GEOTECHNICAL INVESTIGATION REPORT FOR FILLING STATION AT MOKGANYAKA, EPHRAIM MOKGALE LOCAL MUNICIPALITY (EMLM) OF SEKHUKHUNE DISTRICT MUNICIPALITY (SDM), LIMPOPO PROVINCE

PREPARED FOR: MOKGANYAKA TAXI ASSOCIATION (PTY) LTD

C: 082 269 4524 I T: 015 547 0524

admin@greatwarthog.co.za

www.greatwarthog.co.za

NO.114 Dzata Street
Vleifontein
Office no.004
0948

DEGREE OF CONFIDENTIALITY	
Report Title	**GEOTECHNICAL INVESTIGATION REPORT FOR FILLING STATION AT MOKGANYAKA, EPHRAIM MOKGALE LOCAL MUNICIPALITY (EMLM) OF SEKHUKHUNE DISTRICT MUNICIPALITY (SDM), LIMPOPO PROVINCE**
Date of Issue	March 2021
Report Compiled by	**Great Warthog Geo-Environmental (Pty) Ltd** NO.114 Dzata Street Vleifontein Office no.004 0948 admin@greatwarthog.co.za 015 547 0524 / 082 269 4524 www.greatwarthog.co.za
Client Details	**Mokganyaka Taxi Association (Pty) Ltd**

DISCLAIMER

While every effort is made during the fieldwork phase to identify the different soil horizons, areas subject to a perched water table, areas of poor drainage, areas underlain by hard rock and to estimate their distribution, it is impossible to guarantee that isolated zones of poorer foundation material or harder rock have not been missed. For this reason, this investigation has sought to highlight areas of potential foundation, groundwater and excavation problems, to provide prior warning to the developer. This report is specifically compiled for the proposed Mokganyaka Filling Station, thus cannot be used to generalize geotechnical parameters of any nearby areas or sites

Prepared by	**Great Warthog Geo-Environmental (Pty) Ltd**	
Compiled and Authored By	**Thaha S.P**	**Cand Sci- Reg No 125798**
Reviewed by	***Mavhetha L***	**Pr. Sci. Nat.- Reg. No. 126057**

EXECUTIVE SUMMARY

- Great Warthog Geo-Environmental (Pty) Ltd was appointed by Mokganyaka Taxi Association (Pty) Ltd to undertake a geotechnical investigation for the proposed filling station at **Mokganyaka Village.**
- The proposed site, falls under Ephraim Mokgale Local Municipality (EMLM) of Sekhukhune District Municipality (SDM), Limpopo Province. The geographical coordinates for the site **are** 24°59'17"S and 29°23'24"E..
- The investigation methodology included literature review, site walkover survey, field investigation, laboratory testing, analysis of laboratory results and final reporting. The field investigation included excavation of **3** trial pits, soil profiling, soil sampling.
- Two (2) disturbed samples were taken from the trial pit for laboratory analysis including particle size distribution, Atterberg limits determination, CBR, MDD, OMC and MOD ASSHTO and chemical test, detailed results are provided.
- Generalized soil profiles of the site consist of clayey/silty sands material underlain by residual silty sands and silt mixtures.
- The site is underlain by the rocks of the Vryheid formation of the Ecca Group in the Karoo Supergroup
- Soft to Intermediate excavation in terms of SABS 1200D is generally anticipated from surface to depths in excess maximum of approximate **2.00m** below ground level.
- The main geotechnical constraints for the site are **Slight soil activity and compressibility.** According to the site class designation, the site is classified as: ***C1/S1.***
- Laboratory results indicate that the residual material has a Bulk density of 2060 to 2203 kg/m^3, an optimum moisture content of 6.8-8.3% and grading analysis show that material can be classified as clayey/silty sands material with 19-20 %liquid limit, 0.8**-1.0%** grading modulus and the material has **low plasticity**.
- Due to the predominantly geotechnical characteristics of the material onsite, it is advised that the most appropriate foundations options are modified normal, soil raft and compaction of an insitu material.

- The comments and recommendations contained within this report are based on a limited number of test pits. It is therefore recommended that all excavation and foundation trenches be inspected by a geotechnical engineer or engineering geologist during construction to verify that the founding condition are not at variance with those described herein.

TABLE OF CONTENT

Table of Figures

Table of Tables

Appendices:

1. INTRODUCTION

Great Warthog Geo-Environmental (Pty) Ltd was appointed by Mokganyaka Taxi Association (Pty) Ltd to undertake a geotechnical investigation for the proposed filling station at Mokganyaka, ERF 1059 on portion 2 of 750 KS under the jurisdiction of Ephraim Mokgale Local Municipality (EMLM) of Sekhukhune District Municipality (SDM), Limpopo Province. This report presents the results and findings of the geotechnical investigation conducted for the proposed filling station development.

2. SCOPE OF THE WORK

The investigation was carried out in accordance with the GFSH-2 guidelines published by the Department of Housing (2002), The application of the national building regulations (SANS 10400-H) and SANS 634 (Geotechnical investigation for Housing developments) guidelines.

The objectives of the geotechnical investigation included but not limited to:

- Describing the location, topography, and geology of the proposed site,
- Evaluate the geological and geotechnical conditions of the soils underlying the site,
- Establish the soil profiles across the site and expected founding conditions,
- Evaluate their engineering properties and suitability for the proposed development,
- Highlighting any problem soils, slope stability or drainage issues,
- Assess the groundwater conditions, including surface run off possibilities, seepage, ponding, and note the occurrence of any perched or permanent water tables.
- Evaluate the workability of the site materials regarding their excavatability and compatibility,
- Determining the suitability of the site for the proposed development and make recommendations for the design earthwork, foundations, and engineering services.

3. AVAILABLE INFORMATION

The following maps and/or plans were available for reference purposes and are reproduced in this report:

- Google Earth® imagery maps,
- 1:250 000 Geological maps of the area
- Generic Specification GFSH-2, National Department of Housing Specification: Geotechnical site investigations for housing development, September 2002
- NHBRC Home Building Manual, Part 1 and 2, dated March 2015
- South African National Standards: Geotechnical investigations for township development (SANS 634:2012)

4. GENERAL DESCRIPTION OF SITE

4.1. Location

The proposed filling station is Mokganyaka, ERF 1059 on portion 2 of 750 KS under the jurisdiction of Ephraim Mokgale Local Municipality (EMLM) of Sekhukhune District Municipality (SDM), Limpopo Province. The geographical coordinates for the site are 24°59'17"S and 29°23'24"E.

