaf-folding Frog	Endangered
Medium	Avifauna	*Aneuryphymus montanus*	Yellow-winged Agile Grasshopper	Vulnerable
High + Medium	Avifauna	*Bradypterus sylvaticus*	Knysna Warbler	VU, VU
High + Medium	Avifauna	*Circus ranivorus*	African Marsh Harrier	Endangered
Medium	Avifauna	*Neotis denhami*	Denham's Bustard	VU, NT
Medium	Avifauna	*Stephanoaetus coronatus*	Crowned Eagle	VU, NT
Medium	Mammal	*Chlorotalpa duthieae*	Duthie's Golden Mole	Vulnerable
Medium	Mammal	Sensitive Species 8		Vulnerable

* Red list status as per SANBI's Red List of South African Species http://speciesstatus.sanbi.org.

2.2 Scope of work

The purpose of this report is to verify the sensitivity of the proposed development site of Garden Route City for the terrestrial animal species theme in accordance with the protocols specified in the Published Government Notice No. 1150, Government Gazette 43855 (30 October 2020).

The site sensitivity verification includes:

- A desktop assessment, to:
    - Characterize the vegetation, climate, general habitat features, and topography of the property.
    - Assess the property's location within the context of the Western Cape Biodiversity Spatial Plan (WCBSP).
    - Conduct a historical assessment of the property and immediate surroundings for any disturbances, development, and changes in land use or habitat characteristics over time.
    - Provide information on the habitat requirements for Species of Conservation concern (SCC) highlighted by the DFFE online screening tool, in addition to other SCC indicated through online resources (e.g. Virtual Museum, iNaturalist) for the property and surrounding areas.
- On-site inspection(s) and field assessments to:
    - Verify the current land use and identify current impacts or disturbances on the property.
    - Characterize faunal habitats, determine the habitat suitability and the likelihood of SCC occurring on the property.
    - Conduct taxa-specific sampling for SCC in suitable habitats.
- Any other available and relevant information from
    - Discussions with landowners/neighbours.
    - Previous report findings for the property or surrounding areas.

Should the site sensitivity verification indicate a **LOW** sensitivity, then a Terrestrial Animal Species Compliance Statement will be issued.

Should the site sensitivity verification indicate a **HIGH** sensitivity, then a Terrestrial Animal Species Specialist Assessment will be compiled.

3. DESKTOP ASSESSMENT

3.1 Vegetation, Climate and General Habitat

George has moderately hot summers and cool winters. Climate in the region is described as temperate with no dry season and warm summers according to the Köppen-Geiger Climate Zone classification (namely, 'Cfb'). As such it receives a moderate amount of rainfall throughout the year (673mm mean annual rainfall) with peak precipitation occurring in November (57mm). The coldest month of the year is July (5^0C daily minimum with 18^0C daily

maximum, on average) and the hottest months of the year are January and February (15^{0}C daily minimum with 28^{0}C daily maximum, on average) (Figure. 4).

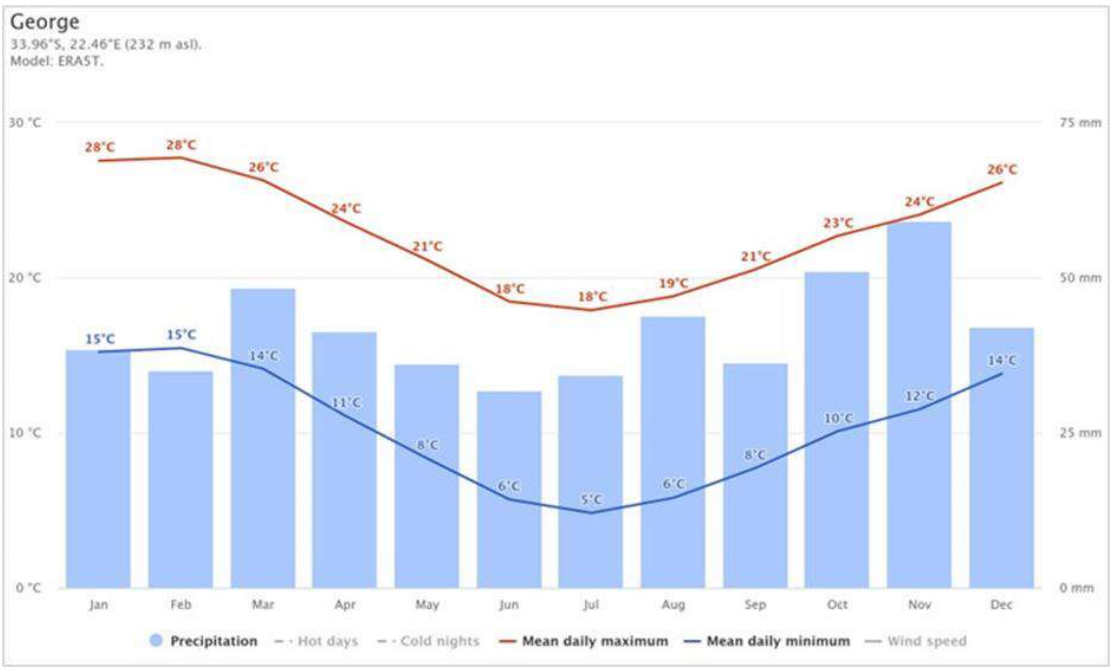

Figure 4. The climate of George indicating the daily maxima and minima averaged across the month, and precipitation from recent years (https://www.meteoblue.com/)

Satellite imagery from Google Earth and Cape Farm Mapper was used to assess general vegetation structure, elevational gradients, and water bodies within the project area (Figure 55). The site mainly comprises of dense vegetation across most of the site, with density showing a decrease in the west. Dirt roads are present across the property. A large quarry is also present in the centre of the development area. Areas of low elevation are present in channels which contain tributaries to the Meul River. No wetlands are mapped for the site (Figure. 5).

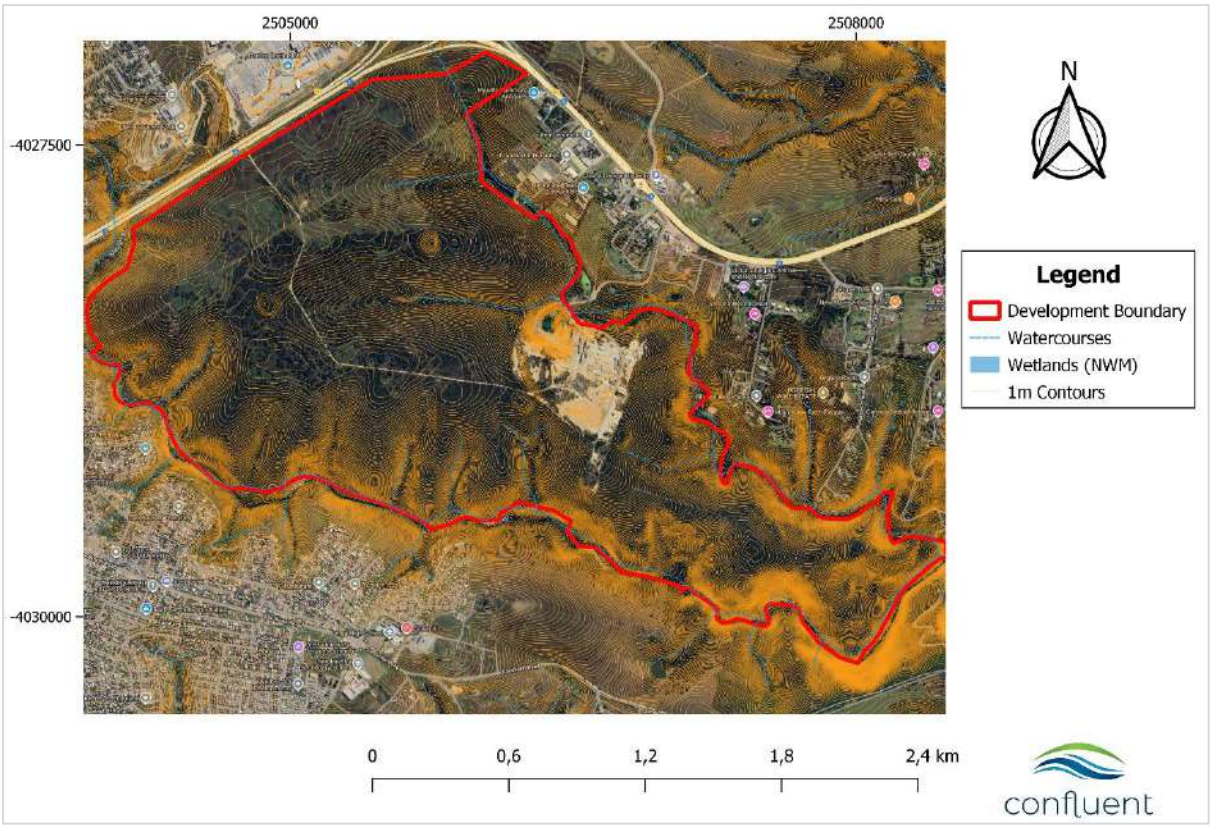

Figure 5. The proposed development sites with contour lines and in relation to mapped watercourses.

3.2 Western Cape Biodiversity Spatial Plan

Additional mapping layers were applied to the site to include the Western Cape Biodiversity Spatial Plan (CapeNature 2017), with Critical Biodiversity Areas (CBAs), Protected Areas (PAs), and Ecological Support Areas (ESAs) assessed in Figure 6 and Table 2. The site falls within a CBA 1 zone concentrated around watercourses, patches of CBA 2, a large ESA 2 zone mapped for RE/23/195, 7/195, and 12/195, The property 48/195 is mapped as a PA (Figure 6). The reasons for the biodiversity spatial plan assignments are listed below. Grey entries either do not apply to the site or are outside of the scope of this report to provide comment on. Although these features may be a habitat for some terrestrial animal species, its protection is to be addressed in the aquatic specialist report (F. de Ridder-Confluent Environmental) and the botanical specialist report (B. Fouche- Confluent Environmental).

- Bontebok Extended Distribution Range: This indicates that the habitat is modelled to be suitable for bontebok should the range of the species need to be expanded. Bontebok are currently not present outside of Bontebok National Park. An urbanized, fragmented, and open-access landscape such as this would not be suitable for the species.
- Water source protection- Kaaimans
- Watercourse protection- South Eastern Coastal Belt
- Garden Route Granite Fynbos (CR)
- Indigenous Forest Type
- Wolwedans Grassy Fynbos (Vlok variant- CR)

- Coastal resource protection- Eden
- Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland
- Groot Brak Dune Strandveld (EN)
- South Strandveld Western Strandveld Channelled Valley Bottom Wetland
- South Strandveld Western Strandveld Floodplain Wetland
- South Strandveld Western Strandveld Seep Wetland

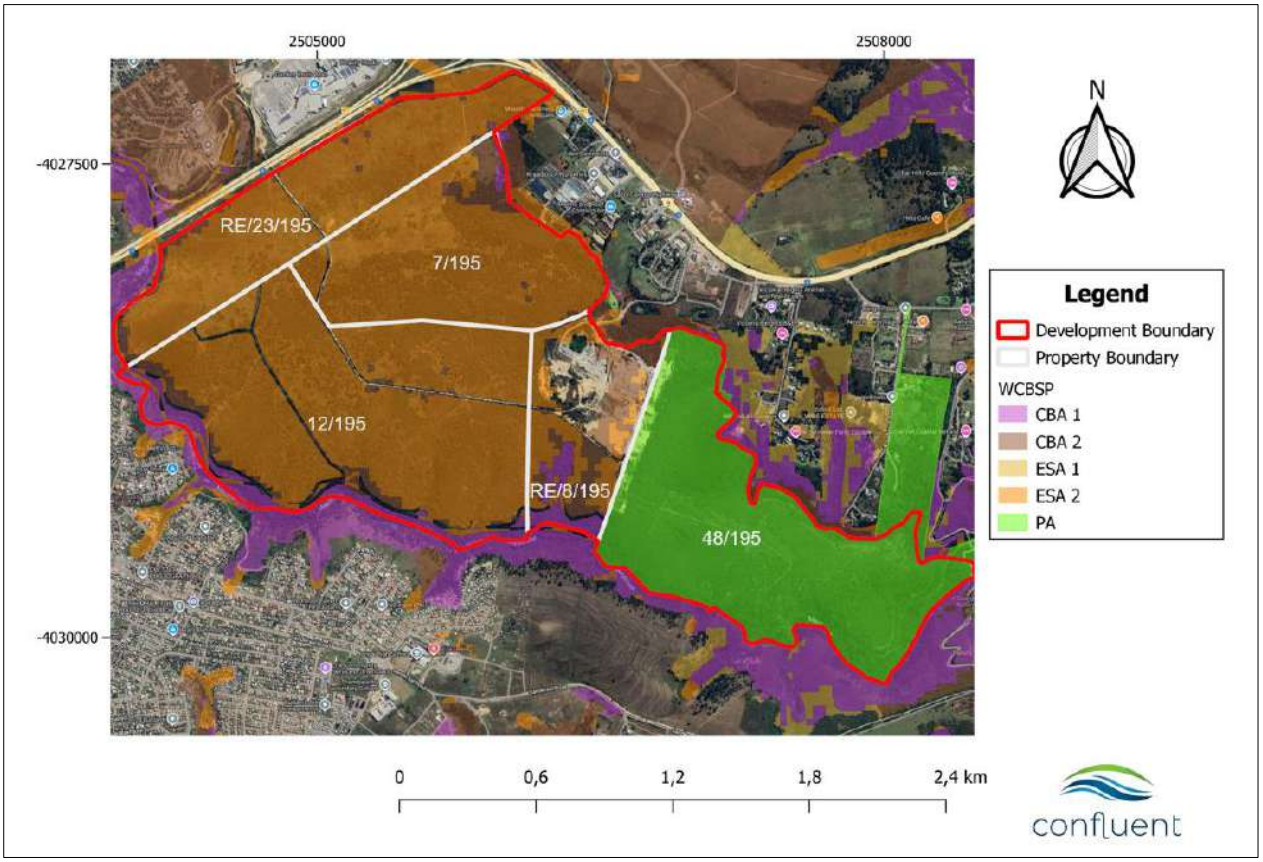

Figure 6. Site map with layers for the Western Cape Biodiversity Spatial Plan's Critical Biodiversity Areas (CBA1), Ecological Support Areas (ESA2), and Protected Area (PA) (namely Blydskap / George Private Nature Reserve). Properties are separated by white lines and labelled in white.

Table 2. Definitions and objectives for conservation categories identified in the Western Cape Biodiversity Spatial Plan (CapeNature 2017).

WCBSP Category	Definition	Management Objective
Critical Biodiversity Area 1 (CBA1)	Areas in a natural condition. Required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.
Critical Biodiversity Area 2 (CBA2)	Areas in a degraded or secondary condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land-uses are appropriate.

WCBSP Category	Definition	Management Objective
Ecological Support Area 2 (ESA 2)	Areas severely degraded or have no natural cover and ecological functioning severely impaired. Not essential for meeting biodiversity targets but support ecological functioning and delivering ecosystem services.	Restoration required to return ecological functioning. Some limited habitat loss may be acceptable. A greater range of land uses over wider areas is appropriate but ensures the underlying biodiversity objectives and ecological functioning are not compromised.

3.3 Historical Assessment of Project Area

The oldest historical images that can be obtained for the area is in 1974 where we see that the properties are situated in a largely agricultural landscape with urbanization increasing until 2024. The bare lines across the site which later become dirt roads suggests this land use on at the site previously. Three strips of land (yellow arrows) are bare within the development area and the quarry (green arrow) is established on a small scale.

Between 1974 and 1989, agriculture returns as the major land use for the development area with fields appearing from the north-east to the centre of the site. The quarry shows expansion. One of the narrow strips of land is inundated with water whilst the second serves as a border (agriculture only takes place west of the line). The third of the strips is revegetated.

By 2005 traces of the agricultural use of the land remains in the form of bare lines across the site. An expansion of this activity occurred post-1989, but the practice had ceased some time before 2005.

2011 shows an increase in woody vegetation across the site and an expansion of the quarry to the east. Both of these trends become more pronounced by 2017 where an expansion in the size of the quarry has taken place and vegetation becomes woodier. Increases in woody vegetation has obscured the dirt roads in the eastern extent of the development area. Further increases in woody and bushy vegetation are observed by 2024.

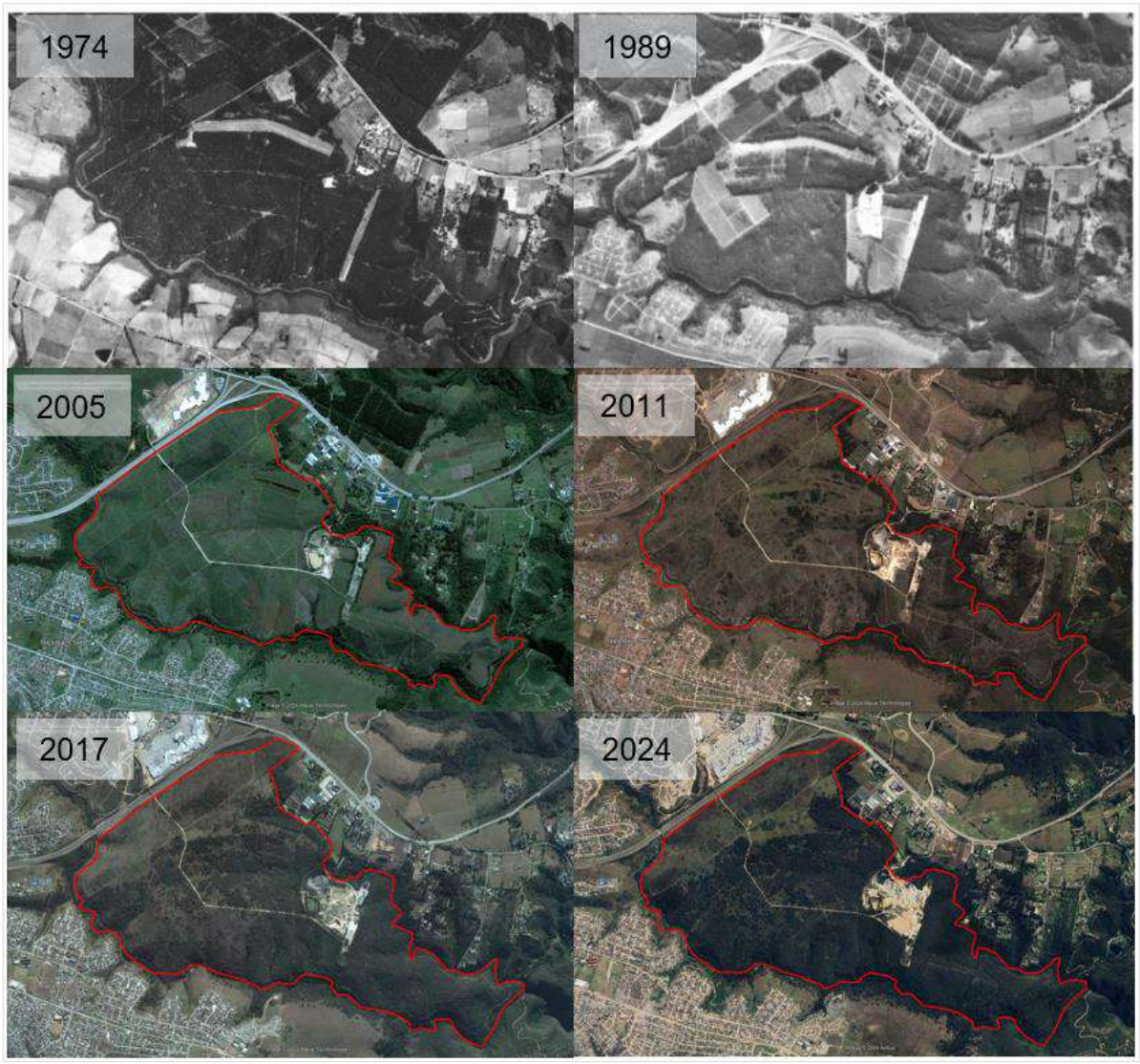

Figure 7. Historical imagery of the site sourced from the CD: NGI geospatial portal and Google Earth. The development boundary is indicated by the red line.

3.4 Species of Conservation Concern

In addition to the SCC highlighted by the DFFE screening tool (Table 1), the following public resources were consulted to provide additional SCC for the development site and its immediate surroundings:

1. iNaturalist (all taxa) within 2km x 2km of the project area.
2. Virtual Museum for herpetofauna, mammals and invertebrate taxa within the Quarter Degree Square (QDS) 3322DC, 3322CD, and 3422AB: DungBeetleMAP, FrogMAP, LacewingMAP, LepiMAP, MammalMAP, OdonataMAP, ReptileMAP, ScorpionMAP, SpiderMAP.
3. South African Bird Atlas Project (SABAP2) for pentad 3355_2225, 3355_2230, 3400_2225, and 3400_2230.

Some SCC reported on the platforms were highly unlikely to occur at the site given either clearly unsuitable habitat or being deemed a vagrant/ transient animal. For example, species that are fully adapted to marine environments would not occur at the site. For the purposes of this report these animals were excluded from further assessment (see also Section 4.2 and Appendix 1 for additional information).

The combined list of SCC (from DFFE Screening Tool and public resources) possibly occurring in the development area, along with their habitat, breeding, and feeding requirements are listed in Table 3. The information for each SCC presented in Table 3 stems largely from the online SANBI Red List of South African Species (http://speciesstatus.sanbi.org) in addition to a few key resources for each taxa:

1. Avifauna: Roberts Birds of Southern Africa VII (Roberts, et al. 2005)
2. Mammals: The Mammals of the Southern African Subregion (Skinner 2005)
3. Invertebrates:
    a. Field guide to the insects of South Africa (Picker, Griffiths and Weaving 2019)
    b. Field guide to the butterflies of South Africa (Woodhall 2005)
    c. Field guide to the spiders of South Africa (Dippenaar-Schoeman 2023)
4. Amphibians: A complete guide to the frogs of Southern Africa (Du Preez and Carruthers 2015)

Any information presented from different sources is cited in the text.

Table 3. Summary of habitat, breeding and feeding requirements for animal SCC potentially occurring on at the site and its surroundings.

Species	Red list status	Habitat	Breeding	Feeding
AMPHIBIANS				
Afrixalus knysnae Knysna Leaf-folding Frog	Endangered	Typically inhabit endorheic (inward draining) wetlands with shallow water (< 50cm), high clarity, and sufficient vegetation suitable for breeding (De Lange & Du Preez, 2018). No streaming or running water recorded at any of the sites where they have been recorded. The frog is associated with vegetation it can use for breeding which includes indigenous and exotic species for example, Slender Knotweed (*Persicaria decipiens*) and Kikuyu Grass (*Cenchrus clandestinus*). The species requires a habitat with diverse plant species, including shrubs, grasses, and ferns, providing shelter and breeding sites (De Lange and Du Preez, 2018).	Females lay eggs on leaves which are folded and sealed by males, creating a protected environment (Du Preez & Carruthers, 2017). Breeding occurs during warmer wetter months such as September to November (De Lange, 2019). Breeding takes place near deeper parts of the waterbody, but still close to the water's edge.	The Knysna Leaf-folding Frog is an insectivorous amphibian feeding on small invertebrates found in its habitat (e.g. insects and spiders). Foraging behaviour includes actively searching for prey on the forest/fynbos floor and in the leaf litter. The frog uses its sticky, projectile tongue to capture and quickly ingest prey. It is primarily active at night, relying on its vision to locate and capture prey in the darkness.
AVIFAUNA				
Circus maurus Black Harrier	Endangered	In Western Cape, mostly found in fynbos, especially montane fynbos and strandveld. Less common in dry restios and renosterveld. Elsewhere, occurs in dry grassland, karoo scrub, crop fields (wheat), and grasslands (sometime > 3000 meters above sea level in elevation). Many move from fynbos to karoo and grasslands during the winter, likely to follow rodent numbers (e.g. capitalise on late summer litter of Sloggett's ice rats in Free State and Lesotho). Birds move away following fires and do not return for several years.	Mainly monogamous but some polygamy observed. Mate fidelity is low. Usually solitary nester and territorial, but in Western Cape some semi-colonial nesting observed with less territorial behaviour. Nest is a small structure of grass, stems and small twigs. Usually on or just above ground in rank marsh grasses or near fynbos bushes and sedges (*Juncus* spp.) Nests most often in marshes or next to small streams, but also on damp soil or dry ground. Nests are reused in successive years (one	Specialist predator of mice and birds. Predominantly rodents (vlei rats, mice) eaten by birds in fynbos areas and small birds dominate diet of birds in mountain areas. Also takes reptiles, frogs, and insects to a lesser extent. Sometimes caches prey. Forages most actively on blustery days (windy and rainy), hovers 1-3 m above vegetation with buoyant flight. Flashes into vegetation, hits prey hard and eats on ground. Perch hunting rare.

