SALDANHA BAY MUNICIPALITY

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN (ST HELENA BAY)

Preliminary Engineering Report

(Revision 01)

P09414

COMPILED FOR:

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SALDANHA BAY MUNICIPALITY
CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 200 IRDP ERVEN (ST HELENA BAY)

DOCUMENT REVIEW

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CLIENT	:	SALDANHA BAY MUNICIPALITY
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1. INTRODUCTION

Saldanha Bay Municipality appointed iX engineers to investigate the existing bulk services and compile a services report for the installation of engineering services for the proposed development of IRDP erven, on portion 4 of farm 6 in Stompneus Bay (St Helena Bay). This report will mainly focus on the existing and proposed infrastructure, to demonstrate how it will conform to all requirements and to describe the implementing, management, and funding strategy.

The proposed development (draft 4 layout) includes the following:

- 214 residential Zone 1 erven (approx. 120m^2 erven) for IRDP housing;
- 1 place of public worship (1087m^2);
- 1 institutional zone erf – cheche (1081m^2)

The main findings and recommendations are summarised in this report.

Liaison with the relevant engineering departments of the Local Authority will be undertaken to finally agree services standards, materials to be used etc. prior to undertaking the final services design. The outcome of these workshops will be used to amend the information contained below as required.

2. LOCATION

St Helena Bay is situated within the boundaries of Saldanha Bay Municipality.

St Helena Bay includes the suburb of Stompneus Bay, which consists mainly of a residential area with many high-density low-income housing units.

The proposed development falls on portion 4 of farm 6 in Stompneus Bay (St Helena Bay).

The exact location of this proposed development in Laingville is as follows:

- Latitude (S) 32° 43’ 48”
- Longitude (E) 17° 58’ 32”

The proposed development is situated within a 3,50 km radius from the town centre of St Helena Bay.

3. AVAILABLE INFORMATION AND INVESTIGATIONS

The following information was made available to us:

- Geotechnical Investigation (Phase 1) carried out for the Stompneus Bay 200 IRDP Housing project, St. Helena Bay, dated February 2024 (completed by Gondwana Geo Solutions).
- Subdivision Plan (SDP) Draft 4, as produced by Rumboll CK and Partners.
- Capacity Analysis of the Bulk Water & Sewer Services: Development of 214 IRDP Housing Units in Stompneus Bay dated April 2024 preformed for Saldanha Bay Municipality (GLS Consulting).
- Traffic Impact Statement (TIS) for the proposed Stompneus Bay IRDP Housing Project, dated May 2024 (completed by Sturgeon Consulting).
- Stormwater Management Plan: Stompneus Bay IRDP Housing, dated May 2024 (completed by iX Engineers) (see attached Annexure H).
- As-built drawings as produced by Saldanha Bay Municipality.

4. SITE TOPOGRAPHY AND SOIL CONDITIONS

The site is situated in a large open area at the north-western side of established housing area of Stompneus Bay (near the ocean). It is bounded on the northeast by an existing gravel road and established housing area. Access to the site is either off Main Street (MR0053) which connects St Helena with Stompneus, or via Concorde Road on the northwest which comes of Main Street as well.

Topographically, the site slopes downwards from the southeast to Main Street, and in the general direction of the ocean. It Is covered in short wild grass and scattered shrubs. Occasional bare ground areas and mole excavations are found between this vegetation.

The topography of the proposed development area is very flat with several low points, an average gradient (from south-east to north-west) is approx. 1,5% (6,0m height over 400m) and from southwest to northeast of approx. 1,0% (1,0m height over 100m). The natural gradient falls from the south-eastern side to the northern western side (i.e. average gradient of 1:100).

5. CLIMATE AND VEGETATION

The climate of the area is typical to that of the West Coast. The area falls within the winter rainfall region with the bulk of the rainfall occurring between May and August. The average rainfall is 230mm per annum. The prevailing wind direction is south-westerly. The average daily temperature varies from 15°C to 27°C in the summer and 7°C to 18°C in the winter.

The site is covered in short wild grass and scattered shrubs. Most of the site comprises a mantle of loamy dune sands (Q2) which grade into 'brackish, calcareous soil' (Q4) within shallow depths. The Q4 layer generally comprises a dorbank which is a poorly to well cemented sandy material where gypsum and calcite are the cementing agents. In smaller, localised areas on the site (i.e. TP3 and TP4) the Q4 layer also comprises a poorly to moderately cemented calcrete or calcified dune sand. The Q4 layer is relatively thick and ranges to an average depth of between 2 and 3 metres below existing ground level (mbegl).

This mantle of soils is underlain by residual soils and porphyritic granite rocks of the Vredenburg Granite suite, which were only encountered in TP6 and TP7 at an average depth of about 1.7mbegl.

The TLB either refused or was stopped due to extremely slow excavation progress on either the dorbank or granite. No groundwater seepage was encountered in trail pits, groundwater expected in the rainy months.

6. EXISTING SERVICES IN ST. HELENA BAY

6.1 WATER SERVICES

Bulk water is supplied to Vredenburg and surrounding townships from the Berg River Water Scheme via the Withoogte Treatment Works and Besaansklip Reservoir. From here water is supplied to Vredenburg, Louwville, Langebaan, Paternoster, Jacobsbaai, St Helena Bay, Laingville and the immediate rural areas.

The water master planning indicated that the development area should be accommodated in the existing Midwest PRV water distribution zone, which is supplied with water from the Blueberry Hill reservoir, which in turn is supplied with water from the West Coast District Municipality's (WCDM) Vergeleë bulk reservoirs. The Blueberry Hill reservoir is supplied with bulk water through the 375 mm Ø pipeline (known as the "R-line") between the WCDM's Vergeleë reservoirs and St Helena Bay.

The existing 375 mm Ø bulk pipeline that supplies bulk water to the Blueberry Hill reservoir also supplies bulk water to the St Helena Views Lower, Hannas Bay and Laingville Lower reservoirs in St Helena Bay. Existing 75 mm / 110mm Ø internal pipes supplies water to the adjacent "Smartie Town's" reticulation network.

6.2 SANITATION SERVICES

Sanitation refers to the principles and practices relating to the collection, removal or disposal of human excreta, household wastewater and refuse as they impact upon people and their environment. Good sanitation includes appropriate health and hygiene awareness and behaviour as well as acceptable, affordable, and sustainable sanitation services. And no doubt that sanitation is affected by and affects water resource availability, and therefore it needs to be incorporated when developing water reconciliation strategies. According to the South Africa census completed in 2011, about 7% of the people in Vredenburg do not have water borne sewage and 25% of the people do not have piped water inside their dwelling.

The development falls within the existing Smartie Town pumping station (PS) drainage area. The existing sewer network consists of 160 mm diameter gravity mains that drains to the existing Smartie Town PS in Mercury street / Viking Crescent. From here, the sewerage is pumped through an existing 160 mm diameter rising main to the Ocean Brands PS.

6.3 ROADS AND STORMWATER

The main access roads to the proposed development will be from Minor Road 7664 (width approx. 6,0m), Mercury Street (width approx. 5,0m) and Viking Cresent (width approx. 4,5m).

The abovementioned streets are surfaced and have road furniture. The existing road consists of a mixture of asphalt and chip & spray (13,2mm and 6,7mm) surfacing.

Mercury street runs over a portion of erf no 2331 (existing church) and plot needs to be subdivided. Saldanha Bay Municipality property section will have to enter into negotiations with the landowners (Church) and obtain the POA before final design / construction of the development commences.

Storm water of the section of Mercury Street drains via the roads to catch pits (end of road), from where it is drains through existing 375mm Ø / 450mm Ø underground stormwater pipelines. The stormwater discharges into existing stormwater pond to the north-eastern side of the site.

Storm water of the surrounding Viking Cresent and section of Mercury Street drains via the roads to catch pits (end of road), from where it is drains through existing 375mm Ø / 450mm Ø underground stormwater pipes. The stormwater discharges into existing stormwater pond to the north-eastern side of the site.

No subsoil storm water drainage system exists next to the existing roads.

7. NEW SERVICES FOR PROPOSED DEVELOPMENT

7.1 WATER SERVICES

GLS Consulting (Pty) Ltd was appointed to provide a report as an extension to the Water Master Plan (performed for Saldanha Bay Municipality, April 2024) for the proposed development. GLS Consulting (Pty) Ltd report is attached to **Annexure B**.

It is proposed that new 160 mm and 110 mm diameter uPVC Class 12 pipelines be installed within the road reserves 1,0 m from the erf boundary. The water network will be connected (at five places) to the existing 150 / 75 mm Ø main supply water pipeline situated east of the proposed development adjacent to Boundary Road and Main Street. The internal design for this proposed development will also require new fire hydrants positioned at a maximum of 180 m (moderate fire-risk) from each other. See **Annexure E** for layout of the proposed water.

Erf connections will be 25/20 mm diameter HDPe Class 12 pipelines installed for each erf.

With reference to the GLS report, new external master plan items SHW.B.25 and SHW.B.27 (improve the existing bulk water system from Vergeleë reservoirs and the Blueberry Hill reservoir) is a requirement for the development. No upgrades are required to accommodate the proposed development within the existing water reticulation network of the Blueberry Hill reservoir supply area. The existing Blueberry Hills reservoir is at capacity, but it is recommended that the proposed development is accommodated within the existing reservoir supply area, subject to the augmentation of the existing bulk supply system through the implementation of master plan items SHW.B25 & SHW.B27. These are the minimum items required for the development. The cost estimate in this report includes all known external services.

The design standards are according to the Guidelines for Human Settlement Planning and Design. The design criteria applied to the water supply system components of Stompneus Bay (including 10 % water losses), are as follows:

Abbreviations:

- AADD = Annual average daily demand
- PFd = Peak day factor (1,5 assumed)
- PDD = Peak day demand (midsummer peak day demand)
  = PFd x AADD
- PHD = Peak hour demand
  = PFh x AADD
- PFh = Peak hour factor (4,0 assumed)

TABLE 1: ESTIMATED WATER CONSUMPTION FOR THE DEVELOPMENT

AREA	Units	c/unit	PER CAPITA CONSUMPTION@ (ℓ/c/d) / (	AADD
Water Demand: Housing units	214	5	90	96.30 Kℓ/d
Businesses	1		Not peak times	0 Kℓ/d
SUBTOTAL 10 %1) Water losses				96.30 Kℓ/d 9.63 Kℓ/d
TOTAL for AADD (Incl. Losses)				105.93 Kℓ/d
PDD (1.5 x AADD)				158.90 Kℓ/d
PHD (4.0 x AADD)				423.72 Kℓ/d
Additional Reservoir Capacity (AADD x 2 days)				211.86 Kℓ

7.2 SANITATION SERVICES

GLS Consulting (Pty) Ltd was appointed to provide a report as an extension to the Sewer Master Plan (performed for Saldanha Bay Municipality, April 2024) for the proposed development. GLS Consulting (Pty) Ltd report is attached to **Annexure B**.

It is proposed that new 160 mm diameter uPVC 400 KPa pipelines be installed for the internal sewer network, 1,50 m from the erf boundary. Minimum pipeline gradients will be 1:180 and maximum 1:10.

The sewer network will connect at various places to the existing 250 mm diameter outfall sewer running through the development. See **Annexure D** for a layout of the proposed sewer.

Erf connections will be 110 mm diameter uPVC 400 KPa pipelines (minimum gradient 1:60), installed for each erf.

The existing bulk sewer reticulation system between the proposed development and existing WWTW has the capacity required.

With reference to the GLS report, new external master plan items 1 and SHW.B.25.4 are required to accommodate the proposed development. These are the minimum external upgrades required for the development. The cost estimate in this report includes all known external services.

The ADWF of the development is 67.41 Kℓ/d (0,78 ℓ/s). At an infiltration rate of 25 %, a PWWF for the development is calculated at 318.59 Kℓ/d (3,69 ℓ/s).

Abbreviations:

- ADWF = Average Dry Weather Flow (70% of water demand)
- PF = Peak Factor (According to the Harmon Formula (3,781))
- PDWF = Peak Dry Weather Flow (ADWF x PF)
- PWWF = Peak Wet Weather Flow (PDWF x 25%)

7.3 ROADS AND STORMWATER

The access roads to the development will be from Minor Road 7664 (width approx. 6,0m), Mercury street (width approx. 5,0m) and Victory street (width approx. 4,50m).

A Traffic Impact Statement (TIS) for the proposed development was completed by Sturgeon Consulting.

The detailed design of the proposed main access on OP7664 needs to be completed and approval must be obtained from approved by the responsible Road Authority. The detailed design of this newly proposed access will be done by the next appointed Consultant for the Detail Design phase.

Proposed new roads situated in the 10m road reserves will be 5,5m and 5,0m wide. The roads will have kerbs installed on both sides, namely CK5 and MK10. See **Annexure C** for proposed street layout.

Parking should be addressed at the detailed design stage and satisfy the relevant parking requirements contained in the *Saldanha Bay Municipality Integrated Zoning Scheme By-Law, March 2020.*

The geometric design of the project streets will be done in accordance with the recommended design standards.

Surface drainage will be accommodated on the streets and will consist of a CK5 kerb. Storm water runoff will be discharged on surface and into kerb inlets will be provided at certain positions.

The minimum K- values and vertical design criteria will be according to the normal standards.

Road signage should be provided where applicable.

The design approach for this project will be based on the Following Principles :

- To optimise the use of in-situ materials.
- To provide an appropriate pavement structure for the selected design life.
- The design must be economical and cost effective also in terms of maintenace operations.

The following pavement structure are envisaged for the new roads but are subject to final design and approval by Saldanha Bay Municipality.

Asphalt surfacing (5,5m wide roads)

- 30mm asphalt surfacing
- 125mm G4 base course compacted to 98% MOD AASHTO (imported)
- 125mm G5 subbase compacted to 95% MOD AASHTO (imported)
- 150mm G7 subgrade compacted to 93% MOD AASHTO (imported)
- 150mm in-situ material compacted to 93% MOD AASHTO (100% for sand)
- Precast concrete kerbs, CK5 and MK10.

Asphalt surfacing (5,0m wide roads)

- 30mm asphalt surfacing
- 125mm G4 base course compacted to 98% MOD AASHTO (imported)
- 125mm G5 subbase course compacted to 95% MOD AASHTO (imported)
- 150mm in-situ material compacted to 93% MOD AASHTO (100% for sand)
- Precast concrete kerbs, CK5 and MK10.

Run-off peaks with return period of the 1:5-year flood frequency will be used in the stormwater run-off calculations to confirm the required pipeline diameters. The site is situated above the 1:100 flood line.

The Manning equation for circular pipes and the design flow charts were used to determine the required pipeline diameters and to confirm the capacities required. Minimum longitudinal slopes play a major role in the design of the capacity of the pipelines, as well as in obtaining self-cleansing velocities to prevent siltation and thus keep maintenance to a minimum.

The proposed 375mm Ø / 450mm Ø underground stormwater pipe system with grid inlets will be constructed to ensure sufficient drainage from the area. The proposed stormwater system will drain to the new retention pond. See **Annexure F** for proposed stormwater layout.

iX Engineers was appointed by Saldanha Bay Municipality to provide a stormwater management plan for the new development taking the existing and future surrounding developments into account (see attached **Annexure H)**. With reference to the stormwater management report, the following external stormwater attenuation dams and networks is proposed to be upgraded:

- An earth berm/cut-off channel is recommended along the south-west boundary of the proposed development to prevent runoff from the larger catchment area to enter the development properties.

- Catchment A (new facility) : A new attenuation facility (with new fencing) is proposed for the new development area which will reduce up to the 1 in 100-year post-developed peak runoff to the 1 in 2-year pre-developed runoff. An emergency overflow will also form part of the design of the storage facility should a storm exceeding the 1 in 100-year storm occur.

- Catchment B (existing facility) : It is recommended that the existing attenuation facility be extended, an emergency overflow be constructed, and the extended facility be fenced off.

The above three above-mentioned points will have to be taken into consideration by the next appointed Consultant for the Detail Design phase.

7.4 MASS EARTHWORKS

The topography of the proposed development area is very flat with several low and high points, an average gradient (from south-east to north-west) is approx. 1,5% (6,0m height over 400m) and from southwest to northeast of approx. 1,0% (1,0m height over 100m). The natural gradient falls from the south-eastern side to the northern western side (i.e. average gradient of 1:100).

With reference to the topographical survey and Phase 1 Geotechnical Site investigation report, mass earthworks will be limited to cuts and fills not exceeding 1,5m in height. It is recommended that all earthworks be carried out in accordance with SABS 1200 DM.

8. PROJECT BUDGET

The total estimated cost for the Civil Engineering Services for Stompneus Bay (214 IRDP erven) is detailed below:

INTERNAL CIVIL SERVICES	
CONSTRUCTION	
DESCRIPTION	**TOTAL AMOUNT**
Preliminary and general	R 2 606 000.00
Site clearance	R 80 000.00
Mass Earthworks	R 700 000.00
Earthworks (Roads, subgrade)	R 498 000.00
Sewers	R 2 002 000.00
Stormwater and subsurface drains	R 2 244 000.00
Water reticulation and erf connections	R 1 232 000.00
Cable ducts (electrical)	R 235 400.00
Subbase	R 913 000.00
Kerbing and channeling	R 747 000.00
Base	R 996 000.00
Asphalt surface treatment	R 2 158 000.00
Ancillary Roadworks	R 41 500.00
SUB TOTAL	**R 14 452 900.00**
Contingencies (10%)	R 1 445 290.00
SUB TOTAL (INTERNAL CIVIL)	**R 15 898 190.00**

INDIRECT COSTS	
DESCRIPTION	**TOTAL AMOUNT**
Concept stage:	
Concept stage (Normal, Additional, & Adhoc services)	R 128 660.00
Environmental consultant (Concept stage)	R 332 325.00
Town planning & Topograpical surveyor (excludes placing erf pe	R 194 250.00
Geotechnical report (Phase 1)	R 48 500.00
GLS Studies	R 67 171.13
Add Other Specialist Services - Stormwater Management plan	R 60 000.00
Add Other Specialist Services - Traffic Impact Assessment	R 48 530.00
Preliminary & Design stage:	
Professional fees (Civil services only estimated 4,5%)	R 715 418.55
Topograpical surveyor	R 20 000.00
Construction stage:	
Project Management (Civil services only estimated 3%)	R 476 945.70
Construction Monitoring Level 2 (estimated 6 months)	R 210 000.00
Health and Safety Officer	R 35 000.00
Environmental Control Officer (ECO)	R 60 000.00
Geotechnical report (Phase 2)	R 50 000.00
Town planning (placing internal erf pegs)	R 100 000.00
Add Other Specialist Services	R 50 000.00
Ad hoc matters	R 50 000.00
Recoverable Expenses	R 50 000.00
SUB TOTAL (INDIRECT COSTS)	**R 2 696 800.38**
SUB TOTAL (INTERNAL CIVIL SERVICES) (INCLUDING 10% CONTINGENCIES & EXCLUDING VAT)	**R 18 594 990.38**
EXTERNAL CIVIL SERVICES	
CONSTRUCTION	
Preliminary and general	R 24 499 000.00
Site clearance	R 50 000.00
Sewers (External)	
Master plan item 1: New conservancy	R 2 391 000.00
Master plan item SStS25.4: 685 m x 200 mm Ø outfall sewer	R 1 356 000.00
Water (External)	
Master plan items SHW.B25: 9425 m x 550 mm Ø bulk supply	R 65 400 000.00
Master plan items SHW.B27: 5714 m x 550 mm Ø bulk supply	R 39 824 000.00
Stormwater (External)	
Stormwater pipelines (Mercury & Victory)	R 770 000.00
Cost estimate as per SWMP	R 1 560 000.00
SUB TOTAL	**R 135 850 000.00**
Contingencies (10%)	R 13 585 000.00
SUB TOTAL (EXTERNAL CIVIL)	**R 149 435 000.00**

EXTERNAL CIVIL SERVICES	
INDIRECT COSTS	
DESCRIPTION	**TOTAL AMOUNT**
Professional fees & Project Management (allow 10%)	R 6 724 575.00
Topograpical surveyor	R 100 000.00
Environmental consultant	R 200 000.00
Health and Safety Officer	R 100 000.00
Ad hoc matters	R 100 000.00
Recoverable Expenses	R 100 000.00
SUB TOTAL (INDIRECT COSTS)	**R 7 324 575.00**
SUB TOTAL (EXTERNAL CIVIL SERVICES) (EXCLUDING VAT)	**R 156 759 575.00**
SUB TOTAL (INTERNAL & EXTERNAL CIVIL SERVICES) (EXCLUDING VAT)	**R 175 354 565.38**
PROJECT INCOME	
DESCRIPTION	**TOTAL AMOUNT**
Housing subsidies (214 IRDP erven):	
Civil services (A Grade) (R 72 107 / erf)	R 15 430 898.00
SUB TOTAL (INCOME)	**R 15 430 898.00**
SURPLUS (+) / DEFICIT (-)	**-R 159 923 667.38**

Notes:
1. Contract price adjustment not included.
2. All above cost excludes 15% VAT.
3. All above cost excludes Electrical network.
4. All above cost includes all know External services.

Due to the remote location of Stompneus Bay (St Helena Bay), approximately 180km from Cape Town, the Preliminary and General cost for the project will be higher as the contractor qualified for this construction work will most probably be based in Cape Town. Although most material can be sourced locally, some of the materials will have to be hauled from Cape Town which will increase the construction cost.

9. PROJECT PROGRAMME

For Anticipated planning programme & Preliminary Project implementation plan (construction), see **Appendix G** attached.

10. PROJECTED CASH FLOW

The projected cash flow (based on estimated cost and anticipated programme) for the Civil Engineering Services for Stompneus Bay (214 IRDP erven) is detailed below:

PROJECTED CASH FLOW						
INTERNAL CIVIL SERVICES						
DESCRIPTION	**2023/2024**	**2024/2025**	**2025/2026**	**2026/2027**	**2027/2028**	**TOTAL AMOUNT**
Civil (Indirect costs)	R 137 264.23	R 742 171.90	R 529 251.13	R 911 167.42	R 376 945.70	R 2 696 800.38
Civil (Construction)	R 0.00	R 0.00	R 0.00	R 7 949 095.00	R 7 949 095.00	R 15 898 190.00
SUB TOTAL (INTERNAL CIVIL)	**R 137 264.23**	**R 742 171.90**	**R 529 251.13**	**R 8 860 262.42**	**R 8 326 040.70**	**R 18 594 990.38**
EXTERNAL CIVIL SERVICES						
Civil (Indirect costs)	R 0.00	R 0.00	R 0.00	R 4 334 745.00	R 2 989 830.00	R 7 324 575.00
Civil (Construction)	R 0.00	R 0.00	R 0.00	R 74 717 500.00	R 74 717 500.00	R 149 435 000.00
SUB TOTAL (EXTERNAL CIVIL)	**R 0.00**	**R 0.00**	**R 0.00**	**R 79 052 245.00**	**R 77 707 330.00**	**R 156 759 575.00**
TOTAL (CIVIL)	**R 137 264.23**	**R 742 171.90**	**R 529 251.13**	**R 87 912 507.42**	**R 86 033 370.70**	**R 175 354 565.38**

Notes:
1. Contract price adjustment not included.
2. All above cost excludes 15% VAT.
3. All above cost excludes Electrical network.
4. All above cost includes all know External services.

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11. RECOMMENDATION

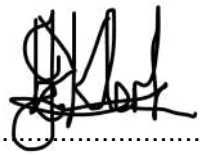
The civil engineering services for the proposed development of 214 IRDP Housing erven were prioritised by Saldanha Bay Municipality and will be implemented as soon as funding is acquired.

Considering the terrain, proposed upgrading scenarios and expectations, the following findings:

- Funding (see project budget) should be obtained for this project (subsidies).
- Additional funding (see project budget) is required for this project. The subsidy amount (for construction) for A grade civil services is not adequate.
- Additional funding for Geotechnical variance must be requested from Western Cape Government (Department of Infrastructure).
- Additional funding is required for the external services. Planning and budgeting for these major bulk upgrades will have to be done by Saldanha Bay Municipality Water & Sanitation and Roads & stormwater Departments prior execution of this project, as these upgrades are a requirement for the development.
- Tenders should be invited for the internal civil engineering services as discussed in this report.
- The estimated budget can be financed during five financial years (Civil services).

12. CONCLUSION

We trust that this report meets your expectations and provides enough motivation for funds to be allocated to this project.



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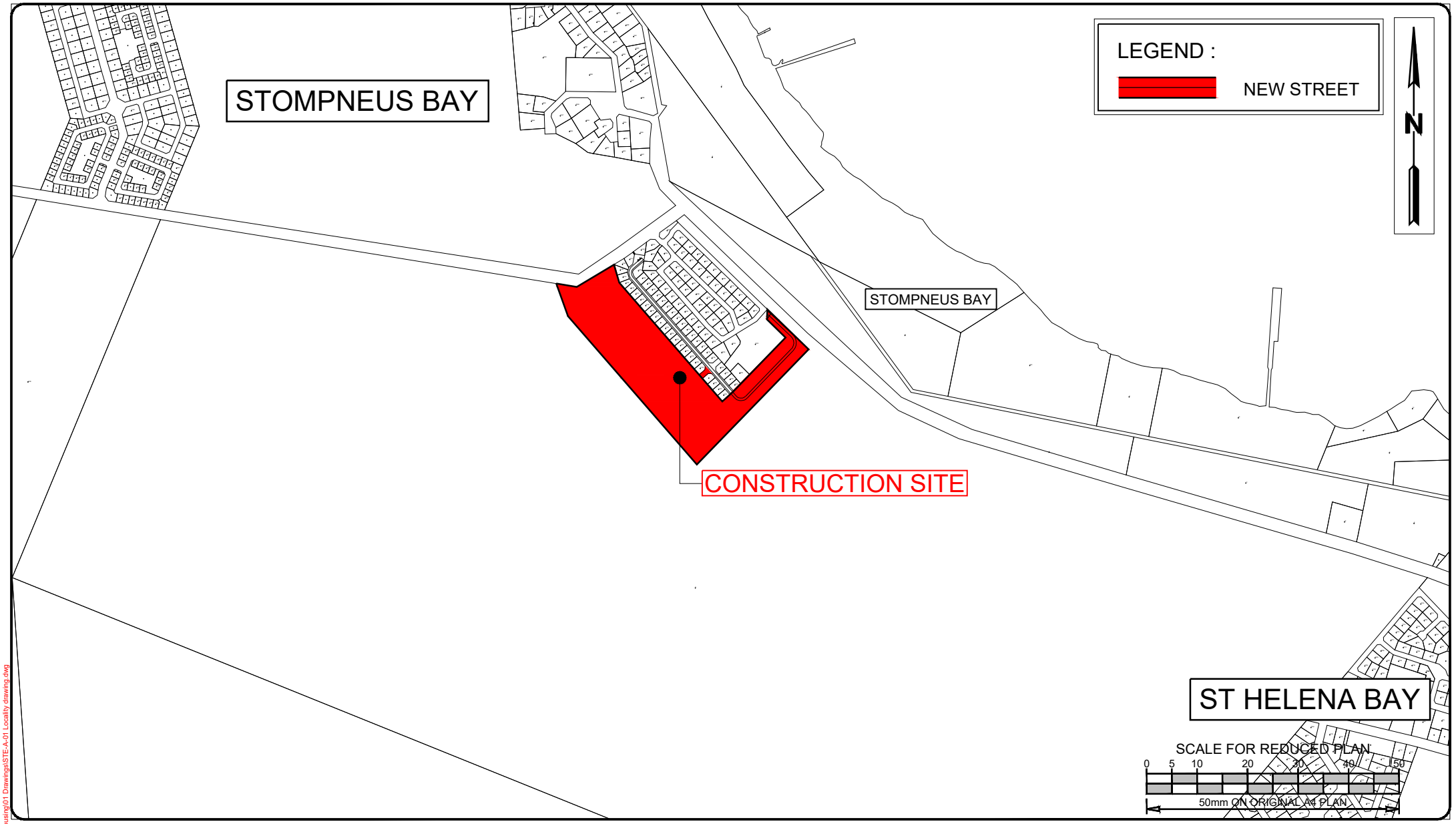
J de Klerk Pr Tech Eng

Annexure A:

Locality Plan



PRELIMINARY

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PROJECT

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN, ST HELENA BAY

DRAWING DESCRIPTION

LOCALITY PLAN

DESIGNED	DRAWN	CHECKED
J.de Klerk	J.de Klerk	J.de Klerk

DATE	SCALE
MAY 2024	1 : 10000

DRAWING NUMBER	REV
STE/A-01	A

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Annexure B:

Capacity Analysis of Bulk Water and Sewer Services (GLS Report)

GLS

Infrastructure planning

29 April 2024

iX Engineers
31 Allen Drive
Loevenstein
Cape Town
7530

Attention: Mr Jéan de Klerk

Dear Sir,

DEVELOPMENT OF 214 IRDP HOUSING UNITS IN STOMPNEUS BAY, ST HELENA BAY: CAPACITY ANALYSIS OF THE BULK WATER AND SEWER SERVICES

Your request regarding comments on the bulk water supply and sewage discharge of the proposed development on a portion of Farm 6 in Stompneus Bay, St Helena Bay, refers.

This document should inter alia be read in conjunction with the Water Master Plan (performed for the Saldanha Bay Municipality (SBM)) dated June 2023 and the Sewer Master Plan (performed for SBM) dated June 2023.

Future development area STH9, which included the proposed development area, was conceptually taken into consideration for the June 2023 master plans for the St Helena Bay water and sewer networks.

