TENDER DOCUMENT

BID No: ALMT 14/2025

THE CONSTRUCTION OF EMPULUZI/METHULA BULK WATER SUPPLY SCHEME IN CHIEF ALBERT LUTHULI LOCAL MUNICIPALITY, PHASE 1, EMPULUZI DAM

SITE INFORMATION AND GEOTECHNICAL REPORT

ISSUED BY	PREPARED BY
MUNICIPAL MANAGER	**CLIENT REPRESENTATIVE**
CHIEF ALBERT LUTHULI MUNICIPALITY PRIVATE BAG X719 CAROLINA 1185	KUFANIKIWA CONSULTING 11 DERBY PLACE, DERBY DOWNS OFFICE PARK, FOREST SQUARE, UNIT 6, WESTVILLE, 3630
Tell: +27 17 843 4000 Fax: +27 17 843 4001	Tell: 031 701 1038 Fax: 031 701 0963

***CIDB GRADING*: 9CE**

REGISTERED NAME OF TENDERER: _____

_____

CLOSING DATE: **10th JULY 2026** TIME: **12H00**

SITE INFORMATION AND GEOTECHNICAL REPORT

PART C4 : SITE INFORMATION

C4 SITE INFORMATION

C4.1 Nature of Ground

Empuluzi is underlain underlain primarily by the ancient, highly stable granites and gneisses.. The bedrock is dominated by the Mpuluzi Batholith. The information given is intended as a guide to the Tenderer, who must make his own independent assessment as to the nature of the ground conditions. The tender must refer to the geotechnical report

The Tenderer will be permitted to excavate trial holes in the area of the works at his own expense provided that they are properly safeguarded and reinstated. Should the Tenderer wish to excavate his own trial holes; he shall first ascertain, in conjunction with the Engineer, the position of any underground services, which may exist in the area. The Tenderer shall indemnify the Municipality against the cost of repairing any underground services damaged by the Tenderer or his agents, while carrying out such excavations.

C4.2 Spoil Material

No indiscriminate spoiling of material will be allowed. All unsuitable or surplus material shall be spoiled off site to a spoil site/municipal dump, chosen by the Contractor.

C4.3 Finishing – off the Site

The site shall be finished-off in accordance with the specifications as well as to the requirements of all applicable environmental standards.

C4.4 Existing Services

Although every effort has been made to depict existing services (water mains, electric cables, telephone cables etc.), as accurately as possible on the contract drawings, insofar as they are known, variations do arise and the Contractor shall exercise extreme care when working in the area. Items have been allowed in the Schedule of Quantities for dealing with and protecting services.

The Contractor shall take whatever precautions are required to protect these services from damage during the period of the Contract.

C4.5 Proving of Underground Services

It is stressed that all services in a particular area must be proven before commencing work in that area.

Insofar as bulk earthworks are concerned, where services are indicated on the drawings or where from site observations can reasonably be expected that such services are likely to exist where excavations are to take place, the Contractor shall without instructions from the Engineer carefully excavate by hand to expose and prove their positions.

When a service is not located in its expected position the Contractor shall immediately report such circumstances to the Engineer who will decide what further searching or other necessary action is to be carried out and shall instruct the Contractor accordingly.

Should any service be damaged by the Contractor in carrying out the works, and should it be found that the procedure laid down in this clause has not been followed than all costs in connection with the repair of service will be to the Contractors account.

Proving of services shall be completed at least two weeks in advance of the actual programmed date for commencing work in the area. The position of these services located must be co-ordinated and levelled by the Contractor, and the information given in writing to the Engineer’s representative.

The requirements of this clause do not relieve the Contractor of any obligations as detailed under the General Conditions of Contract or the Special Conditions of Contract.

ENGEOLAB (PTY) LTD

Reg. No. 2017/536405/07 VAT Reg. No. 4710205925

Directors: P.G. Hansmeyer *Pr.SciNat*; G.N. Choma

Branches: Gauteng_Pretoria / KZN_Mtunzini / Mpumalanga_eMalahleni

Contact: Enquiries - info@engeolabcc.co.za
Finances - finance@engeolabcc.co.za / 082 800 2245
Sales - paul@engeolabcc.co.za / 082 881 5370

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VOLUME 6A

REPORT ON THE QUARRY & DAM BASIN SITE's GEOTECHNICAL INVESTIGATION FOR THE PROPOSED EMPULUZI/METHULA BULK WATER SUPPLY SCHEME

Gert Sibande District Municipality

Vumesa Pty - Ltd

INGEROP *Inventing for tomorrow*

Project:	**LL3876**
Date:	**SEPTEMBER 2024**
Version:	**Version 1**
By:	**P.G. Hansmeyer *Pr.Sci.Nat.***
Technical Advisor:	**J.J. Christensen *Pr.Sci.Nat.***

EXECUTIVE SUMMARY

This report presents the geotechnical investigation carried out on the quarry and dam basin sites in 2023/2024 for Vumesa Ingerop SA JV on behalf of Gert Sibande District Municipality for the Empuluzi/Methula Bulk Water Supply Scheme, Phase 1, a new municipal water supply dam near Oshoek, Mpumalanga Province.

The quarry and dam basin sites investigated are located on the farm Caithness 239 IT located between Mpuluzi and Fernie villages, in close proximity to the Swartwater - and Mpuluzi River confluence, at southings 26°21'05.9"S and eastings 30°48'26.9"E. Two alternative routes from the tar road between Fernie and Mpuluzi have also been identified. These routes are much shorter than the main access road from Fernie to the site.

The area investigated is underlain by ancient granite associated with the Mpuluzi Batholith which covers quite a large area extending from beyond Fernie and Mpuluzi into Eswathini. The granite bedrock is characterised by randomly scattered pegmatite, aplite, and to a lesser extent quartz veins and has been intruded by a number of diabase dykes exposed along the fringes of the Swartwater – and Mpuluzi Rivers.

Unconsolidated Quaternary alluvium predominantly comprising fairly coarse silty sand partially blankets the flood plain and the upstream surfaces of the confluence area and most of the Mpuluzi River's left flank. The alluvium is absent along the banks of the Swartwater River, which is rather narrow, deep (>2m) and relatively fast flowing.

A walk-over survey was conducted to determine accessibility, potential hazards and to obtain a general overview of the two proposed quarry sites and the dam basin. Aerial photographs and a hand-held GPS were used during the walk-over survey to assist in the site orientation. This was supplemented with additional walk-over surveys, test pitting as well as geotechnical drilling and a seismic survey on the main Quarry A site. An airborne magnetic survey was also carried out.

The main concern on the development of a quarry site was the blast effect on the weir site some 300m downstream from Quarry A and the potential harm to people residing in the immediate area and their livestock. The blast effects were assessed by an explosives engineer and by following their recommendations, the effect and hence control of the quarry development should be manageable.

Twenty test pits were excavated within the quarry and dam basin area and twenty representative soil samples were taken for analyses by a civil engineering laboratory.

Eight diamond core boreholes were drilled to depths ranging from 10 to 20m and a range of weathering from decomposed to slightly weathered to fresh, granite, pegmatite and pegmatite-granite mixes were encountered. Drill cores were selected for mineralogical analyses, rock strength testing, the assessment of coarse aggregate characteristics for concrete mixes as well as concrete strength tests. Although up to 75% of the granite, granite-pegmatite mixes and pegmatite comprises silica, it did not initiate aggregate-cement reactions.

On completion of the diamond core drilling, the boreholes were marked with white coated concrete plinths with 50mm diameter PVC standpipes and the water levels were recorded on three occasions.

After a thorough inspection of potential fine aggregate sources required for concrete mixes and filter sand on site, it was found that the local deposits may be suitable for concrete mixes and filter sand, but sieving and crushing will be required to accommodate the dominating coarser sand fraction.

A source of good quality road building material is located in the central section of the dam basin but will require hard ripping to excavate and grid rolling once placed.

A water sample taken at the confluence of the Swartwater – and Mpuluzi Rivers, was chemically analysed and found to comply with the requirements for concrete mixes; however the turbidity levels of the river water will increase during flood periods.

Geophysical surveys comprising single channel refraction seismic traverses and drone-flown, airborne magnetic surveys were also carried out, highlighting areas that require additional attention.

A preliminary risk assessment was undertaken to investigate potential geotechnical hazards and quantify their risks to the immediate and long-term success of the project. The primary geotechnical risks identified include: -

- possible rockfalls/collapses from upslope granite outcrops,
- flooding of access roads during high rain fall periods;
- inadequate supplies of construction materials;
- a zone of deep weathering detected along the south-western portion of the quarry site;
- possible diabase intrusion(s) in eastern portion of quarry site, resulting in breaks in mining continuity;
- overtopping by the Swartwater River and flooding of the quarry;
- mining of fine aggregate challenges on Mpuluzi River's left flank where a shallow perched water table prevails and excavations have very short stand-up times, and; -
- inadequate blast preparations and planning, causing harm to residents and livestock and damaging the weir's foundations, unless properly mitigated against.

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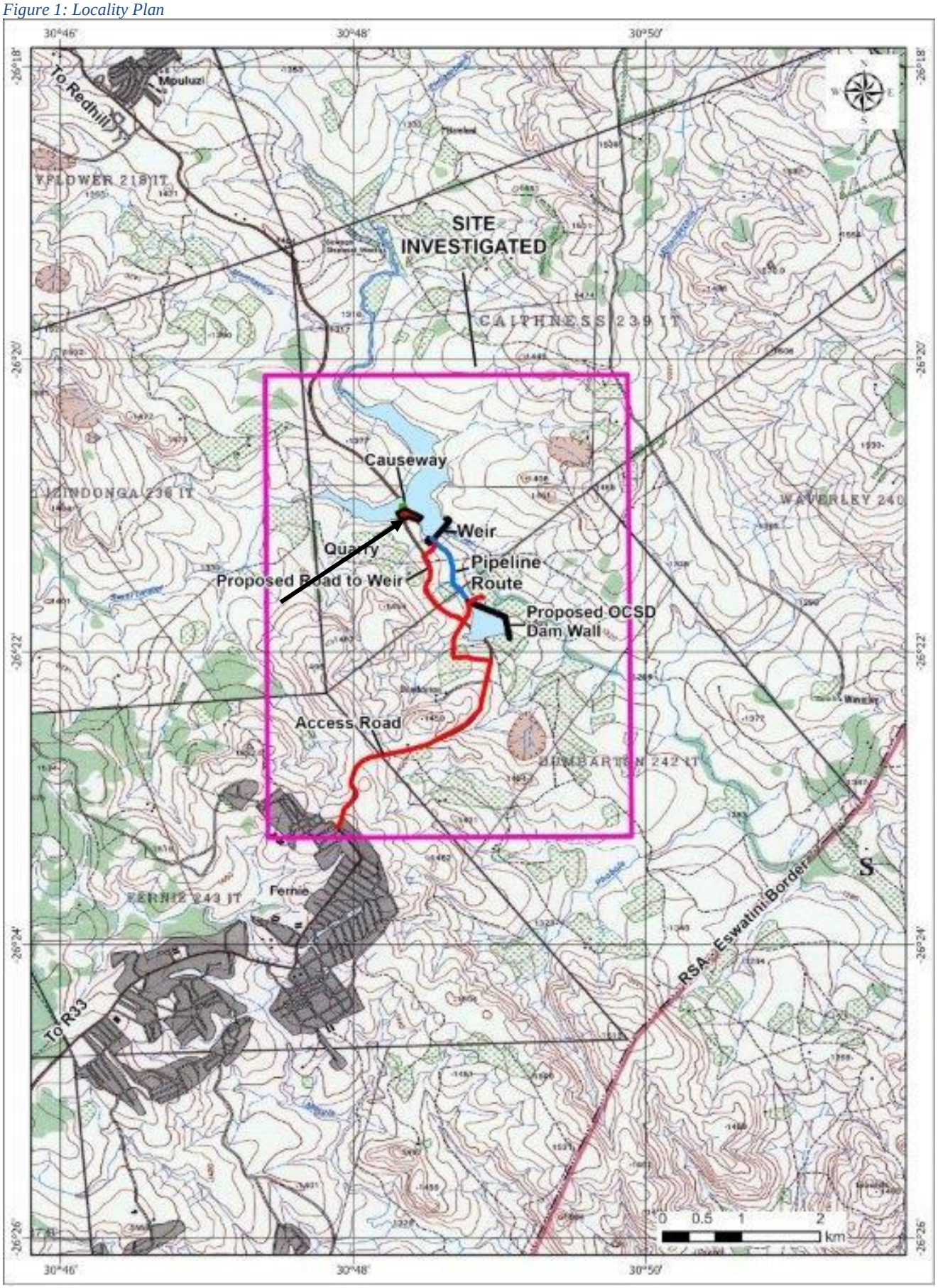
Figure 1: Locality Plan



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VOLUME 6A

REPORT ON THE QUARRY & DAM BASIN SITE's GEOTECHNICAL INVESTIGATION FOR THE PROPOSED EMPULUZI/METHULA BULK WATER SUPPLY SCHEME

1. INTRODUCTION

This report presents Volume Six of the geotechnical investigation carried out in 2023/2024 for Vumesa Ingerop SA JV on behalf of Gert Sibande District Municipality for the Empuluzi/Methula Bulk Water Supply Scheme, Phase 1, a new municipal water supply dam near Oshoek, Mpumalanga Province.

The quarry site investigated is located on the farm Caithness 239 IT and in close proximity to the Swartwater - and Mpuluzi River confluence, upstream and on the right flank from the proposed weir site on the Mpuluzi River. The dam basin essentially encompasses an area of some 20ha that will be flooded upstream from the weir including the confluence as indicated on the Locality Plan, Figure 1 in the beginning of the report. The site is located at southings 26°21'05.9"S and eastings 30°48'26.9"E.

The report and appendices are presented in this document as Volume 6A, while the drawings are contained in a separate booklet as Volume 6B.

1.1 Scope of Work

The proposed scope of work to be undertaken for this part of the investigation included the following two sites: -

❖ QUARRY SITE: -

- excavation of 10 test pits on the proposed quarry site;
- drilling of 8 vertical geotechnical boreholes at the quarry site to confirm the geology and the volume and quality of concrete aggregate available;
- mineralogical testing on the drill cores to confirm the granitic rock types recorded in the borehole cores;
- determine the intact rock strength;
- obtain coarse aggregates from the crushed drill cores as well as fine aggregate sampled within the dam basin on the banks of the Mpuluzi River for concrete trial mixes and to verify their volumes and suitability as course – and fine aggregates required for concrete mixes;
- assess the potential impact of the blasting activities on the weir and areas surrounding the proposed quarry development.

❖ DAM BASIN: -

- excavation of 10 test pits on the dam basin site – that is 5 within the confluence area between the Swartwater – and Mpuluzi Rivers and 5 on the left flank of the Mpuluzi River;

- aerial photographic interpretation and ground-truthing by means of walk-over surveys to confirm the geology and the potential volume and quality of fine aggregate available as well as construction materials encountered;
- to verify the water quality and the suitability of the perennial Mpuluzi River's water for concrete mixes.

1.2 Objectives

The quarry site is located approximately 170m upstream of the weir centreline and west of the confluence of the Mpuluzi - and Swartwater Rivers, both of which originate in the hills to the north-west of the villages of Fernie and Mayflower.

The objectives of the site investigation were to establish the availability, quality and quantity of on-site construction materials for the weir as well as the impact of the blasting at the proposed quarry site as set out below: -

i) Determine the distribution of the site soils and bedrock types and establish the depth to bedrock where possible;
ii) Evaluate the engineering properties of the quarry rock materials and their suitability as well as quantities for the proposed construction;
iii) Evaluate the engineering properties of the fine aggregates and their suitability as well as quantities for the proposed construction;
iv) Evaluate the engineering properties of road building materials and their suitability as well as quantities;
v) Determine the impact of quarry blasting on the concrete weir structure, which at its nearest is only some 200m from the southwestern corner of the quarry;
vi) To confirm the water quality of the Mpuluzi River for concrete mixes;
vii) Establish the presence of on-site or near-site diabase dykes/sills.

1.3 Available Information

Information was obtained from the following sources: -

i) Topographical map of the area published in 1969, to a scale 1:50 000;
ii) Garmap SA Topographical map of the area;
iii) Mbabane geological map published in 1986, sheet 2630 to scale of 1:250 000;
iv) Satellite Images in digital format from Google Earth © 2016;
v) Survey data of the proposed site supplied by E. Geerdts of Topocad Surveyors.

1.4 Site Detail

Two quarry sites were proposed within the dam basin – that is a centrally located quarry between the two rivers just above the confluence, and a second quarry located upslope on the right flank of the Swartwater River, to the west of the confluence with the Mpuluzi River - refer to Figure 2A, the Site Plan, Volume 6B.

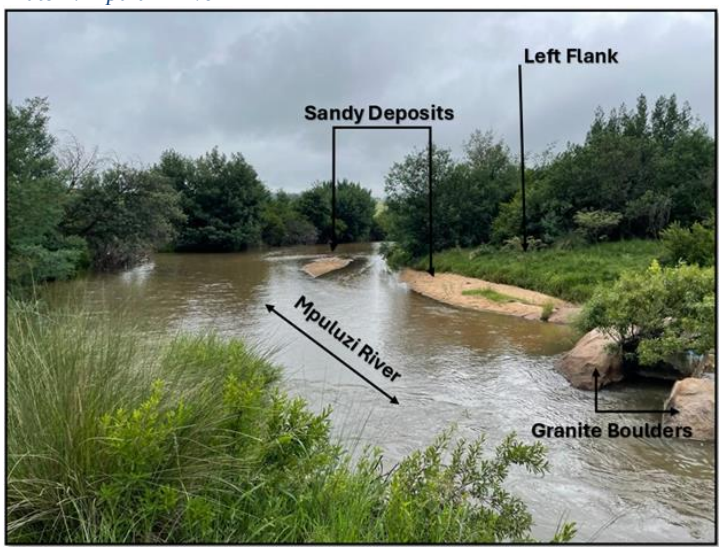
Current access to the dam basin and quarry sites is via the historical gravel road from Fernie to Mpuluzi which had become redundant after the causeway over the Swartwater River was washed away some time ago – refer to Plate 1 on the following page.

Plate 1: Causeway over Swartwater River

In comparison to the undulating and steepening side flanks of the dam site in the vicinity of the weir, the dam basin slopes gently upwards from the confluence, characterised by whaleback outcrops with a localized and fairly large deposit of hardpan ferricrete in the central section where groundwater seeps emanate on top of the hard, impermeable granite – refer to Figure 2B, Site Plan, Volume 6B.

The Mpuluzi River's left flank upstream from the confluence is blanketed by fairly thick (up to 3.3m) deposits of alluvial silty sand covered by thick stands of wattle trees – a handy tell-tale sign of the sandy riverine deposit's distribution – refer to Plate 2 below. These alluvial deposits are characteristically flat and at times fairly broad, usually extending from the river's edge up to the granite outcrops that line the left flank.

Plate 2: Mpuluzi River



1.5 Quarry Site Selection

The two proposed quarry sites are characterised by granitic outcrops with a thin and scattered soil cover, are fairly accessible but could be affected by flood waters. The larger of the two proposed quarry sites (Area B) which covers an approximate area of some 35,000m² is located on the upslope area above the confluence, with Quarry A just slightly smaller at 25,000m², is located on the right flank of the Swartwater River, just above the confluence with the Mpuluzi River and about 300m

from the weir's centre line – refer to Figure 2A. Both sites are located below the full water level of the dam.

Quarry site A was chosen on the grounds of the planned access road between the OCSD site and the weir and also it's year-round accessibility whereas Site B's access over the Swartwater River may be a problem during the rainy season. Two alternative routes from the tar road between Fernie and Mpuluzi have also been identified. These routes are much shorter than the main access road from Fernie to the site – refer to Figure 2C, the Site Plan – Alternative Routes, Volume 6B.

The proposed quarry is to be located upstream and on the right flank of the Swartwater River, opposite the confluence and below the full supply level of the dam. The proposed quarry site – that is Quarry A - has an undulating and steepening right flank characterised by typical whaleback granite outcrops. The site is covered mostly by grassland with scattered to abundant alien vegetation and indigenous riverine scrub along the Swartwater River.

Besides the weir itself which will be located about 300m south-east of the centre of Quarry A, there are some smallholdings in the area – the closest 650m to the south and the furthest 1650m to the north-west. As drilling and blasting will be required to develop the quarry, the possible impact of the blasting operations on the surrounding areas, the inhabitants, their dwellings and their livestock will have to be considered.

2. GENERAL GEOLOGY

Information regarding the regional geology was obtained from the published geological map, Mbabane 2630 – refer to Figure 3, Geology. The area investigated is underlain by ancient granite associated with the Mpuluzi Batholith which covers quite a large area extending from beyond Fernie and Mpuluzi into Eswathini.

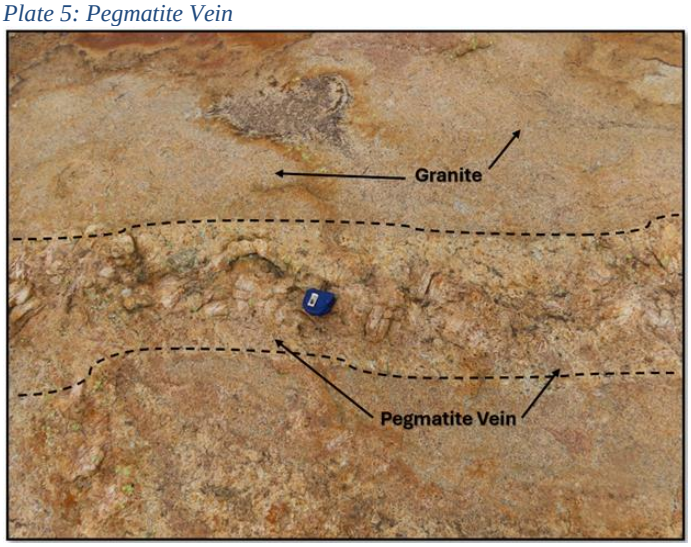
Generally, the granitic landscape comprises scattered whalebacks of solid granite sloping towards the two drainage courses, interspersed with scattered outcrop of randomly stacked boulders – Refer to Plates 3 and 4 below.

Plate 3: Granite Boulders

Plate 4:Granite Whaleback

The granite bedrock is characterised by randomly scattered pegmatite -, aplite -, and to a lesser extent quartz veins – refer to Plate 5 on the following page. A single, 5mm wide shear zone was mapped on the bedrock exposed at the confluence.

Plate 5: Pegmatite Vein



The photographic record of borehole Q6 presented by Plate 6 on the following page is a typical example what the pegmatite-rich granitic bedrock appears like in a vertically orientated, 20m deep diamond core borehole. The bedrock with an average density of 2.62g/cm³ is described in more detail below.

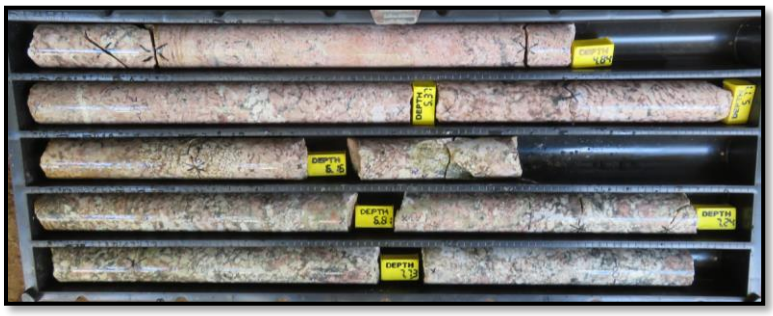
- **Granite** is a coarse-grained intrusive igneous rock composed mostly of quartz, alkali feldspar, and plagioclase. It forms from magma with a high content of silica and alkali metal oxides that slowly cools and solidifies underground.
- **Aplite** is an intrusive igneous rock that has a granitic composition, are fine-grained to aphanitic and may consist of only quartz and feldspar. They are associated with the later stages of many larger intermediate to felsic intrusions.
- **Pegmatite** is an igneous rock showing a very coarse texture, with large interlocking crystals usually greater in size than 1 cm and sometimes greater than 1 meter. Most pegmatites are composed of quartz, feldspar, and mica, having a similar silicic composition to granite.

For example, in borehole Q6 below the granite is typically more grey and medium grained, while the pegmatite is quite "pink", due to the abundance of feldspar, while the pegmatitic granite is a combination/blend of the two. See a section of the borehole log below where GR denotes granite; PEG denotes pegmatite and PGR denotes pegmatitic granite.

Interval / Sub-interval From0 (m)	Interval / Sub-interval To (m)	Lithology Code	Fabric / Texture
0.00	1.21	GR	C
1.21	3.81	PGR	VC
3.81	6.16	PEG	VC
6.16	10.85	PGR	VC
10.85	16.60	PEG	VC
16.60	18.70	GR	C
18.70	20.05	PGR	VC

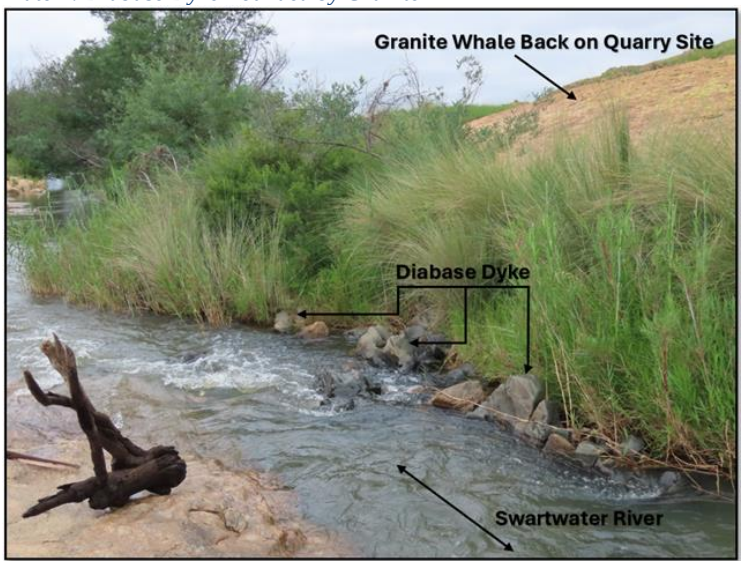
The purpose of distinguishing between the granite types, was in case the alkaline silicate reactions differed, but this was not the case from the laboratory test results.

Plate 6: Geotechnical Borehole Q6

BOX 1 of 5 _ Depth (m): 0.00 – 4.11	
BOX 2 of 5 _ Depth (m): 4.11 – 7.73	
BOX 3 of 5 _ Depth (m): 7.73 – 11.82	
BOX 4 of 5 _ Depth (m): 11.82 – 16.08	
BOX 5 of 5 _ Depth (m): 16.08 – 20.05	

An intrusive diabase dyke, striking south-east and partially obscured by the reed beds and wattle tree saplings occurs along the right flank of the Swartwater River, extending from the causeway towards the confluence, ostensibly pinching out against a granite whaleback – refer to Plate 7 below.

Plate 7: Diabase Dyke Bounded by Granite



Another diabase dyke, characterised by dark grey oblong boulders imbedded in the surface was recorded to the south of the quarry, striking north-west – refer to Figure 2B, Site Plan, Volume 6B. The deep weathering (9 – 10m) encountered along the westerly edge of the proposed quarry is seemingly associated with this diabase dyke.

Unconsolidated Quaternary alluvium predominantly comprising fairly coarse silty sand partially blankets the flood plain and the upstream surfaces of the confluence area and most of the river's left flank where the shallow (~1.0m) Mpuluzi River flows sluggishly over a broader plain. The alluvium is absent along the banks of the Swartwater River, which is rather narrow, deep (>2m) and relatively fast flowing in the section between the causeway and the confluence with the Mpuluzi River.

Due to the generally high-energy depositional environment, clays are mostly absent in the stream beds and for the largest part only present in the matrix within the downstream layered alluvial gravels.

The cover soils are rather thin and widespread between the granitic whalebacks which characterise the quarry area and upslope dam basin areas. The omnipresent outcrops on the proposed Quarry A site seem to pinch out in the western portion of the quarry, where bedrock is present within a depth range of 8.5 – 9.0m – refer to boreholes Q1 and Q2 presented on Figure 4, Profiles, Volume 6B.

Hardpan ferricrete - a dark brown superficial deposit is present in the upper reaches of the confluence area and covers an area of about 1.5ha – refer to Figure 2B, Site Plan, Volume 6B. Ferricrete is typically associated with an iron-rich source, in this case likely the diabase dykes.

The study area has a climatic N-value of about 2.0 Weinert, 1967[REF.1], consequently the main mode of weathering of bedrock is by means of chemical decomposition. However, due to the local setting, the weathering patterns of the granite and diabase have also been influenced to a large extent by mechanical weathering by the Mpuluzi - and Swartwater Rivers.

3. METHODS OF INVESTIGATION

3.1 Walk-Over Survey

A walk-over survey in March 2024 was conducted to determine accessibility, potential hazards and to obtain a general overview of the two proposed quarry sites and the dam basin. Aerial photographs and a hand-held GPS were used during the walk-over survey to assist in the site orientation.

This was supplemented with additional walk-overs, test pitting as well as geotechnical drilling and a seismic survey in on the Quarry A site. Attention was also given to the quarry's left flank in close proximity to the Swartwater River and the steeper upslope sections along the quarry's right flank. Features reminiscent of ancient rock falls and landslides were not observed and talus is rather thinly spread.

The hardpan ferricrete deposit in the upper reaches of the confluence area was also included as a possible source of good quality road building material.

3.2 Blast Assessment

The main concern on the development of a quarry site was the blast effect on the weir site some 300m downstream from Quarry A and the surrounding area where there are some dwellings and cattle and goats which roam the area. Cambrian CC, from Irene, Pretoria - a geotechnical firm specializing in blast assessments and risks has assessed the quarry sites and conducted a blast evaluation. Their correspondence is attached as Appendix A to the report. The assessment focused on the following aspects: -

i) Prediction of ground vibration for increasing charge mass at various distances;
ii) Prediction of air blast as above and; -
iii) Assessment of unwanted side effects such as fly rock, post blast fumes and dust.

3.3 Test Pitting, Profiling, Soil Sampling and Laboratory Testing

Twenty test pits were excavated within the dam basin area, with 10 in the preferred quarry site (TPDB1 – TPDB10), five in the confluence area (TPDB11 – TPDB15) and another five on the left bank of the Mpuluzi River – refer to Figure 2B, the Site Map, Volume 6B. However, most of the test pits excavated on the quarry site and the central portions of the dam basin generally refused at fairly shallow depths on sound bedrock or indurated hardpan ferricrete. Test pits excavated within the alluvial deposits along the banks of the Mpuluzi River experienced sudden collapse at depths >1m in areas where a shallow water table prevails. The test pit profiles, attached as Appendix B to the report, were profiled in accordance with the visual and tactile guidelines for Soil and Rock Logging in SA[REF. 2]. Twenty representative soil samples were taken on which twenty road indicators and ten compaction tests were carried out by Letaba Lab (Pty)Ltd; a civil engineering laboratory based in Nelspruit. A summary of the test data (attached as cover page) and the test results is attached as Appendix C to the report.

3.4 Diamond Core Drilling

Eight diamond core boreholes (Q1 – Q8) were drilled by Geopractica (Pty)Ltd - a Durban based geotechnical drilling contractor. These boreholes were drilled to depths ranging from 10 to 20m and encountered a range of decomposed, slightly weathered to fresh, hard-rock granite, pegmatite and pegmatite-granite mixes from surface to borehole end-depth as tabulated by Table 3-4-1 on the following page.

The borehole profiles inclusive of the photographic records are attached as Appendix D to the report and are graphically presented by Figure 4, Borehole Profiles, Volume 6B.

Table 3-4-1: Summary of Quarry Borehole Depths

BH Number	BH Depth (m)	Rockhead Level Depth Range (m) Below Surface
Q1	14.6	8.5
Q2	15.1	9.0
Q3	20.3	3.9
Q4	11.7	2.5
Q5	10.2	1.5
Q6	20.0	0.1
Q7	20.0	3.6
Q8	10.2	0.4

3.5 Borehole Marking

On completion of the diamond core drilling, the boreholes were marked with white coated concrete plinths with 50mm diameter PVC standpipes – refer to Plate 8 below. The standpipes permit water level recordings to be carried out – the only drawback is that veld fires usually melt the standpipes.

Plate 8: Borehole Plinth with PVC Sleeve

3.6 Search for Fine Aggregate Required for Concrete Mixes

After a thorough inspection of potential fine aggregate sources required for concrete mixes on site, it was found that the local deposits along the banks of the Mpuluzi River and especially the left flank as well as the central area in the vicinity of the confluence with the Swartwater River predominantly comprise silt-sand mixes suitable for concrete mixes – refer to Figure 2B, the Site Plan, Volume 6B.

The alluvial deposits were mapped using a combination of test pits, aerial photographs and walk-over surveys. The more accessible sandy deposits within the confluence area were mined by small scale cement-brick manufacturers whilst the left flank where the main deposit occurs is still intact – mainly due to its inaccessibility.

The small deposit of ~100m³ on the northern boundary of the quarry just downstream from the causeway is intact which is attributed to its limited aerial distribution and being rather thin – that is 0.1m. A summary of the fine aggregate distribution is presented by Table 3-6-1 on the following page.

Table 3-6-1: Summary of Fine Aggregate Deposits in the Dam Basin Area

Section	Test Pit Distribution	Thickness (m)	Estimated Reserve (m^3)	Comments
Quarry area near causeway	DBTP10	0.1	100	Limited distribution
Confluence	DBTP11 & DBTP14	~2	800	Partially mined out
Mpuluzi River left bank	DBTP16	~3.3	648,000	Intact, but tree roots extend to at least 1.2m

Although not observed, mixes of clay, pebbles, gravels, cobbles and boulders in various concentrations and thicknesses may occur both up- and downstream from the sampled sites.

- ***Sampling and Laboratory Testing of Hardpan Ferricrete for Pavement Construction***: the central portion of the upper confluence area is overlain by a superficial deposit, some 0.2m thick of hardpan ferricrete, covering an area of about 1.5ha. The 24 tonne CAT excavator encountered some difficulty in penetrating the well cemented material and had to resort to a 'ripping' motion with the bucket to penetrate deep enough. A representative sample was taken and analysed and the material was found to comply with the requirements of G5 class pavement construction material suitable for construction of subbase layers[REF.3] – refer to Table 3-6-2 below. The estimated volume of this G5 class pavement construction material of hardpan ferricrete is about 15,000m^3. Note however, the ferricrete is well-cemented and hard ripping with a powerful dozer will be required and once placed, grid rolling will be required to pulverize the ferricrete boulders, chunks and tabular blocks into a workable sizes.

Table 3-6-2: Summary of Hardpan Ferricrete Material's

TP No.	Depth (m)	Material Type	Origins	Mod. Dry Density (Kg/m^3)	CBR @ 95% Mod.	G – Class*
DBTP15	0.0 – 0.8	Silt-clay-sand mixes	Ferricrete	2097	66	G5

- ***Sampling and Laboratory Testing of Fine Aggregate***: The fine aggregate (predominantly a silty sand) used for the concrete mix design comprises river sand deposited along the banks of the Mpuluzi River – see Plate 9 below. The soil test results had been summarized and are presented in terms of the plasticity, the material type (Unified Soil Class[REF.4]), grading modulus and sieve analyses pertaining to coarse and fine sand as well as silt and clay fractions as presented by Table 3-6-3 on the following page.

Plate 9: Sandy Deposit Distribution

Table 3-6-3: Fine Aggregate Characteristics

Section	Test Pit Distribution	Thickness (m)	Material Type	PI	GM	Mortar Analyses Coarse Sand % Fine Sand% Silt-Clay%
Quarry near causeway	DBTP10	0.2	Silty sand	SP	1.7	51; 20; 29
Confluence Area	DBTP11 DBTP12	0.9 ~2	Poorly graded sand Silty sand	NP NP	2.5 1.3	93; 06; 01 42, 38, 20
Mpuluzi River left flank	DBTP16 DBTP18	~3.3 ~2	Well graded sand Well graded silty river sand	NP NP	2.4 2.0	76; 22; 02 75; 17; 08

The two samples taken from the left bank of the Mpuluzi River where the main fine aggregate deposit is located, recorded well-graded 'clean' sand – that is there is no, or very little silt and clay and the samples are dominated by the coarse sand fractions which constitute up to three quarters of the sample – refer to Plate 10 below and Table 3-6-3 above. Overall, the test pits excavated along the two rivers revealed the same material type with variations in material size with the coarse sand fraction seemingly dominating the alluvial deposit – refer to Plate 11 below.

The confluence area is pockmarked by artisanal sand mining activities that are usually smoothed over by subsequent floods and the deposits between the causeway and the proposed quarry and the left flank of the Mpuluzi River are untouched.

Plate 106: Well-graded River Sand, DBTP16

Plate 11: Test Pit DBTP16, Left Flank, Mpuluzi River

❖ ***Sampling of Drill Cores*:** Drill cores were selected from the 8 diamond core boreholes drilled on the proposed quarry site for mineralogical analyses, rock strength testing, the assessment of coarse aggregate characteristics for concrete mixes as well as concrete strength tests. Photographic records of the cores and sampled sections of the various boreholes are attached to the report as 'Core Photographs', Appendix D.

The samples of granite, pegmatite and granite-pegmatite mixes were submitted to Rocklab and SGS Matrolab, both SANAS accredited laboratories based in Pretoria. The sample schedule is presented by Table 3-6-4 on the following page and the test data is respectively attached as Appendix E (Rocklab) and F (SGS Matrolab) to the report.

Table 3-6-4: Rocklab & SGS Matrolab Schedule

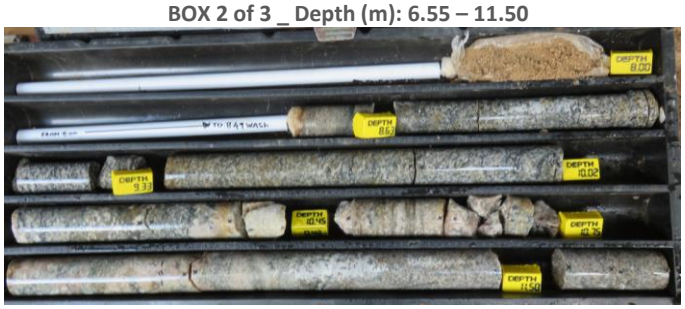
Lab	Borehole Sample No.	Sample ID Label	Lithology	Hardness Value	Weath Grade	Depth From (m)	Depth To (m)	Sample Length cm / m	Test Code
ROCK LAB	Q1	Q1/1	Granite	895	1	12.07	12.30	23	UCS
	Q4	Q4/1	Pegmatite	885	1	8.34	8.57	23	UCS
	Q5	Q5/1	Pegmatite-granite mix	890	1	7.07	7.30	23	UCS
		Q5/2	Pegmatite-granite mix	860	1	9.81	10.15	34	UCS
	Q6	Q6/1	Pegmatite	900	1	16.82	17.00	18	UCS
	Q7	Q7/1	Granite	895	1	7.59	7.78	19	UCS
	Q8	Q8/1	Granite	895	1	3.67	3.89	22	UCS
SGS MATROLAB	Q4	Q4/2	Pegmatite	885	1	2.36	11.70	9.11	AGG
	Q5	Q5/3	Pegmatite-granite mix	854	1	1.50	10.23	8.16	AGG
	Q6	Q6/2	Pegmatite	890	1	0.20	9.00	8.80	AGG
		Q6/6	Pegmatite	846	1	9.00	20.05	11.05	AGG
	Q7	Q7/2	Granite	865	1	7.10	11.10	4.00	AGG
		Q7/2	Granite	885	1	15.75	16.60	0.85	AGG
		Q7/3	Pegmatite	890	1	3.80	19.98	11.33	AGG
	Q8	Q8/2	Granite	863	1	0.32	10.13	9.59	AGG

As an example of the core sections that were selected and sampled, borehole Q1's photographic profile is presented by Plate 12 below and the 23cm long sample that was taken from the core in Box 3 of 3 extends from 12.07 to 12.30m.

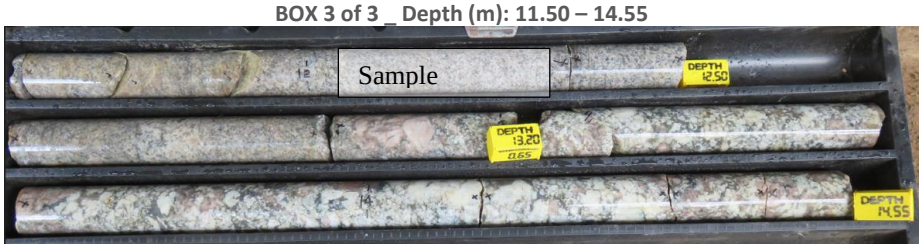
Plate 12: BH Q1 Core Boxes

BOX 1 of 3 _ Depth (m): 0.00 – 6.55

BOX 2 of 3 _ Depth (m): 6.55 – 11.50



BOX 3 of 3 _ Depth (m): 11.50 – 14.55



3.7 Water Sample

A water sample was taken at the confluence of the Swartwater – and Mpuluzi Rivers – refer to Plate 13 on the following page. The sample was submitted to Yanka Laboratories (Pty)Ltd, a SANAS accredited water laboratory based in Witbank, Mpumalanga. The results of the chemical analyses carried out on the 2L water sample are attached as Appendix G of the report.

Plate 13: Water Sample Taken at The Confluence

3.8 Static Water Level Recordings:

Static water levels of the eight boreholes drilled on the preferred quarry site were recorded on three dates, viz. 5 June, 10 June and 20 June 2024.

A summary of the recordings is presented by Table 3-8-1 below.

Table 3-8-1: Summary of Static Water Level Recordings: Boreholes Q1 – Q8

BH Quarry (Q) / BH Weir (W)	BH Depth (m)	BH Orientation	Static Depth (m) 5-6-24	Static Depth (m) 10-6-24	Static Depth (m) 20-6-24
Q1	14.6	vertical	5.30	5.66	5.89
Q2	15.1	vertical	3.84	3.93	4.30
Q3	20.3	vertical	6.89	7.00	7.70
Q4	11.7	vertical	4.00	4.75	4.86
Q5	10.2	vertical	3.27	3.30	4.00
Q6	20.1	vertical	8.14	8.29	9.20
Q7	20.0	vertical	3.90	3.71	2.70
Q8	10.2	vertical	0.50	0.60	0.70

Apart from Q7, which had seemingly reached a point of 'equilibrium', the remaining boreholes show an average decline of about 20% over the 2-week period, likely due to seepage of drilling water into the surrounding soils and rocks.

3.9 Geophysical Surveys

3.9.1Seismic Traverses

Geophysical surveys comprising single channel refraction seismic traverses, were carried out on the quarry site to determine the following: -

- The depth to bedrock especially in the areas not drilled, and; -
- The presence / absence of possible paleo-channels or other geophysical anomalies (including dykes, faults and/or major fracture zones).

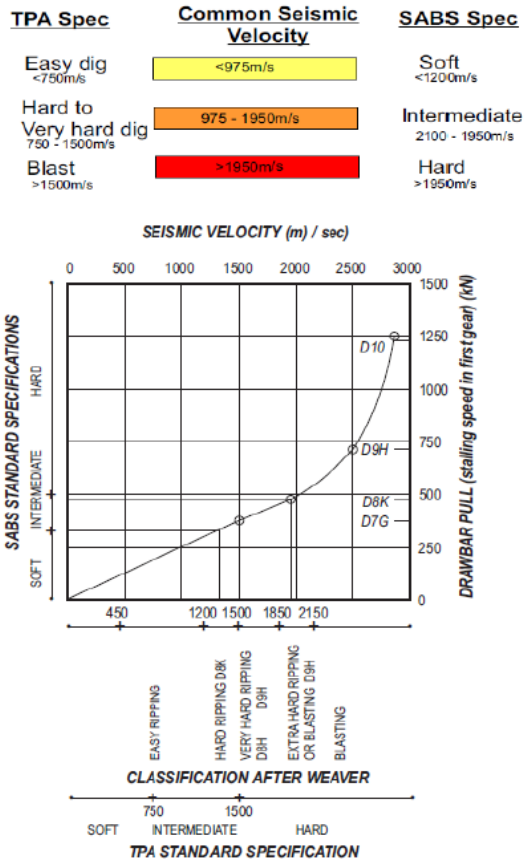
In order to supplement the understanding of the subsurface conditions, these geophysical surveys were conducted along the proposed quarry's central-southerly section - refer to Figure 5, Site Map - Seismic Surveys. This investigation comprised six seismic traverses and the graphs have been appended in Appendix H. A summary of the refraction seismic traverses is provided below: -

Table 3-9-1: Seismic Survey Results Summary

AVERAGE OF TYPICAL LAYERS IN QUARRY AREA

Overall Seismic Average*		*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*
Velocity	m/s	410	745	1915	3735
	Average depth (m)		1.4	4.6	11.2

Layer 1	410 m/s	Loose to medium dense sandy material	
Layer 2	745 m/s	Dense sand to very soft rock	*Easy rip*
Layer 3	1915 m/s	Very dense to soft rock	*V hard rip/blast*
Layer 4	3735 m/s	Very hard rock.	*Blast*

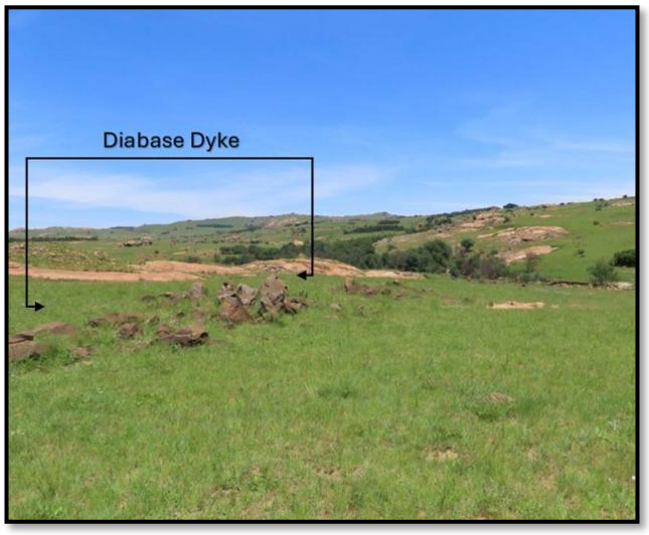


The differences between the traverses are due to undulations in the rock surface and deeper weathering in the westerly portion. The traverse locations were deliberately set out away from outcrop and where there were gaps in the drilling information. The closest borehole to a traverse was BH-Q5 located between traverses Q4F & Q4R (forward & reverse), which gave depths of 0.8m (overburden) and 3,2m to solid rock (blast rock), compared with BH-Q5 log - 0.8m overburden, 1.5m decomposed granite and 3.15m to solid, slightly weathered, hard rock granite.

3.9.2 Airborne Geophysics

The deep weathering exposed on the western portion of the quarry in close proximity to a diabase dyke – see Plate 14 below as well as another diabase dyke within the Swartwater River opposite the proposed quarry and a third diabase dyke outcropping in the Mpuluzi River on the weir's centreline motivated the implementation of an airborne magnetic survey, covering the quarry, the dam basin and the weir and also extending up to the OCSD site – refer to Figures 6A and 6B, Volume 6B. The survey was carried out by Geofocus, a geophysical practitioner based in Johannesburg.

Plate 14: Diabase Dyke Western Portion of Quarry



The drone-flown magnetic survey's data was superimposed on the quarry site, indicating a possible diabase intrusion in the easterly portion of the quarry, between boreholes Q6 and Q8, extending up to the southern boundary between boreholes Q5 and Q7.

The presence of an intrusion is also reflected in seismic traverses Q5 & Q6 on the dyke alignment, which show deeper rock depths, averaging 1.5m of cover soils and 5.4m to very hard rip/blast rock.

3.10 Laboratory Testing

3.10.1 Soil Mechanics Tests

The laboratory testing included tests on fine and coarse aggregates, concrete trial mixes, mineralogical and rock strength tests detailed as follows: -

- *Requirements for Fine Aggregate*:
  - The main requirements for sand to be used in concrete mixes such as grading, dust content and fineness modulus are summarized below (Owens G., 2009)[REF.5]. The results of the laboratory analyses are attached as Appendix C. The laboratory test data was summarised for convenience and is attached as a cover page to the laboratory test data.
  - Well-graded, 'clean' river sand which was sampled at two localities on the left flank of the Mpuluzi River upstream from the confluence is regarded as representative of the largest deposit on site which will most likely be exploited. The mortar analyses of both samples recorded the following: -
    i) a dominating coarse sand fraction;
    ii) a fine fraction within specification;

iii) acceptable dust fraction and: -

iv) a fineness modulus also within specification. The grading analyses was primarily used to determine proportions to be used in calculating concrete trial mixes that followed.

- Note that: -

i) fine sands with high dust content (as we have here with an average of 11% passing the 75µm sieve) are suitable for lean mixes. It must be noted that the influence of sand grading is significant in lean mixes which increases as workability increases of a fresh mix, and;

ii) the coarse sand fraction will have to be excluded by on-site sieving or alternatively, the coarse fraction should be crushed to an acceptable size.

Table 3-10-1-1: Main Requirements for Fine Aggregate in Concrete Mixes

Parameter	Requirement	Test Result	Remark
Grading	Not less than 90% shall pass the 4 250µm sieve and; - between 5 and 25% shall pass the 150µm sieve	11% 11%	Coarse fraction not within specification Fine fraction within specification
Dust content	The material passing a 75µm sieve shall not exceed 5%	1%	Dust content acceptable
Fineness Modulus (FM)	The FM shall fall within the range 1.2 – 3.5	2.3	Within specification

❖ *Requirements for Coarse Aggregate*:

The properties of aggregates can influence the physical properties of hardened concrete and for this reason the dimensional properties (flakiness), soundness and durability, grading (mainly to determine the proportions of materials in a trial concrete mix) were determined. The strength of concrete stone had to be assessed as well and these parameters are summarized by Table 3-10-1-2 below (Owen's G., 2009)[REF.5]. The aggregates were obtained from drill cores that were crushed in-house with a single phase jaw crusher and sieved. The laboratory test results are attached as Appendix F to the report.