Species	Red list status	Habitat	Breeding	Feeding
			observation of nest site used for 26 years).	
Circus ranivorus Marsh Harrier	Endangered	Considered a waterbird. Roosts on taller trees around wetland edges from where it has a good vantage point. Can adapt to novel wetland habitats such as wastewater treatment works.	Breeding occurs between September and December. Egg-laying is from August to November in South Africa. Nests are made of grass, reed stems, or sticks in reedbeds, short sedge areas, or in trees along the water's edge. The same nest is often reused by the same pair in following years.	Dietary assessment (Simmons *et al*., 1991) of pellets and prey deliveries to nests includes birds, frogs, fish, eggs, and micromammals (*Rhabdomys*, *Otomys*, and shrews). Hunts primarily in wetland habitats using various flight methods including soaring, hovering, and low flight over wetlands and along the water's edge. May hunt in open grasslands or pastures near wetland areas.
Polemaetus bellicosus Martial Eagle	Endangered	Savanna, Karoo shrubland, semi desert. Can occur in open farmland with clumps of trees. Rare in mountainous and forest areas.	Monogamous, pair bond lasts several seasons. Solitary nester. Nest is a substantial platform of sticks (up to 1.5 m long and 3 cm thick) on tall trees or pylons. Nest tree usually tallest in vicinity, and nest placed in a large fork below the canopy. Rarely uses rocky outcrops.1 egg laid per season. Incubation is 48-53 days, predominantly done by female bird.	Mainly small mammals like hare, jackal, small antelope, mongoose, small baboons, but also small stock animals, birds (especially gamebirds) and reptiles (especially monitor lizards). Usually hunts on the wing by soaring high and attacking in long slanting stoop. Surprises prey by using available cover. Occasionally hunts from a perch, especially at waterholes or along game trails. Prey killed by impact or strangulation and taken to high perch to eat.
Bradypterus sylvaticus Knysna warbler	Vulnerable	Inhabits dense understorey vegetation along riverbanks in fynbos forest patches, riverine woodland, and afromontane forest and has adapted to thickets of non-native brambles (e.g. *Rubus*). (BirdLife International, 2016).	Breeds from August to December coinciding with the greatest abundance of invertebrate species. (BirdLife International, 2016).	Mostly on the ground, creeping through dense, matted vegetation and scratching in humus. Eats mostly grasshoppers, insect larvae, spiders, slugs, worms.
Sarothrura affinis Striped Flufftail	Vulnerable	Dry, upland grasslands. Montane grassland and fynbos. Only rarely enters wetlands and marshes. Alongside streams in grassland habitats. Key structural elements for habitat include dense cover with open ground for	Monogamous, pair bond likely permanent. Nest is a bowl of dried grass that is built into a tuft of grass or sedge. Surrounding vegetation sometimes used to create a woven canopy. Laying occurs in September. Incubation is at least 15 days.	Eats mainly insects (adult and larvae), but diet also includes earthworms, spiders, and grass or sedge seeds. Forages throughout the day, searching for food through open patches of dry vegetation, occasionally on damp soils and shallow water.

Species	Red list status	Habitat	Breeding	Feeding
		foraging. Also found at sites with bracken fern, brambles, woody vegetation (*Protea* spp., *Buddleja* spp.) or close to forest edges. In Western Cape, found in mesic mountain fynbos with fountain bush and mountain daisy species (*Psoralea* and *Osmitopsis*). Can occur on croplands (i.e. millet, lucern). Loss of grassland, too frequent burning, and overgrazing is major threats to habitat in South Africa.		
Stephanoaetus coronatus Crowned eagle	Vulnerable	Forest (including gallery forest), dense woodlands, and forested gorges in savannas and grasslands. Can also be found in *Eucalyptus* and Pine plantations. Perches for long periods, resting in canopy. Sometimes soars high over territory, then descends vertically to perch. Manoeuvers agilely through thick forest, can take off vertically from forest floor.	Monogamous, possibly long-term pair bond. Territorial (at least 10 km^2), solitary nester. Tallest trees used to build large stick platform nest (sticks/ branches up to 1.5m long, 3cm thick). Nest copiously lined with beachwood (*Faurea saligna*), Pine or *Eucalyptus* leaves/needles. Nest often reused and added to in consecutive years, can reach up 2-3 m in diameter, 3 m high. Nest trees often at the base of a cliff/ ravine or at the edge of plantation. Nest trees usually White stinkwood (*Celtis africana*), yellowwoods (*Podocarpus* spp.), Cabbage tree (*Cussonia spicata*) but also *Eucalyptus* and Pine species. Incubation 49-51 days.	Predominantly feeds on mammals (96% diet), mostly hyrax, antelope, and primates. Will also take porcupine, hares, mongoose, sometimes domestic stock and domestic cats/ dogs. Avian prey includes Hadeda Ibis, Egyptian geese and domestic chickens. Reptile prey is mainly monitor lizards. Most prey taken on ground, but occasionally crashes into dense foliage in pursuit. Frequently still-hunts (stalks prey) and hunts from concealed perches frequently above waterholes in the evening waiting for antelope to drink. Pair sometimes hunt monkeys cooperatively. Prey struck with downward blow of open foot, massive hind claw penetrates the skull killing instantly. Large prey that cannot be lifted are partly eaten and dismembered on the ground and then cached in trees.
Alcedo semitorquata Half-collared Kingfisher	Near Threatened	Clear, well-vegetated, fast-flowing perennial streams in forested habitat. Stream habitat usually narrow and secluded with dense marginal vegetation, near rapids. Also occurs in estuaries and	Monogamous, solitary nester, territorial. Territory is ca. 1 km of river. Burrows into vertical riverbanks (usually 1 m high) with overhanging vegetation and roots providing screening. Entrance usually 40 cm below top of embankment, and	Sits motionless on perch for long time before diving steeply into water. Rarely hovers above water. Diet is mainly fish (3 - 7 cm in size), carried back to perch to eat. Also consumes crabs, aquatic insects, and amphibians.

Species	Red list status	Habitat	Breeding	Feeding
		well-vegetated lake shores but generally avoids dams.	sometimes only 15 cm above water. Burrow chamber lined with fish bones. Laying dates are September to March. Eggs incubated for > 16 days, and brooding limited to 5 days. Fledgling dependence on adults limited.	
Camphetera notata Knysna Woodpecker	Near Threatened	Territorial, occurring in thornveld, *Euphorbia* thickets, riparian, and montane evergreen forests. Marginal occurrence in *Protea* communities, coastal white Milkwood (*Sideroxylon inerme*) thickets, and alien trees	Monogamous, solitary nester. Nests in a hole in a trunk/ branch usually in a dead stem 1.2 – 6 m off the ground. Holes infrequently reused in successive years, but a new hole can be excavated in the same branch. Laying is from August to November.	Forages at all levels of trees, especially mid-canopy. Pecks and probes for ants and termites on dead branches, but occasionally forages on the ground.
Chaetops frenatus Cape Rockjumper	Near Threatened	Rocky mountain fynbos, especially on high slopes and ridges (high rainfall windswept areas), but down to sea level around Cape Hangklip, Western Cape. Threatened by alien vegetation, climate change, predation, and changes in land use. Distribution from Piketberg to the Cederberg to Cape Hnagklip to Uitenhage.	Monogamous, facultative cooperative breeder. Group comprises breeding pair and sometimes one or two additional birds. Territorial solitary nester. Nest is an untidy bowl of grasses, twigs, moss, lichen, fine restios, roots, fur, and hairy protea seeds. Placed on the ground at the base of a boulder or slab, hidden by vegetation and protected from wind.	Feeds on the ground, scratching and probing in the sand at the bases of bushes and boulders. Eats mostly arthropods, occasionally lizards, rarely amphibians.
Buteo trizonatus Forest Buzzard	Least Concern (Regional), Near Threatened (Global)	Afromontane forests and plantations (mainly Pine, but also *Eucalyptus*). Generally unobtrusive, perching on large branches partially concealed under canopy, sometimes perching in the open at the edge of forests.	Monogamous, territorial, solitary nester. Nest is a platform of sticks, cup-lined with green leaves. Nests in plantations are smaller than in native forests. Laying dates from August to November. Breeding is confined to the Western Cape and Eastern Cape Provinces.	Forages along forest edges and within forests and plantations. Hunts mainly from a perch. Diet consists of small mammals (mice and moles), small birds, snakes, lizards, frogs, and invertebrates.
TERRESTRIAL INVERTEBRATES				
Chrysoritis thysbe mithras Brenton Sparkling Opal Butterfly	Critically Endangered	Endemic to the Western Cape Province in South Africa, only recorded from the Still Bay area in the west, Brenton-on-Sea near Knysna and from Goesabos (Tsitsikamma) in the east. Declining due	Adults are on wing year-round with peaks in October and March.	Larvae feed on *Chrysanthemoides incana, C. monilifera, Osteospermum polygaloides, Lebeckia plukenetiana, Aspalathus, Zygophyllum* and *Thesium* species. Host ant species is *Crematogaster peringueyi* ants.

Species	Red list status	Habitat	Breeding	Feeding
		to dense stands of alien plant invasions (i.e. pines (*Pinus radiata*), Rooikrans (*Acacia cyclops*), Port Jackson Willow (*Acacia saligna*), and Black Wattle (*Acacia mearnsii*))-At Brenton on Sea on both north- and south-facing slopes at an altitude of 80 m to 120 m in disturbed areas of Knysna Sand Fynbos with a high abundance of *Osteospermum monilifera* (Bitou). Habitat at Stilbaai is by contrast on limestone fynbos-covered hillsides at altitudes up to 300 m.		
Thestor barbatus Bearded Skolly	Critically Endangered	Range restricted and endemic to the Nama karoo in the Western Cape. Only present in one location in Paardepoort mountain range, north of George. Rocky terrain on the higher slopes of mountains. Threatened by alien tree encroachment (Pine and *Hakea*).	Single brood in December.	Larval food not known.
Aneuryphymus montanus Yellow-winged Agile Grasshopper	Vulnerable	Very low area of occupancy between 100 and 1000 km^2. Threatened by declining habitat due to invasion by aliens and habitat transformation. Strong association with sclerophyllous fynbos vegetation on the southern slopes of the Outeniqua mountains, post-fire. Threats to the species include habitat transformation and invasion by alien plants.	Not known.	Not known.
Syncordulia gracilis Yellow Presba	Vulnerable	Montane streams and rivers, with undisturbed fynbos margins. Clear, fast, hard-bottomed rivers in treeless river valleys (Samways, 2006). Rare everywhere in its range, and for a long time it has not been seen at many sites where it historically was present (e.g.,	Not known.	Little is known, but taxon is insectivorous.

Species	Red list status	Habitat	Breeding	Feeding
		Michell's Pass). With the removal of invasive alien trees, it has recovered at some localities (e.g., Franschhoek Pass). Two populations are known: one in the Western Cape, and one in the Eastern Cape. Removal of alien invasive trees in catchment areas is beneficial for this species.		
Syncordulia venator Mahogany Presba	Vulnerable	This species is very sensitive to impacts from invasive alien trees but has shown rapid recovery when these trees are removed. Found at clear mountain streams with deposition pools and high, rocky, montane streams partially fringed with trees (Samways, 2006).	Not known.	Little is known, but taxon is insectivorous.
Aloeides pallida littoralis Knysna Pale Copper Butterfly	Near Threatened	Endemic taxon to the Western Cape Province. Relatively flat terrain near the coast, coastal Fynbos	Little known, but *Lepisiota capensis* ants are hosts for subspecies *A. p. grandis.*	Little is known, but larval food for the subspecies *A. p. pallida* and *A. p. jonathani* feed on *Aspalathus* species. The larvae of subspecies *A. p. grandis* are fed by trophallaxis by *Lepisiota capensis* ants and feed on these ant eggs.
Ceratogomphus triceraticus Cape Thorntail Dragonfly	Near Threatened	Wide range throughout the Western Cape. Found in pools in streams, and occasionally in reservoirs. The species is also found in rocky, shallow rivers, with deposition pools, and possibly farm dams. Usually in fairly open or hilly countryside. Main threat is invasive alien trees, loss of habitat, water pollution and to lesser extent agriculture. Clearing of alien trees greatly benefits species.	Not known.	Little is known, but taxon is insectivorous.
Ecchlorolestes nylephtha Queen Malachite Damselfly	Near Threatened	Known from streams near Storms River and in the Tsitsikamma Forest (Western Cape and Eastern Cape) (Samways, 2006). Endemic to South Africa.	Little known, but the genus typically lays eggs on tender green shoots of vegetation overhanging streams	Little is known, but taxon is insectivorous.

Species	Red list status	Habitat	Breeding	Feeding
		Occupies a very specific microhabitat and inhabits small, fern-fringed streams in the deep shade of the forest.		
MAMMALS				
Chlorotalpa duthieae Duthie's Golden Mole	Vulnerable	Occur on alluvial sands and sandy loams in southern Cape Afrotemperate forests (Bronner, 2014). Preference for forest vegetation over fynbos. Narrow coastal band 275 km long between Wilderness and Port Elizabeth with fairly disjunct populations. Can occur in gardens and pastures adjoining forests. Mainly active at night.	Little is known but a female was recorded with a litter of two young in November (Bronner, 2014).	Shallow subsurface foraging tunnels radiate outwards from beneath the roots of trees. Forages at night in tunnels and through the leaf litter. Diet includes earthworms.
Sensitive Species 8	Vulnerable	Specialised habitat requirements within a home range of ca. 0.75 ha (Skinner & Chimimba, 2005). Strong habitat preference for dense vegetation with good undergrowth providing good cover into which to retreat. Forest, thicket, dense coastal bush, independent of water. Can inhabit forest edges and transitional zones. Requires a diverse plant community with variety of tree and shrub species. Can adapt to fragmented habitat given sufficient cover and food availability. Actively avoids open grasslands and areas with human disturbance.	This species can breed throughout the year. Males establish territories and exhibit aggressive behaviours towards other males and to attract females.	Highly selective feeders, often feeding on food below troops of monkeys or frugivorous birds which drop lots of material. Preference for fruit, but also fallen leaves, flowers, and insects. Seldom actively browse. Active in the early morning and late afternoon, foraging for around 8 hours a day within their territory.
Amblysomus corriae Fynbos Golden Mole	Near Threatened	Sandy soils and soft loam in mountain fynbos, grassy fynbos, and renosterveld of south-west Cape. Also, afromontane forest and southern African moist savanna along the southern Cape coast. Favours richer and wetter soils (Broom, 1907) preferring forest fringes and	Fynbos Golden Moles probably breed aseasonally: pregnant females have been captured in August, May, and December. Mean litter size is two; young are altricial and hairless at birth.	Insectivorous, mainly feeding on earthworms and insects (Skinner & Chimimba, 2005).

Species	Red list status	Habitat	Breeding	Feeding
		associated fynbos. Thrives in gardens, cultivated lands, golf courses, and livestock paddocks. Present also in exotic plantations but at lower densities (Bronner, 2013).		
Pelea capreolus Grey Rhebok	Near Threatened	Associated with rocky hills, grassy mountain slopes, and plateau grasslands. Also occur in rocky hills of mountain fynbos and the little Karoo. They require good grass cover for shelter and to hide from predators but will feed in steep open areas. Can occur in agricultural areas, especially when adjacent to protected areas.	Males aggressively defend a harem of 2 - 7 females and any young. Unusually for antelope, the single dominant male remains with the harem long-term until displaced by another dominant male. Breeding season is from March to May. Males are very active, defending territory and testing females for signs of oestrus. Gestation is 261 days, with a single calf born.	Predominantly browsers, but also mixed feeders. Often feeding on forbs which constitutes majority of diet. Largely water independent.
Poecilogale albinucha African Striped Weasel	Near Threatened	Rare in range and easily overlooked, predominantly nocturnal and well adapted to a subterranean lifestyle. Most abundant in savanna and grasslands, particularly with rainfall > 600 mm per year. The species has also been found in lowland rainforest, semi-desert grassland, fynbos (with dense grass), and pine plantations (Child et al., 2016).	Breeding season is during spring and summer months in southern Africa. Usually only one litter per season, comprises of 1 - 3 pups, fully grown at 20 weeks.	Preys on small mammals up to own body weight in size, but occasionally takes birds also. Has a fast metabolism and requires an abundance of prey in territory (Child et al., 2016). Considered to have very close association with mole-rats, likely as a food source but also for habitat preference, especially in western, drier sections of its range (Child et al., 2016).

4. FIELD ASSESSMENT

4.1 Methods

Following the Species Environmental Assessment Guidelines (SANBI 2020) and Table 3, taxa-specific sampling techniques were conducted in habitats where SCC were likely to occur. Taxa-specific sampling was interspersed with a meander across the project area to collect additional opportunistic data for all fauna and inspect all habitat types (Table 4).

Table 4. Sampling techniques conducted for potential SCC occurring at the site.

Taxon	Field methods	Public platform where observations were reported
Avifauna	• Meander* across site for direct observations. • Point counts (5-minute bird counts).	iNaturalist (photos)
Mammals	• Meander* across site for direct observations, tracks, scats, and signs. • Camera traps set up in high traffic areas.	iNaturalist (photos)
Amphibians	• Meander* across site for direct observations. • Active searching. • Sound equipment deployed at suitable wetlands. • Collection of tadpoles for in-field identification.	iNaturalist (photos)
Invertebrates	• Meander* across site for direct observations. • Active searching. • Sweep netting.	iNaturalist (photos)

* Meandering involved over slow walking across the site through various habitat types and key landscape features as well as driving most of the roads within the site. Active observations took place for all fauna which was then supplemented by taxa specific sampling methods in habitats deemed most suitable for SCC.

4.2 Assumptions and Limitations

1. While the public platforms mentioned in Section 3.4 are excellent sources of additional information for animal species occurring within an area, these results require some expert interpretation to determine which of the SCC are relevant to include in the faunal assessment of the project area. For example, the coarse spatial scale of reporting within the Virtual Museum platforms (Quarter Degree Square level (27km x 27km) or SABAP2 pentad level (9km x 7 km)) can result in species records from habitats quite different to those present on site. Additionally, these platforms include sightings of vagrant or transient animals upon which an assessment cannot reasonably be based. Expert interpretation is therefore applied to the full list of SCC identified by the various public platforms (see Appendix 1) and some species are then excluded from further assessment due to the project area clearly lacking suitable habitat or the species clearly representing a vagrant or transient animal outside its normal range. The SCC assessed in this report therefore represent those which may reasonably occur on site. However, there is always the possibility that some SCC (although highly unlikely to occur on site) are overlooked in this process.

2. Multiple site visits took place for the faunal assessment since favourable weather conditions were sought for particular taxa (cool, wet nights to capture frog calls and hot, windstill days to conduct insect surveys, for example). Detectability of animal species also increases with more visits. This assessment, however, only represents “snap-shots” in time and it is possible that SCC occurring on site were not observed during the visits. These results should therefore be interpreted with this in mind and not be treated as an exhaustive list of species occurring on site.
3. Site visits took place during daylight hours so the likelihood of encountering nocturnal species was limited.
4. The site visit coincided with spring. This may be of consequence for some species showing seasonal variation in breeding and activity patterns.
5. Evidence of animals in the form of tracks, scat, and signs always brings with it a level of uncertainty, but best efforts were made in this regard and uncertainties are highlighted in the report.
6. Due to time constraints, sound recording equipment was deployed at only two wetland sites on consecutive nights. This limited sampling period and area restricts the diversity of amphibians heard using this method and these data should be interpreted as a minimum estimate.

4.3 Site Inspection Details

Five site visits took place on the 7th, 13th, 20th, 21st, and 22nd of November 2024. The weather on most of these days was clear and warm with the exception of 13 November which was cool and rainy. Vegetation type mapped for the site according to the National Vegetation Map is Garden Route Granite Fynbos in the west with Groot Brak Dune Strandveld dominating the east.

Habitat types found on the site consist mainly of Fynbos, Wetlands, Invaded Areas dominated by Black wattle (*Acacia mearnsii*), and Grassy Areas dominated by Kikuyu grass (*Cenchrus clandestinus*) (Figure. 8; See the Botanical Specialist’s report for a detailed list of vegetation and land cover types as well as full botanical species lists). There is also a fairly large burnt area. An effort was made to cover the project area with the meander and to conduct taxa specific sampling techniques across a range of suitable habitats for potential SCC (Figure. 9).



Figure 8. Habitat types identified at the site namely (A.) Fynbos; (B.) Wetlands; (C.) Invaded Areas; (D.) Grassy Areas; and (E.) Burnt Areas.

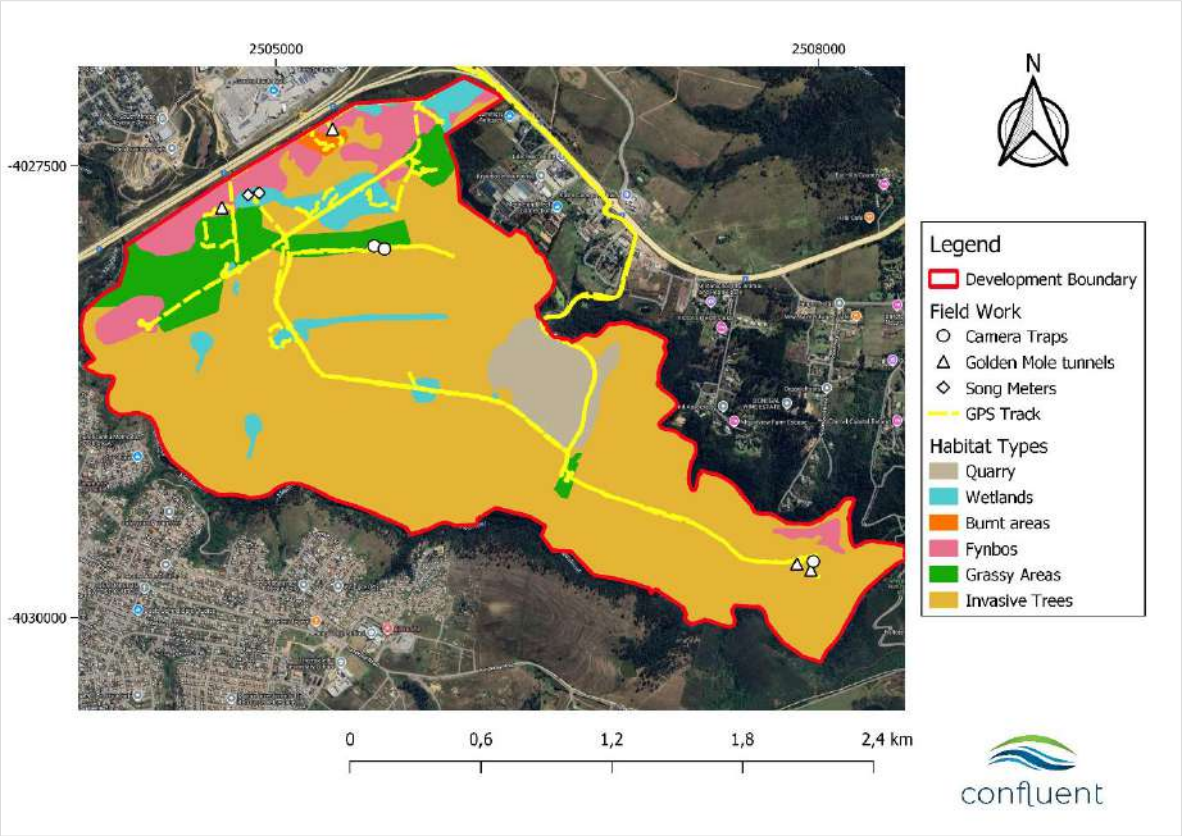

Figure 9. Habitats, locations of camera trap and song meter deployments, locations where golden mole tunnels were spotted, and GPS tracks for the site visits conducted in November 2024.

4.4 Results

4.4.1 Avifauna

A Forest Buzzard (*Buteo trizonatus*) was observed flying overhead and landed at the site. Additionally, a woodpecker was heard excavating a nest but it was not possible to ascertain which species it was. Although it is noted that Knysna Woodpecker (*Camphetra notata*) is highlighted as a SCC for this area. No further SCC was encountered during the site visit. Nesting and roosting sites were actively searched for in suspected habitat. A bird nest was found in the burnt area but identification of the species was not possible (Figure. 10). A total of 29 bird species were identified during the site visit (See Appendix 2).



Figure 10. Nest (Class Aves) found at the site in the burn area.

4.4.2 Mammals

There was evidence of sub-surface tunnelling by golden moles found on site, of which two species are identified as possibly occurring at the site (Figure. 11). It was determined to be a new foraging tunnel by digital inspection. Evidence of Caracal (*Caracal caracal*) and Cape Grey Mongoose (*Herpestes pulverulentus*) were found at the site while a female Southern Bushbuck (*Tragelaphus sylvaticus*) was directly observed. See Appendix 3 for the list of mammals observed at the site during the site visits.



Figure 11. Golden Mole (Family Chrysochloridae) foraging tunnels identified during site visits. The width of the tunnel was determined as 3cm.

4.4.3 Terrestrial invertebrates

No SCC were found during the site inspections. Cocktail ants (*Crematogaster peringueyi*.) were found in carton nests. A variety of butterflies and moths (Lepidoptera) (including a caterpillar (Figure. 12)) and beetles (Coleoptera) were identified. Spiders (Araneae) were found on site as were Zebra agate snails (*Cochlitoma zebra*). Odonatans were also observed (Figure. 12). *Aspalathus* sp. and many ant species were found at the site indicating that some parts might be suitable habitat for butterfly SCC.

