GEORGE MUNICIPALITY

PROJECT 20 (5): UPGRADING THEMBALETHU BULK SEWER – PHASE 3 AND 4

CONCEPT & VIABILITY REPORT

REPORT NO: 1762: REV NO. 2

22 JULY 2024

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GEORGE MUNICIPALITY

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CONCEPT & VIABILITY REPORT

REPORT NO: 1762 REVISION 3

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1. INTRODUCTION

1.1 BACKGROUND

The purpose of this Concept and Viability Report is to establish George Municipality's requirements and preferences for the concept design for the upgrading of bulk sewer mains in Thembalethu in support of the Upgrading of Informal Settlements Programme (UISP). The Phase 3 and 4 bulk sewer mains are required to accommodate upstream flow as well as future housing developments to allow fully serviceable sites and the implementation of formal housing units in the identified areas. The proposed bulk sewer forms part of the overall bulk sewer upgrades required in Thembalethu as part of the Sanitation Master Plan.

The Municipality is placed under strain when dealing with the operation and maintenance of these sewerage systems due to constant blockages by foreign matter, not only causing a financial burden but resulting in environmental spillages and increased operation and maintenance requirements. The informal areas within Thembalethu currently do not have waterborne sanitation systems and a portion of this project will address these services allowing formal development of the area by extending the current bulk network to include areas that can easily be connected to the existing sanitation infrastructure. The existing upstream bulk sewers and pump stations will be utilised, where possible sewage will be conveyed through the new bulk sewer Phase 3 and 4 to the Outeniqua Waste Water Treatment Works (WWTW).

The bulk sewer will be implemented in a phased approach subject to available funding.

1.2 TERMS OF REFERENCE

George Municipality has appointed Lukhozi Consulting Engineers (Pty) Ltd as their professional engineering service provider for the Upgrading of Thembalethu Bulk Sewer Phase 3 and Phase 4.

The scope of services under the appointment is outlined below:

- Inception, concept design, detail design, documentation & procurement and implementation of Thembalethu Phase 3 and 4 bulk sewerage Infrastructure.
- Advise on criteria that could influence the project life cycle cost significantly.
- Provide the necessary information within the agreed scope of the project to other consultants involved.

- Provision of additional services required to develop and implement the project including construction monitoring.

1.3 PURPOSE OF THE REPORT

The purpose of this report is to provide details pertaining to the concept and viability planning, design, and implementation of Thembalethu Bulk Sewers- Phase 3 and 4.

This report outlines the recommended levels of services to be installed in conformance with the minimum design standards and requirements and, serves to establish the design criteria to be applied to the project.

1.4 PROJECT TEAM

The parties listed below will be involved in the planning, design and implementation of this project.

Employer .... George Municipality (GM)
Consulting Engineer.. Lukhozi Consulting Engineers Pty (Ltd)
Geotechnical Engineers.. Outeniqua Geotechnical Services
Engineering Surveyors.. Joubert & Brink Surveys (Pty) Ltd
Health and Safety Agents .... Xaks Consulting
Environmental Assessment Practitioner (EAP) .... Cape EAPrac

Refer to **Annexure A** – project organogram, for details of the Professional teams' members.

2. <u>SITE DETAILS</u>

2.1 LOCALITY

Thembalethu is located within the jurisdictional boundaries of George Local Municipality of the Western Cape Province.

Coordinates of the centre of the area are 34°0'39.94" S & 22°28'38.70" E.

Access to Thembalethu is obtained via the Thembalethu interchange on the N2 national road from Knysna to Mossel Bay. The site spans along the western boundary of Thembalethu along the Schaapkop River. Access to the site is via Nelson Mandela Boulevard and residential roads, where available.

Refer to locality plan in **Figure 1** below.

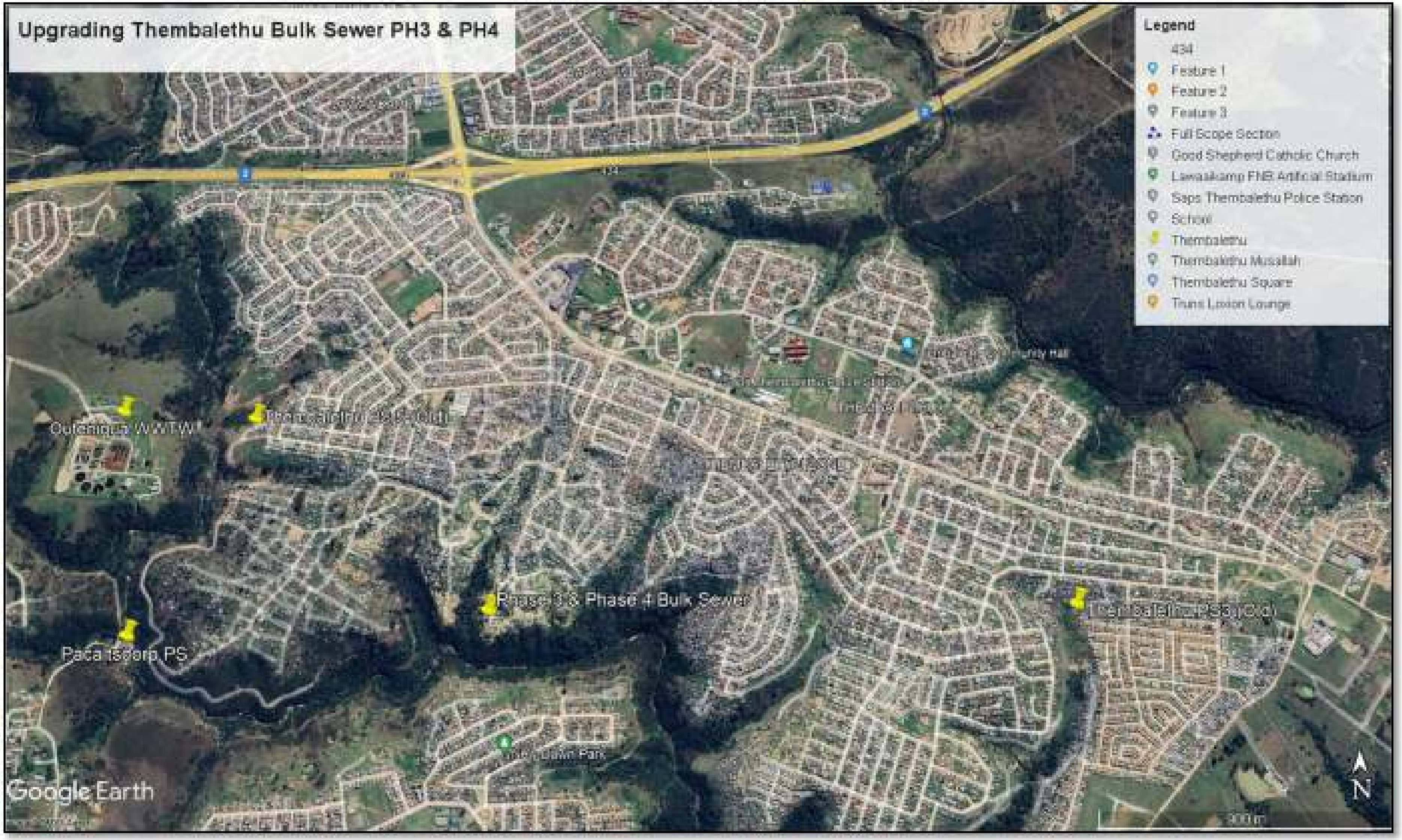


Figure 1: Locality of the planned Phase 3 & Phase 4 bulk sewer and decommissioned Thembalethu pump station no. 3

2.2 ENGINEERING SURVEY

Joubert and Brink Surveys were appointed as the engineering surveyor for this project. A LiDAR and Topographical survey were performed for areas being considered under the Thembalethu Bulk Sewers- Phase 3 and 4 scope of works. The engineering survey was completed, and the final information supplied to Lukhozi on 20 November 2023 and has been used in the concept & viability design.

2.3 GEOTECHNICAL INVESTIGATION

Outeniqua Lab and Geotechnical Services were appointed as the geotechnical engineering sub-consultant for this project. A geotechnical site investigation and report was prepared and submitted for areas being considered under the Thembalethu Bulk Sewers- Phase 3 and 4 scope of works. This is required to focus on identifying potential hazards, defining ground conditions, and offering detailed soil profiles and groundwater occurrence. The geotechnical site investigation was completed in December 2023 and the provisional soil test data was supplied on 14 December 2023. The final soil test and report was submitted on 1 February 2024. A copy of the geotechnical report is attached as Annexure B to this report.

Early indications from the soil test data show that the area will be suitable for the installation of sewers, with soils generally expected to be classified as ‘soft excavation’ over the majority of the route. Some trench shoring may be required in isolated areas with poor soil stability and dewatering of marshy areas may also be needed. These specifics will be confirmed through field and laboratory testing which will form part of the detailed geotechnical investigation report.

2.4 ENVIRONMENTAL INVESTIGATION

An Environmental Assessment Practitioner (EAP), Cape EAPrac, has been appointed to assess the Thembalethu Bulk Sewers- Phase 3 and 4 scope, and commence with the application to the Department of Environmental Affairs & Development Planning (DEA&DP), necessary permit/s with Department of Forestry, Fisheries and the Environment (DFFE) and necessary Water Use License Authorisation (WULA).

An existing environmental authorisation is in place for the implementation of various sanitation infrastructure in Thembalethu, including the Phase 3 & 4 bulk sewers. However, any change to the scope or alignment of the authorisation will require amendment.

The EAP, fresh water ecologist and other specialists undertook a site inspection on 1 November 2023, to determine the environmental sensitivity in relation to any potentially concerning environmental features.

CAPE EAPrac completed the Notice of Intent (NOI) and submitted it to the DEA&DP on 1 December 2023. A feedback letter with respect to the NOI letter was received from DEA&DP on 26 January 2024. The Department indicated that a Part 1 amendment to the existing Environmental Authorisation (EA) can be applied for if the proposed amendment will not change the scope of a valid environmental authorisation, nor increase the level or nature of the impact, which impact was initially assessed and considered when an application was made for an environmental authorisation; or relates to the change of ownership or transfer of rights and obligations. They further indicated that since the proposed amendment (i.e. this Phase 3 & 4) will change the scope of the authorisation (i.e. new pipeline route not currently in the authorisation), regardless of what the reason is, a Part 1 amendment process cannot be followed for this change. DEA&DP is therefore of the opinion that a Part 2 amendment should be applied for instead.

Further environmental investigation and specialist studies will proceed as required by DEA&DP and a Part 2 amendment which will identify any environmental concerns that may affect the implementation of the Thembalethu Bulk Sewers- Phase 3 and 4 scope. This will be further addressed as the detail design stage will proceed.

Necessary adjustments to the designs will be made based on the final findings of the Basic Assessment if required.

3. SCOPE OF WORKS

3.1 PORTION 2

The Phase 3 and Phase 4 bulk sewers will serve the following areas that will tie into an existing 250mm Diameter bulk sewer line, situated south and south-east of the UISP Areas 5 & 6A and will gravitate to the existing Pacaltsdorp Sewer Pump Station 1. This pump station transfers the sewage to the Outeniqua WWTW, see Figure 2 below. This scope of work is seen as Portion 2.

During the detailed design stage it will be determined if the existing 250mm diameter bulk sewer line requires an upgrade to accommodate the new bulk sewer that will service Phase 3 and Phase 4 internal sewers.

Table 1: Portion 2 Estimated Bulk Gravity Sewers per concept design

Phase	Area	Anticipated Length	Planned Pipe Dia
3	Area 2 and the remainder of the bulk services required to fully service Area 5, 6A and 6B	Approx. 1460m	200mm (160mm was the proposed diameter per the Municipality's project appointment. This diameter is regarded as too small for bulk sewer reticulation for this area due to the small hydraulic loading and the nature and characteristics of the sewage)
4	Old All Brick Quarry Area	Approx. 970m	
Total estimated length of Planned Bulk Gravity Sewer		**2 430m**	

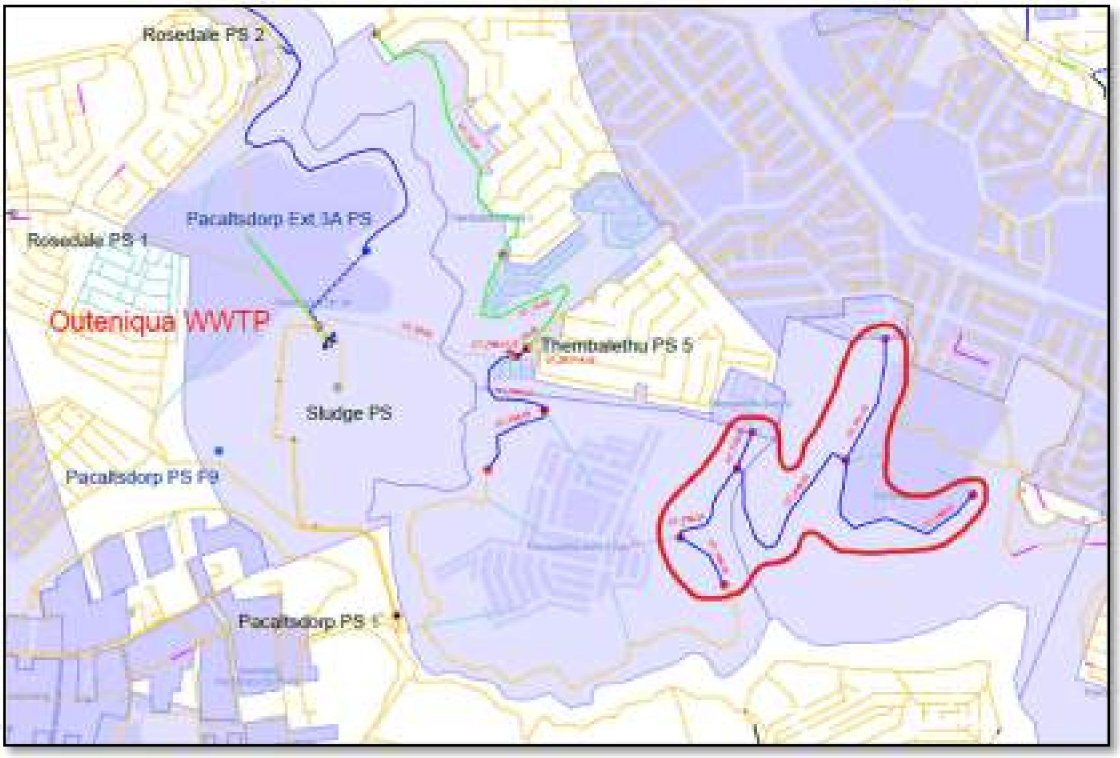


Figure 2: Portion 2 - Phase 3 and Phase 4 gravity bulk sewer (Outlined in red)

3.2 PORTION 1

A portion of the existing gravity sewer near the old, decommissioned Thembalethu sewer pump station no. 3 must be connected to the existing gravity sewer network to the western embankment of Ward 21 existing bulk sewer. This portion of the work is situated east of the planned Phase 3 and Phase 4 bulk sewer lines, but in totality creates the western bulk sewer line. Refer to Figure 3 below.

This portion of the scope of construction works will include the following as a minimum:

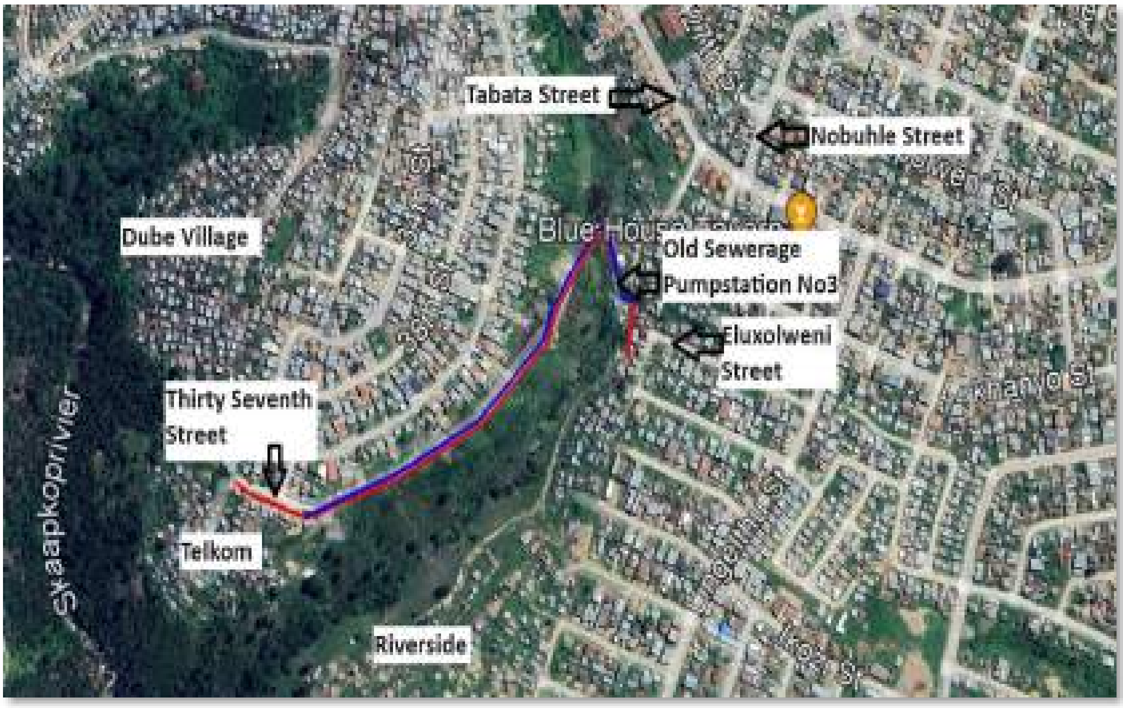
- Sewer connection to existing gravity sewer
- Stream crossing
- Construction of associated manholes
- Bulk earthworks and stabilization of erosion donga
- Stormwater crossing for future draining of Siyabulela and Eluxolweni Streets.

This scope of work is currently under construction, as part of T/ING/008/2020: The Appointment of Ad-Hoc Civil Engineering Contractors for a period of three years.

Table 2: Portion 1 Estimated Bulk Gravity Sewers per concept design

Portion	Area	Anticipated Length	Planned Pipe Dia
1A	Ward 9	316 m (200 mm Dia) 50 m (355 mm Dia)	200 mm and 355 mm Dia as per the existing pipeline with steeper falls of minimum 1 in 150
1B	Ward 21	120 m (355 mm Dia)	355 mm Dia as per the existing pipeline with steeper falls of minimum 1 in 150

Portion	Area	Anticipated Length	Planned Pipe Dia
Total estimated length of Planned Bulk Gravity Sewer for Portion 1		**486m**	



Legend:
Existing bulk sewer with poor gradient
New bulk sewer with min fall 1 in 150

Figure 3: Portion 1A&B Ward 9 & Ward 21 existing bulk sewer upgrade

4. <u>WAYLEAVE APPLICATION STATUS</u>

Planning wayleave applications to be submitted where applicable. Table 3 below indicates the status and outcome of each application.

Construction wayleaves will be applied for prior to commencing with construction by the applicable contractor/s.

Table 3: Wayleave Application Status

Service Provider	Service Affected	Comments
George: Electricity Department	Yes	Must be notified 5 days prior any construction. Electrical Representatives to inspect area prior excavation. Form to be filled out.
George: Civil Engineering Services	Yes	Sewer and water affected.
George: Environmental Services	Yes	Check if yellow woods or other protected trees will be in the way of new bulk sewer.

5. SUB-CONSULTANTS AND SPECIALIST SERVICE PROVIDERS

5.1 HEALTH AND SAFETY INVESTIGATION

George Municipality has appointed Xaks Consulting as the H&S Agent on 24 May 2023 for this project and will be involved during all required stages of the project.

The Health and Safety Agent is required to:

a) Attend design meetings.
b) Prepare baseline risk assessment and site-specific health and safety specification. A draft of the baseline risk assessment and site-specific health and safety specification was completed on 14 August 2023. This baseline risk assessment and site-specific health and safety specification will have to be reviewed and finalised during the compilation of the tender document for construction for portion 2.
c) Review the bill of quantities to confirm there are sufficient items and acceptable quantities and pricing prior to and post pricing.
d) Evaluate and approve the successful Contractor's Health and Safety Plan, which will be prepared in response to the risk assessment and specification.
e) Prepare and apply for a Construction Work Permit if required.
f) Attend monthly site meetings and perform monthly audits (minimum two site visits per month).
g) Prepare and submit monthly Health and Safety audit reports.
h) Manage the Contractor's compliance with his Health and Safety Plans, the Health and Safety Specifications and the OHS legislation.
i) Prepare and submit a Health and Safety close-out report on completion of both construction contracts.
j) Accept the duties and responsibilities of the Client as set out in the Construction Regulations.

6. CONCEPT DESIGN CRITERIA

6.1 STANDARDS APPLIED

The following references will be used for the design of the sewerage reticulation network:

- The Neighbourhood Planning & Design Guide: Section K - Sanitation (Red Book 2019)
- SANS 10400-P: Drainage
- George Municipality Civil Engineering Services: Civil Engineering Standards & Requirements for Services (Updated January 2009)

6.2 SEWER FLOW

The Instantaneous Peak Wet Weather Flows (IPWWF) for each of the drainage areas have been calculated using the sewer flow and peak factor method contained in section K.4 of the Human Settlements Planning and Design Guidelines (Red Book 2019). The following was allowed for in the design.

• Unit Hydrographs	:	UH 4	(PDDWF)
• Peak factor	:	2.0	(IPDWF)

- Groundwater infiltration rate : 0.03 (l/min/m/m Ø)
- Allowance for stormwater ingress : 50 % (IPWWF)

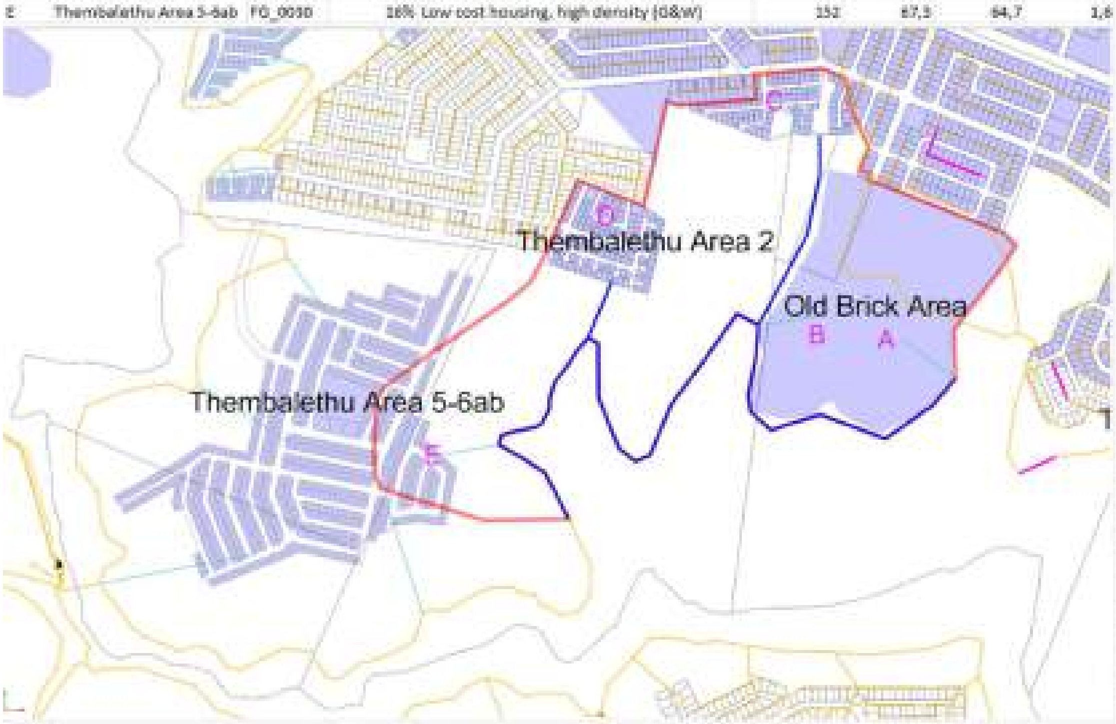
Refer to **Annexure C** attached to this Report for the design flow calculations for the bulk sewer as determined by Lukhozi.

6.2.1 Future Development flows

Table 4 provides a summary of the accumulated flows per drainage areas to a collection point that will drain via the proposed bulk sewers titled phase 3 and 4 in Thembalethu from the recent Sanitation Master Plan.

Table 4: GLS Design flows for Phase 3 and 4

Point	Future Development	Link Code	Portion	Landuse	Units	AADD (kL/d)	PDDWF (kL/d)	MP Design Flow (L/s)
A	Old Brick Area	FG_1120	50%	Low cost housing, very high density (G&W)	206	80,1	78,8	2,0
B	Old Brick Area	FG_1127	50%	Low cost housing, very high density (G&W)	206	80,1	78,8	2,0
C	Thembalethu Area 2	FG_0021	50%	Low cost housing, high density (G&W)	125	55,6	53,4	1,3
D	Thembalethu Area 2	FG_0035	50%	Low cost housing, high density (G&W)	125	55,6	53,4	1,3
E	Thembalethu Area 5-6ab	FG_0030	16%	Low cost housing, high density (G&W)	152	67,5	64,7	1,6



In accordance with the sanitation master plan, the theoretical design flows of the gravity sewer is indicated in **Table 5** below.

Table 5: GLS latest design flows for Phase 3 and 4

Drainage_Area	Model_Type	MP_Item_Type	MP_Item_No	Project_No	Project_Description	MP_Description	Design_Flow	Design_Flow_Unit
Outeniqua WWTW	Gravity	FM	OT_F81.00	RET_OT_060	Construct Thembalethu (2) outfall sewer	New Gravity	1.35	L/s
Outeniqua WWTW	Gravity	FM	OT_F82.00	RET_OT_060	Construct Thembalethu (2) outfall sewer	New Gravity	1.32	L/s
Outeniqua WWTW	Gravity	FM	OT_F96.01	RET_OT_061	Construct Old Brick Area outfall sewer	New Gravity	2.03	L/s
Outeniqua WWTW	Gravity	FM	OT_F96.02	RET_OT_060	Construct Thembalethu (2) outfall sewer	New Gravity	5.41	L/s
Outeniqua WWTW	Gravity	FM	OT_F96.03	RET_OT_060	Construct Thembalethu (2) outfall sewer	New Gravity	6.76	L/s
Outeniqua WWTW	Gravity	FM	OT_F96.04	RET_OT_060	Construct Thembalethu (2) outfall sewer	New Gravity	8.37	L/s

From the design flow calculations, as indicated by GLS, it can be seen that the future design flows are in the order of 1.3 to 2.0 l/s for the various areas with a maximum total design flow of 8.2l/s to 8.4 l/s. The design flow calculations as determined by Lukhozi (including an additional 50% stormwater infiltration) are in the order of 2.04 l/s to 6.75 l/s with a maximum total design flow of 13.5 l/s. The design flows are higher than the calculations as seen on the master planning reports, however this is mainly due to the stormwater infiltration, of 50%, designed for by Lukhozi. When working on an average stormwater infiltration rate of 15% the flows compare closer with the flows as calculated by GLS i.e. in the order of 1.96 l/s to 5.2 l/s with a maximum total design flow of 10.35 l/s. We find the flow rates determined by GLS, considering the actual extensive stormwater infiltration in George, as insufficient. It is necessary to determine the peak flow when sizing the proposed bulk sewer infrastructure and we therefore recommend the maximum design flow rate of 13.5l/s, as calculated by Lukhozi, be used for design purposes.

6.3 SEWERS

6.3.1 Bulk Sewer

The bulk sewers will be installed at an absolute minimum gradient of 1 in 150 per the Municipality’s requirements.

The site is not a “greenfield” site since there are informal dwellings that exist along most of the planned bulk sewers proposed route. It can therefore be classified as “brownfield” site. This will mean some informal dwellings will have to be moved to temporary positions during construction to enable the installation of the bulk sewer pipelines as can be seen on the concept design layouts attached to the report. Refer to Annexure D. The exact scope of dwellings to be relocated is unknown and will be determined during detail design and the construction stages.

In addition to the extend of the informal dwellings that are restricting access and construction, benching of steep sloped areas will be required to allow access, and create workable platforms and allow maintenance of the bulk sewer pipelines in future. Sufficient allowance will be made in the tender document to perform this activity ahead of construction. Reinstatement and rehabilitation will be required of all disturbed areas. See heading 6.3.5 of this report discussing the access requirements to construct the bulk sewer pipeline.

The proposed bulk sewers will be positioned along the boundaries of existing informal areas, to allow drainage of the areas below gradients of 1 in 25. However, it will not be possible to drain all the existing informal dwellings. Some of these dwellings are developed at embankments steeper than 1 in 25, where the Municipality does not allow formal development. It is recommended, that these dwellings also be relocated to formal areas as part of the Thembalethu Upgrading of Informal Settlement Programme(UISP) for the area, by the Housing Department.