Table 3-10-1-2: Main Requirements of Coarse Aggregates in Concrete Mixes

Parameter	Requirement	Test Result	Remark
Water absorption	<1% is deemed safe	0.2 – 0.3%	Within specification
Grading – nominal size of aggregate = 37,5mm	Mass material to pass sieves as follows: - Sieve (mm) %Mat Pass 50.0 100 37.5 85 - 100 28.0 0 – 50 20.0 0 – 25 14.0 0 - 5 0.075 0 - 2	Material passing 28mm, 20mm, 14mm sieve 100 100 77 – 90 46 – 50 28 - 37 Material passing 0.075mm sieve within specification (1.3)	Test results fall outside grading envelope due to the single phase jaw crusher used by the lab which creates different masses of material that pass various sieves as per 37,5mm nominal aggregate size

Parameter	Requirement	Test Result	Remark
Flakiness Index -28 +20mm -20 – 14mm	<35%	11.4 – 21.4%	within specification
Soundness	< 15%	0.12	within specification
Crushing Strength of Broken Rock %ACV (dry) 10% FACT (dry)	29% (maximum) 110KN (minimum)	21.3 – 22.0 % 120 - 140KN	within specification
Durability	Test data to give rough indication of long-term durability of an aggregate	Durability Index (DI) after 20 days = 0	Long-term durability excellent

❖ Alkali-Silica Reaction:

Alkali-Silica Reaction (ASR) associated with reactive components that may be present in the granite and granite-pegmatite mixes to be mined in the quarry include high percentage of visible quartz which consists primarily of silica. Laboratory XRF (X-ray Fluorescence) tests were carried out on three lots of core samples representing the 8 boreholes drilled on the quarry site. The test results showed that the rock samples have a relatively high silica content (ave. ~ 76%) which will be a determining factor on the strength, blastability and excavatability. The XRF test data is attached as Appendix I to the report.

Laboratory tests recorded an ASR value of <0.20% which is viewed as 'non-reactive' or 'innocuous' – refer to Table 3-10-1-3 below: -

Table 3-10-1-3: Most Widely Accepted ASR Criteria

% Criteria Limits	Comment	Quarry Aggregate ASR Value %
< 0.1	Innocuous/non-reactive	<0.2
0.1 – 0.2	Slowly reactive	-
≥ 0.2	Deleteriously reactive	-

❖ Drying Shrinkage and Wet Expansion of Aggregate:

Drying shrinkage contraction takes place in concrete when water is removed or lost within the structure of the hardened concrete. Shrinking aggregates that give rise to unacceptably high drying shrinkage are usually associated with sandstone, shale, mudstone and may also occur in basalt. The granite and granite-pegmatite mixes to be quarried are therefore not expected to exhibit this phenomena.

The test methods for identifying shrinking aggregates have an upper limit of 175% and the two test samples recorded 108.9% and 116.4% respectively – indicating that these aggregates have a low water requirement (absorption test results: 0.2 – 0.7%) and that drying shrinkage of the quarry aggregate is rather limited and will not influence concrete mixes.

Wetting expansion is the converse of drying shrinkage if concrete has undergone shrinkage through loss of moisture. When wetted, some shrinkage will be recovered and typically 50 – 70% of drying shrinkage is recovered. Repeated drying and wetting of concrete leads to micro-cracking of concrete. The average expansion of the test aggregate

at 108.9% of the reference indicate that aggregate expansion activities will have a negligible influence on concrete mixes.

❖ Concrete Cube Crushing Strength:

Using coarse aggregates obtained from crushed drill cores, fine aggregate sampled from the banks of the Mpuluzi River and PPC 42,5N Sure Build Cement, trial mixes were carried out to obtain the target concrete cube strength of 25MPa after 28 days. Cubes were crushed on 7, 14 and 28 days and cube crushing strengths of 22, 27 and 34MPa were recorded respectively. The test data is attached as Appendix J to the report.

It must however be noted that although the silica content constitutes as much as 75% of the samples used and tested, the ASR is 'non-active' and: -

i) the strength of the concrete in the laboratory is only an index or indication of the strength of the concrete to be used;
ii) aggregates with certain types of silica react adversely with high-alkali cements.

3.10.2 Rock Mechanics Tests

It will nevertheless be advisable to carry out excavation and blast trials to identify the optimum excavation method for the site rocks. The excavatability has been determined by using the rock mass condition (GSI) and Lilly's Blastability Index (Lilly, PA, 1986)[REF.6] - for each rock mass as described in the borehole logs – refer to the full Rock Mass Summaries in Appendix D.

Rock samples were taken from the drill cores of the 8 boreholes drilled on the quarry site for unconfined compressive strength tests. The results from all the strength test work undertaken is shown on Table 3-10-2-1 below. Note also that unusually high compressive strengths exceeding 200MPa were measured by the laboratory on the intact rock samples (YA) and this accounts for the 'Extremely Hard Rock' classification. The full laboratory rock mechanics test results are provided in Appendix E in this report.

Table 3-10-2-1: Summary of Laboratory Test Results on Rock Cores

UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS – MPULUZI QUARRY DRILL CORE SAMPLES									
BH	**Depth (m) From to**	**Lithology**	**Weathering**	**Leeb Hardness**	**Est Str Code**	**Density g/m³**	**UCS (MPa)**	**Failure Code**	**Rock Hardness Class**
Q1	12.07 – 12.30	Granite	unweathered	888	5.5	2.62	239.3	YA	EHR
Q4	8.34 – 8.57	Pegmatite	unweathered	891	5.5	2.61	161.3	XB	HR
Q5	7.07 – 7.30	Pegmatite-granite mix	unweathered	910	5.5	2.61	152.1	YA	HR
Q5	9.81 – 10.15	Pegmatite-granite mix	unweathered	900	5.5	2.63	223.7	YA	EHR
Q6	16.82 – 17.0	Pegmatite	unweathered	890	5.5	2.59	66.8	3B	S
Q7	7.59 – 7.79	Granite	unweathered	860	5.5	2.62	213.0	YA	EHR
Q8	3.67 – 3.89	Granite	unweathered	888	5.5	2.64	214.8	XA	EHR

WHERE **S** = strong rock; **HR** = hard rock; **EHR** = extremely hard rock

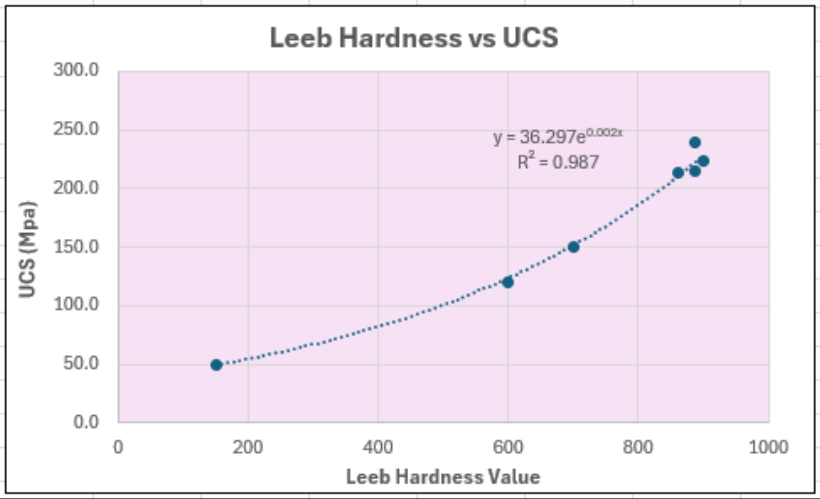
The intact rock strength results at the quarry were used to obtain a correlation between the hardness values obtained on the rock cores during logging and the predicted UCS strengths as obtained from the laboratory results - refer to Table 3-10-2-2 on the following page.

Table 3-10-2-2: UCS vs LEEB Hardness Correlation

Leeb Hardness	Est UCS (MPa)	
150	50.0	Typical values
600	120.0	Typical values
700	150.0	Typical values
860	213.0	Lab values
888	239.3	Lab values
888	214.8	Lab values
900	223.7	Lab values

Correlation Formula for Quarrry Granites

UCS = 36.3 x exp(0.002 x Leeb Val)



Note that the lower strengths were not recorded in the strong granite rocks at the quarry and that the lower Leeb values used in graphing are typical values from other sites for lower strength rocks. For example, a Leeb hardness of about 750 would equate to an unconfined compressive strength of approximately 160MPa.

As a general guideline, a rock with a UCS of >100 MPa is classed as a Hard Rock and a UCS of >200 MPa is classed as Extremely Hard Rock (ISRM Standard).

3.11 Water Quality Tests

- ***Specifications for concrete mixing water***: The quality of the mixing water in concrete can influence the setting time and strength development of concrete, as well as the protection provided to any reinforcement against corrosion. The water used for concrete should primarily be potable and therefore clean and free from deleterious materials, detrimental amounts of acid, alkali, sugar and any other organic substances; in addition, the TDS concentration should not exceed 150ppm. Other specifications include that the mixing water for concrete should not contain chlorides in the form of sodium chloride in excess of 500ppm for prestressed concrete; 1000ppm for concrete with reinforcement and 4,500ppm concrete without reinforcement. Sulphates occurring as sodium sulphate in excess of 2,000ppm are considered unacceptable (Owen's G., 2009)[REF.5]. Limits for the pH of mixing water should preferably range from 4 to 6, but up to 8 is still acceptable.

- **Sample analyses**: The water sample was chemically analysed and found to comply with Class 1 type water suitable for long term human consumption and as such is regarded as acceptable for use in concrete – refer to water analyses attached as Appendix G to the report. Some of the main constituents that may have an influence on the concrete strength and the setting time of concrete as reflected by the analyses of the water sample are presented by Table 3-11-1 on the following page, confirming that the mixing water is suitable for concrete – be it prestressed concrete, grout, and concrete with or without reinforcement (Owens, G., 2009)[REF.5].

Table 3.111-1: Summary of Concrete Mixing Water Parameters

Parameters	Result ppm	Fulton's Concrete Guidelines ppm	Remarks
TDS	46.5	<150	Considered as a 'pure water group' with no detrimental concentrations of salts that may reduce concrete strength
Chloride	4.25	500 1000 4500	Suitable for prestressed concrete & grout Suitable for concrete with reinforcement Suitable for concrete without reinforcement
Nitrate	<0.35	<500	No harm to concrete mixes
Sulphate	4.5	<2000	No harm to concrete mixes
Lead	Not tested	<100	No harm to concrete mixes

Notes: i) the turbidity values exceed the requirements for potable water but should not harm concrete mixes;
ii) the raw water sample is slightly corrosive.

4. GEOTECHNICAL EVALUATION

4.1 Blast Effects

The blast effect modelling results indicate that the disturbance levels that could be experienced at the various locations mentioned above may cause damage to structures located in close proximity to the operation – that is single storey structures with cement-brick walls constructed by local contractors within a radius of 300m from the quarry. As most of the structures are more than double the distance away from the quarry, the likelihood of damage is regarded as low. Provided that individual sequenced hole firing is applied and small charges are used, the blast induced seismicity will be properly controlled and no damage will be inflicted on the weir foundations, thereby creating a condition of 'no harm'.

4.2 SEEPAGE AND GROUNDWATER

- **Seepage – Quarry Area**: Despite seasonal seeps draining downslope along the granitic whalebacks which form the steeper southern boundary of the proposed quarry, seepage was only recorded in the 2.3m deep test pit DBTP10 at a depth of 1.8m. This particular test pit was excavated close to borehole Q4 and about 10m from the Swartwater River where excavation refusal was recorded on slightly weathered hard granite at a depth of 2.36m below surface level.
- **Seepage - Confluence Area**: In the confluence area, seepage was recorded at a depth of 1.4m in test pit DBTP14 which was excavated on the banks of the Mpuluzi River as well as at a depth of 0.8m in test pit DBTP15 which was excavated in the central, upper confluence section where refusal was recorded on a fairly large superficial deposit of hardpan ferricrete.
- **Seepage – Left Flank, Mpuluzi River**: Seepage was also recorded in areas blanketed by sandy alluvial deposits overgrown by thick stands of wattle trees along the Mpuluzi River's left flank. This alluvial deposit is characterised by a shallow water table, present at an average depth of 2m – more or less at the Mpuluzi River's level at the time of investigation (December 2023).
- **Static Water Levels of Quarry Boreholes**: The static water levels of the 8 vertical geotechnical boreholes drilled on the proposed quarry site 'A' were monitored over a short period in in June 2024 only – refer to Table 3-8-1, page 20. The static water elevations of the boreholes drilled along the river frontage – that is Q2, Q4, Q6 and Q8 were recorded at depths that are below the Swartwater River's elevation – refer to Table 4-2-1 below. Cognisance must also be taken of the fact that the static water elevations of boreholes Q4, Q6 and Q8 more or less correspond with the slightly weathered to unweathered, fresh sections of the drill cores which were either solid or displayed widely scattered singular fractures and joints.

Borehole Q2 is located in the deeply decomposed south-westerly section of the proposed quarry and recorded a static water level at least 3m below the Swartwater River's elevation, indicating that the weathered bedrock most probably pinches out towards the river and there is no connection between the river itself and this portion of the quarry.

The static water levels of boreholes Q4, Q6 and Q8 are 0.6 – 8.1m below the Swartwater River's elevation and similar to borehole Q2, this section of the quarry is seemingly unaffected by the Swartwater River. Borehole Q7's static water level has seemingly stabilized at 2.7m below surface level. This is attributed to seepage emanating from a possible diabase contact zone nearby.

Table 4-2-1: Static Water Levels of Boreholes in Relation to Swartwater River Elevation

BH No.	BH Elevation (m)	BH Static Water Level Elevation (m)	River[1] Elevation (m)	BH Water Level Below River[1]	Recorded Material Type	Fracture/Joint Frequency
Q2	1304.2	1300.4	1303	3.8	Sandy residuum	n/a but seemingly highly permeable
Q4	1301.1	1294.3	1300	6.8	Unweathered fresh rock	No fractures
Q6	1303.4	1295.3	1299	8.1	Unweathered fresh rock	Single fracture, single joint
Q8	1298.6	1298.0	1299	0.6	Slightly weathered	No fractures

Notes: River[1] : Swartwater River elevations along the northern boundary of the quarry

At the quarry, the groundwater flow direction appears to be northwards, draining at a hydraulic gradient of some 2% towards the Swartwater River, more or less emulating the topography of the site.

4.3 Concrete Aggregate

Concrete aggregate and rockfill material will have to be supplied from the quarry on the right flank of the dam basin. This would form part of the main construction contract or supplied through a separate contract, initiated earlier to avoid delays in materials supply. A summary of the boreholes drilled in the quarry area and their intersection depths with rippable and solid rock (requiring blasting) is provided in Table 4-3-1 below.

Table 4-3-1: Quarry Borehole Summary

BH No	BH Elevation (m)	BH Depth (m)	Rippable Depth (m)	Rippable Elevation (m)
Q1	1310.1	14.6	8.5	1301.6
Q2	1304.2	15.1	9.0	1295.2
Q3	1310.5	20.3	5.3	1305.2
Q4	1301.1	11.7	2.4	1398.7
Q5	1308.4	10.2	1.5	1306.9
Q6	1303.4	20.1	1.2	1302.2
Q7	1304.3	20.0	0.8	1303.5
Q8	1298.6	10.2	1.2	1297.4

The overburden thickness increases towards the stream valley/gulley in the west of the quarry basin area – refer Figure 7, Site Map – Quarry Isopachs, showing elevation to base of dozable/rippable material.

Unweathered material from boreholes Q1- Q8, which were drilled at the proposed quarry site were combined and submitted to SGS Matrolab for a range of aggregate tests to determine the suitability of the quarry material for use as concrete aggregate including: -

- *Grading Test*
- *Flakiness Index Test*

- *ARD, BRD & water absorption Test*
- *ACV (wet or dry) Test*
- *10% FACT (wet or dry) Test*
- *Petrographic analysis Test*
- *Methylene blue value Test*
- *Soundness of aggregate Test*
- *Durability Test*
- *Alkali-Silica Reaction Test (ASR) for aggregate*
- *Drying Shrinkage and Wet Expansion of aggregate Test*
- *Concrete cube crushing Test*

Rock excavated from the quarry comprises predominantly granite, pegmatite and granite-pegmatite variations with an average density of 2.62g/cm^3. Although up to 75% of the granite, granite-pegmatite mixes and pegmatite comprises silica, it did not initiate aggregate-cement reactions and the quarry rock complies with the requirements of aggregate for concrete mixes and is considered beneficial to strength gain in concrete. The effect on water demand in mixes and related harshness may depend on the actual site-specific qualities of the rock and should be investigated.

The inclusion of fly ash in concrete mixes will probably be mandatory, to reduce the likelihood and effects of alkali-silica reactions and will also assist in temperature control.

In terms of their durability, the granite, granite-pegmatite and pegmatite will provide excellent rockfill, road fill, gabions, and if required, rip-rap. The complete results have been included in Appendix F and commented upon in Chapter 3.10.1, Laboratory Testing.

5. POTENTIAL GEOTECHNICAL RISKS

Risk is defined as "Probability of Occurrence (of a hazard) x Consequence" and is generally represented by a Hazard/Risk Assessment (HRA) matrix. A hazard is any activity or situation with the potential to cause harm, such as injury or death, damage to the environment, damage to physical assets and/or loss of production. The severity of risk is determined by the likelihood of the incident occurring (i.e. causing harm) and the magnitude of its consequences, usually within a given period of time.

The main purpose of such an analysis is to increase awareness of the possibility of geotechnical hazards and potential risks and what can be reasonably done to mitigate against such incidents.

A preliminary risk assessment was therefore undertaken to investigate potential geotechnical hazards and quantify their risks to the immediate and long-term success of the project. The primary geotechnical risks identified at the proposed quarry and the dam basin site include: -

- Possible rockfalls from upslope granite outcrops along most of the southern perimeter of the quarry.
- Construction materials – adequate quality/quantity – sieving and possible crushing of fine aggregate required to comply with grading requirements for concrete mixes and filter sand. Quantities for both the weir and OCSD will have to be estimated and in both cases, a great quantity of general rockfill will need to be confirmed.
- Foundation rock quality - zone of deep weathering detected along the south-western portion of the quarry site.
- Possible diabase intrusion in eastern portion of quarry site.

- Major hazards identified include the following with high to very high risk and major to catastrophic probabilities of occurrence: -
    i) seasonal flooding of the Swartwater River;
    ii) over-topping of the Swartwater River, flooding the quarry site;
    iii) mining of fine aggregate on Mpuluzi River's left flank where a shallow perched water table prevails and side walls of excavations collapse rapidly.
- The basin slope risk assessment is considered very low to low.
- Blast preparations - all people and livestock within a 500m radius of the blast area must be evacuated prior to the blast being set off to ensure very low to low risk.

The hazards on the site largely relate to possible rockfalls, overtopping of the Swartwater River and flooding the quarry, deep weathering and diabase intrusions and a shallow perched water table in the Mpuluzi River's flood plain underlain by ample deposits of fine aggregate and filter sand, inadequate supplies for concrete mixes as well as the effects of blasting. The flooding potential of the quarry can be almost eliminated by good site flood management, and adequate pumping.

Despite the identification of the hazards and the likelihood of them being mainly possible to unlikely, the consequence of such an event occurring can be moderate and even major for the reasons defined above. The overall risk assessment is therefore classified as **L2 – H13** according to Table 5-1 below.

Table 5-1: Classification of Potential Hazard Risk

RISK MATRIX

Probability of Occurrence	Very Low	Low	Moderate	Major	Catastrophic
Almost certain	M11	H16	E20	E23	E25
Likely	M7	H12	H17	E21	E24
Possible	L4	M8	H13	E18	E22
Unlikely	L2	L5	M9	H14	E19
Rare	L1	L3	M6	M10	H15

The following section looks at potential remedial measures to mitigate against the risks. The preceding paragraphs determined that the hazards on the site largely relate to flooding and blasting. It is possible to implement certain safety procedures that can reasonably minimize the risk, as outlined in Table 5-2 below.

Table 5-2: Hazard and Risk Mitigation

Minimize	Hazard Description	Remedial Action
Hazard/Risk	Injury / fatality from small to large falling blocks / rocks off right flank from upslope steep granite outcrops during construction.	Monitor/map rock fall debris below crest. Undertake slope and inspections to identify hazards. Install catch fences / drapes in areas of high rockfall risk – base of Right flank/river section. Training of staff in awareness of rockfall safety issues. Use of correct PPE (protective clothing)
Hazard/Risk	Basin slope failures in deeply weathered zone on the western portion of the quarry	Careful survey monitoring of the slopes above the suspected failure areas. Detailed contour survey of the potential failure zones Detailed soil investigation in the failure areas during construction to improve shear strength estimates and minimize potential failures.

Minimize	Hazard Description	Remedial Action
Risk	Ingress of flood water into quarry excavations	Flood control and good site drainage Provision of sumps and pumps
Hazard/Risk	Left flank of Mpuluzi River underlain by fine aggregate and filter sand deposits with shallow water table	High probability of excavation collapse – this can be mitigated by draining the target area and mining from the landward side
Risk	Blast induced seismicity influencing bedrock integrity of weir	Properly controlled blasting with individual hole firing with small charges; removal of livestock and people within 500m radius of blast area
Risk	Inadequate supplies of good quality construction materials – coarse as well as fine aggregate and filter sand	A quarry has been identified within the dam basin with good quality granite rock suitable for rockfill, coarse aggregate and rip-rap. Fine aggregate may be obtained from crushing and screening if alluvial deposit is too difficult to mine

Note: The above suggested remedial measures are related only to geotechnical issues observed during the geotechnical issues observed during the investigation and are by no means exhaustive.

6. CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

❖ Quarry Site & Construction Materials

The quarry site is located upstream of the dam and within the full supply level to minimize the environmental impact. The quarry is expected to provide adequate sources of granite, granite-pegmatite mixes and pegmatite material for both rockfill and concrete, however the basin does have some good quality road building material but insufficient sources of fine aggregate.

Large deposits of fine aggregate and filter sand line the left flank of the Mpuluzi River extending upstream from the confluence for a considerable distance. Being located within the floodplain of the Mpuluzi River, seasonal flooding and a shallow perched water table may jeopardize the mining effort. Access to this portion of the site also needs to be investigated. However, indications are that the fine aggregate's coarse sand fraction tends to be too high and some crushing and sieving will be required.

The overall quality of the granite, granite-pegmatite mixes and pegmatite aggregate is regarded as suitable and therefore problems with quality are not anticipated. Although no diabase was encountered in any of the eight boreholes that were diamond drilled on the quarry site, the airborne magnetic survey data indicated a possible intrusion in the easterly portion of the quarry.

The quality of the water was also tested for concrete mixes and was found to be potable and of excellent quality – that is if the turbidity of the river water is excluded. The turbidity levels of the river water will no doubt increase during a flood and it is recommended that a temporary reservoir (impermeable plastic liner within an excavation at natural ground level) be constructed in the weathered section on the western portion of the quarry.

❖ Seepage in Quarry

During the diamond drilling, a drilling mud is used to lubricate the cutting process or else the diamond bit will get stuck. The drilling mud comprises a water-polymer mix to suspend the fines and wash the drill cuttings out of the borehole. In a permeable environment, the water-based lubricant usually evaporates quite rapidly but on the quarry site, the lowering of the water table within the solid hard rock is rather slow. The fact that the current water levels are below the Swartwater River indicates that the quarry is isolated and although some joints and fractures exist, there is no connection.

❖ **Geotechnical Risks**

A preliminary risk assessment was undertaken to investigate potential geotechnical hazards and quantify their risks to the immediate and long-term success of the project.

The primary geotechnical risks identified at the Mpuluzi dam site include: -

- Basin slope instability.
- High wall instability.
- Construction materials.
- Foundation rock quality.
- Flooding potential by the Swartwater River.
- Blast damage.
- Inaccessibility of fine aggregate deposits and filter sand on the left flank of Mpuluzi River.
- Excavation collapse of excavations for fine aggregate and filter sand on the left flank of Mpuluzi River where a shallow perched water table prevails.

Each risk was evaluated using a hazard classification and risk matrix. The hazard / risk is quantified and described in the report and remedial options are provided.

6.2 Recommendations

It is recommended that the following additional geotechnical related activities be undertaken at the start of construction and during construction: -

i) Excavation trials to evaluate the best excavation method of hard rock in the quarry – drilling/blasting, ripping and/or hydraulic breaking.

ii) Additional and on-going quality control tests on aggregate and concrete quality, as well as fine aggregate and filter sand.

iii) Individual hole firing must be used when firing these blasts; clear and precise blast notifications should be given to all interested and affected parties prior to a blast; all people and livestock within a 500m radius of the blast area must be evacuated prior to the blast being set off; the first blast must be audited; the charging operation must be accurately controlled; the blast should be monitored at locations considered to be sensitive; after the first blast, the actual seismograph measurements made should be compared to the modelled predictions and the original design can then be adjusted accordingly.

iv) Flood water ingress into quarry to be prevented and flood precautions to be taken.

v) Alternative routes to the quarry from the tar road should be considered.

7. GENERAL

While every effort was made during the investigation to ensure that generally accepted practices of our profession were used in the sub-surface evaluation of the site, and that the sampling and testing was representative of the soil/rock conditions observed on-site. However, it is impossible under the constraints of a restricted investigation of this nature to guarantee that zones of poorer geological materials were not identified that could have a significant bearing on the outcomes of this investigation. The investigation has therefore attempted, through interpolation and extrapolation at known test locations, to identify problem issues of a geotechnical nature on which this report is based. Variances in soil and rock quality and quantity from those predicted may be encountered during construction and

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9. APPENDICES

- Appendix A – Blasting Correspondence
- Appendix B – Test Pit Profiles
- Appendix C – Letaba Lab Test Results
- Appendix D – BH Profiles & Core Photos
- Appendix E – Rocklab Test Data
- Appendix F – SGS Matrolab Quarry & Aggregate Tests
- Appendix G – Yanka Lab Water Sample Analysis
- Appendix H – Seismic Test Data
- Appendix I – XRF Data
- Appendix J – SGS Matrolab Concrete Mix Designs

APPENDIX A
BLASTING CORRESPONDENCE

QUARRY & DAM BASIN SITE's

Cambrian CC
Reg. No. 2001/031939/23
VAT Reg. No. 4230207062

5 Club Crescent
Southdowns Estate
Irene x52
0062
South Africa

Engeolab (Pty) Ltd
Cleopatra Ave
Die Heuwel Ext 1
eMalahleni 1034

Dear Paul,

BLAST EVALUATION OF THE DRILL AND BLAST OPERATION FOR THE MPULUZI DAM HARD ROCK QUARRY.

1. Background.
When blasting takes place numerous disturbances occur that impact on people and infrastructure found in the vicinity of the blasting operation. When blasts are set off ground vibration and air blast disturbances occur. Thes diminish in intensity with increase in distance. Fly rock, after blast fumes and dust may also occur.

These disturbances occur unexpectedly particularly where blasting occurs on surface such as in quarries or open pit mines. To help manage this situation a systematic approach to the drill and blast operation needs to be adopted. This approach should initially assess the potential impact of the drill and blast operation and then control and manage the day-to-day operations to ensure that the impacts are managed such that the disturbance levels fall within accepted industry norms. The aim of this report is to assess the possible impact of the drill and blast operation and to provide guidelines to help ensure that the blasting process is correctly implemented.

2. Quarry Site.
Two potential quarry sites have been identified for use. These are designated in the attached locality map as Quarry A and Quarry B (Appendix 1). They are both close to the position of the weir that is planned to be constructed. Drilling and blasting will be required when operating these quarries.

There are numerous smallholdings within the quarry footprint areas as well as adjoining these areas. There are also large villages to the north and south of these areas. There is a church to the east, a school to the west and a teacher's training centre to the north. The proposed weir will be located about 300m south-east of Quarry A.

3. Objective.
This report considers the possible impact of the blasting operations on the surrounding areas. It provides an assessment of the possible disturbance levels that may be experienced at various distances from the quarries. It considers the preliminary work that should be carried out prior to the start of blasting and then the ongoing monitoring work that is required when blasting is underway.

The following aspects of the blasting operation were assessed:

3.1 Blast design and general safe blasting practice.
3.2 Ground vibration levels.
3.3 Airblast levels.
3.4 Side effects such as fly rock, after blast fumes and dust.
3.5 Disturbance monitoring. This may be an aspect to consider at the start of the drill and blast operations as a precautionary measure. The equipment required, placing of equipment and the standards against which disturbance levels are measured and assessed for compliance are reviewed.

3.1 Blast Design.

Prior to the start of blasting a proposed blast design should be modelled to determine the firing sequence, number of holes firing together and the combined charge mass per delay. Based on these figures the peak particle velocities can be calculated at the points of concern. These predictions should be compared to recognised standards - such as the United States Bureau of Mines Standard (USBM RI 8507) and / or the Deutsches Institut für Normung (DIN 4150 standard) - to ensure compliance. See Appendix 2 for a summary of these standards. When acceptable results are obtained, the design should be fixed for use.

The final blast design should be clearly marked and drilled off as per the standard operating procedures. After the blast is drilled off and charging commences then the process should be audited to ensure that all stages of the operation are proceeding as planned. The blast pattern, the hole depths and the accuracy of the drilling should be checked. The explosive charge mass per hole and the final stemming lengths must be verified.

3.2 Ground Vibration.

Ground vibration may attract comments from people in the vicinity of a mine. Ground vibration disturbances will need to be quantified to ensure compliance with recognised and accepted industry standards such as the USBM RI 8507 or the DIN Standard.

Factors Affecting Ground Vibration and Prediction of Ground Vibration Levels.

Ground vibrations are an inevitable consequence of blasting activity. The intensity of the vibrations depends on several factors, some of which can be managed and controlled to help reduce the impact.

The two principal factors that control vibration levels are distance and charge weight. Vibration energy is attenuated by the rock mass so normally lower amplitudes are experienced further from a blast. Vibration levels will increase as the charge weight increases. The larger the charge mass the higher the amplitude of the vibration. The charge weight can be controlled by reducing the blasthole diameter or limiting the number of holes that fire at an instant in time.

Vibration Control.

Effective vibration control can be exercised by making use of a propagation law developed by the US Bureau of Mines, which relates peak particle velocity (vibration), charge weight and distance. This is referred to as the “Scaled Distance Relationship” which takes the following form:

$$Sd = D/\sqrt{E}$$

and

$$PPV = a(Sd)^{-n}$$

Where

Sd = Scaled distance. Sd should be greater than or equal to 31 where no monitoring is carried out.

PPV = Peak Particle Velocity in millimetres per second (mm/sec).

D = Distance to property of concern in metres (m).

E = Mass of explosive per delay in kilograms (kg).

a = Site specific constant, which is a function of the rock mass.

n = Site specific constant, which is a function of the rock mass.

This method should initially be used as an estimate only, since it assumes site-specific constants, which differ from site to site depending on the rock types. In the absence of site-specific information, a value of 1.143 for "a" and a value of –1.6 for "n" can be used (Chiappetta, training course). Calculated values using these constants are usually conservative but provide a useful starting point.

The maximum allowable ground vibration amplitudes are frequency dependant with higher frequencies allowing higher peak amplitudes (Graph 1, Appendix 2). In general, at lower frequencies, the ground vibration should not exceed 12.7 mm/sec at houses, but at higher frequencies, the limit can increase to 50 mm/sec. Suggested maximum levels for peak particle velocity are summarized in the table below (Chiappetta, training course).

PPV damage thresholds for various infrastructure.

Nature of structure	**PPV in mm/sec**
Heavily reinforced concrete structures.	120
Property owned by concern performing blasting (minor plaster cracks acceptable)	84
Private property where maximum level of public concern is taken into account.	12
National roads / Tar roads	150
Steel pipelines	50
Green Concrete i.e. aged for less than 3 days	5
Concrete > 10 days	20

Human Response.

Human beings are easily disturbed at low levels of vibration. Levels of 0.76 to 2.54 mm/sec are quite perceptible, but the likelihood that damage to property will occur is almost non-existent. Levels between 2.54 and 7.62 are considered to be disturbing and levels above 7.62 can be very unpleasant.

Human perception is also affected by frequency. The approximate human response curves are combined with the USBM limiting curve for damage to property (Graph 2, Appendix 2). These curves slope in opposite directions. In other words, humans are more tolerant to low frequency vibrations.

Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za

To avoid damage to buildings the USBM limiting curve should be applied. To avoid constant complaints from residents, the vibration should be kept below the unpleasant curve and definitely below the intolerable curve.

Vibration Levels – Predictions.
No information relating to the blast parameters was provided. Based on similar quarry operations I modelled a blast pattern based on a 102mm diameter blasthole. The drill and blast parameters are shown in the summary table below.

102 mm Diameter Holes	Engeo
ROCK	
Rock Blastability Index (0 to 100)	76
Rock Density (g/cm3)	2,6
Rock UCS (MPa)	295
EXPLOSIVE	
Explosive Type	Bulk
Charge Mass/Metre (kg/m)	9,8
Explosive Mass Per Hole (kg)	79
Effective Charge Diam	102
Average In-hole Density	1,20
BLAST GEOMETRY	
Stemming Length (m)	3,00
Column Length (m)	7,90
Hole Depth (m)	10,90
Bench Height (m)	10,00
Sub-Drill (m)	0,90
Hole Diameter (mm)	102
PATTERN	
Burden (m)	3,0
Spacing (m)	3,5

The number of holes firing together (and hence the charge mass) was progressively increased from 1 to 6 holes to determine the effect on the PPV levels at various distances. The distance was progressively increased from 250m to 1750m to simulate this. The following PPV levels were predicted:

Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za

Predicted PPV levels for increasing charge mass and distance.

VIBRATION						
Holes Detonated Per Delay	1	2	3	4	5	6
Combined charge mass firing	78	155	233	311	388	466
Distance increment in metres						
100	Engeo	Engeo	Engeo	Engeo	Engeo	Engeo
Distance (m)	PPV (mm/s)	PPV (mm/s)	PPV (mm/s)	PPV (mm/s)	PPV (mm/s)	PPV (mm/s)
250	4,58	8,11	11,34	14,37	17,28	20,08
350	2,63	4,66	6,51	8,25	9,92	11,53
450	1,74	3,08	4,30	5,45	6,55	7,61
550	1,25	2,21	3,09	3,91	4,70	5,47
650	0,95	1,68	2,34	2,97	3,57	4,15
750	0,75	1,32	1,85	2,35	2,82	3,28
850	0,61	1,08	1,51	1,91	2,29	2,67
950	0,51	0,90	1,25	1,59	1,91	2,22
1050	0,43	0,76	1,06	1,35	1,62	1,88
1150	0,37	0,65	0,91	1,16	1,39	1,62
1250	0,32	0,57	0,80	1,01	1,21	1,41
1350	0,28	0,50	0,70	0,89	1,07	1,24
1450	0,25	0,45	0,62	0,79	0,95	1,10
1550	0,23	0,40	0,56	0,71	0,85	0,99
1650	0,20	0,36	0,50	0,64	0,77	0,89
1750	0,18	0,33	0,46	0,58	0,70	0,81

The data tabulated above shows how the PPV levels for a given charge mass attenuate rapidly with increase in distance. By way of example, if the data for three holes firing is reviewed, this shows that at a distance of 250 m from the blast a PPV level of 11.34 mm/sec is predicted. As the distance increases to 750 m this has reduced to 1.85 mm/sec and at 1250 m this has reduced to 0.80 mm/sec. In human response terms a PPV level of 11.34 mm/sec falls into the very disturbing category. The human response at 750 m falls into the strongly perceptible category and at 1250 m into the distinctly perceptible category

The attenuation can be seen more clearly when the data is graphed. Only three data sets were graphed i.e. 1 hole, 3 holes and 5 holes (Figure 1 below).

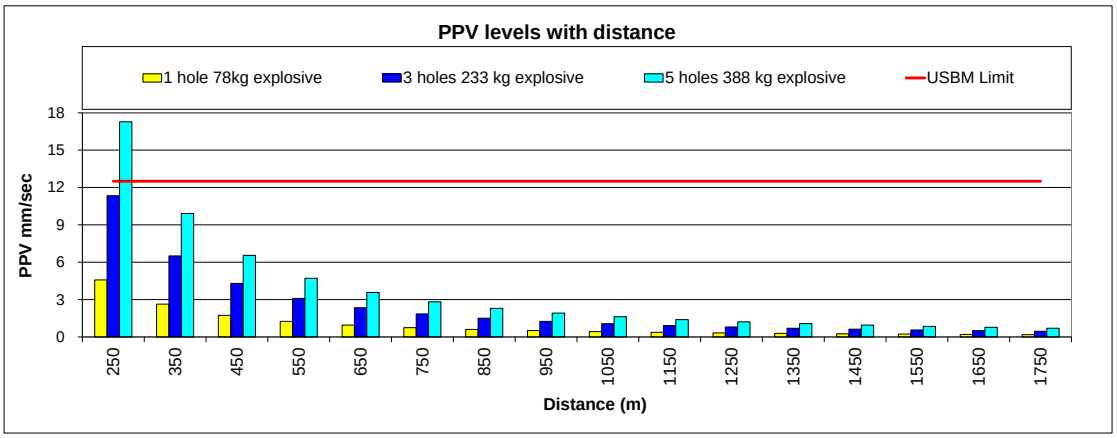


Figure 1: Predicted PPV levels plotted against distance.

In my experience the results obtained using the USBM formula with the given constants are conservative and the actual vibration levels are usually lower than those predicted. The geology in the area surrounding the mine will control the attenuation of the shock waves.

Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za

3.3 Airblast

Airblast is usually the main cause of blasting related complaints. Airblast is an atmospheric pressure wave consisting of high frequency sound that is audible and low frequency sound or concussion that is sub-audible and cannot be heard. Either or both of the sound waves can cause damage if the sound pressure is high enough (Konya and Walter 1990).

Airblast results from explosive gasses being vented to the atmosphere that results in an air pressure pulse. This occurs as a consequence of stemming ejections or hole blowouts, direct rock displacement through face ruptures or surface cratering, the use of high Velocity of Detonation (VOD) accessories that are left unconfined and / or uncovered (e.g. detonating cord on surface), by ground vibration or by various combinations of the above.

It is difficult to predict air blast levels with certainty due to unknown blast conditions as well as varying atmospheric conditions. However, airblast can be successfully contained below 130 decibels (dB) by precise control of the charging operation. Airblast amplitudes up to 135dB should not cause damage but it is recommended that the airblast be kept below the 130dB level. Overcharged holes can generate amplitudes that exceed 142dB.

Suggested threshold limits for air blast (below) have been proposed by Personn et.al. 1994. Chiappetta (personal communication) recommends that a threshold level of 125dB should be used to avoid all complaints. The USBM recommended threshold for human irritation is 134dB.

Damage thresholds for airblast.

120 dB	Threshold of pain for continuous sound
>130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

Airblast Prediction.

Given the variables associated with airblast any attempt to predict air blast levels can only be regarded as subjective. In the opinion of the specialist, good blast management coupled with the correct blast procedures will keep the airblast levels to acceptable limits. Blasts that have been correctly designed, laid out and executed should not result in excessive airblast and this should be the focus.

There are a number of equations that can be used to try and predict airblast. Airblast is scaled according to the cube root of the charge weight:

$$K = D/W^{0.33}$$

The following equation can be used for the calculation of air blast:

$$L = 165 - 24 \text{ Log10 } (D/W^{0.33})$$

Where

K = Scaled distance value.
L = Airblast level (dB)

D = Distance from source (m)
W = Charge mass per delay (kg)

The study has calculated the air blast levels using the same charge masses that were used for the prediction of ground vibrations. The airblast levels relating to the surface infrastructure are given in the table below. Only three data sets were graphed i.e. 1 hole, 3 holes and 5 holes (Figure 2 below).

Predicted airblast levels for increasing charge mass and distance.

AIRBLAST						
Holes Detonated Per Delay	1	2	3	4	5	6
Combined charge mass firing	78	155	233	311	388	466
Distance increment in metres						
100 Distance (m)	Engeo dB	Engeo dB	Engeo dB	Engeo dB	Engeo dB	Engeo dB
250	122	125	126	127	128	129
350	119	121	123	124	124	125
450	116	119	120	121	122	122
550	114	117	118	119	120	120
650	112	115	116	117	118	119
750	111	113	115	116	117	117
850	110	112	113	114	115	116
950	109	111	112	113	114	115
1050	107	110	111	112	113	114
1150	107	109	110	111	112	113
1250	106	108	109	110	111	112
1350	105	107	109	110	110	111
1450	104	106	108	109	110	110
1550	103	106	107	108	109	110
1650	103	105	107	108	108	109
1750	102	105	106	107	108	108

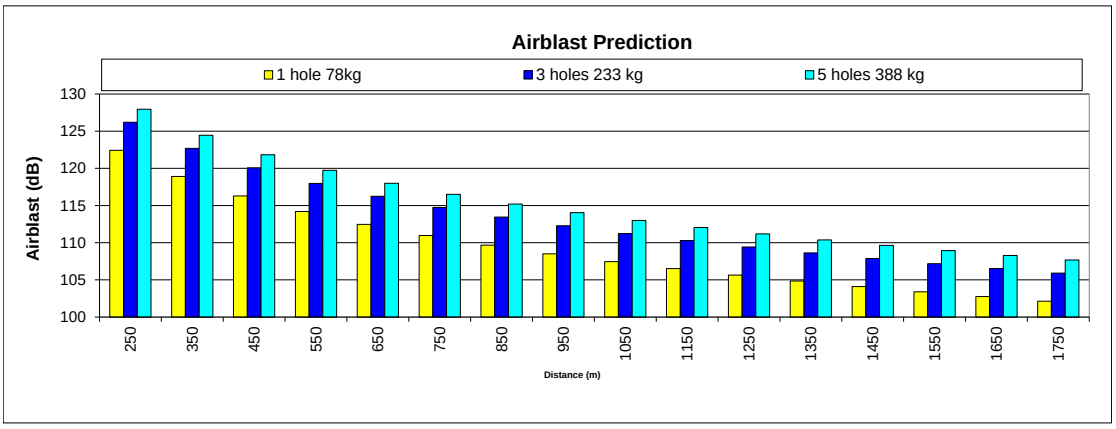


Figure 2: Predicted airblast levels plotted against distance.

The airblast levels are all below the recommended Persson threshold limit. Damage to structures will not occur at these levels. It will however attract unwelcome attention, which may well lead to complaints from people in the adjoining communities.

Airblast will have no impact on the weir structure.

3.4 Side Effects - Fly Rock.
Side effects such as fly rock are undesirable and usually occur unexpectedly, sometimes for unknown reasons. Fly rock typically originates either from the breaking face or the surface of the blast. The main causes are under-burdened holes, geological discontinuities, poor blast timing leading to over confinement of holes and overcharged blast holes that result in hole blow outs. Secondary blasting can also produce fly rock.

Post Blast Fumes and Dust.
Explosives are formulated to be oxygen balanced to minimize fumes and optimize the energy output. Fumes such as carbon monoxide and oxides of nitrogen can be produced in the detonation process. Dust on the other hand is an inevitable consequence of blasting.

Several factors can contribute to the creation of fumes. A number of these are mentioned below:

- Poor quality control and incorrect formulation.
- Excessively long sleep times.
- Damage to the explosive.
- Inadequate water resistance.
- Poor ground conditions.
- Premature loss of confinement.
- Inadequate priming; and
- Insufficient charge diameter.

It is difficult to ensure that post blast fumes never occur because some of the factors mentioned above are outside the blasters control. The best tools here are to ensure that strict quality control standards are in place and to exercise ongoing care and control during all stages of the charging up side of the operation. This is easily controlled if packaged explosive is used, as this is factory manufactured.

3.5 Disturbance Monitoring – Ground Vibration and Airblast.
It is recommended that the initial blasts are monitored to record blast vibration and airblast levels. The measurements made can be used to ensure that the predicted and recommended vibration amplitudes and air blast levels are not being exceeded. The disturbance levels recorded should be compared to the predictions as well as accepted industry norms to ensure compliance with design and standard. The records give a clear indication of whether or not changes to the blast design need to be considered. The records can also be used to demonstrate compliance.

Disturbance monitoring should be carried out using industry standard seismographs such as White Industrial Seismology equipment. Each seismograph is equipped with a triaxial geophone and a separate microphone. This allows ground vibrations and air blast to be measured simultaneously. The ground vibrations are measured in three directions. The three primary measurements can be plotted directly against an accepted standard, the two most common being the USBM and DIN standards. The USBM is most commonly used in South Africa. The DIN standard is more stringent as it restricts vibration levels to lower limits than the USBM standard. Attached are two printouts of measurements taken of a blast event (Appendix 3). The first shows the data measured at a specific monitoring station

plotted against the USBM standard and the second shows the same data plotted against the frequency spectrum.

Air blast can be measured at levels in excess of 100dB with the White seismographs. The peak air blast level as well as the associated frequency spectrum is measured.

Seismographs can initially be positioned at potentially sensitive locations on a blast-by-blast basis. Once ongoing production blasting is underway (and if it is required), then it will be simpler to establish a number of permanent monitoring stations. These stations remain in place for as long as necessary and can be moved to different locations as required. This is useful as it shows the level of local disturbance (caused for example by storms) that goes unnoticed. A reference database should be established and all data saved here. An independent third party should carry out the ground vibration and air blast monitoring.

3.6 Mitigation Measures.

A number of measures are suggested to ensure that the drill and blast operation proceeds smoothly. Some of the measures (e.g. quality acceptance) apply to specific areas of the operation. Others apply to a number of aspects of the operation to varying degrees.

- Exercise ongoing care and control during all stages of the drilling and blasting operation. Check, check and check again.
- Prior to charging up the blast, the holes drilled should be inspected and all 'problem' holes identified for corrective action. Examples of 'problem' holes could include holes that are under-burdened, holes that are short drilled, holes surrounded by badly cracked ground and off pattern holes that could potentially lead to problems.
- Production quality control checks must be implemented as part of the Standard Operating Procedures. The bulk explosive product should be sampled on an ongoing basis to ensure acceptable quality.
- After charging up is complete and prior to stemming the holes closed, they should be taped to determine the explosive column rise to ensure that the required stemming length is obtained. Any errors must be corrected before the hole is stemmed closed.
- The tie up should be carried out according to the blast plan to ensure that the timing and sequencing of the blast proceeds as planned.
- Avoid prolonged sleeping of blasts particularly in wet ground conditions. It is preferable to charge and blast in the shortest possible time frame.
- If fumes occur after a blast, then the area must be kept clear until these have dissipated. The stipulated re-entry times must be enforced.

Keep accurate and comprehensive blast records. All of the blast parameters as well as the timing and sequencing used to delay the blast should be recorded, as the individual seismograph measurements made need to be linked to the blasts. The blast information can be referenced and used to assist with future blast designs. To facilitate this, the drill and blast contractor should keep accurate records of the following, which are essential inputs to the blast vibration report:

- Blast type (e.g. waste, aggregate, etc.).
- Hole diameter drilled.
- Final drilled hole depths.
- Blast pattern – dimensions, number of rows and holes per row, burden and spacing.
- Total number of holes per blast – design and actual.

- Position of any additional or relieving holes.
- Any irregularities in the blast such as under-burdened or overburdened holes.
- Explosive type used to charge the blast.
- Explosive charge mass per individual hole and the total amount of explosive used per blast.
- The explosive column rise and the final stemming length achieved.
- Details of the final blast tie up with a schematic showing the position and value of the time delays used as well as the number of holes per delay.
- The date and time of firing the blast.

4. Knowledge Gaps.

The prediction of the possible disturbance levels at various distances is based on reasonable assumptions regarding the blast patterns to be drilled and blasted. Generally accepted equations and modeling methods were used to perform the calculations on which the predictions are based. However, prior to the start of the drill and blast operation these figures must be reviewed to correct for any variances between 'actual' versus 'modeled'.

5. General Information.

The scope of this report was to assess the potential impact of blasting activities on areas surrounding the proposed quarry development and focused on:

- Prediction of ground vibration for increasing charge mass at various distances.
- Prediction of air blast as above; and
- Assessment of unwanted side effects such as fly rock, post blast fumes and dust.

The report was compiled to provide input to assist with information required to address routine ongoing drill and blast applications.

6. Conclusions and recommendations.

The modelling results indicate that the disturbance levels that could be experienced at the various locations around the planned quarry may cause damage to houses located in close proximity to the operation.

Individual hole firing results in the lowest disturbance levels. Individual hole firing must therefore be used when firing these blasts.

Clear and precise blast notifications should be given to all interested and affected parties prior to a blast. The notification should indicate where the blasting will be carried out.

All people in the vicinity of the blast areas must be evacuated prior to the blast being set off. Normally a minimum safety radius of 500m around the blast is required.

The first blast should be audited. Aspects such as pattern layout, hole depths, method of charging holes, explosive column rise, stemming length and finally the timing and sequencing of the blast must be checked. The purpose of the exercise is to spot potential problems to allow these to be corrected before a blast is set off. The audit helps ensure

compliance with design and addresses “finger problems” such as overcharged holes, under-burdened holes etc.

The charging operation must be accurately controlled. Overcharged holes can result in excessive disturbance levels and are therefore unacceptable. It is therefore essential that the correct control measures are put into place from day one to help control and minimise the disturbance levels.

The blast should be monitored at locations considered to be sensitive. This will allow the disturbance levels to be quantified and compared to accepted industry standards. Industry approved seismographs capable of recording ground vibration and airblast simultaneously should be used for this. The monitoring locations will need to be decided on prior to each blast.

After the first blast the actual seismograph measurements made should be compared to the predictions. The design can then be remodelled if required.

If you have any queries regarding the above, please contact me at 083 488 1392.

Yours sincerely

Erik Kohler.