1. WATER DISTRIBUTION SYSTEM

1.1 Distribution zone

The water master planning indicated that the development area should be accommodated in the existing Midwest PRV water distribution zone, which is supplied with water from the Blueberry Hill reservoir, which in turn is supplied with water from the West Coast District Municipality's (WCDM) Vergeleë bulk reservoirs. The Blueberry Hill reservoir is supplied with bulk water through the 375 mm Ø pipeline (known as the "R-line") between the WCDM's Vergeleë reservoirs and St Helena Bay.

The existing 375 mm Ø bulk pipeline that supplies bulk water to the Blueberry Hill reservoir also supplies bulk water to the St Helena Views Lower, Hannas Bay and Laingville Lower reservoirs in St Helena Bay.

The water connections for the proposed development should be made to the existing 110 mm Ø internal pipes of the adjacent "Smartie Town's" reticulation network, and to the existing 150 mm Ø in Minor Road 7664, as shown on Figure 2 attached.

The proposed development is situated inside the water priority area.

1.2 Water demand

The original water analysis for the master plan was performed with a total annual average daily demand (AADD) of 139,3 kL/d for the proposed development area (future development area STH9 in the June 2023 water master plan).

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PO Box 814
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South Africa

Directors: Marius de la Rey, Garreth Young

For this re-analysis, AADD and fire flow for the proposed development was calculated as follows:

- 214 Group housing units @ 0,45 kL/d/unit = 96,3 kL/d
- Fire flow criteria (Low risk) = 15 L/s @ 7 m

1.3 Present situation

1.3.1 Reticulation network

The existing water reticulation system of the Midwest PRV water distribution zone has sufficient capacity to accommodate the proposed development.

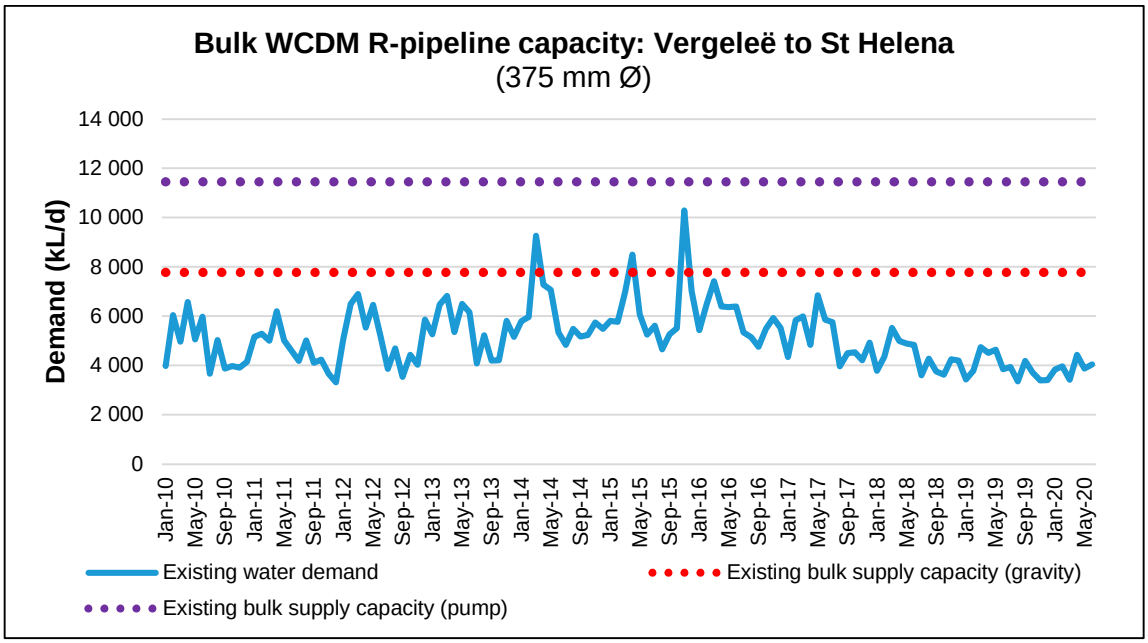
1.3.2 Bulk supply

St Helena Bay is supplied with bulk water from the WCDM system through meter no. R7, located just before the Laingville Lower reservoir. Bulk water is supplied to meter no. R7 from the WCDM's Vergeleë reservoirs through the existing 375 mm Ø pipeline known as the "R-line." In the SBM June 2023 Water Master Plan it is however proposed that the operation of the "R-line" from the Vergeleë reservoirs to meter no. R7 is taken over by SBM.

As part of this report's analysis of the capacity of the bulk system for accommodating the proposed development therefore includes the capacity of the portion of pipeline between the WCDM's Vergeleë reservoirs and meter no. R7 ("R-line").

The capacity of the existing bulk system from the Vergeleë reservoirs to St Helena Bay is calculated at 7,8 ML/d, as shown on Figure 1 below.

Figure 1: Bulk water supply capacity:



The existing St Helena Bay bulk system is currently operated under capacity but has however reached capacity in the past (prior to the drought and again in the summer of 2022) as peak monthly demand for St Helena Bay often occur during the holiday season. The capacity of the existing bulk system has therefore insufficient spare capacity to accommodate additional developments.

In the water master plan it is proposed that bulk water supply from the Vergeleë reservoirs to the existing reservoirs in St Helena Bay is augmented through the replacement of the existing 375 mm Ø main supply pipeline in order to accommodate any additional developments together with existing vacant erven (with existing water rights) in St Helena Bay.

Note: The option to augment the supply capacity of the "R-line" through the implementation of booster pumps on the line was investigated as part of the Water Master Plan. This option is however not feasible as the condition of the old R-line is such that it cannot accommodate any additional pressure within the pipeline.

The impact of the development on the existing demand of the St Helena Bay system is calculated at 2,2%.

1.3.3 Reservoir capacity

The criteria for total reservoir volume used in the Water Master Plan is 48 hours of the AADD (of the reservoir supply zone).

The existing Blueberry Hill reservoir currently has 47,6 hours of storage capacity. With the development included the storage capacity decreases to 45,6 hours of storage capacity.

In the water master plan additional storage capacity is proposed in order to accommodate any additional developments together with existing vacant erven (with existing water rights) in St Helena Bay. The existing Blueberry Hill reservoir therefore technically has insufficient capacity to accommodate the proposed development on a portion of Farm 6.

The impact of the development is, however, not that significant as the existing storage capacity is close to the required 48 hours x AADD supplied, and it is therefore recommended that the proposed development is accommodated within the existing water system (without the implementation of additional storage capacity for the supply area).

1.3.3 WCDM bulk supply

St Helena Bay is supplied with bulk water from the WCDM's Vergeleë reservoirs.

The analysis of the capacity of the WCDM system in order to accommodate the proposed development is discussed in a separate report, addressed to WCDM.

1.4 Implementation of the master plan

The following master plan items will be required in the near future to provide additional storage capacity to accommodate the proposed development together with other future development areas in the existing St Helena Bay water network, as shown on Figure 3 attached:

<u>Reservoir capacity upgrades:</u>

• SHW7.1	: 680 m x 500 mm Ø new supply pipeline to Shelley Point	= R	6 761 000 *
• SHW.B13	: 26 m x 400 mm Ø parallel reinforcement of bulk supply pipeline	= R	515 000 *
• SHW.B14c	: 120 L/s @ 38 m pump station to new reservoir	= R	750 000 *
• SHW.B15	: 708 m x 400 mm Ø new bulk supply pipeline	= R	4 730 000 *
• SHW.B16a	: 5 000 kL new reservoir for Shelley Point area	=	<u>R 19 648 000</u> *
	Sub-total	= R	32 404 000 *

The following master plan items will be required to reinforce the existing bulk water system from the WCDM Vergeleë reservoirs to St Helena Bay in order to accommodate the proposed development together with other future development areas in the existing St Helena Bay water network, as shown on Figure 4 attached:

Bulk supply upgrades:

- SHW.B25 : 9 425 m x 550 mm Ø parallel reinforcement of bulk supply pipe = R 95 756 000 *
- SHW.B27 : 5 714 m x 550 mm Ø parallel reinforcement of bulk supply pipe = R 58 306 000 *

Sub-total = R154 062 000 *

Total = R186 775 000 *

(* Including P & G, Contingencies and Fees, but excluding VAT - Year 2022/23 Rand Value. This is a rough estimate, which does not include major unforeseen costs).

The routes of the proposed pipelines are shown schematically on Figures 3 and 4 attached, but have to be finalised subsequent to detailed pipeline route investigations.

1.5 Minimum items required

No upgrades are required to accommodate the proposed development within the existing water reticulation network of the Blueberry Hill reservoir supply area.

The existing bulk supply system between the Vergeleë reservoirs and the Blueberry Hill reservoir is, however, at capacity and master plan items SHW.B25 & SHW.B27 are required to accommodate any additional developments within St Helena Bay.

The existing Blueberry Hills reservoir is at capacity, but it is recommended that the proposed development is accommodated within the existing reservoir supply area, subject to the augmentation of the existing bulk supply system through the implementation of master plan items SHW.B25 & SHW.B27.

2. SEWER NETWORK

2.1 Drainage area

The development falls within the existing Smartie Town pumping station (PS) drainage area. The proposed connection points to the existing sewer system is to the existing Smartie Town PS and to the existing outfall sewer in Viking Crescent, as shown on Figure 5 attached.

The location and diameter of the existing outfall sewer in Viking Crescent is schematically shown on Figure 5 and the layout of the outfall sewer should be verified by SBM.

The development is inside the sewer priority area.

2.2 Sewer flow

The original sewer analysis for the master plan was performed with a total peak day dry weather flow (PDDWF) of 120,9 kL/d for the proposed development area (future development area STH9 in the June 2023 water master plan).

For this re-analysis, the PDDWF for the proposed development was calculated as 62,6 kL/d.

2.3 *Present situation*

Presently the sewage collected at the Smartie Town PS is pumped across Concorde drive to the Ocean Brands PS. From the Ocean Brands PS sewage is pumped directly to the existing Shelley Point wastewater treatment plant (WWTP).

There is sufficient capacity at the Smartie Town PS and the Ocean Brands PS to accommodate the additional sewage from the proposed development.

The Shelley Point WWTP, however, has insufficient capacity to accommodate the proposed development.

2.4 *Implementation of the master plan*

The master planning for St Helena Bay indicated that the proposed development should ultimately be accommodated in the Future St Helena PS no. 5 drainage area.

It is proposed that sewage from the existing Smartie Town PS be diverted to the proposed Future St Helena PS no. 5 via a new gravity outfall sewer, as shown on Figure 6 attached.

From the proposed Future St Helena PS no. 5 it is proposed that sewage is pumped to the proposed "Future St Helena PS no. 3" drainage area, from where sewage should gravitate to the proposed Future St Helena PS no. 3.

The location of the Future St Helena PS no. 3 is proposed to the south of Brittania Bay where the combined sewage from the Brittania Bay, Shelley Point, Golden Mile, and Stompneus Bay suburbs should be collected and pumped via a new 355 mm diameter rising main directly to the proposed future Brittanica Bay WWTP.

2.4.1 *Short to medium term upgrades*

It is proposed that sewage from the proposed St Helena PS no. 5 be accommodated in the short to medium term at an interim conservancy tank at the site of the proposed St Helena PS no. 5, as shown on Figure 6 attached.

The following new sewer infrastructure will be required to connect the proposed development to the proposed interim conservancy tank at the location of the future St Helena PS no. 5:

Link services:

• Item 1	: New conservancy tank (sump for future St Helena PS no. 5)		= R 3 501 000 *
• SStS25.4	: 685 m x 200 mm Ø new outfall sewer		= R 1 985 000 *
		Sub-total	= R 5 486 000 *

2.4.2 *Short to medium term upgrades*

In the longer term (as part of implementing a full waterborne sanitation system for the whole St Helena Bay), it is proposed that the interim conservancy tank is upgraded to a PS and sewage is conveyed to the proposed future Brittanica Bay WWTP, as shown on Figure 6 attached.

The following master plan items will be required to convey sewage from the proposed Future St Helena PS no. 5 to the proposed Future St Helena PS no. 3:

Network infrastructure:

• SStS8.1	: New 92 L/s St Helena PS no. 5 (upgrading of conservancy tank)		= R 2 099 000 *
• SStS8.2	: 1 649 m x 315 mm Ø new St Helena PS no. 5 rising main		= R 6 965 000 *
• SStS5.1	: 15 m x 525 mm Ø new outfall sewer		= R 182 000 *
• SStS5.2	: 2 008 m x 525 mm Ø new outfall sewer		= R 14 468 000 *
		Sub-total	= R 23 714 000 *

The following master plan items will be required to transfer sewage collected from the Brittania Bay, Shelley Point, Golden Mile, and Stompneus Bay suburbs to the proposed Brittanica Bay WWTP:

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Bulk sewer infrastructure:

- SStS5.5 : New 150 L/s St Helena PS no. 3 = R 7 879 000 *
- SStS5.6 : 679 m x 355 mm Ø new St Helena PS no. 3 rising main = R 3 575 000 *
- SStS.B2 : New 4,3 ML/d Brittanica Bay WWTP** = R108 136 000 *

Sub-total = R119 590 000 *

Total = R148 790 000 *

(* Including P & G, Contingencies and Fees, but excluding VAT - Year 2022/23 Rand Value. This is a rough estimate, which does not include major unforeseen costs).

(** This can be phased, the ultimate capacity required is 4,3 ML/d).

The routes of the proposed pipes and the positions of the proposed pumping stations and WWTP are shown schematically on Figure 6 attached, but have to be finalised subsequent to detailed pipeline route and pumping station and WWTP location investigations.

2.5 Minimum items required

The minimum items required to accommodate the proposed development in the existing sewer system are master plan items 1 and SStS25.4.

3. CONCLUSION

The developer of a portion of Farm 6 in St Helena Bay, may be liable for the payment of a Development Contribution (as calculated by the Saldanha Bay Municipality) for bulk water and sewer infrastructure as per Council Policy.

The water master planning indicated that the development area should be accommodated in the existing Midwest PRV water distribution zone. The water connections for the proposed development should be made to the existing 110 mm Ø internal pipes of the adjacent “Smartie Town’s” reticulation network, and to the existing 150 mm Ø in Minor Road 7664, as shown on Figure 2 attached.

The existing water reticulation network of the Blueberry Hill reservoir supply area has sufficient spare capacity to accommodate the proposed development.

The existing bulk supply system between the Vergeleë reservoirs and the Blueberry Hill reservoir is, however, at capacity and master plan items SHW.B25 & SHW.B27 are required to accommodate any additional developments within St Helena Bay.

The existing Blueberry Hills reservoir is at capacity, but it is recommended that the proposed development is accommodated within the existing reservoir supply area, subject to the augmentation of the existing bulk supply system through the implementation of master plan items SHW.B25 & SHW.B27.

The development falls within the existing Smartie Town pumping station (PS) drainage area. The proposed connection points to the existing sewer system is to the existing Smartie Town PS and to the existing outfall sewer in Viking Crescent, as shown on Figure 5 attached.

The existing Shelley Point WWTP has insufficient treatment capacity to accommodate the proposed development.

The master planning for St Helena Bay indicated that sewage flow from the proposed development should ultimately be accommodated at the proposed Brittanica Bay WWTP. New bulk infrastructure will have to be constructed in order to connect the proposed development to the proposed future Brittanica Bay WWTP.

In the interim (before the proposed Brittanica Bay WWTP and accompanying bulk infrastructure is implemented), it is proposed that the development on a portion of Farm 6 is serviced through a conservancy tank constructed at the location of the proposed Future St Helena PS no. 5.

The minimum items required to accommodate the proposed development in the existing sewer system are master plan items 1 & SStS25.4.

We trust that you find this of value.

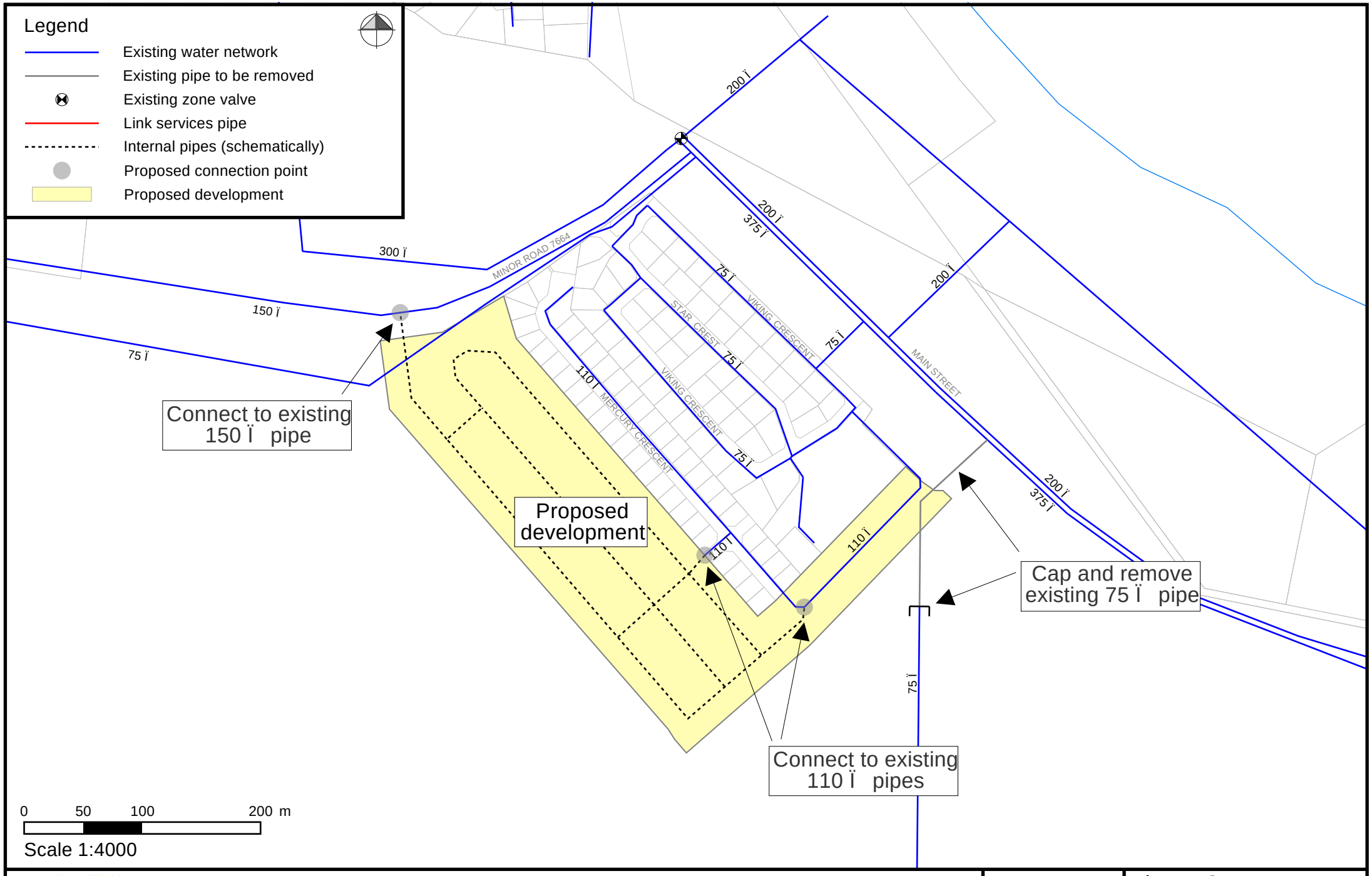
Yours sincerely,

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

_____
Per: PC DU PLESSIS

cc. The Director: Technical Engineering Services
Saldanha Bay Municipality
Private Bag X12
Vredenburg
7380

Attention: Mr Gavin Williams

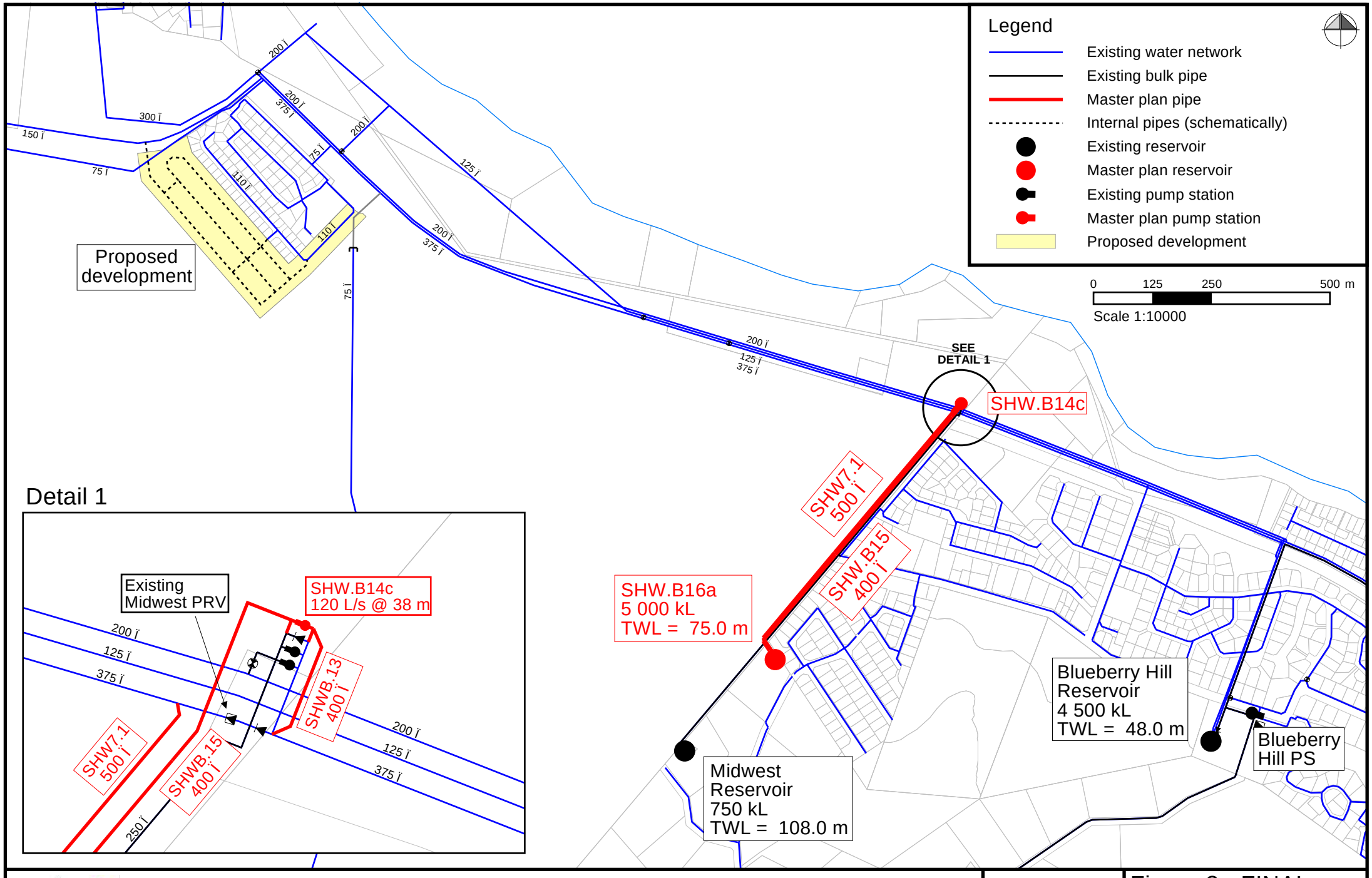


April 2024

Proposed development of 200 IRDP Housing Units in Stompneus Bay - St Helena Bay

Figure 2 - FINAL

Proposed development
Stompneus Bay IRDP Housing - St Helena Bay
Existing water system



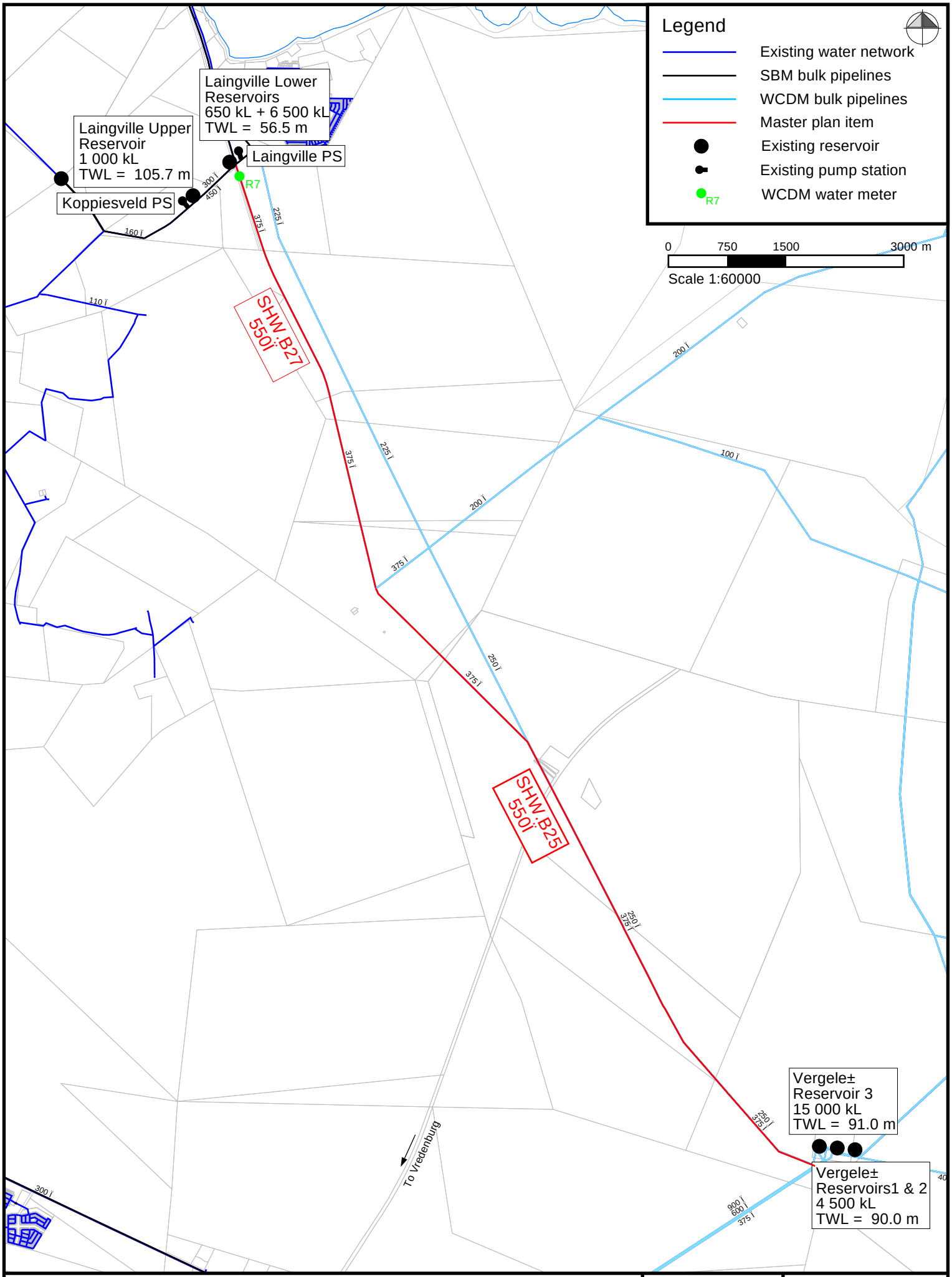
April 2024

Proposed development of 200 IRDP Housing Units in Stompneus Bay - St Helena Bay

GLS Infrastructure planning

Figure 3 - FINAL

Proposed development
Stompneus Bay IRDP Housing -
St Helena Bay
Water master plan