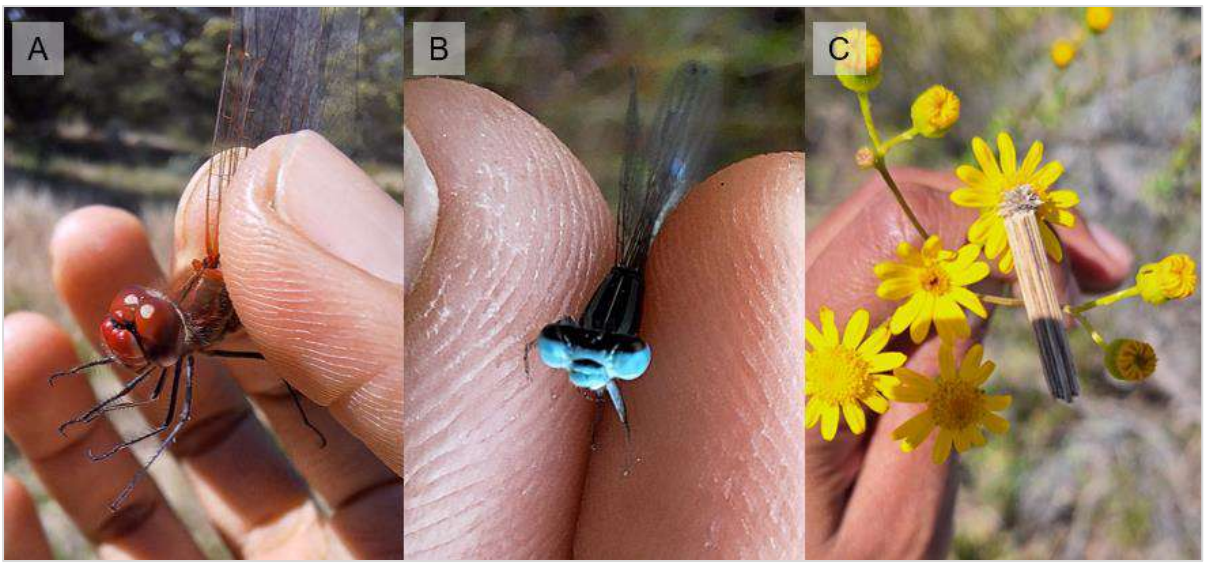

Figure 12. Some invertebrates observed at the site. A) Red-veined darter (Sympetrum fonscolombii), B) Swamp bluet (Africallagma glaucum), and C) Bagworm moth caterpillar (order Psychidae).

4.4.4 Amphibians

Four amphibian species were heard calling, but no adults were directly observed. A dedicated effort was made to locate Knysna leaf-folding Frog (*Afrixalus knysnae*) due to the wetlands at the site being suitable habitat for the species. A call similar to that of the frog was recorded on the song meter deployed at one wetland. It is feasible that this species could be found at many wetlands at this site.

4.4.5 Reptiles

No reptile SCC were highlighted for this site by the DFFE Screening Tool or any of the public platforms. As such, no targeted sampling took place for this group. None were encountered during the site visits.

4.4.6 Likelihood of Occurrence for SCC

Following the terrestrial fauna surveys and site inspection, the possible SCC occurring on the site were evaluated according to their likelihood of occurrence. It is always possible that a species assessed as having a low probability of occurrence can still occur on the site, especially species which are listed as having a low likelihood of detection, and therefore this table should only be used as a guideline.

Table 5. Likelihood table for faunal SCC suspected to occur at the site.

Species	Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
				AMPHIBIANS	
Afrixalus knysnae Knysna Leaf-folding Frog	Endangered	No	Yes	Confirmed- Very High	The call of this species was recorded on song meter equipment deployed at one wetland site. The species is deemed present at wetlands across the site based on an assessment of suitable habitat.
AVIFAUNA					
Circus maurus Black Harrier	Endangered	No	No	Low	The site may be used for foraging but with human presence across the site and well as busy roads surrounding the site, it is unlikely that this SCC would be present.
Circus ranivorus Marsh Harrier	Endangered	No	No	Very Low	No suitable habitat.
Polemaetus bellicosus Martial Eagle	Endangered	No	No	Very Low	No suitable habitat.
Bradypterus sylvaticus Knysna warbler	Vulnerable	No	No	Low	There are dense understorey vegetation patches at the site but these are not associated with running water as is the species' preferred habitat. The species is adaptable but the suitability of forests caused by invasive woody species as habitat for the SCC is unknown.
Sarothrura affinis Striped Flufftail	Vulnerable; Least Concern (Global)	No	No	Low	No suitable habitat.
Stephanoaetus coronatus Crowned eagle	Vulnerable	No	No	Low	No suitable habitat is available at the site. This SCC has been observed close to the site but with low frequency and closer to montane habitats.
Alcedo semitorquata Half-collared Kingfisher	Near Threatened	No	No	Very Low	Habitat and feeding requirements are not met at this site.
Camphetera notata Knysna Woodpecker	Near Threatened	No	Yes	High	A woodpecker was heard excavating a nest at the site. Since its species could not be determined based on this alone, the SCC is assigned a high likelihood of occurrence due to the precautionary principle. Additionally, suitable habitat is available at the site.
Chaetops frenatus Cape Rockjumper	Near Threatened	No	No	Very Low	Although observed close to the site, no suitable rocky mountain fynbos is available.

Species	Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
Buteo trizonatus Forest Buzzard	Least Concern; Near Threatened (Global)	Yes	Yes	Confirmed- Very High	The SCC was observed flying overhead multiple times at this site and landed once. It is known to occur in alien tree plantations.
TERRESTRIAL INVERTEBRATES					
Chrysoritis thysbe mithras Brenton Sparkling Opal Butterfly	Critically Endangered	No	Yes	High	Although not found at the site during the assessment, a wide variety of insects in this order were found in habitat suitable for this butterfly. Additionally, a previous specialist reports confirms the observation of a species of *Chrysoritis* (namely, *Chrysorits palmus margueritae* for which a Red List Assessment is still underway).
Thestor barbatus Bearded Skolly	Critically Endangered	No	No	Very Low	The site is outside of the typical range of the species and does not have the correct conditions to support it.
Aneuryphymus montanus *Yellow-winged Agile Grasshopper*	Vulnerable	No	No	Very Low	No suitable habitat is available, and this location is not within the known distribution of the species.
Syncordulia gracilis Yellow Presba	Vulnerable	No	No	Very Low	The site is very heavily invaded, but suitable fynbos may exist should aliens be cleared. That is, the site may in future be suitable for a reintroduction of this species.
Syncordulia venator Mahogany Presba	Vulnerable	No	No	Very Low	The site is heavily invaded and therefore unsuitable to host the species.
Aloeides pallida littoralis Knysna Pale Copper Butterfly	Near Threatened	No	No	Medium	Although a subspecies of *A. pallida* is reported as present in a previous specialist report (compiled in 2006), the location it was found is now heavily invaded and supports none of the plants and insects with which the SCC has a close relationship. The species may, however, be found in fynbos areas in close proximity to its previous habitat.
Ceratogomphus triceraticus Cape Thorntail Dragonfly	Near Threatened	No	No	Very Low	Wetlands at the site are plentiful but are not suitable habitats for this SCC.
Ecchlorolestes nylephtha Queen Malachite Damselfly	Near Threatened	No	No	Very Low	There are no suitable flowing waterbodies at the site.
MAMMALS					

Species	Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
Chlorotalpa duthieae Duthie's Golden Mole	Vulnerable	No	Yes	Confirmed- Very High	The distinctive foraging tunnels of this family (Chrysochloridae) were found at the site. Identification to species level using tunnels alone is not possible. This SSC and Fynbos Golden Mole are therefore declared as present per the precautionary principle.
Sensitive Species 8	Vulnerable	No	No	Low	No suitable habitat is available at this site since the SCC prefers coastal forest, thick coastal bushes, and thicket.
Amblysomus corriae Fynbos Golden Mole	Near Threatened	No	Yes	Confirmed- Very High	The distinctive foraging tunnels of this family (Chrysochloridae) were found at the site. Identification to species level using tunnels alone is not possible. This SSC and Duthie's Golden Mole are therefore declared as present per the precautionary principle. It is noted that genetic studies conducted at a site 6km away confirmed the identity of Fynbos Golden Mole rather than Duthie's Golden Mole, although the vegetation structure at these sites differ, with this site having more woody species, potentially suited to supporting Duthie's Golden Mole.
Pelea capreolus Grey Rhebok	Near Threatened	No	No	Low	The species typically occupies montane habitats.
Poecilogale albinucha African Striped Weasel	Near Threatened	No	Yes	High	Fynbos is present as well as a food source (mole rats). This species is predominantly nocturnal and has a subterranean lifestyle and its therefore difficult to observe. It is given a high likelihood of occurrence due to the precautionary principle.

5. SITE SENSITIVITY VERIFICATION

After the site visit and fauna surveys, it is determined that the site sensitivity for the terrestrial animal theme of the site is **HIGH**. This agrees with the high sensitivity assigned by the DFFE Screening tool.

Based on the information in this report during the desktop and field assessment, the following reasons support this finding:

- The discovery of golden mole foraging tunnels confirms the presence of Near Threatened Fynbos Golden Mole (*Amblysomus corriae*) or Vulnerable Duthie's Golden Mole (*Chlorotalpa duthieae*) or both, resulting in a high sensitivity rating across the part of the site where golden mole tunnels were found.
- The observation of a Forest buzzard (*Buteo trizonatus*) and the very high likelihood that it uses the site as habitat and/or foraging grounds.
- The confirmed presence of Knysna leaf-folding frog (*Afrixalus knysnae*) in wetlands at the site.
- The assignment of a high likelihood of occurrence due to the precautionary principle to African striped weasel (*Poecilogale albinucha*) and Knysna woodpecker (*Camphetra notata*).
- The butterfly SCCs Knysna Pale Copper (*Aloeides pallida littoralis*) and Brenton Sparkling Opal (*Chrysoritis thysbe mithras*) are given a medium and high likelihood of occurrence respectively, due to suitable habitat and the presence of a closely related subspecies in a previous assessment conducted in 2006.

As per the Published Government Notice No. 1150, Government Gazette 43855 (30 October 2020), the **HIGH** sensitivity of the site requires a Terrestrial Animal Species Specialist Assessment be conducted.

6. SITE ECOLOGICAL IMPORTANCE

The Site Ecological Importance (SEI) is determined for habitats within the property, taking associated fauna SCC into account (Table. 6).

SEI is a function of biodiversity importance (BI) and receptor resilience (RR) such that: SEI = BI + RR. BI is further defined as a function of conservation importance (CI) and habitat functional integrity (FI), with BI = CI + FI, and is determined by means of a matrix. SEI can therefore be fully understood as SEI = (CI + FI) + RR, where:

Conservation Importance (CI): The importance of a site for supporting biodiversity features of conservation concern present.

Functional Integrity (FI): A measure of the ecological condition of the impact receptor (i.e., habitat type) as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts.

Receptor Resilience (RR): The intrinsic capacity of the receptor (i.e., habitat type or SCC) to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention.

The SEI is derived for each habitat type or SCC within a project site by making use of two matrixes: first to calculate the BI and then the SEI. These matrices and further details can be found in Appendix 6.

Table 7 provides the SEI calculations for each habitat type and Figure 13 illustrates the SEI results for the property. It is important to note that the SEI reported here is specific to the proposed development and associated activities of this report and can only be used to compare multiple layouts and/or locations for the development.

Table 6. SCC likely or confirmed to occur at the site and assessed for Site Ecological Importance.

Taxon	Species	Red list status	Likelihood of occurrence
Mammal	*Amblysomus corriae* Fynbos Golden Mole	Near Threatened	Very High-Confirmed
Mammal	*Chlorotalpa duthieae* Duthie's Golden Mole	Vulnerable	Very High-Confirmed
Mammal	*Poecilogale albinucha* African Striped Weasel	Near Threatened	High
Invertebrate	*Chrysoritis thysbe mithras* Brenton Sparkling Opal Butterfly	Critically Endangered	High
Invertebrate	*Aloeides pallida littoralis* Knysna Pale Copper Butterfly	Near Threatened	Medium
Amphibian	*Afrixalus knysnae* Knysna Leaf-folding Frog	Endangered	Very High-Confirmed
Avifauna	*Buteo trizonatus* Forest Buzzard	Least Concern; Near Threatened (Global)	Very High-Confirmed
Avifauna	*Camphetera notata* Knysna Woodpecker	Near Threatened	High

Table 7. Site Ecological Importance assessment for the site. Conservation status for SCC is abbreviated to indicate Critically Rare/Endangered (CR), Endangered (EN), Vulnerable (VU) or Near Threatened (NT). When relevant, the extent of occurrence (EOO) is indicated as part of the justification for the conservation importance (CI) metric.

Habitat and associated SCC	Conservation Importance (CI)	Functional Integrity (FI)	Biodiversity Importance (BI)	Receptor Resilience (RR)	Site Ecological Importance (SEI)
Burnt Area SCC: *A. corriae* (NT) *C. duthieae* (VU)	**High** Burning is essential in fynbos ecosystems, so it is presumed that this area would recover to the same type of fynbos it is surrounded by. Evidence of Golden mole (EOO > 10km^2 for both species highlighted) was found near to this area which suggests that it would be recolonised by this species once species diversity recovers.	**Medium** Very small (ca. 2.5 ha) but will eventually form part of the natural fynbos by which it is surrounded (ca. 20 ha).	**Medium**	**Low** Developments of this nature leave very little room for the recovery of animal species in general but one of the SCC highlighted (namely Fynbos Golden Mole (*A corriae*) is known to occur in built up areas should enough green spaces be left available to it. It is, however, noted that should this area recruit fynbos plants as expected, SCC highlighted for the fynbos habitat within close proximity would follow namely *P. albinucha*.	**High** BI: MEDIUM RR: LOW
Fynbos SCC: *A. corriae* (NT) *C. duthieae* (VU) *P. albinucha* (NT) *A. pallida littoralis* (NT) *C. thysbe mithras* (CR)	**High** Confirmed or highly likely occurrence of a SCC with a global EOO of >10km^2.	**Medium** Medium intact area for Garden Route Granite Fynbos (CR) is present with good connectivity while one portion is very small with poor connectivity to the larger landscape.	**Medium**	**Low** The SCC highlighted for the habitat type are not well adapted to change and populations would not endure should vegetation quality be compromised. This especially holds for the butterfly SCC highlighted and expected to occur in the east of the site. In the west, the butterfly SCCs are not expected to occur. Mammal SCCs highlighted are more mobile and may more readily recolonise new spaces.	**High** BI: MEDIUM RR: LOW
Quarry SCC: None	**Very Low** No confirmed and highly unlikely populations of SCC.	**Very Low** No habitat connectivity and large amounts of	**Very Low**	**Very High** Since the habitat is already heavily disturbed, its ability to return to that state is high.	**Very Low** BI: VERY LOW

Habitat and associated SCC	Conservation Importance (CI)	Functional Integrity (FI)	Biodiversity Importance (BI)	Receptor Resilience (RR)	Site Ecological Importance (SEI)
		environmental and noise disturbance.			RR: VERY HIGH
Grassy Areas SCC: *A. corriae* (NT) *C. duthieae* (VU)	**High** Golden Mole tunnels were found at the site but the species is uncertain. It is therefore assumed that the species present is the one with the higher Red List Status per the precautionary principle.	**High** Large area with good connectivity.	**High**	**Very High** After the conclusion of construction, the environment would be heavily modified. Given the nature of the landscape, it can be reasonably assumed that the species of Golden Mole present in this habitat is Fynbos Golden Mole (*A. corriae* (NT)). Fynbos Golden Moles can thrive in modified habitats. Depending on the layout of the development, the continued existence of this population is possible.	**Low** BI: HIGH RR: VERY HIGH
Wetland SCC: *Afrixalus knysnae* (EN)	**High** Confirmed or highly likely occurrence of SCC with EOO of 816 km^2.	**Medium** Small area ca. 20 ha. Connectivity is poor for this SCC, but disjunct populations is what is expected for species so closely tied to wetland habitats over so large a site. Wetlands are in good condition.	**Medium**	**Low** The habitat may recover but the SCC is very sensitive to disturbance and would not recolonise a space that has been modified.	**High** BI: MEDIUM RR: LOW
Invasive Trees SCC: *B. trizonatus* (LC)	**Medium** Knysna woodpecker is assigned a high likelihood of occurrence, although it is noted that Olive Woodpecker (*Dendropicos griseocephalus*) is more common in the area.	**High** The area is large (>20 ha) with good connectivity to the larger landscape.	**Medium**	**High** The recovery of botanical diversity is possible since invasive plants readily colonise. The recovery of structural functionality of the space for use by the SCC outlined, however, would take time. Refuges do exist in this	**Low** BI: MEDIUM RR: HIGH

Habitat and associated SCC	Conservation Importance (CI)	Functional Integrity (FI)	Biodiversity Importance (BI)	Receptor Resilience (RR)	Site Ecological Importance (SEI)
C. notata (NT)				landscape that would enable the SCC to recolonise.	

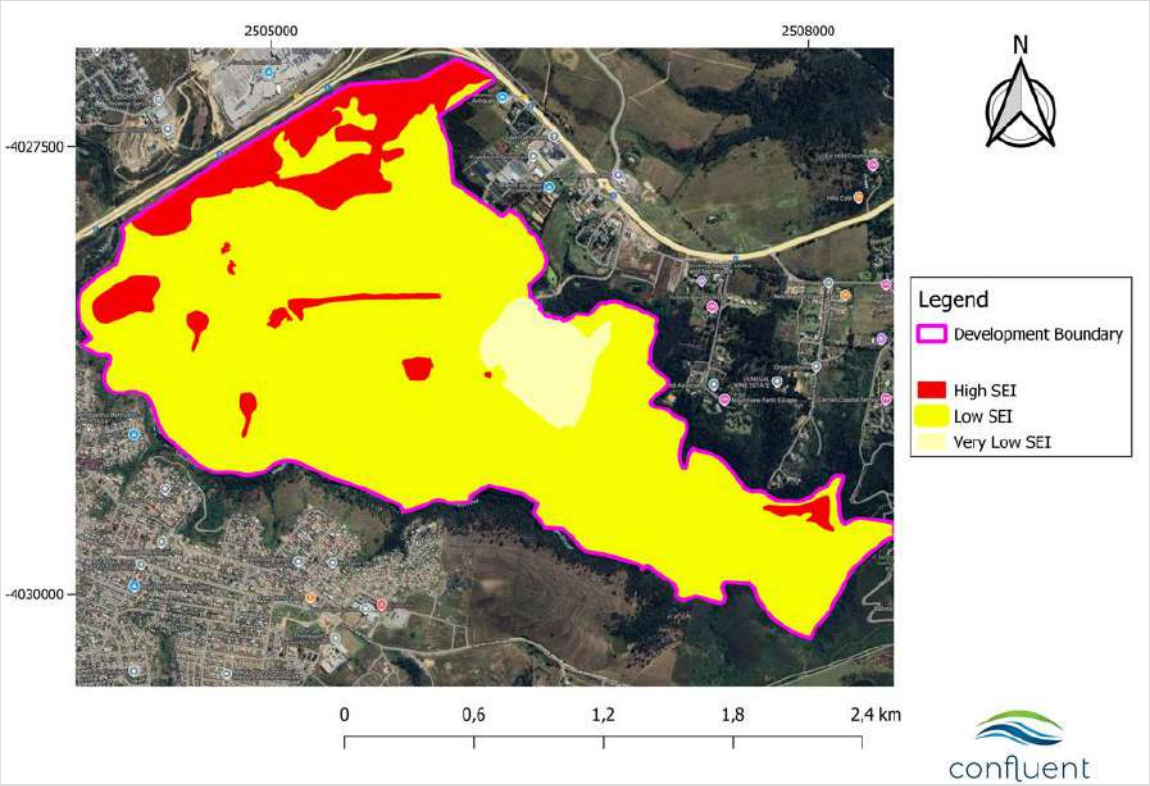

Figure 13. Site Ecological Importance (SEI) map with regards to fauna for the site.

Most of the property has a **LOW** SEI due to the utility of invasive alien trees to bird species with a high likelihood of occurring at the site (Figure. 13; Table. 7). According to the guidelines for interpreting SEI ratings in terms of development (Table. 8 (SANBI, 2020)), minimisation and restoration mitigation should be implemented, and development activities of medium to high impact are acceptable followed by restoration. This is acceptable for the Invasive Trees habitat since the SCC highlighted for that area are birds which are a highly mobile taxon in a landscape with many refuges east of the site. It is also appropriate for Grassy Areas, which hold SCC that may colonise modified spaces such as gardens. Areas of **VERY LOW** SEI allow for medium to high impact development where restoration may not be required. This is appropriate for the Quarry which is devoid of all botanical and faunal species. In contrast, Wetlands and Fynbos have a **HIGH** SEI due to them representing rare habitat for SCC that do not readily colonise new spaces and have no refuges. The Burnt Area, also highlighted as having a **HIGH** SEI, may not represent important habitat now, but is key in maintaining connectivity between the eastern fynbos patches and will recruit fynbos plant species vital to the survival of fauna.

Table 8. Guidelines for interpreting Site Ecological Importance for proposed developments (SANBI 2020)

Site ecological importance	Interpretation in relation to proposed development activities
Very high	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e. last remaining populations of species, last remaining good condition patches of ecosystems/ unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

7. CONCLUSION

The proposed site for the development of Garden Route City (7/195. 12/195, 48/195, RE/8/195, and RE/23/195) has historically been used for agriculture and is today used as a throughfare for pedestrians, a site to collect fuel wood, and a quarry. It also forms part of a larger natural area to the east, and a heavily developed urban area to the west. The site ecological importance (SEI) for most of the property was determined to be **LOW** which would allow for development of high impact with appropriate mitigation measures. It is noted that the zoning map provided overlaps with high and very high SEI areas in RE/23/195. It is therefore advised that the SDP accommodate these habitats, essential to the survival of SCC highlighted for the site. The **HIGH** SEI for wetlands at the site indicates that they be avoided in the final SDP. The **HIGH** SEI patch in the east is afforded adequate protection by the butterfly sanctuary proposed. Protecting natural habitat is one of the best ways to protect indigenous fauna, particularly those with a high conservation status (i.e. at greater risk of extinction).

The presence of invasive alien plant species is a current impact on the property. It is advised that alien clearing take place, especially in the east of the site in the **HIGH** SEI area to facilitate the recovery of butterfly numbers. Despite the potentially positive impact of invasive trees on bird SCC seeking high perches to use as habitat, these should be felled before the development proceeds outside of the breeding season of both bird SCC observed at the site.

It is the specialist's opinion that for this development habitat loss can be further reduced on through minimizations of footprints. The development as proposed requires a Terrestrial Animal Species Impact Assessment be conducted once a final SDP is submitted.

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APPENDIX 1: SCC IDENTIFIED FROM PUBLIC PLATFORMS FOR THE PROJECT AREA.

SCC were included or excluded from further analysis in this report based on expert interpretation for the presence/absence of key landscape and habitat features on site. See Section 4.2 Assumptions and Limitations for more information.

Species	Common name	Red List status	Source	Assessed Y/N
AMPHIBIANS				
Afrixalus knysnae	Knysna Leaf-folding Frog	Endangered	Virtual Museum; Screening Tool	Y
AVIFAUNA				
Alcedo semitorquata	Half-collared Kingfisher	Near Threatened	SABAP2	Y
Bradypterus sylvaticus	Knysna Warbler	Vulnerable	SABAP2; Screening Tool	Y
Buteo trizonatus	Forest Buzzard	Least Concern (Regional), Near Threatened (Global)	SABAP2	Y
Aquila verreauxii	Verreaux's Eagle	Vulnerable	SABAP2	N
Campethera notata	Knysna Woodpecker	Near Threatened	SABAP2	Y
Chaetops frenatus	Cape Rockjumper	Near Threatened	iNaturalist	Y
Circus maurus	Black Harrier	Endangered	SABAP2	Y
Circus ranivorus	African Marsh Harrier	Endangered	SABAP2; Screening Tool	Y
Polemaetus bellicosus	Martial Eagle	Endangered	SABAP2	Y
Sarothrura affinis	Striped Flufftail	Vulnerable	SABAP2	Y
Neotis denhami	Denham's Bustard	Vulnerable	SABAP2; Screening Tool	N
Falco biarmicus	Lanner Falcon	Vulnerable	SABAP2	N
Grus paradisea	Blue Crane	Near Threatened	SABAP2	N
Hydroprogne caspia	Caspian Tern	Vulnerable	SABAP2	N
Morus capensis	Cape Gannet	Vulnerable	SABAP2	N
Stephanoaetus coronatus	Crowned Eagle	Vulnerable	iNaturalist; Screening Tool	Y
Oxyura maccoa	Maccoa Duck	Near Threatened (Regional)	SABAP2	N
Phalacrocorax capensis	Cape Cormorant	Endangered	SABAP2	N
Sagittarius serpentarius	Secretarybird	Vulnerable	SABAP2	N

Species	Common name	Red List status	Source	Assessed Y/N
Thalassarche cauta	Shy Albatross	Near Threatened	SABAP2	N
TERRESTRIAL INVERTEBRATES				
Aloeides pallida littoralis	Giant russet	Near Threatened	Virtual Museum; Butterfly report	Y
Aneuryphymus montanus	Yellow-winged Agile Grasshopper	Vulnerable	Screening Tool	Y
Ceratogomphus triceraticus	Cape Thorntail	Near Threatened	Virtual Museum	Y
Chrysoritis palmus	Water Opal	Least Concerned	Butterfly report	Y
Ecchlorolestes nylephtha	Queen Malachite	Near Threatened	Virtual Museum	Y
Syncordulia gracilis	Yellow Presba	Vulnerable	Virtual Museum	Y
Syncordulia venator	Mahogany Presba	Vulnerable	Virtual Museum	Y
Thestor barbatus	Bearded skolly	Critically Endangered	Virtual Museum	Y
Sarophorus punctatus	Dung beetle	Endangered	iNaturalist	N
MAMMALS				
Aonyx capensis	African Clawless Otter	Near Threatened	Virtual Museum	N
Damaliscus pygargus pygargus	Bontebok	Vulnerable	Virtual Museum	N
Mirounga leonina	Southern Elephant Seal	Near Threatened	iNaturalist	N
Panthera pardus	Leopard	Vulnerable	Virtual Museum	N
Amblysomus corriae	Fynbos Golden Mole	Near Threatened	Virtual Museum	Y
Chlorotalpa duthieae	Duthie's Golden Mole	Vulnerable	Virtual Museum; Screening Tool	Y
Cistugo seabrae	Angolan Wing-gland Bat	Near Threatened	Virtual Museum	Y
Pelea capreolus	Vaal Rhebok	Near Threatened	Virtual Museum	Y
	Sensitive species 8	Vulnerable	Virtual Museum; Screening Tool	Y
Poecilogale albinucha	African Striped Weasel	Near Threatened	Virtual Museum	Y

APPENDIX 2: AMPHIBIAN SPECIES OBSERVED DURING THE SITE VISITS

Species of Conservation Concern are indicated in red text.