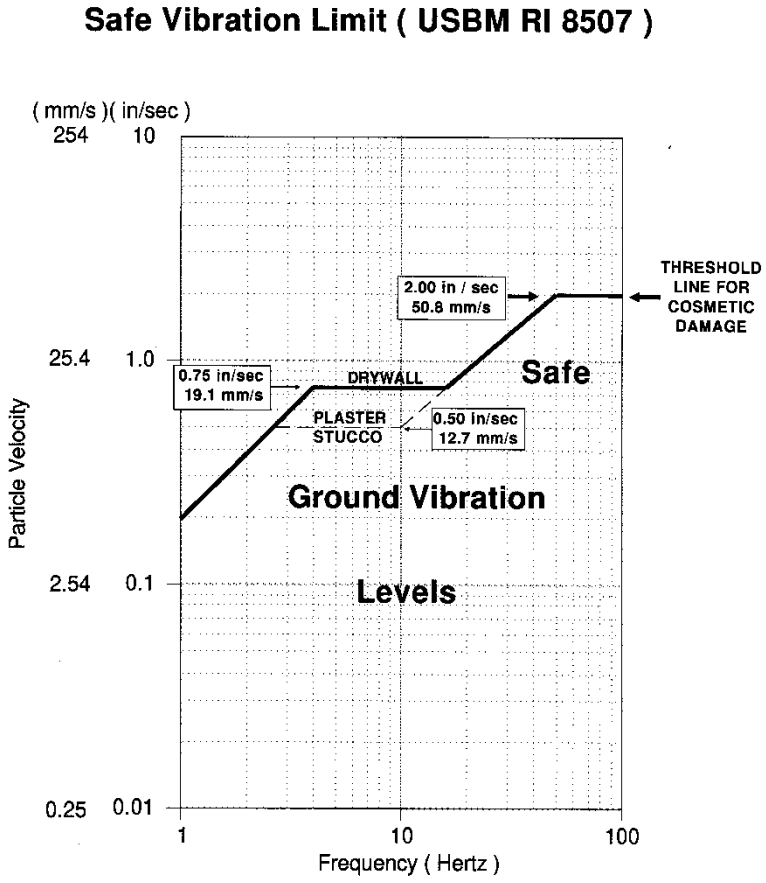
Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za

<u>Appendix 1</u>. Proposed quarry locations.

Vibration and Air Blast Limits.

Ground Vibration - Building response to ground vibration

Although there are no legislated limits to vibration, the US Bureau of Mines limits are commonly applied in South Africa. The limiting curve is shown in Graph 1 and has been developed from empirical studies (Siskind et.al. 1980).



Graph 1: USBM curve that is generally used in South Africa (After Chiappetta, March 2000)

The limiting curve in Graph 1 represents the limit for cosmetic damage to a house. The maximum ground vibration amplitudes are frequency dependent with higher frequencies allowing higher peak amplitudes. Most modern blasting seismographs will display the vibration data in terms of the USBM limiting criterion. In general, at lower frequencies, the ground vibration should not exceed 12.7 mm/s, but at higher frequencies, the limit can increase to 50 mm/s.

Appendix 2: Vibration and Airblast Limits.

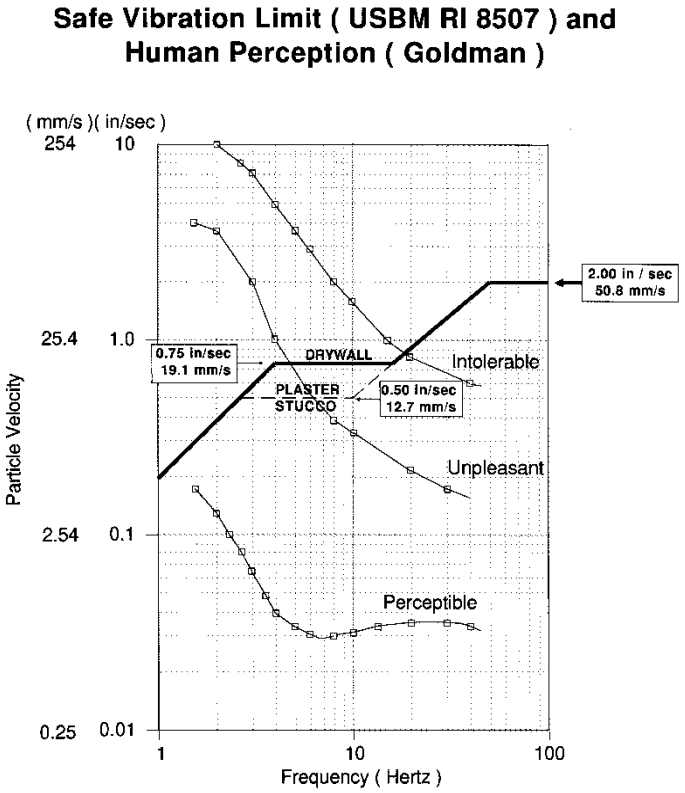
Human response to ground vibration

Although buildings can withstand ground vibration amplitudes of 12.7 mm/s or more, depending on the frequency, human beings are easily disturbed at lower levels. The typical human response to ground vibration is illustrated in the table below.

Table 1: Human response to vibration (Chiappetta, 2000)

Effects on Humans	Ground Vibration Level mm/s
Imperceptible	0.025 – 0.076
Barely perceptible	0.076 – 0.254
Distinctly perceptible	0.254 – 0.762
Strongly perceptible	0.762 – 2.540
Disturbing	2.540 – 7.620
Very disturbing	7.620 – 25.400

Ground vibration levels of 0.76 to 2.54 mm/s received at a structure are quite perceptible, but the probability of damage is almost non-existent. Levels in the 2.54 to 7.6 mm/s can be disturbing and levels above 7.6 mm/s can be very unpleasant, although permanent damage is unlikely.



Graph 2: Human response curves compared with potential damaging limits (After Chiappetta, 2000).

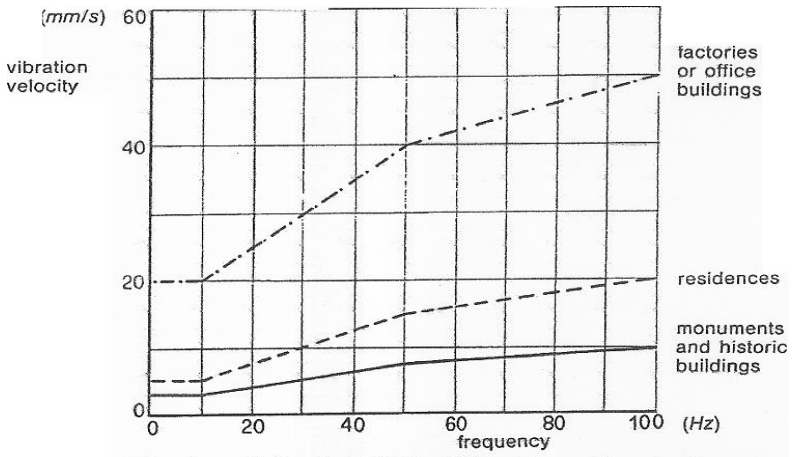
Appendix 2 (cont): Vibration and Airblast Limits.

Human perception is also affected by frequency. The approximate human response curves are combined with the USBM limiting curve for damage in Graph 2. These curves slope in the opposite direction. In other words, humans are more tolerant to low frequency vibrations.

To avoid damaging buildings, the USBM limiting curve should be applied. However, to avoid constant complaints from neighbours, the vibration should preferably be kept beneath the *unpleasant* curve and definitely be kept beneath the *intolerable* curve.

DIN STANDARD 4150 (Western Germany, 1983). Limit values of vibration expressed in mm/sec.

Type of structure \ Recording spots	Foundations			Floor of the highest storey of the building
	< 10 *Hz*	10 – 50 *Hz*	50 – 100 *Hz*	Any frequency
1. Office or factory building	20	20 – 40	40 – 50	40
2. Residential building with plastered walls	5	5 – 15	15 – 20	15
3. Historic and other buildings to be treated with care	3	3 – 8	8 – 10	8
With frequencies > 100 Hz higher levels may be accepted				



Vibration velocity threshold for different types of constructions as a function of frequency, as defined by DIN STANDARD 4150 (West Germany)

Graph 3: DIN standard.

Appendix 2 (cont): Vibration and Airblast Limits.

It may be prudent to apply the DIN standard where 3rd world housing is encountered, as these buildings are often poorly constructed.

Air Blast Limits

As with ground vibration, there are no legislated limits to air blast amplitudes from blasting activity.

Siskind *et.al.* (1980) indicate that monitored air blast amplitudes up to 135 dB are safe for structures, provided the monitoring instrument is sensitive to low frequencies (down to 1 Hz). Persson *et.al.* (1994) have published the following estimates of damage thresholds based on empirical data.

Table 2: Damage thresholds for air blast.

120 dB	Threshold of pain for continuous sound
>130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

References

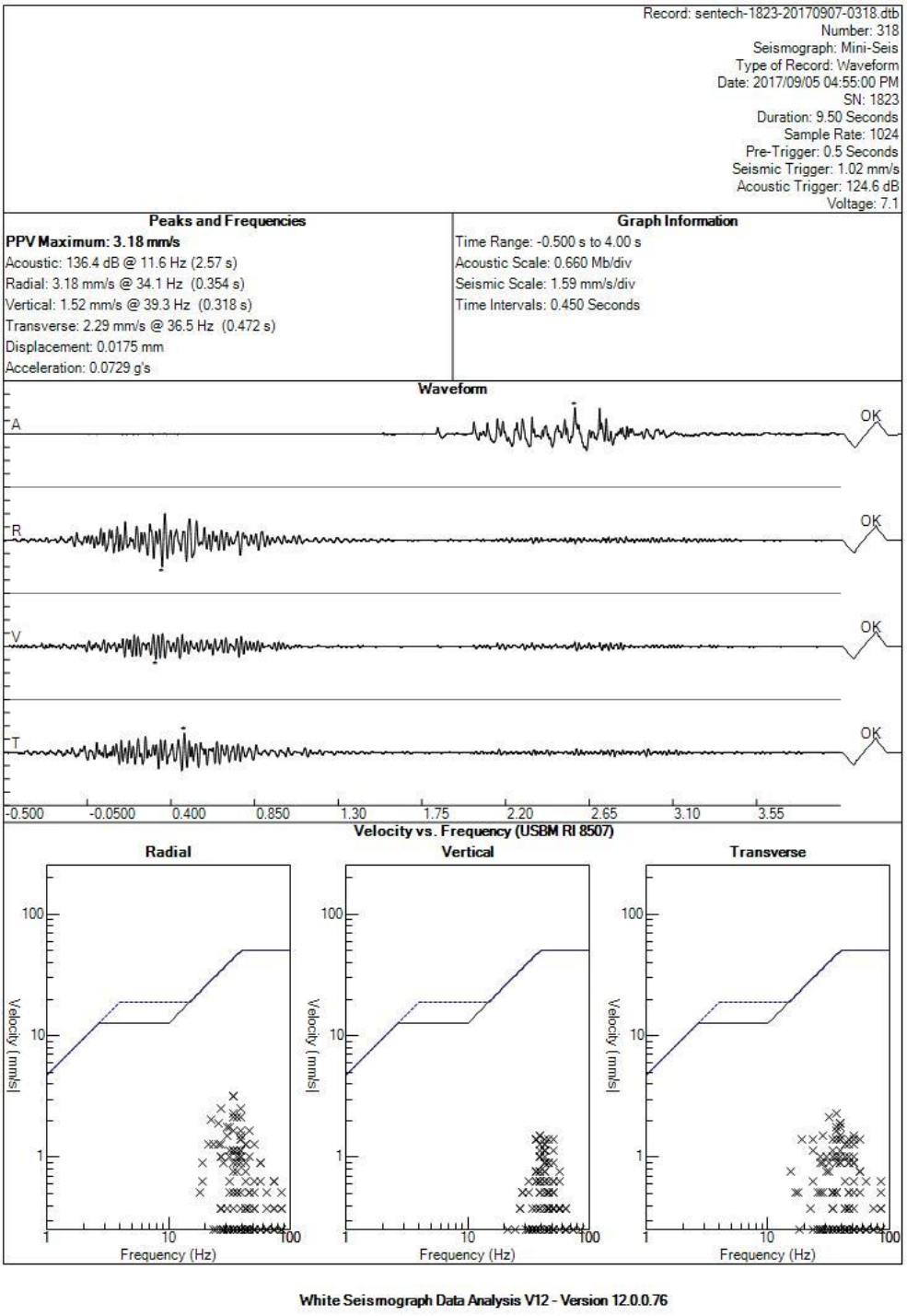
Siskind, D.E., Stagg, M.S., Kopp, J.W. & Dowding, C.H., 1980. *Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting*, U.S. Bureau of Mines RI 8507.

Chiappetta, R.F., 2000, *Vibration/airblast controls, Damage criteria, record keeping and dealing with complaints*. The Institute of Quarrying, Southern Africa, Symposium, Durban

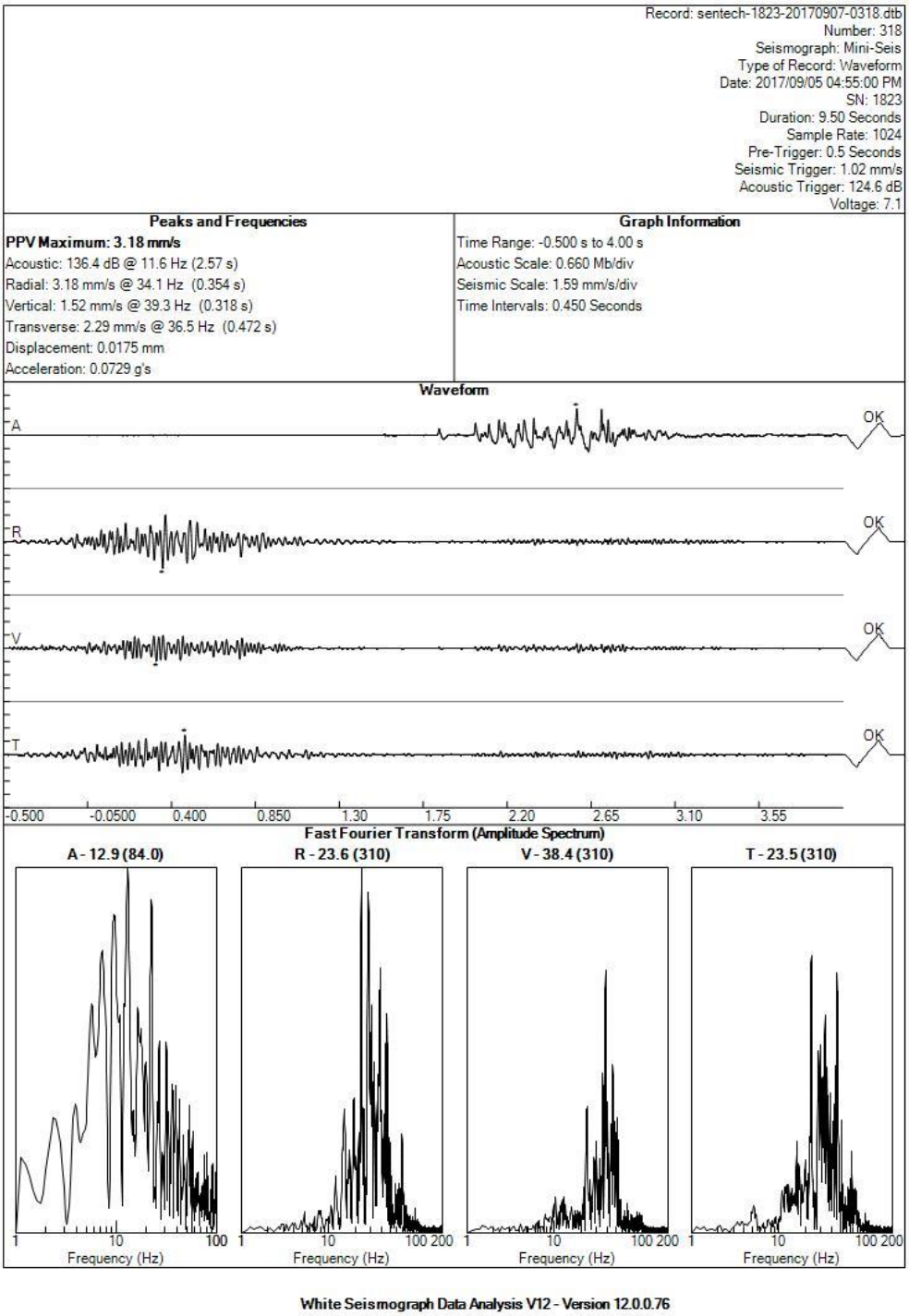
Persson, P-A, Holmberg, R and Lee, J, 1994, *Rock Blasting and Explosives Engineering*. CRC Press, USA.

Siskind, D.E., Stachura, V.J., Stagg, M.S. & Kopp, J.W., 1980. *Structure Response and Damage Produced by Airblast from Surface Mining*, U.S. Bureau of Mines RI 8485.

Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za



<u>Appendix 3</u>: Vibration and Airblast Data plotted against the USBM Standard.



Appendix 3 (cont): Vibration and Airblast Data plotted against frequency.

Cambrian CC
Reg. No. 2001/031939/23
VAT Reg. No. 4230207062

5 Club Crescent
Southdowns Estate
Irene x52
0123
South Africa

To: **Engeolab (Pty) Ltd**
Att: **Paul Hansmeyer**
From: **Erik Kohler (083 488 1392)**
Date: **25th January 2024**
Re: **Possible blasting impact on Mpuluzi dam weir.**
Pages: **Three**

Dear Paul,
Our discussion of yesterday refers. I have crudely plotted the site investigated area and the proposed quarry A and B locations (attached). I could not accurately position the locations but the image provides a general idea of the quarry area footprints and the surroundings.

There are numerous smallholdings within the footprint areas as well as adjoining these areas. There are large villages north and south of these areas. There is a church to the east, a school to the west and a teacher's training centre to the north. The proposed weir will be located about 300m south-east of quarry A.

When blasts are set off air overpressure (air blast) and ground vibration disturbances are caused. The disturbance levels are greatest close to the source and attenuate with increase in distance. The disturbance levels are related to the explosive charge mass per delay. Blasts must therefore be designed to ensure individual hole firing to keep this to a minimum. I will provide more detailed modelling information to illustrate this is in a separate report.

Human response to ground vibration.
Well-constructed buildings can withstand ground vibration amplitudes of 12.7 mm/sec or more, depending on the frequency, human beings are easily disturbed at lower levels. The typical human response to ground vibration is illustrated in the table below.

Effect on Humans	Ground Vibration Level in mm/sec
Imperceptible	0.025 – 0.076
Barely perceptible	0.076 – 0.254
Distinctly perceptible	0.254 – 0.762
Strongly perceptible	0.762 – 2.540
Disturbing	2.540 – 7.620
Very disturbing	7.620 – 25.400

Based on the above, you should anticipate that damage complaints will originate from people living close to as well as far away from the quarry. The complaints will typically be related to crack damage in walls, plaster detachment, cracks in paving, movement of roof tiles etc and cracked or broken windows.

Air Blast.
Based on work carried out by Siskind *et.al.* (1980), air blast amplitudes up to 135 dB are safe, provided the monitoring instrument is sensitive to low frequencies (down to 1 Hz).

Persson *et.al.* (1994) have published the following estimates of damage thresholds based on empirical data. The regulatory limit defined by USBM is 133 dB-L.

Damage thresholds for air blast.

120 dB	Threshold of pain for continuous sound
>130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

Human response to airblast.

Average human response	Airblast (dB)
Barely to distinctly perceptible	50 to 70
Distinctly to strongly perceptible	70 to 90
Strongly perceptible to mildly unpleasant	90 to 120
Mildly to distinctly unpleasant	120 to 140
Distinctly unpleasant to intolerable	140 to 170

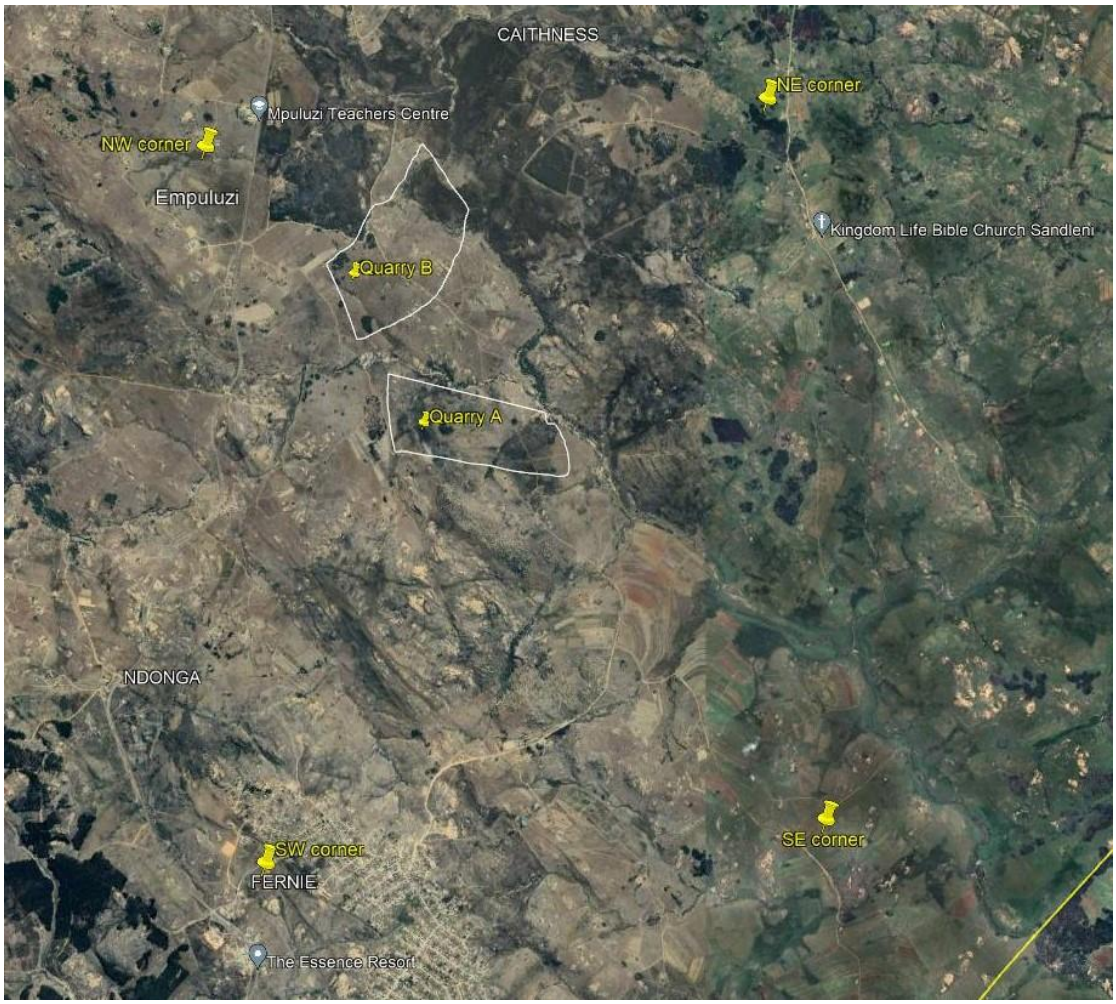
Impact to the weir.
For fracturing of the granite to occur at the weir location, the ground vibration levels experienced would have to be high enough to exceed the tensile strength of the in-situ rock mass. I am of the opinion that the impact to the rock mass where the weir will be constructed will be minimal provided that no unusual geological conditions (e.g. fractures, weathering, hardness, jointing, faults, shear zones) are encountered.

Regards,

E. Kohler

Erik Kohler.

Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za



Members: Erik Kohler (managing)
Tel: ….. Fax to mail: +27 865501012 Cell: 083 488 1392
e-mail: ekohler@absamail.co.za

APPENDIX B
TEST PIT PROFILES

QUARRY & DAM BASIN SITE's

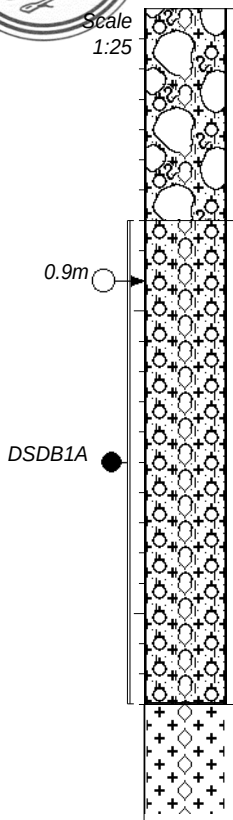
APPENDIX A – SOIL PROFILES

DAM BASIN

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP01
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 — Abundant blocky GRANITE boulders and some gravels loosely packed in a sparse matrix of moist dark black-brown, loose, intact, medium grained silty SAND with shrub roots.

0.70 — Randomly scattered decomposed to highly weathered soft to medium hard subrounded and blocky GRANITE gravels in a matrix of moist becoming wet from 0.9m, orange-brown mottled light beige, loose to medium dense, intact, coarse sugary textured silty SAND.

2.30 — Slow penetration of excavator in beige mottled ivory, coarse grained soft becoming hard rock GRANITE.

NOTES

1) Water seepage from 0.9m
2) Side walls collapsing
3) Base of test pit under water after 5 hours
4) Sampled as follows: DSDB1A from 0.7m--2.3m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
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ELEVATION :
X-COORD : S26˚21'11.7"
Y-COORD : E030˚48'28.8"

HOLE No: DBTP01

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP02
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25

0.00 — Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.30 — Moist becoming very moist from 2.8m and wet from 2.9m, medium dense becoming loose from 2.9m, intact, medium grained sugary textured medium to coarse grained silty SAND derived from in situ decomposed GRANITE.

DSDB2A

2.9m

3.80 — Beige-ivory, decomposed to moderately weathered, coarse grained very soft rock GRANITE.

4.00 — Refusal on beige-ivory, coarse grained hard rock GRANITE.

NOTES

1) Water seepage from 2.9m
2) Side walls collapsing from 2.9m
3) Ponding in base of test pit
4) Sampled as follows: DSDB2A from 0.3m--3.8m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

ELEVATION :
X-COORD : S26˚21'09.2"
Y-COORD : E030˚48'31.7"

HOLE No: DBTP02

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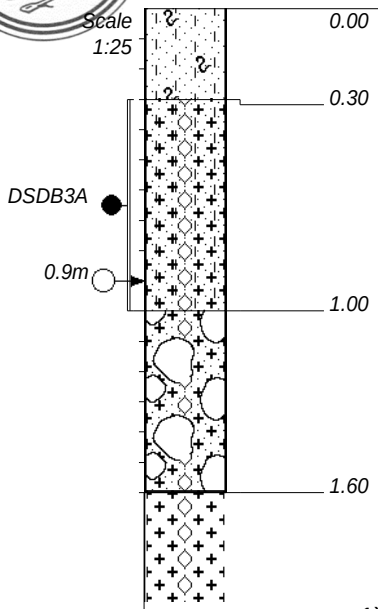
Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP03
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 — Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.30 — Moist becoming very moist from 0.8m and wet from 0.9m, dull khaki-brown, loose, intact, medium to coarse grained sugary textured silty SAND derived from in situ decomposed GRANITE.

1.00 — Subrounded and blocky GRANITE boulders, in a matrix of wet, light brown mottled beige-ivory, loose, intact, sugary textured coarse SAND.

1.60 — Refusal of excavator on beige coarse grained hard GRANITE.

NOTES

1) Water seepage from 0.9m
2) Ponding in base of test pit
3) Sampled as follows: DSDB3A from 0.3m--1.0m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

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DATE : 14/12/2023

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Y-COORD : E030˚48'30.0"

HOLE No: DBTP03

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP04
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25

0.00 Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

DSDB4A

0.80 Scattered tabular, blocky and subrounded GRANITE boulders in a matrix of moist, brown, medium dense, intact, very coarse sugary textured siLty SAND.

1.60 Moist becoming wet from 2.1m, ivory mottled brown, medium dense to 2.1m becoming loose, intact, coarse sugary textured silty SAND derived from in situ decomposed GRANITE.

2.1m

DSB4B

3.70 Refusal of excavator on ivory-beige, moderately weathered coarse grained GRANITE.

NOTES

1) Water seepage from 2.1m
2) Side walls collapsing from 2.1m
3) Ponding in base of test pit
4) Sampled as follows: DSDB4A from 0.1m--0.8m and DSB4B from 0.8m--3.7m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

ELEVATION :
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Y-COORD : E030˚48'29.0"

HOLE No: DBTP04

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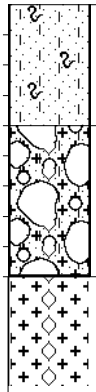
Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP05
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00	Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.
0.40	Abundant blocky GRANITE boulders and some angular gravels and GRANITE fragments in a matrix of moist, light brown speckled ivory, loose, coarse grained sugary textured, intact, silty SAND.
0.90	Refusal of excavator on beige-ivory, moderately weathered coarse grained GRANITE.

NOTES

1) No seepage

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

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DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
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X-COORD : S26˚21'05.9"
Y-COORD : E030˚48'28.4"

HOLE No: DBTP05

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP06
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25

DSDB6A

0.00 Abundant angular gravels, fragments and GRANITE boulders in a matrix of moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Talus.

0.60 Moist, orange-brown mottled ivory, medium dense, intact, medium to coarse grained sugary textured silty SAND derived from in situ decomposed GRANITE.

2.10 Refusal on ivory-white, coarse grained medium fractured hard rock GRANITE.

NOTES

1) No seepage

2) Sampled as follows: DSDB6A from 0.6m--2.1m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

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Y-COORD : E030°48'27.0"

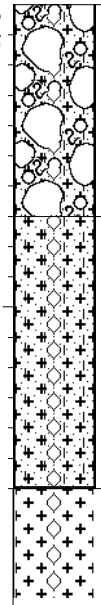
HOLE No: DBTP06

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP07
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00 Abundant angular gravels, fragments and GRANITE boulders in a matrix of moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Talus.

0.70 Moist, orange-brown mottled ivory, medium dense, intact, medium to coarse grained sugary textured silty SAND derived from in situ decomposed GRANITE.

1.60 Refusal on ivory-white, coarse grained medium fractured hard rock GRANITE.

NOTES

1) No seepage

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

ELEVATION :
X-COORD : S26˚21'05.3"
Y-COORD : E030˚48'24.0"

HOLE No: DBTP07

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP08
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25

DSDB8A

DSB8B

0.00 Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass roots to 0.1m; Colluvium.

0.20 Abundant sand coated ferricrete nodules in a matrix of moist, khaki-brown, medium dense, intact, coarse SAND; Pedocrete.

0.50 Moist, maroon mottled khaki-brown, partially ferruginised, intact, medium to coarse grained silty SAND; Pedocrete.

1.60 Moist, pink mottled beige and speckled ivory, medium dense to dense, intact, sugary textured coarse silty SAND derived from in situ decomposed GRANITE.

3.60 Refusal on beige, moderately weathered coarse GRANITE.

NOTES

1) No seepage

2) Sampled as follows: DSDB8A from 0.2m--0.5m and DSB8B from 0.5m--3.6m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

ELEVATION :
X-COORD : S26˚21'05.5"
Y-COORD : E030˚48'20.1"

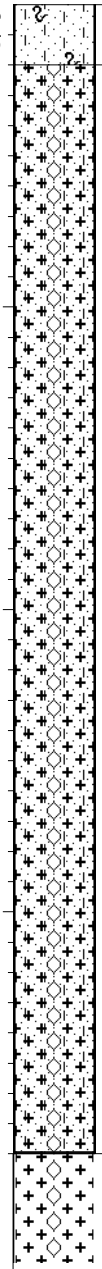
HOLE No: DBTP08

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP09
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00 Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.20 Moist, maroon-brown speckled ivory, medium dense, intact, coarse sugary textured silty SAND derived from in situ decomposed GRANITE.

3.80 Refusal on beige-ivory, moderately weathered coarse GRANITE.

NOTES

1) No seepage

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

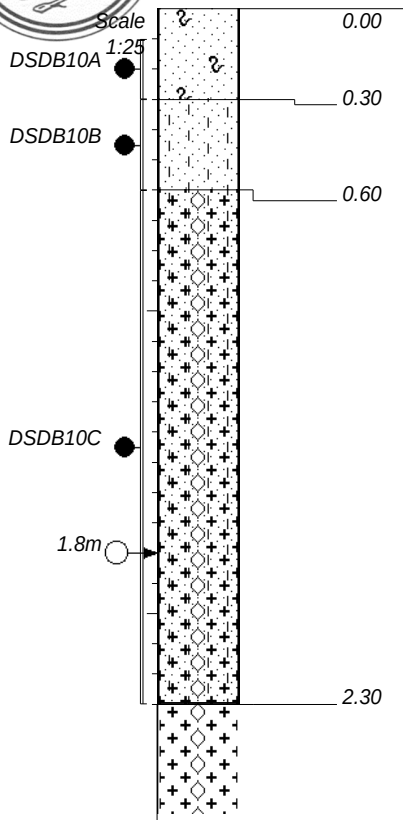
ELEVATION :
X-COORD : S26˚21'12.6"
Y-COORD : E030˚48'23.9"

HOLE No: DBTP09

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP10
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 – 0.30: Slightly moist, maroon-brown, loose, coarse SAND with grass roots to 0.1m; Alluvium.

0.30 – 0.60: Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND; Alluvium.

0.60 – 2.30: Moist becoming wet from 1.8m, dull beige-brown, medium dense to dense, intact, medium to coarse sugary textured silty SAND derived from in situ decomposed GRANITE.

2.30: Refusal of excavator on beige-brown, highly weathered coarse grained GRANITE.

NOTES

1) Water seepage from 1.8m
2) Ponding in base of test pit
3) Sampled as follows: DSDB10A from 0.1--0.3m, DSDB10B from 0.3--0.6m and DSDB10C from 0.6m--2.3m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

ELEVATION :
X-COORD : S26˚21'02.0"
Y-COORD : E030˚48'21.3"

HOLE No: DBTP10

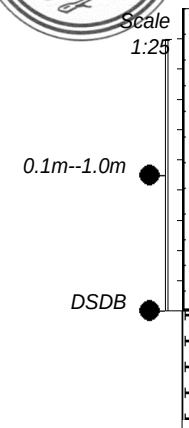
TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP11
Sheet 1 of 1

JOB NUMBER: LL3876



Light brown, coarse to very coarse clean SAND.

Refusal on hard rock GRANITE.

NOTES

1) No Seepage

2) Sampled as follows: DSDB RiverSand 1 from Depth 0.1m--1.0m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

ELEVATION :
X-COORD : S26˚21'00.8"
Y-COORD : E030˚48'29.0"

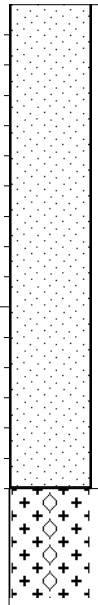
HOLE No: DBTP11

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP12
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00 Light khaki-brown, medium grained SAND.

1.60 Refusal on hard rock GRANITE.

NOTES

1) No Seepage

2) Sampled as follows: DSDB RiverSand 2 from Depth 0.1m--1.6m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

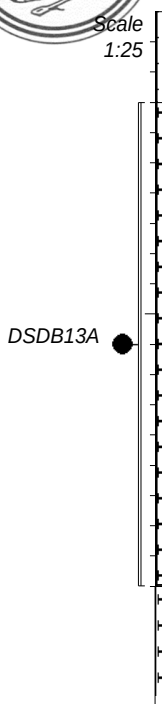
ELEVATION :
X-COORD : S26˚21'03.3"
Y-COORD : E030˚48'29.6"

HOLE No: DBTP12

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP13
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 – 0.30: Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.30 – 1.90: Moist, yellow speckled ivory, medium dense, intact, medium to coarse grained, sugary textured silty SAND derived from in situ decomposed GRANITE.

1.90: Refusal on beige-yellow speckled ivory, moderately weathered hard rock GRANITE.

NOTES

1) No seepage

2) Sampled as follows: DSDB13A from 0.3m--1.9m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

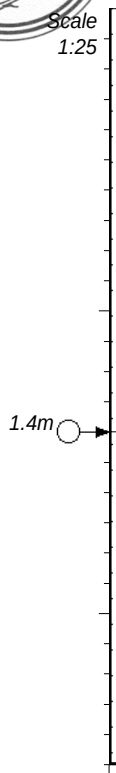
ELEVATION :
X-COORD : S26˚20’59.7"
Y-COORD : E030˚48’25.5"

HOLE No: DBTP13

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP14
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 Moist, light brown, medium grained SAND; Alluvium.

1.40 Coarse clean River SAND; Alluvium.

2.50

NOTES

1) Water seepage from 1.4m

2) Side walls collapsed

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

ELEVATION :
X-COORD : S26˚20'58.1"
Y-COORD : E030˚48'26.2"

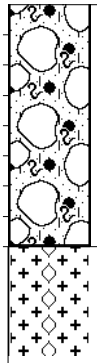
HOLE No: DBTP14

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP15
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



DSDB15A

0.00

Dark brown, coarse ferruginous concretions and FERRICRETE boulders in a sparse matrix of moist, becoming wet from 0.7m, brown, loose, intact, medium grained silty SAND with grass roots to 0.05m; Pedocrete.

0.80

Refusal on beige, hard rock GRANITE.

NOTES

1) Point water seepage at bedrock level

2) Sampled as follows: DSDB15A from 0.1m--0.8m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 14/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

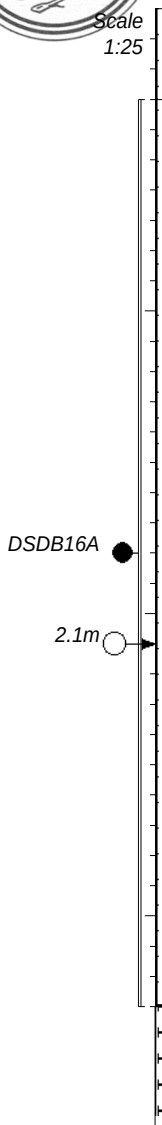
ELEVATION :
X-COORD : S26˚20'42.2"
Y-COORD : E030˚48'32.1"

HOLE No: DBTP15

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP16
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 Moist, dark brown, silty SAND with roots.

0.30 Moist becoming very moist and wet from 2.1m, light brown, very loose, coarse SAND; Alluvium.

3.30 Refusal on light brown, hard rock GRANITE.

NOTES

1) Water seepage from 2.1m
2) Sampled as follows: DSDB16A from 0.3m--3.3m
3) Test hole collapsed from 2.1m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 15/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

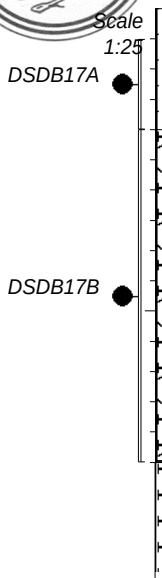
ELEVATION :
X-COORD : S26˚20'55.9"
Y-COORD : E030˚48'27.1"

HOLE No: DBTP16

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP17
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.40 Angular and blocky fragments, gravels and GRANITE boulders randomly scattered within a matrix of moist, light orange stained ivory, medium dense, intact, medium to coarse sugary textured SAND.

1.50 Refusal on brown, moderately weathered hard rock GRANITE.

NOTES

1) No seepage

2) Sampled as follows: DSDB17A from 0.1m--0.4m and DSDB17B from 0.4m--1.5m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 15/12/2023

ELEVATION :
X-COORD : S26˚20'59.4"
Y-COORD : E030˚48'31.8"

HOLE No: DBTP17

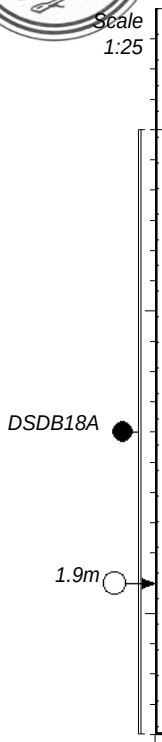
TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP18
Sheet 1 of 1

JOB NUMBER: LL3876



0.00 — Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Alluvium.

0.40 — Moist becoming wet from 1.9m, light brown, medium to coarse grained layered clean SAND; Alluvium.

2.40

NOTES

1) Water seepage from 1.9m (strong inflow)
2) Continuous side wall collapse
3) Test hole abandoned
4) Sampled as follows: DSDB18A from 0.4m--2.4m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

INCLINATION :
DIAM :
DATE :
DATE : 16/12/2023

ELEVATION :
X-COORD : S26˚21'03.1"
Y-COORD : E030˚48'33.4"

HOLE No: DBTP18

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

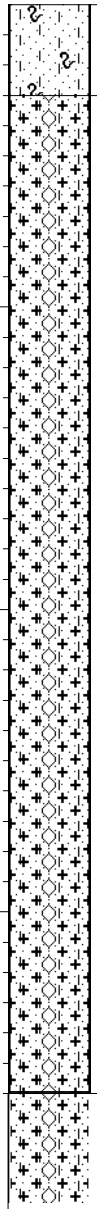
DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP19
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00 — Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.30 — Moist, yellow-brown mottled beige and speckled ivory, medium dense, intact, medium to coarse sugary textured silty SAND derived from in situ decomposed GRANITE.

3.60 — Very slow penetration of excavator from xxm, on beige-ivory, coarse, sugary textured silty SAND - decomposed GRANITE.

NOTES

1) No seepage

2) Sampled as follows: DSDB19A from 0.3m--3.6m

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 16/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

ELEVATION :
X-COORD : S26˚21'06.4"
Y-COORD : E030˚48'35.8"

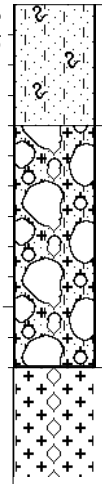
HOLE No: DBTP19

Empuluzi/Methula Bulk Water Supply Scheme
Dam Basin

HOLE No: DBTP20
Sheet 1 of 1

JOB NUMBER: LL3876

Scale 1:25



0.00 Moist, dark greyish-brown, loose to medium dense, intact, medium grained silty SAND with grass and tree roots; Colluvium.

0.40 Decomposed orange-brown GRANITE gravels and boulders in a matrix of moist, orange-brown, medium dense to dense, intact, coarse sugary textured silty SAND.

1.20 Refusal on dull beige, moderately weathered coarse grained hard rock GRANITE.

NOTES

1) No seepage

CONTRACTOR : iKotwe
MACHINE : CAT 323D Excavator
DRILLED BY : Jeffrey
PROFILED BY : P Hansmeyer

TYPE SET BY : R du Randt
SETUP FILE : STANDARD.SET

INCLINATION :
DIAM :
DATE :
DATE : 16/12/2023

DATE : 23/12/2023 12:22
TEXT : ..LES\LL3876ProfilesDB.txt

ELEVATION :
X-COORD : S26˚21'06.8"
Y-COORD : E030˚48'33.6"

HOLE No: DBTP20

APPENDIX C
LETABA LAB TEST DATA

QUARRY & DAM BASIN SITE's

Table: Summary of Soil Test Date

Test Pit No	Sample No	Lab Test No	Depth	Origin	Material Type	% OMC	MDD Kg/m³	USC	G CLASS	CBR 95%	Liquid Limit	Plastic Index	Linear shrinkage	% Moisture
DBTP 01	DSDB1A	39017-3	0.7-2.3	Residual Granite	Clayey sand	11.3	1904	SC	G6	50	35	9	4.6	14.3
DBTP 02	DSDB2A	39017-9	0.3-3.8	Residual Granite	Clayey sand	9.2	2001	SC	G7	21	28	8	3.8	16.3
DBTP 03	DSDB3A	39017-10	0.3-1.0	Residual Granite	Silt-clay-sand	5.3	1983	SM/SC	G6	36	25	6	3.1	21.4
DBTP 04	DSDB4A	39017-81	0.1-0.8	Colluvium	Silt-clay-sand	-	-	SM/SC	-	-	26	7	3.7	-
	DSDB4B	39017-80	0.8-3.7	Residual Granite	Clayey sand	-	-	SC	-	-	28	8	4.1	-
DBTP 06	DSDB6A	39017-17	0.6-2.10	Residual Granite	Clayey sand	12.6	1890	SC	G6	31	32	9	4.4	22.2
DBTP 08	DSDB8A	39017-20	0.2-0.5	Pedocrete	Clayey sand	-	-		-	37	28	10	5.1	-
	DSDB8B	39017-23	0.5-3.6	Residual Granite	Clayey sand	8.4	1935	SC	G6	33	28	9	4.2	21.9
DBTP 10	DSDB10A	39017-95	0.1-0.3	Alluvium	Silty sand	-	-	SM	-	-	-	SP	1.3	19
	DSDB10B	39017-94	0.3-0.6	Residual Granite	Clayey sand	-	-	SC	-	-	30	9	4.6	25.1
	DSDB10C	39017-96	0.6-2.3	Residual Granite	Silt-clay-sand	-	-	SM/SC	-	-	26	4	2	7.7
DBTP 11	DSDB11A	39017-112	0.1-1.0	Alluvium	Poorly graded river sand	-	-	SP	-	-	-	NP	0	-
DBTP 12	DSDB12A	39017-98	0.1-1.6	Alluvium	Silty river sand	-	-	SM	-	-	-	NP	0	15.3
DBTP 13	DSDB13A	39017-34	0.3-1.9	Residual Granite	Silt-clay-sand	10.6	1933	SM/SC	G6	44	28	7	3.3	16.9
DBTP 15	DSDB15A	39017-37	0.1-0.8	Pedocrete	Silt-clay-sand	6.1	2097	SM/SC	G5	66	24	5	3.7	12.7
DBTP 16	DSDB16A	39017-99	0.3-3.3	Alluvium	Well-graded river sand	-	-	SW	-	-	-	NP	0	6.3
DBTP 17	DSDB17A	39017-100	0.1-0.4	Colluvium	Silt-clay-sand	-	-	SM/SC	-	-	23	4	2	18.1
	DSDB17B	39017-42	0.4-1.5	Residual Granite	Clayey sand	9.0	1970	SC	G5	46	29	10	4.9	17.2
DBTP 18	DSDB18A	39017-101	0.4-2.4	Alluvium	Well graded silty river sand	-	-	SW/WM	-	-	NP	0	1	7.2
DBTP 19	DSDB19A	39017-45	0.3-3.6	Residual Granite	Clayey sand	10.6	1953	SC	G7	20	29	8	4	21.7

LETABA LAB (Pty) Ltd

24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/3(i) | Date Sampled : **12-Dec-23**

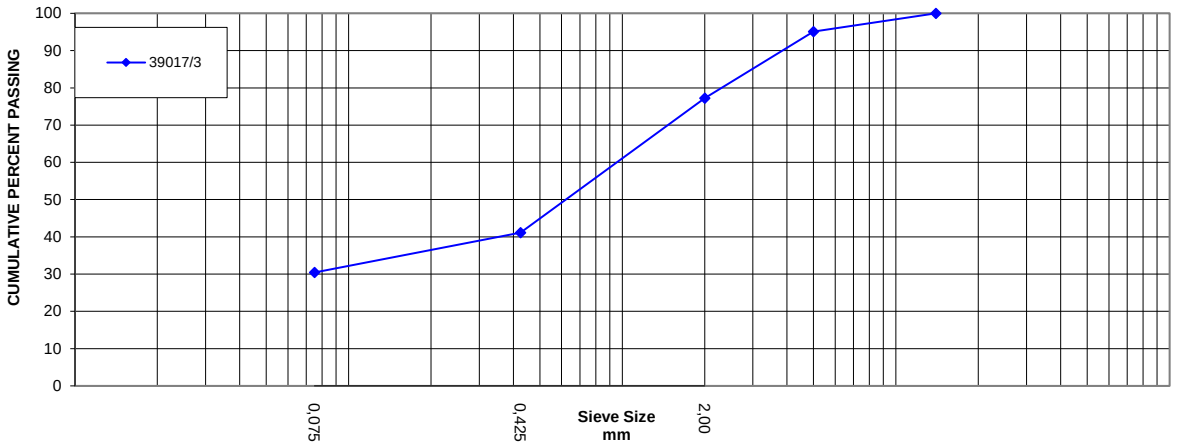
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **17-Jan-24**

Description : **DBTP 1 - DBDS 1A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.7-2.3	39017/3	lt Red. Orange Clayey sand					100	95	77	41	30	1,5	35	9	4,6	SC	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**954**
Curvature co-eff. :	**0,1**
Oversize Index :	**0**
Shrinkage Product :	**189**
Grading co-eff. :	**21,6**

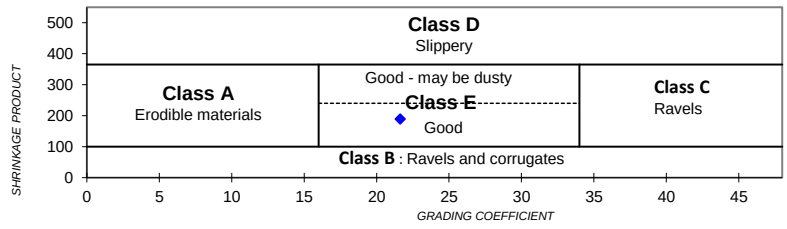
CBR RESULTS (%) :

@ 100% comp. :	**71**
@ 98% comp. :	**61**
@ 97% comp. :	**57**
@ 95% comp. :	**50**
@ 93% comp. :	**43**
@ 90% comp. :	**35**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**46,8%**
Fine Sand (<0.425>0.075mm):	**13,8%**
Silt & Clay (<0.075mm):	**39,4%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:53:35 +02'00'

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24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

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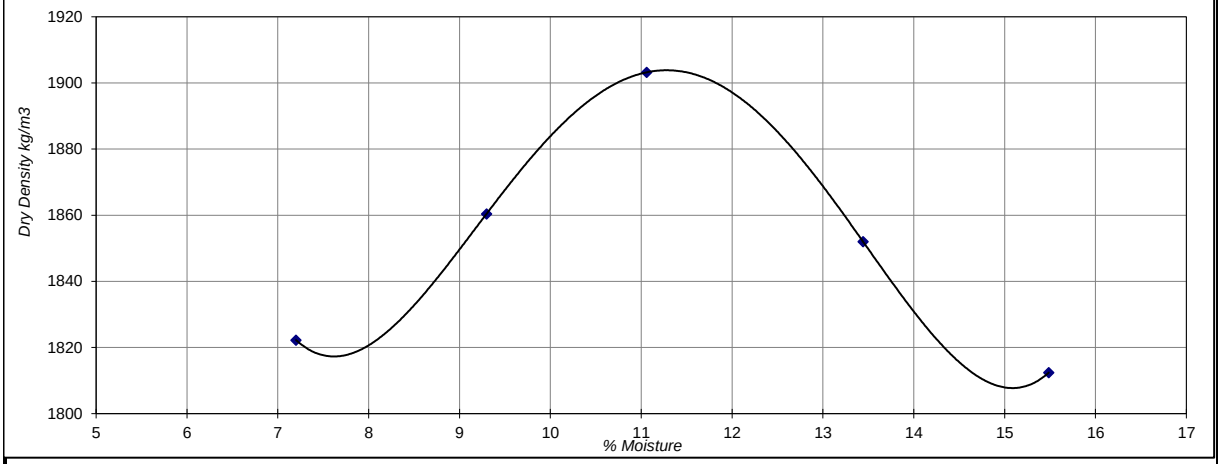
LETABA LAB