April 2024

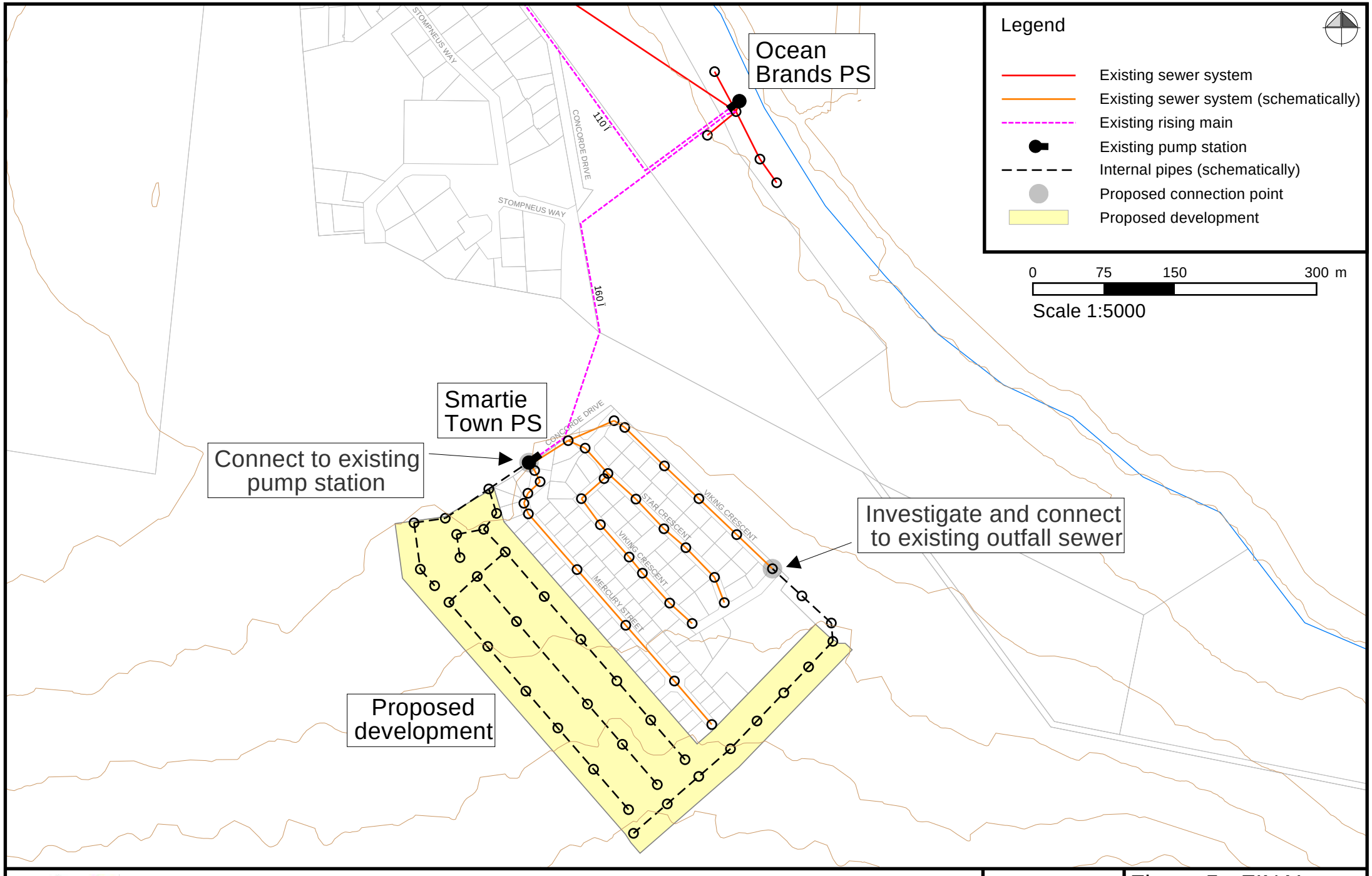
Proposed development of 200 IRDP Housing Units in Stompneus Bay - St Helena Bay

SALDANHA BAY MUNICIPALITY | MUNICIPALITY | UMASIPALA

GLS Infrastructure planning

Figure 4 - FINAL

Proposed development
Stompneus Bay IRDP
Housing - St Helena Bay
Water master plan

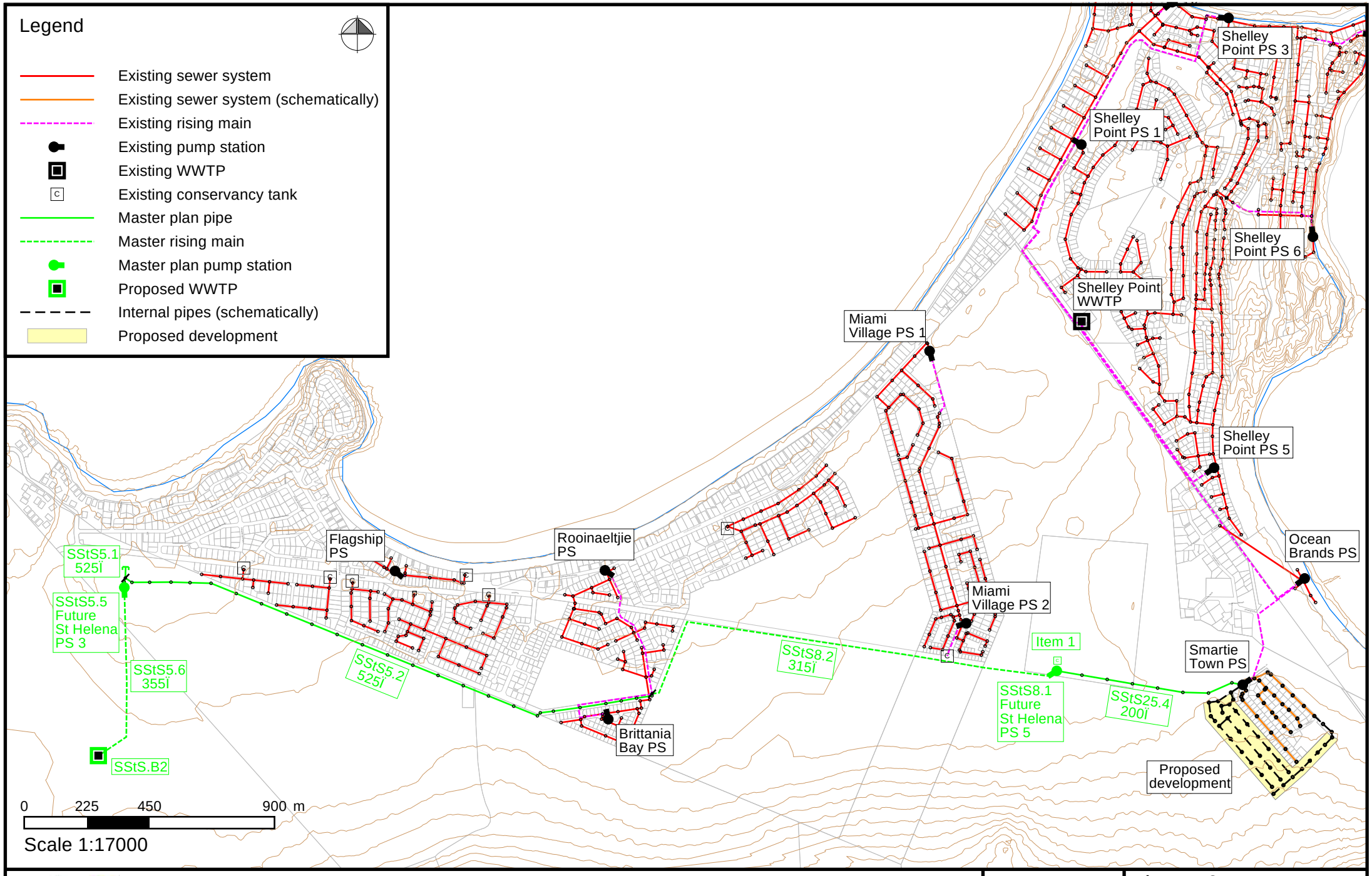


April 2024

Proposed development of 200 IRDP Housing Units in Stompneus Bay - St Helena Bay

GLS Infrastructure planning

Figure 5 - FINAL
Proposed development
Stompneus Bay IRDP Housing - St Helena Bay
Existing sewer system



April 2024

Proposed development of 200 IRDP Housing Units in Stompneus Bay - St Helena Bay

Figure 6 - FINAL

Proposed development
Stompneus Bay IRDP Housing -
St Helena Bay
Sewer master plan

Annexure C:

Street Layout

LEGEND - ROAD

ITEM	NEW
ROAD AT 5,0m WIDE	
ROAD AT 5,5m WIDE	

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL PLAN

NOTES

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE	PR No	DATE
	200770016	MAY 2024

CLIENT

SIGNATURE	DATE

DESIGNED	DRAWN	CHECKED
JdeK	JdeK	JdeK

PRELIMINARY

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CLIENT

SALDANHA BAY MUNICIPALITY

PROJECT

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN, ST HELENA BAY

DRAWING DESCRIPTION

PROPOSED STREET LAYOUT

DATE	SCALE	ORIGINAL SIZE
MAY 2024	1:750	A1

DRAWING NUMBER	REV
P09414/02	00

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Annexure D:

Sewer Layout

LEGEND - SEWER

ITEM	EXISTING	NEW
EXISTING Ø160mm SEWER PIPE		
Ø160mm uPVC CLASS 34 SEWER PIPE		
SEWER MANHOLE		
CONNECTING TO EXISTING SYSTEM		

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL PLAN

NOTES

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE

200770016 PR No

MAY 2024 DATE

CLIENT

SIGNATURE DATE

DESIGNED	DRAWN	CHECKED
JdeK	JdeK	JdeK

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PROJECT

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN, ST HELENA BAY

DRAWING DESCRIPTION

PROPOSED SEWER LAYOUT

DATE	SCALE	ORIGINAL SIZE
MAY 2024	1:750	A1

DRAWING NUMBER P09414/04

REV 00

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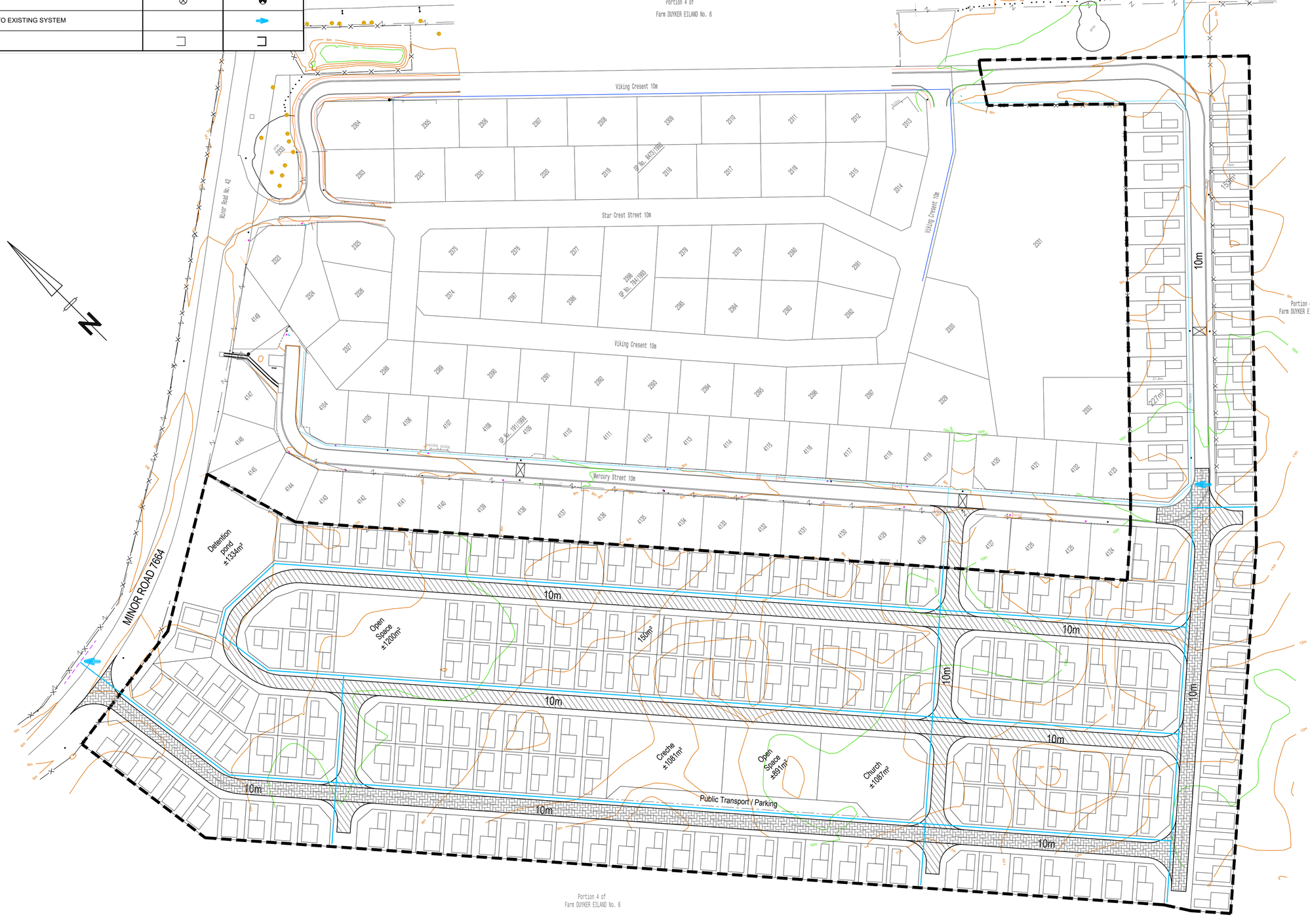
Annexure E:

Water Layout

LEGEND - WATER

ITEM	EXISTING	NEW
EXISTING Ø75mm WATER PIPE		
EXISTING Ø200mm WATER PIPE		
EXISTING Ø150mm WATER PIPE		
Ø110mm WATER PIPE		
WATER VALVE		
FIRE HYDRANT		
CONNECTING TO EXISTING SYSTEM		
ENDCAP		



SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL PLAN

NOTES

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | 200770016 PR No | MAY 2024 DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED
JdeK	JdeK	JdeK

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PROJECT

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN, ST HELENA BAY

DRAWING DESCRIPTION

PROPOSED WATER LAYOUT

DATE	SCALE	ORIGINAL SIZE
MAY 2024	1:750	A1

DRAWING NUMBER P09414/03 | REV 00

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Annexure F:

Stormwater Layout

LEGEND - STORMWATER

ITEM	EXISTING	NEW
STORMWATER PIPE		
375mm STORMWATER PIPE		
450mm STORMWATER PIPE		
MANHOLE		
CATCHPIT		
IN-OR OUTLET		
CONNECTING TO EXISTING SYSTEM		
MANHOLE WITH PIPE		

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50

50mm ON ORIGINAL PLAN

NOTES

No	DATE	DESCRIPTION	DRW	CHK

REVISION SCHEDULE

CONSULTING ENGINEER

SIGNATURE | 200770016 PR No | MAY 2024 DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED
JdeK	JdeK	JdeK

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CLIENT

SALDANHA BAY MUNICIPALITY

PROJECT

CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN, ST HELENA BAY

DRAWING DESCRIPTION

PROPOSED STORMWATER LAYOUT

DATE	SCALE	ORIGINAL SIZE
MAY 2024	1:750	A1

DRAWING NUMBER: P09414/05 | REV: 00

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Annexure G:

Anticipated Planning Programme & Preliminary Project Implementation Programme (Construction)

P09414 : CIVIL ENGINEERING SERVICES FOR STOMPNEUS BAY 214 IRDP ERVEN (ST HELENA BAY)

ANNEXURE F: ANTICIPATED PLANNING PROGRAMME (CIVIL SERVICES)

2024-05-07

	Description	Due Date
1.	**PLANNING, DESIGN AND CONSTRUCTION PHASE:**	
1.1	**Geotechnical report Phase 1:**	
1.1.2	Geotechnical report (complete)	5 February 2024
1.2	**Water and sewer investigations (GLS):**	
1.2.1	Appointment of subconsultant (SBM)	22 November 2023
1.2.2	Investigation report (start)	22 April 2024
1.2.3	Investigation report (complete)	3 May 2024
1.3	**EIA, LUPO & Town Planning (EIA & LUPO process):**	
1.3.1	Appointment of subconsultants (SBM)	22 November 2023
1.3.2	Topographical survey complete	9 February 2024
1.3.3	Determine scope of Environmental & Heritage assessment (BA)	26 April 2024
1.3.4	Complete special reports for environmental application	8 March 2024
1.3.5	Urban Design Prepare viable layout plan	8 March 2024
1.3.6	Draft layout submitted to Saldanha Bay Municipality (SBM)	8 March 2024
1.3.7	Draft layout approved by SBM	19 April 2024
1.3.8	Subconsultants assist with Project Feasibility Report (PFR)	13 May 2024
1.3.9	Start with Basic Environmental Assessment	3 May 2024
1.3.10	Basic Environmental Assessment complete (estimated)	21 February 2025
1.3.11	Start with Land Use application	7 May 2024
1.3.12	Land Use application complete	16 June 2025
1.3.13	General plan (GP) approved	29 August 2025
1.4	**Preliminary Engineering report (Civil services):**	
1.4.1	Preliminary Engineering Services report (Civil services)	10 May 2024
1.5	**Project Feasibility Report (PFR) (Civil services):**	
1.5.1	iX engineers submit PFR (Civil services) to SBM	**17 May 2024**
1.5.2	Await approval of Project Feasibility Report (PFR) (4 months)	**20 September 2024**
1.6	**SBM decision to proceed with project (SBM) (3 months):**	3 November 2025
1.7	**SBM to tender & appoint Consultant (SBM) (3 months):**	3 March 2026

1.8	**Design and tender (Civil):**	
1.8.1	Civil services Design and complete tender (Consultant – allow 12 weeks)	3 June 2026
1.8.2	Approval of design and tender (SBM – allow 4 weeks)	3 July 2026
1.8.3	PIRR report (SBM & Consultant – allow 2 weeks)	17 July 2026
1.8.4	PIRR report approval by Department (allow 2 months)	17 September 2026
1.8.5	Tender process (allow 10 weeks)	30 November 2026
1.9	**Construction (internal civil services):**	
1.9.1	Appointment of Civil Contractor (SBM)	29 February 2027
1.9.2	Site hand-over (allow 21 day appeal period)	21 March 2027
1.9.3	End of Construction (allow 6 months construction period)	30 September 2027
1.10	**Retention period (Civil services):**	
1.10.1	End of retention period (Civil services)	30 September 2028

* **The dates of the Programme is subject to Draft layout accepted by SBM, Department & EIA approval by DEA&DP on or before the due dates.**

Annexure H:

Stormwater Management Plan (Stompneus Bay IRDP) – iX engineers

STOMPNEUS BAY IRDP

STORMWATER MANAGEMENT PLAN

FINAL

P09414

MAY 2024

COMPILED FOR:	COMPILED BY:
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ANNEXURES

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Annexure B – Proposed Site Development Plan

Annexure C – Existing Services and Survey

Annexure D – Geotechnical Investigation

Annexure E – Proposed Stormwater Infrastructure

Annexure F – Peak Flow Calculations

Annexure G – Attenuation Calculations

Annexure H – Rainfall and Evaporation Data

1 INTRODUCTION AND LOCALITY

iX Engineers was appointed to investigate and report on the stormwater management of the proposed development of portion 4 of farm 6 in Stompneus Bay. This report addresses the stormwater attenuation and management for the development.

The site is located along the west coast, between Britannia Bay and St Helena Bay with GPS Coordinates 32°43'43.7" and 17°58'27.1", refer to **Annexure A** - Locality Plan.

The size of the portion of farm is 614.9ha and the area to be developed is 5.92ha. The site is currently vacant and bound by the existing Stompneus Village to the north-east, vacant land to the south and west and with Minor Road 7664 on the northern boundary.

The proposed development will consist of 214 residential erven with sizes varying between 150m^2 and 227m^2. The development will also include public open spaces, a creche and a church.

The full extent of the proposed development shown in **Annexure B** – Proposed Site Development Plan.

2 SCOPE OF THE SWMP

This report details the approach and methodology used to compile the stormwater management plan and provides design peak flow rates, as well as conceptual design details of the conveyances required to effectively manage stormwater runoff generated on the proposed development site and surrounding catchment area.

The stormwater management plan was executed through the following stages:

- Data collection;
- Catchment delineation and determination of catchment parameters;
- Obtain rainfall and evaporation data;
- Hydrological calculations;
- Stormwater management analysis and planning;
- Preliminary layout planning and conceptual design of the major stormwater drainage system including flood escape routes;
- Reporting.

3 DATA AND INFORMATION

The following information was available and collected for this study:

- 1 in 50 000 Topographical Maps and 20m contours (Department of Land Affairs, Chief Directorate of Survey and Mapping): 3217DB & DD Vredenburg from the National Geospatial Information site http://www.cdngiportal.co.za/cdngiportal/;
- Topographical site survey used for design from CK Rumboll & Partners;
- Google Earth Imagery (2024);
- Photos from site visit – 18 April 2024;
- Rainfall Data from South Africa Weather Bureau – Rainfall Station 0060864W Vredenburg;
- Rainfall and Evaporation data from Department of Water and Sanitation Website;
- "The Neighbourhood Planning and Design Guide Part 2 – Planning and Design Guidelines", developed by the Department of Human Settlements, dated July 2019 (Revised Red Book);
- As-built information supplied by Element Engineers, BKS Engineering and Management and iX Engineers;
- Construction drawings of Upgrading of the Main Road 00533 between KM22 and KM23 from Ero Engineers;
- Geotechnical Investigation by Gondwana Geo Solutions.

4 SITE TOPOGRAPHY AND GEOTECHNICAL CONDITIONS

4.1 TOPOGRAPHY

The extent of the proposed development on Portion 4 of Farm 6 is approximately 5.92ha in total. A topographical survey was conducted by CK Rumboll & Partners and 0.5m contours were provided.

Refer to **Annexure C** – Site Survey and Existing Stormwater Infrastructure. The proposed site to be developed is reasonably flat with a natural slope of 1.5% from the south to the north.

The site currently has no building or structures on it and the vegetation consist mainly of grasslands.

Figure 1: Proposed site viewed in a southern direction from Minor Road 7664

Bulk earthworks will allow the site to be free-draining and eliminate localized low points. The earthworks will generally consist of shaping of the existing terrain to slope constantly towards Minor Road 7664 along the northern boundary where the natural low point is.

4.2 GEOTECHNICAL CONDITIONS

A geotechnical investigation was undertaken by Gondwana Geo Solutions in February 2024, and the in-situ material was found to be favourable for the proposed development. The site is underlain by a mantle of dune sands and calcareous sands overlying pedogenic calcrete and/or dorbank cemented horizons, known as “brackish calcareous soil”.

No groundwater seepage was encountered in any of the trail pits which depth ranged between 2.1m and 3. 0m deep. However, perched groundwater flows could be expected between the soil and calcrete interfaces during rainy months. Subsoil drains are proposed for all roads, parking areas and paved areas to protect the structural layers from water ingress during heavy rainfall periods.

Since the permeability rate was not evaluated during the geotechnical investigation laboratory testing, the soil classification according to the SCS Soil Groups were used to determine the permeability of the material on site. According to the Distribution of SCS Soil Groups(Schulzer, 2010), the Stompneus Bay area falls within the Soil Group B region and the material can be classified as soil with a moderate infiltration rate.

A moderate infiltration rate typically varies between 20mm/hour and 63mm/hour. Sand typically has a permeability rate of 180mm/hour and calcrete typically infiltrates at 12mm/h.

See attached geotechnical report in **Annexure D** – Geotechnical Report.

5 EXISTING STORMWATER SYSTEM

There is currently no formal stormwater infrastructure on the proposed development area. The existing Stompneus Bay residential area adjacent to the proposed development area do have stormwater infrastructure which drains in a northern direction and discharges into an existing attenuation facility situated at the intersection of Main Road 00533 and the Minor Road 7664.

Refer to **Annexure C** – Site Survey and Existing Stormwater Infrastructure.

The existing infrastructure consists mainly of kerb inlets, manholes and Ø375mm and Ø450mm stormwater pipes. The attenuation facility of the existing residential area currently has two inlet pipes and no outlet pipe. It is assumed that the pond empties by a combination of infiltration and evaporation.

The footprint of the attenuation facility is ±300m^2 and 1.35m deep and fenced off. The current capacity of the facility is calculated as 405m^3. Refer to figure 2 below for a photo of the facility.

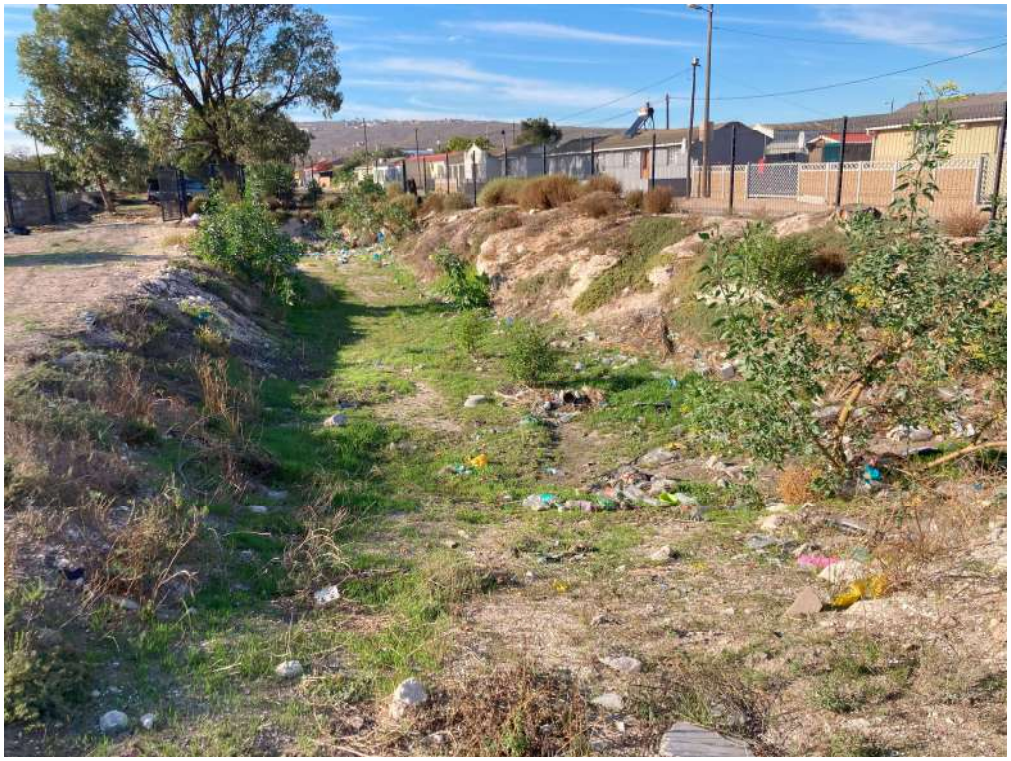

Figure 2: Existing attenuation facility at the intersection of Minor Road 7664 and Main Road 00533

The Main Road 00533 adjacent to the existing Stompneus Bay residential area is currently undergoing construction upgrades. Construction drawings were obtained from ERO Engineers who is the consulting engineers responsible for the design of the upgrading to Main Road 00533.

According to the construction details, the section of road adjacent to the existing Stompneus Bay residential area will have an unlined side drain on the side of the road, adjacent to the existing attenuation facility. A Ø600mm pipe culvert is proposed to cross Minor Road 7664 to drain the road runoff from the side drain in a northern direction towards the ocean. The figure below shows the current state of the Main Road 00533 construction works.

Figure 3: Main Road 00533 adjacent to the existing attenuation facility

6 CATCHMENT DELINEATION

The proposed site forms part of a larger catchment area draining from a high point towards the coastline in a south to north direction. The larger catchment area is 123.7ha in size and have an average slope of 5.3% towards the coastline.

The figure below shows the extent of the catchment area.

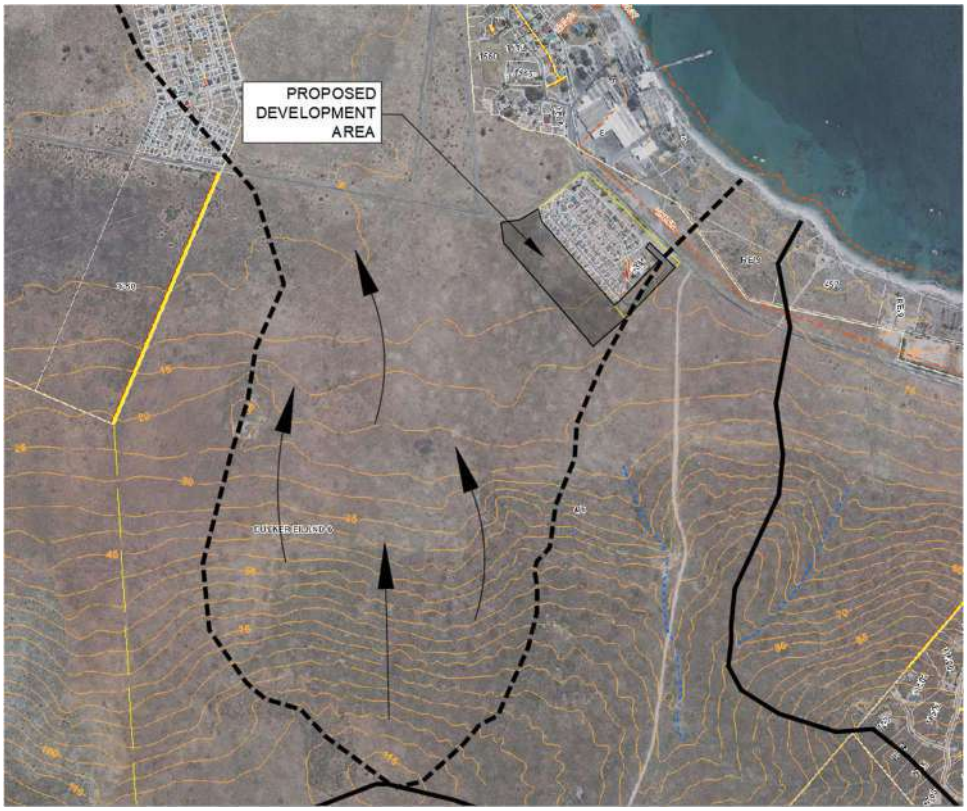

Figure 4: Catchment Area draining towards proposed Stompneus Bay development

The pre-developed stormwater runoff generated within the boundaries of the proposed development currently flows overland towards Minor Road 7664.

It is proposed that an earth berm/cut-off channel be constructed behind the erven along the south-west boundary of the proposed development. This is to prevent runoff from the larger catchment area to enter the development properties, but rather be channelled towards the Minor Road 7664 as it naturally flows.

Due to the limited existing stormwater infrastructure in the area, it was decided to also investigate the existing attenuation facility in the Stompneus Bay residential area.

Therefore, two catchment areas were evaluated, one being the proposed development area(Catchment A) and the other being the existing residential area(Catchment B).

The figure below shows the catchment delineation of the two areas below.