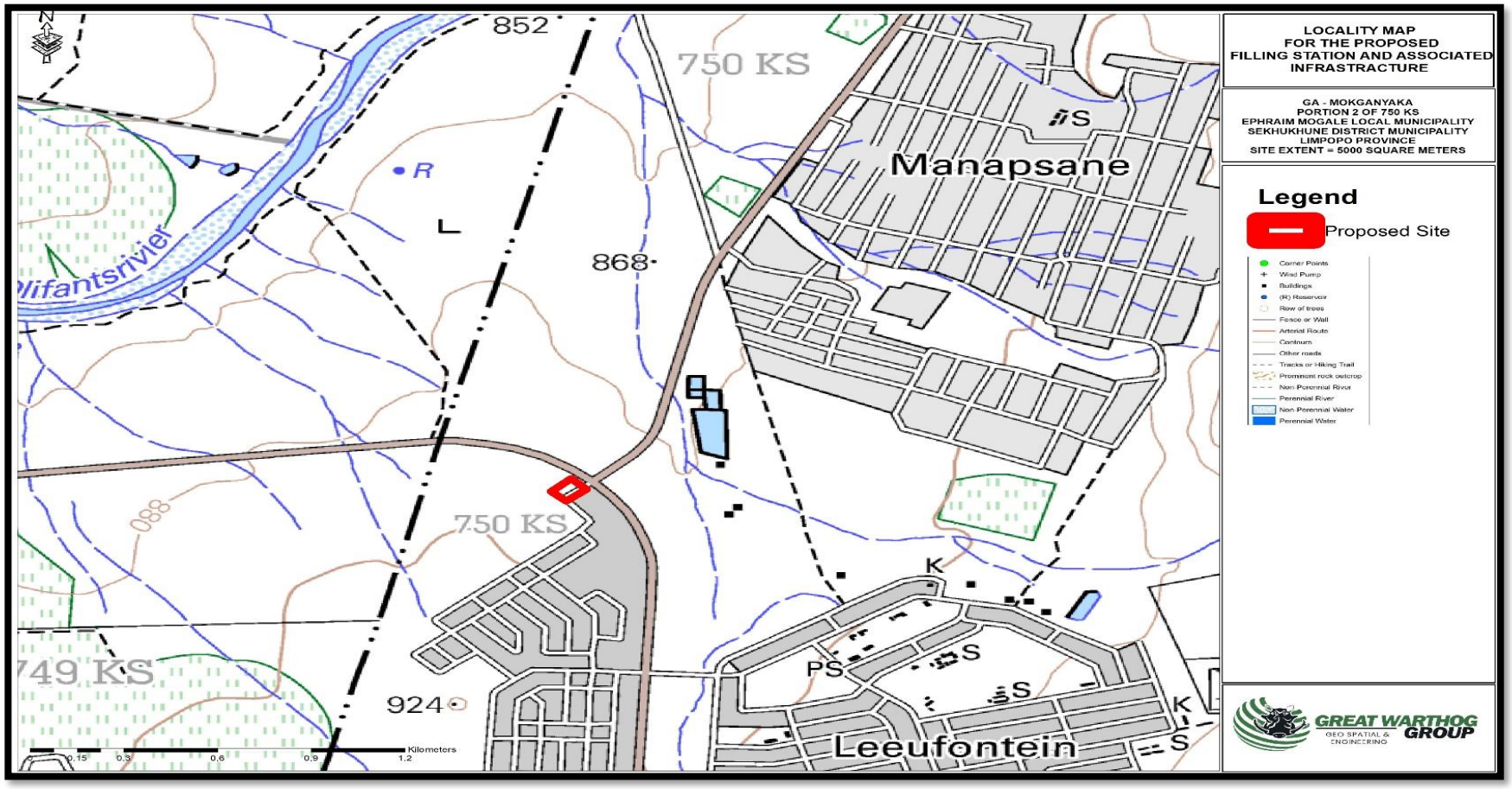


Figure 1: Mokganyaka Village Locality Map

7.2 4.2 Climate

The average temperatures show moderate fluctuation with average summer temperature 23°C, with a maximum of 28°C and a minimum of 18°C. In winter the average is 13, 5°C with a maximum of 20°C and a minimum of 7°C as measured at the Sekhukhune Land Weather Station

4.3 Site Geology

The site falls within the Vryheid formation of the Ecca Group in the Karoo Supergroup.

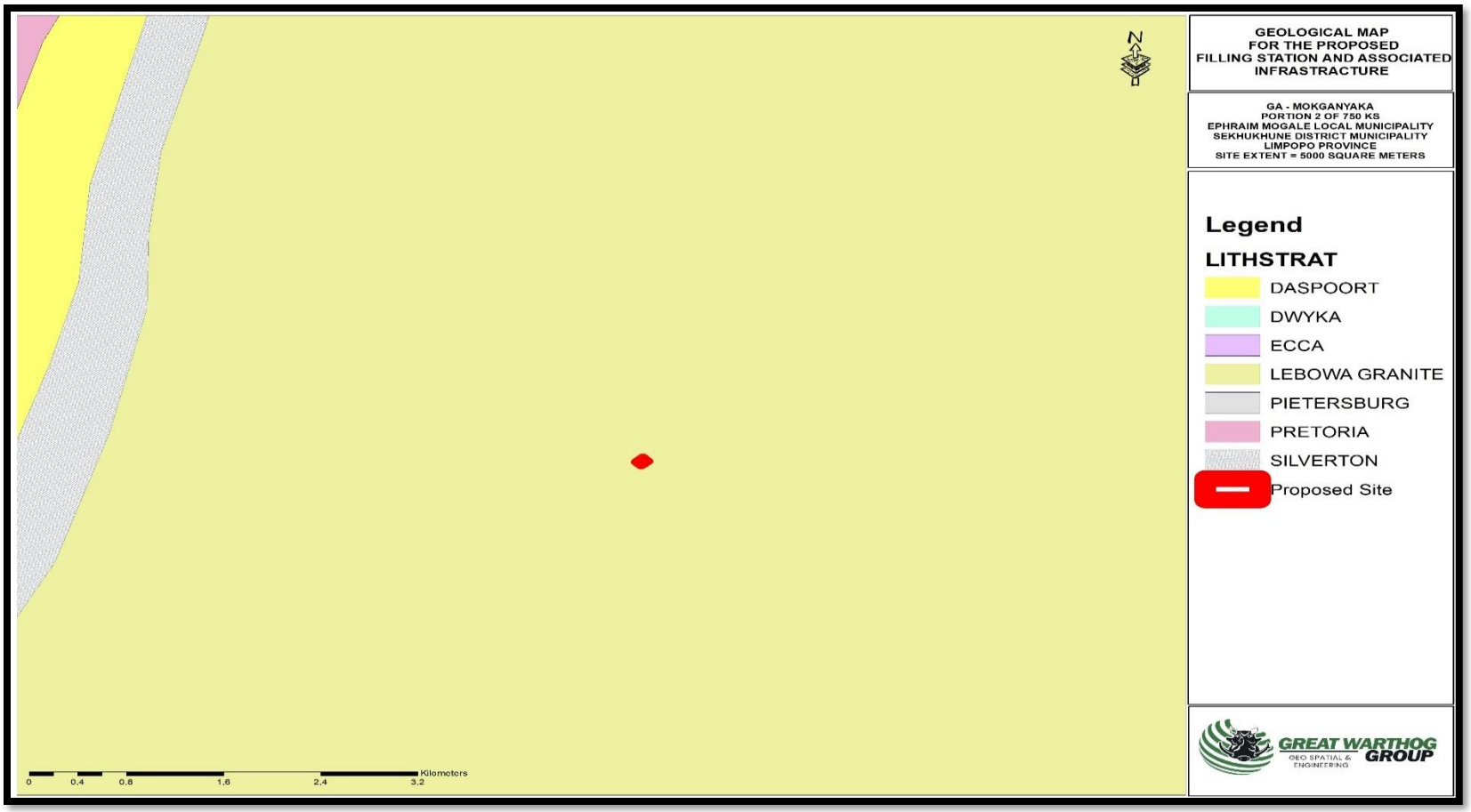


Figure 2 : Mokganyaka Geological Map

5. NATURE OF THE INVESTIGATION

The site investigation was carried out on the 26th February 2020, this involved a site walkover site survey and a subsurface investigation on the site.