CBR and Maximum Dry Density test report

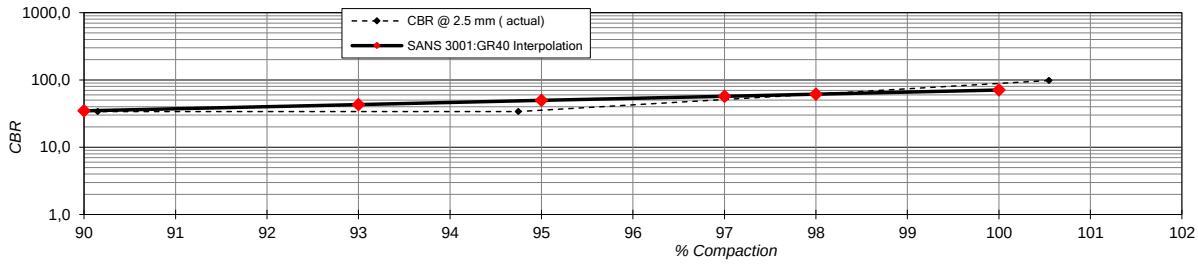
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**17-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 1 - DBDS 1A sampled by client - uncrushed material***	*Sample no:*	**39017/3**
		Doc no:	**39017/3(II)**

Maximum Dry Density =	**1904**	**kg/m³**
Optimum moisture content =	**11,3**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**71**	**61**	**57**	**50**	**43**	**35**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,5%**	**94,7%**	**90,2%**
Dry Density (kg/m³):	**1914**	**1804**	**1716**
Compaction Moisture (%):	**11,0**	**11,2**	**11,1**
% Swell:	**0,1**	**0,2**	**0,4**

This sample was sampled by the client and prepared for compaction by using the Scalping method

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P.O Box 739,
White River, 1240

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/9(i) | Date Sampled : **12-Dec-23**

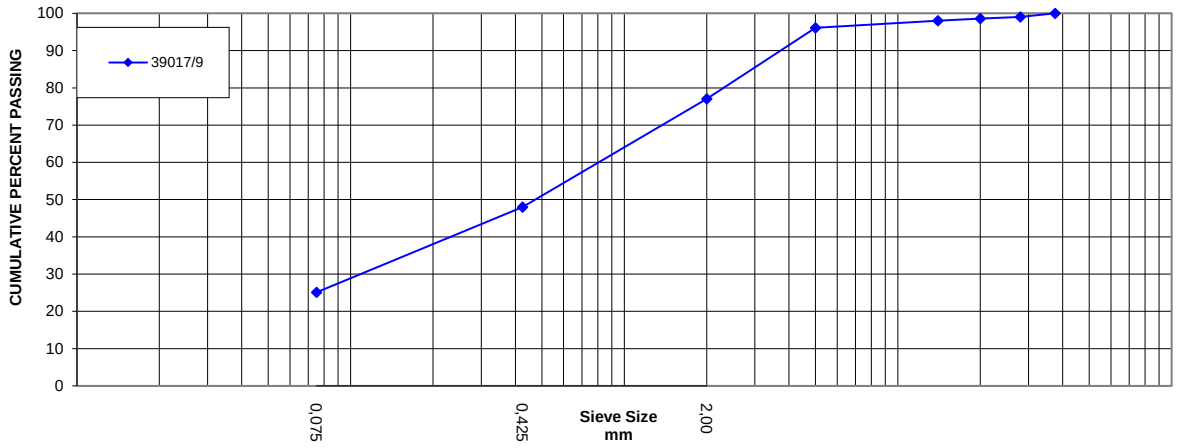
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **18-Jan-24**

Description : **DBTP 2 - DSDB 2A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.3-3.8	39017/9	lt Brown Clayey sand		100	99	99	98	96	77	48	25	1,5	28	8	3,8	SC	G7	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**806**
Curvature co-eff. :	**14,6**
Oversize Index :	**0**
Shrinkage Product :	**182**
Grading co-eff. :	**21,2**

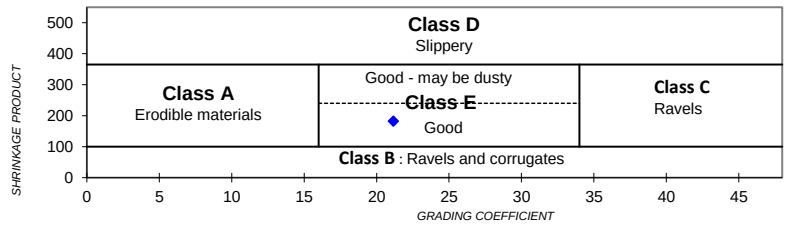
CBR RESULTS (%) :

@ 100% comp. :	**46**
@ 98% comp. :	**33**
@ 97% comp. :	**28**
@ 95% comp. :	**21**
@ 93% comp. :	**15**
@ 90% comp. :	**9**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**37,7%**
Fine Sand (<0.425>0.075mm):	**29,7%**
Silt & Clay (<0.075mm):	**32,6%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

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Nelspruit, 1200
P.O Box 739,
White River, 1240

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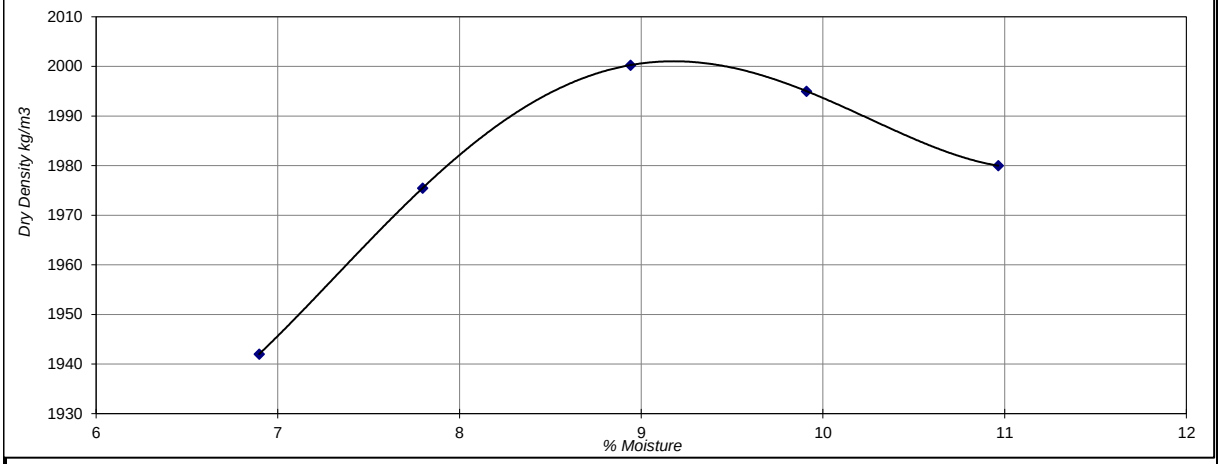
LETABA LAB

CBR and Maximum Dry Density test report

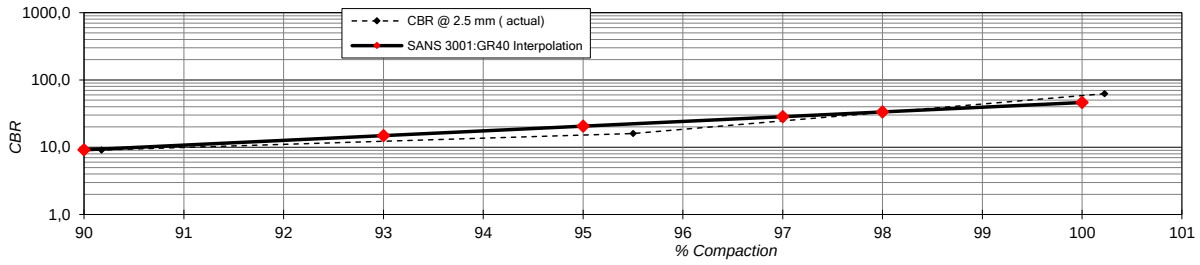
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**18-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 2 - DSDB 2A sampled by client - uncrushed material***	*Sample no:*	**39017/9**
		Doc no:	**39017/9(II)**

Maximum Dry Density =	**2001**	**kg/m³**
Optimum moisture content =	**9,2**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**46**	**33**	**28**	**21**	**15**	**9**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,2%**	**95,5%**	**90,2%**
Dry Density (kg/m³):	**2006**	**1911**	**1804**
Compaction Moisture (%):	**9,0**	**9,0**	**8,9**
% Swell:	**0,1**	**0,1**	**0,4**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/10(i) | Date Sampled : **12-Dec-23**

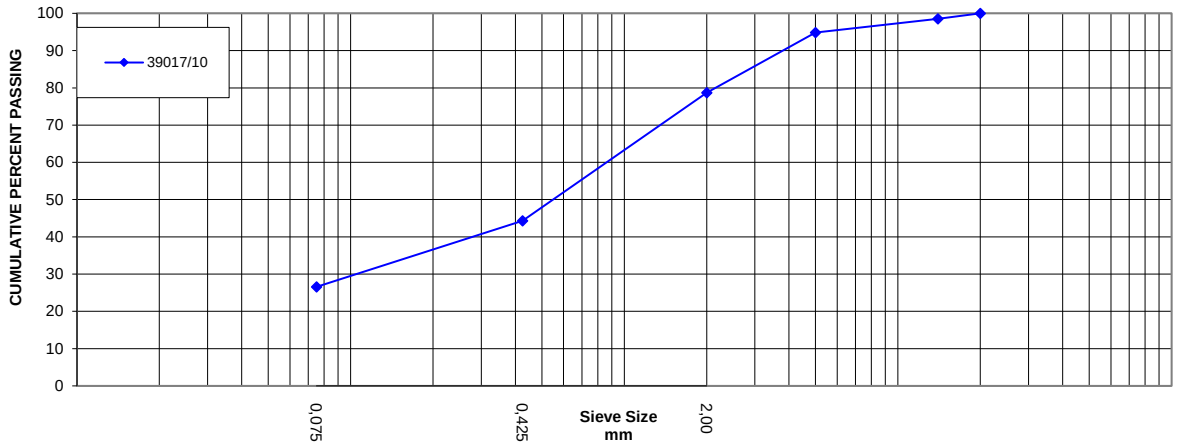
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **17-Jan-24**

Description : **DBTP 3 - DSDB 3A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.3-1.0	39017/10	drk Brown Silty/clayey sand				100	99	95	79	44	27	1,5	25	6	3,1	sm/sc	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**862**
Curvature co-eff. :	**12,8**
Oversize Index :	**0**
Shrinkage Product :	**137**
Grading co-eff. :	**20,2**

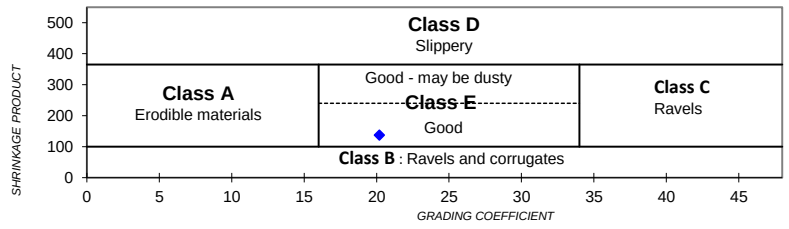
CBR RESULTS (%) :

@ 100% comp. :	**72**
@ 98% comp. :	**55**
@ 97% comp. :	**47**
@ 95% comp. :	**36**
@ 93% comp. :	**27**
@ 90% comp. :	**18**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**43,7%**
Fine Sand (<0.425>0.075mm):	**22,5%**
Silt & Clay (<0.075mm):	**33,8%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:52:32 +02'00'

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Nelspruit, 1200
P.O Box 739,
White River, 1240

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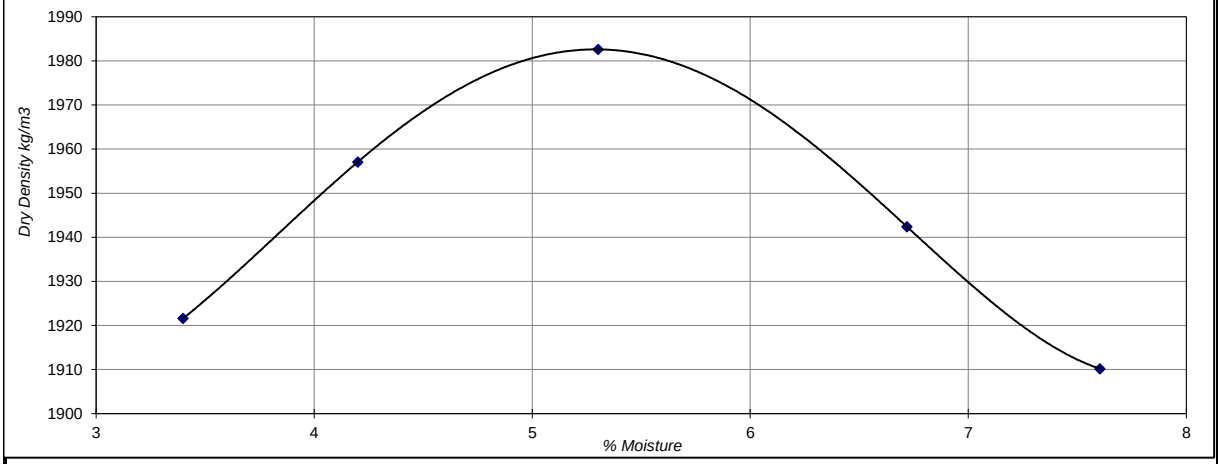
LETABA LAB

CBR and Maximum Dry Density test report

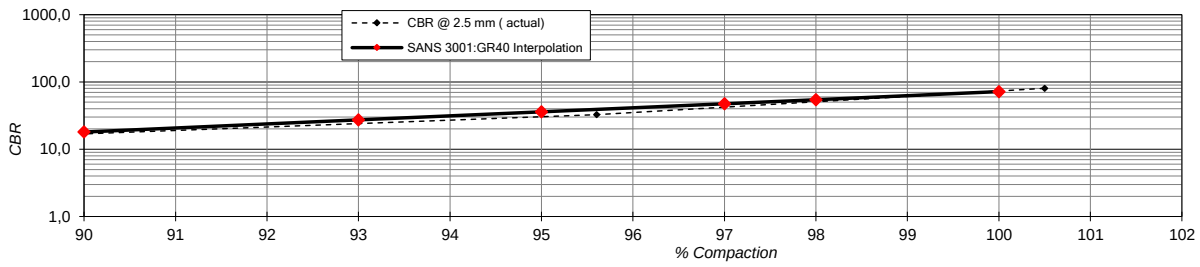
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**17-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 3 - DSDB 3A sampled by client - uncrushed material***	*Sample no:*	**39017/10**
		Doc no:	**39017/10(II)**

Maximum Dry Density =	**1983**	**kg/m³**
Optimum moisture content =	**5,3**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**72**	**55**	**47**	**36**	**27**	**18**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,5%**	**95,6%**	**90,0%**
Dry Density (kg/m³):	**1992**	**1895**	**1784**
Compaction Moisture (%):	**5,3**	**5,1**	**5,2**
% Swell:	**0,1**	**0,2**	**0,5**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:52:43 +02'00'

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Nelspruit, 1200
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White River, 1240

T0549

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/17(i) | Date Sampled : **12-Dec-23**

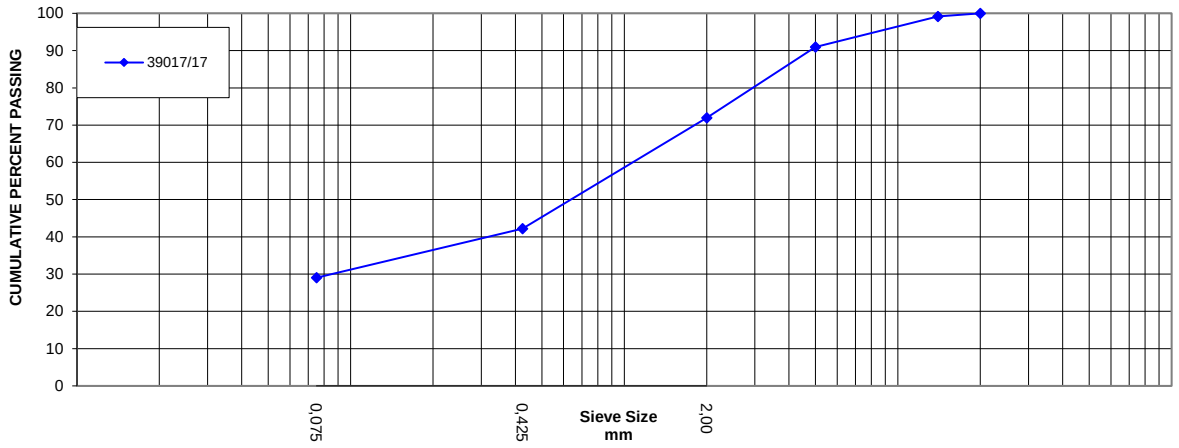
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **15-Jan-24**

Description : **DBTP 6 - DSDB 6A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,6-2.10	39017/17	lt Reddish Brown Clayey sand				100	99	91	72	42	29	1,6	32	9	4,4	SC	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**1073**
Curvature co-eff. :	**6,8**
Oversize Index :	**0**
Shrinkage Product :	**186**
Grading co-eff. :	**25,5**

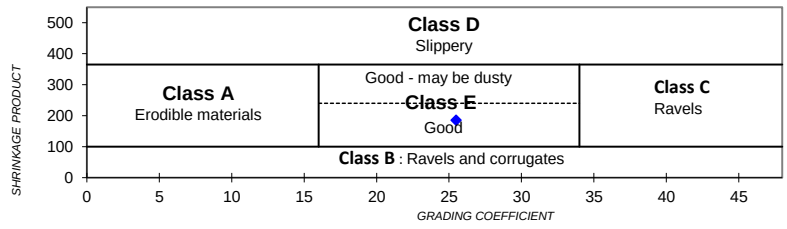
CBR RESULTS (%) :

@ 100% comp. :	**67**
@ 98% comp. :	**49**
@ 97% comp. :	**42**
@ 95% comp. :	**31**
@ 93% comp. :	**23**
@ 90% comp. :	**15**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**41,4%**
Fine Sand (<0.425>0.075mm):	**18,3%**
Silt & Clay (<0.075mm):	**40,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:52:10 +02'00'

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P.O Box 739,
White River, 1240

T0549

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Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

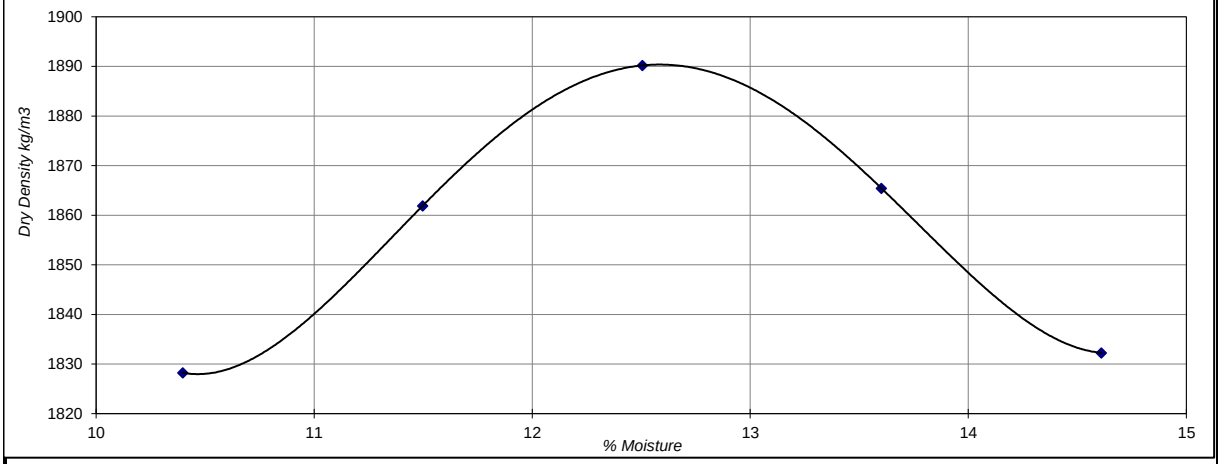
LETABA LAB

CBR and Maximum Dry Density test report

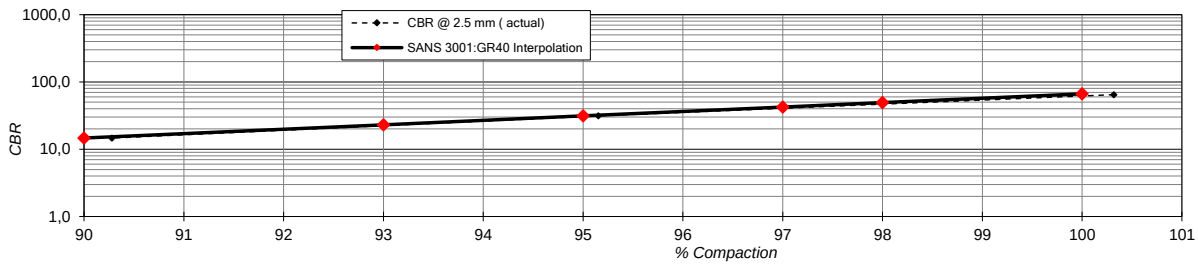
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**15-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 6 - DSDB 6A sampled by client - uncrushed material***	*Sample no:*	**39017/17**
		Doc no:	**39017/17(II)**

Maximum Dry Density =	**1890**	**kg/m³**
Optimum moisture content =	**12,6**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**67**	**49**	**42**	**31**	**23**	**15**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,3%**	**95,2%**	**90,3%**
Dry Density (kg/m³):	**1896**	**1798**	**1706**
Compaction Moisture (%):	**12,5**	**12,6**	**12,7**
% Swell:	**0,1**	**0,2**	**0,5**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:52:20 +02'00'

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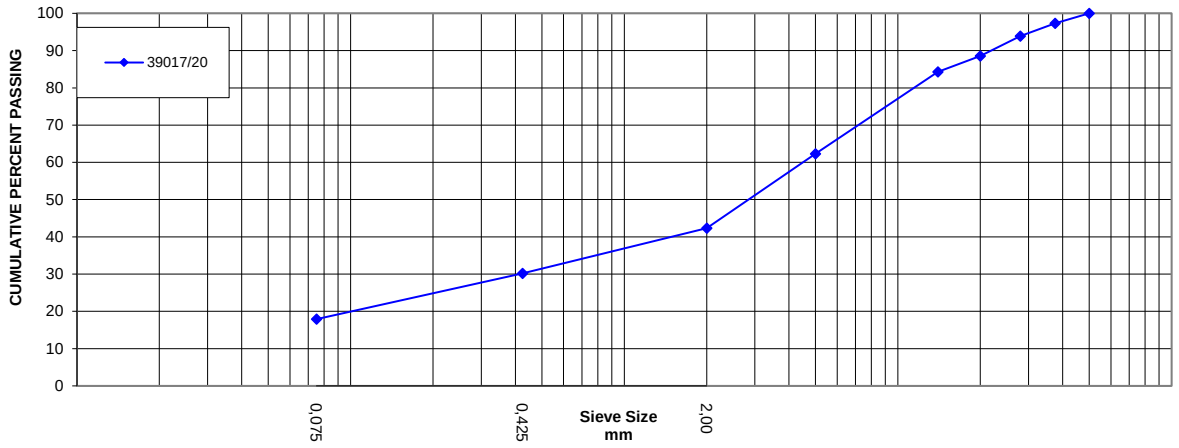
GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab**	Doc No: 39017/20(i)	Date Sampled : **12-Dec-23**
Address: -		Date Received: **15-Jan-24**
Contract : **LL3876**		Date Tested : **28-Jan-24**
Description : **DBTP 8 - DSDB 8A sampled by client - uncrushed material**		

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.2-0.5	39017/20	drk Brown Clayey sand	100	97	94	89	84	62	42	30	18	2,1	28	10	5,1	SC	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**4496**
Curvature co-eff. :	**37,9**
Oversize Index :	**3**
Shrinkage Product :	**154**
Grading co-eff. :	**32,2**

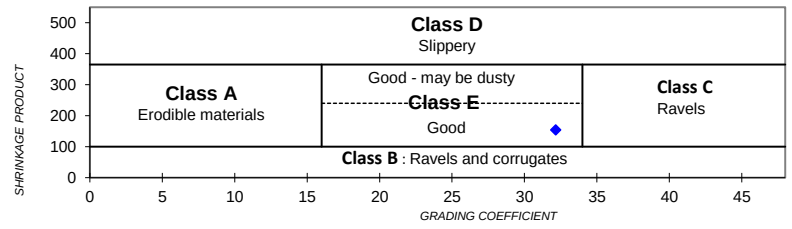
CBR RESULTS (%) :

@ 100% comp. :	**75**
@ 98% comp. :	**57**
@ 97% comp. :	**49**
@ 95% comp. :	**37**
@ 93% comp. :	**28**
@ 90% comp. :	**18**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**28,6%**
Fine Sand (<0.425>0.075mm):	**29,0%**
Silt & Clay (<0.075mm):	**42,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

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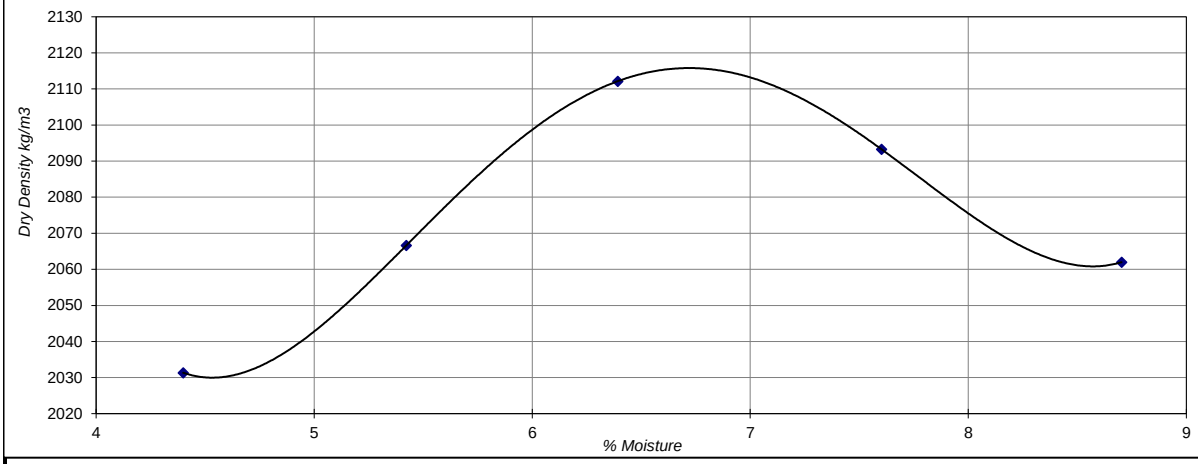
LETABA LAB

CBR and Maximum Dry Density test report

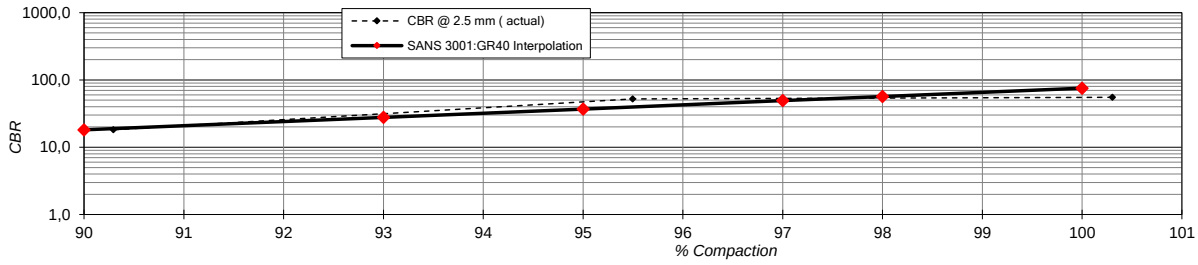
SANS 3001 Methods
GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**28-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 8 - DSDB 8A sampled by client - uncrushed material***	*Sample no:*	**39017/20**
		Doc no:	**39017/20(II)**

Maximum Dry Density =	**2116**	**kg/m³**
Optimum moisture content =	**6,7**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**75**	**57**	**49**	**37**	**28**	**18**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,3%**	**95,5%**	**90,3%**
Dry Density (kg/m³):	**2122**	**2021**	**1911**
Compaction Moisture (%):	**6,2**	**6,3**	**6,3**
% Swell:	**0,1**	**0,1**	**0,3**

This sample was sampled by the client and prepared for compaction by using the Scalping method

*Please note that test results are only relevant to the sample delivered to the lab, and based on information and/or instructions provided by the client. Any results may only be reproduced in their entirety with the written consent of LETABA LAB (Pty) Ltd, and any opinions and interpretations expressed,or results marked *, fall outside our Scope of Accreditation.*

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/23(i) | Date Sampled : **12-Dec-23**

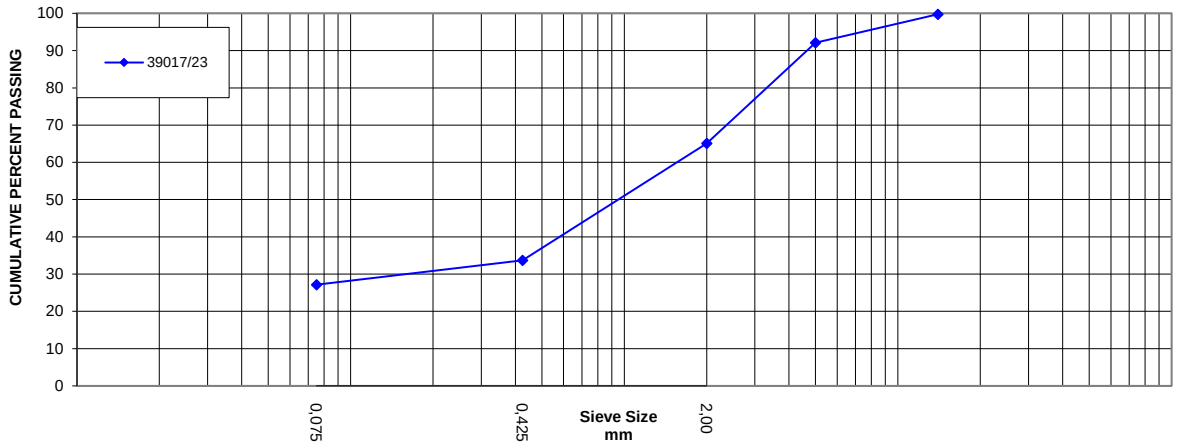
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 8 - DSDB 8B sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,5-3,6	39017/23	lt Yel. Orange Clayey sand					100	92	65	34	27	1,7	28	9	4,2	SC	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**1557**
Curvature co-eff. :	**16,2**
Oversize Index :	**0**
Shrinkage Product :	**142**
Grading co-eff. :	**32,2**

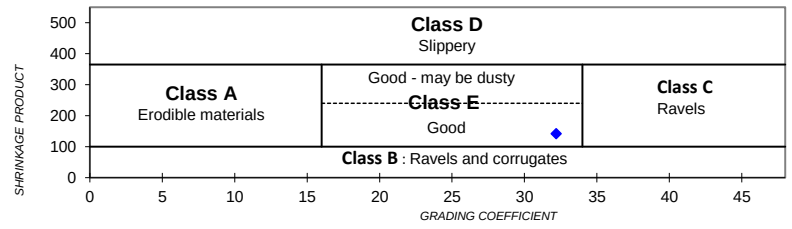
CBR RESULTS (%) :

@ 100% comp. :	**72**
@ 98% comp. :	**53**
@ 97% comp. :	**45**
@ 95% comp. :	**33**
@ 93% comp. :	**25**
@ 90% comp. :	**16**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**48,2%**
Fine Sand (<0.425>0.075mm):	**10,0%**
Silt & Clay (<0.075mm):	**41,8%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:51:21 +02'00'

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Nelspruit, 1200
P.O Box 739,
White River, 1240

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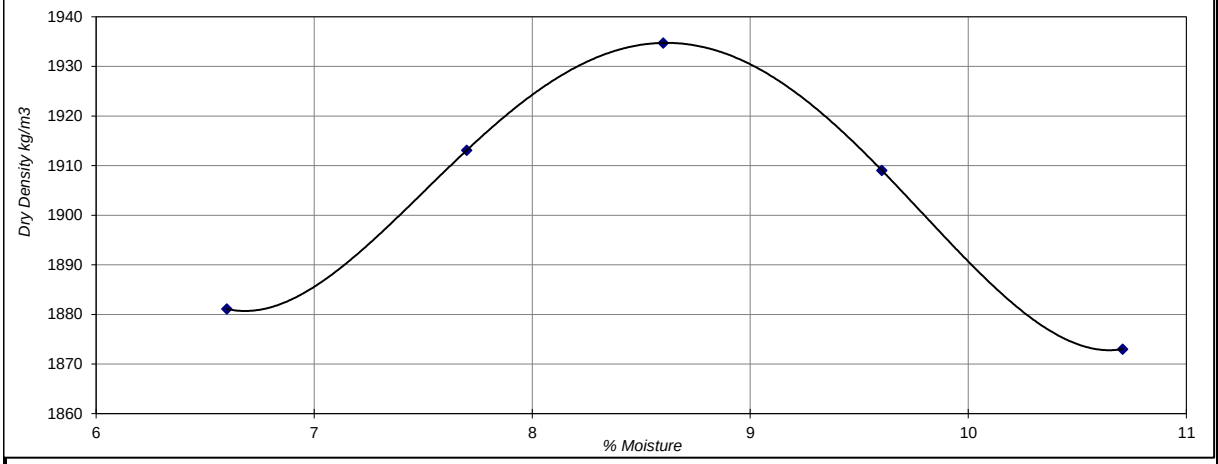
LETABA LAB

CBR and Maximum Dry Density test report

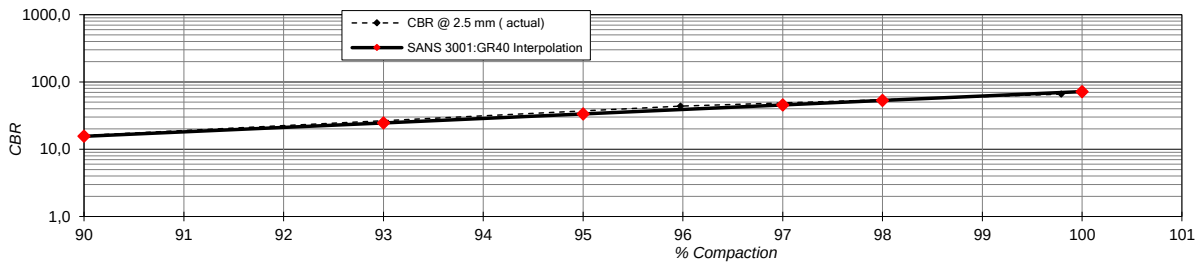
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**27-Jan-24**
Contract :	***LL3876***	*Date Received:*	**12-Dec-23**
Description:	***DBTP 8 - DSDB 8B sampled by client - uncrushed material***	*Sample no:*	**39017/23**
		Doc no:	**39017/23(II)**

Maximum Dry Density =	**1935**	**kg/m³**
Optimum moisture content =	**8,6**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**72**	**53**	**45**	**33**	**25**	**16**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**99,8%**	**96,0%**	**89,9%**
Dry Density (kg/m³):	**1931**	**1857**	**1740**
Compaction Moisture (%):	**8,6**	**8,5**	**8,7**
% Swell:	**0,1**	**0,2**	**0,4**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/34(i) | Date Sampled : **12-Dec-23**

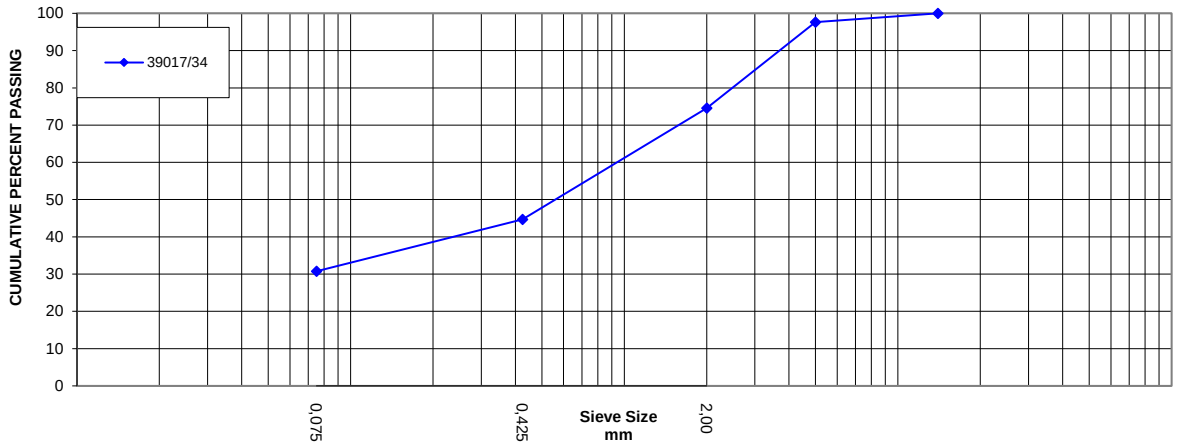
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **17-Jan-24**

Description : **DBTP 13 - DSDB 13A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.3-1.9	39017/34	lt Reddish Brown Silty/clayey sand					100	98	75	45	31	1,5	28	7	3,3	sm/sc	G6	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**939**
Curvature co-eff. :	**0,1**
Oversize Index :	**0**
Shrinkage Product :	**148**
Grading co-eff. :	**24,8**

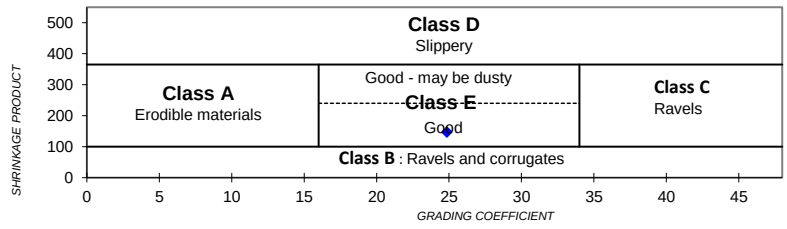
CBR RESULTS (%) :

@ 100% comp. :	**79**
@ 98% comp. :	**63**
@ 97% comp. :	**56**
@ 95% comp. :	**44**
@ 93% comp. :	**35**
@ 90% comp. :	**25**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**40,0%**
Fine Sand (<0.425>0.075mm):	**18,7%**
Silt & Clay (<0.075mm):	**41,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

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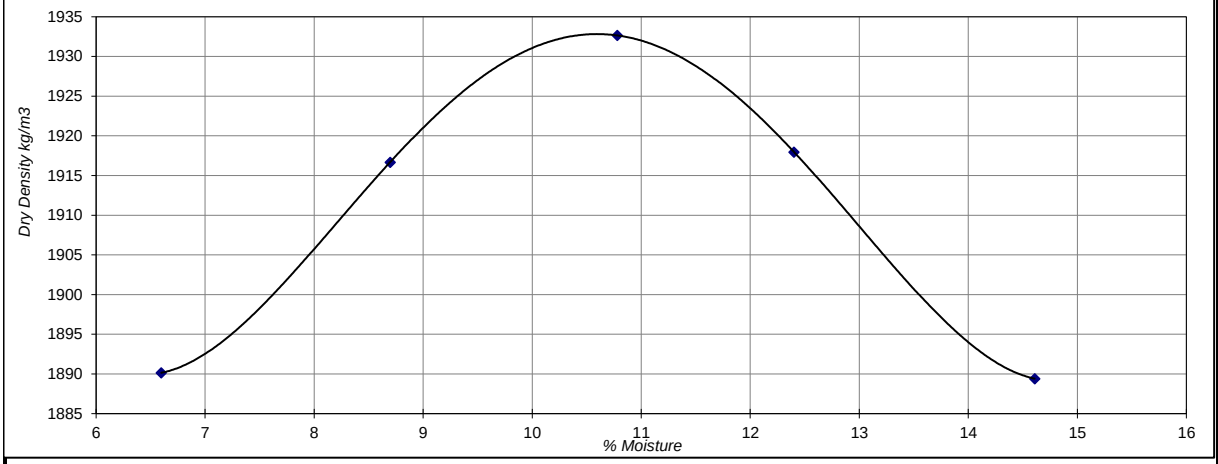
LETABA LAB

CBR and Maximum Dry Density test report

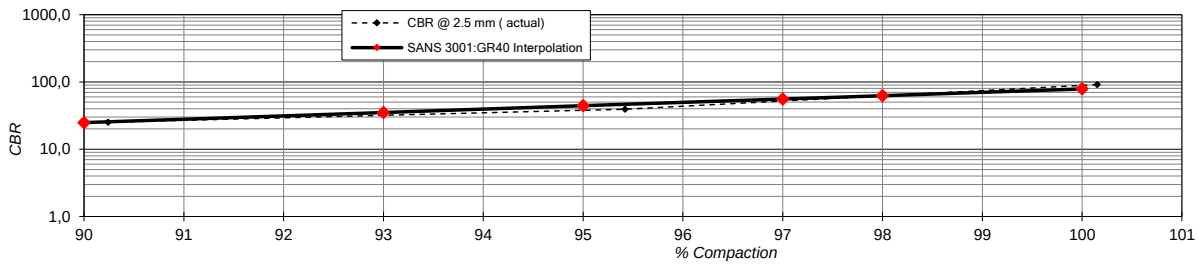
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**17-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 13 - DSDB 13A sampled by client - uncrushed material***	*Sample no:*	**39017/34**
		Doc no:	**39017/34(II)**

Maximum Dry Density =	**1933**	**kg/m³**
Optimum moisture content =	**10,6**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**79**	**63**	**56**	**44**	**35**	**25**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,2%**	**95,4%**	**90,2%**
Dry Density (kg/m³):	**1936**	**1844**	**1744**
Compaction Moisture (%):	**10,8**	**10,6**	**10,7**
% Swell:	**0,1**	**0,1**	**0,4**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06

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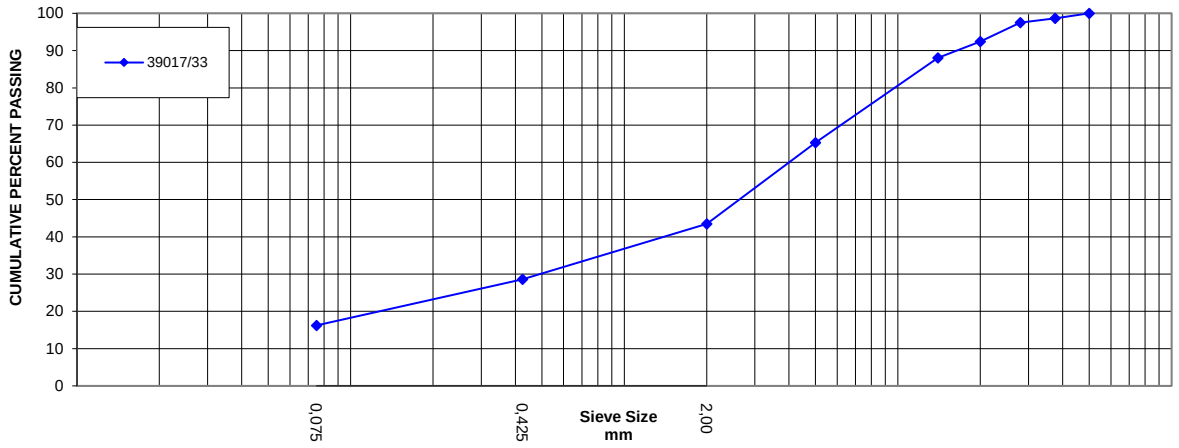
GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab**	Doc No: 39017/33(i)	Date Sampled : **12-Dec-23**
Address: -		Date Received: **12-Dec-23**
Contract : **LL3876**		Date Tested : **27-Jan-24**
Description : **DBTP 15 - DSDB 15A sampled by client - uncrushed material**		

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,1 0,8	39017/33	drk Brown Silty/clayey sand	100	99	98	92	88	65	43	29	16	2,1	24	5	3,7	sm/sc	G5	A-1-b	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**4006**
Curvature co-eff. :	**60,0**
Oversize Index :	**1**
Shrinkage Product :	**106**
Grading co-eff. :	**35,3**

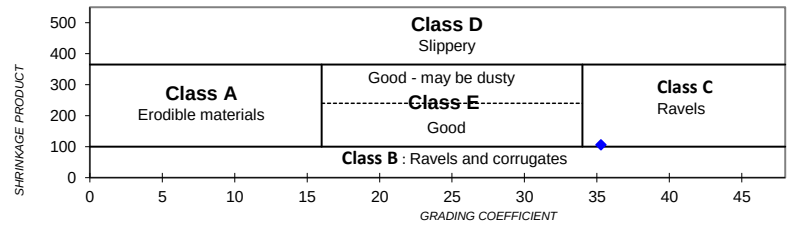
CBR RESULTS (%) :

@ 100% comp. :	**128**
@ 98% comp. :	**98**
@ 97% comp. :	**86**
@ 95% comp. :	**66**
@ 93% comp. :	**51**
@ 90% comp. :	**35**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**34,2%**
Fine Sand (<0.425>0.075mm):	**28,5%**
Silt & Clay (<0.075mm):	**37,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and prepared for compaction by using the Scalping method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:50:29 +02'00'

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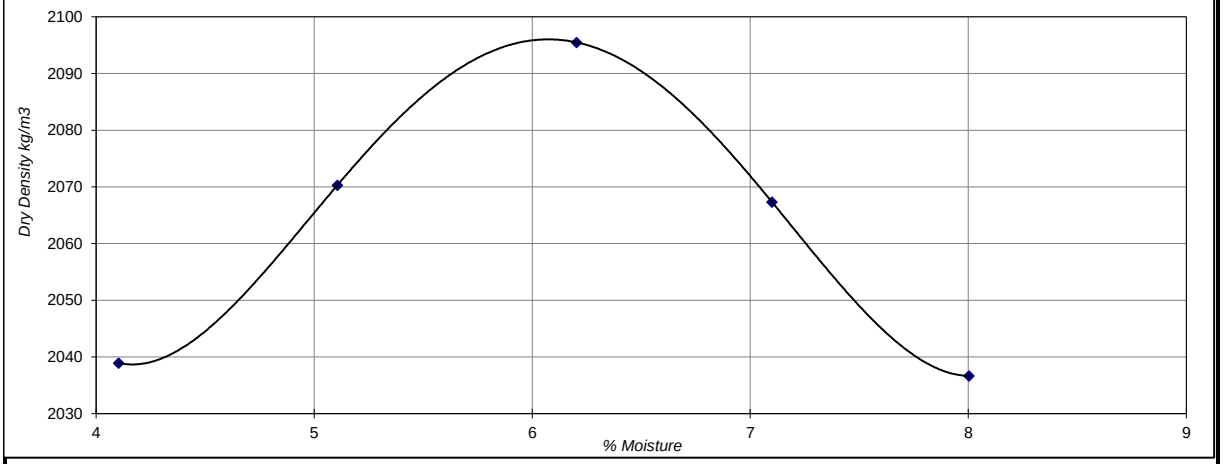
LETABA LAB

CBR and Maximum Dry Density test report

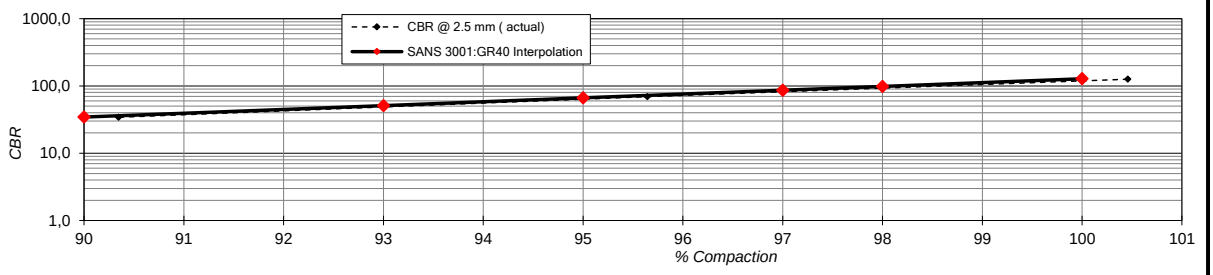
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**27-Jan-24**
Contract :	***LL3876***	*Date Received:*	**12-Dec-23**
Description:	***DBTP 15 - DSDB 15A sampled by client - uncrushed material***	*Sample no:*	**39017/33**
		Doc no:	**39017/33(II)**

Maximum Dry Density =	**2097**	**kg/m³**
Optimum moisture content =	**6,1**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**128**	**98**	**86**	**66**	**51**	**35**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,5%**	**95,6%**	**90,3%**
Dry Density (kg/m³):	**2107**	**2006**	**1895**
Compaction Moisture (%):	**6,0**	**6,1**	**6,2**
% Swell:	**0,1**	**0,1**	**0,3**

This sample was sampled by the client and prepared for compaction by using the Scalping method

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:50:43 +02'00'

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/42(i) | Date Sampled : **12-Dec-23**