Single lane stop and go traffic will be created during construction to allow residents access to their properties during the construction phase. The necessary Traffic Management Plan (TMP) and traffic accommodation allowances will be made in the tender document and Bill of Quantities (BoQ) for this. Re-instatement of existing roads, stormwater, water and sewer reticulation will form part of the works where required.

The anticipated length of bulk sewer and manholes to be constructed are indicated in Table 6 below.

Table 6: Summary of quantities

Phase	Estimated Sewer Pipe Length (m) / Dia (mm)	Estimated Manholes (No.)
3 (Pipeline A from SMH A34 to SMH A61 including pipelines B and C see drawings Annexure D)	Approx. 1460 (200mm Dia)	53
4 (Pipeline A from SMH A1 to SMH A34 see drawings Annexure D)	Approx. 970 (200mm Dia)	34
SUB-TOTAL: PORTION 2	**2 430**	**87**
Portion 1A	316m (200mm Dia) 50m(355 mm Dia)	11
Portion 1B	120m(355 mm Dia)	6
SUB-TOTAL PORTION 1	**486**	**17**
TOTAL	**2916**	**104**

6.3.2 Design

The bulk sewers are designed to the following standards:

- Minimum design pipe velocity : 0.7 m/s (design flows calculated velocities are between 0.7-1.5m/s)
- Maximum full pipe velocity : 3.5 m/s (0.8D full depth velocities are between 1.3-3.5m/s)
- Minimum cover to pipes : 1.0 m below finished road level 0.8 m below finished ground level.
- Maximum depth : 4.0 m below finished ground level
- Maximum manhole spacing : 80 m
- Minimum pipe size : 200 mm diameter
- Minimum Erf Connection size : 110 mm diameter
- Minimum gradient sewer main : 1:150 (per George Municipality requirements)
- Maximum gradient sewer main : 1:25

The sewerage reticulation will be designed according to the minimum diameters and gradients shown.

6.3.3 Pipe Materials

Sewer mains will be uPVC Class 34 heavy-duty solid wall complying with SANS 1601, with a pipe stiffness of 400 kPa and smooth inner and outer walls complete with integral sockets, joints, and rubber seal rings.

All fittings will comply with SANS 791.

6.3.4 Manholes

Sewer manholes are to be constructed using 1.0 m diameter precast concrete rings to depths in accordance with the designs and drawings. Manholes deeper than 1.5 m will be reduced to 0.75 m diameter precast rings up to a depth of 1.5 m and 1.0 m diameter precast rings for the rest of the depth. Heavy duty precast concrete type manhole cover and frames will be used for all manholes constructed in the roadways. The manhole cover for sewers with diameter 315 mm Diameter and below will be standard concrete manhole covers. The manhole cover for sewers with diameter above 355 mm Diameter will be specially made security concrete manhole covers to prevent the public from tampering with manholes.

Finished manhole cover levels will be flush with road level in roadways, 50 mm above finished ground level in road reserves and 500 mm above finished ground level in open spaces.

Precast manhole sections will comply with SANS 1294.

6.3.5 Access and maintenance gravel roads

The existing informal gravel access roads, where practically possible, will be used to develop the Thembalehtu Phase 3 and 4 bulk sewers. However, due to the topography of the Thembalethu Phase 3 and 4 with deep erosion areas, dongas etc as well as the minimum gravity falls required for the bulk sewer, new access from the existing informal access roads will have to be constructed to create access and platforms for construction of the new bulk sewer for Portion 2. This will be required along the whole length of the new bulk sewer alignment which mainly follows all along the low-lying contours of the Thembalehtu Phase 3 and 4 areas.

It is estimated that the construction width of average of between 8-15m will be required to construct these access roads and platforms. In extreme cases the construction width could be as wide as a maximum of 25m due to cutting into the disturbed informal areas. This will be created to prevent excessive fill of the undisturbed an existing vegetate areas along the gravity pipeline. To prevent extreme wide cutting into informal and disturbed embankments the construction of gabions and reno mattresses may be considered during construction to prevent erosion of these embankments. Storm water will have cross the access roads at positions where the access roads are in fill and at low points where the storm water will have to be discharged from the gravel access roads in a controlled manner by means of gabions and mattresses. This is to prevent erosion downstream of the roads and bulk sewer pipeline

The final access roads widths will be between 3.5-4.5m wide and will be used by the Municipality's maintenance team for routine maintenance of the bulk sewer in future. The details for these access roads are shown on the drawings found in Annexure D of this document.

6.3.6 Main stream crossings

Due to the topography of Thembalethu and Skaapkop River that flow at the foot hills, various minor and main streams commence within the settlement until it reaches the river.

Because the proposed new gravity sewer follows the lowest possible contour line to obtain maximum drainage, three(3) main stream crossings will have to be crossed and accommodated in the design along the length of the bulk sewer pipelines. The sewer pipelines will have to cross these main stream crossings by means of sewer pipe bridges as indicated on the layout and long section drawings.

It is proposed that the main stream and/or river crossings be constructed with reinforced concrete bridge structures. The detail for these crossings is shown on the stream crossings and stormwater detailed drawings found in Annexure D of this document.

The reasons for proposing reinforced concrete bridge structures are as follows;

a) Concrete is renowned for its exceptional durability, with concrete exhibiting resistance to corrosion, fire, and external forces. They can withstand challenging environments and provide long-lasting service life, reducing maintenance and replacement costs.
b) Concrete possess excellent structural strength, enabling it to bear heavy loads and resist deformation under pressure.
c) Properly designed concrete mixes can be resistant to chemical attacks, such as sulphur or acidic substances, making them suitable for a wide range of applications, including sewer systems and industrial environments.
d) Concrete offers a reliable and cost-effective solution due to its longevity and minimal maintenance requirements. It requires fewer repairs and replacements compared to alternative materials, resulting in reduced lifecycle costs.
e) It is robust and will last for years as can be seen at other concrete pipe bridges in the Thembalethu area.
f) The bridge structure can be designed in such a way that the bulk sewer pipe can be safely supported within the concrete bridge structure with concrete lids supported over its entire length. This can protect the pipe against vandalism and also allow pipe replacement by removing the concrete lids with lifting equipment should maintenance be required in future.

Steel bridge structures were considered but are not recommended due to the following reasons;

a) Steel in the Thembalethu area is prone to vandalism and/or theft.
b) Steel is not resistant to chemical attacks where leaks can occur, such as sulphur or acidic substances, making them unsuitable for this installation.
c) The main disadvantage of steel bridges, compared to concrete, is that they corrode under the action of the atmosphere, easily rust, and have high maintenance costs, which are expensive in comparison to concrete bridge structures.
d) Steel bridges have design limitations, which can make them unsuitable for certain applications, such as long-span bridges and high-load bridges.
e) Some people may find steel bridges to be unattractive or visually intrusive, particularly in scenic or historic areas.
f) Steel bridges require ongoing maintenance and inspections to ensure their safety and structural integrity over the long term.

Pipe and/or rectangular culverts are proposed for the minor stream crossings. The detail for these minor crossings will also be designed during the detailed design stage.

6.3.7 Minor stream crossings

Due to the topography of Thembalethu and Skaapkop River that flow at the foot hills, various minor and main streams commence within the settlement until it reaches the river.

Because the proposed new gravity sewer follows the lowest possible contour line to obtain maximum drainage, various minor stream crossings will also have to be crossed and accommodated in the design along the length of the bulk sewer pipeline. At these various minor stream crossings, the sewer pipelines will have to be protected from being undermined or scoured away by stormwater by means of stormwater protection measures as indicated on the drawings.

Piping of stormwater is proposed above or below the new bulk sewer pipelines. The detail of these minor stream crossings is detailed under the drawings found in Annexure D of this document. The inlets and outlets to these stormwater piped structures will be protected by a combination of soil rip-rap, gabion baskets and reno mattresses where required, to prevent erosion. It is recommended that the exposed faces of these baskets and mattresses be protected by means of “shotcrete”/gunite from vandalism as well as theft experienced in the Thembalethu area.

6.3.8 Erf Connections

Erf connections (if/where required) will be constructed for each erf indicated on the drawings and will comprise of 110 mm uPVC pipe. Typically, erf connections extend 1.0 m into the erf boundary however, this is a brownfields project with established homes with concrete block boundary walls, fencing, retaining block walls etc. The Employer should therefore consider revising this standard to have the erf connection terminate just outside the boundary of the erf, to avoid any potential damage that may occur to this privately owned infrastructure.

Each erf will receive a single erf connection from the main sewer and where feasible, will be positioned in a manner that aligns itself with the existing sewers, septic / conservancy tanks (if any) to allow for ease of connection.

Female stop end pieces to be solvent welded to the ends of erf connection pipes after the required air testing has been carried out.

The locations of all sewer erf connections are to be marked with No. 8 gauge wire or 5mm Co-Polymer non-biodegradable rope. The wire/rope must be attached to a brick placed at the level of the upper end of the connection and is to extend 0.5 m above the ground.

7. INFORMATION TO BE PROVIDED

For the purposes of this project, Lukhozi Consulting Engineers will provide the following information:

7.1 CONCEPT AND VIABILITY STAGE

Preliminary design layout plans showing known existing services based on information gathered through desktop exercises and surveys together with an indication of the proposed works. Separate drawings have been created for each of the proposed work Portions.

Typical details pertaining to the sewer manholes, trench details, erf connections, bridge crossings, stormwater and road crossing details have been created.

The above drawings are included in **Annexure D** of this document.

8. PROCUREMENT STRATEGY

8.1 CONTRACTOR PROCUREMENT

To ensure the best possible standard of work during the implementation of this complicated project, it is recommended to procure a single Contractor with the highest CIDB grading possible linked to the value of the contract (a minimum 6 CE in this instance). This strategy will allow a high level of accountability, quality of work, and financial security during the implementation phase. Participation Goal requirements could then be achieved by securing various sub-contractors who would report to the main contractor.

Due to limited budget for funding of this project, the Employer may decide if the scope of works will be split the into separate contracts with each main contract being administered independently. This strategy attracts a higher risk of failure due to the inexperience and financial reserves of contractors with lower CIDB gradings.

Each of the contracts will be subject to the conditions set out below.

8.2 CONSTRUCTION CONTRACT

The construction contract will be prepared in accordance with the relevant legislation and George Municipality's supply chain management policy and will consist of the following:

- The format of the Tender / Contract will be prepared in accordance with George Municipality's standard tender document and checked for compliance with SANS10845.
- The contract will be advertised on the online tender bulletins with the relevant CE CIDB grading depending on the estimated value of construction and applicable newspapers.
- Preference scoring will be applied in accordance with the prevailing Preferential Procurement Policy at the time of tender.
- Functionality will be used as a prequalifying criterion.
- The form of contract will be the SAICE General Conditions of Contract for Construction Works, Third Edition, 2015.
- A re-measurable (Bill of Quantities) pricing strategy will be used.
- SANS1200 Construction Standards as amended will apply.

9. FINANCIAL

9.1 AVAILABLE BUDGET

The cost breakdown, provided in table 7 below, of the available budget is based on the provisional budget as previously provided by George Municipality as part of the project appointment. The costs are summarised in Table 7 below.

Table 7: Available Direct and Indirect Costs

ITEM	DESCRIPTION	PROVISIONAL BUDGET (R)
1	**Direct Construction Costs (Client's estimate) (Including Contingencies and Escalation)**	**R8 200 000.00**
2	**Indirect Costs**	

ITEM	DESCRIPTION	PROVISIONAL BUDGET (R)
2.1	Percentage Fee	R894 168.00
2.2	Construction Monitoring	R600 000.00
2.3	Sub-Consultants	R600 000.00
2.4	Reimbursable expenses	R0.00
2.5	**Total Indirect Costs**	**R2 094 168.00**
3	**TOTAL DIRECT + INDIRECT COSTS (EXCLUDING VAT)**	**R10 294 168.00**

9.2 FIRST ORDER ESTIMATE

The cost breakdown of the required budget is based on actual estimates for Portion 1 as well as first order estimates for Portion 2.

The estimate for Portions 1A&B is summarised in Table 8 below.

Table 8: Portion 1 - Estimated required Direct and Indirect Costs

ITEM	DESCRIPTION	PROVISIONAL BUDGET (R)
1	**Direct Construction Costs (EA's estimate) (Including Contingencies and Escalation. Excl. VAT)**	**R4 063 880.00**
2	**Indirect Costs**	
2.1	Percentage Fee	R447 467.00
2.2	Construction Monitoring	R274 428.00
2.3	Sub-Consultants	R200 000.00
2.4	Reimbursable expenses	R0.00
2.5	**Total Indirect Costs**	**R921 895.00**
3	**TOTAL DIRECT + INDIRECT COSTS (EXCLUDING VAT)**	**R4 985 775.00**

The first order estimate for Portion 2 (the main scope) are summarised in Table 9 below.

Table 9: Portion 2 - Estimated required Direct and Indirect Costs

ITEM	DESCRIPTION	PROVISIONAL BUDGET (R)
1	**Direct Construction Costs (EA's first order estimate) (Excluding Contingencies and Escalation)**	**R9 600 000.00**
2	**Indirect Costs**	
2.1	Percentage Fee	R908 068.50
2.2	Construction Monitoring	R550 000.00
2.3	Sub-Consultants	R400 000.00
2.4	Reimbursable expenses	R0.00
2.5	**Total Indirect Costs**	**R1 858 068.50**
3	**TOTAL DIRECT + INDIRECT COSTS (EXCLUDING VAT)**	**R11 458 068.50**

Note the direct cost for Portion 2 excludes;

i. Contingencies
ii. Contract Price Adjustment (CPA)

iii. The stream/river crossings via bridges and culverts as well as erosion protection structures required.
iv. Relocation of informal dwellings and "starter packs" housing etc.

9.3 CASHFLOW FORECAST

The estimated cashflow forecast for the required indirect and direct costs for the complete scope of work is summarised per financial year in Table 10 below.

Table 10: Cashflow Forecast

FINANCIAL YEAR	ESTIMATED INDIRECT EXPENDITURE (R)	ESTIMATED DIRECT EXPENDITURE (R)	ESTIMATED INDIRECT AND DIRECT EXPENDITURE (R)
2022/23	R22 354,20	R0,00	**R22 354,20**
2023/24	R1 756 000,00	R4 063 880,00	**R5 819 880,00**
2024/25	R1 001 609,30	R9 600 000,00	**R10 601 609,30**
TOTAL BUDGET (EXCLUDING VAT)	**R2 779 963,50**	**R13 663 880,00**	**R16 443 843,50**

10. CONCLUSION

In terms of the project brief, Lukhozi Consulting Engineers (Pty) Ltd is appointed as the Consulting Engineer to implement the Phase 3 & 4 Thembalethu bulk sewer which entails the installation of the bulk sewer manholes and related pipe bridge structures to drain the proposed future housing developments to allow fully serviceable sites and the implementation of formal housing units in the identified areas.

The designs have progressed sufficiently to allow for the completion of the concept and viability design report as per the relevant standards and specifications.

The potential additional sewer flow that will be added to the sewer network and wastewater treatment works from the 'Phase 3 & 4' project equates to 584.6 kl/day.

It is further recommended that the George Municipality:

- Confirm the funding availability.
- Approve this report and provide instruction to commence with the detailed design stage.

2024/11/29

KOENRAAD POTGIETER (Pr Tech Eng)
PROFESSIONAL ENGINEERING TECHNOLOGIST

GREG TUCKER (Pr Eng, Pr CPM)
MANAGING DIRECTOR

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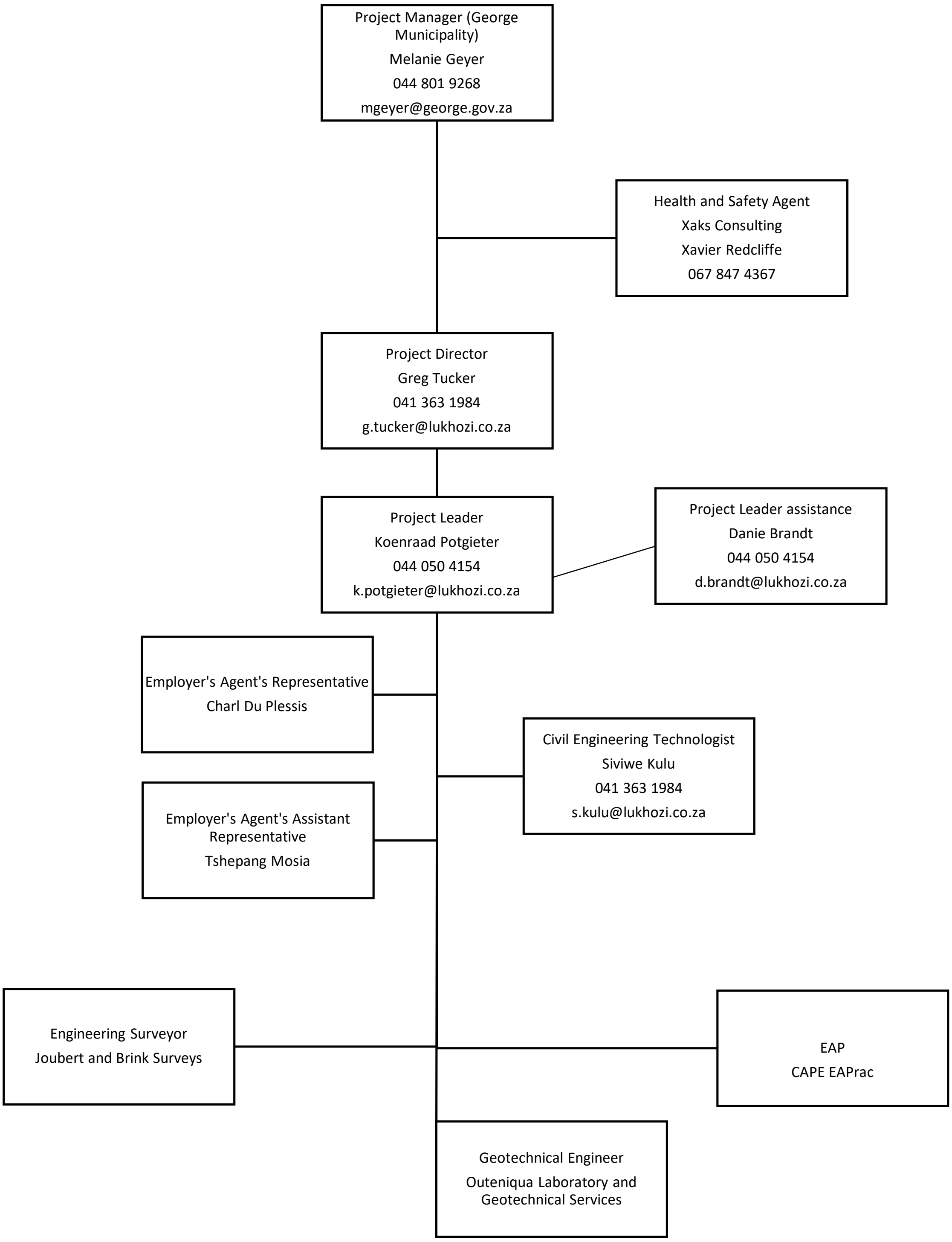
Date: 14 June 2024

ANNEXURE A
PROJECT ORGANOGRAM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EAP
CAPE EAPrac
Geotechnical Engineer
Outeniqua Laboratory and Geotechnical Services

ANNEXURE B

GEOTECHNICAL REPORT

ANNEXURE C

SEWER DESIGN FLOWS

ANNEXURE D

DRAWINGS

DOCUMENT CONTROL SHEET

CLIENT: George Municipality

JOB NO: 1762

PROJECT: Thembalethu Bulk Sewer Phase 3 and 4

TITLE: Concept & Viability Design Report

	Prepared By	Reviewed By	Approved By
ORIGINAL	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION 1	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION 2	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

REVISION 3	NAME S Kulu	NAME G Tucker	NAME K Potgieter
DATE 2024/11/29	SIGNATURE	SIGNATURE	SIGNATURE 2024/11/29

GEOTECHNICAL REPORT

PROPOSED UPGRADES FOR THE THEMBALETHU BULK SEWER – PHASE 3 AND 4, GEORGE MUNICIPALITY

24 January 2024 (Rev 0)

Prepared by:
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Ref No: 2023\Lukhozi\ Thembalethu Bulk Sewer – Phase 3 And 4 George\Report\Geotech Report 24.1.2024 Rev0

Report review history:

Revision No	Date	Prepared by:	Reviewed by:	Approved by:
0	24.1.2023	I Paton Pr Sci Nat Pr Tech Eng	S Ntanzi BSc Geol	I Paton Pr Sci Nat Pr Tech Eng

Authors qualifications and affiliations:

Iain Paton has post graduate degrees in Geology and Geotechnical Engineering and has over 25 years' experience in the mining, energy and construction industries. Iain Paton is a registered geotechnical professional with the Engineering Council of South Africa (ECSA) and the South African Council for Natural and Scientific Professions (SACNSP). Iain Paton is a member of the Geotechnical Division of the South African Institute of Civil Engineering (SAICE), South African Institute of Engineering and Environmental Geologists (SAIEG), the and the Institute of Municipal Engineering of South Africa (IMESA).

Declaration of independence:

The authors of this report are independent professional consultant with no vested interest in the project, other than remuneration for work associated with the compilation of this report.

General limitations:

1. The investigation has been conducted in accordance with generally accepted engineering practice, and the opinions and conclusions expressed in the report are made in good faith based on the information at hand at the time of the investigation.
2. The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result or either natural processes or human activity. In addition, advancements in the practice of geotechnical engineering and changes in applicable practice codes may affect the validity of this report. Consequently, this report should not be relied upon after an eclipsed period of one year without a review by this firm for verification of validity. This warranty is in lieu of all other warranties, either expressed or implied.
3. Unless otherwise stated, the investigation did not include any specialist studies, including but not limited to the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present.
4. The investigation is conducted within the constraints of the budget and time and therefore limited information was available. Although the confidence in the information is reasonably high, some variation in the geotechnical conditions should be expected during and after construction. The nature and extent of variations across the site may not become evident until construction. If variations then become apparent this could affect the proposed project, and it may be necessary to re-evaluate recommendations in this report. Therefore, it is recommended that Outeniqua Geotechnical Services is retained to provide specialist geotechnical engineering services during construction in order to observe compliance with the design concepts, specifications and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction. Any significant deviation from the expected geotechnical conditions should be brought to the author's attention for further investigation.
5. The assessment and interpretation of the geotechnical information and the design of structures and services and the management of risk is the responsibility of the appointed engineer.

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1. Introduction

1.1 Background information

An upgrade of the bulk sewer infrastructure has been proposed in Thembalethu Phase 3 and 4 in the George Municipality of the Western Cape (see location of site in Figure 1 and topographic map in Figure 2). The proposed bulk sewer system will be required to manage sewage from the various UISP areas and accommodating all internal reticulation requirements for the proposed formal housing requirements in the area.

The Phase 3 and 4 bulk sewers will serve areas situated south and south-east of the UISP Areas 5 & 6A and will tie into an existing 250mm diameter bulk sewer line. The sewer line will gravitate to the existing Pacaltsdorp Sewer Pump Station 1 which then transfers the sewerage to the Outeniqua WWTW.

The site was investigated in order to determine the geology and general geotechnical properties of the site for the structural and civil engineering designs.

1.2 Scope of work

The scope of the work was to conduct a broad-scope geotechnical site investigation along the proposed pipeline route to assess and insitu soil types, excavatability, material useability and soil bearing capacity along the route, and the following methods were proposed and accepted by the consultants:

- Review the geological and geotechnical data for the area.
- Conduct a subsurface investigation consisting of the following methods:
    - Excavate a limited number of test pits across the site.
    - Profile and photograph a series of test pits according to SAICE Code of Practice.
    - Collect and transport soil samples for testing at SANAS-accredited civil engineering laboratory.
    - Conduct insitu DCP penetrometer testing at each test position to max depth of GL-2.0m or refusal.
- Analyse results and prepare a detailed factual and interpretive report containing all information from the investigation and including recommendations for the design of earthworks, structures and services or any further investigations.

1.3 Available information

The following information was available for consultation:

- 1:50 000 and 1:250 000 geological maps of the area, obtained from the Council for Geoscience.
- Topo-cadastral data for the area, obtained from the National Geospatial Institute (NGI).
- Aerial photos of the area, obtained from the NGI and Google Earth.
- Site layout plans provided by the consultant.

Figure 1: Site locality map

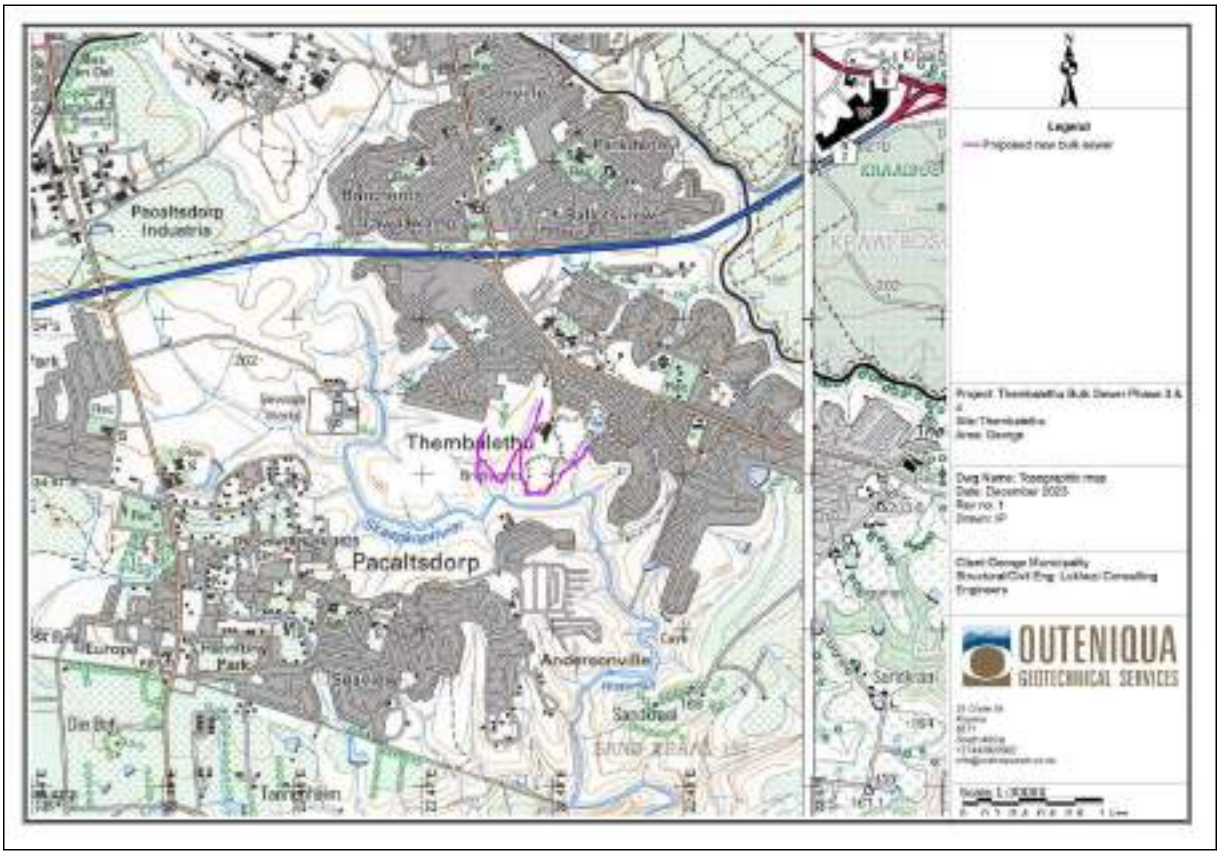


Figure 2: Topographic map of the area showing the proposed bulk sewer lines

2. Site description

The site was located in the township of Thembalethu, approximately 6km southeast of

George Central Business District (CBD). The site area was accessible via 13th Street and Mfayana Street, south of the formal Thembalethu Township (see Figure 2).

The natural topography of the area is generally characterised by gently sloping plateau areas (gradient 1:10 – 1:50), which then slope downward at moderate to steep gradients into the surrounding natural watercourses that drain southward into tributaries of Skaapkop River (see Figure 3). The site area was largely occupied by informal dwellings (shacks) and kraal structures and access around the site was limited to a few gravel roads and many footpaths. The vegetation cover was highly transformed and sparse in most areas but dense towards the main natural drainage lines, consisting of long grass, fynbos and alien trees (see Figure 4 and Figure 6). There were several small dams and poorly drained areas (ponds) where stormwater had collected and there was some existing stormwater infrastructure noted in some areas (See Figure 7).