Test pits positions were located with the aid of a handheld GPS as shown in Table 1. Three (3) trial pits were excavated with the aid of a Tractor Load Back-actor (TLB) to the depth of at least 2.5m or the refusal to mechanical excavation. Each trial pit was profiled by a field engineer in accordance with the Code of Practice proposed by Brink and Bruin.

Soil samples were collected and submitted to Letaba Civil Engineering Material Laboratory for the th.e following tests:

- Foundation indicator test (Grading, Atterberg limits and potential expansiveness),
- MOD/CBR/ Indicator tests (Determine the suitability for possible road pavements material use),

6. MISCELLANEOUS SUB-SURFACE ISSUES

6.1 Undermining

There are no prehistoric mining activities that took place in the study area or around its immediate surroundings, as such; geotechnical issues relating to subsurface mining are not be applicable Therefore risks due to earth tremors that are mine-induced cannot be expected.

6.2 Dolomite Stability

As far as it could be reasonably determined the area is not underlined by dolomitic formations and no record exists, and there are no records that indicate the occurrence of mining activities close to the study area, no record and documentation exist with Department of Mineral Resources, Council for Geoscience and Local Municipality. Therefore, the site is considered a non-dolomitic land and, the establishment and design of the Filling Station cannot be impacted from this regard.

6.3 Groundwater Conditions

Ground water seepage not encountered during the geotechnical investigation on site, however a perched aquifer along the pebble marker and at contacts between the residual sandstone and sandstone bedrock during wet seasons

7. INVESTIGATION RESULTS

7.1 Soil Profiles

Descriptions of the several soil strata were encountered in the test pits during the field investigations and their descriptions are given Table 2.

The soil profile of the site comprises of three (3) distinct soil horizons i.e. Transported top layer underlain residual soil from the underlying weathered Sandstone bedrock.

Transported Material –This horizon was slighty moist, brown, loose, silty sand. This horizon was of variable thickness throughout the site from the depth of 0-0.35m.

Residual Material- The horizon was moist, reddish brown, compact, intact, silty sand, residual. Residual material was encountered at all test pits. Was encountered at depth between 0.29 and 0.58m.

Bedrock - Reddish brown, highly weathered sand stone. This material was encountered in all test pits at depth of 0.8m+.

Table 1: Summary of Soil Profiles

Test Pit Id	Trasported soil	Residual soil	Weathered Bedrock	Bedrock	Test Pit Depth (M) Refusal
Pit 1	0 – 0.27m	0.27 –0.48m	0.48-0.8m	0.8+	Refusal
Pit 2	0 – 0.28m	0.28 –0.54m	0.54-0.8m	0.8+	Refusal

Pit 3	0 – 0.35m	0.35 –0.58m	0.54-0.8m	0.8+	Refusal

7.3 Laboratory Test Results

The laboratory tests were performed in order to determine the geo-mechanical and chemical properties of typical soil horizons encountered on the site. Foundation Indicator Tests; these tests are used as index tests to establish the soil type; its potential for heave. The tests give an indication of its suitability for use in pavement layers and engineered fills. PH and Conductivity was also conducted; all tests are done according to standard procedures prescribed for this type of work. Disturbed soil samples were collected from the various soil layers.

A summary of the results is presented in Tables below and detailed results are included on Appendix D of this report. These tests permit a basic classification of the soils and group them according to typical engineering properties and evaluation of their suitability for use as construction materials.

7.3.1 Grading, Atterberg limits and potential expansiveness

The laboratory report indicated that the site was comprised SM(d) material which are silty sands and silt mixtures according to UCS classification.

The soil predominantly consisted of coarse sand which comprises 36.4- 41.2% of the sample and was characterized by a low clay content of 9.7-10.7%. The soil had a plasticity index of 2-5% and low linear shrinkage of 1.2-1.3%, indicating the slight plastic nature of the soil thus slight heave potential. The material had a grading modulus of 1.9-2.1%, with 19-20 % liquid limit, and the material had a low plasticity potential. The soil was classified as A-1-b in accordance to AASHTO thus rated as excellent when used as subgrade, was also classified as G5 according to COLTO.

Table 2: Foundation indicators summary

Hole ID	DEPTH (m)	Soil Composition					Atterberg Limits			Soil Classification		
		Clay (%)	Silt (%)	Fine Sand (%)	Coarse Sand (%)	GM	LL (%)	PI (%)	LS (%)	UCS	AASHTO	COLTO
Trial Pit 1	1.2–1.75	9.7	11.1	27.9	41.2	1.9	20	3	1.3	SM(d)	A-1-b	G5
Trial Pit 2	1.35–1.65	10.7	11.6	27.3	36.4	2.1	19	3	1.2	SM(d)	A-1-b	G5
LEGEND **GM = Grading Modulus , LL= Liquid Limit, PI = Plasticity Index, LS = Linear Shrinkage USC=Unified soil classification**												

Table 3 : Soil classification related to plasticity index, (Van Der Merwe, 1964)

I_p (%)	Soil Description
0	Non plastic
1-5	Slightly plastic
5 to 10	Low plastic
10 to 20	Medium Plastic

20 to 40	Highly Plastic
>40	Very highly plastic

Table 4 : Activity based classification of clays (Van Der Merwe, 1964)

Activity	Classification
< 0.75	Inactive
0.75-1.25	Normal
>1.25	Active

7.2.2 Compaction Characteristics and CBR

From Table 3, the soil samples possess a moderate MDD of 2060 to 2203 kg/m^3 and a low OMC of 6.8-8.3%. The a high CBR value of 44-46 was obtained when the soil was compacted to 93% which is the density that is typically specified in the field.

Table 5: Compaction characteristics and CBR results

Sample ID	**OMC (%)**	**MDD (kg/m^3)**	**CBR Values**					
			90	93*	95	97	98	100
Trial Pit 1	8.3	2060	36	46	54	64	69	82
Trial Pit 2	6.8	2203	30	44	56	73	82	106

7.3.2 pH and conductivity

pH measurements conducted indicated that the pH of the area is 6.2-6.6 (slightly acidic). This pH indicates that the soil on the site is slightly acidic. Based on Evans guideline (1977)

a soil pH less than 6 indicates serious corrosion potential. Conductivity measurements indicated that the soil had an electrical conductivity of 0.002 to 0.012. The area can be safely classified as not generally corrosive.