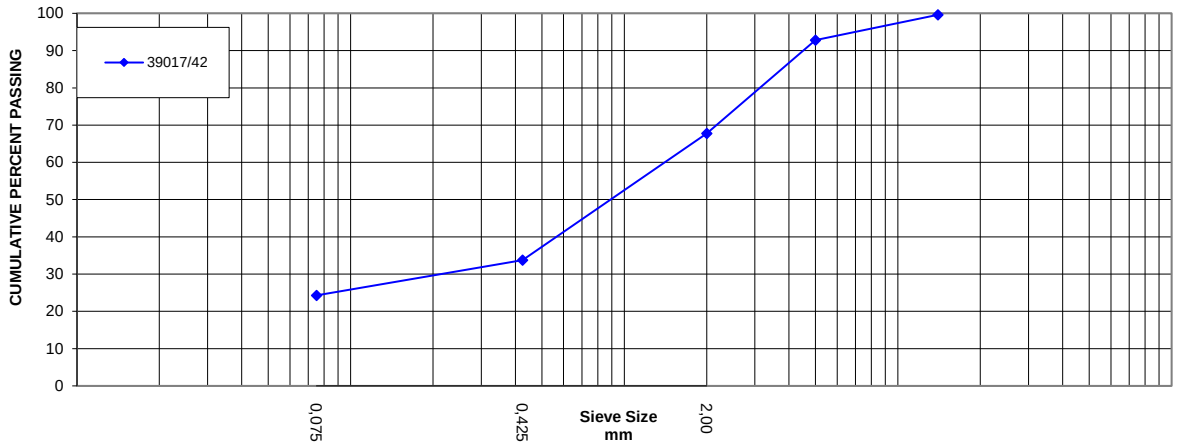
Address: - | Date Received: **15-Jan-24**

Contract : **LL3876** | Date Tested : **15-Jan-24**

Description : **DBTP 17 - DSDB 17B sampled by lab - crushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.4-1.5	39017/42	drk YellowClayey sand					100	93	68	34	24	1,7	29	10	4,9	SC	G5	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**1404**
Curvature co-eff. :	**32,6**
Oversize Index :	**0**
Shrinkage Product :	**165**
Grading co-eff. :	**29,9**

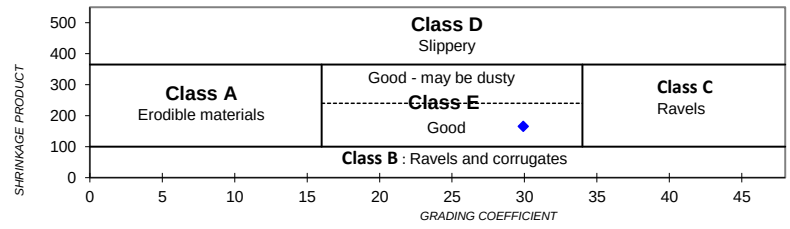
CBR RESULTS (%) :

@ 100% comp. :	**92**
@ 98% comp. :	**70**
@ 97% comp. :	**61**
@ 95% comp. :	**46**
@ 93% comp. :	**35**
@ 90% comp. :	**23**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**50,2%**
Fine Sand (<0.425>0.075mm):	**13,9%**
Silt & Clay (<0.075mm):	**35,8%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by Letaba Lab and prepared for compaction by using the Crushing method

Please note that pH and Electrical Conductivity tests were not requested for this sample

Technical signatory

Date Issued: 2024/03/06 *(Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:50:06 +02'00'

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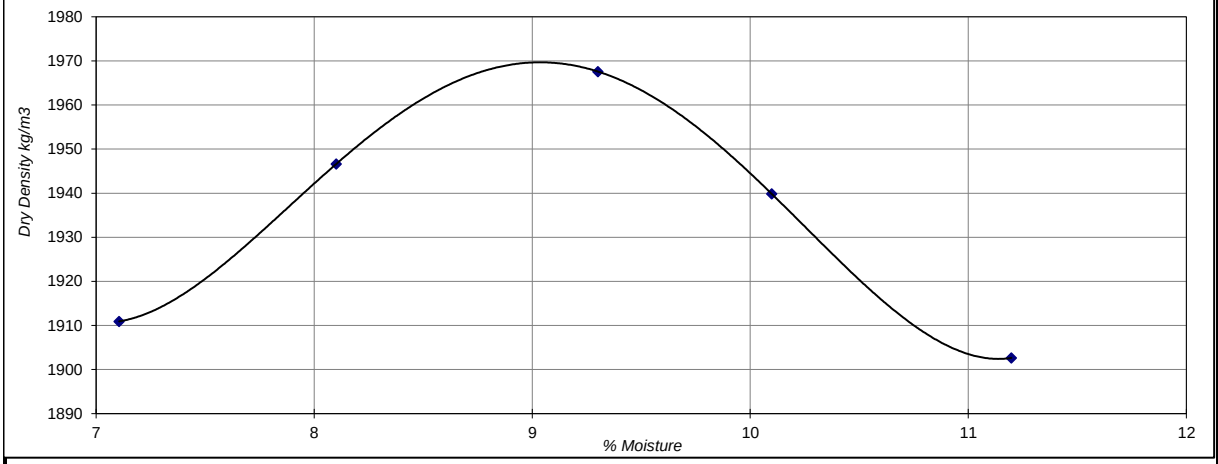
LETABA LAB

CBR and Maximum Dry Density test report

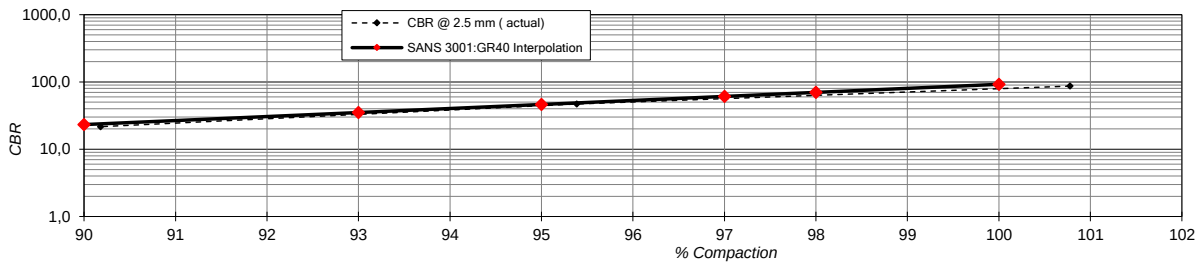
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**15-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 17 - DSDB 17B sampled by lab - crushed material***	*Sample no:*	**39017/42**
		Doc no:	**39017/42(II)**

Maximum Dry Density =	**1970**	**kg/m³**
Optimum moisture content =	**9,0**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**92**	**70**	**61**	**46**	**35**	**23**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,8%**	**95,4%**	**90,2%**
Dry Density (kg/m³):	**1985**	**1879**	**1777**
Compaction Moisture (%):	**9,0**	**9,2**	**9,2**
% Swell:	**0,1**	**0,2**	**0,4**

This sample was sampled by Letaba Lab and prepared for compaction by using the Crushing method

*Please note that test results are only relevant to the sample tested and based on information and/or instructions provided by the client. Samples were taken in accordance with TMH5 : 1981, Method MA2 : Test Pit, by the lab at positions and frequencies stipulated by client. Any results may only be reproduced in their entirety with the written consent of LETABA LAB (Pty) Ltd, and any opinions and interpretations expressed, or results marked *, fall outside our Scope of Accreditation.*

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P.O Box 739,
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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** Doc No: 39017/45(i)

Address: -

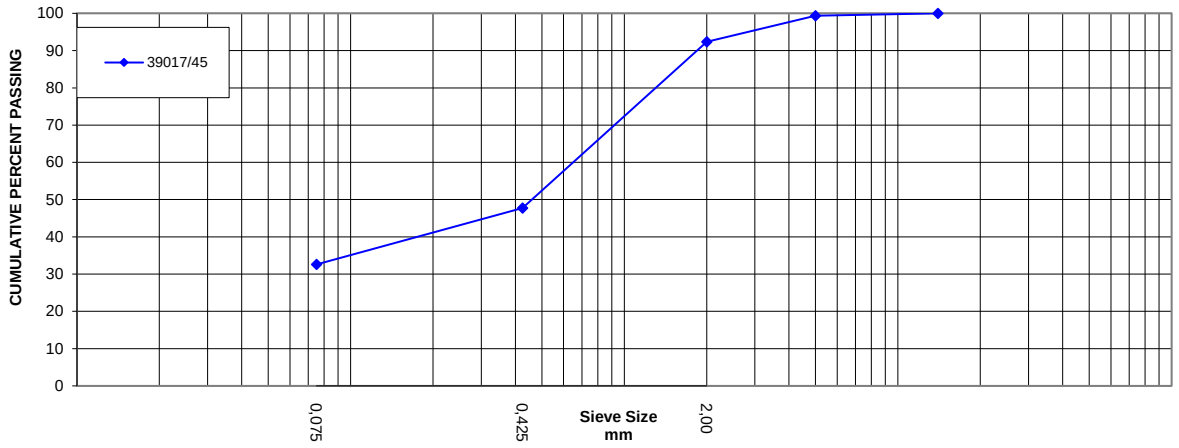
Contract : **LL3876**

Description : **DBTP 19 - DSDBTP 19A sampled by lab - crushed material**

Date Sampled : **12-Dec-23**
Date Received: **15-Jan-24**
Date Tested : **15-Jan-24**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.3-0.6	39017/45	drk Yel. Orange Clayey sand					100	99	92	48	33	1,3	29	8	4,0	SC	G7	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**651**
Curvature co-eff. :	**0,2**
Oversize Index :	**0**
Shrinkage Product :	**191**
Grading co-eff. :	**7,6**

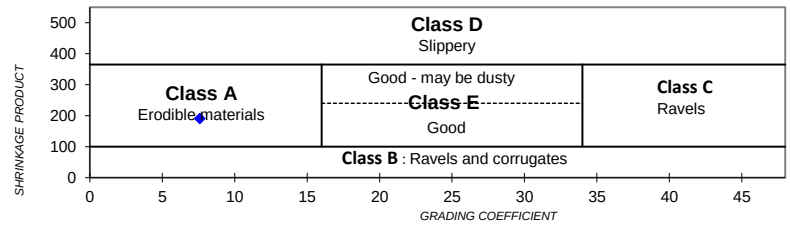
CBR RESULTS (%) :

@ 100% comp. :	**32**
@ 98% comp. :	**27**
@ 97% comp. :	**24**
@ 95% comp. :	**20**
@ 93% comp. :	**16**
@ 90% comp. :	**12**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**48,3%**
Fine Sand (<0.425>0.075mm):	**16,4%**
Silt & Clay (<0.075mm):	**35,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS

Please note that this material was clasified as a non-calcretic material

This sample was sampled by Letaba Lab and prepared for compaction by using the Crushing method

Please note that pH and Electrical Conductivity tests were not requested for this sample

*Please note that test results are only relevant to the sample tested and based on information and/or instructions provided by the client. Samples were taken in accordance with TMH5 : 1981, Method MA2 : Test Pit, by the lab at positions and frequencies stipulated by client. Any results may only be reproduced in their entirety with the written consent of LETABA LAB (Pty) Ltd, and any opinions and interpretations expressed, or results marked *, fall outside our Scope of Accreditation.*

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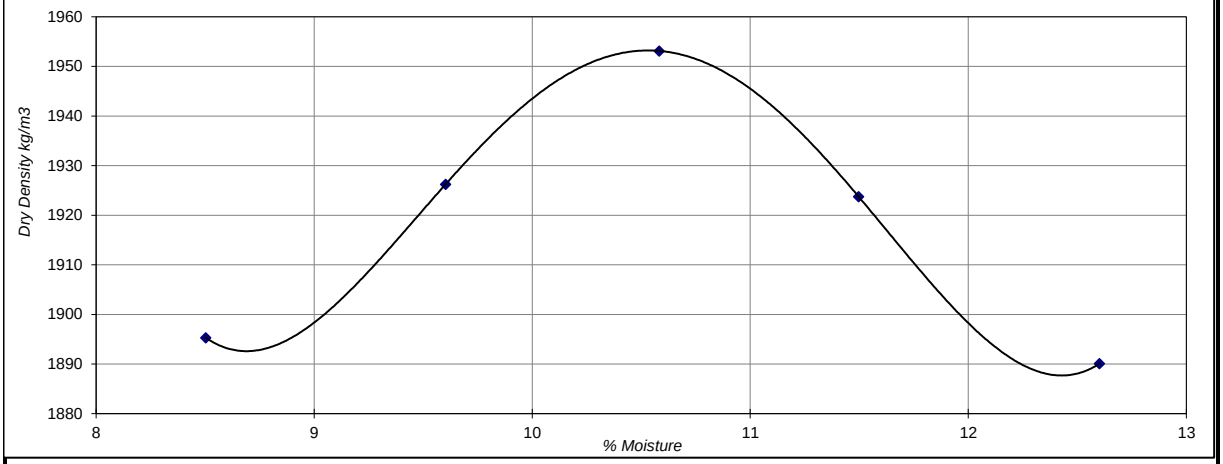
CBR and Maximum Dry Density test report

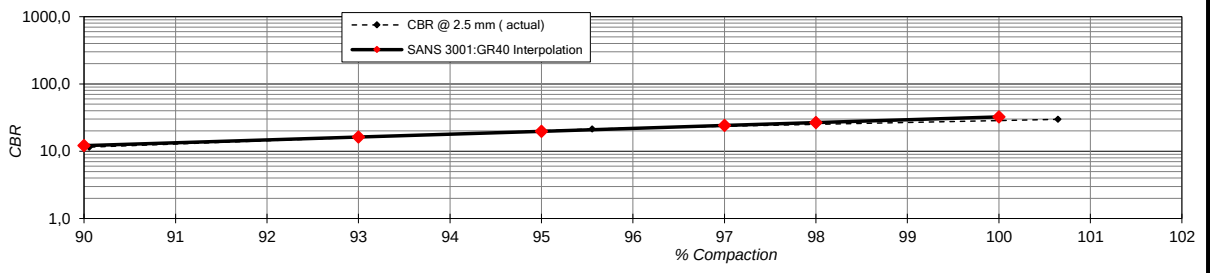
SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client:	***Engeo Lab***	*Date tested:*	**15-Jan-24**
Contract :	***LL3876***	*Date Received:*	**15-Jan-24**
Description:	***DBTP 19 - DSDBTP 19A sampled by lab - crushed material***	*Sample no:*	**39017/45**
		Doc no:	**39017/45(II)**

Maximum Dry Density =	**1953**	**kg/m³**
Optimum moisture content =	**10,6**	**%**



California Bearing Ratio



% Compaction	**100**	**98**	**97**	**95**	**93**	**90**
CBR of 13.3 kN	**32**	**27**	**24**	**20**	**16**	**12**

** tests done at Mbombela (Nelspruit) branch

REMARKS

Briquette Information			
% Compaction of MDD:	**100,6%**	**95,6%**	**90,1%**
Dry Density (kg/m³):	**1966**	**1866**	**1759**
Compaction Moisture (%):	**10,5**	**10,6**	**10,7**
% Swell:	**0,1**	**0,1**	**0,1**

This sample was sampled by Letaba Lab and prepared for compaction by using the Crushing method

*Please note that test results are only relevant to the sample tested and based on information and/or instructions provided by the client. Samples were taken in accordance with TMH5 : 1981, Method MA2 : Test Pit, by the lab at positions and frequencies stipulated by client. Any results may only be reproduced in their entirety with the written consent of LETABA LAB (Pty) Ltd, and any opinions and interpretations expressed, or results marked *, fall outside our Scope of Accreditation.*

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** Doc No: 39017/80(i)

Address: -

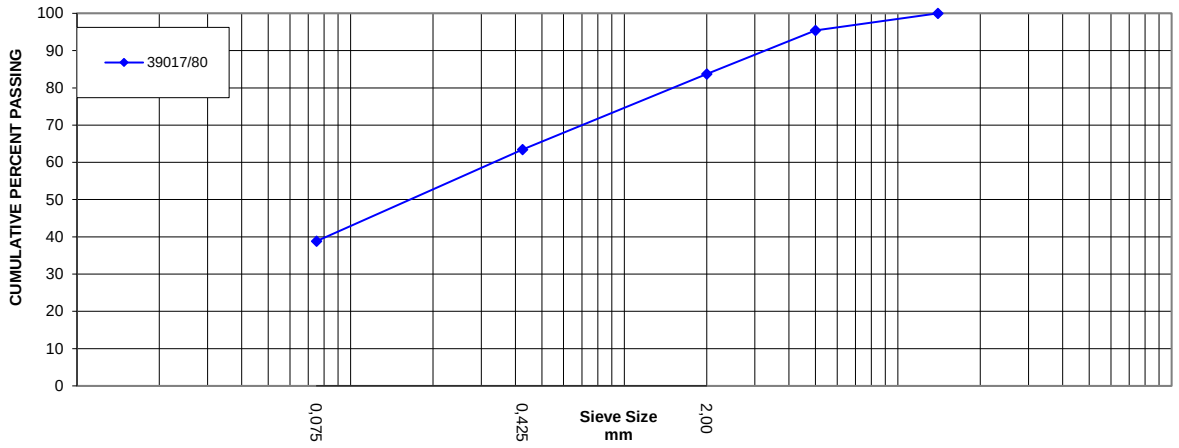
Contract : **LL3876**

Description : **DBTP 4 - DSDB 4B sampled by client - uncrushed material**

Date Sampled : **12-Dec-23**
Date Received: **12-Dec-23**
Date Tested : **14-Jan-24**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,8 - 3,7	39017/80	lt Yel. Orange Clayey sand					100	95	84	63	39	1,1	28	8	4,1	SC	N/A	A-4	1

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**333**
Curvature co-eff. :	**0,3**
Oversize Index :	**0**
Shrinkage Product :	**260**
Grading co-eff. :	**15,6**

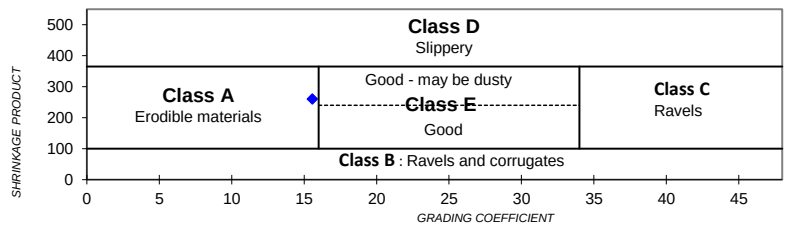
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**24,2%**
Fine Sand (<0.425>0.075mm):	**29,4%**
Silt & Clay (<0.075mm):	**46,4%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/81(i) | Date Sampled : **12-Dec-23**

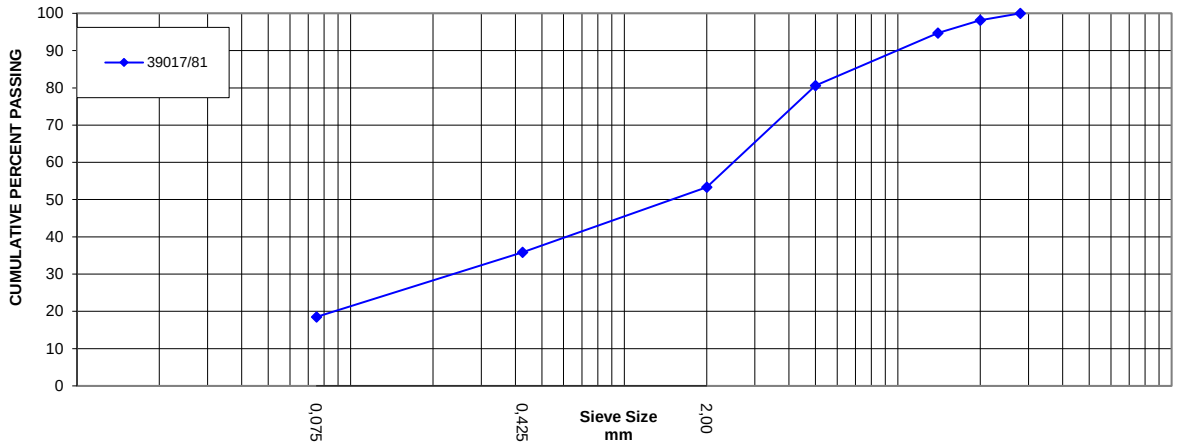
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 4 - DSDB 4A sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,1-0,8	39017/81	drk Brown Silty/clayey sand			100	98	95	81	53	36	19	1,9	26	7	3,7	sm/sc	N/A	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**2504**
Curvature co-eff. :	**22,3**
Oversize Index :	**0**
Shrinkage Product :	**133**
Grading co-eff. :	**37,6**

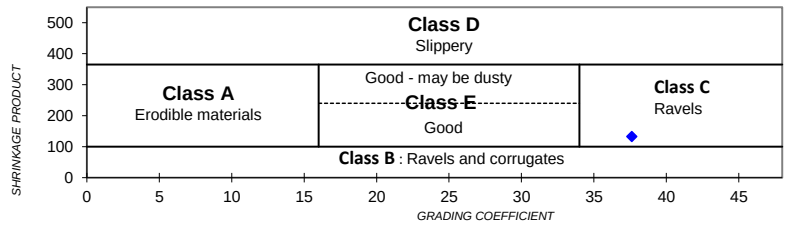
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**32,7%**
Fine Sand (<0.425>0.075mm):	**32,6%**
Silt & Clay (<0.075mm):	**34,7%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/94(i) | Date Sampled : **12-Dec-23**

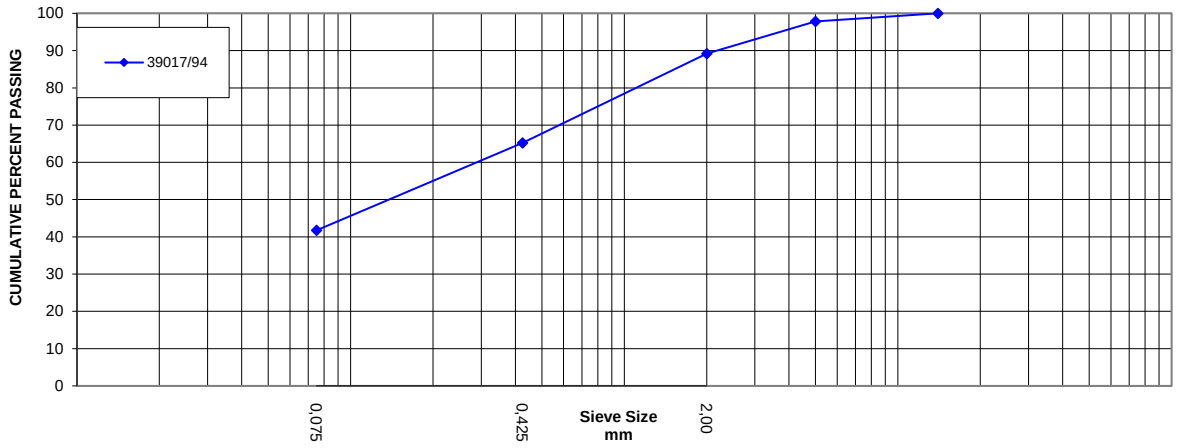
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 10 - DSDB 10B Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,3 - 0,6	39017/94	drk Brown Clayey sand					100	98	89	65	42	1,0	30	9	4,6	SC	N/A	A-4	1

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**289**
Curvature co-eff. :	**0,3**
Oversize Index :	**0**
Shrinkage Product :	**300**
Grading co-eff. :	**10,6**

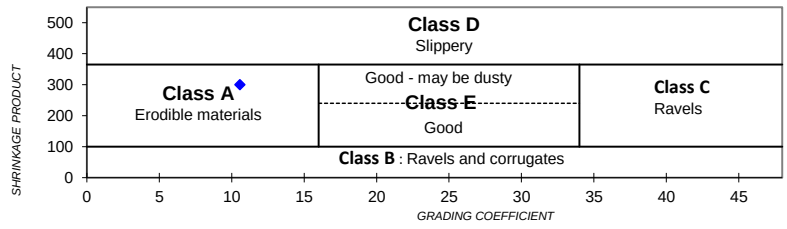
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**26,9%**
Fine Sand (<0.425>0.075mm):	**26,3%**
Silt & Clay (<0.075mm):	**46,8%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/95(i) | Date Sampled : **12-Dec-23**

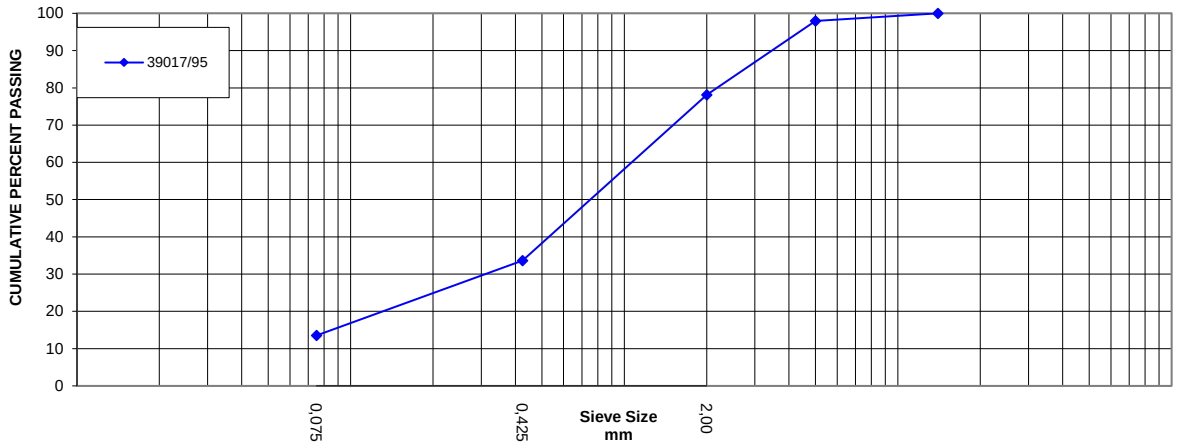
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 10 - DSDB 10A Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,1 - 0,3	39017/95	drk Reddish Brown Silty sand					100	98	78	34	14	1,7		SP	1,3	SM(d)	N/A	A-1-b	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**1064**
Curvature co-eff. :	**90,5**
Oversize Index :	**0**
Shrinkage Product :	**44**
Grading co-eff. :	**21,4**

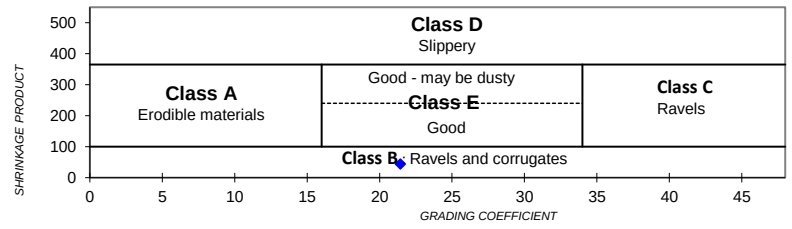
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**56,9%**
Fine Sand (<0.425>0.075mm):	**25,8%**
Silt & Clay (<0.075mm):	**17,3%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:48:55 +02'00'

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/96(i) | Date Sampled : **12-Dec-23**

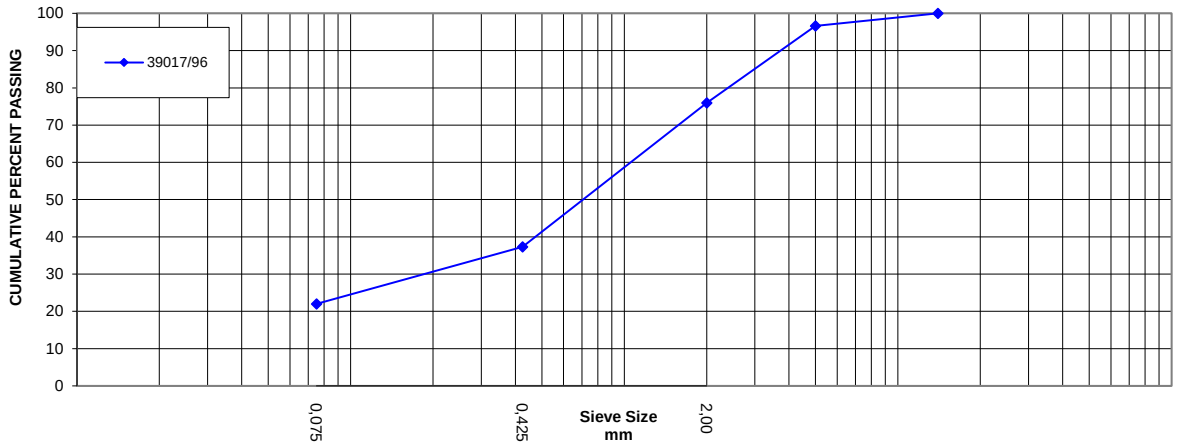
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 10 - DSDB 10C Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,6 - 2,3	39017/96	lt Reddish Brown Silty/clayey sand					100	97	76	37	22	1,6	26	4	2,0	sm/sc	N/A	A-1-b	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**1055**
Curvature co-eff. :	**32,6**
Oversize Index :	**0**
Shrinkage Product :	**75**
Grading co-eff. :	**23,2**

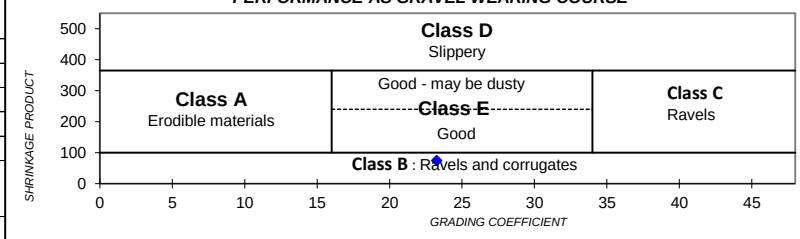
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**50,9%**
Fine Sand (<0.425>0.075mm):	**20,1%**
Silt & Clay (<0.075mm):	**29,0%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:48:40 +02'00'

1 of 1

LETABA LAB (Pty) Ltd

24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/98(i) | Date Sampled : **12-Dec-23**

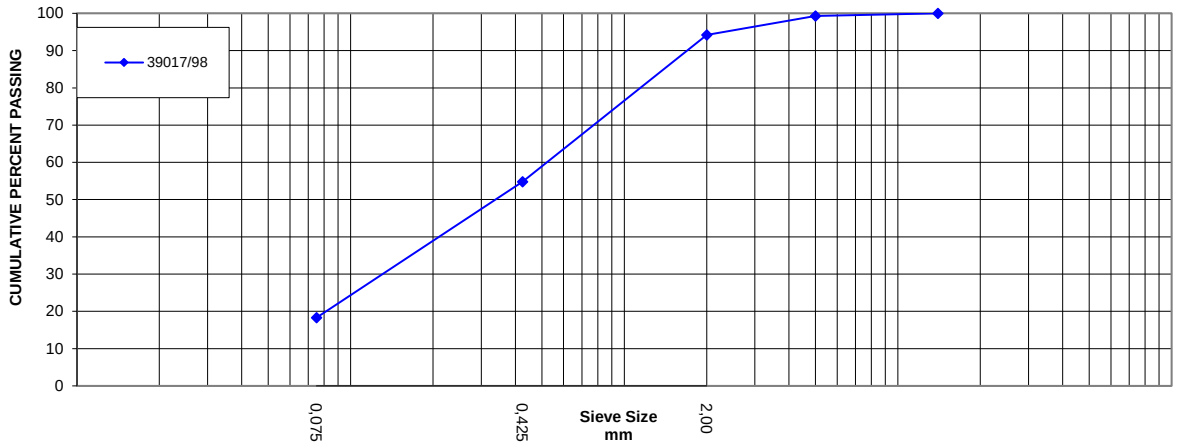
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 12 - River sand Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,1 - 1,6	39017/98	drk Brown Silty sand					100	99	94	55	18	1,3		NP	0,0	SM(d)	N/A	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**521**
Curvature co-eff. :	**32,8**
Oversize Index :	**0**
Shrinkage Product :	**0**
Grading co-eff. :	**5,7**

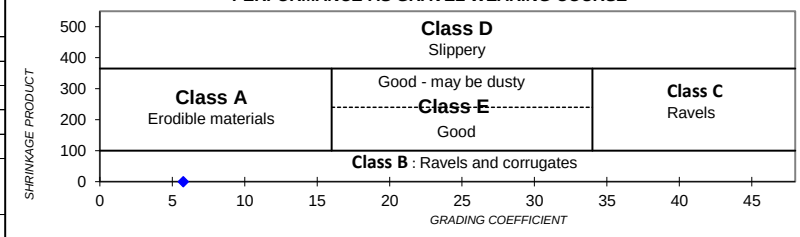
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**41,8%**
Fine Sand (<0.425>0.075mm):	**38,7%**
Silt & Clay (<0.075mm):	**19,4%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:48:26 +02'00'

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LETABA LAB (Pty) Ltd

24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/99(i) | Date Sampled : **12-Dec-23**

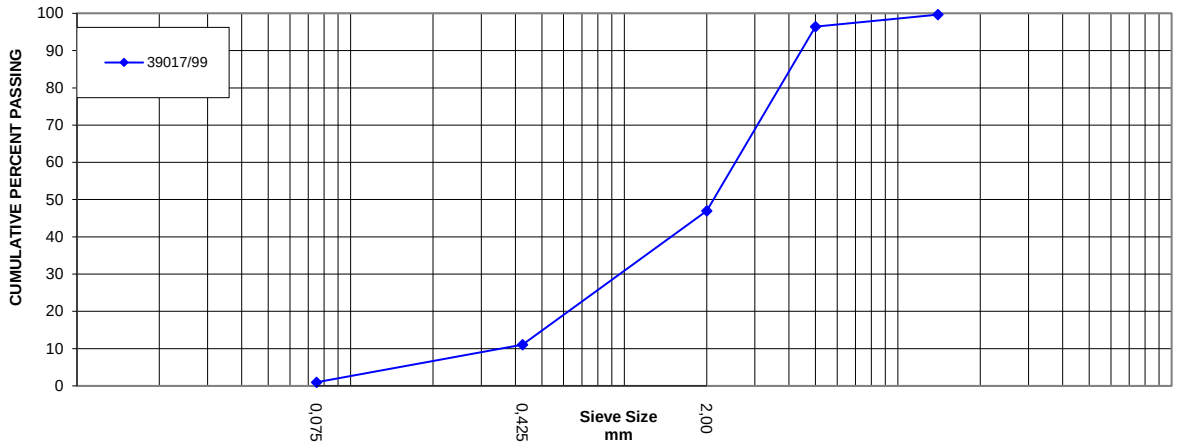
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 16 - DSDB 15A Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.3-3.3	39017/99	drk Brown Well graded sand					100	96	47	11	1	2,4		NP	0,0	SW	N/A	A-1-a	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**0,352**
Uniformity co-eff. :	**7**
Curvature co-eff. :	**1,0**
Oversize Index :	**0**
Shrinkage Product :	**0**
Grading co-eff. :	**51,1**

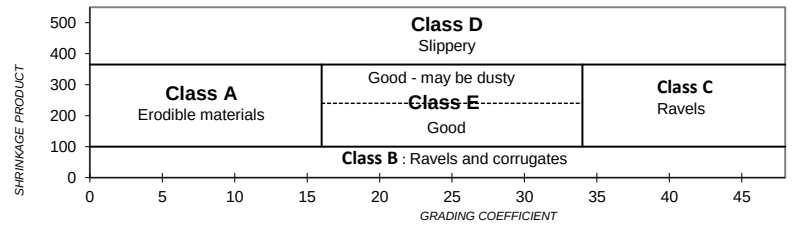
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**76,4%**
Fine Sand (<0.425>0.075mm):	**21,5%**
Silt & Clay (<0.075mm):	**2,1%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:48:10 +02'00'

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24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

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GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/100(i) | Date Sampled : **12-Dec-23**

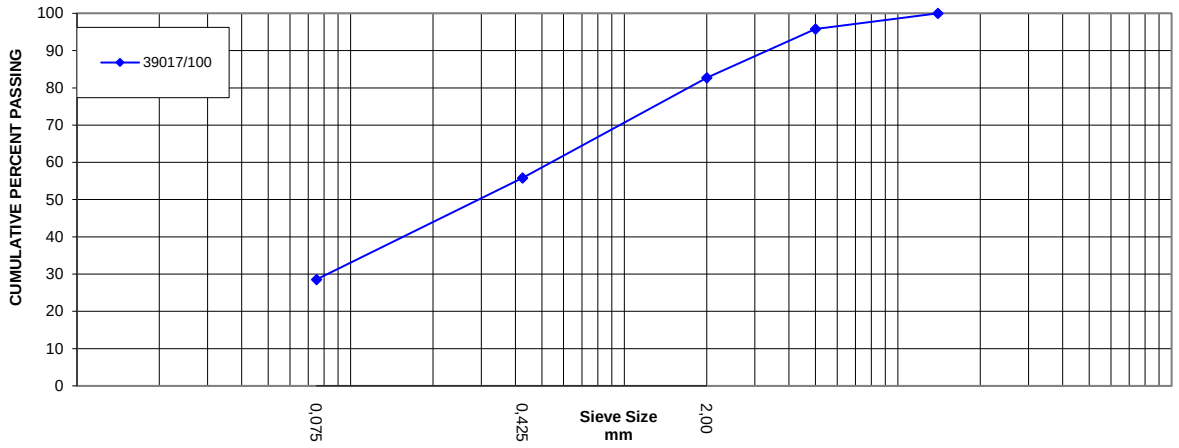
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 17 - DSDB 17A Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.1-0.4	39017/100	drk Brown Silty/clayey sand					100	96	83	56	29	1,3	23	4	2,0	sm/sc	N/A	A-2-4	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**<0.075**
Uniformity co-eff. :	**541**
Curvature co-eff. :	**12,5**
Oversize Index :	**0**
Shrinkage Product :	**112**
Grading co-eff. :	**16,6**

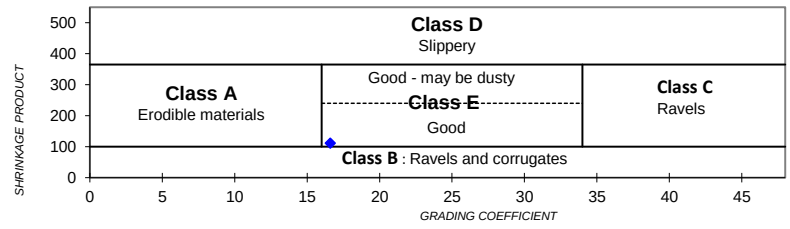
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**32,5%**
Fine Sand (<0.425>0.075mm):	**32,9%**
Silt & Clay (<0.075mm):	**34,6%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:47:56 +02'00'

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LETABA LAB (Pty) Ltd

24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/101(i) | Date Sampled : **12-Dec-23**

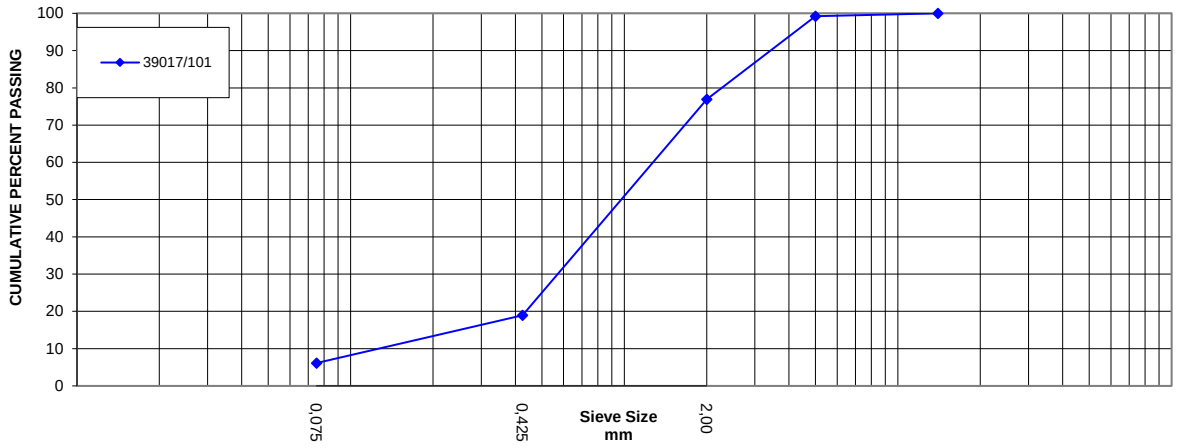
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **28-Jan-24**

Description : **DBTP 18 - DSDB 18A Material sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0.4-1.4	39017/101	lt Brown Well graded Silty sand					100	99	77	19	6	2,0		NP	0,0	sw/sm	N/A	A-1-b	0

GRADING ANALYSIS



GENERAL *

Effective size (mm): **0,127**
Uniformity co-eff. : **10**
Curvature co-eff. : **2,0**
Oversize Index : **0**
Shrinkage Product : **0**
Grading co-eff. : **22,9**

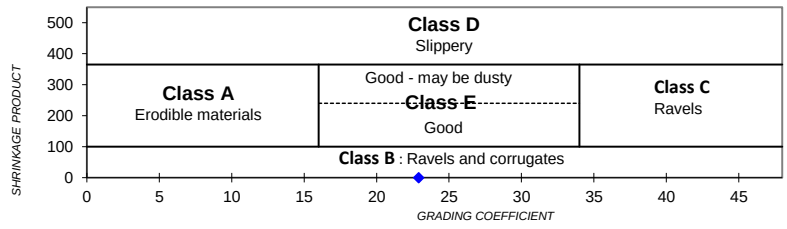
CBR RESULTS (%) :

@ 100% comp. : **N/A**
@ 98% comp. : **N/A**
@ 97% comp. : **N/A**
@ 95% comp. : **N/A**
@ 93% comp. : **N/A**
@ 90% comp. : **N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm): **75,3%**
Fine Sand (<0.425>0.075mm): **16,7%**
Silt & Clay (<0.075mm): **8,0%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06

Technical signatory (Name & signature) : Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:47:39 +02'00'

1 of 1

LETABA LAB (Pty) Ltd

24 Kragbron Street,
Nelspruit, 1200
P.O Box 739,
White River, 1240

T0549

CIVIL ENGINEERING MATERIALS LABORATORY

Tel. No: 087 285 0816 **e-mail :** letaba@letabalab.co.za www.letabalab.co.za

GRAVEL, SOIL AND SAND TEST REPORT

SANS 3001 Methods GR1, GR5, GR10, GR20, GR30 & GR40

Client : **Engeo Lab** | Doc No: 39017/112(i) | Date Sampled : **12-Dec-23**

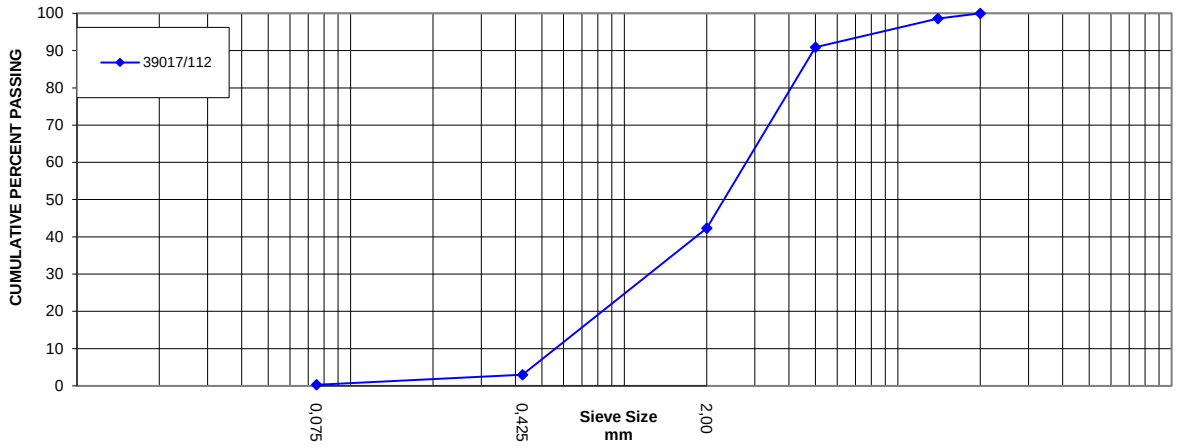
Address: - | Date Received: **12-Dec-23**

Contract : **LL3876** | Date Tested : **27-Jan-24**

Description : **DBTP 11 - DSDB River sand 1 sampled by client - uncrushed material**

Depth (m)	Sample No	Description * (Unified Soil Classification)	Sieve Analysis Cumulative percentage passing 50,0	37,5	28	20,0	14,0	5,0	2,00	0,425	0,075	Grading Modulus	Atterberg Limits (%) Liquid Limit	Plasticity Index	Linear Shrinkage	Classification * Unified Soil	COLTO : 1998	US. Highway	Group Index
0,1 - 1,0	39017/112	lt Brown Poorly graded sand				100	99	91	42	3	0	2,5		NP	0,0	SP	N/A	A-1-a	0

GRADING ANALYSIS



GENERAL *

Effective size (mm):	**0,559**
Uniformity co-eff. :	**5**
Curvature co-eff. :	**1,0**
Oversize Index :	**0**
Shrinkage Product :	**0**
Grading co-eff. :	**52,4**

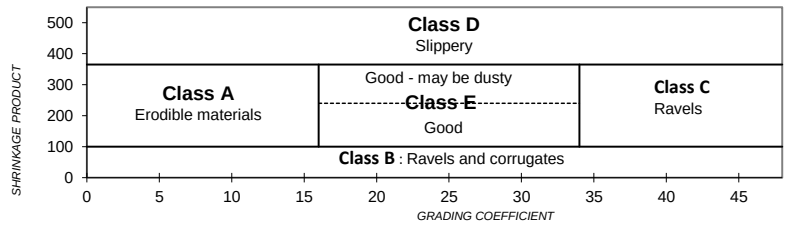
CBR RESULTS (%) :

@ 100% comp. :	**N/A**
@ 98% comp. :	**N/A**
@ 97% comp. :	**N/A**
@ 95% comp. :	**N/A**
@ 93% comp. :	**N/A**
@ 90% comp. :	**N/A**

Soil Mortar Analysis : SANS 3001-PR5 *

Coarse Sand (<2.0>0.425mm):	**92,8%**
Fine Sand (<0.425>0.075mm):	**6,5%**
Silt & Clay (<0.075mm):	**0,7%**

PERFORMANCE AS GRAVEL WEARING COURSE *



*** tests done at Mbombela (Nelspruit) branch*

REMARKS ***No COLTO classification possible as MDD & CBR were not requested***

Please note that this material was clasified as a non-calcretic material

This sample was sampled by the client and no MDD and CBR was requested

Please note that pH and Electrical Conductivity tests were not requested for this sample

Date Issued: 2024/03/06 *Technical signatory (Name & signature) :* Digitally signed by Jacobus Strydom Koster Date: 2024.03.06 10:47:23 +02'00'

1 of 1

APPENDIX D
BH PROFILES & CORE PHOTOS

QUARRY & DAM BASIN SITE's

Northing: 26:21:04.9030 | **Easting:** 30:48:19.6715 | **Elevation:** 1310.05

GEOTECHNICAL CORE LOG

Date Logged: 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA												No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures				Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent Ff/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength		
Q1	0.00	0.20	0.20	100	NA	999		0.00	1.50	1.40	0.10	93	TCOL		NA	999	0.0	999	999						6								10	Decomposed / residuum, Soil-like, Defects not measureable, Colluvium (undif.)
Q1	0.20	0.95	0.65	87	NA	999		1.50	8.49	0.85	6.14	12	GR	M	NM	999	2.0	999	999						5				CL	4.0			10	Completely weathered, Soil-like, Shattered, Granite
Q1	0.95	1.50	0.55	100	NA	999		8.49	10.10	1.45	0.16	90	GR	M	1.45	90	4.5	10	6	0	0	0	0	0	1.5	12	901	5.5	KF	1.0			70	Slightly weathered to fresh, Very strong, Blocky widely jointed, Granite
Q1	1.50	3.00	0.20	13	NA	999		10.10	11.10	0.95	0.05	95	PEG	C	0.95	95	5.0	3	3	0	0	0	0	1	1	11	900	5.5	-				75	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q1	3.00	4.50	0.20	13	NA	999		11.10	12.80	1.68	0.02	99	GR	M	1.68	99	4.5	0	0	1	1	0	0	2	1	13	888	5.5	-				87	Unweathered/fresh, Very strong, Blocky widely jointed, Granite
Q1	4.50	5.50	0.15	15	NA	999		12.80	14.55	1.57	0.18	90	PEG	C	1.57	90	5.0	0	0	1	0	0	0	1	1	14	880	5.5	-				86	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q1	5.50	6.55	0.15	14	NA	999		14.55										0	0															
Q1	6.55	8.00	0.15	10	NA	999																												
Q1	8.00	8.63	0.13	21	NM	999																												
Q1	8.63	9.33	0.59	84	0.59	84																												
Q1	9.33	10.02	0.60	87	0.60	87																												
Q1	10.02	10.45	0.41	95	0.41	95																												
Q1	10.45	10.75	0.30	100	0.30	100																												
Q1	10.75	11.50	0.75	100	0.75	100																												
Q1	11.50	12.50	0.93	93	0.93	93																												
Q1	12.50	13.20	0.57	81	0.57	81																												
Q1	13.20	14.55	1.35	100	1.35	100																												
	14.55																																	

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q1 **Logged by:** JJC **Date Logged:** 07/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
11.76	JN	GRD	35		1	1	2.5	Se	Qz	1	4.0	1		N	1		
11.90	JN	GRD	30		1	1	2.5	Se	Qz	1	4.0	1		N	1		
13.25	JN	PEG	30		1	1	3.5	Se	Qz	1	4.0	1		I	2		

GERT SIBANDE DISTRICT MUNICIPALITY

INGEROP Inventing for tomorrow

Vumesa Pty - Ltd

ENGEOLAB
Reg. No. 2017/536405/07

Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q1**	Hole Depth (m):	**14.55**		Core Samples:		**WET**