Common name	Scientific name
Bronze caco	*Cacosternum nanum*
Raucous toad	*Sclerophrys capensis*
Clicking stream frog	*Strongylopus grayii*
Knysna leaf-folding frog	*Afrixalus knysnae*

APPENDIX 3: AVIFAUNA SPECIES OBSERVED DURING THE SITE VISITS

Species of Conservation Concern are indicated in red text.

Common name	Scientific name
Egyptian goose	*Alopochen aegyptiaca*
Bar-throated apalis	*Apalis thoracica*
Heron	*Ardea* sp.
Hadeda ibis	*Bostrychia hagedash*
Forest buzzard	*Buteo trizonatus*
Fiery-necked nightjar	*Caprimulgus pectoralis*
Amethyst sunbird	*Chalcomitra amethystina*
Neddicky	*Cisticola fulvicapilla*
Levaillants cisticola	*Cisticola tinniens*
Cape crow	*Corvus capensis*
Black Cuckoo	*Cuculus clamosus*
Red-chested Cuckoo	*Cuculus solitarius*
Fork-tailed drongo	*Dicrurus adsimilis*
Yellow bishop	*Euplectes capensis*
Southern boubou	*Laniarius ferrugineus*
Fiscal shrike	*Lanius collaris*
Cape longclaw	*Macronyx capensis*
Cape wagtail	*Motacilla capensis*
Malachite sunbird	*Nectarinia famosa*
Helmeted guineafowl	*Numida meleagris*
Red winged starling	*Onychognathus morio*
Black-headed oriole	*Oriolus larvatus*
Cape Sparrow	*Passer melanurus*
Woodpecker	Picidae
Karoo prinia	*Prinia maculosa*
Black saw-wing	*Psalidoprocne pristoptera*
Cape canary	*Serinus canicollis*
Cape Grassbird	*Sphenoeacus afer*
European starling	*Sturnus vulgaris*

APPENDIX 4: MAMMAL SPECIES OBSERVED DURING SITE VISITS

Species of Conservation Concern are indicated in red text.

Common name	Scientific name	Evidence
African molerat	Bathyergidae	Hills found
Domestic cattle	*Bos taurus*	Direct observation
Caracal	*Caracal caracal*	Scat found
Golden mole	Chrysochloridae	Tunnels found
Cape grey mongoose	*Herpestes pulverulentus*	Scat found
Southern African Vlei Rat	*Otomys irroratus*	Paths found
Bushpig	*Potamochoerus larvatus*	Scat found
Southern Bushbuck	*Tragelaphus sylvaticus*	Prints and scat found
Domestic dog	*Canis familiaris*	Direct observation
Vervet monkey	*Chlorocebus pygerythrus*	Direct observation

APPENDIX 5: INVERTEBRATE SPECIES OBSERVED DURING SITE VISITS

Order	Family	Common name	Scientific name
Araneae	Agelenidae	Grass funnel-web spiders	*Agelena* sp.
Araneae	Theridiidae	Dewdrop spider	*Argyrodes* sp.
Araneae	Thomisdae	African Mask spider	*Synema imitatrix*
Araneae	Thomisidae	Crab spider	*Thomisus* sp.
Blattodea	Blattidae	Red-headed Cockroach	*Deropeltis erythrocephala*
Coleoptera	Anthicidae	Ant-mimicking beetles	Anthicidae
Coleoptera	Carabidae	Ten-spot beetle	*Anthia decemguttata*
Coleoptera	Cerambycidae	Metallic Longhorn beetle	*Promeces longipes*
Coleoptera	Chrysomelidae	Leaf beetle	Chrysomelidae
Coleoptera	Cicadidae	Cicada	Cicadidae
Coleoptera	Tenebrionidae	Striped Toktokkie	*Mariazofia gibba*
Coleoptera		Monkey beetle	Hopliini
Diptera	Hippoboscidae	Louse fly	*Hippobosca rufipes*
Diptera	Syrphidae	Hoverfly	Syrphidae
Hemiptera	Cercopidae	Spittlebug	Cicadamorpha
Hemiptera	Coreidae	Leaf-footed bugs	Coreidae
Hymenoptera	Apidae	Giant carpenter bee	*Xylocopa flavorufa*
Hymenoptera	Formicidae	Ant	Formicidae
Hymenoptera	Formicidae	Cocktail ants	*Crematogaster peringueyi*
Hymenoptera	Pompilidae	Spider hunting Wasp	Pompilidae
Lepidoptera	Erebidae	Crimson spotted footman	*Utetheisa pulchella*
Lepidoptera	Geometeridae	Geometer moths	Geometridae
Lepidoptera	Lycaenidae	Vivid blue	*Tarucus thespis*
Lepidoptera	Lycaenidae	Geranium bronze	*Cacyreus fracta*
Lepidoptera	Noctuidae	Cutworm moth	Noctuidae
Lepidoptera	Nymphalidae	African monarch	*Danaus chrysippus orientis*
Lepidoptera	Nymphalidae	Painted lady	*Vanessa cardui*
Lepidoptera	Nymphalidae	Rainforest Brown	*Cassionympha cassius*
Lepidoptera	Papilionidae	Citrus Swallowtail	*Papilio demodocus*

Lepidoptera	Pieridae	Eastern Dotted Border	*Mylothris agathina*
Lepidoptera	Pieridae	Meadow White	*Pontia helice*
Lepidoptera	Psychidae	Bagworm moth	Psychidae
Odonata	Coenagrionidae	Swamp Bluet	*Africallagma glaucum*
Odonata	Libellulidae	Red-veined darter	*Sympetrum fonscolombii*
Orthoptera	Acrididae	Grasshopper	Acrididae
Stylommatophora	Achatinidae	Zebra Agate Snail	*Cochlitoma zebra*

ANNEXURE 23

Site Sensitivity Verification for the Proposed Developments on Portions RE/8, RE/23, 7, 12, and 48 of Farm 195, called Kraai Bosch in Geroge Municipality

Specialist Plant Species and Terrestrial Biodiversity Report



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ABBREVIATIONS

BGIS	Biodiversity Geographic Information System
BPA	Biodiversity Priority Area
WC BSP	Western Cape Biodiversity Spatial Plan
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Area
CD:NGI	Chief Directorate: National Geo-spatial Information
DFFE	Department of Forestry, Fisheries and the Environment
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Area
GRI	Garden Route Initiative
IAP	Ianvsive and Alien Plants
NEM:BA	National Environmental Management: Biodiversity Act
NVM	National Vegetation Map
PA	Protected Area
POSA	Plants of Southern Africa
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
SEI	Site Ecological Importance
SSVR	Site Sensitivity Verification Report
SWSA	Strategic Water Source Area
VAST	Vegetation Assets States and Transitions

DECLARATION OF SPECIALIST INDEPENDENCE

The consulting services comprise an assessment of the potential sensitivity of the ecosystems and flora that fall within the development footprint for the site. The following declaration is given by the appointed specialist:

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP).
- At the time of conducting the field assessment and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this report has reference to, except for financial compensation for work done in a professional capacity.
- Work performed for this site was done in an objective manner. Even if this results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public.
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data.
- I do not have any influence over decisions made by the governing authorities.
- I undertake to disclose all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by a competent authority to such a relevant authority and the applicant.
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity.
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.



Bianke Fouche (MSc Conservation Biology)

Signed: 07 January 2025

BIANKE FOUCHÉ ABRIDGED CV

Qualifications

- B.Sc. Environmental Sciences (Nelson Mandela University),
- B.Sc. Honours in Botany (Nelson Mandela University),
- M.Sc. Conservation Biology (University of Cape Town)

SACNASP Registration No: 141757 (Professional Botanical; Candidate Ecological)

Skills and Core Competencies

- My MSc research will add to our understanding of plant community niche construction and Alternative Stable State (ASS) theory. The knowledge gained will be used to advise landscape stewardship practices, especially regarding reforestation initiatives in the Overstrand.
- I have worked closely with the conservation team of the Grootbos Foundation, where I assisted with vegetation surveys, mounting voucher specimens in the Grootbos herbarium, and taken part in controlled fynbos fires in the Overberg.
- Postgraduate studies of mine included assessing the allelopathic effects of *Eucalyptus* leaves on garden peas and leeks and assessing the accuracy of the climate leaf analysis multivariate programme (CLAMP) in predicting the climate of fynbos vegetation.
- In Cape Town I regularly took part in alien clearing activities and helped to identify relevant listed invasive plants.
- I am currently a member of SACNASP, the International Association for Impact Assessment (IAIA) in South Africa, Botanical Society of South Africa, and the custodians for rare and endangered wildflowers (CREW-Outramps) in George.

References

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1. INTRODUCTION

1.1 Background

Confluent Environmental was appointed by HilLand Environmental on behalf of the applicant (George Municipality) to provide Botanical and Terrestrial Biodiversity specialist inputs for the proposed development on five portions of Farm 195 called Kraai Bosch. The Portions included were:

- RE/8/195, which covers 40.82 ha
- RE/23/195, which covers 66.6 ha
- 7/195, which covers 68.69 ha
- 12/195, which covers 139.18 ha
- 48/195, which covers 103.7 ha

This amounts to a total assessment area of ca. 419 ha. The Terrestrial Plant Species and Terrestrial Biodiversity Themes in this report are assessed according to the environmental protocols (Protocols for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impact Assessments, 2020). The scope of work for this report is guided by the legislative requirements of the National Environmental Management Act (NEMA; Act No. 108 of 1998). .

SANBI ecosystem remnants are illustrated in Fig. 1 to show how the site is situated within these mapped remnant natural areas. The red critically endangered (CR) vegetation in Fig. 1 represents Garden Route Granite Fynbos remnants, and the smaller sections of orange endangered (EN) vegetation mapped in the surrounding landscape is Garden Route Shale Fynbos. The extent of the five portions are also illustrated with blue outlines in Fig. 1.

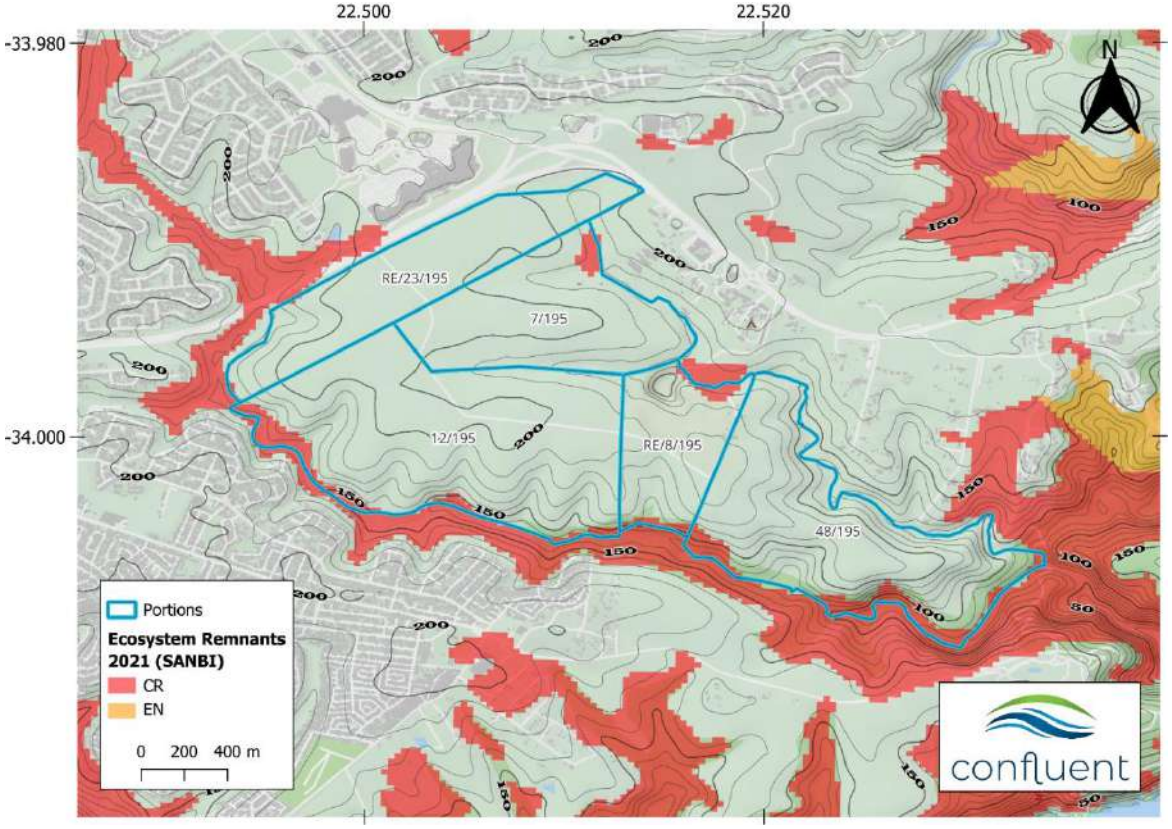

Figure 1: The location of the site in relation to mapped 2021 ecosystem remnants (produced by SANBI).

1.2 Screening Tool

According to the Department of Forestry, Fisheries, and the Environment (DFFE) Screening Tool, the SSVR is required because the Terrestrial Plant Species theme has been highlighted as having a **High, Medium, and Low** sensitivity in different sections of the site, and the terrestrial biodiversity has an overall **Very High** sensitivity (Fig. 2).

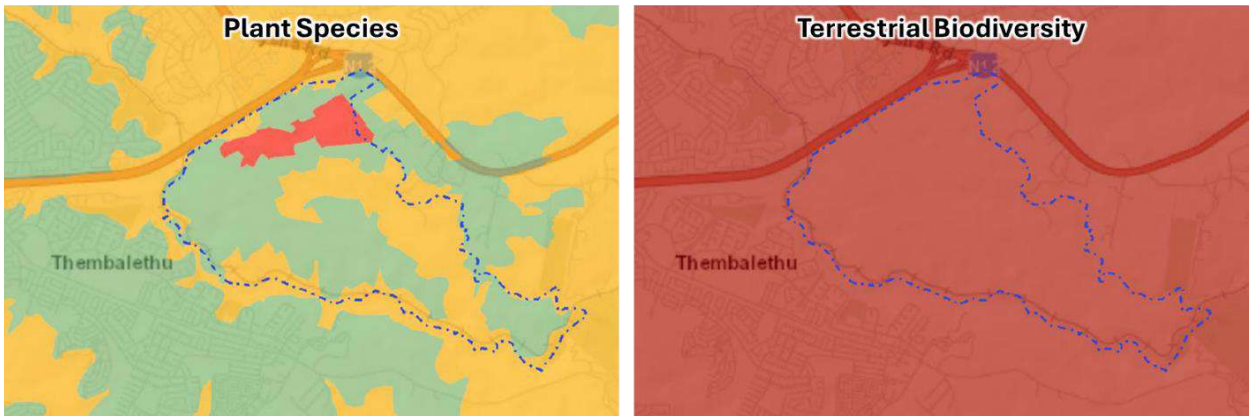

Figure 2: The Screening Tool sensitivity maps produced for the terrestrial plant species theme and terrestrial biodiversity theme.

For plant species, a Medium sensitivity indicates that models predict the occurrence of some species of conservation concern (SCC), although there are no confirmed populations. In this case, the plant SCC that were highlighted by the Screening Tool are illustrated in Table 1.

Table 1: List of species of conservation concern (SCC) highlighted by the Screening Tool. Note that the Screening Tool excludes all near threatened (NT) and Rare species from their analysis.

Sensitivity	
High & Medium areas	*Leucospermum glabrum* (EN)
Medium areas	*Diosma passerinoides* (VU)
Medium areas	*Erica glandulosa* subsp. *fourcadei* (VU)
Medium areas	*Erica glumiflora* (VU)
Medium areas	*Hermannia lavandulifolia* (VU)
Medium areas	*Lampranthus pauciflorus* (EN)
Medium areas	*Lebeckia gracilis* (EN)
Medium areas	Sensitive species 1024 (EN)
Medium areas	Sensitive species 1032 (VU)
Medium areas	Sensitive species 500 (EN)
Medium areas	Sensitive species 800 (VU)

The following definitions are given in the Species Environmental Assessment Guideline (Verburgt et al., 2020) for the High and Medium plant species theme sensitivities respectively:

Terrestrial plant species theme High sensitivity

"Recent occurrence records for all threatened (CR, EN, VU) and/or Rare endemic species are included in the high sensitivity level. Spatial polygons of suitable habitat have been produced for each species by intersecting recently collected occurrence records (those collected since the year 2002) that have a spatial confidence level of less than 250 m with segments of remaining natural habitat. For birds, species distribution models (SDMs) and SABAP2 data (http://sabap2.birdmap.africa/) were combined to delineate the 'high' sensitivity areas."

Terrestrial plant species theme Medium sensitivity

"Model-derived suitable habitat areas for threatened and/or rare species are included in the medium sensitivity level. Two types of spatial models have been included. The first is a simple rule-based habitat suitability model where habitat attributes such as vegetation type and altitude are selected for all areas where a species has been recorded to occur. The second is a species distribution model which uses species occurrence records combined with multiple environmental variables to quantify and predict areas of suitable habitat. The models provide a probability-based distribution indicating a continuous range of habitat suitability across areas that have not been previously surveyed. A probability threshold of 75% for suitable habitat has been used to convert the modelled probability surface and reduce it into a single spatial area which defines areas that fall within the medium sensitivity level."

A Very High sensitivity rating for Terrestrial Biodiversity is triggered for all Biodiversity Priority Areas (BPAs) and other sensitive features (Stewart et al., 2021). BPAs include the various management layers of the Western Cape Biodiversity Spatial Plan (WC BSP), as well as the other sensitive features in Table 2.

Table 2: Sources of BPA data for the Terrestrial Biodiversity Theme sensitivity (Stewart et al., 2021).

Sensitivity layer	Data included and source
Red Listed Ecosystems	Any ecosystem that is Vulnerable, Endangered, or Critically Endangered according to the "Revised National List of Ecosystems that are Threatened and in Need of Protection" (NEM:BA Act no.10 of 2004, amended November 2022). Mapped within the proposed development footprint is critically endangered (CR) Garden Route Granite Fynbos & CR Groot Brak Dune Strandveld.
Critical Biodiversity Areas	These areas are essential for maintaining ecosystem health and functionality, including areas that support biodiversity patterns, processes, and species persistence, and are prioritized for conservation. Mapped are CBA 1 and CBA 2 areas for forests and terrestrial biodiversity.
Ecological Support Areas	ESAs are strategically identified areas that play a vital role in supporting CBAs and aiding in the maintenance of ecosystem functionality, supporting biodiversity persistence, and ensuring ecological connectivity by sustaining essential processes. Mapped are ESA 1 areas as well as ESA 2 areas for "Restore from other land use" and also "Restore from plantation or high-density IAP".
Strategic Water Source Areas for surface water	Surface strategic water source areas, delineated by Mervyn Lotter in October 2020 with substantial input from the SWSA spatial task team as part of the SWSA spatial task team. Note that the protocol only applies to the terrestrial parts of the SWSAs. Mapped is the Outeniqua SWSA-sw.
Protected Areas (PAs)	Most recent update from the DFFE's "South African Protected Area Database". Mapped within the proposed development footprint are the 1) George Private Nature Reserve, and 2) Blydskap Private Nature Reserve.
SAN Parks Buffer Areas	A buffer area for a National Park is defined in the February 2012 schedule on Biodiversity Policy and Strategy for South Africa's Strategy on Buffer Zones of National Parks. Mapped is the Garden Route National Park 10km wide buffer.
Priority Areas for Protected Areas Expansion	The latest priority expansion areas per province, and expansion footprint for national parks as per the approved management plan for national parks. Areas identified in the National Protected Area Expansion Strategy (NPAES) are included on the site.

1.3 Development Description

The current proposal is for a large-scale mixed-use development in the five portions included in this assessment (Fig. 3). In addition to the planning on-site, there will also need to be additional upgrades to infrastructure that fall outside of the cadastral boundaries of this proposed development. The botanical sensitivity of these proposed upgrade areas required and upgrade routes for linear infrastructure have not been determined in this report, therefore a detailed assessment must take place for these areas during the impact assessment phase.

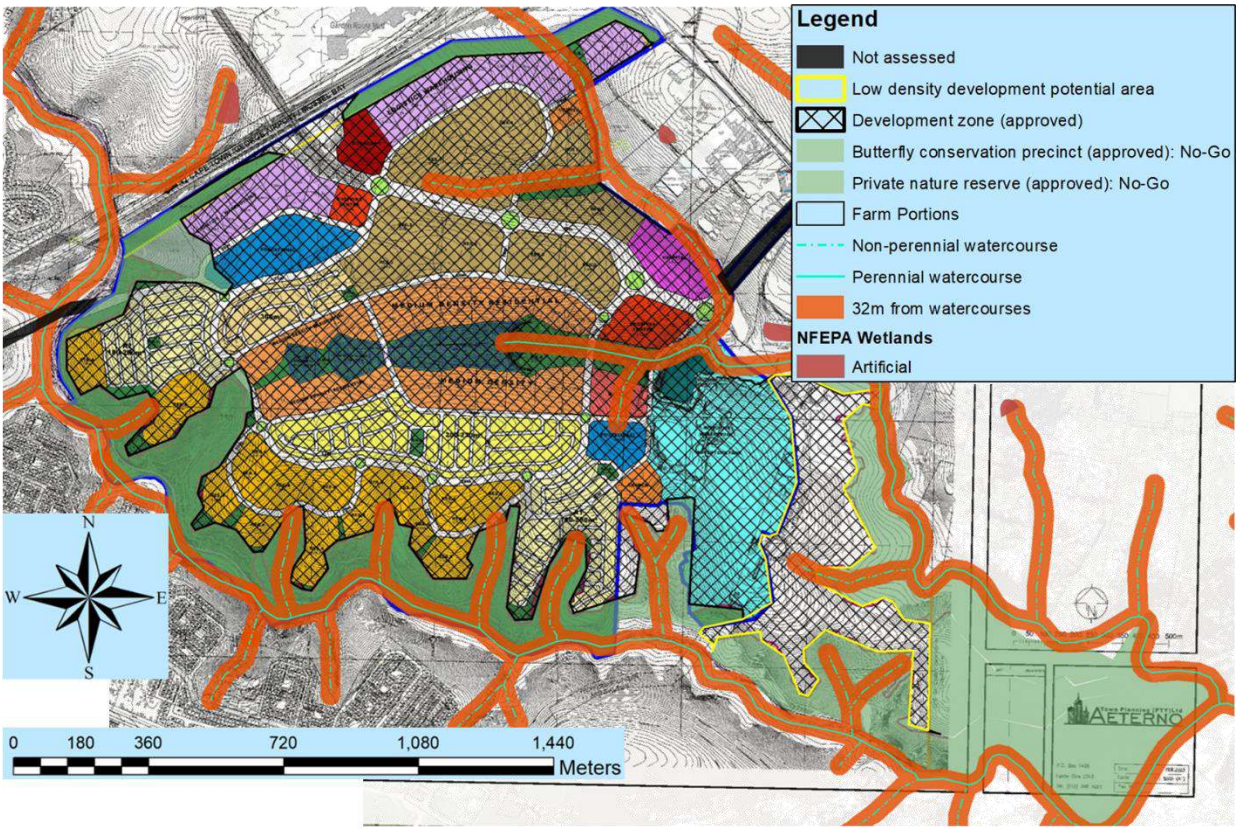

Figure 3: The general site layout. The site development plan is subject to amendment and is still in the planning phase.

2. TERMS OF REFERENCE

This report provides information on Terrestrial and Botanical diversity and sensitivity in relation to the proposed development. The results presented are based on a desktop and field assessment, which includes a consideration of historical photographic records of the site. The assessment presented in this report follows the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity, and Terrestrial Plant Species themes. This assessment follows the requirements of:

- The Environmental Impact Assessment Regulations, as promulgated in terms of Section 24 (5) of the National Environmental Management Act, 1998 (Act No. 107 of 1998), which includes:
    - The protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial plant species (28 July 2023).

  - The protocol for the specialist assessment and minimum report content requirements for environmental impacts on terrestrial biodiversity (20 March 2020).

- Additional guidelines for the terrestrial biodiversity theme:
  - Ecosystem Guidelines for Environmental Assessment in the Western Cape (de Villiers et al., 2016).
  - The Western Cape Biodiversity Spatial Plan Handbook and summary booklet (CapeNature, 2017; Pool-Sandvliet et al., 2017).
  - The Subtropical Thicket Ecosystem Programme Handbook: Integrating the natural environment into land-use decisions at the municipal level: towards sustainable development (Pierce & Mader, 2006).
  - Ecosystem Guidelines for the Albany Thicket Biome (SANBI & CEN Integrated Environmental Management Unit, 2021)
- Additional guidelines for the terrestrial plant species theme:
  - Species Environmental Assessment Guideline: Guidelines for the implementation of the Terrestrial Flora (3c) & Terrestrial Fauna (3d) Species Protocols for environmental impact assessments in South Africa (Verburgt et al., 2020).

The assessment was undertaken by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP) with relevant expertise in the field of Botanical and Ecological science.

3. METHODOLOGY

3.1 Desktop Assessment

The desktop assessment was performed using Cape Farm Mapper and QGIS version 3.36 called “Maidenhead”. Plant species data was sourced from the following sources:

- The DFFE screening tool listed SCC.
- Information on plant occurrence prior to the site visit was sourced from SANBIs Botanical Research and Herbarium Management System (BRAHMS) for the Plants of Southern Africa (POSA) database.
- iNaturalist observations of the property and surrounding areas.
- Past specialist reports and insight into the species likely present in the area.