Table 6: Soil acidity and Conductivity

Sample ID	**Ph**	**Electrical Conductivity(Ms/m**
Trial Pit 1	6.6	0.002
Trial Pit 2	6.2	0.012

The conductivity of the soil has a profound influence on the rate of corrosion of buried metallic objects. Based on significance of soil resistivity on corrosivity, Duligal (1996) provides the following table for evaluation of the conductivity of soil:

Table 7: Guideline Values of Interpretation of Soil Conductivity (duligal; 1996)

SOIL CONDUCTIVITY		
Soil Conductivity (Ms/m)	**Soil Resistivity (Ohm.cm)**	**Corrosively Classification**
More than 50	0 – 2000	Extremely Corrosive
25 – 50	2000 - 4000	Very Corrosive
20 – 25	4000 - 5000	Mildly Corrosive
10 – 20	5000 - 10000	Corrosive
Less than 10	>10000	Not generally Corrosive

8. GEOTECHNICAL SITE CLASSIFICATION

The impact of the geotechnical constraints on the development will be evaluated according to Table below, which is a summary of the general geotechnical constraints relevant to filling station developments. (Partridge, Wood and Brink, 1993), the Class column indicates the severity of the specific constrains for the site.

Table 8: Geotechnical classification for urban Development (after partridge, Wood and Brink)

Constraint		Most favorable (1)	Intermediate (2)	Least favorable (3)
A	collapsible	Any collapsable horizon or any consecutive horizon totaling a depth of less than 750mm in thickness.	Any collapsible horizon or consecutive horizons with a depth a depth of more than 750mm in thickness.	A least favorable situation for this constraint does not occur
B	seepage	Permanent or perched water table more than 1.5m below ground surface.	Permanent or perched water table less than1.5 m of below surface	Swamp and marshes
C	active	Low soil-heave potential anticipated	Moderate soil heave potential anticipated	High soil-heave potential anticipated
D	High compressible soils	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodibility of soils	Low	Moderately dispersive	Highly dispersive soil
F	Difficulty of excavation to 1,5m depth	Scattered or occasional boulders less than 10% of total volume	Rock or hardpan pedocretes between 10 and 40% of the total volume.	Rock or hardpan pedocretes more than 40% of the total volume
G	Undermined ground	Undermining at depth greater than 240m	Old undermined areas to a depth of	Mining within less than 90-240m of

		below surface (Except where the total extraction mining has not occurred)	90-240 below surface where the stope closure has ceased.	the surface or where total extraction mining has taken place
H	Stability: (Dolomite and limestone)	Possibly stable, areas of dolomite overlain by Karoo rocks or intruded by sills. Areas of Black Reef rocks. Anticipated Inherent Risk Class 1	Potentially characterized by instability. Anticipated Inherent Risk Class 2-5	Probably unstable , Known Sinkholes and dolines. Anticipated Inherent Risk Classes 6-8.
I	Steep slopes	Slope <6%	Slope 6-12%	Slope >12%
J	Area of unstable natural slopes	Low risk	Intermediate risk	High risk
K	Area subject to seismic activity	10% probability of an event less than 100cm/s^2 within 50 years	Mining induced seismic activity more than 100cm/s^2	Natural seismic activity more than 100cm/s^2
L	Rea subject to flooding		Areas adjacent to known drainage channel or flood plain with slope less than 1%	Areas with a known drainage channel or flood plain

8.1 Collapsible soils

Collapsible soils consist of loose, dry, low-density materials that collapse and compact under the addition of water or excessive loading specifically in areas of young alluvial fans, debris flow sediments, and loess (wind-blown sediment) deposits. Collapsible soils appear to be strong and stable in their natural (dry) state, but rapidly consolidate under saturation, generating large and often unexpected settlements.

The material onsite is slightly moist, dark to light brown, loose, shattered, silty sand, with scattered roots, and its thickness varies throughout the site. Material on site is likely collapsible because the highly weathered bedrock horizon is loose and thick. The site was classified as **1A**

8.2 Shallow Seepage/Groundwater levels

No groundwater was present within any of the trial pits excavated during the investigation. It can generally be expected though that groundwater seepage will occur at the interface between the transported and residual soil, between residual soil and bedrock. This would occur especially during or shortly after periods of intense or continuous rainfall. The site was classified as **1B.**

8.3 Active Soils

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral, its chemical composition and mechanical character. A material is potentially expansive and active if it exhibits the following properties (Kantey and Brink, 1952):

- Clay content greater than 12%,
- Plasticity index of more than 12%,
- Liquid limit of more than 30%, and
- Linear shrinkage of more than 8%.

According to the laboratory results the material on site exhibits the following properties:

- Clay content is **9.7-10.7%,**
- Plasticity index is **2-3%,**
- Liquid limit is **19-20%,**
- Linear shrinkage is **1.2-1.3%.**

As indicated by the laboratory tests, soil parameters i.e. clay content, plasticity index, liquid limit and linear shrinkage are below the active soils' threshold thus the site was classified as **1C.**

8.4 Highly Compressible Soil

Fine-grained soils which contain at least 50 percent of silt + clay may be listed in three classes of compressibility based on their liquid limit. They are as follows:

- Low compressibility: LL smaller than 30.
- Medium compressibility: LL from 30 to 50.
- High compressibility: LL greater than 50.

Due to the consistency of the material and the laboratory result, the material has medium liquid limit of **23%**, if a moist mass of this material is subjected to compression, there will be a very low significant change in the volume, the material has **low compressibility**. The site was classified as **1D.**

8.5 Erodibility of Soil

The material on site **(silty sands)** are generally prone to erosion by wind and water, however no evidence of erosion features such as galleys, dongas or erosion channels was observed within the boundary of the investigated site. The site was classified as **1E**.

8.6 Difficult of Excavation

The excavatability characteristics were estimated from the performance of the TLB ***(JCB 3CX)*** used for the Investigation. The site is classified as beings soft to intermediate excavations (Classification of material for machine excavation SANS 1200 D) with

maximum depth of **2.20m**) However hard excavation conditions occurs in very shallow depths in some portions of the site**.** This site was classified as **1F**.

Table 9: Classification of material for machine excavation (SANS 1200 D)

Classification	Descriptions
	Non-cohesive soils with a consistency ranges from loose to dense and for cohesive soils with consistency ranging from soft to stiff. This include all material that can be excavated with a TBL.
Hard rock excavation	Rock that would be difficult to excavate with an excavator and may require the use of rock breaking equipment, i.e. medium hard to hard rock, or areas where outcrops was encountered, including hard pedogenic soils. Excavation in material can be efficiently ripped by a bulldozer.
Boulder excavation (Class A)	Excavation in material containing more than 40 % by volume boulders of size in the range of 0,03-20m3, in a matrix of soft material or smaller boulders.
Boulder excavation (Class B)	Excavation in material containing 40 % or less by volume boulders of size in the range of 0,03-20m3, in a matrix of soft material or smaller boulders and which require individual drilling and blasting in order to be loaded by a track type front-end loader or back-acting excavator

8.6 Undermined Ground

There are no other closed or working shafts or other signs of mining activity within a radius of 1km of the site therefore site was classified as **1G.**

8.7 Stability: Dolomite and Limestone.

No indication of the presence of soluble rock formations was found during the desk study and field investigation, based on the geology of an area the area is underlain by the

rocks of the Vryheid formation of the Ecca Group in the Karoo Supergroup. The area is non-dolomitic. The site is classified as **1H.**

8.8 Steep Slopes

Slope is a measure of change in elevation. On a topographic map the amount of elevation change is related to the number of contour lines. The site fairly flat with elevation ranging between 594 and 59 m above the sea level.