BOX 1 of 3

Depth (m): 0.00 – 6.55

BOX 2 of 3

Depth (m): 6.55 – 11.50

BOX 3 of 3

Depth (m): 11.55 – 14.55

Northing: 26:21:02.9773 | **Easting:** 30:48:18.9175 | **Elevation:** 1304.161

GEOTECHNICAL CORE LOG

Date Logged: 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA												No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-interval Fromo (m)	Interval / Sub-interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Core Loss Explanation	Lithology Code	Fabric / Texture	RQD (m) / interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent FF/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q2	0.00	0.50	0.36	72	NA	999		0.00	0.50	0.36	0.14	72	SG	TCOL	C	NA	999	0.0	999	999						6								10	Decomposed / residuum, Soil-like, Defects not measureable, Colluvium (undif.)
Q2	0.50	1.00	0.45	90	NA	999		0.50	3.50	2.45	0.55	82	SG	GR	C	NM	999	1.0	999	999						5								0	Completely weathered, Soil-like, Crushed - gravelly, Granite
Q2	1.00	1.50	0.50	100	NA	999		3.50	9.00	2.40	3.10	44	SG	GR	C	NM	999	2.0	999	999						4.5	1							0	Highly to completely weathered, Soil-like, Shattered, Granite
Q2	1.50	2.00	0.40	80	NA	999		9.00	9.90	0.90	0.00	100		GR	C	0.90	100	5.0	4	4	1	0	0	0	1	1	11	888	5.5	-				73	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q2	2.00	3.50	1.10	73	NA	999		9.90	12.20	2.25	0.05	98	FG	PEG	VC	2.25	98	4.5	0	0	0	0	0	0	0	1	12	887	5.5	-				86	Unweathered/fresh, Very strong, Blocky widely jointed, Pegmatite
Q2	3.50	5.00	0.50	33	NA	999		12.20	15.07	2.81	0.06	98	UN	PEG	VC	2.59	90	4.0	16	5	3	0	0	3	3	1.5	10	864	5	Kf	1.0	HC.c	0.0	68	Slightly weathered to fresh, Very strong, V. Blocky medium jointed, Pegmatite
Q2	5.00	6.50	0.60	40	NA	999		15.07																										
Q2	6.50	8.00	0.75	50	NA	999																												
Q2	8.00	9.00	0.55	55	NA	999																												
Q2	9.00	10.25	1.25	100	1.25	100																												
Q2	10.25	10.93	0.66	97	0.66	97																												
Q2	10.93	12.43	1.46	97	1.40	93																												
Q2	12.43	13.63	1.15	96	1.10	92																												
Q2	13.63	15.07	1.44	100	1.44	100																												
	15.07																																	

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q2 **Logged by:** JJC **Date Logged:** 07/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
9.05	JN	GR	23	-	1	4	3	Fe	Cl	2	4.2	1	2	N	1		
11.66	JN	PEG	50	-	1	1	4		Qz	1	5.0	1	2	I	2		
13.00	JN	PEG	14	-	1	3	4			2	5.0	1	3	N	1		
14.75	JN	PEG	14	-	1.5	1	4	Qz	Li	1	4.4	1	3	N	1		
14.90	JN	PEG	15	-	1.5	4	4	Qz	Li	1	4.4	1	3	N	1		

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ENGEOLAB
Reg. No. 2017/536405/07

Main Client:	GERT SIBANDE DM	Client:	Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV		
Contract:	VU-WTR-21/002112/LTR001/2023/11/26	Project No.	LL3876	Date:	22 JUNE 2024
Project:	MPULUZI WATER SUPPLY SCHEME	Site:	MPULUZI - QUARRY		
Borehole No.:	Q2	Hole Depth (m):	15.07	Core Samples:	WET

BOX
1 of 4

Depth (m):
0.00 – 5.00

BOX
2 of 4

Depth (m):
5.00 – 10.25

BOX
3 of 4

Depth (m):
10.25 – 13.63

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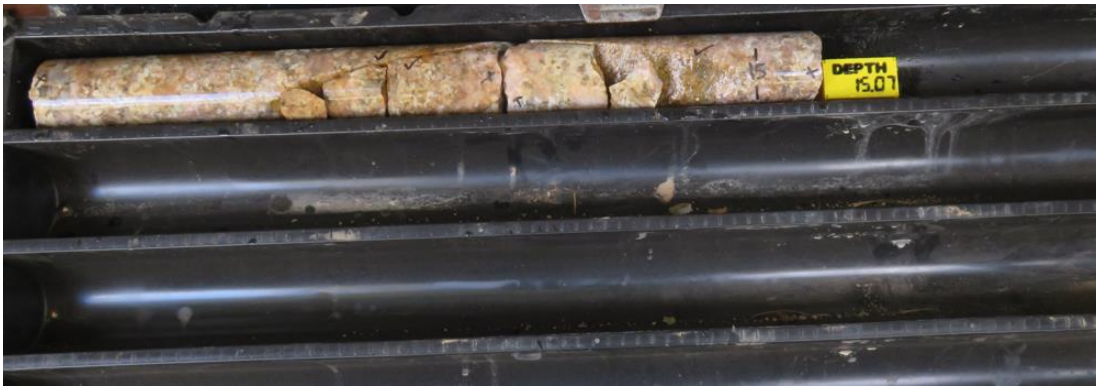
Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q2**	Hole Depth (m):	**15.07**		Core Samples:		**WET**

BOX
4 of 4

Depth (m):
13.63 – 15.07



Northing: 26:21:04.7795 | **Easting:** 30:48:21.8507 | **Elevation:** 1310.482

GEOTECHNICAL CORE LOG

Date Logged: 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY					GEOTECHNICAL DOMAIN / INTERVAL DATA														No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Core Loss Explanation	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent Ff/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q3	0.0	0.8	0.60	80		0.00	0.75	0.60	0.15	80	SG	COL		NA	999	0.0	999	999						6	0							10	Decomposed / residuum, Soil-like, Defects not measureable, Breccia
Q3	0.8	1.5	0.60	80		0.75	3.50	1.22	1.53	44	SG	GR		NM	999	2.0	999	999						4	0	50	0	CY	4.0			10	Highly weathered, Soil-like, Shattered, Granite
Q3	1.5	2.5	0.22	22		3.50	5.30	0.60	1.20	33	SG	GR		1.07	59	3.0	109	60	0	0	0	60	3	3.5	5	75	0.5	CY	3.0			28	Moderately to Highly weathered, Extremely weak, Fragmented v.closely jointed, Granite
Q3	2.5	3.5	0.40	40		5.30	7.30	0.30	1.70	15	SG	GR		0.00	0	2.0	425	213	0	0	0	85	3	3.5	5	75	0.5	CY	3.0			18	Moderately to Highly weathered, Extremely weak, Shattered, Granite
Q3	3.5	4.8	0.82	63		7.30	8.50	0.32	0.88	27	FG	GR		0.18	15	3.0	63	52	0	0	0	44	3	3.5	5	75	0.5	CY	3.0			21	Moderately to Highly weathered, Extremely weak, Fragmented v.closely jointed, Granite
Q3	4.8	6.2	0.60	44		8.50	9.70	0.00	1.20	0	FG	GR		0.00	0	2.0	120	100	0	0	0	60	3	3.5	5	75	0.5	CY	3.0			18	Moderately to Highly weathered, Extremely weak, Shattered, Granite
Q3	6.2	7.3	0.30	26		9.70	11.20	0.50	1.00	33	FG	GR		0.37	25	3.0	69	46	0	0	0	50	3	3	7	100	1.5	CY	2.0			26	Moderately weathered, Very weak rock, Fragmented v.closely jointed, Granite
Q3	7.3	8.5	0.32	27		11.20	13.90	2.10	0.60	78		GR		2.13	79	4.0	47	17	1	0	0	30	3.0	2.5	10	512	3	CY	1.0			30	Slightly to moderately weathered, Medium strong, V. Blocky medium jointed, Granite
Q3	8.5	9.7	0.00	0		13.90	16.20	1.86	0.44	81		PEG		1.76	77	4.0	40	18	2	0	0	22	2.0	2	12	819	4	Kf				55	Slightly weathered, Strong, V. Blocky medium jointed, Pegmatite
Q3	9.7	11.2	0.50	33		16.20	20.31	4.11	0.00	100		PEG		4.11	100	5.0	0	0	0	0	0	0	0.0	1	14	900	5	Kf				87	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q3	11.2	12.4	1.20	100		20.31																											
Q3	12.4	13.9	1.03	69																													
Q3	13.9	15.1	0.97	81																													
Q3	15.1	16.1	0.87	83																													
Q3	16.1	16.9	0.70	97																													
Q3	16.9	17.8	0.94	100																													
Q3	17.8	19.2	1.38	99																													
Q3	19.2	20.3	1.08	98																													
	20.3																																

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q3 **Logged by:** JJC **Date Logged:** 07/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
12.30	JN		63	-	2	1	2	Fe		1	4.0	1		I	2		
13.45	JN		10	-	1.5	3	3	Li	Qz	1	2.6	1		I	2		
14.00	JN		10		1.5	1	3	Li	Qz	1	2.6	1		N	1		
14.80	JN		12		1.5	3	3	Li	Qz	2	2.6	3		I	2		
15.20	JN		10		1	3	3	Li	Qz	2	2.6	3		N	1		

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Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q3**	Hole Depth (m):	**20.31**		Core Samples:		**WET**

BOX
1 of 5

Depth (m):
0.00 – 4.80

BOX
2 of 5

Depth (m):
4.80 – 9.70

BOX
3 of 5

Depth (m):
9.70 – 13.90

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Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q3**	Hole Depth (m):	**20.31**		Core Samples:		**WET**

BOX
4 of 5

Depth (m):
13.90 – 19.21

BOX
5 of 5

Depth (m):
19.21 – 20.31

Northing: 26:21:02.4165 | **Easting:** 30:48:21.8263 | **Elevation:** 1301.032

GEOTECHNICAL CORE LOG

Date Logged: 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA											No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures				Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent FF/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength		
Q4	0.00	0.75	0.25	33	NA	999		0.00	2.36	0.17	2.19	7	GR	C	NM	999	1.0	999	999						5	4	50	0.5	CL	4.0			11	Completely weathered, Extremely weak, Crushed - gravelly, Granite
Q4	0.75	1.50	0.26	35	NA	999		2.36	3.83	1.47	0.00	100	GR	C	1.44	98	4.0	3	2	0	0	3	0	2	1.5	13	887	5	Kf	2.0			81	Slightly weathered to fresh, Very strong, V. Blocky medium jointed, Granite
Q4	1.50	2.53	0.17	17	NM	999		3.83	6.90	3.07	0.00	100	PEG	VC	3.07	100	5.0	1	0	0	0	1	0	1	1	10	881	5					85	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q4	2.53	3.83	1.30	100	1.27	98		6.90	7.10	0.20	0.00	100	PEG	VC	0.14	70	3.0	3	15	0	0	1	2	2	2	13	837	5	Kf	2.0			60	Slightly weathered, Very strong, Fragmented v.closely jointed, Pegmatite
Q4	3.83	4.78	0.95	100	0.95	100		7.10	9.10	2.00	0.00	100	PEG	VC	2.00	100	5.0	3	2	0	0	3	0	2	1	14	891	5					84	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q4	4.78	5.95	1.17	100	1.17	100		9.10	10.65	1.38	0.17	89	PEG	VC	1.20	77	4.5	13	8	1	0	2	3	2	2.5	11	678	4	Kf	2.0	HC.c	0.0	57	Slightly to moderately weathered, Strong, Blocky widely jointed, Pegmatite
Q4	5.95	7.47	1.52	100	1.40	92		10.65	11.70	1.00	0.04	96	GR	C	1.00	96	5.0	4	4	1	0	0	0	1	1	12	853	5					74	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q4	7.47	8.57	1.10	100	1.10	100		11.70																										
Q4	8.57	9.62	0.83	79	0.83	79																												
Q4	9.62	10.24	0.57	92	0.57	92																												
Q4	10.24	11.17	0.79	85	0.79	85																												
Q4	11.17	11.65	0.48	100	0.48	100																												
	11.65																																	

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q4 **Logged by:** JJC **Date Logged:** 07/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
3.17	JN	GR	72	-	1.5	2	3	Fe		0	5.0			I	2		
3.63	JN	GR	60	-	1.5	2	4	Fe		0	5.0			N	1		
3.66	JN	GR	62	-	1.5	5		Fe		0	5.0			I	2		
4.41	JN	PEG	63	-	1	5				1	4.0	1		I	2		
6.96	FO	PEG	80	-	1.5	6	4	Fe		1	4.0	3		I	2		
7.03	JN	PEG	75	-	2	6	4	Fe		0	5.0	3		I	2		
7.09	JN	PEG	66	-	2	5	4	Fe		0	5.0	3		N	1		
9.30	JN	PEG	13	-	1.5	3		Fe		0	5.0	1		N	1		
10.15	FO	PEG	75	-	1.5	4		Fe	Go	1	4.0	1		I	2		
10.41	FO	PEG	80	-	2	1		Fe	Go	1	4.0	1		I	2		
10.50	FO	PEG	80	-	2	5	3	Fe	Go	1	4.0	3		N	1		
11.30	JN	GR	10	-	1	1		Fe		0	5.0			N	1		

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Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q4**	Hole Depth (m):	**11.65**		Core Samples:		**WET**

BOX
1 of 4

Depth (m):
0.00 – 3.83

BOX
2 of 4

Depth (m):
3.83 – 7.47

BOX
3 of 4

Depth (m):
7.47 – 11.17

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Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q4**	Hole Depth (m):	**11.65**		Core Samples:		**WET**

BOX
4 of 4

Depth (m):
11.17 – 11.65

Northing: 26:21:05.0764 | **Easting:** 30:48:24.1382 | **Elevation:** 1308.363

GEOTECHNICAL CORE LOG

Date Logged: 08/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA												No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent FF/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q5	0.0	0.8	0.22	29	NA	999		0.00	0.75	0.22	0.53	29	TCOL	M	NA	999	0.0	999	999						6								10	Decomposed / residuum, Soil-like, Defects not measureable, Colluvium (undif.)
Q5	0.8	1.5	0.35	47	NM	999		0.75	1.50	0.35	0.40	47	DI	M	NM	999	2.0	999	999						5				CY	4.0			0	Completely weathered, Soil-like, Shattered, Diorite
Q5	1.5	2.5	0.88	85	0.88	85		1.50	3.15	1.56	0.09	95	PGR	C	1.36	82	3.5	10	6	2	0	0	0	2	2	13	710	4	Kf	1.0	HC.c	0.0	68	Slightly weathered, Strong, Broken closely jointed, Pegmatitic granite
Q5	2.5	3.8	1.25	96	1.10	85		3.15	5.00	1.75	0.10	95	PEG	VC	1.60	86	4.0	3	2	0	0	0	2	1	1.5	14	880	5					81	Slightly weathered to fresh, Very strong, V. Blocky medium jointed, Pegmatite
Q5	3.8	4.6	0.80	100	0.80	100		5.00	6.06	1.06	0.00	100	PGR	C	1.06	100	5.0	0	0	0	0	0	0	0	1	15	870	5					88	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q5	4.6	5.6	0.96	100	0.96	100		6.06	9.60	3.52	0.02	99	PEG	VC	3.52	99	5.0	0	0	0	0	0	0	0	1	15	910	5.5					88	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q5	5.6	6.1	0.50	100	0.50	100		9.60	10.23	0.63	0.00	100	GR	M	0.63	100	5.0	0	0	0	0	0	0	0	1	15	900	5					88	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q5	6.1	6.6	0.50	100	0.50	100		10.23																										
Q5	6.6	7.3	0.71	100	0.71	100																												
Q5	7.3	8.0	0.68	100	0.68	100																												
Q5	8.0	8.5	0.48	100	0.48	100																												
Q5	8.5	9.4	0.96	100	0.96	100																												
Q5	9.4	10.2	0.81	100	0.81	100																												
	10.2																																	

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q5 **Logged by:** JJC **Date Logged:** 08/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
2.85	JN	PEG	20		2	3	3.5	Fe	Go	1	4.0	1		N	3		
3.15	JN	PEG	25		2	3	4	Fe	Qz	1	4.0	1		N	3		

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Vumesa Pty - Ltd

ENGEOLAB
Reg. No. 2017/536405/07

Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q5**	Hole Depth (m):	**10.23**		Core Samples:		**WET**

BOX
1 of 3

Depth (m):
0.00 – 5.59

BOX
2 of 3

Depth (m):
5.59 – 9.42

BOX
3 of 3

Depth (m):
9.42 – 10.23

Northing: 26:21:03.3419 | **Easting:** 30:48:24.5221 | **Elevation:** 1303.428 | **Date Logged:** 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

GEOTECHNICAL CORE LOG

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA												No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent Ff/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating -SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q6	0.00	0.53	0.53	100	0.50	94		0.00	1.21	1.21	0.00	100	GR	C	1.18	98	4.5	999	999	0	0	0	0	0	1.5	13	906	5.5					32	Slightly weathered to fresh, Very strong, Blocky widely jointed, Granite
Q6	0.53	0.96	0.46	107	0.46	107		1.21	3.81	2.60	0.00	100	PGR	VC	2.60	100	5.0	999	999	0	0	0	0	0	1	14	874	5					33	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q6	0.96	1.21	0.25	100	0.25	100		3.81	6.16	2.35	0.00	100	PEG	VC	2.35	100	5.5	10	4	0	0	0	0	0	1	14	901	5.5					79	Unweathered/fresh, Very strong, Solid, Pegmatite
Q6	1.21	1.40	0.19	100	0.19	100		6.16	10.85	4.69	0.00	100	PGR	VC	4.69	100	5.0	3	1	1	0	0	0	1	1	15	887	5	-		HC.c	0.0	87	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q6	1.40	1.51	0.11	100	0.11	100		10.85	16.60	5.75	0.00	100	PEG	VC	5.75	100	5.0	0	0	0	1	0	0	1	1	15	900	5.5	-				88	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q6	1.51	2.47	0.96	100	0.96	100		16.60	18.70	2.10	0.00	100	GR	C	2.10	100	5.5	0	0	0	0	0	0	0	1	16	895	5	-				88	Unweathered/fresh, Very strong, Solid, Granite
Q6	2.47	2.99	0.52	100	0.52	100		18.70	20.05	1.32	0.03	98	PGR	VC	1.32	98	5.5	0	0	0	0	0	0	0	1	16	892	5					88	Unweathered/fresh, Very strong, Solid, Pegmatitic granite
Q6	2.99	3.81	0.82	100	0.82	100		20.05																										
Q6	3.81	4.11	0.30	100	0.30	100																												
Q6	4.11	4.84	0.73	100	0.73	100																												
Q6	4.84	5.37	0.53	100	0.53	100																												
Q6	5.37	5.77	0.40	100	0.40	100																												
Q6	5.77	6.16	0.39	100	0.39	100																												
Q6	6.16	6.81	0.65	100	0.65	100																												
Q6	6.81	7.24	0.43	100	0.43	100																												
Q6	7.24	7.73	0.49	100	0.49	100																												
Q6	7.73	8.41	0.68	100	0.68	100																												
Q6	8.41	8.77	0.36	100	0.36	100																												
Q6	8.77	9.05	0.28	100	0.28	100																												
Q6	9.05	9.61	0.56	100	0.56	100																												
Q6	9.61	10.08	0.47	100	0.47	100																												

GEOTECHNICAL CORE LOGGING SHEET - DEFECT MEASUREMENTS

Campaign: Phase 4 - Construction **BH Inclination:** -90 **Azimuth:** **Type of Mark**

Project: Mpuluzi Weir **Borehole #:** Q6 **Logged by:** JJC **Date Logged:** 07/03/2024

DISCONTINUITY DATA **Page ___ of ____:**

Depth_m	Structure Type	Lithology	Alpha	Beta	Weathering	Surface Profile - Macro	Roughness - Micro	Fracture Infill 1	Fracture Infill 2	Infill Thickness Code	Fill Hardness	Joint Wall Alteration - JWA	Joint Set No - Jn	Defect Origin	Defect Condition	Orientation Reliability	Oriented Structure Comments
6.30	JN	PGR	14	-	1	3	3	Qz		1	4.0	1		N	1		
16.00	JN	PEG	36	-	1	1	3	Se	Qz	1	4.0	1		N	1		

GERT SIBANDE DISTRICT MUNICIPALITY

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Vumesa Pty - Ltd

ENGEOLAB
Reg. No. 2017/536405/07

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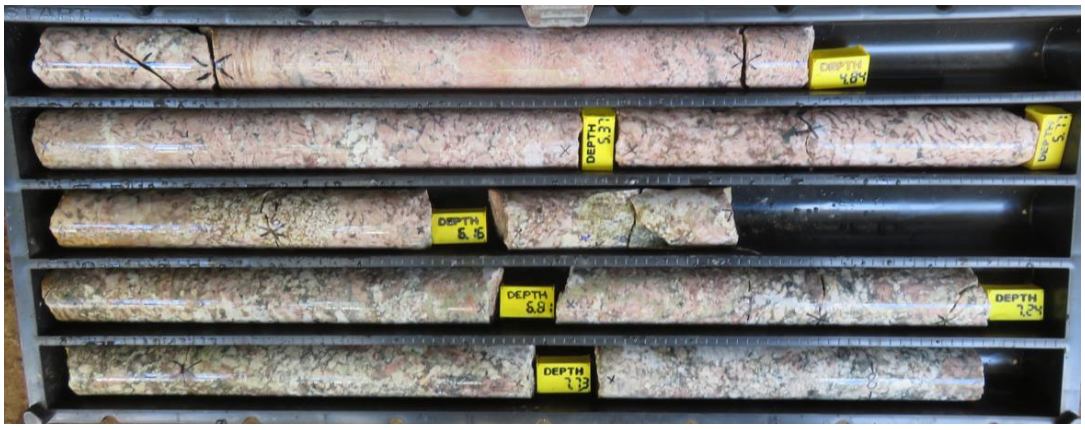
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q6**	Hole Depth (m):	**20.05**		Core Samples:		**WET**

BOX
1 of 5

Depth (m):
0.00 – 4.11

BOX
2 of 5

Depth (m):
4.11 – 7.73



BOX
3 of 5

Depth (m):
7.73 – 11.82

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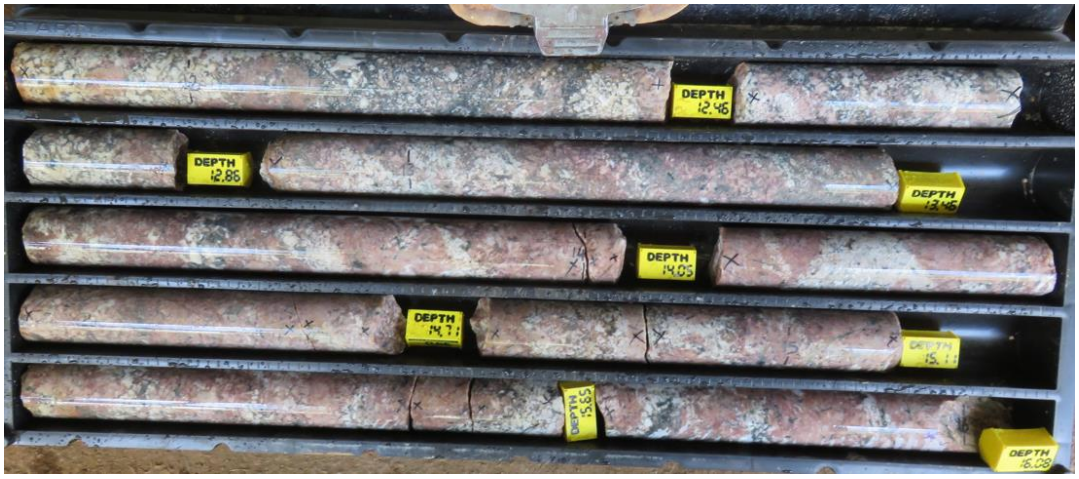
Main Client:	**GERT SIBANDE DM**		Client:	**Vumesa (Pty) Ltd – IngeropSA (Pty) Ltd JV**			
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q6**	Hole Depth (m):	**20.05**		Core Samples:		**WET**

BOX
4 of 5

Depth (m):
11.82 – 16.08



BOX
5 of 5

Depth (m):
16.08 – 20.05

Northing: 26:21:05.9601 | **Easting:** 30:48:26.5915 | **Elevation:** 1304.263 | **Date Logged:** 08/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

GEOTECHNICAL CORE LOG

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA												No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-Interval Fromo (m)	Interval / Sub-Interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Core Loss Explanation	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent FF/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating - SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Attn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q7	0.0	0.3	0.23	77				0.00	0.30	0.23	0.07	77	SG	TCOL	M	NA	999	0.0	999	999	NA	NA	NA	NA		6			0					9	Decomposed / residuum, Soil-like, Defects not measureable, Colluvium (undif.)
Q7	0.3	1.0	0.33	51				0.30	0.75	0.33	0.12	73	SG	TALL	C	NA	999	0.0	999	999	NA	NA	NA	NA		6			0					9	Decomposed / residuum, Soil-like, Defects not measureable, Alluvium (undif.)
Q7	1.0	1.7	0.75	100				0.75	1.70	0.75	0.20	79	FG	GR	C	0.50	53	3.5	42	45	0	0	0	40	15	3.5	6	50	0.5	Kf	4.0			29	Moderately to Highly weathered, Extremely weak, Broken closely jointed, Granite
Q7	1.7	3.2	0.40	27				1.70	3.20	0.40	1.10	27	FG	GR	C	0.40	27	3.0	70	47	0	0	0	50	20	3.5	6	345	1	Kf	3.0			24	Moderately to Highly weathered, Very weak rock, Fragmented v.closely jointed, Granite
Q7	3.2	4.2	0.56	56				3.20	3.80	0.20	0.40	33	FG	GR	C	0.00	0	2.0	26	43	0	0	0	16	20	4.5	5	0	0	Kf	4.0			16	Highly to completely weathered, Soil-like, Shattered, Granite
Q7	4.2	4.9	0.66	89				3.80	4.20	0.40	0.00	100	FG	PGR	VC	0.40	100	4.0	1	3	0	0	0	1	2	3	8	715	3	Kf	2.0			66	Moderately weathered, Medium strong, V. Blocky medium jointed, Pegmatitic granite
Q7	4.9	5.6	0.67	100				4.20	5.93	1.63	0.10	94	FG	PEG	VC	1.63	94	4.5	0	0	0	0	0	0	0	1.5	10	885	4.5			HC.c	0.0	83	Slightly weathered to fresh, Strong, Blocky widely jointed, Pegmatite
Q7	5.6	6.5	0.92	100				5.93	7.14	1.21	0.00	100		PGR	VC	1.21	100	5.0	0	0	0	0	0	0	0	1	12	915	5.5					87	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q7	6.5	7.1	0.61	100				7.14	11.15	4.01	0.00	100		GR	C	4.01	100	5.0	0	0	0	0	0	0	0	1	12	860	5					86	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q7	7.1	7.6	0.45	100				11.15	13.10	1.95	0.00	100		PEG	VC	1.95	100	5.5	0	0	0	0	0	0	0	1	12	870	5			VN.c	0.0	86	Unweathered/fresh, Very strong, Solid, Pegmatite
Q7	7.6	8.2	0.60	100				13.10	14.42	1.32	0.00	100		PGR	VC	1.31	99	5.5	0	0	0	0	0	0	0	1	12	890	5					86	Unweathered/fresh, Very strong, Solid, Pegmatitic granite
Q7	8.2	8.8	0.56	100				14.42	15.80	1.38	0.00	100		PEG	VC	1.38	100	5.0	2	1	0	1	0	0	2	1	11	885	5					83	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q7	8.8	9.9	1.13	100				15.80	16.63	0.83	0.00	100		GR	C	0.83	100	5.0	0	0	0	0	0	0	0	1	12	885	5					86	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q7	9.9	11.1	1.23	100				16.63	17.95	1.32	0.00	100		PEG	VC	1.32	100	5.0	4	3	1	0	0	0	2	1	13	890	5					79	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatite
Q7	11.1	12.5	1.37	100				17.95	19.46	1.51	0.00	100		PGR	VC	1.51	100	5.0	2	1	0	1	0	0	1	1	11	860	5					83	Unweathered/fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q7	12.5	13.3	0.84	100				19.46	19.98	0.52	0.00	100		GR	C	0.52	100	5.0	0	0	0	0	0	0	0	1	12	890	5					86	Unweathered/fresh, Very strong, Massive v.widely jointed, Granite
Q7	13.3	14.4	1.05	100				19.98																										
Q7	14.4	15.2	1.05	124																														
Q7	15.2	15.8	0.53	100																														
Q7	15.8	16.8	1.00	100																														
Q7	16.8	17.7	0.94	100																														

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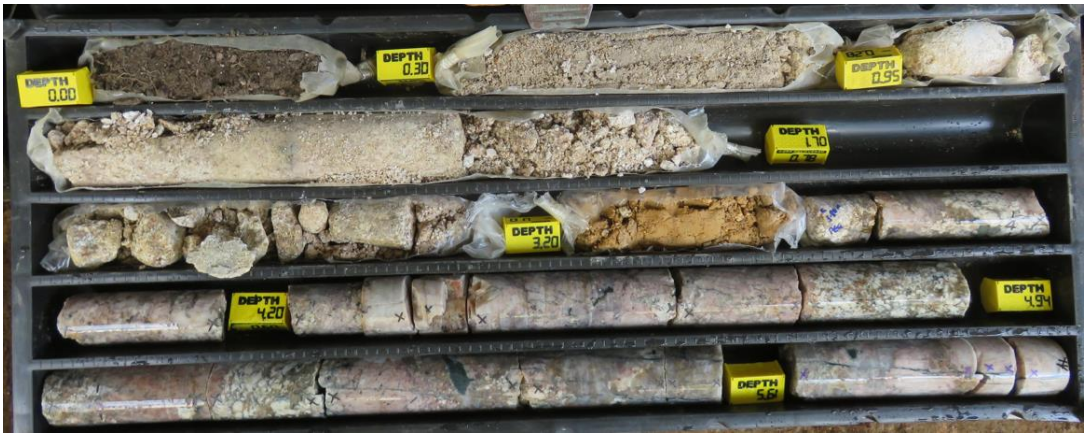
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q7**	Hole Depth (m):	**19.98**		Core Samples:		**WET**

BOX
1 of 5

Depth (m):
0.00 – 5.61



BOX
2 of 5

Depth (m):
5.61 – 9.88

BOX
3 of 5

Depth (m):
9.88 – 14.37

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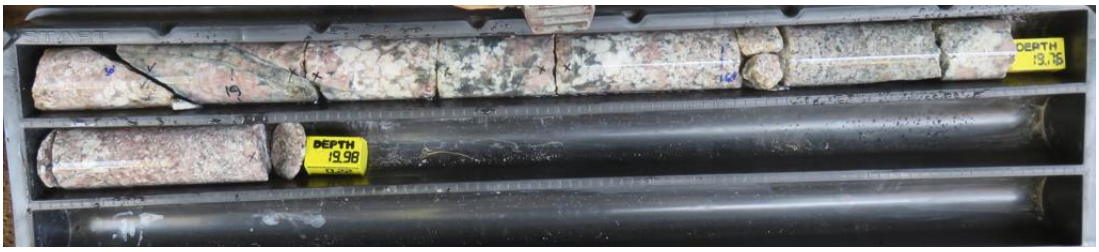
Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q7**	Hole Depth (m):	**19.98**		Core Samples:		**WET**

BOX
4 of 5

Depth (m):
14.37 – 18.81

BOX
5 of 5

Depth (m):
18.81 – 19.98



Northing: 26:21:04.4030 | **Easting:** 30:48:27.4987 | **Elevation:** 1298.595

GEOTECHNICAL CORE LOG

Date Logged: 07/03/2024 | **Logged by:** JJC | **Client:** INGEROP | **Inclination:** -90

LOCATION: Mpuluzi

RUN CORE RECOVERY							GEOTECHNICAL DOMAIN / INTERVAL DATA													No. of Fractures / Bin					ROCK MASS DATA				Tertiary Structures					
Hole ID	mFrom	mTo	TCR (m)	TCR (%)	RQD (m)	RQD (%)	Domain Identity	Interval / Sub-interval Fromo (m)	Interval / Sub-interval To (m)	Core Recovery / Interval (m)	Core Loss per Interval (m)	Core Recovery %	Core Loss Explanation	Lithology Code	Fabric / Texture	RQD (m) / Interval	RQD (%)	Appearance Code	No. Fractures / Interval	Weighted Avg Jv Equivalent FF/m	0 - 30 deg	30 - 60 deg	60 - 90 deg	Random	No of Joint Sets	Weathering code	Surface Condition Rating- SCR *joints*	Hardness Value	Strength - ISRM Code Visual/Tactile	Geotech Altn	Alteration Intensity	Micro defects	Micro-defect Strength	Overall Average GSI	DESCRIPTION - Weathering, Strength, Structure, Lithology
Q8	0.00	0.66	0.56	85	0.34	52		0.00	0.30	0.25	0.05	83	SG	TCOL		NA	999	0.0	999	999														Overburden - Soil-like, Defects not measureable, Colluvium (undif.)
Q8	0.66	0.99	0.33	100	0.33	100		0.30	1.22	0.92	0.00	100		PEG		0.92	100	4.5	0	0	0	0	0	0	0	2	10	845	5					83	Slightly weathered, Very strong, Blocky widely jointed, Pegmatite
Q8	0.99	1.21	0.22	100	0.22	100		1.22	1.96	0.74	0.00	100		PGR		0.74	100	5.0	0	0	0	0	0	0	0	1.5	12	875	5.5					86	Slightly weathered to fresh, Very strong, Massive v.widely jointed, Pegmatitic granite
Q8	1.21	1.48	0.27	100	0.27	100		1.96	4.95	2.99	0.00	100		GR		2.99	100	5.5	0	0	0	0	0	0	0	1	14	888	5.5					88	Unweathered/fresh, Very strong, Solid, Granite
Q8	1.48	1.96	0.48	100	0.48	100		4.95	7.68	2.73	0.00	100		PGR		2.73	100	5.5	0	0	0	0	0	0	0	1	14	880	5.5					88	Unweathered/fresh, Very strong, Solid, Pegmatitic granite
Q8	1.96	2.76	0.80	100	0.80	100		7.68	8.56	0.88	0.00	100		GR		0.88	100	5.5	0	0	0	0	0	0	0	1	14	860	5.5					88	Unweathered/fresh, Very strong, Solid, Granite
Q8	2.76	3.32	0.56	100	0.56	100		8.56	9.16	0.60	0.00	100		PEG		0.60	100	5.5	0	0	0	0	0	0	0	1	14	845	5					87	Unweathered/fresh, Very strong, Solid, Pegmatite
Q8	3.32	3.89	0.67	118	0.67	118		9.16	10.13	0.97	0.00	100		GR		0.97	100	5.5	0	0	0	0	0	0	0.0	1	14	850	5					87	Unweathered/fresh, Very strong, Solid, Granite
Q8	3.89	4.31	0.42	100	0.42	100		10.13																										
Q8	4.31	4.56	0.25	100	0.25	100																												
Q8	4.56	5.45	0.89	100	0.89	100																												
Q8	5.45	5.88	0.43	100	0.43	100																												
Q8	5.88	6.20	0.32	100	0.32	100																												
Q8	6.20	6.58	0.38	100	0.38	100																												
Q8	6.58	7.04	0.46	100	0.46	100																												
Q8	7.04	7.28	0.24	100	0.24	100																												
Q8	7.28	7.90	0.62	100	0.62	100																												
Q8	7.90	8.40	0.50	100	0.50	100																												
Q8	8.40	8.67	0.27	100	0.27	100																												
Q8	8.67	9.11	0.44	100	0.44	100																												
Q8	9.11	10.13	1.02	100	1.02	100																												

GERT SIBANDE DISTRICT MUNICIPALITY

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Contract:	**VU-WTR-21/002112/LTR001/2023/11/26**			Project No.	**LL3876**	Date:	**22 JUNE 2024**
Project:	**MPULUZI WATER SUPPLY SCHEME**			Site:	**MPULUZI - QUARRY**		
Borehole No.:	**Q8**	Hole Depth (m):	**10.13**		Core Samples:		**WET**

BOX
1 of 3

Depth (m):
0.00 – 3.89

BOX
2 of 3

Depth (m):
3.89 – 7.90

BOX
3 of 3

Depth (m):
7.90 – 10.13

APPENDIX E
ROCKLAB TEST DATA

QUARRY & DAM BASIN SITE's

ROCKLAB REPORT **CONFIDENTIAL**
2024-ENGEOLAB-02

Issued by:

ROCKLAB
(ROCK MECHANICS & EXCAVATION LABORATORIES)
P O BOX 72928
LYNNWOOD RIDGE 0040
TEL: 012 8134910
E-MAIL: CHENJ@ROCKLAB.CO.ZA

RESULTS OF ROCK PROPERTIES TESTS

Sampling Site: Quarry, Mpuluzi Dam

BY

DR J. F. CHEN

Submitted to:

ENGEOLAB CC

3 SEPTEMBER 2024

C O N T E N T S

TABLE 1 RESULTS OF UNIAXIAL COMPRESSIVE STRENGTH TESTS

ROCKLAB
DIVISION OF SOILLAB (PTY) LTD
Tel: 0027 12 813 4910
E-mail: Chenj@rocklab.co.za

Client: Engeolab Sampling Site: Mpuluzi 04-07-2024

SPECIMEN PARTICULARS							SPECIMEN DIMENSIONS					SPECIMEN TEST RESULTS			
Rocklab Specimen No. 9735-	Site	Borehole ID	Sample ID	Depth From.. (m)	Depth To..	Lithology	Diameter mm	Height mm	Ratio of Height to Diameter	Mass g	Density g/cm³	Failure Load kN	Strength (UCS) MPa	Failure Code	Note
UCS-20	Quarry	Q5	Q5/1	7.07	7.30	PGM Gr	60.04	159.64	2.7	1179.51	2.61	430.5	152.1	YA	
UCS-21		Q5	Q5/2	9.81	10.15	PGM Gr	60.32	160.20	2.7	1204.39	2.63	639.2	223.7	YA	
UCS-22		Q6	Q6/1	16.82	17.00	PGM	60.37	160.00	2.7	1188.20	2.59	191.1	66.8	3B	
UCS-23		Q7	Q7/1	7.59	7.78	GRN	60.06	156.83	2.6	1163.72	2.62	603.4	213.0	YA	
UCS-24		Q4	Q4/1	8.34	8.57	PGM	60.55	159.61	2.6	1198.93	2.61	464.6	161.3	XB	
UCS-25		Q1	Q1/1	12.07	12.30	GRN	60.47	157.80	2.6	1185.95	2.62	687.2	239.3	YA	
UCS-26		Q8	Q8/1	3.67	3.89	GRN	59.82	157.51	2.6	1169.58	2.64	603.7	214.8	XA	

Note: All tests were conducted according to the ISRM's (International Society for Rock Mechanics) specification.
Failure codes refer to Appendix 1

APPENDIX 1

CLASSIFICATION OF ROCK SPECIMEN FAILURE MODE INFLUENCED / NOT INFLUENCED BY DISCONTINUITIES DURING COMPRESSION TESTING

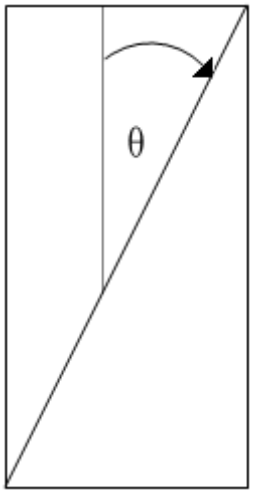
FAILURE NOT INFLUENCED BY DISCONTINUITIES (INTACT)

TYPE CODE	DESCRIPTION OF SUB CODES	
	A	B
X	SLIDING SHEAR FAILURE	COMPLETE CONE DEVELOPMENT
Y	SPLITTING	BREAKING INTO A LOT OF PIECES

FAILURE INFLUENCED BY DISCONTINUITIES

TYPE CODE	DESCRIPTION OF SUB CODES	
	A	B
	PARTIAL FAILURE ON DISCONTINUITY	FAILURE COMPLETELY ON DISCONTINUITY
1	AT 0-10° TO AXIS	AT 0-10° TO AXIS
2	AT 11-20° TO AXIS	AT 11-20° TO AXIS
3	AT 21-30° TO AXIS	AT 21-30° TO AXIS
4	AT 31-40° TO AXIS	AT 31-40° TO AXIS
5	AT 41-50° TO AXIS	AT 41-50° TO AXIS
6	AT 51-70° TO AXIS	AT 51-70° TO AXIS
7	AT 71-90° TO AXIS	AT 71-90° TO AXIS
0	Multiple Discontinuities	Multiple Discontinuities

Example: Failure Type3B: Failure completely on a discontinuity with an orientation of between 21°and 30° to the specimen axis.



APPENDIX F
SGS MATROLAB QUARRY AGGREGATE TESTS

QUARRY & DAM BASIN SITE's

SGS MATROLAB

sanas Testing Laboratory T0025

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg No.: 2003/029180/07 - VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park, Pretoria.
P.O. BOX 912387 SILVERTON 0127
Tel. : 012-800 1299
Fax. :
Email : stephan.husselman@sgs.com

ETHYLENE GLYCOL DURABILITY INDEX FOR ROCK - SANS 3001:AG14

CLIENT: ENGEOLAB CC
ADDRESS: PO BOX 4177 WITBANK 1035

Project: LL 3876

Your Ref: 11.07.2024
Our Ref: PL/63053
Date Reported: 05.09.2024

Attention: Paul Hansmeyer

Record of deterioration over time and calculation of durability index

Lab No: A24/1643 Client Sample Description:

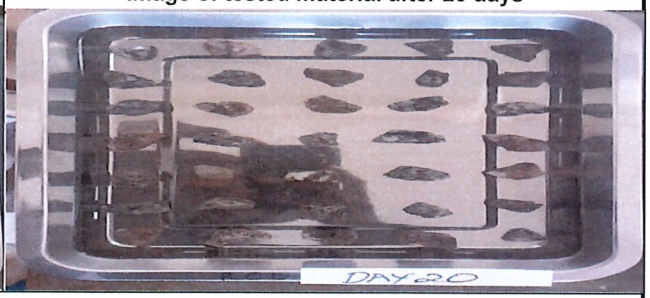
Day	Spalled	D*f*	Fractured	D*f*	Disintegraded	D*D*	Durability index
1	0	0,0	0	0,0	0	0,0	0,0
5	0	0,0	0	0,0	0	0,0	0,0
10	0	0,0	0	0,0	0	0,0	0,0
20	0	0,0	0	0,0	0	0,0	0,0

Durability index ratio 0,0

Evaluation: *	5 Day		20 Day	
Subbase: Durability Index <20	0,0	Pass	0,0	Pass
Base Course: Durability Index <10	0,0	Pass	0,0	Pass
Surfacing: Durability Index <3	0,0	Pass	0,0	Pass
Durability Index after 20 days: <1.5 x Durability Index after 5 days	N / A		0/0	Pass

Image of tested material after 5 day

Image of tested material after 20 days



Remarks: * P. Paige-Green and R. Leyland. *A revised ethylene glycol test for assessing the durability of basic crystalline materials for road aggregate.* CSIR Built Environment: Pretoria. 2010.

for SGS Matrolab (Pty) Ltd. Technical Signatory: Stephan Husselmann

SGS MATROLAB

sanas Testing Laboratory T0025

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg No.: 2003/029180/07 - VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park, Pretoria.
P.O. BOX 912387 SILVERTON 0127
Tel. : 012-800 1299
Fax. :
Email : stephan.husselman@sgs.com

ETHYLENE GLYCOL DURABILITY INDEX FOR ROCK - SANS 3001:AG14

CLIENT: ENGEOLAB CC
ADDRESS: PO BOX 4177 WITBANK 1035

Project: LL 3876

Your Ref: 11.07.2024
Our Ref: PL/63053
Date Reported: 05.09.2024

Attention: Paul Hansmeyer

Record of deterioration over time and calculation of durability index

Lab No: A24/1644 Client Sample Description:

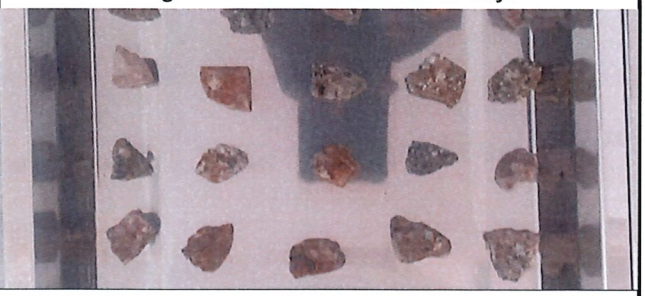
Day	Spalled	Df	Fractured	Df	Disintegraded	DD	Durability index
1	0	0,0	0	0,0	0	0,0	0,0
5	0	0,0	0	0,0	0	0,0	0,0
10	0	0,0	0	0,0	0	0,0	0,0
20	0	0,0	0	0,0	0	0,0	0,0

Durability index ratio 0,0

Evaluation: *	5 Day		20 Day	
Subbase: Durability Index <20	0,0	Pass	0,0	Pass
Base Course: Durability Index <10	0,0	Pass	0,0	Pass
Surfacing: Durability Index <3	0,0	Pass	0,0	Pass
Durability Index after 20 days: <1.5 x Durability Index after 5 days	N / A		0/0	Pass

Image of tested material after 5 day

Image of tested material after 20 days



Remarks: * P. Paige-Green and R. Leyland. *A revised ethylene glycol test for assessing the durability of basic crystalline materials for road aggregate.* CSIR Built Environment: Pretoria. 2010.

for SGS Matrolab (Pty) Ltd. Technical Signatory: Stephan Husselmann

SGS MATROLAB

sanas Testing Laboratory T0025

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg No.: 2003/029180/07 - VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park, Pretoria.
P.O. BOX 912387 SILVERTON 0127
Tel. : 012-800 1299
Fax. :
Email : stephan.husselman@sgs.com

ETHYLENE GLYCOL DURABILITY INDEX FOR ROCK - SANS 3001:AG14

CLIENT: ENGEOLAB CC
ADDRESS: PO BOX 4177 WITBANK 1035

Project: LL 3876

Your Ref: 11.07.2024
Our Ref: PL/63053
Date Reported: 05.09.2024

Attention: Paul Hansmeyer

Record of deterioration over time and calculation of durability index

Lab No: A24/1645 Client Sample Description:

Day	Spalled	Df	Fractured	Df	Disintegraded	DD	Durability index
1	0	0,0	0	0,0	0	0,0	0,0
5	0	0,0	0	0,0	0	0,0	0,0
10	0	0,0	0	0,0	0	0,0	0,0
20	0	0,0	0	0,0	0	0,0	0,0

Durability index ratio 0,0

Evaluation: *	5 Day		20 Day	
Subbase: Durability Index <20	0,0	Pass	0,0	Pass
Base Course: Durability Index <10	0,0	Pass	0,0	Pass
Surfacing: Durability Index <3	0,0	Pass	0,0	Pass
Durability Index after 20 days: <1.5 x Durability Index after 5 days	N / A		0/0	Pass

Image of tested material after 5 day

Image of tested material after 20 days

Remarks: * P. Paige-Green and R. Leyland. *A revised ethylene glycol test for assessing the durability of basic crystalline materials for road aggregate.* CSIR Built Environment: Pretoria. 2010.

for SGS Matrolab (Pty) Ltd. Technical Signatory: Stephan Husselmann

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria.
P.O Box 912387,Silverton,0127
Tel. : (012) 800 1299
Fax :
Email : stephan.husselman@sgs.com

sanas Testing Laboratory T0025

TEST RESULTS

ENGEOLAB CC
P.O BOX 4177
WITBANK
1035
Attention:

Project : LL3876 Mpuluzi

Your Ref :
Our Ref : PL/63053
Date Reported : 15.07.2024

AGGREGATE REPORT
(SANS 3001:AG1,AG4,AG9,AG10,AG20,AG21,AG22, SANS 5845)

SAMPLE NO.	A24/1643	A24/1644	A24/1645	Specification
DESCRIPTION	Cores (Red)	Cores (Yellow)	Cores (Blue)	
	Quarry	Quarry	Quarry	Min : Max
SIEVE ANALYSIS (% PASSING)				
37.50 mm	100	100	100	
28.00 mm	77	80	90	
20.00 mm	50	46	46	
14.00 mm	37	28	28	
10.00 mm	28	23	22	
7.100 mm	22	19	18	
5.000 mm	17	16	14	
2.000 mm	10	11	9	
1.000 mm	7	8	6	
0.600 mm	5.3	5.8	4.7	
0.425 mm	4.3	4.6	3.7	
0.300 mm	3.5	3.7	3.0	
0.150 mm	2.1	2.0	1.7	
0.075 mm	1.3	1.1	1.1	

AGGREGATE CRUSHING VALUE (DRY) (%)	21.3		22.0		21.6	
10% FACT.(DRY) (kN)	140		120		140	
10% FACT.(WET) (kN)	125		110		130	
10% FACT.(WET/DRY ratio) (%)	91		90		93	
FLAKINESS INDEX (%)	21.4		18.5		11.4	
APPARENT DENSITY(Base) (kg/m^3)	2628		2609		2614	
LOOSE BULK DENSITY (kg/m^3)	1440		1460		1440	
COMPACTED BULK DENSITY (kg/m^3)	1530		1560		1500	
BULK DENSITY (>5mm/<5mm) (kg/m^3)	2613	2613	2598	2575	2605	2575
APPARENT DENSITY (>5mm/<5mm) (kg/m^3)	2625	2627	2620	2596	2627	2598
WATER ABSORPTION (>5mm/<5mm) (%)	0.2	0.2	0.3	0.3	0.3	0.3
TRETON IMPACT VALUE (%)	30.2		34.9		33.4	

Remarks :

FORM: AG1

4.5.0(SGS)(2021.05.05)

Technical Signatory : S. Husselmann

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg No.: 2003/029180/07 - VAT Reg No.: 4040210587

256 Brander street, Jan Niemand Park,
Pretoria.
P.O. BOX 912387 SILVERTON 0127
Tel. : 012-800 1299
Email : stephan.husselman@sgs.com

TEST RESULTS

CLIENT: ENGEOLAB
ADDRESS: PO BOX 4177
WITBANK
1035
Attention: Paul Hansmeyer

Project: LL3876
Your Ref:
Our Ref: PL/63053
Date Reported: 05.09.2024

Test description	Sample Description / Source / Additional Info / Client Ref No	Test method	Lab no	A24/1643	A24/1644	A24/1645	
			UNITS	Red	Yellow	Blue	
Soundness MgSO4		SANS 3001:AG12	%	0.11	0.09	0.12	

Remarks: Sampled by client.

for SGS Matrolab (Pty) Ltd. Technical Signatory: Stephan Husselmann

SGS MATROCAST

sanas Testing Laboratory T0245

SGS MATROCAST (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2000/030983/07 - VAT. Reg.No.: 4130197405
a SANAS Accredited Testing Laboratory, No. T0245