Ecosystem/ vegetation type data was sourced from:

- The 2018 and 2024 updated South African Beta version of the National Vegetation Map (NVM) from SANBIs Biodiversity Geospatial Information System (BGIS) database, and the National Biodiversity Assessment report of 2018 (Skowno et al., 2018).
- Shapefiles for the Western Cape Biodiversity Spatial Plan (WC BSP) were downloaded from BGIS database (CapeNature, 2017; Pool-Sandvliet et al., 2017).

- Cape Farm Mapper for additional spatial information required for the site.
- Chief Directorate: National Geo-spatial Information (CD: NGI) Geospatial Portal and Google Earth for the acquisition of historical aerial imagery of the site.
- The conservation status of ecosystems was found in the Revised National List of Ecosystems that are Threatened and in need of protection, published under the National Environmental Management: Biodiversity Act (Act No. 10, 2004, as revised in Nov. 2022), and also using the Vegetation of South Africa, Lesotho, and Swaziland (Mucina & Rutherford, 2006).

3.2 Field Assessment

Field work on the property was undertaken on multiple dates, including three main surveys on the 07th and 13th of November 2024, as well as on 05 December 2024. A drive through on the site was undertaken on the 22nd of November, during which time two additional species were added to the species list. The method for identifying species was similar to a BioBlitz, also described as a "timed meander", where the specialist records plant species composition of the site, and actively searches for rarer and threatened species. Some Red Listed plant species are found more easily during a site survey than other species. This survey method is an attempt to account for the short and single survey period, where detection probability of some rare and threatened species (e.g., geophytes, small succulents, small perennials etc.) may be low (Garrard et al., 2008; Wintle et al., 2012). Observations of individual species and environmental characteristics were photographed and then uploaded to iNaturalist, an open-source online platform.

3.3 Assumptions & Limitations

This assessment is subject to a few assumptions, uncertainties, and limitations, as listed below:

- Surveys were limited to late spring in November of 2024. Although spring is generally a good time for a survey, it is not a guarantee that all species were flowering or visible.
- Due to the large area of the proposed development, a comprehensive walkthrough of the site is impractical. In order to make up for this shortcoming, representative patches of vegetation were sampled and surveyed, and all observed quality fynbos patches were surveyed.
- Invaded sections (including areas invaded by bracken ferns) of the site, as well as areas where land management is poor (e.g., fire regime shifts due to anthropogenic reasons) may obscure the true potential diversity of the site.
- Luckily there were many sections where invasive plant species (esp. Acacias) were absent, although it is understood that past invasions have occurred in the currently open areas.
- Most of the observed fynbos on the site was senescent / moribund, which also means that the true potential of species diversity on the site could not be captured under the current land-management conditions.
- Some rare and threatened plant species are difficult to locate and some are easily overlooked when not flowering or where past disturbance has almost led to their

eradication from the landscape. E.g., the high screening tool sensitivity trigger for *Leucospermum glabrum* was not confirmed. However, to mitigate against a false negative for this species on the site, the precautionary principle must be applied, assuming the species is present, or will return under more favourable ecology-focused landscape management.

- The species list reported is not exhaustive (Cowling et al., 2010; Perret et al., 2023).

4. RESULTS: DESKTOP ASSESSMENT

4.1 Terrestrial Biodiversity

4.1.1 Climate

The climate of George is described as warm and temperate. The rainfall pattern is a-seasonal, with rain typically occurring even in the driest months of the year. Mean annual precipitation (MAP) is over ca. 700 mm, with two seasonal peaks during the spring and winter. The mean annual temperature (MAT) for this area is around 21˚C. There is also far more annual variation in rainfall patterns compared to the more predictable annual temperature patterns. All graphs in Fig. 4 were provided by worldweatheronline.com.

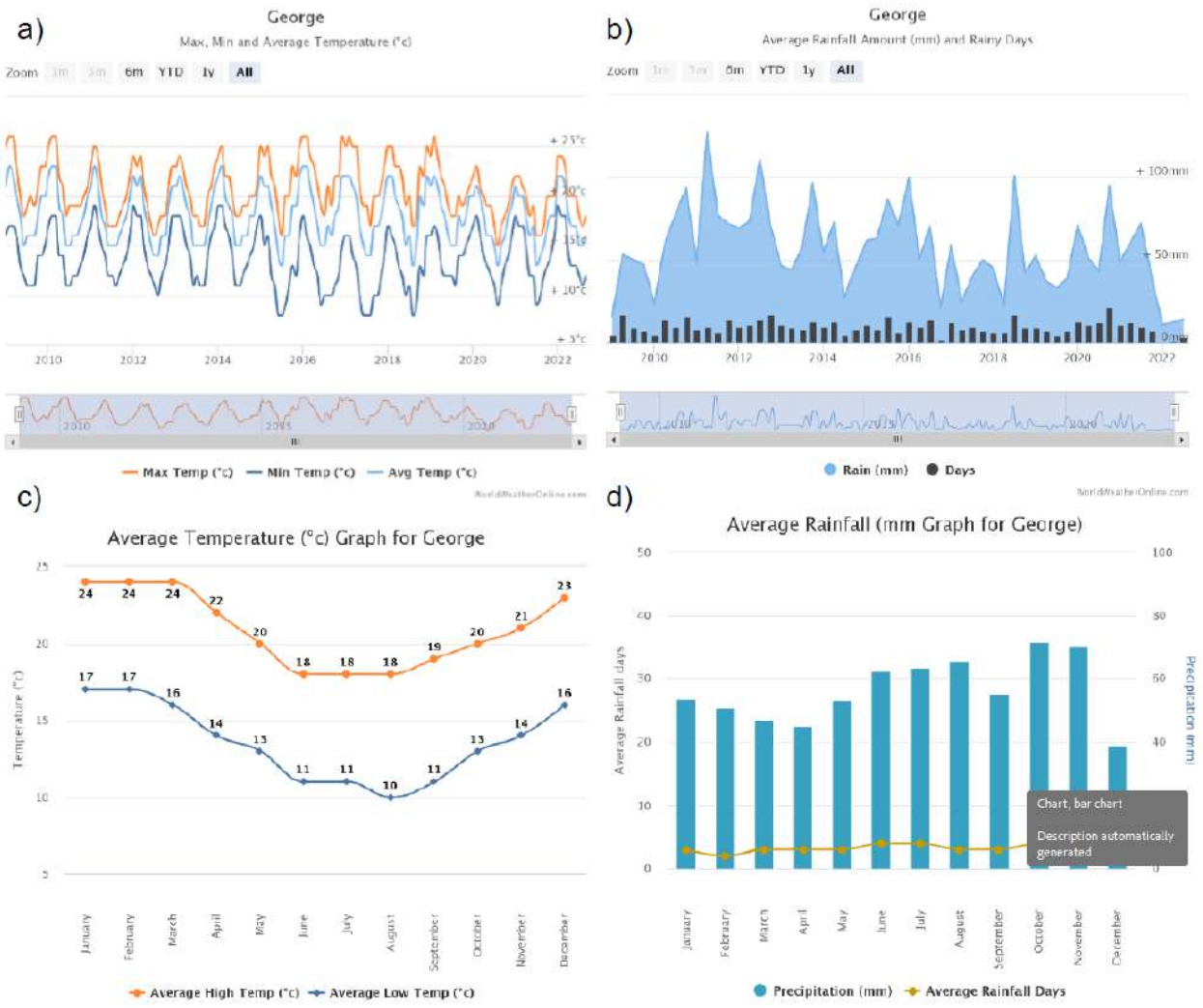

Figure 4: Climate charts for George in the Western Cape showing a) temperature ranges from 2010 to 2022, b) precipitation trends over the period 2010 to 2022, c) monthly minimum and maximum temperatures, and d) monthly average rainfall (mm) and days of rain.

4.1.2 Geology and Soil

The geology of the site is described as being part of the Cape Granite Suite (Browning & Macey, 2015). These granites are from the late Precambrian. The Maalgaten Granite, considered the main part of the George Pluton (i.e., a body if intrusive igneous rock), is likely present at the site and stretches from Wilderness in the East to the Klein Brak River in the West (Browning & Macey, 2015) as shown in Fig. 5. It is thought that this granite covers an approximate area of 248 km2. Soil in the area of the proposed development is categorised as highly erodible (with an erodibility factor of 0.74), as described in Cape Farm Mapper. The soils in this area have strong textural contrasts in the soil profile, and therefore diagnostic horizons are usually clearly visible in the soil profile.

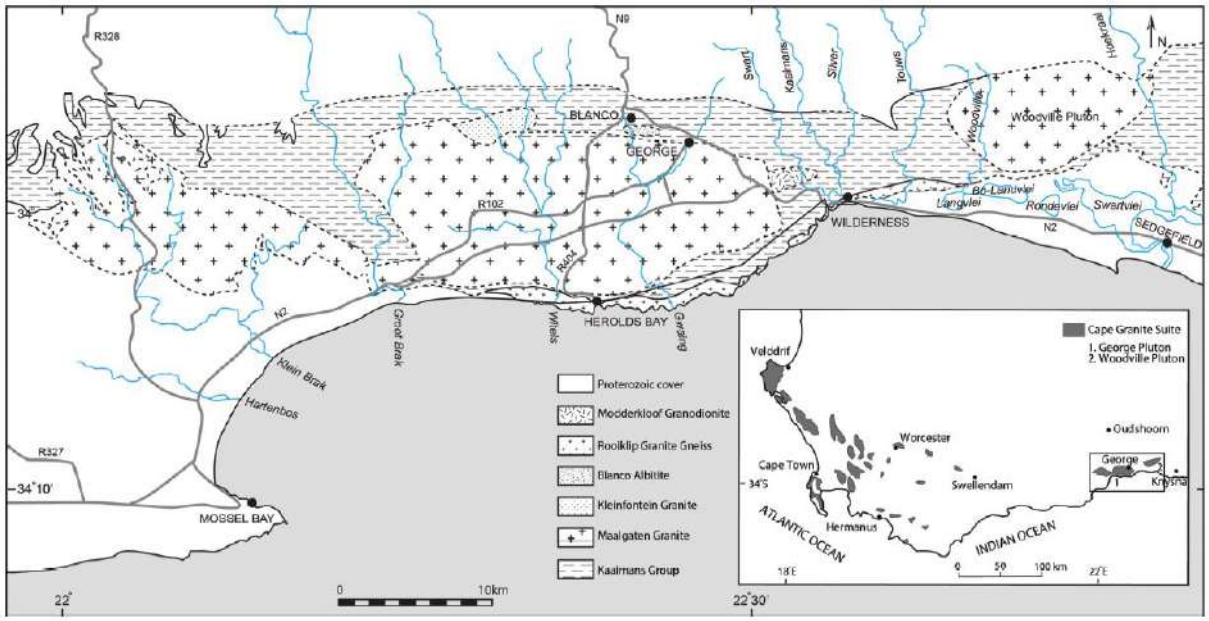

Figure 5: A map taken from the (Browning & Macey, 2015) paper showing the distribution of the George and Woodville Pluton granitoids. The inset illustrates additional areas where outcrops of the Cape Granite Suite occur.

4.1.3 Vegetation Type(s)

The mapped vegetation for the proposed development area is critically endangered (CR) Garden Route Granite Fynbos (FFg 5; Fig. 6). The beta 2024 National Vegetation Map (NVM) matches the 2018 vegetation types mapped in the assessment area (Dayaram et al., 2019; Mucina & Rutherford, 2006). The Garden Route Initiative (GRI) map (Vlok et al., 2008) was produced at aa regional scale and may therefore indicate a more refined layer of detail, which might be missing in the NVM. The GRI vegetation communities highlighted for the site is “Wolwedans Grassy Fynbos” and along the valleys and drainage lines “Groot Brak River Floodplain” is mapped. The Wolwedans Grassy Fynbos in this case is the equivalent vegetation type to the CR FFg 5 of the NVM.

Garden Route Granite Fynbos occurs in three main blocks along the coastal plain south of the Outeniqua Mountains, from Botterberg near Brandwaghoogte to Groot Brak River, and eastwards to Woodville and Hoogekraal Pass (Mucina & Rutherford, 2006). It is found at altitudes between 0 and 300 meters. The landscape consists of moderately undulating plains and hills, with dense proteoid and graminoid fynbos, and ericaceous fynbos in seeps. Proteas dominate in the west, while graminoid and ericaceous fynbos are more prominent in the east, especially on flat plateaus. The vegetation is supported by deep, well-drained soils. This vegetation type has only around 1% conserved in the Garden Route National Park. Well over 70% of the area has been transformed for agriculture, pine plantations, and urban development, leading to moderate to high erosion in many areas around George. Remnants of the fynbos are confined to isolated pockets, primarily on steeper slopes. Historically this vegetation type was dominated by proteoid fynbos, however much of the area has been converted to graminoid fynbos through regular fires, competing invasive plants, and the introduction of pasture grasses.

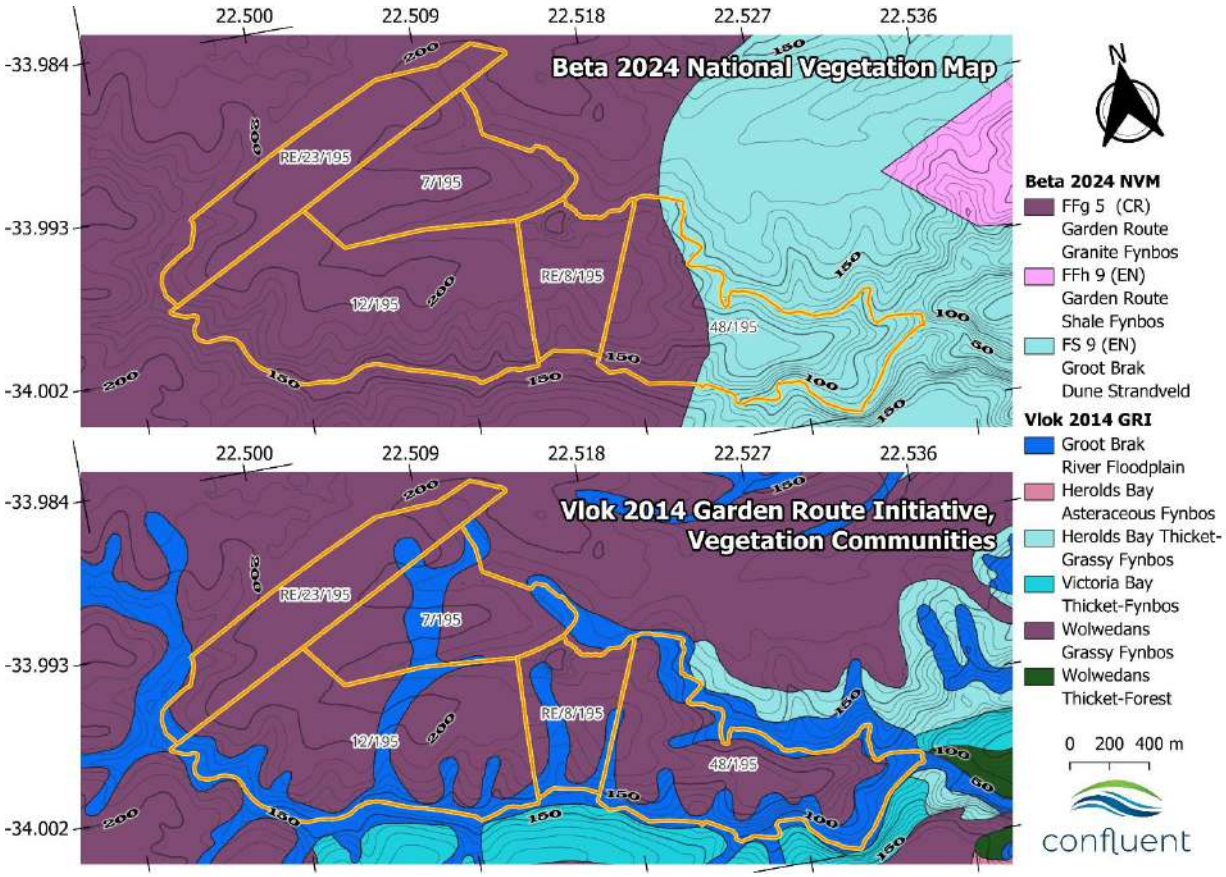

Figure 6: The mapped 2024 National Vegetation Map (NVM) vegetation types and Garden Route Initiative vegetation communities. The 2024 and 2018 versions of the NVM match in this area.

4.1.4 Western Cape Biodiversity Spatial Plan

The Biodiversity Spatial Plan for the Western Cape (WC BSP) contains several conservation planning layers that are used to set priority areas for conserving biodiversity. The definition and objectives of all of the different WC BSP layers is given in BOX 1. Appendix 10.1 illustrates the recommended land-uses associated with the various BSP layers.

BOX 1: The Biodiversity Spatial Plan

Critical Biodiversity Area 1

Definition: Areas in a natural condition. Required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure.

Objective: Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.

Critical Biodiversity Area 2

Definition: Areas in a degraded or secondary condition. Required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure.

Objective: Maintain in a functional, natural, or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.

Ecological Support Area 1

Definition: Not essential for meeting biodiversity targets. An important role in supporting the functioning of PAs or CBAs. Often vital for ecosystem services.

Objective: Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided underlying biodiversity objectives/ecological functioning are not compromised.

Ecological Support Area 2

Definition: Not essential for meeting biodiversity targets. Important in supporting functioning of PAs or CBAs. Often vital for ecosystem services.

Objective: Restore/minimise impact on ecological infrastructure functioning, especially soil and water-related services.

Other Natural Areas

Definition: These areas retain most of their natural character and perform biodiversity and ecological infrastructure functions but have not been prioritised in the current Western Cape Biodiversity Spatial Plan.

Objective: Minimise habitat and species loss to ensure ecosystem functionality through strategic landscape planning. Some flexibility in permissible land uses, but authorisation

Portions RE/23/195, 12/195, and 7/195 are all largely classified as ecological support areas (ESA 2) for the category “Restore from plantation or high-density invasive alien plants (IAP)” (Fig. 7). This classification is accurate in these areas, as the fynbos here does face a large threat from wattles, primarily black wattles (*Acacia mearnsii*). Along the Meul River critical biodiversity areas (CBA 1 & 2) for wetlands and terrestrial biodiversity is mapped. Portion RE/8/195 contains a large area excluded from the BSP due to the quarry there. East of the quarry a section is mapped as a CBA2 for terrestrial biodiversity, although the invasive wattle stands there are a monoculture without much understorey present. Portion 48 of 195 is a Protected Area (PA).

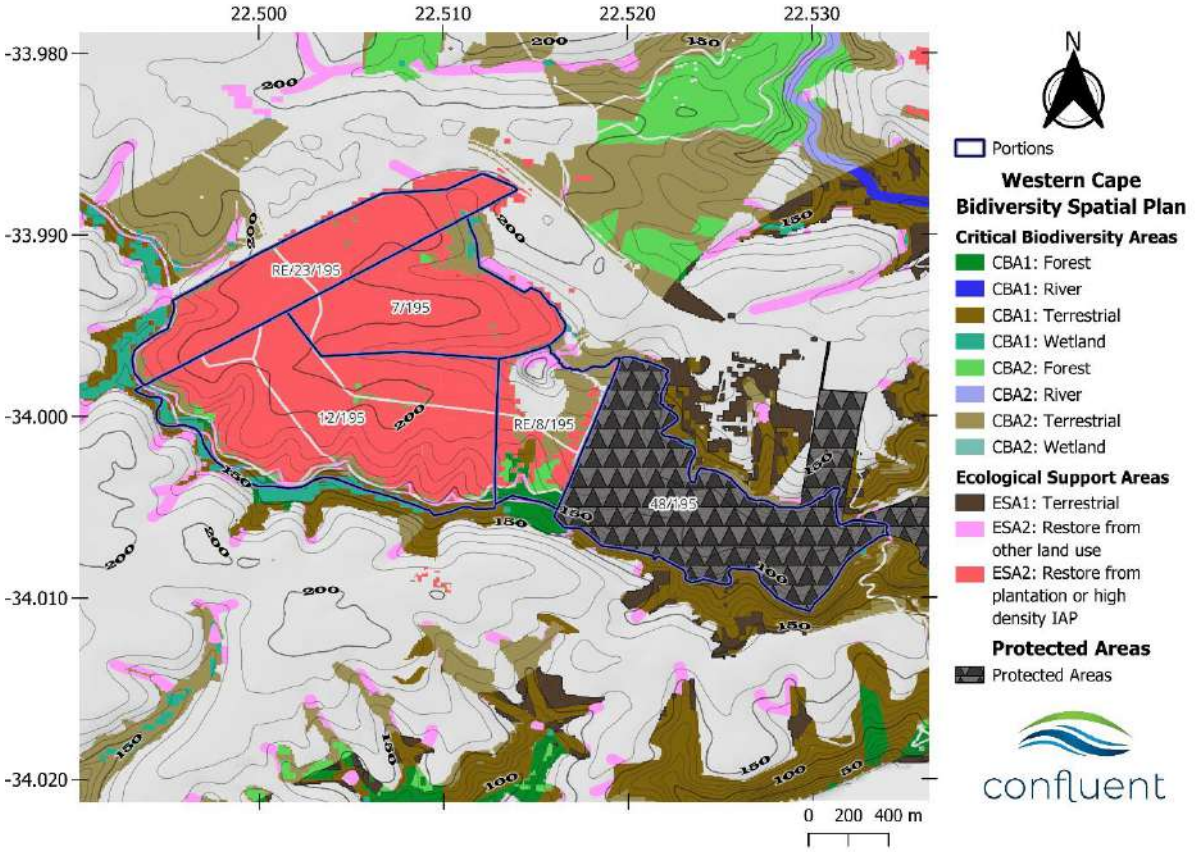

Figure 7: The mapped Western Cape Biodiversity Spatial Plan (WC BSP) categories that have been mapped for the Portions.

The assignment of BSP layers, as shown in Fig. 7, is informed by the hexagonal regions of the Biodiversity Spatial Plan (BSP), each of which encompasses multiple criteria for mapping. The hexagons underlying the BSP layers mapped for the Portions are presented in Fig. 8.

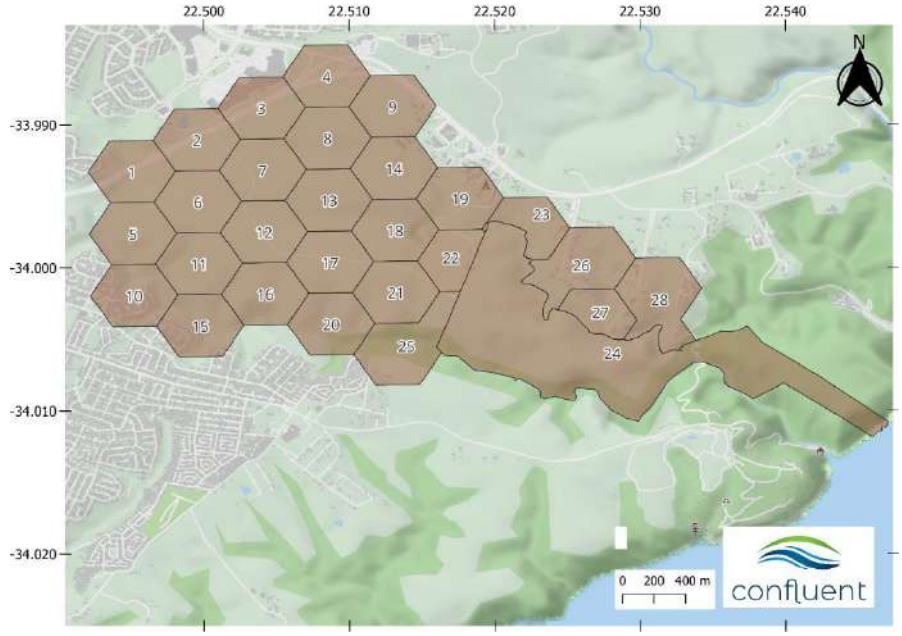

Figure 8: A map showing the BSP reasons polygons mapped for the portions. Table 3 lists all the reasons listed per polygon.

Each of the hexagons in Fig. 8 are labelled with a number which corresponds to the numbers presented per entry in Table 3. While some of the reasons are consistent between most of the mapped hexagons, many are also different or unique. For this reason, the reasons for each hexagon in Fig. 8 is listed separately in Table 3. The reasons are colour coded to make it easier to see which reasons are shared between different hexagons.

Table 3: The reasons that apply for each mapped polygon mapped in Fig. 8.

No.	Reasons Applicable	No.	Reasons Applicable
1	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Eastern Fynbos Renosterveld Granite Fynbos Depression Wetland Garden Route Granite Fynbos Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)	15	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)
2	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	16	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
3	Bontebok Extended Distribution Range Water source protection- Kaaimans	17	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
4	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	18	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
5	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Garden Route Granite Fynbos Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)	19	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
6	Bontebok Extended Distribution Range Water source protection- Kaaimans	20	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Garden Route Granite Fynbos Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
7	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	21	Bontebok Extended Distribution Range Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)

No.	Reasons Applicable	No.	Reasons Applicable
8	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	22	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
9	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	23	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
10	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)	24	Bontebok Extended Distribution Range Coastal resource protection – Eden Eastern Fynbos Renosterveld Granite Fynbos Channelled Valley Bottom Wetland Eastern Fynbos Renosterveld Granite Fynbos Seep Wetland Garden Route Granite Fynbos Groot Brak Dune Strandveld Indigenous Forest Type South Strandveld Western Strandveld Channelled Valley Bottom Wetland South Strandveld Western Strandveld Floodplain Wetland Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)
11	Bontebok Extended Distribution Range Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	25	Bontebok Extended Distribution Range Eastern Fynbos Renosterveld Granite Fynbos Depression Wetland Garden Route Granite Fynbos Indigenous Forest Type Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt Wolwedans Grassy Fynbos (Vlok variant)
12	Bontebok Extended Distribution Range Water source protection- Kaaimans	26	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
13	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	27	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt
14	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt	28	Bontebok Extended Distribution Range Water source protection- Kaaimans Watercourse protection- South Eastern Coastal Belt

4.1.5 Historical Aerial Imagery

The oldest aerial image presented in Fig. 9 is from 1974. During that time the majority of the five portions in this assessment were utilised by forestry, with plantations visible. Yellow arrows in Fig. 9 indicate bare areas observed. The reason for the bare areas seen is not clear, however the vegetation in those strips did not represent fynbos vegetation. The green arrow indicates the position of the quarry, which was very small in 1974 compared to the present (2024).