8.9 Area of Unstable Natural Slopes

Steeper slopes have greater risks for instability. The natural tendency of steep slopes is to move some of its materials downwards until the natural angle of repose is found. Any form of slope modification will eventually impact the stability of a slope. No evidence of unstable natural slope was observed on site during site investigation. The site is classified as **1J.**

8.10 Seismic Activity

According to Kijko et. al (2003), the peak ground acceleration for the area is less than 0,04 m/s2, with a 10% probability of being exceeded in a 50-year period. The seismic activity in the area is therefore low. The site is classified as **1K.**

8.11 Areas Subject to Flooding (1:50 And 1:100 Year Flood Lines)

A 1:50 year flood line implies that an area below that line has a high probability of being flooded at least once in every fifty-year period. Similar contextual definition applies for the 1:100-year flood line.

By law, developments below the 1:50 year flood lines areas are prohibited. This is due to the risk of flooding leading to property damage, health and life hazards, inconveniences etc. A hydrological study should be commissioned to determine the 1 in 50-year flood line. Proper flood line should be available from the Local Municipality Town Planning Department **1L.**

9. NHBRC SITE CLASSIFICATION

The residential site class designation according to NHBRC is marked with class symbols within the areas designated. The site designation classes will also be determined based on the laboratory results.

Table 10: Residential Class Designations" after Watermeyer and Tromp (1992) and the Joint Structural Division of the SAICE as prescribed by the NHBRC.

	Geotechnical Characteristics			
TYPICAL FOUNDING MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENTS (mm)	ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)	SITE CLASS
Fine grained soils (clayey silts of and clay soils sands of low plasticity) sands, sandy and gravelly soils.	Compressible soils	10-20	50%	S1
Silty sands, sands, sandy and gravel soils	Compressible and collapsible soils	5-10	75%	C1

10 GEOHYDOLOGICAL RISK ASSESSMENT

An environmental assessment of potential impacts on the groundwater regime resulting from the construction of a filling station within the study area was conducted. To conduct this risk assessment scientific measurements were taken and professional judgements to identify the significance of the environmental impacts associated with proposed project. The views and concerns of the IAPs were considered and the sensitivity of the receiving environment.

The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The consequence of the impact is a result of the extent of the impact, the duration over which the impact occurs and its intensity.

Table 11: Criteria used to calculate impacts on groundwater

CRITERIA	**DESCRIPTION**			
Extent	National (4)	Regional (3)	Local (2)	Site (1)
	The whole of South Africa	Provincial and parts of neighboring provinces	Within a radius of 2 km of the construction site	Within the construction site
Duration	Permanent (4)	Long-term (3)	Medium-term (2)	Short-term (1)
	Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient	The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter. The only class of impact	The impact will last for the period of the construction phase, where after it will be entirely negated	The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase

		which will be non-transitory		
Intensity	Very High (4)	High (3)	Moderate (2)	Low (1)
	Natural, cultural and social functions and processes are altered to extent that they permanently cease	Natural, cultural and social functions and processes are altered to extent that they temporarily cease	Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way	Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected
Probability Of Occurrence	Definite (4)	Highly Probable (3)	Possible (2)	Improbable (1)
	Impact will certainly occur	Most likely that the impact will occur	The impact may occur	Likelihood of the impact materializing is very low

Impact Reversal	Highly Impossible (4)	Moderate (3)	Possible (2)	Definite (1)
	Impact reversal will certainly be impossible	Impact can be reversed to some extent with loss of natural resources	High possibility of impact reversal	Impact can be totally reversed
Loss of irreplaceable resources	Definite (4)	Highly Probable (3)	Possible (2)	Improbable (1)
	Resources definitely be lost	Most likely that resources will be lost	Resources may be lost	Loss of resources is highly unlikely

11

Low impact/ Minor (3 -10 points)	A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
Mediumimpact/ Moderate (11 -20 points)	Mitigation is possible with additional design and construction inputs.
High impact (21 -30 points)	The design of the site may be affected. Mitigation and possible remediation are needed during the construction

	and/or operational phases. The effects of the impact may affect the broader environment.
Very high impact/ Major (31 - 48 points)	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a "very high impact" is likely to be a fatal flaw.
Status	Denotes the perceived effect of the impact on the affected area.
Positive (+)	Beneficial impact.
Negative (-)	Deleterious or adverse impact.
Neutral (/)	Impact is neither beneficial nor adverse.
It is important to note that the status of an impact is assigned based on the status quo – i.e. should the project not proceed. Therefore not all negative impacts are equally significant.	

The impacts associated with the proposed development are summarised in Table 5 below

Table 12: Impacts on Ground water

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
Construction Phase							
Waste Water	Contamination of groundwater and/or soil	Local (1)	Medium (2)	Impact may occur (2)	Low	Low	No wastewater is expected to be generated during the construction phase.

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
Operational Phase							
Accidental Spills	Contamination of Soil and Groundwater	Local (2)	Long term (4)	Definite (4)	Very High	High	On hard surfaces, the product will be covered and adsorbed with biodegradable absorbent materials. Spills on soil would require the

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
							determination of the lateral and vertical extent of the contamination and then based on the risk that the contamination pose to the receiving environment, remedial actions will be implemented.

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
Diversion of sub-surface water through the installation of underground tanks	Contamination of soil	Local(1)	Medium term (2)	Improbable if mitigated (1)	Medium	Low	
Overfill	Contamination of groundwater and soil	Local (2)	Long term (3)	Definite (4)	Very High	High	As part of the SABS 089-3 requirements, secondary containment features will be

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
							Installed around the filler points and on top of the tanks. These units are sealed and facilitate the recovery of product in the event of an overfill or spill.
Leakage of hydrocarbons into groundwater from leaking		Local (1)	Medium (2)	Possibly the impact may occur (2)	Medium	Low	As part of the SABS 089-3 requirements, secondary containment features will be

Impact	Possible Impacts	Extent	duration	Probability	Significance		Mittigation plan
					Pre Mitigation	Post Mitigation	
pipes and/or underground pipes							Installed around the filler points and on top of the tanks. These units are sealed and facilitate the recovery of product in the event of an overfill or spill.

11 CONCLUSIONS AND RECOMMENDATIONS

Based on the profiles of 3 test pits excavated within the area proposed for the proposed construction of Filling Station, evaluation of geotechnical constraints and laboratory results the following can be concluded:

- This geotechnical report contains the findings and development recommendations for the construction of the proposed filling station development at **Mokganyaka *Village*.**
- Two (2) disturbed samples were taken from the trial pits for laboratory analysis. The disturbed samples were sent for particle size distribution, hydrometer analysis, double hydrometer test, and Atterberg limits determination.
- The site is underlain by the rocks of the Vryheid formation of the Ecca Group in the Karoo Supergroup
- Soft to Intermediate excavation in terms of SABS 1200D is generally anticipated from surface to depths in excess maximum of approximate **2.20m** below ground level.
- The site is composed of silty sand and is classified as A-1-b according to the AASHTO soil classification, thus it is typically composed of stone fragments, gravel and sand, this soil performs excellently when used as subgrade
- The site is classified as class S according to the NHBRC Site Classification
- The main geotechnical constraints for the site are **slight soil activity and compressibility.**
- Due to the predominantly geotechnical characteristics and consistency of the material onsite it is advised that the most appropriate foundations options are modified normal and compaction of in-situ materials.
- No groundwater was present within any of the trial pits excavated during the investigation, however appropriate measures should be in place to mitigate ground water contamination.