4 HARBOT CLOSE , BRACKENDUST ,7560
P.O.BOX 1106 , BRACKENFELL
Tel. : 021 9815558/9
Fax : 021 9816724
Email : nico.engelbrecht@sgs.com

CLIENT :	SGS MATROLAB PRETORIA	OUR REF.:	65744
ADDRESS :	257 HENNING STREET JAN NIEMAND PARK PRETORIA, 0186	YOUR REF.:	63053
ATTENTION :	Mr. S. Husselman	DATE :	21.08.2024

PROJECT : ENGEOLAB

SGS MATROCAST

a SANAS Accredited Testing Laboratory, No. T0245

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

TEST REPORT / RESULTS

Sample/s:	Sampled by :	Client
	Date Received / Sampled :	21.07.2024
	Date Tested :	23.07.2024 - 16.08.2024
	Tested at :	SGS MATROCAST (PTY) LTD

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

Section / Position tested identified by : CLIENT

Number of pages in this Report : 4

General : ASR TEST RESULTS

: LL3876

Opinions and interpretations expressed herein are outside the Scope of SANAS Accreditation.
Results only have bearing on the samples tested.
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a SANAS Accredited Testing Laboratory, No. T0245

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P.O.BOX 1106 , BRACKENFELL
Tel. : 021 9815558/9
Fax : 021 9816724
Email : nico.engelbrecht@sgs.com

Technical Signatory - Mr Gilmour Zimri (N.DIP Chem.Eng)

SGS MATROCAST

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

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Fax : 021 9816724
Email : nico.engelbrecht@sgs.com

sanas Testing Laboratory T0245

CLIENT :	SGS MATROLAB PRETORIA	OUR REF.:	65744
ADDRESS :	257 HENNING STREET JAN NIEMAND PARK PRETORIA, 0186	YOUR REF.:	63053
ATTENTION :	Mr. S. Husselman	DATE :	21.08.2024

PROJECT : ENGEOLAB

TEST RESULTS

ALKALI-SILICA REACTION OF AGGREGATES (SANS (6245:2006)

Lab Number	D05010
Sample Mark/Reference	A24/1643
Description	Crushed Rock Cores

TEST	% LINEAR EXPANSION		Specification (Fulton Concrete Technology)
	Individual	Average	
Sample I.D.: Red	0.074 0.075 0.071	0.073	
Outcome/Interpretation	Innocuous/None Reactive		< 0.20 %

SPECIFICATION : According Fulton Concrete Technology 9th Edition, expansion less than 0.10 % is non-reactive

Technical Signatory : Mr Gilmour Zimri (N.DIP Chem.Eng)

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Tel. : 021 9815558/9
Fax : 021 9816724
Email : nico.engelbrecht@sgs.com

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CLIENT :	SGS MATROLAB PRETORIA	OUR REF.:	65744
ADDRESS :	257 HENNING STREET JAN NIEMAND PARK PRETORIA, 0186	YOUR REF.:	63053
ATTENTION :	Mr. S. Husselman	DATE :	21.08.2024

PROJECT : ENGEOLAB

TEST RESULTS

ALKALI-SILICA REACTION OF AGGREGATES (SANS (6245:2006)

Lab Number	D05010
Sample Mark/Reference	A24/1643
Description	Crushed Rock Cores

TEST	% LINEAR EXPANSION		Specification (Fulton Concrete Technology)
	Individual	Average	
Sample I.D.: Yellow	0.074 0.075 0.072	0.074	
Outcome/Interpretation	Innocuous/None Reactive		< 0.20 %

SPECIFICATION : According Fulton Concrete Technology 9th Edition, expansion less than 0.10 % is non-reactive

Technical Signatory : Mr Gilmour Zimri (N.DIP Chem.Eng)

SGS MATROCAST

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CLIENT :	SGS MATROLAB PRETORIA	OUR REF.:	65744
ADDRESS :	257 HENNING STREET JAN NIEMAND PARK PRETORIA, 0186	YOUR REF.:	63053
ATTENTION :	Mr. S. Husselman	DATE :	21.08.2024

PROJECT : ENGEOLAB

TEST RESULTS

ALKALI-SILICA REACTION OF AGGREGATES (SANS (6245:2006)

Lab Number	D05010
Sample Mark/Reference	A24/1645
Description	Crushed Rock Cores

TEST	% LINEAR EXPANSION		Specification (Fulton Concrete Technology)
	Individual	Average	
Sample I.D.: Blue	0.070 0.068 0.070	0.069	
Outcome/Interpretation	Innocuous/None Reactive		< 0.20 %

SPECIFICATION : According Fulton Concrete Technology 9th Edition, expansion less than 0.10 % is non-reactive

Technical Signatory : Mr Gilmour Zimri (N.DIP Chem.Eng)

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- CIVIL ENGINEERING SERVICES -
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Tel. : (012) 800 1299
Fax :
Email : stephan.husselman@sgs.com

sanas Testing Laboratory T0025

TEST RESULTS

ENGEOLAB CC
P.O BOX 4177
WITBANK
1035
Attention:

Project : LL3876 Mpuluzi
Your Ref :
Our Ref : PL/63053
Date Reported : 15.07.2024

AGGREGATE REPORT
(SANS 3001:AG1,AG4,AG9,AG10,AG20,AG21,AG22, SANS 5845)

SAMPLE NO.	A24/1643	A24/1644	A24/1645	Specification
DESCRIPTION	Cores (Red)	Cores (Yellow)	Cores (Blue)	
	Quarry	Quarry	Quarry	Min : Max
SIEVE ANALYSIS (% PASSING)				
37.50 mm	100	100	100	
28.00 mm	77	80	90	
20.00 mm	50	46	46	
14.00 mm	37	28	28	
10.00 mm	28	23	22	
7.100 mm	22	19	18	
5.000 mm	17	16	14	
2.000 mm	10	11	9	
1.000 mm	7	8	6	
0.600 mm	5.3	5.8	4.7	
0.425 mm	4.3	4.6	3.7	
0.300 mm	3.5	3.7	3.0	
0.150 mm	2.1	2.0	1.7	
0.075 mm	1.3	1.1	1.1	

AGGREGATE CRUSHING VALUE (DRY) (%)	21.3		22.0		21.6	
10% FACT.(DRY) (kN)	140		120		140	
10% FACT.(WET) (kN)	125		110		130	
10% FACT.(WET/DRY ratio) (%)	91		90		93	
FLAKINESS INDEX (%)	21.4		18.5		11.4	
APPARENT DENSITY(Base) (kg/m^3)	2628		2609		2614	
LOOSE BULK DENSITY (kg/m^3)	1440		1460		1440	
COMPACTED BULK DENSITY (kg/m^3)	1530		1560		1500	
BULK DENSITY (>5mm/<5mm) (kg/m^3)	2613	2613	2598	2575	2605	2575
APPARENT DENSITY (>5mm/<5mm) (kg/m^3)	2625	2627	2620	2596	2627	2598
WATER ABSORPTION (>5mm/<5mm) (%)	0.2	0.2	0.3	0.3	0.3	0.3
TRETON IMPACT VALUE (%)	30.2		34.9		33.4	

Remarks :
FORM: AG1

4.5.0(SGS)(2021.05.05)

Technical Signatory: S. Husselmann

APPENDIX G
YANKA LAB WATER SAMPLE ANALYSIS

QUARRY & DAM BASIN SITE's

YANKA LABORATORIES
(Pty) Ltd.
Registration No. 2012/113891/07 VAT No. 4380263659
PO Box 11396, AERORAND, 1055, South Africa
Office: 6 Drakensberg Str., Aerorand, MIDDELBURG, MP
Laboratory: 40 Minerva Ave., Reyno Ridge, WITBANK, MP
Phone: +27-87-701-9265 or 6
Cell: +27-83-232-3230 / Fax: +27-86-551-1071
E-Mail: yanka@yanka.co.za

ENGEOLAB CC
Attention: Rozette du Randt
P.O Box 4177
WITBANK
1035

Job No: **E76585 - W24_6869**
Report Reference: **ER_ENG_2024-09-12_02758_001**
Enquiries: **Rita Botha**
Date: **2024/09/12**
RitaB@yanka.co.za
Job Reference: **W24/6869 - Advice Note 2409W332**
Job Description: **1 x Routine Analysis**
Project: **LL3876 MPULUZI DAM WATER**

TEST RESULTS FOR Engeolab - LL3876 Mpuluzi Dam Water - 10 September 2024

This report contains results pertaining only to the water/dust samples analysed.

For Standards referenced, and methods base, please see http://www.yanka.co.za/TestsAndStandards.htm

Please contact us if you have any queries concerning the information contained herein. Thank you for your support.

Electronically approved

RITA BOTHA (Technical Signatory)
ENVIRONMENTAL SERVICES

ANALYSED WITHIN 10 September 2024 - 2024/09/16
SANAS Certificate obtainable from the address below
http://www.yanka.co.za/Services.htm

*Results not marked with a Test Method YE###***, as well as results marked "Subcontracted" or "Outsourced" , in this report, are not included in the SANAS Schedule of Accreditation for this laboratory. However, outsourced results may be within the Schedule of Accreditation of the source laboratory.*
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Limits shown to the right of results are for information only and may need further interpretation, and is not suitable for conformance evaluation as shown.

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Samples were tested as received, except where indicated otherwise. This report relates only to the specific sample(s) tested as identified herein and may not be reproduced in part without written permission from Laboratory Management.

ANALYSTS
Marné, Magda, Venna, Drieka, Sue, Rosemary, Vida, Elize, Petricia, Stefan, Nadine, Corlia, Lindie, Jolene, Audrey, Mariëtte, Nicolene

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpEngeo 1
SAMPLE DESCRIPTION			LL3876 Mpuluzi Dam
SAMPLE NUMBER			E76585-001
SAMPLED		Test Method **	2024/09/10 00:00
Remarks			Clear
Acidity	mg $CaCO_3$/L	YE011Ac	4.50
Total Alkalinity (pH>4.5)	mg $CaCO_3$/L	YE010Alk	34.4
Bicarbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	34.4
Carbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	0.00
M Alkalinity (8.3>pH>4.5)	mg $CaCO_3$/L	YE010Alk	34.4
P Alkalinity (pH>8.3)	mg $CaCO_3$/L	YE010Alk	0.00
Conductivity (Laboratory)	mS/m	YE020CON	8.50
pH (Laboratory)		YE030pH	7.26
Total Hardness	mg $CaCO_3$/L	YE061H	25.0
Calcium Hardness	mg $CaCO_3$/L	YE061H	13.7
Magnesium Hardness	mg $CaCO_3$/L	YE061H	11.4
Total Dissolved Solids (TDS)	mg/L	Calculation	46.5
Suspended Solids (TSS)	mg/L	YE081TSS	2.00
Temperature	°C	Thermometer	21.0
Turbidity	NTU	YE082TB	5.90
Ammonia and Ammonium	mg N/L	YE070AK	<0.45
Calcium	mg Ca/L	YE060ICP	5.48
Chloride	mg Cl/L	YE070AK	4.25
Magnesium	mg Mg/L	YE060ICP	2.76
Nitrate and Nitrite (TON)	mg N/L	YE070AK	<0.35
Ortho Phosphate	mg P/L	YE070AK	0.04
Potassium	mg K/L	YE060ICP	1.19
Sodium	mg Na/L	YE060ICP	6.53
Sulphate	mg SO_4/L	YE070AK	4.50
Aluminium	mg Al/L	YE060ICP	0.25
Fluoride	mg F/L	YE070AK	0.10
Iron	mg Fe/L	YE060ICP	0.66
Manganese	mg Mn/L	YE060ICP	0.01
Langelier Index (indicative, not SANS)		Calculation	-1.89
pHs (indicative, not SANS)		Calculation	9.15
Sodium Absorption Ratio (indicative)		Calculation	0.57
TDS to EC Ratio (indicative, not SANS)		Calculation	5.47
Corrosion Ratio (indicative, not SANS)		Calculation	0.42
Ryznar Index (indicative, not SANS)		Calculation	11.05
Anion Sum			0.91
Cation Sum			0.88
Difference			-0.03
% Difference			-1.69%

Methods adapted to accommodate local laboratory conditions.
SM refers to the Standard Methods for the Examination of Water and Wastewater.
Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.
Ion balance is not used as QC check where pH<3.5.
**** Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards, please see http://www.yanka.co.za/TestsAndStandards.htm . For ranges, uncertainties, etc., please contact us.**

YANKA LABORATORIES

MICROBIOLOGY TEST RESULTS

LABORATORY NUMBER			SpEngeo 1	STANDARD LIMIT SANS 241:2015	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance 4% of	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance of 1% of	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION			LL3876 Mpuluzi Dam					
SAMPLE NUMBER			E76585-001					
SAMPLED		Test Method	2024/09/10 00:00					
Remarks			Clear					
Standard Plate Count or Heterotrophic Pl. Count	count/mL	YE100SPC / ISO 9308 based	>3000	< 1000	No Limit	Alert 5000		
Total Coliforms	CFU/100mL	YE101TC / ISO 9308 based	>300	< 10	No Limit	Alert 10		
Faecal Coliforms	CFU/100mL	YE102FC / ISO 9308 based	>300	0	0	1	<1000	0

Methods adapted to accommodate local laboratory conditions.

SM refers to the Standard Methods for the Examination of Water and Wastewater.

*** Methods Starting with YE are accredited. For ranges, uncertainties, etc., please contact us.*

QUARRY & DAM BASIN SITE's

Table: Quarry Static Water_Depths

BH_Quarry (Q)/ Weir (W)	BH Depth (m)	BH Orientation	Static_Depth (m) 5-6-24	Static_Depth (m) 10-6-24	Static_Depth (m) 20-6-24
Q1	14.6	Vertical	5.30	5.66	5.89
Q2	15.1	Vertical	4.30	3.84	3.93
Q3	20.3	Vertical	7.70	6.82	7.00
Q4	11.7	Vertical	4.00	4.75	4.86
Q5	10.2	Vertical	4.00	3.27	3.30
Q6	20.1	Vertical	9.20	8.14	8.29
Q7	20.0	Vertical	2.70	3.91	3.95
Q8	10.2	Vertical	0.50	0.60	0.70

APPENDIX H
SEISMIC TEST DATA

QUARRY & DAM BASIN SITE's

Quarry Seismic Traverses

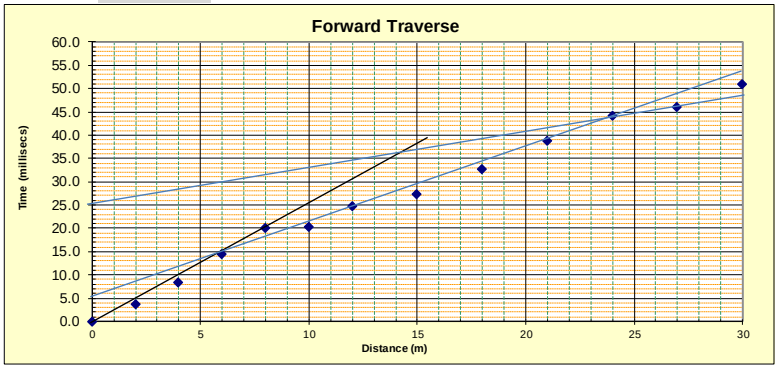
ENGEOLAB (PTY) LTD

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	**FILE No.**	LL3876
PROJECT	Mpuluzi Water Supply Scheme	**EQUIPMENT**	Nimbus ES125
SITE	Quarry Traverses	**DATE**	10/04/2024

FORWARD TRAVERSE **TRAVERSE #** **QST01**

Strike Distance (m)	Time (msecs)
0	0.0
2	3.7
4	8.4
6	14.4
8	20.2
10	20.4
12	24.8
15	27.4
18	32.8
21	38.7
24	44.3
27	46.1
30	51.0



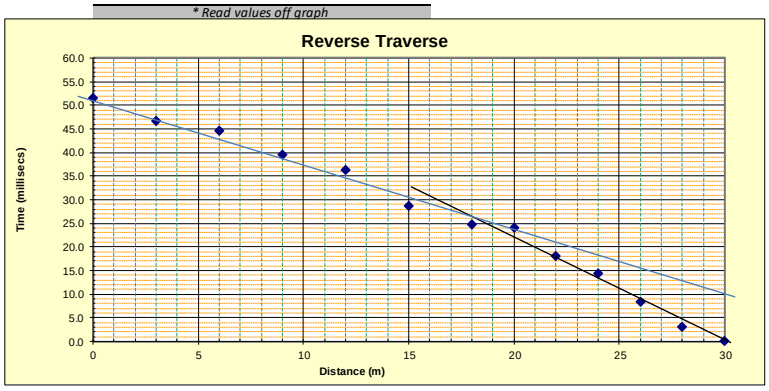
	Breaks of Slope (m)	0 8	6 18			14.4 32.8

Forward		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	396	652		
Critical Distance	m		5.7		
Time Intercept	msecs		5.2		
Depth of Layers - 2 methods	*Critical Distance Method*		1.4		
	Time Intercept Method		1.3		
	Average depth (m)		**1.4**	**Too deep**	**Too deep**

REVERSE TRAVERSE

** Read values off graph*

Strike Distance (m)	Time (msecs)
30	0.0
28	3.0
26	8.2
24	14.4
22	18.0
20	23.9
18	24.6
15	28.7
12	36.3
9	39.5
6	44.6
3	46.5
0	51.4



	Breaks of Slope (m)	30 22	20 0		

Reverse		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	444	727		
Critical Distance	m		18.8		
Time Intercept	msecs		10.0		
Depth of Layers - 2 methods	*Critical Distance Method*		2.8		
	Time Intercept Method		2.8		

Seismic Average*		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	420	688		
Critical distance	m	*Mean of F & R*	8.5		
Time intercept	msec	*Mean of F & R*	7.6		
Depth of Layer - 2 methods	*Critical Distance Method*		2.1		
	Time Intercept Method		2.0		
	Average depth (m)		**2.0**	**Too deep**	**Too deep**

Seismic Average for uneven surfaces*

Average Layer Velocity (m/s)			*Velocity ratios*	
V1	420	m/s	v2/v1 =	1.636
V2	688	m/s	v3/v2 =	
V3		m/s		
V4	-	m/s	Ratio factor R =	NA

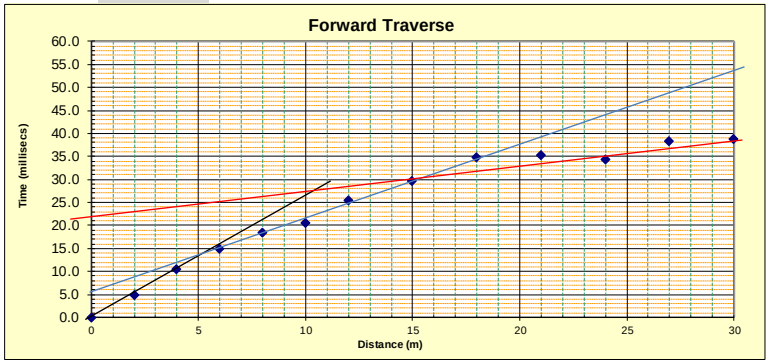
ENGEOLAB (PTY) LTD

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	**FILE No.**	LL3876
PROJECT	Mpuluzi Water Supply Scheme	**EQUIPMENT**	Nimbus ES125
SITE	Quarry Traverses	**DATE**	10/04/2024

FORWARD TRAVERSE **TRAVERSE #** **QST02**

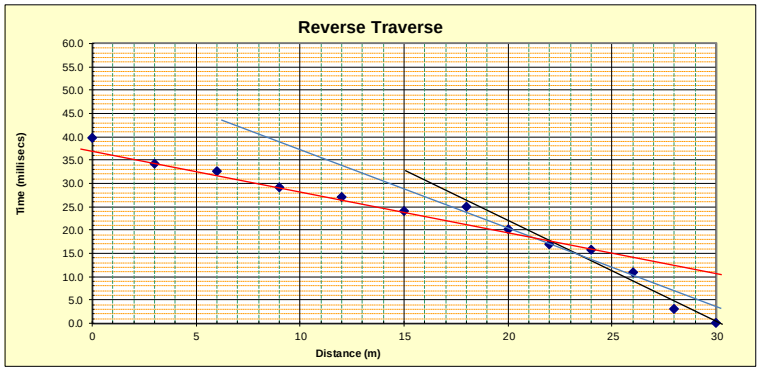
Strike Distance (m)	Time (msecs)
0	0.0
2	4.8
4	10.5
6	14.9
8	18.4
10	20.6
12	25.4
15	29.8
18	34.8
21	35.4
24	34.3
27	38.3
30	38.7



	Breaks of Slope (m)	0 4	6 18	15 30		14.9 34.8	29.8 38.7
Forward		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***		
Velocity	m/s	381	603	1685			
Critical Distance	m		5.7	15.0			
Time Intercept	msecs		5.0	20.9			
	Critical Distance Method		1.4	6.2			
	Time Intercept Method		1.2	6.5			
	Average depth (m)		**1.3**	**6.3**	**Too deep**		

REVERSE TRAVERSE

Strike Distance (m)	Time (msecs)
30	0.0
28	2.9
26	10.9
24	15.6
22	16.8
20	20.1
18	24.9
15	24.1
12	27.1
9	29.0
6	32.5
3	34.2
0	39.6



	Breaks of Slope (m)	30 24.0	26 18	18 3	
Reverse		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	385	571	1613	
Critical Distance	m		26.0	21.8	
Time Intercept	msecs		3.5	10.5	
	Critical Distance Method		0.9	3.5	
	Time Intercept Method		0.9	3.0	
	Average depth (m)		**0.9**	**3.3**	**Too deep**

Seismic Average*		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	383	587	1648	
Critical distance	m	*Mean of F & R*	4.9	11.6	
Time intercept	msec	*Mean of F & R*	4.2	15.7	
Depth of Layer - 2 methods	*Critical Distance Method*		1.1	4.9	
	Time Intercept Method		1.1	4.7	
	Average depth (m)		**1.1**	**4.8**	**Too deep**

*Seismic Average** *for uneven surfaces*

Average Layer Velocity (m/s)			*Velocity ratios*	
V1	383	m/s	v2/v1 =	1.533
V2	587	m/s	v3/v2 =	2.809
V3	1648	m/s		1.67
V4	-	m/s	Ratio factor R =	0.264

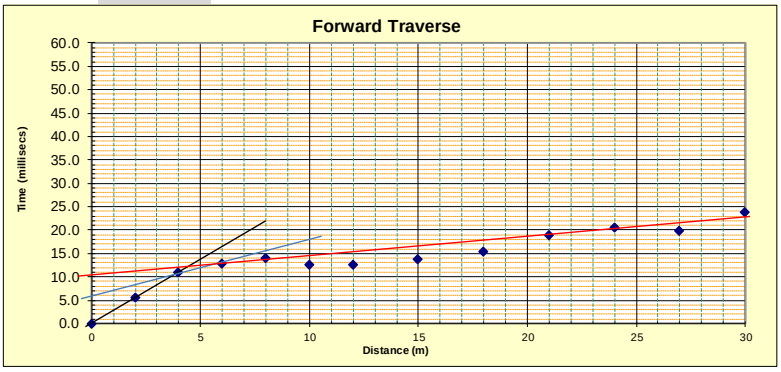
ENGEOLAB (PTY) LTD

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	**FILE No.**	LL3876
PROJECT	Mpuluzi Water Supply Scheme	**EQUIPMENT**	Nimbus ES125
SITE	Quarry Traverses	**DATE**	10/04/2024

FORWARD TRAVERSE **TRAVERSE #** **QST03**

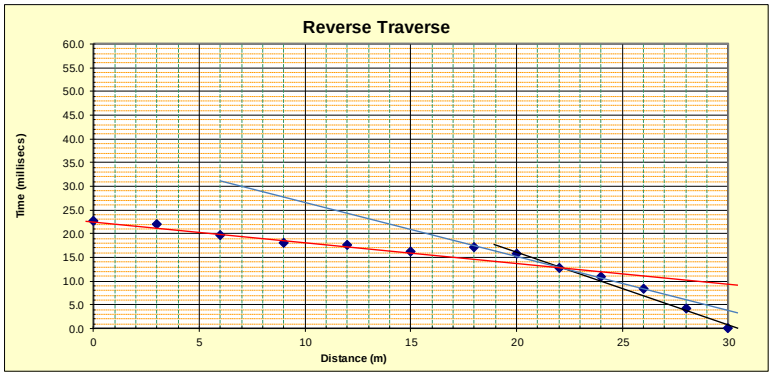
Strike Distance (m)	Time (msecs)
0	0.0
2	5.5
4	10.9
6	12.9
8	13.9
10	12.6
12	12.6
15	13.7
18	15.5
21	19.0
24	20.5
27	19.9
30	23.9



	Breaks of Slope (m)	0 4	4 6	6 24		10.9 12.9	12.9 20.5
Forward		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***		
Velocity	m/s	367	1000	2368			
Critical Distance	m		3.5	6.0			
Time Intercept	msecs		6.9	10.4			
	Critical Distance Method		1.2	2.9			
	Time Intercept Method		1.4	5.2			
	Average depth (m)		**1.3**	**4.0**	**Too deep**		

REVERSE TRAVERSE

Strike Distance (m)	Time (msecs)
30	0.0
28	4.1
26	8.3
24	10.9
22	12.7
20	15.6
18	17.1
15	16.2
12	17.5
9	18.1
6	19.7
3	21.8
0	22.6



	Breaks of Slope (m)	30 26	26 20	22 0	
Reverse		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	482	822	2222	
Critical Distance	m		26.0	21.5	
Time Intercept	msecs		3.5	10.5	
	Critical Distance Method		1.0	3.7	
	Time Intercept Method		1.0	4.2	
	Average depth (m)		**1.0**	**4.0**	**Too deep**

Seismic Average*		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	424	902	2293	
Critical distance	m	*Mean of F & R*	3.8	7.3	
Time intercept	msec	*Mean of F & R*	5.2	10.4	
Depth of Layer - 2 methods	*Critical Distance Method*		1.1	3.3	
	Time Intercept Method		1.3	4.6	
*Seismic Average**	***Average depth (m)***		**1.2**	**3.9**	**Too deep**

for uneven surfaces

Average Layer Velocity (m/s)			*Velocity ratios*	
V1	424	m/s	v2/v1 =	2.126
V2	902	m/s	v3/v2 =	2.541
V3	2293	m/s		1.66
V4	-	m/s	Ratio factor R =	0.296

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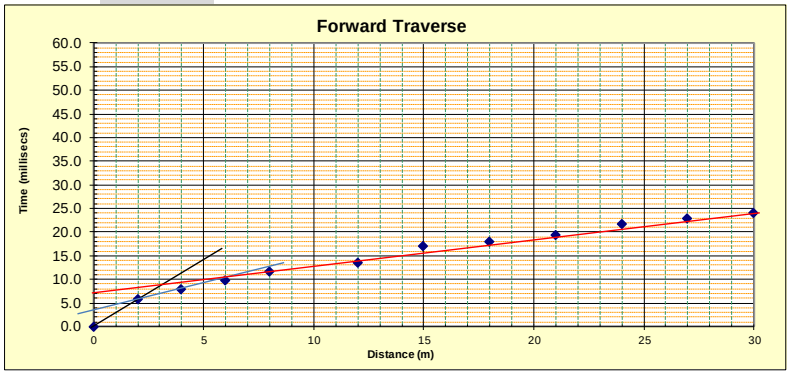
SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	**FILE No.**	LL3876
PROJECT	Mpuluzi Water Supply Scheme	**EQUIPMENT**	Nimbus ES125
SITE	Quarry Traverses	**DATE**	10/04/2024

FORWARD TRAVERSE **TRAVERSE #** **QST04**

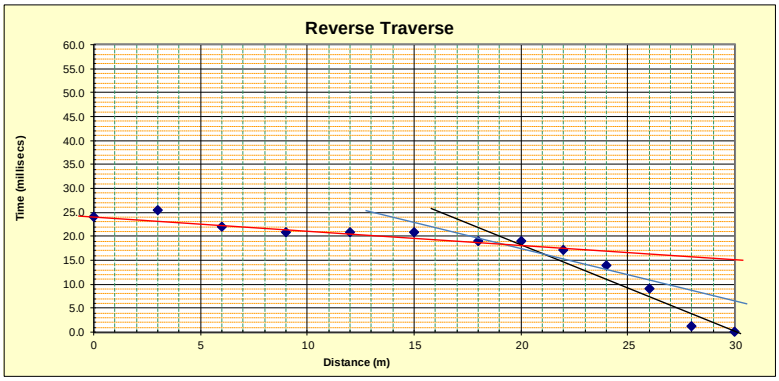
Strike Distance (m)	Time (msecs)
0	0.0
2	5.8
4	8.0
6	9.8
8	11.6
10	
12	13.6
15	17.1
18	18.1
21	19.4
24	21.8
27	22.9
30	24.0



	Breaks of Slope (m)	0 2	2 4	8 30		5.8 11.6 8.0 24.0
Forward		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***	
Velocity	m/s	345	909	1774		
Critical Distance	m		2.0	6.5		
Time Intercept	msecs		3.6	7.1		
	Critical Distance Method		0.7	4.2		
	Time Intercept Method		0.7	3.5		
	Average depth (m)		**0.7**	**3.9**	**Too deep**	

REVERSE TRAVERSE

Strike Distance (m)	Time (msecs)
30	0.0
28	1.2
26	9.0
24	13.9
22	17.0
20	19.0
18	19.0
15	20.8
12	20.7
9	20.8
6	22.0
3	25.3
0	24.0



Breaks of Slope (m)	30 26	26 20	18 0		
Reverse	***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***	
Velocity m/s	444	600	3600		
Critical Distance m		26.0	21.5		
Time Intercept msecs		3.5	10.5		
Critical Distance Method		0.8	4.2		
Time Intercept Method		1.2	2.9		
Average depth (m)		**1.0**	**3.5**	**Too deep**	

Seismic Average*		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	395	723	2377	
Critical distance	m	*Mean of F & R*	3.0	7.5	
Time intercept	msec	*Mean of F & R*	3.6	8.8	
Depth of Layer - 2 methods	*Critical Distance Method*		0.8	3.4	
	Time Intercept Method		0.8	3.1	
Seismic Average for uneven surfaces*	***Average depth (m)***		**0.8**	**3.2**	**Too deep**

Average Layer Velocity (m/s)		*Velocity ratios*	
V1	395 m/s	v2/v1 =	1.832
V2	723 m/s	v3/v2 =	3.288
V3	2377 m/s		1.68
V4	- m/s	Ratio factor R =	0.220

ENGEOLAB (PTY) LTD

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	**FILE No.**	LL3876
PROJECT	Mpuluzi Water Supply Scheme	**EQUIPMENT**	Nimbus ES125
SITE	Quarry Traverses	**DATE**	10/04/2024

FORWARD TRAVERSE **TRAVERSE #** **QST05**

Strike Distance (m)	Time (msecs)
0	0.0
2	4.1
4	10.5
6	12.8
8	14.1
10	15.3
12	17.5
15	15.8
18	22.4
21	23.6
24	26.9
27	32.7
30	29.0

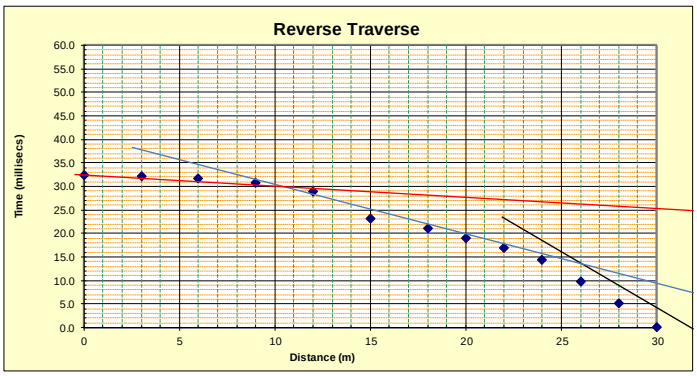
Insert 2 points from each layer's straight line

	Breaks of Slope (m)	0	4	6	10.5	12.8
		4	6	24	12.8	26.9

Forward		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	381	870	1277	
Critical Distance	m		3.7	6.0	
Time Intercept	msecs		5.9	8.1	
	Critical Distance Method		1.2	3.5	
	Time Intercept Method		1.3	4.3	
	Average depth (m)		**1.2**	**3.9**	**Too deep**

REVERSE TRAVERSE

Strike Distance (m)	Time (msecs)
30	0.0
28	5.1
26	9.7
24	14.4
22	16.9
20	18.9
18	21.0
15	23.0
12	28.8
9	30.7
6	31.7
3	32.0
0	32.3



	Breaks of Slope (m)	30	24	12		
		24	12	0		

Reverse		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	417	833	3429	
Critical Distance	m		24.0	11.5	
Time Intercept	msecs		7.5	23.5	
	Critical Distance Method		1.7	8.6	
	Time Intercept Method		1.8	9.5	
	Average depth (m)		**1.8**	**9.0**	**Too deep**

Seismic Average*		***Layer 1***	***Layer 2***	***Layer 3***	***Layer 4***
Velocity	m/s	399	851	1860	
Critical distance	m	*Mean of F & R*	4.9	12.3	
Time intercept	msec	*Mean of F & R*	6.7	15.8	
Depth of Layer - 2 methods	*Critical Distance Method*		1.5	4.9	
	Time Intercept Method		1.5	7.0	
Seismic Average for uneven surfaces*	***Average depth (m)***		**1.5**	**6.0**	**Too deep**

Average Layer Velocity (m/s)			*Velocity ratios*	
V1	399	m/s	v2/v1 =	2.134
V2	851	m/s	v3/v2 =	2.186
V3	1860	m/s		1.65
V4	-	m/s	Ratio factor R =	0.353

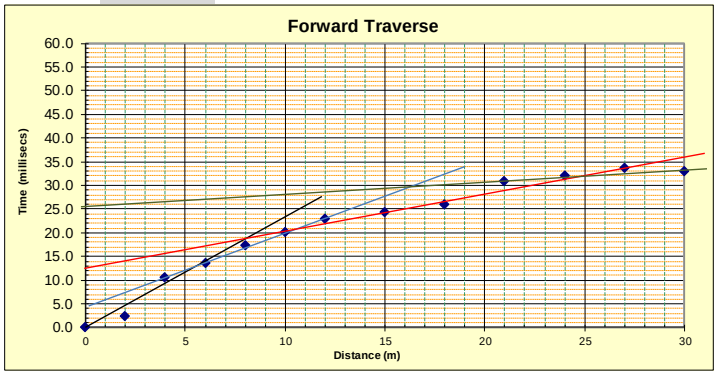
ENGEOLAB (PTY) LTD

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

CLIENT	INGEROP JV	FILE No.	LL3876
PROJECT	Mpuluzi Water Supply Scheme	EQUIPMENT	Nimbus ES125
SITE	Quarry Traverses	DATE	10/04/2024

FORWARD TRAVERSE — TRAVERSE # QST06

Strike Distance (m)	Time (msecs)
0	0.0
2	2.4
4	10.7
6	13.6
8	17.5
10	20.3
12	23.1
15	24.5
18	26.0
21	31.0
24	32.0
27	33.8
30	33.0

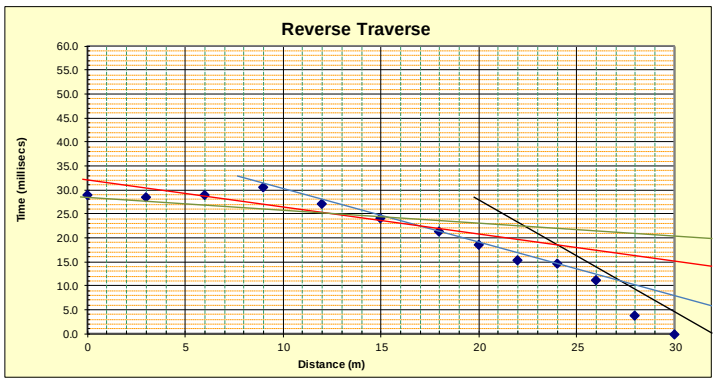


Breaks of Slope (m)	0	6	10	21	13.6	20.3	31.0
	6	12	27	30	23.1	33.8	33.0

Forward		Layer 1	Layer 2	Layer 3	Layer 4
Velocity	m/s	441	632	1259	4500
Critical Distance	m		6.2	10.0	25.0
Time Intercept	msecs		4.1	12.4	26.3
Critical Distance Method			1.3	3.9	12.5
Time Intercept Method			1.3	4.1	13.2
Average depth (m)			**1.3**	**4.0**	**12.8**

REVERSE TRAVERSE

Strike Distance (m)	Time (msecs)
30	0.0
28	3.8
26	11.3
24	14.6
22	15.4
20	18.6
18	21.3
15	24.2
12	27.1
9	30.7
6	28.9
3	28.5
0	28.9



Point distances on Vel	30	26	18	15	28.9	26.0	24.5
	24	9	6	0	#N/A	13.6	0.0

Reverse		Layer 1	Layer 2	Layer 3	Layer 4			
Velocity	m/s	411	876	1579	3191	Layer 1/2	Layer 2/3	Layer 3/4
Critical Distance	m		25.5	15.5	11.5	Avg Time Intercept - millisecs		
Time Intercept	msecs		6.5	14.5	19.5	5.3	13.43	22.91666667
Critical Distance Method			1.4	5.0	9.3			
Time Intercept Method			1.5	7.0	9.7			
Average depth (m)			**1.4**	**6.0**	**9.5**			

Seismic Average*		Layer 1	Layer 2	Layer 3	Layer 4
Velocity	m/s	426	734	1401	3734
Critical distance	m	*Mean of F & R*	5.4	12.3	21.8
Time intercept	msec	*Mean of F & R*	5.3	13.4	22.9
Depth of Layer - 2	*Critical Distance Method*		1.4	4.5	11.0
methods	*Time Intercept Method*		1.4	5.3	11.5
*Seismic Average**	***Average depth (m)***		**1.4**	**4.9**	**11.2**

for uneven surfaces

Average Layer Velocity (m/s)		*Velocity ratios*		
V1	426 m/s	v2/v1 =	1.723	0.29
V2	734 m/s	v3/v2 =	1.909	0.26
V3	1401 m/s	v4/v3 =	2.665	0.17
V4	3734 m/s		1.66	
		Ratio factor R =	0.674	

SEISMIC REFRACTION SURVEY RESULTS SUMMARY

INGEROP JV		**FILE No.**	LL3876
Mpuluzi Water Supply Scheme		**EQUIPMENT**	Nimbus ES125
Quarry Traverses			

TRAVERSE # **QST01**

		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		420	688		
m	*Mean of F & R*		8.5		
msec	*Mean of F & R*		7.6		
Critical Distance Method			2.1		
Time Intercept Method			**2.0**		
	Average depth (m)		2.0	Too deep	Too deep

TRAVERSE # **QST02**

		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		383	587	1648	
m	*Mean of F & R*		4.9	11.6	
msec	*Mean of F & R*		4.2	15.7	
Critical Distance Method			1.1	4.9	
Time Intercept Method			**1.1**	**4.7**	
	Average depth (m)		1.1	4.8	Too deep

TRAVERSE # **QST03**

		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		424	902	2293	
m	*Mean of F & R*		3.8	7.3	
msec	*Mean of F & R*		5.2	10.4	
Critical Distance Method			1.1	3.3	
Time Intercept Method			**1.3**	**4.6**	
	Average depth (m)		1.2	3.9	Too deep

TRAVERSE # **QST04**

		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		395	723	2377	
m	*Mean of F & R*		3.0	7.5	
msec	*Mean of F & R*		3.6	8.8	
Critical Distance Method			0.8	3.4	
Time Intercept Method			**0.8**	**3.1**	
	Average depth (m)		0.8	3.2	Too deep

TRAVERSE # **QST05**

		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		399	851	1860	
m	*Mean of F & R*		4.9	12.3	
msec	*Mean of F & R*		6.7	15.8	
Critical Distance Method			1.5	4.9	
Time Intercept Method			**1.5**	**7.0**	
	Average depth (m)		1.5	6.0	Too deep

TRAVERSE # **QST06**

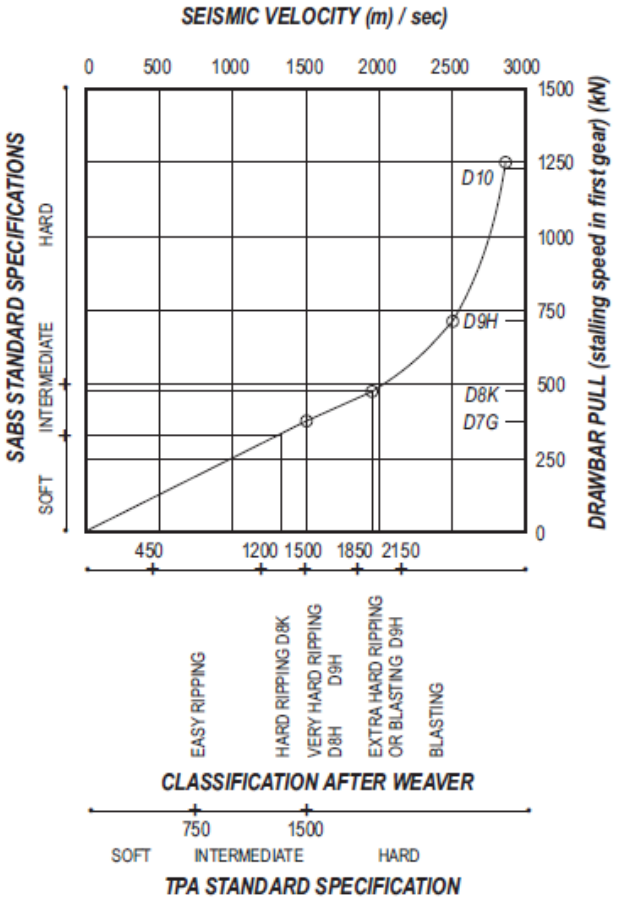
		Layer 1	*Layer 2*	*Layer 3*	*Layer 4*
m/s		426	734	1401	3734
m	*Mean of F & R*		5.4	12.3	21.8
msec	*Mean of F & R*		5.3	13.4	22.9
Critical Distance Method			1.4	4.5	10.95
Time Intercept Method			**1.4**	**5.3**	**11.5**
	Average depth (m)		1.4	4.9	11.2

AVERAGE OF TYPICAL LAYERS IN QUARRY AREA

Overall Seismic Average*		*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*
Velocity	m/s	410	745	1915	3735
	Average depth (m)		1.4	4.6	11.2

Layer 1	410 m/s	Loose to medium dense sandy material	
Layer 2	745 m/s	Dense sand to very soft rock	*Easy rip*
Layer 3	1915 m/s	Very dense to soft rock	*V hard rip/blast*
Layer 4	3735 m/s	Very hard rock.	*Blast*

TPA Spec	Common Seismic Velocity	SABS Spec
Easy dig <750m/s	<975m/s	Soft <1200m/s
Hard to Very hard dig 750 - 1500m/s	975 - 1950m/s	Intermediate 2100 - 1950m/s
Blast >1500m/s	>1950m/s	Hard >1950m/s



SUMMARY of BOREHOLE LOGGING

	Description	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	Overburden (Residuum/Alluvium/Colluvium)	1.50	0.50	0.75	0.00	0.75	0.00	0.75	0.30
2	Completely to Highly weathered rock	8.50	9.00	3.50	2.36	1.50	1.21	3.80	
3	Moderately to slightly Weathered rock	10.10		13.90		3.15		4.20	
4	Fresh/Sl weathered rock	14.55	15.07	20.31	11.70	10.23	20.05	19.98	10.13
		EOH	EOH	EOH	EOH	EOH	EOH	EOH	EOH

	0.5m	Overburden
	>3m	Weatherd rock
	>10m	Moderately to Slightly weathered

Poorest rock

Q1	Overburden & deeply weathered - 10m	
Q2	Overburden & deeply weathered - 9m	
Q3	Weathered to 14m!	***Q3 on drawing is between outcrops- switched Q4?***
Q7	Weathering to 4.2m	

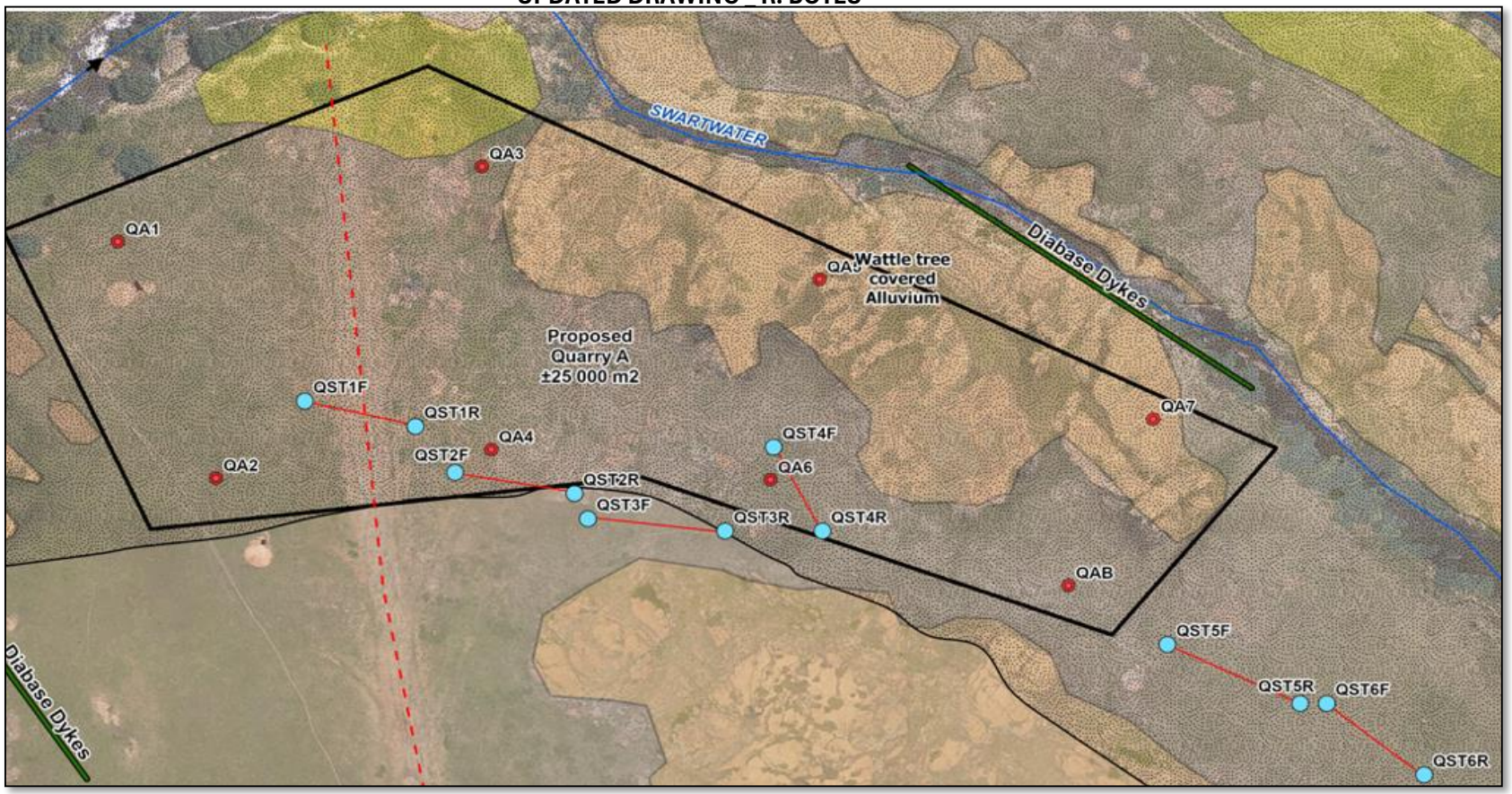
Best rock

Q4	Some weathered rock near surface	
Q6	Almost no weathered rock	
Q8	On outcrop	***Q7 on drawing is on outcrop - switched Q8?***

Intermediate rock

Q5	Shallow overburden and weathered to 3.15m	
		Q5 on drawing is on outcrop - switched Q6?