By 1989 some of the plantation blocks had been harvested and the quarry area had increased substantially. By 2005, all of the plantation trees had been harvested, and the majority of the Portions were covered in open-canopy vegetation cover. Only the watercourses and valleys retained some woody tree cover. Some sections of fynbos is visibly seen returning to the site as darker grey blotches in the 2005 imagery, directly south of the N2, where the Garden Route Mall construction is also visible. By 2011 adventive woody growth is visibly returning to the site. Note that the initial botanical surveys for the “Destiny Africa” project took place between the 2005 and 2011 period.

Since 2011, the portions have all become densely invaded, with the exception of Portion RE/23/195, which to this day is largely open-canopy. RE/23/195 is also the Portion which, in 2024, supports the largest extant area of secondary fynbos within the assessment area. The PA on Portion 48/195 is currently severely invaded with some natural vegetation isolated near the Portion’s northern boundary.

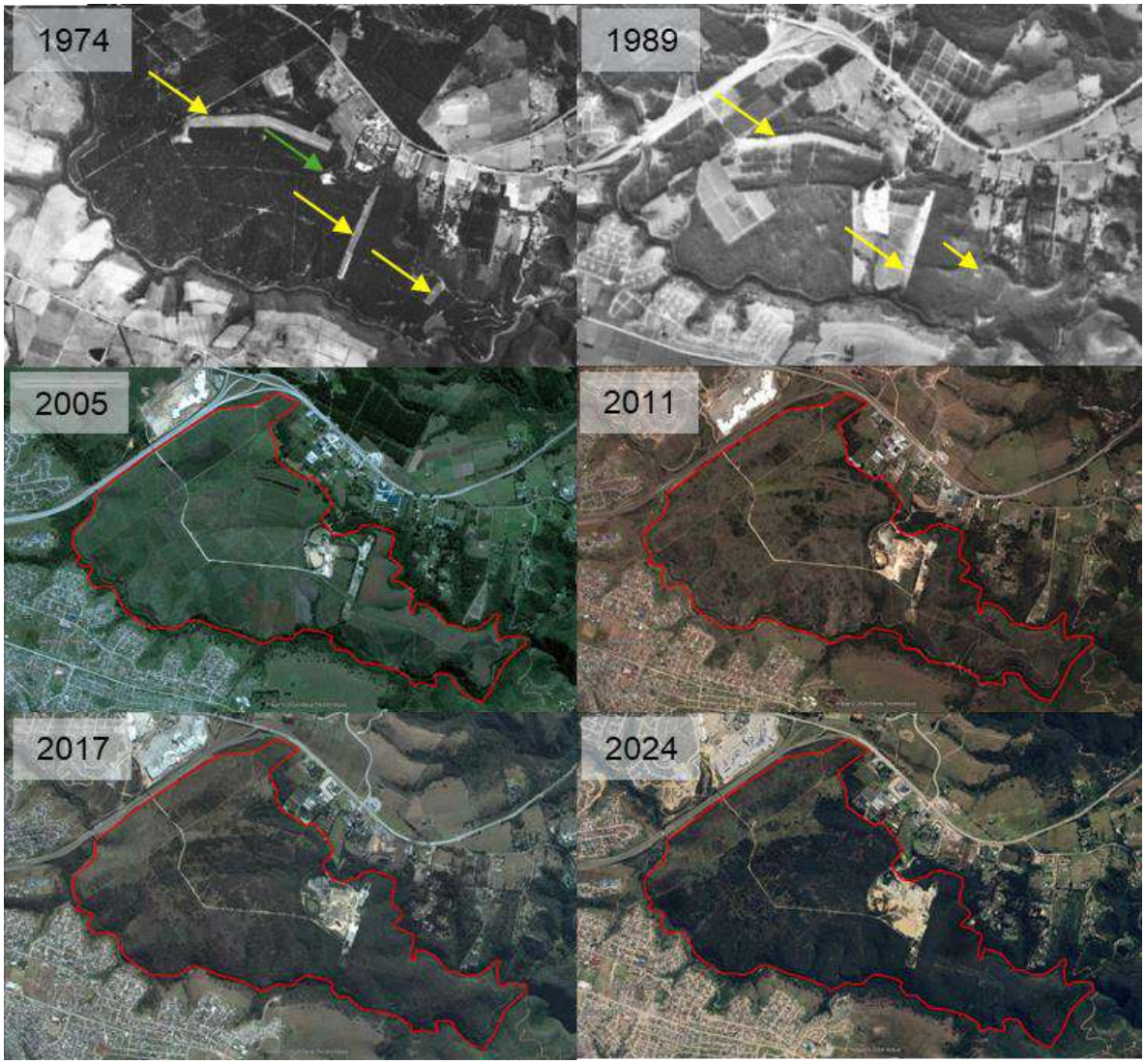

Figure 9: A series of historical images on the five Farm Portions in George going back to 1974.

4.2 Plant Species

The plant species theme sensitivity of Medium is dependent on the presence, or likely presence, of several plant species of conservation concern (SCC). The SCC likelihood of occurrence is assessed later in the report. A species list for the important taxa of Garden Route Granite Fynbos is presented in Table 4.

Table 4: Garden Route Granite Fynbos (CR; FFg 5) Important Taxa. Entries highlighted in green represent taxa that were found during the site assessment, and entries with a in the "Information" column were also in the transformed or densely invaded sections of the site.

Family	Growth Form	Species	Information
FFg 5 Garden Route Granite Fynbos (CR)			
ASTERACEAE	Low Shrubs	*Cullumia bisulca*	
ASTERACEAE	Low Shrubs	*Eriocephalus africanus*	
ASTERACEAE	Low Shrubs	*Metalasia pungens*	
ASTERACEAE	Low Shrubs	*Relhania calycina*	
ASTERACEAE	Low Shrubs	*Syncarpha paniculata*	[d]
CYPERACEAE	Graminoids	*Ficinia nigrescens*	
CYPERACEAE	Graminoids	*Tetraria cuspidata*	[d]
ERICACEAE	Low Shrubs	*Erica canaliculata*	
ERICACEAE	Low Shrubs	*Erica diaphana*	
ERICACEAE	Low Shrubs	*Erica discolor*	[d]
ERICACEAE	Low Shrubs	*Erica formosa*	
ERICACEAE	Low Shrubs	*Erica peltata*	[d]
FABACEAE	Low Shrubs	*Aspalathus asparagoides*	
GERANIACEAE	Low Shrubs	*Pelargonium fruticosum*	
LOBELIACEAE	Low Shrubs	*Lobelia tomentosa*	
MALVACEAE	Low Shrubs	*Hermannia angularis*	
AIZOACEAE	Succulent Shrub	*Lampranthus sociorum*	
POACEAE	Graminoids	*Brachiaria serrata*	
POACEAE	Graminoids	*Eragrostis capensis*	
POACEAE	Graminoids	*Heteropogon contortus*	
POACEAE	Graminoids	*Pentaschistis eriostoma*	
POACEAE	Graminoids	*Themeda triandra*	
PROTEACEAE	Low Shrubs	*Leucadendron salignum*	
PROTEACEAE	Low Shrubs	*Mimetes cucullatus*	
PROTEACEAE	Tall Shrubs	*Protea coronata*	
PROTEACEAE	Tall Shrubs	*Protea lanceolata*	
PROTEACEAE	Tall Shrubs	*Protea neriifolia*	
RESTIONACEAE	Graminoids	*Restio triticeus*	
RHAMNACEAE	Low Shrubs	*Phylica confusa*	[d]
ROSACEAE	Low Shrubs	*Cliffortia falcata*	
ROSACEAE	Tall Shrubs	*Cliffortia serpyllifolia*	

Family	Growth Form	Species	Information
RUBIACEAE	Low Shrubs	*Anthospermum prostratum*	
RUTACEAE	Low Shrubs	*Agathosma ovata*	
SANTALACEAE	Semiparasitic Shrubs	*Colpoon compressum*	
SANTALACEAE	Semiparasitic Shrubs	*Thesium virgatum*	
SCHIZAEACEAE	Geophytic Herb	*Schizaea pectinata*	
THYMELAEACEAE	Tall Shrubs	*Passerina corymbosa*	[d]
VISCACEAE	Semiparasitic Epiphytic Shrub	*Viscum capense*	
FS 9 Groot Brak Dune Strandveld (CR)			
FABACEAE	Herb	Indigofera tomentosa	
IRIDACEAE	Geophytic Herb	Freesia alba	
ACANTHACEAE	Soft Shrub	Hypoestes aristata	
AIZOACEAE	Succulent Shrubs	Tetragonia fruticosa	
AMARYLLIDACEAE	Geophytic Herbs	Brunsvigia orientalis	
ANACARDIACEAE	Tall Shrubs	Rhus crenata	
ANACARDIACEAE	Tall Shrubs	Rhus glauca	
ANACARDIACEAE	Tall Shrubs	Rhus longispina	
ANACARDIACEAE	Tall Shrubs	Rhus lucida	
APOCYNACEAE	Herbaceous Climbers	Astephanus triflorus	
APOCYNACEAE	Herbaceous Climbers	Cynanchum obtusifolium	
APOCYNACEAE	Low Shrubs	Carissa bispinosa	
APOCYNACEAE	Woody Succulent Climber	Sarcostemma viminale	
ARALIACEAE	Tall Shrubs	Cussonia thyrsiflora	
ASPARAGACEAE	Low Shrubs	Asparagus suaveolens	
ASPARAGACEAE	Woody Climbers	Asparagus aethiopicus	
ASPHODELACEAE	Succulent Shrubs	Aloe arborescens	[d]
ASTERACEAE	Low Shrubs	Eriocephalus africanus var. africanus	
ASTERACEAE	Low Shrubs	Helichrysum teretifolium	
ASTERACEAE	Succulent Herbs	Senecio radicans	
ASTERACEAE	Tall Shrubs	Metalasia muricata	
ASTERACEAE	Tall Shrubs	Tarchonanthus littoralis	
CELASTRACEAE	Low Shrubs	Lauridia tetragona	
CELASTRACEAE	Tall Shrubs	Gymnosporia buxifolia	
CELASTRACEAE	Tall Shrubs	Maytenus procumbens	
CELASTRACEAE	Tall Shrubs	Mystroxylon aethiopicum	
CELASTRACEAE	Tall Shrubs	Pterocelastrus tricuspidatus	
CELASTRACEAE	Tall Shrubs	Putterlickia pyracantha	

Family	Growth Form	Species	Information
COMMELINACEAE	Herb	Commelina africana	
CRASSULACEAE	Succulent Herbs	Crassula expansa subsp. expansa	
CRASSULACEAE	Succulent Shrubs	Cotyledon orbiculata var. dactylopsis	
CRASSULACEAE	Succulent Shrubs	Crassula perforata	
CRASSULACEAE	Succulent Shrubs	Crassula pubescens subsp. pubescens	
CUCURBITACEAE	Herbaceous Climbers	Kedrostis nana	
CYPERACEAE	Graminoids	Ficinia indica	
EBENACEAE	Tall Shrubs	Diospyros dichrophylla	
EBENACEAE	Tall Shrubs	Euclea racemosa subsp. racemosa	
EUPHORBIACEAE	Low Shrubs	Clutia daphnoides	
EUPHORBIACEAE	Succulent Shrubs	Euphorbia burmannii	
EUPHORBIACEAE	Succulent Shrubs	Euphorbia mauritanica	
FABACEAE	Tall Shrubs	Schotia afra var. afra	
GENTIANACEAE	Low Shrubs	Chironia baccifera	
GERANIACEAE	Herbaceous Succulent Climber	Pelargonium peltatum	
IRIDACEAE	Geophytic Herbs	Chasmanthe aethiopica	
IRIDACEAE	Geophytic Herbs	Hesperantha falcata	
LAMIACEAE	Low Shrubs	Ballota africana	
MALVACEAE	Tall Shrubs	Grewia occidentalis	
MENISPERMACEAE	Woody Climbers	Cissampelos capensis	
MESEMBRYANTHEMACEAE	Succulent Herbs	Carpobrotus edulis	
MYRICACEAE	Tall Shrubs	Morella cordifolia	
MYRSINACEAE	Tall Shrubs	Myrsine africana	
OLEACEAE	Small Trees	Chionanthus foveolatus	
OLEACEAE	Tall Shrubs	Olea exasperata	
POACEAE	Graminoids	Cynodon dactylon	
POACEAE	Graminoids	Ehrharta erecta	
POACEAE	Graminoids	Panicum deustum	
POACEAE	Graminoids	Stipa dregeana	
POLYGALACEAE	Low Shrubs	Polygala myrtifolia	
RHAMNACEAE	Low Shrubs	Phylica axillaris	
RUTACEAE	Small Trees	Clausena anisata	
SALVADORACEAE	Tall Shrubs	Azima tetracantha	
SANTALACEAE	Semiparasitic Shrubs	Osyris compressa	
SANTALACEAE	Semiparasitic Shrubs	Thesidium fragile	
SAPOTACEAE	Tall Shrubs	Sideroxylon inerme	
VITACEAE	Woody Climbers	Rhoicissus digitata	
ZYGOPHYLLACEAE	Succulent Shrubs	Zygophyllum morgsana	

5. RESULTS: FIELD ASSESSMENT

5.1 Ecosystems and Vegetation Observed

The ecosystems on the site consist primarily of fynbos, wetlands, and areas dominated by invasive alien vegetation, primarily black wattles (*Acacia mearnsii*), although stands of other invasive woody species like *Eucalyptus* and *Pinus pinaster* were also found. The state of the ecosystems on the Portions varied significantly, with large areas showing signs of severe degradation, while smaller areas retain elements of recovering or senescent fynbos vegetation.

The majority of the assessment area is heavily invaded by alien species, notably black wattle (*Acacia mearnsii*), which form dense monocultures in many areas. In the eastern sections / Portions of the assessment area, some fynbos persists under the wattles or in small clearings, but these remnants are senescent and species-poor. A notable observation in the west was the presence of bracken ferns (Pteridium aquilinum), which dominated in disturbed and post-fire environments. These ferns, while opportunistic, hinder the recovery of fynbos by rapidly colonizing and outcompeting native species, especially in areas where past disturbance has degraded the stability and resilience of the natural fynbos ecosystem.

Most wetland ecosystems on the site were surrounded by black wattles, however the wetlands themselves contained a high diversity of plant taxa. The remnant patches of secondary fynbos represent critically endangered Garden Route Granite Fynbos, and have a high conservation value although they are isolated by surrounding transformed landscapes and highly invaded areas. These fynbos areas exhibit some species richness, with fynbos elements such as *Tetraria robusta* acting as pioneers in disturbed sections. In larger patches, diversity is greater, though some key fynbos species, particularly members of the Proteaceae, are absent or scarce. The confirmed screening tool presence of *Leucospermum glabrum* could also not be verified on the site – although this does not mean that it is absent.

Fire and land management practices are affecting the natural fynbos that remains. Recent fires have burned invasive stands of *Eucalyptus*, leading to regrowth dominated by bracken ferns (*Pteridium aquilinum*) with minimal return of fynbos species. Poor fire timing and frequency have likely exacerbated the colonization of bracken ferns. Furthermore, the lack of alien clearing on the site since 2005 is evident as the wattle invasions on the Portions are dense and established, now spanning many hectares. These invasions have effectively choked returning fynbos on the majority of the assessment sites. The track walked during the site assessment is presented in Fig. 10, with the locations of representative imagery of the site stamped on the map (including the location of a large stand with 100s of vulnerable *Erica glandulosa fourcadei*, no.12 in Fig. 10). Each of the locations indicated in Fig. 10 are then illustrated and briefly discussed in Table 5.

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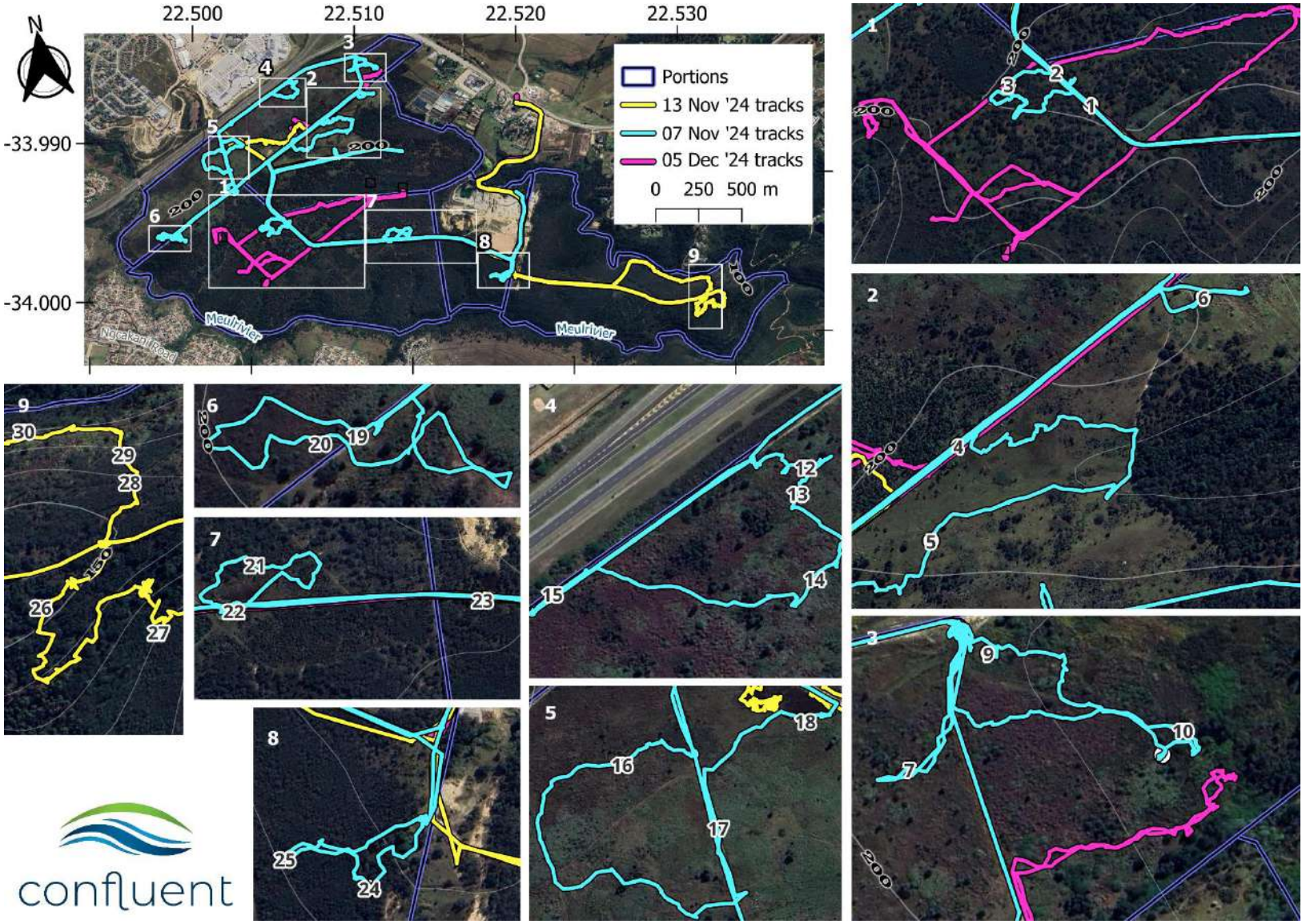

Figure 10: The assessment tracks on 7 (blue) and 13 (yellow) November 2024. Numbered inset maps illustrate photo locations that are linked to the numbered photos in Table 4.

Imagery from the site assessment is presented and discussed in Table 5, where the location of each photo is indicated in Fig. 10. These visuals provide context for the descriptions of vegetation and areas impacted by invasive species.

Table 5: Images taken of the landscape during the site assessment.

No	Photo	Information
1		The majority of the assessment area was densely covered by predominantly black wattles (*Acacia mearnsii*). There are areas inbetween where some fynbos species / stands persist (E.g., *Erica quadrangularis* and *Stoebe alopecuroides*).
2		
2	Black wattles surrounding a wetland, with some fynbos persisting under the wattles. This wetland was split by the dirt road running through it.	
3		An old grassy path in a dense black wattle invasion. This area was more invaded than the rest of the surrounding area.
4	 	
4	A recent fire burned a large patch of Eucalyptus that was growing on the edge of fynbos patches on the site. Bracken ferns are the dominant species that is returning under the wattles. Very few fynbos species are returning to this area, and many of the gum trees are coppicing and surviving post-fire.	

5	
5	One of the large seep wetlands on the site. The vegetation here was transformed and does not represent natural fynbos. Black wattle invasions are visible in the background.
6	
6	An example of a grassy field with some invasions by fishbone ferns (*Nephrolepis cordifolia*) visible. Some fynbos elements were present in some places, but this was highly depauperate, where depauperate means that the remaining fynbos species found were sparsely located, not abundant or dominant, and species poor.
7	 Fynbos visible with a light invasion by black wattles. This fynbos can be classified as Garden Route Granite Fynbos and is likely able to recover if appropriate landscape and fire management is in place.
8	
8	A photo of the wetland in the north-east of the property, with fynbos visible in the background. In the foreground the grassy edge of the road is visible.
9	 The wetland *Cliffortia odorata* visible as the dominant species in the foreground. In the background of the photo more terrestrial senescent fynbos vegetation is visible.

10	 	
10	A large wetland area in the middle of a large remnant patch o fynbos. Black wattles are visible in the far background of each photo.	
11		Bracken ferns (*Pteridium aquilinum*) taking over adjacent to the wetland area in the images just above. Bracken ferns are opportunistic and aggressive colonizers in the fynbos biome, particularly in disturbed or stressed environments and can destabilize fynbos. Bracken ferns often invade where soil and vegetation have been disturbed after agricultural activities, overgrazing, or fire mismanagement.
12		A large stand of the vulnerable (VU) *Erica glandulosa fourcadei* was found on the site. The location of this stand corresponds with the number 12 in Fig. 10.
13		The fynbos surrounding the *Erica glandulosa fourcadei* patch was senescent, and in some places rapidly transitioned to bracken ferns (visible behind the fynbos in the foreground)
14		While fynbos is adapted to fire, the timing, frequency, and intensity of fires are critical. Too frequent or poorly timed fires can reduce seed banks of fynbos species and create conditions favourable to bracken ferns (*Pteridium aquilinum*). Bracken ferns regenerate rapidly after fires from their resilient rhizomes, often dominating before fynbos species can recover.

15	
15	The landscape on the site where a recent fire took place. Few fynbos species are seen returning in the post-fire environment, and large areas are being colonised almost exclusively by bracken ferns.
16	
16	A large patch of remnant secondary fynbos that is relatively species rich compared to other areas on the site. Minimal invasion is also visible in this image. This fynbos patch is clearly visible from satellite imagery too.
17	
17	The degraded and bracken fern dominated landscape beyond the fynbos patch. Transitions between relatively in-tact fynbos and this degraded landscape was relatively abrupt.
18	
18	A large and species diverse wetland observed. During the rime of the assessment, the water level on the wetland was relatively high, as seen in the inset image. Wetland species composition differs from that of the surrounding fynbos, and is generally dominated by species such as *Juncus effusus* and members of the Cyperaceae family.

19	
19	Senescent fynbos in the foreground with an established black wattle invasion visible left of the road in the image.
20	
20	Another large section of the landscape where secondary fynbos was observed. This area was ca. 4 ha in size and represented the second smallest patch of largely uninvaded fynbos still persisting within the proposed development area. Members of the Proteaceae were largely lacking, with only a few isolated Leucadendrons observed.
21	
21	Four images of a wetland (top left) and the black wattle (*Acacia mearnsii*) invaded fynbos surrounding the wetland. Fynbos between the wattle stands were senescent, and proper planning would be required in order to preserve this fynbos due to the long-term landscape level changes that have placed severe stress on the fynbos ecosystem here.
22	
22	A small dam opposite the road which is part of the wetland mentioned above. Black wattle invasion is visible behind the dam.

23		Another small wetland that was observed south of the quarry. Again, an established black wattle invasion is visible in the background beyond the wetland
24		An example of the erosion that can occur along slopes where black wattles have formed a monoculture and where no fynbos species persist in the understorey any longer.
25		
25	A photo from taken in the crown of a black wattle tree overlooking the slopes leading to the Meulrivier to the south. All of the slopes observed from this vantage point were densely invaded by wattles.	
26		
26	These images were all taken within stands of black wattles in the easternmost section of the site. Some fynbos persisted in some places in the understorey or where there were small clearings, however the majority of the area here were black wattles that formed monocultures and have displaced all / nearly all of the fynbos that once grew there.	

27		
27	There were two patches in the landscape in the eastern section of the site where a relatively abrupt shift from wattle monoculture (right image) to senescent fynbos (left image) was visible.	
28		An old path in the site with dense wattle invasion and some patches of remaining fynbos in between. This path led to the only remaining relatively in-tact fynbos patch in the eastern section of the site.
29		
29	The remaining fynbos patch contained a lot of *Tetraria robusta* (clearly visible in the foreground of the left image). *Tetraria robusta* often thrives in disturbed areas, such as after fire events or in cleared sites. If the area has been subject to alien clearing or other management interventions, *Tetraria robusta* may establish and proliferate quickly due to reduced competition from invasive species. In some fynbos ecosystems, *Tetraria robusta* acts as a pioneer species, dominating early successional stages before being replaced by a more diverse plant community over time. Here, a high diversity of fynbos species were observed, and therefore the fynbos does seem to be recovering with the *Tetraria* acting as a pioneer species.	
30		The end of the fynbos patch, where the landscape again became increasingly invaded with wattles and *Pinus pinaster*.