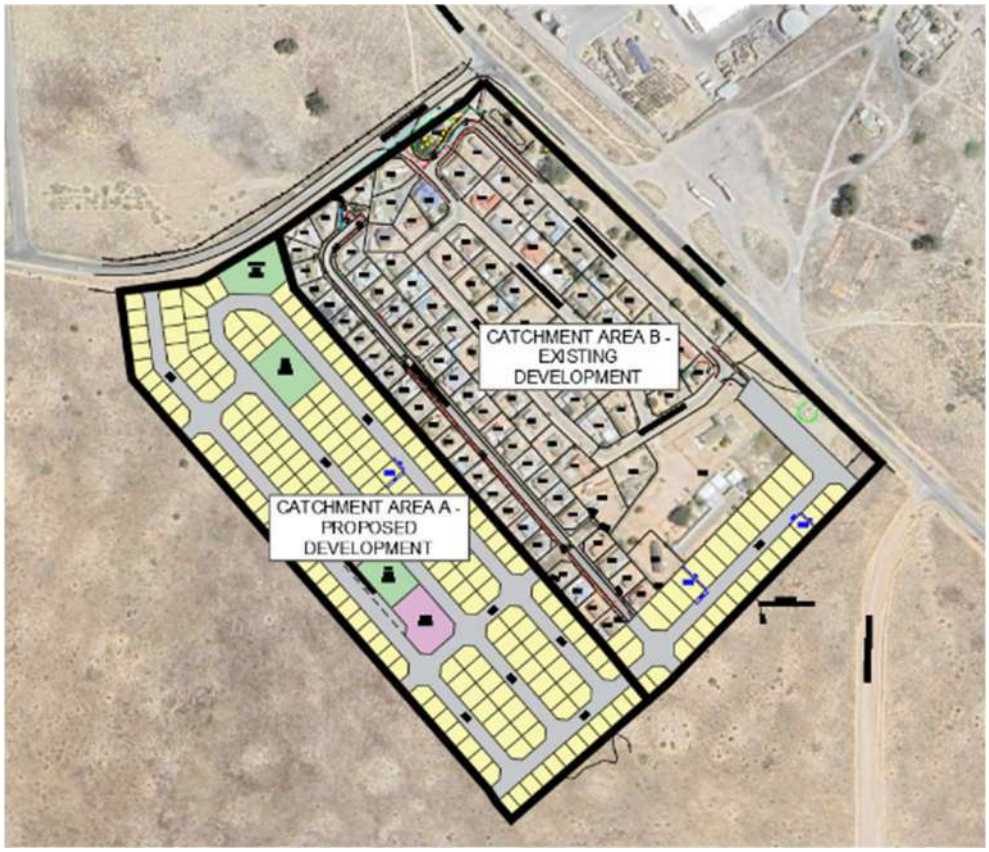

Figure 5: Catchment Areas

7 STORMWATER MANAGEMENT

The “Neighbourhood Planning and Design Guide”, also referred to as the revised Red Book, states that the minor stormwater system for a residential development should be designed to accommodate the 1:5 year stormwater peak flows.

Therefore, the minor drainage system for the proposed Stompneus Bay development will be designed to accommodate the 1:5 year storm runoff generated on site and discharge into the proposed attenuation facility. The minor drainage system will consist of kerb inlets, grid inlets and stormwater pipes conveying the stormwater runoff to proposed attenuation facility.

The following items were considered in the preliminary design stage:

- Bulk earthworks to eliminate any low laying trapped low points in the development;
- Minor stormwater system with sufficient capacity for up to the 1:5 year storm;
- Using the roads to convey the overland runoff from storms larger than 1:5 year return period and up to the 1:50 year return period;
- Attenuation facility to reduce the post-developed flows to pre-developed flows;
- Overland escape routes for the 1:100 year storm.

A stormwater attenuation facility is proposed for the development area to reduce the post-developed peak flows to the pre-developed peak flows for the site. This will ensure that the existing stormwater infrastructure still have sufficient capacity, as the runoff being discharged will not exceed the runoff that was discharged prior to the construction of the new development.

It is proposed that the outflow and emergency overflow from the new attenuation facility be discharged into the downstream existing attenuation facility as this is the natural lowest point and the current pre-developed runoff is also discharged into this pond.

In order to further reduce the volume of runoff being discharged to the existing attenuation facility, it was decided to size the proposed attenuation facility for the 1:100 year storm event and to limit the outflow towards the existing attenuation facility to the 1:2 year pre-developed flows.

The proposed attenuation facility should also be designed with an emergency overflow should a larger storm event occur than the 1:100 year event.

The bulk earthworks design, in combination with the development layout, will ensure that the emergency overflow will drain in an earth channel towards the existing attenuation facility. The overland drainage routes are shown on the drawing in **Annexure E**.

It is proposed that the existing attenuation facility be cleared from grub and rubble and be enlarged to provide more capacity within the facility.

8 STORMWATER RUNOFF VOLUME MANAGEMENT

8.1 STORMWATER RUNOFF

When calculating the peak flows for the two catchment areas, the South African Weather Bureau rainfall station data was used. The closest rainfall station to the site is 0060864W Vredenburg (Pol), with a mean annual precipitation of 275mm. The following table summarizes the rainfall depths of the relevant rainfall station.

Table 1: Rainfall Data for SAWB station 0060780W Saldanha Bay

Recurrence Interval	1:2 Year	1:5	1:10	1:20	1:50	1:100
1 day depth (mm)	26.0	35.0	41.0	47.0	54.0	59.0
24 h depth (mm)	28.9	38.9	45.5	52.2	59.9	65.5

The rational method was then used to determine the pre- and post-development stormwater runoff for the various recurrence intervals of the proposed development area. The peak flows were calculated for the subcatchment areas.

The pre-developed and post-developed peak flows were calculated with a c-values as per the Drainage Manual. The peak flow calculations are shown in **Annexure F** – Peak Flow Calculations with the peak flows summarized in Table 2 below.

Table 2: Storm run-off for the for Stompneus Bay Existing and Proposed Residential Areas

Catchment Area (Figure 5)	1:2 Runoff (m3/s)	1:5 Runoff (m3/s)	1:10 Runoff (m3/s)	1:20 Runoff (m3/s)	1:50 Runoff (m3/s)	1:100 Runoff (m3/s)
Catchment A: Pre-developed	0.041	0.061	0.078	0.100	0.142	0.178
Catchment A: Post-developed	0.211	0.284	0.333	0.382	0.438	0.488
Catchment B: Pre-developed	N/A					
Catchment B: Post-developed	0.323	0.435	0.509	0.584	0.671	0.733

8.2 PROPOSED STORAGE FACILITIES

The required storage capacity to reduce the 1:50 year storm and the 1:100 year storm peak flows to 1:2 year pre-developed peak was calculated for catchment area A and B is summarized in table 3 below.

Table 3: Pond Volumes required for stormwater attenuation

Catchment Area (Figure 5)	1:10 Pond Volume (m^3)	1:50 Pond Volume (m^3)	1:100 Pond Volume (m^3)	Outflow (1:10 pre-developed)
Catchment A (new facility)	466.6	689.3	780.3	41ℓ/s in Ø250mm SW pipe at 1:250 slope
Catchment B (existing facility)	1355.6	1958.8	2195.9	7ℓ/s infiltration & 24hour storm period

Refer to **Annexure G** for the attenuation calculations of the required storage capacities for each catchment area. In **Annexure E** the proposed pond's position and outflow route is shown.

8.3 PROPOSED ATTENUATION FACILITY

Sufficient space was allowed for the new attenuation facility in the site development plan to reduce the 1:100 year post-development peak runoff to the 1:2 year pre-developed peak runoff. An area of 1334m^2 was allowed for in the site development plan.

The proposed facility is shown of the drawing in **Annexure E**. It is proposed that the attenuation facility is 1.1m deep with 1 in 3 side slopes as a safety precaution and to reduce possible erosion along the embankments. The proposed facility will have a capacity of 830m^3 which is more than the required 780m^3 for the 1 in 100 year storm event.

It is further proposed that the pond be fenced around to reduce rubble dumping and prevent people from entering the pond. Safety signage should also be erected around the attenuation facility. Clearview or Betafence type fencing is proposed to match with the fencing at the existing attenuation facility.

To restrict the outflow of the proposed facility, an Ø250mm outlet pipe at a slope of 1:250 to the existing facility is proposed.

The outlet pipe will only discharge the pre-developed 1 in 2 year runoff towards the existing facility.

Although the facility is designed for the 1:100 year storm event, an emergency overflow is also proposed, should a larger storm event occur, or to serve as a backup should the outflow pipe be blocked of damaged. The overflow is proposed as an open channel which could be lined with amorflex to prevent erosion along the Minor Road 7664 up to the existing facility.

8.4 EXISTING ATTENUATION FACILITY

The capacity of the existing attenuation facility is currently calculated as 405m^3 which is not sufficient for the 1 in 10 year storm event. This is mainly due to the absence of an outlet. During the site visit the facility was completely dry, it is evident that between the infiltration and the evaporation the pond does empty between storm events.

It is however proposed that the facility be widened towards the Main Road and also be extended in a southeast direction by approximately 20m. The depth of the facility could also be increased from 1.35m to 2.5m. By extending and deepening the existing facility, the capacity could be increased to 1400m^3. The proposed extended attenuation facility is shown on the drawing in **Annexure E**.

As there is no existing stormwater system to connect to, an outlet pipe for the existing facility will have to be constructed to discharge into the ocean. This will trigger an environmental approval process and since the quality of stormwater might vary between dry periods and wet periods it cannot be guaranteed that the stormwater discharging into the ocean will be pollution free. Therefore, alternative methods were investigated to empty the attenuation facility such as infiltration and evaporation.

Based on an average infiltration rate of 100mm/hour since the in-situ material was classified as sand(180mm/h) and calcrete(12mm/h), the infiltration over the extended surface area of 250m^2(for an almost empty pond) will be 600m^3 per day, or 7ℓ/s.

Evaporation rates from the nearest meteorological station were obtained from the Department of Water and Sanitation. The nearest station is G1E007 at Langebaan Road

with 27 years of data. The graph below summarizes the rainfall and evaporation depths per month for a hydrological year.

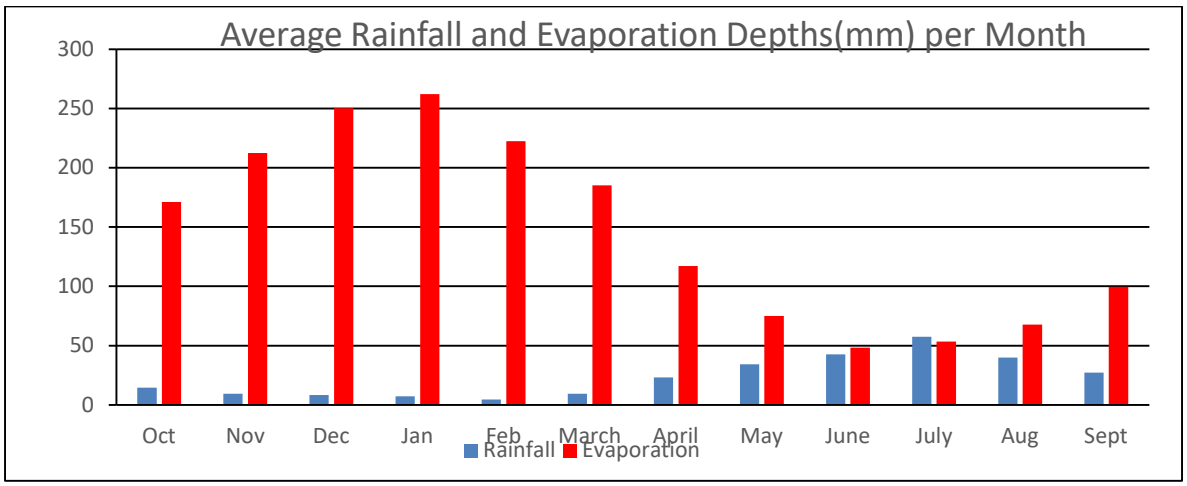

Figure 6: Summary of average rainfall and evaporation at station G1E007

Based on the average evaporation over the surface area of the pond, the annual evaporation per year is calculated as 1552.8m^3. The rainfall and evaporation data from station G1E007 is shown in **Annexure H**.

The extended capacity of the existing facility in combination with the infiltration and evaporation of the facility should provide sufficient storage during storm events. It is recommended that the existing fencing also be extended around the facility to prevent people from entering the area and that safety signage be installed.

The facility currently has no formal overflow. Although the runoff in the facility should infiltrate at a fairly quick rate, an emergency overflow is proposed in the event of a major storm where the runoff rate exceeds the infiltration rate, and the facility is already to full capacity. The overflow is proposed at the northern corner of the facility, as shown in **Annexure E**.

The overflow can be in the form of a shaped open channel towards the unlined side drain of Main Road 00533. The runoff will be conveyed across Minor Road 7664 by means of the new Ø600mm pipe culvert and from there the runoff should be able to drain along the road towards the ocean. This will ensure that the runoff drains away from the existing dwellings adjacent to the facility.

9 ESTIMATE OF PROPOSED BULK STORMWATER INFRASTRUCTURE

The proposed attenuation facility was sized to provide capacity for the 1 in 100 year storm runoff with outflow equivalent to the 1 in 2 year pre-developed flows. The following estimate is a high order cost estimate, a detail design with detailed estimate is recommended before the project continue to construction stage.

The estimate allows for clear and grub as well as rubble clearance at the existing attenuation facility. Allowance was made for the necessary excavation and backfill of the proposed facility and the extended existing facility. Some quantities for gabions were included in the estimate should it be decided at detail design stage to construct the emergency overflow at the proposed attenuation facility with gabions and reno mattresses.

Clearview/Betafence type fencing and access gate was included in the estimate around the new facility in order to match the fencing around the existing facility. Allowance was also made in the estimate for the extension of the existing fencing around the existing attenuation facility.

Table 4: Cost Estimate

DESCRIPTION	AMOUNT R
PRELIMINARY AND GENERAL	R400 077.70
SITE CLEARANCE	R112 860.00
EARTHWORKS	R1 011 010.00
GABIONS AND PITCHING	R75 405.00
STORMWATER DRAINAGE	R619 260.00
SUBTOTAL	R2 218 612.70
10% CONTINGENCIES	R221 861.27
SUBTOTAL	R2 440 473.97
15% VAT	R366 071.10
TOTAL	**R2 806 545.07**

The estimated total cost including VAT and contingencies amounts to R 2 806 545.07 for the construction of the new attenuation facility with outflows and the extension of the existing attenuation facility.

10 STANDARD OPERATING PROCEDURES FOR MAINTENANCE

It is proposed that a maintenance program be implemented to do regular cleaning and maintenance on the stormwater infrastructure. The purpose of such a maintenance program is to organise and coordinate the maintenance and monitoring of all stormwater infrastructure within the proposed development area.

The recommended main actions for stormwater maintenance should include the activities provided in the following table.

Table 5: Stormwater maintenance activities for attenuation pond

Activity	Schedule
Assess kerb inlets, grid inlet, manholes, pipes, and open kerb channels for structural damage and repair all damaged infrastructure	Quarterly
Clean all grid inlets, kerb inlets and manholes from litter and sediment	Monthly in winter months – April to August
Flush pipes to clear sediment	Annually in April, at the beginning of winter the months
Clean open channels from debris and repair erosion, trim grass	Quarterly
Remove sediment and debris from inlet to attenuation pond	Monthly
Assess and clean attenuation facility	Annually in April, at the beginning of winter the months
Stabilize any eroded vegetation areas in attenuation facility	As and when needed

11 CONCLUSIONS AND RECOMMENDATIONS

From this SWMP it can be concluded that the stormwater management of the proposed development will adhere as far as possible to the guidelines as set out in The Neighbourhood Planning and Design Guide (Version 1.1. July 2019) and best practices.

An earth berm/cut-off channel is recommended along the south-west boundary of the proposed development to prevent runoff from the larger catchment area to enter the development properties.

A new attenuation facility is recommended for the new development area which will reduce up to the 1 in 100-year post-developed peak runoff to the 1 in 2-year pre-developed runoff. An emergency overflow will also form part of the design of the storage facility should a storm exceeding the 1 in 100-year storm occur. The new facility should be fenced and safety signage should also be put in place to ensure the safety of residents.

It is recommended that the existing attenuation facility be extended, an emergency overflow be constructed, and the extended facility be fenced off.

It is therefore, recommended that this Stormwater Management Plan be approved for the proposed development of 214 erven on Portion 4 of Farm 6 in Stompneus Bay.

Annexure A – Locality Plan

C:\BNC\BNC Engineering\BNC 24004 -Stompneus Bay SWMP\SWMP\Stompneus Bay SWMP Drawings - Apr 2024.dwg

FOR INFORMATION

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

23/04/2024 3:59:00 Printed By: Esmare Erasmus

REVISION SCHEDULE

No	DATE	DESCRIPTION
A	26/04/2024	FOR INFORMATION

CONSULTING ENGINEER

Erasmus — SIGNATURE | 201370381 — PR No | 03/05/2024 — DATE

CLIENT

SIGNATURE | DATE

CLIENT

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PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

LOCALITY PLAN

DESIGNED	DRAWN	CHECKED
EE	EE	EE

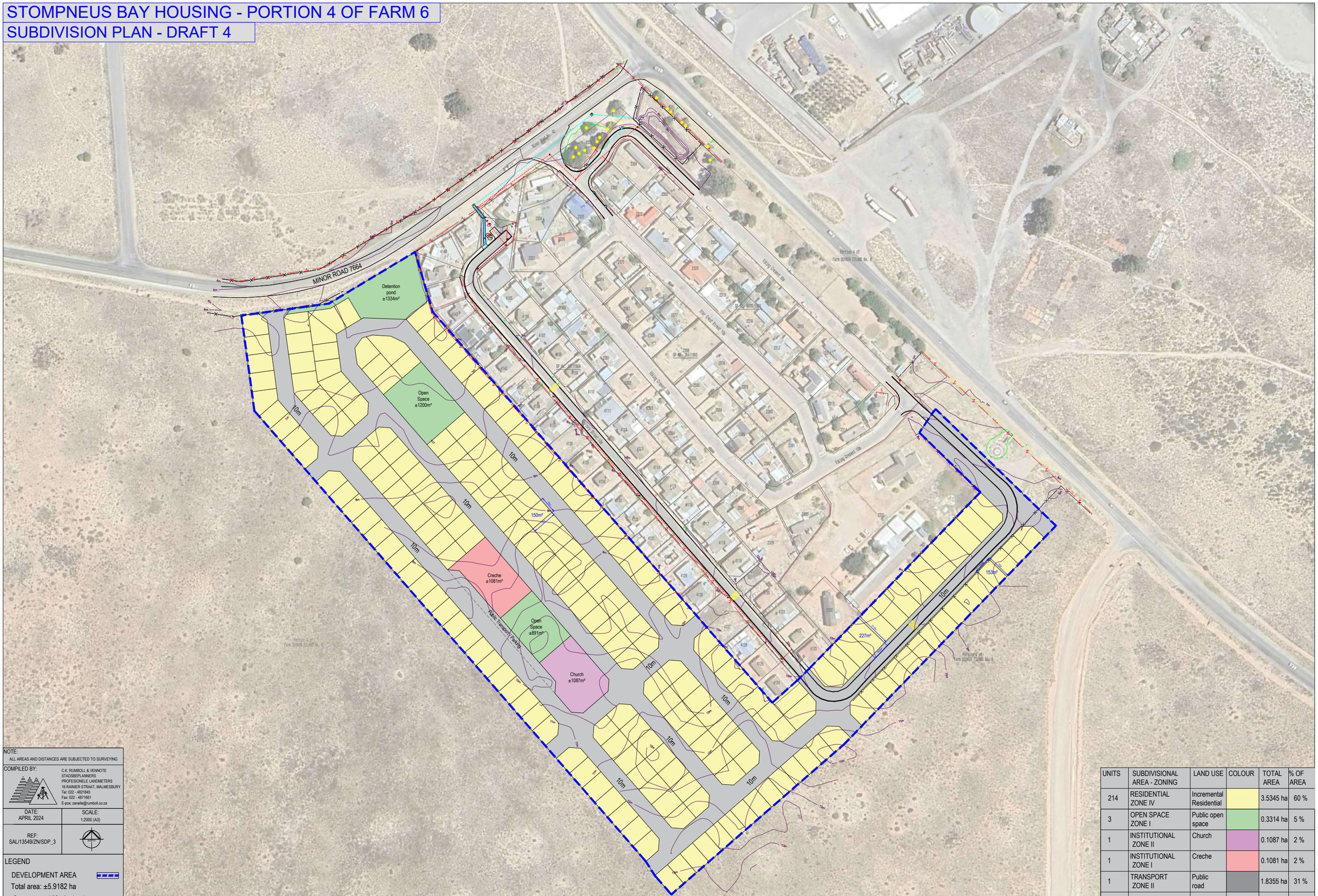
DATE	SCALE
APRIL 2024	1:20 000

DRAWING NUMBER	REV
P09414-SW-001	A

Annexure B – Proposed Site Development Plan

STOMPNEUS BAY HOUSING - PORTION 4 OF FARM 6

SUBDIVISION PLAN - DRAFT 4



NOTE:
ALL AREAS AND DISTANCES ARE SUBJECTED TO SURVEYING

COMPILED BY:
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DATE:	SCALE:
APRIL 2024	1:2000 (A3)
REF: SAL/13549/ZN/SDP_3	

LEGEND

DEVELOPMENT AREA

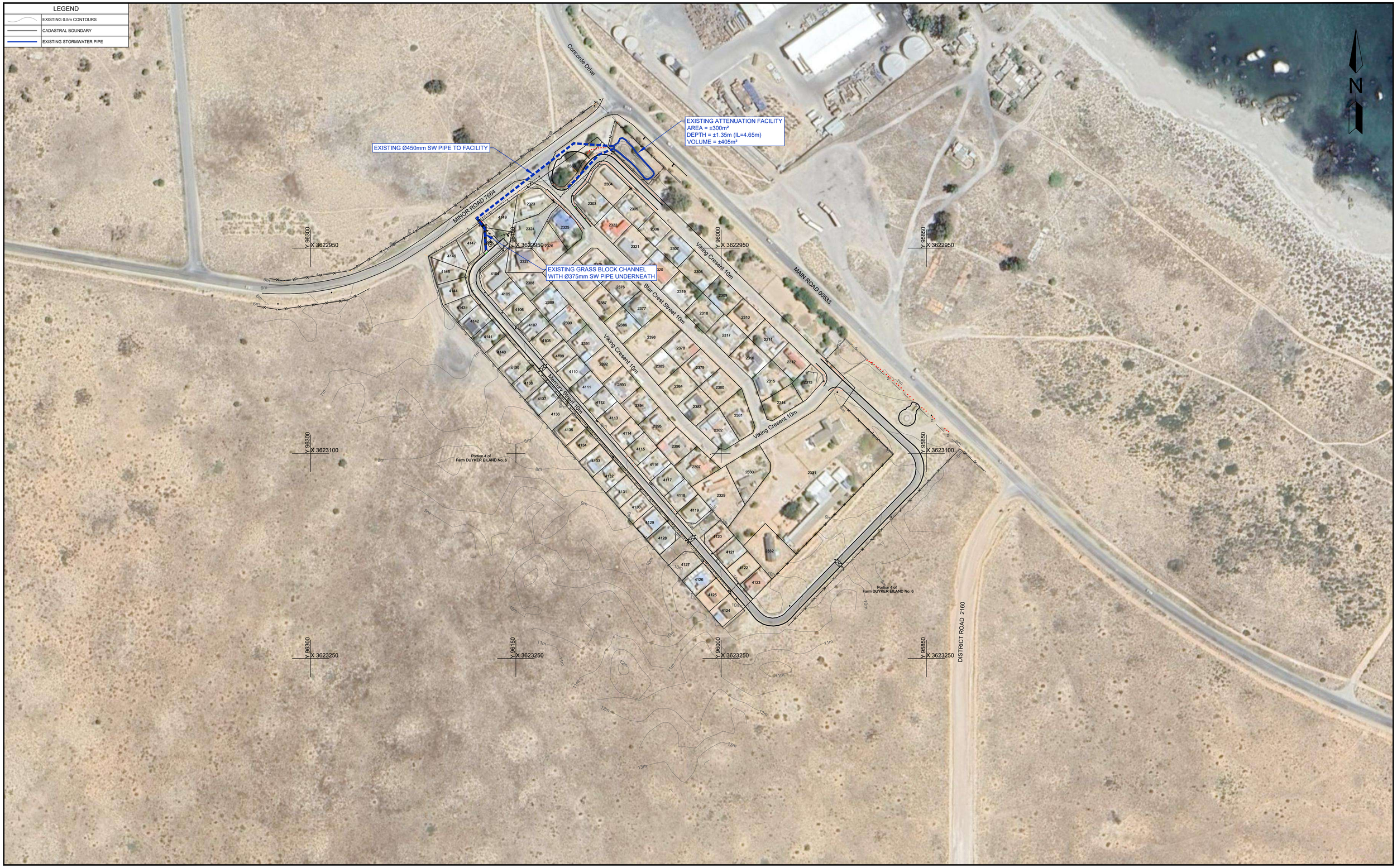
Total area: ±5.9182 ha

On average 150m² sized erven

214 UNITS

UNITS	SUBDIVISIONAL AREA - ZONING	LAND USE	COLOUR	TOTAL AREA	% OF AREA
214	RESIDENTIAL ZONE IV	Incremental Residential		3.5345 ha	60 %
3	OPEN SPACE ZONE I	Public open space		0.3314 ha	5 %
1	INSTITUTIONAL ZONE II	Church		0.1087 ha	2 %
1	INSTITUTIONAL ZONE I	Creche		0.1081 ha	2 %
1	TRANSPORT ZONE II	Public road		1.8355 ha	31 %
	TOTAL			5.9182 ha	100 %

Annexure C – Existing Services and Survey



FOR INFORMATION

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

REVISION SCHEDULE

No	DATE	DESCRIPTION	DRW	CHK
A	26/04/24	FOR INFORMATION	EE	EE

CONSULTING ENGINEER

Erasmus — SIGNATURE | 201370381 — PR No | 03/05/2024 — DATE

CLIENT

_____ SIGNATURE | _____ DATE

DESIGNED	DRAWN	CHECKED
EE	EE	EE
_____	_____	_____

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CLIENT

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PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

EXISTING STORMWATER INFRASTRUCTURE AND SURVEY

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50
50mm ON ORIGINAL PLAN

DATE	SCALE	ORIGINAL SIZE
APRIL 2024	1:1 500	A1

DRAWING NUMBER	REV
P09141-SW-002	A

Annexure D – Geotechnical Investigation

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

Project No.: 23-123R01

Date Issued: February 2024

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

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Appendix A : Test Pit Logs
Appendix B : DPL Test Results
Appendix C : Laboratory Test Results

	PREPARED:
DATE:	**February 2024**
NAME:	**Mark Richter**
SIGNATURE:	

Report to iX Engineers on a Phase 1 Geotechnical Investigation Stompneus Bay 200 IRDP Housing Project, St. Helena Bay, Western Cape

1. INTRODUCTION

At the request of Mr Jean de Klerk of iX Engineers, Gondwana Geo Solutions (Pty) Ltd (or GGS) submitted a cost estimate for a Phase 1 Geotechnical Investigation for the Stompneus Bay 200 IRDP Housing Project in Stompneus Bay near St. Helena Bay, Western Cape, on the 16th November 2023. Mr de Klerk subsequently instructed GGS to proceed with the investigation as proposed on the 5th December 2023.

This report contains the results of the geotechnical investigation, which was carried out in accordance with the guidelines of SANS 634:2012[1] for a Phase 1 Geotechnical Investigation for general township establishment.

The results of the Phase 1 geotechnical investigation are provided. Recommendations are also provided for site stability, earthworks, excavation requirements, materials usage, foundations, subgrade treatment and drainage. The site is zoned in terms of the NBRC foundation class system.

2. INFORMATION SUPPLIED

The following information was provided by Mr De Klerk:

- Google Image of the site titled *" Stompneus Bay IRDP"*
- Document titled *"Stompneus Bay IRDP Layout proposed development"*

3. SITE DESCRIPTION

The site is situated in a large open area at the north-western side of the established housing area of Stompneus Bay. It is bounded on the northeast by an existing gravel road and established housing area. It extends away from the existing township area towards the southwest and southeast. Access to the site is either off Main Street (MR0053) which connects St Helena with Stompneus, or via Concorde Road on the northwest which comes of Main Street as well.

Topographically, the site slopes downwards from the southeast to Main Street, and in the general direction of the ocean. It Is covered in short wild grass and scattered shrubs. Occasional bare ground areas and mole excavations are found between this vegetation.

The following plates provide a more detailed perspective of the site:

[1] SANS 634: GEOTECHNICAL INVESTIGATIONS FOR TOWNSHIP DEVELOPMENT 2012, pp11-16

Plates 1 to 8: General perspectives of the site taken from the north and east

The site layout is shown in Figure 1 below.