The local site topography and ground surface conditions at the time of the investigation were very uneven in places due to historical mining operations associated with the old Allbrick Quarry, and there were several old excavations, erosion dongas and mounds of soil, producing a highly irregular ground surface (see Figure 8 to Figure 10).

The climate of the area was classified as temperate and seasonally wet, with a Wienert N-Value of approximately 2-3. The surface conditions on the site at the time of the investigation were very moist to wet due to recent heavy rains with several ponds of stagnant water lying about the site.

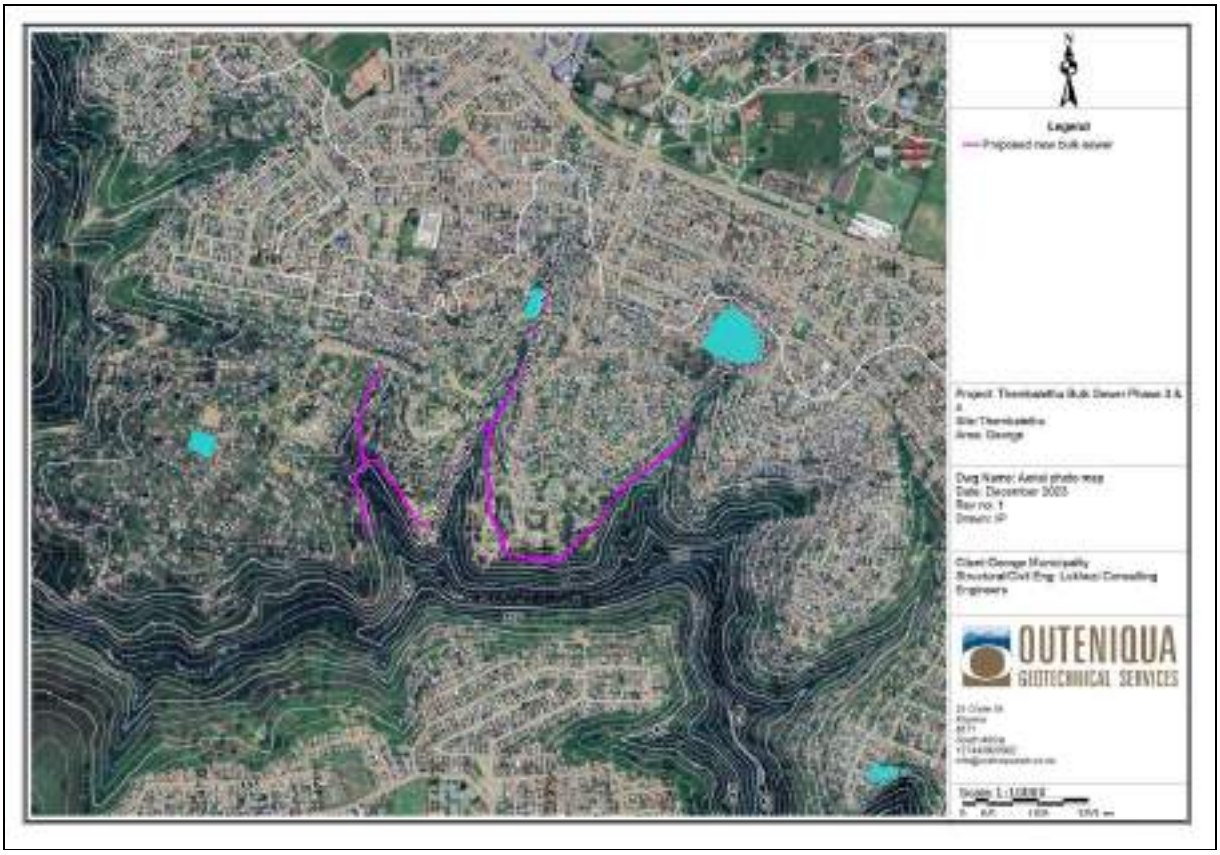


Figure 3: Aerial photo of the site area

Figure 4: Gravel access roads on the site

Figure 5: Footpaths on site

Figure 6: Typical site conditions

Figure 7: Existing stormwater pipe culvert near TP4


Figure 8: Old quarry area on site


Figure 9: Mounds of soil associated with the old mining activities

Figure 10: Erosion dongas commonly seen on the site

3. Methods of investigation

A review of available geotechnical data was conducted prior to mobilising to site. Once on site, a brief site walk-over inspection was conducted before commencing with the subsurface investigation.

The subsurface investigation consisted of 8 test pits excavated with a pick and shovel (See **Appendix 1** for a plan of the test positions). The subsurface investigations were conducted in order to establish the near-surface geology and general geotechnical profile of the site. The soil profiles and photographs of the test pits were included in **Appendix 2** of this report.

Samples of insitu soils were collected from test pits for Foundation Indicator (grading, Atterberg limits and moisture content), Modified AASHTO maximum dry density, optimum moisture content and CBR. The tests were conducted at a SANAS-accredited civil engineering laboratory in accordance with standard South African test methods. See **Appendix 3** for details.

In situ dynamic cone penetrometer (DCP) tests were conducted at each of the test pit positions. The tests were done in accordance with TMH6 ST6. The probes were driven from ground surface to a depth of NGL-2.0m or refusal. Details of the tests were included in **Appendix 4** of this report.

The site testing data was then collated and assessed by a professional engineering geologist/geotechnical engineer.

4. Results of the site investigation

4.1 Regional geology

The geological mapping of the area indicated that the site was underlain by granite of the Maalgaten suite of the George pluton (see Figure 11) which is well exposed in old mining excavations across the site (see Figure 12). The George pluton consists of several granitic bodies that were intruded into older country rocks of the Kaaimans Group of meta-sediments during the Cambrian era. Younger meta-sedimentary rocks of the Peninsula Formation (Table Mountain group) occur to the north of the George area. The George pluton has been subjected to intense deformation, similar to that of the older country rocks of the Kaaimans Formation and typically exhibit strong penetrative planar and linear fabrics. In some places the granite has been intensely sheared, mainly along its margins. There are no major geological faults in the immediate vicinity of the site, and there is a low risk of seismic activity in the area.

The Maalgaten granite is the most voluminous lithological unit of the George pluton which underlies most of the George area. The granite rock is poorly exposed in the George area and is typically covered by a thick soil overburden of weathered saprolite. The underlying "fresh" zone is typically dark to light grey, slightly weathered to unweathered, moderately to slightly fractured, medium hard to very hard. The dominant mineral types are quartz, K-feldspar, plagioclase, muscovite, chlorite, biotite and epidote.

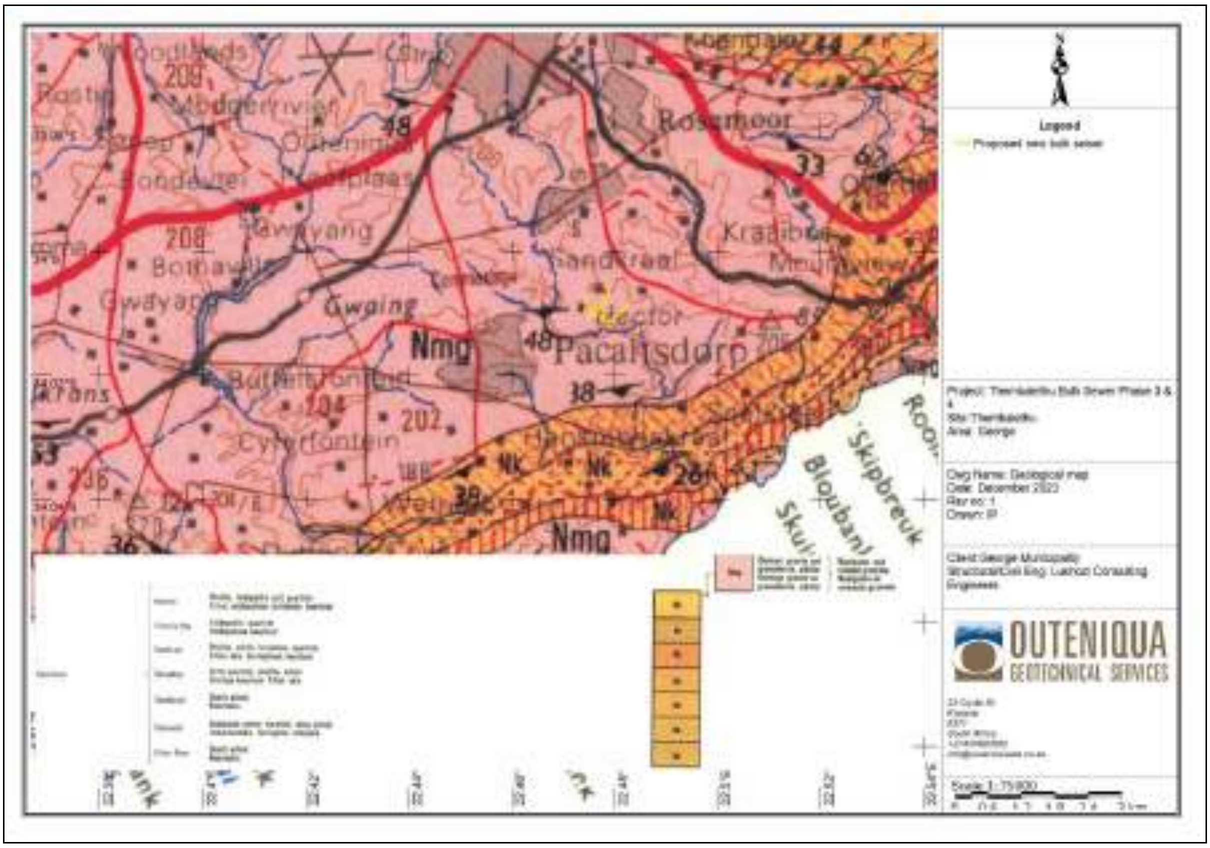


Figure 11: Geological map of the area

Figure 12: Exposure of weathered granite near site

4.2 Local soil and rock types

Test pits conducted on the site (see Figure 13) indicated that the general soil profile consisted of the following horizons for surface downward (See also Figure 14):

- Imported fill (disturbed/dumped soil) – Silty/clayey gravelly sand
- Colluvium/hillwash (topsoil) silty sand
- Pedogenic ferricrete (plinthite/laterite) – silty/clayey sandy gravel
- Residual completely weathered granite clayey/silty gravelly sand or silty sandy gravel.

The underlying rock profile consisted of a "weathered zone" underlain by a "fresh zone". The weathered zone typically ranges from light grey to light orange brown, highly to moderately weathered, highly fractured, very soft to soft rock which can probably be ripped using mechanical methods. Apart from some isolated metapelitic xenoliths (schist, phyllite), no other rock types or formations occur in the quarry area.

The soil horizons were described in detail in the following paragraphs.

Figure 13: Test pits conducted on site

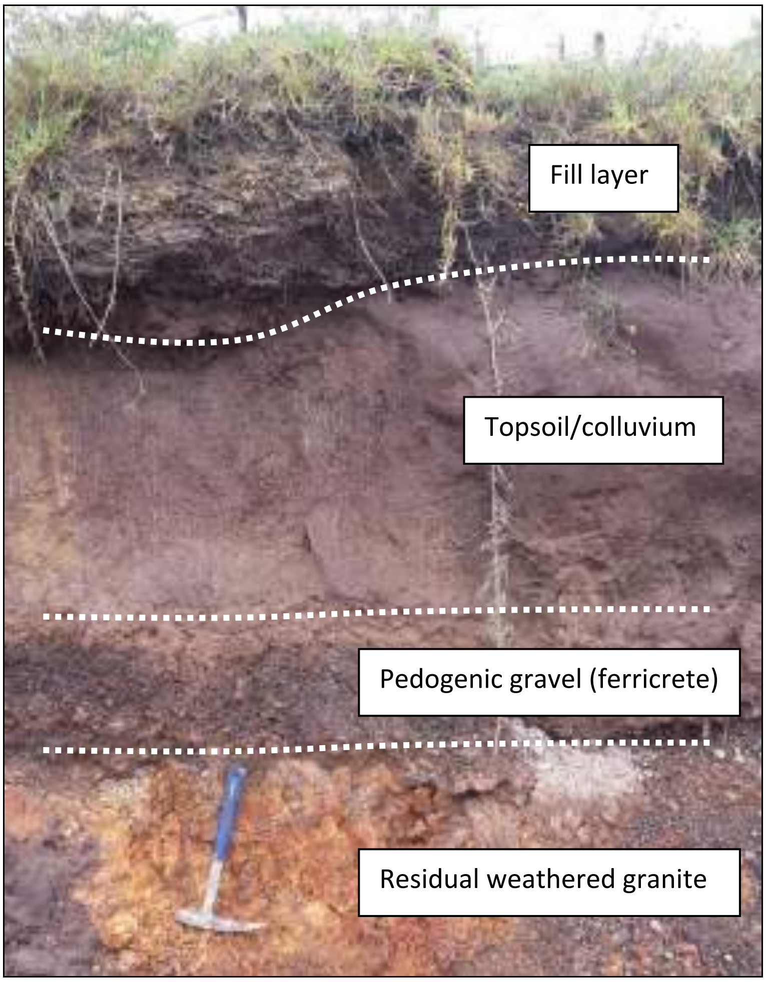


Figure 14: Typical soil profile observed in the area

Imported Fill

Superficial fill material recorded in some test pits was generally described as moist, dark yellow to dark red orange, clayey/silty sandy gravel or clayey/silty sand with varying consistency. In some areas, this fill layer also contained building rubble (see Figure 15) and rubbish. The thickness of this horizon varied widely but was typically less than 1m but exceeded 1.5m in some areas.

Transported soil (Colluvium and alluvium)

The naturally transported soil appeared to primarily consist of moist, dark grey/brown, silty fine sand. In the upper portion of the horizon, the soil is described as loose and pinholed, with some organic content. Lower down, horizon may transition to an intact state. Sporadic occurrences of alluvial gravel were also encountered, exhibiting a more dense consistency compared to the finer colluvial soils.

Residual

The residual soil, derived from the in situ weathering of the underlying granite rock, was generally described as moist, light yellowish/reddish orange in colour, medium dense/firm to dense/stiff, fissured/intact clayey silty gravelly sand or clayey sandy gravel (see Figure 16). Some localised black staining along fissures indicated groundwater seepage. Overall, the residual soil profile pointed towards a well-established granitic base with a potential localized variation in moisture content.

Figure 15: Brick rubble fill encountered at TP1

Figure 16: Typical soil types exposed at TP5

A map of the test positions was provided in Figure 17 and a summary of the test pit data was provided in Figure 18 and Table 1.

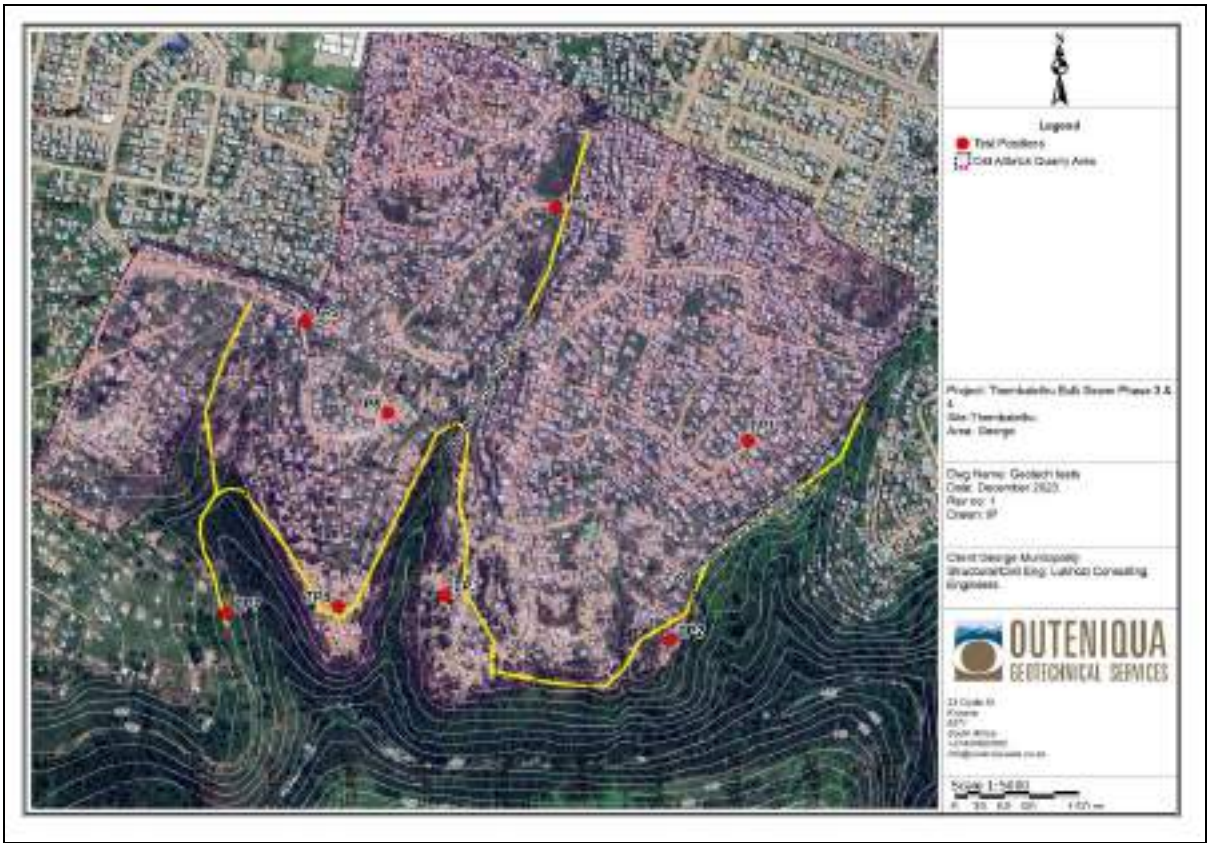


Figure 17: Geotechnical map

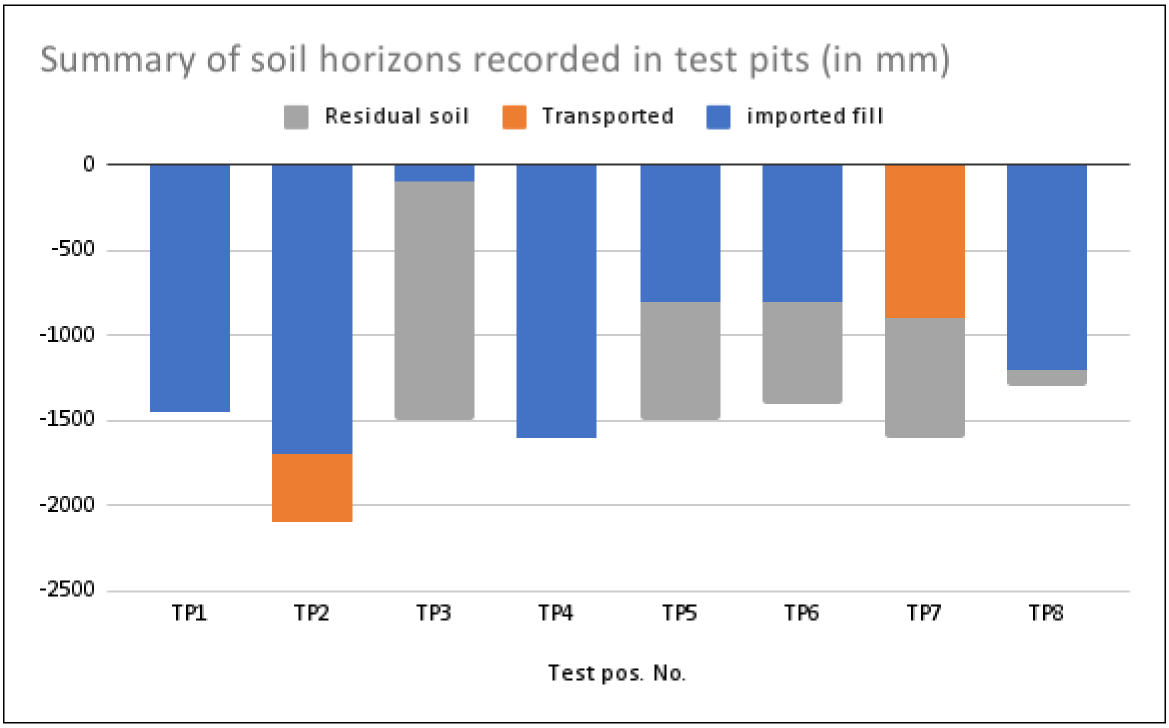


Figure 18: Summary of the soil profiles

Table 1: Summary of test pit data (layer thickness in mm)

Test pos. No.	***Imported soil (fill)***	***Colluvium/ alluvium***	***Residual***	***Total depth of test pit***	***Refusal depth***
TP1	0-1450	-	-	1450	-
TP2	0-1700	1700-2100	-	2100	-
TP3	0-100	-	100-1500	1500	-
TP4	0-800	-	800-1500	1500	-
TP5	-	0-2500	-	2500	-
TP6	0-800	-	800-1600	1600	-
TP7	-	0-900	900-1600	1600	-
TP8	0-1200	-	100	1300	-

4.3 Groundwater

During the investigation, free groundwater was not encountered in any of the test pits but there was evidence of previous seepage from existing exposures and in some mottled soils. Seasonal seepage was also expected due to the typical wet climate of the area.

4.4 Insitu tests

In situ penetration tests (DCP) conducted through the upper 2m of the profile indicated the that the soil was typically variable in consistency/strength. The fill material was typically loose/very loose (see TP2, TP4, TP5 & TP6) but the natural soil profile was relatively dense (medium dense to dense/stiff). There were some localised increases in penetration rate near the upper contact of the residual soil, which may indicate the presence of moist soil or seepage (e.g. at TP7 @1m).

4.5 Lab tests

Representative samples of the insitu soil types were collected for Foundation Indicator tests to determine the particle size distribution (grading) and Atterberg limits. The results of the Foundation Indicator tests were shown in Table 2 and an analysis of the particle size distributuions were presented in Figure 19.

Table 2: Summary of Foundation Indicator tests

Test Pit No	Sample Depth (mm)	Atterberg Limits			Particle Analysis (%)				MC*	PE**	USC ***
		PI	LL	LS	Clay	Silt	Sand	Gravel			
TP1	0-300	12	28	6	14	25	27	34	0	LOW	GC
TP2	0-700	14	29	7	25	18	40	17	0	LOW	SC
TP3	100-1500	9	36	5	13	26	28	33	0	LOW	GM
TP4	1300-1600	13	25	7	16	34	36	14	0	LOW	CL
TP5	400-800	15	30	8	3	10	32	55	0	LOW	GC
TP6	0-800	12	43	6	12	60	21	7	0	LOW	ML
TP7	800-1600	13	38	13	28	18	39	15	0	LOW	SM
TP8	0-1200	12	38	6	12	38	35	15	0	LOW	ML

* Insitu Moisture Content ** Potential Expansiveness *** Unified Soil Classification

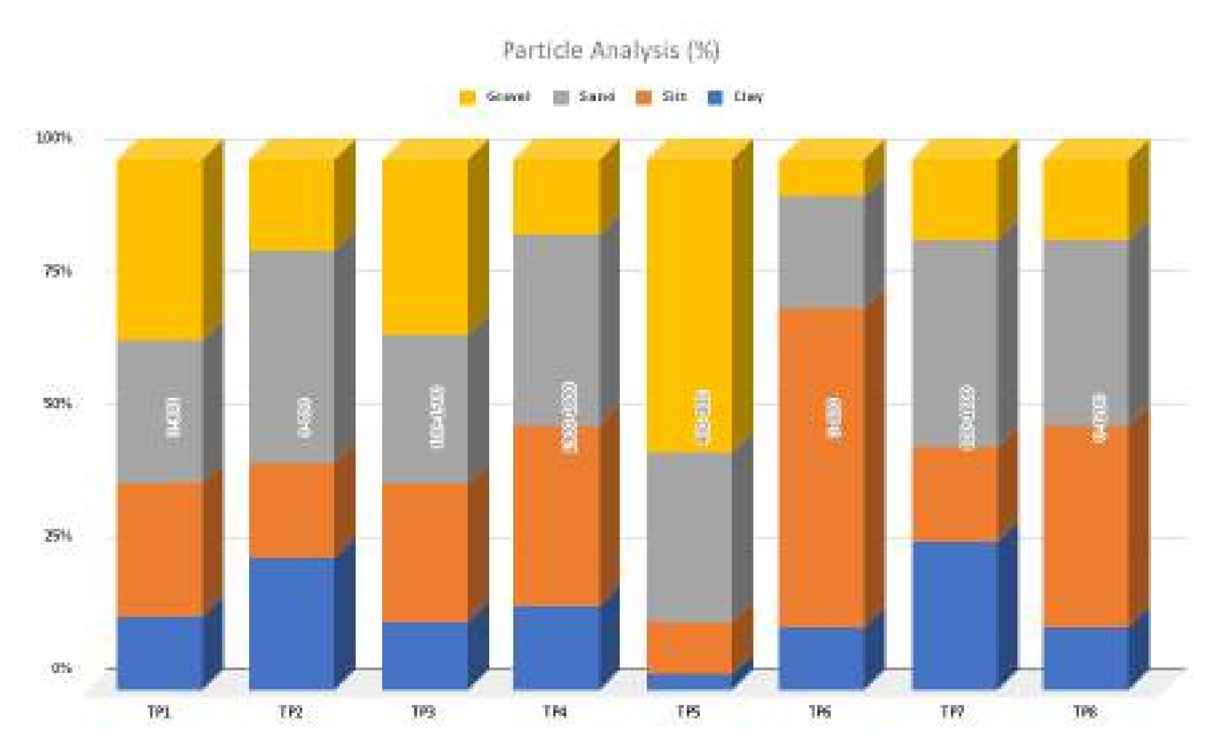


Figure 19: Particle size distribution

The results of the tests indicated that the soils in the test pits exhibited a range of particle sizes from clay to gravel. The clay content of the soils ranged from 3% to 28%, and the silt content ranged from 10% to 60%. The plasticity index (PI) was typically low-medium, ranging from 9 to 14%.

The soil samples recovered from test pits were classified according to the Unified Soil

Classification System (USCS), based on their grain size distribution and plasticity, as:

- CL (clays with low to medium plasticity)
- ML (silty fine sands, silts)
- SM (Silty sands)
- SC (clayey sands)
- GC (clayey gravels)

Representative samples were collected for maximum dry density (Mod. AASHTO), CBR & Road Indicator tests to determine the potential of the material for structural fill purposes and/or for subgrade fill in pavement designs. The results of the tests were summarised in Table 3.

Table 3: Summary of CBR tests

Test Pit No	*Sample Depth (mm)*	*CBR at*					*Swell (%)*	*PI (%)*	*GM*	*MDD / OMC*	*COLTO Class*
		100 %	*98%*	*95%*	*93%*	*90%*					
TP1	0-300	7	6	5	5	4	1.5	12	1.51	1948/ 9.3	G9 Subgrade
TP2	0-700	5	3	2	1	1	2.4	14	1.37	1876/ 12.8	Not Classified
TP3	100-1500	6	5	4	4	3	1.8	9	1.89	1957/ 8.0	Not Classified
TP4	1300-1600	9	5	6	5	3	1.3	13	1.1	1.14	Not Classified
TP5	400-800	14	10	6	4	2	1.7	15	1.9	2006/ 8.2	Not Classified
TP6	0-800	2	2	1	1	1	6	12	0.72	1750/ 13.3	Not Classified
TP7	900-1600	4	2	1	1	1	2.9	13	1.21	1868/ 11.2	Not Classified
TP8	0-1200	3	3	2	2	1	2.8	12	1.22	1978/ 8.4	Not Classified

The CBR test results indicated that the soils encountered on site were generally poor quality. General site observations did, however, indicate some sporadic deposits of coarser-grained soils such as sands & gravels related to the old quarrying activity which could be potentially useful as general/bulk fill on platforms or lower subgrade fill in roads but these were not sampled and would have to be identified in further investigations.

5. Geotechnical assessment

5.1 Groundwater, permeability and site drainage

Localised groundwater seepage, possible small springs and surface water ponding was expected in the area, requiring attention to site drainage and stormwater management. High percentages of surface run-off due to low permeability soils was also expected.

5.2 Excavations and natural slope stability

Anticipated excavation classification in terms of SABS1200D for the proposed pipeline were provisionally classified under "Soft" class.

The proposed pipeline route runs across a highly variable topography due to the historical mining operations and current human activity, and there were several excavations, erosion dongas and heaps of soil with potentially unstable steep slopes on the site.

Trench sidewalls up to 1.5m deep were expected to be marginally stable for short periods of time with minimal shoring/overbreak required, but excavations deeper than 1.5m would require battering of sidewalls to approx. 45°.