- Two boreholes should be drilled at the up-gradient and down– gradient of the filling station.
- Depth and flow direction of groundwater should be determined, and be monitored
- Groundwater Monitoring Procedure should be should be established and water should be monitored regularly.
- It is important that the design of the storm water management system, allow for the drainage of accumulated surface water from the site into the natural drainage lines, this will ensure a stable site as the surface water is controlled and removed from the property.
- In this regard, it is important that an engineering geologist or geotechnical engineer carry out periodic inspections of the site during construction to ensure that any variation in the anticipated ground conditions can be assessed, and revised recommendations made to avoid unnecessary delays and expense.
- In general, it is considered that the conditions prevailing on site during the site investigation are such that the site is considered suitable for the development, provided that the recommendations outlined in this report are adhered to.

12 REFERENCES

- Profiling for Civil Engineering Purposes in Southern Africa. The Civil Engineer in SA. pp 3-12 January 1973.
- SAICE. 2010. Code of Practice: Site Investigation.
- SAIEG, 1996. Guidelines for Soil and Rock Logging. SAICE/SAIEG.
- Weinert, H.H., 1980. The Natural Road Construction Materials of Southern Africa.
- COLTO (1998) - Standard Specification for Roads and Bridge Works for State Authorities.
- 1:250 000 Geological Map 2528 Pretoria.
- Jennings, J E B, Brink, A B A and Williams, A A B. Guidelines for Soil and Rock Logging in SOUTH AFRICA (2002)
- National Institute for Transport and Road Research (NITRR). Guidelines for Road Construction Materials. TRH 14, Pretoria, CSIR, 1987.
- South African Bureau of Standards, 1988. Standardized Specification for Civil Engineering Construction. DA: Earthworks (Small Works). SABS 1200 DA-1988, (As amended 1990).
- SAICE. 1995. Code of Practice: Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction. Joint Structural Division, Johannesburg. First Edition.
- South African institute of civil engineers/institution of structural engineers, 1995. Code of Practice: Foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction. Joint Structural Division, Johannesburg.
- Swartz, K., 1985. "Problem Soils in South Africa - State of the art: Collapsible Soils", The Civil Engineer in South Africa, July 1985.
- The National Home Builders Registration Council (NHBRC), 2002. Geotechnical site investigations for housing developments: generic specification GFSH-2, September 2002.
- Van Der Merwe, D.H. (1964). The prediction of heave from the plasticity index and percentage clay fraction of soils. The Civil Engineer in S A. June 1964.
- SANS 634 - Geotechnical Investigations for township Development.

APPENDIX A

Laboratory Test Results

LETABA LABORATORIES AND SURVEYORS (Pty)
CIVIL ENGINEERING MATERIALS LABORATORY

123 River Street
Polokwane, 0699
P.O Box 795
Fauna Park, 0787

T0863

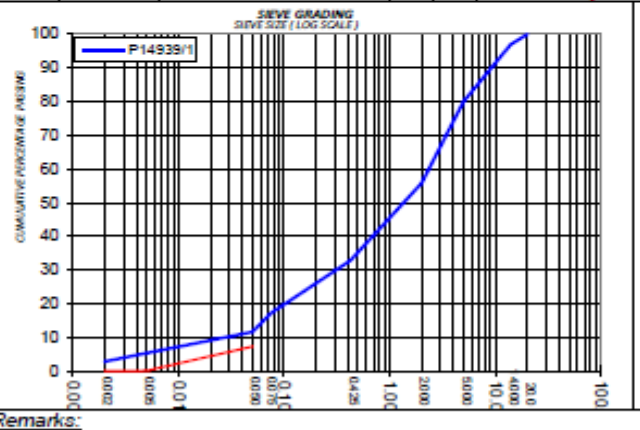
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

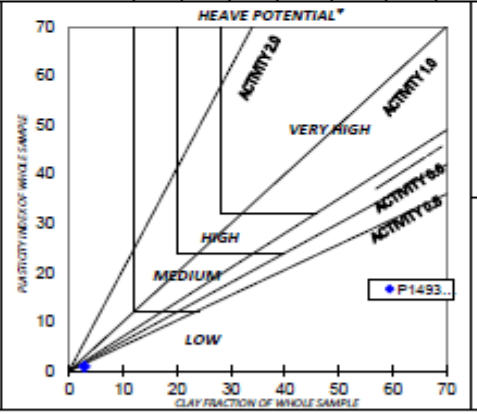
GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

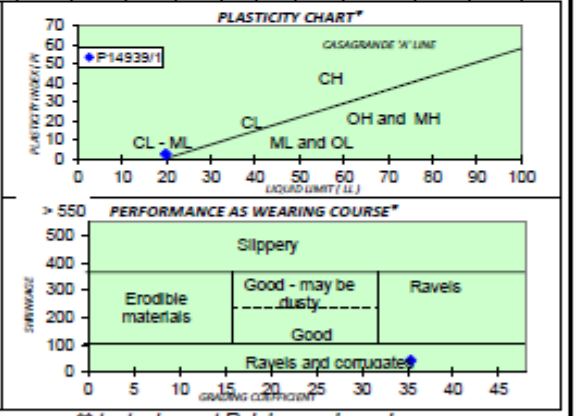
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

Client : Great Warthog Group Address: - **Date Sampled: 16-Feb-21**
Contract : **Mokganaka Filling Station** **Doc No:** P14939/1(i)
Description : **Material delivered to lab , TP1 sampled by client - m - uncrushed material** **Date Tested: 18-Feb-21**

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing: 50,0 mm	37,5 mm	28,0 mm	20,0 mm	14,0 mm	5,0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0,005 mm*	0,002 mm*	Soil Mortar Analysis % of mat. <2,00 mm*: Coarse sand <2,0 >0,425mm	Fine sand <0,425 >0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm	Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits: Liquid Limit	Plasticity Index	Linear Shrinkage	Classifications*: Unified Soil	COLTO	U.S.Highway	Group Index
-	P14939/1	lt Brown Silty sand				100	97	80	56	33	17	11.6	5.4	2.9	41.2	27.9	11.1	9.7	0.027	85	1.5	1.9	20	3	1.3	SM(d)	G5	A-1-b	0
						*Double Hydrometer Values:						7.3	0.1	0.0															







Remarks:

The Shrinkage Product of this material was 43

***DOUBLE HYDROMETER RESULT : 3 %** *If Double Hydrometer result is above 40%, the material is considered to be dispersive.*