5.2 Plant Species

A species accumulation curve for the site assessment is in Fig. 11 below. By the end of the assessment, which lasted almost nine hours, the species accumulation curve was still increasing, and the increase is mostly caused by the discovery of additional fynbos taxa, and not invasive or exotic species. The species list will grow with more survey effort.

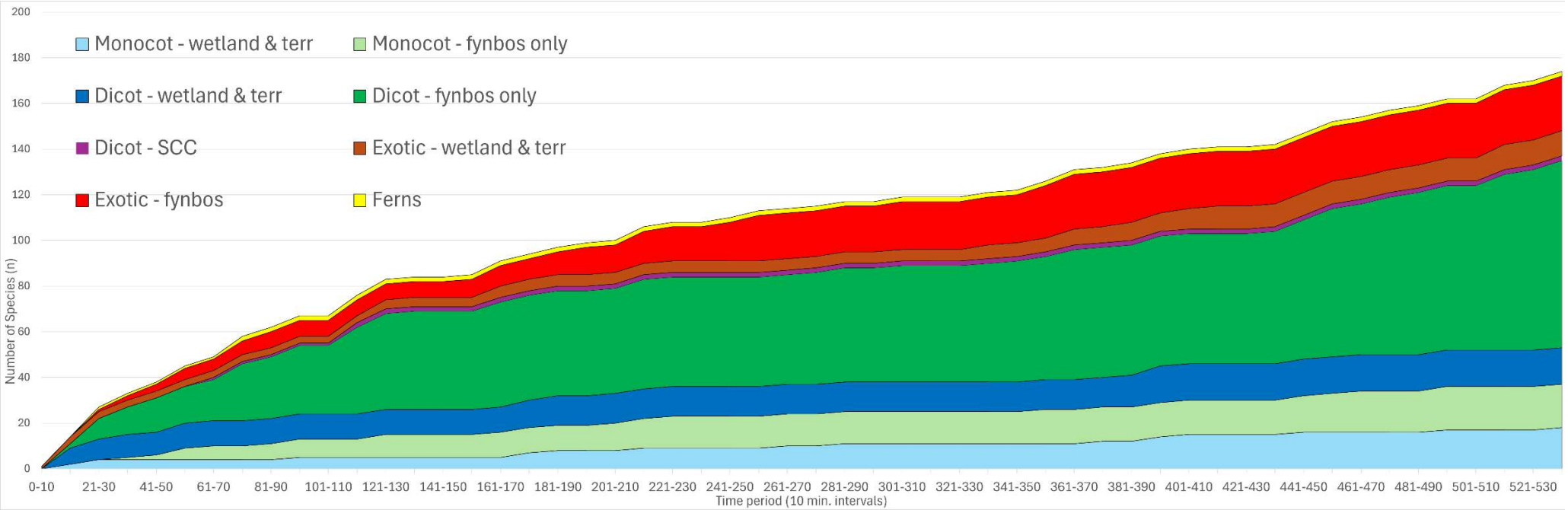

Figure 11: Species accumulation curve for the site assessment on the 7th and 13th of November 2024.

The NEMBA (National Environmental Management: Biodiversity Act, Act No. 10 of 2004) and CARA (Conservation of Agricultural Resources Act, Act No. 43 of 1983) categories for the listed invasive species observed are listed in the species list in Table 6. In short, NEMBA categorizes invasive species into four groups (Rooikrans is in category 1b):

- Category 1a: Species that must be eradicated and prevented from being introduced or spread.
- Category 1b: Species that must be controlled to prevent further spread and impact.
- Category 2: Species that can be grown only in specific, controlled conditions, with a focus on prevention of escape.
- Category 3: Species that are already widely spread but must not be introduced or propagated further.

CARA focuses on controlling invasive plants that affect agricultural resources, categorizing them into (here Rooikrans is category 2):

- Category 1: Species that must be eradicated from land.
- Category 2: Species that must be controlled to prevent spread, with restrictions on planting.
- Category 3: Species that must be managed to avoid negative impacts on land use, with restrictions on their spread.

In addition to the invasive alien species observed, a large stand of vulnerable *Erica glandulosa fourcadei* was confirmed south of the N2 in recovering fynbos vegetation, and a potential new species of *Drosera* was observed (Fig. 12). The species list for the site assessment is presented in Table 6.



Figure 12: The SCC observed during the site assessment. The new *Drosera* does not yet have a Red List status as this species had not yet been evaluated.

Table 6: Species list for the site assessments conducted. Blue entries were found in wetlands, and blue-green in wetlands and fynbos. Exotic species are colour coded in three colours, where orange entries were found in fynbos, red were found in fynbos and wetlands, and pink were found in wetlands. The one green entry indicates the SCC found.

Family	Species	Common name	Information
Liliopsida (Monocots)			
ARACEAE	*Zantedeschia aethiopica*	calla lily	Wetland
ASPARAGACEAE	*Agave sisalana*	sisal	Fynbos. Invasive - NEMBA 2; CARA 2
ASPARAGACEAE	*Asparagus rubicundus*	Redstem Asparagus	Fynbos
CYPERACEAE	*Carex aethiopica*		Fynbos & Wetland
CYPERACEAE	*Carex capensis*	Cape Sedge	Fynbos & Wetland
CYPERACEAE	*Carpha capitellata*		Wetland
CYPERACEAE	*cf. Schoenus sp.*	Sedges	Fynbos & Wetland
CYPERACEAE	*Cyperus usitatus*	Indian Grass	Fynbos. Naturalised exotic
CYPERACEAE	*Eleocharis limosa*	Figner rush	Wetland
CYPERACEAE	*Ficinia cf. lateralis*	Star Grasses	Wetland
CYPERACEAE	*Ficinia fascicularis*	Sedges	Fynbos & Wetland
CYPERACEAE	*Fuirena hirsuta*	Hairy Hippo-Sedge	Fynbos & Wetland
CYPERACEAE	*Isolepis ludwigii*	Sedges	Fynbos & Wetland
CYPERACEAE	*Isolepis sp*	Sedges	Wetland
CYPERACEAE	*Schoenus sp.*	Bogrushes	Fynbos & Wetland
CYPERACEAE	*Tetraria robusta*	Massive Tetrar	Fynbos
HYPOXIDACEAE	*Hypoxis hemerocallidea*	African Stargrass	Fynbos
IRIDACEAE	*Aristea ecklonii*	Blue corn-lily	Fynbos & Wetland
IRIDACEAE	*Aristea pusilla*		Fynbos
IRIDACEAE	*Bobartia aphylla*	Garden Route Rushiris	Fynbos
IRIDACEAE	*Gladiolus liliaceus*	Large Brown-Afrikaner	Fynbos
IRIDACEAE	*Romulea flava*	Greenbract Froetang	Fynbos
IRIDACEAE	*Sisyrinchium micranthum*	Blue Pigroot	Fynbos. Naturalised exotic
JUNCACEAE	*Juncus capensis*	Cape Rush	Wetland
JUNCACEAE	*Juncus effusus*	Soft Rush	Wetland
JUNCACEAE	*Juncus oxycarpus*	Lax Rush	Wetland
JUNCACEAE	*Juncus sp. 1*	Rushes	Wetland
JUNCACEAE	*Juncus sp. 2*	Rushes	Wetland
ORCHIDACEAE	*Disa bracteata*	Bract Disa	Fynbos & Wetland
POACEAE	*Briza minor*	Little quaking-grass	Fynbos. Naturalised exotic
POACEAE	*Cortaderia selloana*	Pampas Grass	Fynbos & Wetland. Invasive - NEMBA 1b; CARA 1
POACEAE	*Cynodon dactylon*	Bermuda grass	Fynbos
POACEAE	*Eragrostis capensis*	Cape Love Grass	Fynbos
POACEAE	*Eragrostis curvula*	African love grass	Fynbos
POACEAE	*Hyparrhenia hirta*	thatching grass	Fynbos
POACEAE	*Paspalum urvillei*	Vasey Grass	Fynbos & Wetland. Naturalised exotic
POACEAE	*Pentameris pallida*	Pale Fiveawn	Fynbos
POACEAE	*Phalaris sp.*	Canarygrasses	Fynbos. Naturalised exotic
POACEAE	*Phragmites australis*	common reed	Wetland. Naturalised exotic

Family	Species	Common name	Information
POACEAE	*Setaria sp.*	foxtails and bristlegrasses	Fynbos. Naturalised exotic
POACEAE	*Stenotaphrum secundatum*	Saint Augustine grass	Fynbos
POACEAE	*Themeda triandra*	Kangaroo Grass	Fynbos
RESTIONACEAE	*Restio sp. 1*	Restios	Fynbos
RESTIONACEAE	*Restio sp. 2*	Restios	Fynbos
RESTIONACEAE	*Restio triticeus*	Wheat Capereed	Fynbos
RESTIONACEAE	*Thamnochortus insignis*	True Thatchreed	Fynbos
TECOPHILAEACEAE	*Cyanella lutea*	Yellow Ladieshand	Fynbos
Magnoliopsida (Dicots)			
ANACARDIACEAE	*Laurophyllus capensis*	Iron Martin	Fynbos
ANACARDIACEAE	*Searsia chirindensis*	Red Currant-rhus	Fynbos
ANACARDIACEAE	*Searsia lucida*	Glossy Currantrhus	Fynbos
ANACARDIACEAE	*Searsia rehmanniana*	Bluntleaf Currantrhus	Fynbos
APIACEAE	*Centella asiatica*	Gotu Cola	Fynbos & Wetland. Naturalised exotic
APIACEAE	*Centella macrocarpa*	Largeseed Capepurse	Fynbos & Wetland. Naturalised exotic
APOCYNACEAE	*Gomphocarpus physocarpus*	balloonplant	Fynbos
ASTERACEAE	*Achyranthemum paniculatum*	Sewejaartjie Chafflower	Fynbos
ASTERACEAE	*Arctotheca prostrata*	Prostrate Capeweed	Fynbos
ASTERACEAE	*Athanasia dentata*	Tooth Kanniedood	Fynbos
ASTERACEAE	*Athanasia trifurcata*	Three-tooth Kanniedood	Fynbos
ASTERACEAE	*Berkheya armata*	Giant Capethistle	Fynbos
ASTERACEAE	*Cirsium vulgare*	Bull Thistle	Fynbos. Invasive - NEMBA 1b; CARA 1
ASTERACEAE	*Delairea odorata*	Cape-ivy	Fynbos
ASTERACEAE	*Gerbera piloselloides*	Blacktea Gerbera	Fynbos
ASTERACEAE	*Helichrysum anomalum*	Fimbril Everlasting	Fynbos
ASTERACEAE	*Helichrysum cymosum*	Fume Everlasting	Fynbos & Wetland
ASTERACEAE	*Helichrysum felinum*	Strawberry Everlasting	Fynbos
ASTERACEAE	*Helichrysum foetidum*	Stinking Everlasting	Fynbos & Wetland
ASTERACEAE	*Helichrysum odoratissimum*	Kooigoed Everlasting	Fynbos
ASTERACEAE	*Helichrysum petiolare*	Licorice plant	Fynbos & Wetland
ASTERACEAE	*Helichrysum teretifolium*	Needle Everlasting	Fynbos
ASTERACEAE	*Metalasia acuta*	Pointy Blombush	Fynbos
ASTERACEAE	*Metalasia densa*	Fynbos Blombush	Fynbos
ASTERACEAE	*Metalasia trivialis*	Eastern Blombush	Fynbos
ASTERACEAE	*Nidorella ivifolia*	Ivy Vleiweed	Fynbos & Wetland
ASTERACEAE	*Oedera calycina*		Fynbos
ASTERACEAE	*Osteospermum moniliferum*	Bietou	Fynbos
ASTERACEAE	*Plecostachys serpyllifolia*	petite-licorice	Fynbos & Wetland
ASTERACEAE	*Senecio glastifolius*	Woad-leaved ragwort	Fynbos

Family	Species	Common name	Information
ASTERACEAE	*Senecio ilicifolius*	Kowanna Ragwort	Fynbos
ASTERACEAE	*Senecio purpureus*	Purple Ragwort	Fynbos
ASTERACEAE	*Seriphium cinereum*	Karoo Snakebush	Fynbos
ASTERACEAE	*Seriphium plumosum*	Bankrupt Bush	Fynbos
ASTERACEAE	*Stoebe alopecuroides*	Foxy Slangbos	Fynbos
ASTERACEAE	*Tarchonanthus littoralis*	Coastal Camphorbush	Fynbos
ASTERACEAE	*Ursinia discolor*		Fynbos
ASTERACEAE	*Ursinia heterodonta*	Twotooth Paraseed	Fynbos
BRASSICACEAE	*Heliophila subulata subulata*	Sunsorrels	Fynbos
CAMPANULACEAE	*cf. Lobelia sp.*	Twobract Lobelias	Fynbos
CAMPANULACEAE	*Lobelia erinus*	Garden Lobelia	Fynbos
CAMPANULACEAE	*Lobelia neglecta*	Rough Lobelia	Fynbos
CAMPANULACEAE	*Monopsis unidentata unidentata*		Fynbos & Wetland
CAMPANULACEAE	*Wimmerella arabidea*	Common Softbell	Wetland
CELASTRACEAE	*Gymnosporia buxifolia*	Common spikethorn	Fynbos
CELASTRACEAE	*Pterocelastrus tricuspidatus*	Candlewood	Fynbos
CELASTRACEAE	*Putterlickia pyracantha*	Bastard Spikethorn	Fynbos
CONVOLVULACEAE	*Dichondra micrantha*	Asian ponysfoot	Fynbos & Wetland. Naturalised exotic
DROSERACEAE	*Drosera sp. nov. "cryptica"*	Alice Sundew	Fynbos & Wetland. SCC – new species with an unevaluated Red List status
EBENACEAE	*Diospyros dichrophylla*	Poison Starapple	Fynbos
ERICACEAE	*Erica canaliculata*	Hairy Grey Heather	Fynbos
ERICACEAE	*Erica discolor*	Discolorous Heath	Fynbos
ERICACEAE	*Erica formosa*	Stunning Heath	Fynbos
ERICACEAE	*Erica gibbosa*	Heaths	Fynbos
ERICACEAE	*Erica glandulosa fourcadei*	Ridged Glandular Heath	Fynbos. SCC - Vulnerable B1ab(ii,iii,iv,v)
ERICACEAE	*Erica gracilis*	Graceful Heath	Fynbos
ERICACEAE	*Erica peltata*	Shield Heath	Fynbos
ERICACEAE	*Erica quadrangularis*	Smoke Heath	Fynbos
ERICACEAE	*Erica scabriuscula*	Grit Heath	Fynbos
ERICACEAE	*Erica sessiliflora*	Bottle Green Heath	Fynbos
ERICACEAE	*Erica sparsa*	Spartan Heath	Fynbos
EUPHORBIACEAE	*Acalypha rhomboidea*	common copperleaf	Fynbos. Naturalised exotic
FABACEAE	*Acacia cyclops*	western coastal wattle	Fynbos & Wetland. Invasive - NEMBA 1b; CARA 2
FABACEAE	*Acacia elata*	Cedar Wattle / Pepper tree wattle	Fynbos & Wetland. Invasive - NEMBA 1b; CARA 3
FABACEAE	*Acacia mearnsii*	black wattle	Fynbos & Wetland. Invasive - NEMBA 2; CARA 2
FABACEAE	*Acacia melanoxylon*	blackwood	Fynbos & Wetland. Invasive - NEMBA 2; CARA 2
FABACEAE	*Podalyria myrtillifolia*	Myrtle Capesweetpea	Fynbos
FABACEAE	*Psoralea acuminata*	Longsepal Dottypea	Fynbos

Family	Species	Common name	Information
FABACEAE	*Psoralea asarina*	Spearleaf Fountainbush	Fynbos & Wetland
FABACEAE	*Trifolium repens*	white clover	Fynbos. Naturalised exotic
FABACEAE	*Vicia sativa*	Common Vetch	Fynbos
GENTIANACEAE	*Sebaea aurea*	Golden Yellowwort	Fynbos
GERANIACEAE	*Geranium ornithopodon*		Fynbos & Wetland
GERANIACEAE	*Pelargonium cordifolium*	Heartleaf Storksbill	Fynbos
HALORAGACEAE	*Laurembergia repens*	Redmats	Wetland
LAMIACEAE	*Coleus barbatus*	Woolly Plectranthus	Fynbos. Naturalised exotic
LAMIACEAE	*Stachys aethiopica*	African Stachys	Fynbos
LAURACEAE	*Cassytha ciliolata*	devil's tresses	Fynbos
LINDERNIACEAE	*Lindernia parviflora*	Small-flower False Pimpernel	Wetland
MALVACEAE	*Hermannia angularis*	Angular Dollsrose	Fynbos
MALVACEAE	*Hibiscus aethiopicus*	Cape Hibiscus	Fynbos
MALVACEAE	*Unidentified sp.*	Mallow and Hibiscus Family	Fynbos
MELIACEAE	*Melia azedarach*	Chinaberry	Fynbos. Invasive - NEMBA 1b, and 3 in urban areas; CARA 3
MENYANTHACEAE	*Nymphoides thunbergiana*	Yellow Pondlily	Wetland
MYRICACEAE	*Morella serrata*	Water Waxberry	Fynbos & Wetland
MYRTACEAE	*Eucalyptus cf. cladocalyx*	Sugar gum	Fynbos & Wetland. Invasive - NEMBA 1b in riparian areas, Pas, Listed Ecosystems. Category 2 in plantations, woodlots, bee-forage areas, wind-rows, & avenues. Notlisted in cultivated land at least 50m away from untransformed land; CARA 2
MYRTACEAE	*Melaleuca linearis linearis*	Pine bottlebrush	Fynbos. Invasive - Species not explicitly named on NEMBA or CARA, but M. hypericifolia is NEMBA 1a & M. quinquenervia is NEMBA 1b.
NYMPHAEACEAE	*Nymphaea nouchali*	Day Waterlily	Wetland. Naturalised exotic
OXALIDACEAE	*Oxalis punctata*	Dotted Sorrel	Fynbos
PENAEACEAE	*Penaea cneorum*	Common Brickleaf	Fynbos
PERACEAE	*Clutia affinis*		Fynbos
PHYTOLACCACEAE	*Phytolacca octandra*	Inkweed	Fynbos. NEMBA 1b; not on CARA
POLYGALACEAE	*Polygala fruticosa*	Heartleaf Falsepea	Fynbos
PRIMULACEAE	*Lysimachia arvensis*	scarlet pimpernel	Fynbos. Naturalised exotic
PRIMULACEAE	*Lysimachia loeflingii*	Pimpernels	Fynbos. Naturalised exotic
PRIMULACEAE	*Rapanea melanophloeos*	Cape beech	Fynbos
PROTEACEAE	*Hakea sericea*	Bushy needlebush	Fynbos. Invasive - NEMBA 1b; CARA 1

Family	Species	Common name	Information
PROTEACEAE	*Leucadendron eucalyptifolium*	Gumleaf Conebush	Fynbos
PROTEACEAE	*Leucadendron salignum*	Sunshine Conebush	Fynbos
RHAMNACEAE	*Phylica purpurea*	Purple Hardleaf	Fynbos
ROSACEAE	*Agrimonia bracteata*	Agrimonie	Fynbos. Naturalised exotic
ROSACEAE	*Cliffortia filicaulis*	Finestem Caperose	Fynbos
ROSACEAE	*Cliffortia linearifolia*	Stream Caperose	Wetland
ROSACEAE	*Cliffortia odorata*	No-odour Caperose	Wetland
ROSACEAE	*Rubus pinnatus*	South African Raspberry	Fynbos
ROSACEAE	*Rubus rigidus*	White Bramble	Fynbos. Can become invasive, although not listed on NEMBA or CARA lists.
RUBIACEAE	*Anthospermum aethiopicum*	Tall Flowerseed	Fynbos
RUBIACEAE	*Anthospermum galioides*	Common Flowerseed	Fynbos
RUBIACEAE	*Burchellia bubalina*	Wild Pomegranate	Fynbos
RUTACEAE	*Agathosma ovata*	False Buchu	Fynbos
SANTALACEAE	*Colpoon compressum*	Cape Sumach	Fynbos
SCROPHULARIACEAE	*Nemesia floribunda*	Common Lionface	Wetland
SCROPHULARIACEAE	*Selago corymbosa*	Stiff Bitterbush	Fynbos
SCROPHULARIACEAE	*Selago dolosa*	Ball Bitterbush	Fynbos
SCROPHULARIACEAE	*Selago glomerata*	Eden Bitterbush	Fynbos
SOLANACEAE	*Brugmansia arborea*	Angel's Trumpet	Fynbos. Naturalised exotic
SOLANACEAE	*Solanum mauritianum*	bugweed	Fynbos. Invasive - NEMBA 1b; CARA 1
STILBACEAE	*Halleria lucida*	African honeysuckle	Fynbos
STILBACEAE	*Nuxia floribunda*	Forest Elder	Fynbos
THYMELAEACEAE	*Gnidia juniperifolia*	Yellow Capesaffron	Fynbos
THYMELAEACEAE	*Gnidia nodiflora*	Scruffy Capesaffron	Fynbos
THYMELAEACEAE	*Passerina falcifolia*	Weeping Gonna	Fynbos
THYMELAEACEAE	*Struthiola hirsuta*	Shaggy Capespray	Fynbos
VERBENACEAE	*Lantana camara*	common lantana	Fynbos. Invasive - NEMBA 1b; CARA 1
VERBENACEAE	*Verbena bonariensis*	purpletop vervain	Fynbos. Invasive - NEMBA 1b; not on CARA
Pinopsida (Conifers)			
PINACEAE	*Pinus pinaster*	maritime pine	Fynbos. NEMBA 1b, category 2 in wond-rows and plantations, and national heritage trees are not listed. CARA 2
Polypodiopsida (Ferns)			
DENNSTAEDTIACEAE	*Pteridium aquilinum capense*	Southern Bracken	Fynbos & Wetland

Family	Species	Common name	Information
NEPHROLEPIDACEAE	*Nephrolepis cordifolia*	Fishbone Fern	Fynbos. NEMBA 1b; N. exaltata is categpry 3 on CARA.
PTERIDACEAE	*Cheilanthes viridis*	Green Cliff Brake	Fynbos

5.3 Additional SCC that may be Found

All SCC that may be present on the site have been identified using the screening tool report for the site, iNaturalist nearby observations, and the POSA database (Table 7). The likelihood of occurrence for each SCC identified in this report was assessed to ensure that conservation efforts towards conserving SCC follows the precautionary principle. By assessing SCC likelihood of occurrence, the knowledge gained from the field assessment, as well as historical nearby records are integrated to show which species are most at risk due to the proposed development.

Table 7: Plant SCC probability of occurrence on the five portions included in this assessment.

Species	Common name	Family	SANBI red list status	Likelihood (Remnant fynbos and invaded fynbos)	Likelihood (Transformed areas or monoculture invasions)
Drosera sp. nov. "cryptica"	New sundew species	DROSERACEAE	Undetermined	**Confirmed** This species was observed during the site assessment	**Low** Unlikely to occur in transformed and densely invaded areas
Erica glandulosa subsp. fourcadei	Ridges glandular heath	ERICACEAE	Vulnerable B1ab(ii,iii,iv,v)	**Confirmed** This species was observed during the site assessment	**Medium** Following the precautionary principle, it is conceivable that this species might be present
Leucospermum glabrum	Outeniqua pincushion	PROTEACEAE	Endangered B1ab(iii,v)c(iv) +2ab(iii,v)c(iv); C2a(i)	**Very High** This species is confirmed in the fynbos by the screening tool, despite not being found during the survey.	**Low** Unlikely to occur in transformed and densely invaded areas
Bartholina etheliae	Club spider orchid	ORCHIDACEAE	Global IUCN: Vulnerable D2; SANBI regional listing: LC	**High** This species could be present in the fynbos habitat.	**Very Low** Not present in transformed areas
Leucospermum praecox	Mossel Bay pincushion	PROTEACEAE	Vulnerable A2c+3c+4c	**High** This species could be present in the fynbos habitat.	**Very Low** Not present in transformed areas
Sensitive species 1024	-	ORCHIDACEAE	Endangered B1ab(iii,v)+2a b(iii,v); C2a(ii)	**Medium** Following the precautionary principle, it is conceivable that this species might be present	**Low** Unlikely to occur in transformed and densely invaded areas
Sensitive species 1032	-	ORCHIDACEAE	Vulnerable C2a(i)	**Medium**	**Low**

Species	Common name	Family	SANBI red list status	Likelihood (Remnant fynbos and invaded fynbos)	Likelihood (Transformed areas or monoculture invasions)
				Following the precautionary principle, it is conceivable that this species might be present	Unlikely to occur in transformed and densely invaded areas
Lampranthus pauciflorus	Beach brightfig	AIZOACEAE	Endangered B1ab(ii,iii,iv,v)	**Medium** Following the precautionary principle, it is conceivable that this species might be present in the fynbos	**Low** Unlikely to occur in transformed and densely invaded areas
Ruschia duthiae	Tentfig species	AIZOACEAE	Vulnerable B1ab(ii,iii,iv,v) +2ab(ii,iii,iv,v)	**Medium** Following the precautionary principle, it is conceivable that this species might be present.	**Low** Unlikely to occur in transformed and densely invaded areas
Sensitive species 800	-	IRIDACEAE	Vulnerable B1ab(iii)	**Low** This species is unlikely to be present following all the past disturbances on the site.	**Very Low** Not present in transformed areas
Hermannia lavandulifolia	Lavender dollsrose	MALVACEAE	Vulnerable A2c	**Low** If this species was present the likelihood of detection is high. Because it was not found, it is probably not on this site.	**Low** If this species was present the likelihood of detection is high. Because it was not found, it is probably not on this site.
Sensitive species 500	-	ORCHIDACEAE	Endangered C2a(i)	**Low** Habitat not right and species unlikely to occur due to current & past disturbance.	**Very Low** Not present in transformed areas
Sensitive species 763	-	ORCHIDACEAE	Endangered C2a(i)	**Low** Habitat not right and species unlikely to occur due to current & past disturbance.	**Very Low** Not present in transformed areas
Euchaetis albertiniana	Albertina beard-buchu	RUTACEAE	Endangered A2c	**Low** Distribution not quite right.	**Very Low** Not present in transformed areas
Diosma passerinoides	Silcrete bitterbuchu	RUTACEAE	Vulnerable A2c; C2a(i)	**Very Low** Incorrect habitat	**Very Low** Not present in transformed areas

6. SITE SENSITIVITY VERIFICATION

6.1 Terrestrial Biodiversity

The original terrestrial biodiversity sensitivity of the site is based on several biodiversity priority areas (BPAs). Following the assessment of the site presented in this report, the terrestrial biodiversity sensitivity of the site is complex, where some sections of the site have a **Very High** sensitivity (such as the returning fynbos), while other degraded transformed areas have a **Low** sensitivity. This is expanded upon in the site ecological importance (SEI) section of this report. The following conclusions are made regarding the BPA triggers of the screening tool (Table 8).