6. Recommendations

The design of structures and civil services remains the responsibility of the appointed civil and structural engineers. The recommendations contained herein do not supersede or override any applicable standards, codes, project specifications or designs provided by the appointed engineers.

The following recommendations were based on limited information gained from the site investigation, and although the confidence in the information was high, some variation in ground conditions was expected to occur between information points. All geotechnical information should therefore be confirmed during construction and if necessary, additional investigations may have to be commissioned. Any significant variations should be brought to the attention of the authors or appointed geotechnical engineers for comment or further recommendations. It was recommended that the structural engineer discuss his/her conceptual design with the geotechnical engineers to ensure that any calculations and recommendations were in line with current information.

The following recommendations were provided for consideration by the civil engineers:

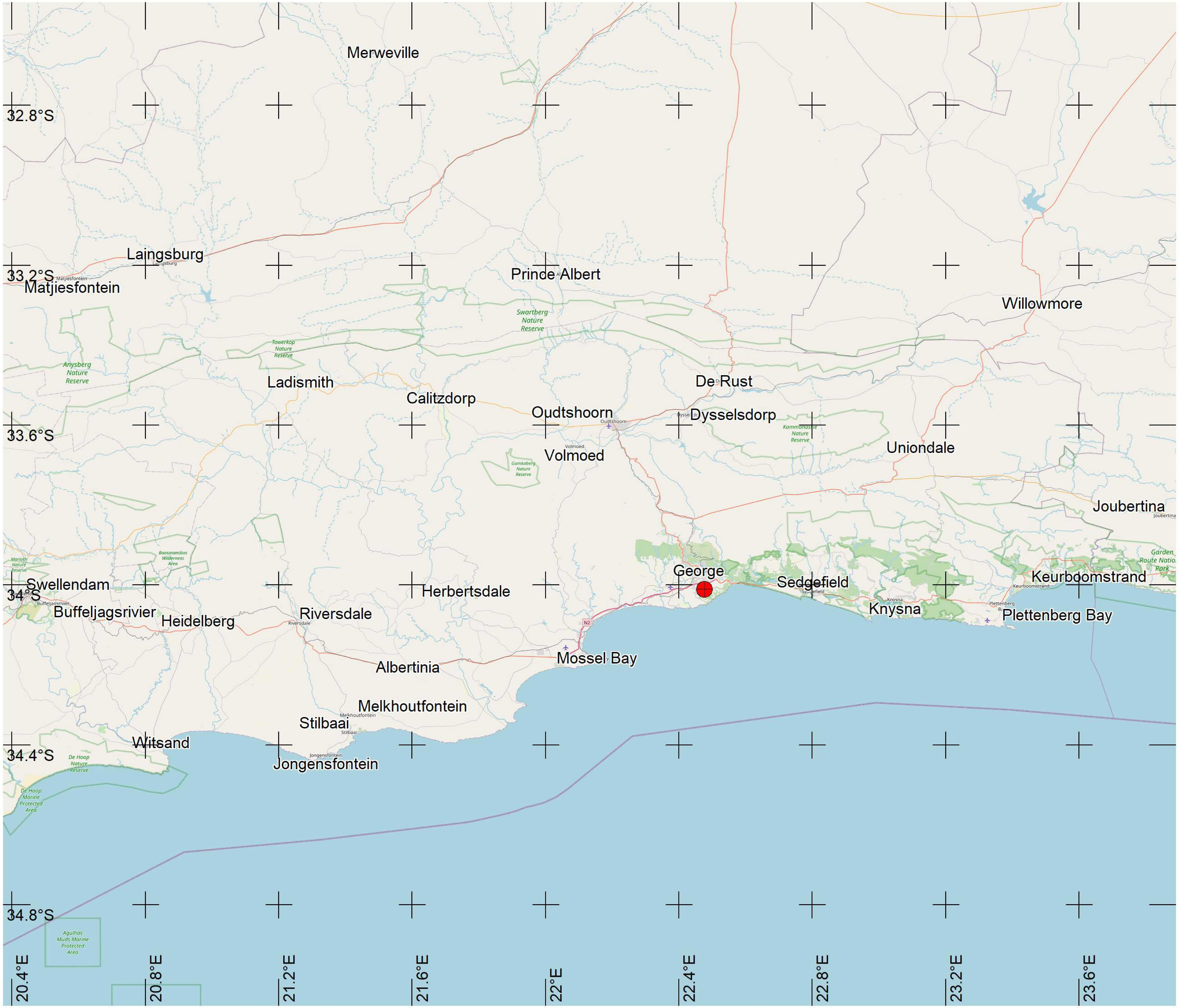
- Difficult access, steep slopes, and unsafe working conditions were expected along the route, requiring consideration for appropriate plant and site clearance along the proposed sewer line route. Crossing of natural drainage lines also requires careful consideration of poor/wet ground conditions and high erosion potential.
- Some dewatering of excavations may be required in places (mainly near existing drainage lines/low areas).
- Pipelines should be embedded in a cradle of well compacted imported material at a minimum depth of 1.5m. Pipe bedding and blanket materials should be imported selected granular material as per SABS 1200LB. Compaction of pipe cradle materials should be done in accordance with SABS 1200LB.
- Soil obtained from excavations should be stockpiled and inspected by the engineer for possible use as selected main fill material over the pipe cradle. General fill should be compacted to min 93%MDD.
- Structures such as manholes, pumpstations and pipe support structures (thrust blocks, piers, etc) should be founded on dense residual (insitu) soil at a minimum depth of NGL-1m and vertical bearing pressures should be limited to 150kPa. It is further recommended that the founding conditions be verified by a geotechnical engineer before foundations are cast.

7. Conclusions

The investigations indicated that the design of the proposed pipeline route presents some technical challenges, including access, existing informal dwelllings, topography variations, old quarrying areas, site drainage problems and poor soils. Some preliminary recommendations were provided for consideration by the design engineers but all information should be verified during construction.

Appendix 1

Maps



Legend

Site Location

Project: Thembalethu Bulk Sewer Phase 3 & 4
Site:Thembalethu
Area: George

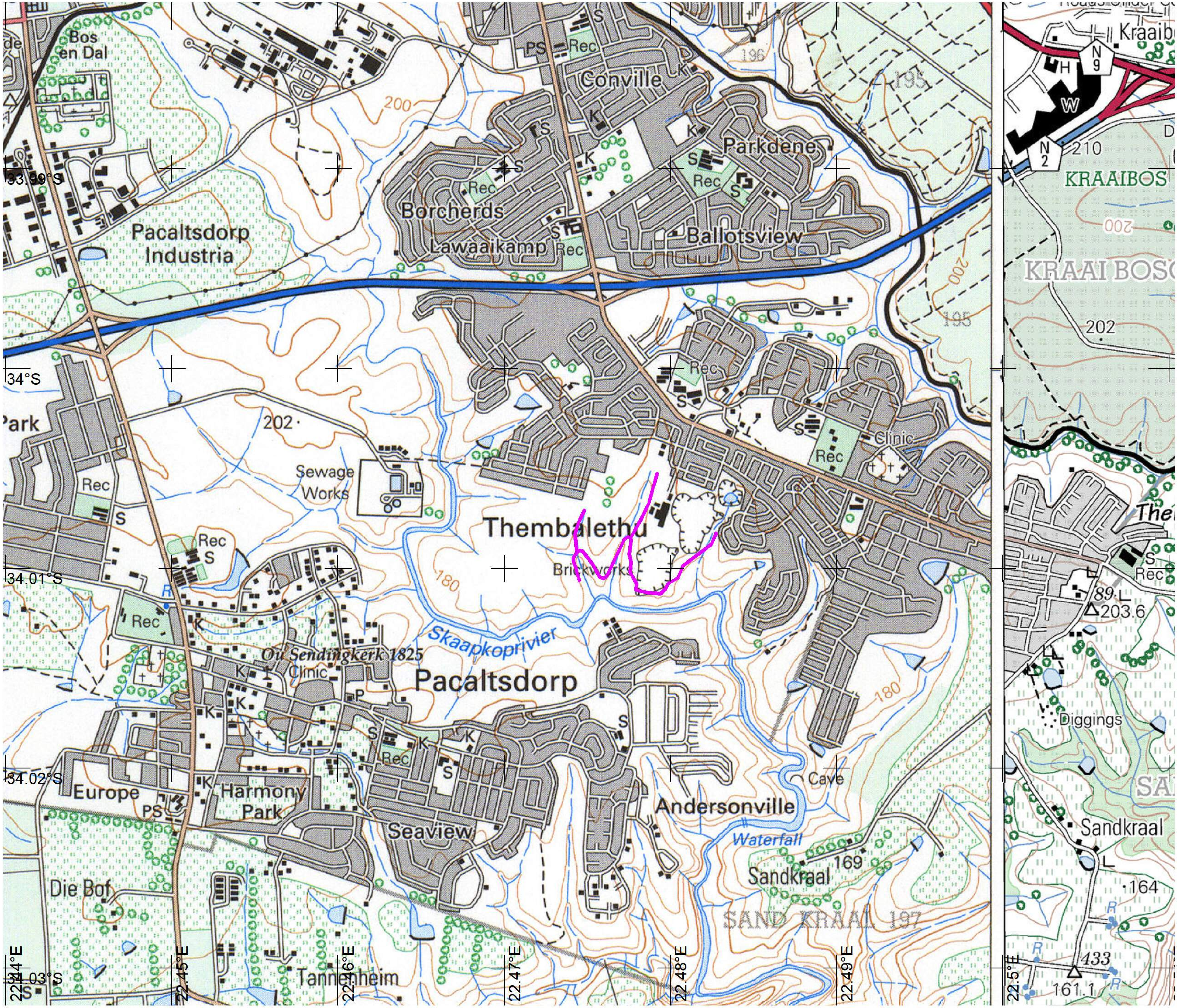
Dwg Name: Locality map
Date: December 2023
Rev no: 1
Drawn: IP

Client:George Municipality
Structural/Civil Eng: Lukhozi Consulting Engineers

OUTENIQUA GEOTECHNICAL SERVICES

23 Clyde St
Knysna
6571
South Africa
+27443820502
info@outeniqualab.co.za

Scale 1:1500000
0 6 24 36 48 60 km



N

Legend

Proposed new bulk sewer

Project: Thembalethu Bulk Sewer Phase 3 & 4
Site:Thembalethu
Area: George

Dwg Name: Topographic map
Date: December 2023
Rev no: 1
Drawn: IP

Client:George Municipality
Structural/Civil Eng: Lukhozi Consulting Engineers

OUTENIQUA GEOTECHNICAL SERVICES

23 Clyde St
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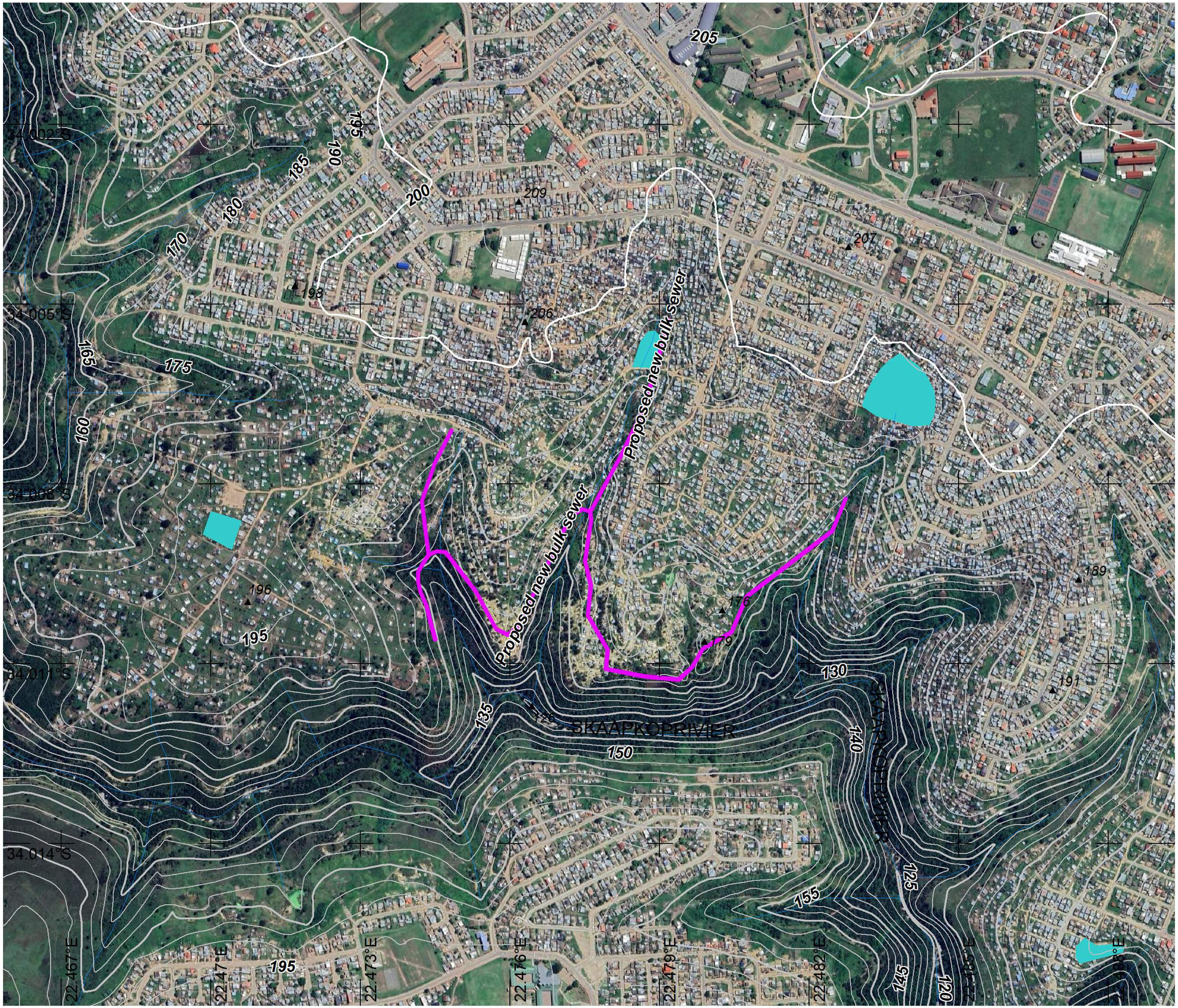
6571
South Africa
+27443820502
info@outeniqualab.co.za

Scale 1:30000
0 0.2 0.4 0.6 0.8 1 km



N

Legend

Proposed new bulk sewer

Project: Thembalethu Bulk Sewer Phase 3 & 4
Site:Thembalethu
Area: George

Dwg Name: Aerial photo map
Date: December 2023
Rev no: 1
Drawn: IP

Client:George Municipality
Structural/Civil Eng: Lukhozi Consulting Engineers

OUTENIQUA
GEOTECHNICAL SERVICES

23 Clyde St
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6571
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+27443820502
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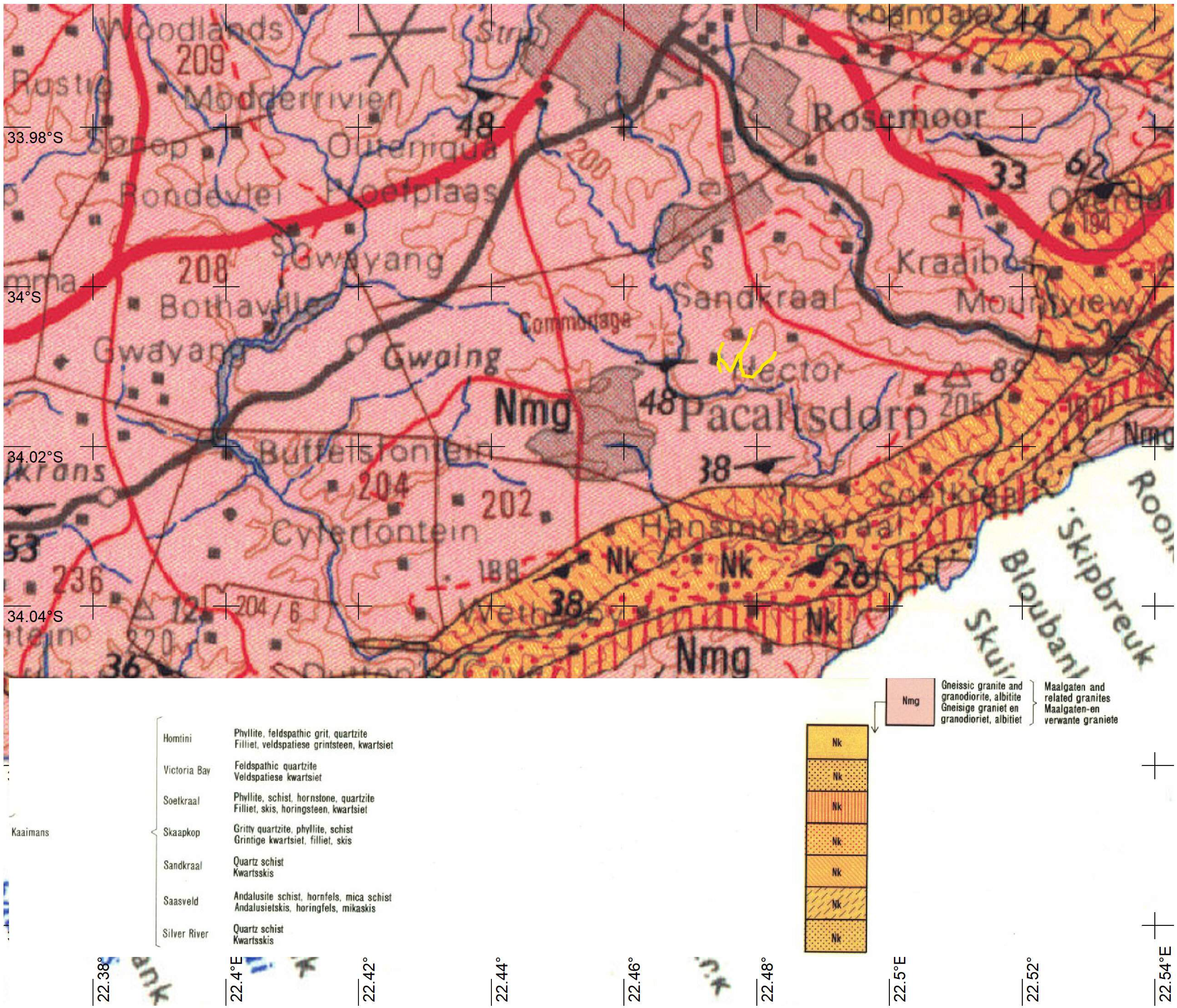
Scale 1:10000
0 60 180 300 m



N

Legend

Proposed new bulk sewer

Project: Thembalethu Bulk Sewer Phase 3 & 4
Site:Thembalethu
Area: George

Dwg Name: Geological map
Date: December 2023
Rev no: 1
Drawn: IP

Client:George Municipality
Structural/Civil Eng: Lukhozi Consulting Engineers

OUTENIQUA GEOTECHNICAL SERVICES

23 Clyde St
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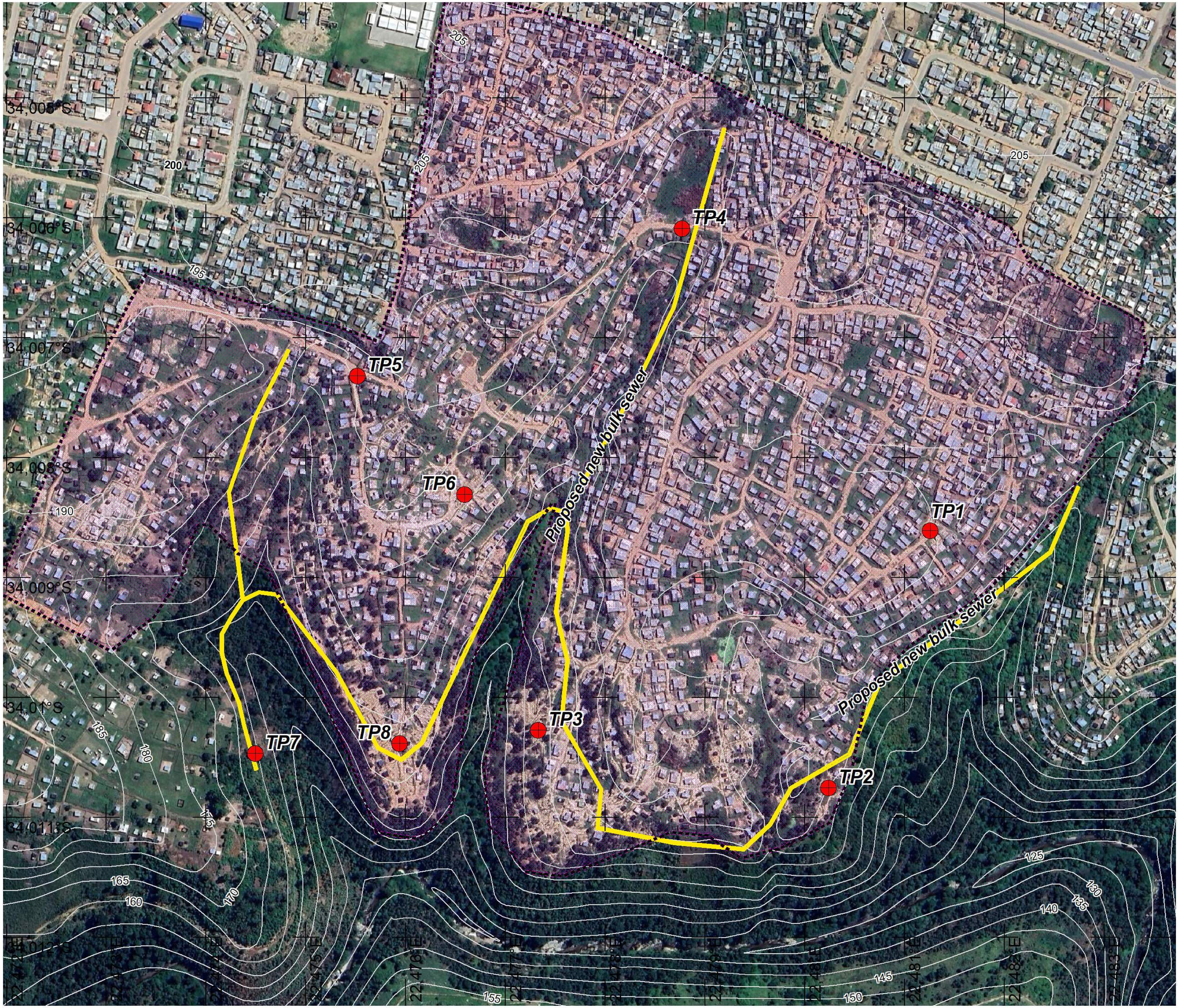
Scale 1:75000

0 0.6 1.2 1.8 2.4 3 km



N

Legend

- Test Positions
- Old Allbrick Quarry Area

Project: Thembalethu Bulk Sewer Phase 3 & 4
Site:Thembalethu
Area: George

Dwg Name: Geotech tests
Date: December 2023
Rev no: 1
Drawn: IP

Client:George Municipality
Structural/Civil Eng: Lukhozi Consulting Engineers

OUTENIQUA GEOTECHNICAL SERVICES

23 Clyde St
Knysna
6571
South Africa
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info@outeniqualab.co.za

Scale 1:5000
0 30 60 90 150 m

Appendix 2

Test pit profiles

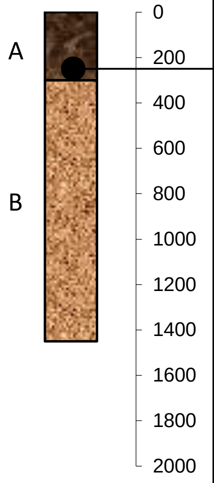
Geotechnical Soil Profile

OUTENIQUA GEOTECHNICAL SERVICES

Client:	Lukhozi Consulting Engineers
Project:	Thembalethu Bulk Sewer Phase 3 & 4
Area:	George Municipality
Date:	14.11.2023
Excavator:	By Hand

TP 1

Datum:	NGL	Co-ords:	23 Y0047919 X3764737
Key to symbols:	● Sample taken	▼ Groundwater	



(0 to 300) Slightly moist, dark reddish brown, medium dense, intact, **CLAYEY SILTY SANDY GRAVEL**, imported (fill made ground)

Foundation Indicator & MOD/CBR/Indicator

(300 to 1450) Moist, dark red, dense, intact, **BRICK FILL RUBBLE**, imported (fill made ground)

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

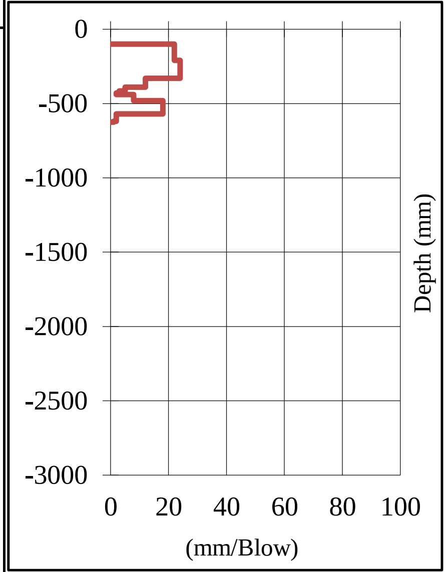
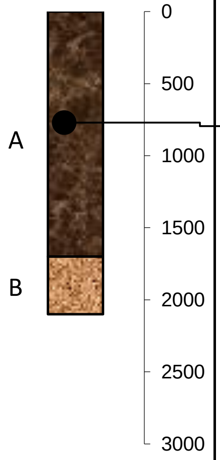


Photo of Test Pit

TP 2

Datum:	NGL	Co-ords:	23 Y0048012 X3764976
Key to symbols:	● Sample taken	▼ Groundwater	



(0 to 1700) Very moist, dark yellow, very loose, intact, **GRAVELLY SILTY CLAYEY SAND & RUBBISH**, imported (fill worked ground)

Foundation Indicator & MOD/CBR/Indicator

(1700 to 2100) Moist, dark grey, loose, pinholed, **SILTY SAND**, transported.

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

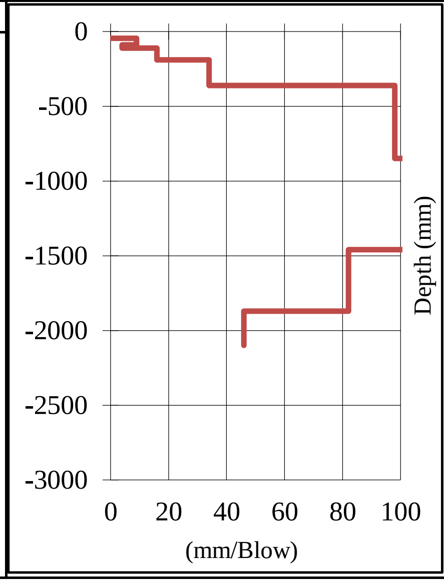
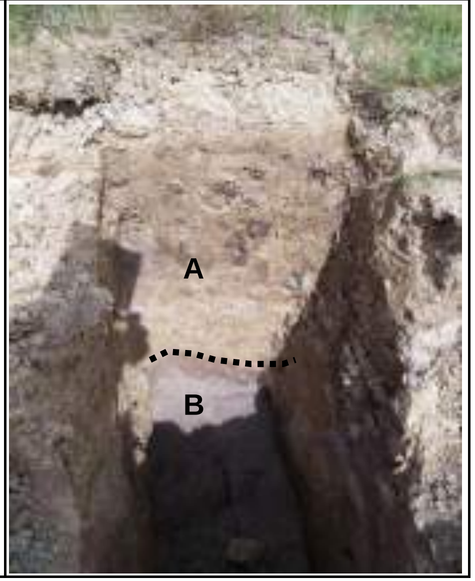


Photo of Test Pit



Geotechnical Soil Profile

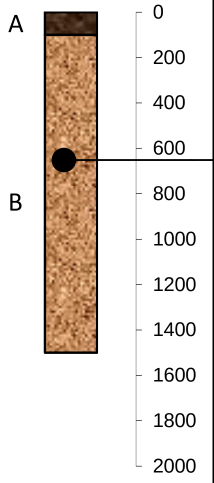
OUTENIQUA GEOTECHNICAL SERVICES

Client:	Lukhozi Consulting Engineers
Project:	Thembalethu Bulk Sewer Phase 3 & 4
Area:	George Municipality
Date:	14.11.2023
Excavator:	By Hand

TP 3

Datum: NGL | Co-ords: 23 Y0048281 X3764924

Key to symbols: ● Sample taken | Groundwater



(0 to 100) Moist, dark yellowish orange, dense, intact, **SANDY GRAVEL**, imported (fill made ground)

(100 to 1500) Moist, light yellowish orange, dense to very dense, intact, **CLAYEY SILTY SANDY GRAVEL**, residual.