UPDATED DRAWING _ R. BOTES



	Layer 1		Layer2	Layer3	Layer4			
QST-1F	1.4	Ovb						
QST-1R	2.8	Ovb						
QST-1Avg	2.0	Ovb						
					>2.8 rock to deep to determine			
QST-2F	1.3	Ovb	6.3	M. weath		Nearest	Quarry hole ~=	Q4
QST-2R	0.9	Ovb	3.3	M. weath				
QST-2Avg	1.1	Ovb	4.8	M. weath				
					>4.8m Hard rock			

QST-3F	1.3	Ovb	4.0	Hard rock						
QST-3R	1.0	Ovb	4.0	Hard rock						
QST-3Avg	1.2	Ovb	3.9	Hard rock						
QST-4F	0.7	Ovb	3.9	Hard rock				Nearest	Quarry hole ~=	Q6
QST-4R	1.0	Ovb	3.5	Hard rock						
QST-4Avg	0.8	Ovb	3.2	Hard rock						
QST-5F	1.2	Ovb	3.9	M. weath				Nearest	Quarry hole ~=	Q8
QST-5R	1.8	Ovb	9.0	M. weath						
QST-5Avg	1.5	Ovb	6.0	M. weath						
					>6m		Hard rock			
QST-6F	1.3	Ovb	4.0	M. weath	12.8		Hard rock			
QST-6R	1.4	Ovb	6.0	M. weath	9.5		Hard rock			
QST-6Avg	1.4	Ovb	4.9	M. weath	11.2		Hard rock			

APPENDIX I
XRF DATA

QUARRY & DAM BASIN SITE's

FINAL CERTIFICATE OF ANALYSIS
REVISION: 0

TO:	Sabine Verryn	FROM:	UIS Analytical Services
CLIENT NAME:	XRD Analytical and Consulting CC		XRF Laboratory
CLIENT ADDRESS:	75 Kafue Street, Lynnwood Glen Pretoria	ADDRESS:	13 Esdoring Nook, Highveld Technopark, Centurion
TEL:		TEL:	+27 12 665 4291
MOBILE:	+27 83 548 0586	FAX:	+27 12 665 4294
EMAIL:	sabine.verryn@xrd.co.za	REQUEST DATE:	18-Jul-2024

		Fe_2O_3	SiO_2	Al_2O_3	K_2O	P_2O_5	Mn_3O_4	CaO	MgO	TiO_2	Na_2O	V_2O_5	BaO	Cr_2O_3	SrO	ZrO_2	SO_3	ZnO	LOI	Total
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
CLIENT SAMPLE ID	UIS SAMPLE ID																			
SGS/ENG/63053/LL/3876/A24/1643/RED	960813	1.263	75.240	13.288	5.266	0.018	0.019	0.871	0.155	0.122	3.443	<0.010	0.030	0.020	<0.010	0.019	0.012	<0.010	0.360	100.138
SGS/ENG/63053/LL/3876/A24/1644/YELLOW	960814	1.108	77.498	12.265	4.453	<0.004	0.018	0.842	0.156	0.113	3.315	<0.010	0.023	0.018	<0.010	<0.010	0.023	<0.010	0.479	100.328
SGS/ENG/63053/LL/3876/A24/1645/BLUE	960815	1.186	75.966	13.351	3.131	<0.004	0.021	1.240	0.155	0.123	4.417	<0.010	0.019	0.018	<0.010	0.011	<0.010	<0.010	0.501	100.159
SGS/ENG/63053/LL/3876/A24/1645/BLUE	960815 QC	1.203	76.008	13.394	3.151	<0.004	0.022	1.222	0.165	0.122	4.395	<0.010	0.017	0.016	<0.010	0.011	<0.010	<0.010	0.501	100.251

NOTES:
*Samples dried at 105°C
*LOI determined at 1000°C
*Sulphur might be incorporated in the LOI
*The results relate specifically to the items as tested
*The report shall not be reproduced except in full, without the written approval of the laboratory

Identification of test method:	Major and Minor Elements by XRF	Identification file:	UIS 61220_Report
UIS method identification:	UIS-XF-T007	Authorisation date:	31-Jul-2024
Instrument model:	ARL PERFORM'X SERIES	Authorised by:	NAME: E Langa
Asset number:	UIS-AS 1071		DESIGNATION: Technician

APPENDIX J
SGS MATROLAB CONCRETE MIX DESIGNS

QUARRY & DAM BASIN SITE's

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria
P.O.Box 912387,Silverton ,0127
Tel. : (012)800 1299
Fax :
Email : stephan.husselman@sgs.com

sanas Testing Laboratory T0025

TEST RESULTS

ENGEOLAB CC
P.O.BOX 4177
WITBANK
1035
Attention:

Project : LL3876

Your Ref :
Our Ref : PL/63053
Date Received : 26/07/2024

CURING & COMPRESSIVE STRENGTH OF CONCRETE CUBES (SANS 5861/3, 5863)

DETAILS AS SUPPLIED BY CLIENT

ORIGIN	REQ-UIRED (MPa)	SLUMP (mm)	DATE REPORTED	CUBE NUMBER	DATE CAST	DATE TESTED	AGE DAYS	MASS (g)	COMPRESSIVE STRENGTH (MPa)
MIX DESIGN	25		10/08/24	3140	25/07/24	01/08/24	7	2373	22,0
MIX DESIGN	25		10/08/24	3141	25/07/24	08/08/24	14	2386	27,0
MIX DESIGN	25		04/09/24	3142	25/07/24	22/08/24	28	2349	34,0

Remarks : CUBES MADE BY CLIENT.

FORM: D1

4.4.1(SGS)(2019.12.04)

Technical Signatory: Stephan Husselman

SGS MATROLAB

256 brander Street, Jan Niemand Park, Pretoria
PO BOX 912387, Silverton, Pretoria
Tel: : 012 800 1299
Email : stephan.husselman@sgs.com

Reg. No. 2003/029180/07 – VAT Reg. No. 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

CONCRETE MIX DESIGN

ENGEOLAB
PO Box 4177
WITBANK
1035
Attention: Paul Hansmeyer

Project: : LL3876
Our Ref : PL/63053B
Date Reported : 01.08.2024

Mix Design

The rock was crushed to -19mm and combined from Red, Blue and Yellow samples

Crushed Aggregate	850	kg/m^3
River Sand	1050	kg/m^3
Cement (PPC 42.5N Surebuild)	310	kg/m^3
Water	243	l/m^3
Slump Achieved	115mm	

Technical Signatory : Stephan Husselmann

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria.
P.O Box 912387,Silverton,0127
Tel. : (012) 800 1299
Fax :
Email : stephan.husselman@sgs.com

sanas Testing Laboratory T0025

TEST RESULTS

ENGEOLAB CC
P.O BOX 4177
WITBANK
1035
Attention:

Project : LL3876

Your Ref :
Our Ref : PL/63053B
Date Received : 16.07.2024

CURING & COMPRESSIVE STRENGTH OF CONCRETE CUBES (SANS 5861/3, 5863)

DETAILS AS SUPPLIED BY CLIENT

ORIGIN	REQ-UIRED (MPa)	SLUMP (mm)	DATE REPORTED	CUBE NUMBER	DATE CAST	DATE TESTED	AGE DAYS	MASS (g)	COMPRESSIVE STRENGTH (MPa)
Mix Disign	25		01.08.24	3140	25.07.24	01.08.24	7	2373	22.0
Mix Disign	25		15.08.24	3141	25.07.24	08.08.24	14	2386	27.0

Remarks : CUBES MADE BY CLIENT.

FORM: D1

4.5.0(SGS)(2021.05.05)

Technical Signatory : S. Husselmann

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria
P.O.Box 912387,Silverton ,0127
Tel. : (012)800 1299
Fax :
Email : stephan.husselman@sgs.com

sanas Testing Laboratory T0025

TEST RESULTS

ENGEOLAB CC
P.O.BOX 4177
WITBANK
1035
Attention:

Project : LL3876

Your Ref :
Our Ref : PL/63053
Date Received : 26/07/2024

CURING & COMPRESSIVE STRENGTH OF CONCRETE CUBES (SANS 5861/3, 5863)

DETAILS AS SUPPLIED BY CLIENT

ORIGIN	REQ-UIRED (MPa)	SLUMP (mm)	DATE REPORTED	CUBE NUMBER	DATE CAST	DATE TESTED	AGE DAYS	MASS (g)	COMPRESSIVE STRENGTH (MPa)
MIX DESIGN	25		10/08/24	3140	25/07/24	01/08/24	7	2373	22,0
MIX DESIGN	25		10/08/24	3141	25/07/24	08/08/24	14	2386	27,0

Remarks : CUBES MADE BY CLIENT.

FORM: D1

4.4.1(SGS)(2019.12.04)

Technical Signatory : Stephan Husselman

SGS MATROLAB (PTY) LTD
- CIVIL ENGINEERING SERVICES -
Reg.No.: 2003/021980/07 - VAT. Reg.No.: 4040210587
a SANAS Accredited Testing Laboratory, No. T0025

256 Brander Street,Jan Niemand Park,Pretoria.
P.O Box 912387,Silverton,0127
Tel. : (012) 800 1299
Fax :
Email : stephan.husselman@sgs.com

T0025

TEST RESULTS

ENGEOLAB CC
P.O BOX 4177
WITBANK
1035
Attention:

Project : LL3876

Your Ref :
Our Ref : PL/63063A
Date Received : 16.07.2024

CURING & COMPRESSIVE STRENGTH OF CONCRETE CUBES (SANS 5861/3, 5863)

DETAILS AS SUPPLIED BY CLIENT

ORIGIN	REQ-UIRED (MPa)	SLUMP (mm)	DATE REPORTED	CUBE NUMBER	DATE CAST	DATE TESTED	AGE DAYS	MASS (g)	COMPRESSIVE STRENGTH (MPa)
Mix 2 Design	25	120	22.07.24	2974	17.07.24	19.07.24	2	2338	7.5
Mix 2 Design	25	120	24.07.24	2975	17.07.24	24.07.24	7	2305	15.0

Remarks :

FORM: D1

4.5.0(SGS)(2021.05.05)

Technical Signatory : S. Husselmann

REPORT ON THE GEOTECHNICAL INVESTIGATION FOR THE PROPOSED EMPULUZI METHULA BULK WATER SUPPLY SCHEME

VOLUME 6B _ QUARRY AND DAM BASIN

PROJECT NO.: LL3876

DATE: OCTOBER 2024

CONSULTING ENGINEERS:

Vumesa

INGEROP
Inventing for tomorrow

ENGEOLAB (PTY) LTD

Reg. No. 2017/536405/07 VAT Reg. No. 4710205925

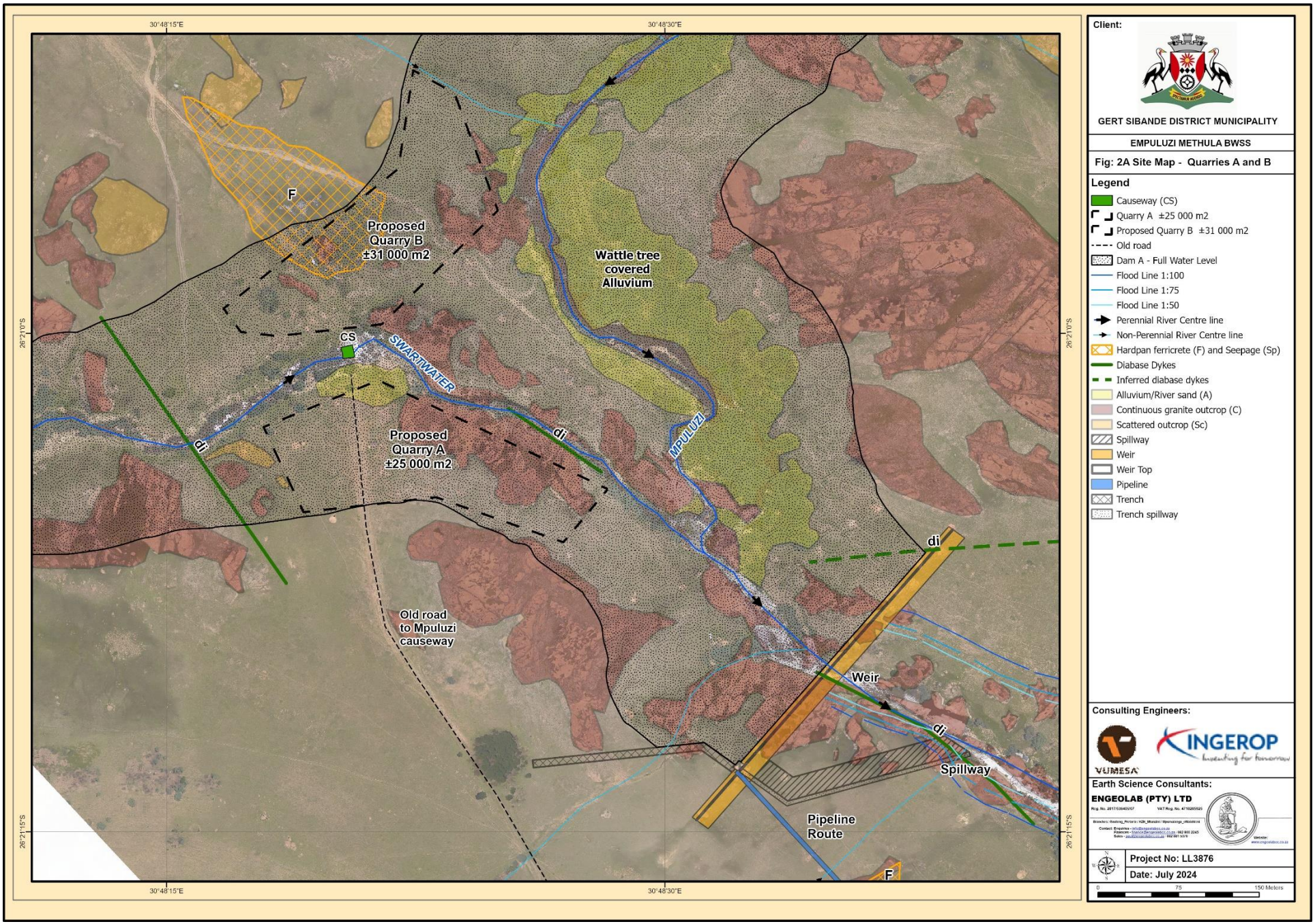
Directors: P.G. Hansmeyer *Pr.SciNat*; G.N. Choma

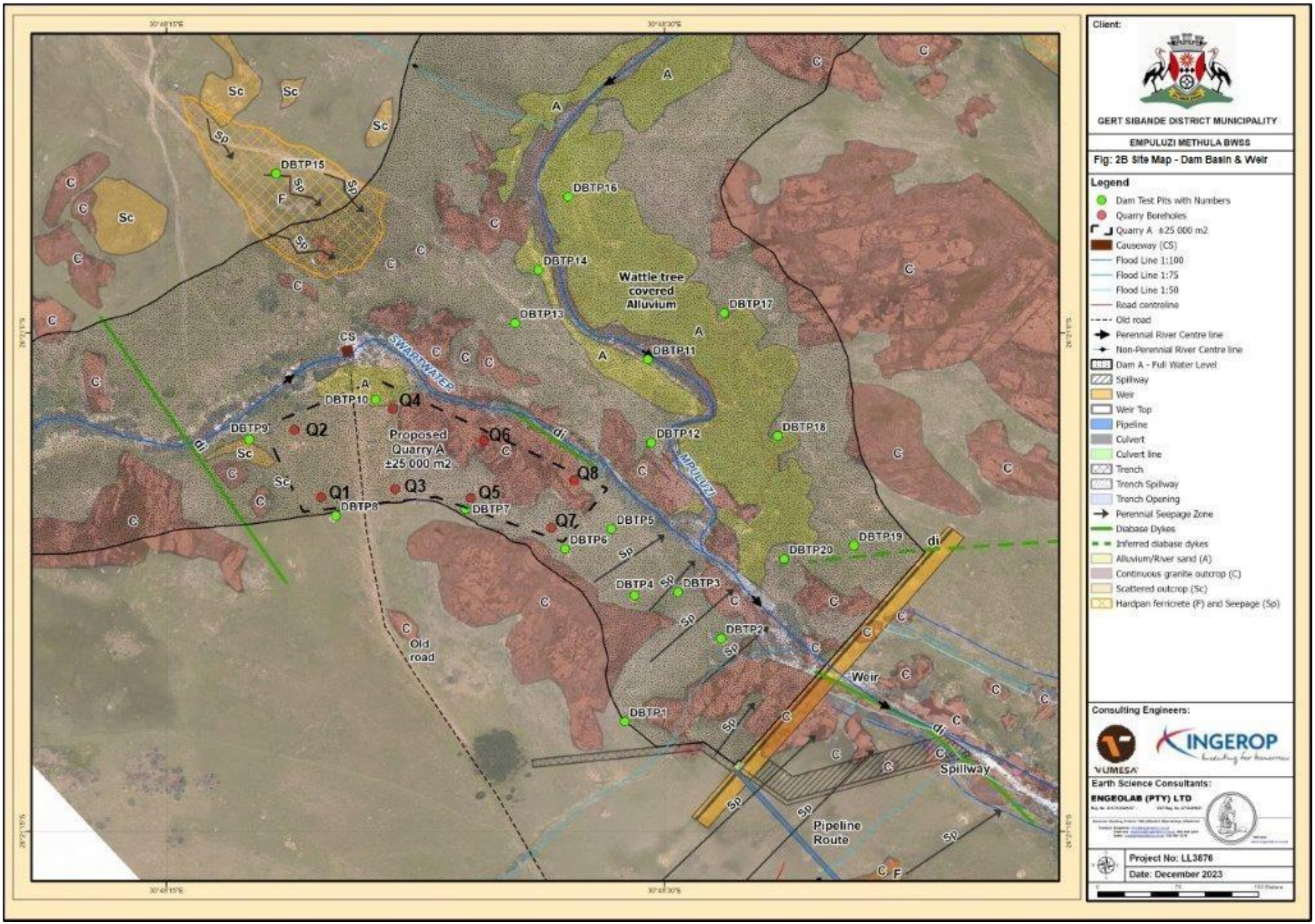
Branches: Gauteng_Pretoria / KZN_Mtunzini / Mpumalanga_eMalahleni

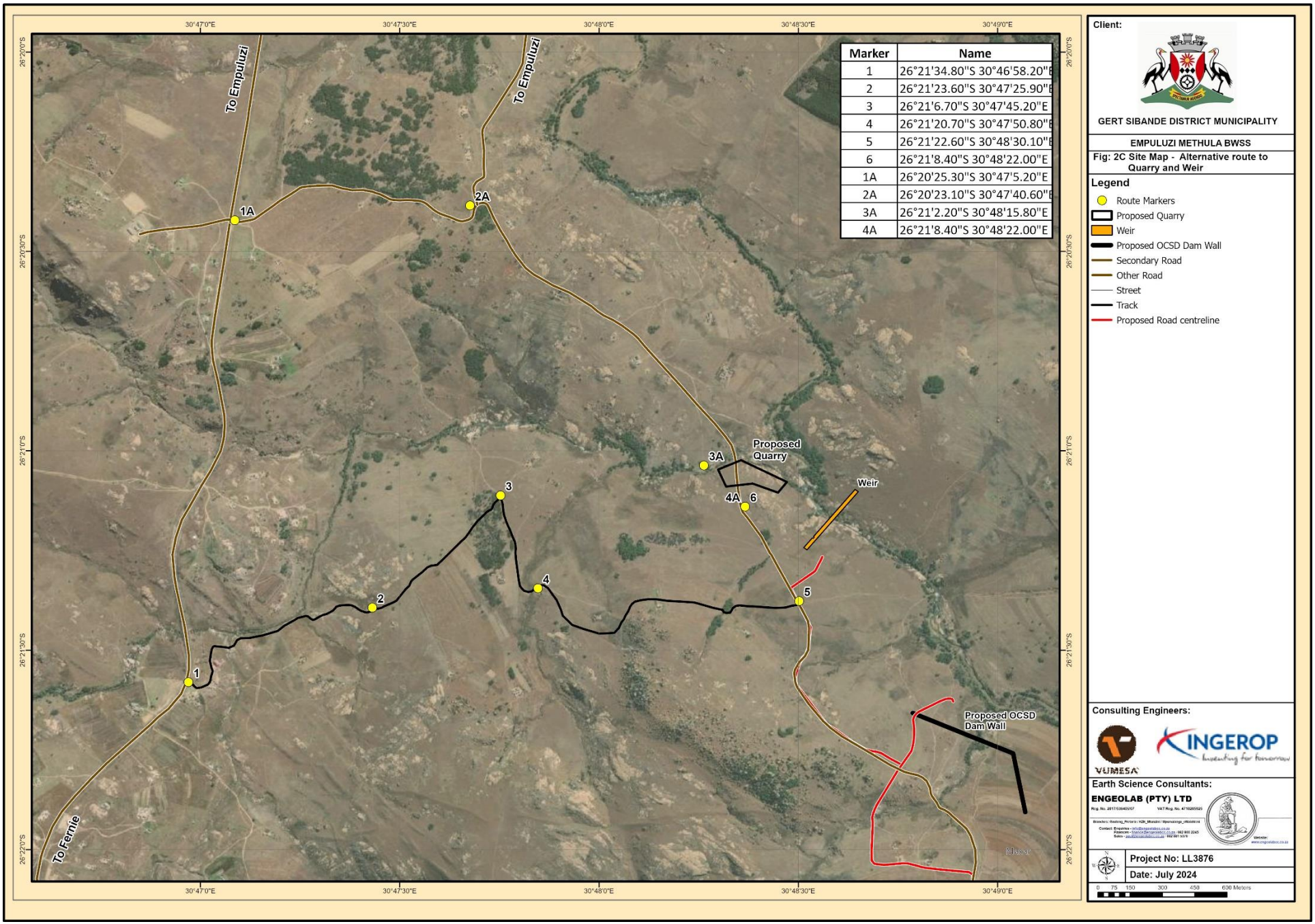
Contact: Enquiries - info@engeolabcc.co.za
Finances - finance@engeolabcc.co.za / 082 800 2245
Sales - paul@engeolabcc.co.za / 082 881 5370

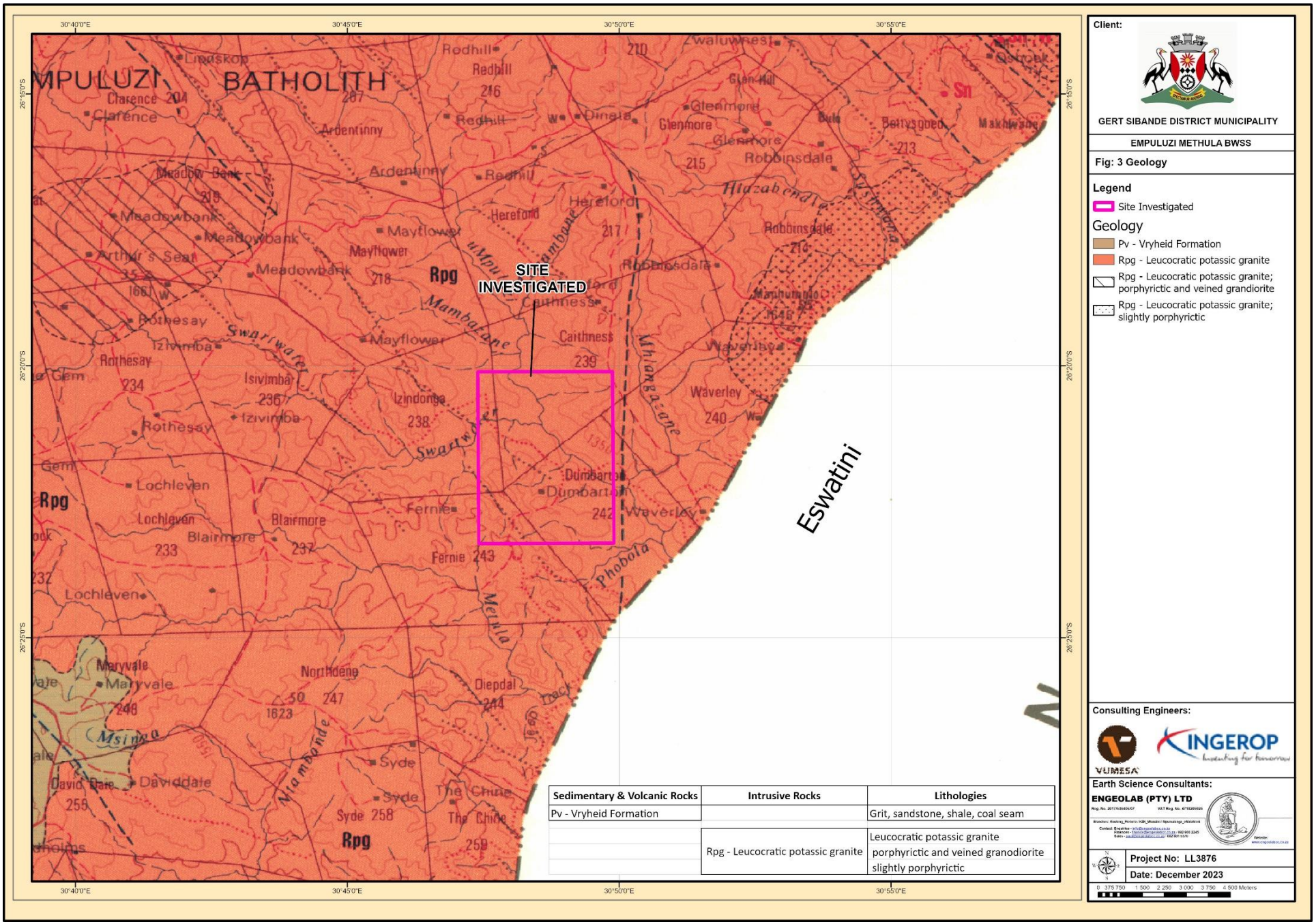
B-BBEE: ENGEOLAB is a Level 2 BEE Contributor

Website: www.engeolabcc.co.za

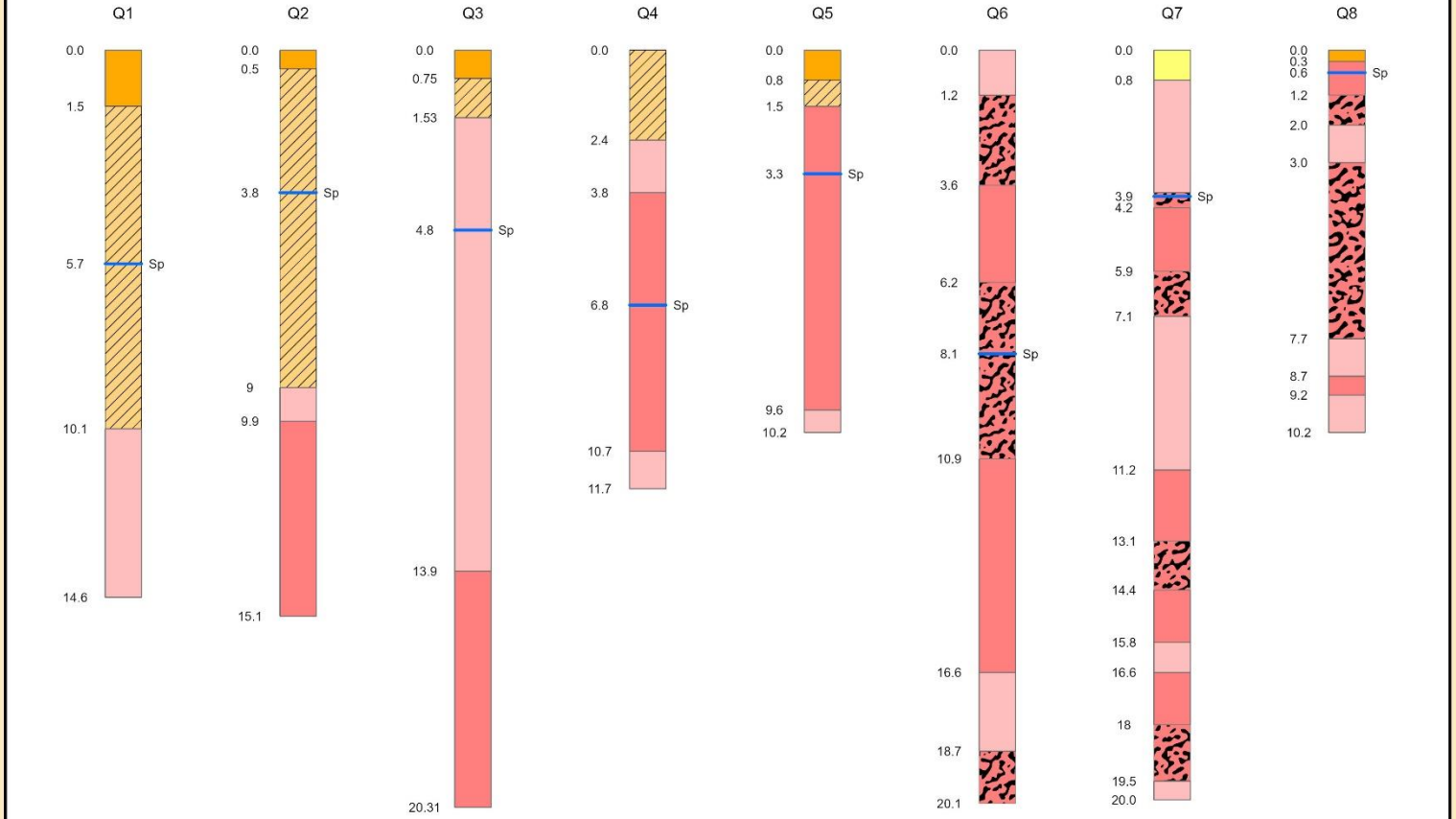

30°48'15"E
30°48'30"E
26°21'0"S
26°21'15"S
F
Proposed
Quarry B
±31 000 m2
Wattle tree
covered
Alluvium
CS
SWARTWATER
MPULUZI
di
Proposed
Quarry A
±25 000 m2
Old road
to Mpuluzi
causeway
Weir
Spillway
Pipeline
Route
Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 2A Site Map - Quarries A and B
Legend
Causeway (CS)
Quarry A ±25 000 m2
Proposed Quarry B ±31 000 m2
Old road
Dam A - Full Water Level
Flood Line 1:100
Flood Line 1:75
Flood Line 1:50
Perennial River Centre line
Non-Perennial River Centre line
Hardpan ferricrete (F) and Seepage (Sp)
Diabase Dykes
Inferred diabase dykes
Alluvium/River sand (A)
Continuous granite outcrop (C)
Scattered outcrop (Sc)
Spillway
Weir
Weir Top
Pipeline
Trench
Trench spillway
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024
0
75
150 Meters


Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 2B Site Map - Dam Basin & Weir
Legend
Dam Test Pits with Numbers
Quarry Boreholes
Quarry A ±25 000 m2
Causeway (CS)
Flood Line 1:100
Flood Line 1:75
Flood Line 1:50
Road centreline
Old road
Perennial River Centre line
Non-Perennial River Centre line
Dam A - Full Water Level
Spillway
Weir
Weir Top
Pipeline
Culvert
Culvert line
Trench
Trench Spillway
Trench Opening
Perennial Seepage Zone
Diabase Dykes
Inferred diabase dykes
Alluvium/River sand (A)
Continuous granite outcrop (C)
Scattered outcrop (Sc)
Hardpan ferricrete (F) and Seepage (Sp)
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: December 2023
DBTP15
DBTP16
DBTP14
DBTP13
DBTP17
DBTP11
DBTP10
DBTP9
DBTP8
DBTP7
DBTP6
DBTP5
DBTP4
DBTP3
DBTP2
DBTP1
DBTP12
DBTP18
DBTP19
DBTP20
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
CS
Wattle tree covered Alluvium
Proposed Quarry A ±25 000 m2
SWARMWATER
MPULUZI
Old road
Weir
Spillway
Pipeline Route


30°47'0"E
30°47'30"E
30°48'0"E
30°48'30"E
30°49'0"E
26°20'0"S
26°20'30"S
26°21'0"S
26°21'30"S
26°22'0"S
To Empuluzi
To Empuluzi
To Fernie
1A
2A
3A
4A
1
2
3
4
5
6
Proposed Quarry
Weir
Proposed OCSD Dam Wall
Marker
Name
1
26°21'34.80"S 30°46'58.20"E
2
26°21'23.60"S 30°47'25.90"E
3
26°21'6.70"S 30°47'45.20"E
4
26°21'20.70"S 30°47'50.80"E
5
26°21'22.60"S 30°48'30.10"E
6
26°21'8.40"S 30°48'22.00"E
1A
26°20'25.30"S 30°47'5.20"E
2A
26°20'23.10"S 30°47'40.60"E
3A
26°21'2.20"S 30°48'15.80"E
4A
26°21'8.40"S 30°48'22.00"E
Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 2C Site Map - Alternative route to Quarry and Weir
Legend
Route Markers
Proposed Quarry
Weir
Proposed OCSD Dam Wall
Secondary Road
Other Road
Street
Track
Proposed Road centreline
Consulting Engineers:
VUMESA
KINGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024
0 75 150 300 450 600 Meters



Sedimentary & Volcanic Rocks	Intrusive Rocks	Lithologies
Pv - Vryheid Formation		Grit, sandstone, shale, coal seam
	Rpg - Leucocratic potassic granite	Leucocratic potassic granite porphyritic and veined granodiorite slightly porphyritic



Client:

GERT SIBANDE DISTRICT MUNICIPALITY

EMPULUZI METHULA BWSS

Fig: 4 Empuluzi Quarry Boreholes

Legend

- Water Level (WL)

Geology

- Alluvium
- Colluvium
- Completely to highly weathered granite (Mainly coarse sand)
- Pegmatite
- Pegmatitc granite
- Granite

Consulting Engineers:

VUMESA

INGEROP

Earth Science Consultants:

ENGEOLAB (PTY) LTD

Reg. No. 2017/539405/07 VAT Reg. No. 4719285505

Branches: Gauteng_Pretoria | KZN_Mandini | Mpumalanga_Middelburg

Contact Enquiries - info@engeolabcc.co.za

Finances - finance@engeolabcc.co.za | 082 960 2245

Sales - sales@engeolabcc.co.za | 082 941 5570

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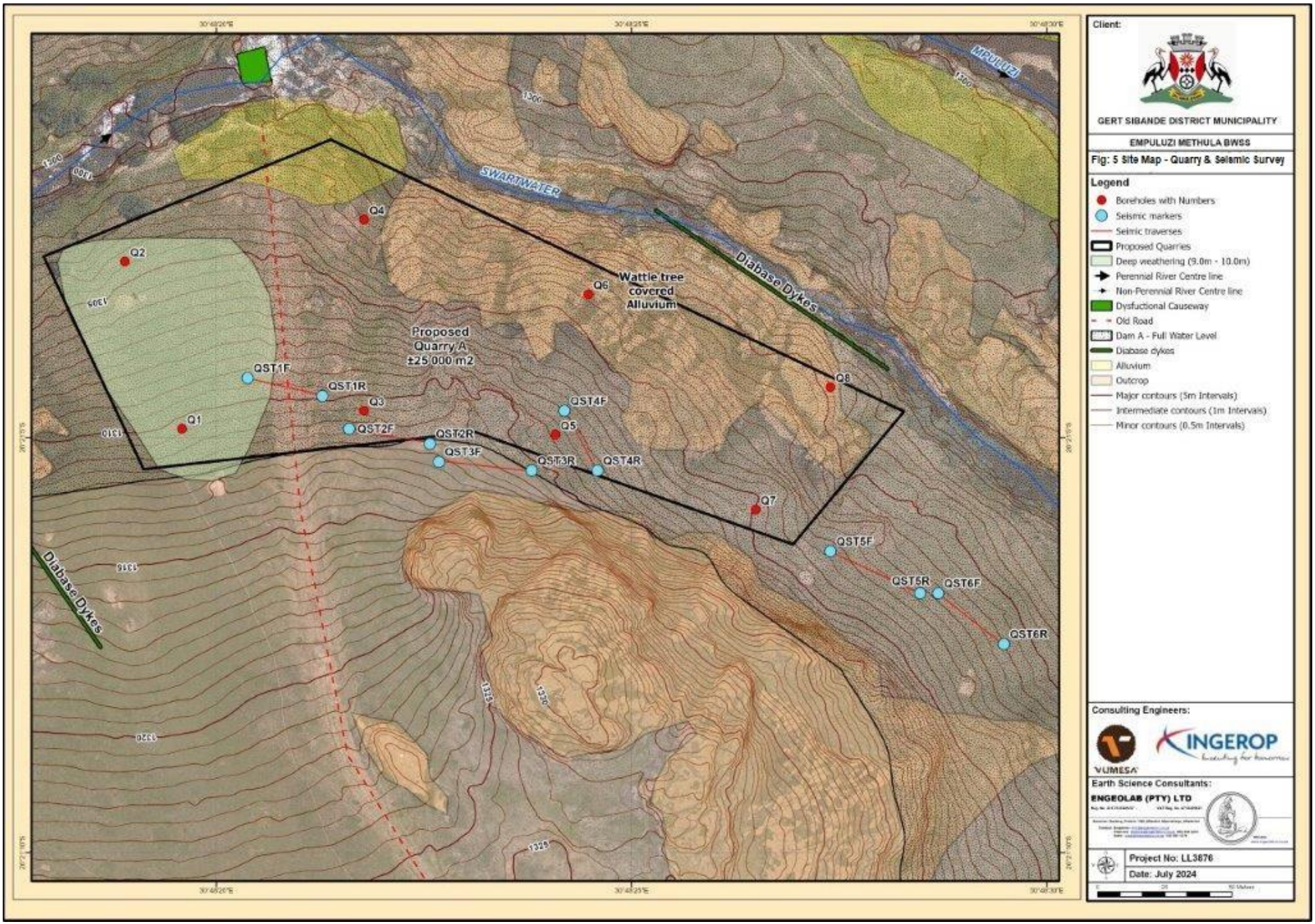
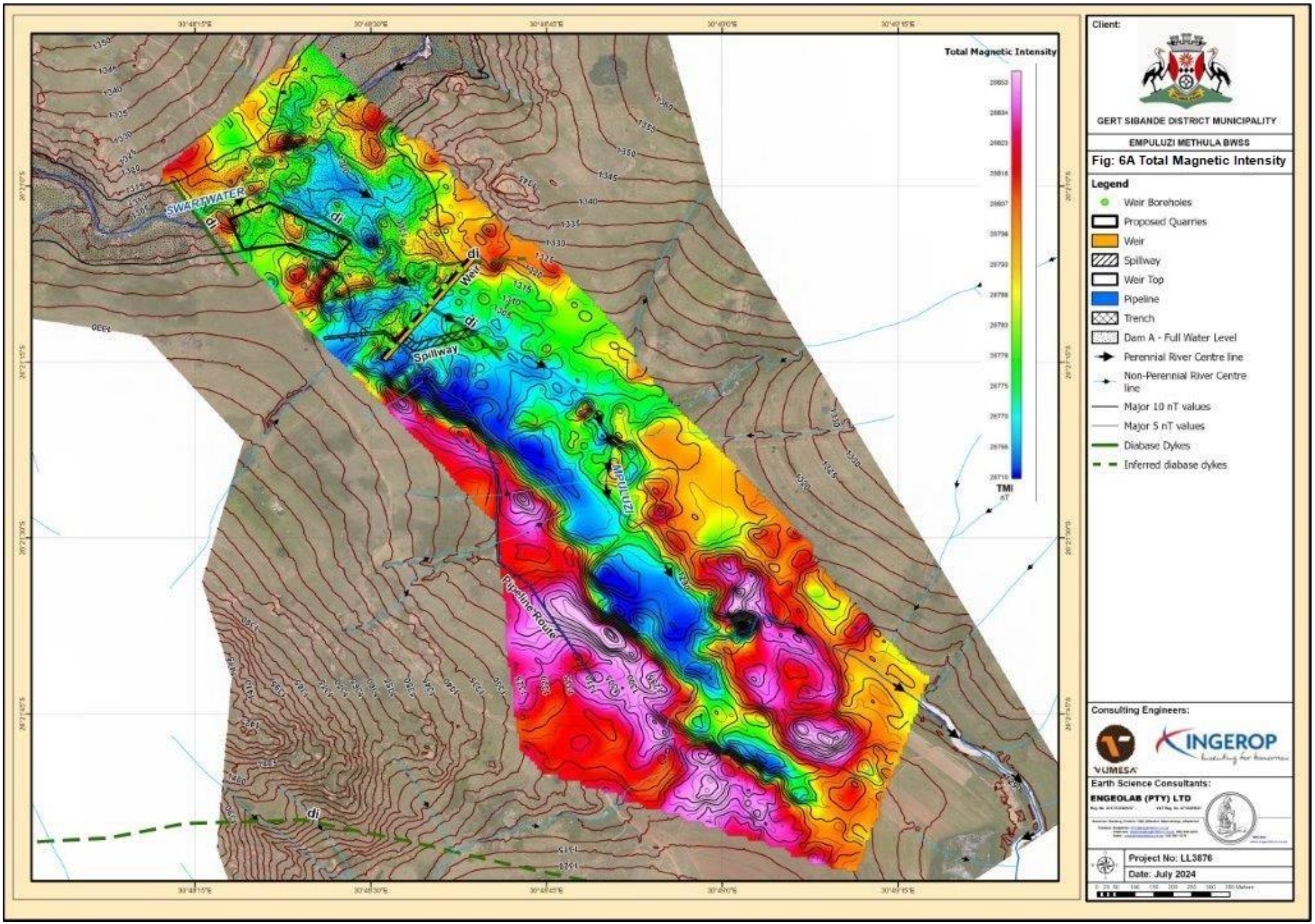
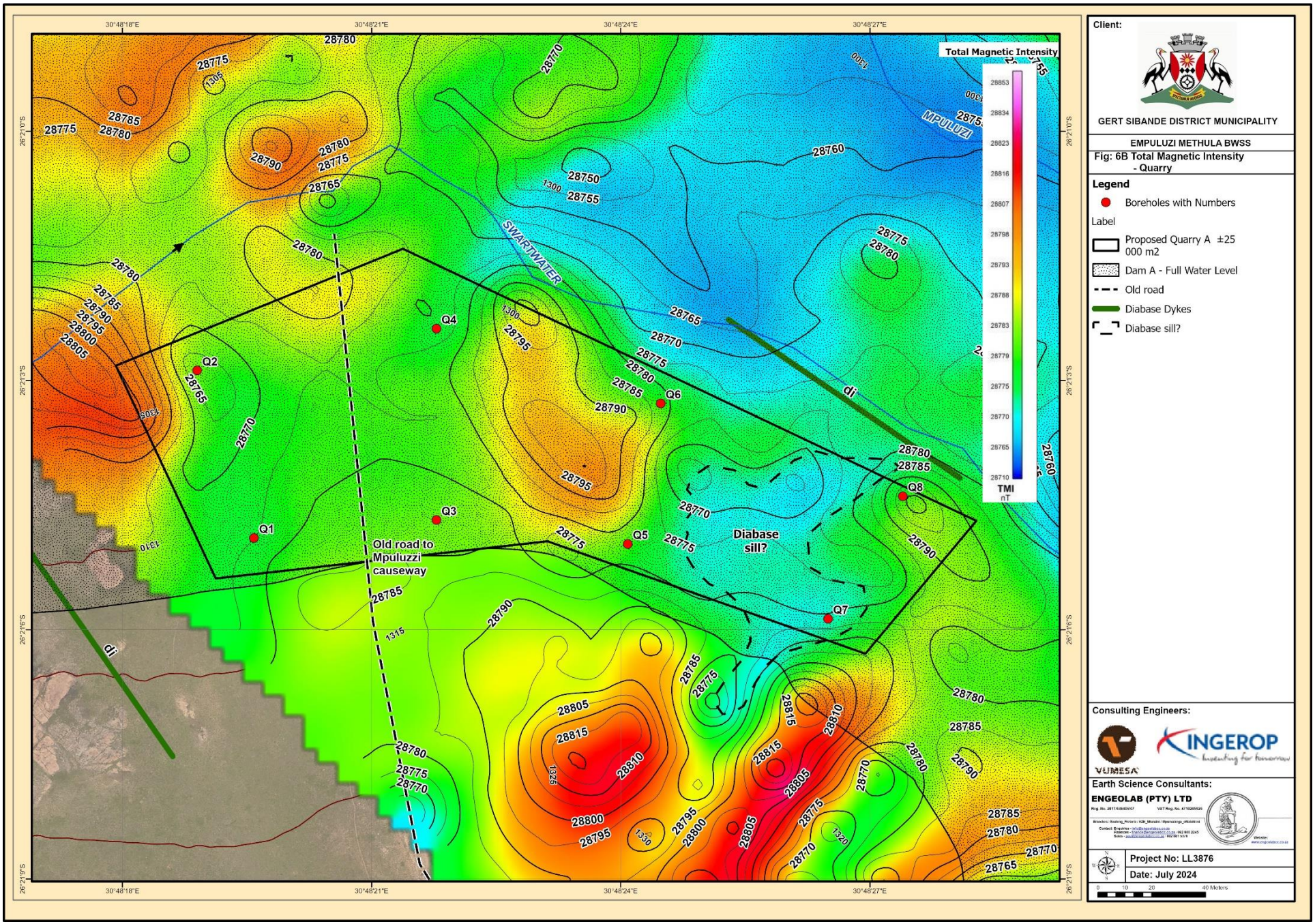
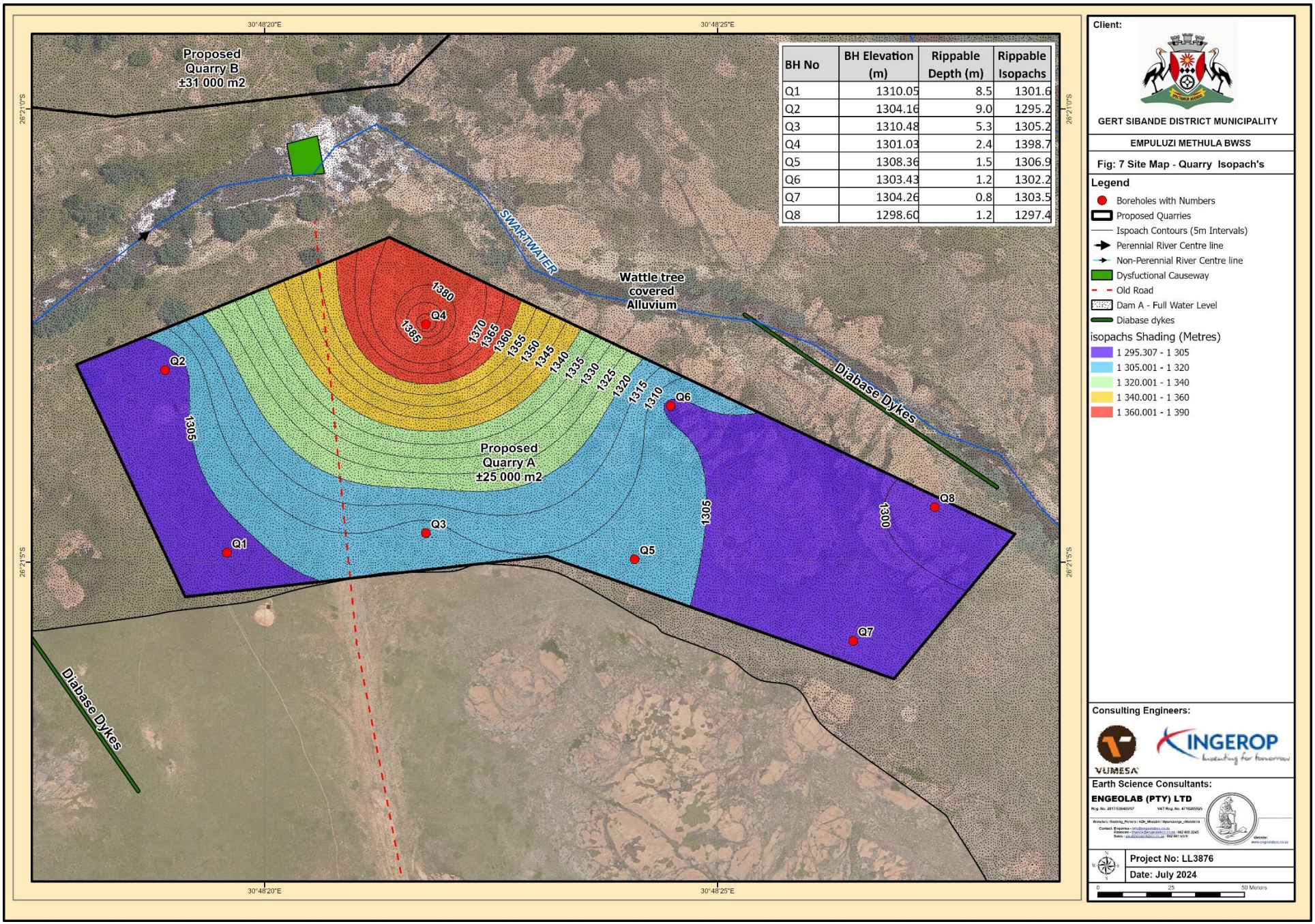
Date: July 2024


Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 5 Site Map - Quarry & Seismic Survey
Legend
Boreholes with Numbers
Seismic markers
Seismic traverses
Proposed Quarries
Deep weathering (9.0m - 10.0m)
Perennial River Centre line
Non-Perennial River Centre line
Dysfuctional Causeway
Old Road
Dam A - Full Water Level
Diabase dykes
Alluvium
Outcrop
Major contours (5m Intervals)
Intermediate contours (1m Intervals)
Minor contours (0.5m Intervals)
SWARTWATER
MPULUZI
Diabase Dykes
Wattle tree covered Alluvium
Proposed Quarry A ±25 000 m2
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
QST1F
QST1R
QST2F
QST2R
QST3F
QST3R
QST4F
QST4R
QST5F
QST5R
QST6F
QST6R
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024


Total Magnetic Intensity
TMI
nT
SWARTWATER
Weir
Spillway
Pipeline Route
di
Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 6A Total Magnetic Intensity
Legend
Weir Boreholes
Proposed Quarries
Weir
Spillway
Weir Top
Pipeline
Trench
Dam A - Full Water Level
Perennial River Centre line
Non-Perennial River Centre line
Major 10 nT values
Major 5 nT values
Diabase Dykes
Inferred diabase dykes
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024


Total Magnetic Intensity
TMI
nT
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Old road to Mpuluzi causeway
Diabase sill?
SWARTWATER
MPULUZI
di
Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 6B Total Magnetic Intensity - Quarry
Legend
Boreholes with Numbers
Label
Proposed Quarry A ±25 000 m2
Dam A - Full Water Level
Old road
Diabase Dykes
Diabase sill?
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024


30°48'20"E
30°48'25"E
26°21'0"S
26°21'5"S
Proposed Quarry B ±31 000 m2
SWARTWATER
Wattle tree covered Alluvium
Diabase Dykes
Proposed Quarry A ±25 000 m2
Diabase Dykes
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
1380
1385
1370
1365
1360
1355
1350
1345
1340
1335
1330
1325
1320
1315
1310
1305
1300
BH No | BH Elevation (m) | Rippable Depth (m) | Rippable Isopachs
Q1 | 1310.05 | 8.5 | 1301.6
Q2 | 1304.16 | 9.0 | 1295.2
Q3 | 1310.48 | 5.3 | 1305.2
Q4 | 1301.03 | 2.4 | 1398.7
Q5 | 1308.36 | 1.5 | 1306.9
Q6 | 1303.43 | 1.2 | 1302.2
Q7 | 1304.26 | 0.8 | 1303.5
Q8 | 1298.60 | 1.2 | 1297.4
Client:
GERT SIBANDE DISTRICT MUNICIPALITY
EMPULUZI METHULA BWSS
Fig: 7 Site Map - Quarry Isopach's
Legend
Boreholes with Numbers
Proposed Quarries
Ispoach Contours (5m Intervals)
Perennial River Centre line
Non-Perennial River Centre line
Dysfuctional Causeway
Old Road
Dam A - Full Water Level
Diabase dykes
isopachs Shading (Metres)
1 295.307 - 1 305
1 305.001 - 1 320
1 320.001 - 1 340
1 340.001 - 1 360
1 360.001 - 1 390
Consulting Engineers:
VUMESA
INGEROP
Earth Science Consultants:
ENGEOLAB (PTY) LTD
Project No: LL3876
Date: July 2024
0
25
50 Meters

ENGEOLAB PTY LTD
Earth Science Consultants
Geotechnical & Geohydrological Specialists