Table 8: Sources of BPA data for the Terrestrial Biodiversity Theme sensitivity (Stewart et al., 2021).

Sensitivity layer	Data included and source
Red Listed Ecosystems	Garden Route Granite Fynbos is present in recovering patches within the assessment area. Some forest and thicket elements (CR Groot Brak Dune Strandveld) were observed in the valleys, however a proper survey of these have not yet been undertaken and no development will occur in valleys.
Critical Biodiversity Areas	Mapped are CBA 1 and CBA 2 areas for forests and terrestrial biodiversity are confirmed along the drainage lines and valleys.
Ecological Support Areas	Mapped are ESA 1 areas as well as ESA 2 areas for “Restore from other land use” and also “Restore from plantation or high-density IAP” are accurate on the site.
Strategic Water Source Areas for surface water	Mapped is the Outeniqua SWSA-sw. Currently the invasive wattles, *Eucalyptus*, pines, and pampass grass are all affecting the water in the assessment area
Protected Areas (PAs)	Mapped within the proposed development footprint are the 1) George Private Nature Reserve, and 2) Blydskap Private Nature Reserve. The Protected Area Portion 48/195 must also include an urgent plan for the clearing of invasive wattles.
SAN Parks Buffer Areas	Mapped is the Garden Route National Park 10km wide buffer could potentially link to the assessment area, but invasives and long-term detrimental land management practices means that this would not be the most functional connection.
Priority Areas for Protected Areas Expansion	Areas identified in the National Protected Area Expansion Strategy (NPAES) are included on the site. Priority should be given to improve the management of the existing PA on Portion 48/195 before more PAs are considered that might be equally neglected from an ecological point of view

6.2 Botanical diversity

Similar to the terrestrial biodiversity sensitivity, the fynbos vegetation has a **High** sensitivity, while the vegetation in transformed fields and densely invaded wattle monocultures are unlikely to support SCC and therefore has a **Low** sensitivity. Again, refer to the SEI for a more refined analysis of the sensitivity of the site.

7. SITE ECOLOGICAL IMPORTANCE

The site ecological importance (SEI) assessment is a function of biodiversity importance (BI) and receptor resilience (RR), which is defined as:

> *"The intrinsic capacity of the receptor (i.e., habitat type in question) to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention."*

The function is as follows: SEI = BI + RR. BI is a function of conservation importance (CI) and habitat functional integrity (FI), so that BI = CI + FI. The definition of CI given by the Species Environmental Assessment Guideline of 2022 is:

> *"The importance of a site for supporting biodiversity features of conservation concern present, e.g., populations of IUCN threatened and Near Threatened species (CR, EN, VU and NT), Rare species, range-restricted species, globally significant populations of congregatory species, and areas of threatened ecosystem types, through predominantly natural processes."*

Most features included in CI are provided by the screening tool but needs to be evaluated at a finer scale from the field work assessment. FI is defined as:

> *"A measure of the ecological condition of the impact receptor as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts."*

The criteria for defining RR, CI and FI are provided in the Species Environmental Assessment Guidelines of 2022. BI can be derived from a simple matrix of CI and FI, as illustrated in Table 9 below.

Table 9: The matrix that defines the biodiversity importance (BI) of a given habitat type, as identified from a desktop and field assessment.

Biodiversity Importance		**Conservation Importance**				
		Very High	High	Medium	Low	Very Low
Functional Integrity	Very High	Very High	Very High	High	Medium	Low
	High	Very High	High	Medium	Medium	Low
	Medium	High	Medium	Medium	Low	Very Low
	Low	Medium	Medium	Low	Low	Very Low
	Very Low	Medium	Low	Very Low	Very Low	Very Low

SEI can then be derived from a second matrix, as depicted in Table 10. SEI is specific to the proposed development and can therefore only be compared between alternative layouts for the same proposed development, but not between developments.

Table 10: The matrix that defines the site ecological importance (SEI) of a given habitat type, as identified from a desktop and field assessment.

Site Ecological Importance		**Biodiversity Importance**				
		Very High	High	Medium	Low	Very Low
Receptor Resilience	Very High	Very High	Very High	High	Medium	Low
	High	Very High	Very High	High	Medium	Very Low
	Medium	Very High	High	Medium	Low	Very Low
	Low	High	Medium	Low	Very Low	Very Low
	Very Low	Medium	Low	Very Low	Very Low	Very Low

The overall SEI score is intended to provide a more refined overview of the sensitivity of the various habitats that have been identified on the site. The benchmark for "fully natural" vegetation is defined according to the Vegetation Assets, States, and Transitions (VAST)

framework, which considers natural vegetation to be the state pre-European conditions (i.e., period prior to the 1700s or 1600s). The habitats and ecosystems of the property are therefore defined according to the VAST framework, which acts as an aid for the SEI calculation, especially in determining the appropriate RR to assign. The VAST framework categories are summarised in Appendix 10.2, and is an aid for the SEI calculation as it helps to (Thackway & Lesslie, 2006):

- Describe and accounts for changes in the condition and status of vegetation.
- Make explicit links between land management (current) and vegetation modification.
- Provide a mechanism for describing the consequences of certain land management on vegetation.
- Contribute to the analysis of terrestrial ecosystem services that are provided by vegetation, including comparison between various land-use

The SEI map only includes the five portions that were assessed in this report (Fig. 13), as the areas where additional infrastructure upgrades will be required is not yet known. Table 11 below describes the recommended mitigation for each SEI category based on the Species Environmental Guidelines (Verburgt et al., 2020).

Table 11: The mitigation guidelines for interpreting the various SEI categories for the proposed development activities (Verburgt et al., 2020).

Site Ecological Importance	Recommendation for activities based on the mitigation hierarchy
Very High	Avoidance mitigation – no destructive development activities should be considered. Offset mitigation not acceptable/not possible (i.e. last remaining populations of species, last remaining good condition patches of ecosystems/unique species assemblages). Destructive impacts for species/ecosystems where persistence target remains.
High	Avoidance mitigation wherever possible. Minimisation mitigation – changes to project infrastructure design to limit the amount of habitat impacted; limited development activities of low impact acceptable. Offset mitigation may be required for high impact activities.
Medium	Minimisation and restoration mitigation – development activities of medium impact acceptable followed by appropriate restoration activities.
Low	Minimisation and restoration mitigation – development activities of medium to high impact acceptable followed by appropriate restoration activities.
Very Low	Minimisation mitigation – development activities of medium to high impact acceptable and restoration activities may not be required.

The vegetation observed on the site was classified into the classes presented in Fig. 13. The SEI map presented in Fig. 13 above is only applicable to the Botanical and Terrestrial Biodiversity protocol themes. Other specialists will also produce their own SEI maps, and the combined map from all the specialist disciplines must be used to guide the planning of the proposed developments. The combined map will follow the precautionary principle by assigning the highest SEI assessed to a polygon when all the specialist SEI maps are combined.

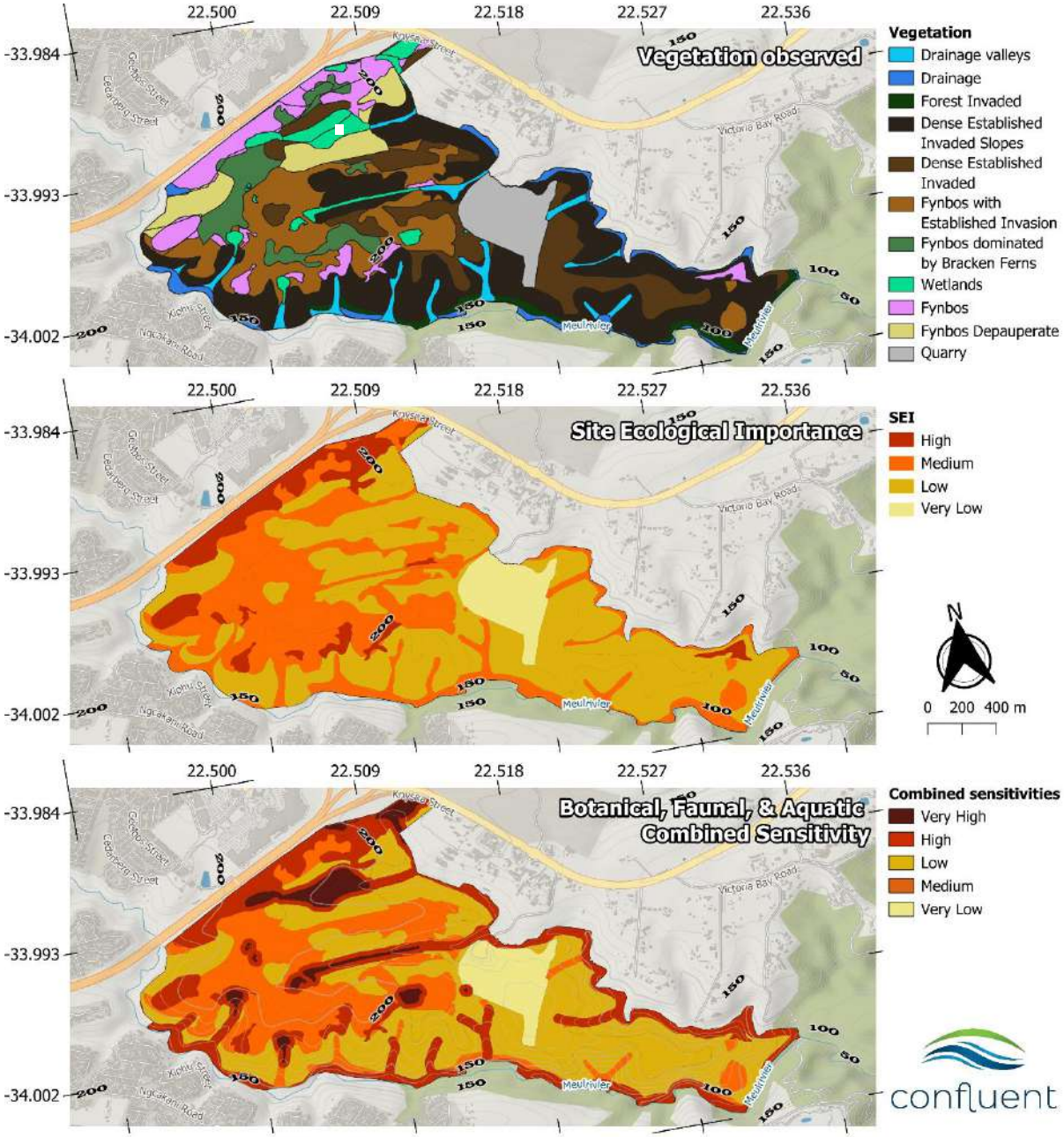

Figure 13: The vegetation, SEI, and combined sensitivity maps.

The vegetation classes were then assessed suing the SEI methodology in order to generate the final SEI map. The SEI evaluation is presented in Table 12. Note that the site ecological importance (SEI) was difficult to calculate in this instance. The past land use of this site was as a plantation, with secondary fynbos returning to the site following the removal of the plantation and fires that have occurred since. The current SEI is based on observations made during the site assessments that took place during 2024, and this map may change over time, especially if the influence of invasive plant species and vagrants making use of the land increases or decreases. Under the increasing invasion and land-occupation scenario, it is certain that the SEI will deteriorate over time. If invasive wattles, pines, and eucalypts are controlled according to a management plan, and vagrants are not allowed on the site, the SEI can improve, however this scenario would require a large amount of investment.

It is therefore likely that, should no development be permitted here, the SEI would deteriorate due to ongoing problems with vagrants and a lack of funding to properly manage the land. This deterioration would mean that the remaining fynbos observed will become smaller, more fragmented, and may even disappear over the next few decades (i.e., the nearby future). The receptor resilience (RR) was therefore very hard to assess, due to the numerous management decisions that will affect the vegetation of this assessment area, as well as the stunning recovery of fynbos following the removal of plantations. A RR of medium was therefore assigned for all the vegetation observed, apart from the quarry, which has a High RR as this area will remain transformed (Table 12).

The combined sensitivities at the bottom of Figure 13 is an illustration of the aquatic, botanical & terrestrial biodiversity, and faunal SEI and sensitivities observed. The combination of these maps was done in a similar way to that proposed in the Species Environmental Assessment guidelines (Verburgt et al., 2020). Individual SEI / sensitivity maps were combined, and the highest rating out of these three disciplines per polygon was assigned as the final sensitivity rating.

Table 12: The evaluation of the SEI for the vegetation/habitats present within and surrounding the proposed development.

Land use / Land cover	Conservation Importance (CI)	Functional Integrity (FI)	Receptor Resilience (RR)	Site Ecological Importance
Fynbos	**Very High** Any area of natural habitat of a CR ecosystem type. Stands of *Erica glandulosa fourcadei* confirmed in places.	**Medium** The patches of secondary fynbos remaining on the site are fragmented and surrounded by dense wattle invasions. To the north and west the N2 highway also fragments the landscape, and to the east Thembalethu. There is clear evidence of past disturbance (e.g., the recent fire & historical imagery indicating transformation of the landscape for forestry prior to 2005).	**Medium** VAST class II: Modified The fynbos is under threat from invasive plants and edge effects in the fragmented landscape. The habitat will recover slowly, as is already evident from historical records.	**High** BI: High RR: Medium
Fynbos with Established Invasion & Fynbos dominated by Bracken Ferns	**Medium** > 50% of receptor contains natural habitat with potential to support SCC.	**Medium** There is clear evidence of past disturbance (e.g., the recent fire & historical imagery indicating transformation of the landscape for forestry prior to 2005). Moderate rehabilitation potential.	**Medium** VAST class III: Transformed The fynbos is already quite degraded due to edge effects, invasion, and unfavourable landscape management. With some aid, the habitat could slowly recover.	**Medium** BI: Medium RR: Medium
Wetlands	**Medium** > 50% of receptor contains natural habitat with potential to support SCC.	**Medium** The wetlands on the site were also impacted in the past by various disturbances, of which the most notable was the forestry activity prior to 2005. The wetlands have a good	**Medium** VAST class II: Modified Wetlands are resilient, but also quite prone to invasion by wattles & other invasives like pampass grass.	**Medium** BI: Medium RR: Medium

Land use / Land cover	Conservation Importance (CI)	Functional Integrity (FI)	Receptor Resilience (RR)	Site Ecological Importance
		diversity of species, and if invasives like Pampass grass are managed on an ongoing basis, they have a moderate rehabilitation potential		
Forest Invaded & Drainage & Drainage Valleys	**Medium** > 50% of receptor contains natural habitat with potential to support SCC.	**Medium** Only narrow corridors of good habitat connectivity along drainage lines, and dense invasions and urban areas beyond. These areas are also not as accessible and have a moderate rehabilitation potential if surrounding invasions are controlled over the long-term.	**Medium** VAST class II: Modified The valley forest & drainage lines are resilient, but also quite prone to invasion by wattles & other invasives like bugweed.	**Medium** BI: Medium RR: Medium
Fynbos Depauperate	**Low** < 50% of receptor contains natural habitat with limited potential to support SCC.	**Low** Some fynbos elements still persist here (e.g., *Anthospermum aethiopicum*), however the vegetation is largely transformed and will require significant intervention to return to functional fynbos. Less than 50% of the original species composition with a high likelihood of invasive species taking over.	**Medium** VAST class IV: Replaced – Adventive While grasses and exotic species have a high resilience here, there is a potential for fynbos to return if the remaining fynbos fragments are well cared for. Long-term alien clearing will result in many fynbos species having a moderate likelihood of returning.	**Low** BI: Low RR: Medium
Dense Established Invaded & Dense Established Invaded Slopes	**Low** < 50% of receptor contains natural habitat with limited potential to support SCC.	**Low** Some fynbos elements still persist here (e.g., *Erica quadragnularis* quite common between wattles), however the vegetation is largely transformed and will require significant intervention to return to functional fynbos. Less than 50% of the original species composition with dense established wattle invasions.	**Medium** VAST class IV: Replaced – Adventive While the wattle invasion has a high resilience here, the fynbos that persists under the canopy is also remarkably resilient despite the ongoing impacts. Long-term alien clearing will result in many fynbos species having a moderate likelihood of returning.	**Low** BI: Low RR: Medium
Quarry	**Very Low** No natural habitat remaining.	**Very Low** Several major current negative ecological impacts.	**High** VAST class VI: Removed As long as the quarry is operational it will remain mostly bare. Adventive return of vegetation will likelt be invasive species.	**Very Low** BI: Very Low RR: High

8. CONCLUSION

This assessment highlights that the five Portions of Kraai Bosch Farm included in this proposal have undergone significant disturbances related to forestry in the past. Over the decades, the landscape has shifted from forestry plantations to a mix of invasive alien vegetation, degraded ecosystems, and pockets of recovering secondary fynbos. The presence of secondary Garden Route Granite Fynbos, albeit fragmented and somewhat isolated on the Portions, retains significant conservation importance due to the critically endangered nature of this ecosystem type.

These remnants provide a foundation for potential recovery but face ongoing threats from invasive species, non-ecologically friendly land-management practices (e.g., altered fire regimes), and land-invasion from the nearby informal settlement. The wetlands found, although surrounded by dense wattle invasions, remain diverse and ecologically distinct, offering some resilience amidst the broader landscape level degradation observed. The systematic clearing of invasive species according to an Invasive Plant Species Eradication Plan, and the application of appropriate fire regimes according to a Fire Management Plan would be required in order to sustain and manage remnant fynbos patches. These requirements must be incorporated in the design of any future development here. Without better landscape management, the persistence of critically endangered fynbos and its unique biodiversity, including vulnerable species like *Erica glandulosa fourcadei*, remains compromised.

The site ecological importance (SEI) was not easy to assess in this case due to the complexity of the processes at play, such as the dynamic nature of fynbos recovery following the removal of plantations. Observations made during the 2024 site assessments formed the basis of the SEI assessment, but it remains subject to change over time as management actions—or the lack thereof—shape the landscape. Without active intervention, including the systematic clearing of invasive wattles, pines, and eucalypts, and restrictions on informal land use, it is probable that the SEI will degrade further. Conversely, development here may result in some vegetation loss but can also be the source of investment required for sustainable management of remaining natural areas. Development, if applied with proper consideration of the mitigation hierarchy and ecology, can facilitate the long-term sustainable management of remaining natural areas.

The findings of this assessment emphasize the need for a detailed impact assessment to address the significant ecological challenges present on the site. Any proposed infrastructure upgrades must be clearly specified within the Site Development Plan (SDP) to ensure informed decision-making and appropriate mitigation measures. Given the extent of ecological transformation and the presence of critically endangered fynbos remnants, a biodiversity offset may be required for the loss and degradation of remnant CR vegetation.

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10. APPENDICES

10.1 Land-Use Recommendations According to the WC BSP

The recommended land-uses for each of the different BSP layers are outlined in Table 13.

Table 13: The land-use planning proposed by the Western Cape Biodiversity Spatial Plan. IUCN Red Listing Criteria for species

LAND USE CATEGORIES		Conservation		Agriculture		Tourism and Recreational Facilities		Rural Accomodation		Urban			Business & Industrial				Infrastructure Installations			
LAND USE SUB-CATEGORIES (Refer to table 4.7 for descriptions)		Proclaimed Protected Areas	Other Nature Areas	Intensive Agriculture	Extensive Agriculture	Low Impact Facilities	High Impact Facilities	Agri-worker Accommodation	Small holdings	Urban Development & Expansion	Community Facilities & Institutions	New Settlements	Rural Business	Non-place-bound Industry (low-moderate impact)	Non-place-bound Industry (high impact)	Extractive Industry (incl. Prospecting)	Linear - roads & rail	Linear - pipelines & canals	Linear - powerlines	Other Utilities
MAP CATEGORY	DESIRED MANAGEMENT OBJECTIVE	Y = Yes: Permissible land uses that are not likely to compromise the biodiversity objective						R = Restricted: Land uses that may compromise the biodiversity objective are only permissible under certain conditions (refer to Table 4.7 for conditions)							N = No: Land uses that will compromise the biodiversity objective and are not permissible							
Protected Area	Must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.	Land use within proclaimed protected areas are subject to management plan drawn up for that specific protected area.																		
Critical Biodiversity Area 1	Keep natural, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.	Y	Y	N	R	N	N	N	N	N	N	N	N	N	N	N	N	N	R	N
Critical Biodiversity Area 2	Keep natural, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.	Y	Y	N	R	R	N	N	N	N	N	N	N	N	N	N	R	R	R	N
Ecological Support Area 1: Terrestrial	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.	Y	Y	N	R	R	N	N	N	N	N	N	R	R	N	N	R	R	R	R
Ecological Support Area 1: Aquatic	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.	Y	Y	N	R	R	N	N	N	N	N	N	N	N	N	N	R	R	R	N
Ecological Support Area 2	Restore and/or manage to minimise impact on ecological infrastructure functioning, especially soil and water-related services.	Y	Y	N	R	R	N	N	R	N	N	N	N	N	N	N	R	R	R	R
ONA: Natural to Near-Natural	Minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. Offers flexibility in permissible land uses, but some authorisation may still be required for high impact land uses.	Y	Y	R	Y	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
ONA: Degraded	Minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. Offers flexibility in permissible land uses, but some authorisation may still be required for high impact land uses.	R	R	R	Y	Y	R	R	Y	R	R	R	R	R	R	R	Y	Y	Y	Y
No Natural Remaining	These areas are suitable for development but may still provide limited biodiversity and ecological infrastructure functions and should be managed in a way that minimises impacts on biodiversity and ecological infrastructure.	R	R	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

10.2 Vegetation Assets, States, and Transitions (VAST)

A table summarising the VAST score is presented in Table 14.

Table 14: Vegetation Assets, States, and Transitions (VAST) framework with columns representing states. Shifts between states are defined as transitions, as laid out in (Lesslie et al., 2010; Thackway & Lesslie, 2006).

Increasing modification

		Native vegetation cover Dominant plant species indigenous to the locality and spontaneous in occurrence, i.e. a vegetation community described using definitive vegetation types relative to estimated pre 1750 types				**Non-native vegetation cover** Dominant structuring plant species indigenous to the locality but cultivated; alien to the locality and cultivated; or alien to the locality and spontaneous		
Vegetation cover classes		**Class 0: RESIDUAL BARE** Areas where native vegetation does not naturally persist	**Class I: RESIDUAL** Native vegetation community structure, composition, and regenerative capacity intact—no significant perturbation from land use or land management practice. Class I forms the benchmark for classes II to VI	**Class II: MODIFIED** Native vegetation community structure, composition and regenerative capacity intact—perturbed by land use or land management practice	**Class III: TRANSFORMED** Native vegetation community structure, composition and regenerative capacity significantly altered by land use or land management practice	**Class IV: REPLACED -ADVENTIVE** Native vegetation replacement—species alien to the locality and spontaneous in occurrence	**Class V: REPLACED -MANAGED** Native vegetation replacement with cultivated vegetation	**Class VI: REMOVED** Vegetation removed
Diagnostic criteria	Current regenerative capacity	Natural regenerative capacity unmodified—ephemerals and lower plants	Natural regenerative capacity unmodified	Natural regeneration tolerates or endures under past and or current land management practices	Natural regenerative capacity limited or at risk under past and or current land use or land management practices. Rehabilitation and restoration possible through modified land management practice	Regeneration of native vegetation community has been suppressed by ongoing disturbances of the natural regenerative capacity; limited potential for restoration	Regeneration of native vegetation community lost or suppressed by intensive land management; limited potential for restoration	Nil or minimal
	Vegetation structure	Nil or minimal	Structural integrity of native vegetation community is very high	Structure is predominantly altered but intact, e.g. a layer or strata and or growth forms and or age classes removed	Dominant structuring species of native vegetation community significantly altered, e.g. a layer or strata frequently removed	Dominant structuring species of native vegetation community removed or predominantly cleared or extremely degraded	Dominant structuring species of native vegetation community removed	Vegetation absent or ornamental
	Vegetation composition	Nil or minimal	Compositional integrity of native vegetation community is very high	Composition of native vegetation community is altered but intact	Dominant structuring species present—species dominance significantly altered	Dominant structuring species of native vegetation community removed	Dominant structuring species of native vegetation community removed	Vegetation absent or ornamental