Foundation Indicator & MOD/CBR/Indicator

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

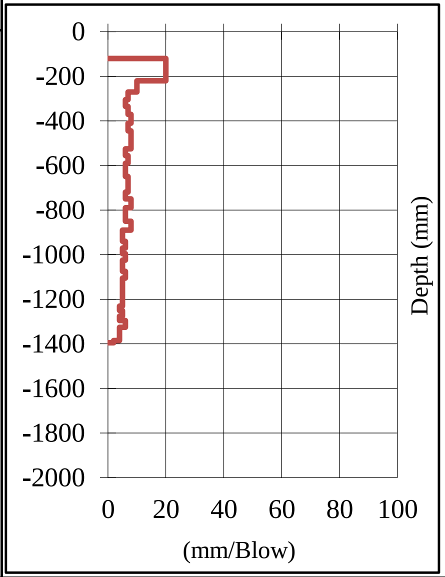
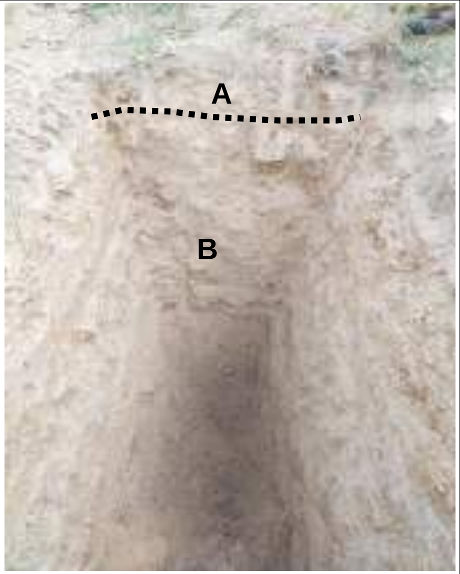


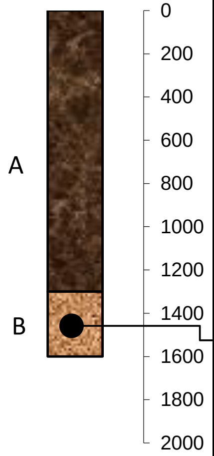
Photo of Test Pit



TP 4

Datum: NGL | Co-ords: 23 Y0048150 X3764459

Key to symbols: ● Sample taken | Groundwater



(0 to 1300) Slightly moist, dark reddish brown, medium dense, intact, **SILTY SANDY GRAVEL**, imported (fill made ground)

(1300 to 1600) Moist, light brown to dark red brown, medium dense, intact, **GRAVELLY CLAYEY SILTY SAND**, imported (fill made ground)
Foundation Indicator & MOD/CBR/Indicator

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

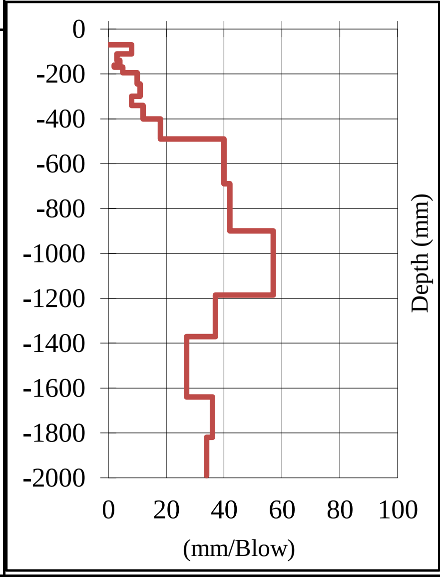


Photo of Test Pit

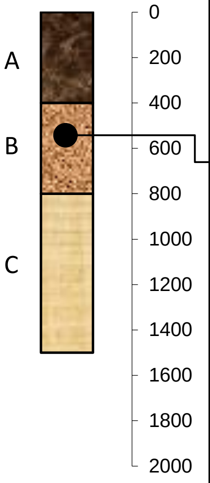
Geotechnical Soil Profile

OUTENIQUA GEOTECHNICAL SERVICES

Client:	Lukhozi Consulting Engineers
Project:	Thembalethu Bulk Sewer Phase 3 & 4
Area:	George Municipality
Date:	14.11.2023
Excavator:	By Hand

TP 5

Datum:	NGL	Co-ords:	23 Y0048450 X3764597
Key to symbols:	● Sample taken		Groundwater



(0 to 400) Slightly moist, dark reddish brown, medium dense, intact, **SILTY SANDY GRAVEL**, imported (fill made ground)

(400 to 800) Moist, dark yellowish orange, dense, intact, **SILTY SANDY GRAVEL**, imported (fill made ground)

Foundation Indicator & MOD/CBR/Indicator

(800 to 1500) Moist, light yellowish orange, very dense, intact, **SILTY SANDY GRAVEL**, residual.

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

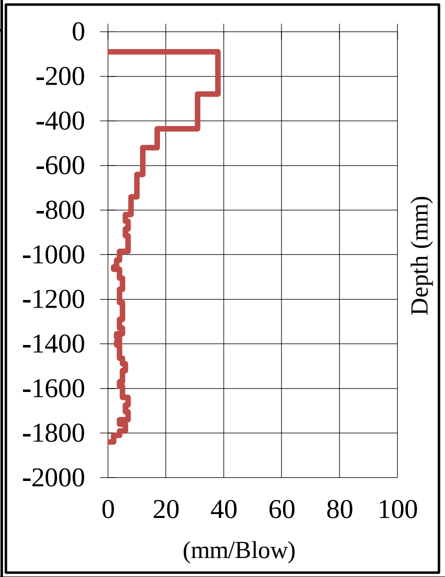
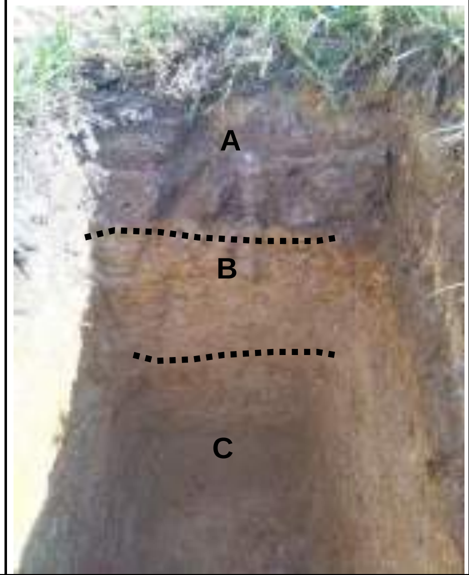
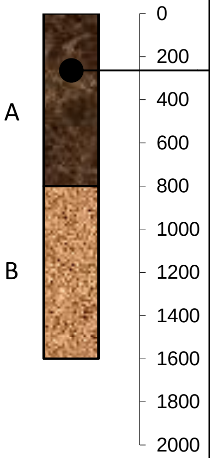


Photo of Test Pit



TP 6

Datum:	NGL	Co-ords:	23 Y0048351 X3764706
Key to symbols:	● Sample taken		Groundwater



(0 to 800) Moist, light brown, medium dense, intact, **CLAYEY SANDY SILT & RUBBISH**, imported (fill made ground)

Foundation Indicator & MOD/CBR/Indicator

(800 to 1600) Moist, dark brown, stiff, slickensided, **CLAYEY GRAVELLY SAND GRAVEL**, residual.

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

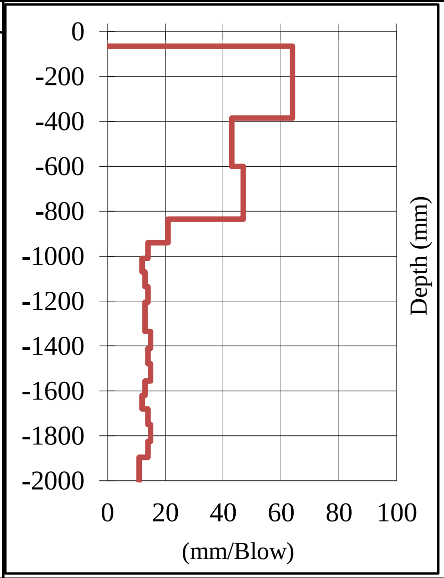
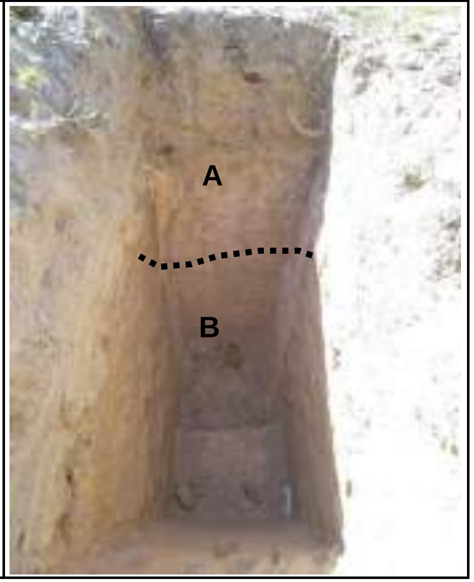


Photo of Test Pit



Geotechnical Soil Profile

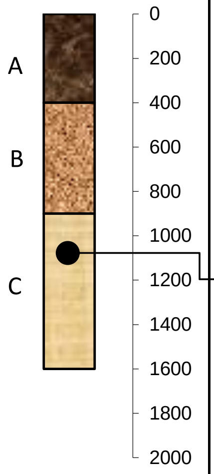
OUTENIQUA GEOTECHNICAL SERVICES

Client:	Lukhozi Consulting Engineers
Project:	Thembalethu Bulk Sewer Phase 3 & 4
Area:	George Municipality
Date:	14.11.2023
Excavator:	By Hand

TP 7

Datum: NGL | Co-ords: 23 Y0048543 X3764947

Key to symbols: ● Sample taken | Groundwater



(0 to 400)	Moist, dark grey, loose, intact, **SILTY SAND**, Transported
(400 to 900)	Moist, dark reddish brown, medium dense, **SANDY GRAVEL**, transported.
(900 to 1600)	Moist, dark yellowish orange stained black, medium dense, **GRAVELLY CLAYEY SILTY SAND**, residual. **Foundation Indicator & MOD/CBR/Indicator**

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

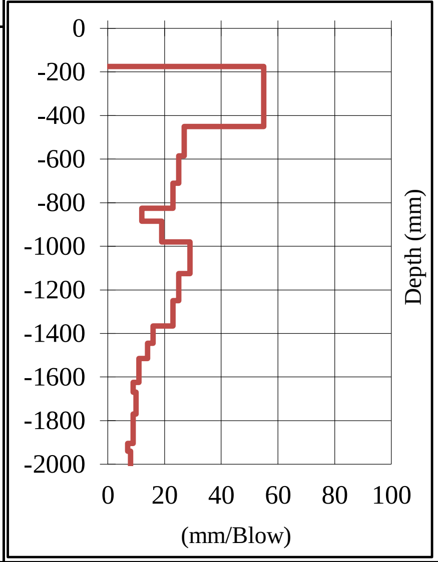
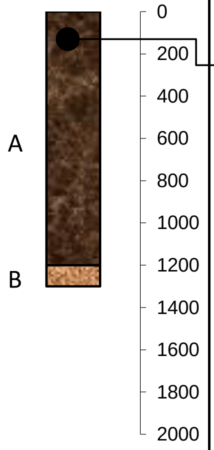


Photo of Test Pit

TP 8

Datum: NGL | Co-ords: 23 Y0048410 X3764937

Key to symbols: ● Sample taken | Groundwater



(0 to 1200)	Moist, light brown, dense, intact, **CLAYEY SANDY SILTY GRAVEL**, imported (fill made ground) **Foundation Indicator & MOD/CBR/Indicator**
(1200 to 1300)	Moist, light yellowish orange, very dense, intact, **GRAVELLY SILTY CLAYEY SAND**, residual.

TP Stopped
No Water

Dynamic Cone Penetrometer (DCP)

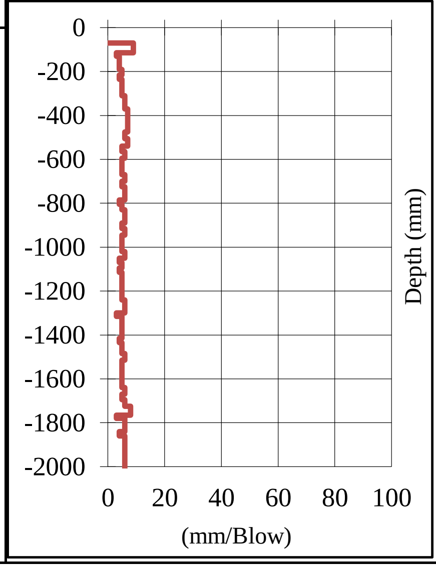
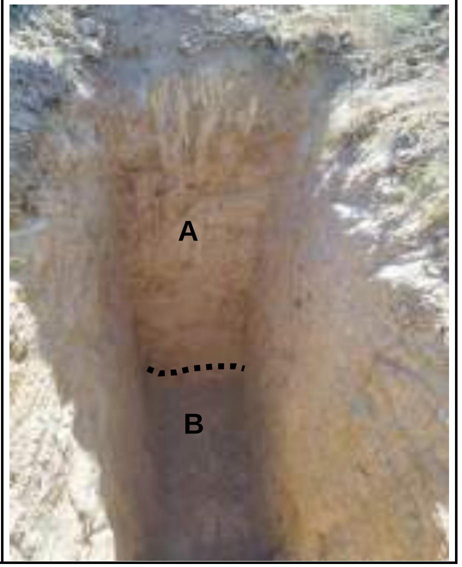


Photo of Test Pit



Appendix 3

Lab test data

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

T0347

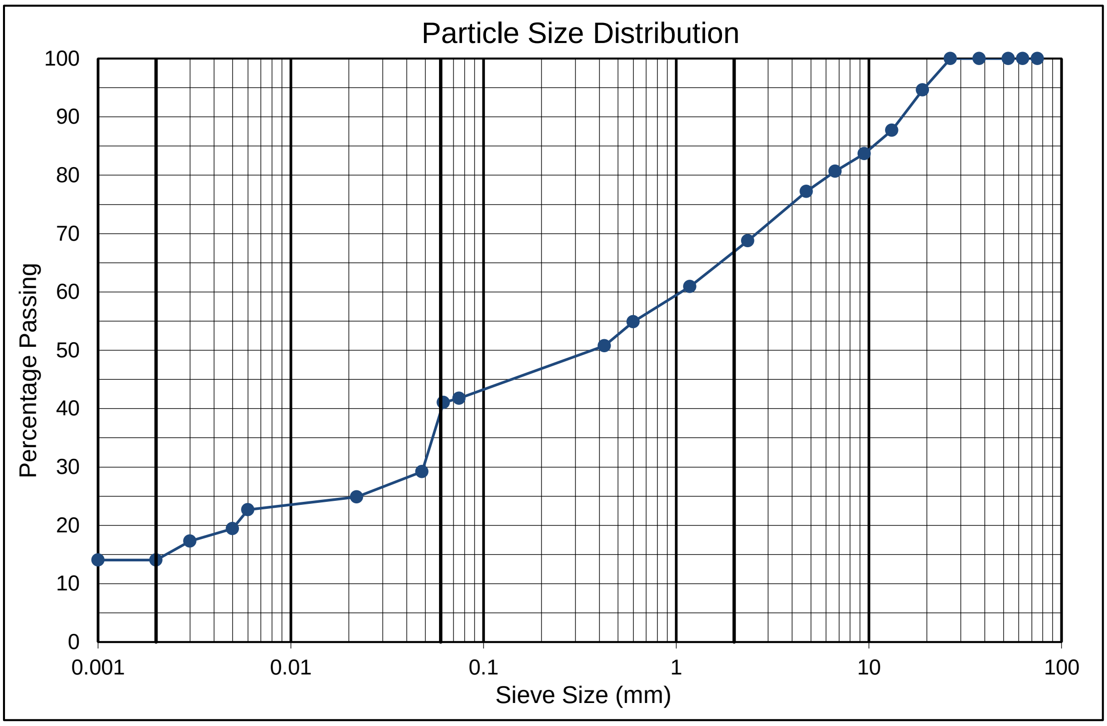
Customer :	Outeniqua Geotechnical Services	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	1/8

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)	TP1
Depth (mm):	0-300
Sample No.:	87333
Materials Description: Source	In-situ
Colour	Dark Reddish Brown
Soil Type	Clayey Gravel with Sand
Classification	Existing

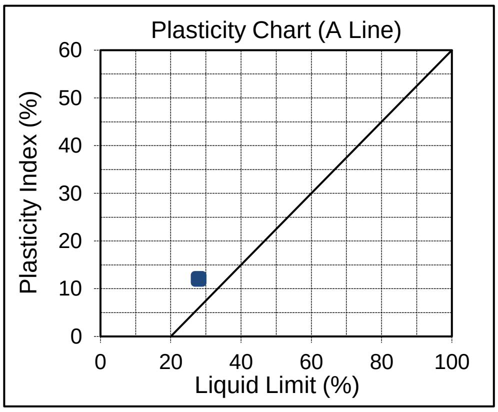
Sieve	Percentage Passing
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	95
13.2mm	88
9.5mm	84
6.7mm	81
4.75mm	77
2.36mm	69
1.18mm	61
0.6mm	55
0.425mm	51
0.075mm	42
0.062mm	41
0.048mm	29
0.022mm	25
0.006mm	23
0.005mm	19
0.003mm	17
0.002mm	14
0.001mm	14

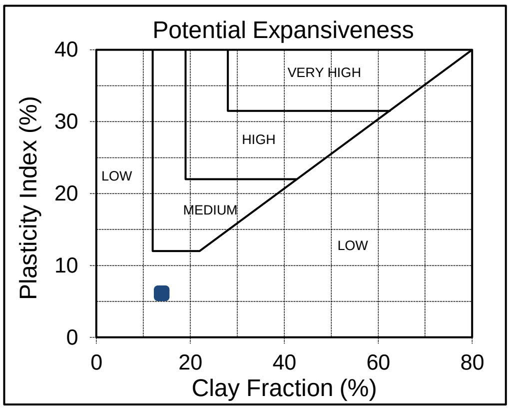


Liquid Limit (%)	28
Plasticity Index (%)	12
Linear Shrinkage (%)	6
Moisture Content (%)	0.0

% Clay	14
% Silt	25
% Sand	27
% Gravel	34

Unified Soil Classification	GC
AASHTO Soil Classification	A-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07
Materials Testing Laboratory
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za T0347

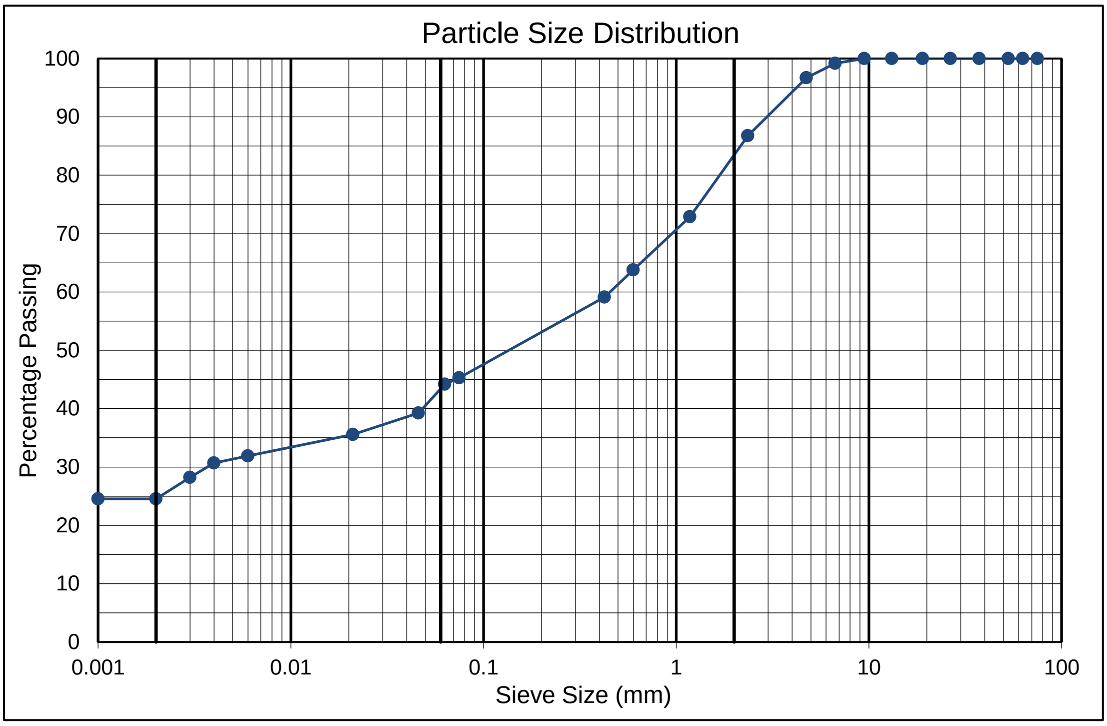
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	2/8

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)	TP2
Depth (mm):	0-700
Sample No.:	87334
Materials Description: Source	In-situ
Colour	Dark Yellowish Brown
Soil Type	Clayey Sandy Gravel
Classification	Existing

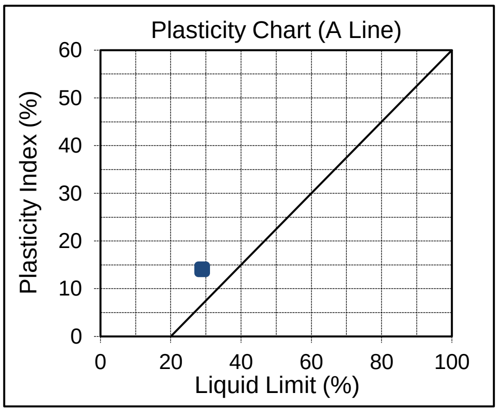
Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	99
4.75mm	97
2.36mm	87
1.18mm	73
0.6mm	64
0.425mm	59
0.075mm	45
0.063mm	44
0.046mm	39
0.021mm	36
0.006mm	32
0.004mm	31
0.003mm	28
0.002mm	25
0.001mm	25

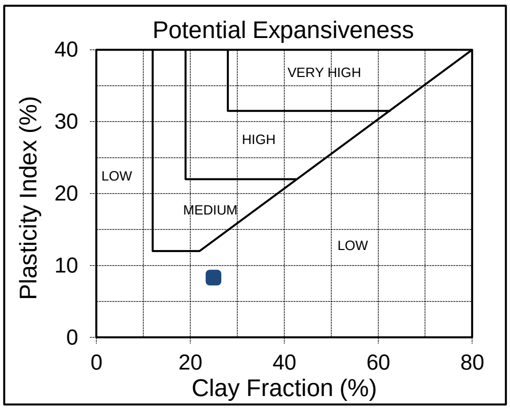


Liquid Limit (%)	29
Plasticity Index (%)	14
Linear Shrinkage (%)	7
Moisture Content (%)	0.0

% Clay	25
% Silt	18
% Sand	40
% Gravel	17

Unified Soil Classification	SC
AASHTO Soil Classification	A-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

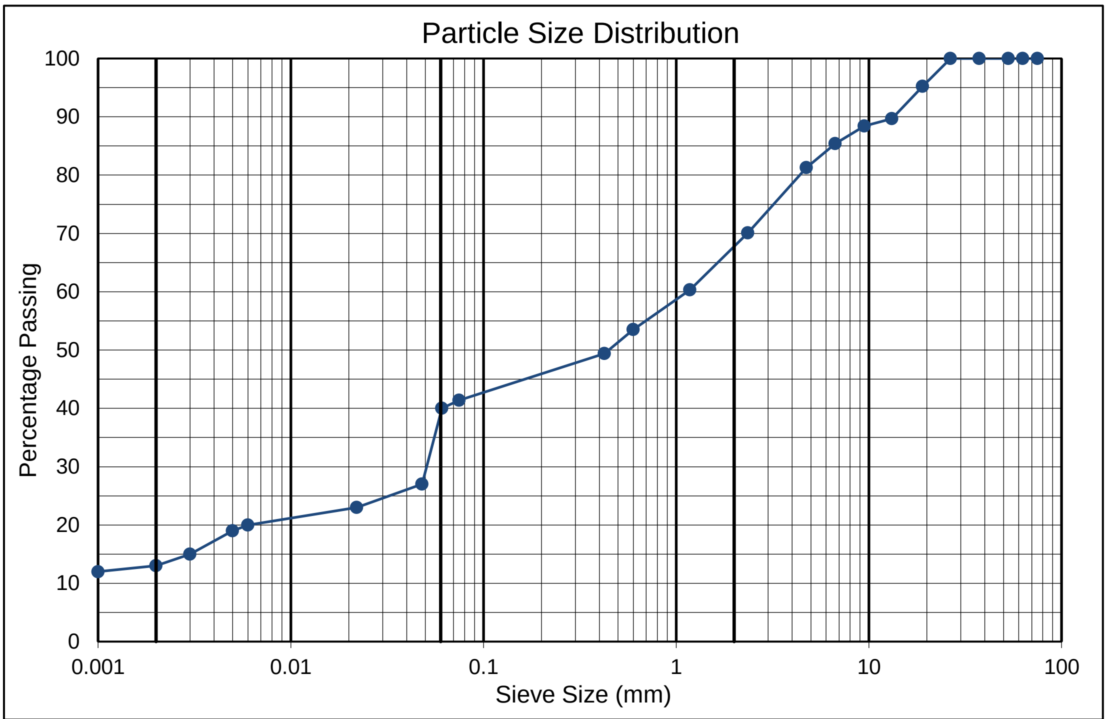
Customer :	Outeniqua Geotechnical Services	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	3/8

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP3
Depth (mm):		100-1500
Sample No.:		87335
Materials Description	Source	In-situ
	Colour	Light Yellowish Orange
	Soil Type	Silty Sandy Gravel
	Classification	Existing

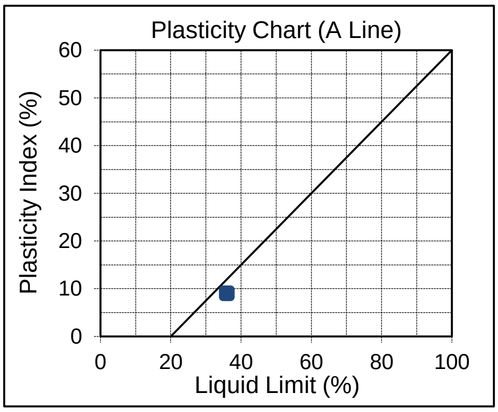
Percentage Passing	
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	95
13.2mm	90
9.5mm	88
6.7mm	85
4.75mm	81
2.36mm	70
1.18mm	60
0.6mm	54
0.425mm	49
0.075mm	41
0.061mm	40
0.048mm	27
0.022mm	23
0.006mm	20
0.005mm	19
0.003mm	15
0.002mm	13
0.001mm	12

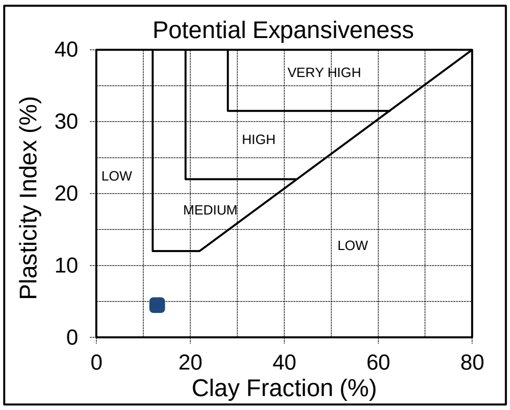


Liquid Limit (%)	36
Plasticity Index (%)	9
Linear Shrinkage (%)	5
Moisture Content (%)	0.0

% Clay	13
% Silt	26
% Sand	28
% Gravel	33

Unified Soil Classification	GM
AASHTO Soil Classification	A-4





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB
OUTENIQUA LAB (Pty) Ltd.
Registration No. 95/07742/07
Materials Testing Laboratory
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