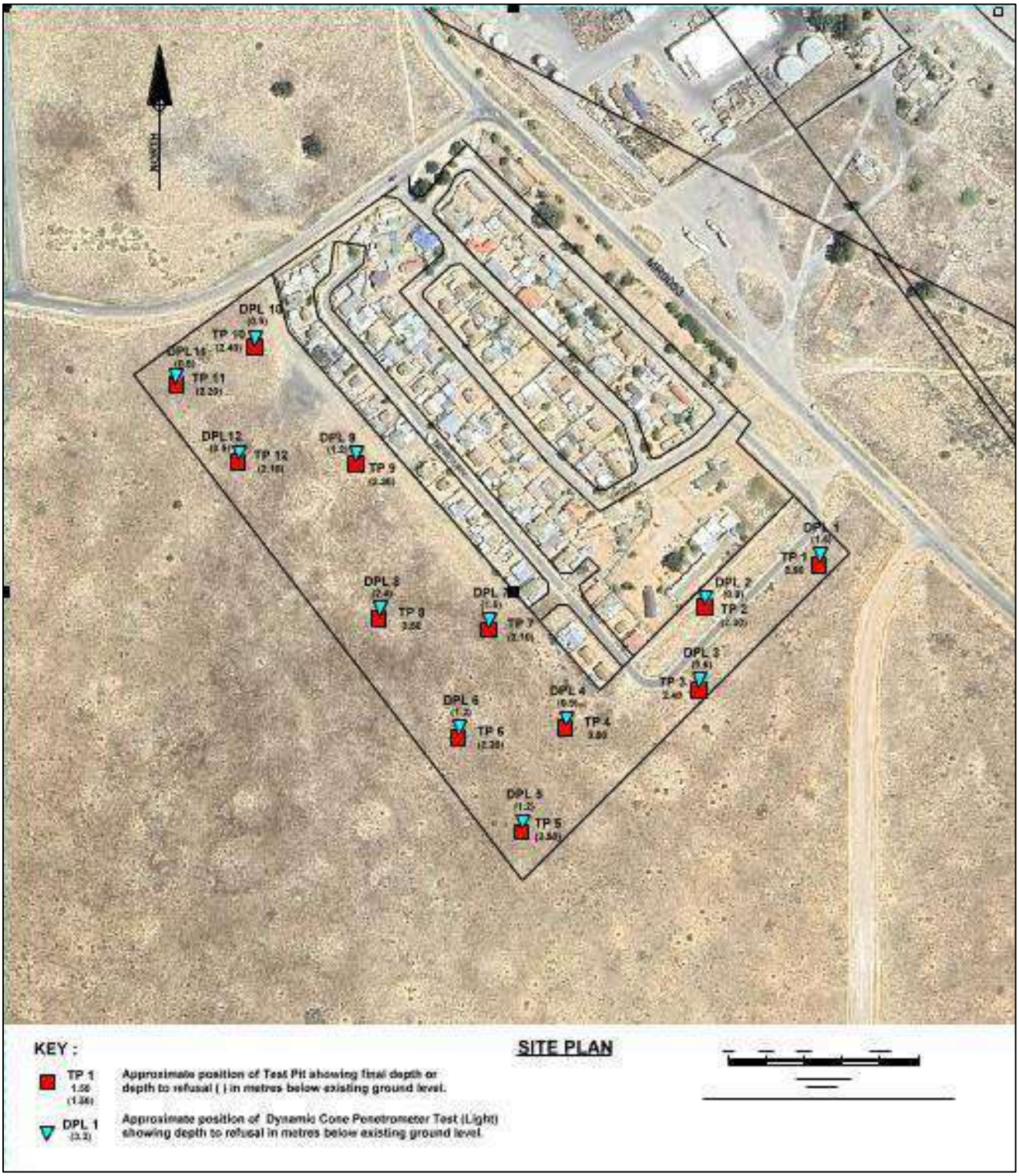


Figure 1: Site Plan showing positions of geotechnical tests

4. FIELDWORK

The fieldwork for the investigation was carried out in December 2023 and comprised the following:

- Test Pits and
- Dynamic Cone Penetrometer (Light) Tests

4.1 Test Pits

Twelve test pits, designated TP1 to TP12, were excavated by a CASE 570T TLB supplied by Superior Plant Hire in St Helena Bay at the approximate positions shown in Figure 1 to allow soil identification and sampling of the subgrade materials.

The test pits were dug to depths ranging between 2.10 and 3.00 metres below existing ground level (mbegl).
The test pits were logged and profiled[2] and representative soil samples were recovered for later laboratory testing.

The detailed logs are given in Appendix A and summarised in Table 1 below.

Table 1
Summary of Test Pit Details

TP No.	Depth (mbegl)	Geology
TP1	2.90	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-2.90m: Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand (calcified). **Final depth at 2.90m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP2	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.50m: Dry light brown mottled white very dense gravelly fine medium and coarse SAND. Fill. 0.50-1.90m: Dry light brown dense to very dense with depth poorly to moderately cemented silty fine medium and coarse SAND. Dune Sand. 1.90-2.30m: Dry light and dark brown very dense to very soft rock well cemented Hardpan Dorbank. **Final depth at 2.30m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP3	2.40	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.40m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.40-2.40m: Off white to cream mottled grey very dense with zones of very soft rock HARDPAN CALCRETE. **Final depth at 2.40m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP4	3.00	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-3.00m: Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete. **Final depth at 3.00m. No refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP5	2.50	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.60m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.60-2.50m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.50m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**

[2] Geoterminology Workshop (2002) – Guidelines for Soil and Rock Logging - SAIEG-AEG-SAICE (Geotech Div) pp47

TP No.	Depth (mbegl)	Geology
TP6	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.10m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 1.10-1.60m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. 1.60-2.30m: Dry yellowish brown mottled grey very dense to very soft rock silty gravelly SAND. Residual Granite. **Final depth at 2.30m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP7	2.10	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.30m: Dry light brown loose becoming medium dense and dense with depth silty fine and medium SAND. Dune Sand. 1.30-1.80m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. 1.80-2.10m: Dry brown mottled green very dense to very soft rock gravelly SAND. Residual Granite. **Final depth at 2.10m. Refusal.** **No groundwater seepage.** **No sidewall collapse.**
TP8	3.50	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.30m: Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete. 1.30-3.50m: Slightly moist brown apparently loose to medium dense silty fine and medium SAND. Dune Sand. **Final depth at 3.50m. No refusal.** **No groundwater seepage.** **Severe sidewall collapse below 1.30m.**
TP9	2.30	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-1.00m: Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Colluvium. 1.00-2.30m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.30m Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP10	2.40	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.80m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.80-2.40m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.40m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP11	2.20	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.60m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.60-2.20m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.20m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**
TP12	2.10	0.00-0.20m: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil. 0.20-0.80m: Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium. 0.80-2.10m: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank. **Final depth at 2.10m. Refusal on Dorbank.** **No groundwater seepage.** **No sidewall collapse.**

Note: mbegl = metres below existing ground level

The following plates provide a perspective on the site geology:

Plates 9 & 10: Test pits mostly refused at relatively shallow depths on the very dense dorbank, in some areas beneath the site

4.2 Dynamic Cone Penetrometer (Light) or DPL Tests

Nine Dynamic Cone Penetrometer (Light), or (DPL), tests, designated DPL1 to DPL9, were carried out at the approximate positions shown in Figure 1 to determine the consistency of the soils underlying the site and possible depth to bedrock or a competent founding substrate.

The DPL test comprises a 25mm diameter solid steel retractable cone driven vertically into the ground using a 10 kg hammer dropped through a height of 550mm. The resistance to penetration is measured in terms of number of blowcounts per 300mm advance. It should be noted that material on which DPL tests refuse cannot be accurately determined since the test does not allow any samples to be recovered for identification. Therefore, refusal may occur on very dense / very stiff, cemented or gravelly horizons, as well as on bedrock.

The DPL's were advanced to refusal depths of between 0.60 and 2.40 mbegl.

The results of the DPL tests, consisting of blow count and inferred consistency against depth are attached in Appendix B and summarised in Table 2 below.

Table 2
Summary of DPL Test Results

DPL No.	Depth (mbegl)	Comments
DPL1	1.50	Very loose to 0.30m Loose to 0.60m Medium dense to 1.50m Refusal
DPL2	0.90	Loose to 0.30m Medium dense to 0.90m Refusal
DPL3	0.60	Loose to 0.30m Medium dense to 0.60m Refusal
DPL4	0.90	Medium dense to 0.30m Dense to 0.90m Refusal
DPL5	1.20	Loose to 0.60m Medium dense to 1.20m Refusal

DPL No.	Depth (mbegl)	Comments
DPL6	1.20	Loose to 0.30m Medium dense to 0.60m Loose to 0.90m Medium dense to 1.20m Refusal
DPL7	1.50	Very loose to 0.30m Medium dense to 1.50m Refusal
DPL8	2.40	Loose to 0.30m Medium dense to 2.40m Refusal
DPL9	1.20	Very loose to 0.30m Loose to 1.20m Refusal
DPL10	0.90	Very loose to 0.30m Medium dense to 0.60m Dense to 0.90m Refusal
DPL11	0.60	Very loose to 0.30m Dense to 0.60m Refusal
DPL12	0.90	Loose to 0.30m Medium dense to 0.60m Dense to 0.90m Refusal

Note: mbegl = metres below existing ground level

5. SITE GEOLOGY

As may be inferred from the extract of the 1:250 000 geological map published by the Council for Geo-Sciences, 3218 Clanwilliam, the site geology comprises a mantle of loamy dune sands (Q2) which grade into 'brackish, calcareous soil' (Q4) within shallow depths (Figure 2 below). The Q4 layer generally comprises a *dorbank* which is a poorly to well cemented sandy material where gypsum and calcite are the cementing agents. In smaller, localised areas on the site(i.e. TP3 and TP4) the Q4 layer also comprises a poorly to moderately cemented calcrete or calcified dune sand. The Q4 layer is relatively thick and ranges to an average depth of between 2 and 3 metres below existing ground level (mbegl).

This mantle of soils is underlain by residual soils and porphyritic granite rocks of the Vredenburg Granite suite, which were only encountered in TP6 and TP7 at an average depth of about 1.7mbegl

The TLB either refused or was stopped due to extremely slow excavation progress on either the dorbank or granite.

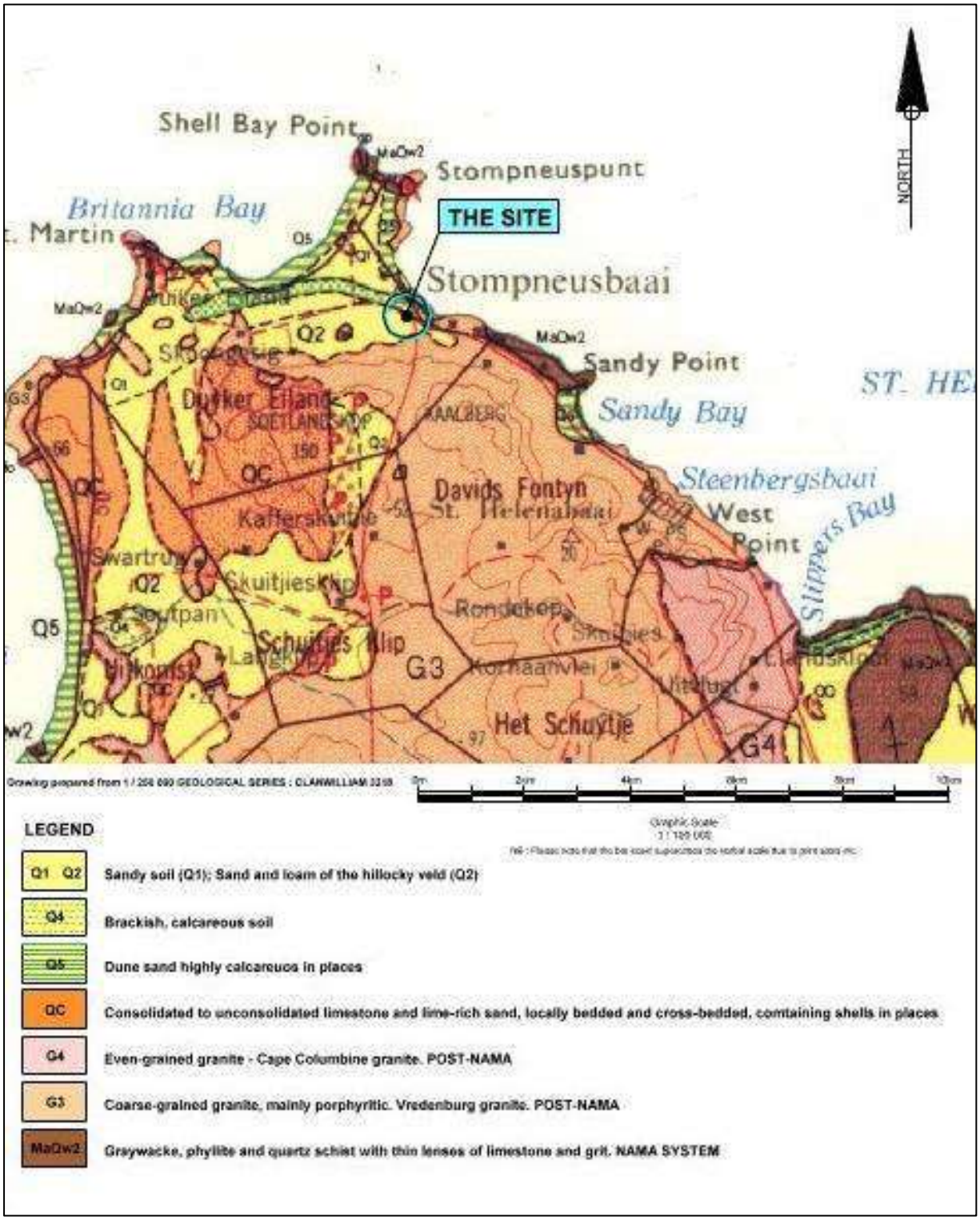


Figure 2: General geology of the Site

6. GROUNDWATER

No groundwater seepage was encountered in any of the trial pits put down. It is expected, however, that perched groundwater flows at the soil / calcrete or dorbank interface may occur in places in the rainy months. Any excavations intercepting this interface may have groundwater seepage at these times.

7. LABORATORY TESTING

Laboratory testing was carried out on soil samples taken during the fieldwork and comprised the following:

- Foundation Indicator tests (Particle Size Analysis, Atterberg Limit Determination and Hydrometer Analysis)
- Mod AASHTO dry density tests,
- California Bearing Ratio tests, and
- pH and Electrical Conductivity (Ec) tests

The laboratory test results are summarised in Table 3 and 4 below, and the detailed results are contained in Appendix C.

Table 3
Summary of Results of Particle Size Distribution Analysis, Atterberg Limit Determinations and CBR tests

TP No	Depth (m)	Description	Particle Size %				Atterberg Limits			GM	Modified AASHTO		CBR Values (%) Compaction MDD (%)					Swell (%)	Classification and Activity
			Clay	Silt	Sand	Gravel	LL	PI	LS %		MDD (kg/m³)	OMC %	90	93	95	98	100		
TP1	0.20-2.90	Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand.	1.7	4.6	78.4	15.3	40	10	5.0	1.23									A-2-7(0); SM; Low; anticipate less than G9 quality; Type A Gravel Wearing Course
TP8	0.20-1.30	Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.	4.3	7.4	73.3	15.0	27	6	3.0	1.22	1726	15.9	2.7	4.2	5.7	9.0	12	0.25	A-2-4(0); SM-SC; Low; Less than G9 quality; Type A Gravel Wearing Course
TP9	0.20-1.00	Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Weakly cemented Dorbank/Colluvium.	3.9	6.7	80.2	9.3	32	10	5.0	1.23	1781	14.6	10	12	15	18	21	0.32	A-2-4(0); SC; Low; G8; Type A Gravel Wearing Course

LL - Liquid Limit
PI - Plasticity Index
LS - Linear Shrinkage
GM - Grading Modulus
MDD - Maximum Dry Density
OMC - Optimum Moisture Content

Classification in Terms of:
USPRA[3]
Unified Soil Classification System[4]
Van Der Merwe (1964)[5]
COLTO[6]
TRH20 (1990)[7]
Suitability for Gravel Wearing Course
A - Erodible Materials
B - Ravels and Corrugates
C - Ravels
D - Slippery when Wet
E - Good

[3] US Public Roads Administration Classification (Modified from Allen 1945)
[4] ASTM D 2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). June 2006
[5] D.H. Van Der Merwe (1964). The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils. The Civil Engineer, pp 103-107
[6] COLTO Standard Specifications for Road and Bridge Works for State Road Authorities (1998)
[7] TRH20 (1990) - The Structural Design, Construction and Maintenance of Unpaved Roads, Committee of State Road Authorities

Table 4
Soil Corrosivity Potential

TP No.	Depth (m)	Material	pH	Electrical Conductivity (EC) S/m	Comment[8]
TP8	0.20-1.30	Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.	8.35	0.102	• Moderately alkaline • Highly corrosive
TP9	0.20-1.00	Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Weakly cemented Dorbank/Colluvium.	8.45	0.0980	• Strongly alkaline • Highly corrosive

8. MATERIALS CLASSIFICATION AND USAGE

The *insitu* materials sampled from the site have been classified in terms of their suitability for use in general earthworks and road construction based on field observations and laboratory test results.

8.1 Site Materials

Dune Sands (uncemented)

Two samples of the greyish brown silty fine and medium sand with *partial cementation with calcrete* were selected for laboratory testing. The results of the laboratory tests yielded the following:

Soil Classifications:

- Plasticity Index (PI) ranges from 6 to 10
- Grading Modulus (GM) value 1.22 to 1.23
- Combined silt & clay content of 6.3 to 11.7%, with the remainder comprising fine and medium sand and very small amounts of gravel
- Material classifies as A-2-7(0) to A-2-4(0) in the PRA system and SM to SC in the USC system.
- In terms of COLTO the sample does not satisfy G9 quality
- Type A gravel wearing course – erodible materials

Recommended Usage:

This material will be suitable for use as:

- General subgrade material in the construction of roads and fills
- Compacted backfill behind retaining walls
- Suitable for use as bedding / blanketing material for buried flexible pipelines, consisting of uPVC., HDPE and GRP, as well as steel and ductile iron pipes

Cemented Dune Sands (Dorbank)

One sample of the cemented dune sands, comprising *weakly formed dorbank*, was evaluated:

Soil Classifications:

- PI =10
- GM = 1.23
- Combined silt & clay content of 10.6%, with the remainder comprising fine and medium sand and very small amounts of gravel
- Material classifies as A-2-4(0) in the PRA system and SC in the USC system.
- Material classifies as G8 quality material
- Type A gravel wearing course – erodible materials

[8] Stapelberg, PDJ (2005); The Engineering Geology of Cape Town and Environs: Western Cape, South Africa

Recommended Usage:

This material will be suitable for use as:

- Selected material in the construction of roads and paved areas,
- Compacted backfill behind retaining walls
- Suitable for use as bedding / blanketing material for buried flexible pipelines, consisting of uPVC., HDPE and GRP, as well as steel and ductile iron pipes

8.2 Soil Corrosivity and pH

A summary of the pH and Electrical Conductivity (EC) values for the laboratory tests on the soil materials are given in Table 4 above.

The soil materials are *moderately to strongly alkaline and highly corrosive* in nature. It is recommended that this be considered in the design of concrete foundations and buried steel and concrete pipes.

9. GENERAL SITE STABILITY

The shows no signs of general ground instability in the form of unstable landforms such as tension cracks, slope deformation, hummocky land, slip surfaces, excessive groundwater emissions, or similar characteristics of potentially unstable ground. Therefore, given its relatively gentle level gradient, the site is considered generally stable and suitable for general township development provided the recommendations in this report are adhered to.

10. DEVELOPMENT RECOMMENDATIONS

10.1 Proposed Development

The site for the Stompneus Bay 200 IRDP Housing Project will consist of 200 low-cost single storey housing units. The development will be serviced with sewer, water supply, electricity, roads, parking and public open space areas.

10.2 Excavatability & Trenching

An indication of the depth to which Soft Excavation[9] material occurs is obtained from the final depths of the Test Pits. These depths are shown in Figure 1. Excavations will classify as Soft Excavation to at least 2.20m depth on average. Advancing below this depth will require Soft to Intermediate Excavation.

Trench side sidewalls of up to maximum depth 1.2m may be constructed vertically. Such trenches should not be open for more than 24 hours, otherwise should be constructed to a batter not steeper than 1V:1.5H, or should be laterally supported if left open indefinitely. Where saturation of the soils occurs either during rainy periods or by high ambient groundwater conditions, they will need to be battered to a slope not steeper than 1V:2H.

All excavations must be inspected daily by a competent person to confirm that they are safe for entry.

10.3 Pipe Bedding

All dune sands, excavated dorbank and calcrete materials, will be suitable for use as bedding and blanketing for steel, ductile iron and flexible pipes such as HDPE, GRP and uPVC. They will however, not meet the strict grading requirements of Selected Granular Fill material for concrete pipes as per SABS1200LB, which if required, will need to be imported to site.

10.4 General Earthworks

Given the gentle to moderate slope across the site it is expected that earthworks will be limited to cuts and fills not exceeding 1.5m in height. It is recommended that all earthworks be carried out in accordance with SABS 1200 (DM).

[9] SANS634:2012: Geotechnical Investigations for Townships: pp16, Table 5 - Classification of material for machine excavation

10.5 Drainage

10.5.1 Surface Water Drainage

An important factor in the promotion of a stable site is the control and removal of surface water from the site. It is important that the design of the stormwater management system allow for the drainage of accumulated surface water towards the existing stormwater infrastructure. Disposal of stormwater should in any case conform to the Local Authority's requirements.

10.5.2 Subsurface Drainage

While no groundwater seepage was observed in any of the trial pits, it is recommended that all roads, parking and paved areas have subsoil drainage to protect the structural layers from water ingress which may occur during periods of heavy rainfall.

10.6 Foundations

From the results of the DPL tests the Q2 dune soils generally show the following trend in consistency:

Very loose to 0.30m
Loose to 0.60m
Medium dense to 1.50m

The very loose and loose soils occurring to an average depth of 0,6m beneath existing ground level are not considered a suitable founding horizon for the proposed structures in their natural form. All foundations for houses should be taken through this layer to a minimum depth of 0.6mbegl, where the more competent partially cemented horizon of at least medium dense consistency is found.

Where houses are constructed on cut-to-fill platforms the house should be positioned in cut to facilitate founding. Should houses be placed over the cut-fill line of platforms, or in fill, the soils should be properly engineered to ensure that differential settlements are minimised.

The NHBRC[10] site class **S**, given in Table 5 below, which provides the foundation design, building procedures and precautionary measures for single storey residential structures where consolidation settlement is expected to be less than 10mm, is considered applicable to the entire site, as shown in Figure 3 below.

The requirements for Site Class **S** are provided in Table 5 below.

Table 5
Foundation design, building procedures and precautionary measures for single storey residential structures founded on soil horizons subject to settlement

Site Class	Estimated Total Settlement (mm)	Construction Type	Foundation Design and Building Procedures (Expected damage limited to Category 1)
S	<10	Normal	• Normal construction (strip footing or slab-on-the-ground) foundation • Foundation bearing pressure not exceeded 50kPa • Good site drainage

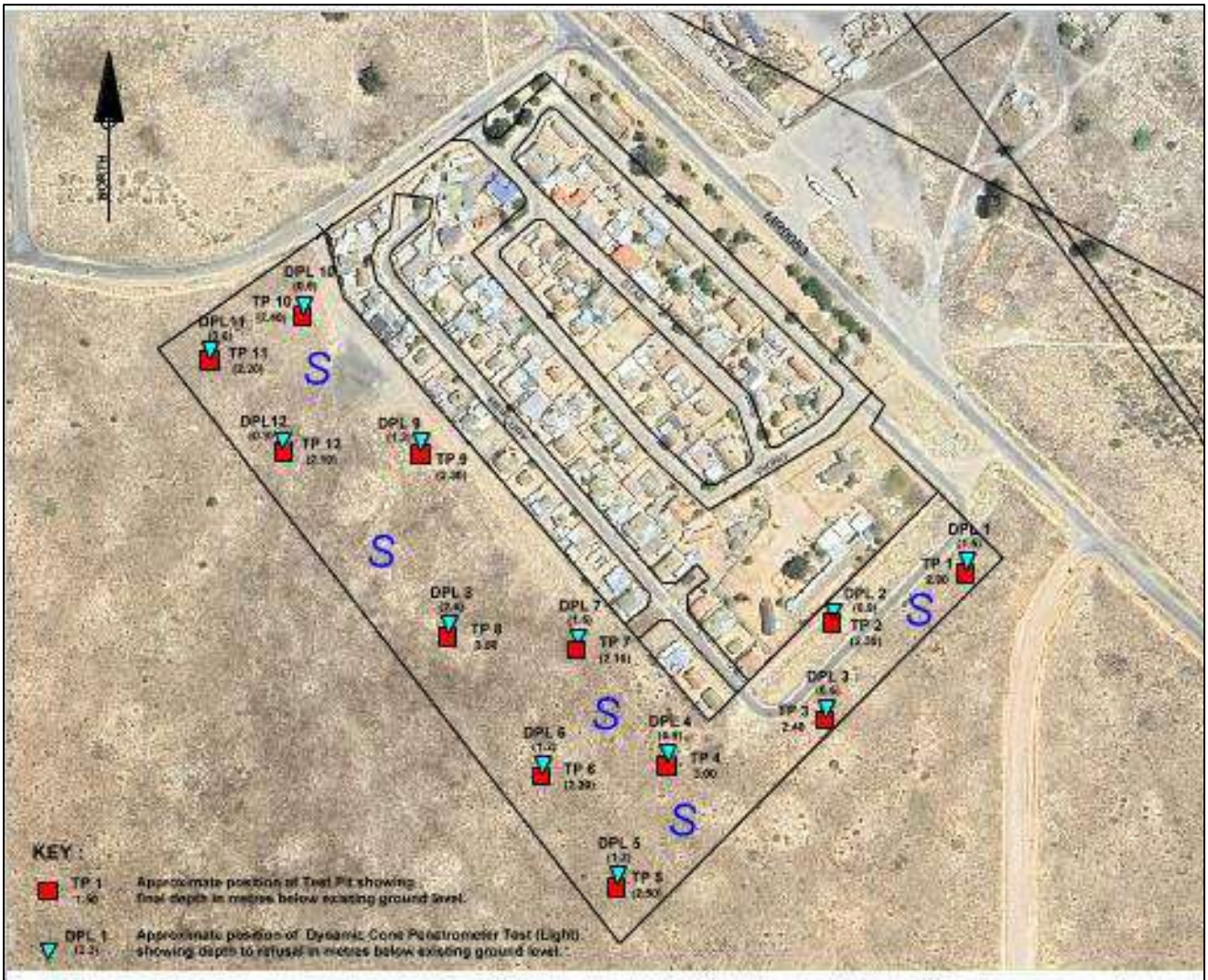
Notes:
- **Differential heave assumed to equal 50% of total**
- **The relaxation of some of these requirements, e.g. the reduction or omission of steel or articulation joints, may result in a Category 2 level of expected damage.**

In addition to the information given in Table 5, the following is recommended:

- Foundations to comprise normal 600mm wide strip foundations (maximum allowable bearing pressure 50kPa)
- Minimum founding depth 0,6m below existing ground level

[10] NHBRC House Building Manual Parts 1 & 2; Revision No. 1, February 1999

- Provided this is carried out the anticipated total settlement will be less than 10mm, with differential settlement 50% of this value
- Note that the slab-on-the-ground foundation option in Table 5 is not recommended for this site unless designed as a raft foundation with thickened (reinforced) edge beams under external walls and thickened beam sections under internal walls. Compaction of the subgrade to be minimum 95% MDD to minimum depth 300mm before constructing the raft foundation.
- No foundations should be founded in fill unless it is specifically engineered for this purpose.
- It is recommended that GGS inspect and approve all foundations before concrete is cast.



Foundation design, building procedures and precautionary measures for single storey residential structures founded on soil horizons subject to consolidation settlement. (NHBRC 1999)

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
S	<10	Normal	• Normal construction (strip footing or slab-on-the-ground) foundation • Foundation bearing pressure not exceeded 50kPa • Good site drainage

Figure 3: NHBRC site classification: Stompneus Bay 200 IRDP Housing Project

10.7 Recommended Good Building Practice

The following good building practice is recommended to limit cracking of walls due to moisture change in the foundation soils:

- All houses should have a concrete surround minimum width 1m with falls to promote drainage away from the house and thus prevent surface water gaining ingress into the foundation soils.
- No effluent, sewage or stormwater soak pits should be positioned within 3m of the dwelling.
- No trees or flower beds should be established within 3m of the building.

10.8 Subgrade Treatment - Roads and Parking Areas

The dune soils and those weakly cemented with calcrete are less than G9 quality on average and, as such, of relatively poor to fair subgrade quality. However, the more cemented variety comprising weakly to well cemented dorbank, is expected to classify as G8 material.

The dune sands cemented with calcrete proved disappointing and did not meet G9 quality.

As a general observation, the *cemented dorbank materials* will provide the better road building materials and should be selected in areas of cut or imported from borrow areas either on the site or elsewhere.

Where roads and paving are to be constructed directly on the uncemented or calcretised dune sands, it is recommended that the insitu material to top of subgrade, or road formation level, be ripped to a depth of 300mm, or as determined by the Design Engineer, wet and recompacted to minimum 93% MDD where a CBR of 3 may be adopted for design.

Where the dorbank infused dune soils are exposed at the top of road subgrade level by earthworks, they should be ripped be ripped to a depth of 300mm, or as determined by the Design Engineer, wet and recompacted to minimum 93% MDD where a CBR of 8 may be adopted for design.

11. CONCLUSIONS

This report contains the results of a Phase 1 Geotechnical Investigation carried out for the proposed Stompneus Bay 200 IRDP Housing Project near St Helena Bay, Western Cape.