***pH =6.6 , *Electrical Conductivity =0.02 S/m, tested on the -5mm fraction**

** tests done at Polokwane branch*

Date Issued: 26-Feb-21 *Technical signatory (Name) :* H.C Nolte *Signature:* Hermias Cornelius Nolte 2021.02.26 11:51:58 +02'00'

1 of 2

SF 7.8-104_F-Ind_CBR_EC_pH_disp Colto_Rev 33_Eff Date: 2021-02-19

LETABA LABORATORIES AND SURVEYORS (Pty)
CIVIL ENGINEERING MATERIALS LABORATORY

123 River Street
Polokwane, 0699
P.O Box 795
Fauna Park, 0787

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

T0863

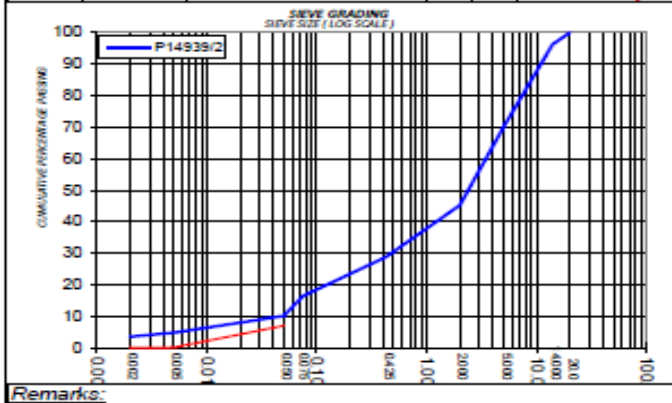
GRAVEL, SOIL AND SAND ANALYSIS : FOUNDATION INDICATOR TEST REPORT

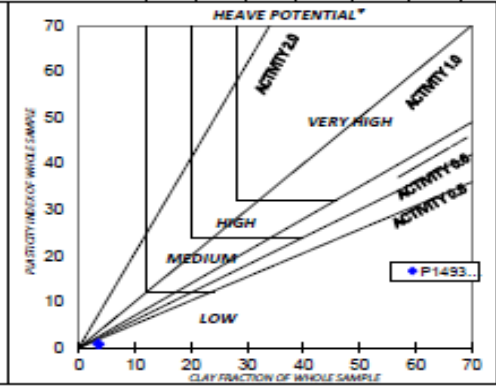
SANS 3001 Methods GR1, GR3, GR5, GR10, GR20, GR30 & GR40

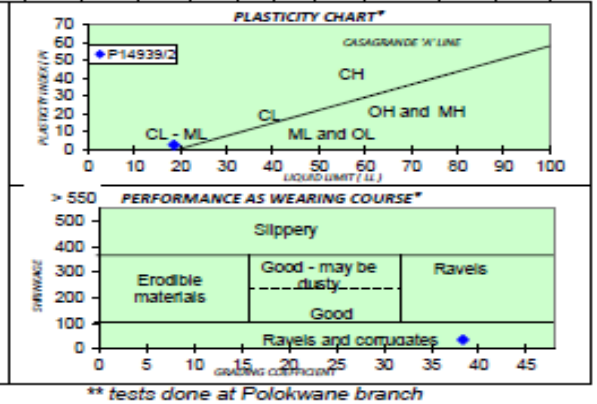
Client : **Great Warthog Group** Address: -
Contract : **Mokganaka Filling Station**
Description : **Material delivered to lab , TP2 sampled by client - m - uncrushed material**

Date Sampled: 16-Feb-21
Doc No: P14939/2(i)
Date Tested: 18-Feb-21

Depth (m)	Sample No.	Description (Unified Soil Classification - ASTM D2487*)	Sieve analysis Cumulative percentage passing												Soil Mortar Analysis % of mat. <2,00 mm*				Effective size*	Uniformity - coef.*	Curvature coef.*	Grading modulus*	Atterberg Limits			Classifications*			
			50,0 mm	37,5 mm	28,0 mm	20,0 mm	14,0 mm	5,0 mm	2,00 mm	0,425 mm	0,075 mm	0,05 mm*	0,005 mm*	0,002 mm*	Coarse sand <2,0 >0,425mm	Fine sand <0,425 >0,075mm	Silt <0,05 >0,005mm	Clay <0,005 mm					Liquid Limit	Plasticity Index	Linear Shrinkage	Unified Soil	COLTO	US Highway	Group Index
-	P14939/2	lt Brown Silty sand				100	96	70	45	29	16	10.1	4.8	3.6	36.4	27.3	11.6	10.7	0.048	72	1.4	2.1	19	3	1.2	SM(d)	G5	A-1-b	0
						*Double Hydrometer Values:						7.0	0.1	0.0															







** tests done at Polokwane branch

Remarks:

The Shrinkage Product of this material was 35

***DOUBLE HYDROMETER RESULT : 3 %** *If Double Hydrometer result is above 40%, the material is considered to be dispersive.*

***pH =6.2 , *Electrical Conductivity =0.012 S/m, tested on the -5mm fraction**

Date Issued: 26-Feb-21 *Technical signatory (Name) :* **H.C Nolte** *Signature:* Hermias Cornelius Nolte 2021.02.26 11:52:28 +02'00'

1 of 2

SF 7.8-104_F-Ind_CBR_EC_pH_disp Colto_Rev 33_Eff Date: 2021-02-19

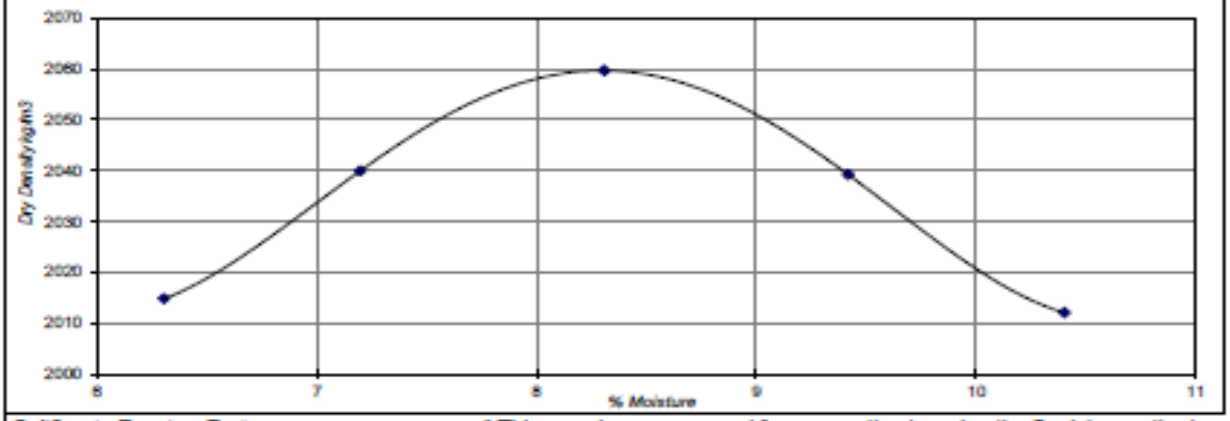
LETABA LABORATORIES AND SURVEYORS (Pty) Ltd
CIVIL ENGINEERING MATERIALS LABORATORY
123 River Street
Polokwane, 0699
P.O Box 795
Fauna Park, 0787
T0883
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