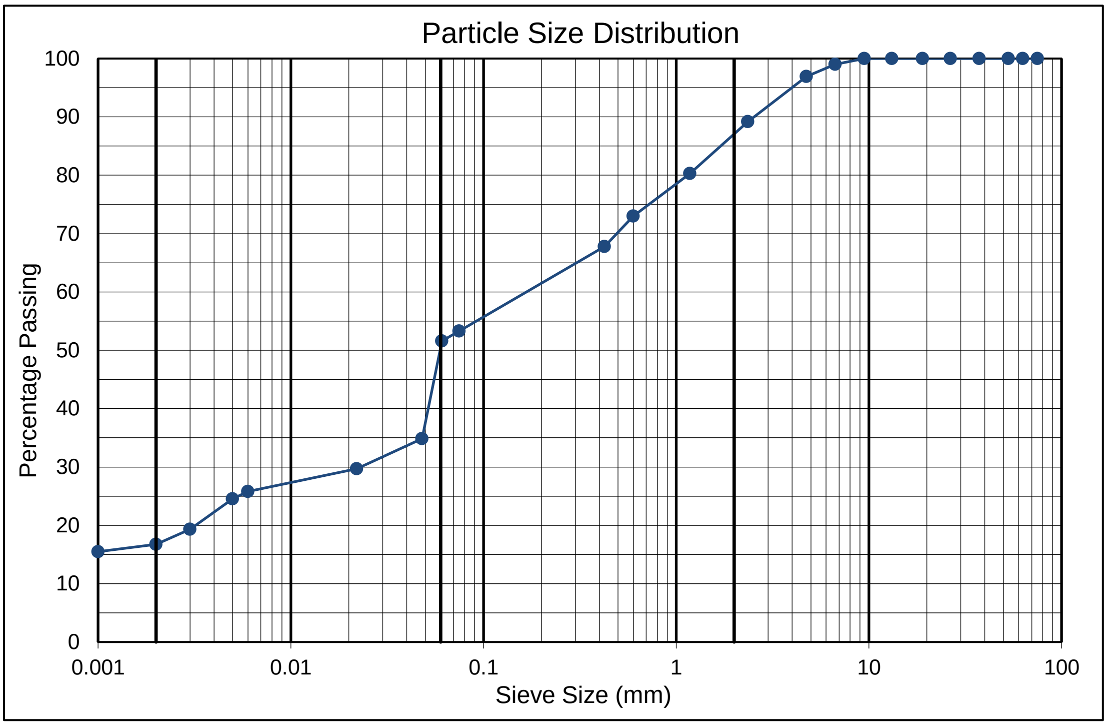
sanas T0347

Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	4/8

TEST REPORT
FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP4
Depth (mm):		1300-1600
Sample No.:		87336
Materials Description	Source	In-situ
	Colour	Dark Reddish Brown
	Soil Type	Silty Sandy Gravel
	Classification	Existing

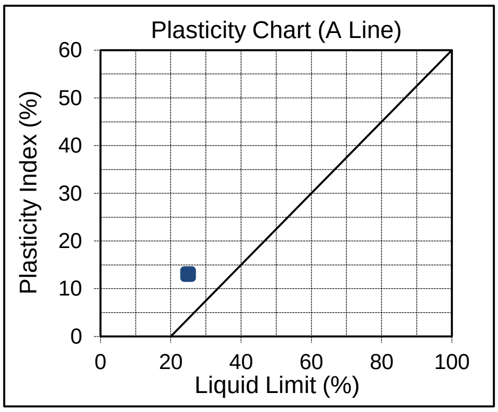
Percentage Passing		
	75.0mm	100
	63.0mm	100
	53.0mm	100
	37.5mm	100
	26.5mm	100
	19mm	100
	13.2mm	100
	9.5mm	100
	6.7mm	99
	4.75mm	97
	2.36mm	89
	1.18mm	80
	0.6mm	73
	0.425mm	68
	0.075mm	53
	0.061mm	52
	0.048mm	35
	0.022mm	30
	0.006mm	26
	0.005mm	25
	0.003mm	19
	0.002mm	17
	0.001mm	15

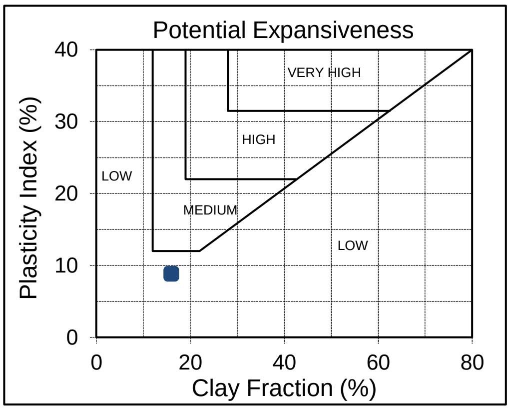


Liquid Limit (%)	25
Plasticity Index (%)	13
Linear Shrinkage (%)	7
Moisture Content (%)	0.0

% Clay	16
% Silt	34
% Sand	36
% Gravel	14

Unified Soil Classification	CL
AASHTO Soil Classification	A-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

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Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

T0347

Customer :	Outeniqua Geotechnical Services	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	5/8

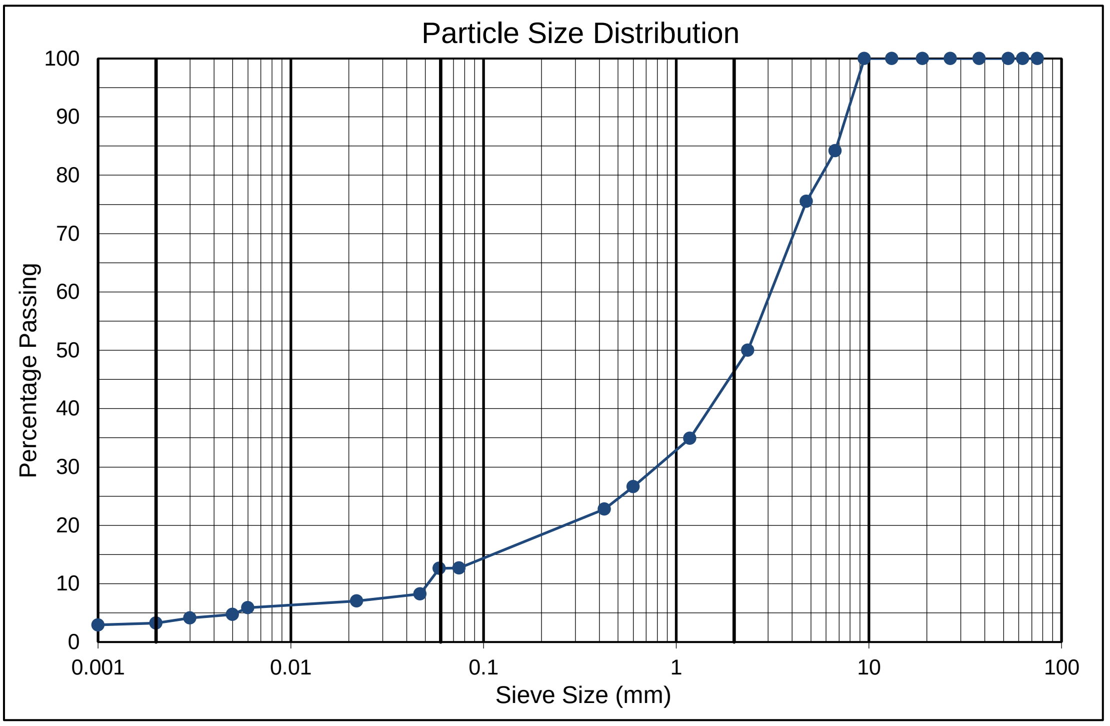
TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)	TP5
Depth (mm):	400-8000
Sample No.:	87337
Materials Description – Source	In-situ
Colour	Dark Yellowish Orange
Soil Type	Silty Sandy Gravel
Classification	Existing

Percentage Passing

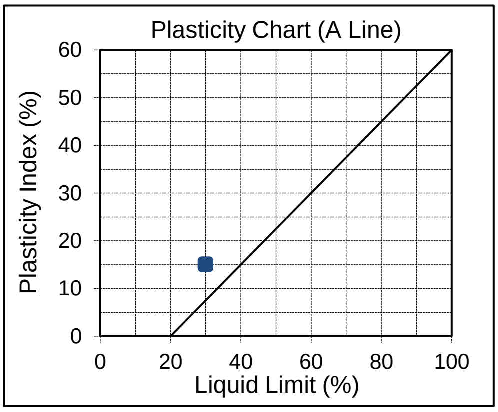
Sieve	%
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	84
4.75mm	76
2.36mm	50
1.18mm	35
0.6mm	27
0.425mm	23
0.075mm	13
0.059mm	13
0.047mm	8
0.022mm	7
0.006mm	6
0.005mm	5
0.003mm	4
0.002mm	3
0.001mm	3

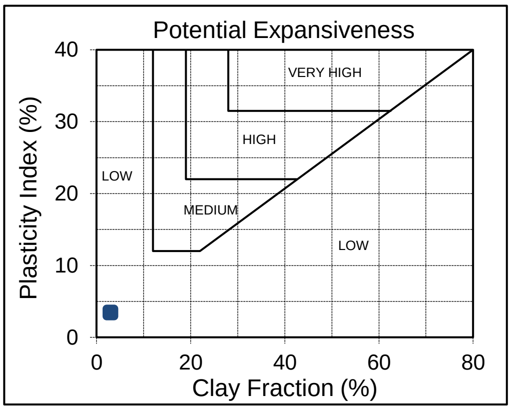


Liquid Limit (%)	30
Plasticity Index (%)	15
Linear Shrinkage (%)	8
Moisture Content (%)	0.0

% Clay	3
% Silt	10
% Sand	32
% Gravel	55

Unified Soil Classification	GC
AASHTO Soil Classification	A-2-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07
Materials Testing Laboratory
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

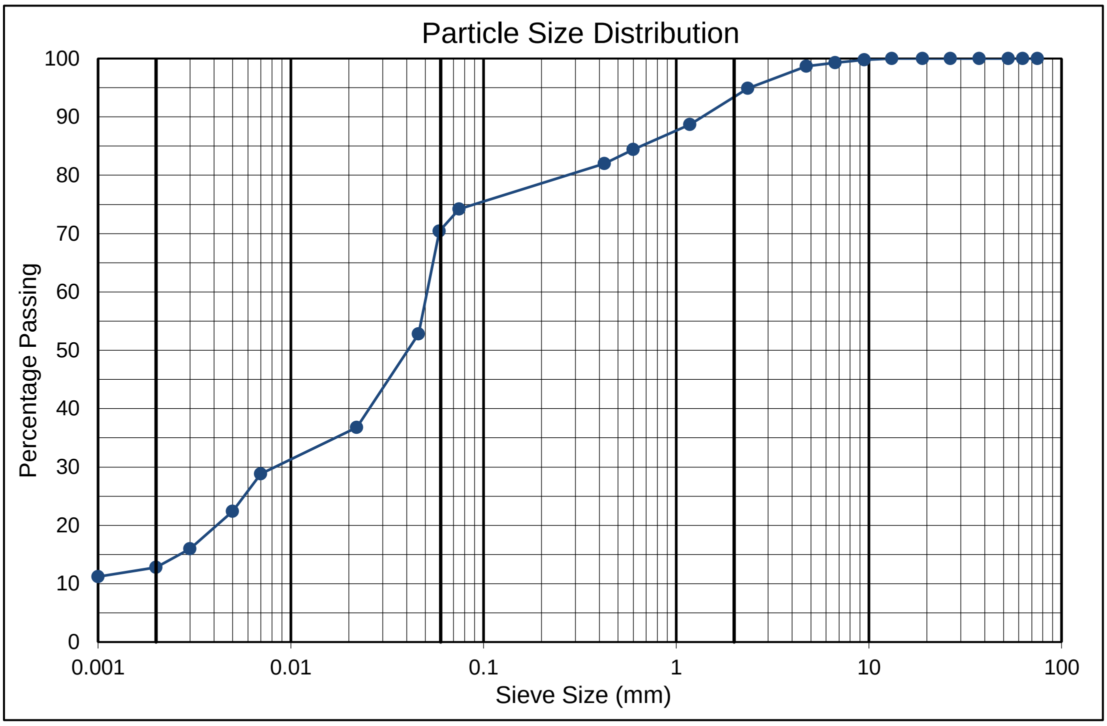
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	6/8

TEST REPORT
FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP6
Depth (mm):		0-800
Sample No.:		87338
Materials Description	Source	In-situ
	Colour	Light Brown
	Soil Type	Silty Sandy Gravel
	Classification	Existing

Percentage Passing

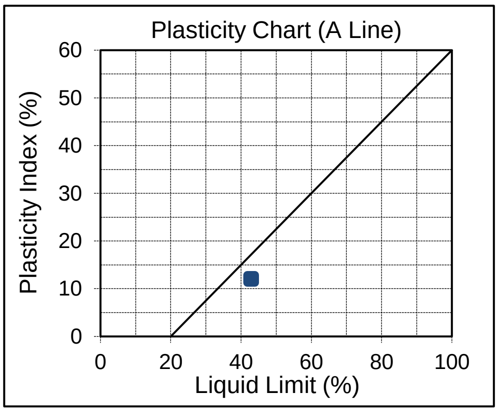
75.0mm	100
63.0mm	100
53.0mm	100
37.5mm	100
26.5mm	100
19mm	100
13.2mm	100
9.5mm	100
6.7mm	99
4.75mm	99
2.36mm	95
1.18mm	89
0.6mm	84
0.425mm	82
0.075mm	74
0.059mm	70
0.046mm	53
0.022mm	37
0.007mm	29
0.005mm	22
0.003mm	16
0.002mm	13
0.001mm	11

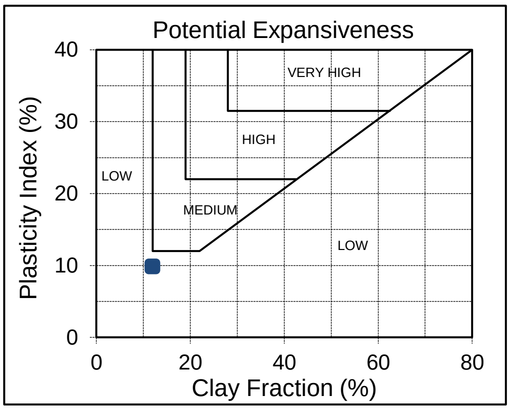


Liquid Limit (%)	43
Plasticity Index (%)	12
Linear Shrinkage (%)	6
Moisture Content (%)	0.0

% Clay	12
% Silt	60
% Sand	21
% Gravel	7

Unified Soil Classification	ML
AASHTO Soil Classification	A-7-5





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

R-FIND-1-6 Jan-22

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07
Materials Testing Laboratory
6 Mirrorball Street, George : PO Box 3186, George Industria, 6536
Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za T0347

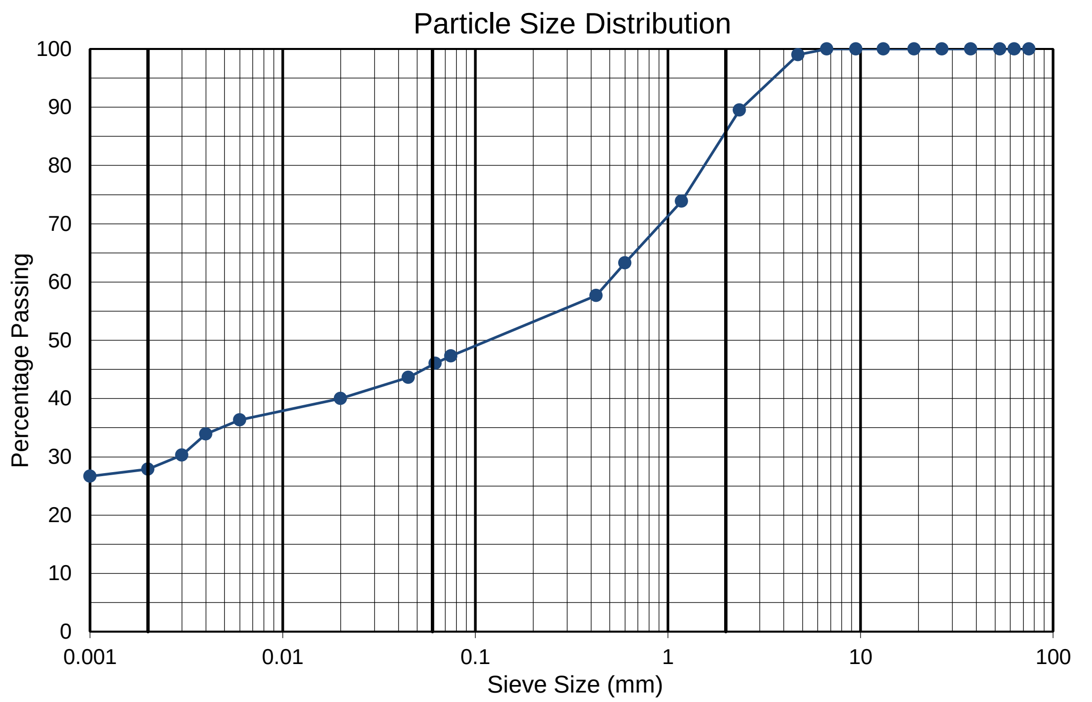
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	7/8

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP7
Depth (mm):		900-1600
Sample No.:		87339
Materials Description	Source	In-situ
	Colour	Dark Yellowish Orange Stained Black
	Soil Type	Silty Sandy Gravel
	Classification	Existing

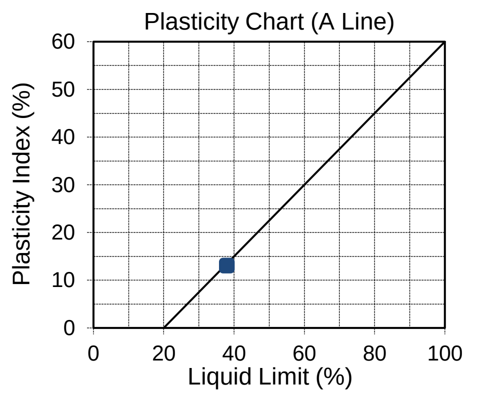
Percentage Passing		
	75.0mm	100
	63.0mm	100
	53.0mm	100
	37.5mm	100
	26.5mm	100
	19mm	100
	13.2mm	100
	9.5mm	100
	6.7mm	100
	4.75mm	99
	2.36mm	90
	1.18mm	74
	0.6mm	63
	0.425mm	58
	0.075mm	47
	0.062mm	46
	0.045mm	44
	0.02mm	40
	0.006mm	36
	0.004mm	34
	0.003mm	30
	0.002mm	28
	0.001mm	27

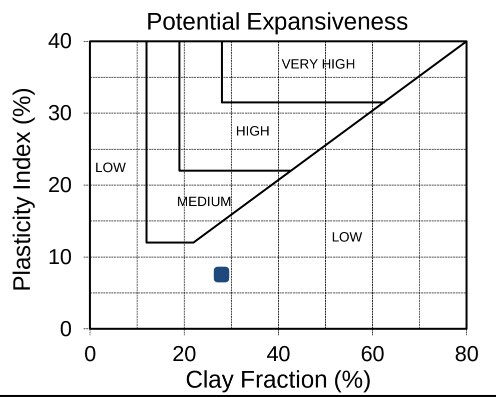


Liquid Limit (%)	38
Plasticity Index (%)	13
Linear Shrinkage (%)	7
Moisture Content (%)	0.0

% Clay	28
% Silt	18
% Sand	39
% Gravel	15

Unified Soil Classification	SM
AASHTO Soil Classification	A-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

R-FIND-1-6 Jan-22

Registration No. 95/07742/07

Materials Testing Laboratory

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Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

T0347

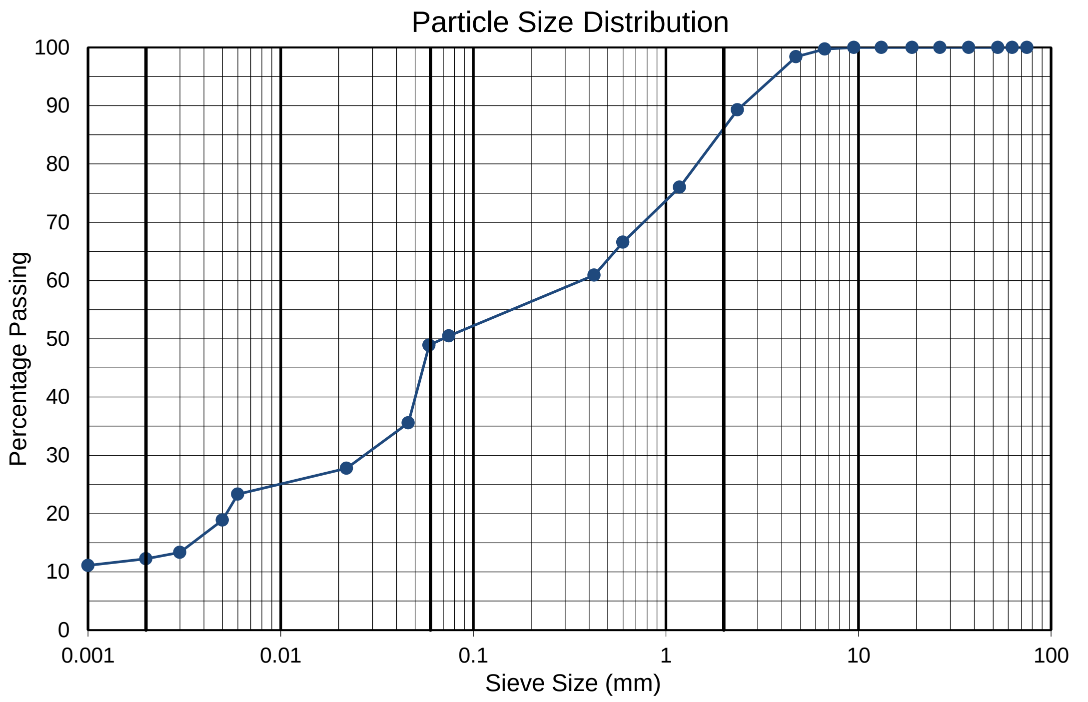
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	8/8

TEST REPORT

FOUNDATION INDICATOR - (ASTM Method D422)

Sample Position (SV)		TP8
Depth (mm):		0-1200
Sample No.:		87340
Materials Description	Source	In-situ
	Colour	Light Brown
	Soil Type	Silty Sandy Gravel
	Classification	Existing

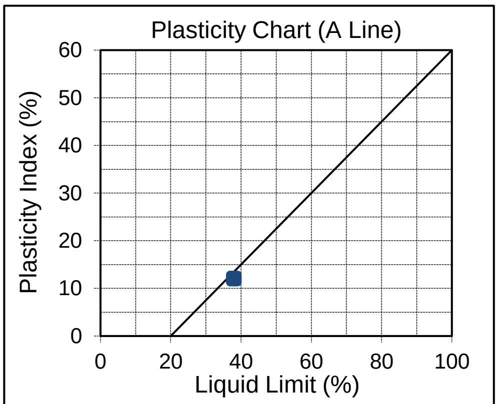
Percentage Passing		
	75.0mm	100
	63.0mm	100
	53.0mm	100
	37.5mm	100
	26.5mm	100
	19mm	100
	13.2mm	100
	9.5mm	100
	6.7mm	100
	4.75mm	98
	2.36mm	89
	1.18mm	76
	0.6mm	67
	0.425mm	61
	0.075mm	51
	0.059mm	49
	0.046mm	36
	0.022mm	28
	0.006mm	23
	0.005mm	19
	0.003mm	13
	0.002mm	12
	0.001mm	11

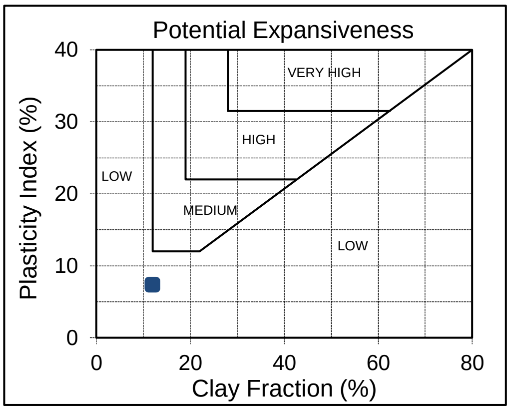


Liquid Limit (%)	38
Plasticity Index (%)	12
Linear Shrinkage (%)	6
Moisture Content (%)	0.0

% Clay	12
% Silt	38
% Sand	35
% Gravel	15

Unified Soil Classification	ML
AASHTO Soil Classification	A-6





- **Specimen delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

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sanas Testing Laboratory T0347

Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
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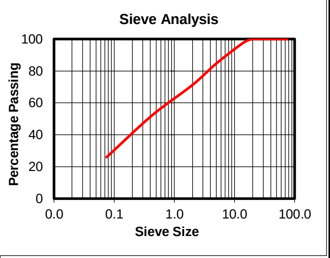
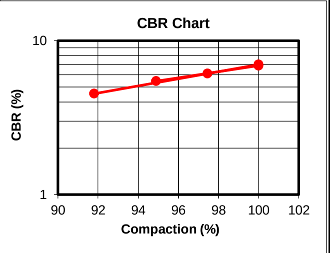
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	1/8

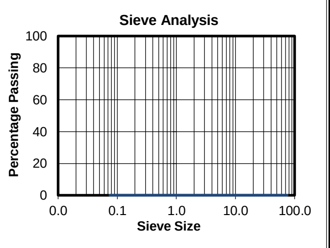
TEST REPORT
CALIFORNIA BEARING RATIO

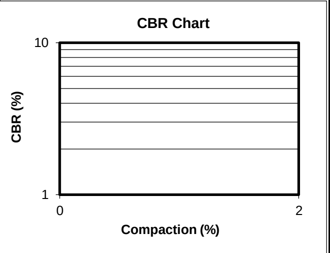
Sample Position (SV)		TP1	COLTO:	
Depth (mm)		0-300	G9	
Sample No		**87333**	**Subgrade**	
Materials Description	Source	In-situ		
	Colour	Dark Reddish Brown		
	Soil Type	Clayey Gravel with Sand		
	Classification	Proposed (G9)		
Material Indicators - (SANS 3001 Method GR1)				Opinion
Percentage Passing	75 mm	100		
	63 mm	100		
	50 mm	100		
	37.5 mm	100		
	28 mm	100		
	20 mm	100		
	14 mm	98		
	5 mm	85		
	2 mm	71		
	0.425 mm	52		
	0.075 mm	26.0		
Material Indicators - (SANS 3001 Method PR5)				
Grading Modulus *		1.51	0.75 - 2.70	✓
Coarse Sand Soil-Mortar (%)		27		
Atterberg Limits - (SANS 3001 Method GR10)				
Liquid Limit (%)		28		
Plasticity Index (%)		12	≤ 12	∗
Linear Shrinkage (%)		6.0		
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)				
MDD	Max Dry Density (kg/m^3)	1948		
	Optimum Moisture Content (%)	9.3		
	Mould Moisture Content (%)	9.2		
A	Relative Compaction (%)	100.0		
	Swell (%)	1.5	≤ 1.5	✓
B	Relative Compaction (%)	94.9		
	Swell (%)	1.6		
C	Relative Compaction (%)	91.8		
	Swell (%)	1.9		
CBR	@100% Max Dry Density	7		
	@98% Max Dry Density	6		
	@95% Max Dry Density	5		
	@93% Max Dry Density	5	≥ 7	∗
	@90% Max Dry Density	4		
Material Condition				
Insitu Moisture Content (%)				
Soil Classification Of The Material Based Only On The Tests Results Above				
COLTO Specification:		G9 Subgrade		
AASHTO System		A-2-6		
Unified System		SC		

87333

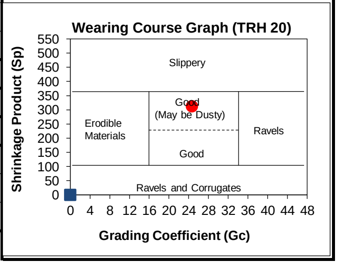








● 87333 ■



- **Tests marked with a (*) are NOT SANAS Accredited results.**
- **Specimens delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (✓), non compliant (×) and uncertain (∗) opinion indicators are based on an approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
2. The uncertain (∗) indicates that the test result is either equal to or is above / below the specified limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliant (✓) or non compliant (×) based on a 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
3. This report (with attachments) is the correct record of all measurements made, and may not be reproduced other than with full written approval from the Director of Outeniqua Lab (Pty) Ltd.
4. Measuring Equipment, traceable to National Standards is used where applicable. Results reported in this Test Report relate only to the items tested and are an indication only of the sample provided and/or taken.
5. While every care is taken to ensure the correctness of all tests and reports, neither Outeniqua Lab (Pty) Ltd nor its employees shall be liable in any way whatever for any error made in the execution or reporting of tests or any erroneous conclusions drawn therefrom or for any consequence thereof.