The site is underlain by a mantle of dune sands (Q2) and calcareous sands overlying pedogenic calcrete and /or dorbank cemented horizons (Q4), known as .'brackish calcareous soil"

It is considered that conditions prevailing at the site are generally favourable for the proposed development, provided the recommendations given in this report are adhered to.

Recommendations for earthworks and drainage to promote the stable development are given. The site has been classified as Site Class **S** in terms of the NHBRC. The proposed houses must be founded according to the criteria laid down by the NHBRC, summarised in Table 5 above.

Recommendations for subgrade treatment beneath roads, paved and parking areas are provided.

Finally, the ground conditions described in this report refer specifically to those encountered in the test pits and DPL tests done on site. It is therefore quite possible that conditions at variance with those discussed above can be encountered elsewhere. It is therefore important GGS carry out periodic inspections of the earthworks and open foundation excavations. Any change from the anticipated ground conditions could then be considered to avoid unnecessary expense.

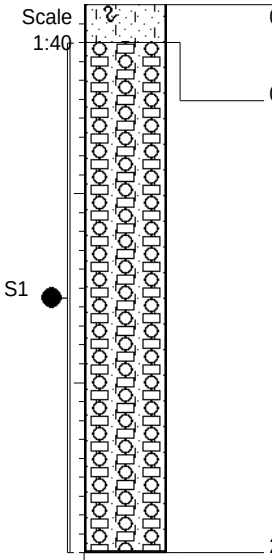
APPENDIX A

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP1**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00 Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 Dry to slightly moist yellowish brown medium dense to dense becoming dense with depth poorly cemented silty fine SAND with occasional calcrete gravel and nodules. Dune Sand (calcified).

2.90

NOTES

1) Final depth at 2.90m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) Samples taken :
   S1 0.20--2.90m (1 x Bulk)

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

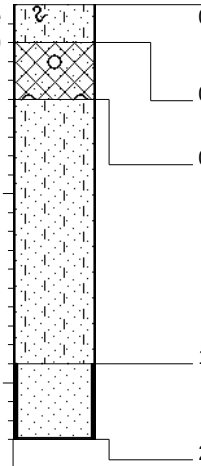
HOLE No: **TP1**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP2**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown mottled white very dense gravelly SAND. Fill.
0.50	Dry light brown dense to very dense with depth poorly to moderately cemented silty fine medium and coarse SAND. Dune Sand.
1.90	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.30	

NOTES

1) Final depth at 2.30m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.
5) DPL2 done below fill layer.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP2**

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

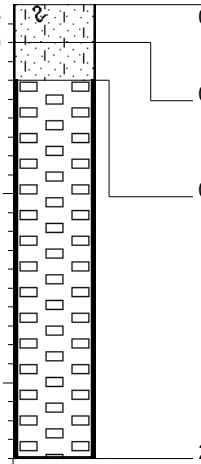
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP3**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.40	Off white to cream mottled grey very dense with zones of very soft rock HARDPAN CALCRETE.
2.40	

NOTES

1) Final depth at 2.40m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP3**

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

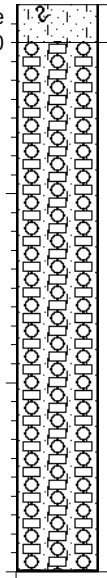
GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP4**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00 Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.

3.00

NOTES

1) Final depth at 3.00m. No refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

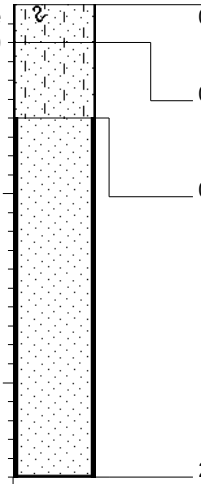
HOLE No: **TP4**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP5**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.60	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.50	

NOTES

1) Final depth at 2.50m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP5**

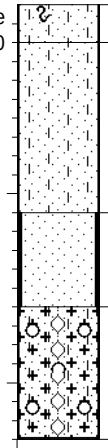
GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP6**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
1.10	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
1.60	Dry yellowish brown mottled grey very dense to very soft rock silty gravelly SAND. Residual Granite.
2.30	

NOTES

1) Final depth at 2.30m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP6**

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

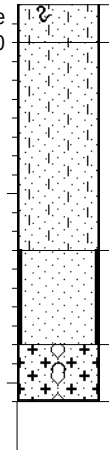
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP7**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown loose becoming medium dense and dense with depth silty fine and medium SAND. Dune Sand.
1.30	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
1.80	Dry brown mottled green very dense to very soft rock gravelly SAND. Residual Granite.
2.10	

NOTES

1) Final depth at 2.10m. Refusal.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP7**

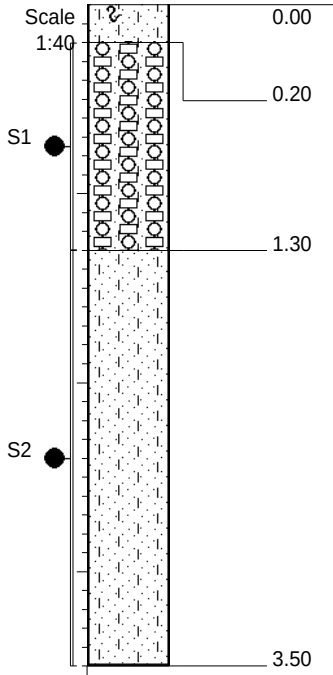
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP8**
Sheet 1 of 1

JOB NUMBER: 23-123



Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

Dry light brown mottled cream to off white medium dense becoming dense with depth silty SAND with much calcrete gravel (lenses and nodules). Poorly cemented Calcrete.

Slightly moist brown apparently loose to medium dense silty fine and medium SAND. Dune Sand.

NOTES

1) Final depth at 3.50m. No refusal.
2) No groundwater seepage.
3) Severe sidewall collapse below 1.30m.
4) Samples taken :
   S1 0.20--1.30m (3 x Bulk)
   S2 1.30--3.50m (3 x Bulk)

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

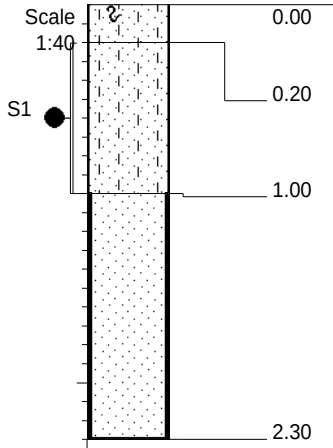
HOLE No: **TP8**

GONDWANA GEO SOLUTIONS

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP9**
Sheet 1 of 1

JOB NUMBER: 23-123



0.00 – 0.20: Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

0.20 – 1.00: Dry light brown mottled grey dense poorly cemented silty fine medium and coarse SAND. Colluvium.

1.00 – 2.30: Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

NOTES

1) Final depth at 2.30m Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) Samples taken :
   S1 0.20--1.00m (3 x Bulk)

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP9**

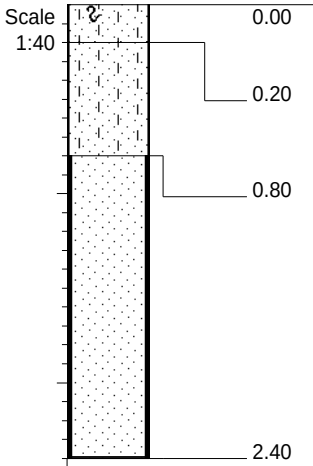
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP10**
Sheet 1 of 1

JOB NUMBER: 23-123



Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.

Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.

Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.

NOTES

1) Final depth at 2.40m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR
TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023
DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

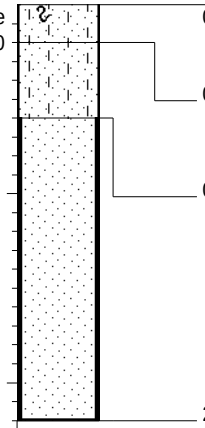
HOLE No: **TP10**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP11**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.60	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.20	

NOTES

1) Final depth at 2.20m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

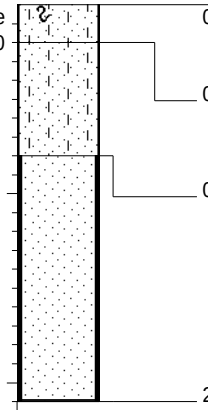
HOLE No: **TP11**

iX ENGINEERS
Stompneus Bay IRDP Housing Project
St. Helena Bay

HOLE No: **TP12**
Sheet 1 of 1

JOB NUMBER: 23-123

Scale 1:40



0.00	Dry light brown loose slightly silty fine medium and coarse SAND with roots. Topsoil.
0.20	Dry light brown medium dense to dense slightly silty fine medium and coarse SAND. Colluvium.
0.80	Dry light and dark brown very dense to very soft rock well cemented fine medium and coarse SAND. Hardpan Dorbank.
2.10	

NOTES

1) Final depth at 2.10m. Refusal on Dorbank.
2) No groundwater seepage.
3) No sidewall collapse.
4) No samples taken.

CONTRACTOR :
MACHINE : Case 570T
DRILLED BY :
PROFILED BY : MVR

TYPE SET BY : MC
SETUP FILE : GGS-ST~1.SET

INCLINATION :
DIAM :
DATE : December 2023
DATE : December 2023

DATE : 07/02/2024 10:17
TEXT : ..Project\Logs\TP1TP12.doc

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: **TP12**

APPENDIX B

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 1***

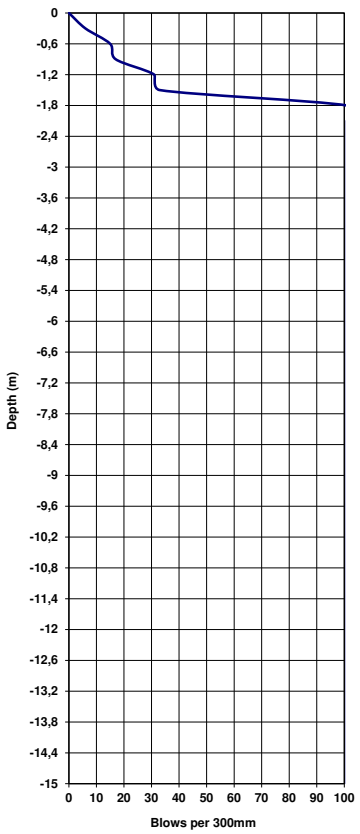
Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 2***

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 3***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

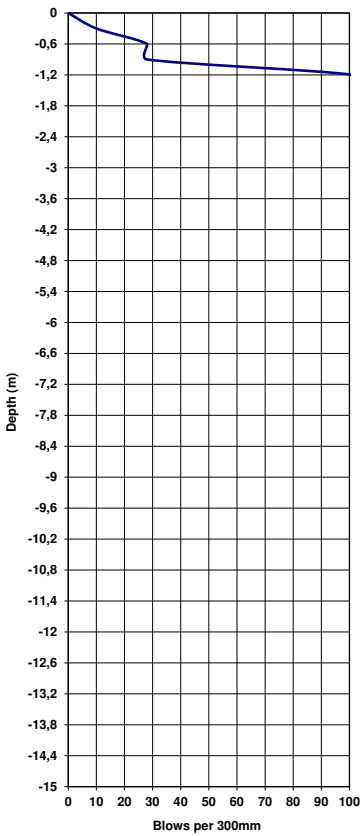
Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	15	Loose
0,9	17	Med.Dense
1,2	31	Med.Dense
1,5	33	Med.Dense
	Ref	



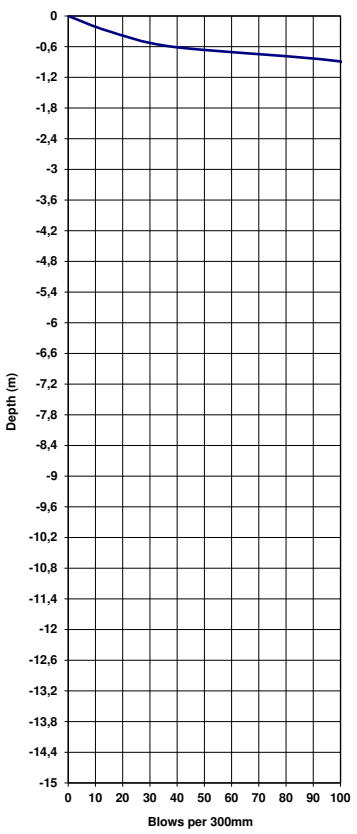
Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	10	Loose
0,6	28	Med.Dense
0,9	28	Med.Dense
	Ref	



Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings
C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	15	Loose
0,6	38	Med.Dense
	Ref	



GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

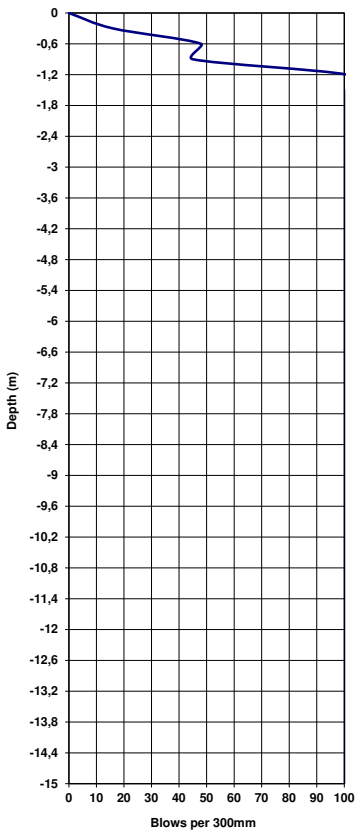
Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 4***

THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	16	Med.Dense
0,6	48	Dense
0,9	45	Dense
	Ref	

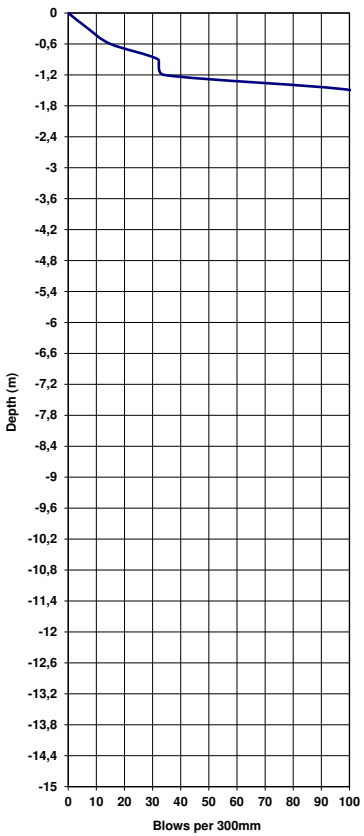


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 5***

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	15	Loose
0,9	32	Med.Dense
1,2	34	Med.Dense
	Ref	

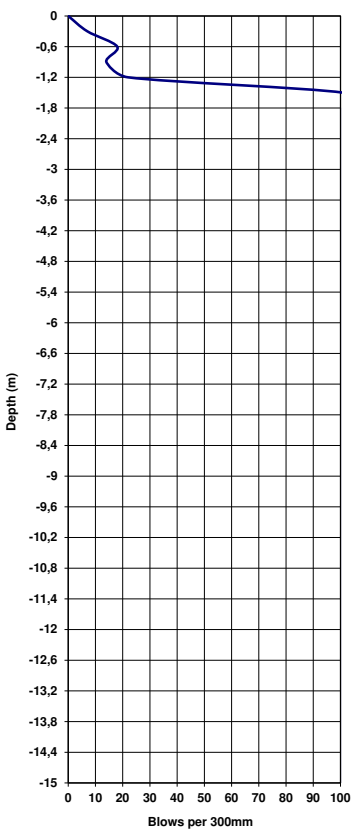


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 6***

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	18	Med.Dense
0,9	14	Loose
1,2	22	Med.Dense
	Ref	



GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

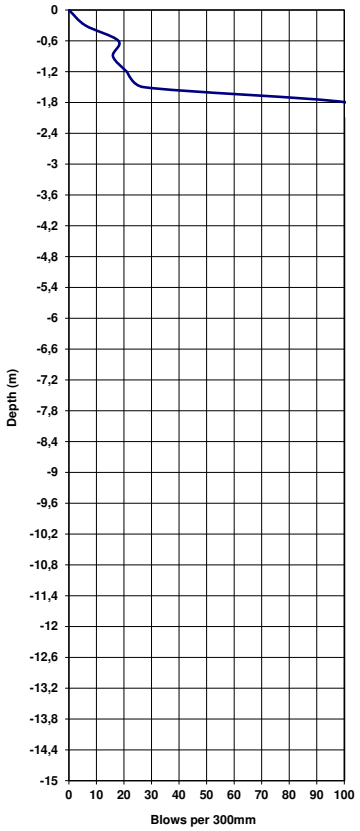
Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 7***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	18	Med.Dense
0,9	16	Med.Dense
1,2	21	Med.Dense
1,5	27	Med.Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

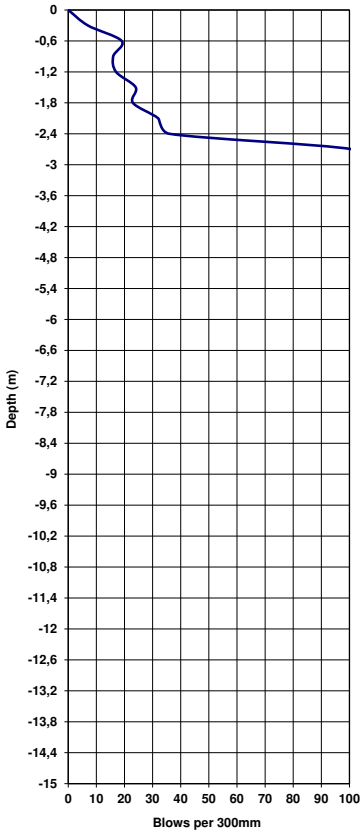


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 8***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	7	Loose
0,6	19	Med.Dense
0,9	16	Med.Dense
1,2	17	Med.Dense
1,5	24	Med.Dense
1,8	23	Med.Dense
2,1	32	Med.Dense
2,4	36	Med.Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

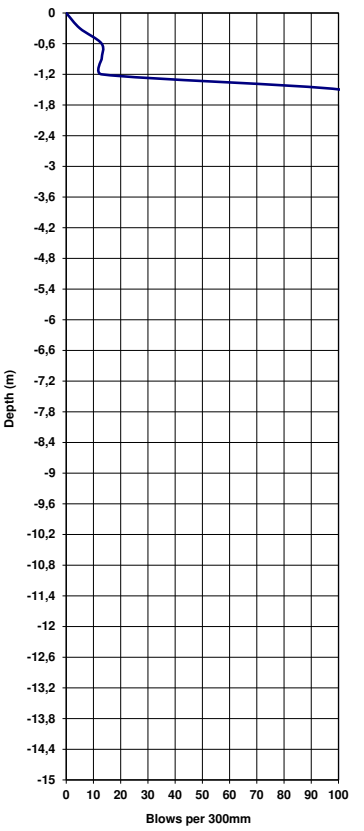


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 9***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	5	Very Loose
0,6	13	Loose
0,9	13	Loose
1,2	13	Loose
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0



THE INSITU STRENGTH DEPENDS ON SOIL MOISTURE CONTENT AND GRAIN STRUCTURE WHICH HAVE NOT BEEN ASSESSED AND MAY CHANGE. THE VALUES GIVEN ARE THEREFORE INDICATIVE ONLY AND SHOULD BE VERIFIED BY TEST OR OBSERVATION

GONDWANA GEO SOLUTIONS

Consulting Geotechnical Engineers & Engineering Geologists

Cape Town Office:
13 Rocklands Road
Simonstown
CAPE TOWN
7975

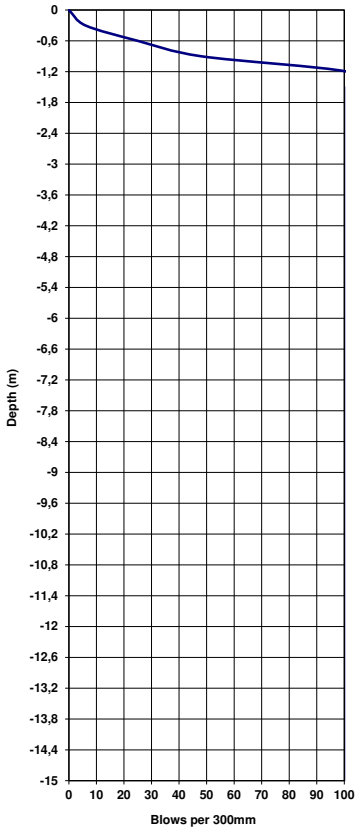
Client:	**iX ENGINEERS**	**Ref.No. 23-123**
Project:	**Stompneus Bay IRDP Housing Project**	**Date: December 2023**
Section:	**St Helena Bay**	**Operator: PT**

Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 10***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	25	Med.Dense
0,9	48	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

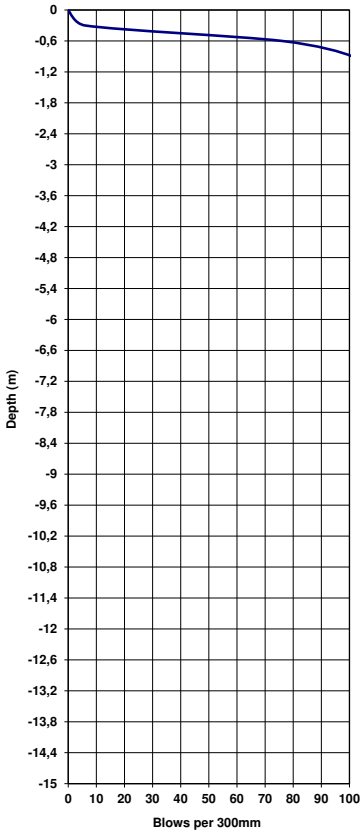


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 11***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	6	Very Loose
0,6	76	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0

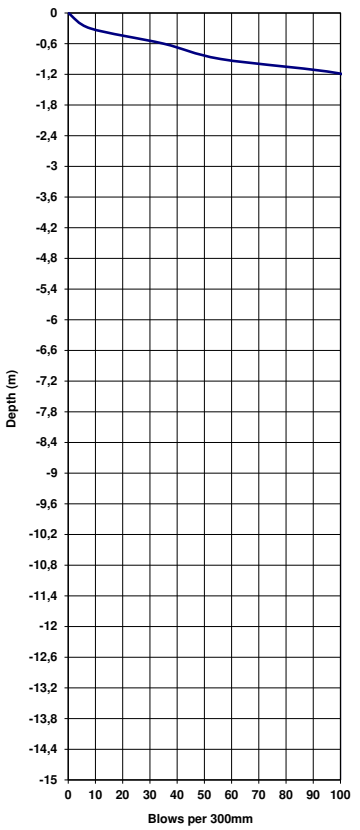


Light Dynamic Penetrometer Probe ---------- ***Test No. DPL 12***

Depth metres	Blows per 300mm	Inferred Consistency
0		
0,3	8	Loose
0,6	35	Med.Dense
0,9	56	Dense
	Ref	

Hammer: 10kg falling 550mm
Cone: 25mm diameter with 60 degree apex angle
Rods: 16mm diameter, 22mm diameter couplings

C=1
Phi=0



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APPENDIX C

SGS MATROCAST (PTY) LTD
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a SANAS Accredited Testing Laboratory, No. T0245

4 HARBOT CLOSE , BRACKENDUST ,7560
P.O.BOX 1105 , BRACKENFELL
Tel. : 021 9815558/9
Fax : 021 9816724
Email : gregory.bell@sgs.com

CLIENT :	GONDWANA GEOSOLUTIONS	OUR REF.:	59005
ADDRESS :	17 KINGSMEAD DRIVER WESTVILLE DURBANVILLE	YOUR REF.:	23-123/1
ATTENTION :	MR M.RICHTER	DATE :	29.01.2024

PROJECT : STOMPNEUS BAY IRDP HOUSING PROJECT

SGS MATROCAST

a SANAS Accredited Testing Laboratory, No. T0245

Tests marked * "Not SANAS Accredited" in this Report are not included in the SANAS Schedule of Accreditation for the laboratory.

TEST REPORT / RESULTS

Sample/s:

Sampled by :	Client
Date Received / Sampled :	08.01.2024
Date Tested :	08.01.2024-29.01.2024
Tested at :	SGS MATROCAST (PTY) LTD

Sampling method : Sampled by client and results apply to the sample as received

Section / Position tested identified by : CUSTOMER

Number of pages in this Report : 10

General : CBR CLASSIFICATION & FOUNDATION INDICATOR TEST RESULTS

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

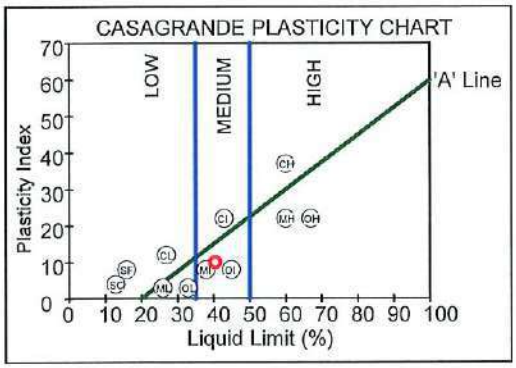
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

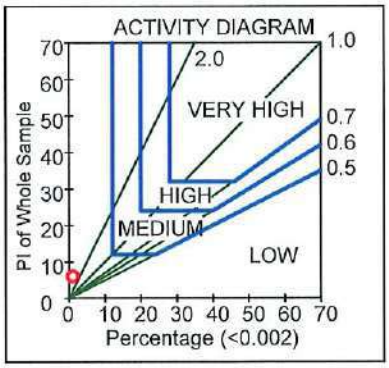
FOUNDATION INDICATOR (ASTM: D422)

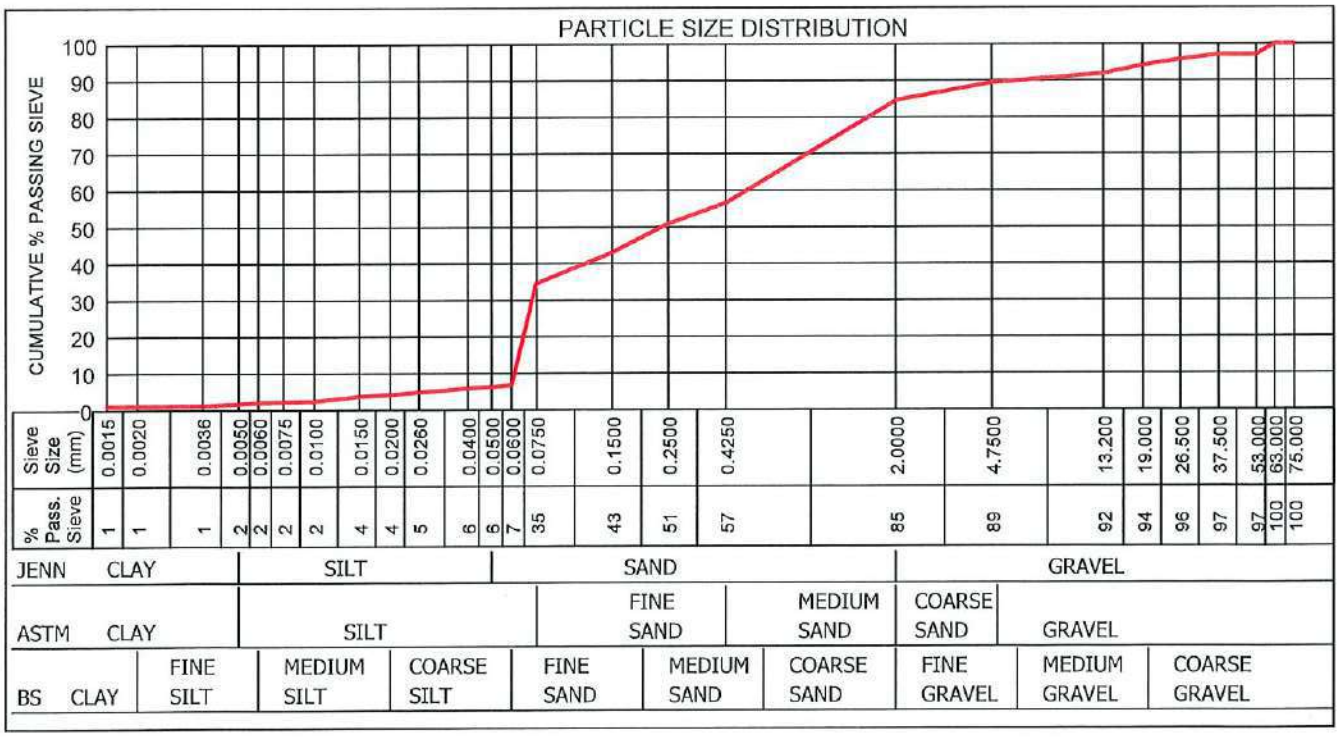
Sample No.	: D 02701
Hole No.	: TP.1
Depth	: 0.20-2.90
Liquid Limit (%)	: 40
Plasticity Index	: 10
Linear Shrinkage (%)	: 5,0
PI of Whole Sample	: 6
P.R.A. Classification	: A-2-7(0)
Unified Soil Classificati	: SM
Activity	: 6,00
Heave Classification	: LOW
Grading Modulus	: 1,23
Percentage (<0.002)	: 1,0
Moisture Content (%)	: 8,6
Relative Density	: 2,324