CBR and Maximum Dry Density Test Report

SANS 3001 Methods GR20, GR30 & GR40

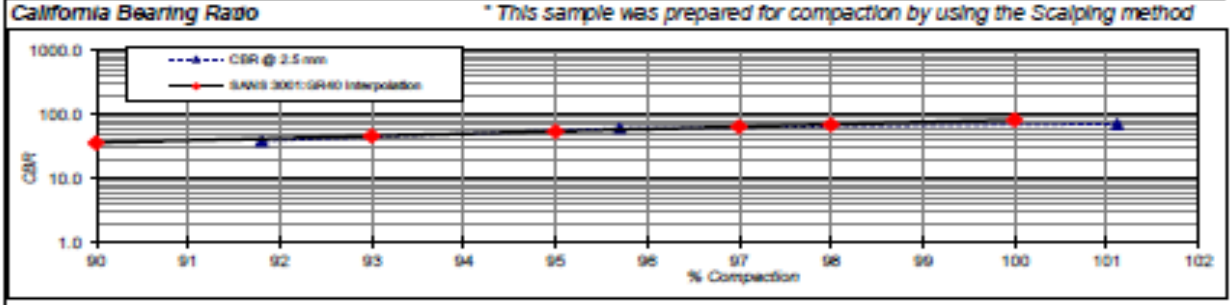
Client:	Great Warthog Group	Date tested:	18-Feb-21
Contract :	Mokganaka Filling Station	Date Sampled:	16-Feb-21
Description:	Material delivered to lab , TP1 sampled by client - m - uncrushed material	Sample No.	P14539/1

*Maximum Dry Density =	2060	kg/m³
Optimum moisture content =	8.3	%



California Bearing Ratio

* This sample was prepared for compaction by using the Scalping method



% Compaction	100	98	97	95	93	90
CBR of 13.3 kN	82	69	64	54	46	36

** tests done at Polokwane branch

REMARKS

Briquette Information			
Compaction (%)	101.1	95.7	91.8
Dry Density (kg/m³)	2083	1971	1891
Compaction Moisture (%)	8.4	8.4	8.4
% Swell	0.02	0.05	0.06

Date Issued: 26-Feb-21 Technical signatory (Name) : H.C Nolte Signature: Hermias Cornelius Nolte 2021.02.26 11:52:07 +02'00'

2 of 2

SF 7.8-104_F-Ind_CBR_EC_pH_disp Colto_Rev 33_Eff Date: 2021-02-19

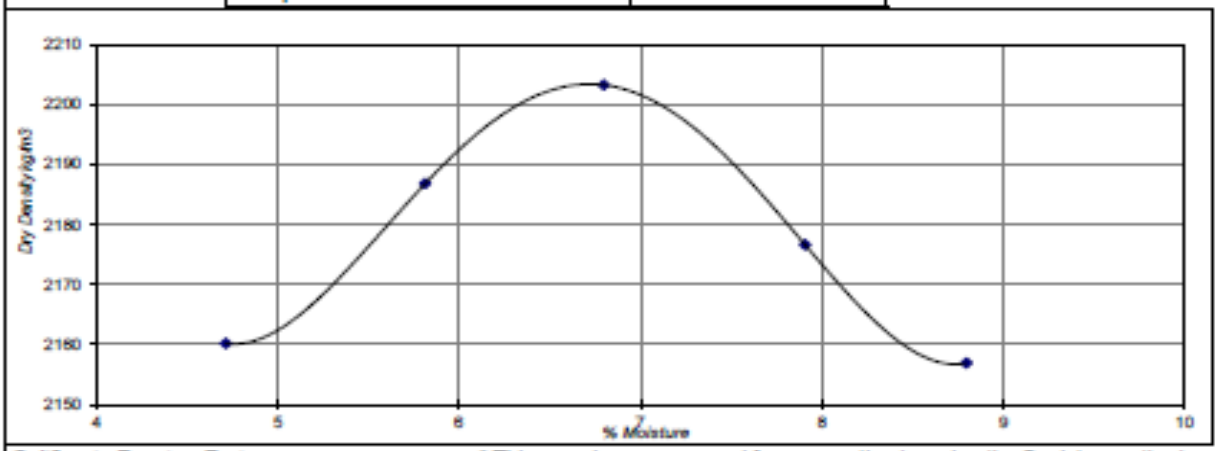
LETABA LABORATORIES AND SURVEYORS (Pty) Ltd
CIVIL ENGINEERING MATERIALS LABORATORY
123 River Street
Polokwane, 0699
P.O Box 795
Fauna Park, 0787
T0883
Tel. No: 087 285 0816 e-mail : letaba@letabalab.co.za www.letabalab.co.za

CBR and Maximum Dry Density Test Report

SANS 3001 Methods GR20, GR30 & GR40

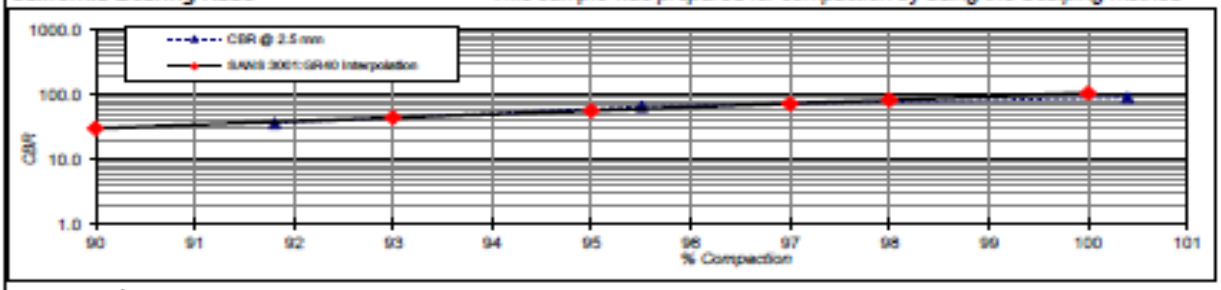
Client:	Great Warthog Group	Date tested:	18-Feb-21
Contract :	Mokganaka Filling Station	Date Sampled:	16-Feb-21
Description:	Material delivered to lab , TP2 sampled by client - m - uncrushed material	Sample No.	P14939/2

*Maximum Dry Density =	2203	kg/m³
Optimum moisture content =	6.8	%



California Bearing Ratio

* This sample was prepared for compaction by using the Scalping method



% Compaction	100	98	97	95	93	90
CBR of 13.3 kN	106	82	73	56	44	30

** tests done at Polokwane branch

REMARKS

Briquette Information			
Compaction (%)	100.4	95.5	91.8
Dry Density (kg/m³)	2212	2104	2022
Compaction Moisture (%)	6.7	6.7	6.7
% Swell	0.03	0.05	0.06

Date Issued: 26-Feb-21 Technical signatory (Name) : H.C Nolte Signature: Hermias Cornelius Nolte 2021.03.26

3 of 3

SF 7.8-104_F-Ind_CBR_EC_pH_disp Colto_Rev 33_Eff Date: 2021-02-19

APPENDIX B

Test Pit

Trial Pit 1

Trial Pit 2

Trial Pit 3