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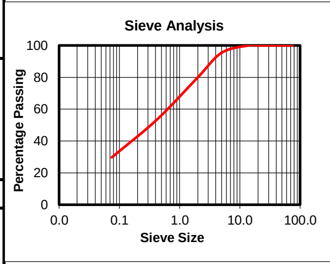
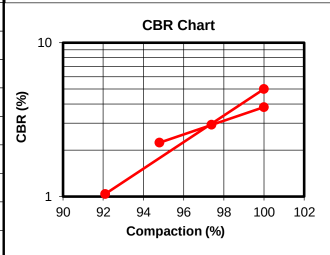
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	2/8

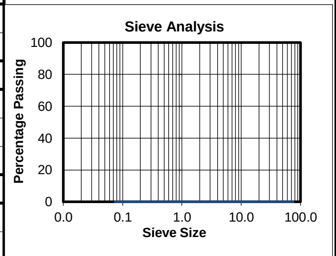
TEST REPORT
CALIFORNIA BEARING RATIO

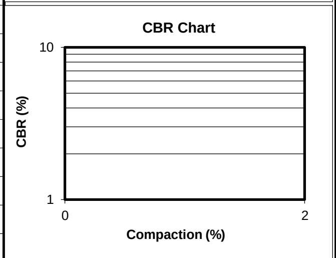
Sample Position (SV)		TP2	COLTO:			
Depth (mm)		0-700	Not			
Sample No		**87334**	Classified			
Materials Description	Source	In-situ				
	Colour	Dark Yellowish Brown				
	Soil Type	Clayey Sandy Gravel				
	Classification	Existing				
Material Indicators - (SANS 3001 Method GR1)				Opinion		
Percentage Passing	75 mm	100				
	63 mm	100				
	50 mm	100				
	37.5 mm	100				
	28 mm	100				
	20 mm	100				
	14 mm	100				
	5 mm	95				
	2 mm	80				
	0.425 mm	54				
	0.075 mm	29.7				
Material Indicators - (SANS 3001 Method PR5)						
Grading Modulus *		1.37				
Coarse Sand Soil-Mortar (%)		33				
Atterberg Limits - (SANS 3001 Method GR10)						
Liquid Limit (%)		29				
Plasticity Index (%)		14				
Linear Shrinkage (%)		7.0				
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)						
MDD	Max Dry Density (kg/m^3)	1876				
	Optimum Moisture Content (%)	12.8				
	Mould Moisture Content (%)	12.9				
A	Relative Compaction (%)	100.0				
	Swell (%)	2.4				
B	Relative Compaction (%)	94.8				
	Swell (%)	2.7				
C	Relative Compaction (%)	92.1				
	Swell (%)	2.9				
CBR	@100% Max Dry Density	5				
	@98% Max Dry Density	3				
	@95% Max Dry Density	2				
	@93% Max Dry Density	1				
	@90% Max Dry Density	1				
Material Condition						
Insitu Moisture Content (%)						
Soil Classification Of The Material Based Only On The Tests Results Above						
COLTO Specification:		Not Classified				
AASHTO System		A-2-6				
Unified System		SC				

87334

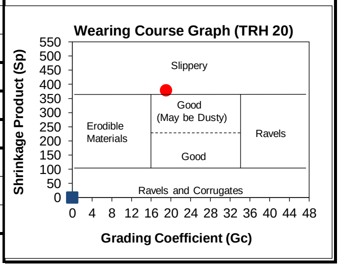








● 87334 ■



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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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R-CBR-1-9 Jun-23

OUTENIQUA LAB (Pty) Ltd.

Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

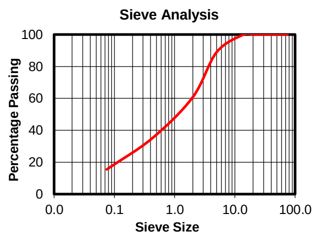
T0347

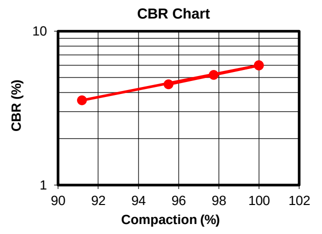
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	3/8

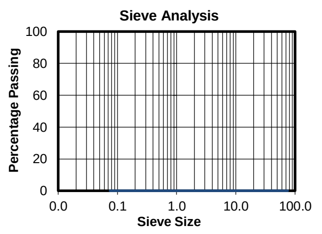
TEST REPORT
CALIFORNIA BEARING RATIO

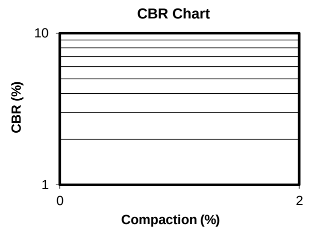
Sample Position (SV)		TP3	COLTO: Not Classified
Depth (mm)		100-1500	
Sample No		**87335**	
Materials Description	Source	In-situ	
	Colour	Light Yellowish Orange	
	Soil Type	Silty Sandy Gravel	
	Classification	Existing	
Material Indicators - (SANS 3001 Method GR1)			Opinion
Percentage Passing	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	89	
	2 mm	61	
	0.425 mm	35	
	0.075 mm	15.5	
Material Indicators - (SANS 3001 Method PR5)			
Grading Modulus *		1.89	
Coarse Sand Soil-Mortar (%)		42	
Atterberg Limits - (SANS 3001 Method GR10)			
Liquid Limit (%)		36	
Plasticity Index (%)		9	
Linear Shrinkage (%)		4.5	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)			
MDD	Max Dry Density (kg/m^3)	1957	
	Optimum Moisture Content (%)	8.0	
	Mould Moisture Content (%)	8.1	
A	Relative Compaction (%)	100.0	
	Swell (%)	1.8	
B	Relative Compaction (%)	95.5	
	Swell (%)	2.0	
C	Relative Compaction (%)	91.2	
	Swell (%)	2.5	
CBR	@100% Max Dry Density	6	
	@98% Max Dry Density	5	
	@95% Max Dry Density	4	
	@93% Max Dry Density	4	
	@90% Max Dry Density	3	
Material Condition			
Insitu Moisture Content (%)			
Soil Classification Of The Material Based Only On The Tests Results Above			
COLTO Specification:		Not Classified	
AASHTO System		A-2-4	
Unified System		SM	

87335

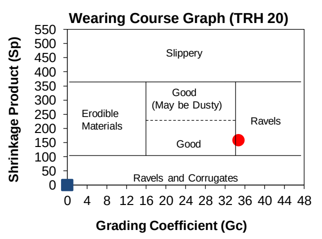








● 87335 ■



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Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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R-CBR-1-9 Jun-23

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T0347

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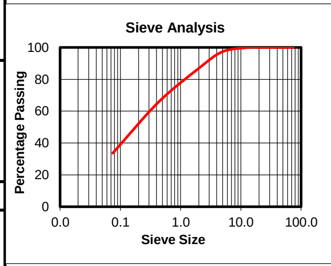
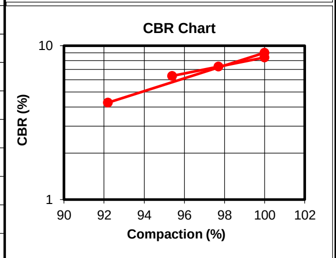
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	4/8

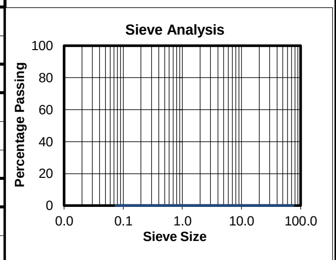
TEST REPORT
CALIFORNIA BEARING RATIO

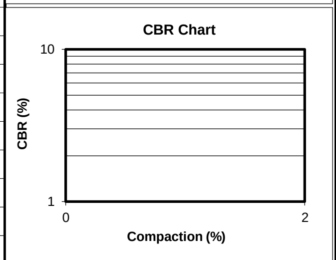
Sample Position (SV)		TP4	COLTO: Not Classified
Depth (mm)		1300-1600	
Sample No		**87336**	
Materials Description	Source	In-situ	
	Colour	Dark Reddish Brown	
	Soil Type	Silty Sandy Gravel	
	Classification	Existing	
Material Indicators - (SANS 3001 Method GR1)			Opinion
Percentage Passing	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	97	
	2 mm	87	
	0.425 mm	65	
	0.075 mm	33.6	
Material Indicators - (SANS 3001 Method PR5)			
Grading Modulus *		1.14	
Coarse Sand Soil-Mortar (%)		25	
Atterberg Limits - (SANS 3001 Method GR10)			
Liquid Limit (%)		25	
Plasticity Index (%)		13	
Linear Shrinkage (%)		6.5	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)			
MDD	Max Dry Density (kg/m^3)	1971	
	Optimum Moisture Content (%)	9.8	
	Mould Moisture Content (%)	9.9	
A	Relative Compaction (%)	100.0	
	Swell (%)	1.3	
B	Relative Compaction (%)	95.4	
	Swell (%)	1.5	
C	Relative Compaction (%)	92.2	
	Swell (%)	1.8	
CBR	@100% Max Dry Density	9	
	@98% Max Dry Density	8	
	@95% Max Dry Density	6	
	@93% Max Dry Density	5	
	@90% Max Dry Density	3	
Material Condition			
Insitu Moisture Content (%)			
Soil Classification Of The Material Based Only On The Tests Results Above			
COLTO Specification:		Not Classified	
AASHTO System		A-2-6	
Unified System		SC	

87336

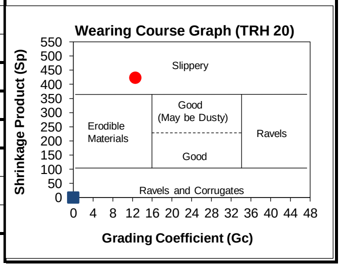








● 87336 ■



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Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

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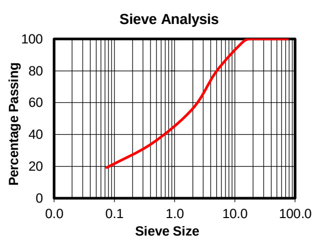
T0347

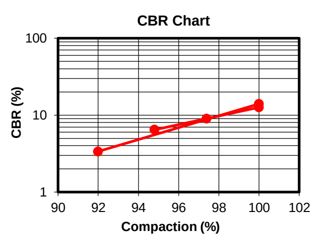
Customer :	Outeniqua Geotechnical Services	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	5/8

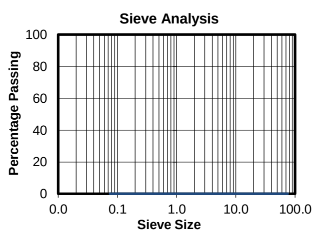
TEST REPORT
CALIFORNIA BEARING RATIO

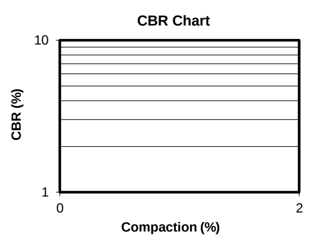
Sample Position (SV)		TP5	COLTO:
Depth (mm)		400-800	Not
Sample No		**87337**	Classified
Materials Description	Source	In-situ	
	Colour	Dark Yellowish Orange	
	Soil Type	Silty Sandy Gravel	
	Classification	Existing	
Material Indicators - (SANS 3001 Method GR1)			Opinion
Percentage Passing	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	98	
	5 mm	80	
	2 mm	56	
	0.425 mm	34	
	0.075 mm	19.2	
Material Indicators - (SANS 3001 Method PR5)			
Grading Modulus *		1.90	
Coarse Sand Soil-Mortar (%)		39	
Atterberg Limits - (SANS 3001 Method GR10)			
Liquid Limit (%)		42	
Plasticity Index (%)		15	
Linear Shrinkage (%)		7.5	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)			
MDD	Max Dry Density (kg/m^3)	2006	
	Optimum Moisture Content (%)	8.2	
	Mould Moisture Content (%)	8.1	
A	Relative Compaction (%)	100.0	
	Swell (%)	1.7	
B	Relative Compaction (%)	94.8	
	Swell (%)	2.0	
C	Relative Compaction (%)	92.0	
	Swell (%)	2.2	
CBR	@100% Max Dry Density	14	
	@98% Max Dry Density	10	
	@95% Max Dry Density	6	
	@93% Max Dry Density	4	
	@90% Max Dry Density	2	
Material Condition			
Insitu Moisture Content (%)			
Soil Classification Of The Material Based Only On The Tests Results Above			
COLTO Specification:		Not Classified	
AASHTO System		A-2-7	
Unified System		GM	

87337

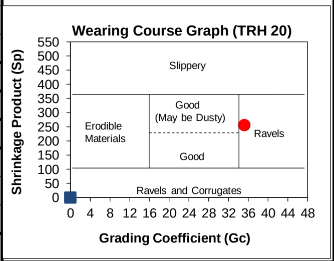








● 87337 ■



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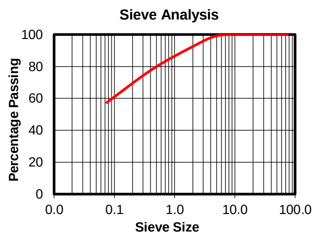
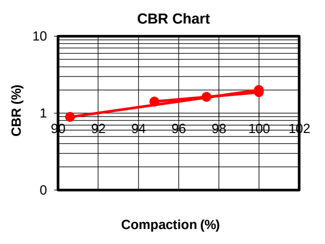
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	6/8

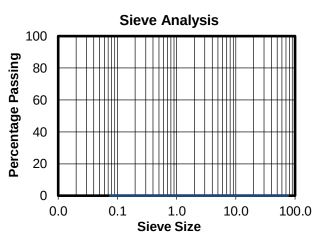
TEST REPORT
CALIFORNIA BEARING RATIO

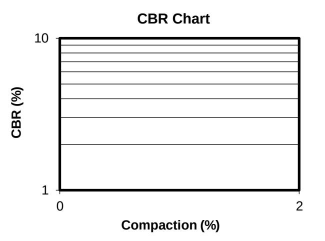
Sample Position (SV)		TP6	COLTO: Not Classified
Depth (mm)		0-800	
Sample No		**87338**	
Materials Description	Source	In-situ	
	Colour	Light Brown	
	Soil Type	Silty Sandy Gravel	
	Classification	Existing	
Material Indicators - (SANS 3001 Method GR1)			Opinion
Percentage Passing	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	99	
	2 mm	92	
	0.425 mm	78	
	0.075 mm	57.4	
Material Indicators - (SANS 3001 Method PR5)			
Grading Modulus *		0.72	
Coarse Sand Soil-Mortar (%)		15	
Atterberg Limits - (SANS 3001 Method GR10)			
Liquid Limit (%)		43	
Plasticity Index (%)		12	
Linear Shrinkage (%)		6.0	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)			
MDD	Max Dry Density (kg/m^3)	1750	
	Optimum Moisture Content (%)	13.3	
	Mould Moisture Content (%)	13.3	
A	Relative Compaction (%)	100.0	
	Swell (%)	6.0	
B	Relative Compaction (%)	94.8	
	Swell (%)	8.3	
C	Relative Compaction (%)	90.6	
	Swell (%)	9.2	
CBR	@100% Max Dry Density	2	
	@98% Max Dry Density	2	
	@95% Max Dry Density	1	
	@93% Max Dry Density	1	
	@90% Max Dry Density	1	
Material Condition			
Insitu Moisture Content (%)			
Soil Classification Of The Material Based Only On The Tests Results Above			
COLTO Specification:		Not Classified	
AASHTO System		A-7-5	
Unified System		ML	

87338

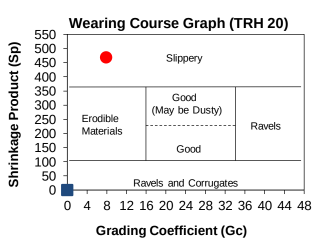








● 87338 ■



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Registration No. 95/07742/07

Materials Testing Laboratory

6 Mirrorball Street, George : PO Box 3186, George Industria, 6536

Tel: 044 8743274 : Fax: 044 8745779 : e-mail: llewelyn@outeniqualab.co.za

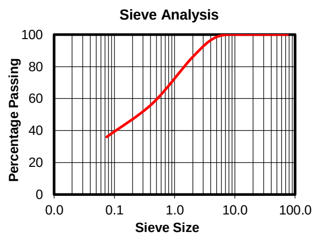
sanas T0347

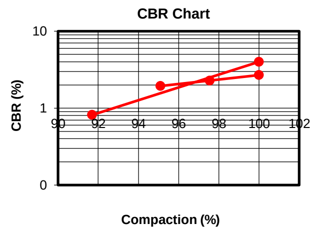
Customer :	Outeniqua Geotechnical Services P O Box 964 Knysna 6570	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
		Date Received :	22/11/2023
		Date Reported :	29/11/2023
		Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	7/8

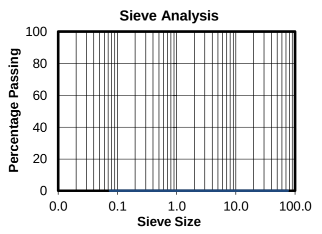
TEST REPORT
CALIFORNIA BEARING RATIO

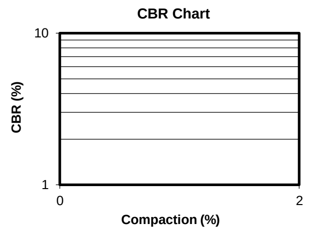
Sample Position (SV)		TP7	**COLTO: Not Classified**	Opinion
Depth (mm)		900-1600		
Sample No		**87339**		
Materials Description	Source	In-situ		
	Colour	Dark Yellowish Orange Stained Black		
	Soil Type	Silty Sandy Gravel		
	Classification	Existing		
Material Indicators - (SANS 3001 Method GR1)				
Percentage Passing	75 mm	100		
	63 mm	100		
	50 mm	100		
	37.5 mm	100		
	28 mm	100		
	20 mm	100		
	14 mm	100		
	5 mm	99		
	2 mm	86		
	0.425 mm	57		
	0.075 mm	36.0		
Material Indicators - (SANS 3001 Method PR5)				
Grading Modulus *		1.21		
Coarse Sand Soil-Mortar (%)		34		
Atterberg Limits - (SANS 3001 Method GR10)				
Liquid Limit (%)		38		
Plasticity Index (%)		13		
Linear Shrinkage (%)		6.5		
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)				
MDD	Max Dry Density (kg/m^3)	1868		
	Optimum Moisture Content (%)	11.2		
	Mould Moisture Content (%)	11.2		
A	Relative Compaction (%)	100.0		
	Swell (%)	2.9		
B	Relative Compaction (%)	95.1		
	Swell (%)	3.4		
C	Relative Compaction (%)	91.7		
	Swell (%)	3.7		
CBR	@100% Max Dry Density	4		
	@98% Max Dry Density	2		
	@95% Max Dry Density	1		
	@93% Max Dry Density	1		
	@90% Max Dry Density	1		
Material Condition				
Insitu Moisture Content (%)				
Soil Classification Of The Material Based Only On The Tests Results Above				
COLTO Specification:		Not Classified		
AASHTO System		A-6		
Unified System		SM		

87339

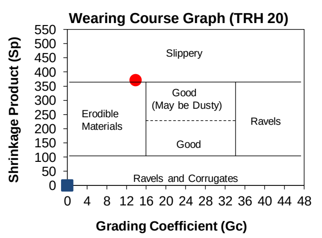








● 87339 ■



- **Tests marked with a (*) are NOT SANAS Accredited results.**
- **Specimens delivered to Outeniqua Lab in good order.**

Ruaan Lesch
Technical Signatory
For Outeniqua Lab (Pty) Ltd.

1. The opinion column is an interpretation of the direct comparison between the quoted specification and the single test sample results obtained. The compliant (✓), non compliant (×) and uncertain (∗) opinion indicators are based on an approximate 95% level of confidence with reference to SAMM GUIDANCE 1, Issue 2 : 20 June 2007 Section 2.
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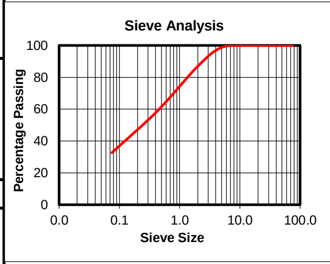
sanas T0347

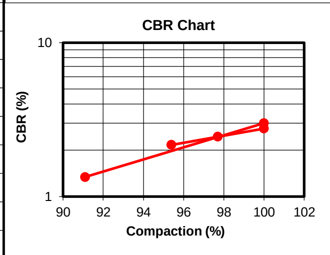
Customer :	Outeniqua Geotechnical Services	Project :	Proposed Upgrade of the Thembalethu Bulk Sewer PH3 & 4 - George Municipality
	P O Box 964	Date Received :	22/11/2023
	Knysna	Date Reported :	29/11/2023
	6570	Req. Number :	4102/23
Attention :	Iain Paton	No. of Pages :	8/8

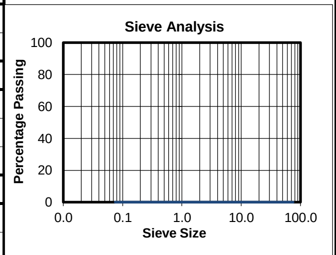
TEST REPORT
CALIFORNIA BEARING RATIO

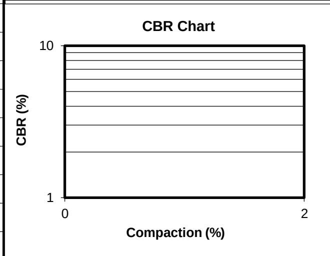
Sample Position (SV)		TP8	COLTO: Not Classified
Depth (mm)		0-1200	
Sample No		**87340**	
Materials Description	Source	In-situ	
	Colour	Light Brown	
	Soil Type	Silty Sandy Gravel	
	Classification	Existing	
Material Indicators - (SANS 3001 Method GR1)			Opinion
Percentage Passing	75 mm	100	
	63 mm	100	
	50 mm	100	
	37.5 mm	100	
	28 mm	100	
	20 mm	100	
	14 mm	100	
	5 mm	99	
	2 mm	87	
	0.425 mm	59	
	0.075 mm	32.6	
Material Indicators - (SANS 3001 Method PR5)			
Grading Modulus *		1.22	
Coarse Sand Soil-Mortar (%)		32	
Atterberg Limits - (SANS 3001 Method GR10)			
Liquid Limit (%)		38	
Plasticity Index (%)		12	
Linear Shrinkage (%)		6.0	
Material Strength - (SANS 3001 Method GR30,GR40 - SCALPED)			
MDD	Max Dry Density (kg/m^3)	1978	
	Optimum Moisture Content (%)	8.4	
	Mould Moisture Content (%)	8.2	
A	Relative Compaction (%)	100.0	
	Swell (%)	2.8	
B	Relative Compaction (%)	95.4	
	Swell (%)	3.3	
C	Relative Compaction (%)	91.1	
	Swell (%)	3.8	
CBR	@100% Max Dry Density	3	
	@98% Max Dry Density	3	
	@95% Max Dry Density	2	
	@93% Max Dry Density	2	
	@90% Max Dry Density	1	
Material Condition			
Insitu Moisture Content (%)			
Soil Classification Of The Material Based Only On The Tests Results Above			
COLTO Specification:		Not Classified	
AASHTO System		A-2-6	
Unified System		SM	

87340

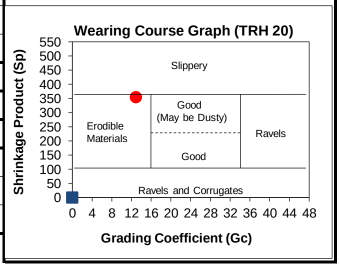








● 87340 ■



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Appendix 4

DCP test data

Outeniqua Geotechnical Services cc.

Geotechnical Engineering Consultants

Registration No. 1999/062743/23

18 Clyde Street, Knysna : PO Box 964, Knysna, 6570

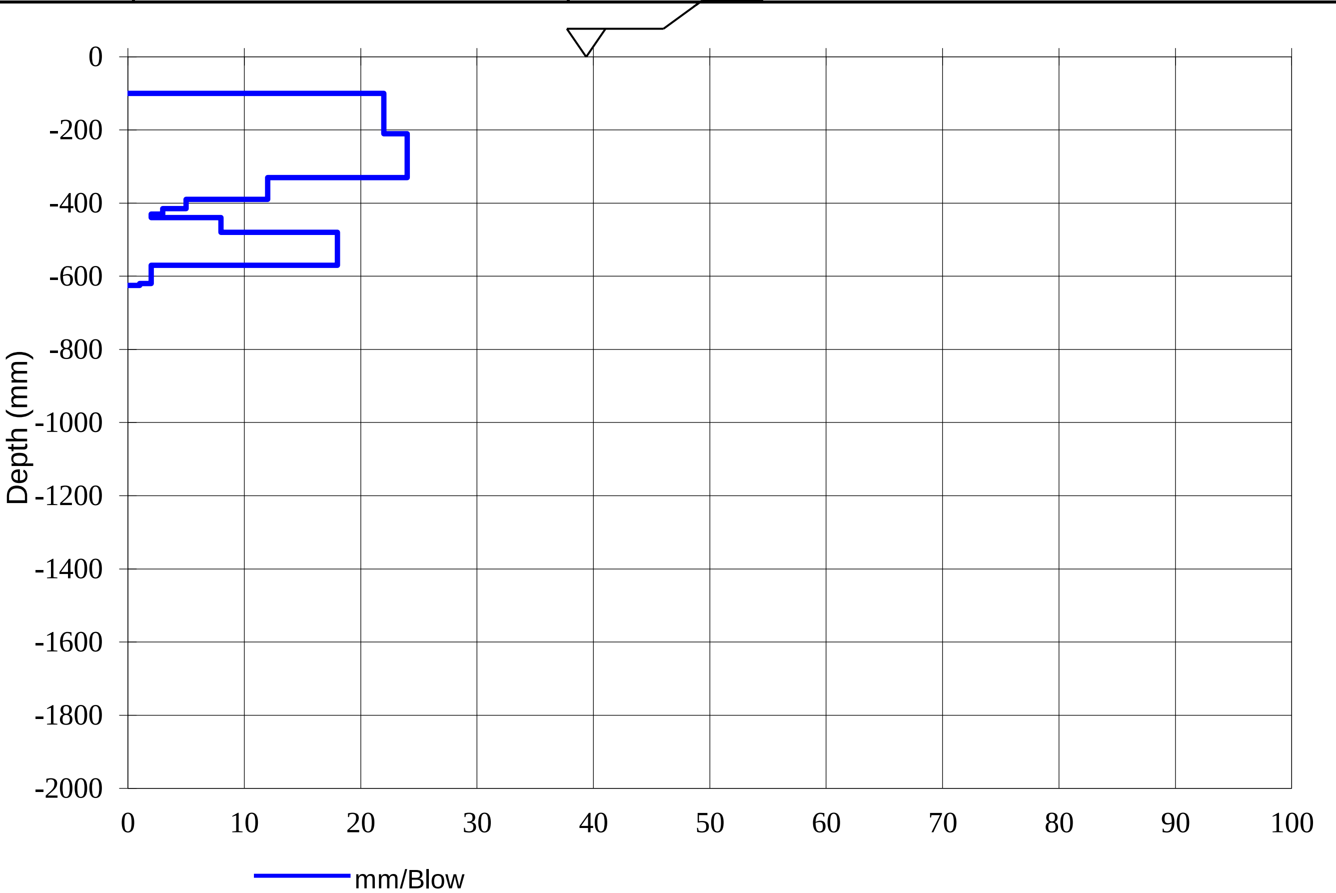
Tel: 044 3820502 : Fax: 044 3820503 : e-mail: iain@outeniqualab.co.za

Customer :	Lukhozi Consultinig Engineers	Project :	Thembalethu Bulk Sewer Ph 3 & 4 George Municipality
	8 St John's Street, 1st Floor Office	Date Received :	27.10.2023
	No 20 St John's Place	Date Reported :	14.11.2023
	Dormehldrift George 6529	Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	1 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP1	Datum Level:	NGL



I Paton (Member)
For Outeniqua Geotech. Services cc.
Technical Signatory

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Geotechnical Engineering Consultants