Material Description : LIGHT BROWN SILTY SAND

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	1,7	4,6	78,4	15,3	SAND
Astm	1,7	32,8	54,9	10,6	SILTY SAND
British Standard	1,1	5,6	77,9	15,3	SAND







Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

4.5.0(SGS)(2021.05.05)

Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

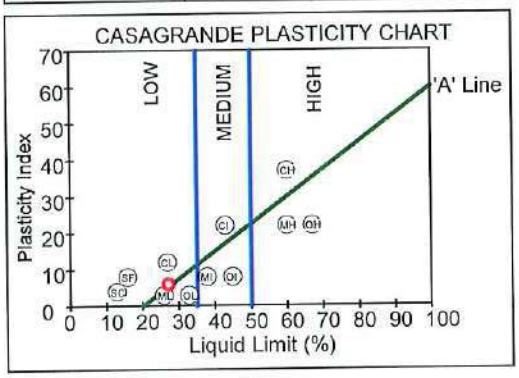
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

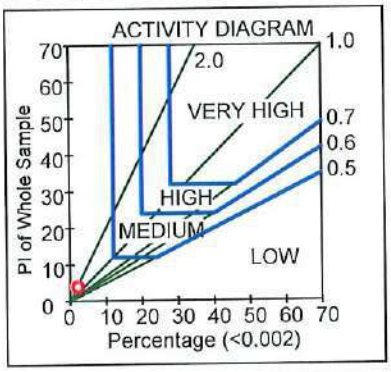
FOUNDATION INDICATOR (ASTM: D422)

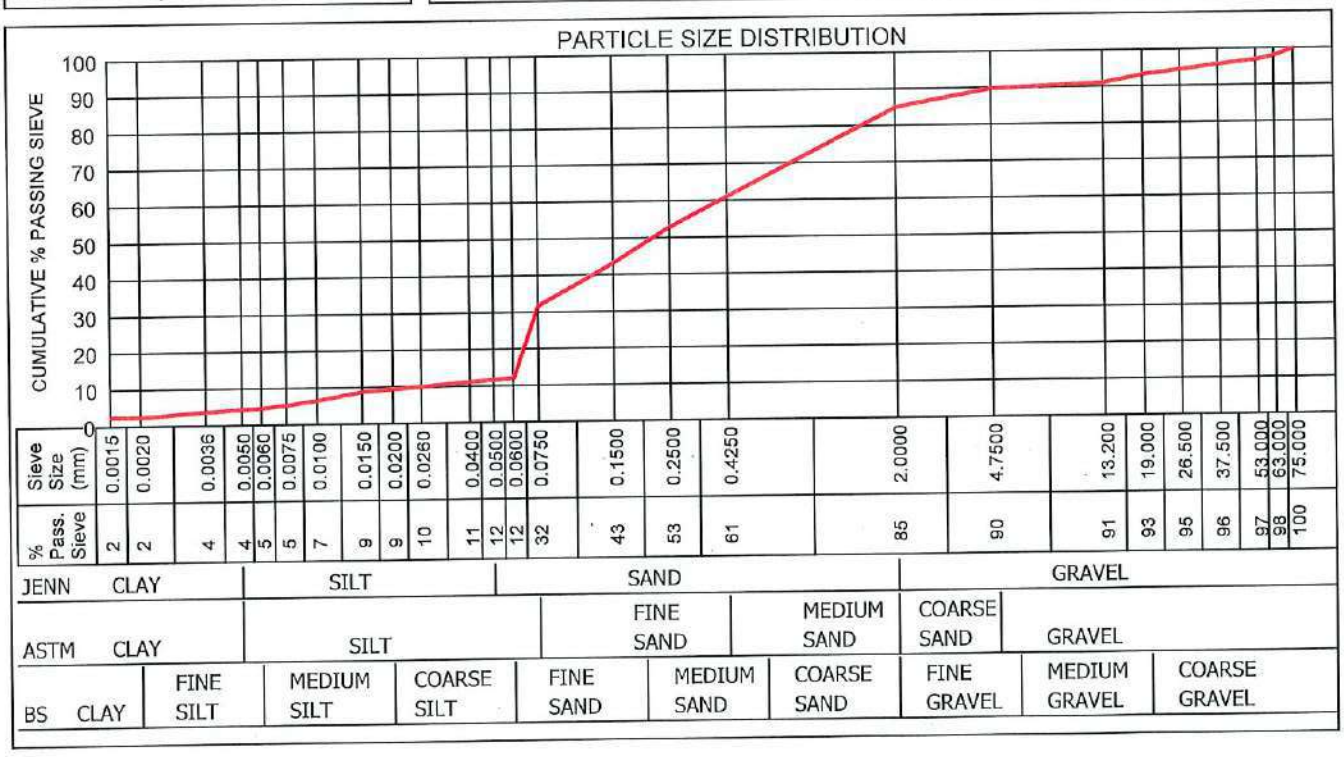
Sample No.	: D 02702
Hole No.	: TP.8
Depth	: 0.2-1.3
Liquid Limit (%)	: 27
Plasticity Index	: 6
Linear Shrinkage (%)	: 3,0
PI of Whole Sample	: 4
P.R.A. Classification	: A-2-4(0)
Unified Soil Classificati	: SM-SC
Activity	: 2,00
Heave Classification	: LOW
Grading Modulus	: 1,22
Percentage (<0.002)	: 2,0
Moisture Content (%)	: 7,2
Relative Density	: 2,473

Material Description : LIGHT BROWN SILTY SAND + CALCRETE GRAVEL

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	4,3	7,4	73,3	15,0	SAND
Astm	4,3	27,4	58,1	10,2	SILTY SAND
British Standard	2,4	9,7	72,9	15,0	SAND







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0280	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	2	2	4	4	5	5	7	9	9	10	11	12	12	32	43	53	61	85	90	91	93	95	96	97	98	100

JENN	CLAY	SILT		SAND			GRAVEL			
ASTM	CLAY	SILT			FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		
BS	CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	MEDIUM GRAVEL	COARSE GRAVEL

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

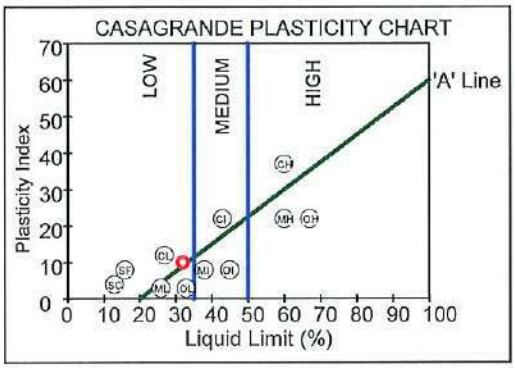
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

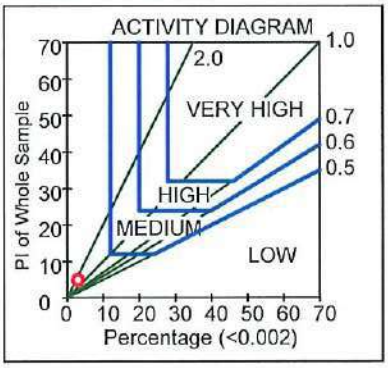
FOUNDATION INDICATOR (ASTM: D422)

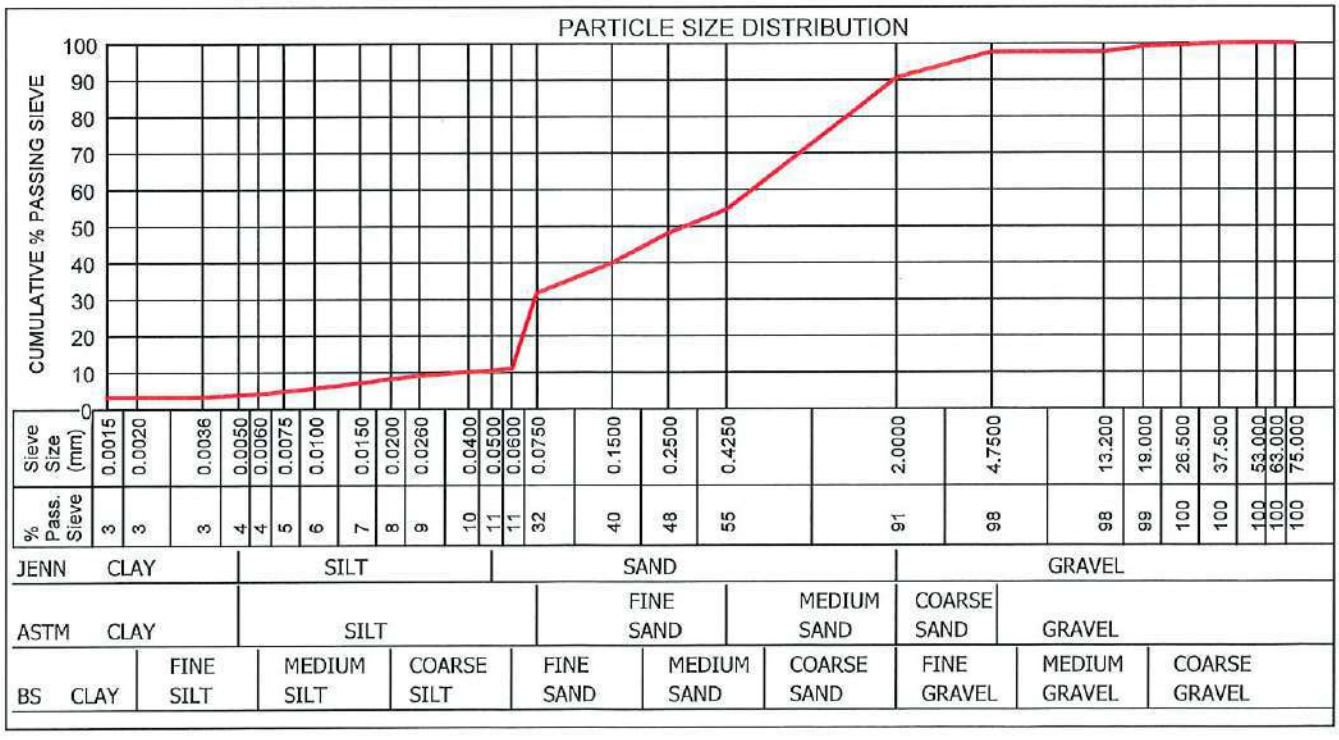
Sample No.	: D 02703
Hole No.	: TP.9
Depth	: 0.2-1.0
Liquid Limit (%)	: 32
Plasticity Index	: 10
Linear Shrinkage (%)	: 5,0
PI of Whole Sample	: 5
P.R.A. Classification	: A-2-4(0)
Unified Soil Classificati	: SC
Activity	: 1,67
Heave Classification	: LOW
Grading Modulus	: 1,22
Percentage (<0.002)	: 3,0
Moisture Content (%)	: 7,8
Relative Density	: 2,482

Material Description : LIGHT BROWN SILTY SAND

	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Classification
Jennings	3,9	6,7	80,2	9,3	SAND
Astm	3,9	27,7	66,0	2,4	SILTY SAND
British Standard	3,3	7,7	79,7	9,3	SAND







Sieve Size (mm)	0.0015	0.0020	0.0036	0.0050	0.0060	0.0075	0.0100	0.0150	0.0200	0.0260	0.0400	0.0500	0.0600	0.0750	0.1500	0.2500	0.4250	2.0000	4.7500	13.200	19.000	26.500	37.500	53.000	63.000	75.000
% Pass. Sieve	3	3	3	4	4	5	6	7	8	9	10	11	11	32	40	48	55	91	98	98	99	100	100	100	100	100

JENN	CLAY		SILT			SAND			GRAVEL	
ASTM	CLAY		SILT		FINE SAND		MEDIUM SAND	COARSE SAND	GRAVEL	
BS	CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	MEDIUM GRAVEL	COARSE GRAVEL

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: A6

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Technical Signatory : Mr Gregory Bell (N.DIP Civ.Eng)

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TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR MARK RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

SIEVE ANALYSIS, CONSTANTS, CBR(SANS 3001:GR1,GR10,GR12,GR20,GR30,GR40)

SAMPLE NO.	D 02702	D 02703			Preparation Method:
HOLE NO.	TP.8	TP.9			Sample was scalped on the 37.5mm sieve
ROAD NO.	-	-			
DEPTH	0.2-1.3	0.2-1.0			
CHAINAGE	On Site	On Site			
LAYER TYPE	-	-.			
STABILISED WITH	Neat	Neat			
SUPPLIER	N/a	N/a			
CURING METHOD	N/a	N/a			
DATE TESTED					
DESCRIPTION	Light Brown Sity Sand+Calcrete Gravel	Light Brown Sity FMC Sand			- Specification
SIEVE ANALYSIS (% PASSING)					
100.0 mm					
75.00 mm	100				
63.00 mm	98				
50.00 mm	97				
37.50 mm	96	100			
28.00 mm	95	100			
20.00 mm	93	99			
14.00 mm	91	99			
5.000 mm	90	98			
2.000 mm	85	91			
0.425 mm	61	55			
0.075 mm	32	32			
SOIL MORTAR					
COARSE SAND <2.0mm >0.425mm	28	39			
FINE SAND <0.425mm >0.075mm	35	26			
MATERIAL <0.075mm	37	35			
CONSTANTS					
GRADING MODULUS	1,22	1,23			
PRA CLASSIFICATION	A-2-4(0)	A-2-4(0)			
UNIFIED SOIL CLAS.	SM-SC	SC			
COLTO CLASSIFICATION	---	G8			
LIQUID LIMIT (%)	27	32			
PLASTICITY INDEX (0.425mm)	6	10			
LINEAR SHRINKAGE (%)	3,0	5,0			
MDD					
MAXIMUM DRY DENSITY (kg/m^3)	1726	1781			
OPTIMUM MOISTURE CONTENT(%)	15,9	14,6			
MOULDING MOISTURE (%)	16,0	14,4			
TYPE OF TEST	CBR	CBR			
CBR-UCS @ 100% MDD	12	21			
CBR-UCS @ 98% MDD	9,0	18			
CBR-UCS @ 97% MDD	7,8	17			
CBR-UCS @ 95% MDD	5,7	15			
CBR-UCS @ 93% MDD	4,2	12			
CBR-UCS @ 90% MDD	2,7	10			

CBR-UCS @ % MDD derived from calculation.

% SWELL MOULD [A][B][C]	0,19	0,26	0,31	0,24	0,31	0,40							

Remarks : SAMPLED AND DELIVERED BY CUSTOMER IN A GOOD CONDITION

FORM: GR40

4.5.0(SGS)(2021.05.05)

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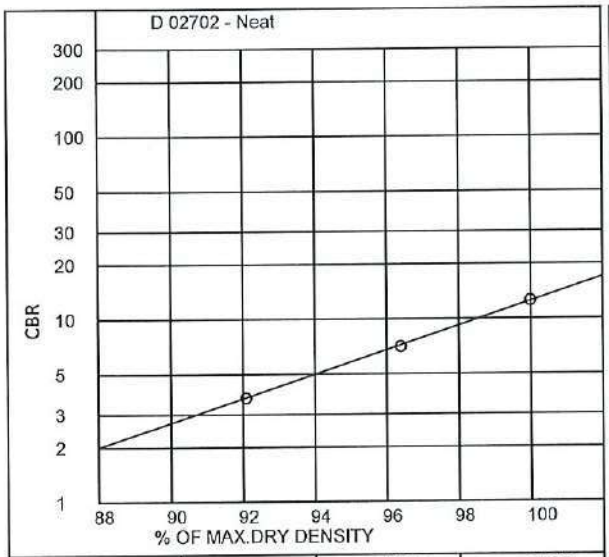
TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVER
WESTVILLE
DURBANVILLE
Attention: MR MARK RICHTER

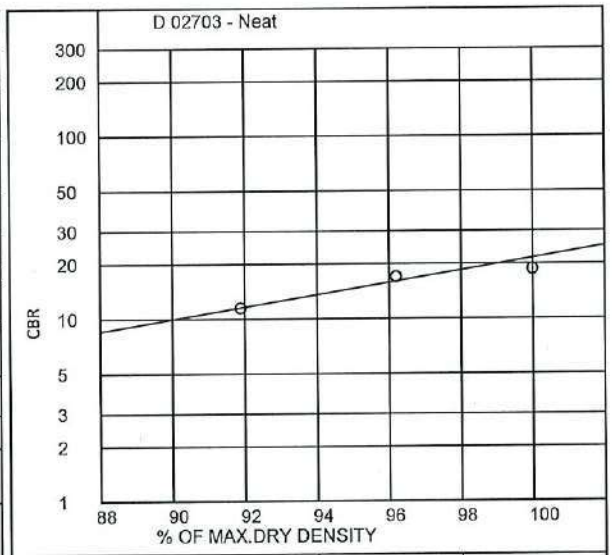
Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 29.01.2024

CBR-UCS GRAPH/S (OPTIONAL INFORMATION)



	PROC	NRB	MOD
COMPACTION (%)	92,1	96,4	100,0
CBR	3,7	7,0	13



	PROC	NRB	MOD
COMPACTION (%)	91,9	96,2	100,0
CBR	12	17	19

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Email : Nico.Engelbrecht@sgs.com

sanas Testing Laboratory T0245

TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVE
WESTVILLE
3630
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

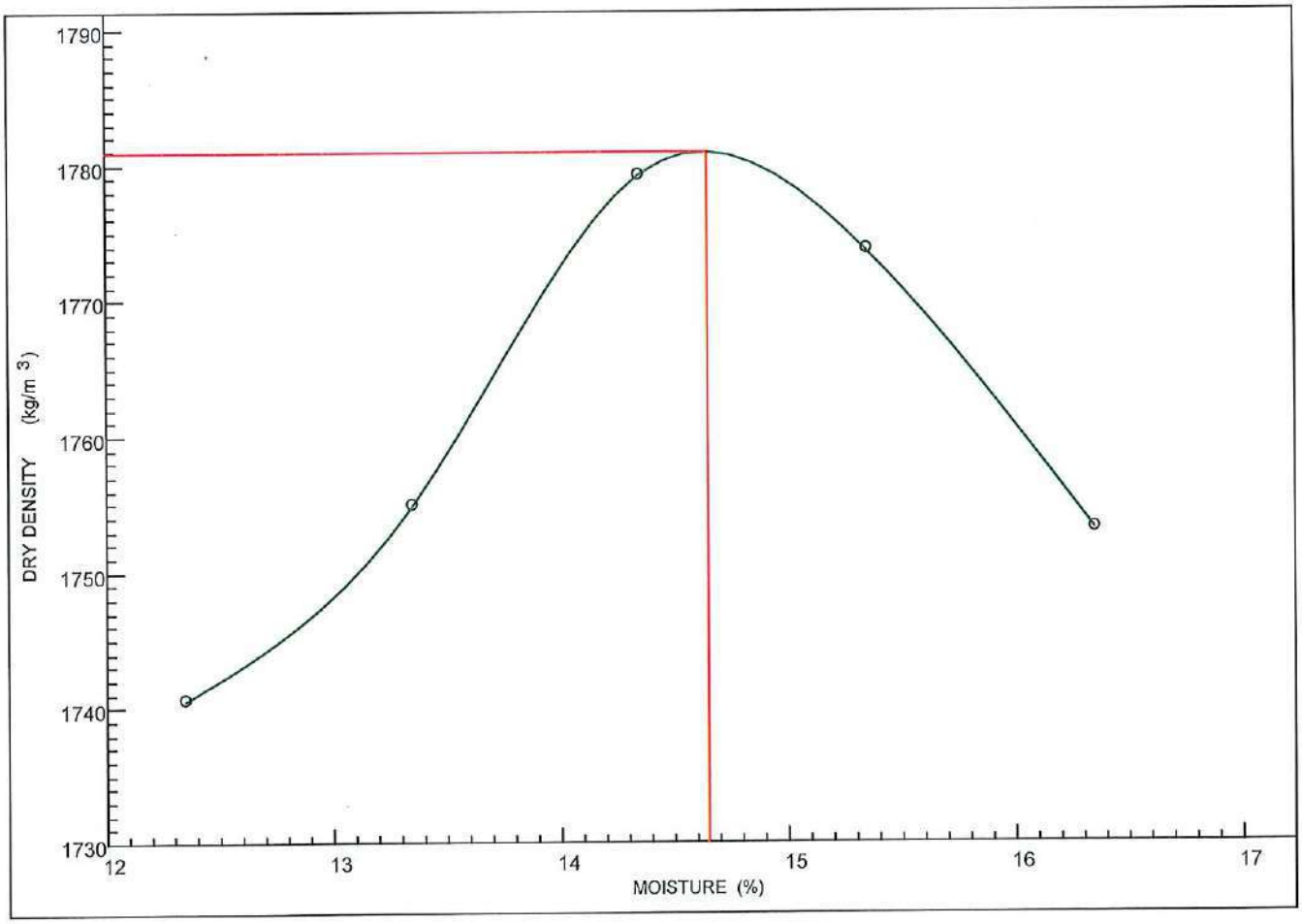
Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 24.01.2024

MOISTURE / DENSITY RELATIONSHIP(SANS 3001: GR30(MOD))

Sample No.: D 02703	Hole No. : TP.9	Depth (mm) : 0.2-1.0
Origin : -	Stabilized With : Neat	Compaction Energy : MOD
Material Description : Light Brown Silty FMC Sand		

Maximum Dry Density (kg/m^3): 1781
Optimum Moisture Content (%) : 14,6

Point No.	1	2	3	4	5			
Moisture (%)	12,3	13,3	14,3	15,3	16,3			
Density (kg/m^3)	1741	1755	1779	1774	1753			



Remarks :
FORM: GR30

4.4.1(SGS)(2019.12.04)

Technical Signatory : Mr Gregory F.Bell (N.Dip Civ.Eng)

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Reg.No.: 2000/030983/07 - VAT. Reg.No.: 4130197405
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Email : Nico.Engelbrecht@sgs.com

sanas Testing Laboratory T0245

TEST RESULTS

GONDWANA GEOSOLUTIONS
17 KINGSMEAD DRIVE
WESTVILLE
3630
Attention: MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

Your Ref : 23-123/1
Our Ref : 59005
Date Reported : 24.01.2024

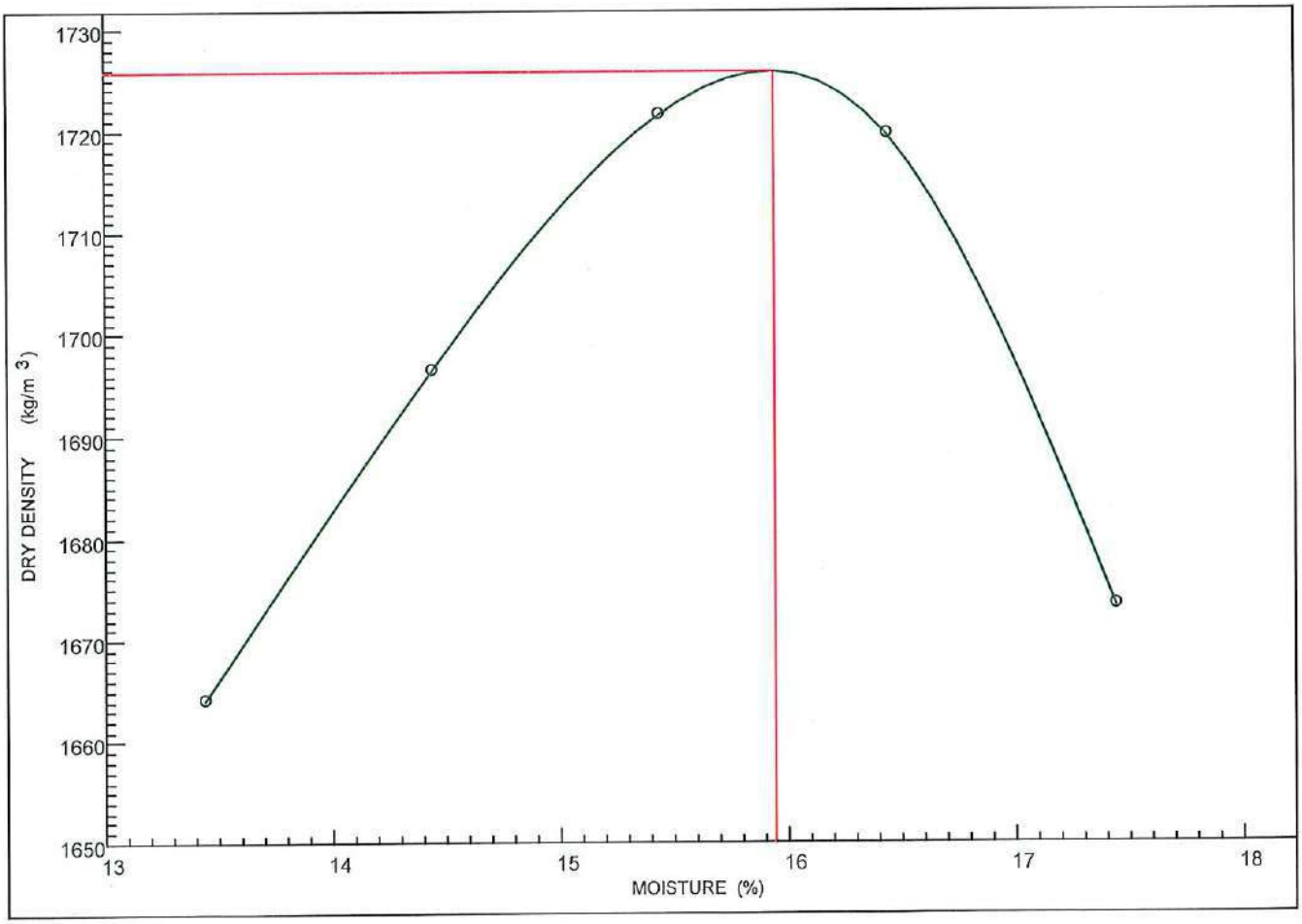
MOISTURE / DENSITY RELATIONSHIP(SANS 3001: GR30(MOD))

Sample No.: D 02702	Hole No. : TP.8	Depth (mm) : 0.2-1.3
Origin : -	Stabilized With : Neat	Compaction Energy : MOD
Material Description : Light Brown Sand + Calcrete Gravel		

Maximum Dry Density (kg/m^3): 1726

Optimum Moisture Content (%) : 15,9

Point No.	1	2	3	4	5			
Moisture (%)	13,4	14,4	15,4	16,4	17,4			
Density (kg/m^3)	1664	1697	1722	1720	1673			



Remarks :

FORM: GR30

4.4.1(SGS)(2019.12.04)

Technical Signatory : Mr Gregory F.Bell (N.Dip Civ.Eng)

SGS MATROCAST

CIVIL ENG.LABORATORY SERVICES
Reg.No.:2000/030983/07 - VAT.Reg No.:4130197405
a SANAS Accredited Testing Laboratory,No.T0245

sanas South African National Accreditation System

4 HARBOT CLOSE,BRACKENDUST , 7560
P.O BOX 1106 , BRACKENFELL
Tel : 021 981 5558/9
Fax 021 981 6724
Email : Gregory.bell@sgs.com

GONDWANA GEOSOLUTIONS (PTY)LTD
17 KINGSMEAD DRIVER
WESTVILLE
DURBAN , 3629
Attention : MR M.RICHTER

Project : STOMPNEUS BAY IRDP HOUSING PROJECT

You're Ref. : 23-123/1
Our Ref : 59005
Date Reported : 19.01.2024

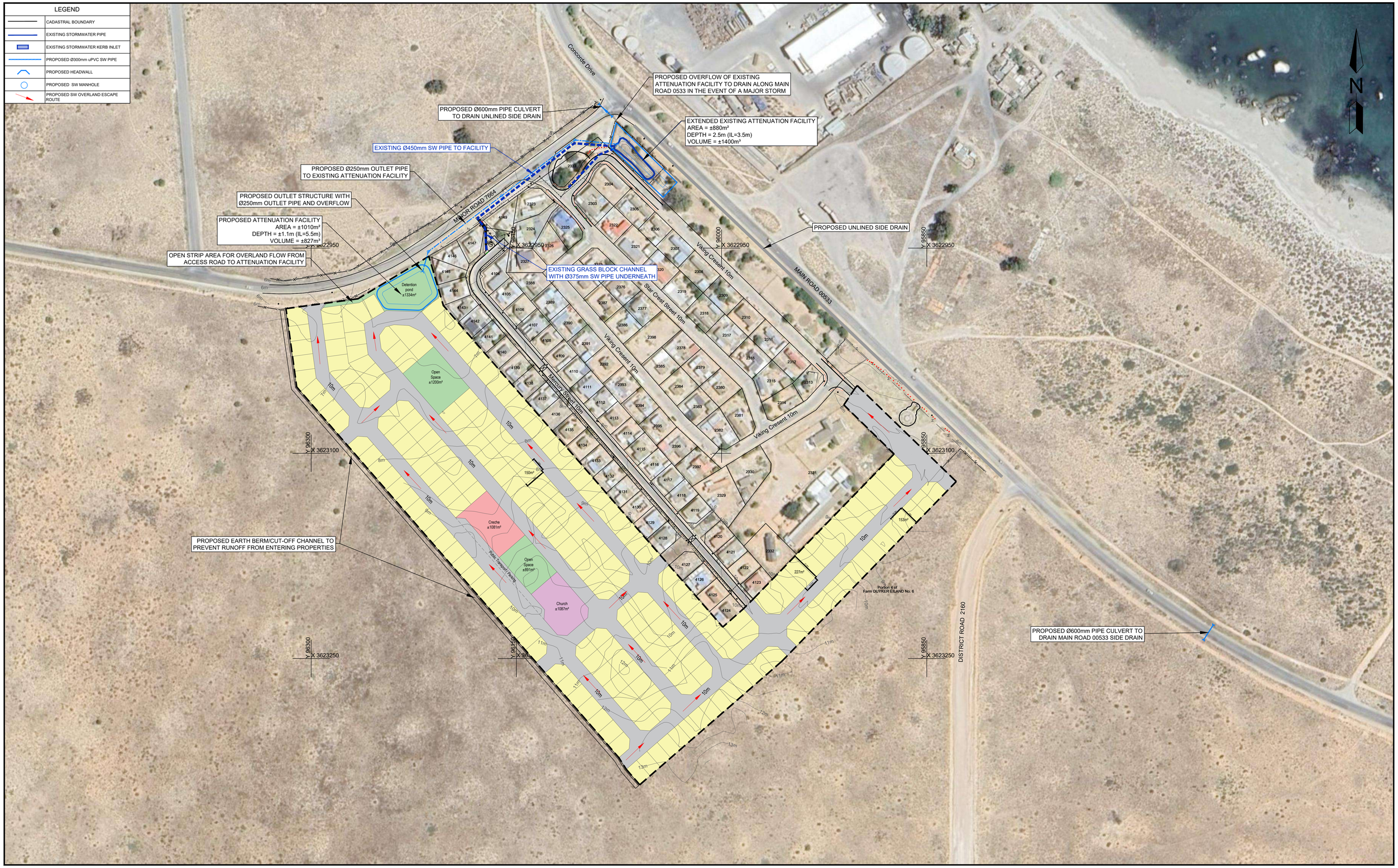
TEST RESULTS
CHEMICAL PROPERTIES OF SOILS