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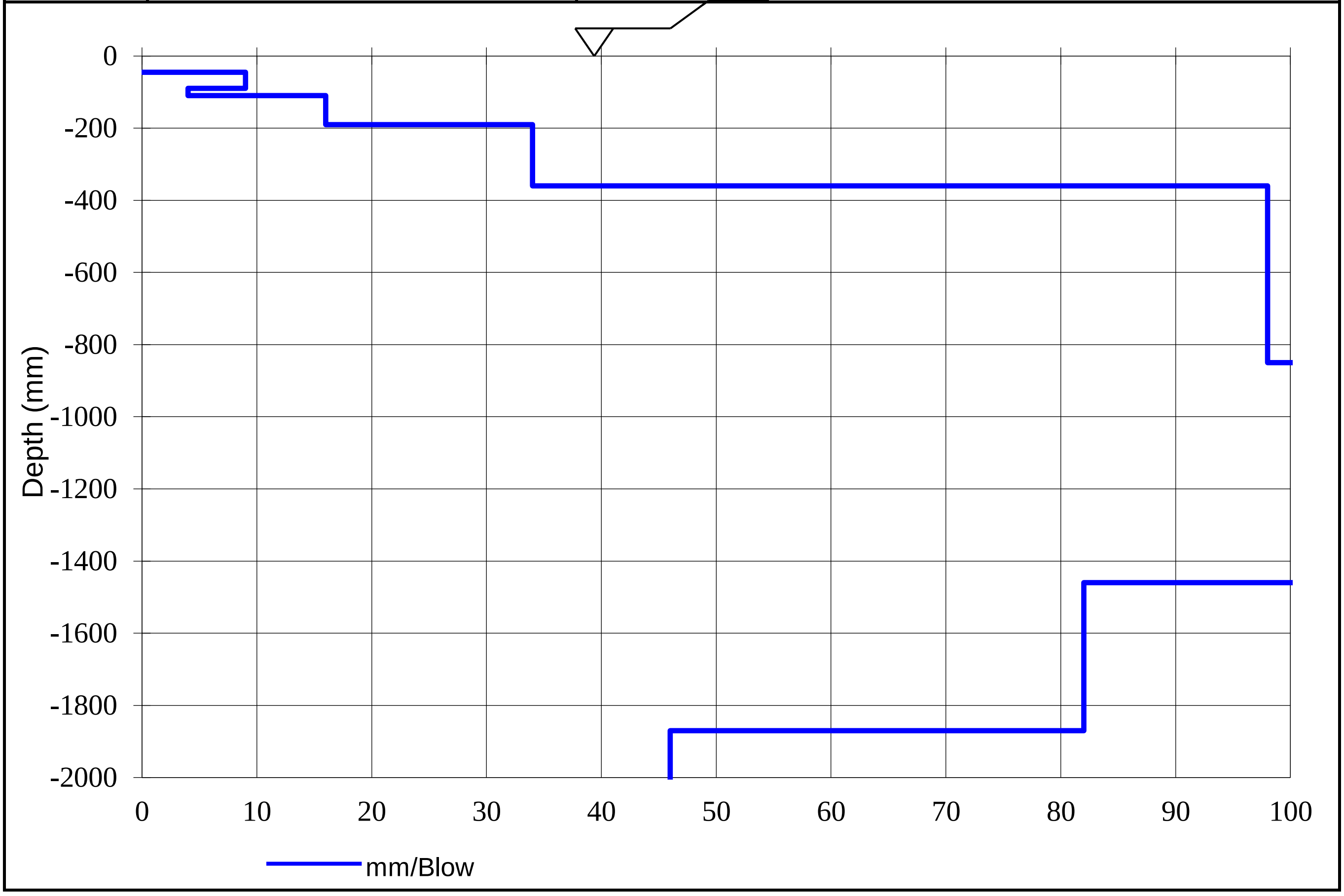
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	2 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP2	Datum Level:	NGL



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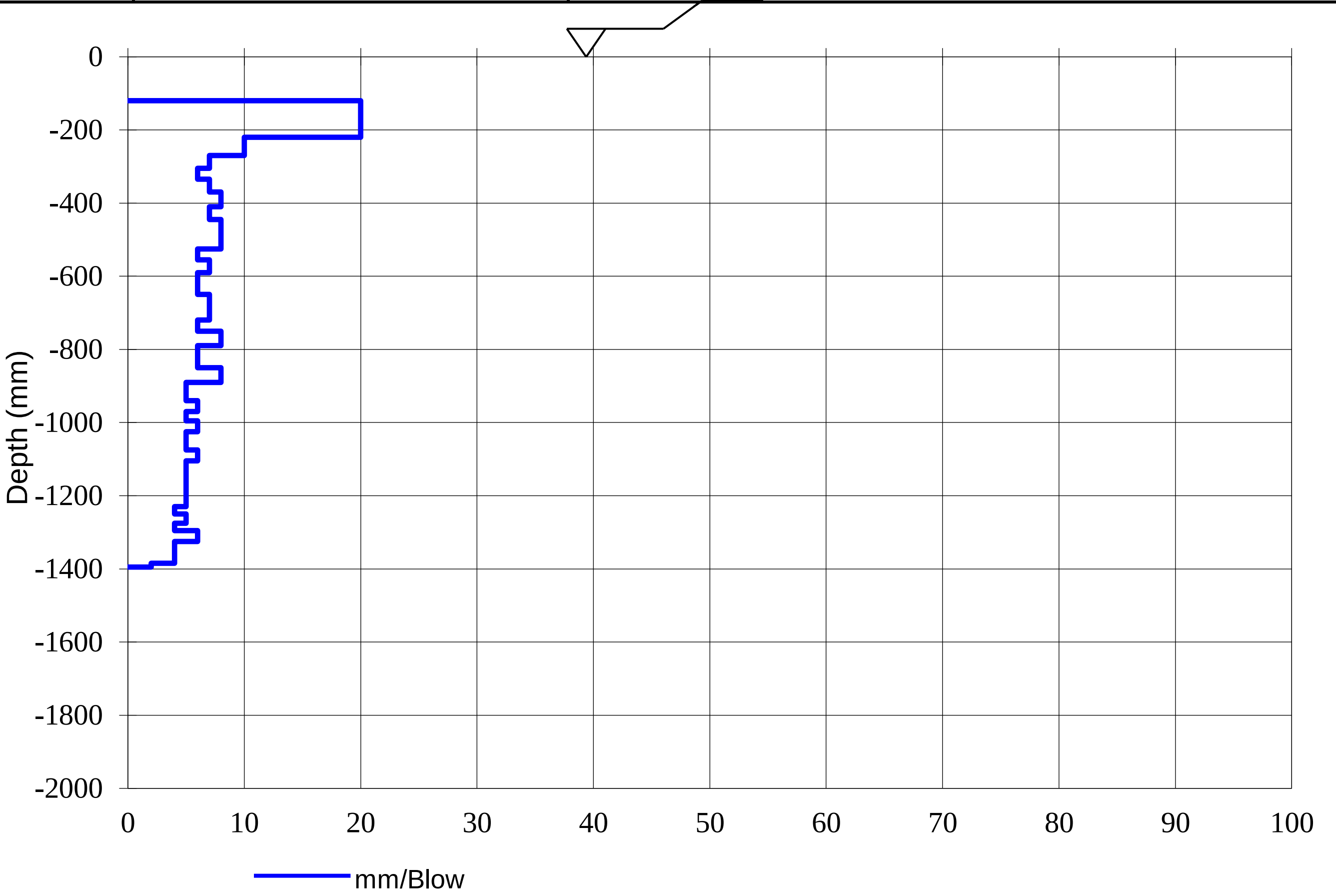
Customer :	Lukhozi Consultinig Engineers 8 St John's Street, 1st Floor Office No 20 St John's Place Dormehldrift George 6529	Project :	Thembalethu Bulk Sewer Ph 3 & 4 George Municipality
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	3 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP3	Datum Level:	NGL



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For Outeniqua Geotech. Services cc.
Technical Signatory

Outeniqua Geotechnical Services cc.

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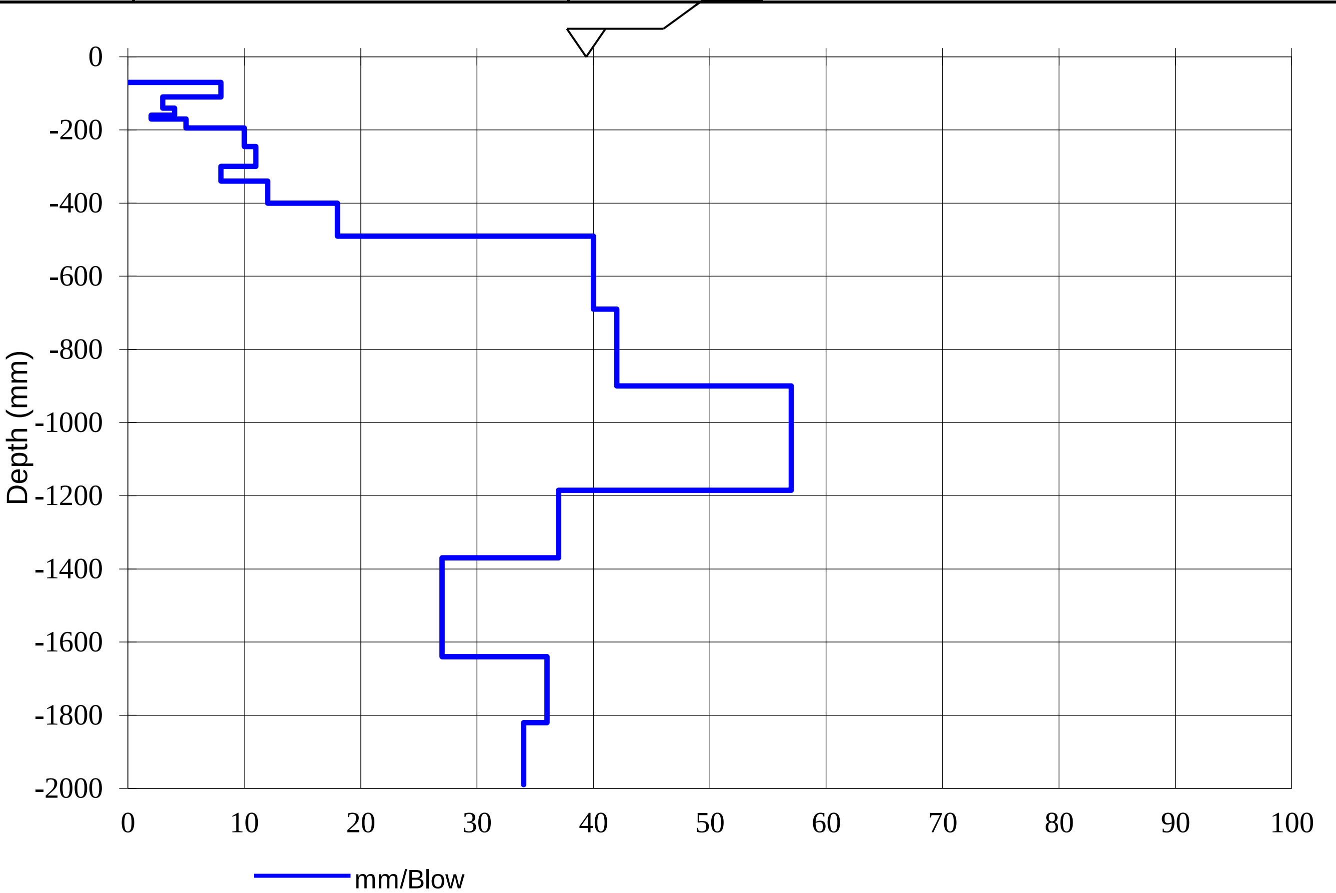
Customer :	Lukhozi Consultinig Engineers 8 St John's Street, 1st Floor Office No 20 St John's Place Dormehldrift George 6529	Project :	Thembalethu Bulk Sewer Ph 3 & 4 George Municipality
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	4 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP4	Datum Level:	NGL



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For Outeniqua Geotech. Services cc.
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Outeniqua Geotechnical Services cc.

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Registration No. 1999/062743/23

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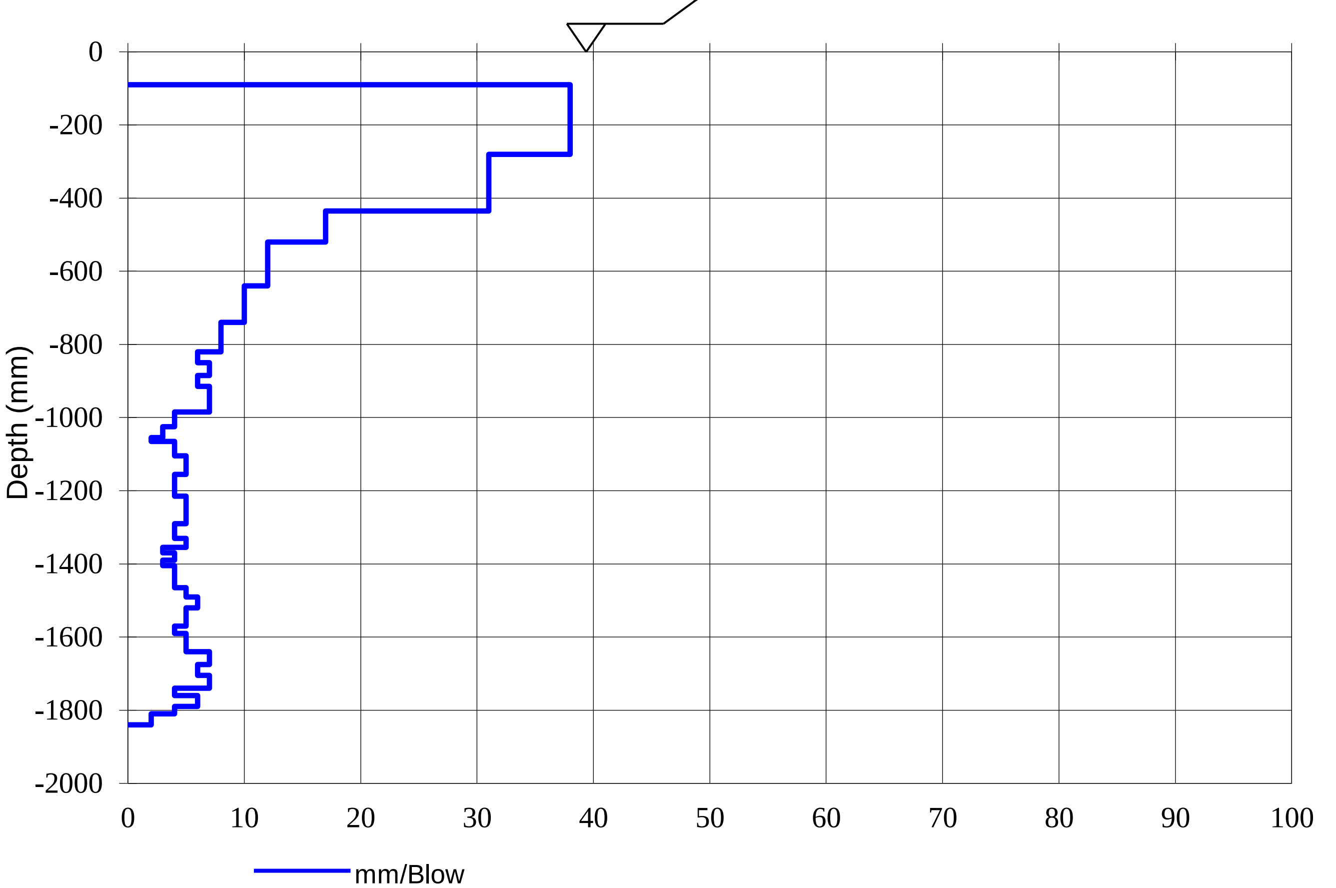
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	5 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP5	Datum Level:	NGL



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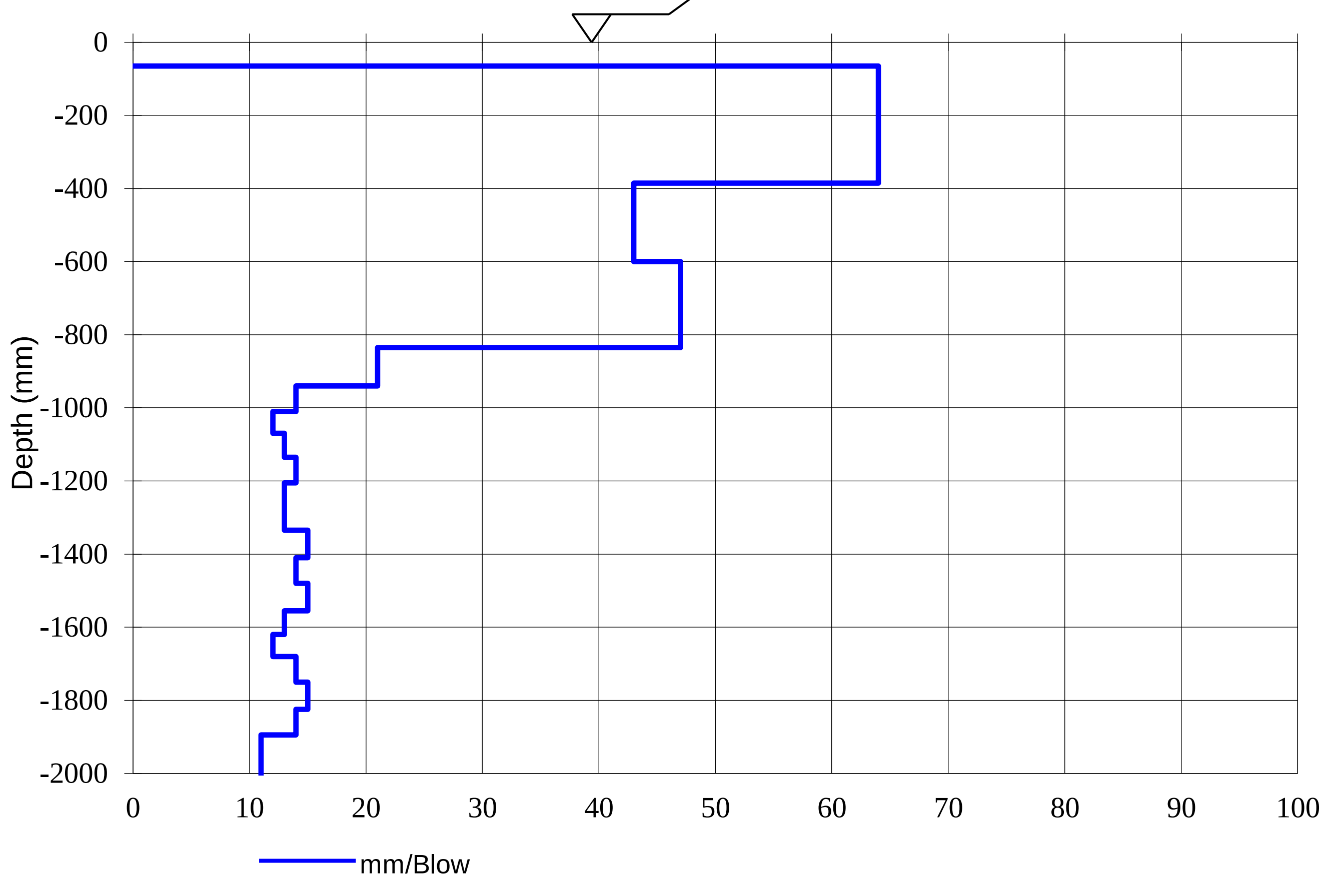
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	6 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP6	Datum Level:	NGL



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For Outeniqua Geotech. Services cc.
Technical Signatory

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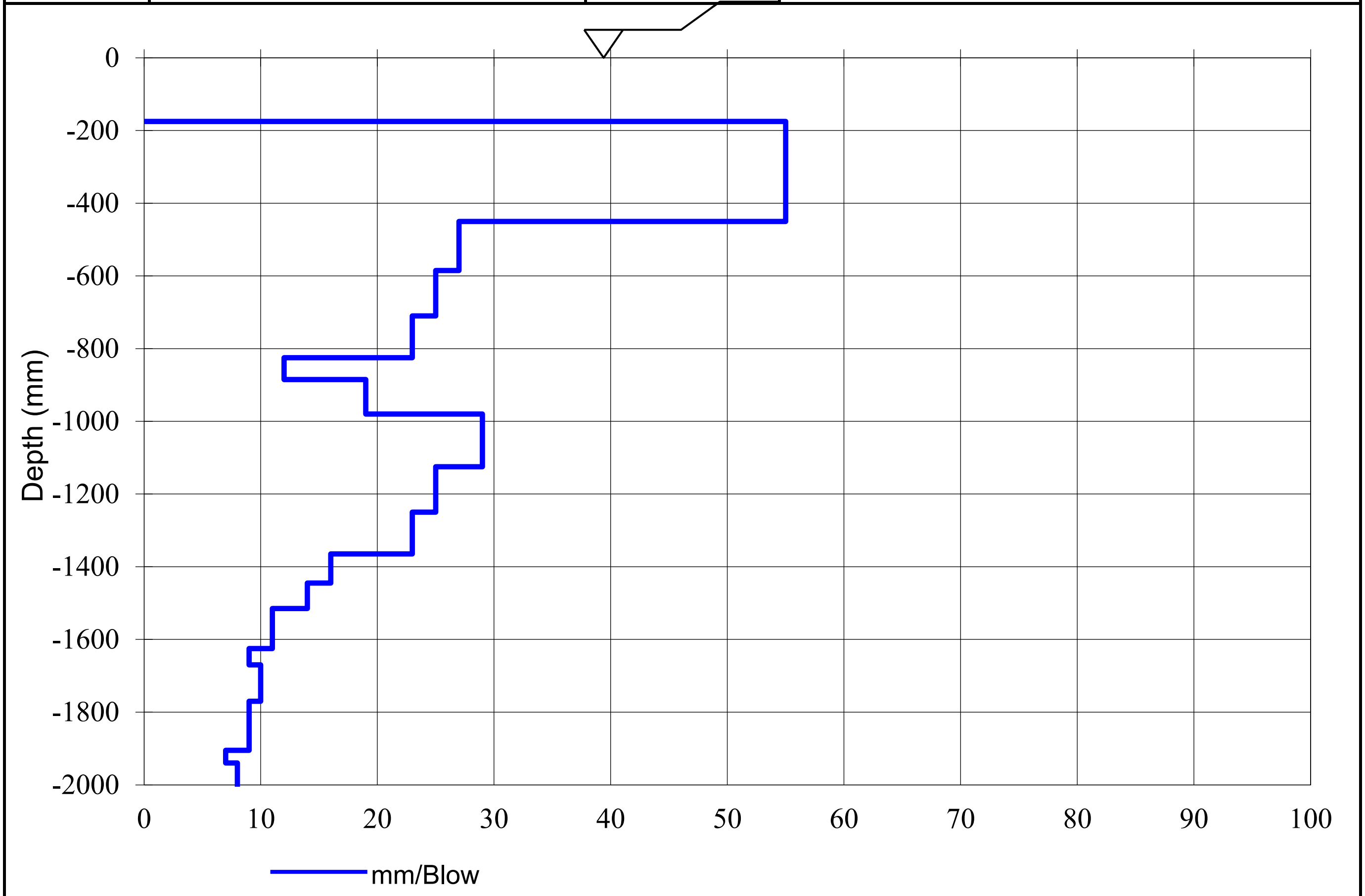
		Date Received :	27.10.2023
		Date Reported :	14.11.2023
		Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	7 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP7	Datum Level:	NGL



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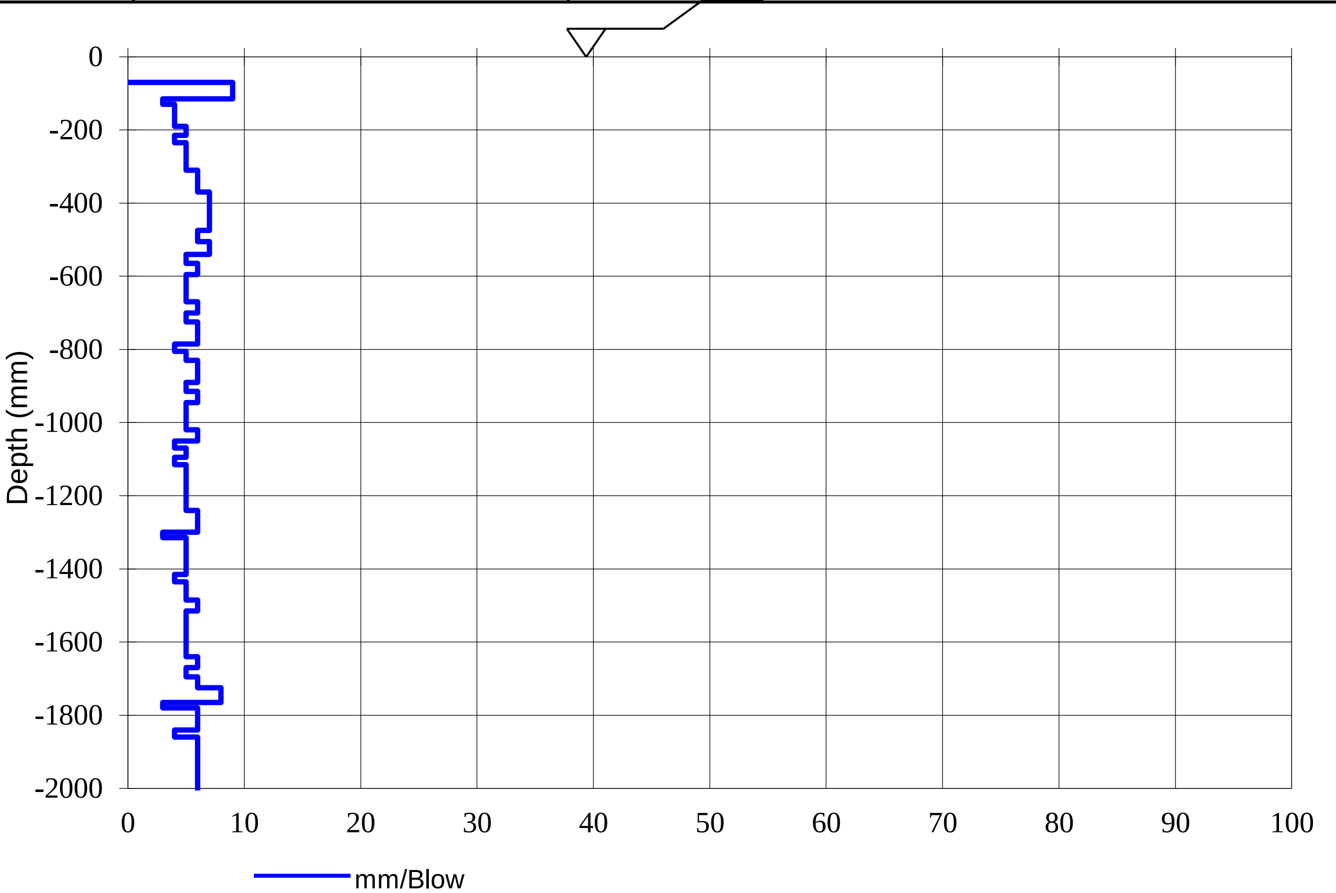
	Dormehldrift George 6529	Req. Number :	
Attention :	Koenraad Potgieter	No. of Pages :	8 of 8

TEST REPORT

Dynamic Cone Penetrometer (DCP) - (TMH 6 Method ST6)

Position:	TP8	Datum Level:	NGL



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For Outeniqua Geotech. Services cc.
Technical Signatory

DESIGN FLOW CALCULATIONS
(Section K.4 - Red Book 2019 [method (iii) Sewer flow and peak factor method]

FULL DEVELOPMENT (ALL ERVEN)

SEWER FLOW:

	Area ha	density units/ha	Land Use Res.	Unit Hydrograph	Unit Q kl/d/unit	Erven No.	PDDWF kl/day	PF 2	IPDWF kl/day
Old Brick Area	61,9	6,7	Low Cost , High Density	UH4	0,29	412	119,5		239,0
Thembalethu Area 2	5,0	50,3	Low Cost , High Density	UH4	0,29	250	72,5		145,0
Thembalethu Area 5 - 6ab	68,0	13,9	Low Cost , High Density	UH4	0,29	152	44,1		88,2
						814	236,1		472

GROUNDWATER INFILTRATION:

	inf rate L/min/m/mØ	Unit	pipe /erf T K.11	Pipe Length m	Pipe Ø m				INF FLOW kl/day
Old Brick Area	0,03	UH4	10	4120	0,2				35,60
Thembalethu Area 2	0,03	UH4	10	2500	0,2				21,60
Thembalethu Area 5 - 6ab	0,03	UH4	10	1520	0,2				13,13
									70

DESIGN FLOWS:

	IPDWF kl/day	INF FLOW kl/day	TOT kl/day	IPWWF kl/day					IPWWF l/s
Old Brick Area	239,0	35,60	274,6	392,2					4,5
Thembalethu Area 2	145,0	21,60	166,6	238,0					2,8
Thembalethu Area 5 - 6ab	88,2	13,13	101,3	144,7					1,7
	472,1	70,33	542,4	612,8					9,0

PROJECT DATA

Project Name:	THEMBALETHU BULK SEWER PHASE 3 AND 4 - PORTION 2
Project Number	1762
Pipe Description:	BULK LINE
Analysed By:	Siviwe Kulu
Date:	10-Apr-24
File Path:	P:\GG\1762 Thembalethu Bulk Sewer Phase 3 and 4\04 Design & Drawings\05 Sewer\Design Flows\1762_Circular Partial Pi

INPUT

Pipe Material:	uPVC	
Pipe Internal Diameter:	188,2	mm
Pipe Slope:	0,67	%
Mannings "n":	0,009	
Required Flow:	13,50	l/s

HYDRAULIC OUTPUT

Required Flow	13,50	l/s	Wetted Perimeter	0,275	m
Calculated Flow	13,49	l/s	Flow Area	0,012	m^2
Velocity	1,126	m/s	Specific Energy	148	mm
Flow Depth	84	mm	Froude Number	1,42	
Flow Depth / Pipe Dia.	45	%	Flow Type	Supercritical