LABORATORY TECHNICIAN		GILMORE ZIMRI (N.DIP. CHEM.ENG.)	
Material Description		Light Brown Sand + Calcrete	Light Brown Silty Fine Sand
SGS Lab. Number	UOM	D 02702	D 02703
Client Sample Number		TP8	TP.9
Depth	mm	0.20-1.30	0.20-1.00
pH (Sans 5854)	%	8.35	8.45
Conductivity (SANS 6240)	Sm-1	0.102	0.0980

Technical Signatory: Gregory Belll

End of report

Annexure E – Proposed Stormwater Infrastructure



FOR INFORMATION

REVISION SCHEDULE

No	DATE	DESCRIPTION	DRW	CHK
A	26/04/24	FOR INFORMATION	EE	EE

CONSULTING ENGINEER

Erasmus — SIGNATURE | 201370381 — PR No | 03/05/2024 — DATE

CLIENT

SIGNATURE | DATE

DESIGNED	DRAWN	CHECKED
EE	EE	EE

CONSULTANT

iX engineers — Infrastructure Excellence

31 Allen Drive | Loevenstein | Cape Town | 7530
Tel: +27 (0) 21 912 3000
www.ixengineers.co.za

CLIENT

SALDANHA BAAI BAY
MUNISIPALITEIT | MUNICIPALITY | uMASIPALA
www.sbm.gov.za

PROJECT

STOMPNEUS BAY HOUSING DEVELOPMENT

DRAWING DESCRIPTION

PROPOSED STORMWATER INFRASTRUCTURE

SCALE FOR REDUCED PLAN

0 5 10 20 30 40 50
50mm ON ORIGINAL PLAN

DATE	SCALE	ORIGINAL SIZE
APR 2024	1:1 500	A1

DRAWING NUMBER	REV
P09414-SW-003	A

Annexure F – Peak Flow Calculations

Farm 4/6 Stompneus Bay Housing Development
Summary

Run-off							
Sub-catchment	**Area (m2)**	**1:2 Runoff (m^3/s)**	**1:5 Runoff (m^3/s)**	**1:10 Runoff (m^3/s)**	**1:20 Runoff (m^3/s)**	**1:50 Runoff (m^3/s)**	**1:100 Runoff (m^3/s)**
Catchment A: Pre-developed	49285.0	0.041	0.061	0.078	0.100	0.142	0.178
Catchment A: Post-developed	49285.0	0.211	0.284	0.333	0.382	0.438	0.488
Catchment B: Pre-developed	75387.0	N/A					
Catchment B: Post-developed	75387.0	0.323	0.435	0.509	0.584	0.671	0.733

Pond Sizing						
1:10 Pond Volume (m^3)	**1:50 Pond Volume (m^3)**	**1:100 Pond Volume (m^3)**	**Outflow (=1:10 Pre)**	**Pond Invert Level**	**Emergency Overflow Level**	**Capacity (m^3)**
466.6	689.3	780.3	41ℓ/s in Ø250mm pipe at 1:250 slope	±6.0m	±7.1m	827.3
1355.6	1958.5	2195.9	24h storm & 7ℓ/s infiltration	±4.65m	N/A	1400

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
RATIONAL METHOD FOR PRE-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0490	km^2
Longest watercourse (L)	0.367	km
Average slope(S_{av})	0.0150	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	100.00%
Urban	0.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	100.00%	0.01	0.01
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	100.00%	-	0.01
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	50.00%	0.06	0.03
Semi-permeable	50.00%	0.12	0.06
Impermeable	0.00%	0.21	0.00
Total	100.00%	-	0.09
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	50.00%	0.17	0.09
No vegetation	50.00%	0.26	0.13
Total	100.00%	-	0.22

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	0.00%	0.10	0.00
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	0.00%	0.50	0.00
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	0.00%	0.95	0.00
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	0.00%	-	0.00

Time of Concentration (T_c)

Tc (overland flow)	0.57	hours
Tc (watercourse)	**0.15**	**hours**
Tc total	0.73	hours
Tc (select value)	**0.50**	**hours**

30 min

r Value to use: 0.3
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.315	0.315	0.315	0.315	0.315	0.315
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.158	0.173	0.189	0.211	0.261	0.315
Combined run-off (C_T)	0.158	0.173	0.189	0.211	0.261	0.300

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	19.2	25.8	30.3	34.7	39.8	43.5
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	19.2	25.8	30.3	34.7	39.8	43.5
PEAK FLOW (m^3/s)	0.041	0.061	0.078	0.100	0.142	0.178
PEAK FLOW (ℓ/s)	41.1	60.9	77.8	99.6	141.8	177.8

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
RATIONAL METHOD FOR POST-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0490	km^2
Longest watercourse (L)	0.367	km
Average slope(S_{av})	0.0150	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	0.00%
Urban	100.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	0.00%	0.01	0.00
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	0.00%	-	0.00
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	0.00%	0.06	0.00
Semi-permeable	0.00%	0.12	0.00
Impermeable	0.00%	0.21	0.00
Total	0.00%	-	0.00
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	0.00%	0.17	0.00
No vegetation	0.00%	0.26	0.00
Total	0.00%	-	0.00

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	25.00%	0.10	0.03
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	44.00%	0.50	0.22
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	31.00%	0.95	0.29
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	100.00%	-	0.54

Time of Concentration (T_c)

Tc (overland flow)	0.16	hours
Tc (watercourse)	**0.15**	**hours**
Tc total	0.32	hours
Tc (select value)	**0.25**	**hours**

15 min

r Value to use: 0.02
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.000	0.000	0.000	0.000	0.000	0.000
Combined run-off (C_T)	0.540	0.540	0.540	0.540	0.540	0.550

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	28.7	38.7	45.3	52.0	59.7	65.2
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	28.7	38.7	45.3	52.0	59.7	65.2
PEAK FLOW (m^3/s)	0.211	0.284	0.333	0.382	0.438	0.488
PEAK FLOW (ℓ/s)	211.1	284.1	332.8	381.6	438.4	488.3

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
RATIONAL METHOD FOR POST-DEVELOPED FLOWS

Physical characteristics

Size of catchment (A)	0.0750	km^2
Longest watercourse (L)	0.4	km
Average slope(S_{av})	0.0125	m/m
Mean Annual Rainfall (MAR)	275	mm

Area distribution facto

Rural	0.00%
Urban	100.00%
Lakes	0.00%
Rainfall Region	Coastal

Surface slope, permeability, vegetation & land use

Rural

Surface slope	**%**	**Factor**	**C_s**
Vleis, pans (<3%)	0.00%	0.01	0.00
Flat areas (3-10%)	0.00%	0.06	0.00
Hilly (10-30%)	0.00%	0.12	0.00
Steep areas (>30%)	0.00%	0.22	0.00
Total	0.00%	-	0.00
Permeability	**%**	**Factor**	**C_p**
Very permeable	0.00%	0.03	0.00
Permeable	0.00%	0.06	0.00
Semi-permeable	0.00%	0.12	0.00
Impermeable	0.00%	0.21	0.00
Total	0.00%	-	0.00
Vegetation	**%**	**Factor**	**C_v**
Thick bush, plantation	0.00%	0.03	0.00
Light bush, farmlands	0.00%	0.07	0.00
Grasslands	0.00%	0.17	0.00
No vegetation	0.00%	0.26	0.00
Total	0.00%	-	0.00

Urban

Lawns	**%**	**Factor**	**C_s**
Sandy, flat (<2%)	25.00%	0.10	0.03
Sandy, steep (>7%)	0.00%	0.20	0.00
Heavy soil, flat (<2%)	0.00%	0.17	0.00
Heavy soil,steep (>7%)	0.00%	0.35	0.00
Residential Areas			
Houses	44.00%	0.50	0.22
Flats	0.00%	0.70	0.00
Industry			
Light Industry	0.00%	0.80	0.00
Heavy Industry	0.00%	0.90	0.00
Business			
City Centre	0.00%	0.95	0.00
Suburban	0.00%	0.70	0.00
Streets	31.00%	0.95	0.29
Maximum Flood	0.00%	1.00	0.00
Total (C_2)	100.00%	-	0.54

Time of Concentration (T_c)

Tc (overland flow)	0.18	hours
Tc (watercourse)	**0.18**	**hours**
Tc total	0.35	hours
Tc (select value)	**0.25**	**hours**

15 min

r Value to use: 0.02
(Clean soil: 0.1; Paved area: 0.02; Sparse grass: 0.3; Mod. grass: 0.4; Thick grass: 0.8)

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Run-off coefficient, C_1	0.000	0.000	0.000	0.000	0.000	0.000
Adjustment factor (F_t)	0.500	0.550	0.600	0.670	0.830	1.000
Adjustment run-off (C_{1T})	0.000	0.000	0.000	0.000	0.000	0.000
Combined run-off (C_T)	0.540	0.540	0.540	0.540	0.540	0.540

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**
Point Rainfall(mm), P_T	26.0	35.0	41.0	47.0	54.0	59.0
Point Intensity(mm/h),P_{iT}	28.7	38.7	45.3	52.0	59.7	65.2
Area Reduction Factor (ARF)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Average Intensity(mm/h), I_T	28.7	38.7	45.3	52.0	59.7	65.2
PEAK FLOW (m^3/s)	0.323	0.435	0.509	0.584	0.671	0.733
PEAK FLOW (ℓ/s)	323.1	434.9	509.5	584.0	671.0	733.1

Annexure G – Attenuation Calculations

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:10 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	10	1 day	41.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	10	24	45.1	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	10	0.25		44.9

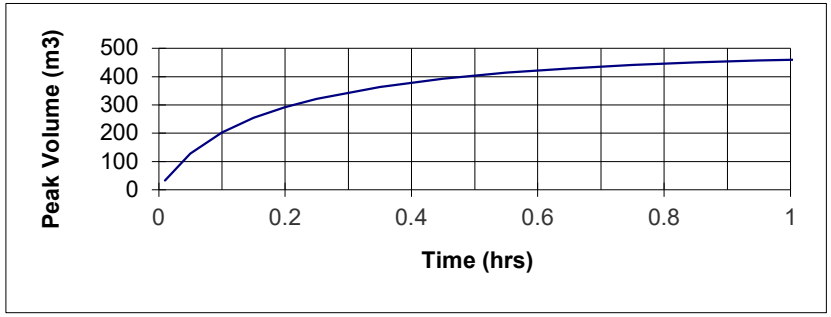
Rational method: Runoff coefficients

C before development	0.189
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in 10)	78	l/s	333	l/s

Developed, attenuated catchment:

Recurrence interval 1:	10	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**466.6**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:50 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	50	1 day	54.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	50	24	59.4	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	50	0.25		59.2

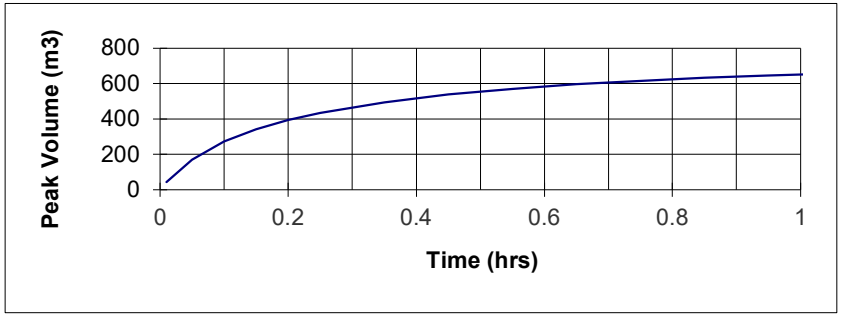
Rational method: Runoff coefficients

C before development	0.261
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in 50)	142	l/s	438	l/s

Developed, attenuated catchment:

Recurrence interval 1:	50	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**689.3**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT A
DETENTION VOLUME FOR 1:100 YEAR RETURN PERIOD

Catchment:

Total catchment	5.9	ha
Attenuated catchment	5.9	ha
Unattenuated catchment	0	ha
Area to be developed	5.9	ha
Pre-developed area	5.9	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	100	1 day	59.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	100	24	64.9	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	100	0.25		64.6

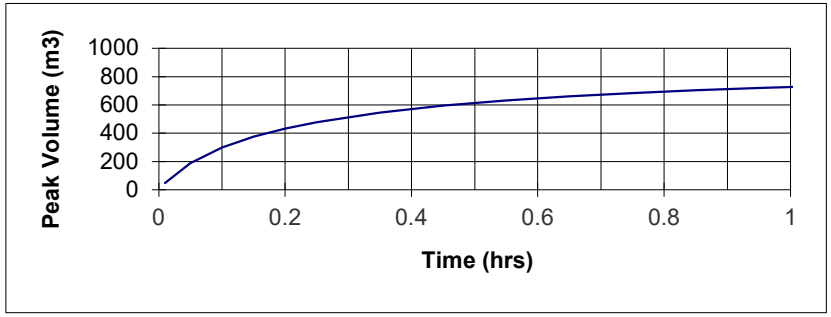
Rational method: Runoff coefficients

C before development	0.300
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)	61	l/s	284	l/s
Major RI (1 in100)	178	l/s	488	l/s

Developed, attenuated catchment:

Recurrence interval 1:	100	yrs
Q :- dam outflow	41	l/s
Req'd attenuation vol.	**780.3**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:10 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	10	1 day	41.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	10	24	45.1	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	10	0.25		44.9

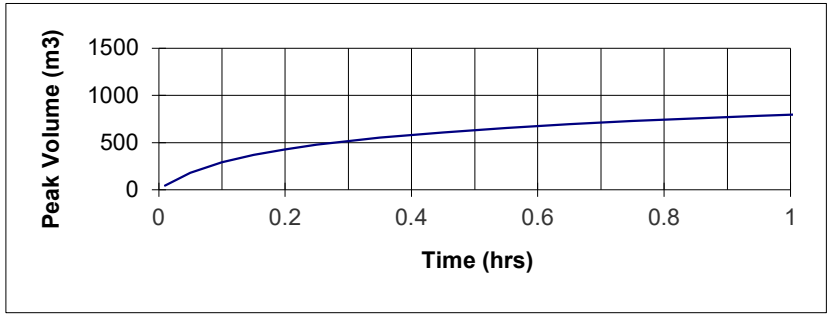
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in 10)		l/s	509	l/s

Developed, attenuated catchment:

Recurrence interval 1:	10	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**1355.6**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:50 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	50	1 day	54.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	50	24	59.4	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	50	0.25		59.2

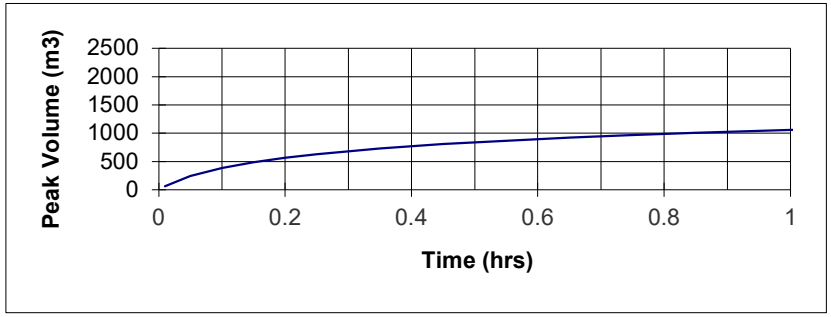
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in 50)		l/s	671	l/s

Developed, attenuated catchment:

Recurrence interval 1:	50	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**1958.5**	**m3**



FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
CATCHMENT B
DETENTION VOLUME FOR 1:100 YEAR RETURN PERIOD

Catchment:

Total catchment	7.992	ha
Attenuated catchment	7.992	ha
Unattenuated catchment	0	ha
Area to be developed	7.992	ha
Pre-developed area	7.992	ha
Time of concentration Tc	0.25	h

Storm rainfall:	RI (yrs)	Duration (h)	Rain depth (mm)	Rain int. (mm/h)
Minor RI; 1 day rain	5	1 day	35.00	
Major RI; 1 day rain	100	1 day	59.00	
Minor RI; 24h rain	5	24	38.5	
Major RI; 24h rain	100	24	64.9	
Minor RI; critical storm intensity	5	0.25		38.3
Major RI; critical storm intensity	100	0.25		64.6

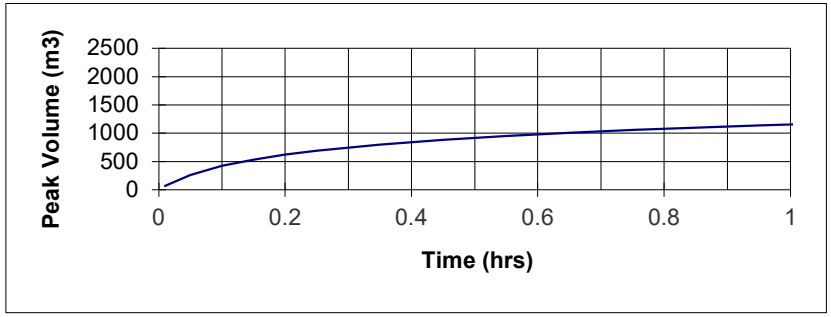
Rational method: Runoff coefficients

C before development	
C after development	0.540

Peak flows	Natural catchment:		Developed catchment without attenuation:	
Minor RI (1 in 5)		l/s	435	l/s
Major RI (1 in100)		l/s	733	l/s

Developed, attenuated catchment:

Recurrence interval 1:	100	yrs
Q :- dam outflow	7	l/s
Req'd attenuation vol.	**2195.9**	**m3**



Annexure H – Rainfall and Evaporation Data

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT

Rainfall @ Station G1E007

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978/79	0.0	0.0	0.0	9.3	10.4	4.0	0.9	47.1	37.8	30.4	28.8	28.8	0.0
1979/80	22.0	3.9	1.2	9.3	2.6	0.0	20.7	66.7	48.6	10.9	40.0	10.8	236.7
1980/81	2.6	65.8	12.6	6.1	0.0	30.4	8.7	5.4	21.1	70.2	61.3	35.5	319.7
1981/82	8.6	7.2	2.9	21.8	1.6	14.7	37.1	17.9	47.7	50.6	41.3	3.6	255.0
1982/83	11.5	4.2	19.6	13.8	17.0	11.3	6.2	82.2	56.3	47.5	18.9	26.7	315.2
1983/84	2.0	5.6	9.0	0.6	1.3	9.9	12.2	101.8	15.4	38.5	20.1	56.5	272.9
1984/85	67.5	0.0	33.7	10.0	4.6	46.6	44.2	16.6	49.1	90.9	51.2	32.9	447.3
1985/86	2.3	2.3	1.9	7.5	1.3	18.0	13.5	13.9	92.7	55.3	48.0	52.3	309.0
1986/87	16.4	14.7	1.7	15.2	5.4	1.2	29.1	69.5	47.7	80.7	66.3	23.1	371.0
1987/88	7.2	3.7	22.5	0.6	0.0	10.3	58.5	19.1	59.4	48.1	56.1	27.3	312.8
1988/89	6.9	7.5	2.1	1.3	6.5	25.9	33.6	34.7	20.8	77.7	49.2	58.1	324.3
1989/90	19.2	7.0	0.8	10.6	5.4	0.3	90.5	60.9	56.5	74.1	14.9	5.2	345.4
1990/91	0.9	4.8	17.8	0.9	0.0	0.0	0.0	0.0	52.5	240.3	10.4	68.4	0.0
1991/92	34.4	7.4	4.0	0.5	8.3	4.5	14.2	22.2	53.4	37.8	14.9	22.5	224.1
1992/93	37.2	2.4	0.0	0.0	0.0	0.0	47.4	12.1	59.7	38.1	54.9	4.5	0.0
1993/94	1.5	0.4	8.9	3.2	0.0	1.6	31.4	12.6	0.0	30.2	6.2	17.7	113.7
1994/95	10.7	4.7	2.2	4.7	2.0	19.6	5.0	16.5	49.9	67.2	42.7	0.0	225.2
1995/96	1.6	0.0	8.2	0.0	29.0	0.0	21.3	28.9	29.2	38.0	45.4	47.1	248.7
1996/97	9.9	17.0	12.6	1.2	0.0	8.0	14.8	27.6	67.0	14.4	20.9	0.0	193.4
1997/98	3.0	20.0	2.2	4.2	0.0	3.8	10.8	39.4	30.2	37.4	23.0	6.4	180.4
1998/99	6.2	35.5	15.6	0.4	0.0	0.4	14.8	47.2	45.4	59.3	71.6	46.4	342.8
1999/00	0.0	9.8	0.0	3.2	0.0	0.0	5.0	27.6	11.2	35.0	21.6	32.2	145.6
2000/2001	2.2	2.8	0.0	9.2	4.4	0.2	21.2	59.2	26.4	116.3	63.8	34.0	339.7
2001/2002	22.4	15.3	3.4	41.2	10.9	5.4	11.0	53.4	49.8	53.9	47.9	26.7	341.3
2002/2003	24.4	3.8	17.0	0.0	0.0	7.6	8.0	4.8	4.8	18.0	80.8	29.8	199.0
2003/2004	7.8	0.0	15.8	9.2	0.0	4.1	14.2	0.8	52.6	35.4	34.8	11.2	185.9
2004/2005	48.2	2.0	3.8	6.0	2.4	3.8	26.8	36.2	64.0	0.0	0.0	0.0	0.0
Avg:	**14.5**	**9.5**	**8.4**	**7.3**	**4.5**	**9.3**	**23.1**	**34.2**	**42.6**	**57.5**	**39.8**	**27.2**	**271.7**

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT

Evaporation @ Station G1E007

	Oct	Nov	Dec	Jan	F0b	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978/79	0.0	0.0	0.0	357.1	263.5	226.9	138.0	95.2	57.3	58.3	80.3	118.5	**1395.1**
1979/80	151.0	216.9	271.6	266.9	210.3	171.7	101.1	71.6	58.2	55.2	71.9	117.0	**1763.4**
1980/81	175.1	176.8	224.6	247.1	226.5	178.4	119.2	81.9	48.8	47.7	85.3	104.5	**1715.9**
1981/82	181.1	215.7	279.9	235.3	232.6	207.2	123.4	70.4	38.7	42.6	59.0	121.1	**1807.0**
1982/83	195.0	192.0	228.1	251.3	189.5	168.3	125.7	65.5	37.4	55.1	73.9	80.7	**1662.5**
1983/84	167.0	198.1	0.0	255.1	239.3	199.9	131.7	70.7	57.6	56.0	68.1	80.0	**1523.5**
1984/85	142.5	244.5	225.7	231.5	216.8	157.6	104.2	77.9	44.2	53.7	74.4	95.9	**1668.9**
1985/86	172.3	238.8	259.9	284.0	226.3	176.0	109.5	72.5	56.5	48.3	66.2	104.3	**1814.6**
1986/87	168.4	221.7	284.7	239.2	195.4	177.7	104.1	72.5	58.4	47.1	62.3	93.1	**1724.6**
1987/88	162.2	202.2	210.1	245.0	238.0	167.3	119.4	81.9	43.9	38.7	64.9	97.3	**1670.9**
1988/89	163.4	235.0	288.6	258.3	231.5	172.9	124.1	63.8	44.1	46.5	56.7	90.0	**1774.9**
1989/90	168.2	226.0	259.8	265.1	213.9	186.8	102.3	65.4	42.7	39.4	71.9	110.7	**1752.2**
1990/91	196.9	211.3	242.3	251.9	0.0	0.0	0.0	0.0	0.0	55.7	71.6	91.8	**1121.5**
1991/92	148.3	199.4	263.5	280.5	210.3	190.7	100.2	59.3	0.0	0.0	0.0	0.0	**1452.2**
1992/93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.8	**94.8**
1993/94	178.7	223.6	253.0	273.1	241.3	182.1	108.5	59.5	0.0	44.0	73.2	93.5	**1730.5**
1994/95	192.9	219.2	274.7	257.1	206.1	191.8	125.7	82.3	41.3	50.6	48.5	0.0	**1690.2**
1995/96	147.5	213.0	215.2	248.0	206.5	167.1	120.3	83.3	35.5	86.0	60.6	64.5	**1647.5**
1996/97	140.0	172.5	189.9	243.3	204.0	154.3	106.8	79.8	50.3	71.8	53.7	131.0	**1597.4**
1997/98	220.0	196.6	239.7	257.1	201.5	181.3	105.3	60.9	32.1	52.1	80.2	113.7	**1740.5**
1998/99	168.3	199.5	259.1	262.4	220.0	197.4	137.2	85.8	53.5	59.3	65.3	81.9	**1789.7**
1999/00	209.8	190.8	248.0	241.8	241.0	215.0	133.0	83.2	53.6	59.6	61.2	101.1	**1838.1**
2000/2001	203.2	217.2	258.5	265.2	233.4	190.2	118.2	61.4	60.1	34.1	0.0	77.4	**1718.9**
2001/2002	153.5	228.1	259.3	261.3	229.7	174.9	118.5	89.8	42.6	45.3	77.0	113.8	**1793.8**
2002/2003	170.9	227.3	273.5	283.5	221.5	189.1	117.0	87.8	60.3	65.5	66.8	82.6	**1845.8**
2003/2004	148.3	229.5	226.8	271.2	227.0	199.1	110.2	84.3	49.7	49.9	55.3	114.7	**1766.0**
2004/2005	150.0	213.0	269.8	281.0	237.4	204.8	126.8	69.6	44.4	0.0	0.0	0.0	**1596.8**
Avg:	**171.0**	**212.3**	**250.3**	**262.1**	**222.5**	**185.1**	**117.2**	**75.1**	**48.3**	**52.6**	**67.3**	**98.9**	**1742.9**

FARM 4/6 STOMPNEUS BAY HOUSING DEVELOPMENT
Evaporation Pond Volume Calculation

Month	Average Rainfall		Average Evaporation		Pond capacity		Capacity	
	mm	m3	mm	m3	In	Out	needed	
Oct	14.5	591.3	171	150.5	591.3	150.5	440.9	
Nov	9.5	387.4	212.3	186.8	387.4	186.8	641.5	
Dec	8.4	342.6	250.3	220.3	342.6	220.3	763.8	
Jan	7.3	297.7	262.1	230.6	297.7	230.6	830.9	
Feb	4.5	183.5	222.5	195.8	183.5	195.8	818.6	
March	9.3	379.3	185.1	162.9	379.3	162.9	1035.0	
April	23.1	942.1	117.2	103.1	942.1	103.1	1873.9	
May	34.2	1394.8	75	66.0	1394.8	66.0	3202.7	
June	42.6	1737.3	48.3	42.5	1737.3	42.5	4897.5	
July	57.5	2345.0	53.4	47.0	2345.0	47.0	7195.5	
Aug	39.8	1623.2	67.7	59.6	1623.2	59.6	8759.1	
Sept	27.2	1109.3	99.7	87.7	1109.3	87.7	**9780.7**	**m3**
Oct	14.5	591.3	171	150.5	591.3	150.5	10221.5	
Nov	9.5	387.4	212.3	186.8	387.4	186.8	10422.2	
Dec	8.4	342.6	250.3	220.3	342.6	220.3	10544.5	
Jan	7.3	297.7	262.1	230.6	297.7	230.6	10611.5	
Feb	4.5	183.5	222.5	195.8	183.5	195.8	10599.3	
March	9.3	379.3	185.1	162.9	379.3	162.9	10815.6	
April	23.1	942.1	117.2	103.1	942.1	103.1	11654.6	
May	34.2	1394.8	75	66.0	1394.8	66.0	12983.4	
June	42.6	1737.3	48.3	42.5	1737.3	42.5	14678.2	
July	57.5	2345.0	53.4	47.0	2345.0	47.0	16976.2	
Aug	39.8	1623.2	67.7	59.6	1623.2	59.6	18539.8	
Sept	27.2	1109.3	99.7	87.7	1109.3	87.7	**19561.4**	**m3**
Tot vol/year:		11333.5		1552.8				

C factor	0.54	
Rainfall Area	75523.6	m2
Evaporation Area	880	m2